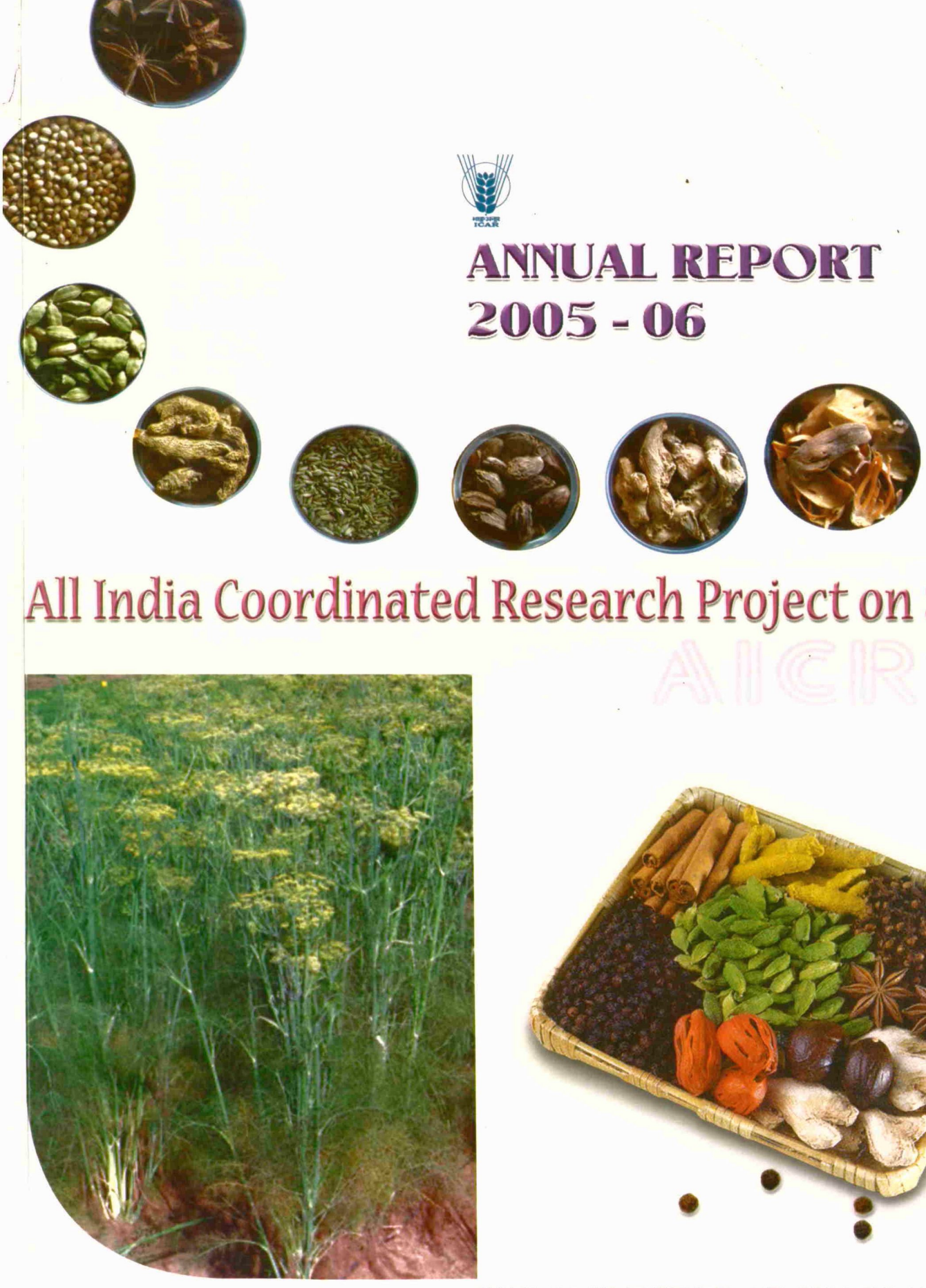

ANNUAL REPORT
2005 - 06

All India Coordinated Research Project on Spices

AICRPS

INDIAN INSTITUTE OF SPICES RESEARCH

(Indian Council of Agricultural Research)

Calicut - 673012, Kerala

ALL INDIA COORDINATED RESEARCH PROJECT ON SPICES

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

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Hindi Translation
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Cover design by
A. Sudhakaran

Correct citation
All India Coordinated Research Project on Spices,
Annual Report, 2005-2006
Indian Institute of Spices Research,
Calicut, Kerala

March 2007

Printed at
M/s Niseema Printers and Publishers, Cochin

CONTENTS

परियोजना समन्वयक की रिपोर्ट

अखिल भारतीय समन्वित मसाला अनुसंधान परियोजना (ए आई सी आर पी एस) अपना मुख्यालय भारतीय मसाला फसल अनुसंधान संस्थान, कालिकट में 12 मसले फसलों में अनुसंधान का आयोजन और समन्वय करने के लिए निहित होता है! ए आई सी आर पी एस का अब 14 राज्यों में व्याप्त 15 राज्य कृषि विश्व विद्यालय में स्थित 19 केन्द्र है! इसके अलावा 4 आश्रित केन्द्रए जिसमें भारतीय इलायची अनुसंधान संस्थान (स्पाइसस बोर्ड) भी शामिल होता है, इस परियोजना के साथ सहयोगी कार्य किया जा रहे हैं! ए आई सी आर पी एस की दसवीं योजना की बजट 700 लाख रूपए है और जिसका वर्ष 2005- 06 में 150 लाख (आई सी ए आर का हिस्सा) रूपए का संशोधित आकलन किया गया है! अधिदेश मसाले फसलों का लगभग 110 शोध कार्यक्रम विभिन्न केन्द्रों में आयोजित किया जा रहा है!

सत्रहवीं ए आई सी आर पी एस गोष्ठी के निर्णय के अनुसार दिनांक 25.2.2004 को आई आई एस आर, कालिकट में वराइटल इवालुवेशन ट्रयल (वी ई टी1 से वी ई टी 4) को पुनर्निर्धारित करने के लिए और मुडिगरे केन्द्र में इलायची पर चल रहे सभी परियोजनाओं की प्रगति की समीक्षा करने के लिए एक ग्रूप मीटिंग संपन्न हुआ! मुडिगरे केन्द्र में चल रही इलायची की जननिक संसाधन, फसल सुध ाार और जैवरसायन के अधीन आनेवाली सभी परियोजनाओं की प्रगति के बारे में आलोचनात्मक समीक्षा हुई और बैठक के निर्णयों का कार्यान्वयन हो गयी।

आई आइ एस आर, कालिकट में संपन्न हुई सत्रहवीं ए आई सी आर पी एस गोष्ठी/क्यु आर टी की सिफारिशों के अनुसार जननिक संसाधन, फसल सुधार और जैव रसायन पर 25.2.2004 को इलायची के लिए, 23.3.2004 और 25.3.2004 को काली मिर्च, अदरक, हल्दी और वृक्ष मसालों के लिए तथा 26.3.2004 को प्रमुख मसालों के फसल उत्पादन पहलुओं का पनर्विन्यास करने और नये शोध कार्यक्रमों को पुनर्गठित करने के लिए छ उपदल बैठक संपन्न हुए और नये कार्यक्रम का रूपांकन भी किया! बीज मसालों में नये तकनीकी कार्यक्रमों के रूपांकन लिए 27.4. 2004 को एक अन्य ग्रूप मीटिंग संपन्न हुई! बाद में एक बैठक राष्ट्रीय बीज मसाला अनुसंधान केन्द्र, अजमीर, राजस्थान में 29.6. 2004 से 30.6. 2004 तक संपन्न हुई और बीज मसालों में तकनीकी कार्यक्रमों का अंतिम रूप दे दिया!

वर्ष 2005-06 में ए आई सी आर पी एस के अन्तर्गत विकसित प्रमुख उपलब्धियों और तकनोलजियों का संक्षिप्त रूप निम्न प्रकार है!

फसल सुधार

मसाले फसलों की उपलब्ध जर्मप्लासम के साथ काली मिर्च में 680, इलायची में 273, अदरक में 630 हल्दी में 1326, वृक्ष मसालों में 77और बीज मसालों में 2540 अक्सशनें जोडकर जननिक संसाधनों को समृद्ध बना दिया! अब ए आई सी आर पी एस के विभिन्न केन्द्रों में मसाले जर्मप्लासम की कुल 5529 अक्सशनें होती है! अच्छे मसाला जर्मप्लासम को प्राथमिक मूल्यांकन परीक्षण (IET) और तुलनात्मक प्रजातीय परीक्षण (CVT) के द्वारा विभिन्न केन्द्रों में

मूल्यांकन किया जा रहा है! काली मिर्च जर्मप्लासम मूल्यांकन में करिमुंडा III अधिकतम स्पाइक उपजता 4.57 कि ग्राम/बेल अकित किया जिसके बाद आता है पन्नियूर केन्द्र का टी एम बी IV (4.09 कि ग्राम/ बेल)। जहां पी एन-57 येरकाड केन्द्र में उच्चतम उपजता 2.95 कि ग्राम/बेल अंकित किया! सी वी टी (तुलनात्मक प्रजातीय परीक्षण CVT) के अन्तर्गत कल्चर एच बी 813 औसत अधिकतम स्पाइक उपजता 8.01 कि ग्राम/बेल और उच्चतम सूखे प्राप्ति 3.22 कि ग्राम/बेल पन्नियूर केन्द्र में अंकित किया!

इलायची के आशाजनक पांच नये प्रकार (मोहिनी 1, मोहिनी 2, एस बी 1 , एस बी 1 और एलापारा 1) और वाषुका प्रकार जिसमें घने कैप्स्यूल और अधिक मात्रा में बीज होता है (एलापारा 1) इडुक्कि जिला से सग्रहित किया! इलायची के उच्च उपजवाली कल्टिवर्स जिसका नाम है पनिकुलंकरा 1 और 2 वट्टियारकल्लर, केरल के इडुक्कि जिला के पांपाडुमपारा केन्द्र (वाषुका प्रकार के खुले परागित बीज पौधों से चयनित है) से संग्रहित किया! कम छायेदार हालत में भी ये अक्सशनें अच्छी तरह बढते हैं जिसमें पत्तों की रोगबाधा भी कम होती है! पापाडुमपारा केन्द्र द्वारा 73 इलायची अक्सशनों (सी आर एस पी 1 - सी आर एस पी 73) के लिए एन बी पी जी आर, नई दिल्ली से आई सी नंबर्स (547920 से 547992) प्राप्त किये।

अदरक जर्मप्लासम मूल्यांकन में, सोलन केन्द्र मे 286 संग्रहो मे एस जी 705 और एस जी 933 अधिकतम राइसोम उपजता (9-10 कि ग्राम/3मी 2 प्लॉट) प्राप्त हुई! जगतियाल में हल्दी में उच्चतम साफ हल्दी राइसोम 41. 4 टन/हेक्टर, जो पी टी एस 59 मे अकित किया जिसके बाद आता है आर एच 5 (39.1 टन/हेक्टर) ! हन्दी की छान बीन परीक्षण में टी सी पी 198, 93,104,43, 115,118, 19, 53, 70 को पुंडिबारी केन्द्र में पत्तों के दोनों रोग पर्ण छिद्र और पर्ण दाग के सहय देख लिया। लौग के तुलनात्मक प्रजातीय परीक्षण में मूल्याकन किये दस अक्सशनों में चयन 10 को पचिपराइ केन्द्र में उच्चतम उपजता 1.325 कि ग्राम/वृक्ष के साथ आशाजनक देख लिया!

गुटूर में धनिया की एल सी सी 216 उच्चतम उपजता 563 कि ग्राम/ हेक्टर अकित किया, जिसके बाद आता है एल सी सी 170(554कि ग्राम/हेक्टर) और जे सी ओ 340 (554कि ग्राम/हेक्टर)! हिसार मे धनिया की डी एच 228 उच्चतम पर्ण उपजता देता है जब प्रजाति पंत हरीतिमा की तुलना करने पर जिसके निकट आता है डी एच 202! सौंफ की 117 अक्सशनों में 13 अक्सशनें आर एफ 125 की अपेक्षा अधिक उपजता दी जाती है! उत्तम उपजता के आधार पर पहचान किये कुछ आशाजनक अक्सशनें है यु एफ 114, यु एफ 157, यु एफ 136, यु एफ 177, यु एफ-189, यु एफ 20, यु एफ 79, यु एफ 138, यु एफ 145, यु एफ 153, और यु एफ 187 ! गुंटूर में मेथी में एल एफ सी 84 अधिकतम धान उपजता 1069 कि ग्राम/हेक्टर अकित किया जिसके बाद आता है एल एफ सी 87 (994 कि. ग्राम/हेक्टर) और महत्वपूर्ण ढंग से उच्चतम होता है लाम चयन 1 (826.0 कि. ग्राम/हेक्टर)

फसल उत्पादन

पन्नियूर केन्द्र में काली मिर्च में जैव कृषि परीक्षण में पूरी तरह जैव उपचार करने पर काली मिर्च में औसत स्पाइक उपजता (22.17 कि ग्राम/बेल) प्राप्त हुए जबकि अजैव कृषि में यह (15. 88 कि. ग्राम/बेल) होता है। काली मिर्च मे अजैव नाइट्रोजन 100%+ असोस्पिरिल्लम 50 ग्राम + 10 कि ग्राम एफ वाई एम लगाने पर अधिकतम उपजता 3.76 कि ग्राम/बेल अंकित की!

सोलन केन्द्र में ZnSO4@ 2.5 कि ग्राम/ हेक्टर और बोराक्स 20कि ग्राम/हेक्टर की दर में लगाने पर अदरक की अधिकतम राइसोम उपजता प्राप्त हुई।

धनिया में किये गये जैव नियामक अध्ययन में

एन ए ए 10 ppm अधिक उपजता (600 कि ग्राम/हेक्टर) अंकित की जो ट्रयाकोन्टानोल 1 मि लिटर (580 कि ग्राम/हेक्टर) की दर में लगााने के समान होता है। छिडकने की संख्या के बारे मे बता दे तो गुटूर में बीज बोने के 40 और 60 दिन के बाद दो बार छिडक देने पर उत्तम उपजता (553 कि ग्राम/ हेक्टर) अंकित की!

फसल संरक्षण

पांम्पाडुमपारा केन्द्र में काली मिर्च में शल्क कीटो की संख्या कम करने के लिए नीम गोल्ड (0.5%) और नीम तेल (0.5%) का बयोरेशनल मूल्यांकन करने पर मत्स्य तेल कीटनाशीय साबुन (2.5%)उत्तम देख लिया जाता है! पाम्पाडुमपारा, चिन्तापल्ली और धापोली केन्द्र में काली मिर्च नर्सरी में फाइटोफथोरा बाधा के नियंत्रण के लिए ट्राइकोडरमा हरजियानम 1ग्राम/कि ग्राम की दर मे सोलाराइस्ड पोटिंग मिश्रण के साथ मजबूत करके और वासिकुलार आरबुस्कुलार माइकोर्हिसे (वी ए एम) 100 cc/ कि ग्राम पोटिंग मिश्रण की दर में लगााना प्रभावी देख लिया। काली मिर्च के फाइटोफथोरा खुर गलन रोग के नियन्त्रण के लिए सिरसी, मुडिगरे, पाम्पाडुमपारा, पन्नियूर और अम्बलवयल केन्द्रों मे पोटैशियम फास्फोनट (अकोमिन प्रति लिटर में 3 से 5 मि लिटर) दो बार छिडकना या भिगो देना , मनसून के पहले (जून की पहली सप्ताह में) और मनसून के बाद (अगस्त की दूसरी सप्ताह में) ट्राइकोडरमा हरजियानम (107 cfu 50 ग्राम/बेल) एक कि ग्राम नीम केक और साथ लगाना संस्तुत किया जाता है।

इलायची के मूल खोदने, बासिलप्टा फुल्विकोर्ने (जाकोबी)की प्रारभिक दशा मे जो साधारणतया अप्रैल/मई और सितंबर/अक्तूबर महीने में मिट्टी मे देखा जाता है, उसका नियन्त्रण करने के लिए मिट्टी में इमिडाक्लोप्रिड 0.015% (5 लिटर/पौधे) या क्लोरफिरिफोस 0.07% की दर मे (5 लिटर/पौधे) या कारबोफुरान 3.0 g.a.i / झुरमुट (प्रत्येक पौधे के चारों ओर 10 -15 से मीटर) की दर में लगाा दिया जा सकता है! कवगनाशी लगाने के पहले कवग/घासपात को हटाकर मिट्टी में डालने पर पाम्पाडुमपारा केन्द्र में उत्तम फल देख लिया! इलायची अनुसंधान केन्द्र पाम्पाडुमपारा में स्थानीय स्ट्रेन वियुक्ति हेटेरोहाबडिटिस इनडिकस को खेत मे इलायची मूल खोदक बाधित देख लिया! इलायची रूट ग्रब का अधिक नाश वहां देख लिया जहां पौधों को एन्टोमोपाथेजनिक नेमटोड, हेटेरोर्हाबडिटिस इनडिकस (100 IJ/ग्रब) और इमिडाक्लोप्रिड 0.01% दवा दिया था। प्ररोह और कैप्स्यूल बेधक को इक्नयुमोनिड और डिप्टेरान पारसिटोयिड्स द्वारा पराश्रयी कर दिया! परभक्षी जीव को फाइटोफागस टेट्रानिकिड जीव साथ सहयोगी करके देख लिया जाता है!

एकीकृत प्रबन्धन में अदरक का पिथियम, फुसेरियम और राल्स्टोनिया राइसोम सोलाराइसेशन (45 मिनिट) करने के बाद गरम पानी का उपचार करने पर रोग स्तर कम हो गया और उपजता बढा दी! सोलन केन्द्र मे सोलाराइसेशन करने पर अंकुरण बढा दी (92.2%), पिथियम गलन (5.3%, फुसेरियम पीलापन 4 37% और राल्स्टोनिया म्लानी 3.1% के रूप मे कम होते अंकित की गयी। पश्चिम बंगाल (कलिंपाग के तीन ब्लोक)के पहाडी क्षेत्रों में अदरक के रोग आपतन के लिए एक सर्वेक्षण चालू किया, जिससे अदरक के राइसोम गलन – म्लानी के कारण कुछ जगहों में बडी हानी 80 % प्रकट हुई ।

पुडिबारी केन्द्र में हल्दी के पर्ण दाग और पर्ण चित्ती रोग के प्रति उत्तम उपचार के रूप में बीज उपचार और उसी प्रकार मानकोजेब और कारबन्डासिम (0.2%) छिडकना देख लिया! हल्दी की राइसोम गलन के लिए जैव नियन्त्रण में, संस्तुत मात्रा मे एन पी के और एफ वाई एम के साथ बीज उपचार एवं ट्राइकोडरमा विरिडे और प्स्यूडोमोनस फलूरसन्स 12 5 कि ग्राम/हेक्टर और 25 कि ग्राम/ हेक्टर को क्रमश बासल एवं टोप ड्रस्सिंग लगाना कोयबतोर मे हल्दी के राइसोम गलन के लिए उत्तम उपचार के रूप में देख लिया!

ट्राइकोडरमा + एफ वाई एम और 0.25% की दर में मानकोजेब के साथ छिडकने से जोबनर में अधिकतम बीज उपजता 475 कि ग्राम/हेक्टर के साथ जीरा के म्लानी रोग के प्रति प्रभावी देख लिया !

जोबनर में किये खेत परीक्षण में मेथी का यु एम 352 और यु एम-351 पाउडरी मिल्ड्यू रोग से मुक्त देख लिया और आर आर.टी.पी.-9, टी पी-10 और आर एम टी-1 रूट नॉट नेमटोड के प्रतिरोधक देख लिया! मेथी की मूल गलन का नियन्त्रण करने के लिए मिट्टी में ट्राइकोडरमा विरिडे 5 कि ग्राम/ हेक्टर की दर में बोने के 20 दिन पहले और मिट्टी में नीम केक 150 कि ग्राम /हेक्टर की दर में लगाना संस्तुत किया जाता है!

किसानों के खेत में तकनोलजी के निर्धारण पर संपन्न कार्यक्रम के अन्तर्गत मसालों की कुल 20 प्रमाणित तकनोलजियों 13 राज्य कृषि विश्व विद्यालयों द्वारा 14 ए आई सी आर पी एस केन्द्रों में चालू हो गये! अब ए आई सी आर पी एस के अन्तर्गत राज्य कृषि विश्व विद्यालयों/अन्य संगठनों में आठ आई सी ए आर तदर्थ योजनाएं चालू हो रही है!

ए आई सी आर पी एस के केन्द्रों में चालू किये विभिन्न परियोजनाओं की देन का विवरण आगामी पन्नों में दिया जाता है।

PROJECT COORDINATOR'S REPORT

The All India Coordinated Research Project on Spices (AICRPS) is vested with the mandate to conduct and coordinate research in 12 spice crops with its headquarter at Indian Institute of Spices Research, Calicut. AICRPS has at present 19 centres spread over 14 states based in 15 State Agricultural Universities (SAUs). In addition, 4 Voluntary Centres including Indian Cardamom Research Institute (Spices Board) are collaborating with this project. The X Plan budget of AICRPS was Rs. 700 lakhs with an Revised Estimate (RE) of Rs. 150 lakhs (ICAR share) during 2005-2006. About 110 research programmes covering the mandate spice crops are being conducted at various centres.

As per the decision of XVII AICRPS Workshop, a group meeting was held on 25.2 2004 at IISR, Calicut to recast Varietal Evaluation Trials (VET-1 to VET-4) and to review the progress of all exsisting projects on cardamom at Mudigere centre. The progress of all the projects under genetic resources, crop improvement and biochemistry in cardamom being carried out at Mudigere centre were critically reviewed and the decisions of the meeting implemented.

Six subgroup meetings to reorient the on going research projects and formulation of new research programmes as per the recommendations of XVII AICRPS Workshop/ QRT were also held at IISR Calicut on genetic resources, crop improvement and biochemistry on 25 2 2004 for cardamom, on 23 3 04 and 25.3.2004 for black pepper, ginger, turmeric and tree spices, on 26 3.2004 in crop production aspects of major spices and new programmes were finalized. Another group meeting was also held on 27.4.2004 for formulating new technical programme in seed spices Subsequently a meeting was held at National Research Centre for Seed Spices, Ajmer, Rajasthan during 29 6 2004 to 30 6 2004 and finalized the technical programme in seed spices.

The major achievements and the technologies developed under AICRPS during the period 2005-06 are summarized below·

CROP IMPROVEMENT

Genetic resources of spice crops have been enhanced with the germplasm holdings of 680 accessions in black pepper, 273 in cardamom, 630 in ginger, 1326 in turmeric, 77 in tree spices and 2540 in seed spices. At present, a total of 5529 accessions of spices germplasm are being conserved at various centres of AICRPS. The promising spices germplasm are being evaluated through Initial Evaluation Trials (IETs) and Comparative Varietal Trials (CVTs) at various centres. In black pepper germplasm evaluation, the variety Karimunda III recorded the maximum spike yield of 4.57 kg /vine, followed by TMB IV (4 09 kg/vine) at Panniyur centre, whereas PN-57 recorded the highest yield of 2.95 kg/Vine at Yercaud centre. Under CVT, culture HB 813 recorded the maximum average spike yield of 8.01 kg/vine and the highest dry yield of 3.22 kg/vine at Panniyur centre.

Five promising new cardamom types (*Mohini 1, Mohini 2, SB 1, SB 2 and Elapara 1)* and a *Vazhukka* type with bold capsules and more number of seeds (*Elapara 1*) were collected from Idukki District, Kerala. High yielding cardamom cultivars namely, *Panikulankkara* 1 and 2 (selected from open pollinated seedlings of *Vazhukka* type) were collected from *Vattiyarkallar,* Idukki District by Pampadumpara centre. These accessions are found to be performing well even under less shade condition with least incidence of foliar infection. IC numbers (547920 to 547992) were obtained for 73 cardamom accessions (CRSP 1- CRSP 73) from National Bureau of Plant Genetic Resources (NBPGR), New Delhi by Pampadumpara centre.

In ginger germplasm evaluation, out of 286 collections, SG 705 and SG 933 gave maximum rhizome yield (9-10 kg/3m^{2}plot) at Solan centre. In

turmeric highest fresh turmeric rhizome yield of 41.4 t/ha was recorded with PTS-59, followed by RH-5 (39.1 t/ha) at Jagtial. In a screening trial of turmeric, TCP 198, 93, 104, 43, 115, 118, 19, 53, 70 were found to be tolerant to both leaf blotch and leaf spot diseases at Pundibari centre. In CVT of clove, among the ten accessions evaluated, Sel. 10 was found to be promising with the highest yield of 1 325 kg/tree at Pechiparai centre.

Coriander LCC - 216 recorded significantly highest yield of 563 kg/ha, followed by LCC-170 (554 kg/ha) and JCO-340 (554 kg/ha) at Guntur. Coriander DH-228 gave highest leaf yield, which was closely followed by DH-202, when compared to check variety, Pant Haritima at Hisar. Out of 117 accessions of fennel, 13 accessions yielded better than the check, RF-125. Some of the promising accessions identified on the basis of yield performance were UF-114, UF-157, UF-136, UF-177, UF-189, UF-20, UF-79, UF-138, UF-145, UF-153 and UF-187. In fenugreek LFC-84 recorded maximum grain yield of 1069 kg/ha, followed by LFC-87 (994 kg/ha) and are significantly superior to check, Lam Selection-1 (826.0 kg/ha) at Guntur.

CROP PRODUCTION

In organic farming trial of black pepper, maximum average spike yield was obtained with organic treatment (22 17 kg/vine), followed by inorganic (15.88 kg /vine) in Panniyur centre. Inorganic N 100% + *Azospirillum* 50g +10 kg FYM recorded the maximum spike yield of 3.76 kg/vine in black pepper.

Application of ZnSO4@ 2.5kg/ha and borax @ 20kg/ha produced maximum rhizome yield in ginger at Solan centre.

In the studies of bio-regulators on coriander NAA 10 ppm recorded significantly higher yield (600 kg/ha) which is on par with Triacontanol @ 1 ml (580 kg/ha). With respect to number of sprays, two sprayings at 40 and 60 days after sowing (DAS) recorded significantly highest yield (553 kg/ha) at Guntur.

CROP PROTECTION

Among the biorationals evaluated, neem gold (0.5%) and neem oil (0.5%) were found to be superior to fish oil insecticidal soap (2.5%) in reducing the population of scale insects in black pepper at Pampadumpara centre. Solarized potting mixture fortified with *Trichoderma harzianum* @ 1 g/kg and Vesicular Arbuscular Mycorrhizae (VAM) @ 100cc/kg potting mixture was found effective for the management of *Phytophthora* infections in black pepper nursery in Pampadumpara, Chintapalle and Dapoli centres. Application of Potassium phosphonate (Akomin, 3 to 5 ml per litre) as spray and drench twice, during pre-monsoon (first week of June) and post-monsoon (second week of August) periods along with the soil application of *Trichoderma harzianum* (10^7 cfu, @ 50g vine^{-1}) with 1 kg of neem cake is recommended by the Sirsi, Mudigere, Pampadumpara, Panniyur and Ambalavayal centres for the management of *Phytophthora* foot rot disease of black pepper.

Early stages of the cardamom root grub, *Basilepta fulvicorne* (Jacoby) that are usually present in soil during April/May and September/ October can be managed by soil drenching of Imidacloprid 0.015% (5 litres/plant) or Chlorpyrifos @ 0.07% (5 litres/plant) or application of Carbofuran @ 3.0 g a.i./clump (10-15 cm around the plant). Removal of mulch/weed cover and forking of soil prior to application of insecticides produced better results at Pampadumpara. The local strains of *Heterorhabditis indicus* from Cardamom Research Station (CRS), Pampadumpara were found to infect cardamom root grub under field condition. Highest mortality of cardamom root grub was observed in plants drenched with entomopathogenic nematodes, *Heterorhabditis indicus* (100 IJ/grub) and Imidacloprid 0 01% at Pampadumpara centre. Shoot and capsule borer was parasitized by *ichneumonid* and dipteran parasitoids. Predatory mites are found to be associated with phytophagous tetranychid mites.

In the integrated management of *Pythium, Fusarium* and *Ralstonia* of ginger, rhizome solarization (45 min) reduced the disease levels and increased the yield significantly, followed by hot water treatment. Solarization recorded increased sprouting (92.2%), decreased *Pythium* rot by 5.3%, *Fusarium* yellows by 4.37% and *Ralstonia* wilt by 3.1% at Solan centre. A survey for ginger disease incidence carried out in the hill region of West Bengal (three blocks of Kalimpong) has revealed heavy loss up to 80% in some places due to rhizome rot - wilt complex of ginger.

Seed treatment as well as spraying with mancozeb + carbendazim (0.2% each) is the best treatment against leaf blotch and leaf spot of

turmeric in Pundibari centre. In the biocontrol of rhizome rot in turmeric, the treatment including seed treatment as well as soil application of *Trichoderma viride* and *Pseudomonas fluorescens* @ 12.5 kg/ha and 25 kg/ha as basal and top dressing, respectively along with application of recommended NPK + FYM was the best treatment against rhizome rot of turmeric in Coimbatore.

Trichoderma + FYM and spray with Mancozeb @ 0.25% was found effective against wilt of cumin with maximum seed yield 475 kg/ha at Jobner.

Fenugreek entries, UM-352 and UM-351 were found to be free from powdery mildew disease and RTP-9, RTP-10 and RMt-1 were found resistant against root knot nematode under field conditions at Jobner. Soil application of *Trichoderma viride* @ 5 kg/ha at 20 days before sowing and soil application of neem cake @ 150 kg/ha is recommended for biocontrol of root rot in fenugreek.

Under the programme on assessment of technology in farmer's field, a total of 20 proven technologies in spices were operated in 14 AICRPS centres through 13 SAUs. At present, eight ICAR ad-hoc schemes are being operated at SAUs/other organization under AICRPS. The details of the findings of various projects undertaken in AICRPS centres are given in the following pages.

PROGRESS OF WORK AND ACHIEVEMENTS

1. BLACK PEPPER

1.1 Genetic Resources and Crop Improvement

1.1.1 Germplasm collection, characterization, evaluation and conservation

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

The Panniyur centre maintains 167 cultivated types of black pepper and 22 wild types. During the year 2005-06, the variety Karimunda II recorded the maximum spike yield of 4.410 kg/vine, followed by Angamali (3.013 kg/vine) and Nilgiris (2.820 kg/vine). The number of spikes were maximum for Karimunda II (1555), followed by Angamali (1440). Fifty cultivated accessions and 50 wild types of black pepper were collected from Kannur and Kasaragod districts, pepper growing *Kavu's*, Kerala-Karnataka forests and *Phytophthora* hot spot areas by the Panniyur centre during the period.

Two promising accessions were added to the existing black pepper collections totalling to 119 at Sirsi. Among six cultivars (including Panniyur-1) observed for two years, maximum dry yield was recorded in Ademane pepper (3.15 kg /vine), followed by in Selection-1 (3.13 kg /vine) and in Kudragutta (2.64 kg/vine). The maximum dry recovery was 31.3% in the cultivar Kudragutta. The spike length was maximum in Ademane pepper (15.80 cm). There was significant differences in the yield among the accessions.

During the period under report, Dapoli centre collected a local indigenous type available in the forest area of Padve Majgaora, Dodamarg Dist., Sindhudurg. The promising accession collected is having short spikes, medium yield and drought tolerance.

Chintapalli centre maintains 58 accessions in black pepper. Neelamundi recorded highest dry yield of 3.3 kg/vine out of 22 accessions evaluated.

During 2005-2006 at Yercaud, out of 132 germplasm accessions berry set was observed in 33 accessions of which PN 57 recorded the highest yield of 9.2 kg and 2.95 kg green and dry berry yield respectively, which is followed by PN-33 with 8.3 kg wet and 2.6 kg dry berries.

A total of 17 accessions consisting of nine improved verities collected from IISR (2000), Kottanadan collected from CPCRI Mohitnagar (2002) and seven new genotypes collected from sub-himalayan region adjoining to Bhutan are maintained at Pundibari.

The black pepper germplasm at different *AICRP centres are given in Table-1.*

Table 1. Germplasm collection of black pepper at the AICRP centres

Center	Indigenous		Exotic	Total
	Cultivated	Wild and related sp.		
Panniyur	164	72	3	289
Sirsi	97	19	1	117
Chintapalle	58	-	-	58
Yercaud	122	10	-	132
Pundibari	16	1	-	17
Dapoli	67	-	-	67
Total	**524**	**102**	**4**	**680**

1.2 Hybridization Trial

1.2.1 Inter-varietal hybridization to evolve high yielding varieties

(Panniyur)

At Panniyur among the intervarietal hybrids, P6 X P5 is found to be promising Culture HB 20051 recorded the highest yield of 4 200 kg/vine with an average yield of 2 455 kg/vine Culture HB 20041 is also found promising (1.550 kg/vine).

Table 2. Biometric and yield characteristics of black pepper cultivars under CVT (2001-02 to 2005-06) - Ambalavayal

Treatments	Wet weight of berries/ (kg) vine	Dry weight of berries/ (kg) vine	No.of spikes/ vine	Spike length (cm)	No.of berries/ spike	1000 berry weight (g)	1000 berry volume (cc)
Sreekara	0 176	0.077	63 41	6.86	35.32	101 57	91.81
Subhakara	0 088	0.042	33 62	6.40	33.59	110.44	101.05
Panchami	0.801	0.254	189 43	9.21	62.15	123.96	110.93
Ottaplackal	0 206	0 078	53 85	7 81	37.95	113 89	102.26
Kottanadan (ACC 2426)	0.399	0.127	101 99	8 34	53.36	123 83	110.15
Kottanadan (ACC 2445)	0 514	0.162	125 12	8 28	46.69	130.96	112 11
Panniyur - 1	0 295	0 138	66.51	9 22	47 54	146.76	124.38
Panniyur - 2	0 481	0.180	112.35	8 22	44 46	129 77	118 75
Panniyur - 3	0 469	0 165	83.56	9.31	58.34	135 88	120.52
Panniyur - 4	0.584	0 166	147.53	8 20	51 41	121 78	106.64
Cul 1558	0.153	0 048	52.89	8.77	40 98	85.60	81.38
Cul 5128	0.308	0 105	56 10	8.03	43.38	170.56	144.38
Panniyur - 5	0.340	0.126	73.66	9.69	45.59	125 24	118.19
Karimunda	0.127	0 061	47.46	6.95	36 81	99.44	94.19
CD (P=0.05)	0 433	0.141	78 71	1.41	13.27	24.05	22 72

1.3 Coordinated Varietal Trial (CVT)

1.3.1 CVT 1991 Series IV

(Ambalavayal, Yercaud and *Dapoli)*

The trial started during 1992 with 14 entities at Ambalavayal Pepper cultivars showed significant differences for all the characters studied. The pooled mean data for biometrical and yield characteristics of the black pepper cultivars studied at Ambalavayal are given in Table-2.

Among the cultivars, Panchami (0.801kg), Panniyur-4 (0.584 kg), Acc. 2445 (0.514 kg), Panniyur-3 (0.469 kg) and Acc. 2426 (0.399kg) were significantly superior to other cultivars with respect to wet weight of berries per standard. Regarding the dry weight of berries per standard, Panchami (0.254 kg), Panniyur-2 (0.180 kg), Panniyur-4 (0.166 kg), Panniyur-3 (0.165 kg), Acc. 2445 (0.162 kg), Panniyur-1 (0.138 kg), Acc. 2426 (0.127 kg) and Cul. 239 (0.126 kg) showed superiority over other cultivars. Panchami (189.43), Panniyur-4 (147.53) Acc.2445 (125.12) Panniyur-2 (112.35) were significantly superior to other cultivars with (147 53) respect to number of spikes per standard. Spike length showed significant variation among the cultivars with highest in Panniyur-5 (9.69 cm), followed by Panniyur-3 (9.31 cm), Panniyur-1 (9.22 cm), Panchami (9 21cm) and number of berries per spike highest in Panchami (61.15 cm) The study revealed that Panchami, Panniyur-4, Panniyur-3, Acc. 2445, Acc. 2426 and Panniyur-2 were found promising for high range region of Kerala.

The trial started at Dapoli with 11 cultivars. The mean yield obtained during 2003-04, 2004-05 and 2005-06 are presented in Table-3.

Table 3. Yield performance of black pepper under CVT 1991 (2003-04 to 2005-06) - Dapoli

Cultivars	Yield of dry berries (kg/vine)		
	2003-04	2004-05	2005-06
Panniyur – 1	1.050	1.256	1.258
Panniyur – 2	0.566	0 702	0.737
Panniyur – 3	0.744	0.789	0.813
Panniyur – 4	0 481	0.627	0.672
Panniyur – 5	0.516	0.664	0.711
Panchami	0 315	0.462	0 518
Pournami	0.258	0.474	0.484
Shreekara	0.214	0.399	0.426
Shubhakara	0.185	0.387	0.406
P - 24	0.092	0.302	0.342
Karimunda	0 055	0 297	0 337
Mean	0 407	0.509	0 612
Range	0 55-1 050	0 302-1.256	0.337-1.258
S D.	287 60	0 274	11.48
C.V (%)	70.64	48.155	30.35

Among different cultivars under study, Panniyur-1 recorded highest yield of dry berries i.e. 1.05, 1.256, 1 258 kg/vine during the years 2003-04, 2004-05 and 2005-06 respectively. From the yield performance, Panniyur-1 variety appeared to be suitable for cultivation at Dapoli area of Maharashtra.

At Yercaud among the 14 accessions, yield

was observed in all the accessions during 2005-06. Among the accessions Panniyur-3 performed well with mean yield of 8.6 kg green berry and 2.58kg dry berry. The increase in yield in Panniyur-3 is due to long spike length and spike intensity (Table-4.)

Table 4. Yield attributes of pepper under CVT-1991 for 2006 - Yercaud

Accession	Spike length (cm)	No. of berries / spike	Green berry yield (kg)	Dry berry yield (kg)
Sreekara	10 6	55 0	3 8	1.10
Subhhahara	10 8	56 0	3.2	0.90
Panchami	10 28	66 0	2 4	0.68
Acc 856	10 30	64.0	3 2	0.86
Acc 2426	9.8	62 0	2 2	0 66
Acc 2445	9.9	60 0	3 4	0.88
Panniyur - 1	11 2	68 0	5.2	1.60
Panniyur - 2	10 1	58 0	3.6	1.04
Panniyur - 3	12 9	70 0	8.6	2.58
Panniyur - 4	10.5	62.0	2.4	0 70
Acc 239	10 8	60 0	2 8	0.84
Cul 1558	10 2	62 0	3.6	1.04
Cul 5128	10 5	62 0	3 6	1 06
Karimunda	10 2	58.0	3.6	1.06

1.3.2 CVT 2000 Series V

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

The trial started during 2002 at Pampadumpara with the 12 entries (HP-34, HP-105, HP-813, Coll.1041 OPKM, PRS-17, HP-1411, PRS-21, PRS-22, Cul. 5308, Cul. 5489 and Panniyur-1) to evaluate the performance of released varieties as well as promising selections of black pepper. Among the twelve accessions evaluated, significant differences existed all yield attributing for characters except leaf length. Cul. 5308 recorded the highest fresh (1960 g) as well as dry yield (600.5 g) per plant and was found to be significantly superior than other accessions. Fresh and dry yield of Cul. 5489 (1751 g and 563.5 g) and Col. 1041 (1216.7 g and 471. 6 g) were found to be higher than Panniyur-1 The high yielding types were not bold berried however, the increase in yield may be attributed to more number of spikes per plant, lengthy spikes and more number of berries per spike. Even though OPKm had bold berries, its performance in high ranges of Idukki District was not impressive due to poor setting percentage of spikes.

The trial was started during 2001 at Panniyur. During 2005-06, all the varieties produced spikes and the spike yield per vine was maximum for Karimunda OP (500g/vine), followed by Coll. 1041 (496 g/vine), which were statistically on par, (Table 5). The number of spikes/vine was higher in Karimunda (187) and maximum spike length was noted in Cul. 5489 (11.1cm).

Table 5. Performance of black pepper under CVT 2000 (2005-06) - Panniyur

Varieties/Cultures	Spike yield (g/vine)	No. of spikes / vine	Spike length (cm)
Kalluvally IV	181	94	7.6
Karimunda II	57	40	6 3
Karimunda III	182	49	9.9
Cul 5308	315	89	9.3
Cul 5489	198	66	**11.1**
HP 34	213	67	6.9
HP 105	50	15	6.2
HP 813	154	74	8.9
HP 1411	130	47	8 0
Karimunda OP	**500**	149	10.0
Coll.1041	496	177	7.7
Karimunda	403	**187**	7 3
Panniyur 1	373	74	10 9
CD(P=0.05)	213	61	1.3
CV (%)	50	42	9

At Chintapalli, out of 12 entries planted in 2005, HP-34 recorded the highest plant height (42.3 cm), followed by Cul. 1041 (39.8 cm), whereas PRS-21 recorded the lowest plant height (16 cm) and PRS-17 recorded significantly more number of leaves (6).

The trial was laid out with 13 cultivars during 2005 at Ambalavayal. Among the cultivars, Panniyur-1 recorded maximum dry yield (0.094 kg/ vine) and the trial is in progress.

At Sirsi, the 14 entries were planted in 2003 on Arecanut standard. Growth parameters were observed during 2005-06. The height of the plant was maximum in PRS-22 (3.07m), followed by Coll-1041 (2.69 m) and C-1411 (2.33 m). The entries *viz*, HP-105, C-1041, P-24 and Cul-5308 gave the yield of 0.25 kg, 0.12, 0.13 kg and 0.08 kg, respectively.

1.4 Nutrient Management Trial

1.4.1 Effect of biofertilizer, *Azospirillum* on black pepper production

(Panniyur, Sirsi, Ambalavayal and *Yercaud)*

The study on the effect of biofertilizer,

Table 6. Effect of *Azospirillum* on yield of black pepper - Panniyur

Treatment		Yield (kg/vine)			
		2003-04	2004-05	2005-06	Mean
T1 -	Inorganic N 100% +*Azospirillum* 50g+10 kg FYM	5.813	5 500	3.767	5 027
T2 -	Inorganic N 75% + *Azospirillum* 50g+10 kg FYM	4.590	3 800	2.525	3.638
T3 -	Inorganic N 50% +*Azospirillum* 50g+10 kg FYM	3 663	3.233	3.200	3 365
T4 -	FYM 10 kg + *Azospirillum* 50g	3.527	2 400	1.857	2.595
T5 -	FYM 10 kg alone	2.923	3 033	2.350	2.769
T6 -	Recommended fertilizer dosage alone	5 593	3.967	3.213	4 258
T7 -	Control, Recommended Package of Practice	1.353	2.233	1.783	1 790
	CD (P=0 05)	2 40	1 38	NS	1 052

Azospirillum on the yield of black pepper was laid out in a standing crop of Panniyur-1 during 2001-02 with six different treatments at Panniyur. Among the treatments, T1 (inorganic N 100 % + *Azospirillum* 50 g + 10 kg FYM) recorded the maximum spike yield of 3.767 kg/vine followed by T6 (normal package of practice) with 3.213 kg/vine. But there was no significant difference between treatments during 2005-06. The pooled analysis of three years data presented in Table 6 revealed the significance of treatment T1 (inorganic N 100% + *Azospirillum* 50g + 10 kg FYM and T6-(POP) over other treatments.

The treatment, T1 recorded the maximum yield of 5.027 kg/vine, followed by T6 (4.258 kg/ ha). The treatment T1 was significantly superior to all other treatments except T6 and were statistically at par with T6. From this experiment, it is evident that applying 50 g of *Azospirillum* per vine is highly effective in increasing the spike yield of black pepper.

The five years study on the effect of biofertilizer, *Azospirillum* at Sirsi on the yield of black pepper in Areca nut mixed cropping system is present in Table 7. It is revealed that the application of *Azospirillum* @ 50g along with the recommended 100% inorganic nitrogen and 10 kg FYM per vine recorded higher fresh berry yield (6.83 kg) compared to recommended dose of fertilizer alone (6.12 kg). This was followed by the vine supplied with *Azospirillum* @ 50 g along with recommended 75 % nitrogen and 10 kg FYM/vine (6.57 kg). Application of *Azospirillum* (50g) in addition to the regular recommendations resulted in maximizing the C:B ratio of 1:3.29.

Table 7. Effect of biofertilizer, *Azospirillum* on the yield of black pepper - Sirsi

Treatments		Fresh berry yield (kg/ vine)					Mean of	C : B
		2000-01	01-02	02-03	03-04	04-05	5 years	ratio
T1 -	100% Inorg. N + 50 g *Azospirillum* + 10 Kg FYM	6 49	6 20	6.25	7.98	7.23	6 83	1 : 3 29
T2 -	75% Inorg. N + 50 g *Azospirillum* + 10 Kg FYM	6.23	6 35	6.52	7 34	6 40	6.57	1 . 3.15
T3 -	50% Inorg. N + 50 g *Azospirillum* + 10 Kg FYM	6.49	6.32	5.99	6.66	6 20	6.33	1 . 2.58
T4 -	50 g *Azospirillum* + 10 Kg FYM	6.40	6.08	5.57	7.01	6.18	6 25	1 : 3.01
T5 -	10 Kg FYM alone	6 83	5.67	5 27	5 76	4.83	5.67	1 · 2 81
T6 -	Recommended dose of fertilizer alone	5.91	6.19	4.38	7 34	6 78	6 12	1 · 3 03
	SEm +	0.46	0.27	0.23	0.07	0.31	0 24	
	CD (P=0 05)	NS	NS	0.70	0.19	0 93	0 72	

At Ambalavayal, the treatments did not show any significant difference in yield. However among the seven different treatments in the study T1 (inorganic N 100% + *Azospirillum* (50 g) + 10 kg FYM recorded the highest dry weight of berries (1.170 kg/vine) follow by T2 (1.080kg/vine).

The trial was laid out in 2000-01 at Yercaud. The observation on vine length, number of leaves and leaf area were recorded. The maximum vein height (168.0 cm) was recorded in the T2 (Inorganic N 75% + *Azospirillum* 50 g + 10 kg FYM) and the number of leaves and leaf area were higher (58.0+ 64.00 cm^2) in the treatment T3 (Inorganic N 50% + *Azospirillum* 50 g + 10 kg FYM)

1.4.2 Effect of biofertilizer, P- solubilizers (Phosphobacteria) on black pepper

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

The study on the effect of biofertilizer phosphobacteria on the yield of black pepper was laid out in standing crop of Panniyur-1 at Panniyur centre during 2001-02 with 6 treatments and control. The yield data for three years and over pooled mean three years are presented in Table 8 During 2005-06, T1 (Inorganic P100% + P-solubilizers 50 g + 10 kg FYM) recorded the maximum spike yield of 3 063 kg/vine, followed by T6 (POP) with 2 760 kg/vine. however, there was no significant difference between the treatments The yield data of three years (2003 to 2006) were subjected to pooled analysis and found that treatment T1 was higher yielder (5.588 kg/vine), followed by T6 (4.930 kg/vine). The treatments T6 and T2 were statistically on par with T1. The treatments T1 were significantly superior to all the treatments except T6 and T2.

The experiment started during the year 2003 at Ambalavayal. The treatments did not show any significant difference in yield. However T7 (recommended dose of inorganic fertilizers) recorded maximum dry yield (1.263 kg/vine)

The trial laid out at 2000-01 and continued for 5 years at Sirsi. It was revealed from the five years data (Table 9) that the application of P-solubilizers @ 50 g along with recommended 100% inorganic P and 10 kg FYM/vine recorded higher fresh berry yield (6.81 kg) compared to others This was followed by the treatment with P- solubilizers @ 50 g along with recommended 75% inorganic P and 10 kg FYM/vine (6 43 kg). Application of P-solubilizers (50 g) in addition to the regular recommendations resulted in maximizing the C:B ratio of 1:3.30.

Table 8. Effect of phosphobacteria on yield of black pepper - Panniyur

Treatments		Yield of black pepper (kg/vine)			
		2003-04	2004-05	2005-06	Mean
T1 -	Inorganic P 100% + P-solubilizers 50g +10 kg FYM	4 900	8 800	3 063	5 588
T2 -	Inorganic P 75% + P-solubilizers 50g+10 kg FYM	2 833	7 400	2 290	4 174
T3 -	Inorganic P 50% + P-solubilizers 50 g+10 kg FYM	1 833	4 767	1 960	2 853
T4 -	FYM 10 kg + P-solubilizers 50g	2 500	4.233	1 850	2 861
T5 -	FYM 10 kg alone	2.300	4 167	1 917	2 795
T6 -	Recommended dose of fertilizer alone	4 467	7 567	2 757	4 930
T7 -	Control	1 433	3 233	1 557	2 074
	CD (P=0 05)	2 27	0 301	NS	1 594

Table 9. Effect of biofertilizer, P-solubilizers on the yield of black pepper - Sirsi

Treatments		Fresh berry yield (kg/ vine)					Mean of	C : B
		2000-01	01-02	02-03	03-04	04-05	5 years	ratio
T1 -	100% Inorg P + 50 g P-solubilizers + 10 kg FYM	6 68	6 27	6 63	7 28	7 17	6 81	1 3 30
T2 -	75% Inorg P + 50 g P-solubilizers + 10 kg FYM	5 74	6 20	6 53	6 96	6 71	6 43	1 3 14

Treatments		Fresh berry yield (kg/ vine)					Mean of	C : B
		2000-01	01-02	02-03	03-04	04-05	5 years	ratio
T3 -	50% Inorg P + 50 g P-solubilizers + 10 kg FYM	6 31	6 00	6 57	6 60	6 33	6 36	1 : 2.97
T4 -	50 g P-solubilizers + 10 kg FYM	6.00	6.31	6 13	6.03	5.99	6 00	1 : 2.66
T5 -	10 kg FYM alone	5.74	6 71	4.77	6 19	5 80	5 84	1 : 2 72
	Recommended dose of fertilizer alone	6 28	6 06	4.82	7.12	6 98	6.25	1 : 3 17
	SEm +	0.37	0.35	0.29	0 20	0 20	0.22	
	CD (P=0.05)	NS	NS	0 86	0 54	0.62	0.66	

The trial was laid out in the year 2000 at Yercaud. The height of the vine was higher 160.0 cm in the T4 (FYM 10 kg + phosphobacteria 50 g, the number of leaves per vine was higher (42.0) in the treatment T2 (Inorganic P 75% + phosphobacteria 50g + 10 kg FYM and the leaf area was higher 69.4 cm^2 in Treatment –T1 (Inorganic P. 100% + phosphobacteria 50 g + 10 kg FYM.

1.4.3 Organic farming in black pepper

(*Panniyu, Yercaud* and *Sirsi*)

An experiment to study the effect of different organic manures on black pepper was laid out in a standing crop of pepper (Panniyur-1) at Panniyur during 2002 with 7 treatments. During the year 2005-06, T6 (POP) recorded maximum spike yield of 3.367 kg/vine, followed by T2 (vermin-compost 2 kg + 10 kg FYM +P 40 g + wood ash 2 kg) with 3 240 kg/vine (Table-10). The treatments T6, T2, T4, T1 and T5 were statistically on par. Pooled analysis of data of three years indicated that T4 (FYM 10 kg + *Azospirillum* 50 g + wood ash 2 kg) recorded maximum spike yield of 6.489 kg/vine, followed by T6 (POP) with an yield of 5.434 kg/ vine. The treatments T4, T1 and T2 were statistically at par with the package of practice recommendation. The lowest yield was obtained in the zero tillage treatments which was almost half of the yield in the best treatment (T6). (Table 10).

A trial started in 2000-01 at Sirsi on black pepper on arecanut standard. The five years yield data presented in (Table-11) revealed that significantly highest mean fresh berry yield was recorded in plants supplied with FYM 10 kg+ burnt earth 10 kg (6.43 kg/vine). The Cost: Benefit ratio was also high for the same treatment (1:4.17), followed by treatment FYM 10 kg/vine (5.41 kg/ vine).

The trail with 6 treatments started in 2001-02 at Yercaud. The treatment T3 (T3- FYM 10 kg + 1 kg neem cake + 50 g phosphobacteria recorded the green berry yield of 6.30 kg and 1.85 kg dry berry yield and spike length of 11.6 cm and number of berries of 68.0.

Table 10. Effect of organic nutrition on black pepper yield (2003-2006) - Panniyur

Treatments		Yield of black pepper (kg/vine)			
		2003-04	2004-05	2005-06	Mean
T1 -	10 kg FYM + P 40g + 2kg wood ash	6 033	6 100	2 700	4.944
T2 -	Vermicompost 2kg+10 kg FYM+ P 40g+2kg wood ash	5.067	5.433	3.240	4 580
T3 -	10 kg FYM + burnt earth 10 kg	5.067	4.133	1.897	3 699
T4 -	FYM 10 kg + *Azospirillum* 50g + 2kg wood ash	5.967	10.400	3.100	6.489
T5 -	FYM-10 kg +leaf manure 10kg + 2kg wood ash	4 933	4 633	2.427	3.998
T6 -	Package of practices recommendations	6 067	6 867	3.367	5 434
T7 -	Leaf mulch + zero tillage	3.000	3.767	1 823	2.863
	CD (P=0.05)	NS	2.51	0.986	1.94

Table 11. Effect of organic farming on black pepper yield (2000-01 to 2004-05) Sirsi

Treatments	Fresh berry yield (kg/ vine)					Mean	C : B
	2000-01	01-02	02-03	03-04	04-05		ratio
FYM 10 kg/vine	5.36	5.84	5 13	4.98	5.73	5 41	1 : 3 85
Vermicompost (2kg) + wood ash (1kg/vine)	5.06	5.40	5.02	4.19	4.20	4 77	1 3 77
FYM 10 kg + burnt earth 10 kg	6.74	6.52	5.94	6.20	6.75	6 43	1 . 4 17
FYM 10kg+ *Azospirillum* 50g/vine	5.05	5062	4 72	4.70	4.75	4.97	1 . 3 87
FYM 10 kg + leaf manure 10 kg	5.61	5.82	4.09	3.62	4 15	4.66	1 : 3 33
SEm ±	0 27	0.16	0.18	0.06	0.28	0 19	
CD (P=0.05)	0.85	0.49	0.55	0.17	0.88	0.56	

1.4.4 Development of organic package for spice based cropping systems

(*Chintapalli* and *Dapoli*)

The observational trial started in 2005 at Chintapalli using the variety, Panniyur 1 in a 6 year old plantation with organic package practice *viz.*, cover/green manure crop (cow pea), on farm compost (maize debries), *Trichoderma harzianum*, 5% neem oil (NSKE) and neem cake. In organic practice, 4.47 m vine growth was recorded, whereas inorganic practice produced 4.96 m height. The dry yield of 265 g and 290 g per vine was recorded in organic practice and inorganic practice, respectively.

A trial on development of organic package in black pepper has been initiated at Dapoli during 2004-05. The observation on vegetative growth has been recorded. The organic package practices include 1) Cover/ green manuring crops suitable to the location/area, 2) On farm composting with locally available organic resudes/sources, 3) Biocontrol agents and botanical pesticides and natural enemies for controlling major pests and diseases.

1.5 Disease Management Trial

1.5.1 Management of *Phytophthora* disease in black pepper- nursery

(*Pampadumpara, Chintapalli* and *Dapoli*)

The effect of soil solarization, application of biocontrol agents and fungicides were evaluated for management of *Phytophthora* disease in black pepper nursery by the Pampadumpara center. The study conducted using the local variety Karimunda with 8 different treatments. The results revealed that the temperature under the polythene sheet during solarization rose to 47°C compared to 37°C in non solarised soil. The effect of soil solarization on sprouting growth and disease incidence of the three years is given in Table 12. Maximum sprouting, no. of roots per cutting and root length were recorded in the solarized soil fortified with *T. harzianum* and VAM, followed by solarized soil with the application of metalaxyl MZ and solarized soil with the application of copper oxychloride (Table 12).

Table 12. Effect of soil solarization on sprouting, growth and disease incidence of black pepper- Pampadumpara

Treatments	2001-2002			2002-2003			2003-2004	
	No.of cuttings sprouted	No.of roots per cutting	Root length (cm)	No.of cuttings sprouted	No.of roots per cutting	Root length (cm)	Sprouting %*	No.of diseased cutting**
T1	62.3	3.3	5.5	72.7	4.0	8.5	66.7 (54 76)	15.0 (3.84)
T2	34.0	2.5	5.5	46.7	0.8	0.8	17.8 (24.81)	37.3 (6 07)
T3	63.0	5.0	9.5	87.7	6.3	12.5	85 0 (67.67)	9.0 (2.99)

Treatments	2001-2002			2002-2003			2003-2004	
	No.of cuttings sprouted	No.of roots per cutting	Root length (cm)	No.of cuttings sprouted	No.of roots per cutting	Root length (cm)	Sprouting %*	No.of diseased cutting**
T4	61.3	0.7	2.3	51.3	5.4	10 5	15.8 (22 96)	27.3 (5 15)
T5	50 7	4.0	5.7	64.3	4.9	6 5	75 5 (60.36)	25.7 (5.05)
T6	45 3	1 7	3.4	55.0	2 1	2.8	7.50 (15.88)	36.0 (5.98)
T7	38.3	3 8	8 5	73 7	1 0	4.4	74.2 (59.49)	15.7 (3.94)
T8	30.7	1.0	4.8	65.0	2.3	1 3	19.7 (26 29)	39.0 (6.21)
CD (P= 0 05)	7.42	NS	4.11	22 0	2.9	NS	5.81	1.19

T1- Planting in solarized soil.
T2- Planting in non solarized soil
T3- Solarized soil fortified with *T harzianum* @ 1g kg $^{-1}$ + VAM @ 100cc kg ^{1} of soil.
T4- Non-solarized soil with *T harzianum* and VAM
T5- Planting in solarized soil + Ridomil MZ WP spray and drench @ 1.25 g litre^{-1}
T6- Planting in non solarized soil + Ridomil MZ WP spray and drench @ 1.25 g litre^{-1}
T7- Planting in solarized soil + COC @ 0.2% drench
T8- Planting in non solarized soil + COC @ 0.2% drench
Ss= Soil solarized N.Ss = Non solarized soil
*Values in parentheses are angular transformed values.
**Values in parentheses are IX transformed values.

Disease incidence was minimum when the rooted cuttings were planted in the solarised soil fortified with *T. harzianum* and VAM. The potting mixture samples were analyzed for microbial population before and after soil solarization. The population of fungi, bacteria and actinomycetes were significantly altered by soil solarization. More number of fugal colonies observed in solarized soil fortified with *Trichoderma* (59.4 colonies). (Table 13). The population of bacteria was more in the case of solarized potting mixture added with biocontrol agents (6.8) while that of actinomycetes was less compared to that of non-solarized soil. Present study concludes that solarized soil fortified with *T. harzianum* @ 1 g/kg and VAM @ 100 CC/kg of soil was found to be effective in the management of *Phytophthora* disease in black pepper nursery.

For the management of nursery disease in black pepper (nursery trial) at Chintapalli, it was found that planting the cuttings in solarized soil fortified with *T. harzianum* (1 g/kg of soil and VAM inoculum @100 g/kg soil observed to be the best for the development of more length of rooted cutting in the nursery and in terms of lowest disease incidence. (Table 14).

Table 13. Effect of soil solarization and biological control organisms on soil micro flora in black pepper nursery (2001-02 to 2003-2004) -Pampadumpara

Treatment	Fungi before solarization (cfu x 10^{-4})	Fungi after solarization (cfu x 10^{-4})	Bacteria after solarization (cfu x 10^{-7})	Actinomycetes after solarization (cfu x 10^{-5})
Solarization	10.8	16.0^{c}	5.9^{a}	7.8^{a}
Solarization + Biocontrol agents	20.8	59.4^{a}	6.8^{a}	5.2^{b}
Non- Solarization	17.8	25.0^{b}	2.6^{b}	9.2^{a}
Non- Solarization +Biocontrol agents	17.8	24.6^{b}	2.2^{b}	13.6^{a}
CD (P=0.05)	NS	6.9	3.0	5.9

Table 14. Management of nursery diseases in black pepper - Chintapalli

Treatment		Length of the cuttings (cm)	Un-sprouted cuttings	Time taken for sprouting	Mortality of the cuttings	Number of leaves/cutting	Biomass of 25 cuttings (g)
T1 -	Planting in solarized soil	43 1	42 0	53 3	7 4	4 7	117 8
T2 -	Planting in non solarized soil	40 0	59 0	53 7	9 8	4 6	112 4
T3 -	T1+ *Trichoderma harzianum* +VAM	49 4	17 7	55 7	3 5	5 6	260 7
T4 -	T2+*Trichoderma harzianum* +VAM	37 6	27 0	52 3	4 7	4 7	169 8
T5 -	T1+Ridomil MZ-72 spray and drench	47 4	37 7	56 0	6 5	4 3	190 4
T6 -	T2+Ridomil MZ-72 spray and drench	43 6	45 7	56 0	7 0	4 4	168 7
T7 -	T1+ COC 0 2% drench + 1 % Bordeux mixture spray	44 4	25.7	54 3	4 9	3.8	201 0
T8 -	T2+ COC 0 2% drench + 1% Bordeux mixture spray	42 3	46 3	52 7	7 9	3.3	140 1
T9 -	T1+T *viride*	42 7	28.0	55.3	5 4	4 5	176 2
T10 -	T2 + T *Viride*	40 0	43 0	53 3	8 2	3 7	140 4
	Mean	430 5	372 1	542 6	65 3	43 6	1677 5
	CD (P= 0 05)	8.9	13 6	7 5	25.2	1 6	32 2
	CV %	12 1	21 3	8.1	22 4	21.4	10.8
	Sem±	3 0	4.6	2 5	8 5	0 5	10.9

A trial conducted to control mortality of sprouted cutting in nursery combination of effective fungicides like Bordeaux mixture 1%, copperoxychloride 0.2%, Ridomil (metalaxyl) and biocontrol agents viz. *T harzianum* and VAM fungi coupled with soil solarization were evaluated in a nursery during 2004-05 and 2005-06 at Dapoli. Maximum disease control (79.41%) of *Phytophthora* foot rot was obtained by soil solarization + *T harzianum* + VAM. It was significantly superior to rest of the treatments except soil solarization + COC and soil solarization + Ridomil. Soil solarization coupled with biocontrol agents or fungicides prevent more effectively than those with non-solarized soil.

1.5.2 Control of *Phytophthora* foot rot disease in black pepper in farmers field - observational trial

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

In order to develop an effective and economic management practices to control *Phytophthora* disease, an experiment was conducted using fungicides and biocontrol agent (*Trichoderma harzianum*). At Pampadumpara, the experiment was conducted at two locations *viz.*, CRS Pampadumpara and farmers field located at Vellakadavu with 7 treatments. All the treatments differ significantly in checking the pathogen compared to the control. Although the biocontrol agent and potassium phosphonate were evaluated individually, the disease incidence was very low in vines treated with potassium phosphonate in combination with *T harzianum* At both locations, a similar trend was observed with respect to disease management (Tables 15 & 16).

Table 15. Effect of biocontrol agents on percentage reduction of yellowing and defoliation indices as well as yield of black pepper (2004-2005) - Pampadumpara

Treatments	CRS, Pampadumpara			Vellakkadavu	
	Reduction in yellowing (%)	Reduction in defoliation index (%)	Yield (g /plant)	Reduction in yellowing (%)	Reduction in defoliation index (%)
Metalaxyl gold MZ	15.48 (19 20)	37.59 (36.83)	840.6	72.48 (63.41)	37.08 (36 94)
Potassium phosphonate @ 5ml	67.89 (61.23)	66.67 (60.0)	995.5.0	63 3 (54 0)	83 33 (75.0)
Trichoderma harzianum @ 50 gm / vine + 1kg neem cake	95.48 (88.20)	78 22 (67 07)	1100.67	88 9 (78.25)	100 (90.0)
Metalaxyl gold MZ @2 5 g/L + *Trichoderma harzianum* and 1kg neem cake	33.33 (30.27)	33.33 (30.0)	820.33	33.3 (30.0)	33 33 (30.0)
Potassium phosphonate- 5ml / l + *Trichoderma harzianum* and 1kg neem cake	90.83 (84.50)	85 (75 0)	1135	95 (88.12)	100 (90.0)
Neem cake –1 kg	24.06 (24.37)	45 46 (37.1)	680.5	46.3 (38.54)	47.02 (43.29)
Control	0 (0)	0 (0)	475 6	0 (0)	0 (0)
CD (P=0.05)	3 23	5.12	10.16	7.53	13.86

Values in parenthesis are arc sine transformed

Table 16. Management of *Phytophthora* foot rot of black pepper (2003-2004) -Pampadumpara

Treatments	Disease index (%)	Dry berry yield (g / plant)
Metalaxyl gold MZ 68% WP @2 5 g/L	2.2	1155
Potassium phosphonate @ 5ml / l	2.7	1280
Trichoderma harzianum @ 50 gm / vine +1kg neem cake	2.1	1491
Metalaxyl gold MZ @2 5 g/L + *Trichoderma harzianum* and 1kg neem cake	2.7	1327
Potassium phosphonate – 5ml / l + *Trichoderma harzianum* and 1kg neem cake	1.3	1529
Neem cake –1 kg	3.0	980
Control	3.6	660
CD (P=0 05)	1.28	11 86

Application of the fungicide potassium phosphonate (5 ml/ l) along with soil application of *T. harzianum* (@ 50 g/vine) and neem cake (1 kg) was found significantly superior over other treatments at both locations followed by the application of *Trichoderma* alone. The present study confirmed that the application of potassium phosphonate (5 ml/l), *Trichoderma harzianum* (50 g/vine) and neem cake (1 kg) was found to be effective in the management of *Phytophthora* foot rot of black pepper.

The trial started in farmers field in 2000-01 at Sirsi and continued during the 6th year (2005-06) in two locations Edahalli and Hosabale villages consisting of six treatments under areacanut based cropping system. The observations were taken on leaf infection, percent defoliation and foliar yellowing in grades (0-3 grades) at different intervals viz during onset of monsoon, peak monsoon and post monsoon. The four years pooled data (2000-01 to 2003-04) on disease incidence is presented in Table 17.

Table 17. Control of *Phytophthora* disease of black pepper in farmers' field observation trial (2000-01 to 2003-04)- Sirsi

Treatments	Per cent disease incidence				Pooled mean
	2000-01	2001-02	2002-03	2003-04	
Metalaxyl gold MZ 68 WP (@ 100 ppm, 2 5 g l ^{1}) as spray (2 l/vine) and drench (3 l/ vine) twice	17.50 (24 16) *	15 00 (22 48)	7 50 (13 82)	7 50 (11 25)	11 87 (17 93)
Potassium phosphonate (Akomin, @ 0 5 per cent) 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)
Soil application of *Trichoderma harzianum* (10 ^{7} cfu, @ 50 g/ vine) 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)
Metalaxyl gold MZ 68 WP (@ 100 ppm, 2 5 g l ^{1}) as spray (2 l /vine) and drench (3 l/vine) twice + Soil application of *Trichoderma harzianum* (10 ^{7} cfu,@ 50g/vine) 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)
Potassium phosphonate (Akomin, 0 5 per cent) as spray and drench twice + Soil application of *Trichoderma harzianum* (10^{7} cfu, @ 50 g/vine) 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)
Neem cake application @ 1 kg/ vine	37 50 (37 72)	55 00 (47.89)	32 50 (33.97)	35 00 (36 06)	40 00 (38 91)
Untreated control	52 50 (46 50)	62.50 (52 34)	40.00 (39 17)	45 00 (42 11)	50 00 (45 03)
SEm±	3 12	2 20	4.45	4.32	1 84
CD (P=0 05)	9 30	6 54	13 08	12 70	5 16

*angular transformed values

Phytophthora foot rot of black pepper was minimum with respect leaf infection (5.46 per cent), defoliation (0.42 grade), foliar yellowing (0.67 grade), no collar infection and maximum yield (4.39 kg fresh yield/vine and 1.38 kg dry yield/vine) with application of Ridomil gold (@ 0.25 per cent) as spraying (@ 2 l ^{vine}) and drenching (@ 3 l ^{vine}) along with *Trichoderma harzianum* (@50 g, cfu 10^{7}) and one kg of neem cake as application to root zone of the vines during June and August. However, treating the vine with potassium phosphonate (@ 0.5 per cent) as spraying (@ 2 l $^{-vine}$) and drenching (@ 3 l ^{vine}) two times during June and August with bio agent *T harzianum* (@ 50 g ,cfu 10^{7}) and one kg of neem cake as root zone application combated the disease with less leaf infection (6.51per cent), collar infection (2.50 per cent), defoliation (0.92grade) foliar yellowing (0.71 grade) and more yield (3 62 kg fresh yield/vine and 1.12 kg dry yield/ vine). There was maximum leaf infection (29.84 per cent), collar infection (20 per cent), defoliation (2 05 grade) and foliar yellowing (1.96 grade) and minimum yield 1.34 kg fresh yield/vine and 0.39 kg dry yield /vine) in untreated vines.

The pooled data of six years 2000-01 to 2005-06 revealed that black pepper vines were less affected when the vines were treated either with metalaxyl gold MZ 64 WP (Ridomil gold) @ 2.5 g/vine or potassium phosphonate (0.5 per cent) as spray (@ 2 l ^{vine}) and drench twice (@ 3 l ^{vine}) during before on set of monsoon and second application in the month of August coupled with soil application of antagonistic organism i.e., *Trichoderma harzianum* @ 50 g (cfu 10^{7}) along with 1 kg of neem cake to the root zone of the vine. Application of systemic fungicides alone i.e , metalaxyl gold MZ 64 WP (Ridomil gold) @ 2.5 g/vine or potassium

phosphonate (0.5 per cent) as spray (@ 2 l^{-vine}) and drench twice (@ 3 l^{-vine}) twice also showed effectiveness in combating the disease. There was more incidence of the disease when vines were applied with either neem cake or *Trichoderma harzianum* alone. There was maximum incidence of the disease in the unprotected vines.

Apart from following all recommended cultural practices, the diseases could be managed by treating vines twice in the season (June and August) with metaxyl gold MZ 68 WP (Ridomil gold) @ 2.5 g /lit) as spray (2 l^{-vine}) and drench (3 l^{-vine}) alone and or in combination with bioagents i.e *Trichoderma harzianum* @50 g of 10^7 cfu/vine along with 1 kg of neem cake as soil application to the basin. (June and August). Treatment with potassium phosphonate @5 ml/l as spray and drench in combination with bioagent *T. harzianum* @50 g/ vine twice in the season (June and August) is also effective in combating the disease.

The trial was laid out at two locations (Valiampara and Padiyoor) by the Panniyur centre during 2001 using Panniyur-1 variety with seven treatments including control. The result of the trial at Panniyur indicated that metalaxyl gold MZ (2.5 g/ha) and *T. harzianum* was found to be effective in controlling the foot rot disease followed by application of Akomin (3 ml/L) and *T. harzianum*. The disease incidence was very low when Metalaxyl gold MZ combined with soil application of *T. harzianum* (Table 18 and 19).

Table 18. Management of foot rot disease of black pepper -Panniyur (at Padiyoor)

Treatments		Disease Incidence								
		May		September			December			
		Y	Y	D	LI	CI (%)	Y	D	LI	CI (%)
T1 -	Metalaxyl goldMZ 68 % WP (2.5 gm/l) spary & drench	9.47	8.43	6.44	13.86	5.00	5.13	5.14	7.15	0.00
T2 -	Akomin - spray& drench- (3 ml/ l)	10.04	7.88	6.63	14.50	0.00	6.64	5.15	7.48	0.00
T3 -	*Trichoderma harzianum* (50 gm / vine)	8.62	7.33	6.41	11.26	5.00	5.26	5.06	6.69	0.00
T4 -	Metalaxyl gold MZ 68 % WP (2.5 gm/l) spary & drench + *Trichoderma harzianum*	8.98	6.27	5.36	10.96	0.00	4.28	4.63	5.03	0.00
T5 -	Akomin –spray& drench (3ml/ l)+ *T. harzianum*	8.97	6.37	5.76	11.04	0.00	4.66	4.83	5.81	0.00
T6 -	Neem cake – 1 kg / vine	11.34	10.26	8.27	17.59	10.00	8.37	6.29	12.94	5.00
T7 -	Control	14.63	13..46	12.60	21.94	15.00	12.49	12.50	23.15	20.00
	CD (P=0.05)	1.02	1.01	2.11	1.23	1.21	1.25	1.43	1.34	2.23

Y=Yellowing D = Defoliation LI = leaf infection CI = Collar infection

(Yelowing Index 0 = Nil; 1= upto 25% ; 2 = 25% to 50% ; 3 => 50%)

(Defoliation Index 0 = Nil; 1= upto 25% ; 2 = 25% to 50% ; 3 => 50%)

Table 19. Management of foot rot disease of black pepper-Panniyur at Valiamapara

Treatments		Disease Incidence								
		May		September			December			
		Y	Y	D	LI	CI (%)	Y	D	LI	CI (%)
T1 -	Metalaxyl goldMZ 68 % WP (2.5 gm/l) spary & drench	11.91	10.13	8.52	15.93	5.00	7.11	7.11	9.14	0.00
T2 -	Akomin - spray& drench- (3 ml/ l)	12.01	9.98	8.54	16.11	0.00	8.59	7.12	9.45	0.00
T3 -	*Trichoderma harzianum* (50 gm / vine)	10.89	9.03	8.11	13.24	5.00	7.23	7.01	8.54	0.00

Treatments		Disease Incidence								
		May		September			December			
		Y	Y	D	LI	CI (%)	Y	D	LI	CI (%)
T4 -	Metalaxyl gold MZ 68 % WP (2.5 gm/l) spary & drench +*Trichoderma harzianum*	10.67	8.14	7.35	12.97	0.00	6.13	6.54	7.02	0.00
T5 -	Akomin - spray& drench- (3 ml/ l)+ *T. Harzianum*	10.98	8.35	7.74	13.01	0.00	6.23	6.87	7.89	0.00
T6 -	Neem cake – 1 kg / vine	13.34	12.12	10.08	19.43	10.00	10.12	8.27	14.91	5.00
T7 -	Control	16.56	15..55	14.99	23.93	15.00	14.15	14.71	25.15	20.00
	CD (p=0.05)	1.12	1.05	2.01	1.31	1.11	1.52	1.44	1.35	2.12

Y=Yellowing D=Defoliation LI =leaf infection CI=Collar infection

The pepper yield presented in Table 20 also showed that the highest yield obtained in these treatments.

Table 20. Effect of Chemicals and *Trichoderma* on yield of black pepper- Panniyur

Treatments		Fresh (kg)	Dry (kg)
T1 -	Metalaxyl Gold MZ 68 % WP (2.5 gm/l) spary & drench	11.566	3.800
T2 -	Akomin - spray& drench- (3 ml/ l)	10.766	3.663
T3 -	*Trichoderma harzianum* (50 gm / vine)	11.100	3.633
T4 -	Metalaxyl Gold MZ 68 % WP (2.5 gm/l) spary & drench + *Trichoderma harzianum*	13.166	4.333
T5 -	Akomin - spray& drench- (3 ml/ l)+ *T. harzianum*	12.033	3.986
T6 -	Neem Cake-1 Kg /vine	9.733	3.200
T7 -	Control	7.500	2.666
	CD (P=0.05)	2.10	1.05

The trail started at Mudigere during 2000 (in 1996 planted vines) with 8 treatment combinations. The pooled data of three years and the treatment details are presented in Table 21. Spraying and drenching of Ridomil Gold 68 WP (2.50 g/lit.-5L/ vine) and its combination with Bio-agent (*Trichoderma harzianum*) 50 g pure culture with 1 kg neem oil cake per vine during the first week of June and September was found effective in checking the disease and they are on par and significant over the check during 2000 and 2001. However, disease did not appear during 2002 and 2003 due to unfavorable weather conditions. But spraying and drenching of Bordeaux Mixture 1% @ 5L/vine during May/June and July/August was found most effective during 2004 which is followed by the combined application of Ridomil with bio control agent and Ridomil alone as they are on par and significant as compared to other treatments.

Table 21. Effect of different treatments on the incidence of foot rot in black pepper (pooled data of 2000, 2001 and 2004) -Mudigere

Treatment		Dosage per vine	Mean PDI for 2 locations					
			2000	2004	Mean of 2 yrs.	2004	Mean of 2 yrs.	Effecti veness
T1 -	Akomin 40 SL Ridomil MZ 72WP,	5 ml/L- 5 L/v. Spray & drench 1.25 g/L-5L/v. ,	5.99	25.00	15.49	05.48	10.49	4 (A)
T2 -	Ridomil Gold 68WP	2.5g/L-5L/v. Spray & drench	3.23	00.00	01.62	04.96	03.29	2 (B)
T3 -	Bio agent (*T. harzianum*)	50 g. with 1 kg NC/v soil appln.	3.41	25.00	14.20	09.37	11.79	4 (B)
T4 -	T_3+T_1	As above (Soil and spray)	6.04	12.50	09.27	01.12	05.20	3
T5 -	T_3+ T_2	As above (Soil and spray)	3.75	00.00	01.86	04.24	03.10	2 (A)

Treatment		Dosage per vine	Mean PDI for 2 locations 2000	2004	Mean of 2 yrs.	2004	Mean of 2 yrs.	Effecti veness
T6 -	Neem oil cake	1kg/v. soil appln.	7.46	29.67	18.56	11.79	15.18	
T7 -	Control	---	8.61	33.84	21.22	15.10	18.16	
T8 -	Bordeaux mixture	1% - 5L/v. Spray & drench	---	---	---	00.00	00.00	1
	CD (P=0.05)		3.21	1.75		3.37		

At Ambalavayal, the treatments did not show any significant difference. However out of seven treatments, T4 (*T. harzianum* + Neem cake + Ridomil) recorded the highest berry weight (0.825 kg/ha).

1.5.3 *Phytophthora* foot rot incidence in black pepper under different plant densities in arecanut garden

(*Panniyur* and *Sirsi*)

The trial laid out at Panniyur on 2001 with 4 treatments in RBD. Establishment (94.6%) and height of the vines (4.34 m) were high and disease incidence was less (0.98%) (Table 22). When the pepper vines were planted in 25% population of areca garden (T1 and maximum in 75 % areca population (2.22%). Establishment of pepper vines in T1 and T2 are significantly higher than T3 and T4. Similarly growth of the vines showed same trend. Incidence of *Phytophthora* rot was significantly less than other treatments.

Table 22. *Phytophthora* foot rot incidence in black pepper, disease score - Panniyur

Treatments		Establishment (%)	Vine height (m)	% disease incidence
Tl -	Pepper in 25% population of Areca garden	94.6	4.34	0.98
T2 -	Pepper in 50% population of Areca garden	93.4	3.03	2.06
T3 -	Pepper in 75% population of Areca garden	83.6	2.73	2.22
T4 -	Pepper in 100 % population of Areca garden	75.2	2.00	1.26
	CD (P= 0.05)	2.56	0.78	0.34

Under 25 percent population density of black pepper vines in arecanut garden the *Phytophthora* foot rot was least (0.2 grade) with more plant height (3.82 m), more collar girth (5.26 cm), more number of branches (27.55), more number of spikes (32.15 per sq m), more spike length (11.65 cm) and fresh berry yield (1.58kg/vine) as compared to 100 per cent population density of vines in areca nut garden where in vines were showing more disease incidence (0.55 grade) and less plant height (3.51 m), less collar girth (5.05 cm), less number of branches (26.80), less number of spikes (28.40 per sq m), less spike length (11.68cm) and less fresh berry yield (1.18kg/vine)

The experiment conducted at Sirsi during 2000-01 to 2005-06 using the variety Panniyur-1. The pooled analysis of two years 2004-05 and 2005-06 presented in table 24. Low population i.e., 25 per cent density of black pepper under arecanut garden showed less *Phytophthora* foot rot of black pepper (0.18grade) followed by improvement in plant characters viz., more plant height (3.66 m), more collar girth (5.12 cm), more number of branches (27.18), more number of spikes (33.13 per sq m), more spike length (12.18 cm) and fresh berry yield (1.47kg/vine). The disease incidence was maximum (0.45 grade) in high population i.e., 100 per cent density of black pepper coupled with poor plant characters *viz.*, less plant height (3.34 m), less collar girth (4.87 cm), less number of branches (25.53), less number of spikes (28.73 per sq m), less spike length (11.51cm) and less fresh berry yield (1.0 kg/vine) (Table 23).

The result of the present finding clearly showed that the low population densities (25 and 50 percent) of the vines in arecanut garden showed low disease of *Phytophthora* foot rot and high yield with good plant characters *viz.*, more plant height, more collar girth, more number of branches, more number of spikes, more spike length and fresh berry yield as compared to 75 and 100 per cent population densities. The less disease incidence in low population density could be due to increase in the distance of the host and the altered microclimate that affect the spread of the pathogen. Further, in

Table 23. *Phytophthora* foot rot incidence of black pepper under different densities in an arecanut garden (2004-05&2005-06) - Sirsi

Treatment		Disease incidence (Grade)	Plant height (m)	Collar girth (cm)	Branches (nos)	No. of spikes (per sq. m)	Spike length (cm)	Fresh yield* (kg/vine)
T1-	Black pepper in 25 per cent population of arecanut	0.18	3.66	5.12	27.18	33.13	12.28	1.47
T2-	Black pepper in 50 per cent population of arecanut	0.30	3.49	5.01	26.73	32.00	12.35	1.36
T3-	Black pepper in 75 per cent population of arecanut	0.45	3.43	5.04	25.70	29.65	11.55	1.16
T4-	Black pepper in 100 per cent population of arecanut	0.45	3.34	4.87	25.53	28.73	11.51	1.10
	S Em ±	0.02	0.01	0.01	0.36	0.35	0.32	0.03
	CD (P=0.05)	0.07	0.04	0.04	1.23	1.20	1.10	0.10

*Dryage was 28.40

low population densities of the vines, improved in the plant growth characters were attributed to good light penetration, less humidity, more nutrient and soil moisture unlike in high population densities of the vines.

1.5.4 Incidence, epidemiology and management of *anthracnose* disease in black pepper

(*Mudigere, Pampadumpara* and *Dapoli*)

The study started in 2002 and continued for three years at Mudigere. The treatment details are as follows.

Treatment details:

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)

T5 - Control

Incidence of anthracnose disease in black pepper was recorded from 4.6 to 8.4 PDI on leaves during the year 2005. But, the incidence was maximum at 6.4% during August due to the prevalence of low temperature with maximum relative humidity of 88.58% coupled with a total rainfall of 898.4 mm received during August in 23 continuous rainy days. But, no disease incidence was observed on spike during 2003, 2004 and 2005

However, on an average disease incidence was recorded from 3.63 to 6.28% (mean) PDI during 2003 and 2005. But, the maximum disease incidence was recorded during the month of June and July at a temperature ranging from 19.19 – 24.21°C with a maximum relative humidity of 88.37% coupled with a rainfall ranging from 532.3 mm to 677.5 mm in 20.25 to 26.5 rainy days. It reveals from two years data that the maximum rainfall and relative humidity are.

Three sprays of 1.0% Bordeaux mixture during the last week of May, July and August was found most effective in controlling the disease with mean PDI of 2.23%. This was followed two sprays of 0.1%npropiconazole (Tilt) @ 5 lit/vine during the last week of June and August with the PPI 2.39%. The other treatments namely two sprays of 1% Bordeaux mixture and two sprays of 0.2% Mancozeb during June and August was found as par as compare to check. (Table 24).

Table 24. Effect of different fungicides in the management of anthracnose disease in black pepper (2003 – 2005) (Mean PDI) - Mudigere

Treatment		Time of application	PDI (before treat.)			Mean PDI	PDI (after treat.)			Mean PDI
			2003	2004	2005		2003	2004	2005	
T1 =	1% Bordeaux mixture (2 sprays @ 5 l/vine)	May/June & Aug/Sept.	9.00	5.40	7.4	7.26	4.14	2.20	2.9	3.08
T2 =	1% Bordeaux mixture (3 sprays @ 5 l/vine)	May, July & Aug	7.00	6.40	7.2	6.86	2.74	1.40	2.55	2.23
T3 =	0.2% Mancozeb (2 sprays @ 5 lit/vine)	June & Aug.	6.20	10.40	6.6	7.73	3.80	3.00	2.86	3.22
T4 =	0.1% Propiconazole 25EC (2 sprays @ 5 lit./vine)	June & Aug.	5.75	09.80	5.4	6.98	2.80	1.75	2.63	2.39
T5 =	Control		7.60	13.60	5.8	9.00	6.47	9.40	6.05	7.31
	CD (P=0.05)						0.56	1.74	0.797	
	CV (%)						9.08	31.85	14.48	

The Pampadumpara centre made surveys on the incidence of fungal anthracnose in black pepper gardens of Idukki District. The survey was initiated during 2001 and continued up to 2004. Survey was conducted in different Panchayats of entire Idukki district to assess the occurrence of the anthracnose disease of black pepper. Three gardens were surveyed in each Panchayath @ 25 vines/garden. All the weather parameters including elevation were also recorded simultaneously during the survey period. The disease incidence of the leaves and spikes was observed and the per cent age of disease was calculated The percentage incidences of anthracnose on black pepper at various Panchayats of Idukki are presented in Table-25. The data revealed that the occurrence of foliar anthracnose disease progressively increased with the increase in elevation. Three years data showed maximum incidence in Vandanmedu and Chakupallam Panchayaths of Idukki where the elevation exceeds 1000m above MSL. Minimum disease incidence was noticed in Vellathoval and Konnathadi Panchayaths. The disease incidence ranged from 0.7 to 50.4 %.

Table 25. Incidence of anthracnose disease of black pepper at high ranges of Idukki District-Pampadumpara

Panchayats	Elevation (m above MSL)	2001-2002		2002-2003		2003-2004
		Leaf (%)	Spike (%)	Leaf (%)	Spike (%)	Leaf (%)
Kamakshi	850	15.8	-	-	-	0.7
Vathikudi	850	18.4	-	-	-	2.6
Konnathadi	860	13.8	-	-	-	1.1
Mannakandam	850	7.9	-	-	-	4.6
Vellathoval	800	2.1	-	-	-	-
Bison valley	920	18.8	-	-	-	-
Pallivasal	950	15.3	-	-	-	-
Vandiperiyar	920	14.7	-	-	-	-
Karunapuram	1100	29.2	16.8	29.2	12.3	7.3
Vandanmedu	1246	36.4	16.6	36.6	42.5	13.6
Kumily	925	21.8	12.8	11.6	18.9	-
Chakupallam	1000	50.4	10.1	17.8	41.2	12.3

Panchayats	Elevation (m above MSL)	2001-2002		2002-2003		2003-2004
		Leaf (%)	Spike (%)	Leaf (%)	Spike (%)	Leaf (%)
Pampadumpara	1100	-	-	20.1	26.2	2.2
Kattapana	940	-	-	-	-	4.5
Nedumkandam	980	-	-	-	-	0.7
Udubanchola	1100	-	-	-	-	0.9
Senapathy	1100	-	-	-	-	1.2
Erattayar	900	-	-	-	-	1.2

Another field experiment on the management of anthracnose was also laid out at Pampadumpara. The experiment was conducted during 2003 and 2004 with seven treatments to asses the efficacy of certain fungicides. Data pertaining to the percent disease reduction and yield are presented in Table 26. Values in parenthesis are *arc sine* transformed. These fungicides are sprayed at spike formation stage (July- October).

The anthracnose disease incidence was minimum in vines sprayed with the combination fungicide containing both carbendazim and mancozeb @ 0.1% followed by the spraying of carbendazim (0.1%) alone. Percentage reduction of foliar anthracnose ranged from 22.54 to 86.79%. Highest reduction of the disease (86.79%) was recorded in vines treated with fungicide containing both carbendazim and mancozeb (0.1%) which was on par with carbendazim @ 0.1 % and Bordeaux mixture (1%) treated vines. Yield was also found to be highest in vines treated with the combination fungicide *ie., c*arbendazim and mancozeb 0.1%. It was concluded that the anthracnose disease incidence was maximum at higher elevations. Application of a combination fungicide containing both carbendazim and mancozeb @ 0.1% was found effective in the management of anthracnose disease of black pepper in the high ranges of Idukki district. (Table 26).

Surveys were conducted at Dapoli during 2001-02 to 2005-06 record the incidence of various foliar diseases in black pepper viz. *Phytophthora* leaf blight and anthracnose and incidence of foot rot and slow decline in Konkan region. During the reported period visited 19 black pepper gardens recorded the incidence of different diseases in the Konkan regions. Slow declain, foot rot and *Phytophthora* leaf blight were found to be the major

Table 26. Effect of various fungicides in the management of anthracnose disease of black pepper - Pampadumpara

Treatment		2003-2004		2004 -2005	
		Spike infection (%)	Yield (g/plant)	Disease reduction on leaves (%)	Disease reduction on spikes (%)
T1 -	Bordeaux mixture1% twice foliar spray	23.50 (4.95)	330.3	46.15 (42.35)	58.85 (50.29)
T2 -	Bordeaux mixture1% thrice foliar spray	11.17 (3.44)	412.7	60.30 (50.99)	33.33 (30.0)
T3 -	Mancozeb@0.2% twice foliar spray	7.17 (2.84)	379.7	39.68 (34.19)	62.65 (52.7)
T4 -	Propiconazole @0.1 foliar spray	11.83 (3.43)	446.0	42.72 (40.03)	43.16 (36.23)
T5 -	Carbendazim +0.1% foliar spray	6.17 (2.44)	616.3	86.55 (68.51)	87.28 (69.16)
T6 -	Combination of Carbendazim and Mancozeb 0.1% foliar spray	3.83 (1.93)	742.7	86.79 (71.22)	91.67 (80.0)
T7 -	Control	19.17 (4.45)	346.7	22.54 (23.42)	7.23 (12.49)
	CD (P= 0.05)	1.303	126.7	28.55	24.29

diseases throughout the region. Maximum incidence (10.70%) of slow decline was observed at Dodamarg, Sindhudurg whereas minimum (0.88%) at Chaul, Raigad, maximum incidence of (9.16%) of *Phytophthora* leaf blight was noticed at Borli, Raigad and minimum (2.13%) at Lanja, Ratnagiri. Foot rot also observed throughout the region but percent intensity was low.

1.6 Pest Management Trail

1.6.2 Management of scale insects in black pepper with organic products

(*Mudigere* and *Pampadumpara*)

The efficacy of evaluating organic insecticides started in 2004 at Mudigere. The observations recorded as pre treatment and post treatment on population of scale insects. It was found 7.65 and 12.35 mean population on leaf and twig and 84.00 and 95.00 mean population on leaf and twig as pre treatment respectively. The mean population of pre and post treatment was gradually reduced to 2.4 and 8.97 on leaf and 4.77 and 21.4 on twigs respectively. Among the treatments neem oil (2.4 and 4.77) and fish oil (3.07 and 4.98). Monocrotophos (5.7 and 9.8) and eco-neem (8.97 and 21.4) found to be effective and significantly low populations compare to control. However eco-neem (8.97 and 21.4) found slightly higher population compare to other treatments. The treatments neem oil and fish oil rosin (3.07 and 4.98) found to be effective and superior and on par with each other. As a consequence of mussel scale control with organic products viz., neem oil and fish oil rosin, four sprays at interval of 15 days from on set of pest infestations was found effective compared to monocrotophos 2 sprays at 21 days interval.

The evaluation of botanicals and insecticides for the management of scales conducted in farmers field at Pampadumpara during 2005-2006. Observation on scale population was recorded after second and fourth spray in plants treated with biorationals and after the first and the second spray in insecticide treated vines (Table 27).

The population of scale insects on black pepper was found to be 11.98 per cm^2 on leaves and 33.93 per 2.5 cm twigs, respectively as a pre-treatment count. All treatments were found to significantly reduce the scale population on both leaves as well as twigs. In leaf, the scale population was reduced from 10.3 to 2.3 on monocrotophos-treated plants after the first spray. Scale population on vines treated with fish oil and neem oil were found at par. Similarly the scale population on vines treated with neem gold and Thiamethoxam were found non-significant. After the second/fourth spray scale population was reduced to 1.3 on monocrotophos-treated vines followed by vines treated with Thiamethoxam (1.8). Among the biorationals evaluated, neem gold was found to be superior than neem oil and fish oil in reducing scale population.

Table 27. Effect of organic products on scale insects of black pepper- Pampadumpara

Treatment	Scale population					
	Leaf			Twig		
	Initial count per cm^2	I* /II# spray	II* / IV# spray	Initial count per 2.5 cm	I* /II# spray	II* / IV# spray
Neem oil (0.5%)#	12.5 (3.53)	8.5 (2.92)	4.8 (2.18)	34.3 (5.85)	23.8 (4.88)	14.5 (3.81)
Neem gold (0.5%)#	12.8 (3.56)	4.0 (1.99)	2.5 (1.57)	34.5 (5.87)	16.5 (4.06)	9.8 (3.12)
Fosco (3%)#	11.5 (3.39)	8.25 (2.87)	4.5 (2.12)	33.5 (5.79)	23.0 (4.79)	15.3 (3.90)
Thiamethoxam (0.013%)*	11.3 (3.35)	4.0 (1.99)	1.8 (1.31)	33.5 (5.79)	14.8 (3.84)	8.0 (2.83)
Monocrotophos (0.05%)*	11.0 (3.32)	2.3 (1.47)	1.3 (1.10)	33.8 (5.81)	9.5 (3.10)	1.5 (1.21)
Control	11.0 (3.32)	10.3 (3.20)	9.3 (3.04)	34.0 (5.83)	33.5 (5.79)	29.5 (5.43)
CD (P=0.05)	NS	0.320	0.280	NS	0.159	0.199

Values in parentheses are *square root* transformed

A similar trend was observed in scale population on twig that was reduced from 33.5 to 9.5 in moncrotophos-treated vines after the first spray. Scale population in neem oil (23.8) and fish oil-treated vines (23.0) were found to be non-significant and inferior compared to that of vines treated with Thiamethoxam (14.8) and Neem Gold (16.5). After second / fourth spray vines treated with monocrotophos resulted in least population of scale insects (1.5) followed by Thiamethoxam-treated vines (8.0). Among the biorationals evaluated, neem gold was found to be effective in the suppression of scale population and the least scale population was recorded in vines treated with monocrotophos.

2. CARDAMOM

2.1. Genetic Resources

2.1.1 Germplasm collection, characterization, evaluation and conservation

(*Mudigere* and *Pampadumpara*)

The Mudigere centre maintains 132 cardamom germplasm collections. Out of 132 germplasm evaluated, maximum number of suckers per plant was observed in Darmala (35.33) than Mudigere-2 (35.00). Among the entries evaluated, K-1 was the tallest (300.77 cm), followed by Erveet (292 cm), H 5-1 (289.92 cm) compared to 278.55 cm in Mudigere-2.

The existing 141 accessions in the germplasm block has been relaid out in a new area at Pampadumpara (August, 2005). During the year 5 more accessions collected from the cardamom plantations of Idukki District and added to the genebank. In the evaluation, the highest capsule yield of 2645g/plant (fresh) and dry yield of 525 g/plant was recorded in CRSP-4 followed by CRSP-24 with 2578g/plant and 510g/plant of fresh and dry yield respectively. Thrips infestation was less in the accessions, CRPS-4 (2.3%) and CRSP-72 (5.6%). Damage by capsule borer was very less in CRP-6 (0.8%), followed by CRSP-41 (1.5%). The cardamom germplasm at different AICRP centres are given in Table 28.

Table 28. Germplasm collection of Cardamom at the AICRP centres

Centre	Indigenous		Total
	Cultivated	Wild and related sp.	
Pampadumpara	141	-	141
Mudigere	132	-	132
Total	273	-	273

2.2 Hybridization and Selection

2.2.1 Evaluation of OP progenies under intensive management

(*Mudigere*)

Eight promising cardamom clones which were identified as better general combiners were planted during 1995-96 at Mudigere with a closer spacing (6' x 3') and allowed for open pollination for collection of seeds. From the crosses made, 30 cardamom genotype (OP seedlings) were identified and planted in the main field during 2000. Among the OP progenies evaluated 5 C8 was the tallest (298.73 cm) followed by 4 C8 (288.86 cm) and 16 C8 (283.12 cm). However, 4 C8 recorded higher number of bearing suckers (16.6) and panicle (32.2) per plant. OP progeny 4 C8 recorded maximum panicle length (58.12 cm) and higher number of capsules. (73.26) OP progeny 4 C8 recorded more dry capsule yield (366.96 kg/ha) followed by 1C8 (341.23 kg/ha), 5 C8 (277.68 kg/ha) 7 C8 (274.98 kg/ha) 6 C8 (274.97 kg/ha) and 4 C8 (259.90 kg/ha) compared to the check M1 (244.76 kg/ha) M-2 (123.02 kg/ha)

2.2.2 CVT 2000-Series IV

(*Pampadumpara, Mudigere* and *Sakleshpur*)

At Pampadumpara among the 12 accessions evaluated, significant variation existed among all accessions for the ten characters studied. Highest yield in terms of fresh (2472.9 g/plant) and dry (461.6 g/plant) was recorded in S1 which was found to be significantly superior than other accessions including check. Dry yield of PS-44 (339.4 g/plant) was found to be higher than the Green Gold even though the fresh yield was low indicating higher recovery percentage (22.7%). PS-44 registered highest plant height (280 cm) followed by the check green gold (279 cm), highest number of panicle per clump was recorded in green gold (60). Highest panicle length was recorded in PS-44 (93.7 cm) which was found to be longer than green gold. All the accessions recorded lesser damage by thrips than the check. Capsule borer damage also was lesser than the check in other accessions. Higher capsule rot infection observed in SKP-165 and SKP-170. Similarly hybrids MHC-13 and MHC-347 were found to be susceptible to capsule rot infection whereas PS-44 was found to be tolerant.

Among the clones evaluated at Mudigere, the dry capsule yield data indicated that clones SKP-

165 (357.8 kg/ha), CL-692, (354.5 kg/ha), MIK-18 (354.2kg/ha) and MHC-10 (300.3 kg/ha) were found superior compared to Mudigere-2 (273.3 kg/ ha).

The trial started in 2002 at ICRI Sakleshpur with 14 treatments is in the 3rd year of progress. Morphological observations have been recorded and analyzed in 2005. Plant height was significantly more in PS-44 (235 cm). SKP 170, ICRI-3 and CL-692 had significantly maximum number of tillers with 37, 34, and 33 respectively. Bearing tillers and panicle did not show any significant difference between the treatments. Racemes were significantly more in PS-44. Yield was significantly more in SKP 170 (1113 kg/ha) followed by PS-44 (1013 kg/ha), maximum percentage of bold capsules are found in PS-44 (51%), followed by SKP1700 (50%).

2.2.3 CVT-2005-Series V

(*Mudigere* and *Pampadumpara*)

The new CVT (CVT-2005) with the entries *viz.*, MCC-73, MCC-246, MCC-309, MHC-26 (ICRI- Myladumpara), P5-27 (CRS Pampadumpara), CL-722 (RARS- Mudigere), Mudigere-1 and Mudigere-2 Green gold (checks) were initiated in 2005 at Mudigere and Pampadumpara centres.

2.3 Varietal Evaluation Trial (VET)

2.3.1. Initial evaluation trial (IET-I)

(*Mudigere*)

The IET started in 1999 at Mudigere. Among the 15 clones tested, OP progeny 7-1-D11 (279.66 cm) was the tallest, followed by 23-8-D11 (275.19 cm). The clone, 26-16 D11 recorded more number of suckers (38.8), bearing suckers (9.6) and panicles (17.2) per plant compared to checks, Mudigere-1 and Mudigere-2. OP progeny 8-4-D11 was numerically superior in dry capsule yield (271.83 kg/ha), compared to check Mudigere-1 and Mudigere-2.

2.2.4 Initial evaluation trial (IET-II)

(*Mudigere*)

The better performing progenies of the OP seedlings of promising clones multiplied and clones planted in 1999 at Mudigere. Among the clones, CL-726 (347.19 kg/ha), CL 722 (295.67 kg/ha), CL-692 (288.96 kg/ha) and CL-691 (270.28 kg/ha) were numerically superior for dry capsule yield compared to Mudigere-1 (238.16 kg/ha) and Mudigere-2 (219.09 kg/ha).

2.3 Nutrient Management Trial

2.3.1 Integrated nutrient management (INM) in cardamom

(*Mudigere*)

The experiment was replanted during July 2000 at Mudigere. The results revealed that the application of inorganic fertilizers alone performed significantly superior over other treatment giving an yield of 204.04 kg dry yield/ha, followed by application of 25% FYM +75 inorganic fertilizers (Table-29). The observations on yield attributing characters also had similar tendency as that of the yield.

Table 29. Effect of INM on growth and yield of cardamom- Mudigere

Treatment	Bearing suckers	Capsule / Panicle	Panicle length(cm)	Flow. Panicles	Yield (Fresh) (g/plant)	Yield (Dry) (g/plant)	Yield (Dry) (kg/ha)
100 % Organic (OM)	18.35	17.08	35.95	26.55	192.03	37.80	116.64
75% OM + 25% (IOF)	19.75	17.78	37.10	28.70	202.70	40.48	124.91
50% OM + 50% (IOF)	21.15	18.62	39.97	31.05	225.26	45.63	140.80
25% OM + 75% (IOF)	22.60	19.41	43.13	31.80	273.97	52.55	162.15
100% Inorganic (IOF)	23.80	20.21	53.84	33.85	285.38	66.15	204.04
Control	17.50	12.96	28.72	23.05	108.69	21.98	67.71
S.Em ±	0.31	0.70	1.26	0.98	12.57	0.81	2.53
CD (P=0.05)	0.93	2.11	3.80	2.95	37.88	2.47	7.62
C.V.(%)	3.07	2.29	6.31	6.74	11.71	3.64	3.70

OM - 12 t/ha IOF - 75 N: 75 P_2O_5; 150 K_2O kg /ha

2.3.2 Effect of biofertilizer, *Azospirillum* on cardamom

(*Mudigere, Pampadumpara* and *Myladumpara*)

The experiment was laid out in July 2000 at Mudigere. The results revealed that the application of 100% inorganic N alone or with *Azospirillum* (50 g) performed significantly superior over other treatments (Table 30) giving an yield of 213.2kg dry capsules/ha. This was closely followed by application of inorganic N 75 % of recommended doze with *Azospirillum*. Application of FYM alone with or without bioorganism yielded very less. The supporting yield parameters also had similar tendency as that of yield obtained. The effect of various treatments on the soil nitrogen content were estimated at intervals also showed non significant results. The nitrogen content in plant parts under various treatments showed significant difference in N-content in bearing pseudostem and husk, where as mere significant in bearing leaves, panicle and seed.

The experiment started during 2001 with 8 treatment combinations at Pampadumpara. During the period highest capsule yield (dry wt) was recorded with the application of inorganic nitrogen 100% + *Azospirillum* 50 g+ 5 kg FYM (447.5 kg/ ha) and was found to be significantly superior than other treatments. Application of *Azospirillum* along with higher levels of FYM (10 kg) was found to be superior than *Azospirillum* with lower levels of FYM (5 kg) suggesting the role of FYM in increasing the yield of cardamom in combination with biofertilizer, Azospirillum.

2.3.2 Effect of biofertilizer, P-solubilizers on cardamom

(*Mudigere, Pampadumpara* and *Myladumpara*)

The experiment was laid out during second fortnight of July 2000 at Mudigere. The results revealed that the application of recommended 100% inorganic P alone or with P-solubilizer was significantly superior in terms of growth and yield

Table 30. Effect of *Azospirillum* in INM on growth and yield of cardamom-Mudigere

Treatment	Bearing suckers	Capsule / Panicle	Panicle length(cm)	Flow. Panicles	Fresh weight (g/plant)	Dry weight (g/plant)	Dry weight (kg/ha)
T1	24.80	22.44	61.67	37.40	349.87	69.13	213.24
T2	22.60	20.30	59.31	35.13	290.80	57.20	176.52
T3	20.53	19.29	58.82	31.60	264.02	52.30	161.38
T4	17.67	14.50	56.49	30.00	271.00	45.40	140.10
T5	18.47	14.90	51.62	30.73	213.60	42.30	130.52
T6	18.60	15.12	56.13	29.40	201.60	39.30	121.27
T7	20.53	15.83	55.22	32.53	188.50	37.20	114.88
T8	24.80	22.57	65.11	39.40	325.70	64.37	198.62
T9	21.27	18.97	59.33	32.00	264.04	51.67	159.44
S.Em. + / -	0.71	0.48	1.52	1.44	13.28	0.91	2.79
C.D.(P=0.05)	2.13	1.44	4.26	4.32	39.81	2.73	8.42
C.V.(%)	5.86	4.62	4.52	7.55	8.75	3.07	3.07

P and K were given as per recommended package (75:150 kg/ha/yr in two splits)

T-1 Inorganic N (100%) + *Azospirillum* (50g) + 5kg FYM

T-2 Inorganic N (75%) + *Azospirillum* sp (50g) + 5 kg FYM

T-3 Inorganic N (50%) + *Azospirillum* sp.(50g) + 5kg FYM

T-4 FYM (5 kg) + *Azospirillum* sp.

T-5 FYM (5 kg)

T-6 FYM (10 kg) + *Azospirillum* sp. (50g)

T-7 FYM (10 kg)

T-8 Inorganic N (100%)T-9 Inorganic N (75%)

over other treatments. This was closely followed by application of 75% of recommended inorganic P along with P-solubilizers. The supporting yield parameters also had similar tendency as that of yield obtained. The analysis of P in soil under different treatments were non significant at 0-15cm depths samples where as in soil 15-30 cm depths the P content was significant. Similarly the P content was non significant in plant parts except in bearing leaves.

The experiment started during 2003 at Pampadumpara with 8 treatment combinations. The observations on biometrical parameters were studied. Highest plant height (232.75 cm) was recorded with application of inorganic P 100% + Phosphobacteria 50 g + 5 kg FYM and the lowest in control plot (183.75 cm). Reduction of inorganic P progressively reduced the number of tillers as well as plant height and was significantly lower than replaced with 50%P.

2.3.3 Effect of neemcake on the productivity, pest and disease incidence in cardamom

(*Mudigere* and *Pampadumpara*)

The experiment was started during August 2003 with five treatments at Mudigere consisting of 2 doses in 2 applications. The plants started bearing during 2005. Application of 1 kg neem cake per plant (applied during May) recorded significantly higher dry cardamom yield (246.48 kg/ ha dry yield). It was followed by application of neem cake @ 0.5 kg/ plant during May (233.74kg/ ha, dry), followed by the dose one kg applied equally at May and September (225.56 kg/ha, dry).

The experiment on the influence of neem cake on biometrical characters of cardamom and reaction to insect-pest started during 2003 at Pampadumpara. Application of neem cake two times irrespective of the doses could significantly increase the number of tillers and plant height. Maximum number of tillers (39.3) and tallest tillers (216.8 cm) were observed in plants treated with recommended schedule of fertilizers. Application of neem cake has significantly reduced the damage caused by shoot and capsule borer on cardamom tillers. Occurrence of root grubs was found at par for all the treatments ranging from 2.0 to 2.5 in 30 cm^3 soil.

2.4 Pest Management Trial

2.4.1 Bioecology of natural enemies of major pests of cardamom

(*Mudigere* and *Pampadumpara*)

The experiment started in 2004 at Mudigere and observation recorded at fortnightly intervals on natural enemies of the major pests of cardamom with special reference to cardamom thrips and capsule borer. The study indicated that general predators like spiders in cardamom ecosystem, larvae of *Chrysoperla* sp and certain mites were found to be the predators of thrips more often. Weather factor (rainfall) playing a vital role in minimizing thrips population. The observation on larvae of *Conogethes punctiferalis* found being parasitized by *Xanthopimpla* sp, *Ropalidia* sp and unidentified sp. of *Ichnuemonid*. No microbes were found infecting these pests.

The study is in progress during the V^{th} year at Pampadumpara. Shoot and capsule borer, *Conogethes punctiferalis* was parasitized by at least two different types of *Ichnuemonids viz., Agrypon* sp and *Temeluchur* sp. An unidentified weevil and grub in close association with cardamom thrips, *Sciothrips cardamomi* within the leaf sheath. This was prevalent in areas applied with limited plant protection chemicals. Leaf sheath mite, *Dolichotetranychus elattariae* was observed in certain plants. An unidentified predatory mite of leaf red spider mite, *Tetranychus* sp. was also recorded. The percentage of parasitisation of shoot and capsule borer on different months of 2005-06 were recorded. Parasitization of cardamom shoot borer larvae by *Ichnuemonids* ranged from 53.8% to 100% and occurred during all months under investigation. Highest parasitization was recorded during February (100%). Cardamom root grub, *Basilpeta fulvicorne* was found to be naturally infected by *Metarhizium* sp. to a maximum of 14.4% under field conditions. The local species of *Heterorhabditis indicus* (CRS isolate) survived better and infected cardamom root grub, *Basilepta fulvicorne* under field condition when soil moisture regime is adequate (20%) without saturation.

2.4.2 Estimation of quantitative and qualitative losses due to thrips damage in cardamom

(*Mudigere* and *Pampadumpara*)

The trail initiated during 2004 at Mudigere. The thrips damage was assessed based on the per

cent scabbed surface areas of the capsules . Capsules harvested and dried were graded into four groups as 0= no damage 1= up to 10% scabbed area, 2= 11% to 33% scabbed area and 3= >33 % scabbed area. Observations recorded showed significant reductions in the number of seeds with the increase in scabbed area by thrips. Reduction in capsule weight, husk weight number of healthy seeds. The previous years analysis showed that the quality parameters are not effected by thrips damage.

The qualitative and quantitative parameters such as acid phosphate, trypsin like protease activity, protein and volatile oil contents were evaluated in the healthy and itch capsules at Pampadumpara. Variation observed in qualitative parameters of healthy and thrips infected capsules is summarized in Table-

The weight of 100 fresh as well as dried capsules decreased significantly as the severity of thrips damage increased. It was found that 160.1 healthy capsules were accommodated in 100 cc which further increased to 222.5 capsules for thrips-infested capsules (category 3). Husk weight of five capsules indicated a progressive decline with increase in thrips infestation. Though the volatile oil content did not differ significantly, 1,8-cineole was found higher in thrips infested capsules (31.2%) than healthy capsules (26.1%). Peptidase activity of healthy cardamom capsules declined progressively as the maturity advanced. Highest trypsin-like activity in healthy capsules was observed in fresh white seed (46.04 nmoles *p*NA / min/g) and lowest in dried black seed stage (10.18 nmoles *p*NA / min/g).

2.4.1 Shoot fly infestation in cardamom observational trial

(*Mudigere*)

The study initiated in 2004 at Mudigere. The observations on the population of shoot fly at fortnightly intervals repeatedly recorded through out the year during the year 2005 also. The population ranged from 1.10 to 8.37. The maximum population was recorded in the month of February, March and May and population declined from June to August. There was a slight increase in population from first fortnight of September onwards. The graphical observation showed two peaks in the population of shoot fly in February to March with a slight decrease in March after the blossom showers and the second in May. Significantly better peak indicated larger breeding populations.

3. GINGER

3.1 Genetic Resources

3.1.1 Germplasm collection, characterization, evaluation and conservation

(*Dholi, Chintapalli , Raigarh, Solan, Kumaraganj, Pottangi* and *Pundibari*)

At Dholi, out of the 43 germplasm evaluated, RG-.5, produced maximum yield of 17.0 kg, followed by RG-25 with 16.50 kg fresh rhizome per 7.2 m^2.

Germplasm collections were made from high attitudes and tribal zones of Chintapalli. Among the 6 collections evaluated, Vemugedda and Bailukin changi recorded the highest yield of 10 t /ha.

Forty germplasm accessions of ginger were evaluated at Raigarh. Highest yield was obtained in genotype 1G-5-14 (12.66 t/ha), followed by 1G-5-2 (12.36 t/ha) 1G-5-25 (11.46 t/ha), 1G-5-1 (11.26 t/ha) and 1G-5-28(11.26 t/ha). The centre maintains a total of 44 cultivated germplasm, which includes 3 new additions made in 2005-06.

The Pottangi centre maintains 174 germplasm collections. Out of the total 174 ginger accession conserved at Pottangi centre 145 accessions were evaluated of which only 26 accession yielded more than 9 kg/3m^2, the range of yield being 2.40 kg to 12.3 kg/3m^2. The highest fresh rhizome yield was recorded by PCS-12 (12.3 kg/ 3m^2) followed by V_1S_1-4 (12.0 kg/3m^2), V_1E_S-4 (11.8 kg/3m^2) .

Table 31. Quantitative parameters of healthy and itch cardamom capsules-Pampadumpara

Treatments	100 capsule Fresh wt (g)	No. of seeds / capsule	Dried 100 capsule wt.(g)	No. of capsules in 100 cc	Driage (%)	5 capsule husk wt.(g)
Category 0 (Healthy)	124.5	20.5	24.4	160.1	21.7	0.4768
Category 1 (10% itch)	101.9	19.7	22.1	184.3	21.4	0.4126
Category 2 (11-33% itch)	92.7	19.2	18.4	198.3	21.5	0.3846
Category 3 (>33% itch)	72.9	18.4	15.3	225.5	20.6	0.3138
CD (P=0.05)	14.49	NS	3.89	11.94	NS	0.020

Two hundred and eighty six collections were evaluated under field conditions for different horticultural characters at Solan centre. The yield of germplasm varied from 1.90 to 9.5 kg in 3 x 1 m plot and SG-866 gave maximum yield, less disease incidence (1.5%) and minimum crude fibre (3.50%). SG-1130 gave essential oil and oleoresin to the tune of 2.50% and 6.54%, respectively. In the screening of ginger, 5 lines *viz.*, SG 873, SG-994, SG-985, SG-902 and SG-970 were identified as moderately resistant to rhizome rot.

At Pundibari a total of 40 accessions were maintained including the two new accessions collected during 2005-06. Twenty nine entries were evaluated in 2005-06 for identification of promising entry(s) for this agro-climatic zone. The Terai agro climatic zone being a hot spot of rhizome rot of ginger requires tolerant varieties for its successful cultivation. Germplasm evaluation reveals that genotype GCP-31, GCP-32, GCP-08, GCP-20 and GCP-21 were appreciable for their rhizome yield. Out of these GCP-20 andGCP-21 were also having lower disease infection for rhizome rot and may be termed as promising. Coordinated Varietal Trial of ginger indicated the *Gorubathan*, SG-692 and V_1S_1-8 to be the better culture considering its rhizome yield and percentage disease infection simultaneously (projected yield of 14.86 tons/ha, 14.05 tons/ha and 13.16 tons/ha, respectively.)

Fifty lines were valuated in augmented design during 2005-06 at Kumarganj. Fresh rhizome yield range (1.52 to 14.15 t/ha). Highest yield was recorded in NDG-28 (14.15 t/ha) followed by NDG-27 (12.50 t/ha) and NDG-9 (12.35 t/ha) none of the lines showed resistance against rhizome rot disease. The ginger germplasm at different AICRP centres are given in Table 33.

3.2 Coordinated Varietal Trial (CVT)

3.2.1 CVT 2000 Series V

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

The trial was initiated in Raigarh during 2001-02 and is in the fifth year of progress. Seven entries were evaluated. Some were badly affected by rhizome rot. The yield levels were low and highest yield obtained with IG-1 (14.54 t/ha), followed by IG 3 (11.89 t/ha) and IG-2 (10.52 t/ha). The five years pooled data revealed that 1G-1 was the best entry with mean yield of 8.83 kg/ 3 m^2 bed, followed by 1G-2 and 1G-3 each gives an yield of 7.36 kg/plot (Table 34).

Table 32. Performance of 10 top yielding lines in ginger at Solan

Name	Yield/ plot (kg)	Convert incidence (%)	Disease incidence (%)	Dry matter (%)	E oil (%)	Oleoresins (%)	Crude fibre (%)
SG866	9.5	9.5	1.5	27.70	1.00	4.69	3.50
SG 08/04	9.0	9.0	2.0	19.40	1.00	4.12	-
SG 873	8.7	8.7	3.0	26.90	1.00	4.34	5.00
SG 10/30	8.7	8.7	3.0	24.40	1.50	5.69	4.50
SG 32/04	8.4	8.4	3.0	24.00	1.05	.06	4.00
SG 983	8.0	8.0	2.5	23.40	2.00	4.89	4.50
BLPT 15	7.8	7.8	5.0	28.50	1.00	4.50	5.03
SG 23/01	7.75	7.75	5.0	27.60	1.00	4.00	4.7
SG 1/04	7.60	7.60	5.0	19.10	1.50	5.58	4.00
	7.40	7.40	5.0	21.50	2.50	6.54	4.50

Table 33. Germplasm collection of ginger at the AICRP centres

Center	Indigenous		Exotic	Total
	Cultivated	Wild and related sp.		
Ginger				
Pottangi	167	2	3	172
Solan	286	-	2	288
Dholi	43	-	-	43
Kumarganj	45	-	-	45
Pundibari	38	-	-	38
Raigarh	44	-	-	44
Total	623	2	5	630

The CVT with 8 entries evaluated for four years (2002-2005) at Solan. The pooled mean yield per plot of four years indicated that yield per plot was maximum in local check Himgiri (7.01 kg/plot). In general local entries gave better preference than the entries from Pottangi and IISR, Calicut. (Table -35).

The CVT with 7 entries started in 2001-02 at Pundibari is in the 4th year of progress during 2001-02 significant difference between the entries was found for plant height, number of tillers, rhizome yield/plot, PDI and projected yield. Other traits showed non-significant differences among the genotypes. Considering the plant height, SG-692 (63.22 cm) was found to be the tallest culture followed by Gorubathan (60.12 cm). ACC-35 was found to be having lowest height (53.37). Similarly, highest number of tillers/plant was found in Gorubathan (7.69) whereas lowest tillers were there in ACC-35 (4.07). PDI was another important parameter which showed that ACC-117 (65.83%) had highest disease infestation followed by ACC-35 (57.50%). Lowest PDI was recorded in Gorubathan (14.96 t/ha) followed by SG-692 914.05 t/ha) and V_1S_1-8 (13.16 t/ha). The lowest was recorded in case of ACC-35(10.12 t/ha).

The trial started in 2005-06 at Pottangi with 6 accessions. Significant differences were observed in yield. Highest yield observed in Z 0-2 (23.69 t/ ha) with 25.9% increase over Suprabha and V_1S_1-2 (26.90 t/ha) with 43.0% increase over Suprabha.

3.2.1 CVT 2005

(Solan)

A new CYT initiated at Solan in 2005 with six entries. The result showed significant differences for yield per plot, Himgiri gave maximum yield (10.07 t/ha). The quality analysis showed that dry matter was maximum in SG-1079 (24.0%), essential oil and oleoresin in SG-999 (2.5 % and 5.29% respectively). Himgiri gave minimum crude fibre (3.5%).

3.3 Varietal Evaluation Trail

3.3.1 Comparative yield trial CYT-I and II

(Raigarh)

A total of six entries were evaluated in the CYT during 2005 at Raigarh. 1G-1 gave the highest yield (12.84 t/ ha) followed by 1G-3 (10.79 t/ha) and 1G-2 (9.65 t/ha). The pooled data of five years presented in the Table 36 revealed that 1G-1 was

Table 34. Performance of ginger entries under CVT- Raigarh

Entry	Yield (kg/3 m² bed)					Mean yield
	2001-02	2002-03	2003-04	2004-05	2005-06	(kg/plot)
IG - 1	15.93	7.00	6.00	8.00	7.23	8.83
IG - 2	14.56	6.00	5.00	6.00	5.23	7.36
IG - 3	11.90	5.00	7.00	7.00	5.92	7.36
IG - 4	12.63	6.00	4.00	8.00	4.20	6.97
IG - 5	9.53	7.00	5.00	8.00	3.03	6.51
ACC - 35	2.90	1.30	1.10	1.25	2.12	1.73
ACC - 117	7.90	4.20	3.20	2.40	-	4.43
V_1S_1 - 2	1.75	0.40	0.50	0.80	2.27	1.14
V_1C - 8	0.80	0.70	0.75	0.90	-	0.78

Table 35. Pooled performance of ginger for yield per plot (kg)- Solan

Name	2002	2003	2004	2005	Mean	Projected yield t/ha
V1S1 - 2	5.68	4.33	4.0	9.9	6.10	12.26
V1C1 - 8	6.00	3.90	5.33	10.7	6.40	13.02
ACC - 35	5.47	5.10	4.50	9.4	6.11	12.28
ACC - 117	5.93	4.70	5.17	9.0	6.20	12.46
SG 682	6.48	5.50	5.50	9.4	6.72	13.51
SG 692	6.67	5.40	5.33	8.7	6.52	13.10
SG 54	5.47	5.30	5.00	11.1	6.71	13.48
Himgiri	6.27	5.60	6.00	10.2	7.01	14.09
Mean	5.99	4.85	5.16	9.75	-	-
SE+	0.72	0.73	0.61	0.70	-	-
CD (P=0.05)	NS	NS	NS	1.49	-	-

the best entry with mean yield of 17.41 t/ha, followed by IG-2 (15.02 t/ha)

3.3.2 Initial evaluation trial (IET)

(Solan, Pottangi)

At Solan, 16 accessions including check were evaluated in IET in 2005. Significant differences were observed among collections for yield per plot and yield varies from 3.25 kg/3m^2 plot (SG-716) to 5.38 kg/3 m^2 plot (17/04).

The IET with 16 accessions was initiated in 2005-06 at Pottangi centre. There is significant difference among the treatments. Highest yielder are V_1 E_{5-4} (29.51 t/ha) with 47.55% increase over Suprabha and PGS 9 (29.28 t/ha) with 46.04% increase.

3.4 Quality Evaluation Trial

3.4.1 Evaluation of ginger germplasm for quality

(Solan)

Ninety genotypes were evaluated for various quality attributes viz. dry matter, oleoresin and essential oil content. The dry matter varied from 13.65 to 29.80%. The oleoresin and essential oil ranged form 3.40 to 6.86% and 1.0 to 2.50%, respectively.

3.5 Nutrient Management Trial

3.5.1 Effect of biofetilizer using *Azospirillum* on ginger

(Pundibari)

In the effect of bio-fertilizer using *Azospirillum on ginger* at Pundibari during 2005-06, maximum fresh rhizome yield of 25.22 t/ha and B: C ratio of 1.12 were recorded with the application of inorganic N 100% + *Azospirillum* 50g + FYM 5 kg per 3m^2 plot (T_1). It was closely followed by T_2 (22.21t/ha) with inorganic N 50% + *Azospirillum* 50g+ FYM 5 kg per 3m^2 plot. These were not statistically different. Minimum yield of 11.19 t/ha was recorded with application of FYM @ 5 kg/plot (T_6). Considering quality parameters, both treatments T_1 and T_2 recorded non-significant good performance. (Table 37)

Table 36. Yield performance of ginger entries under CYT-I & II-Raigarh

Genotype	Yield (t/ha)					Mean yield
	2001-02	2002-03	2003-04	2004-05	2005-06	(t/ha)
IG-1 (check)	32.01	14.07	12.06	16.08	12.84	17.41
IG-2	29.26	12.06	10.05	14.07	9.65	15.02
IG-3	23.91	10.05	14.07	14.67	10.79	14.70
IG-4	25.38	12.06	8.04	14.07	7.71	13.45
IG-5	19.15	14.07	10.05	16.08	6.53	13.18
SG-554	8.10	1.20	0.8	1.13	8.12	3.87
ACC-64	9.90	1.80	1.60	1.40	-	3.68

Table 37. Effect of bio-fertilizer using *Azospirillum* on yield of ginger var. Gorubathan at Pundibari (2005-2006)

Treatment		Fresh rhizome yield (g/plant)	Fresh rhizome yield (kg/3 sq.m. plot)	Projected fresh rhizome yield (t/ha)
T1 -	100% inorganic nitrogen + Azospirillum (50 gm) + 5 kg FYM	94.5	9.5	25.22
T2 -	75% inorganic nitrogen + Azospirillum (50 gm) + 5 kg FYM	88.2	8.3	22.21
T3 -	50 % inorganic nitrogen + Azospirillum (50 gm) + 5 kg FYM	58.5	6.7	17.94
T4 -	Azospirillum (50 gm) + 5 kg FYM	60.0	4.9	12.97
T5 -	Azospirillum (50 gm) + 10 kg FYM	78.3	5.7	15.18
T6 -	5 kg FYM	50.2	4.2	11.19
T7 -	10 kg FYM	64.5	5.4	14.18
T8 -	Recommended dose of fertilizer (80:80:120 NPK kg/ha)	63.9	7.4	19.62
	CD (P=0.05)	9.8	1.3	3.36

Table 38. Effect of organic inputs on ginger (2003-04 to 2005-06)- Dholi

Treatments \ Character		Height of the Plant(cm)				No. of Tillers per plant				Yield (t/ha)			
		2003-2004	2004-2005	2005-2006	Mean	2003-2004	2004-2005	2005-2006	Mean	2003-2004	2004-2005	2005-2006	Mean
T1 -	ABCDEF	46.60	64.33	69.47	60.13	12.80	24.07	28.13	21.66	12.72	23.67	23.89	20.09
T2 -	BCDEF	33.73	54.20	54.87	47.60	8.00	15.07	17.67	13.58	7.06	16.11	17.78	13.65
T3 -	ACDEF	33.80	55.00	55.90	48.23	9.13	17.60	19.53	15.42	11.11	18.22	17.22	15.51
T4 -	ABDEF	39.80	55.60	57.17	50.85	9.87	18.60	20.60	16.35	9.56	19.00	19.44	16.00
T5 -	ABCEF	40.33	58.07	57.63	52.01	10.60	19.53	22.00	17.37	10.39	19.89	20.56	16.44
T6 -	ABCDF	42.93	59.80	64.00	55.57	10.93	21.60	22.20	18.24	11.11	21.00	21.66	17.92
T7 -	ABCDE	44.40	61.13	65.00	56.84	11.80	22.93	23.93	19.55	11.89	21.00	23.00	18.63
T8 -	Recommended Dose of NPK	34.87	52.53	49.40	45.60	8.33	16.27	15.20	13.26	8.11	17.00	13.89	13.00
	CD (P=0.05)	5.37	6.45	10.03	5.94	1.05	2.57	3.18	2.21(T)	1.73	3.67	2.54	3.45(T)
	CV (%)	7.73	6.40	8.77	6.99	5.89	7.53	8.58	8.09	9.67	10.75	7.38	12.81

A - FYM
B - Pongamia oil cake
C - Neem oil cake
D - Sterameal
E - Rock phosphate
F - Wood ash.

3.5.2 Organic farming in ginger

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

The experiment conducted for three yeas 2003-04 to 2005-06 at Dholi with seven treatments. The pooled data presented in Table-38 showed that all the organic inputs gave the maximum height of the plant, number of tillers and yield in comparison to inorganics.

Among the organic and inorganic inputs, application of FYM @ 330q/ha and the +Pongamia oil cake @ 25q/ha+ neem oil cake 25q/ha + sterameal @ 25q/ha +rock phosphate @ 25q/ha + wood ash @ 25q/ha. (T1) gave the maximum plant height (61.13 cm), no. of tillers per plant (21.66) and fresh rhizome yield (20.09 t/ha) followed by (T7) FYM @ 330q/ha + Pongamia oil cake @ 25q/ha + neem oil cake @ 25q/ha+ sterameal @ 25 q/ha + rock phosphate @ 25q/ha. So far increase in yield is concerned T1 (7.09 t/ha 54.54%) followed by T7 (4.92 t/ha) and 37.85% was observed over control inorganic farming. The maximum profit was recorded with inorganic farming due to low cost of input in comparison to organic farming. The cost benefit ratio of inorganic farming (T8) was quite higher (1:1.16) as compared to other organic inputs.

3.5.2 Effect of micronutrients on ginger

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

The micronutrients such as zinc, boron and iron were tested in ginger with 27 treatment combinations. The trial started during 2004-05 at Dholi. Application of these micronutrients alone or in combinations enhanced the yield of ginger compared to control. Soil application of zinc sulphate @ 25 kg/ha, boron @10.0 kg/ha and foliar application of ferrous sulphate @1.0% at 60 and 90 days interval significantly increased the number of tillers per plant (28.46), yield per plot (18.83 kg) and yield (31.39 t/ha) in comparison to other treatment and control. Interaction was found non significant regarding plant height and number of leaves per tiller. However interaction was found significant regarding number of tiller and yield.

The effect of micronutrient such as zinc, boron & iron were tested on ginger yield at Pottangi during 2005-06. Application of these micronutrients alone or in combination were studied with 27 treatments. There were significant difference among the treatments. Highest fresh rhizome yield observed with soil dressing with 25 kg zinc sulphate + 25 kg Iron sulphate and 25 kg borax giving a yield of 18.55 t/ha.

The trial initiated in 2005 at Raigarh using three micronutrients at 3 levels of treatment each. *viz.* zinc sulphate, 0 kg/ha, 25 kg/ha and 0.5% foliar spray (60 and 90 DAP). Ferous sulphate 0kg/ha, 10

kg/ha, 1.0 % foliar sprays (60 and 90 DAP). The effect of different micronutrients with yield of ginger s presented in Table 39. The interaction effect between Zn, Bo and Fe was not found significant, but the yield was appreciably higher at higher levels of Zn, Bo, and Fe. The maximum rhizome yield of 25.48 t/ha was recorded with foliar spray of 0.05% zinc sulphate, 0.2% of borax and 1.0 % ferrous sulphate.

Table 39. Effect of micronutrients on ginger-Raigarh

Treatments	Yield t/ha
Zinc Sulphate levels (kg/ha)	
Z0	18.21
Z1	19.84
Z2	21.65
SEm ±	0.277
CD (P=0.05)	0.783
Borax level (kg/ha)	
B0	17.81
B1	20.40
B2	21.49
SEm±CD (P=0.05)	0.2770.783
Ferrous Sulphate levels (kg/ha)	
F0	19.43
F1	19.85
F2	20.40
CD (P=0.05)	NS

At Pundibari in effect of micronutrients on ginger trial, soil and foliar application of zinc, boron and iron recorded significant increase in yield and quality parameters of ginger, separately over its no application (control). There was also a significant interaction effect for zinc and boron and also for zinc and iron towards increase in yield. Soil application of each micronutrient gave better results for yield and quality over its foliar spray. The treatment combination was soil application of 10 kg borax, 25 kg zinc sulphate and 10 kg ferrous sulphate per hectare (B_{10} Zn_{25} Fe_{10}) that recorded 23.3 t/ha fresh rhizome, 1.32% essential oil and 6.52% oleresin.

At Kumarganj the experimental plots of ginger were severely affected by rhizome rot disease. Highest yield of 1.46 t/ha was recorded in T-27 (foliar application of Zn (0.5%), Boron (0.2 %) and Iron (1.0 %) after 60 and 90 days of planting) and in T-19 (foliar spray of boron).

The micronutrients such as Zinc, boron and iron were tested on ginger yield. The trial consisting of 5 treatment combinations and the result of the first year at Solan showed significant differences among the treatment for yield per plot. The yield was maximum (5.30 kg/plot) with application of ferrous sulphate (10 kg/ha), followed by zinc sulphate (25 kg/ha) while other characters showed no significant difference.

3.6 Disease Management Trial

3.6.1 Disease surveillance and etiology of rhizome rot in ginger

(*Pundibari* and *Solan*)

The disease surveillance with regard to rhizome rot of ginger undertaken in districts Sirmour, Solan, Mandi, Bilapur and Shimla by the Solan centre. The incidence of rhizome rot of ginger was maximum in Sirmaur district (16.5%) followed by Solan (10%) and Simla.

The ginger disease survey indicated that Kalimpong 1 block of Kalimpong sub-division of Darjeeling District is one of the hot spots for rhizome rot complex disease of ginger. In the survey it was also found that leaf spot of ginger is also prevalent in this area but it is not so serious disease. Only 2-9% leaf spot disease was found in the survey. After isolation from soil of Kalimpong (Hill area), *Ralstonia* sp and *Fusarium* sp. were found. In management of *Pythium*, *Fusarium* and *Ralstonia* on ginger, it was found that minimum disease incidence was recorded by hot water treatment at 51°C for 30 minutes (T_4) which is closely followed by seed treatment with Ridomil Mancozeb (T_5) and seed treatment with *Trichoderma harzianum* (T_2). T_4, T_5 and T_2 showed 67.50%, 66.25% and 64.84% disease reduction respectively. The highest yield was also obtained by T_4 (5.13 kg/plot) followed by T_5 (4.85 Kg/plot) and T_2 (4.65 Kg/plot). In disease survey and monitoring project on ginger it was found that in Hills of West Bengal rhizome rot complex starts from 2 months after sowing and it reaches maximum at 3 month after sowing. Whereas in the plains the disease starts from 2 and half month age of the plant, reaches maximum damage at 3 and half month age of the plant. *Phyllosticta* leaf spot disease starts from 2 month age of the plant (June) and continue up to 4 month age of the plant in both hills (Kalimpomg) and plains of West Bengal (Coochbehar district). No disease occurs in storage even when no control measure has been taken in storage. Only one insect named as scale insect comes in the storage. It was estimated that 15-20%

rhizome in the storage and on an average 10-15 insects are found on an infected rhizome.

3.6.2 Biocontrol studies on rhizome rot of ginger

(*Kumaraganj, Pottangi* and *Raigarh*)

Trials were carried out to evaluate the efficacy of hot water treatment, fungicide and biocontrol agent for the management of rhizome rot disease of ginger at Raigarh. The trial indicated that neem cake 1 kg + 100 g bioagent in 3 kg FYM (mixed 7 days before sowing and watering regularly (T8) and seed treatment with hot water 51°C + 100 g bioagent in 1 kg neemcake at sowing (T6) gave good results in respect of survival of rhizome and yield. Minimum disease incidence (4.5%) and maximum plot yield (4.875 kg) was recorded in treatment T8 followed by T7 which was statistically at par with respect to disease incidence (6.5%) and plot yield (4.075 kg).

At Pottangi the trial with 8 treatment combination showed no significant difference for yield. However highest fresh rhizome yield of 14.52 t/ha obtained with seed treatment with mancozeb 3 g/l + carbendazim 1 g/l +chloropyriphos 2 ml/l for 30 min and soil application of Thimet (10 g 1 kg ai/ha). Followed by treatment (T6) seed treatment with hot water + *Trichoderma*, FYM, Neemcake soil application (13.64 t/ha).

At Kumarganj, all the treatments significantly decreased the incidence of rhizome rot disease. Minimum incidence of rhizome rot was observed when rhizomes were treated with hot water at 51°C for 10 minutes + seed treatment of rhizomes with *T. harzianum* mixed with neem cake followed by seed treatment with hot water at 51°C for 10 minutes. Maximum yield was recorded in seed treatment with hot water at 51°C for 10 minutes and seed treatment of rhizomes with Mancozeb.

3.6.3 Integrated management of *Pythium*, *Fusarium* and *Ralstonia* in ginger

(*Kumaraganj, Solan, Pundibari, Raigarh, Pottangi*)

Trial was conducted to evaluate the efficacy of hot water treatment, fungicide and biocontrol agent for the management of various pathogens of rhizome rot disease of ginger. At Raigarh, minimum disease incidence (3.5%) and maximum plot yield (4.7 kg) was recorded in T4 (Ridomil Mancozeb 100 ppm of Metalaxyl).

A trial with biocontrol agents *Pseudomonas/ Trichoderma* consisting of seven treatments as seed treatment/soil dressing started in 2005-06 at Pottangi. There is significant difference among the treatments. Highest yield was obtained in the control using chemical (21.76 t/ha). Increase of 56.32 % over control followed by T6, seed treatment with biocontrol gents with 16.56 t/ha increase of 18.96% over control.

Trial was conducted to evaluate the efficacy of physical, chemical and biocontrol agents for the management of various pathogens which causes soft rot, yellows and bacterial wilt of ginger. The observations on disease were recorded in the six treatments at Solan. Rhizome solarization and hot water treatment to rhizomes before sowing decreased incidence of *Pythium* rot, *Fusarium* yellows and *Ralstonia* wilt of ginger. Hot water treatment (45°C for 30 min) increased the sprouting (97.27%) and yield (8.250 kg/3m²) of ginger and reduced *Ralstonia* wilt (3.87%) significantly over all other treatments. *Trichoderma harzianum* application was found to increase yield of ginger and showing plant growth promoting type of activity. The trial started in 2003-04 at Pundibari with 6 treatments viz.7,

T1 = Mancozeb (0.3%)

T2 = 250 g formulation of *Trichoderma harzianum* in 10 litre of water for 10 Kg seed rhizomes

T3 = Solarization of rhizomes in polythene bags of size 30 x45 cm for 1 Kg seed rhizomes for 2 hours (9 a.m. to 11 a.m.) before sowing

T4 = Hot water treatment at 51° C for 30 minutes

T5 = Ridomil Mancozeb (100 ppm Metalaxyl)

T6 = Control

From Table 40, it is clear that minimum disease incidence was recorded by hot water treatment at 51°C for 30 minutes (T4) which is closely followed by seed treatment with Ridomil Mancozeb (T5) and seed treatment with *Trichoderma harzianum* (T2). T2, T4 and T5 are statically at par with each other. T4 , T5 and T2 showed 67.50%, 66.25% and 64.84% disease reduction respectively. The highest yield was also obtained by T4 (5.13 Kg/plot) followed by T5 (4.85 Kg/plot) and T2 (4.65 Kg/plot). T4 and T5 are statistically at par with each other in respect of yield. So, best treatment in this experiment was found to

Table 40. Effect of different treatments on *Pythium*, *Fusarium* and *Ralstonia* of ginger

Treatments	Germination (%)	Disease Incidence (%)			Percent reduction over control	Yield (Kg/plot)	Projected yield (t/ha)
		1st Observation	2nd observation	3rd observation			
T1	85.93	5.20 (13.18)	7.60 (16.00)	12.89 (21.04)	29.95	3.28	6.61
T2	84.44	3.27 (10.42)	4.77 (12.62)	6.47 (14.74)	64.84	4.65	9.37
T3	79.26	4.27 (11.93)	7.46(15.85)	10.57(18.97)	42.55	3.15	6.35
T4	88.89	2.50 (9.10)	3.86(11.33)	5.98(14.15)	67.50	5.13	10.34
T5	88.89	3.15 (10.22)	4.55(12.32)	6.21(14.43)	66.25	4.85	9.78
T6	62.22	8.16 (16.60)	12.01(20.28)	18.40(25.40)	-	2.25	4.54
SEM±		1.742	1.356	2.076		0.112	
CD (at 5%)		5.251	4.088	6.259		0.337	

be T4 followed by T5 and T2 as compared to control.

At Kumarganj all the treatments significantly decreased the incidence of rhizome rot disease. Lowest incidence of rhizome rot was observed with seed treatment of rhizome with Mancozeb. Controlling disease by 42.10% with maximum yield over control followed by seed treatment of rhizomes with *T. harzianum.*

3.6.5 Survey and monitoring of disease in ginger

(Raigarh,Kumarganj and Pundibari)

Surveys conducted in 25 locations in Raigarh districts during August 2005- February 2006 during second year to record the incidence of diseases on ginger indicated that the rhizome rot incidence was maximum (20.26%) at Tarda village and lowest recorded at Bijana village 93.26% of Raigarh.

This project was initiated during 2004-2005 crop season. Under this project survey was conducted in Hills as well as in the plains of West Bengal. It was found that in Hills of West Bengal rhizome rot complex starts from 2 months after sowing and it reaches maximum and cause highest damage in crop at 3 month after sowing (i.e. in the rainy season) and continue to damage up to 4 month age of the crop. Whereas in the plains the disease starts from 2 and half month age of the plant, reaches maximum damage at 3 and half month age of the plant and continue its damage until 5 month age of the plant (as rainy season is very prolonged in the plains of terai region of West Bengal). Another disease named as *Phyllosticta* leaf spot disease starts from 2 month age of the plant (June) and continue up to 4 month age of the plant in both hills (Kalimpong) and plains of West Bengal (Coochbehar district). The damage caused by the disease is very little and it does not cause any serious loss of the crop.

No disease occurs in storage even when no control measure has been taken in storage. It was estimated that 15-20% rhizomes in the storage are infected by this insect. It was also estimated that on an average 10-15 insects are found on an infected rhizome.

The soil samples were collected from Kalimpong sub division of Darjeeling district and the pathogen was isolated in the laboratory. The bacterium was identified as *Ralstonia* sp. and fungus was identified as *Fusarium sp.* The soil samples (sick soil) were also collected from plain area of West Bengal (Pundibari, Coochbehar) and the pathogens were isolated from that soil, and were identified as *Pythium sp.* and *Fusarium* sp.)

The Kumarganj center 32 Samples collected experimental field, six samples collected from farmers' field and 11 samples collected from traders showed incidence of rhizome rot in field or during the storage in the Faizabad, Kushinagar, Padrauna, Lucknow, Kasya and Gorakhpur areas.

4. TURMERIC

4.1 Genetic Resources

4.1.1 Germplasm collection, characterization and conservation

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

At Dholi, 85 germplasm of turmeric were tested to identify promising lines in respect of yield. Out of 85, RH-50 yielded 35.80 kg per 7.2m^2

followed by RH-5 and RH 9/90 (32.0 kg/7.2m²). The yield of germplasm varied from 6 kg (Tu-1 and Dugirala) to 35.80 kg (RH-50) in an area of 7.2m².

A total of 352 accessions are being maintained at Jagtial which includes 84 accessions added during 2003-04 and 79 during 2004-05. Among all germplasm lines tested during the year 2005-06, JTS-1 has given high fresh rhizome yield (40.0 t/ha) followed by PTS-52 and JTS-14 (37.33 t/ha)

At Coimbatore centre 255 accession were evaluated during 2005-06. The accession exhibited a wide variation in yield which ranged from 7.22 to 66.34 t/ha. The CL 209 registered the highest yield of 66.34 t/ha followed by CL-207 (64.66 t/ha). Among 255 accessions 15 accessions registered fresh rhizome yield higher than 60 t/ha were identified for further evaluation.

Forty two germplasm lines were evaluated during 2005-06 at Raigarh. IT-2 gave the highest yield (17.42 t/ha) closely followed by IT-3 (16.15 t/ha) and IT-10 (15.75 t/ha). The centre maintains 45 germplasm including 3 in *Curcuma amada* (Mango ginger).

At Pundibari, 146 accessions including 6 new additions were maintained and 116 cultures of turmeric were screened for characterization. Germplasm were evaluated and it was found that seven entries out yielded the local check (variety Suranjana) viz. TCP-57 (24.40 tones/ha), TCP-58 (28.62 t/ha), TCP-66 (41.12 t/ha), TCP-82 (25.84 t/ha), TCP-107 (24.58 t/ha), TCP-115 (24.98 t/ha) and TCP-133 (27.82 t/ha) in terms of fresh rhizome yield.

The Pottangi centre maintains 195 turmeric accessions and out of this 173 were evaluated. Among the 173 accessions evaluated during 2005-06, 153 were *C. longa* 20 were *C. aromatica* and 4 were *C.amada*. The range in fresh rhizome yield / 3m² in *C.longa* varied from 4.4 to 14.2 kg/3m² and thirty six accessions gave more than 9 kg/3m² in yield. In *C.aromatica* the range in fresh rhizome yield varied from 6.62 kg/3m² to 9.42 kg/3m² and five accessions gave more than 7.5 kg/3m² yield. Out of four *C.amada* types the range in yield was 7.2 kg/3m² to 12.0 kg/3m².

At Kumarganj trial was conducted with early (30) medium (55) and late (35) genotypes including check in augmented design during 2005-06 to evaluate the performance of turmeric. Lines which is collected from different district of U.P. yield range was in early (18.00-37.75 t/ha) & medium group NDH-18 (37.75t/ha to 37.71t/ha) and late group NDH-9 (38.00t/ha). Highest yield was recorded by NDH-18 (37.22t/ha) in early group 37.71 t/ha medium group and NDH-9 in late group (38.00 t/ha). The germplasm accessions maintained at different centres are summarized in Table 41.

Table 41. Germplasm collection of Turmeric at the AICRP centres

Crop/Center	Indigenous		Total
	Cultivated	Wild and related sp.	
Turmeric			
Pottangi	171	22	193
Jagtial	352	-	352
Dholi	83	2	85
Raigarh	42	-	42
Kumarganj	114	-	114
Pundibari	126	14	140
Solan	145	-	145
Coimbatore	255	-	255
Total	**1288**	**38**	**1326**

4.1 Coordinated Varietal Trial (CVT)

4.2.1 CVT 2000-Series V

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

Out of 30 cultures tested, PTS-59 has recorded more fresh rhizome yield (41.4 t/ha) followed by RH-5 (39.1 t/ha) in comparison with Duggirala red check variety (34.2t/ha) at Jagtial.

Among the 8 accessions CL-34 registered the highest fresh rhizome yield of 46.2 t/ha during 2005-06 at Coimbatore.

At Raigarh the CVT 2000 is in the Vth year of progress. During 2005-06, highest yield was obtained in the entry TCP-1 (17.95 t/ha) followed by TCP-2 (17.82 t/ha) and IT.2 (17.09 t/ha). The variety TCP-1 showed an increase of 34% over the check variety RH-5 which gave an yield of 13.40 t/ha.

The CVT series V with 15 entries started in 2000-01 is in the 6th year of progress at Pundibari. TCP-2 (25.74 t/ha), TCP-1 (23.65 t/ha), TCP-11 (22.50 t/ha), RH-5 (22.44 t/ha), PTS-55 (18.59

t/ha) and PTS-52 (17.40 t/ha) had higher yield than national check Prabha with 74.86, 60.61, 52.85%, 52.45%, 26.29% and 18.21% respectively increment over check in fresh rhizome yield.

In the CVT with 15 accessions at Pottangi, significant difference among the accessions for fresh rhizome yield was observed during 2005-06. Highest yielders PTS-39 (24.29 t/ha) with 42.88% increase over Roma PTS-11 (25.76 t/ha) with 38.94% increase, PTS-4 (25.76 t/ha) with 38.94% increases, over Roma.

4.2.2 CVT- 2004-series VI

(Raigarh, Pundibari, Pottangi)

The CVT with 13 entries laid out at Raigarh. The experiment is in the second year of progress. Highest yield was obtained in TCP-82 (21.95 t/ha), followed by TCP-11 (21.74 t/ha) and IT.2 (17.29 t/ha). Nine out of the 13 entries out yielded the check variety, Prabha that recorded 11.79 t/ha yield.

The CVT of Pundibari IT-2 (25.06 ton/ha), TCP-56 (24.26 t/ha), IT-3 (24.06 t/ha), TCP-82 (23.79 t/ha), TCP-11 (22.71 t/ha), IT-1 (22.51 t/ha) and PTS-39 (16.13 t/ha) had higher yield than national check, Prabha with 73.55%, 68.01%, 66.62%, 64.75%, 57.27%, 55.89% and 11.70%, respectively increment in fresh rhizome yield over check Prabha.

The CVT with 6 accessions at Pottangi initiated in 2005-06. Significant differences were observed and highest yielders were PTS-47 (25.07 t/ha) with 15.31% increase over Roma, PTS-39 (23.92 t/ha) with 10% increase over Roma.

4.2 Varietal Evaluation Trial

4.3.1 Comparative yield trial-CVT-1999

(Raigarh and Pundibari)

At Raigarh, the trial is in the VI year which started in 1999-2000 with 8 entries. During 2004-05, maximum fresh rhizome yield was obtained in IT-1 (8.7 kg/ plot) followed by IT-2 (8.6 kg/plot) and Acc. 593 (7.93 kg/plot). The pooled data from 1999-00 to 2004-05 presented in Table 42 revealed that IT-1 and 2 were superior to the check varieties Prathibha and Prabha, producing maximum fresh rhizome yield of 23.07 t/ha and 20.66 t/ha respectively.

At Pundibari the trial started in 2004-05 with 20 entries, TCP-70 (27.72 t/ha), TCP-57 (27.22 t/ha), TCP-56 (26.81 t/ha), TCP-54 (26.01 t/ha), TCP-129 (24.90 t//ha) and TCP-82 (24.80 t/ha), TCP-119 (24.70 t/ha), TCP-72 (24.19 t/ha) and TCP-84 (23.83 t/ha) out yielded TCP-2 (Suranjana, local check, 19.54 t/ha) with at least 20% yield increment whereas TCP-97 (22.99 t/ha), TCP-104 (21.78 t/ha) showed more than 10% yield increment over local check, and TCP-11 (2085 t/ha) and TCP-107 (20.66 t/ha) showed minor yield increment over check. It indicated the potentiality of these genotypes.

4.3.2 Comparative yield trial-CYT 2005-06

(Jagtial and *Coimbatore)*

At Jagtial out of 10 promising turmeric cultures tested during 2005-06, JTS-406 has recorded highest fresh rhizome yield (42.5 t/ha) followed by JTS-408 (39.5 t/ha). The cultures JTS-404 and JTS-405 recorded on par yields. The check variety PCT-13 recorded a fresh rhizome yield of 29.1 t/ha.

Among the 10 accessions tested at Coimbatore, the accession CL-13 registered the highest fresh rhizome yield of 36.98 t/ha.

4.3.3 Initial evaluation trial

(Dholi and *Pottangi)*

The IET conducted for 2003-04 to 2005-06

Table 42. Performance of turmeric accessions under CYT - Raigarh

Genotype	Yield (t/ha)						Mean yield
	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05	(t/ha)
Prabha	23.6	12.3	12.3	13.4	9.4	12.78	13.96
Pratibha	22.1	11.3	20.1	11.6	10.18	14.33	14.93
ACC-584	22.0	10.6	6.5	8.6	7.7	10.11	10.91
ACC-585	20.6	11.2	6.1	6.7	11.38	14.79	11.79
ACC-126	20.4	12.7	12.1	10	2.61	7.83	10.94
IT-1	-	-	39.2	24.5	11.12	7.83	23.07
IT-2	-	-	36.8	16	12.46	17.48	20.66

at Dholi. The pooled data presented in Table 43 showed that among the genotypes none of them were found significantly superior over check Rajendra Sonia regarding plant height and number. of tillers/plant. But RH-80, RH-9/90 and RH-14 were recorded significantly delayed maturity as compared to check. RH-9/90, RH-50 and RH-80 showed significantly superiority in yield over check in which genotypes RH 9/90 gave the maximum yield 47.45 t/ha followed by RH-50 and RH-80 (46.29 t/ha). So far cost: benefit ratio is concerned RH 9/90 gave more 1:2.37 over others.

The IET with 13 accessions initiated in 2005-06 at Pottangi showed significant difference among the treatments for fresh rhizome yield. Highest yielders were VK-9 (25.14 t/ha) with 25.19% increase over control. PTS-3 (23.5 t/ha) with 17.18% increases over control.

4.4 Quality Evaluation Trial

4.4.1 Quality evaluation of germplasm

(Coimbatore)

Fifteen promising germplasm accessions identified at Coimbatore from the germplasm pool.

Table 43. Performance of Turmeric entries under IET (2003-04 to 2005-06 Pooled data) - Dholi

Entries	Height of the Plant (cm)				No. of Tillers per plant				Days to maturity (Days)			
	2003-04	2004-05	2005-06	Mean	2003-04	2004-05	2005-06	Mean	2003-04	2004-05	2005-06	Mean
RH - 14	90.53	134.13	90.80	105.15	4.33	3.60	3.46	3.79	227.67	228.33	226.00	227.33
RH - 16	84.87	141.87	101.40	109.38	4.20	3.53	4.40	4.04	219.33	218.33	215.33	217.66
RH - 17	107.33	152.33	99.67	119.77	3.60	4.07	4.00	3.89	213.33	215.67	214.00	214.33
RH - 24	82.67	140.07	101.53	108.09	3.33	3.60	3.80	3.57	213.00	214.33	211.00	212.77
RH - 50	94.80	143.27	106.33	114.80	4.13	3.93	4.73	4.26	212.33	217.00	215.66	214.99
RH - 80	89.93	142.73	97.60	110.08	5.00	2.87	3.93	3.93	229.33	229.00	225.66	228.00
RH - 9/90	84.40	133.07	89.40	102.29	5.33	3.93	4.33	4.53	222.33	221.67	223.00	222.33
RH - 13/90	102.93	146.53	117.80	122.42	3.40	2.67	2.47	2.84	208.67	210.67	213.66	211.00
Rajendra Sonia (Check)	91.86	140.93	107.63	113.47	4.53	4.00	4.27	4.26	212.33	211.33	211.66	211.77
CD (P=0.05)	NS	NS	12.57	12.72(T)	NS	0.90	1.17	NS	3.42	2.61	5.90	267(T)
CV (%)	9.86	6.34	7.16	6.99	17.77	14.52	17.21	15.90	0.90	0.69	1.19	0.75

Table 43. Contd.

	Yield (t/ha)				Increase in yield over check		Cost benefit ratio
	2003-04	2004-05	2005-06	Mean	t/ha	%	1:1.83
RH-14	30.56	52.54	26.85	36.65	-2.46	-6.29	1:1.81
RH-16	28.24	52.55	27.55	36.11	-3.00	-7.67	1:1.84
RH-17	37.27	50.23	22.92	36.80	-2.31	-5.91	1:1.74
RH-24	29.63	53.01	30.79	34.72	-4.39	-11.22	1:2.32
RH-50	34.03	63.66	41.20	46.29	7.18	18.36	1:2.32
RH-80	37.04	64.12	37.73	46.29	7.18	18.36	1:2.37
RH-9/90	43.06	62.50	36.81	47.45	8.34	21.32	1:2.22
RH-13/90	40.74	58.80	33.80	44.44	5.33	13.63	1:1.96
Rajendra Sonia (Check)	31.94	53.93	31.48	39.11	-	-	
CD (P=0.05)	5.88	5.05	6.03	5.41(T)			
CV(%)	9.86	5.13	10.85	8.12			

* Cost of production Rs. 60,000/- per hectare including seed cost

** Selling rate of fresh turmeric rhizomes Rs .3000/- per tonne.

Out of the 255 turmeric germplasm accessions screened for the resistance against leaf spot and leaf blotch diseases, the accessions *viz.*, 158, 171, 209, 237 and 238 were resistant to both the foliar diseases. The analysis of quality parameters are in progress.

4.4.2 Impact of environment on quality of turmeric

(Coimbatore)

In these studies the impact of environment on quality of turmeric was ascertained using six turmeric varieties. Rajendra Sonia (CL-141) recorded the highest yield of 13.13 t/ha and the analysis of quality parameters are in progress at Coimbatore.

4.5 Nutrient Management Trial

4.5.1 Effect of biofertilizer, *Azospirillum* on turmeric

(Coimbatore, Pundibari and Kumarganj)

The trial conducted to ascertain the efficiency of *Azospirillum* and combination of FYM and graded level of nitrogenous fertilizers along with the recommended dose of P and K on turmeric. The last three years data at Coimbatore revealed that treatment which received FYM (5t/ha) + inorganic N (50 %) + *Azospirillum* (5 kg/ha) as soil application recorded the highest yield which is considered as a best treatment for enhancing the yield in turmeric. The treatment gave a yield of 49.00 t/ha during 2005-06.

At Pundibari in the effect of bio-fertilizer using *Azospirillum* on turmeric trial, application of 75% of recommended inorganic nitrogen with *Azospirillum* @ 5kg/ha and FYM @ 15 t/ha (T_2) gave the highest yield of 28.36 t/ha as against 23.37 t/ha in the control, having recommended dose of fertilizer 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 100% recommended inorganic nitrogen with *Azospirillum* @ 5 kg/ha and FYM @ 15 t/ha (T_1) with an yield of 27.14 t/ha. The lowest yield of 20.48 t/ha was recommended in the treatment of sole application of FYM @ 15 t/ha (T_6). The curcumin content was not markedly different for the treatments.

An experiment was conducted with 8 treatments at Kumarganj variety Rajendra Sonia in RBD during 2005-06 at Kumarganj. Observations were recorded on yield and yield attributing traits. Maximum fresh rhizomes yield 36.16 tonnes / ha was recorded with treatment T_1 (Inorganic N 100% + *Azospirillum* @ 5.0 kg /ha seed treatment + FYM 5.0 tonnes /ha) followed by T_6 (FYM 10.0 tonnes / ha + *Azospirillum* 5.0 kg /ha seed treatment) 34.57 t/ha.

4.5.2 Organic farming in turmeric

(Pundibari)

In organic farming trial of turmeric, significant differences were observed for fresh rhizome yield. Application of all the organic inputs (*viz.*, FYM-10 kg. Pongamia cake 250 gm, Rock phosphate 500 gm, Wood ash 250 gm per $3m^2$) except neem cake resulted maximum fresh rhizome yield (26.11 t//ha). Yield of organic turmeric was always statically lower from the treatment with recommended dose of fertilizer. The curcumin content was not markedly different for the treatments.

4.5 Disease Management Trial

4.5.1 Survey and identification of disease causing organism in turmeric and screening of turmeric germplasm against diseases

(Coimbatore, Pundibar, Dholi, Raigarh and *Kumarganj)*

At Coimbatore all the 255 germplasm accessions were screened for their resistance against leaf spot and leaf blotch diseases. Among these, five accessions *viz.*, (CL-158, 171, 209, 237) and 238 were resistant to the foliar diseases *viz.*, leaf blotch and leaf spot. The study revealed that the occurrence of leaf blotch incidence was higher than the leaf spot disease.

A survey was conducted in 4 blocks of Coochbehar district. The blocks in which the survey was taken are Coochbehar 1, Coochbehar 11, Tufanganj 1 and Dinhata 1 block to identify the disease occurring in the area and to access the severity of different diseases of turmeric in this area. Nine well distributed locations within those blocks were selected for the survey. In each location the survey was done in at least 2-3 different places. Three major diseases were found to prevent in this area, namely, leaf blotch of turmeric (*Taphrina* spp). leaf spot of turmeric (*Colletotrichum* spp.) and

rhizome rot. Another leaf spot disease was founding the survey. The causal organism of this disease was found to be *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. In the survey it was found that leaf blotch disease severity is highest in Coochbehar I and Tufanganj I block (average 35%) and it was followed by Coochbehar II block (average 22.06%) and Dinhata I block (Average 13.33%). Regarding leaf spot of turmeric it was found that disease severity is little higher in Coochbehar II block (average 14.71%) than in Tunfanganj I block (average 12.33%) It is followed by Coochbehar I block (Average 11.67%) and Dinhata I block (Average 7.33%).

Screening of the collected germplasm was done against both leaf blotch and leaf spot diseases of turmeric. The germplasms found to be tolerant against leaf blotch disease are TCP 4, 9, 32, 35, 37, 77, 90, 92, 94, 100, 109, 132, 137, TCP A, J 6, KAST COL, etc. and the germplasms found to be tolerant against leaf spot disease are 31-1, 53, 92, 101, 152, 173, etc.

The study started in 2004 at Raigarh centre and in the 3rd year of progress. The screening studies of germplasm/MLT lines results indicated that TCP-11, Roma, Kashmir, Suguna, Surma, Sudarshana, TCP-56, Prathibha and IT-10 showed resistance to *Taphrina* leaf blotch and *Colletotrichum* leaf spot. Some germplasm accessions showed resistance to *Taphrina* leaf blotch only whereas IT-11 was resistant only to *Colletotrichum* leaf spot.

The survey made by the Kumarganj at different locations in Faizabad, Gonda and Lucknow showed incidence leaf blotch and leaf spot diseases in all the fields. Rhizome rot (Soft-rot) was not observed in any of field.

4.5.2 Investigation on the casual organism of rhizome rot of turmeric and screening of biocontrol agents for its management

(*Coimbatore, Raigarh, Kumarganj,Pottangi.* and *Pundibari,*)

A field trial was conducted to test the bio efficiency of biocontrol agents against rhizome rot of turmeric is in the Vth year of progress at Coimbatore. The results of the study revealed that seed and soil application of *Trichoderma viride* and *Pseudomonas fluorescens* @ 4 g/kg and 12.5 kg/ha was found to be effective and was free from rhizome rot symptoms with a maximum yield of 69.36 t/ha. The same treatment also recorded the maximum C:B ratio of 3.3.

The Raigarh center made intensive survey but no incidence of rhizome rot of turmeric reported.

At Pundibari a survey was made in Coochbehar 1, Tufanganj 1, Dinhata 1 and Coochbehar II block to identify the major disease problem of the area, which happens to be leaf blotch caused by *Taphrina* and leaf spot caused by *Colletotrichum* sp. A less amount of rhizome rot disease was also found. It was found that leaf blotch disease severity is highest in Coochhehar II and Tufanganj I block (average 35%) and it is followed by Coochbehar 11 block (Average 22.06%) and Dinhata 1 block (Average 13.33%). Regarding leaf spot of turmeric it was found that disease severity is little higher in Coochbehar 11 block (average 14.71%) than in Tufanganj 1 block (average 12.33%). It is followed by Coochbehar 1 block (Average 11.67%) and Dinhata 1 block (Average 7.33%). Another disease caused by *Helminthosporium* sp. was found in the University trial plots. Screening of the collected germplasm was done against both leaf blotch disease are TCP 4,9, 32, 37, 77, 90, 92, 100, 109, 132, 137, TCP A, J 6, KAST COL, etc. and the germplasm found to be tolerant against leaf spot disease are 31-1, 53, 92, 101, 152, 173, etc. In screening of bio control agents are management of rhizome rot of turmeric trial, the best treatment was T_7 i.e. seed treatment as well as soil application of *Trichoderma viride* and *Pseudomonas fluoresces* with application of recommended NPK and FYMh. T_7 gave 71.85% disease reduction over control. Regarding yield T_7 produced highest yield of 7.77 Kg/3m^2 plot (15.66 ton /ha). So, it can be concluded that T7 is the best treatment in the present experiment. The causal organism of rhizome rot disease of turmeric was found to be *Fusarium* sp.

Soft rot disease was not observed in field or in storage at Kumarganj. Highest yield was recorded in recommended dose of NPK +*T.viride* + *Pseudomonas fluorescens* applied to soil @ 12.5 and 25.0 kg /ha as basal and top dressing (T4) and in T5 treatment i.e. application of recommended dose NPK + FYM + Seed treatment of rhizomes with *T.viride* + *Psuedomonas fluorescens* @ 4 g / kg.

A trial using biocontrol agents *Pseudomonas* and *Trichoderma* initiated in Pottangi with 8 treatment combination as seed treatment and soil dressing. The fresh yield observed significant difference among the treatments. Highest yield was recorded with seed treatment with *Pseudomonas* only & soil dressing with *Pseudomonas* (19.76 t/ ha) which is 7.39% increase over check followed by treatment with *Trichoderma* @ 10 g/l with 19.05 t/ha with 6.5% increase over check.

4.5.3 Management of *Taphrina* leaf blotch and *Colletotrichum* leaf spot of turmeric

(*Raigarh*)

Two separate studies were conducted at Raigarh during the period 2001-02 to 2003-04 under natural conditions with seven treatments. The pooled data presented in Table-34 revealed that all the treatments tested in present experiment were statistically superior than the untreated control. Mancozeb + carbendazim (0.2%) spray alternate spray (T3) were the maximum reduction of the disease severity of *Taphrina* leaf blotch and production of higher yield with closely followed by carbendazim (0.2%) spray (T2) in respect of disease intensity and yield (Table 44). With regard to leaf spot, lowest disease severity and maximum fresh rhizome yield was recorded in Mancozeb+ carbendazim (0.2%) spray alternate spray (T3) closely followed by carbendazim (0.2%) spray (T2) and Mancozeb (0.2%) spray (T1), -respectively (Table 45).

Table 44. Management of *Taphrina* leaf blotch disease of turmeric-Raigarh

Treatment	Disease severity of leaf blotch				Yield per plot (kg/3 m²)			
	2001	2002	2003	Pooled	2001	2002	2003	Pooled
T1-Mancozeb (0.2%) spray	42.7	14.0	41.6	35.6	4.90	3.70	1.71	3.40
T2-Carbendazim (0.2%) spray	33.0	12.8	39.9	30.4	5.70	5.13	2.47	3.90
T3-Mancozeb + Carbendzim (0.2%) spray alternate spray	28.7	09.3	38.3	27.7	6.40	5.63	2.63	4.50
T4-Seed and soil treatment with *Trichoderma* (100g. for each) with addition of neem cake in soil (1kg.)	67.5	23.1	53.6	49.9	6.00	3.70	1.57	3.60
T5- Mancozeb as seed treatment and *Trichoderma* as soil application	65.3	26.7	58.4	52.7	4.10	3.67	1.43	2.90
T6-Carbendazim as seed treatment and *Trichoderma* as soil application	62.5	24.4	60.2	51.7	2.30	3.47	1.27	2.90
T7-Untreated check	66.8	43.2	71.0	61.6	2.60	2.67	0.77	1.60
CD (P=0.05)	17.5	03.2	04.3	9.96	2.07	1.15	0.33	1.14

Table 45. Management of *Colletotrichum* leaf spot disease of turmeric-Raigarh

Treatment	Disease severity of leaf spot			Yield per plot (kg/3 m²)		
	2002	2003	Pooled	2002	2003	Pooled
T1-Mancozeb (0.2%) spray	14.0	28.6	21.3	3.70	1.33	2.58
T2-Carbendazim (0.2%) spray	12.8	29.5	21.2	5.13	1.50	3.32
T3-Mancozeb+ Carbendzim (0.2%) spray alternate spray	09.3	23.6	15.9	5.63	2.50	4.07
T4- Seed and soil treatment with *Trichoderma* (100g. for each) with addition of neem cake in soil (1kg.)	23.1	40.3	31.8	3.70	1.20	2.47

Treatment	Disease severity of leaf spot			Yield per plot (kg/3 m²)		
	2002	2003	Pooled	2002	2003	Pooled
T5- Mancozeb as seed treatment and *Trichoderma* as soil application	26.7	41.5	34.1	3.67	1.33	2.40
T6-Carbendazim as seed treatment and *Trichoderma* as soil application	24.4	44.0	34.3	2.47	1.30	2.38
T7- Untreated check	43.2	61.3	52.3	2.67	0.70	1.68
CD (5%)	3.18	6.43	06.9	1.15	0.57	0.59

5 TREE SPICES

5.1 Genetic Resources

5.1.1 Germplasm collection, characterization, evaluation and conservation of clove, nutmeg and cinnamon

(Dapoli and Yercaud/Pechiparai)

Clove: The trial initiated during 1992 at Pechiparai with 22 accessions and among which Sel. 13 performed well and gave the yield of 1.250 kg dried buds per tree. The height of the tree ranged between 2.12 m (SA.22) to 7.5 m (SA.7). The centre also collected one new accession during 2005-06. The Dapoli centre maintains 3 clove accessions. IISR seedling progenies of clove recorded vigorous growth and higher yield than the Kallar types during 2005-06.

Nutmeg: In nutmeg germplasm, four selections collected from IISR, Calicut are being maintained along with selections from State Horticulture Farm, Courtallam and local collections. Among the 20 accessions evaluated at Pechiparai, the performance of Sel. 2 was good for growth and yield. The height of the tree ranged between 1.16 m (Sel.15) to 6.08 m (Sel.2). The highest yield of 450 nuts/tree was recorded in the Sel.2.

The Dapoli centre maintains 95 nutmeg accessions. The centre collected one local type nutmeg from Konkan region and multiplied for further evaluation. During the year 2005-06, the data on morphological characters did not differ significantly among genotypes. The average height ranged from 3.40 m to 4.09m. The average girth ranged from 19.09 cm to 24.33 cm and number of branches from 31.33 to 37.77 and spread ranged from 2.43 m to 3.16 m. The genotype, A-9/4 R1-2 and A-9/79 R1-1 produced large sized fruits and also seems promising with respect to fruit characters. The accession, A-9/79 RF1 registered highest fruit yield per plant (135 nuts).

Cinnamon: Nine elite cinnamon selections collected from IISR are under evaluation along with 3 local types at Pechiparai. Among the accessions, Sel. 65 performed well and gave an yield of 0.291 kg of dried bark per tree.

The Dapoli centre maintains 11 accessions in cinnamon and 6 in cassia. The morphological and quality characters of cinnamon accessions are recorded. During 2005-06, the vegetative growth characters *viz.*, height, girth, no. of branches and spread did not differ significantly among different genotypes under study.

Table 46. Germplasm collection in Tree spices at the AICRP centres

Crop/Center	Indigenous		Exotic
	Cultivated	Wild and related sp.	
Clove			
Pechiparai	22	-	-
Dapoli	3	-	-
Yercaud	13	-	-
Total	**38**	-	-
Nutmeg			
Pechiparai	20	-	-
Dapoli	95	-	-
Total	**115**	-	-
Cinnamon			
Pechiparai	12	-	-
Dapoli	49	-	-
Yercaud	16	-	-
Total	**77**	-	-

5.1 Coordinated Varietal Trial (CVT)

5.2.1 CVT-1992 in clove

(Pechiparai/Yercaud)

Nine genotypes collected form IISR are being maintained at Pechiparai and growth parameters are studied. Among the 10 selections, Sel-9 was found to be promising in terms of growth and yield characters giving an yield of 760.84 g dried buds per tree.

5.2.2 CVT 1992 in cinnamon

(Ambalavayal)

The trial started in 1992 with seven cinnamon types. The pooled mean data for wet and dry weight of quills/plant recorded the highest wet weight of 0.617kg at dry 0.258 kg weight of quills/plant in SL-203. 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 Acc. no.2.

5.2.3. CVT 2001 in nutmeg

(*Pechiparai* and *Dapoli*)

At Pechiparai, six accessions (IISR collection) are being maintained and evaluated along with a local check. Among the accessions, A9/150 has recorded the highest plant height of 61.77 m.

During the second year, the morphological characters like height, spread and braches did not differ significantly among genotypes at Dapoli. In general, genotype A9/150 recorded significantly maximum girth (7.83 cm) and branches (7.0) over other entries under study.

5.2.4. CVT 2001 series in cassia

(*Pechiparai, Dapoli* and *Ambalavayal*)

At Pechiparai, among the four selections D3 was found to be promising with highest plant height (136.8 cm)

In the CVT with 6 entries at Dapoli during 2005-06, the morphological characters *viz.*, height, girth, branches and spread did not differ significantly among different genotypes. At Ambalavayal, the trial started in 2003 with four cassia types. The stand of the crop is satisfactory.

5.3 Propagation/Multiplication Trial

5.3.1 Vegetative propagation in nutmeg, clove and cinnamon

(Dapoli)

Soft wood grafting in clove

The grafting trial was initiated to find out feasibility of compatible root stock for vegetative propagation of elite types of clove. A study initiated to find out optimum season for soft wood grafting in clove using various rootstock in order to find out the feasibility of compatible root stock and also optimum season for vegetative propagation of elite types of clove. Initially (one month after grafting) success of about 20-50% was observed, but survival recorded after three months was 0.0%.

A seasonal trial on soft wood grafting in clove and feasibility of various root stocks of *Syzygium* was carried out at Dapoli using species *viz.*, *S. cumini*, *S. rubicundum* and *S. heyneanum.*

5.4 Disease Management Trial

5.4.1 Survey for disease incidence in tree spices

(Pechiparai, Dapoli and *Ambalavayal)*

Clove: Surveys conducted by Pechiparai centre reported the maximum incidence of leaf spot in clove caused by *Colletotrichum gloeosporioides* which is recorded during the north east monsoon period. The percent disease incidence (PDI) was high at Keeriparai area (17.8%) and minimum of 11.4 % was recorded at Kaliyal area. Seedling wilt in clove caused by *Rhizoctonia* sp. was maximum (10.2%) at Maramalai followed by Keeriparai (7.5%). The survey conducted around Pechiparai area noticed fruit rot incidence of nutmeg (3.2%).

Survey conducted by Dapoli to observe the incidence of diseases of nutmeg in the Konkan region. Shot hole disease (*Colletotrichum gloeosporioides*) was observed in all orchards visited, fruit rot (*Diplodia natalensis*) recorded in few orchards, dieback or sudden wilt of branches (*Rhizoctonia bataticola, Fusarium solani*) was observed in all orchards visited. The present incidence of leaf rot ranged between 12.27% at Bhoighar, Raigarh and 36.18% at Dapoli. Leaf spot incidence was maximum (4.62%) at Bhoighar, Raigarh and minimum (1.02%) at Vengurle and Sindhudurg. Per cent incidence of die back ranged between 0.97 at Bhoighar, Raigarh and 2.15 at Bhatye, Ratnagiri.

Cinnamon: Survey was conducted by Dapoli centre in 7 orchards to study the incidence of diseases in cinnamon. Low incidence of leaf blight (*Phytophthora* sp.) leaf spot (*Colletotrichum gloeosporioides*) and pink disease (*Pellicularia Salmonicolor*) was observed.

6. CORIANDER

6.1 Genetic Resources

6.1.1 Germplasm collection, characterization, evaluation, conservation and screening against diseases

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

Forty four new accessions were added to the germplasm pool consisting of 230 accessions thus raising the total to 274 at Coimbatore. All those were evaluated during 2005-06 *Rabi* season. Among the accessions, 51 accessions registered high seed yield of 900 to 950 kg/ha during 2005-06 *Rabi* season. Two hundred and seventy four accessions were screened for their resistance to powdery mildew disease (using 0-5 scale) and none were found resistant to powdery mildew disease. The accessions, 107, 110, 251 and 252 recorded the powdery mildew incidence of 15.36, 14.23 and 15.23 PDI, respectively and they were moderately resistant.

At Jagudan 93 entries were raised and evaluated with G.Cori-1 and G. Cori-2 as checks for different yield attributes. Out of which 13 entries were selected for leafy type, earliness, bold seed, compact seed in umbel, small seed etc. At Jagudan, a total 110 (108 +2) entries received from Jobner, Kumarganj, Hisar and Guntur along with Jagudan entries were screened against powdery mildew disease under natural conditions. The incidence of Powdery mildew was reported to be very high and ranged from 62.50 to 96.25%. None of the entry was found to be resistant or tolerant against the disease.

The Jobner centre holds 885 coriander accessions which include 60 additions made during the reporting period. Out of the 126 accessions evaluated wide range of variability was found for all the characters studied. Out of 126 accessions, 16 accessions were better than check variety, RCr-20. Some of the promising accessions identified on the basis of yield per plot were UD-784, UD-118, UD-77, UD-285, UD-269, UD-136, UD-126, UD-142, UD-340 and UD-114. Out of sixteen entries of coriander, UD-480 was found free from wilt, powdery mildew followed by UD-118 (5% wilt) and (one score- powdery mildew) with the seed yield of 1844 kg/ha and 1632 kg/ha respectively. The control resulted in maximum diseases incidence (10% wilt) and 4 score-powdery mildew with the minimum seed yield of 1042 kg/ha. Stemgall disease did not appear.

Out of 10 entries evaluated in IET, UD-475 and UD-20-130-278 was found free from wilt and powdery mildew diseases with the maximum seed yield. UD-707 and local check resulted in highest wilt percentage (15%) and 4-score powdery mildew with the seed yield of 1017 kg/ha and 1076 kg/ha respectively. In all the entries stem gall disease did not appear. Out of 20 entries of coriander tested against stem gall disease at farmer's field at Danta (Sikar), UD-118 and UD-480 are found free from disease and rest others are fond resistant to highly susceptible. Out of twenty entries of coriander tested against root knot disease at ARS, Durgapura only UD-118 and UD-480 were found resistant and rest others were found moderately resistant to highly susceptible.

The Hisar centre maintains a total of 204 accessions. Ninety two germplasm accession of coriander were evaluated using Hisar Anand, narnaul selection and Pant Haritima as checks at the Hisar centre during 2004-05. The seed yield ranged from 210 g (DH-328) to 490 g (DH-294). Fifty three lines gave higher seed yield than Hisar Anand, 72 higher than narnaul selection and 76 out yielded Pant Haritima. The promising high yielding lines were DH-209, DH-219, DH-220, DH-239, DH-286, DH-294 and DH-317.

At Guntur during 2005-06 *Rabi* 124 collections were evaluated. Among the entries evaluated LCC-159 recorded highest yield (689 kg/ha), followed by LCC-211 (672 kg/ha), LCC-213 (647 kg/ha), LCC-214 (589 kg/ha) and LCC-240 (567 kg/ha). The check, Sadhana has recorded an yield of 416 kg/ha.

At Dholi center out of 85 germplasm, RD-366 gave maximum yield of 0.67kg/3m^2 followed by RD-365 0.65kg/3m^2. The yield level of the germplasm varied from 0.17 kg/m^2, JCo-75&62) to 0.67kg/m^2 (RD-366).

At Kumarganj seventy five lines were evaluated during 2005-06. Yield range was (0.20-

1 85 t ha $^{-1}$) Highest yield was recorded in genotype ND Cor-67 (1 85 t ha $^{-1}$) followed by ND Cor-2 (1.77 t ha $^{-1}$) and NDcor-49 (1.66 t ha $^{-1}$). The Coriander germplasm at different centres are given in Table 47.

Table 47. Germplasm collection of coriander at the AICRP centres

Crop	Indigenous		Total
	Cultivated	Wild and related sp.	
Jobner	773	112	885
Jagudan	90	20	120
Coimbatore	274	-	-
Hisar	204	-	-
Guntur	124	-	-
Dholi	85	-	-
Kumarganj	75	-	-
Total	**1625**	**142**	**1767**

6.1 Coordinated Varietal Trial

6.2.1 CVT 2001 Series V

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

At Coimbatore, 19 accessions collected form various centres were evaluated for growth and yield characters during 2005-06 Rabi season. The cultivar Hisar Anand was used as national check. Among them, accession LCC-170 registered the highest yield of 1135 kg/ha followed by J.Cor. 375 (915 kg/ha). All these accession were screened against powdery mildew disease, but none of the accession were resistant to powdery mildew disease.

At Jagudan, the pooled data over three years (2002-03 to 2004-05) showed significant yield difference among the entries. Entry, JC-328 yielded the highest (1729 kg/ha) followed by G.Co-2 and J Cori-360, DH-234 and DH-205. All these genotypes significantly out yielded the national check Hisar Anand (1228 kg/ha) However none of the test entries except J Cori-328 could out yielded the local check variety GCo-2 which was 6 40% higher than the check

At Jobner the mean yield performance of the entries evaluated in CVT over 2002-03, 2003-04 and 2004-05 revealed superior performance of UD-480 yielding 1324.82 kg/ha, followed by UD-118(1167.28 kg/ha). The character wise pooled mean over three years (2002-03, 2003-04 and 2003-04) also indicated that the entries differed significantly for all the characters studied. The mean seed yield of the 11 entries were presented in Table 48.

The CVT at Hisar with 12 entries was conducted during 2002-03 to 2004-05. Significant differences were obtained for all the yield contributing characters. The maximum seed yield were recorded in DH –234, followed by DH-205. On the basis of three years average yield (2002-03 to 2004-05), the maximum seed yield was recorded in DH-234 (1839 kg/ha), followed by DH-205 and Kumarganj selection (Table 49).

Table 48. Yield performance of coriander entries under CVT- Jobner

Entries	Seed yield (kg/ha)				% increase
	2002-03	2003-04	2004-05	Mean	over check
UD - 118	889 0	980 9	1631 9	1167 3	21 0
UD - 480	1014 3	1116 4	1843 8	1324 8	37.4
DH - 205	630 0	868 1	1062 5	853 5	-
DH - 234	888 7	859 4	1312 5	1020 2	5 2
J Cori - 328	743 3	546 9	1437 5	909 2	-
J Cori - 360	705 3	651 0	1416.7	924 3	-
LCC - 174	222 3	477 5	1076 4	592 1	-
LCC - 225	333 3	460 1	1409 7	734 4	-
RCr - 20 (Check)	453 3	783 0	1447 9	894 8	-
RCr - 435 (Check)	867 7	883 7	1142 4	964 8	-
Local (Check)	371 3	477 5	1041 7	630 2	-
CD (F=0 05)	87 8	58 8	207 1	-	-
CV (%)	8 1	4 9	9 1	-	-

Table 49. Yield performance of coriander accessions under CVT - Hisar

Entries	Seed yield (kg/ha)				% increase over check	
	2002-2003	2003-2004	2004-2005	Mean	Hisar Anand	N. Sel.
LCC - 174	1473	1378	1075	1309	-12 4	-6 8
LCC - 225	1057	1114	1175	1115	-25 4	-20 6
DH - 205	1710	1611	1809	1710	14 5	21 8
DH - 234	1880	1779	1859	1839	23 1	31 0
JCO - 328	1493	1334	1390	1406	-05 9	00 1
JCO - 360	1647	1421	1198	1422	-04 8	12 8
UD - 118	1292	1414	1319	1342	-10 2	-04 4
UD - 480	1663	1465	1457	1528	02 3	08 8
K selection	1265	1596	1796	1552	03 9	10 5
NDC - 2	1548	1254	1564	1455	-02 6	03 6
Hisar Anand	1503	1428	1551	1494	-	-
Narnaul selection (Check)	1390	1394	1428	1404	-	-
C D. (P=0 05)	158	157	154	249	-	-

In the CVT at Guntur among the 20 entries tested during *Rabi* 2005-06, LCC-216 recorded significantly highest yield of 563 kg/ha follow by LCC-170 (554 kg/ha) and JCo-340 (554 kg/ha). The check variety Sadhana recorded an yield of 444 kg/ha. National check Hisar Sonali recorded an yield of 297 kg/ha, yield increase observed in LCC-216 was 26.9% and in LCC-170 and JCo-340 was 24.9% over the check Sadhana.

Twenty entries were evaluated at Raigarh. ICS-2 gave highest yield (679.04 kg/ha), followed by RD-366 (613.04 kg/ha) and ICS-3 (477.58 kg/ha) The check variety. Hisar Anand yielded 163.25 kg/ha.

At Dholi, among fourteen genotypes none of the entries was found significantly superior over national check, Hisar Anand and local check Rajendra Swathi regarding plant height. Among 14 genotypes, RD-366 were recorded in maximum number of branches per plant (8.830 number of umbels per plant (38.73) no of grains per umbel (30.93) yield per plot (1.27 kg0 with a projected yield of 1320 kg/ha followed by genotype RD-154.

At Kumarganj, thirty eight entries including three checks were evaluated in RBD during 2005-06 Observations were rerecorded on yield and other essential characters. Maximum yield was recorded in entry NDCor-30 (1.83 t ha^{-1}) followed by NDCor-2 (1 75 t ha^{-1} and Rcr-41, 1.56 t ha^{-1}) Most of the entries were found inferior than the check variety, Hisar Anand.

6.2.2 CVT 2004 Production of leafy type coriander during off-season

(*Coimbatore, Hisar* and *Guntur*)

The CVT was laid out at Coimbatore with 12 leafy types of coriander during off-season and was evaluated during 2005-06. Among those genotypes, DH-232, DH-228, CO-2 and LCC-234 registered the maximum leaf yield of 3.70, 3.4, 3.32 and 3.30 t/ha, respectively.

In leafy type coriander out of eleven entries evaluated in coordinated varietal trial during 2005 at Hisar, the entry DH-228 was late in flowering and gave highest leaf yield, which was closely followed by DH-202. It was better in performance than check variety, Pant Haritima. The entries CO-2, CO-4, LCC-232 and LCC-234 were of short duration and took about 22 to25 days to flowering, bolting, therefore did not produce green leaf yield.

At Guntur 8 genotypes were sown and all the entries failed to germinate due to high temperature.

6.2.3 Initial evaluation trial

(*Hisar, Guntur, Jobner* and *Jagudan*)

The IET in coriander was conducted at Hisar with 10 accessions during 2004-05 to 2005-06 The results indicated that the accessions DH-220 and DH-233 gave significantly better yield over Hisar Anand (check) showing an increase in yield of 29.4% and 34.2%, respectively.

At Guntur, among the twelve entries tested during 2005-06, LCC-237 recorded highest yield of 574 kg/ha, followed by LCC-240 and LCC-236 with 570 kg/ha and 562kg/ha, respectively which is superior over check, Sadhana (450 kg/ha). LCC-228 recorded highest oil percentage (0.5%) followed by LCC-237 (0.44%) compared with 0.35% in the check Sadhana. Highest volatile oil yield was recorded in LCC. 237 (2.52 L/ha) followed by LCC.228 (2.47 L/ha) and LCC 236 (2.36 L/ha).

The trial started in Jobner in *Rabi* 2004-05 with 10 entries. The analysis of variance revealed significant differences among the entries for all the trails including seed yield. The seed yield ranged from 1017.36 to 1645 83 kg/ha. Of the 10 entries evaluated, UD-20-130-278 recorded maximum seed yield of 1645.83 kg/ha, followed by UD-475 (1576 36 kg/ha) RCr-435 check (1444.44 kg/ha) UD-630 (1434.03 kg/ha), Merigold-6 (1409.72 kg/ha), while lowest yield of 1017.36 kg/ha was recorded in UD-707.

At Jagudan the mean yield data over the three years (2002-03 to 2004-05) showed significant yield differences among entries. An entry, JCr-340 recorded maximum yield of 1856 kg/ha (Table 50) which out yielded the check variety.

6.3 Quality evaluation trial

6.3.1 Quality evaluation in coriander

(Jobner)

At Jobner, sixteen entries of coriander under CVT were analysed for volatile oil content during *Rabi* 2002-03 to 2004-05. During 2004-05, the volatile oil content of the CVT entries ranged from 0.32 to 0.47%. The maximum volatile oil of 0.47% was observed in UD-118 and RCr-435 (check). The mean performance of the three years data presented in Table-51 indicated that the mean volatile oil content ranged from 0.36 to. 0.49%. The maximum mean volatile oil of 0.49% was observed in UD-118, followed by 0.47% in RCr-435 (check) 0.45% in DH-234 and LCC-175, 0.44% in UD-480 and DH-205 and minimum of 0.36% in RCr-20 (check). The entry UD-480 ranked first in terms of mean volatile oil yield (5.83 L/ha), followed by UD-118 (5.72 L/ha, DH-234 (4.59 L/ha), RCr-435 check (4.53 L/ha) and J. Cori-328 (3.82 L/ha)

Table 50. Yield performance of coriander accession under IET-Jagudan

Treatment	Yield (kg/ha $^{-1}$)				% increase over check
	2002-03	2003-04	2004-05	Mean	-
JCr - 333	1087	1889	1888	1621	-
JCr - 340	1295	2200	2073	1856	8 98
JCr - 342	997	1637	1781	1472	-
JCr - 375	1258	1877	1960	1698	-
JCr - 376	997	1870	1871	1579	-
JCr - 391	919	1562	1397	1293	-
JCr - 393	1217	1789	1720	1575	-
JCr - 402	1160	1573	1863	1532	-
JCr - 403	1336	1877	1771	1661	-
GCo.-2 (Check)	1340	1986	1782	1703	-
S Em +	53	108	99	55	-
C D. (P=0 05)	157	320	294	156	-
C V. %	7 86	10.23	9.46	9 73	-

Table 51. Mean volatile oil content of coriander entries under CVT (2002-03 to 2004-2005) - Jobner

Entry	Mean seed yield (kg/ha)	Volatile oil (%)				Mean volatile oil yield (l/ha)
		2002-03	2003-04	2004-05	Mean	
UD - 118	1167 3	0 5	0 5	0.5	0 5	5 7
UD - 480	1324 8	0.5	0 4	0 4	0 4	5.8
DH - 205	853.5	0.5	0 5	0 4	0 4	3.8

Entry	Mean seed yield (kg/ha)	Volatile oil (%)				Mean volatile oil yield (l/ha)
		2002-03	2003-04	2004-05	Mean	
DH - 234	1020.2	0 6	0.5	0.3	0.5	4.5
J.Cori - 328	909.2	0 5	0.5	0.4	0 4	3.8
J.Cori - 360	924 3	0.4	0.5	0 4	0.4	3.8
LCC - 174	592 1	0 5	0.5	0.4	0 5	2.7
LCC - 225	734 4	0.5	0 4	0 3	0 4	2.9
RCr - 20 (Check)	894 8	0 4	0.4	0 4	0 4	3.2
RCr - 435 (Check)	964.6	0.5	0 5	0.5	0.5	4 5
Local (Check)	630 2	0 4	0.4	0 3	0.4	2.5

The ten entries of coriander under IET were also tested for volatile oil content at Jobner during *Rabi* 2004-05. The volatile oil content of the IET entries ranged from 0.25 to 0.47%. The maximum volatile oil of 0.47% was observed in Merigold-6 followed by UD-475 and UD-20-130-278 (0.43%), UD-707 (0.40%), RCr-435 check (0.37%) and UD-627 (0.35%) and minimum on local check (0.25%). The entries UD-20-130-278, UD-475 and Merigold-6 have shown better performance compared to best check variety RCr-435 with respect to volatile oil yield (l/ha).

6.4 Nutrient Management Trial

6.4.1 Response of coriander to micronutrients

(*Guntur*)

The study conducted at Guntur for one year during 2004-05 revealed that micronutrients sprays (*viz*, $ZnSO_4$, $FeSo_4$, $CuSO_4$, $MnSO_4$ alone at 0.25% and 0.50% and all combinations at 0.25% and 0.50% (consisting of 12 treatments) had significant effect on coriander growth and yield. The observations recorded significant difference among plant height, number of primary branches, secondary branches, number of days to 50% flowering, number of umbels per plant, number. of umbellets per umbel and yield. Among the twelve treatments, treatment T-10 (Table 52) recorded significantly highest yield (940 kg/ha), followed by Fe SO_4 0.5% (927 kg/ha) and Zn SO_4 0.5% (922 kg/ha) which are on par with each other and significantly superior over control (801 kg/ha).

6.4.1 Effect of biofertilizer, *Azospirillum* on coriander

(*Coimbatore* and *Kumarganj*)

The experiment conducted at Coimbatore to

Table 52. Yield response of coriander to micronutrients -Guntur

	Name of the treatment	No. of umbel lets per umbel	Days to Maturity	Yield per plot (gm)	Yield per ha (kg)
T-1	$ZnSO_4$ 0.25 %	5.7	85 0	787	818
T-2	$ZnSO_4$ 0 5%	5.7	85 0	887	922
T-3	$FeSO_4$ 0 25%	6.3	86.3	829	862
T-4	$FeSO_4$ 0.5%	6 4	85.0	891	927
T-5	$CuSO_4$ 0 25%	6 0	83.7	790	822
T-6	$CuSO_4$ 0 5%	4.9	85.0	822	855
T-7	$MnSO_4$ 0.25%	5.2	84.7	763	794
T-8	$MnSO_4$ 0.5%	5.5	84.7	753	783
T-9	$ZnSO_4$ + FeSO4 + CuSO + $MnSO_4$ 0.25%^	6 2	84.3	873	908
T-10	$ZnSO_4$ + $FeSO_4$ + CuSO + $MnSO_4$ 0.25%^	6.4	84 7	904	940
T-11	Water	5 0	84 7	777	808
	Control	4.4	83 0	770	801
	CD (P=0.05)	1 0	1.4	105 4	109 77
	CV%	10 3	1 0	7 6	7.6

study the efficacy of *Azospirillum* and graded levels of nitrogen on yield of coriander variety. The study revealed that application of FYM (5 t/ha) + inorganic N (50%) + *Azospirillum* (1.5 kg- seed treatment) has recorded the highest yield of 435.2 kg/ha against 296.3 kg/ha in control.

The trial at Kumarganj experiment was conducted on variety Pant Haritima with 10 treatments in RBD during 2005-06. Observations were recorded on yield and ancillary characters. Maximum seed yield (1.37 t ha^{-1}) was recorded by application of FYM 10 t ha^{-1} + *Azospirillum* 1.5 kg ha^{-1} seed treatment followed by inorganic nitrogen 100 % + *Azospirillum* 1.5 kg ha^{-1} seed treatment + FYM 5 t ha^{-1} producing seed yield (1.33 t ha^{-1}).

6.4.3 Effect of bioregulators on coriander

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

The experiment consisting of 13 treatment combinations comprising 4 bio- regulators laid out at Jobner in 2004-05. The application of NAA 50 ppm resulted in significantly higher seed yield of coriander (1728 kg/ha) but it was at par with Triacontanol 1.0 ml/l. Triacontanol 1.0 ml/l was also significantly superior over Triacontanol 0.5 ml/ l and water spray. Data further indicated that with the increase in number of sprays, the seed yield also showed increasing trend but the significant response was observed upto 2 sprays i.e. at 40 and 60 DAS.

At Guntur during 2005-06 *Rabi* season two growth regulators *viz.*, Triacantanol and IAA at two doses and three levels of spray timings were studied to know the effect on yield. Among different treatments, NAA 10 ppm recorded significantly highest yield (600 kg/ha) which is on par with Triacantamole 1 ml (580 kg/ ha). The effect of number of sprays, two spraying at 40 and 60 DAS recorded significantly highest yield (553 kg/ha). (Table 53).

At Dholi, spraying of Triacontanol @ 0.5ml/ l of water gave the maximum number of branches per plant (7.61) number of umbels per plant (52.66), number of grains per umbel (29.69), yield per plot (1.43 kg) (1.43 kg) which is followed by application of Triacontanol application @ 1.0 ml/litre of water study also revealed that three sprays at 40, 60 and 80 DAS gave the maximum number of umbels per plant 53.15 number of grains /umbel (29.23) yield per plot (1.33 kg).

Table 53. Effect of bioregulators on coriander yield (kg/ha) - Guntur

Factor-1 / Factor-2	Tria. 1.0 ml/lt	Tria.0.5 ml/lt	NAA 10 ppm	NAA 50 ppm	Water	Control	Mean
40 DAS	509	486	565	468	454	436	487
40 & 60 DAS	645	546	650	581	462	435	553
40, 60 & 80 DAS	586	585	587	540	469	409	529
MEAN	580	539	600	530	462	427	
CD (Factor-1)(P= 0.05)	55.6						
CD (Factor-2) (P=0.05)	39.4						
Interaction	NS						
CV (%)	11.1						

Table 54. Performance of coriander germplasm lines for drought tolerance - Guntur

Drought tolerance parameter	Range	Germplasm lines	
		Low	High
Biomass (g/5 plants)	90.0-8.0	LCC-153 (8.0), LCC-177 (9.0)	LCC-241 (90.0), LCC-162 (79.0)
Root length	25.2-4.6	LCC-154 (4.6), LCC-153 (4.8)	LCC-133 (25.2), LCC-171 (12.2)
Shoot length	77.0-23.4	LCC-153 (23.4), LCC-197 (32.8)	LCC-238 (77.0), LCC-244 (74.6)
Root : Shoot Ratio	0.58-0.08	LCC-154 (0.08), LCC-235 (0.09)	LCC-133 (0.58), LCC-138 (0.28)
RWC (at 75 days)	80.0-48.0	LCC-179 (48.0), LCC-171 (54.0)	LCC-190 (80.0), LCC-192 (78.0)
Chlorophyll stability index	0.89-0.45	LCC-195 (0.45), LCC-194 (0.53)	LCC-191 (0.89), LCC-185 (0.89)
Proline (micromoles for gram of fresh leaf at 75 DAS)	55-138	LCC-212 (55), LCC-209 (56)	LCC-184 (138), LCC-183 (136)

* RWC, Proline and CSI were recorded only in 36 germplasm lines along with four checks, where as Biomass, Root length, Shoot length, Root-Shoot ratio were recorded in all the 124 germplasm lines.

Experiment was conducted on variety Pant Haritma with 13 treatments in RBD during 2005-06 at Kumarganj. The study indicated that spray of Tricontanol 1.0 ml per liter of water (3 spray) 40, 60, 80 days (T6) given highest seed yield 1.51 t ha^{-1} followed by spray of NAA-50 ppm (3 spray) 40, 60, 80 days (T9) and NAA-50 ppm (2 spray) 40, 60 days (T8) 1.49 t ha^{-1} and 1.39 t ha^{-1}, respectively.

6.4.4 Identification of drought and alkalinity tolerance source in coriander

(*Guntur* and *Kumarganj*)

At Guntur during 2005-06, 124 germplasm lines were evaluated for their drought tolerance and among these 36 lines were studied for their physiological ability of drought tolerance using relative water content and leaf proline content and chlorophyll stability index as drought tolerance parameters. The data related to plant and physiological parameters of drought are given in Table 54.

Among the genotypes evaluated, maximum biomass was recorded in LCC-241 (90 g/five plants). Among the forty lines tested for their drought physiology, RWC value at 75 DAS ranged from 48.0 (LCC-179-48.0, LCC-171-54.0) to 80.0 (LCC-190-80.0, LCC-192-78.0). The chlorophyll stability index at 45 DAS ranged from 0.45 (LCC-195-0.45, LCC-194-0.53) to 0.89 (LCC-191-0.89, LCC-185-0.89). The leaf proline content at 75 DAS ranged from 55.0 (LCC-212-55.0, LCC-209-56.0) to 138.0 (LCC-184-138.0, LCC-183-136.0).

At Kumarganj during 2005-06 the experiment was conducted to test 10 varieties of coriander at various ESP levels increasing the ESP levels up to 40 decrease the seed yield per plant. The maximum seed yield per plant 45 g was obtained when variety NDcor-2 was shown at 10 ESP level followed by variety (NDcor-8) 38.15 g at the same ESP levels.

6.4 Disease Management Trial

6.4.1 Management of powdery mildew and stem gall in coriander

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

A field trial was conducted to test the efficacy of biocontrol agents against stem gall and powdery mildew diseases of coriander under field conditions during 2005-06 at Coimbatore. The results revealed that seed treatments with *Pseudomonas fluorescens* IISR-6 @ 10g/kg of seed followed by foliar spraying @ 10^8 CFU on 60 DAS was found to be effective to contain the powdery mildew disease giving only 10.66 PDI when compared to control (53.2 PDI) and recorded the maximum cost benefit ratio of 1:2.6. This treatment is on par with wettable sulphur @ 0.2% sprayed plot which recorded 9.66 PDI. No stem gall disease was noticed during the period.

At Raigarh, the study is in the second year of progress. Minimum disease intensity of powdery mildew (20.19%) was observed in T6 (spray with wettable sulphur) followed by T5 (20.82%) i.e carbendazim (bavistin) as soil drench and spray (0.1%). Maximum plot yield (1.07 kg) were recorded in T5 followed by T6 and statistically at par in respect of disease intensity and yield. Maximum disease intensity (73.16%) and minimum plot yield (30 kg) recorded in control.

In the trial on the management of stem gall of coriander at Raigarh, minimum disease incidence of 13.74% was observed in treatment T4 (seed treatment, soil drench Tridemorph (Calixin) 0.1% + spray with calixin 0.1% after 60 days) and maximum plot yield 0.94 kg was recorded in treatment T1 (Soil solarization + soil application of *Trichoderma* (1 kg/plot) + spray with Tridemorph (calixin) 0.1 % after 60 days of sowing) followed by T4. In respect of disease intensity and plot yield T1, T4 and T5 were statistically at par. Maximum disease intensity (43.74%) and minimum plot yield 0.39 kg were observed in control.

At Jagudan, the incidence of powdery mildew was high and stem gall disease was not reported. Evaluation of various biocontrol agents and fungicides for the management of the disease did not give significant results. However, as in the last year the minimum incidence was found in treatment T-4 (seed treatment and soil drench with Tridemorph (Calixin) 0.01% + spray with the same on 60 DAS).

At Jobner, a field experiment with seven treatments was conducted in *Rabi* 2004-05. Out of the seven treatments including control minimum powdery mildew (0-score) with maximum seed yield of 1860 kg/ha was recorded in the treatment where solarization + soil application of *Trichoderma* + sprayed with calixin followed by spray with wettable sulphur, with the seed yield of 1720 kg/ha. The control resulted in maximum disease incidence (4-score) and seed yield 1370 kg/ha as compared to all

Table 55. Management of powdery mildew and stem gall in coriander - Jobner

Treatment	College Research Farm			Farmer's field		
	Powdery mildew (0-4)	Stem gall (0-4)	Yield (kg/ha)	Powdery mildew (0-4)	Stem gall (0-4)	Yield (kg/ha)
Soil solarization + soil application of *Trichoderma* + spray with calixin	0	0	1860	0	0	950
Seed treatment with *Pseudomonas flourescence* + Spray with *P.flourescence*	3	0	1530	2	3	630
Soil application of *Bacillus subtilis* + spray with *Bacillus subtilis*	3	0	1487	3	3	620
Seed treatment and drenching calixin + spray with calixin	2	0	1377	1	1	850
Carbendazim (Bavistin) as soil drench and spray	2	0	1507	2	2	800
Spray with wettable sulphur	1	0	1720	1	2	700
Control	4	0	1370	3	4	350
CD (p = 0.05)	---	---	202	---	---	---

other treatments. The stem gall disease did not appear during the period (Table 55).

At Kumarganj, soil drenching and foliar spray of Carbendazim (0.2 %) had minimum stem gall disease and minimum powdery mildew disease was observed when the crop was sprayed with wettable sulphur (0.2 %). Maximum yield of 0.502 t ha^{-1} was obtained with soil application of *Bacillus subtilis* @ 10^8 CFU and spray of *Bacillus subtilis* @ 10^8 CFU and spray of *Bacillus subtilis* after 60 days of sowing over control.

7. CUMIN

7.1 Genetic Resources

7.1.1 Germplasm collection, characterization, evaluation, conservation and screening against diseases

(*Jagudan, Jobner* and *Raigarh*)

The Jagudan centre maintains 226 collections including 7 exotic ones. The 214 entries of cumin were compared with two checks (GC-2 and GC-3) during *Rabi* season. Among them 10 entries observed dwarf type and 13 entries identified as high yielders which recorded a grain yield of more than 800 kg/ha. Out of 76 entries tested none of the entry was found free from blight disease incidence. The PDI ranged from 14 to 95%. The minimum incidence was noticed in JC-2000-55 (14%) and maximum in UC-341 (95%).

At Jagudan during the year, 86 entries including 10 entries received from Kumarganj were screened for the resistance against powdery mildew disease under natural condition and the incidence ranged from 37.50 to 93.75%. None of the entries was found resistant or tolerant against the disease. The minimum incidence was reported in JC-2000-53 (37.50%) followed by JC-2000-46 (40.00%). Total 41 entries were screened for wilt under wilt sick plot conditions. None of the entries was found tolerant against the disease. The per cent wilt disease ranged from 43.09% to 100%, varieties viz. GC-3 (43.09%) GC-4 (46.11%) and JC-3 (43.09%) GC-4 (46.11%) and JC-2000-4 (47.42%) were found resistant.

Jobner centre maintains a total of 376 accessions including 6 exotic ones. Out of this, 152 accessions were evaluated and variability was found for all the characters studied. Forty three accessions were better than the check variety, UC-223. Some of the promising accessions identified on the basis of yield per plot were UC-299, UC-274, UC-220, UC-331, UC-334, UC-239, UC-225, UC-344, UC-273, UC-330, UC-333 and UC-343.

At Jobner out of ten entries of cumin (CVT), entry UC-341, JC-2000-21 and JC-2000-72 gave 5% wilt and (1 score - bligh) and 1 score - powdery mildew with the seed yield of 586 kg/ha, 552 kg/ha and 508 kg/ha, respectively. Maximum disease incidence was in local check (25% wilt), (3 score - blight) and (4 score - powdery mildew) with the seed yield of 253 kg/ha. Out of ten (IET) entries of cumin, UC-345, CMB-79 and UC-343 gave minimum percentage (wilt 10%) (2 score blight)

with the seed yield of 383 kg/ha, 349 kg/ha and 346 kg/ha respectively. The local check resulted in maximum disease incidence (wilt 25%) and (3 score blight) and (3 score - powdery mildew) with the lowest seed yield of 258 kg/ha.

At Raigarh, out of 8 entries, none of the entries germinated and hence the trial failed. The cumin germplasm at different centres are given in Table 56.

Table 56. Germplasm collection of Cumin

Center	Indigenous		Exotic	Total
	Cultivated	Wild and related sp.		
Jobner	370	-	6	376
Jagudan	219	-	7	226
Kumarganj	19	-	-	19
Total	**608**	**-**	**13**	**621**

7.2.2 CVT 2001- Series IV

(Jobner)

The CVT of cumin started in Rabi 2002-03. The character wise pooled mean over three data indicated that the entries differed significantly for all the characters studied. The mean yield performance of the entries evaluated over the three years (2002-03 to 2004-05) revealed the superior performance of UC-341 yielding 405.33 kg/ha followed by JC-2000-21 (379.26 kg/ha). The observation on all the yield characters recorded and the mean seed yield of the 8 entries over the years are presented in Table 57.

7.3 Varietal Evaluation Trial

7.3.1 Initial evaluation trial

(Jagudan)

At Jagudan, non-significant differences for yield observed among entries. The pooled over two years data (2003-04 and 2004-05) showed significant yield differences among the entries. The entries JC-95-12 and JC-95-30 significantly out yielded (1042 kg/ha and 10334 kg/ha) than two checks GC-2 and GC-3, but on par with another check, GC-4. Both these entries are 7-16 days earlier in maturity than the checks.

The trial started in Rabi 2002-03 at Jobner consisted of 10 entries and was concluded in Rabi 2004-05. The pooled mean over three years indicated that the entries differed significantly for all the characters studied. Mean yield performance of the entries presented in Table–58 revealed the superior performance of UC-345 yielding 386.88 kg/ha, followed by UC-349 (332.99 kg/ha), and UC-348 (221.20 kg/ha).

Table 57. Yield performance of cumin entries in CVT (*Rabi* 2002-03, 2003-04 and 2004-05) - Jobner

Entries	Seed yield (kg/ha)				% increase over check
	2002-03	2003-04	2004-05	Mean	
UC-341	260 3	369.8	585 9	405.3	61 7
UC-342	224.8	335.9	380.2	313 6	25.1
JC-2000-21	262 8	322 9	552.1	379.3	51.3
JC-2000-22	275.5	244 8	471 4	330.6	31 8
JC-2000-27	221.5	225.3	401.0	282 6	12.7
JC-2000-72	225.3	226.7	507.8	319.9	27.6
RZ-19 (Check)	215.8	247.4	289.1	250 7	-
Local (Check)	170 8	166.7	252.6	196.7	-
CD at (P=0.05)	38.3	30.7	73 2		
CV (%)	10.7	7 7	11.8		

Table 58. Yield performance of cumin entries evaluated under IET (*Rabi* 2002-03, 2003-04 and 2004-05) - Jobner

Entries	Seed yield (kg/ha)				% increase over check
	2002-03	2003-04	2004-05	Mean	
UC - 343	294 3	322 9	346.4	321.2	13.8
UC - 344	287.0	237 9	289 1	271.3	-
UC - 345	382 0	395.8	382 8	386.9	37.0

Entries	Seed yield (kg/ha)				% increase over check
	2002-03	2003-04	2004-05	Mean	
UC - 346 (CMB-79)	308.0	342.0	348.9	332 9	17.9
UC - 347 (CMB-88)	261 7	236.1	302 1	266.6	-
UC - 348 (CMB-90)	294.3	315.9	309.9	306 7	8.6
UC - 349	203.3	230.9	296.9	243.7	-
RZ - 19 (Check)	308.0	218.8	320 3	282.4	-
RZ - 209 (Check)	220 0	237.9	294.3	250 7	-
Local (Check)	132.0	145 8	257.8	178 6	-
CD (P=0.05)		33.5	34.5	66.9	-
CV (%)	8.4	8 9	14.6	-	-

6.4 Quality evaluation trial

6.4.1 Quality evaluation in cumin

(Jobner)

Ten entries of cumin under CVT were analysed for volatile oil content during 2002-03 to 2004-05 at Jobner. The volatile oil content of the CVT entries ranged from 3.15% to 5.35% in rabi 2004-05. The maximum volatile oil of 5.05% was obtained in GC-3 followed by 5.05% in JC-2000-22 and maximum volatile oil yield in terms of litre/ha was observed in JC. 2000-22 (23.80 l/ha), followed by UC-341 (22.85 l/ha) JC-2000-21 (19.32 l/ha) and minimum in local (8.34 l/ha). The mean performance of three years data (2002-03 to 2004-05) presented in Table 59 indicated that the mean volatile oil content ranged from 3.81% to 4.28%. The entry UC-341 ranked first in terms of mean volatile oil yield (15.69 l/ha) followed by JC-2000-21 (14.75 l/ha), JC-2000-22 (14.15 l/ha) and UC-342 (12.79 l/ha).

The entries of cumin under IET were also analysed for volatile oil content during 2002-03 to 2004-05 at Jobner. The volatile oil content in the entries of cumin ranged from 3.53% to 5.35% and the maximum of 5.35% was recorded in UC-344 followed by 5.08% in CMB-88, 4.7% in CMB-134, 4.55% in UC-343 and CMB-90 and 4.45% in RZ-209 check. The entries UC-343, UC-344, UC-345, CMB-88, CMB-90 and CMB-134 have shown better performance than the best check RZ-209 with respect to volatile oil yield per hectare.

The mean performance of the volatile oil yield data of the three years is presented in Table 60. The mean volatile oil content of these entries ranged from 3.73% to 5.07%. It is noted that all the entries except CMB-79 and UC-345 performed better than all checks with respect to mean volatile oil yield/ha.

Table 59. Mean volatile oil content of cumin entries (CVT) 2002-03 to 2004-2005-Jobner

Entry	Mean seed	Volatile oil (%)				Mean volatile
	yield (kg/ha)	2002-03	2003-04	2004-05	Mean	oil yield (l/ha)
UC - 341	405.3	3.9	3.8	3.90	3 9	15.7
UC - 342	313.6	4.3	4.0	4.00	4.1	12.8
JC - 2000-21	379 3	4 6	3 6	3.5	3.9	14.8
JC - 2000-22	330.6	4.6	3 2	5.1	4.3	14 2
JC - 2000-27	282 6	4.3	3.6	3 7	3 9	10 9
JC - 2000-72	319.9	4.6	4.0	3 2	3.9	12.5
RZ - 19 (Check)	250 7	4.6	3.6	3 3	3 8	9 6
Local (Check)	196 7	3.9	4 8	3.3	4 0	7 9

Table 60. Mean volatile oil content of cumin under IET- Jobner

Entry	Mean seed	Volatile oil (%)				Mean volatile
	yield (kg/ha)	2002-03	2003-04	2004-05	Mean	oil yield (l/ha)
UC - 343	386.9	4.5	4.8	4 6	4.6	17 9
UC - 344	333 0	4 3	5 6	5.4	5 1	16 9
UC - 345	306.7	4.0	4.0	4 1	4.0	12 3

Entry	Mean seed yield (kg/ha)	Volatile oil (%) 2002-03	2003-04	2004-05	Mean	Mean volatile oil yield (l/ha)
CMB - 79	282 4	4 3	3.4	3 5	3 7	10.5
CMB - 88	271.3	4 3	5.2	5 1	4.8	13.1
CMB - 90	266 6	4 0	4.8	4.6	4.5	11.9
CMB - 134	250 7	3 8	4 8	4.7	4.4	11.1
RZ - 19	243 7	4 0	4.0	4.1	4.0	09.8
RZ - 209 (Check)	321 2	4.0	4 4	4.5	4.3	13.8
Local (Check)	178 6	3 5	4.8	4.3	4.2	07.5

7.5 Disease Management Trial

7.5.1 Management of wilt and blight disease in cumin

(*Jobner* and *Jagudan*)

A field experiment with ten treatments was conducted at Jobner in 2004-05 for the management of wilt and blight of cumin. Minimum wilt incidence (5%) and (0-score) blight was recorded in the treatments where *Trichoderma* + FYM applied and sprayed with mancozeb @0.25% and maximum seed yield 308 kg/ha was recorded followed by vermicompost +*Trichoderma* applied and sprayed with mancozeb @0.25% with the wilt (8%) and blight (1-score) with the seed yield of 282 kg/ha. (Table-61)

Field trial on management of wilt and blight diseases in cumin initiated during 2004 at Jagudan was continued. The data revealed that the incidence of blight disease was high while wilt was very low. The result of both the diseases were found non significant (Table 62).

Table 61. Management of wilt and blight in cumin (*Rabi*, 2004-2005) - Jobner

Treatment	Wilt (%)	Blight (%)	Seed yield (kg/ha)
Soil solarization + soil application of *Trichoderma* + FYM (5 t/ha)+ spray with mancozeb 0.25% (60 DAS)	20	3	251
Trichoderma + FYM + spray with mancozeb 0.25% (60 DAS)	5	0	308
Vermicompost (2 t /ha)+ *Trichoderma* + spray with mancozeb 0.25% (60 DAS)	8	1	282
Neem cake (2 t/ha) + *Trichoderma* + spray with mancozeb 0.25% (60 DAS)	10	2	236
Soil drench with carbendazim 0.1% + spray with mancozeb 0.25% (60 DAS)	10	2	232
Pseudomonas fluorescens (IISR-6) 10^8 cfu as seed treatment and spray (60 DAS)	20	3	210
Bacillus subtilis as soil application and foliar spray (60 DAS)	20	3	192
Pseudomonas fluorescens + *Trichoderma* as soil application + P.f. (IISR-6) 10^8 cfu as spray (60 DAS)	25	2	205
B.s. + *Trichoderma* as soil application + *P.f.* (IISR-6) 10^8 cfu as spray (60 DAS)	25	3	175
Control	25	4	174
CD (p = 0.05)	---	---	15

Table 62. Management of wilt and blight disease in cumin - Jagudan

Treatment Details	PDI Blight	Wilt (%)	Yield (kg/ha)
Soil solarization - Soil application of *Tricoderma harzianum* + spray mancozeb 0.25 % (60 DAS)	48.7	10.0	72.2
Soil application of *Trichoderma harzianum* + FYM + spray mancozeb 0.25% (60 DAS)	56 0	13.3	66.9
Vermicompost soil application of *Trichoderma harzianum* + spray mancozeb 0.25% (60 DAS)	53.0	8 3	73.2
Neem cake + soil application of *Trichoderma harzianum* + spray mancozeb 0 25% (60 DAS)	53.3	11 7	43.1
Soil drench with carbendazim 0.1% + Spray mancozeb 0 25% (60 DAS)	60 3	8 3	46.5
Pseudomonas fluorescens (IISR-6) 10^8 cfu as seed treatment and spray (60 DAS)	76.3	5.0	21.5
Bacillus subtillis as soil application and foliar spray (60 DAS)	60.3	8.3	40.4
Pseudomonas fluorescens (IISR-6) 10^8 cfu as seed treatment + soil application of *Trichoderma harzianum* + *Pseudomonas fluorescens* as spray	71.7	6 7	30.3
Bacillus subtillis as soil application + soil application of *Trichoderma harzianum* + *Pseudomonas fluorescens* as spray	68.7	6.7	32.3
Control	60.3	8 3	30.8
Spray mancozeb 0.25% (40, 50, 60 & 70 DAS)	30.0	10.0	136.4
S.Em+	10.9	2.7	6 82
CD (P=0.05)	NS	NS	20 1
CV (%)	32.7	52.9	20 0

However, the minimum incidence of blight disease reported in the recommended treatment (ie spray of mancozeb @ 0.25% at 40, 50, 60 and 70 DAS) and minimum wilt incidence in *Pseudomonas* (IISR-6) 10^8 cfu as seed treatment and spray at 60 DAS. The data on yield showed significant difference among treatment with highest yield (136.36 kg/ha) reported by sprayof mancozeb @ 0.25% at 40, 50, 60 and 70 DAS. Other treatments were at par with each other.

8. FENNEL

8.1 Genetic Resources

8.1.1 Germplasm collection, characterization, evaluation, conservation and screening against diseases.

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

The Jagudan centre maintains 119 fennel accessions including 4 exotic lines. Out of this, 103 indigenous and 4 exotic entries were evaluated with checks GF-1, GF-2 and GF-11 during 2004-05 and promising entries selected for further study. Total 81 entries were screened against blight disease during 2004-05. The disease incidence was very low, but none of the entries were found free from disease. The minimum disease incidence reported in GF-2 (check) JF-544, ACC.1567, ACC-1372, ACC.1627, ACC.1657, ACC.1655 and ACC.1677.

The Hisar centre maintains 94 germplasm accessions. During 2004-05, 94 accessions of fennel were evaluated using PF-35 and GF-1 and local as check. The seed yield ranged from 320 g (HF-190) to 1100g (HF-107) per 2.5 x 1.2 m plot. Twenty three lines gave higher seed yield than the check PF-35. The most promising lines were HF-102, HF-107, HF-114, HF-116, HF-125, HF-129, HF-131, HF-149 and HF-154.

At Dholi, 31 germplasm accessions were evaluated and the seed yield ranged from 300 g (RF-4) to 970 g (RF-34) in 5.4 m^2 area On the basis of the yield performance, 8 accessions gave the maximum yield. Accession *viz*, RF-34 gave maximum yield (970 g/5 4 m^2), followed by RF-20 and RF-18 (950 g/5 4m^2).

At Kumarganj, 40 lines were evaluated in augmented design during 2005-06. Yield range was 0 48-1 25 t /ha. Highest seed yield was recorded in NDF-5 (1 25 t/ha $^{-1}$) followed by NDF-33 (1 10 t/ha $^{-1}$) The fennel germplasm at different centres are given in Table 63.

Table 63. Germplasm collection of Fennel at the AICRP centres

Center	Indigenous		Exotic	Total
	Cultivated	Wild and related sp.		
Coimbatore	3	-	-	3
Jobner	187	-	20	207
Jagudan	115	-	4	119
Hisar	94	-	-	94
Dholi	31	-	-	31
Kumarganj	39	-	-	39
Total	**469**	**-**	**24**	**493**

8.2 Coordinated Varietal Trial

8.2.1 CVT-2004-Series VI

(*Jagudan, Jobne, Dholi, Kumarganj* and *Hisar*)

At Jagudan, among the 12 entries, yield differences were found significant. The entries, JF-444-1 and JF-376 significantly out yielded the national check, RF-101 by producing 50.14 and 48 53 percent higher yield respectively.

The trial initiated in Rabi 2004-05 at Jobner. The analysis of variance revealed significant differences among the entries for all the traits including seed yield. The seed yield ranged from 673.33 to 1256.67 kg/ha. Of the 12 entries evaluated, UF-205 recorded maximum seed yield of 1256 67 kg/ha followed by GF-2 check (1126.67 kg/ha) UF 207 (1076 67 kg/ha) JF-444-1 (1053 33 kg/ha) and HF-118 (996 67 kg/ha) while lowest seed yield of 673.33 kg/ha was recorded in NDF-12.

At Hisar, out of 15 entries evaluated during 2004-05, significant differences were obtained for all the parameters observed The maximum seed yield (2042kg/ha) was obtained with HF-125 which was statistically at par with UF-207, HF-118, UF-205, HF33 (check) and RF-101 (check)

At Dholi, the trial conducted from 2002-03 to 2005-06 with 11 entries. Out of which, RF-31 and RF-21 gave significantly more yield during 2005-06 compared to check, Rajendra Saurabh. RH-31 gave 1380 kg/ha, followed by RF 21 (1330 kg/ha). Another trial started at Dholi during 2005-06 with 10 entries. The yield was very low and entries did not perform well due to late sowing

At Kumarganj, experiment was conducted with 31 entries in RBD during 2005-06. Plant height ranged from 105.67 to 144.00 cm., number of umbel per plant from 105.00 to 150 00 and days to maturity 148.33 to 158 67 days. Highest seed yield was recorded as 1.97 t/ha^{-1} in NDF-5 followed by UF-143, RF-15 and RF-18 (1.91 1.84, 1.84 t ha $^{-1}$), respectively.

8.3 Varietal Evaluation Trial

8.3.1 Initial evaluation trial

(*Jagudan, Jobner* and *Hisar*)

The trial with ten entries started in 2004-05 at Jagudan and non significant yield difference were observed among the entries. However, the entries JF-501-2 and JF-472-2-3 recorded higher yield (2404 and 2342 kg/ha) than check GF-11 during 2004-05.

The IET started in *Rabi* 2002-03 concluded in Rabi 2004-05 at Jobner. The characterwise pooled mean over three years data indicated that entries differed significantly for all the character studied. (Table 64).

Table 64. Yield performance of fennel entries in IET (2002-2003 to 2003-2004 and 2004-05) - Jobner

Entries	Seed yield (kg/ha)			% increase over check	
	2002-03	2003-04	2004-05	Mean	(RF-101)
UF - 33	725 00	1284 67	1230 67	1080 11	11 54
UF - 95	694 33	1048 67	1156 00	966 33	-
UF - 119	798 33	1135 67	967 33	967 11	-

Entries	Seed yield (kg/ha)				% increase over check
	2002-03	2003-04	2004-05	Mean	
UF - 128	569.33	1032.67	1001.33	867.77	-
UF - 136	676.67	1232.67	1027.33	978.89	1.09
UF - 145	812.67	1293.33	1273.33	1126.44	16.33
UF - 175	986.33	1194.33	1301.33	1160.66	19.86
UF - 176	743.33	1055.67	918.00	905.67	-
UF - 131	979.33	902.67	986.00	956.00	-
UF (M) - 1	918.33	1083.33	1199.33	1067.00	10.19
RF - 101 (Check)	736.00	1041.67	1127.33	968.33	
Local (Check)	481.00	916.67	1060.00	819.22	
CD (P=0.05)	154.30	124.30	146.07		
CV (%)	11.99	6.66	7.81		

The mean performance of entries evaluated in over three years (2002-03 to 2004-05) presented in Table 47 revealed the superior performance of UF-175 yielding 1160.60 kg/ha followed by UF-145 (1126.44 kg/ha) UF-33 (1080 kg/ha).

The IET was conducted with 10 accessions at Hisar during 2004-05 and 2005-06. HF-131 and HF-143 gave significantly better yield over GF-2 showing 24.3 and 24.5% increase in yield respectively.

8.2 Quality Evaluation Trial

8.2.1 Quality evaluation in fennel

(Jobner)

At Jobner, 12 entries of fennel under CVT were analysed for volatile oil content during rabi-2004-05 and it ranged from 2.07 to 3.0%. The maximum volatile oil of 3.0% was observed in UF-205 followed by 2.8% in UF-207, 2.73% in NDF-12, 2.67% in local check. 2.53% in UF-206, JF-444-1, HF-118 and IRF-101 check and minimum of 2.07% in JF-421. The entries UF-205, UF-207 and JF-4441 have shown better performance as compare to the check with respect to volatile oil yield/ha.

The 12 entries of fennel under IET were also tested for volatile oil content at Jobner during 2002-03 to 2004-05. The volatile content of the entries of fennel under IET ranged from 2.40 to 3.13% during 2004-05. The mean performance of the three years data (2002-03 to 2004-05) presented in Table 65 indicated that the mean volatile oil content in these entries ranged form 2.19% to 2.94%. The entry UF (M)-1 recorded maximum mean volatile oil content (2.94%) and also performed better with regard to yield as compared to the check varieties. The entries UF (M)-1, UF-145 and UF-175 have better performance as compared to the best check variety RF-101 with respect to volatile oil yield.

Table 65. Mean volatile oil content of fennel under IET(2002-03 to 2004-2005)

Entry	Mean seed	Volatile oil (%)				Mean volatile
	yield (kg/ha)	2002-03	2003-04	2004-05	Mean	oil yield (l/ha)
UF - 33	1080.1	2.5	2.4	2.6	2.5	27.0
UF - 95	966.3	2.5	2.4	3.1	2.7	25.9
UF - 119	967.1	2.4	2.4	3.8	2.6	25.3
UF - 128	867.8	2.6	2.2	2.6	2.5	21.4
UF - 136	978.9	2.4	2.4	3.0	2.6	25.5
UF - 145	1126.4	2.5	2.4	2.9	2.6	29.2
UF - 175	1160.7	2.6	2.2	2.7	2.5	29.1
UF - 176	905.7	2.8	2.2	2.5	2.5	22.7
UF - 131	956.0	2.3	1.8	2.5	2.2	20.9
UF (M) - 1	1067.0	2.5	3.4	2.9	2.9	31.4
RF - 101 (Check)	968.3	2.5	2.2	2.7	2.5	24.0
Local (Check)	819.2	2.5	3.0	2.	2.6	21.6

8.5 Nutrient Management Trial

8.5.1 Effect of bio-fertilizer using *Azospirillum*

(Kumarganj)

The experiment was conducted with variety NDF-6 consisting of 10 treatments in RBD during 2005-06. Observations were recorded on yield and yield contributing traits. Maximum seed yield 0.90 t ha^{-1} was recorded by the application of FYM 10 t ha^{-1} + *Azospirillum* 1.5 kg ha^{-1} seed treatment followed by FYM 5 t ha^{-1} + *Azospirillum* @ 1 5 kg ha^{-1} seed treatment (0.74 t ha^{-1})

8.5.2 Identification of drought/ alkalinity tolerance source in fennel

(Kumarganj)

The trial initiated to test the various ESP levels on 10 varieties/ lines of fennel and found that the maximum seed yield (51.33 g plant^{-1}) was recorded under variety V_6 (NDF-6) at 10 ESP level and next best variety was V_5 (NDF-5) which produce 50.66 g plant^{-1}. Decrease in seed yield per plant was noted with increasing the level of ESP in fennel.

9. FENUGREEK

9.1 Genetic Resources

9.1.1 Germplasm collection, characterization, evaluation, conservation and screening against diseases

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

A total of 26 fenugreek accessions were evaluated *viz*, RMt. 303, RMt.1, RM 28, RM 18 from Dholi, HM 65 HM 232, HM 376, HM 292, HM 444, Hisar sonali and HM 65 from Hisar, NDM 20, NMD 19 and NDM 25 from Faizabad, UM 363, UM 362, UM 351, UM 361, UM 392, UM 1, UM 352, CM 1 and CM 145 from Jobner and JF 270 and JF 244 were evaluated for their growth and yield performance at Coimbatore during rabi 2005-06 CO 2 fenugreek was used as local check. Among the 26 accessions, accession RMt.303 recorded the highest yield of 1030 kg/ha, followed by JF 244 which recorded an yield of 870 kg /ha. The accession HM 232 recorded the lowest yield of 225 kg/ha. All the accessions were screened for their resistance against powdery mildew disease. The CVT entries RMt 303 and JF 270 recorded the minimum disease incidence of 14.23% and 15 23%, respectively.

Jagudan centre is maintaining 63 fenugreek accessions in the gene pool and were evaluated for different characters Eleven entries were found promising for yield (>2600 kg/ha) During the reported period 42 entries were screened against powdery mildew disease. The disease incidence was minimum and it ranged from 10 to 81 25% None of the entries were found free from disease incidence. The minimum incidence was noticed in Kasuri (10%), followed by JFg 13 (18 75%) JFg 182 (20%) JFg-7 (20%), JFg-181 (20%) JFg-178 (25%)

At Jobner, the germplasm entries of fenugreek was screened for the resistance against diseases. Twenty entries of fenugreek tested against root knot nematode at ARS, Durgapura (Jaipur) revealed that out of twenty entries, UM-352 and UM-351 found resistant and rest others were found moderately resistant to highly susceptible.

Twenty entries of fenugreek screened against powdery mildew at farmer's field Danta (Sikar) out of which sixteen entries of fenugreek UM-352 and UM-351 were found free from powdery mildew disease.

During *Rabi* 2004-2005, out of 16 CVT entries of fenugreek, UM-352 and UM-351 were found free from root rot, downy mildew and powdery mildew disease with the maximum seed yield of 2118 kg/ha and 2080 kg/ha, respectively. The local check recorded in maximum disease (15% root rot), (5 score downy mildew) and (4 score, powdery mildew) with the minimum seed yield of 1146 kg/ha. During *Rabi* 2004-05, out of sixteen IET entries of fenugreek, NS-2003-1 and NS-2003-4 was found free from root rot, downy mildew and powdery mildew disease with the maximum seed yield of 2590 kg/ha and 2507 kg/ha, respectively. The local check resulted in maximum disease (10%) root rot, (5 score) downy mildew and (4 score) powdery mildew with the minimum seed yield of 1576 kg/ha.

Hisar centre maintains 134 fenugreek germplasm accessions. During 2004-05 seventy nine germplasm were evaluated using PEB, Hisar sonali and local as checks. The seed yield ranged form 5.20q/ha (GC 107) to 22.75q/ha (GC-78). Twenty seven lines gave higher yield than PEB and five out yielded Hisar sonali. The most promising lines were GC-14, GC-20, GC-29, GC-31, GC-78, GC-94, GC-95, GC-113 and GC-131.

During 2005-06 *Rabi*, 55 accessions were evaluated at Guntur and among these LFC-116 recorded highest yield of 588 kg/ha followed by LFC-95, LFC-111, LFC-90 and LFC-115 with 535, 534, 522 and 509 kg/ha respectively. The check variety, Lam selection-1 recorded an yield of 361 kg/ha.

One hundred and nine accessions were evaluated at Dholi Out of which RM-70 and RM-187 produced maximum grain yield of 1.40 kg/6.0 m^2 followed by RM-18 (1.38 kg/6 m^2).

Seventy four germplasm of fenugreek were evaluated in augmented design during 2005-06 at Kumarganj. Seed yield range was 0.41-2.70 t ha^{-1}. Highest seed yield was recorded in line NDM-61 (2.29 t ha^{-1}) followed by NDM-9 (2.09 t ha^{-1}) and NDM-58 (1 94 t ha^{-1}). The fenugreek germplasm at different centres are given in Table 66.

Table 66. Germplasm collection of Fenugreek at the AICRP centres

Center	Indigenous		Exotic	Total
	Cultivated	Wild and related sp.		
Jobner	353	-	12	365
Jagudan	63*	-	-	63
Coimbatore	255	-	-	255
Guntur	126	-	-	126
Hisar	134	-	-	134
Dholi	109	-	-	109
Raigarh	13	-	-	13
Kumarganj	63	-	-	63
Solan	25	-	-	25
Total	**1141**	**-**	**12**	**1153**

9.3 Coordinated Varietal Trial

9.3.2 CVT 2001- Series V

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

The CVT was started during 2001 and is in the 4th year of progress at Coimbatore. A total of 26 fenugreek accessions were evaluated for their growth and yield performance during Rabi 2005-06 with CO-2 as check. Among this, RMt 303 recorded the highest yield of 1030 kg/ha followed by JF 244 (870 kg/ha). All the accessions were screened for their resistance against powdery mildew disease. RMt 303 and JF 270 scored the minimum disease incidence of 14 23 %and 15 23% of PDI respectively.

The trial was started in 2002-03 at Jagudan with 10 entries and the results were non significant during 2002-03 and 2003-04. Among the entries, significant yield differences were observed in 2004-05 But none of the entry gave significantly superior yield over check. However the entries JFg-244, HM-376 and JFg-270 gave higher yield (2079 kg/ha 2059 kg/ha and 2000 kg/ha respectively) The pooled over three years data presented in Table 67 showed significant yield differences due to entries. An entry JFg-244 significantly out yielded (2011 kg/ha) check GM-1 producing 10.74% higher yield.

The character wise pooled mean of three years also indicated that entries differed significantly for all the morphological and yield characters studied The mean performance of the entries

Table 67. Yield performance of fenugreek under CVT-Jagudan

Entries	Yield (kg/ha)			Mean yield	% increase over check	
	2002-03	2003-04	2004-05		GM-1	Hisar Sonali
JFg-244	2049	1906	2079	2011	10 74	3 08
JFg-270	1838	2030	2000	1956	7.71	0 28
UM-351	1822	1575	1772	1723	-	-
UM-352	1809	1674	1630	1166	-	-
IIM-65	1361	1734	1566	1554	-	-
IIM-372	1544	1730	1815	1696	-	-
IIM-376	1880	1947	2059	1962	8 04	0 56
IIM-444	1931	1900	1797	1876	3 30	-
NDM-19	1657	1678	1786	1707	-	-
NDM-25	1649	1683	1676	1569	-	-
GM-1 (Check)	1838	1760	1846	1815	-	-
Hisar Sonali	-	-	1951	1951*	7 49	-
S Em +	71	80	102	52		
C D (P=0 05)	205	231	295	145		
C V (%)	8 08	8 98	11 21	9 56		

**One year data*

evaluated in CVT over 2001-02 to 2004-05 revealed the superior performance of UM-351 yielding 1840.68 kg/ha followed by UM-352 (1799.96 kg/ha) (Table 68).

In the CVT fenugreek at Hisar 12 entries evaluated during 2002-03 to 2004-05. Significant differences were obtained for all the parameters observed. On the basis of average yield of three years (2002-03 to 2004-05) the maximum seed yield was recorded in HM-444 (213 kg/ha) which was 32.3% higher over local check. (Table. 69)

At Dholi, out of 13 genotypes RM-70 and RM-28 recorded significantly more yield 1.67 and 1.55 t/ha respectively than national check Hisar Sonali.

Table 68. Yield performance of fenugreek entries evaluated in CVT (2001-2002 to 2004-2005)- Jagudan

Entries	Seed yield (kg/ha)					% increase over check
	2001-02	2002-03	2003-04	2004-05	Mean	Hisar Sonali
UM - 351	1668	1944.7	1670.2	2079.9	1840.7	4.9
UM - 352	1750	1797.0	1534.8	2118.1	1799.9	2.7
NDM - 25	-	1745.0	1545.2	1927.1	1739.1	-
JF - 244	1600	1736.3	1484.4	1878.5	1674.8	-
RMt - 1 (Check)	1667	1649.7	1382.0	1784.7	1620.8	-
JF - 270	1500	1554.0	1345.5	1625.0	1506.1	-
HM - 444	-	1519.0	1267.4	1937.5	1574.6	-
NDM - 19	-	1354.3	920.2	1961.8	1412.1	-
HM - 372	-	1345.3	1201.4	1638.9	1395.2	-
HM - 376	-	1293.3	812.5	1847.2	1317.7	-
HM - 65	-	1146.0	928.8	1607.6	1227.5	-
Local (Check)	1000	1276.0	972.2	1145.8	1098.5	-
RM - 18	-	-	1302.1	1510.4	1406.3	-
RM - 28	-	-	1354.2	1822.9	1588.6	-
Hisar Sonali (Check)	-	-	-	1753.5	1753.5	-
NDM - 20	-	-	-	1645.8	1645.8	-
CD P= (0.05)	137	224.8	153.87	323.9		
CV (%)	5.01	11.57	6.21	11.0		

Table 69. Yield performance of fenugreek cultivars under-CVT- Hisar

Entries	Seed yield (kg/ha)				Increase over check (%)
	2002-03	2003-04	2004-05	Mean	
HM - 65	1667	1455	1771	1631	01.2
HM - 372	1737	1625	2000	1787	10.9
HM - 376	1620	1885	2271	1925	19.5
HM - 444	1780	2050	2562	2131	32.3
JF - 244	1640	1960	2437	2012	24.9
JF - 270	1515	1860	2146	1840	14.2
UM - 351	1550	1900	2500	1983	23.1
UM - 352	1535	1700	2334	1856	15.2
NDM - 19	1633	1755	2166	1851	14.9
NDM - 25	1478	1645	2125	1749	08.6
Local (Check)	1458	1550	1825	1611	-
Hisar Sonali	1805	1915	2531	2084	29.4
C.D. (P=0.05)	121	219	314	227	-

The trial was conducted with 30 entries including one check with three replications in RBD during 2005-06 at Kumarganj. Yield and ancillary observations were recorded. Maximum seed yield was recorded with genotype NDM-19 (1.94 t ha^{-1}) followed by JFG-239 (1.59 t ha^{-1}) HM-65 (1.56 t ha^{-1}) and HM-350 (1.38 t ha^{-1}). Highest plant height in entry HM-219 (97.27 cm) number of pods per plant NDM-20 (199.1 cm), number of grain per pod HM-372 (22.33) and days to maturity in J. Fenu-244 (147) were observed.

9.3.3 CVT-2005 Series VI

(*Raigarh* and *Guntur*)

The trial was initiated with 15 entries at Raigarh. Three entries (LFC-87, HM-219 and NMD-19) did not germinate at all. Out of the remaining 12 entries UN-362 gave highest yield (225.77 kg/ha), followed by RM-18 (184.09 kg/ha). The check Hisar sonali yielded 159.77 kg/ha.

The CVT with 18 genotype from different centres started in 2005-06 at Guntur. The entry, HM-219 did not germinate at all and among the 17 entries evaluated LFC-87 recorded significantly higher yield of 433 kg/ha. The check Lam Sel-1 recorded an yield of 274 kg/ha. Low yield recorded in all the entries due to the occurrence of dry root rot and lack of precipitation after sowing.

9.3 Varietal Evaluation Trial

9.4.1 Initial evaluation trial

(*Jagudan, Jobner, Hisar and Guntur*)

At Jagudan mean performance of the entries for three years (2002-03 to 2004-05) showed significant yield difference. An entry, JFg-239 recorded significantly superior yield (2066 kg/ha) than check, GM-1 it was 9.14 per cent higher above GM-1, followed by JFg-273 and JFg 232 (Table 70).

The IET initiated at Jobner in *Rabi* 2003-04 with 16 entries. The analysis of variance revealed significant differences among the entries for all the traits including seed yield. The mean performance of the entries over 2003-04 to 2004-05 revealed superior performance of NS-2003-1 yielding 2016.98 kg/ha (Table 71).

Table 70. Yield performance of IET entries - Jagudan

Entries	Yield (kg/ha)				Increase over check (%)
	2002-03	2003-04	2004-05	Mean	Rmt - 305
JFg - 182	1898	1879	1898	1892	-
JFg - 193	2213	1746	1719	1893	-
JFg - 228	2192	1848	1959	2000	5.65
JFg - 232	1988	1608	1850	1815	-
JFg - 236	2071	1600	1855	1842	-
JFg - 239	2370	1780	2048	2066	9.14
JFg - 258	2071	1793	1933	1932	2.06
JFg - 272	2154	1659	1782	1865	-
JFg - 273	2228	1881	1966	2025	6.97
GM - 1©	2102	1758	1819	1893	-
S.Em. +	93	82	92	52	
C.D. (P=0.05)	NS	NS	NS	148	
C.V(%)	7.60	8.08	8.50	8.05	

Table 71. Yield performance of fenugreek entries evaluated in IET - Jobner

Entries	Yield (kg/ha)			Increase over check (%)
	2003-04	2004-05	Mean	(Rmt-305)
UM - 330	1304.0	2062.5	1683.3	-
UM - 331	1034.0	2166.7	1600.3	-
UM - 337	945.3	1861.1	1403.2	-
NS - 2003 - 1	1443.7	2590.3	2017.0	14.3
NS - 2003 - 2	1055.7	2361.1	1708.4	-
NS - 2003 - 3	1392.7	2291.7	1842.2	4.2
NS - 2003 - 4	1429.3	2506.9	1968.1	11.5
NS - 2003 - 5	1288.7	2152.8	1720.7	-
NS - 2003 - 6	983.3	2222.2	1602.8	-
NS - 2003 - 7	1156.0	2159.7	1657.9	-
NS - 2003 - 8	1274.7	2083.3	1679.0	-
NS - 2003 - 9	1128.7	2208.3	1668.5	-
NS - 2003 - 10	1237.0	1972.2	1604.6	-
RMt - 1 (Check)	1178.3	2277.8	1728.1	-
RMt - 305 (Check)	1203.0	2326.4	1764.7	-
Local (Check)	776.0	1576.4	1176.2	-
CD (P=0.05)	104.6	329.4		
CV (%)	5.30	9.1		

The IET with 10 accessions was conducted at Hisar during 2004-05 to 2005-06. Maximum seed yield was recorded in HM-348 (2675 kg/ha), followed by HM-355 showing an increase of 25.5 and 17.9% respectively.

The trial was conducted for three years (2003-04, 2004-05 and 2005-06) at Guntur. Among the entries, LFC-84 recorded the highest yield of 665 kg/ha, followed by LFC-77 (621 kg/ha) which were on par with check Lam sel.-1. (514 kg/ha) during 2005-06.The pooled data over three years indicated that all the entries varied significantly with respect to growth parameters, yield attributes and grain yield except for pod length. Among the entries, LFC-84 recorded maximum grain yield of 1069 kg/ha followed by LFC-87 (994 kg/ha) and are significantly superior to check Lam sel.-1 (826.0 kg/ha). All the other entries were found on par with the check. Lam sel.-1 (Table 72).

A new IET with 12 genotypes were evaluated at Guntur during 2005-06. Among the 12 entries tested, LFC-103 recorded significantly highest yield of 445 kg/ ha, followed by LFC-105 with 402 kg/ha than the check Lam sel-1 (300 kg/ha).

9.4 Nutrient Management Trail

9.5.1 Effect of biofertilizers using *Azospirillum* on fenugreek

(Coimbatore and Kumarganj)

This trial continued during the fourth year at Coimbatore. Results indicated that application of

Table 72. Performance of Fenugreek entries under IET - Guntur

Entry	No. of seeds per pod	Test weight (g/1000 seed)	Yield (kg/ha)	% increase over check
LFC-74	11.2	10.5	737	-10.8
LFC-77	11.0	9.1	888	7.5
LFC-82	11.2	9.3	941	14.0
LFC-84	13.1	11.9	1069	29.4
LFC-87	12.3	12.4	994	20.3
LFC-90	11.4	10.2	929	12.5
LFC-92	10.2	9.6	755	-8.6
LFC-99	11.1	9.9	827	0.1
LFC-100	10.6	10.4	912	10.4
LFC-101	10.7	10.4	763	-7.7
LS-1 (Check)	10.0	10.7	826	-
CD (P=0.05)	2.2	2.5	163.5	-
CV (%)	11.8	10.6	10.9	-

FYM (5t/ha) + inorganic nitrogen (100%) and *Azospirillum* 1.5 kg/ha recorded the highest plant height (55.87 cm) and number of pods per plant (23.50). The same treatment also recorded the highest yield (700 kg/ha) as against 375 kg/ha in control, which received the recommended dose of inorganic fertilizer.

Trial was conducted on variety Hisar Sonali with 10 treatments in RBD during 2005-06 at Kumarganj. Highest seed yield 1.07 t ha^{-1} was recorded by application of FYM 10 t ha^{-1} + *Azospirillum* @ 1.5 kg ha^{-1} seed treatment followed by FYM 10 t ha^{-1} + alone (0.89 t ha^{-1}).

9.5.2 Identification of source of drought tolerance in fenugreek

(Guntur)

Fifty five fenugreek accessions were evaluated at Guntur during 2005-06 to identify source of drought tolerance.

Among the germplasm lines, biomass varied from 3.5 g (LFC-87) to 36.88 (LFC-79) per five plants. The root length of germplasm lines varied form 5.8 cm (LFC-82) to 14.7 cm (LFC-89). Variation in shoot length was 23.6 cm (LFC-82) to 38.8 cm (LFC-120). The root shot ration of the germplasm lines varied form 0.20 (LFC-121) to 0.45 (LFC-72) (Table 73).

Table 73. Drought tolerance studies in Fenugreek - Guntur

Parameter	Range	Germplasm Lines	
		Low	High
Biomass (g/5 plants)	3.5-36.8	LFC-87 (3.5), LFC-79 (6.1)	LFC-116 (36.8), LFC-95 (22.7)
Root length	5.8-14.7	LFC-82 (5.91), LFC-81 (5.81)	LFC-89 (14.7), LFC-116 (13.91)
Shoot length	23.6-38.8	LFC-82 (23.6), LFC-85 (24.4)	LFC-120 (38.8), LFC-121 (37.6)
Root : shoot ratio	0.2-0.45	LFC-121 (0.20), LFC-83 (0.21)	LFC-72 (0.45), LFC-89 (0.43)

ICAR - ADHOC PROJECTS

I

1. **Project title** : Strengthening the cause of geographical indication appellation of major spices using molecular and quality profiling techniques
2. **Investigators** : B. Sasikumar
   T. John Zachariah
3. **Location** : Indian Institute of Spices Research, Calicut
4. **Duration** : 1-11-2004 to 31-10-2007
5. **Total cost of the scheme** : Rs. 23.524 lakhs
6. **Progress of the work** :

Sample collection

Procured the genuine commercial samples of Malabar pepper, Indian cardamom, Cochin ginger, Alleppey turmeric and Rajapuri turmeric from local markets, Spices Board, Cochin and from farmers. Also procured Sri Lankan, Guatemalan cardamom, Vietnam, Indonesia and Malaysian peppers through Spices Board or through other sources.

Physical and biochemical characterization of Indian, Guatemalan and Sri Lankan cardamoms

Physical quality parameters such as weight of 100 capsules, number of capsules in 100 g, seed husk ratio, bulk density (gL^{-1}), weight of splits (in 100 g), colour intensity, circumference, length of capsules and the biochemical parameters such as total carbohydrates, starch, reducing sugar, protein, total free amino acids, phenols, crude fiber, ash, acid insoluble ash, volatile oil and moisture are given in Table 1.GC profiling of volatile oil of these traded cardamoms are also completed (Table: 2). The study indicates the superiority of the Indian cardamom in terms of physical and biochemical parameters over the Guatemalan and Sri Lankan produces.

Table 1. Comparative physical and biochemical quality parameters of Indian, Guatemalan and Sri Lankan cardamoms

Parameter	Indian cardamom	Guatemalan cardamom	Sri Lankan cardamom
Weight of 100capsules(g)	24.26 ± 0.43	12.18 ± 0.27	18.23 ± 0.27
No. of capsules in 100g	334	807	554
Seed husk ratio	3:1	1.7:1	2.1:1
Bulk density (g/l)	384.64 ± 6.33	338.08 ± 3.45	286 ± 7.24

Parameter	Indian cardamom	Guatemalan cardamom	Sri Lankan cardamom
Weight of splits (in 100g)	21.46 ± 0.49	6.8 ± 0.30	Nil
Colour intensity	23 -13 to 24 -8	24-13 to 24-7	24-10
Circumference of the capsules(cm)	2.46 ± 0.02	2.08 ± 0.02	2.13 ± 0.01
Length of capsules(cm)	1.89 ± 0.12	1.60 ± 0.06	1.95 ± 0.07
Moisture (%)	5.08	15.74	18.84
Essential oil (%)	10	5	14
Starch (%)	39.26	29.4	29.52
Carbohydrate (%)	40.16	35.25	31.75
Reducing sugar (%)	3.14	4.18	3.17
Phenols (%)	3.26	4.75	3.88
Protein (%)	1.03	1.05	1.42
Crude fiber (%)	16.3	12.2	12.5
Ash (%)	7.45	8.4	8.6
Acid insoluble ash (%)	1.76	1.07	1.23

Table 2. GC-profile of volatile oil of cardamoms

Constituent (Area %)	Indian cardamom	Guatemalan cardamom	Sri Lankan cardamom
Pinene	1.95	1.43	1.93
Sabinene+ myrcene	7.11	5.62	7.00
Limonene.	3.60	3.67	3.63
1,8 cineole	32.55	27.89	31.39
α terpinene	2.31	2.32	1.90
Linalyl acetate	0.79	1.81	3.31
Geraniol	2.00	2.94	2.10
α terpinyl acetate	41.20	37.93	34.92

c. Physical and biochemical characterization of different traded varieties of black pepper (Malabar, Vietnam, and Malaysian) is also completed (Table 3).

Table 3. Comparative physical quality parameters of traded samples of black pepper.

Parameter	Malabar pepper (TGEB*)	Malabar pepper (MG**)	Vietnam	Malaysian	Panniyur-1
Bulk density g/l	606.85	552	568.8	198.8	476.53
Size in mm	3 - 4.2	3	4.2 - 4.7	2.5-3	4.2
Oleoresin %	7.5	8.8	7.4	11.3	8.3
Oil %	2.3	2.3	3.3	3.3	2
Moisture %	12	11	14	14	10

* Tellichery Garbled Extra Bold

** Malabar Garbled

Table 4. Comparative biochemical quality parameters of traded samples of black pepper.

Parameters	Malabar pepper (TGEB)	Malabar pepper (MG)	Vietnam	Malaysian	Panniyur1
Starch (%)	43.00	39.41	42.95	14.470	42.33
Carbohydrate (%)	45.73	41.22	44.80	21.41	45.34
Reducing sugar (%)	1.466	1.495	1.466	1.75	1.127
Free amino acids (%)	0.380	0.355	0.340	0.874	0.048
Phenols (%)	0.903	1.17	1.24	3.32	0.622
Protein (%)	2.15	2.17	1.85	3.303	2.06

Standardized the protocol for the isolation of genomic DNA from commercial samples of cardamom.

A modified CTAB method was standardized to isolate genomic DNA from the powdered capsules of Indian, Guatemalan and Sri Lankan cardamoms.

Amplification of DNA using RAPD/ ISSR

Ten random decamer primers (RAPD) tried for PCR amplification, which produced a total of thirtyone polymorphic bands among the Indian, Guatemalan and Sri Lankan cardamoms (Table 1 and Figure 1). In case of three ISSR primers namely $(CAC)_3GC$, $(CTC)_3GC$, $(GACA)_3$ studied, only one primer ($(GACA)_3$ gave two polymorphic band . The other two primers did not show any different banding pattern among the three cardamom.

7. Technology / protocol / prototype model/: process / product (s) developed

An efficient protocol for the isolation of high molecular weight DNA from dry capsules of Indian, Sri Lankan and Guatemalan cardamoms is developed which will help in PCR based characterization of the traded cardamom. This has IPR relevance.

II 1. Project title : Cloning of *Phytophthora* resistance and defense genes from *Piper colubrinum*

2. Investigator(s) : K. Johnson George
M. Anandaraj

3. Location : Indian Institute of Spices Research, Calicut

4. Duration : Nov.2004to2005-06 / 2007

5. Total cost of the scheme : Rs. 16,53,000

6. Progress of the work :

RNA isolation: A modified method based on Trizol (Sigma) was tested for isolation of mRNA from *P. colubrinum* with the inclusion of beta-mercaptoethanol (1%) in the isolation buffer. Even though the method enabled isolation of good quality RNA, the RNA recovery was less compared to the method developed by Johnson *et al* (2005). The sporulating *P. capsici* cultures maintained on carrot agar medium was used for challenging *P. colubrinum* plants and the inoculated leaves were taken after 12 hours for RNA isolation.

Targeted amplification for cloning internal region of the resistance gene:

Targeted amplification of an R gene from mRNA population isolated from *P. colubrinum* challenged with *P. capsici* was done using degenerate primers, designed for the purpose. Out of 14 degenerate primers designed based on conserved sequence motif of disease resistance genes, the primer set IA and IV A gave positive results.

First strand DNA synthesis was performed using a degenerate primer-IV A, second strand synthesis and subsequent amplification using forward and reverse resistance gene specific degenerate primer set IA and IV A. Cloning of the fragment was done using a vector suitable for PCR product cloning. Sequencing of the differentially amplified fragment was done using ABI prism technology.

Sequencing revealed the size of the fragment as 252 bp corresponding to 84 amino acids. Sequence comparison of the deduced amino acid sequences of the fragment was done with NCBI-Blast 2 and SAWTED PSI-BLAST tools. The sequences could match with already identified disease resistance genes in public databases. Homologue of known structure to the sequence

using SAWTED-enhanced PSI-BLAST server indicated that the sequence is also close to *Phytophthora* resistance gene viz., blight resistance protein RPI gene from *Solanum bulbocastanum* and R1 gene from *Solanum tuberosum*. Sequence similarity was also found between other resistance genes from cacao, *Saccharum*,etc. The fragment, having shown significant similarity to NBS-LRR containing resistance proteins confirms that the fragment belongs to the resistance gene.

7. Technology/protocol/prototype/model/: Nil process/product(s) developed

III 1. Project title : Conservation and evaluation of Ajwain (*Trachyspermum ammi* L.) germplasm for identification high yielding quality oil genotypes

2. Investigators : R.V. Paliwal
Rajesh Pandya
S. R. Ahmad

3. Location : Agriculture Research Sub Station, Pratapgarh-312605, (Maharana Pratap University of Agriculture & Technology, Udaipur) Rajasthan

4. Duration : 1-08-2003 to 3-10-2006

5. Total cost of the scheme : Rs. 10.88 Lakhs

6. Progress of the work

In the month of January 2005 and April 2005, 101 germplasm samples of Ajwain crop have been collected from various districts of Madhya Pradesh and Rajasthan states. These samples along with 58 selected samples of previous year were sown in August 2005 at the station and evaluated for various yield and oil characters. These lines were also screened for various disease reactions. In January 2006, 40 superior cultures have been selected having higher seed yield and/or oil per centage and diseases resistance types. 40 superiour lined having higher seed yield and/or oil percentage were finally selected for testing in large scale multilocation trials for confirmation of results. Beside these, a new Ajwain variety Pratap Ajwain-1 (RPA-99) has been developed from local germplasm after testing it for five years in multilocation trials (from the year 2001 to 2005). The variety will be released for cultivation in Rajasthan under conserved moisture situation.

Seed yield and ancillary characters of 40 selected lines (2005-06)

S. No	Accession No.	Seed yield per entry (g)	Umbels per plant	Umbellets per Umbel	Days to maturity	Volatile Oil %
1	AGP - 4	190	182	5	136	3.41
2	AGP - 5	204	200	9	150	3.54
3	AGP - 7	206	204	10	145	3.62
4	AGP - 9	169	150	6	151	3.70
5	AGP - 23	230	205	11	150	3.97
6	AGP - 26	151	142	7	139	3.68
7	AGP - 27	200	181	9	146	3.45
8	AGP - 29	225	207	12	137	3.24
9	AGP - 33	206	201	9	134	3.90
10	AGP - 34	140	143	8	152	3.01
11	AGP - 36	190	173	6	147	3.62

12	AGP - 37	154	140	5	141	3.91
13	AGP - 38	195	185	9	144	3.53
14	AGP - 42	163	155	8	140	3.11
15	AGP - 43	222	210	11	145	3.04
16	AGP - 46	188	190	10	139	3.56
17	AGP - 47	144	142	10	142	3.94
18	AGP - 48	171	166	9	151	3.43
19	AGP - 51	199	195	8	138	3.71
20	AGP - 68	227	211	10	150	3.93
21	AGP - 70	200	204	12	150	3.81
22	AGP - 73	204	199	10	135	3.42
23	AGP - 84	220	201	11	145	3.96
24	AGP - 85	182	170	6	144	3.33
25	AGP - 89	209	193	7	149	3.69
26	AGP - 90	163	165	9	140	4.00
27	AGP - 105	142	138	8	139	3.71
28	AGP - 116	156	150	11	143	3.63
29	AGP - 123	175	181	9	150	3.70
30	AGP - 124	170	170	8	150	3.80
31	AGP - 128	226	212	10	148	3.26
32	AGP - 130	271	141	6	142	3.40
33	AGP - 135	221	208	11	146	3.99
34	AGP - 137	145	160	12	140	3.80
35	AGP - 141	188	175	5	145	4.00
36	AGP - 153	225	212	9	150	3.40
37	AGP - 158	201	205	11	149	2.88
38	AGP - 162	170	165	10	139	2.50
39	AGP - 193	196	190	8	145	3.53
40	AGP - 200	198	186	6	144	2.44
Local	(c)	162	188	9	160	3.58
G.A-1	(c)	181	200	10	154	3.62
P.A-1	(c)	219	210	11	148	

7. Technology/protocol/prototype/model/: Process/product developed

Fourty superior germplasm lines having higher seed yield and/or oil percentage have been selected. These lines will be tested in large scale multilocation trials for confirmation of results. Later on seed of these lines will be send to NBPGR New-Delhi and also to NRC on seed Spices at Ajmer.

Further a new variety of Ajwain, Pratap Ajwain-1 (RPA-99) has been developed at the station for cultivation in Rajasthan State by testing it for five years (from 2001 to 2005) at four locations, ATC trials, FLD's etc.

IV

1. Project title	:	Bioecology and integrated management of root mealybug (*Planococcus* sp.) infesting black pepper
2. Investigators	:	S. Devasahayam K.M. Abdulla Koya M. Anandaraj
3. Location	:	Indian Institute of Spices Research, Calicut
4. Duration	:	1-7-2003 to 30-6-2006
5. Total cost of the scheme	:	Rs. 10,84,616
6. Progress of the work	:	

Surveys were conducted in Idukki (15 locations), Kozhikode (20 locations), Kannur (9 locations) and Kasaragod (9 locaitons) districts of Kerala and Dakshina Kannada (4 locations), Udupi (1 location), Uttara Kannada (4 locations) an Hassan (9 locations) districts of Karnataka to record the incidence of root mealybugs infesting black pepper in these areas.

Infestation by root mealybugs was observed in five lcoaitons in Idukki District (in Nedumkandam, Thookkupalam, Meppara, Kalthoty and Rajakkad) and two locations in Hassan District (in Rayarakoppalu and Belagodu) among the various locations surveyed.

Identification

Collections of root mealybugs infesting black pepper were made from the various locations surveyed and preserved in the laboratory for identification. The various species collected were also studied for morphological variations, if ay.

Three species of root mealybugs namely, *Planococcus* sp., *P. citri* (Risso) and Ferrisia Virgata Ckll. Were recorded infesting roots and basal portions of stems of black pepper viens (Fig. 1). *Planococcus* sp. was oval and dome-shaped when compared to *P. citri* which was oval and flat. There was not much difference in the external dimensions of adult females of both the species. The waxy filaments in *P. citri* on the lateral and posterior regions were of uniform size whereas in *Planococcus* sp., the waxy filaments were more elongated in the posterior region. *F. virgata* could be easily identified by its elongated oval body with two dorsal rows of dark patches and with a pair of long posterior waxy filaments.

Nature of damage

The nature of damage caused by root mealybugs infesting black pepper was studied in the nursery and field. Colonies or root mealybugs were distributed on the main, secondary and tertiary roots on rooted cuttings in the nursery and also on vines of all age groups in the field. The basal portions of stems of vines were also infested, when they were under soil/leaf mulch. In some locations in Wayanad, the root mealybugs were observed to be covered with fungal colonies. Four species of ants were observed to tend root mealybug colonies in the field. The pest infestation resulted in defoliation, yellowing and wilting of leaves and lateral branches and also mortality of vines.

Many of the vines infested with root mealybugs were also infected with *Phytophthora capsici* and nematodes and in such cases, the symptoms of damage were more severe along with rotting of roots. Experiments to study the interaction of root mealybugs and *P. capsici* and nematodes were set up under greenhouse and simulated field conditions.

Bioecology

Methods were standardized for studying the biology of root mealybug (*Planococcus* sp) in the laboratory. Studies on biology of root mealybug were conducted by caging individual specimens in micro-cages fixed on pumpkins. The fecundity of females, morhpometrics and duration of various stages was studied.

There were three instars in the life history of *Planococcus* sp. and males were yet to be recorded. Femaes were viviparous and parthenogenesis

probably took place. The fecundity of females ranged from 22 to 322. The oviposition period ranged form 10 to 40 days. The eggs were oval and yellowing orange. The crawlers were light brown and generally settled after 2 days. All the instars were flesh coloured immediately after moulting. The duration of various stages is presented in Table 1. The total life cycle from 1 instar to adult ranged form 18 to 26 days. The preoviposition period ranged from 9 to 21 days. The morphometrics of various stages is presented in Table 2. The seasonal incidence of root mealybugs in the field was monitored at Wayanad.

The alternate hosts of root mealybugs were recorded in the field at Wayanad. Colonies of root mealybugs were observed on banana rhizomes and base of stem of coffee and *Erythrina* sp. Root mealybugcolonies were also observed on roots of 12 weed plants in black pepper gardens severely infested with the pest.

Mass culturing

The fruits/ vegetables/ tubers, namely, pumpkin, squash, ash gourd, bottle gourd, cucumber, water melon (Cucurbitaceae), colocaisa, elephant foot yam (Araceae), ginger and turmeric (Zingiberaceae) were evaluated for their suitability for mass culturing of root mealybugs. The various host materials were washed with water and immersed in a solution of carbendazim 0.2%and 50 adult females of *Planococcus* sp. were inoculated on each material. The emergence of crawlers, their settlement, growth and multiplication was observed and the number of adults available after 1,2 and 3 months were counted. The earliest date of rooting of various materials was also noted. Among the various host materials, settlement of crawlers aws observed in all the materials except turmeric.

The number of adults obtained was maximum in squash (Cucurbita moschata) when compared to all the other materials which also remained without rooting up to 88 days after inoculation. The number of adults obtained was also higher in pumpkin (*C. pepo*) which remained without rooting up to 83 days after inoculation. It was concluded that both these materials are suitable for culturing *Planococcus* sp.

An experiment was also undertaken to determine the optimum level of adults to be inoculated on C. moschata for multiplication of *Planococcus* sp. The squashes were inoculated with 50 and 100 adults each separately and the number of adults available was counted 1, 2 and 3 months after inoculation.

The study indicated that inoculation of 50 adults per squash resulted in 654 and 1437 adults after 2 and 3 months, respectively; whereas, inoculation of 100 adults per squash resulted in 894 and 1065 adults after 2 and 3 months, respectively.

V **1. Project title** : Studies on salt tolerance in seed spices (Fennel, Coriander and Fenugreek)

2. Investigators : A.C. Yadav
Avtar Singh
S.K. Sharma

3. Location : Chaudhary Charan Singh,
Haryana Agricultural University, Hisar

4. Duration : 01-04-2004 to 31-03-2007

5. Cost of the scheme : Rs.752790/-

6. Progress of work:

Nine genotypes of fennel, & eight of coriander; and fifteen of fenugreek which were found tolerant to salinity in 2004-05, were grown in screen house as well as in a natural saline field during 2005-06 for confirmation and further selection of 4-5 resistant genotypes of each crop.

Screen house experiment

Fennel

As the salinity level increased, germination was delayed.

At 6.0 dSm^{-1} Ece only five genotypes (A.F-1, AF-31, AF-127, HF-33 and JF-303) out of nine sown could germinate.

Growth characters like plant height and number of branches/plant decreased with increase in salinity level.

Per plant seed yield was found higher in control (ranged from 7.2 to 8.6g) which reduced with the increase in salinity level.

At 6.0 dSm^{-1} salinity HF-33 gave highest (4.0g) seed yield followed by JF-303 and AF-127.

Coriander

Germination was delayed with the increase in salinity level.

At 4.0 dsm^{-1} only six genotypes (ACR-12, ACR-53, ACR-102, ACR-123, ACR-230 and Hisar Anand) could germinate.

At 6.0 dSm^{-1} none of the genotype germinated.

Growth parameters like branches per plant and plant height were found higher in control which were decreased with the increase in salinity level.

In non-saline control, per plant seed yield of eight genotypes ranged from 6.9 to 10.5g. However, at 4.0 dsm^{-1} salinity level, per plant yield of six genotypes survived ranged from 1.0 to 4.0g. ACR-53 gave maximum (4.0g) per plant seed yield.

Fenugreek

In non-saline control, the seed of fifteen tolerant genotypes geminated from 4th to 6th day of sowing, however, at 6 dSm^{-1} germination of seeds of genotypes ranged from 17th day to 23rd day of sowing.

At 6,0 dSm^{-1} salinity, only five genotypes (AM-16, AM-61, AM113, HM-3 and AM-57)) survived till harvest.

HM-57 gave maximum per plant seed yield in control (30.0g) as well as at 6.0 dSm^{-1} ECe (6.0g) followed by genotypes HM-3.

Introduction of salt tolerance

Germination of fennel and coriander could take place up to 8.0dSm^{-1} salinity in all the cycocel treatments, although it was delayed at higher salinity levels.

At 10.0 dSm^{-1} Ece the seeds of fennel and coriander could not germinate in any of the cycocel treatments. In case of fenugreek, with the seed treatments of Cycocel, the seeds were able to germinate even at '0.0 dSm^{-1} salinity.

Cycocel 500 ppm was found most effective in terms of growth and yield of all these three crops.

In fenugreek cv. Hisar Sonali (HM-57) the plant could survive upto 6.0 dSm^{-1} salinity with cycocel 500 ppm treatments which gave 5.9g per plant seed yield.

In case of salt solution dipping of seeds in 6.0dSm-1 Ece was found effective in terms of growth and yield parameters in the three crops tested.

Induction of salt tolerance

Nine genotypes of fennel, eight of coriander and fifteen of fenugreek were grown in natural saline field (salinity ranged from 4.6 to 8.8dSm^{-1} Ece).

In fennel, HF-33, JF-303, AF-127, AF-1 and AF-31were found tolerant to salinity in descending order.

In coriander, ACR-53, ACR-12 and Hisar Anand were found most tolerant to salinity as compared to other genotypes.

In fenugreek, HM-57, HM-3, AM-196, AM-191 and AM-113 where found more tolerant to salinity over rest of the genotypes tested.

VI **1. Project title** : Identification and development of diagnostics for the viruses causing stunted disease in black pepper.

2. Investigators : A. Ishwara Bhat
R. Suseela Bhai

3. Location : Indian Institute of Spices Research Calicut

4. Duration : 01-07-05 to 30-06-06

5. Total Cost : Rs.17.10.502/-

6. Progress of the work

To know the variation in virus titre, virus infected black pepper plants belonging to five varieties were tested by DAS-ELISA for piper yellow mottle virus (PYMV) and Cucumber mosaic virus (CMV) at monthly intervals from April 2004 to March 2005. Results indicated that the concentration of both the viruses varied during different months of the year. The concentration of both the viruses was found to be higher during October to January.

Three varieties of infected black pepper vines were selected to study the distribution of PYMV and CMV in different parts of the plant through DAS-ELISA. Results indicated that concentration of PYMV was more in young leaf, old leaf and stem followed by spike and root. The concentration of CMV was found to be more in young leaf and old leaf followed by stem, spike and root.

Of the 2186 black pepper mother vines belonging to eleven different varieties indexed for the presence of PYMV and CMV, 714 plants were tested positive for either one or both the viruses. More than 50% of DAS-ELISA positive black pepper mother vines did not exhibit any external symptoms indicated the need of sensitive technique like ELISA to identify virus-free plants.

Aphid transmission tests were conducted for CMV from infected to healthy black pepper using fir different species of aphids. Subjecting test plants one month after inoculation for the presence of CMV through DAS-ELISA confirmed positive transmission of the virus.

In meristem culture to eliminate virus, the use of TDZ-containing medium to induce the initial growth of dissected meristem and subsequent transfer of the enlarged meristem to MS containing 1 mg/l BAP and 1 mg/l IAA was found to be promising. Meristem regenerated plants were rooted, hardened and screened for the presence of absence of PYMV and CMV through Polymerase chain reaction (PCR)

VII **1. Project title** : Investigations on the etiology and integrated management of rhizome rot of ginger and turmeric in northern Karnataka

2. Investigators : Dr. Srikant Kulkarni
Mr. S.A. Kulkarni
Mr. R.V. Hegde

3. Location : Department of Plant Pathology
University of Agricultural Sciences
College of Agriculture, Dharwad-590 005,
Karnataka

4. Duration : 01-04-06 to 31-12-06

5. Total Cost : Rs.16,16,306/-

6. Progress of work

For management of rhizome rot, better drainage helps in reducing infection, since stagnation leads to high inoculum build up and also rapid spread of the disease through soil water. Crop rotation in ginger is practiced in Karnataka by rotating with paddy. It was found to be beneficial against rhizome rot disease. Rhizome treatment with different fungicides, bioagents, organic amendment was done to both ginger and turmeric. The results revealed that, in the both the crops, rhizomes treated with Carbendazim @ 0/2 per cent was effective in reducing per cent disease incidence and increasing per cent germination and also yield. The next best fungicides were mancozeb Carbendazim (SAAF), Emissan and Metalaxyl MZ. Rhizome treated with different biocontrol agents revealed that, *Trichoderma* harzianum (Dharwad isolate) was effective in increasing per cent germination, yield by way of reducing per cent disease incidence followed by *T. harzianum* and *Pseudomonas fluorescens* in both the crops. Rhizomes of both ginger and turmeric were treated with different organic amendments. Among the different organic amendments tested, neem cake significantly increased the per cent germination, yield and reduced per cent disease incidence followed by *Eupatorium.*

In integrated management studies conducted by pot culture method revealed that, the rhizomes treated with different components like, Metalaxyl MZ, T. harzianum (Dharwad isolate) and soil application of neem cake and Carbofuran gave the best results. The results revealed that, there was increase in per cent germination, yield and decreased per cent disease incidence both in ginger and turmeric.

Pathogen population in solarised and nonsolarized plots was monitored during the experimentation period. Significant reduction in pathogen could be noticed in solarised plots. There was increase in the population of Trichoderma in solarised plot as compared to unsolarized plot. There was also significant reduction in biomass of weed in solarised plot compared to unsolarized plot. This is the added advantage of solarization. The experiments results revealed that, there was significant increase in the per cent germination in solarised plot when compared to non solarised plot.

Among the different treatments rhizome dipped in Metalaxyl MZ @ 0.3% for 30 min.+ Soil application of *T. harzianum* @ 10 kg along with 25t FYM/ha + Soil application of *Eupatorium* @ 10t/ha recorded highest per cent germination, less per cent disease, higher yield of 11720.20 kg/ha. This treatment may be recommended to the farming community for getting maximum yield by reducing the dreaded disease.

VIII 1. Project title : Molecular characterization and Maintenance of National repository of *Phytophthora*

2. Investigators : Dr. M. Anandaraj
Dr. A. Ishwara Bhat

3. Location : Indian Institute of Spices Research Calicut

4. Duration : January 2005- September 2007

5. Total Cost : Rs. 2553000/-

6. Progress of work

Maintenance of National Repository of *Phytophthora*

Three hundred *Phytophthora* isolates were sub cultured and maintained in agar slants at 15°C and also in sterile distilled water at room temperature (25±1°C).

Morphological characterization of *Phytophthora* isolates

Thirty *Phytophthora* isolates from black pepper were characterized morphologically based on colony morphology, growth rate on agar, sporangial morphology and caducity. Growth rate ranged from 0.5 mm to 1mm per hour on carrot agar.

The sporangial ontogeny were umbellate and sympodial. All the isolates produced papillate sporangia, with narrow pore, ovoid, obpyriform, and ellipsoid in shape. The size of the sporangia was 23.4- 59.8µm x 13-23.4µm. All were caducous and mean pedicel length ranged from 31.4µm -182µm.

Determination of Mating Types

Forty-eight isolates of *Phytophthora* from various hosts were tested for mating types and Oospore production. Of the 48 isolates tested for mating type, 38 (79%) were A1 and 10 (21%) A2.

Cryopreservation

Cryopreservation was done for twelve isolates of *Phytophthora* from four different hosts using 10% and 15% sterile Dimethyl Sulfoxide (DMSO) in 1.5ml cryovials. These cryovials were kept at room temperature for 1 hour to permit the uptake of cryoprotectant prior to the cooling process and they were deposited under liquid nitrogen at –196°C. In 10% and 15%DMSO the *Phytophthora* isolates showed 72%, 55.6% and 55.6% survival rate after storing for 24hrs, 15days and 30 days respectively. Isolates from cocoa showed good survival up to one-month storage in compared to black pepper, betel vine and vanilla.

Molecular characterization of *Phytophthora*

RAPD

Phytophthora isolates were screened using 12 RAPD primers based on mating type. The primers OPAA01, OPAA02, OPAA03, OPAA08, OPAA10, showed polymorphic banding pattern. All amplifications revealed scorable polymorphism among the isolates.

ITS-RFLP

Polymerase chain reaction (PCR) amplification of the entire ITS regions encompassing ITS 1, 5.8S and ITS2 of the nuclear rDNA was done using the primers ITS-6 and ITS-4. A PCR amplicon of ~800 to 975bp was obtained for all isolates using ITS 4&6. The amplicons were digested with three restriction enzymes, Alu-1, Taq-1 and Msp-1. The restriction enzymes that produced clear and potentially diagnostic patterns were selected for analysis of all the *Phytophthora* isolates. Species specific bands were obtained with all the three enzymes used. Intraspecific variations were observed among all isolates of each species.

Cloning and sequencing of the ITS products

Three *Phytophthora* isolates from Black pepper (99-166), coconut (VC-9) and cardamom (99-180) were cloned and sequenced. The entire sequence of ITS 1, ITS 2 and 5.8S; partial sequences of 28 S and 18S regions were obtained. The BLAST search of sequences of cloned black pepper isolate of *Phytophthora* showed 98% similarity with *P. capsici* as well as with *P. tropicalis*. Isolates of coconut and cardamom showed 100% similarity with *P.palmivora,* and *P.meadii* respectively.

Designing of Species specific primer

Nucleotide sequences having internal transcribed spacer 1, 5.8S ribosomal RNA gene and internal transcribed spacer 2 and partial sequence of 18S and 28S ribosomal RNA gene of 63 different strains of *P. capsici* were retrieved from Genbank and designed a specific primer for *P. capsici.*

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TECHNICAL PROGRAMMES

Project Code	Title	Centers
BLACK PEPPER		
PEP/CI/1	**Genetic Resources**	
PEP/CI/1.1	Germplasm collection, characterization, evaluation and conservation	Chintapalle, Dapoli, Panniyur, Pundibari, Sirsi and Yercaud
PEP/CI/2	**Hybridization Trial**	
PEP/CI/2.1	Intervarietal hybridization to evolve high yielding varieties	Panniyur
PEP/CI/3	**Coordinated Varietal Trial (CVT)**	
PEP/CI/3.1	CVT 1991 – Series IV	Dapoli, Yercaud and Ambalavayal
PEP/CI/3.2	*CVT 2000 – Series V*	*Chintapalle, Pampadumpara, Panniyur, Sirsi and Ambalavayal*
PEP/CM/2	**Nutrient Management Trial**	
PEP/CM/2.1	Effect of biofertilizers, *Azospirillum* on black pepper production	Panniyur, Sirsi, Yercaud and Ambalavayal
PEP/CM/2.2	Effect of biofertilizers, P-solubilizer on black pepper	Panniyur, Sirsi, Yercaud and Ambalavayal
PEP/CM/2.3	Organic farming in black pepper	Panniyur, Sirsi and Yercaud
PEP/CM/2.4	Development of organic package for spices based cropping system – Observational trial	Chintapalle and Dapoli
PEP/CP/1	**Disease Management Trial**	
PEP/CP/1.1	Management of *Phytophthora* disease in black pepper nursery	Chintapalle, Pampadumpara and Dapoli
PEP/CP/1.2	Control of *Phytophthora* disease of black pepper in farmers' field – observational trial	Mudigere, Pampadumpara, Panniyur, Sirsi and Ambalavayal
PEP/CP/1.3	*Phytophthora* foot rot incidence in black pepper under different densities in arecanut garden	Panniyur and Sirsi
PEP/CP/1.4	Incidence, epidemiology and management of anthracnose disease of black pepper	Dapoli, Mudigere and Pampadumpara

Project Code	Title	Centers
PEP/CP/1.5	Management of foot rot disease of black pepper under coffee based cropping system	Mudigere
PEP/CP/2	**Pest Management Trial**	
PEP/CP/2.2	Management of scale-insects of black pepper with organic products	Mudigere ,Pampadumpara
CARDAMOM		
CAR/CI/1	**Genetic Resources**	
CAR/CI/1.1	Germplasm collection, characterization, evaluation and conservation	Mudigere and Pampadumpara
CAR/CI/2	**Hybridization and Selection**	
CAR/CI/2.1	Evaluation of OP progenies under intensive management	Mudigere
CAR/CI/3	**Coordinated Varietal Trial**	
CAR/CI/3.4	CVT 2000- Series IV	Mudigere, Pampadumpara, Myladumpara and Sakleshpur
CAR/CI/3.5	CVT 2005-series V	Pampadumpara, Mudigere
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/CM/1	**Nutrient Management Trial**	
CAR/CM/1.3	Integrated nutrient management in cardamom	Mudigere
CAR/CM/1.4	Effect of bio-fertilizer, *Azospirillum* on cardamom	Mudigere, Pampadumpara and Myladumpara
CAR/CM/1.5	Effect of biofertilizers, P. solubilizers on cardamom	Mudigere, Pampadumpara and Myladumpara
CAR/CM/1.6	Effect of neem cake on productivity, pest and disease incidence in cardamom	Mudigere and Pampadumpara,
CAR/CP/2	**Pest Management Trial**	
CAR/CP/2.3	Bioecology of natural enemies of major pests of cardamom	Mudigere and Pampadumpara
CAR/CP/2.4	Estimation of quantitative and qualitative losses due to thrips damage in cardamom	Mudigere and Pampadumpara
CAR/CP/2.5	Shortly infestation on cardamom – observational trial	Mudigere

Project Code	Title	Centers
GINGER		
GIN/CI/1	**Genetic Resources**	
GIN/CI/1.1	Germplasm collection, characterization, evaluation and conservation	Dholi, Kumarganj, Pottangi, Pundibari, Raigarh, Chintapalle and Solan
GIN/CI/2	**Coordinated Varietal Trial**	
GIN/CI/2.2	CVT 2000 – Series V	Pundibari, Raigarh, Pottangi and Solan
GIN/CI/2.3	CVT 2005 – Series VI	Solan
GIN/CI/3	**Varietal Evaluation Trial**	
GIN/CI/3.1	Comparative yield trial (CYT-I & II)	Raigarh and Solan
GIN/CI/3.2	Initial evaluation trial (IET)	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, *Azospirillum* on ginger	Pundibari, Solan and Ambalavayal
GIN/CM/1.2	Organic farming in ginger	Dholi, Solan, Pottangi and Raigarh
GIN/CM/1.4 and Raigarh	Effect of micronutrients on ginger	Dholi, Kumarganj, Pottangi, Pundibari
GIN/CP/1	**Disease Management Trial**	
GIN/CP/1.1	Disease surveillance and etiology of rhizome rot in ginger	Pundibari and Solan
GIN/CP/1.2	Biocontrol studies on rhizome rot of ginger	Kumarganj, Pottangi, Raigarh and Ambalavayal
GIN/CP/1.3	Integrated management of *rhizome* rot of ginger	Pundibari, Dholi and Solan
GIN/CP/1.4	Integrated management of *Pythium, Fusarium* and *Ralstonia* on ginger	Dholi, Kumarganj, Pundibari and Raigarh
GIN/CP/1.5	Survey and monitoring of diseases in ginger	Pundibari and Raigarh
TURMERIC		
TUR/CI/1	**Genetic Resources**	
TUR/CI/1.1	Germplasm collection, characterization, evaluation and conservation	Coimbatore, Dholi, Jagtial, Solan, Kumarganj, Pottangi, Pundibari and Raigarh

Project Code	Title	Centers
TUR/CI/2	**Coordinated varietal trial**	
TUR/CI/2.2	CVT 2000 - Series V	Jagtial, Pundibari, Raigarh, Coimbatore and Kumarganj
TUR/CI/2.3	CVT-2004-Series VI	Chintapalle, Coimbatore, Jagtial, Kumarganj, Pottangi, Pundibari and Raigarh
TUR/CI/3	**Varietal evaluation trial**	
TUR/CI/3.1	Comparative yield trial (1999-2000)	Pundibari and Raigarh
TUR/CI/3.2	Comparative yield trial 2005-06	Jagtial and Coimbatore
TUR/CI/3.3	Initial evaluation trial	Dholi and Pottangi
TUR/CI/4	**Quality evaluation trial**	
TUR/CI/4.1	Quality evaluation of germplasm	Coimbatore
TUR/CI/4.2	Impact of environment on quality of turmeric	Coimbatore
TUR/CM/1	**Nutrient Management Trial**	
TUR/CM/1.1	Effect of biofertilizer, *Azospirillum* on turmeric	Coimbatore, Kumarganj and Pundibari
TUR/CM/1.2	Organic farming in turmeric	Pundibari
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, Dholi, Pundibari and Raigarh
TUR/CP/1.2	Management of *Taphrina* leaf blotch and *colletotrichum* leaf spot of turmeric	Raigarh
TUR/CP/1.3	Effect of seed treatment on leaf spot and leaf blotch diseases of turmeric	Dholi, Kumarganj, Pundibari 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, Pundibari, Dholi, Kumarganj, Pottangi and Raigarh
TREE SPICES		
TSP/CI/1	**Genetic Resources**	
TSP/CI/1.1	Germplasm collection, characterization, evaluation and conservation of clove, nutmeg and cinnamon	Dapoli and Yercaud/ Pechiparai

Project Code	Title	Centers
TSP/CI/2	**Coordinated Varietal Trial**	
TSP/CI/2.1	CVT 1992 in clove	Yercaud and Pechiparai
TSP/CI/2.2	CVT 1992 in cinnamon	Ambalavayal
TSP/CI/2.3	CVT 2001 in nutmeg	Dapoli and Pechiparai
TSP/CI/2.4	CVT 2001 in cassia	Dapoli, Pechiparai and Ambalavayal
TSP/CM/1	*Propagation/Multiplication Trial*	
TSP/CM/1.1	***Softwood grafting in clove***	Dapoli
TSP/CP/1	**Disease Management Trial**	
TSP/CP/1.1	Survey for disease incidence in tree spices	Dapoli, Pechiparai 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, Dholi, Guntur, Hisar, Jagudan, Jobner and Kumarganj
COR/CI/2	**Coordinated Varietal Trial**	
COR/CI/2.4	CVT 2001 – Series V	Coimbatore, Hisar, Jobner, Kumarganj, Dholi, Jagudan, Guntur and Raigarh
COR/CI/2.5	CVT 2004 – Production of leafy type coriander during off-season	Coimbatore, Guntur and Hisar
COR/CI/3	**Varietal Evaluation Trial**	
COR/CI/3.2	Initial evaluation trial	Hisar, Guntur, Jobner and Jagudan
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	Guntur
COR/CM/1.2	Effect of biofertilizer, *Azospirillum* on coriander	Coimbatore and Kumarganj
COR/CM/1.3	Effect of bio-regulators on coriander	Dholi, Guntur, Jobner and Kumarganj
COR/CM/1.4	Identification of drought/ alkalinity tolerant source in coriander	Guntur and Kumarganj

Project Code	Title	Centers
COR/CP/1	**Disease Management Trial**	
COR/CP/1.2	Management of powdery mildew and stem gall in coriander	Coimbatore, Jagudan, Jobner,and Raigarh
CUMIN		
CUM/CI/1	**Genetic Resources**	
CUM/CI/1.1	Germplasm collection, characterization, evaluation conservation and screening against diseases	Jagudan, Jobner and Raigarh
CUM/CI/3	**Coordinated Varietal Trial**	
CUM/CI/3.3	CVT 2001-Series V	Jobner and Jagudan
CUM/CI/4	**Varietal Evaluation Trial**	
CUM/CI/4.1	Initial evaluation trial	Jobner
CUM/CI/5	**Quality Evaluation Trial**	
CUM/CI/5.1	Quality evaluation in cumin	Jobner
CUM/CP/1	**Disease Management Trial**	
CUM/CP/1.3	Management of wilt and blight diseases in cumin	Jagudan and Jobner
FENNEL		
FEL/CI/1	**Genetic Resources**	
FNL/CI/1.1	Germplasm collection, characterization, evaluation, conservation and screening against diseases	Dholi, Hisar, Jagudan, Jobner and Kumarganj
FNL/CI/3	**Coordinated Varietal Trial**	
FNL/CI/3.3	CVT – 2004 –Series V	Dholi, Hisar, Jagudan, Jobner and Kumarganj
FNL/CI/4	**Varietal Evaluation Trial**	
FNL/CI/4.1	Initial evaluation trial	Hisar, Jobner and Jagudan
FNL/CI/5	**Quality evaluation trial**	
FNL/CI/5.1	Quality evaluation in fennel	Jobner
FNL/CM/1	**Nutrient Management Trial**	
FNL/CM/1.2	Effect of biofertilizer, *Azospirillum* on fennel	Kumarganj
FNL/CM/1.3	Identification of drought/ alkalinity tolerance source in fennel	Kumarganj

Project Code	Title	Centers
FENUGREEK		
FGK/CI/1	**Genetic Resources**	
FGK/CI/1.1	Germplasm collection, characterization, evaluation conservation and screening against diseases	Dholi, Guntur, Hisar, Jagudan, Jobner and Kumarganj
FGK/CI/3	**Coordinated Varietal Trial**	
FGK/CI/3.3	CVT 2001 – Series V	Coimbatore, Hisar, Jagudan, Dholi, Jobner and Kumarganj
FGK/CI/3.4	CVT 2005 – Series VI	Raigarh and Guntur
FGK/CI/4	**Varietal Evaluation Trial**	
FGK/CI/4.2	Initial evaluation trial	Guntur, Hisar, Jagudan and Jobner
FGK/CM/2	**Nutrient Management Trial**	
FGK/CM/2.2	Effect of biofertilizers, *Azospirillum/ Rhizobium* on fenugreek	Coimbatore and Kumarganj
FGK/CM/2.3	Identification of drought/ tolerance source in fenugreek	Coimbatore and Guntur

STAFF POSITION
PROJECT COORDINATOR'S CELL
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Calicut - 673 012, Kerala

Project Coordinator	:	Dr M Anandaraj (w.e.f 16.02.2006) Dr V A Parthasarathy (26.01.05 to 15.02.06)
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	:	Ms Susamma P George (Post shifted to RARS Ambalavayal)
2. Agronomist (Hort.)	:	Dr K Vasantha Kumar
3. Jr. Entomologist	:	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. Pathologist (Assoc. Professor)	:	Dr K P Mammootty
2. Jr. Breeder (Assi. Professor)	:	Dr V P Neema
3. Jr. Pathologist	:	Vacant
4. Jr. Horticulturist (Agronomy)	:	Vacant
5. Farm Supervisor (Gr. I)	:	Mr P J Joseph
6. Farm Supervisor (Gr. II)	:	Mr K Lakshmanan
7. Farm Supervisor (Sr Gr)	:	Mr P P Muralidharan
8. Lab Assistant (Gr. III)	:	Ms Nirmala Chellath
9. Peon (Sel. Gr.)	:	K Rajeev

3. Regional Research Station, UAS (Bangalore), Mudigere

1. Pathologist	:	Dr S D Rangaswamy
2. Agronomist (Hort.)	:	Dr M Dinesh Kumar
3. Breeder	:	Dr S Ganga Prasad
4. Jr. Entomologist	:	Dr 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. Pathologist (Assoc. Prof.) : Dr M S Lokesh
2. Jr. Horticulturist : Mr Nagesh Naik
3. Technical Assistant : Mr G V Heregowder

5 *Horticultural Research Station, TNAU, Yercaud*
1. Agronomist (Hort.) : Dr V Lakshmanan
2. Jr. Breeder (Hort.) : Dr R Swarnapiria (Posted at HRS Pechiparai)
3. Lab Assistant : Mr P Pappu

6 *Department of Spices & Plantation Crops, TNAU, Coimbatore*
1. Breeder (Horticulturist) : Dr (Mrs.) N. Shoba
2. Jr. Pathologist : Dr P Muthulakshmi
3. Agricultural Assistant : Mr R Swaminathan

7 *Regional Agricultural Research Station, ANGRAU, Chintapalle*
1. Horticulturist : Sri D Lakshminarayana
2. Junior Pathologist : Vacant
3. Technical Assistant : Vacant (since April 1990)

8 *Regional Agricultural Research Station, ANGRAU, Jagtial*
1. Jr. Pathologist : Dr M. Padma Sri (Leave from Nov. 2005)
2. Jr. Horticulturist : Mr M Raja Naik
3. Technical Assistant : Mr G Srikanth

9 *Regional Agricultural Research Station, ANGRAU, Guntur*
1. Horticulturist : Smt C Sarada (Leave from 11.11.05)
2. Jr. Breeder (Hort.) : Sri K Giridhar
3. Sub Assistant : Mr U Veerabhadra Rao

10 *Department of Vegetable Crops, Dr YSPUHF, Solan*
1. Breeder (Olericulturist) : Dr B N Korla
2. Jr. Pathologist : Dr N P Dohroo
3. Jr. Biochemist : Dr Neerja Rana
4. Field Assistant : Mr Rajeshwar Chauhan

11 *High Altitude Research Station, OUAT, Pottangi*
1. Breeder : Vacant
2. Jr. Breeder : Mr D K Dash
3. Technical Assistant : Mr R C Dash
4. Technical Assistant : Mr B N Sahoo

12 *Department of Genetics and Plant Breeding, SKN College of Agriculture, RAJAU, Jobner*
1. Sr Breeder : Dr EVD Sastry
2. Breeder : Dr Dhirendra Singh
3. Jr. Agronomist : Dr N L Jat
4. Jr. Pathologist : Dr K S Shekhawat
5. Jr. Biochemist : Vacant
6. Technical Assistant : Dr S S Rajput
7. Technical Assistant : Mr S R Kumawat

13 *Main Spices Research Station, SDAU, Jagudan*

1. 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. Horticulturist/Oleoriculturist	:	Dr K K Thakkral
2. Assistant Scientist (VC)	:	Dr Suresh Tehlan

15. *Dept. of Horticulture, Tirhut College of Agriculture, RAU, Dholi*

1. Horticulturist	:	Dr S P Singh
2. Jr. Pathologist	:	Vacant (from 01.1.2001)
3. Technical Assistant	:	(Vacant since inception the project)

16. *Dept. of Vegetable Science, NDUAT, Kumarganj*

1. Horticulturist	:	Dr J Dixit
2. Jr. Pathologist	:	Dr R P Saxena
3. Jr. Breeder	:	Dr V P Pandey
4. Technical Assistant	:	Mr R K Gupta
5. Technical Assistant	:	Mr VK Singh

17 *Dept. of Horticulture, UBKVV, Pundibari*

1. Horticulturist	:	Vacant
2. Jr. Breeder	:	Dr N Bhowmik
3. Jr. Pathologist	:	Mr S Bandyopaday
4. Technical Assistant	:	Mr B Mazumder
5. Technical Assistant	:	Mr B Dutta

18 *Dept. of Horticulture, KKV, Dapoli*

1. Horticulturist	:	Dr A D Rangawala
2. Jr. Pathologist	:	Prof U A Garde
3. Jr. Breeder	:	Prof R G Khandekar
4. Technical Assistant	:	Mr S D Tambe
5. Technical Assistant	:	Mr A B Jadhav

19 *Regional Agricultural Research Station, IGAV, Raigarh*

1. Horticulturist	:	Dr C R Gupta
2. Jr. Breeder	:	Dr Shailesh Tripathi
3. Jr. Pathologist	:	Dr A K Singh
4. Technical Assistant	:	Mr D S Kshatri
5. Technical Assistant	:	Vacant

ALL INDIA COORDINATED RESEARCH PROJECT ON SPICES
BUDGET PROVISION 2005-06

(Rs. in lakhs)

Name of the center	Pay & Allowance						Tech.Assmt.	Total	Grand	Grand Total	
	Estt.	ICAR Share	TA	ICAR Share	RC	ICAR share	ICAR Share	RC	Total	ICAR share	State share
Pampadumpara (KAU)	16.414	12.311	0.549	0.412	1.939	1.4540		1.454	18.902	14.177	4.725
Panniyur (KAU)	13.356	10.017	0.732	0.549	2.585	1.9390	0.100	2.039	16.773	12.605	4.168
Mudigere (UAS-B)	15.598	11.699	0.732	0.549	2.585	1.9390		1.939	18.915	14.187	4.728
Sirsi (UAS-D)	5.832	4.374	0.366	0.275	1.293	0.9700		0.970	7.491	5.619	1.872
Yercaud (TNAU)	8.680	6.510	0.366	0.275	1.293	0.9700		0.970	10.339	7.755	2.584
Coimbatore (TNAU)	5.860	4.395	0.366	0.275	1.293	0.9700	0.100	1.070	7.619	5.74	1.879
Chintapalli (APAU)	2.786	2.090	0.365	0.274	1.293	0.9700		0.970	4.444	3.334	1.110
Jagtial (APAU)	4.584	3.438	0.365	0.274	1.293	0.9700	0.050	1.020	6.292	4.732	1.560
Guntur (APAU)	1.857	1.393	0.366	0.275	1.293	0.9700	0.050	1.020	3.566	2.688	0.878
Solan (YSPUHF)	11.833	8.875	0.549	0.412	1.937	1.4530	0.050	1.503	14.369	10.79	3.579
Pottangi (OUAT)	2.098	1.574	0.365	0.274	1.293	0.9700	0.100	1.070	3.856	2.918	0.938
Jobner (RAJAU)	16.701	12.526	0.915	0.686	3.225	2.4190	0.150	2.569	20.991	15.781	5.210
Jagudan (GAU)	6.005	4.504	0.365	0.274	1.293	0.9700	0.100	1.070	7.763	5.848	1.915
Hisar (HAU)	8.104	6.078	0.365	0.274	1.293	0.9700	0.100	1.070	9.862	7.422	2.440
Dholi (RAU)	1.698	1.274	0.365	0.274	1.293	0.9700	0.050	1.020	3.406	2.568	0.838
Kumarganj (NDUAT)	3.246	2.435	0.549	0.412	1.939	1.4540		1.454	5.734	4.301	1.433
Pundibari (BCKVV)	7.178	5.384	0.549	0.412	1.939	1.4540	0.050	1.504	9.716	7.30	2.416
Dapoli (KKV)	13.453	10.090	0.549	0.412	1.939	1.4540	0.050	1.504	15.991	12.006	3.985
Raigarh (IGKVV)	11.084	8.313	0.549	0.412	1.939	1.4540	0.050	1.504	13.622	10.229	3.393
Grand Total	156.367	117.28	9.327	7.000	32.957	24.72	1.000	25.72	199.651	150.00	49.651

Statement of fund released to AICRPS centres (2005-06)

(Rs. in lakhs)

Name of the Centre	RE sanctioned 2005-06	Amount released		Tech. Assmt.	Addl.fund released	Grand total released
		First half	Second half			
Pampadumpara(KAU)	14.177	4.371	4.370		5.436	14.177
Panniyur(KAU)	12.605	4.535	4.533	0.10	3.437	12.605
Mudigere(UAS-B)	14.187	5.865	5.863		2.459	14.187
Sirsi(UAS-D)	5.619	2.008	2.007		1.604	5.619
Yercaud(TNAU)	7.755	2.438	2.437		2.880	7.755
Coimbatore(TNAU)	5.74	2.518	2.517	0.10	0.605	5.74
Chintapalli(APAU)	3.334	2.518	0.816		Nil	3.334
Jagtial(APAU)	4.732	2.008	2.006	0.05	0.668	4.732
Guntur(APAU)	2.688	2.518	0.120	0.05	Nil	2.688
Solan(YSPUHF)	10.79	3.340	3.410	0.05	3.900	10.79
Pottangi(OUAT)	2.918	2.818	0.00	0,10	Nil	2.918
Jobner(RAJAU)	15.781	6.460	6.458	0.15	2.713	15.781
Jagudan(GAU)	5.848	2.518	2.516	0.10	0.714	5.848
Hisar(HAU)	7.422	2.978	2.976	0.10	1.368	7.422
Dholi(RAU)	2.568	2.518	-	0.05	Nil	2.568
Kumarganj(NDUAT)	4.301	3.721	0.580		Nil	4.301
Pundibari(BCKVV)	7.30	3.730	3.520	0.05	Nil	7.30
Dapoli(KKV)	12.006	3.730	3.710	0.05	4.516	12.006
Raigarh(IGKVV)	10.229	3.730	3.710	0.05	2.739	10.229
Grand Total	**150.00**	**64.412**	**51.549**	**1.00**	**33.039**	**150.00**

The BE 2005-06 was Rs. 130.00 L as per the sanctioned X plan EFC Memo. An RE of 150.00 L has been communicated vide letter no. F. 15-5/2006-1A (V) dated 27 July 2006. A savings of Rs. 13.039 L was obtained from (6 centres + PC cell) Chintapalle (Rs. 1.70), Guntur (Rs. 2.397), Pottangi (Rs. 2.816), Dholi (Rs. 2.516), Kumarganj (3.140), Pundibari (0.190) and PC Cell (0.28 L).The overall savings of Rs. 13.039 L + the additional fund of Rs. 20.00 L = 33.039L has been released to 13 centres as additional funds under pay and allowances based on RE sactioned.

METEOROLOGICAL DATA 2005

Pampadumpara

Month	Rainfall (mm)	No. of rainy days	Temperature (°C)		Relative humidity (%)	
			Max.	Min.	Max.	Min.
January	31.6	2	25.1	15.9	91.3	53.7
February	31.2	2	26.9	16.4	85.0	40.8
March	53.4	2	28.8	18.6	91.2	49.7
April	204.6	12	31.5	18.0	95.00	64.86
May	60.6	5	30.5	17.2	94.35	65.00
June	188.0	16	27.5	17.0	97.90	85.00
July	505.2	26	25.0	16.5	98.45	93.13
August	165.7	16	27.5	16.4	96.90	78.45
September	260.4	15	27.4	16.6	96.23	78.27
October	177.6	12	29.0	16.0	95.68	74.52
November	250.4	13	27.0	14.5	94.59	80.69
December	203.8	8	28.0	14.0	94.68	68.13

Panniyur

Month	Rainfall (mm)	No. of rainy days	Temperature (°C)		Relative humidity (%)
			Max.	Min.	Min.
January	0.8	1	34.6	22.9	89.1
February	-	-	36.4	23.1	81.8
March	-	-	36.9	24.8	88.4
April	87.5	5	36.4	26.7	83.8
May	10.2	2	36.8	27.4	80.0
June	829.9	24	30.6	25.6	91.2
July	1024.9	29	28.9	25.1	93.8
August	300.7	22	30.4	24.9	92.1
September	406.6	20	29.7	24.7	93.2
October	248.4	14	31.7	25.1	89.9
November	147.8	9	32.4	24.2	85.6
December	16.0	1	33.5	22.6	87.4

Mudigere

Month	Rainfall (mm)	No. of rainy days	Temperature (°C)		Relative humidity (%)	
			Max.	Min.	Max.	Min.
January	0.0	-	27.45	15.16	82.06	41.93
February	0.0	-	29.89	18.19	81.14	36.42
March	0.0	-	32.04	19.5	80.09	37.74
April	177.6	9	30.38	20.28	83.90	42.90
May	95.0	7	29.75	20.74	82.58	48.70
June	461.5	18	25.33	19.58	84.73	71.93
July	976.0	27	24.20	19.45	86.77	79.61
August	898.4	23	24.75	19.66	88.58	83.48
September	379.0	18	24.56	20.60	86.56	82.06
October	312.6	10	26.59	19.87	88.45	82.51
November	30.6	3	26.40	19.13	86.23	81.86
December	0.0	---	26.79	45.91	70.67	57.77

Sirsi

Month	Rainfall (mm)	No. of rainy days	Temperature (°C)		Relative humidity (%)	
			Max.	Min.	Max.	Min.
January	0	0	29.58	13.39	83.48	64.84
February	31.2	5.0	33.44	13.26	78.93	52.25
March	0	0	35.53	17.47	74.16	41.48
April	0.0	0.0	35.33	20.37	71.57	42.13
May	0.0	0.0	35.23	21.56	78.39	47.13
June	498.8	15	29.85	21.85	86.13	74.93
July	793.0	28.0	27.18	21.02	94.48	93.00
August	492.0	25.0	26.94	20.82	94.39	93.32
September	341.0	22.0	27.80	20.88	92.27	88.30
October	151.0	9.0	30.27	19.90	86.06	81.68
November	0.0	0.0	29.28	15.52	85.60	80.03
December	0.0	0.0	30.19	13.95	90.29	63.19

Coimbatore

Month	Rainfall (mm)	No. of rainy days	Temperature (°C)		Relative humidity (%)	
			Max.	Min.	Max.	Min.
January	-	-	-	-	-	-
February	-	-	-	-	-	-
March	46.2	3	34.4	23.2	86	38
April	77.2	5	33.9	23.2	89	49
May	104.4	7	34.6	21.6	87	51
June	11.4	2	32.2	23.8	78	53
July	40.1	3	30.7	23.4	79	59
August	84.5	4	31.4	22.5	84	53
September	25.4	3	31.2	22.6	86	55
October	333.1	13	30.7	22.2	92	62

November	196.6	9	28.1	20.3	92	66
December	60.1	3	29.2	19.1	93	55

Chintapalle

Month	Rainfall (mm)	No. of rainy days	Temperature (°C)		Relative humidity (%)	
			Max.	Min.	Max.	Min.
January	3.6	-	12.0	27.3	83.0	46.2
February	-	-	10.0	30.9	64.8	31.6
March	34.2	3	16.5	32.4	75.5	35.9
April	57.8	7	18.4	32.6	76.8	48.7
May	92.0	5	19.8	35.4	73.1	52.1
June	209.2	12	22.5	33.1	78.6	58.0
July	155.6	10	21.5	27.5	74.6	59.0
August	103.2	10	20.5	26.2	88.7	76.4
September	542.2	16	20.3	25.5	89.3	86.5
October	281.2	21	19.5	25.4	90.5	84.0
November	88.8	3	13.0	27.3	87.5	52.7
December	6.22	1	9.8	27.5	85.0	47.5

Jagtial

Month	Rainfall (mm)	Temperature (°C)		Relative humidity (%)	
		Max.	Min.	Max.	Min.
January	59.2	30.9	14.9	69.6	39.9
February	9.4	33.9	17.2	66.2	32.1
March	5.0	38.1	20.2	55.6	24.4
April	41.2	40.3	25.4	51.6	24.7
May	1.4	42.9	28.3	44.5	23.3
June	150.6	40.6	28.6	60.4	39.0
July	284.8	31.1	24.5	82.9	70.1
August	109.8	31.0	23.4	81.2	68.5
September	339.8	31.6	23.8	81.9	67.5
October	137.4	31.8	22.1	81.7	59.0
November	0.0	30.7	14.0	78.5	33.7
December	1.0	29.3	12.2	78.1	41.1

Guntur

Month	Rainfall (mm)	No. of rainy days	Temperature (°C)		Relative humidity (%)	
			Max.	Min.	Max.	Min.
January	-	-	-	-	-	-
February	-	-	-	-	-	-
March	-	-	-	-	-	-
April	-	-	-	-	-	-
May	-	-	-	-	-	-
June	10.0	2	39.97	28.8	62.37	36.93
July	255.6	14	32.88	25.56	82.16	62.81

August	70.8	10	34.07	25.14	84.90	62.19
September	318.7	8	32.23	24.27	90.93	79.20
October	216.5	15	30.20	23.30	92.00	82.40
November	12.4	3	30.40	18.30	89.20	73.60
December	3.0	1	29.80	17.50	81.20	62.10

Pottangi

Month	Rainfall (mm)	No. of rainy days	Temperature (°C)		Relative humidity (%)	
			Max.	Min.	Max.	Min.
January	-	-	-	-	-	-
February	-	-	-	-	-	-
March	-	-	33	20	95	40
April	126	7	34	21	95	40
May	75	3	35	20	97	50
June	243	9	35	22	100	47
July	278	17	28	22	110	80
August	263	13	27	20	100	75
September	517.4	17	27	21	110	78
October	357	16	29	20	105	75
November	18.5	2	25	14	100	70
December	-	-	26	12	105	60

Jobner

Month	Rainfall (mm)	No. of rainy days	Temperature (°C)		Relative humidity (%)	
			Max.	Min.	Max.	Min.
January	22.2	3	18.3	4.0	93	54
February	56.5	6	20.5	7.4	93	58
March	57.2	6	27.8	13.1	94	51
April	16.5	1	35.3	15.2	57	21
May	9.7	3	39.0	21.3	57	23
June	71.1	2	41.0	25.6	58	32
July	195.9	8	34.6	26.1	86	66
August	9.4	3	36.0	25.8	81	54
September	181.3	7	33.4	23.2	88	64
October	0.0	0	33.2	15.7	88	33
November	0.0	0	28.4	9.6	83	33
December	0.0	0	21.4	2.8	93	43

Hisar

Month	Rainfall (mm)	No. of rainy days	Temperature (°C)		Relative humidity (%)	
			Max.	Min.	Max.	Min.
January	4.6	1	22.7	2.8	87	34
February	2.5	1	26.7	3.2	83	30
March	-	-	34.5	12.1	82	15
April	-	-	39.2	13.5	50	14
May	-	-	42.0	25.8	54	25

June	27.6	5	42.2	26.8	65	22
July	34.1	12	31.4	25.9	88	20
August	38.4	2	36.4	20.4	80	38
September	35.0	5	36.2	20.6	87	46
October	-	-	33.8	11.6	73	28
November	-	-	25.4	9.8	72	30
December	-	-	23.8	3.8	78	29

Pundibari

Month	Rainfall (mm)	Temperature (°C)		Relative humidity (%)	
		Max.	Min.	Max.	Min.
January	0.5	24.1	8.2	89	53
February	0.3	27.8	12.0	90	50
March	89.5	30.1	14.5	88	57
April	156.0	31.9	16.7	93	76
May	251.5	32.1	17.0	94	79
June	832.8	32.5	21.3	96	78
July	802.6	33.1	24.7	98	79
August	825.0	33.6	24.3	95	76
September	86.0	33.9	24.0	94	80
October	504.2	32.1	19.8	93	83
November	-	29.9	14.4	95	81
December	-	26.4	10.9	89	63

Dapoli

Month	Rainfall (mm)	No. of rainy days	Temperature (°C)		Relative humidity (%)	
			Max.	Min.	Max.	Min.
January	3.4	1	30.4	11.8	96	48
February	0	0	31.0	12.3	92	52
March	0	0	31.9	14.8	96	61
April	0	0	33.3	20.0	89	65
May	0	0	33.1	22.3	86	63
June	672.3	14	31.7	24.1	91	75
July	1333.0	27	28.6	23.7	86	88
August	1157.8	27	28.5	23.5	95	90
September	717.9	23	28.1	22.9	96	94
October	102.0	05	31.3	20.9	95	68
November	0	0	32.2	14.4	93	50
December	0	0	31.3	13.0	92	40

Pechiparai

Month	Rainfall (mm)	No. of rainy days	Temperature (°C)		Relative humidity (%)
			Max.	Min.	Max.
January	25.20	2	33.33	19.59	89.45
February	5.10	1	35.30	19.28	89.39
March	75.30	7	35.54	21.95	87.41

April	601.70	15	32.65	22.25	91.63
May	274.40	8	32.67	22.74	89.19
June	160.80	12	30.00	23.26	89.80
July	403.00	19	29.85	23.72	89.16
August	17.67	3	32.03	24.90	85.48
September	206.40	10	30.40	23.26	89.23
October	278.38	15	30.95	22.45	87.32
November	218.10	17	27.95	22.58	92.16
December	230.95	10	31.59	24.93	88.41

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@spices.res.in

	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)	entojoe2003@yahoo.co.in crsp1956@yahoo.co.in
2.	Pepper Research Station (Kerala Agricultural University) PANNIYUR, PB No.113 Kanjirangadu (P.O) Karimbam (Via), Taliparamba -670 142, Dist. Cannanore, Kerala	(0460) 2227287 (O) (0497) 741821(R)	Fax: 0460-2227287 prskan@sancharnet.in
3.	Regional Research Station (Univ. of Agrl.Sciences, Bangalore) MUDIGERE-577 132 Dist. Chickmangalur, Karnataka	(08263) 228135 (O) (08263) 228008 (R)	Fax: 08263-228135 mudigere@rediffmail.com
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