



Re-maj

वार्षिक रिपोर्ट Annual Report 2008-09

अखिल भारतीय समन्वित मसाला अनुसंधान परियोजना ए आई सी आर पी एस
All India Coordinated Research Project on Spices

बोटापड



iisr

भारतीय मसाला फसल अनुसंधान संस्थान

(भारतीय कृषि अनुसंधान परिषद्)

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Indian Institute of Spices Research

(Indian Council of Agricultural Research)

Calicut - 673012, Kerala, India

ALL INDIA COORDINATED RESEARCH PROJECT ON SPICES

ANNUAL REPORT 2008-2009



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परियोजना समन्वयक की रिपोर्ट

अखिल भारतीय समन्वित मसाला अनुसंधान परियोजना, ए आई सी आर पी एस का मुख्यालय भारतीय मसाला फसल अनुसंधान संस्थान, कालिकट में 12 अधिदेश मसाला फसलों में शोध कार्य और अनुसंधान समन्वय करने के लिए स्थित है। भारत के 21 राज्यों में 21 राज्य/केन्द्रीय कृषि विश्वविद्यालय, राज्य कृषि विश्वविद्यालय/शोध संस्थानों के अन्तर्गत ए आई सी आर पी एस के कुल 34 केन्द्र हैं, जिसमें 19 नियमित, 8 सहयोजित तथा 7 स्वैच्छिक केन्द्र हैं। वर्ष 2008-09 में ए आई सी आर पी एस की ग्यारहवीं योजना का बजट 1400 लाख रूपए है जिसमें भारतीय कृषि अनुसंधान परिषद का अंश 250 लाख रूपए है। अधिदेश मसाला फसलों के लगभग 115 शोध कार्यक्रम विभिन्न केन्द्रों में आयोजित किये जा रहे हैं। यह कार्यक्रम आनुवांशिकी एवं फसल सुधार, फसल उत्पादन तथा फसल संरक्षण जैसे प्रमुख विभागों के अन्तर्गत चल रहे हैं। अधिदेश फसलों की प्रमुख उपलब्धियां इस रिपोर्ट में प्रस्तुत की जा रही हैं।

काली मिर्च

काली मिर्च के सात सौ चौतीस उत्पन्न किये गये, विदेशी, वन्य तथा अन्य संबन्धित उपजातियों के अक्सेशनों का ए आई सी आर पी एस के विभिन्न केन्द्रों में अनुरक्षण किया जा रहा है। जननद्रव्य के मूल्यांकन के फलस्वरूप पन्नियूर केन्द्र से उच्च उपज वाले अक्सेशनों जैसे करिमुंडा ए, अंकमाली, करिमुंडा ए, तथा प्रति बेल से 2 कि. ग्राम हरी बेरी की उपज वाली वलियारमुंडी की पहचान की गई। पन्नियूर I, 2.60 कि. ग्राम शुष्क/बेलद्व तथा अक्सेशन.57, 4 कि. ग्राम शुष्क/बेलद्व को कमशरू सिरसी और येरकाड केन्द्र से उच्च उपज वाली के रूप में पहचान की गई। अन्तर प्रजातीय संकरजों को पन्नियूर केन्द्र में विकसित किया जा रहा है, संकरज पी.6 र पी.5 से 2.5 कि. ग्राम/बेल निर्मल उपज प्राप्त होने के बाद उसे पन्नियूर 8 के रूप में विमोचन करने के लिए प्रस्तावित किया। अम्बलवयल में सीवीटी में काली मिर्च के विभिन्न कल्टिवर्सों का मूल्यांकन किया गया जिनमें सीयूएल.5308 में 3.01 कि. ग्राम बेरी/सहायक तत्पश्चात् पन्नियूर.1 में 2.79 कि. ग्राम वजन अंकित किया गया। पन्नियूर केन्द्र में अधिकतम उपजता/बेल, सीयूएल-5489, 3.8 कि. ग्राम हरी बेरी/बेलद्व तत्पश्चात् सीयूएल-1041 तथा एच पी-105 में 2.5 कि. ग्राम/बेल अंकित की गई। दापोली केन्द्र में काली मिर्च कतरनों के सीधे तने की मूल लगाने से यह निष्कर्ष निकला कि तीन और पाँच नोडवाली कतरनों पी जी पी आर : *प्यूडोमोनास फ्लूरासन्स* -10⁸ केन्द्र में कमशः 97.3% तथा 94.6% सफलता के साथ स्थापित हुई। एकीकृत पोषण प्रबन्ध उपचार करने पर पन्नियूर और सिरसी केन्द्रों में जैविक और अजैविक उपचारों की अपेक्षा

अधिकतम उपजता अंकित की गई, वहीं अजैविक और एकीकृत पोषण प्रबन्ध उपचारों में पीचीपराई केन्द्र में लगभग बराबर उपज अंकित की गई। खुर गलन रोग प्रबन्धन के लिए उपलब्ध प्रचारित तकनीकियों तथा सभी उपचारों द्वारा पाम्पाडुमपारा केन्द्र में खुर गलन रोग आपतन में कमी अंकित की गई। पोटैशियम फॉस्फोनेट, 0.3:1 का छिड़काव, *ट्राइकोडेरमा हरज़ियानम* 50 ग्राम/बेल की दर से तथा 1 कि. ग्राम नीम केक चिन्तापल्ली, पन्नियूर और पाम्पाडुमपारा केन्द्रों में रोग नियन्त्रण करने के लिए उत्तम उपचार था। वही मुडिगरे केन्द्र में बोर्डियो मिश्रण, 1:1:1:1 छिड़कना और सीओसी, 0.03:1 प्रभावी देखा गया। मूल्यांकन किये बायोरेशनल में नीम गोल्ड, 0.05:1 को सीपी शल्क, *लेपिडोसाफस पाइपरिसद्व* की संख्या कम करने में प्रभावी था तथा शल्कों की सबसे कम संख्या डिमैथोयट, 0.005:1 द्वारा उपचार करने के उपरान्त प्राप्त हुई।

इलायची

ए आई सी आर पी एस के दो केन्द्रों (पाम्पाडुमपारा और मुडिगरे) में तीन सौ तेरह जननद्रव्य का अनुरक्षण किया गया। मुडिगरे केन्द्र में मूल्यांकन किये इलायची जननद्रव्य में अक्सेशन पोतमेडु में अधिकतम हरे कैप्सूल (208 कि. ग्राम/हेक्टर) तत्पश्चात् डी-141 तथा सी आई-730 की उपजता अंकित की गई। सी वी टी के अन्तर्गत सी एल-722, पी एस-27, एम सी सी-309 और एम सी सी-246 को मुडिगरे में शुष्क कैप्सूल की उपज (347.96 कि. ग्राम/हेक्टर) थी। मैलाडुमपारा में एम एच सी-26 (1317 कि. ग्राम/हेक्टर), एम सी सी-73 (1172 कि. ग्राम/हेक्टर), एम सी सी-246 (1155 कि. ग्राम/हेक्टर) तथा एम सी सी -309 (1033 कि. ग्राम/हेक्टर) को अधिकतम उपज वाले के रूप में पहचान की गयी। जैव उर्वरक *अजोस्पिरिल्लम* तथा पी सोलुबिलैसेर्स के उपयोगों से इलायची की वृद्धि एवं उपजता बढ़ी। इलायची की उपजता बढ़ाने के लिए 100% अकार्बनिक नाइट्रोजन + 50 ग्राम *अजोस्पिरिल्लम* + 5 कि. ग्राम एफ वाई एम या 100% अकार्बनिक फोस्फोरेस + 50 ग्राम फोस्फोबैक्टीरिया + 5 कि. ग्राम एफ वाई एम डालना चाहिए।

अदरक

ए आई सी आर पी एस के विभिन्न केन्द्रों में अदरक के लगभग 672 जननद्रव्यों का अनुरक्षण हो रहा है। पोटांगी केन्द्र से अदरक की उच्च उपज वाली शुभदा प्रजाति को बीसवीं ए आई सी आर पी एस कार्यशाला में विमोचन के लिए संस्तुत किया गया। कुमारगंज में परीक्षण के फलस्वरूप यह निष्कर्ष निकला कि 0.005:1 जिक सल्फेट, 60 और

90 डीएपीड, 0.2, बोराक्स ,60 और 90 डीएपीड तथा 1.0: फ़ैरस सल्फेट ,60 और 90 डीएपीड का पत्तों पर छिड़काव करने से उपजता :55^०53 कुन्तल/हेक्टरद और गुणवत्ता पैरामीटर्स में वृद्धि हुई। पोटांगी में किये आई ई टी उच्च निर्मल राइजोम की उपजता वी,ई,द 5;24^०35 टन/हेक्टर द तत्पश्चात् पी जी एस - 8 ;23^०49 टन/हेक्टरद में अंकित की गयी। बंदगोभी तथा सरसों के पौधे द्वारा जैव धूमन का प्रयोग करके अदरक का मृदु गलन रोग का नियन्त्रण कर सकते हैं। सोलन में किये गये अध्ययन से यह ज्ञात हुआ कि बंदगोभी के द्वारा जैव धूमन करने पर अंकुरण तथा उपजता ,8^०5 कि. ग्राम/प्लोटद में वृद्धि हुई तथा मृदु गलन रोग ;2^०25:द एवं विषाणु म्लानी आपतन में कमी अंकित की गयी।

हल्दी

ए आई सी आर पी एस के अन्तर्गत आठ केन्द्रों में एक हजार तीन सौ बारह जननद्रव्य अक्सेशनों का अनुरक्षण हो रहा है। जगतियाल में जर्मप्लासम का विवक्तीकरण करने पर दो उच्च उपज वाले अक्सेशनों सी एल आई-317 (20.66 टन/हेक्टर) तथा पी टी एस-52 (17.99 टन/हेक्टर) का लघु सूचीबध किया गया। जगतियाल केन्द्र से सी वी टी में, पी टी एस-59 (29.9 टन/हेक्टर) तथा एन डी एच-9 (28.8 टन/हेक्टर), कुमारगंज से एन डी एच-9 (298.38 कुन्तल/हेक्टर) तथा सी एल-101 (277.53 कुन्तल/हेक्टर) तथा राइगढ केन्द्र से टी सी पी-11 (20.26 टन/हेक्टर) एवं टी सी पी-82 (18.82 टन/हेक्टर) को अधिक उपजवाले के रूप में पहचान की गयी। जर्मप्लासम का विवक्तीकरण करने से पर्ण दाग रोग के लिए कई अक्सेशनों के लघु सूची बध किया। राइगढ में टी सी पी-11 को कोलेटोद्वाइकम पर्ण दाग एवं टपहीना पर्ण दाग के प्रति प्रतिरोधकता पंजीकषत की। हल्दी की गुणवत्ता मूल्यांकन करने पर अधिक कुरकुमिन की मात्रा (सी एल-101 में 3.63%), अधिकतम ओलिओरेसिन की मात्रा (सी एल 213 में 12.5%), अधिकतम सुगन्ध तेल की मात्रा (सी एल-20 में 4.14%) का लघु सूची बध किया गया। हल्दी की दो उच्च उपजवाली प्रजातियां जैसे कोयम्बतोर (टी एन ए यु) से सी एल-101, पोटांगी (ओ यु ए टी) से सुरंगी विमोचित करने के लिए संस्तुत की गयी। एफ वाई एम (30 टन/हेक्टर), 20 कुन्तल/हेक्टर केंचुआ खाद, 8 कुन्तल/हेक्टर नीम ओयल केक मष्दा में डालने पर पौधों की अधिकतम लम्बाई ,126. 67 मी.द प्रत्येक पौधों के शाखाओं की संख्या ,5.40द, प्रत्येक शाखा में पत्तों की संख्या ,14.60द तथा प्रत्येक प्लोट से उपजता ,15.20 कि. ग्राम/3मीटर द या उपजता ,50. 67 टन/हेक्टरद प्राप्त हुआ तत्पश्चात् धोली केन्द्र में मष्दा में 30 टन/हेक्टर एफ वाई एम, 15 कुन्तल/हेक्टर केंचुआ खाद, 8 कुन्तल/हेक्टर नीम ओयल केक डालने पर प्राप्त हुई। हल्दी की गुणवत्ता पर जीन प्रकार x पारिस्थितिक सम्बन्ध के अध्ययन के लिए परीक्षण करने पर यह ज्ञात हुआ कि जीन प्रकारों की उपजता में 18.61 टन/हेक्टर (आई आई एस आर प्रतिभा) से 32.13 (आई आई एस आर आलप्पी सुप्रीम), कुरकुमिन की मात्रा 2.87% (आई आई एस आर प्रतिभा) से 6.07 (नरेन्द्र हल्दी),

तथा ओलिओरेसिन की मात्रा 7.70% (आई आई एस आर आलप्पी सुप्रीम) से 15.30% कोयम्बतोर केन्द्र की रोमा में अन्तर है, जबकि बिहार की जलवायु में अन्य जीन प्रकारों की तुलना में राजेन्द्र सोनिया प्रजाति से अधिक उत्पादन (24.83 कि. ग्राम /3 मी² तथा 82.78 टन/हेक्टर) होता है। चिंतापल्ली में रोमा (30.11 टन/हेक्टर) अति अधिकतम निर्मल राइसोम की उपजता तत्पश्चात् रश्मी (28.78 टन/हेक्टर), जबकि बी एस आर-2 में सबसे कम उपजता (8.78 टन/हेक्टर) अंकित की गई।

वक्शा मसाले

तीन ए आई सी आर पी एस केन्द्रों के अन्तर्गत लौंग की 38, जायफल की 122, दालचीनी की 42 और कैसिया की 10 जननद्रव्यों का अनुरक्षण हो रहा है। पीचिपराई में किये दालचीनी के लक्षण वर्णन से छाल की उपजता 420 ग्राम शुष्क छाल/पौधा और पत्तों की उपजता 6.3 कि. ग्राम/पौधा देने वाले सेलक्शन 65 को चिन्हित किया गया। पीचिपराई से एक साधारण संग्रह जिसकी पर्ण उपजता 6.0 कि.ग्राम/पौधा और छाल उपजता 314.75 ग्राम/पौधा के रूप में चिन्हित किया गया।

धनिया

विभिन्न ए आई सी आर पी एस केन्द्रों में धनिया की एक हजार नौ सौ नब्बे जननद्रव्यों का मूल्यांकन एवं चरित्रांकन हो रहा है। कुमारगंज में दो उच्च उपज वाली अक्सेशनों एन डी कोर-2 (18.75 कुन्तल/हेक्टर) तथा एन डी कोर - 38 (17.18 कुन्तल/हेक्टर) को लघु सूची बध किया। धनिया की तीन प्रजातियां, जैसे एस के एन कर्षण महाविद्यालय, जोबनर (आर ए यु) से आर सी आर - 728, आर ए आर एस, गंदूर (ए पी एच यु) से एल सी सी - 170 तथा हिसार, (एच ए यु) से डी एच - 206 को विमोचन के लिए प्रस्तावित किया गया। जोबनर से यु डी - 475 तथा यु डी - 801, गंदूर से एल सी सी - 237, तथा एल सी सी - 236, हिसार से डी एच - 220 तथा डी एच - 233 तथा कुमारगंज से एन डी सी ओ आर - 30 तथा एन डी सी ओ आर - 49 से आशानक प्रविष्टियां सी वी टी के लिए प्रोन्नत किया गया। गंदूर में असमय में धनिया की पत्तों वाली प्रकार के उत्पादन के लिए दो अक्सेशनों एलसीसी - 244 (6.9 टन/हेक्टर) तथा एलसीसी- 234 (6.18 टन/हेक्टर) की पहचान की गयी। जोबनर में धनिया पर जैव नियामकों के प्रभाव पर किये अध्ययन के फलस्वरूप धनिया फसल से अधिक बीज उपलब्ध होने तथा अधिक लाभ प्राप्त करने के लिए 50 पीपीएम एनएए या 1.0 मि. लिटर/द्राइकोन्टानोल 40 एवं 60 डी ए एस का दो बार पत्तों पर छिड़कने के लिए संस्तुत किया। हिसार में धनिया में बीज उपचार तथा राइजोबैक्टीरियल स्ट्रेन एफ एल - 18 को मष्दा में डालने पर 1962 कि. ग्राम/हेक्टर उपजता प्राप्त हुई। धनिया में पाउडरी मिल्ड्यू की प्रबलता कम करने के लिए फ्यूडोमोनास फ्लूरोसेन्स ,आई आई एस आर 6द बीज के 10 ग्राम/कि. ग्राम की दर में बीज उपचार करना तथा उसके बाद 10° सी एफ यू बीज बोने के 60 दिन बाद पर्णों पर छिड़कने से प्रभावी होते हैं।

जीरा

जोबनर और जगुदान केन्द्र ने जीरा जननद्रव्य में 499 अक्सेशनों का अनुरक्षण किया। जननद्रव्य अक्सेशनों जैसे यु सी - 275, यु सी - 294, यु सी - 276, यु सी - 281, यु सी - 315, यु सी - 340, यु सी - 339, यु सी - 343, यु सी - 320 तथा यु सी - 338 को जोबनर केन्द्र में अर्धक उपज वाले के रूप में पहचान की गयी। जोबनर में म्लानी, ब्लाइट और पाउडरी मिल्ड्यू के प्रति आई ई टी परीक्षण किये दस प्रविष्टियों से युसी.331 और युसी.225 को म्लानी, ब्लाइट और पाउडरी मिल्ड्यू के प्रति प्रतिरोधकता चिह्नित की गई। यु सी - 239 तथा यु सी - 299 प्रविष्टियों को जोबनर में चिह्नित किया तथा उन्हें सी वी टी के लिए प्रोन्नत किया गया। जोबनर में जीरा की एक प्रजाति आर जेड - 34 को विमोचन के लिए संस्तुत किया। ब्लाइट को नियन्त्रण करने के लिए 40, 50, 60 तथा 70 डी ए एस 0.25: की दर से मैनकोजेब का छिड़काव प्रभावी था। मष्दा सौरीकरण, *ट्राइकोडरमा हरजियानम* मिट्टी में डालना, डी ए एस 60 में मैनकोजेब 0.25: की दर से छिड़कना तथा केंचुआ खाद + टी. *हरजियानम* मिट्टी में डालना + डी ए एस 60 में मैनकोजेब 0.25: की दर से छिड़कना भी रोग नियन्त्रण में प्रभावी होता है।

सौंफ

ए आई सी आर पी एस के अन्तर्गत विभिन्न केन्द्रों में छः सौ पच्चीस अक्सेशनों को सुरक्षित रखा गया। जोबनर से यु एफ-205, गुंटूर से एल एफ सी-84, हिसार से एच एम-219 को आशाजनक के रूप में पहचान किया गया तथा उसे विमोचन के लिए संस्तुत किया। धोली से आर एफ-21 तथा आर एफ-31, जोबनर से एनएस- 63, एनएस-46, कुमारगंज से एन डी एफ -16, एन डी एफ -24 तथा हिसार से एच एफ-131, एच एफ-143 को आई ई टी से आशाजनक प्रविष्टियों के रूप में पहचान की गयी तथा उन्हें सी वी टी में मूल्यांकन के लिए प्रोन्नत किया गया। अधिकतम बाष्पशील तेलों की मात्रा 3.20: एन एस-63 तत्पश्चात् एन एस 37-में 2.93%, एन एस-45 में 2.87% तथा एनएस-32 में 2.73% अंकित की गई वहीं न्यूनतम 2.37% एन एस-11 में थी। एन एस-63, एन एस-46, आर एफ-125 तथा एन एस-45 में लोकल चेक की तुलना में बाष्पशील तेल की मात्रा अधिक थी। अकार्बनिक नाइट्रोजन ;100:द्व. एफ वाई एम 5 टन / हेक्टर, *अज़ोस्फिरिल्लम*, अकार्बनिक नाइट्रोजन ;75:द्व. *अज़ोस्फिरिल्लम*, एफ वाई एम 5 टन / हेक्टर, अजैविक नाइट्रोजन ;50:द्व. *अज़ोस्फिरिल्लम*, एफ वाई एम 5 टन / हेक्टर तथा अजैविक नाइट्रोजन ;50:द्व. *अज़ोस्फिरिल्लम*

एफ वाई एम 5 टन / हेक्टर को नियन्त्रण की तुलना में प्रत्येक पौधे से प्राप्त उमवेद की संख्या, प्रत्येक उमवेद में उमवेदर की संख्या, प्रत्येक उमवेदर में धानों की संख्या अधिक थी।

मेथी

ए आई सी आर पी एस के केन्द्रों में मेथी की 989 जननद्रव्य अक्सेशनों का अनुरक्षण किया। जोबनर की प्रविष्टि आरएमटी-361, गुंटूर की एल एफ सी-84 तथा हिसार की एचएम-219 को आशाजनक के रूप में चिह्नित किया गया तथा विमोचन के लिए प्रस्तावित भी किया गया। जननद्रव्य अक्सेशनों यु एम-11, यु एम -16, यु एम-27, आर एम टी-1, आर एम टी-305, यु एम-17, यु एम-13, यु एम-32, यु एम-28, यु एम-7, यु एम-8, यु एम-33, यु एम-6 तथा यु एम-20 थी जोबनर केन्द्र में सीमित नमी अवस्था में सहनशीलता के लिये चिह्नित किया गया। जोबनर की प्रविष्टियां यु एम-330, यु एम-364, यु एम-366 तथा यु एम-365, गुंटूर की एल एफ सी-105, एल एफ सी-103, हिसार से एच एम-348, एच एम-355 तथा कुमारगंज से एन डी एच -25, एन डी एच -19 को आशाजनक के रूप में पहचान की गई तथा उसे सी वी टी के लिए प्रोन्नत किया गया। कोयंबतोर में मेथी में जैव नियामकों के प्रभाव पर किये अध्ययन से यह ज्ञात हुआ कि ट्राइकोन्टानोल 0.5 मि. लिटर / लिटर का 40, 60, तथा 80 डी एस ए में छिड़काव करने पर 522.9 कि. ग्राम / हेक्टर उपजता प्राप्त हुई। जोबनर में मेथी फसल से अधिक बीज उपलब्ध होने तथा अधिक लाभ प्राप्त करने के लिए पत्तों पर 50 पीपीएम एनएए 40 तथा 60 डी ए एस का दो बार छिड़काव करना संस्तुत किया। धोली केन्द्र में मेथी की उपजता बढ़ाने तथा उपजता बढ़ाने के लिए राइजोबैक्टीरियल स्ट्रैन एफएल-18 डोरा बीज उपचार प्रभावी था। मेथी की उपजता पर जैव उर्वरकों के प्रभाव के अध्ययन के लिए किये गये उपचारों में अजैविक नाइट्रोजन ;100:द्व. *अज़ोस्फिरिल्लम*, एफ वाई एम 5 टन / हेक्टर डालने पर प्रत्येक पौधे से अधिकतम फली ;72:द्व तथा उपजता ;0.98 कि.ग्राम / 4. 5मीटर² या 2.18 टन / हेक्टरद्व तत्पश्चात् अजैविक नाइट्रोजन 75: *अज़ोस्फिरिल्लम*, एफ वाई एम 5 टन / हेक्टर डालने पर ;उपजता 0.90 कि. ग्राम / 4.5 मीटर² या 2.00 टन / हेक्टरद्व प्राप्त हुई।

विभिन्न केन्द्रों में चल रहे परीक्षणों का नियमित निरीक्षण तथा ए आई सी आर पी एस केन्द्रों के वैज्ञानिकों तथा विश्वविद्यालय के प्राधिकारियों से परिचर्चा की 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 34 centers which includes 19 regular, 8 co-opting and 7 voluntary centers located in 21 states of India under 21 State/Central Agricultural Universities (SAUs)/Research Institutes. The XI Plan budget of AICRPS is Rs. 1400 lakhs with Rs 250 lakhs (ICAR share) during 2008-09. About 115 research programmes covering the mandate spice crops are being conducted at various centers. These programmes are carried out under the major disciplines of genetics and crop improvement, crop production and crop protection. The salient findings in the mandate crops are presented in this report.

Black pepper

Seven hundred and thirty four accessions of black pepper germplasm consisting of cultivated, exotic and wild and related species are maintained under different AICRPS centers. The characterization of germplasm resulted in identification of high yielding accessions viz., KM III, Angamali, KM II and Valiyaramundi with more than 2 kg/vine of green berry yield from Panniyur center. Panniyur-1 (2.60 kg dry/vine) and Acc. 57 (4 kg dry/vine) were identified as high yielders from Sirsi and Yercaud centers respectively. Among the inter-variety hybrids developed at Panniyur center, the hybrid P6 x P5 was found to be promising with a fresh yield of 2.5 kg/vine and was proposed for release as Panniyur - 8. Among the different cultivars of pepper evaluated at Ambalavayal in CVT, Cul. 5308 recorded the highest wet weight of berries/standard (3.01 kg) followed by Panniyur-1 (2.79 kg). At Panniyur center maximum yield/vine was recorded in Cul. 5489 (3.8 kg green berry/vine) followed by Cul. 1041 and HP 105 with 2.5 kg/vine. Rooting of orthotropic shoot of black pepper cuttings at Dapoli center indicated that treating three and two noded cuttings with the PGPR (*Pseudomonas fluorescens*-10⁸) recorded maximum rooting success of 97.3% and 94.6% respectively. Integrated nutrient management treatment recorded maximum yield at Panniyur and Sirsi centers when compared to organic and inorganic treatments,

whereas, inorganic and integrated nutrient management treatments were found to be on par at Pechiparai center. Among the current technologies available for foot rot management all the treatments were found to be significant in reducing the foot rot incidence at Pampadumpara center. Spraying potassium phosphonate (0.3%) and application of *Trichoderma harzianum* @ 50 g/vine with 1 kg of neem cake was found to be the best treatment in controlling the disease at Chintapalle, Panniyur and Pampadumpara centers whereas, Bordeaux mixture (1%) spray and COC (0.3%) drenching was found to be effective at Mudigere center. Among the bio-rationals evaluated, neem gold (0.5%) was found to be effective in the suppression of mussel scale (*Lepidosaphes piperis*) population and the least scale population was recorded on vines treated with dimethoate (0.05%).

Cardamom

Three hundred and thirteen germplasm have been maintained at two (Pampadumpara and Mudigere) AICRPS centers. Among the cardamom germplasm evaluated at Mudigere center, the accession Pothamedu recorded highest green capsule yield (208 kg/ha) followed by D-141 and CI-730. Under CVT, entries CL-722, PS-27, MCC-309 and MCC-246 were found promising for dry capsule yield (347.96 kg/ha) at Mudigere center. At Myladumpara MHC-26 (1317 kg/ha), MCC-73 (1172 kg/ha), MCC-246 (1155 kg/ha) and MCC-309 (1033 kg/ha) were identified as high yielders. Biofertilizers *Azospirillum* and P-solubilizers were found to increase growth and yield of cardamom. Application of 100% inorganic nitrogen + 50 g *Azospirillum* + 5 kg FYM or 100% inorganic phosphorus + 50 g phosphobacteria + 5 kg FYM was found very effective in increasing yield in cardamom.

Ginger

AICRPS maintains about 672 germplasm of ginger consisting of cultivated, wild and related taxa under various AICRPS centers. A high yielding ginger variety Subhada from Pottangi center has been recommended for release during the XX AICRPS workshop. The experimental results at Kumarganj indicated that foliar

spray of 0.05% zinc sulphate (60 and 90 DAP), 0.2% of borax (60 and 90 DAP) and 1.0% of ferrous sulphate (60 and 90 DAP) increased the yield (55.53 q/ha) and quality parameters. In an IET at Pottangi, highest fresh rhizome yield was recorded in V₁E₄-5 (24.35 t/ha) followed by PGS-8 (23.49 t/ha). Soft rot of ginger could be controlled by bio-fumigation using cabbage and mustard plant refuses. The studies at Solan indicated that bio-fumigation using cabbage increased germination and yield (8.5 kg/plot) by decreasing soft rot (2.25%) and bacterial wilt incidence.

Turmeric

One thousand three hundred and twelve turmeric germplasm accessions have been maintained by eight centers under AICRPS. Screening of germplasm has resulted in short listing of two high yielding accessions CLI-317 (20.66 t/ha) and PTS-52 (17.99 t/ha) at Jagtial. I¹ CVT, PTS-59 (29.9 t/ha) and NDH-9 (28.8 t/ha) were identified as high yielders from Jagtial centre, NDH-9 (298.38 q/ha) and CL-101 (277.53 q/ha) from Kumarganj and TCP-11 (20.26 t/ha) and TCP-82 (18.82 t/ha) from Raigarh centre. Screening of germplasm has helped in short listing several accessions to leaf spot diseases. TCP-11 registered resistance against *Colletotrichum* leaf spot and *Taphrina* leaf spot at Raigarh. Quality evaluation of turmeric resulted in short listing accessions with high curcumin content (CL 101 with 3.63%), highest oleoresin content (CL -213 with 12.5%) and high essential oil content (CL.20 with 4.14%). Two high yielding turmeric varieties viz. CL-101 from Coimbatore (TNAU) and Surangi from Pottangi, (OUAT) were recommended for release. Soil application of FYM (30 t/ha) + vermicompost (20 q/ha) + neem oil cake (8 q/ha) produced maximum plant height (126.67 cm), number of tillers per plant (5.40), number of leaves per tillers (14.60) and yield per plot (15.20 kg/3m²) or yield (50.67 t/ha) followed by soil application of FYM (30 t/ha) + vermicompost (15 q/ha) + neem oil cake (8 q/ha) at Dholi center. In an experiment to study the genotype x environment interaction on the quality of turmeric it was observed that the yield of genotypes varied from 18.61 t/ha (IISR Prathiba) to 32.13 (IISR Alleppy Supreme); curcumin content from 2.87% (IISR Prathibha) to 6.07 (Narendra Haldi); and oleoresin content from 7.70% (IISR Alleppy supreme) to 15.30% in Roma at Coimbatore centre whereas, the variety Rajendra Sonia produced significantly more yield (24.83 kg/3 m² & 82.78 t/ha) when compared to other genotypes in the climatic condition in Bihar. At Chintapalle, Roma (30.11 t/ha) recorded maximum fresh rhizome yield followed by

Rasmi (28.78 t/ha), whereas BSR-2 recorded lowest yields (8.78 t/ha).

Tree spices

A total of 38 clove, 122 nutmeg, 42 cinnamon and 10 cassia germplasm have been maintained under three AICRPS centres. Characterization of cinnamon germplasm at Pechiparai led to the identification of Sel.65 with a bark yield of 420 g of dried bark/tree and leaf yield of 6.3 kg/tree. A local collection from Pechiparai was also identified for high leaf yield of 6.0 kg/tree and bark yield of 314.75 g/tree.

Coriander

One thousand nine hundred and ninety germplasm of coriander have been conserved at various AICRPS centres for further evaluation and characterization. At Kumarganj two high yielding accessions NDCor- 2 (18.75 q/ha) and NDCor-38 (17.18 q/ha) were short listed from the germplasm. Three varieties, coriander viz. RCr-728 from SKN College Agriculture, Jobner (RAU), LCC-170 from RARS Guntur (APHU) and DH-206 from, Hisar (HAU) were proposed for release. The promising entries UD- 475 and UD-801 from Jobner, LCC-237 and LCC-236 from Guntur, DH-220 and DH-233 from Hisar and NDCor- 30 and NDCor-49 from Kumarganj were promoted to CVT. For production of leafy type coriander in off-season at Guntur, two accessions LCC-244 (6.9 t/ha) and LCC-234 (6.18 t/ha) were identified. Studies on the effect of bioregulators on coriander at Jobner recommends two foliar sprays of 50 ppm NAA or 1.0 ml/l triacontanol at 40 and 60 DAS for obtaining higher seed yield as well as net returns from coriander crop. Seed treatment and soil application of rhizobacterial strain FL-18 on coriander at Hisar, gave a yield of 1962 kg/ha in coriander. Seed treatment with *Pseudomonas fluorescens* (IISR-6) at the rate of 10 g/kg of seed followed by foliar application at 10⁸ cfu on 60 days after sowing was found to be effective in reducing the powdery mildew intensity in coriander.

Cumin

Jobner and Jagudan centres hold 499 accessions of cumin germplasm. The germplasm accessions UC-275, UC-294, UC-276, UC-281, UC-315, UC-340, UC-339, UC-343, UC-320 and UC-338 were identified as high yielders from Jobner centres. Out of ten entries in IET tested against wilt, blight and powdery mildew, UC-331 and UC-225 was identified as resistant entries against wilt, blight and powdery mildew at Jobner. The entries UC-239 and UC-299 from Jobner were identified as promising and promoted to CVT. A cumin variety RZ-

345 from Jobner was recommended for release. Spraying mancozeb @ 0.25% at 40, 50, 60 and 70 DAS was found to be effective in controlling blight. Soil solarization + soil application of *Trichoderma harzianum* + spraying mancozeb @ 0.25% at 60 DAS and application of vermicompost + soil application of *T. harzianum* + spraying mancozeb @ 0.25% at 60 DAS were also effective for controlling the disease.

Fennel

Six hundred and twenty five accessions are conserved in different centres under AICRPS. UF-205 from Jobner, LFC-84 from Guntur and HM-219 from Hisar were identified as promising and recommended for release. The entries RF-21 & RF-31 from Dholi, NS-63, NS-46 from Jobner, NDF-16, NDF-24 from Kumarganj and HF-131, HF-143 from Hisar were identified as promising entries from IET and promoted for further evaluation in CVT. The maximum volatile oil of 3.20% was recorded in NS-63 followed by 2.93% in NS-37, 2.87% in NS-45 and 2.73% in NS-32, whereas minimum of 2.37% in NS-11. The entries NS-63, NS-46, RF-125 and NS-45 have shown better performance as compared to local check with respect to volatile oil yield in terms of litre per hectare. Application of inorganic nitrogen (100%) + FYM 5 t/ha + *Azospirillum*, inorganic nitrogen (75%) + *Azospirillum* + FYM 5t/ha, inorganic nitrogen (50%) + *Azospirillum* + FYM 5 t/ha and inorganic nitrogen (50%) + *Azospirillum* + FYM 5 t/ha were found significantly superior as compared to control regarding number of umbels per plant, number of umbellet per umbel, number of grains per umbellet and grain yield.

Fenugreek

Germplasm accessions of fenugreek are maintained at various AICRPS centres and at present 989 accessions are conserved. The entries RMt-361 from Jobner, LFC-84 from Guntur and HM-219 from Hisar were identified as promising and were proposed for release. The germplasm accessions UM-11, UM-16, UM-27, RMt-1, RMt-305, UM-17, UM-13, UM-32, UM-28, UM-7, UM-8, UM-33, UM-6 and UM-20 were identified as tolerant to limited moisture condition from Jobner centre. The entries UM-330, UM-364, UM-366 and UM-365 from Jobner, LFC 105, LFC-103 from Guntur, HM-348, HM-355 from Hisar and NDH-25, NDH-19 from Kumarganj were identified as promising and promoted for CVT. Studies on the effect of bioregulators in fenugreek at Coimbatore indicated that spraying Tricontanol 0.5ml/l at 40, 60 and 80 DAS gave an yield of 522.9 kg/ha. At Jobner, two foliar sprays of 50 ppm NAA at 40 and 60 DAS could be recommended for obtaining higher seed yield as well as net returns from fenugreek crop. Treatment of seed with rhizobacterial strain FL-18 was effective in increasing yield and yield attributing characters in fenugreek at Dohli centre. Among the treatments to study the effect of biofertilizers on yield of fenugreek, inorganic nitrogen 100% + *Azospirillum* + 5t/ha FYM gave the maximum number of pods per plant (72) and yield (0.98 kg/4.5 m² or 2.18 t/ha) followed by inorganic nitrogen 75% + *Azospirillum* + 5 t/ha FYM (yield 0.90 kg/4.5 m² or 2.00 t/ha).

The salient findings during 2008-09, under different projects are presented in this report.

M. Anandaraj

PROGRESS OF WORK AND ACHIEVEMENTS

I. BLACK PEPPER

I.1 Genetic Resources

I.1.1 Germplasm collection, characterization, evaluation and conservation

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

The black pepper germplasm consisting of 58 accessions have been maintained at Horticultural Research Station Chintapalle, out of which 22 accessions are being evaluated for various morphological and yield characters. Among the 22 accessions evaluated, Vellanamban recorded maximum number (1945) of spikes per vine followed by Malamundi (1300). In terms of quality parameters, maximum spike length was recorded in Panniyur-3 (13.0 cm) followed by Vellanamban and Malamundi (12.8 cm). Narayakkodi recorded maximum number of berries per spike (87). Among 22 accessions evaluated Vellanamban recorded highest fresh yield of 7.8 kg/vine followed by Neelamundi (6.9 kg/vine). Vellanamban recorded maximum dry berry yield (2.7 t/ha) followed by Neelamundi (2.37 t/ha).

Four collections of black pepper from Sindhudurg and Ratnagiri Districts were collected and added to the germplasm collections at Dapoli centre. At present 89 accessions of black pepper have been maintained and are being evaluated.

At Panniyur, 217 cultivated types of black pepper and 72 wild types are being maintained at Panniyur centre. During 2008, KM III, Angamali, KM II and Valiyaramundi were the promising genotypes that recorded more than 2 kg/vine of green berry yield. The number of spikes/vine were maximum for Karimunda II (1350) followed by Valiyaramundi (1270). The spike length was maximum for Vally (10 cm). The number of developed berries/spike was more for Vally (22) and

Karimunda II (21). The 100 berry weight was more for Vally (17 g). The dry recovery % was more for Karimunda III (37) (Table 1).

During 2008-09, three new genotypes were collected from Terai region of West Bengal by Pundibari centre making the total collections to 22 accessions.

At Sirsi centre, 126 germplasms are being maintained. Among the six promising accessions under trial, Panniyur-I continued to record maximum dry berry yield (2.60 kg/vine) followed by Ademane pepper (2.50 kg/vine) during 2008-09 with a significant difference to others. But, Panniyur-I was more susceptible with 42 percent disease incidence (PDI) and Ademane pepper was the least with 4 PDI values. There were no major incidences of pests recorded in these accessions. However, there was less than 5 percent incidence of thrips and snail.

Among the 137 germplasm accession evaluated at Yercaud, berry set and yield was observed in 80 accessions of which Acc 57 recorded the highest value of 12.8 kg and 3.9 kg for green and dry berry yield. The accession Acc. 33 recorded the highest value for spike length 12.6 cm and number of berries 70. The black pepper germplasm maintained at different centres are given in Table 2.

I.2 Hybridization Trial

I.2.1 Intervarietal hybridization to evolve high yielding varieties

(Panniyur)

At Panniyur, intervarietal hybridization of black pepper is being carried out every year and among the intervarietal hybrids being evaluated P-6 x P-5 is found to be promising with green berry yield of 2.500 kg/vine.

Table 1. Yield and yield attributing characters of promising germplasm accessions of Panniyur

Cultivars	Green berry yield (kg/vine)	Number of spikes/vine	Spike length (cm)	Number of developed berries/spike	100 Berry weight (g)	Dry recovery (%)
Angamali	2.500	1175	7.5	18	12	35
Karimunda III	2.700	1240	8.0	20	12	37
Moozhiyar	2.000	625	9.5	19	16	35
TMB IV	1.950	1200	9.0	15	13	36
Vally	1.850	750	10.0	22	17	33
Karimunda II	2.800	1350	7.6	21	13	35
Valiyaramundi	2.750	1270	7.0	20	14	36

Table 2. Black pepper germplasm collections maintained at various AICRPS centres

Centre	Indigenous		Exotic	Total
	Cultivated	Wild and related sp.		
Chintapalle	58	-	-	58
Dapoli	83	6	-	89
Panniyur	214	72	3	289
Pechiparai	12	1	-	13
Pundibari	18	4	-	22
Sirsi	124	1	1	126
Yercaud	127	10	-	137
Total	636	94	4	734

1.3 Coordinated Varietal Trial (CVT)

1.3.1 CVT 1991-Series IV

(Yercaud)

At Yercaud, during 2008-09 among the 14 accessions evaluated, Panniyur 3 recorded a maximum yield of 12.8 kg and 3.8 kg of green and dry berry yield and 100 berry weight of 12.6 grams.

1.3.2 CVT 2000 – Series V

(Chintapalle, Pampadumpara, Panniyur, Sirsi and Ambalavayal)

This trial was initiated at HRS-Chintapalle during 2005. Twelve entries viz., HP-1041, PRS-17, PRS-21, PRS-22, Cul - 5308, Cul.5489, HP-34, HP-105, HP-1411, Karimunda OP, Panniyur-I and HP-813 were planted in RBD. Variety Cul-5489 and HP-813 recorded the highest plant height (3.5 m) followed by Cul-1041, PRS-21 and PRS-22 (3.4 m) whereas, Karimunda OP recorded the lowest plant height (2.1 m). Among the varieties PRS-21 recorded more number of

branches per vine (15.8) and variety HP-105 recorded less number of branches per vine (7.1). Regarding the yielding varieties Cul-1041, recorded maximum fresh berry yield (526.7 g) followed by Cul-5308 (410 g).

Among the twelve accessions evaluated at Pampadumpara, significant differences existed in all the traits. Among the accessions Panniyur-I registered the highest dry yield (1271.61g/plant) closely followed by CUL 5308(1186.67g/plant) Minimum dry weight per plant was recorded in culture 1411(134.67 g/plant), OPKM (154.33g/plant) and HP 105(215 g/plant).

At Panniyur centre the trial was initiated during 2001 and during 2008, Cul-5489 recorded the maximum green berry yield of 3.8 kg/vine followed by Cul-1041 and HP 105 with 2.5 kg/vine . Cul-5489 was significantly superior to all other cultures/varieties. The number of spikes/vine was maximum for Cul-5489 (1000) and was on par with HP 105 and Coll. 1041. The maximum spike length was recorded by Cul-5489 (15 cm) and was on par with Panniyur I (14 cm), Karimunda III (14 cm) and HP 105 (13 cm). The number of berries/spike

Table 3. Yield and attributing characters of promising cultures at Panniyur during 2008-09

Varieties/cultures	Green berry yield (kg/vine)	Number of spikes/vine	Spike length (cm)	Berries/spike	100 Berry weight (g)	Drying recovery (%)
Kalluvally IV	1.540	425	9	17	13	30
Karimunda II	1.020	485	9	21	11	32
Karimunda III	1.250	560	13	20	12	39
Cul 5308	1.850	500	10	18	13	42
Cul 5489	3.800	1000	15	30	14	41
HP 34	1.500	280	9	23	14	40
HP 105	2.500	840	9	13	12	35
HP 813	1.280	520	9	11	11	40
HP 1411	1.350	725	11	20	11	35
Karimunda OP	1.570	450	14	23	14	38
Coll.1041	2.500	860	8	16	12	35
Panniyur I	1.950	460	14	26	14	35
Karimunda	1.250	340	8	20	12	38
CD (P=0.05)	0.346	236	2.3	4.2	NS	

was more for Cul- 5489 (30) and was on par with Panniyur I (26). The 100 berry weight was more for Cul-5489, HP-34, Panniyur I and Karimunda OP (14 g). The dry recovery % was more for Cul-5308 and Cul-5489 (42 and 41%) (Table 3).

At Sirsi, the height of the vine attained maximum in Panniyur-I (4.5 m) followed by HP-105 (4.4 m), HP-34 (4.2 m). Most of the entries initiated spiking with a meagre yield. Spike length was maximum in OP Karimunda (12.3 cm) and the least in HP-34 (6.5 cm). Dry berry yield was maximum in Panniyur-I (210 g/vine) followed by HP-34 (185 g/vine) (Table 4).

1.3.3 CVT 2006

(Chintapalle, Dapoli, Panniyur, Pampadumpara, Sirsi, Yercaud and Pechiparai)

This experiment was started during the 2008-09 at Horticultural Research Station Chintapalle. Eight varieties of black pepper namely, PRS-67, HB-20052, Acc-33, Acc-53, Acc-57, Acc-106, C-1090, HP-39 cuttings were brought from IISR, Calicut during July- 2008. These cutting are in the nursery and a 3-5 leaf stage and would be planted in 2009-10.

Table 4. Performance of CVT -2000 black pepper at Sirsi

Sl. No.	Entries	Height of the vine (m)	Number of spikes/vine	Spike length (cm)	Number of berries/spike	Dry berry yield (g/vine)
1	HP-34	4.20	38	6.5	62	185
2	HP - 105	4.40	23	8.3	68	125
3	OP Karimunda	3.60	36	12.3	35	160
4	HP - 813	2.50	14	6.8	39	040
5	HP - 1411	1.85	12	6.6	36	080
6	C - 1041	2.20	-	-	-	-
7	P - 24	2.50	-	-	-	-
8	PRS - 17	3.40	8	7.2	45	020
9	PRS - 21	1.60	-	-	-	-
10	PRS - 22	2.10	6	7.0	22	030
11	C - 5308	2.80	-	-	-	-
12	C -5489	2.90	-	-	-	-
13	Panniyur - I	4.50	43	11.6	68	210
14	Malligesara	2.80	-	-	-	-
	SEm +	0.28	4.72	0.16	6.66	19.82
	CD (P=0.05)	0.80	14.03	0.48	19.80	58.89
	CV (%)	21.52	45.43	4.21	32.52	41.20

At Ambalavayal, Cul. 5308 showed the highest wet weight of berries/standard (3.01 kg) followed by Panniyur-I (2.79 kg). Lowest wet weight was recorded in HP 34 (0.50 kg). PRS 22 showed the maximum dry weight of berries/standard (1.14 kg) followed by PRS 17 and Cul 5308 (1.10 kg each). Lowest dry weight was recorded in HP 105 (0.31 kg). Cul 5308 recorded the maximum number of spikes/standard (717.85) followed by Cul 5489 (527.45) and PRS 21 (460.00). Lowest number of spikes was recorded in the cultivar, HP 34. Panniyur-I showed the highest spike length (14.11 cm) followed by Karimunda OP (12.13cm) and Cul 5489 (11.61) and the lowest spike length was recorded in HP 105 (7.33cm). Maximum setting percentage was shown by Panniyur-I (90.14) followed by Coll.1041 (87.58%). Minimum setting percentage was recorded in Karimunda OP (74.88%). Panniyur-I recorded the highest number of berries/spike (77.61) followed by Cul 5308 (59.86) and Cul 5489 (50.66). Lowest number of berries/spike was recorded in PRS 17. PRS 21 recorded the highest hundred berry weight (19.75 g) followed by PRS 17 (17.01 g) while lowest was recorded in the cultivar Karimunda (9.50 g). Maximum berry volume was shown by PRS 21 (16.00cc) followed by Panniyur-I (14.62cc). Minimum berry volume was recorded in Cul 5308 (8.53cc).

The plant height varied from 20.83 - 55.83 cm. in different varieties at Dapoli centre. The vine growth performance is at initial stage.

At Panniyur centre, all the cultures were kept for multiplication by serpentine method to get enough rooted cuttings and were planted during 2008.

At Pampadumpara, a total of ten accessions namely HB 20052, PRS-88 (Panniyur), Acc.No.53, Acc.No.106 (Sirsi), Acc.No.33 and 57 (Yercaud), C-1090, HP -39 (IISR Calicut) and Panniyur-I and Karimunda (checks) have been planted in three replications in randomized block design during August 2008. Accessions Panniyur-I, Karimunda and Acc. 57 have established well.

Ten entries including two from IISR-Calicut, two from PRS-Panniyur, two from HRS-Yercaud, two from HRS-Sirsi and two checks from the station were planted during August, 2008 to the arecanut standards in Sirsi centre. Plants are in the initial stage of field establishment.

At Yercaud centre, during the year 2008-09 the planting material collected were planted and gap filled.

At Pechiparai centre, eight accessions viz. C.1090, HP39, Acc. 33, Acc.57, HB 20052, PRS88, Acc. 53 and Acc.106 were planted during February 2008. All the plants have established well.

1.4 Nutrient Management Trial

1.4.1 Effect of bio fertilizers, *Azospirillum* on black pepper production (Yercaud)

The application of FYM 10 kg + *Azospirillum* 50g + Phosphobacteria 50g + VAM 200g recorded the maximum yield of 12.8 kg and 3.60 kg of green and dry berries respectively at Yercaud.

1.4.2 Development of organic package for spices based cropping system (Chintapalle, Sirsi, Panniyur, Yercaud and Dapoli)

At Chintapalle centre during the year 2006-07, as per the instructions of Project Co-coordinator, AICRP on Spices, IISR, Calicut fresh plantation was taken up with Panniyur-I variety for conducting the above experiment. Five organic and five inorganic treatments are imposed to the vines. Now the vines are in vegetative phase and the experiment in progress.

At Sirsi, the trial was initiated during 2005-06. Three years after growth the vines supplied with treatments as per package of practices recorded higher yield (1.05 kg/vine) compared to those with only organics (0.83 kg/vine) but, the results are non-significant.

At Panniyur, the trial was started during the year 2006 in a plot of Panniyur 5. Treatments included were T₁-Organic package of practices and T₂-Recommended package of practices (POP). During the year 2008, the treatment T₂ (POP) recorded the maximum spike yield of 5.658 kg/vine followed by T₁ organic (4.575 kg/vine). There was no significant difference between the treatments.

Among the treatments, the integrated farming recorded the maximum yield of 12.8 kg and 3.4 kg/vine green and dry berry yield/vine against inorganic 11.8 kg and 3.1 kg and organic 11.2 kg and 2.8 kg/vine at Yercaud.

At Dapoli centre, the treatment organic package recorded higher plant height (1.00 m/plant). Inorganic package recorded lesser plant height (0.65 m/plant). The growth performance is at initial stage.

1.4.3 Organic farming in black pepper – 2006 (Panniyur, Dapoli, Pechiparai and Sirsi)

At Panniyur during the year 2008, treatment T₂ (integrated management) recorded the maximum spike yield of 1.918 kg/vine followed by T₁-inorganic treatment (1.441 kg/vine). T₂ was significantly superior to other two treatments. The number of spikes/vine was also maximum for T₂ (357) (Table 5).

A new trial on organic farming was initiated at Dapoli centre with fully organic, integrated and inorganic treatments during the year. The experiment has been newly planted by using *Thespesia populnea* standard and variety Panniyur-I. The trial was laid out in August 2008 and is at initial stage. The vines were growing satisfactorily.

At Pechiparai, the trial was imposed in an established pepper vines. The highest yield of 4.50 kg/vine was recorded in the fully inorganic trial and it was followed by integrated which recorded a yield of 3.36 kg/vine.

The vines supplied with the integrated treatments recorded higher dry berry yield (1.06 kg/vine) compared to those with fully inorganics (0.92 kg/vine) and fully organics (0.86 kg/vine) at Sirsi.

1.5 Rooting of orthotropic shoots of black pepper (Panniyur, Sirsi, Yercaud, Pechiparai, Dapoli)

The experiment was started as observational trial during 2007 at Panniyur. The germination was more in *Pseudomonas* treatment (79%) followed by IBA (78%) and sugar (76%) treatments. Irrespective of the treatments, 5 node cutting showed more germination (86%) followed by 3 node (74%) and 2 node (71%) cuttings.

The rooting of orthotropic shoots ranged between 39.46 to 80.00 per cent in various treatments at Pechiparai. Among the different types of nodal cuttings the two nodal cuttings exhibited higher rooting percentage (66.06%) and it is on par with three nodal cuttings (61.9%). All hormone treatments improved the rooting success over control. The IBA treatment was significantly superior (74.55%) over the rest of the treatments and is followed by PGPR treatment (65.79%). The interaction effect was also significant and the treatments with two nodal cuttings along with IBA treatment has recorded a maximum rooting percentage (80%) and it is on par with two nodal cuttings along with IBA treatment (74.32%).

At Dapoli centre, the orthotropic shoot cuttings gave good rooting success. Three node cuttings (N2) was found to be

Table 5. Yield data of black pepper under organic farming at Panniyur

Treatment	Spike yield (kg/vine)	Number of spikes/vine	Yield (kg/vine)	Dry weight (g)
T1 - Fully organic	1441	287	1139	446
T2 - Integrated	1918	357	1515	752
T3 - Inorganic	1352	261	1068	493
CD(P=0.05)	369	70	291	111
CV (%)	23	23	23	20
SEm	123	23	97	37

significantly superior (76.33%) to two-node (72.33%) and five-node (71.66%) cuttings. All hormone/solution treatments improved the rooting success significantly over control. The treatment PGPR (*Pseudomonas fluorescens*-10⁸) was significantly superior (92.88%) to rest of the treatments and followed by common sugar 2% (73.32%) and IBA (68.44%). The interaction effect was found to be significant. The rooting success ranged from 56.00% to 97.33%. The treatment combination three node + PGPR (*P. fluorescens*-10⁸) recorded maximum rooting success (97.33%) followed by 2 node + PGPR (*P. fluorescens*-10⁸) (94.66%) which were on par with each.

At Yercaud, of all the treatments, the treatments with two nodal cuttings with IBA 1000 ppm dipping, resulted in highest percent age of rooting 80% and number of leaves 8 leaves, and fresh and dry weight of leaves.

This experiment could not be carried out at Sirsi centre during the year and will be conducted during 2009.

1.6. Disease Management Trial

1.6.1 Adaptive trial on management of *Phytophthora* foot rot of black pepper in farmer's field

(Chintapalle, Dapoli, Panniyur, Mudigere and Sirsi)

At Chintapalle, the observations revealed that among the three treatments black pepper vines treated with potassium phosphonate (0.3%) + *Trichoderma harzianum* before onset of monsoon (May 2nd fortnight), during monsoon (July 1st week) and after monsoon (September 1st fortnight) recorded less yellowing (11.98%), defoliation (18.64%) and death of vines (7.16%) and more yield/vine (3.54 kg) as compared to the farmers practice (1% B.M as spraying once after the disease appearance and only to affected vines) with 44.82% of yellowing, 49.62% of defoliation and 12.94% of death of vines.

At Dapoli, during the first year 2007-08, incidence of foot rot and *Phytophthora* leaf blight disease was not observed. During the second year (2008-09), incidence of *Phytophthora* leaf blight only was observed. Minimum per cent incidence of *Phytophthora* leaf blight disease (1.10) was observed in the vines treated during onset of monsoon- June and again during third week of August with potassium phosphonate @ 0.3% as spraying and soil application of *Trichoderma harzianum* @ 50 g/vine with one kg of neem cake to the root zone and also recorded maximum berry yield (0.917 kg/vine). It was closely followed by chemical check (2.76 PDI) with application of 1% Bordeaux mixture as spraying and copper oxychloride @ 0.1% a.i. as drenching with berry yield of 0.830 kg/vine. Both of the treatments were found to be significant in reducing foot rot and *Phytophthora* leaf blight disease and increasing the berry yield of black pepper. The severity of the disease in the vines was maximum in the treatment of farmers' practice (check).

At Panniyur centre, defoliation and death of vines were significantly low in (potassium phosphonate + *T. harzianum*) and hence, this treatment is more effective in controlling the disease. There was no significant difference between treatments for yellowing, yield and plant growth data.

The treatments were found effective in reducing the incidence of foot rot at Mudigere centre. Minimum leaf yellowing (10.22%) and foliage infection of 7.75% were recorded in T₂ (1% B.M + 0.3% COC drench and spray) which is followed by T₁ (potassium phosphonate (0.3%) + *T. harzianum*) as compared to control. The higher canopy size of 3.57 and 3.30 m. diameter and higher yield of 523.75 and 528.75 g/vine were recorded in T₁ and T₂ respectively as compared to farmers practice.

At Sirsi centre, *Phytophthora* foot rot was least in black pepper vines with respect to least foliar yellowing (12.49 PDI), least defoliation (12.03 PDI) and least death of vines (9.38%) and highest green berry yield (0.94 kg/vine and 386.69 kg/ha as projected yield) where vines were treated with potassium phosphonate (@ 0.3 per cent) as spraying (@ 2 l/vine) and drenching (@ 3 l/vine) coupled with incorporation of *T. harzianum* (MTCC-5179) @ 50 g per vine with one kg of neem cake to the root zone during pre monsoon (June 2008) and peak monsoon (August 2008). However, recommended check with use of 1% Bordeaux mixture as spraying (@ 2 l/vine) and drenching (@ 3 l/vine) with copper oxychloride (@ 0.1 per cent a.i.) during June 2008 and August 2008, also significantly reduced the disease relating to less foliar yellowing (15.10 PDI), least defoliation (14.58 PDI) and least death of vines (12.50%) and more berry yield (0.82 kg per vine and 339.02 kg/ha as projected yield). In case of farmers practice for management of the disease, by treating vines with 1% Bordeaux mixture as spraying and drenching to the affected vines after the appearance of the disease recorded highest leaf foliar yellowing (33.85 PDI) highest defoliation (34.89 PDI) and maximum death of vines (29.50%) and minimum yield 0.61 kg/vine and 250.14 kg/ha as projected yield).

1.6.2 Trial on management of *Phytophthora* foot rot of black pepper in existing plantations

(Chintapalle, Dapoli, Panniyur, Mudigere and Sirsi)

The observations revealed that among the five treatments, black pepper vines treated with potassium phosphonate (0.3%) + *T. harzianum* before onset of monsoon (May 2nd fortnight), during monsoon (July 1st week) and after monsoons (September 1st fortnight) recorded less yellowing (16.28%), defoliation (20.71%) and death of vines (7.22%) and more yield/vine (3.12 kg) followed by Bordeaux mixture spray (1.0%) - COC (0.1%) drenching with yellowing (22.25%), defoliation (27.31%) and death of vines (9.24%) and yield/vine (2.86 kg) as compared to the control with 61.64% of yellowing, 68.34% of defoliation and 19.72% of death of vines and low yield/vine (1.08 kg) at Chintapalle centre (Table 6).

At Dapoli centre, maximum per cent reduction (83.88) in *Phytophthora* leaf blight incidence was observed in vines treated during onset of monsoon- June and again during third week of August with potassium phosphonate @ 0.3% as spraying and soil application of *T. harzianum* @ 50 g/vine with one kg of neem cake twice to the root zone (T₁), and was significantly superior to rest of the treatments except *T. harzianum* @ 50 g/vine with one kg of neem cake and bacterial

Table 6. Effect of biocontrol agents and chemicals on incidence of *Phytophthora* foot rot in black pepper at Chintapalle

Treatment	Yellowing (%)	Defoliation (%)	Death of vines (%)	Yield/ vine (kg)
T1 Potassium phosphonate (0.3%) + <i>Trichoderma harzianum</i>	16.28	20.71	7.22	3.12
T2 Bordeaux mixture spray (1.0%) - COC (0.1%) drenching	22.25	27.31	9.24	2.86
T3 Consortium of bacteria	36.22	39.48	14.85	1.64
T4 <i>T. harzianum</i> + consortium of bacteria	28.34	32.58	11.66	2.14
T5 Control	61.64	68.34	19.72	1.08
SEm ±	4.33	3.41	0.86	0.32
CV (%)	7.41	6.49	11.98	2.27
CD (P=0.05)	1.57	1.22	2.37	1.08

consortium @ 1 g/l each of *P. fluorescens* - IISR-6 & 859 to the root zone (T4) and Bordeaux mixture @ 1% as spraying and copper oxy chloride @ 0.1% a.i. as drenching (T2). Maximum berry yield (0.900 kg/vine) was recorded in potassium phosphonate and *T. harzianum* and was significantly superior to rest of the treatments except Bordeaux mixture + COC (0.888 kg/vine), and *T. harzianum* + bacterial consortium.

The disease incidence and yield data of Panniyur centre indicated that there was no significant difference between treatments for disease incidence and yield. The control plot showed more yellowing, defoliation and death of vine.

All the treatments were effective in reducing the disease incidence of foot rot (leaf yellowing, defoliation and death of vine) and increasing the canopy size and yield as compared to control at Mudigere centre. The minimum leaf yellowing of (9.25 PDI) was recorded in T₁ (0.3% potassium phosphonate + *T. harzianum*) followed by T₂ (1% Bordeaux mixture spray and 0.2% COC drench) as compared to other treatments. The minimum defoliation (6.47 PDI) was recorded in T₂ followed by T₁ (7.17 PDI) as compared to control (10.62 PDI). Less number of vines wilted in all the treatment compared to control. The maximum canopy size (3.77 m.) and yield/vine (656.25 g) were recorded in T₂ followed by T₁ as compared to control (3.04 m.) and 507.5 g/vine, respectively.

At Sirsi, black pepper vines recorded least leaf infection (12.00 PDI), least yellowing (11.33 PDI), least defoliation (9.33 PDI), least death of vines (8 %) and highest green berry yield (1.03 kg/vine^e and 424.36 kg/ha projected yield) where the vines were protected against *Phytophthora* foot rot of black pepper with application of potassium phosphonate (@ 0.3 per cent) as spraying (@ 2 l/vine) and drenching (3 l/vine) along with bioagent *T. harzianum* (MTCC 5179) 50 g with one kg of neem cake as soil application during first week of June and third week of August 2008 to the root zone. However, spraying of 1% Bordeaux mixture (@ 2 l/vine) and drenching copper oxychloride (0.1 % a.i.) twice during June and August 2008 was also significantly effective in checking the disease with less leaf infection (16.00 PDI), less yellowing (14.00 PDI), less defoliation (12.00 PDI), less death of vines (14 %) and more green berry yield (0.86 kg/vine and 354.32 kg/ha projected yield). In case of bioagents application i.e., consortium of bacteria @ 10⁸ cfu/g (for growth, nematode

and *Phytophthora* suppression -IISR-6 & IISR 859) as spraying (@ 2 l/vine) and drenching (@ 3 l/vine) and *T. harzianum* (MTCC 5179) 50 g with one kg of neem cake as soil application around the root zone of the vine twice (June and August) also significantly reduced the disease i.e., less leaf infection (22.00 PDI), less yellowing (20.00 PDI), less defoliation (14.67 PDI), less death of vines (18 %) and maximum green berry yield (0.75 kg/vine and 287.12 kg/ha projected yield). This was followed by treating of vines alone with Consortium of bacteria @ 10⁸ cfu/g (for growth, nematode and *Phytophthora* suppression -IISR-6 & IISR 859) as spraying (@ 2 l/vine) and drenching (@ 3 l/vine) twice were found to be effective in reduction of leaf infection (24.00 PDI), less yellowing (21.33 PDI), less defoliation (17.33 PDI), less death of vines (20%) and less green berry yield (0.60 kg/vine and 243.45 kg/ha projected yield) The vines with out any protection exhibited highest incidence of leaf infection (54.67 PDI), highest yellowing (36.67 PDI) and highest defoliation (25.33 PDI, highest death of vines (46%) and minimum green berry yield (0.049 kg/vine and 200.23kg/ha projected yield).

1.6.3 Trial on management of *Phytophthora* foot rot of black pepper in new plantation (Chintapalle, Dapoli, Panniyur, Mudigere and Sirsi)

The trial was started during 2006 as adaptive trial in farmers plot at Panniyur centre. Defoliation and death of vines were significantly low in T1 (potassium phosphonate + *Trichoderma*) and hence this treatment is more effective in controlling the disease. There was no significant difference between treatments for yellowing, yield and plant growth data.

The experiment has been initiated at Mudigere, Sirsi, Chintapalle and Dapoli centres.

1.7 Pest Management Trial

1.7.1 Management of gall wasp on *Erythrina* - a popular standard of black pepper (Mudigere)

A survey was conducted during 2008-09 for recording seasonal incidence of *Erythrina* gall wasp in different pepper growing districts of Karnataka mainly Coorg, Hassan, Chikmagalur, Udupi, South Canara and North Canara at Mudigere. The incidence of pests was observed on different

species of *Erythrina*. There are four species of *Erythrina* found during survey and in most of the gardens *Erythrina* species was not used as standard for black pepper. Among the four species, three species were found to be severely affected and one species *Erythrina subumbrans* (Kassk.) Merrill was found to be resistant.

2. CARDAMOM

2.1 Genetic Resources

2.1.1 Germplasm collection, characterization, evaluation and conservation (Mudigere and Pampadumpara)

A total of 152 germplasm were maintained at Mudigere centre. Out of 32 cardamom germplasm evaluated for yield and its attributing traits during 2008, D-141 was the tallest (292 cm), Pothamedu was found superior for number of bearing suckers (18), and panicle number (25). Longest panicle length was observed in Pothamedu and PDP-7. Pothamedu recorded high green capsule yield (208 kg/ha) followed by D-141 and CI-730. Thirty open pollinated progenies were planted in 2002-03 were evaluated. The dry capsule yield was highest in 23C₈ (230.15 kg/ha) followed by 22C₈ (224.50 kg/ha) and 21C₈ (220.15). M-2 was tallest (317.33 cm), 22C₈ and 23C₈ had maximum number of bearing suckers (20 & 27), 6C₈ had longest panicle (70.74 cm) and number of capsules/plant (65.00) was maximum in 4C₈.

At Pampadumpara, highest fresh and dry yield was recorded in S-1 (3375 g/plant & 740 g/plant respectively) closely followed by Pan-1 (3050 g/plant & 650 g/plant respectively). Driage percentage of PS-44 was found to be highest (22.9%) confirming its superiority in recovery percentage than all other accessions under study. PS-44 was also found to be tolerant to azhukal disease and capsule borer damage. IC numbers were obtained for 73 cardamom accessions. The cardamom germplasm maintained at various AICRPS centres are given in Table 7.

2.2 Hybridization and Selection

2.2.1 Evaluation of OP progenies under intensive management (Mudigere)

A crossing block involving 5 elite clones viz., M-1, M-2, HS-1, Njallani Gold and CL-726 was established in 2005-06 at Mudigere to generate all possible cross combinations through both random open pollination and hand pollination and crosses will be made in the year 2009-10.

2.3 Coordinated Varietal Trial

2.3.1 CVT 2005-Series V

(Pampadumpara, Mudigere and Myladumpara)

At Pampadumpara, the CVT trial was laid out with seven accessions namely, MCC 73, MCC 309, MCC 246, MHC 26 (ICRI, Myladumpara), CL 722 (RARS, Mudigree), PS 27 (CRS, Pampadumpara) and *Green Gold* (check) during October 2005. Among the seven accessions MCC 309 (262 cm) registered maximum plant height followed by PS 27 (254.67 cm). Number of tillers ranged from 63.33 (MCC 73) to 40.67 (MCC 246). Three accessions namely, MCC 73 and MCC 309 and CL722 were found to have more number of tillers than the check Greengold (46.33). The yield data could not be obtained due to negligible yield.

Among the clones planted at Mudigere centre, CL-722 was found superior for dry capsule yield (347.96 kg/ha) and was significantly superior over checks (M1 & M2). Other top ranking entries which recorded high dry capsule yield were PS-27, MCC-309 & MCC-246. MCC 246 was tallest (285.96 cm). Number of bearing suckers (16.78) was maximum in PS-27. MCC-246 had maximum number of panicle (67.33), longest panicle (56.33 cm) and maximum number of capsules (25.40).

At Myladumpara, data on growth and yield attributes such as total tillers per clump, tiller height, leaves per tiller, bearing tillers per clump, panicles per clump, racemes per panicle, capsules per raceme and the first stabilized yield were recorded and analyzed statistically. Significant differences could be observed between the clones for all the characters except for the number of leaves per tiller. As in the previous year, performance of PS-27 and CL-722 with regard to yield was inferior when compared to other clones. The highest yield of 1317 kg/ha was recorded in MHC-26 followed by MCC-73 (1172 kg/ha), MCC-246 (1155 kg/ha) and MCC-309 (1033 kg/ha) (Table 8).

2.3.2 CVT 2007-series VI

(Myladumpara, Pampadumpara, Mudigere and Sakleshpur)

The trial was laid out at Myladumpara, Pampadumpara, Mudigere, Sakleshpur during 2008 planting season with eleven accessions namely, IC 349545, IC 349651, IC 547167, IC 547185 (Appangala), CI 726 and CI 691 (RARS, Mudigere), MCC 346 (ICRI, Myladumpara), PI No 14 and CR 6 (CRS, Pampadumpara) and Green Gold, PV-2 (checks). Since the establishment was poor the trial would be re-laid again in the ensuing season.

Table 7. Cardamom germplasm collections of AICRPS centres

Centre	Indigenous		Total
	Cultivated	Wild and related sp.	
Mudigere	161	-	161
Pampadumpara	151	1	152
Total	312	1	313

Table 8. Performance of CVT cardamom at Myladumpara

Clone	Tillers/ clump	Tiller height (cm)	Leaves/ tiller	Bearing tillers/ clump	Panicles/ clump	Racemes/ panicle	Capsules/ raceme	Yield/ plant (kg)	Estimated yield (kg/ha)
MHC-26	76.94	227.14	17.76	41.98	71.09	18.92	7.33	1.317	1317
MCC-73	67.10	211.31	18.48	35.97	65.52	16.38	6.34	1.172	1172
MCC-246	70.55	240.81	18.42	38.96	63.13	17.81	7.28	1.155	1155
MCC-309	65.09	228.11	18.32	38.09	64.00	15.61	5.92	1.033	1033
PS-27	50.94	199.52	18.40	28.02	42.25	14.67	6.68	0.802	802
CL-722	43.25	176.55	17.71	23.56	34.56	11.79	5.52	0.612	612
ICRI-2	64.12	226.21	18.36	36.40	63.30	15.22	5.89	0.992	992
MCC-260	62.24	206.76	17.91	34.41	60.56	14.60	5.87	0.967	967
CD (P= 0.05)	12.98	4.15	NS	7.27	10.77	1.99	1.16	0.175	175

2.4 Varietal Evaluation Trial (VET)

2.4.1 Initial evaluation trial – I

(Mudigere)

Evaluation of fifteen open pollinated progenies was initiated in 1999 at Mudigere and among the progenies, 2-4-D11 yielded highest dry capsule (240.14 kg/ha) followed by 2-5-D11 (215.40 kg/ha) and 7-24-D11 (200.00 kg/ha). 7-10-D11 was tallest (301.00 cm). 24-17-D10 was superior for number of bearing suckers (25.67) and number of panicles/plant (40.00). 2-5-D11 had longest panicle length (64.44 cm) and capsule no./panicle (70.44) was maximum in 2-4-D11.

2.4.2 Initial evaluation trial – II

(Mudigere)

Another initial evaluation trial, consisting of 13 entries was evaluated for yield at Mudigere. The entries, CL-692 yielded highest (340.50 kg/ha) followed by Sel- 800 (312.2 kg/ha) and CL-722 (310.50 kg/ha). CL-722 was tallest (305.33 cm) and had maximum bearing suckers (25.00), HS-I was found superior for number of panicles (50.67), Sel-800 for panicle length (65.80 cm) and CL-691 for number of capsules (55.51).

2.5 Nutrient Management Trial

2.5.1 Effect of biofertilizers, *Azospirillum* on cardamom

(Pampadumpara)

At Pampadumpara, highest wet and dry yield of cardamom was recorded in plots receiving 100% inorganic nitrogen + 50 g *Azospirillum* + 5 kg FYM and was significantly superior than all other treatments. Application of *Azospirillum* in combination with FYM was found significantly superior as compared to plots receiving FYM alone.

2.5.2 Influence of biofertilizer phosphobacteria on growth and yield of cardamom

(Pampadumpara)

Highest wet and dry yield of cardamom was recorded in plots receiving 100% inorganic phosphorus + 50 g phosphobacteria + 5 kg FYM and was significantly superior than all other treatments at Pampadumpara centre. Application

of phosphobacteria in combination with FYM was found significantly superior as compared to plots receiving FYM alone.

2.5.3 Influence of neem cake on cardamom yield and occurrence of insect pest and disease of cardamom

(Pampadumpara)

Application of neem cake twice @ 0.5 kg and 1.0 kg resulted in significantly more number of tillers, higher plant height and yield. Maximum number of tillers (47.5), tallest tillers (262.8 cm) and highest yield (373.8 g/plant) was 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. Damage caused by thrips, borer and azhukal (capsule rot) on cardamom capsules was found to be non-significant.

2.6 Pest Management Trial

2.6.1 Trial on management of panicle and clump rot of cardamom in existing plantation

(Mudigere and Pampadumpara)

The minimum tiller infection of 2.22 PDI, panicle infection of 2.42 PDI, blotch of 3.25 PDI and higher yield of 331.25 kg/ha were recorded in T₄ (0.3% COC drenching) treatment followed by T₅ (potassium phosphonate spray and drench) as compared to control at Mudigere centre.

The trial was not conducted at Pampadumpara centre.

2.6.2 Management of rhizome and panicle rot in cardamom in new plantation

(Mudigere)

The maximum plant height of 173.86 cm and 11.86 tillers were recorded in T₅ (potassium phosphonate spray and drench in IISR Avinash variety) which was followed by T₄ (0.3% COC drenching) as compared to other treatments. The minimum leaf spot incidence of 0.93% was recorded in T₅ (0.3% potassium phosphonate spray and drench in IISR Avinash) and leaf blotch (0.90%) in T₄ (0.3% COC drenching in M-I variety) as compared to control.

3. GINGER

3.1 Genetic Resources

3.1.1 Germplasm collection, characterization, evaluation and conservation

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

Sixty three accessions and three checks were evaluated during 2008-09 at Kumarganj. The yield ranged from 14.6 q/ha in NDG-4 to 342.3 q/h in NDG-55 (Badra sonth). High yield was recorded in accession NDG-55, followed by NDG-28 (136.3 q/ha) and NDG-9(120.9 q/ha).

Out of the total 172 ginger accessions maintained at Pottangi centre, 145 accessions were evaluated in two replications of which only 22 accessions yielded more than 8 kg/3 m², the range of yield being 2.40 kg to 12.3 kg/3 m². The highest fresh rhizome yield was recorded by Acc. 13 (10.77 kg/3 m²), PGS-3 (10.2 kg/3m²) and Z0-9 (10.1 kg/plot).

Fifty one germplasm of ginger were grown for evaluation during 2008-09 at Pundibari centre. Accession GCP-9 recorded maximum plant height (82.24 cm) followed by GCP-10 (78.38 cm), whereas GCP-33 recorded the lowest plant height (29.22 cm). Maximum number of tillers was recorded in GCP-9 (24.80) followed by GCP-10 (18.00) and GCP-12 (3.40) recorded lowest numbers of tillers. GCP-1 recorded maximum number of leaves (21.60) followed by GCP-9 (21.20). Maximum PDI was recorded in the germplasm GCP-44 and GCP-49 (85.00% each) followed by GCP-15, GCP-38

and GCP-48 (80.00% each) and lowest PDI was recorded in GCP-9 (5.00%). Highest rhizome yield/plant was recorded in GCP-9 (285.80 g) followed by GCP-10 (278.20 g), GCP-21 (225.80 g), GCP-8 (221.00 g) and GCP-1 (219.00 g).

Due to continuous heavy rains at Raigarh, germination, initial crop growth and yield was low. Plant mortality was also very high.

Two hundred and eighty six collections were evaluated under field conditions for different horticultural characters at Solan. The yield of ten promising lines varied from 6.92 kg to 12.0 kg whereas the yield range of germplasm varied from 1.50 kg – 12.0 kg. Lajhan and Panesh Local gave maximum yield. Dry matter content (20.00%) and oleoresin contents (6.00%) were maximum in Lajhan while essential oil (2.00%) was maximum in SG1084. Minimum crude fibre (4.80%) was recorded in SG 1023.

At Dholi, all the forty seven germplasm of ginger gave an yield below the average yield due to continuous heavy rainfall resulting in water stagnation condition. The germplasm of ginger maintained in various AICRPS centre is given in Table 9.

3.2 Coordinated Varietal Trial

3.2.1 CVT 2005 – Series VI

(Solan, Pottangi and Pundibari)

At Solan, significant differences amongst collections were observed for yield per plot. SG-827, recorded highest yield per plot (6.60 kg) and was on par with check Himgiri, SG-707 and Suprapha. Minimum yield of 2.90 kg/plot was recorded in

Table 9. Ginger germplasm collection of AICRPS centres

Centre	Indigenous	Exotic	Total
Chintapalle	06	-	06
Dholi	47	-	47
Kumarganj	61	-	61
Pottangi	174	3	177
Pundibari	51	-	51
Raigarh	44	-	44
Solan	286	-	286
Total	669	3	672

Table 10. Performance of CVT ginger at Solan

Accession	Yield/plot (kg)	Yield (t/ha)	Increase over control (%)	Disease incidence (%)	Dry matter (%)	Essential oil (%)	Oleoresin (%)
IG-1	3.73	7.50	-37.09	5.0	17.00	1.50	5.50
IG-2	4.63	9.30	-29.42	5.0	18.00	1.50	6.00
IG-3	2.90	5.82	-51.09	6.0	17.00	1.00	5.00
SG 707	5.50	11.00	-7.25	4.5	19.50	1.50	5.00
SG827	6.60	13.26	0.11	3.5	20.20	2.00	6.20
Suprapha	5.56	11.00	-6.23	3.5	19.50	1.80	5.00
Himgiri	5.93	11.92	-	3.5	18.00	1.50	5.00
SEm ±	0.95	-	-	-	-	-	-
CD (P=0.05)	2.07	-	-	-	-	-	-

IG-3. The dry matter content and essential oil was maximum (19.80% and 2.00%) in SG-827 followed by Suprabha (19.50% and 1.80%). SG-827 and SG-707 also gave maximum oleoresin. The crude fiber content ranged between 5.00 to 6.00%. The disease incidence varied from 3.5% (Himgiri) to 6.00% (IG-3) (Table 10).

There was significant different among the cultivars for fresh rhizome yield at Pottangi. Highest fresh rhizome yield was recorded by Z0-2 (22.20 t/ha), V₁S₁-2 (22.03 t/ha) followed by V2E5-2 (21.46 t/ha).

Amongst fourteen genotypes the values of growth and yield parameters of nine genotypes (GCP-05, GCP-31, V2E5-2, IG-1, IG-2, IG-3, SG-707, SG-827 and PGS-8) were recorded at Pundibari centre. Analysis of data showed that the genotype PGS-8 exhibited the highest plant height (68.45 cm) followed by IG-1 (63.27 cm). GCP-31 was the shortest in plant height (47.83 cm). Highest number of tillers/rhizome was recorded

by V2E5-2 (10.90) where as lowest was shown by GCP-31 (4.10). PGS-8 showed the highest number of leaves (17.80) where as GCP-31 showed the lowest (13.33). GCP-5 showed the highest yield per plot (3.13 kg) followed by SG-707 (2.17 kg) and SG-827 recorded the lowest (1.23 kg). SG-827 had the highest disease infestation (68.33%). Lowest PDI was recorded by IG-1 (15.83%) followed by V2E5-2 (22.50%). Highest rhizome yield was recorded by GCP-5 (6.32 ton/ha) followed by SG-707 (4.37 ton/ha). The lowest yield was recorded by SG-827 (2.49 ton/ha) (Table 11).

3.2.2 CVT 2007

(Pottangi)

There was significance difference among the cultivars for fresh rhizome yield at Pottangi centre. Highest fresh rhizome yield was recorded by V₁E₄-5 (24.27 t/ha), followed by V₂E₅-2 (24.15 t/ha) (Table 12).

Table 11. Growth parameters and yield of ginger under CVT 2006 at Pundibari

Parameters Entries	Plant height (cm)	Number of tillers	Number of leaves	Leaf length (cm)	Leaf breadth (cm)	Pseudostem girth (cm)	Rhizome yield/plot (kg/3m ²)	Disease incidence (%)	Projected yield (t/ha)
SG-707	56.34	6.73	17.77	19.81	2.43	3.01	2.17	38.33	4.37
IG-1	63.27	10.63	17.73	16.88	2.05	2.64	2.12	15.83	4.27
IG-3	55.50	8.07	16.10	16.52	1.93	2.40	1.50	44.17	3.02
SG-827	51.26	4.23	13.40	17.67	2.30	2.70	1.23	68.33	2.49
IG-2	60.05	9.60	16.13	16.59	1.87	2.42	1.85	18.33	3.74
PGS-8	68.45	6.87	17.80	19.25	1.98	2.74	1.85	31.67	3.73
V ₂ E ₅ -2	60.90	10.90	14.40	18.31	1.93	2.41	1.43	22.50	2.89
GCP-5	49.83	6.17	13.53	17.81	2.45	2.44	3.13	35.00	6.32
GCP-31	47.83	4.10	13.33	16.10	2.17	2.79	1.93	59.17	3.90
S Em(±)	2.20	0.40	0.67	0.50	-	-	0.26	5.00	0.53
CD (P= 0.05)	4.67	0.84	1.41	1.06	N.S	N.S	0.55	10.61	1.11

Table 12. Yield performance of CVT ginger at Pottangi

Accession	Plot yield (kg/3m ²)			Yield(t/ha)	Increase over check (%)
	2007	2008	Mean		
IG-1	8.2	6.6	7.40	17.02	
IG-3	7.6	7.1	7.35	16.91	
IG-2	6.4	6.5	6.45	14.84	
S-646	9.1	8.1	8.60	19.78	
V ₂ E ₅ -2	12.3	8.7	10.50	24.15	24.53
Acc-35	10.4	7.2	8.80	20.24	
Singhjhara	11.2	7.7	9.45	21.74	
S-692	11.1	7.8	9.45	21.74	
Acc-117	10.7	7.4	9.05	20.82	
V ₃ S ₁ -8	10.4	8.2	9.80	22.54	15.29
V ₁ S ₁ -2	11.2	8.1	9.65	22.20	
V ₁ S ₁ -8	11.3	8.3	9.80	22.54	
V ₁ E ₄ -5	12.7	8.6	10.55	24.27	24.74
V ₁ C-8	11.6	8.2	8.90	20.47	
Suprabha (C)	9.6	7.4	8.50	19.55	
CD (P=0.05)	2.1	1.2	1.66	3.82	

3.3 Varietal Evaluation Trial

3.3.1 Initial evaluation trial

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

Significant differences were observed for yield per plot and quality attributes at Solan centre. None of the genotypes gave yield more than check. However, SG 680 and PLS-4 were at par with Himgiri. PLS-4 and SG857 gave high dry matter content (18.0%) and essential oil of 1.5% and 1.80%, respectively. The crude fiber content ranged from 4.00% (SG 1107) to 7.00% (SG 03/04). The disease incidence varied from 13.2 to 22.5%.

Significant difference among the cultivars for fresh rhizome yield was recorded at Pottangi centre. Highest fresh rhizome yield was recorded by V₁E₄-5 (24.35 t/ha) followed by PGS-8 (23.49 t/ha).

At Dholi, RG-3, RG-43 and RG-35 gave the maximum yield (22.77, 21.78 and 20.74 t/ha) respectively, as compared to check variety Nadia (19.50 t/ha). Regarding number of days to maturity, RG-8, RG-29 and RG-43 were early maturing as compared to local check variety Nadia.

At Pundibari, TCP-57 recorded maximum plant height (125.93 cm) followed by TCP-129 (121.32 cm). TCP-129 showed the highest mean value for number of tillers/plant (3.27). In respect of number of leaves/plant, TCP-84 recorded the highest (10.00). For pseudo-stem girth, TCP-104 recorded the highest (9.11 cm) while TCP-11 showed the lowest (6.05 cm). In respect of leaf length, TCP-57 recorded the highest length (64.24 cm) and TCP-11 recorded the lowest (47.01 cm). TCP-129 recorded highest leaf breadth (12.52 cm) where as ABN-01 recorded lowest (9.97 cm). A wide range of variability was found among the genotypes for different yield characters as shown in Table 6. In respect of the trait weight of mother clump, TCP-129 recorded the highest value (11.67 g). TCP-64 showed the highest value (2.30 cm) for the trait length of mother clump where as TCP-129 showed the lowest value (2.03 cm). In respect of number of clumps per mother rhizome, TCP-02 showed the highest and TCP-119 lowest value (1.47 and 1.07 respectively). In the trait number of primary fingers, TCP-64 recorded highest value (5.20) whereas TCP-119 recorded lowest value (2.67). TCP-64 achieved the highest weight of primary fingers (94.96 g) and TCP-119 showed the lowest value for the trait (50.60 g). In respect of length of primary fingers TCP-64 recorded the highest length of (2.57 cm) and TCP -57 recorded the lowest length of (2.33 cm). TCP-64 showed the highest value and TCP-140 showed the lowest value (14.16 and 5.67 respectively) for the trait number of secondary fingers. In respect, weight of secondary fingers,

TCP-97 recorded the highest weight (52.40 g) and TCP-140 lowest weight (21.40 g). TCP-02 showed the highest length of secondary fingers (2.18 cm) and TCP-107 showed the lowest length (2.03 cm) for that trait. The highest mean value for clump weight/plant was recorded by TCP-64 (184.93 g) while TCP-119 showed the lowest value for that trait (89.20 g). In respect of plot yield (kg/3m²) and the projected yield (t/ha), TCP-129 recorded the highest mean value (11.67 kg and 23.52 t/ha, respectively), closely followed by TCP-64 (11.33 kg and 22.85 t/ha, respectively); both the genotypes out yielded TCP-2, the local check (Pundibari).

Due to continuous heavy rains at Raigarh, poor germination, initial crop growth and yield was recorded.

3.4 Quality Evaluation Trial

3.4.1 Evaluation of ginger germplasm for quality

(*Solan*)

The samples of the crop harvested during December 2008 were analyzed during 2009 for different quality attributes viz., dry matter, essential oil, oleoresin and fiber content at Solan. Dry matter content ranged between 14.00 and 23.00 per cent in all the collections under study. Essential oil and oleoresin contents varied from 1.4 to 2.0 and 4.0 to 6.9 per cent, respectively. Among these 64 collections SG 1030, 48/04 followed by SG856, SG713, SG1102 and SG827 were found significantly superior for dry matter and essential oil content in comparison to check Himgiri. However, significantly less fibre content was recorded in SG 827, SG716 and SG707 in comparison to check Himgiri. Overall, collections like SG 707, SG 827, SG 716, SG682 and lajhan exhibited better quality attributes along with yield (> 5 kg/plot). However, other collections like SG 1030, SG 48/04, and SG 1102 also exhibited superior quality attributes but recorded lesser yield.

3.5 Nutrient Management Trial

3.5.1 Organic farming in ginger – 2006

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

At Solan, significant differences among treatment were observed for yield per plot. Maximum yield (6.51 kg) was observed in inorganic treatment followed by integrated treatment (6.18 kg). The yield was significantly less in fully organic treatment. Essential oil and oleoresins were slightly higher in organic treatment. However, high dry matter and less crude fibre were observed in integrated treatment with comparable oil and oleoresin to that of organic treatment (Table 13).

Table 13. Yield and quality of ginger under organic farming at Solan

Treatment	Yield /plot	Yield (t/ha)	Dry matter (%)	Essential oil(%)	Oleoresin(%)	Crude fibre(%)
T1 (Organic)	5.48	11.01	17.00	2.00	6.50	5.50
T2 (Inorganic)	6.51	13.08	15.70	1.00	4.54	5.50
T3 (Integrated)	6.18	12.42	18.00	1.80	6.00	5.50
SEm+	0.51					
CD (P=0.05)	1.07		1.05	0.06	0.09	1.003

At Pundibari, application of integrated nutrients on ginger (T_2) produced highest clump weight of 86.83 g and highest yield of 2.87 kg per plot. This treatment also produced highest oleoresin of 3.6% in 2008-09. This treatment is followed by application of organic nutrients on ginger (T_1) which produced clump weight of 79.57 g and yield of 2.34 kg per plot.

There was no significant difference among different treatments for fresh rhizome yield at Pottangi. Highest yield was recorded in fully inorganic treatment (18.40 t/ha).

At Dholi, among the three treatments, fully organic (T_1) and integrated fertilizer management of organic & inorganic (T_2) gave significantly better performance as compared to fully inorganic (T_3). Fully organic (T_1) gave better performance regarding number of tillers (28.46), number of leaves per tiller (20.46), length of leaves (20.49 cm), width of leaves (2.63 cm), area of leaves (53.78 cm²), yield per rhizome (0.23 kg) and yield per plot & per hectare (7.19 kg/3 m² & 23.95 t/ha) followed by integrated fertilizer management of organic & inorganic (T_2).

At Kumarganj, effect of fertilizers, FYM and bioagents were studied and highest yield of 62.14 q/ha was recorded in 50% recommended dose of fertilizer (60:40:40 kg NPK /ha) along with FYM (10 t/ha), *Azospirillum* (5 kg/ha) and seed treatment and soil application of *P. fluorescens* and *Trichoderma* @50 g/m² with maximum increase in yield of 43.44% and rhizome rot disease control by 9.02% over control. The yield in this treatment (62.14 q/ha) was followed by 100% recommended dose of 120:80:80 kg NPK/ha along with FYM (20 t/ha) and seed treatment and soil application of *P. fluorescens* and *Trichoderma* @50g/m² producing fresh rhizome yield of 45.23 q/ha. In three years of pooled study maximum fresh rhizome yield of 45.14 q/ha was obtained in 50% recommended dose of fertilizer (60:40:40 kg NPK /ha) along with FYM (10 t/ha), *Azospirillum* (5 kg/ha) and seed treatment and soil application of *P. fluorescens* and *Trichoderma* @50 g/m² with maximum increase in yield of 36.49 % over controls.

At Raigarh, very poor performance was recorded in yield due to heavy rainfall during the planting and germination. Recommended dosage of fertilizers gave maximum yield kg/plot (4.0).

3.5.2 Effect of biofertilizers (*Azospirillum*) on ginger (Raigarh and Ambalavayal)

At Ambalavayal, highest yield (6.88 kg/plot) was obtained in the treatment where recommended package of practice was followed. This was followed by the application of FYM (10 kg) + *Azospirillum* (50 g) (6.64 kg/plot).

Recommended dosage of fertilizers gave maximum yield of 4.0 kg/plot (8.04 t/ha) at Raigarh.

3.5.3 Effect of micronutrient on ginger (Kumarganj and Pottangi)

At Kumarganj, the crop was severely affected by high incidence of rhizome rot disease and therefore, the fresh rhizome yield was very poor every year. The fresh rhizome

yield of ginger varied every year irrespective of year and treatments. Four years mean values critically indicated that maximum fresh rhizome yield (55.53 q/ha) was observed by foliar spray of zinc @ 0.50 % + boron @ 0.2 % and ferrous sulphate @ 1.0% after 60 days of planting followed by yield of 49.99 q/ha by foliar application of boron @ 0.2%. Low yield of ginger can be attributed to the incidence of rhizome rot diseases and high pH of the soil (8.2). High pH of soil gradually increases the activity of *Pythium aphanidermatum* above pH 4.0 resulting in high incidence of rhizome rot.

At Pottangi, there was significant difference among the treatments. There was significant difference among 27 different treatments for fresh rhizome yield. Best treatment were T_{14} (soil application as basal 25 kg/ha each of ZnSO₄, FeSO₄ & Borax) yield of (18.86 t/ha) and 30.16% increase over check. T_{15} (25 kg/ha Zn, Bo & 0.5 % Fe as foliar spray) yield of (18.11 t/ha) and 24.82 % increase over check (Table 14).

The interaction effect between Zn, Bo and Fe was not found significant at Raigarh, but the yield was appreciably higher at higher levels of Zn, Bo and Fe. The maximum rhizome yield of 12.98 t/ha was recorded with foliar spray of 0.05% zinc sulphate (60 & 90 DAP) spray 0.2% of Borax (60 & 90 DAP) and spray of 1.0% of Ferrous Sulphate (60 & 90 DAP).

3.6. Disease Management Trial

3.6.1 Disease surveillance and etiology of rhizome rot in ginger (Dholi and Solan)

At Dholi, diseased rhizome of ginger collected from Samastipur and Muzaffarpur districts of state were found to be associated with bacterial wilt disease caused by *Ralstonia* sp.

At Solan, the disease surveillance was carried out in Ghumarwin, Bari, Kothi, Kotla, Karot, Rohin, Markand, Namhol and Nalag areas of district Bilaspur and the disease incidence varied from 10 to 23 per cent.

3.6.2 Management of rhizome rot in ginger (Mudigere Chintapalle and Dapoli)

At Mudigere, in solarized plot, the maximum germination (86%) and tiller production (74.5) were observed in T_4 (Mancozeb seed treatment and soil drench) which is followed by 79% germination and tiller production (68.3) in T_3 (application of *T. harzianum* and bacterial consortium). In solarized plot, a minimum of 4.3% soft rot, 2.05% foliage disease and higher yield of 4.91 t/ha was recorded in T_4 (Mancozeb seed treatment & soil drench) as compared to other treatments.

At Dapoli, germination of solarized rhizomes (92.37 per cent) was higher compared to that of non-solarized ones (89.97 per cent). Rhizomes of both solarized and non-solarized treated with Mancozeb (93.68 per cent) or *T. harzianum* alone (91.53 per cent) or bacterial consortium alone (91.32 per cent) or combination of fungal and bacterial bioagents (92.45 per cent) showed improvement in germination. Maximum (14.63 and 14.30 nos.) tiller production was noticed in solarized and non-solarized rhizomes treated with Mancozeb. It was closely

Table 14. Effect of micronutrients on yield of ginger at Pottangi (Pooled)

Sl.No	Treatment	Plot yield (kg/3m ²)				Tons/ha	Increase over control (%)
		2006	2007	2008	Mean		
T ₁	Zn ₀ BO ₀ Fe ₀	8.05	8.0	6.1	6.30	14.49	
T ₂	Zn ₀ BO ₀ Fe ₂₅	8.75	8.6	6.4	6.65	15.30	
T ₃	Zn ₀ BO ₀ Fe _{0.5}	8.90	8.1	6.2	6.46	14.85	
T ₄	Zn ₀ B ₂₅ Fe ₀	8.65	8.8	6.6	6.71	15.43	
T ₅	Zn ₀ B ₂₅ Fe ₂₅	9.30	9.2	6.7	6.90	15.88	
T ₆	Zn ₀ B ₂₅ Fe _{0.5}	9.00	9.1	6.3	6.63	15.25	
T ₇	Zn ₀ B _{0.5} Fe ₀	8.30	8.1	6.2	6.41	14.73	
T ₈	Zn ₀ B _{0.5} Fe ₂₅	9.45	9.1	6.2	6.57	15.11	
T ₉	Zn ₀ B _{0.5} Fe _{0.5}	9.15	8.4	6.2	6.48	14.90	
T ₁₀	Zn ₂₅ Bo Fe ₀	8.30	8.3	6.4	6.76	15.55	
T ₁₁	Zn ₂₅ Bo Fe ₂₅	9.00	9.2	6.4	6.90	15.86	
T ₁₂	Zn ₂₅ Bo Fe _{0.5}	8.80	9.0	6.6	6.77	15.57	
T ₁₃	Zn ₂₅ B ₂₅ Fe ₀	9.25	9.6	7.2	7.26	16.69	
T ₁₄	Zn ₂₅ B ₂₅ Fe ₂₅	10.10	10.6	7.9	8.20	18.86	30.16
T ₁₅	Zn ₂₅ B ₂₅ Fe _{0.5}	9.65	11.2	7.4	7.88	18.11	24.98
T ₁₆	Zn ₂₅ B _{0.5} Fe ₀	9.15	9.2	6.8	7.38	16.97	
T ₁₇	Zn ₂₅ B _{0.5} Fe ₂₅	10.45	9.6	6.6	7.15	16.45	
T ₁₈	Zn ₂₅ B _{0.5} Fe _{0.5}	9.65	10.1	6.5	7.00	16.10	
T ₁₉	Zn _{0.5} Bo Fe ₀	8.30	8.1	6.2	6.68	15.36	
T ₂₀	Zn _{0.5} Bo Fe ₂₅	8.45	8.3	6.4	6.65	15.30	
T ₂₁	Zn _{0.5} Bo Fe _{0.5}	8.35	8.1	6.2	6.64	15.26	
T ₂₂	Zn _{0.5} B ₂₅ Fe ₀	9.45	9.6	6.3	6.51	14.97	
T ₂₃	Zn _{0.5} B ₂₅ Fe ₂₅	9.15	9.4	7.2	6.99	16.07	
T ₂₄	Zn _{0.5} B ₂₅ Fe _{0.5}	8.65	9.3	6.7	7.44	17.10	18.01
T ₂₅	Zn _{0.5} B _{0.5} Fe ₀	8.80	8.3	6.1	6.97	16.03	
T ₂₆	Zn _{0.5} B _{0.5} Fe ₂₅	9.00	9.2	6.4	6.31	14.51	
T ₂₇	Zn _{0.5} B _{0.5} Fe _{0.5}	9.20	8.8	6.2	6.76	15.54	
CD (P=0.05)		1.21	1.02	1.2	6.52	14.98	

followed by rhizomes treated with *T. harzianum* + bacterial consortium (13.78 & 13.50). Tiller production was least in non-solarized rhizomes (11.89 nos.) without any treatment of fungicide or bioagent. Rhizome rot was recorded in both solarized and non-solarized rhizomes. However, incidence of the disease was low. It ranged between 2.25 per cent in solarized rhizomes treated with Mancozeb and 11.82 per cent in non-solarized and untreated rhizomes. It was closely followed by the treatment of *T. harzianum* + bacterial consortium in solarized (2.25 per cent) and non-solarized rhizomes (2.70 per cent). Similarly, highest fresh rhizome yield was recorded in solarized rhizomes treated with Mancozeb and was followed by solarized rhizomes treated with *T. harzianum*, combination of *T. harzianum* + bacterial consortium and bacterial consortium alone in the order mentioned.

Incidence of rhizome rot disease was not recorded during first year (2007-08). It was low during second year. Minimum (2.25 per cent) incidence was noticed in solarized rhizomes treated with mancozeb where as, it was maximum (11.82 per

cent) in non-solarized and untreated rhizomes. Rhizome treatment with mancozeb was closely followed by the treatment of *T. harzianum* + bacterial consortium in solarized (3.13 per cent) and non-solarized (4.33 per cent) rhizomes. Similarly, maximum fresh rhizome yield was mancozeb (26.43 t/ha; 13.93 kg/bed). It was closely followed by solarized rhizomes treated with combination of *T. harzianum* and bacterial consortium (24.93 t/ha; 14.36 kg/bed); *T. harzianum* alone (24.16 t/ha; 13.92 kg/bed); and bacterial consortium (23.84 t/ha; 13.74 kg/bed). Effects of rhizome solarization and rhizome and soil treatment with biocontrol agent alone and in combination in respect to germination of rhizomes and subsequent tiller production were non-significant. However, maximum germination (91.61%) was observed in case of rhizomes treated with mancozeb and was closely followed by the treatments of combination of *T. harzianum* and bacterial consortium; *T. harzianum* alone and bacterial consortium alone in the order mentioned. A similar trend was also noticed in respect of tiller production.

Incidence of rhizome rot of ginger was low i.e. 11.82 per cent in non solarized and unprotected rhizomes during second year (2008-09) of experimentation. The results revealed that the fungicide mancozeb and biocontrol agents alone and in combination exhibited their effectiveness on the reduction of ginger rhizome rot and increased the yield. The treatment of *T. harzianum* plus consortium *P. fluorescens* (IISR -6 and 859) thus can be preferred for ensuring greater protection of rhizomes against *Pythium* spp. when planted into the field. Though difference in main treatment means was significant, it appears that very low (5.22%) disease incidence might have masked its potential in integrated management of rhizome rot disease of ginger.

At Chintapalle, among the treatments, rhizomes solarized in polyethylene bags for 30 min and treated with mancozeb (@ 0.25 %) before planting as seed treatment and soil application as drenching recorded the highest germination (84.31 %), more number of tillers (14.31), low disease incidence (11.33PDI) and highest yield of 3.12 kg per bed. This was followed by solarization of seed material in polyethylene bags for 30 min and *T. harzianum* 50g/l as seed treatment and soil application where in highest germination (82.24%), more number of tillers (10.52), low disease incidence (8.42 PDI) and highest yield of 2.83 kg per bed were recorded (Table 15).

3.6.3 Biocontrol studies in rhizome rot of ginger (Kumarganj and Pottangi)

The field experiment was conducted at Kumarganj for a period of four years (2004-08). Seed rhizomes were treated with hot water 51°C for 30 min, mancozeb 75 W.P (3 g/l) for 30 min and *T. harzianum* @ 8 g/kg of seed rhizomes either alone or in combination. Soil application of neem cake was also made @ 25 kg/ha at the time of planting and sowing. The seed rhizomes after treatment were air dried in shade before sowing. High incidence of rhizome rot disease and low fresh

rhizome yield was recorded during period of investigation irrespective of years and treatment. The critical examination of four years data revealed that lowest incidence of rhizome rot disease (53.99 %) was observed in seed treatment of rhizomes with hot water at 51°C for 30 min and seed treatment of *T. harzianum* and soil application of neem cake over the untreated seeds (91.40%). This treatment controlled the disease by 40.82% with increase in yield of 120.73% over controls. Seed treatment with *T. harzianum* and with hot water at 51°C for 30 min was close to above treatment controlling disease by 27.84% and increase in yield by 86.58%.

At Pottangi, there was no significant difference for yield among different treatments. However highest fresh rhizome yield was obtained in hot water seed treatment seed + treatment with Mancozeb 3 g/l + carbendazim 1g/l + chloropyriphos 2ml/l for 30 min and soil application of thimite (10G) 1kg ai/ha (17.28 t/ha) followed by seed treatment with hot water + soil application of *Trichoderma*, FYM and neem cake (16.81 t/ha).

3.6.4 Integrated management of *Pythium*, *Fusarium* and *Ralstonia* in ginger (Kumarganj)

The field experiment was conducted at Kumarganj, from 2004 - 2008 for a period of four years with six treatments by treating seed rhizomes with mancozeb 75 W P (3g/l) for 30 min, *T. harzianum* @ 4g/l, 1 kg of rhizome solarization in polythene bags for 2 hours, Ridomil (with 100 pp Metalaxyl), and seed treatment with hot water 51 °C for 30 min. Treated rhizomes were air dried prior to sowing in shade. Incidence of rhizome rot disease varied in all the treatments. Examination of four years mean pooled data revealed that treatment of seeds with mancozeb 75 W P (3g/l) for 30 min significantly reduced the incidence of soft disease to a minimum of 40.12% over controls of 67.75% showing reduction in incidence of disease by 45.85%. Seed treatment of rhizomes with

Table 15. Management of rhizome rot in ginger at Chintapalle

Treatment	Solarized				Non- Solarized			
	Germination (%)	Tiller production (No.)	Disease incidence (PDI)	Yield/bed (kg)	Germination (%)	Tiller production (No.)	Disease incidence (PDI)	Yield/bed (kg)
<i>Trichoderma harzianum</i> seed treatment + soil application	82.24	12.62	8.42	2.83	76.34	13.22	15.27	2.52
Bacterial consortium	76.34	10.52	32.64	2.62	69.51	9.41	39.36	1.86
<i>T. harzianum</i> + bacterial consortium	79.05	9.54	19.62	2.06	66.52	7.51	30.85	1.76
Mancozeb seed treatment + soil drench	84.31	14.31	11.33	3.12	71.43	11.56	16.22	2.37
Control	58.26	6.35	42.12	1.22	53.41	7.41	51.92	0.97
SEm±	0.68	0.42	0.27	0.89	0.83	0.42	0.32	0.96
CV (%)	1.58	1.40	1.50	1.33	2.65	1.39	1.69	3.06
CD (0.05)	2.97	5.97	8.52	0.215	6.03	5.78	3.68	8.23
Interaction (MxV)	2.51	NS	1.39	0.24				

Trichoderma @4 g/kg was at par with the *T. harzianum* with that of mancozeb with reduction in disease by 27.49% and increase in yield over control by 19.1%.

3.6.5 Management of soft rot of ginger (biofumigation using cabbage) (Solan, Dholi, Pottangi, and Raigarh)

In the experiment on management of soft rot of ginger (cabbage biofumigation) at Solan, cabbage biofumigation increased germination and yield (8.5 kg/plot) by decreasing soft rot (2.25%) and bacterial wilt incidence. Metalaxyl mancozeb 72%WP increased germination and decreased incidence of soft rot (1.25%).

Among all the treatments T_1 soil treatment by bio fumigation using cabbage and T_2 rhizome treated by fungicides metalaxyl + mancozeb (72%WP) 1.25 g/l was found effective against this disease and incidence was lowest (4.7% and 5.5% respectively) as compared to control (23.4%) and this treatment gave a yield of 3.0 t/ha and 2.6 t/ha respectively at Raigarh.

At Pottangi, no significant difference for yield among different treatments for fresh rhizome yield was observed. Highest rhizome yield was obtained in T_2 (seed treatment with ridomil MZ) (18.2 t/ha) with 56% reduction in disease followed by T_1 (bio-fumigation with cabbage) (15.4 t/ha) with 44% less disease than control.

At Dholi, lowest PDI of bacterial wilt incidence (2.00), highest germination count (96.00%) and yield (9.58 t/ha) compared to control were registered where bio-fumigation of soil was done using cabbage (T_1) and T_5 ie. rhizome treated with endophytic bacterial antagonist (IISR GEB) respectively over control.

3.6.6 Management of soft rot of ginger (biofumigation using mustard) (Pundibari, Solan, Kumarganj and Raigarh)

Among all the treatments T_1 soil treatment by bio fumigation using mustard and T_2 rhizome treated by fungicides metalaxyl + mancozeb (72% WP) 1.25 g/l (commercial formulation) was found effective against this disease and incidence was lowest 5.05% and 6.95% respectively as compared to control (24.5%) and an yield of 2.8 t/ha and 2.6 t/ha respectively at Raigarh.

At Pundibari, it was observed that biofumigation using mustard (T_1) was the best treatment in reducing soft rot disease of ginger (7.48% disease). This treatment was closely followed by rhizome treatment with metalaxyl mancozeb (T_2) which recorded 9.06% soft rot disease incidence. These two treatments were statistically at par with each other in respect of soft rot disease incidence. T_1 produced highest yield of 6.05 kg/plot followed by T_2 which recorded 5.58 kg/plot yield. Lowest yield of 3.24 kg/plot was obtained by T_5 (Control). Minimum and maximum bacterial wilt disease incidence of 11.11% and 20.73% respectively was recorded in T_1 and T_5 (control) respectively. Very little leaf spot disease was found (10 – 14%). No shoot borer incidence was found.

In a field experiment on management of soft rot of ginger (biofumigation using mustard) at Solan, mustard biofumigation increased germination and managed bacterial wilt. Metalaxyl mancozeb 72% WP decreased soft rot (1.12%) and increased yield (7.687 kg/plot) significantly higher over other treatments followed by rhizobacterial and endophytic bacterial antagonist treatments.

Effect of biofumigation with mustard, fungicides and bio agents on ginger was studied to manage the soft rot disease in ginger at Kumarganj. Minimum incidence of soft rot (41.5%) and maximum disease control of 57.14% was observed when seed rhizomes were treated with metalaxyl and mancozeb 75% W.P. The treatment gave maximum fresh rhizome yield of 30.16 q/ha with an increase in yield of 110.02% over control. In this treatment lowest incidence of wilt (6.0%) and leaf spot (14.00%) were recorded. Yield produced by treatment of rhizomes with antagonistic bacteria (IISR-GEB) was next best treatment giving an yield of 24.78 q/ha (72.56% increase in yield over controls) (Table 16).

3.6.7 Management of bacterial wilt of ginger (biofumigation using mustard) (Dholi, Dapoli, Solan, Pundibari, Pottangi, Chintapalle and Kumarganj)

At Dapoli, highest germination count (51.00%) and lowest PDI of bacterial wilt incidence (48.00) with highest rhizome yield (5.08 t/ha) were recorded in soil treatment with bio-fumigation using mustard (T_1) and rhizome treated by endophytic bacterial antagonist (IISR-GEB) (T_5) respectively over control.

At Solan, biofumigation using mustard increased germination, decreased incidence of soft rot and bacterial wilt (2.12%) and increased yield (7.762 kg/plot). The rhizobacterial antagonist was also able to decrease the incidence of bacterial wilt (2.62%).

At Pundibari among the various treatments evaluated it was observed that biofumigation using mustard (T_1) was the best treatment in reducing bacterial wilt disease of ginger (7.53% disease). This treatment was closely followed by soil application with bleaching powder (T_2) which recorded 8.69% bacterial wilt disease incidence. These two treatments were statistically at par with each other in respect of bacterial wilt disease incidence. T_1 produced highest yield of 6.25 kg/plot followed by T_2 which recorded 6 kg/plot yield. Lowest yield of 3.01 kg/plot was obtained by T_6 (Control). Minimum and maximum soft rot disease incidence of 10.21% and 20.13% respectively was recorded in T_1 and T_6 (control) respectively. Very little leaf spot disease was found in the range of about 11 to 15%. No shoot borer incidence was observed.

There was no significance difference for yield among different treatments for fresh rhizome yield at Pottangi. Highest rhizome yield was obtained T_1 (bio fumigation with cabbage) (16.28 t/ha) with 43% reduction in wilt disease followed by T_2 (bleaching powder) (15.40 t/ha) with 43% reduction in disease.

At Dholi, among all the treatments maximum germination count (69.50%), minimum bacterial wilt incidence (PDI=30.00)

giving highest yield (6.96 t/ha) over control were recorded in soil treatment by bio-fumigation using mustard.

The observations revealed that among the five treatments ginger seed material treated with metalaxyl, mancozeb 72% WP (1.25g/l) recorded a germination count of 36.8 clumps out of 40 rhizomes planted, low soft rot incidence (16.2%), leaf spot incidence of (23.2%) and rhizome yield of 2.7 kg per plot at Chintapalle. This was followed by rhizome treatment with rhizobacterial antagonist with a germination count of 37.3 clumps out of 40 rhizomes planted, low soft rot incidence (16.8%), leaf spot incidence of (13.8%) and rhizome yield of 3.0 kg per plot were recorded. Ginger beds were highly affected by soft rot disease with 38% and leaf spot incidence of 37.6 % with low rhizome yield of 0.9 kg per plot in absolute control (Table 17).

At Kumarganj, lowest incidence of wilt (6.00%) and leaf spot (14.00%) was also observed in (T₂) treatment with maximum yield of 30.14 q/ha (Table 16).

3.6.8 Management of bacterial wilt of ginger (bio-fumigation using cabbage)

(Dapoli, Dholi, Pottangi and Solan)

In an experiment on management of bacterial wilt of ginger using biofumigation using cabbage at Dapoli, highest germination count (47.00%) with lowest bacterial wilt incidence (PDI=4.00) with highest yield (4.67t/ha) was recorded in the soil treatment by bio-fumigation using cabbage (T₁).

Highest germination count (47.00%) with lowest bacterial wilt incidence (PDI=4.00) giving consequently highest yield (4.67t/ha) were recorded in the soil treatment by bio-fumigation using cabbage (T₁) at Dholi.

There was no significance difference for yield among different treatments for fresh rhizome yield at Pottangi. Highest rhizome yield was obtained T₁ (bio fumigation with cabbage) (16.28 t/ha) with 43 % reduction in wilt disease followed by T₂ (bleaching powder) (15.40 t/ha) with 43% reduction in disease.

Table 16. Effect of bio-fumigation, fungicides and bio-agents on the incidence of diseases and yield in ginger at Kumarganj

Treatment	Germination (%)	Soft rot incidence	Wilt incidence	Leaf spot incidence	Yield (q/ha)	Percent decrease in soft rot over control	Percent decrease in bacterial wilt over control	Percent decrease in leaf spot incidence over control	Percent increase in yield over control
T ₁ Soil fumigation using mustard	59.00	60.50	7.50	16.00	15.32	12.31	46.42	34.69	6.68
T ₂ Rhizome treatment by metlaxyl-mancozeb 75 % W.P.	67.00	41.50	6.00	14.00	30.16	39.85	57.14	42.85	110.02
T ₃ Rhizome treatment by antagonist (IISR- GRB)	70.00	49.00	9.00	17.50	24.78	28.98	35.71	28.57	72.56
T ₄ Rhizome treatment by endophytic bacteria (IISR- GEB).	61.50	58.50	8.50	18.00	20.20	15.21	39.28	26.53	40.66
T ₅ Absolute control	51.00	69.00	14.00	24.50	14.36	-	-	-	-
SEm ±	3.33	1.67	0.88	1.42	0.93				
CD (P=0.05)	10.06	5.36	2.80	4.28	2.98				
CV (%)	9.45	6.60	24.64	13.67	10.10				

Table 17. Effect of bio-fumigation, fungicides and bio-agents on the incidence of diseases and yield in ginger at Chintapalle

Treatment	Germination count	Soft rot incidence	Bacterial wilt incidence	Shoot borer incidence	Leaf spot incidence	Rhizome yield	Mustard biomass/bed in kg (Before bio fumigation)
T1 Soil treatment by bio-fumigation using mustard	32.0	24.3	0	0	21.2	2.1	2.4
T2 Rhizome treatment by metalaxyl, mancozeb 72% WP (1.25g/l of commercial formulations).	36.8	16.2	0	0	23.2	2.6	2.7
T3 Rhizome treatment by rhizobacterial antagonist	37.3	16.8	0	0	13.8	2.4	3.0
T4 Rhizome treatment by entophytic bacterial antagonist	37.0	17.8	0	0	20.0	2.2	2.9
T5 Absolute control	27.8	38.0	0	0	37.6	0.9	2.8
SEm ±	1.6	1.6	-	-	1.1	0.1	0.2
CV (%)	7.7	14.1	-	-	9.7	1.38	0.48
CD (P=0.05)	2.53	2.9	-	-	2.5	0.3	0.6

At Solan biofumigation using cabbage decreased incidence of bacterial wilt (1.12%) and increased germination and yield (9.3 kg/plot) of ginger. It was followed by rhizobacterial antagonist but was significantly different from the former.

4. TURMERIC

4.1 Genetic Resources

4.1.1 Germplasm collection, characterization, evaluation and conservation

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

At Coimbatore during 2007-08 four more collections from IISR, Calicut viz., Suguna, Sudarshana, Prabha and IISR Prathiba were added and the total of 271 types were evaluated during 2008-09. The yield ranged from 6.0 to 13.50 kg/3m². Among the 271 accessions evaluated 107 accessions recorded yield above the mean yield of 9.12 kg/3 m².

Among ninety germplasm of turmeric maintained at Dholi, only seventeen accessions namely, RH-9/90, RH-9/80, RH-404, RH-405, RH-413, RH-9/90, TCP-2, RH-24, RH-9, G.L.Puram, RH-50, RH-415, RH-410, RH-402, RH-13/90, RH-2/80 and RH-407 were identified as high yielders compared to check RH-5 and Rajendra Sonia. Among seventeen promising accession,

RH-9/90 and RH-8/90 produced maximum yield (20.83 kg/3m²) followed by RH-404 (20.20 kg/3 m²).

Among the germplasm accessions, CLI-317 recorded highest rhizome yield (20.66 t/ha) followed by PTS-52 (17.99 t/ha) at Jagtial.

Out of 31 early maturing accessions evaluated at Kumarganj, the yield ranged from 195.30 q/ha (NDH-52) to 422.51 (NDH-98) q/ha. Among 60 medium maturing accessions yield ranged from 160.40 q/ha (NDH-25) to 355.20 q/ha (NDH-14). However, in late maturing 36 lines yield ranged from 205.10 q/ha in NDH-63 to 350.30q/ha in NDH-9.

At Pottangi, out of total 199 turmeric accessions, 179 were evaluated in two replications. Among 173 accessions evaluated during the year, 155 were *Curcuma longa*, 20 were *C. aromatica* and 4 were *C. amada*. The range in fresh rhizome yield/3 m² in *C. longa* varied from 5.4 kg to 11.3 kg and thirty two accessions gave more than 10.0 kg/3m². High yielders were PTS-41 (11.3 kg/3 m²), PTS-51 (11.0 kg/3 m²) and TU No.6 (10.7 kg/3m²). In *C. aromatica* the range in fresh rhizome yield varied from 6.1 kg/3 m² to 8.8 kg/3 m² and five accessions gave more than 7.0 kg/3m². High yielders were *Chaya Pasupu-II* (8.8 kg/3m²). Out of four *C. amada* types, the range in yield was 7.6 kg/3 m² to 12.9 kg/3 m².

Evaluation of turmeric germplasm at Pundibari indicated that accession TCP-7 was the tallest (162.43 cm) whereas, TCP-54 was the shortest with a height of 74.73 cm. TCP-50 recorded highest number of tillers (5.33). Highest number of leaves and maximum pseudostem girth was recorded in TCP-6 (11.93) and TCP-48 (11.43 cm) respectively. Rhizome yield of individual plant (clump weight) was maximum in TCP-66 (560.80 g). Considering plot yield and projected yield TCP-162 (72.58 tons/ha), TCP-3 (64.51 tons/ha each), TCP-15, TCP-66, TCP-170 (52.42 tons/ha each), TCP-165 (48.38 tons/ha), TCP-67 (38.30 tons/ha), TCP-79 and TCP-90 (36.29 tons/ha each) recorded significantly higher rhizome yield. A total of 9 genotypes out yielded the local check TCP-2 (34.27 t/ha).

Among all the entries evaluated during 2008-09 at Raigarh, IT-3 (11.05 t/ha), IT-7 (10.45 t/ha), IT-20 (9.04 t/ha), IT-21 (9.04 t/ha), IT-23 (9.04 t/ha) and IT-31 (11.25 t/ha) were found superior in respect of yield when compared to check variety Prabha (9.04 t/ha). The germplasm of turmeric maintained at various AICRPS centres is given in Table 18.

Table 18. Turmeric germplasm collections in AICRPS centres

Centre	Indigenous		Total
	Cultivated	Wild and related sp.	
Coimbatore	264	7	271
Dholi	90	2	92
Jagtial	273	-	273
Kumarganj	130	-	130
Pottangi	199	-	199
Pundibari	152	18	170
Raigarh	42	3	45
Solan	132	-	132
Total	1282	30	1312

4.2 CVT-2004-Series VI

4.2.1 Coordinated varietal trial

(Chintapalle, Coimbatore, Jagtial, Kumarganj, Pottangi and Raigarh)

Out of 13 promising turmeric cultivars tested at Chintapalle, PTS-34 (75.3 cm) and PTS-39 (74.9 cm) have recorded maximum plant height. Chintapalle local variety recorded maximum number of tillers (4.3 tillers/plant). Among the 13 varieties evaluated PTS-39 recorded maximum fresh rhizome yield (32.44 t/ha) followed by TCP-11 (27.44 t/ha), whereas TCP-82 recorded the lowest yield (9.44 t/ha).

The accessions obtained from different coordinating centers were evaluated for their growth and yield parameters at Coimbatore centre and the results revealed that, the yield ranged from 6.50 kg/plot to 11.98 kg/plot (3m²). Highest yield of 11.98 kg/plot was registered by PTS 34 followed by TCP 82 and CL 101 (11.80 & 11.08 kg/plot) respectively. The national check recorded a yield of 8.68 kg/plot. The pooled analysis revealed that the yield ranged from 9.77 kg/plot to 16.73 kg/plot. The highest yield of 16.73 kg/plot was registered by NDH 9 from Kumarganj. It was on par with PTS 34 (16.39 kg/plot)

from Pottangi and CL 101 (16.29 kg/plot) from Coimbatore. The percentage increase over check is 42.26, 39.37 and 38.52 per cent by NDH 9, PTS 34 and CL 101 respectively. The weight of the primary rhizomes was higher for genotypes PTS 34 (269.86 g) and NDH 9 (269.37 g) which would have contributed to higher rhizome yield. The weight of the secondary rhizome was highest in CL 101 (126.76 g). Hence among the twelve genotypes evaluated NDH 9, PTS 34 and CL 101 may be considered as suitable to grow under Tamil Nadu conditions.

During the year 2008-09, out of twelve entries tested, PTS-59 has recorded more fresh rhizome yield (29.9 t/ha) followed by NDH-9 (28.8 t/ha) in comparison to Duggirala Red check variety (29 t/ha) at Jagtial centre.

Among the sixteen entries evaluated at Kumarganj, highest yield of 281.111 q/ha fresh rhizome yield was recorded in entry IT-2 followed by the check variety Prabha (277.77 q/ha). Rest of the entries was found inferior in comparison to

check variety Prabha. Pooled analysis of three years yield data indicated that NDH-9 produced maximum fresh rhizome yield of 298.38 q/ha followed by CL-101 yielding 277.53 q/ha and was at par with check Prabha.

There was significant difference in the fresh rhizomes yield among cultivars evaluated at Pottangi centre. Highest fresh rhizome yield was recorded by PTS-39 (25.43 t/ha) followed by PTS-11 (24.68 t/ha) and PTS-4 (24.33 t/ha) (Table 19).

TCP-11 (20.26 t/ha) and TCP-82 (18.82 t/ha) were identified as high yielders at Raigarh centre based on the analysis of three years yield data (Table 20).

4.3 Varietal evaluation trial

4.3.1 Comparative yield trial 2005-06

(Jagtial and Pottangi)

Out of 10 promising turmeric cultures tested during 2007-08 at Jagtial, JTS-401 has recorded high fresh rhizome yield (31.02 t/ha) followed by JTS-402 (29.7 t/ha). The check variety PCT-13 recorded a fresh rhizome yield of 23.1 t/ha.

There was significant difference in fresh rhizomes yield among cultivars at Pottangi centre. Highest fresh rhizome yield

Table 19. Pooled yield of CVT -2004 turmeric at Pottangi

Treatment	Plot yield (kg/3m ²)					Projected yield (t/ha)	Increase over control (%)	Dry yield (t/ha)
	2005	2006	2007	2008	Mean			
PTS-39	11.53	12.3	12.6	10.2	11.06	25.43	29.28	5.8
PTS-11	11.20	11.6	12.2	9.8	10.73	24.68	25.47	5.7
PTS-4	11.20	11.6	12.8	9.3	10.58	24.33	20.20	5.5
PTS-34	10.13	11.2	11.8	10.2	10.62	24.43		
NDH-18	6.73	9.7	18.2	6.8	8.05	18.41		
NDH-14	6.76	9.1	10.6	7.2	8.01	18.42		
NDH-9	7.47	10.2	9.7	6.0	7.56	17.39		
RH-9-90	7.50	9.3	9.6	5.0	7.10	16.33		
RH-13-90	6.73	8.8	9.2	6.2	7.22	16.61		
TCP-11	7.90	9.2	8.5	6.4	7.45	17.14		
TCP-56	7.96	9.6	8.7	6.1	7.43	17.08		
TCP-82	8.06	8.2	8.6	5.7	6.99	16.08		
Roma	8.60	9.1	9.0	8.2	8.55	19.67		
Suroma	9.70	10.1	10.2	8.1	9.05	20.82		
Alleppey	7.00	8.6	9.4	7.0	7.67	19.63		
CD (P = 0.05)	1.02	1.8	1.7	2.3	1.70	3.93		

Table 20. Pooled yield of CVT - 2004 turmeric at Raigarh

Entry	Yield (t/ha)				Pooled
	(2005-06)	(2006-07)	(2007-08)	(2008-09)	
IT-1	14.94	15.61	13.66	8.04	13.06
IT-2	17.29	16.35	15.27	9.04	14.48
IT-3	16.41	12.93	12.66	15.27	14.31
CL-147	5.83	14.74	13.86	14.87	12.32
TCP-82	21.95	18.56	15.27	19.53	18.82
TCP-11	21.74	20.71	17.48	21.12	20.26
TCP-56	13.35	16.68	14.67	16.80	15.37
NDH-9	12.91	13.67	11.05	14.47	13.02
PTS-34	8.72	11.93	10.85	15.27	11.69
PTS-39	9.95	12.26	12.46	11.25	11.48
RH 9/90	14.68	15.81	14.47	5.4	12.59
RH 13/90	12.10	13.87	13.06	16.48	13.87
CL 101	-	8.58	13.46	7.63	9.89
Prabha (Check)	11.79	17.22	14.87	13.46	14.33
CD (P = 0.05)					4.84
CV (%)					21.49

was recorded by PTS-47 (23.23 t/ha) followed by PTS-39 (23.12 t/ha).

4.3.2 Initial evaluation trial

(Pottangi, Kumarganj and Pundibari)

At Pottangi, significant difference was observed among the cultivars for fresh rhizome yield. Highest fresh rhizome yield was recorded by PTS-3 (23.66 t/ha) followed by VK-9(23.66 t/ha).

Maximum yield was recorded in entry NDH-79 (326.63 q/ha) followed by NDH-68 (317.76 q/ha) at Kumarganj. Pooled data indicated that NDH-18 (check) recorded maximum fresh rhizome yield (356.05 q/ha) followed by NDH-79 (326.63 q/ha).

In IET of turmeric at Pundibari, a wide range of variability was found among the genotypes for different yield characters. In respect of the trait weight of mother clump, TCP-129 recorded the highest value (11.67 g). In respect of number of

clumps per mother rhizome, TCP-02 showed the highest and TCP-119 lowest value (1.47 and 1.07 respectively). TCP-64 recorded highest value for the trait length of mother clump (2.30 cm), number of primary fingers, (5.20) weight of primary fingers (94.96 g), length of primary fingers (2.57 cm), number of secondary fingers (14.16) and clump weight/plant recorded by TCP-64 (184.93 g). In respect, weight of secondary fingers, TCP-97 recorded the highest weight (52.40 g). In respect of plot yield (kg/3m²) and the projected yield (t/ha), TCP-129 recorded the highest mean value (11.67 kg and 23.52 t/ha, respectively), closely followed by TCP-64 (11.33 kg and 22.85 t/ha, respectively); both the genotypes out yielded TCP-2, the local check.

4.4 Quality evaluation trial

4.4.1 Quality evaluation of germplasm

(Coimbatore)

Screening of 26 germplasm lines at Coimbatore revealed that the highest curcumin content of 3.63 per cent was recorded by CL 101, highest oleoresin content of 12.5% was registered by CL 213 and the highest essential oil content of 4.14 was recorded by the accession CL-20.

4.4.2 Genotype x Environment interaction on quality of turmeric

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

Total of 11 genotypes obtained from different centres were evaluated during 2008-09 at Coimbatore. Megha turmeric obtained from Meghalaya did not establish. The yield of genotypes varied from 18.61 t/ha (IISR Prathiba) to 32.13 (IISR Alleppy Supreme). The curcumin content ranged from 2.87% (IISR Prathiba) to 6.07 (Narendra Haldi). Regarding the oleoresin content it varied from 7.70% (IISR Alleppy supreme) to 15.30% in Roma.

Among the nine genotypes tested at Jagtial, Roma recorded the highest rhizome yield (17.49 t/ha) followed by Rasmi (15.60

t/ha) and the lowest rhizome yield was observed in CL – 317(7.06) (Table 21).

Among all the eleven genotypes evaluated by Dholi centre, Rajendra Sonia produced significantly more yield (24.83 kg/3 m² and 82.78 t/ha) as compared to other genotypes in the climatic condition in Bihar. Roma, Rasmi and BSR-2 were tall types (146.00, 144.40 and 127.47 cm respectively) as compared to other genotypes. Rajendra Sonia was early maturing (212.00 days) when compared to all genotypes.

At Pottangi, significant difference among the cultivars was recorded for fresh rhizome yield. Highest fresh rhizome yield was recorded by Roma (20.24 t/ha) followed by Rasmi (18.86 t/ha).

At Raigarh, Suranjana was found best (24.92 t/ha) followed by BSR-2 (20.90 t/ha) for yield t/ha.

At Kumarganj, maximum yield was recorded in variety BSR-2 (284.44 q/ha) followed by NDH-18 (273.33 q/ha) and Rajendra Sonia (270.10 q/ha) while lowest yield was found in variety CLI-317 (189.99 q/ha).

At Pundibari, the mean values of growth and yield parameters of the different genotypes of turmeric for 2008-09. Analysis of data showed that the genotype TCP-2 (95.54 cm) achieved highest plant height followed by Megha Turmeric (89.61 cm). Rajendra Sonia was the shortest in height (63.16 cm). Highest tiller number was recorded by the genotype Narandra Haldi-1 (4.47) where as lowest by IISR Kedaram (2.43). TCP-2 showed the highest clump weight (464.27 g) followed by Narendra Haldi-1 (335.53 g) and IISR Pratibha recorded the lowest clump weight (268.33 g). Highest rhizome yield per plot was recorded by TCP-2 (15.17 kg) followed by Rajendra Sonia (13.17 kg) and the lowest value was recorded by Duggirala Red (8.08 kg). In respect of projected yield TCP-2 showed the highest value (30.58 t/ha) followed by Rajendra Sonia (26.54 t/ha) and lowest projected yield was recorded in Duggirala Red (16.30 t/ha).

The variety Roma recorded maximum plant height (113.4 cm) followed by Megha turmeric (112.5 cm) where as variety

Table 21. Impact of environment on plant growth parameters and fresh rhizome yield at Jagtial

Genotype	Plant height (cm)	Number of tillers	Leaf length (cm)	Leaf width (cm)	Rhizome yield/plant (kg)	Rhizome yield/plot (kg)	Fresh rhizome yield t/ha
Megha Turmeric	65.0	2.6	41.8	12.06	0.36	2.21	7.36
IISR Kedaram	66.4	3.4	46.8	12.40	0.40	2.37	7.89
CL-317	63.3	3.2	46.4	11.80	0.40	2.12	7.06
BSR-2	68.1	2.2	45.4	11.80	0.30	2.40	7.99
Suranjana	45.4	1.2	39.6	10.80	0.33	2.20	7.33
Rajendra sonia	53.2	2.0	44.8	11.50	0.30	3.10	10.33
Roma	63.8	3.0	42.2	11.60	0.30	5.25	17.49
Rasmi	70.7	3.6	38.1	13.20	0.50	4.70	15.60
NH-1	54.5	2.9	31.1	11.50	0.45	2.70	8.90
S Em+	3.418	0.131	1.134	0.27	0.07	0.363	
CD (P=0.05)	10.33	0.397	3.42	0.83	NS	1.098	
CV (%)	9.68	8.06	5.413	4.00	4.28	8.24	

Suranjana recorded lowest plant height at Chintapalle centre. Variety Rasmi recorded maximum number of tillers per plant (5.3 nos.) whereas variety Suranjana recorded lowest number of tillers per plant (2.7).

At full vegetative growth stage, Megha turmeric recorded maximum plant height (111.9 cm) and leaf area (55.1 cm x 15.1 cm) while Roma had maximum number of tillers (8.8) closely followed by Megha turmeric (8.5) at Barapani. IISR Pratibha recorded highest dry recovery (27.4%) followed by Rasmi (26.1%) and IISR Kedaram (25.5%). Suranjana was found to be the highest yielder (46.87 t/ha) and lowest was recorded in Roma (23.76 t/ha). The curcumin content was found highest in Megha turmeric (8.53%) closely followed by IISR Kedaram (8.51%), whereas, least curcumin was found in BSR-2 and Rasmi 4.45% and 4.50%, respectively.

The impact of genotype X environment on the curcumin content of turmeric varieties evaluated at various centres are furnished in Table 22.

4.5 Nutrient Management Trial

4.5.1 Organic farming in turmeric

(Pundibari, Pottangi and Coimbatore)

Application of integrated nutrients on turmeric (T₂) produced highest clump weight of 338.08 g and highest yield

of 12.57 kg per 3 m² plot at Pundibari. This treatment produced 9.2% oleoresin, but the highest oleoresin of 10.6% was produced by application of organic nutrients on turmeric (T₁).

There was significant difference among the cultivars for fresh rhizome yield at Pottangi. Highest fresh rhizome yield was recorded by T₃ (fully in-organic) (23.58 t/ha) with CB ratio of 1:1.52 (Table 23).

At Coimbatore the pooled analysis of the three years data revealed that the treatment T₃ (fully inorganic) recorded significantly higher yield (13.60 kg/plot) than T₁ (fully organic) 6.73 kg/plot but was on par with the T₂ (integrated) treatment (11.08 kg/plot). Though the treatments were not significantly different in most of the characters observed significant difference was observed for secondary rhizome number. The C: B ratio was highest for the organically produced turmeric (1: 1.8) when compared to integrated (1: 1.5) and fully organic (1:1.4) (Table 24). The microbial population in the soil was also higher for both *Azospirillum* (2.8×10^5 cfu/g dry weight of soil) and phosphobacteria (5.94×10^3 cfu/g dry weight of soil) in the integrated treatment which had led to the availability of nitrogen and phosphorus more to the plant and which in turn increased the yield.

Trial on organic farming in turmeric was laid out for the second year at Coimbatore during 2008-09. The treatment T₃

Table 22. Curcumin content of turmeric grown in different locations

Accession	Curcumin (%)					
	Mizoram	Calicut	Jagtial	Pundibari	Kumarganj	Pottangi
IISR-Kedaram	3.9	4.9	1.3	2.2	3.9	3.6
Rajendra Sonia	3.5	4.0	1.3	1.7	4.1	4.0
Rasmi	2.8	6.3	1.1	2.7	2.3	
Suranjana	2.1	3.1	1.4		3.2	4.4
IISR- Aleppy Supreme	4.3	3.7	NA	2.0	3.3	3.6
Narendra Haldi-I	3.3	4.5	1.2	2.3	3.4	3.2
Roma	2.3	3.9	1.3	1.3	2.6	2.8
Duggirala	3.1	4.1	NA	2.2	NA	2.8
RCT-I (Mega Turmeric-I)	2.7	4.4	1.0	2.5	3.2	2.4
BSR-2	2.6	4.7	1.4	2.3	2.8	3.6
IISR-Prathiba	3.3	5.4	NA	2.6	2.9	3.2
CLI-317	NA	NA	1.6	NA	4.0	NA
TCP-2	NA	NA	NA	1.7	NA	NA
Ranga	NA	NA	NA	NA	NA	3.2

Table 23. Pooled yield of turmeric under organic farming at Pottangi

Treatment	Fresh rhizome yield (kg/3m ²)				Projected yield (t/ha)	CB ratio
	2006	2007	2008	Mean		
T ₁ -Organic	8.4	8.2	7.1	7.70	17.71	
T ₂ - Integrated	10.2	10.4	7.8	9.05	20.82	
T ₃ - Inorganic	11.6	12.2	8.6	10.25	23.58	1:1.52
CD (P=0.05)	NS	1.2	1.2			

(fully inorganic) recorded the highest yield of 12.5 kg/3m² plot followed by T₂ (integrated) which was on par with 12.4 kg/3m² plot. The treatment T₁ (Fully organic) recorded a yield of 9.2 kg/3m² plot.

ha FYM (T₁), inorganic nitrogen 75% + *Azospirillum* + 5 t/ha FYM (T₂) and inorganic nitrogen 50% + *Azospirillum* + 5 t/ha FYM (T₃), FYM-10 t/ha + *Azospirillum* (T₄) and FYM-10 t/ha alone (T₅) gave significantly better performance as compared

Table 24. Organic farming in turmeric (pooled data) at Coimbatore

Treatment	Mother rhizome number	Mother rhizome weight (g)	Primary rhizome number	Primary rhizome weight (g)	Secondary rhizome number	Secondary rhizome weight (g)	Yield/plot (kg) 3m ²	C:B
T ₁ - Organic	3.03	87.53	9.96	261.04	9.49	131.09	6.73	1:1.8
T ₂ - Integrated	2.97	91.71	10.62	250.10	9.06	135.69	11.08	1:1.5
T ₃ - Inorganic	3.37	84.78	10.04	249.30	10.26	175.40	13.60	1:1.4
SED	2.15	28.33	35.63	65.32	0.03	571.30	3.27	
CD (P=0.05)	4.32	58.98	71.64	131.34	0.06	1148.80	6.58	

Among three treatments, fully organic (T₁) and integrated fertilizer management of organic and inorganic (T₂) gave significantly better performance regarding height of the plant, number of branches per plant, number of leaves per tiller and yield per plot or per hectare as compared to fully inorganic (T₃) at Dholi centre. However, integrated fertilizer management of organic and inorganic (T₂) produced the maximum plant height (132.77 cm), number of tiller per plant (5.63), number of leaves per tiller (10.85) and yield per plot (20.50 kg/3 m²) or per hectare (68.33 t/ha) followed by fully organic (T₁).

4.5.2 Effect of organic farming on turmeric (Adaptive Research) (Dholi and Raigarh)

At Dholi, all the treatments of soil application produced significantly more number of tillers and yield per plot as compared to control except soil application of vermicompost 20 q/ha alone (T₂), FYM-30 t/ha + 8 q/ha neem oil cake (T₃) and 20 q/ha vermicompost + neem oil cake (T₄). However, among the significant treatment of organic fertilizer, soil application of FYM-30 t/ha + 20 t/ha vermicompost + 8 t/ha neem oil cake produced the maximum plant height (126.00 cm), number of tillers per plant (5.47), number of leaves (14.67) and yield per plot (18.07 kg/3 m²) and yield per hectare (60.22 t/ha) followed by soil application of FYM-30 t/ha + 15 t/ha vermicompost + 8 q/ha neem oil cake (T₈).

Among all the treatments evaluated at Raigarh, recommended dose of fertilizers (150:100:120 NPK kg/ha) gave maximum yield of 20.50 t/ha (T₁₅). Next best treatments was T₁₀ (FYM 20 t/ha + ½ the recommended dose of NPK + soil application of *Pseudomonas fluorescens* (50 g) and T₁₁ (FYM 20 t/ha + ½ the recommended dose of NPK + soil application of *T. viride*) gave 19.95 t/ha and yield 18.89 t/ha respectively and all the three treatments were statistically at par.

4.5.3 Effect of bio-fertilizers *Azospirillum* on turmeric (Adaptive Research) (Dholi and Kumarganj)

Among eight treatment including control, soil application of inorganic nitrogen 100% + *Azospirillum* + 5 t/ha

to control at Dholi centre. However, among the treatments, soil application of inorganic nitrogen 100% + *Azospirillum* + 5 t/ha FYM (T₁) gave maximum height of the plant (129.40 cm), number of tillers per plant (6.70) and yield per plot (20.25 kg/3 m²) or yield per hectare (67.50 t/ha) followed by inorganic nitrogen 75% + *Azospirillum* + 5 t/ha FYM (T₂).

At Kumarganj, among the four treatments highest fresh rhizome yield of 275.23 q/ha was recorded in treatment of 50% recommended dose of inorganic fertilizer (60:40:40 kg NPK/ha) + 50% FYM (10 t/ha) + application of 5 kg/ha of *Azospirillum* + seed treatment and soil application of *P. fluorescens* + *Trichoderma* @ 50 g/3m² (T₃) followed by fresh rhizome yield of 265.71 q/ha in T₁ treatment by application of 100 % recommended dose of fertilizer @ 120:80:80 kg NPK/ha. Pooled data analysis indicated that maximum yield of fresh rhizome 320.67 q/ha was obtained in treatment T₄ by application of 100% FYM (20 t/ha) + *Azospirillum* (5 kg/ha) + seed treatment and soil application *P. fluorescens* + *Trichoderma* (50 g/3m).

4.5.4 Effect of micronutrient in turmeric variety Roma (Pottangi)

At Pottangi, significant difference in fresh rhizomes yield was observed among cultivars. Highest fresh rhizome yield (18.86 t/ha and 30.86% increase over check) was recorded by T₁₄ (soil application as basal 25 kg/ha each of ZnSO₄ and Borax) followed by by T₁₅ (Zn, Bo and 0.5% Fe as foliar spray) with an yield of 18.11 t/ha (24.82 % increase over check) (Table 25).

4.6 Disease Management Trial

4.6.1 Survey and identification of disease causing organisms in turmeric and screening of turmeric germplasm against diseases (Coimbatore, Dholi, Pundibari and Raigarh)

Out of 271 turmeric germplasms evaluated at Coimbatore, the turmeric accessions viz., CL 36 and CL 54 were highly resistant to leaf spot (4 PDI) and the accessions viz., CL 1, CL 5, 16, 33, 45, 53 and CL 230 were found to be resistant to leaf

Table 25. Effect of micronutrients on yield of turmeric at Pottangi (Pooled data)

Sl. no	Treatment	Yield (kg/3m ²)					Projected yield (t/ha)	Increase over control (%)
		2005	2006	2007	2008	Mean		
T ₁	Zn ₀ BO ₀ Feo	6.73	6.6	6.0	6.6	7.31	16.81	
T ₂	Zn ₀ BO ₀ Fe ₂₅	6.60	7.0	7.1	7.1	7.89	18.14	
T ₃	Zn ₀ BO ₀ Feo _{0.5}	6.73	6.6	6.8	7.1	7.8	17.94	
T ₄	Zn ₀ B ₂₅ Feo	6.57	6.7	7.2	7.2	7.96	18.31	
T ₅	Zn ₀ B ₂₅ Fe ₂₅	6.63	7.4	7.3	8.1	8.68	19.95	
T ₆	Zn ₀ B ₂₅ Fe _{0.5}	6.60	7.2	7.1	7.5	8.28	19.03	
T ₇	Zn ₀ B _{0.5} Feo	6.53	6.7	6.6	7.1	7.65	17.50	
T ₈	Zn ₀ B _{0.5} Fe ₂₅	6.63	7.2	7.0	7.4	8.34	19.17	
T ₉	Zn ₀ B _{0.5} Fe _{0.5}	6.50	7.0	6.8	7.2	7.99	18.37	
T ₁₀	Zn ₂₅ Bo Feo	6.86	7.4	7.1	7.4	7.85	18.06	
T ₁₁	Zn ₂₅ Bo Fe ₂₅	7.27	7.7	7.2	7.7	8.4	19.32	
T ₁₂	Zn ₂₅ Bo Fe _{0.5}	6.83	7.1	6.9	7.6	8.25	18.98	
T ₁₃	Zn ₂₅ B ₂₅ Feo	7.63	7.6	6.7	8.1	8.76	20.15	19.87
T ₁₄	Zn ₂₅ B ₂₅ Fe ₂₅	8.06	9.4	9.1	8.8	9.58	22.02	30.0
T ₁₅	Zn ₂₅ B ₂₅ F _{0.5}	7.76	8.67	8.7	9.1	9.76	22.45	33.55
T ₁₆	Zn ₂₅ B _{0.5} Fo	8.0	8.2	6.6	7.6	8.39	19.29	
T ₁₇	Zn ₂₅ B _{0.5} F ₂₅	7.5	8.0	7.2	8.4	9.3	21.39	27.25
T ₁₈	Zn ₂₅ B _{0.5} F _{0.5}	7.3	7.0	7.4	7.5	8.69	19.98	
T ₁₉	Zn _{0.5} Bo Fo	6.8	7.1	6.8	7.2	7.7	17.71	
T ₂₀	Zn _{0.5} B ₀ F ₂₅	6.8	7.1	7.4	8.1	8.24	18.94	
T ₂₁	Zn _{0.5} Bo F _{0.5}	6.63	7.0	6.9	7.3	7.76	17.85	
T ₂₂	Zn _{0.5} B ₂₅ Fo	6.47	8.2	7.0	7.6	8.56	19.69	
T ₂₃	Zn _{0.5} B ₂₅ F ₂₅	7.43	7.3	7.4	7.8	8.54	20.48	21.83
T ₂₄	Zn _{0.5} B ₂₅ F _{0.5}	7.63	6.7	6.8	7.4	8.19	18.83	
T ₂₅	Zn _{0.5} B _{0.5} Fo	6.08	7.6	6.8	7.4	7.98	18.34	
T ₂₆	Zn _{0.5} B _{0.5} F ₂₅	6.63	7.4	7.1	7.4	8.25	18.98	
T ₂₇	Zn _{0.5} B _{0.5} F _{0.5}	6.33	1.2	6.7	7.2	8.10	18.63	
C.D (P=0.05)				1.02	0.98	1.07	2.46	

spot. In the case of leaf blotch, the accessions viz., CL.68, 22, 36, 54, 80 and 101 were highly resistant and the leaf blotch intensity was less as compared to leaf spot intensity.

Among 91 germplasm of turmeric screened against disease at Dholi, none of the germplasm was found to be highly resistant, while accession 32 and 30 were found resistant and moderately resistant respectively against *Taphrina* leaf spot. Survey indicated that majority of the turmeric cultivated in Samastipur and Muzaffarpur districts were found to be affected with leaf spot caused by *Taphrina maculans*.

A survey was conducted by Pundibari centre in 2 blocks of Coochbehar (Coochbehar I and II) and some places of Dinhata of Coochbehar district to identify the diseases occurring in the area and to assess the severity of different

diseases of turmeric in this area. Three major diseases of turmeric were found to be prevalent in this area, namely, leaf blotch (*Taphrina* spp.), *Colletotrichum* leaf spot (*Colletotrichum* spp.) and *Helminthosporium* leaf spot (*Helminthosporium* sp.). In the survey it was found that leaf blotch disease severity was highest in Coochbehar I block (average 34.47%) followed by Coochbehar II block (average 31.08%) and Dinhata (average 29.11%). Regarding leaf spot of turmeric it was found that disease severity is highest in Coochbehar II block (average 32.75%) which was followed by Coochbehar I block (average 28.67%) and Dinhata (average 25.22%). Screening of the collected germplasm was done against both leaf blotch and leaf spot diseases of turmeric. The germplasm accessions TCP 42, 56 and 121 were resistant against leaf blotch disease and TCP 11 and 20 were resistant against leaf spot disease.

At Raigarh, TCP-11 was found resistant to *Colletorichum* leaf spot and *Taphrina* leaf spot. TCP-56 and TCP- 82 was found resistant to both the diseases.

4.6.2 Management of foliar disease in turmeric (Coimbatore, Jagtial, Dholi, Raigarh, Kumarganj, Pundibari, Pottangi and Chintapalle)

At Coimbatore, the leaf spot intensity was less in T6 treatment (20.67 PDI) ie foliar spray with propiconazole (0.1%) on 45 and 90 days and this treatment was on par with treatment T8 (22 PDI), T4 (rhizome treatment with carbendazim + mancozeb (0.1%) + foliar spray on 45 and 90 days recorded

the maximum CB ratio of 1:3.2. In the case of leaf blotch, the intensity was less in all treatments as compared to leaf spot. The lowest intensity of 8.67 PDI was recorded in T6 treatment which was on par with T4, T1, T3 and T7. Rhizome rot was absent in all the treatments (Table 26).

At Jagtial there was significant effect of chemicals on rhizome germination and disease index of both leaf spot and leaf blotch. Rhizomes treated with tricyclozole (0.1%) + foliar spray of tricyclozole (0.1%) on 45 and 90 DAP recorded the highest germination (91.7%) which was followed by rhizome treatment with carbedazim + mancozeb (0.1%) + foliar spray of carbedazim + mancozeb (0.1%) on 45 and 90 DAP (90.1)

Table 26. Management of foliar diseases in turmeric at Coimbatore

Treatment	Germination (%)	Disease Intensity (PDI)				Plot yield (kg)	Yield (t/ha)	C:B ratio
		Leaf spot (PDI)	Disease reduction over control (%)	Leaf blotch (PDI)	Disease reduction over control (%)			
T1 - Rhizome treatment with hexaconazole (0.1%) + foliar spray- hexaconazole (0.1%) on 45 and 90 days	59.20	30.00	43.04	10.67	30.40	11.6	23.2	1:2.2
T2 - Rhizome treatment with propiconazole (0.1%) + foliar spray- propiconazole (0.1%) on 45 and 90 days	59.70	28.67	45.56	12.68	17.29	14.0	28.0	1:2.6
T3 - Rhizome treatment with tricyclozole (0.1%) + foliar spray-tricyclozole (0.1%) on 45 and 90 days	61.90	29.30	44.37	10.00	34.77	12.0	24.0	1:1.8
T4 - Rhizome treatment with carbendazim + mancozeb (0.1%)+ foliar spray- carbendazim + mancozeb (0.1%) on 45 and 90 days	63.70	24.00	54.43	9.33	39.14	17.0	34.0	1:3.2
T5 - Foliar spray – hexaconazole (0.1%) on 45 and 90 days	58.20	32.00	39.24	11.33	26.09	13.0	26.0	1:2.8
T6-Foliar spray- propiconazole (0.1%) on 45 and 90 days	77.70	20.67	60.76	8.67	43.44	18.3	36.3	1:3.0
T7 - Foliar spray- tricyclozole (0.1%) on 45 and 90 days	57.80	31.33	40.52	10.67	30.40	11.0	22.0	1:2.0
T8 - Foliar spray- carbendazim + mancozeb (0.1%) on 45 and 90 days	62.90	22.00	58.23	11.33	26.09	16.0	32.0	1:3.1
T9 - Control	60.40	52.67	-	15.33	-	10.3	20.6	-
SED		1.76		1.34			1.48	
CD (P=0.05)		3.73		2.85			3.14	
CV(%)		6.52		8.51			13.26	

and lowest rhizome germination was observed in control (78.5%). Lowest leaf spot per cent disease index was recorded in rhizome treatment with propiconazole (0.1%) + foliar spray of propiconazole (0.1%) on 45 and 90 DAP (18.66) which was followed by rhizome treatment with carbedazim + mancozeb (0.1% + foliar spray of carbedazim + mancozeb (0.1%) on 45 and 90 DAP (21.3). Similarly in case of leaf blotch, the lowest per cent disease index was recorded in rhizome treatment with carbedazim + mancozeb (0.1% + foliar spray of carbedazim + mancozeb (0.1%) on 45 and 90 DAP (14.6) which was followed by propiconazole (0.1%) + foliar spray of propiconazole (0.1%) on 45 and 90 DAP (18.8). Maximum fresh rhizome yield was recorded in rhizome treatment with carbedazim + mancozeb (0.1% + foliar spray

of carbedazim + mancozeb (0.1%) on 45 and 90 DAP (17.1 t/ha) which was followed by rhizome treatment with hexaconazole (0.1%) + foliar spray of hexaconazole (0.1%) on 45 and 90 DAP (16.9 t/ha) (Table 27).

Highest germination (95.33%), lowest PDI (4.00) consequently giving highest reduction in disease incidence (92.31%) and highest yield (38.55 t/ha) were recorded over control in the treatment (T₇) of foliar spray with tricyclozole (0.1%) on 45 and 90 DAP at Dholi centre.

Minimum disease intensity (17.24%) was found when rhizomes treated with carbendazim + mancozeb (1:1) and spray (0.1%) after 45 and 90 days after transplanting (T₄) followed by 22.56 % disease intensity was found with foliar spray of

Table 27. Management of foliar diseases in turmeric at Jagtial

Treatment	Germination (%)	Yield/bed	Leaf spot		Leaf blotch	
			PDI	Disease reduction over control (%)	PDI	Disease reduction over control (%)
T1 Rhizome treatment with hexaconazole (0.1%) + foliar spray of hexaconazole (0.1%) on 45 and 90 DAP	92.33	17.0	26.3	48.93	22.1	48.36
T2 Rhizome treatment with propiconazole (0.1%) + foliar spray of propiconazole (0.1%) on 45 and 90 DAP	95.67	14.7	17.3	65.43	19.6	54.20
T3 Rhizome treatment with tricyclozole (0.1%) + foliar spray of tricyclozole (0.1%) on 45 and 90 DAP	97.33	15.7	23.7	53.98	26.4	38.31
T4 Rhizome treatment with carbendiazim + mancozeb (0.1%) + foliar spray of carbendiazim + mancozeb (0.1%) on 45 and 90 DAP	96.67	17.6	21.3	58.6	15.64	63.45
T5 Foliar spray of hexaconazole (0.1%) on 45 and 90 DAP	89.67	14.6	24.5	52.42	24.5	42.75
T6 Foliar spray of propiconazole (0.1%) on 45 and 90 DAP	91.67	11.5	25.3	50.87	27.3	36.21
T7 Foliar spray of tricyclozole (0.1%) on 45 and 90 DAP	94.67	11.9	28.3	45.63	30.58	28.55
T8 Foliar spray of carbendiazim + mancozeb (0.1%) on 45 and 90 DAP	91.00	14.1	27.5	46.6	25.3	40.88
T9 Check	78.33	9.9	51.5	00	42.8	00
SEm ±	1.54	0.35	1.56	-	1.98	-
CV (%)	6.33	2.56	11.13	-	9.34	-
CD (P=0.05)	4.62	1.07	2.84	-	6.03	-

carbendazim + mancozeb (0.1%) on 45 and 90 DAT (T_8) at Raigarh. Both the treatment gave maximum yield 12.32 t/ha and 10.64 t/ha respectively. These treatments were found statistically at par regarding the disease intensity and yield.

At Kumarganj, minimum leaf blotch incidence of 17.96% was recorded with foliar spray of tricyclazole (0.1%) after 45 and 90 days (T_7) showing maximum disease control of 46.37%. Minimum incidence of leaf spot disease (8.84%) was recorded by seed treatment and foliar spray of propiconazole (0.1%) after 45 and 90 days controlling disease by 69.74%. Maximum yield of 169.8 q/ha was recorded with foliar spray of tricyclazole after 45 and 90 days (T_7).

At Pundibari, foliar spray with carbendazim + mancozeb at 45 and 90 days after planting (T_4) was found to be best treatment in controlling both leaf blotch and leaf spot disease of turmeric. This treatment was closely followed by spraying only with carbendazim + mancozeb at 45 and 90 days after planting (T_8). However, there is no significant difference between T_2 (rhizome treatment as well as foliar spray with propiconazole), T_4 , T_6 (foliar spray with propiconazole only) and T_8 in respect of disease intensity and yield. T_2 produced lowest percent disease index of 14.96 and 14.89 in case of leaf blotch and leaf spot respectively. This treatment also produced the highest yield of 7.35 kg/plot (14.82 t/ha) among all the treatments.

At Pottangi, significant difference among the cultivars was observed for fresh rhizome yield. Highest fresh rhizome yield was recorded by T_4 (rhizome treatment with carbendazim + mancozeb @ 0.1% + foliar spray with carbendazim + mancozeb @ 0.1% on 45 DAP and 90 DAP) (20.68 t/ha) with 60% reduction in foliar disease infection and also with highest cost benefit ratio of (1:2.06).

Among the treatments evaluated at Chintapalle centre, rhizome treatment with propiconazole (0.1%) + foliar spray of propiconazole (0.1%) on 45 and 90 DAP gave the maximum percent disease reduction over control (65.43%) followed by rhizome treatment with carbendiazim + mancozeb (0.1%) + foliar spray of carbendiazim + mancozeb (0.1%) on 45 and 90 DAP (58.98%) in case of leaf spot. Similar trend was observed in acse of leaf blotch. Among the treatments rhizome treatment with carbendiazim + mancozeb (0.1%) + foliar spray of carbendiazim + mancozeb (0.1%) on 45 and 90 DAP gave the maximum percent disease reduction over control (63.45%) followed by propiconazole (0.1%) + foliar spray of propiconazole (0.1%) on 45 and 90 DAP (54.20%) in case of leaf spot.

5. TREE SPICES

5.1 Genetic Resources

5.1.1 Germplasm collection, characterization, evaluation and conservation of clove, nutmeg and cinnamon (Dapoli, Yercaud and Pechiparai)

Clove, nutmeg, cinnamon and cassia are the tree spices maintained at various AICRPS centres and the details of the germplasm conserved are given in Table 28.

Clove

At Dapoli, two accessions of clove viz. IISR Calicut and Kallar have been maintained and evaluated for growth and yield performance. From the germplasm collections planted during the year 1996-97, five promising types have been identified and selected during the year for further evaluation. The growth parameters viz. plant height varied from 5.00 m to 6.80 m, girth 26.00 to 30.00 cm and spread 4.03 m to 7.79 m. The yield of dry buds varied from 116 g to 436 g/tree.

In clove 22 accessions are being maintained at Pechiparai centre and during this year 2 more accessions were collected from Devagiri estate and Thadikarankonam. Among which Sel.13 performed well and gave the yield of 12.75 kg buds per tree (Table 29). From the pooled mean of three years the accessions SA 13, SA 1, SA 12 and SA 3 were identified as promising accessions. These accessions can be promoted to CVT.

Nutmeg

One promising collection of nutmeg from Ratnagiri District was collected and added to the germplasm. At present 98 accessions have been maintained and are being evaluated. From the germplasm collections planted during 1996-97 fifteen promising types have been identified and selected during the year for further evaluation. The yield ranged from 70 – 260 fruits. Sel. B-38 (260 fruits), Sel.- 4/22-56- (250 fruits), Sel. B-9 (208 fruits), Sel. 9/79 – 31 (175 fruits), Sel. – 9/20 -21 (105 fruits), have medium sized fruits. Sel.- 9/4 -26 (70 fruits) produced largest sized fruits (70-100 g). These are being further evaluated for yield and fruit and nut characters.

In nutmeg 22 accessions are being maintained at Pechiparai centre. During 2008-09 accessions from Maramala and Vellarada were added to the germplasm. Three nutmeg accessions Sel.2, Sel. 4 and Sel. 6 were identified as promising entries.

Cinnamon

Two collections of cinnamon from Ratnagiri District were collected and added to the germplasm for evaluation at Dapoli. At present total germplasm of cinnamon consisting of 13 accessions have been maintained and are being evaluated. The germplasm collections planted during 1996-97 was evaluated for growth parameters and the growth parameters did not differ significantly in different genotypes. The plant height ranged from 3.09 m– 3.62 m, the girth 23.89 cm - 30.83 cm, the spread 1.81m – 3.59 m. and the regenerated shoots 3.44 - 7.06.

At Pechiparai, the trial was initiated during 1992 with an objective to collect, maintain, characterize and catalogue the germplasm of cinnamon. Morphological characteristics yield and yield attributing traits are being evaluated to identify promising accessions. In cinnamon, 12 accessions are being maintained. During this year a high yielding selection from Nagercoil was added to the germplasm. Among the accessions, Sel.65 performed well and gave the bark yield of 420 g of

Table 28. Tree spices germplasm collections at AICRPS centres

Crop/Centre	Indigenous/cultivated
Clove	
Dapoli	2
Pechiparai	24
Yercaud	13
Total	39
Nutmeg	
Dapoli	98
Pechiparai	24
Total	122
Cinnamon	
Dapoli	13
Pechiparai	13
Yercaud	16
Cassia	
Dapoli	06
Pechiparai	04
Total	52

Table 29. Growth and yield performance of clove at Pechiparai

Accession	Tree height (m)	Stem girth (cm)	Leaf length (cm)	Leaf breadth (cm)	Flower yield (kg/tree)
SA 1	6.12	28.90	13.40	4.94	10.32
SA 2	6.92	34.05	13.50	4.52	4.68
SA 3	6.00	27.70	12.40	4.68	7.60
SA 4	5.80	26.55	13.21	4.64	5.40
SA 5	5.88	25.30	11.82	4.62	5.91
SA 6	6.00	30.80	13.88	4.68	5.30
SA 7	6.66	31.45	13.64	4.56	7.12
SA 8	5.94	26.75	14.00	4.52	6.80
SA 9	5.78	22.80	12.20	4.44	5.70
SA 10	6.10	30.15	13.12	4.30	5.10
SA 11	5.34	20.95	14.32	4.52	5.50
SA 12	5.42	28.90	14.22	4.58	6.20
SA 13	7.48	34.85	13.08	4.36	12.75
SA 14	5.72	24.05	12.28	4.08	5.00
SA 15	5.36	21.80	11.48	3.58	2.50
SA 16	4.48	21.45	10.72	3.70	2.32
SA 17	5.22	23.80	11.18	3.74	4.50
SA 18	4.93	15.45	9.88	2.74	—
SA 19	3.10	15.00	8.86	2.94	—
SA 20	2.94	15.40	6.12	3.72	—
SA 21	2.82	3.05	9.42	3.38	—
SA 22	2.38	3.10	8.82	3.55	—
SA 23	0.96	3.90	8.54	3.34	—
SA 24	0.68	2.02	10.22	3.32	—
SED	0.38	0.60	0.79	0.39	0.38
CD(P=0.05)	0.79	1.20	1.60	0.80	0.78
CV (%)	9.75	3.40	8.31	11.91	7.82

dried bark/tree and leaf yield of 6.3 kg/tree. A local collection from Pechiparai had recorded the leaf yield of 6.0 kg/tree and bark yield of 314.75 g/tree.

Cassia

Total germplasm of cassia consisting of 6 accessions have been maintained at Dapoli centre and are being evaluated.

5.2 Coordinated Varietal Trial

5.2.1 CVT 1992 – Clove

(Pechiparai)

Nine genotypes collected from IISR, Calicut is being maintained at Pechiparai station and growth parameters were studied. Among the ten selections, Sel.3 was found to be promising with highest yield (6.0 kg buds/tree).

5.2.2 CVT 2001- Nutmeg

(Dapoli and Pechiparai)

There was no significant difference in height, number of branches and spread among the genotypes at Dapoli. The plant height ranged from 0.81 m to 1.70 m., the girth 7.93 cm–13.33 cm. and the spread 0.49 m – 2.47 m.

Six accessions were collected from IISR, Calicut and are being maintained and evaluated along with a local check at Pechiparai. Among the accessions A9/150 has recorded the highest plant height of 107.2 cm.

5.2.3 CVT 2001 - Cassia

(Dapoli and Pechiparai)

The growth parameters did not differ significantly among different genotypes at Dapoli centre. The plant height ranged from 3.69 m- 5.41 m., the girth 15.50 cm– 20.63 cm. and the spread 1.43- 3.91 m. The oil percentage in leaf varied from 2.6 – 3.7%. The genotypes KKVCTSH1 and KKVCTSH2 have strong aroma and recorded 3.5 – 3.7% oil which is higher than other genotypes.

Four genotypes collected from IISR, Calicut is being maintained at Pechiparai and growth parameters were studied. Among the four selections, D3 was found to be promising with the dry leaf yield of 500.0 g/tree (Table 30).

Table 30. Growth and yield performance of cassia at Pechiparai

Accession	Plant height(m)	Stem girth(cm)	Leaf yield(dry)(g/tree)	Bark yield(g/tree)
CI	1.86	8.8	275.0	98.0
D1	1.93	7.4	340.5	76.0
D3	3.04	12.1	500.0	125.0
D5	1.95	11.2	407.0	102.0
SED	0.28	0.4	55.5	18.3
CD (P=0.05)	0.69	1.0	135.9	41.1
CV (%)	15.78	5.0	17.8	20.5

5.3 Propagation/Multiplication trial

5.3.1 Softwood grafting in clove

(Dapoli)

Soft wood grafting of clove was carried out at Dapoli in November and is under observation.

5.4 Post harvest technology studies in cinnamon

(Dapoli and Pechiparai)

Post harvest studies on extraction of bark in cinnamon were carried out during the year 2008-09 at Dapoli centre. The bark could be extracted from the matured shoot having the thickness of 1.0-2.0 cm to 5.0-6.0 cm. The bark weight and thickness before drying (fresh) and after drying were found to increase as the shoot thickness increased. The dry recovery percentage varied from 45.44 to 55.00 % in the shoot length of 50 cm and 45.34 to 51.66 % in the shoot length of 100 cm in genotype Konkani Tej variety. Similar trend was also observed in another genotype (Acc. 11). The shoot length of 50 cm was found to be better than the shoot length of 100 cm from the point of extraction of quill bark. The shoot thickness of 1.0-2.0 and 2.0-3.0 cm were found to be better than the shoot thickness of 5.0-6.0 for extraction of bark. The yield of dried bark varied from 15.38 to 67.69 g from shoot length of 50 cm having different thickness and 26.15 to 119.62 g from shoot length of 100 cm having different thickness in Konkani Tej variety.

There exists significant difference in genotype, length, thickness and G x L and L x T interactions. Among the genotypes evaluated at Pechiparai, G1 recorded significantly higher mean dry weight of quills (42.2 g). Among the lengths, L2 recorded the higher mean dry weight (57.71 g) and with respect to thickness T3 recorded significantly more dry weight (50.61 g). The interaction effect also followed similar trend with respect to G x L and L x T. G1 and L2, L2 and T3 recorded significantly higher dry weight of quills in the above treatments. The genotype, length and thickness did not influence significantly the content of essential oil.

5.4 Disease Management Trial

5.4.1 Trial on management of dieback and wilt disease of nutmeg

(Dapoli)

Studies on management of dieback and wilt disease of nutmeg were initiated to evaluate the efficacy of modern

systemic fungicides for control of disease at Dapoli. Three applications of fungicides were given at 30 days interval starting from November 2008. Observations on incidence of dieback symptoms on vegetative flushes produced by nutmeg plants during October-November were recorded regularly at one month interval up to the last week of May 2009. It was observed that there was no incidence of dieback disease on fungicide treated or untreated (check) plants.

6. CORIANDER

6.1 Genetic Resources

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

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

At Dholi centre, out of one hundred eight germplasm, only fifteen accessions namely RD-388, RD-392, RD-390, UD-73, JCO-360, DH-38, RD-383, RD-393, RD-154, UD-225, UD-684, JCO-52, JCO-72, LCC-225 and DH-115 gave the maximum yield as compared to check Rajendra Swati and Pant Haritima. Among promising accessions RD-388 produced maximum yield (1.4 kg/4.8 m²) followed by RD-392 (1.30 kg/4.8 m²).

During 2008-09, one hundred and eighty three entries were evaluated at Guntur centre. Among the entries evaluated, LCC-147 recorded highest single plant yield (11.13 g) followed

by LCC-194 (10.41 g), LCC-195 (10.15 g), LCC-246 (9.47 g) and LCC-256 (9.20 g) which are on par with each other and significantly superior to the best check Sudha (5.12 g). Six germplasm lines were collected during the period.

At Hisar, 151 accessions of coriander were evaluated and the mean seed yield of the germplasm material ranged from 990 kg/ha (DH-345) to 2266 kg/ha (DH-277). Forty-three lines gave higher seed yield than the highest yielding check, Hisar Anand. The most promising lines for seed yield were DH-210, DH-221, DH-222, DH-229, DH-239, DH-277, DH-282, DH-292, DH-298 and DH-314.

During the year 93 entries were raised and evaluated at Jagudan centre with GC-1 and GC-2 as checks for different yield attributes. Among them, thirteen entries were dwarf type, having less than 69.4 cm plant height. Fourteen entries had more branches i.e. more than 5.8 branches per plant. The umbels per plant were recorded by 11 entries i.e. 12.6. Seven entries recorded equal or more than 7 umbellate per umbel. Eleven entries were promising for more seeds per umbel i.e. > 8.2 seed per umbel. Eight entries observed as early maturing (< 85 days) types. Eleven entries isolated as high yielders recorded more than 685 kg/ha grain yield (Table 31). During the year under report, total 51 (49+2) entries of Jagudan centre, were screened for the resistance against powdery mildew disease under natural condition. The incidence of PM ranged from 70.20% to 95.75%. None of the entries were found resistant against the disease.

Table 31. Promising accessions of coriander germplasm at Jagudan

Character	Range	GC-2 (Ch)	Desirable value	Number of entries	Promising accessions
Dwarf (Plant height in cm)	53.2-75.8	59.2	<69.4	13	Lam-43, UD-375, 51, JCr-283, EC-243366, Lam-23, UD-105, Dhana-41, UD-256, JCr-384, Egyptian, EC-232669 and 350691
More branches (No. of branches/plant)	4.2-7	5.2	>5.8	14	EC-350690, UD-256, EC-232669, Moroccan, Lam -4, JCr-400, 399, 375, Dhana-25, EC-363965, Russian, JCr-379, Dhana-157 and JCr-403
More umbels (No. of umbels/plant)	6-13.4	12	>12.6	11	UD-301, Lam-45, Moroccan, UD-256, Lam -4, JCr-381, Dhana-157, JCr-396, EC-350690, JCr-327 and 402
More umbellates (No. of umbellates/umbel)	4.6-8.6	7	>7	7	JCr-379, 391, 390, 389, 392, GCo-2(Ch) and JCr-388
More seeds (No. of seeds/umbel)	5.4-9	6.8	>8.2	11	Dhana-157, UD -240, JCr-380, 391, 390, UD -90, JCr-376, Dhana-25, JCr-378, 403 and Bulgarian
Early maturity (No. of days)	93-111	96	<85	8	Dhana-25, UD-309, Dhana-157, UD -290, JCr-329, JCr-381, 402 and EC-357849
Grain yield (g/plant)	0.47-2.79	2.14	>2	11	EC-363966, Dhana-157, JCr-327, Lam-4, UD-290, EC-357849, UD-301, Moroccan, GCo-2(Ch), JCr-381 and Lam-45
Projected yield (kg/ha)	157-930	713	>685	11 As above

Among the 275 accessions evaluated at Coimbatore, the yield ranged from 0.64 kg/20 m² to 1.6 kg/20 m². Out of 275 collections evaluated 145 genotypes recorded the yield higher than the mean yield of 1.04 kg/20 m².

Though 127 germplasm accessions were planted for evaluation along with eight checks namely, RCr-20, RCr-41, RCr-435, RCr-436, RCr-446, RCr-480, RCr-684 and Local but the experiment failed due to severe frost damage at Jobner.

Screening of 85 germplasm revealed that maximum yield of 18.75 q/ha was obtained with ND Cor- 2 followed by NDCor-38 (17.18 q/ha) over check of K. selection (16.71 q/ha) and Hisar Anand (11.25 q/ha) during the year 2008-09 at Kumarganj. Increase in yield of NDCor-2 over the local check K. selection was 63.61% over the national check Hisar Anand. The coriander germplasm maintained at various AICRPS centres is given in Table 32.

6.2 Coordinated Varietal Trial

6.2.1 CVT 2005

(Jagudan, Jobner, Guntur, Dholi, Raigarh and Kumarganj)

Twenty one entries from different parts of the country were evaluated under CVT at Jobner. The analysis of variance revealed significant differences among the entries for all the traits including seed yield. The seed yield ranged from 160.44 to 1207.56 kg/ha. Of the twenty one entries evaluated, COR-1 recorded maximum seed yield of 1207.56 kg/ha followed

by COR-3 (772.44 kg/ha), RCr-435 (752.00 kg/ha), COR-2 (744.44 kg/ha) and RCr-684 check (727.56 kg/ha), while lowest seed yield of 160.44 kg/ha was recorded in COR-5 (Table 33).

In CVT, the yield differences among the entries were nonsignificant at Jagudan. However, the entries COR-19, COR-18, COR-20 and COR-16, gave the highest yield (i.e., 580, 563, 561 and 551 kg/ha, respectively), which was 20.49, 16.77, 16.34 and 14.06% higher over check GCori-2, respectively.

During 2008-09 rabi season, eighteen genotypes of coriander from different coordinating centers were tested with Sudha, Sadhana and Local as checks at Guntur. Among the entries evaluated maximum plant height was recorded in Sudha with 72.3 cm and minimum plant height was recorded in COR-22 (53.1 cm). Maximum number of primary branches was recorded in LCC-170 (6.8) which was significantly superior to check Sadhana (4.5). Lowest number of Primary branches was recorded in the COR-(183.3). LCC-170 recorded maximum number of secondary branches (16.9), which was on par with NDC-67 (16.7) and significantly superior to the checks Sudha (14.7) and Sadhana (12.6). Lowest number of secondary branches was recorded in Local variety (7.9). Regarding umbels per plant, LCC-170 recorded maximum (26.7) followed by LCC-212 (24.4). Lowest number of umbels per plant was recorded in Local variety (11.4). NDC-67 recorded maximum number of umbellets per umbel (6.7) followed by UD-728 (6.4) which are on par with check Sudha (6.2) and significantly superior to check Sadhana (5.0). Least

Table 32. Coriander germplasm collection at AICRPS centres

Centre	Indigenous		Total
	Cultivated	Wild and related sp.	
Coimbatore	275	-	275
Dholi	107	3	110
Guntur	309	-	309
Hisar	261	-	261
Jagudan	74	21 (Exotic)	95
Jobner	753	102	855
Kumarganj	85	-	85
Total	1864	126	1990

number of umbellets per umbel was recorded in Local coriander (4.7). During 2008-09 Rabi season, eighteen entries from different Coordinating centers along with three checks were tested in RBD replicated thrice. The entry, LCC-216 recorded highest yield (1363 kg/ha) followed by LCC-170 (1359 kg/ha) and LCC-212 (1352 kg/ha) which were on par with each other and significantly superior to the check Sudha (1225 kg/ha). The pooled analysis of the data indicated that among the sixteen entries evaluated for four years, LCC-170 (850 kg/ha) recorded the highest yield followed by LCC-216 (744 kg/ha) and LCC-212 (713 kg/ha) which were on par with each other and significantly superior to the check Sadhana (527 kg/ha).

At Dholi, the pooled analysis of data revealed that among three check, local check Rajendra Swati gave the maximum plant height (101.87), number of branches/plant (9.05), number of umbels per plant (63.69), number of umbellets per umbel (6.29), number of grains per umbel (32.00) and yield per plot (1.27 kg/7.2 m²) or per hectare (1.76 t/ha) as compared to national check COR-17 and check JCR-340. Among all entries including checks, COR-2, COR-3, COR-8 and COR-9 were taller than national check and local checks while COR-14 and 15 gave more number of grains per umbel. Among the entries COR-14 and COR-15 gave the maximum yield per plot (1.30 and 1.29 kg/7.2 m²) or per ha (1.80 t/ha). COR-14 and COR-15 gave a maximum cost benefit ratio of Rs. 2.38 per unit cost (1:2.38).

Table 33. Performance of coriander -CVT 2005 at Jobner

S.No.	Entries	Days to flowering	Plant height (cm)	Branches per plant	Umbels per plant	Umbellets per umbel	Seeds per umbel	Test weight (g)	Seed yield (kg/ha)	% increase over check
1	COR-1	79.33	92.47	9.07	32.87	5.60	32.20	7.54	1207.56	60.58
2	COR-2	80.33	93.87	8.60	30.53	5.47	29.20	9.68	744.44	
3	COR-3	80.00	110.87	7.33	29.73	5.40	34.40	8.56	772.44	6.17
4	COR-4	71.33	82.73	8.20	26.10	4.73	19.60	11.76	285.78	
5	COR-5	68.00	72.13	6.93	14.00	4.40	11.93	10.57	160.44	
6	COR-6	66.67	62.07	6.00	15.40	4.27	28.27	11.57	368.00	
7	COR-7	66.33	59.80	6.13	12.87	4.27	18.93	10.60	225.33	
8	COR-8	70.00	101.40	7.87	27.27	4.53	15.53	8.58	548.44	
9	COR-9	72.00	92.80	8.20	31.80	5.40	22.53	8.67	492.00	
10	COR-10	56.00	64.53	5.47	12.93	4.40	12.87	11.76	354.67	
11	COR-11	56.33	59.13	5.47	16.00	4.53	25.00	10.74	410.67	
12	COR-12	56.00	66.33	6.53	15.13	4.60	21.60	11.44	385.78	
13	COR-15	65.00	70.20	6.47	16.47	5.13	18.07	11.41	352.44	
14	COR-16	64.67	65.87	6.27	17.53	4.27	15.80	11.13	169.33	
15	COR-17	68.33	62.60	7.20	21.20	4.13	15.40	10.72	249.33	
16	RD-154	64.67	65.27	6.60	13.27	4.73	18.67	10.74	327.56	
17	RD-366	65.33	70.87	6.47	14.67	4.80	22.20	9.11	346.67	
18	RCr-435 (Ch.)	66.33	62.87	6.47	27.87	4.60	29.67	7.77	752.00	Check
19	RCr-436 (Ch.)	65.00	65.27	6.20	29.73	5.80	29.07	9.82	400.89	
20	RCr-684 (Ch.)	62.67	71.60	6.47	25.43	5.00	36.80	10.61	727.56	
21	Local Check	66.67	85.53	5.93	16.00	4.33	16.27	8.86	225.78	
CD (P=0.05)		2.64	16.47	1.48	4.81	0.85	4.83	0.59	107.18	
CV (%)		2.34	13.06	12.86	13.48	10.64	12.76	3.48	14.11	

At Raigarh, maximum yield was found in COR-3 followed by COR-5 and COR -2.

Maximum seed yield in coriander was observed in COR-8 (19.79 q/ha) followed by COR-11 (18.92 q/ha) at Kumarganj. Three years pooled data study showed maximum seed yield in COR-8 (18.28 q/ha). The increase in seed yield of coriander entry was 37.03% over Hisar

6.3 Varietal Evaluation Trial

6.3.1 Initial evaluation trial

(Hisar, Guntur, Jobner, Kumarganj and Jagudan)

The initial evaluation trial (IET) in coriander at Hisar was conducted with ten accessions along with Hisar Anand as check during 2007-08 to 2008-09 and the results indicated that DH-277 and DH-306 gave significantly better yield over Hisar Anand (check) showing 25.9 and 21.3% increase in yield, respectively. Hence, both these lines will be promoted to CVT for further evaluation (Table 34).

During 2008-09, ten promising coriander accessions selected from germplasm were tested along with Sadhana as check at Guntur centre. Among the fourteen entries evaluated, LCC-238 recorded maximum plant height of 79.5 cm and was significantly superior to check Sadhana (64.5 cm). Regarding number of primary branches LCC-242 recorded maximum number (6.5) which was significantly superior to the check Sadhana (4.9). The entries LCC-242 and LCC-238 recorded number of secondary branches (15.8 and 15.1 respectively) and significantly superior to the check Sadhana (12.0). Maximum number of umbels was recorded in LCC-238 and LCC-239 (23.5 each) and was significantly superior to the check Sadhana (18.5). LCC-238 recorded significantly highest yield of 1387 kg/ha followed by LCC-242 with 1352 kg/ha and LCC-237 with 1328 kg/ha which were superior over check Sadhana (974 kg/ha).

At Jobner, ten entries were planted for evaluated but the experiment failed due to severe frost damage.

Table 34. Performance of IET coriander at Hisar

Accession	Seed yield (kg /ha)			Increase over check (%)
	2007-2008	2008-2009	Mean	
DH-222	1953	1887	1920	15.25
DH-224	1770	1814	1792	07.56
DH-229	1838	1777	1807	08.63
DH-239	1740	1793	1766	6.03
DH-254	1670	1690	1680	0.84
DH-277	2061	2130	2095	25.78
DH-282	1887	1940	1913	14.82
DH-298	1882	1843	1862	11.79
DH-306	1990	2050	2020	21.25
Hisar Anand	1652	1680	1666	-
CD (P=0.05)	136	142	-	-

Highest seed yield was recorded in NDCor-2 (17.94q/ha) at Kumarganj centre. This was closely followed by NDCor-30 (17.35 q/ha) during 2007-08. In three years pooled study maximum seed yield of 17.78 q/ha was obtained with NDCor-2 (Table 35).

At Jagudan none of the entries was significantly superior over check GCori-2. The entry JCr-404 gave 1430 kg/ha yield, which was 10.23 per cent higher over check.

6.4 Quality Evaluation Trial

6.4.1 Quality evaluation in coriander (Jobner)

Twenty one entries of coriander under CVT at Jobner centre were tested for volatile oil content during Rabi 2007-08, which was analysed using Clevenger apparatus. The volatile oil content

in the entries ranged from 0.27% to 0.43%. The maximum volatile oil of 0.43% was observed in COR-3, COR-4, COR-7, COR-10, COR-11 and COR-12 followed by 0.40% in RCr-435, RCr-436 and RCr-684, while minimum of 0.27% was recorded in COR-8 and COR-15. The entry COR-1 ranked first in terms of volatile oil yield (3.62 l/ha) followed by COR-3 (3.32 l/ha) and RCr-435 (3.01 l/ha). While lowest volatile oil yield of 0.48 l/ha was recorded in COR-5.

6.5 Nutrient Management Trial

6.5.1 Effect of biofertilizer, *Azospirillum* on coriander (Dholi)

At Dholi, application of inorganic nitrogen (100%) + *Azospirillum* + 5 t/ha FYM (T₁), inorganic nitrogen (75%) +

Table 35. Yield performance of IET coriander at Kumarganj (Pooled data)

Entries	2006-07	2007-08	2008-09	Mean (q/ha)	Increase in yield over check (%)
NDCor-2	17.70	17.70	17.94	17.78	52.22
NDCor-11	13.70	13.70	13.71	13.70	17.29
NDCor-12	13.50	13.50	13.57	13.52	15.75
NDCor-30	17.10	17.10	17.35	17.18	47.08
NDCor-49	17.00	17.20	17.21	17.13	46.66
NDCor-56	14.50	14.60	14.61	14.57	24.74
NDCor-57	13.70	13.30	13.71	13.57	16.18
NDCor-58	11.90	11.60	12.11	11.87	1.62
NDCor-65	13.20	13.00	13.08	13.09	12.07
Hisar Anand (check)	11.40	11.70	11.94	11.68	
SEm ±	0.07	0.38	0.37		
CD (P=0.05)	0.08	0.14	1.11		
CV(%)	8.86	4.69	4.44		

Azospirillum + 5 t/ha FYM (T₂), inorganic nitrogen (50%) + *Azospirillum* + 5 t/ha FYM (T₃) and 100% inorganic nitrogen (T₄) produced significantly more yield (2.11, 94 1.81 and 1.60 t/ha) respectively as compared to control (1.25 t/ha) as well as other treatments. Among the treatments, application of inorganic nitrogen (100% + *Azospirillum* + 5 t/ha FYM (T₁)) gave the maximum plant height (139.40 cm), number of umbels per plant (71.17), number of umbellets per umbel (6.27), number of grains per umbel (50.60) and yield per plot (1.02 kg/4.8 m²) or per hectare (2.11 t/ha) followed by inorganic nitrogen (75%) + *Azospirillum* + 5 t/ha FYM (T₂).

6.5.2 Effect of bio-regulators on coriander (Kumarganj)

At Kumarganj, foliar spray of Tricontanol (1.0 ml/l of water) at 40, 60 and 80 day after sowing gave the maximum seed yield of 1.82 t/ha followed by foliar spray of 50 ppm of NAA after 40, 60 and 80 days after sowing.

6.6 Identification of drought/alkalinity tolerant source in coriander (Guntur, Kumarganj and Jobner)

The study of physiological drought parameters of germplasm at Guntur revealed that low SLA was observed in LCC-231, LCC-199, LCC-253, LCC-256, LCC-159 and LCC-219. The mean SLA for checks was 455 for Sadhana, 416 for Sindhu, 510 for Swathi and 439 for Sudha. Similarly low SLW was recorded in LCC-232, LCC-223, LCC-209, LCC-221 and LCC-215 which are relatively drought susceptible. Ten promising entries were evaluated in two blocks in which soil moisture regime and plant growth was monitored. Both flower initiation, days to 50% flowering and period taken to maturity were less where there was lower soil moisture indicating that coriander can recognize the onset of drought and adjust its life cycle accordingly. On average, there is a yield reduction of 27.9% in block-2 where soil moisture is 15.8% lesser than the block at the time of maturity.

At Kumarganj, ten genotypes of coriander was tested with four levels of ESP. Highest mean seed yield of 35.70 g/plant

was recorded with 44.75 and 41.33 g/plant under 10 and 20 ESP levels in NDCor-14 respectively.

Forty eight genotypes were planted at Jobner for evaluation but the experiment failed due to severe frost damage.

6.7 Production of leafy type coriander in off season (summer) (Coimbatore, Guntur and Hisar)

During the 2008-09 summer, six genotypes were evaluated under three different kinds of shade nets i.e. 35%, 50% and 75% and control conditions at Guntur. Among the shade nets evaluated, maximum green yield was recorded in 50% shade net (8.17 t/ha) which is significantly superior to all other treatments. This is followed by 75% shade net (6.1 t/ha) and 35% shade net (7.01 t/ha). The control plot recorded only 0.132 t/ha. The data regarding yield and yield attributes is presented in Table 36. Among the six genotypes evaluated, LCC-244 recorded maximum yield of 6.9 t/ha followed by LCC-234 (6.18 t/ha) which are significantly superior to check Sadhana (3.37 t/ha).

At Hisar, among the three shade levels, 50% shade resulted in higher leaf yield followed by 75% shade. Among the entries tested, DH-228 produced the maximum leaf yield followed by DH-259.

Among the three shade nets 50% shade level resulted in higher leaf yield followed by 25% at Coimbatore. Among the genotypes DH 228 (2.08 kg/20 m²) followed by CS 11 (2.37 kg/20 m²) was ideal for growing under shade.

6.8 Role of rhizobacteria in growth promotion of coriander (Coimbatore, Guntur, Hisar, Jagudan and Raigarh)

The study on role of rhizobacteria on growth of coriander was conducted during 2008-09 at Coimbatore centre. Among the eight treatments, the treatment T₆ (rhizobacteria FK 14 + FL 18 (seed treatment + soil application)) has recorded the highest yield of 722.2 kg/ha followed by treatment T₄,

Table 36. Performance of leafy type of coriander under different levels of shade at Guntur

Accession	Shadenet			Control	Mean
	35%	50%	75%		
LCC-231	4.88	4.75	5.61	0.12	3.84
LCC-233	7.00	9.13	6.36	0.13	5.66
LCC-234	8.27	9.63	6.69	0.13	6.18
LCC-242	7.31	9.98	6.98	0.14	6.10
LCC-244	9.15	11.17	7.25	0.15	6.93
Sadhana	5.48	4.35	3.55	4.41	4.45
Mean	7.01	8.17	6.07	0.85	
CD (Factor1)	1.01				
CD (Factor2)	1.24				
Interaction	2.69				
CV(%)	28.01				

(rhizobacteria FL 18 (seed treatment + soil application)) which recorded a yield of 677.8 kg/ha. The pooled mean of the data indicated that the yield varied from 450 to 569.45 kg/ha. The highest yield was recorded by the treatment T6 (569.45 kg/ha) which was on par with T2 (530.55 kg/ha), T4 (530.55 kg/ha) and T3 (527.75 kg/ha) respectively (Table 37).

During 2008-09 rabi season, an experiment was conducted to know the effect of rhizobacteria in eight treatments with three replications at Guntur. Among the treatments evaluated, T-6 (seed treatment + soil application with FK 14 + FL 18) recorded maximum yield (1283 kg/ha) followed by T-2 (seed treatment + soil application with FK14) (1269 kg/ha) which are on par with each other and significantly superior to control (1071 kg/ha). The pooled analysis indicated that among the treatments evaluated, T-6 (seed treatment + soil application with FK 14 + FL 18) recorded maximum yield (419 kg/ha) followed by T-2 (seed treatment + soil application with FK14) (398 kg/ha) which were on par with each other and significantly superior to control (323 kg/ha).

At Jagudan, the inoculation of rhizobacteria and its different method of application influenced seed yield significantly. Whereas, growth and yield attributes did not differ remarkably due to rhizobacteria inoculation except number of umbels per plant. Seed and soil inoculation FK14 + FL18 strains produced the maximum seed yield.

At Hisar significant differences were obtained for all the parameters. The maximum seed yield (1962 kg/ha) was recorded with the application of rhizobacteria FL-18 (seed treatment + soil application) followed by *Trichoderma* MTCC-5179 (1820 kg/ha) and rhizobacteria FK 14+FL 18 (seed treatment+soil application) (Table 38).

Seed treatment and soil application of the rhizobacteria FK-14 and FL-18 recorded maximum plant height (72.5 cm. and 71.13 cm respectively) and maximum yield (8.24 q/ha and 8.80 q/ha respectively) at Raigarh centres. Both the rhizobacteria are statistically at par regarding growth promotion and yield.

6.6.9 Disease Management Trial

6.6.9.1 Management of powdery mildew and stem gall in coriander

(Coimbatore, Jagudan, Jobner, Raigarh and Kumarganj)

During 2008-09, the results revealed that seed treatment with *P. fluorescens* (IISR 6) at the rate of 10 g/kg of seed followed by foliar application at 10^8 CFU on 60 days after sowing recorded the minimum powdery mildew incidence of 29.33 PDI when compared to the untreated control (67.33 PDI) at Coimbatore. The yield data was also recorded with

Table 37. Effect of rhizobacteria on growth promotion of coriander (Pooled analysis 2007 – 2009) at Coimbatore

Treatment	Plant height (cm)	Primary branches/plant	Secondary branches/plant	Number of umbels/plant	Number of umbellets/umbel	Seeds/umbel	Yield /ha(kg)
T-1 Rhizobacteria FK 14 (seed treatment)	54.45	6.83	13.55	26.44	6.21	39.49	466.65
T2-Rhizobacteria FK 14 (seed treatment + soil application)	52.70	6.43	13.48	25.70	5.72	35.45	530.55
T3-Rhizobacteria FL 18 (seed treatment)	52.30	6.70	13.39	25.04	6.30	40.33	527.75
T4-Rhizobacteria FL 18 (seed treatment + soil application)	51.71	6.48	12.88	26.89	6.26	41.26	530.55
T5-Rhizobacteria FK 14 + FL 18 (seed treatment)	48.60	6.26	13.27	25.54	6.30	41.66	450.00
T6-Rhizobacteria FK 14 + FL 18 (seed treatment + soil application)	45.63	6.03	12.92	26.33	6.21	40.93	569.45
T7- <i>Trichoderma</i> MTCC 5179 (Recommended dose)	49.26	7.31	14.25	23.66	5.60	38.77	477.80
T8-Control	48.62	6.49	13.48	24.65	6.14	38.61	461.10
SED	2.89	0.37	0.773	1.47	0.35	2.29	29.07
CD(P=0.5)	6.21	0.81	1.65	3.16	0.75	4.92	62.36

Table 38. Effect of rhizobacteria on growth and seed yield of coriander during 2008-09 at Hisar

Treatment	Plant height (cm)	Branches/plant	Umbels/plant	Umbellets/Umbel	Seeds/umbel	Seedyield (kg/ha)
Rhizobacteria FK 14 (seed treatment)	111.2	10.0	56.9	5.6	35.7	1310
Rhizobacteria FK 14 (seed treatment + soil application)	118.8	9.9	61.5	5.5	33.9	1587
Rhizobacteria FL 18 (seed treatment)	114.3	9.8	59.4	5.5	32.8	1607
Rhizobacteria FL 18 (seed treatment + soil application)	107.3	10.4	81.2	5.6	36.7	1962
Rhizobacteria FK 14+FL 18 (seed treatment)	113.3	10.0	64.9	5.3	32.6	1578
Rhizobacteria FK 14+FL 18 (seed treatment + soil application)	115.4	10.9	65.3	5.8	41.8	1785
<i>Trichoderma</i> MTCC 5179 (recommended dose)	116.7	10.5	67.6	5.7	34.4	1820
Control	113.5	10.3	58.3	5.5	34.8	1428
C D (P = 0.05)	4.1		5.9	0.3	3.4	128

C.B ratio. Among the eight treatments, the *P. fluorescens* (IISR 6) recorded the maximum yield of 680 kg/ha with maximum cost benefit ratio of 1:2.6. There was no stem gall disease symptom in the entire experiment plots. This treatment was on par with *B. subtilis* treatment and neem seed kernel extract treatment. The pooled mean analysis for this trial was worked out from 2005-06 to 2008-09 and presented in Table 39. The results revealed that seed treatment with *P. fluorescens* (IISR 6) at the rate of 10 g/kg of seed followed by foliar application at 10^8 CFU on 60 days after sowing recorded the minimum powdery mildew incidence of 21.50 PDI with maximum yield of 720 kg/ha and recorded the highest CB ratio of 1:3.0. This treatment was on par with soil application of *B. subtilis* @ 10^8 CFU after 60 days after sowing.

Among the eight treatments evaluated at Jobner centre, minimum powdery mildew (15.00%) with the maximum seed yield of 711 kg/ha was recorded in the treatment soil solarisation + soil application of *Trichoderma* + spray with calixin closely followed by seed treatment, soil drench + spray with calixin and spray with wettable sulphur (16.67 and 18.33% with the seed yield 667 and 653 kg/ha, respectively). Maximum disease incidence (43.33 %) and lowest seed yield 560 kg/ha was recorded in control. Stem gall disease did not appear. Out of the twenty-one CVT entries of coriander tested against powdery mildew, the minimum disease incidence was recorded in COR-1, COR-5, RCr-435, COR-16 and RD-154 (16.04, 21.83, 26.48, 26.99 and 27.77%, respectively). The local check showed maximum disease incidence 56.43% (Table 40).

At Kumarganj, pooled analysis indicated that lowest incidence of stem gall disease in coriander was recorded by drenching of soil with carbendazim and foliar spray of 0.2%

solution of carbendazim and foliar spray after 60 days of sowing. This treatment gave maximum disease control of 63.08%. The lowest powdery mildew disease was recorded by foliar spray of wettable sulphur (0.2%) recording 65.10% control of disease. Highest yield was recorded by application of *B. subtilis* 10^8 CFU + spray of *B. subtilis* 60 days of sowing.

At Raigarh, minimum disease intensity of powdery mildew was observed in treatment T₆ (spray with wettable sulphur (0.2%) after 60 days of sowing (20.61%) and T₅ (carbendazim (bavistin) as soil drench and spray (0.1%) of sowing (20.61 %). Maximum yield (8.1 q/ha and 8.0 q/ha respectively) was recorded in the same treatment. Both the treatments are found statistically at par regarding disease intensity and yield q/ha.

7. CUMIN

7.1 Genetic Resources

7.1.1 Germplasm collection, characterization, evaluation, conservation and screening against diseases (Jagudan and Jobner)

Two hundred and fourteen genotypes of cumin maintained at Jagudan centre were compared with three checks i.e. GC-1, GC-2, GC-3 and GC-4 during rabi season 2008-09. Among them fifteen entries were tall types, having more than 28.4 cm plant height. Twelve entries had good branches i.e. more or equal to 4.2 branches/plant, 15 entries had more than 20 umbels/plant. Fourteen entries recorded more than 4.8 umbellets/umbel. Eleven entries were promising for more seeds per umbel. i.e. > 24.6 seed per umbel. Thirteen entries observed more or less early maturity (< 90 days). Thirteen entries isolated as high yielder recorded more than 1315 kg/

Table 39. Effect of biocontrol agents for the management of coriander powdery mildew and stem gall diseases at Coimbatore (Pooled mean -2005-06 to 2008-09)

Sl. no.	Treatment	Disease incidence (%)		Yield (kg/ha)	C:B ratio
		Powdery mildew (PDI)	Stem gall (PDI)		
T ₁	Soil solarization + soil application of <i>Trichoderma viride</i> (1 kg/plot) + spray with tridemorph (calixin) 0.1% after 60 days of sowing.	29.86	0	529.67	1:1.90
T ₂	Seed treatment with <i>Pseudomonas fluorescens</i> (IISR-6) + spray with <i>P. fluorescens</i> (IISR-6) 10 ⁸ cfu after 60 days.	21.50	0	720.00	1:3.0
T ₃	Soil application of <i>B. subtilis</i> @ 10 ⁸ cfu + spray with <i>B. subtilis</i> @ 10 ⁸ cfu after 60 days.	25.04	0	654.33	1:2.5
T ₄	Seed treatment, soil drenching with tridemorph (calixin) 0.1% + spray with calixin 0.1% after 60 days	31.74	0	620.42	1:2.2
T ₅	Carbendazim as soil drench and spray (0.1%) (common management strategy for stem gall)	31.17	0	690.42	1:2.4
T ₆	Spray with wettable sulphur powder (0.2%)	14.37	0	699.08	1:2.6
T ₇	Neem seed kernel extract (5%) at 60 DAS	30.29	0	646.59	1:2.6
T ₈	Control	63.76	0	457.08	-
	CD (P=0.05)	5.08		32.87	
	SEd	2.46		15.97	
	CV(%)	10.63		3.53	

Table 40. Management of powdery mildew and stem gall in coriander at Jobner

Treatment	Powdery mildew (%)	Stem gall (%)	Yield (kg/ha)
Soil solarization + soil application of <i>Trichoderma</i> + spray with calixin	15.00	-	711.11
Seed treatment with <i>P. flourescens</i> + spray with <i>P. flourescens</i>	25.00	-	600.00
Soil application of <i>B. subtilis</i> + spray with <i>B. subtilis</i>	28.33	-	573.33
Seed treatment and drenching calixin + spray with calixin	16.67	-	666.67
Carbendazim (Bavistin) as soil drench and spray	21.67	-	640.00
Spray with wettable sulphur	18.33	-	653.33
Seed treatment + spray with neem seed kernel extract 5%	20.00	-	644.44
Control	43.33	-	560.00
CD (P=0.05)	2.68	-	55.23
CV(%)	5.37	-	5.01

ha grain yield (yield kg/ha is calculated on basis of per plant yield) (Table 41). Total thirty five (32+3) entries were screened for the resistance against *Alternaria* blight disease. None of the entries were found free from blight disease incidence. The minimum incidence was noticed in GC-4(Ch) (70.75%). The blight incidence ranged from 70.75 to 95.75%. Overall, all other entries were showed highly susceptible reaction. During the year under report, 35 entries were screened for the resistant against powdery mildew disease under natural condition. The incidence of powdery mildew ranged from 80.20 to 100 %. Forty seven entries were screened under wilt sick plot conditions. The incidence of wilt ranged from 40.25 to 100%. The minimum incidence was found in GC-4 (Check) (40.25%) followed by check GC-3 (55.50%). Other entries showed highly susceptible reaction.

At Jobner, limited range of variability was found for all the characters studied. Out of 111 accessions, 12 accessions were better than check variety RZ-223. Some of the promising accessions identified on the basis of yield per 5 plants were

UC-275, UC-294, UC-276, UC-281, UC-315, UC-340, UC-339, UC-343, UC-320 and UC-338. The germplasm of cumint maintained at Jagudan and Jobner centre are presented in Table 42.

7.2 Coordinated Varietal Trial

7.2.1 CVT 2005

(Jobner and Jagudan)

Eight entries were evaluated at Jobner and the analysis of variance revealed significant differences among the entries for all the traits including seed yield. The seed yield ranged from 281.25 to 501.74 kg/ha. Of the ten entries evaluated, CUM-3 recorded maximum seed yield of 501.74 kg/ha followed by CUM-5 (454.86 kg/ha), RZ-209 (447.92 kg/ha), CUM-2 (383.68 kg/ha) and CUM-4 (361.11 kg/ha), while lowest seed yield of 281.25 kg/ha was recorded in Local (Table 43).

At Jagudan, the trial was vitiated due to heavy incidences of blight and wilt diseases and aphid attack. Analysis of two years data showed that none of the entries were superior over check.

Table 41. Promising accessions of cumint germplasm at Jagudan

Desirable character	Range	GC-4 (Ch)	Desirable values	Number of entries	Promising accessions
Tall (Plant height,cm)	19.4-29.4	20	<28.4	15	JC-2002-13, 95-123, 99-39, 95-126, 95-129, 2002-18, 2002-29, 99-17, 2002-33, 95-71, 2000-58, 95-128, 2000-17, 2000-3 and 95-72
More branches (No. of branches/plant)	2.2-5.6	3.2	>4.2	12	JC-95-128, 95-127, 95-126, 2000-20, 95-32, 2000-3, 2000-4, 2000-21, 95-123, 2002-33, 2002-8 and 2000-11
More umbels (No. of umbels/plant)	4.2-28.2	9.4	>20	15	JC-2000-3, 2000-11, 95-25, 2000-29, 95-22, 95-72, 95-10, 2000-4, 95-71, 2000-9, 95-115, 95-85, 95-30, 99-44 and 2000-20
More umbellates (No. of umbellates/umbel)	3-5.6	4	>4.8	14	JC-2000-22, 2000-9, 2000-4, 99-44, 99-6, 96-37, 2000-11, 95-72, 99-39, Hairy Cumint, JC-2000-47, 95-34, 2002-8 and 96-24
More seeds (No. of seeds/umbel)	13.8-26.8	16.4	>24.6	11	JC-2000-3, 95-71, 2000-9, 95-72, 2000-4, 2002-8, 96-11, 2000-47, 2000-11, 95-85 and 95-31
Early maturity (days)	93-112	105	<90	13	JC-94-262, 95-106, 95-127, 96-16, 99-2, 99-3, 99-5, 99-7, 99-12, 99-16, 2000-57, 2000-60 and 2000-61
High yield (Grain yield (g/plant)	0.24-2.62	0.36	>1.20	13	JC-2000-3, 2000-4, 2000-11, 2000-9, 2000-47, 2000-20, 95-72, 99-44, 2000-40, 99-31, 95-30, 2000-54 and 2000-53
Projected high yield (kg/ha)	254-2820	385	>1315	13 As above....

Table 42. Cumin germplasm collection under AICRPS centres

Centre	Indigenous	Exotic	Total
Jagudan	211	7	218
Jobner	261	20	281
Total	472	27	499

Table 43. Coordinated varietal trial of cumin at Jobner (2007-08)

Entries	Days to flowering	Plant height (cm)	Branches per plant	Umbels per plant	Umbellets per umbel	Seeds per umbel	Test weight (g)	Seed yield (kg/ha)	Increase over check(%)
CUM-1	83.25	32.90	5.70	18.93	5.00	21.55	2.63	335.07	
CUM-2	84.25	30.90	5.40	19.85	4.55	22.50	4.45	383.68	
CUM-3	83.50	32.95	6.15	26.20	4.60	25.30	3.35	501.74	10.72
CUM-4	82.75	31.65	5.80	22.75	4.50	23.35	4.00	361.11	
CUM-5	85.00	31.95	5.30	26.60	4.25	22.10	4.55	454.86	1.55
CUM-6	78.50	34.50	5.10	24.00	4.60	22.10	4.15	298.61	
RZ-209	78.75	34.65	5.15	24.10	4.60	25.70	4.30	447.92	Check
Local	78.75	31.90	4.40	18.50	4.30	22.05	3.50	281.25	
CD (P=0.05)	1.90	NS	0.51	2.20	NS	NS	0.18	62.16	
CV (%)	1.58	8.56	6.51	6.61	9.93	12.56	3.24	11.03	

7.3 Varietal Evaluation Trial

7.3.1 Initial evaluation trial (Jobner and Jagudan)

Ten entries were evaluated at Jobner and the analysis of variance revealed significant differences among the entries for all the traits including seed yield. The seed yield ranged from 270.83 to 489.58 kg/ha. Of the ten entries evaluated, UC-299 recorded maximum seed yield of 489.58 kg/ha followed by UC-239 (444.44 kg/ha), RZ-223 (430.56 kg/ha), UC-331 (399.31 kg/ha) and UC-225 (361.11 kg/ha), while lowest seed yield of 270.83 kg/ha was recorded in UC-273 and Local. Mean performance of the entries evaluated in IET over 2005-06 and 2007-08 revealed superior performance of UC-299 yielding 590.80 kg/ha followed by UC-239 (549.31 kg/ha), RZ-223 check (494.97 kg/ha) and UC-331 (453.48 kg/ha), while lowest seed yield of 304.51 kg/ha was recorded in UC-273.

The trial was vitiated due to heavy incidences of blight and wilt diseases and aphids attack at Jagudan. Two years data showed non-significant yield differences among entries. However, an entry JC-2002-41 gave higher yield (1340 kg/ha), which was 12.79 per cent higher over check.

7.4 Quality Evaluation Trial

7.4.1 Quality evaluation in cumin (Jobner)

Eight entries of cumin under CVT were tested for volatile oil content during Rabi 2007-08 at Jobner centre. The volatile oil content in the entries ranged from 2.63% to 4.55%. The maximum volatile oil of 4.55% was observed in CUM-5 followed by 4.45% in CUM-2 and RZ-19 and minimum of 2.63 in CUM-1. The maximum volatile oil was obtained in CUM-5 (20.70 l/ha) followed by RZ-209 (19.26 l/ha), CUM-2 (17.07 l/ha), CUM-3 (16.81 l/ha) and minimum in CUM-1 (8.81 l/ha) (Table 44).

The volatile oil content in the IET entries of cumin ranged from 2.90% to 4.30%. The maximum volatile oil of 4.30% was recorded in UC-274 followed by 3.68% in UC-299 and 3.60% in UC-225 and minimum of 2.90% in RZ-223. Highest volatile oil yield was recorded in UC-299 (18.02 l/ha) followed by UC-239 (13.56 l/ha) and UC-331 (13.38 l/ha) and minimum was recorded in Local check (8.26 l/ha).

7.5 Identification of drought tolerance source in cumin (Jobner)

The experiment could not be conducted at Jobner due to severe frost and blight damage.

Table 44. Volatile oil contents of cumin entries of CVT at Jobner

Entry	Seed yield (kg/ha)	Volatile oil (%)	Volatile oil yield (l/ha)
CUM-1	335.07	2.63	8.81
CUM-2	383.68	4.45	17.07
CUM-3	501.74	3.35	16.81
CUM-4	361.11	4.00	14.44
CUM-5	454.86	4.55	20.70
CUM-6	298.61	4.15	12.39
RZ-209	447.92	4.30	19.26
Local	281.25	3.50	9.84
CD (P=0.05)	62.16	0.18	
CV (%)	11.03	3.24	

7.6 Role of rhizobacteria on growth and yield of cumin (Jagudan and Jobner)

An experiment was conducted to assess the role of rhizobacteria on growth promotion of cumin at Jobner. Out of eight treatments seed treatment and soil application with FK -14 + FL-18 resulted in minimum wilt incidence and aphid infestation (10.85% and 13.33%) and maximum seed yield and biomass production i.e. 186 kg/ha and 600 kg/ha respectively. Maximum soil population of rhizobacteria was also observed in seed treatment and soil application with FK-14 + FL-18. The control has resulted in higher incidence/infestation of wilt and aphid i.e. 33.38 and 46.33 per cent respectively and minimum yield (128 kg/ha).

The growth and yield attributes as well as seed yield of cumin at Jagudan was not influenced significantly due to different strains of rhizobacteria and its method of application.

However, strains FK14 and FL 18 applied as seed and soil inoculation recorded the maximum growth and yield attributes as well as seed yield in cumin.

7.7 Effect of bio-regulators on cumin (Jobner)

The experiment consisted of thirteen treatment combinations comprising of 4 bio-regulators viz., triacontanol 0.5 ml/l, triacontanol 1.0 ml/l, NAA 50 ppm and water spray and 3 levels of spray viz., one (40 DAS), two (40 and 60 DAS) and three (40, 60 and 80 DAS) along with one absolute control at Jobner. On the basis of first year experiment, application of bioregulators i.e. NAA and triacontanol resulted significantly in higher number of umbellets and seeds per umbel and seed yield of cumin over water spray (Table 45). Data further indicated that number of sprays had not influenced the yield and yield attributes. Significantly lower number of umbellets and seeds per umbel as well as biological and seed yield were

Table 45. Effect of bio-regulators on yield attributes of cumin at Jobner

Treatment	Plant height (cm)	Branches/plant	Umbels/plant	Umbellets/Umbel	Seeds/umbel	Seed yield (kg/ha)	Volatile oil content (%)
Bio-regulators							
Triacontanol @ 0.5ml/litre	42.4	4.62	22.0	4.53	22.3	440	3.13
Triacontanol @ 1.0 ml/litre	42.4	4.80	23.1	4.75	22.3	479	3.22
NAA @ 50 ppm	42.6	4.71	23.1	4.73	23.0	503	3.24
Water spray	41.6	4.49	20.8	4.24	20.0	399	3.00
CD (P = 0.05)	NS	NS	NS	0.26	1.8	39	NS
Sprays							
One (40 DAS)	42.0	4.62	21.9	4.47	21.4	443	3.15
Two (40 & 60 DAS)	42.3	4.67	22.5	4.60	21.9	456	3.13
Three (40, 60 & 80 DAS)	42.4	4.68	22.3	4.62	22.5	467	3.17
CD (P = 0.05)	NS	NS	NS	NS	NS	NS	NS
Control v/s Rest							
Control	41.4	4.40	18.9	4.13	19.4	401	2.87
Rest	42.2	4.66	22.2	4.56	21.9	455	3.15
CD (P = 0.05)	NS	NS	NS	0.32	1.9	47	NS

recorded in the absolute control as compared to the mean of all other treatments.

7.8 Disease Management Trial

7.8.1 Management of wilt and blight diseases in cumin

(Jagudan and Jobner)

The data revealed that the incidence of wilt disease was moderate at Jagudan centre. The results of different treatments were found significant. The minimum incidence of wilt was found in *P. fluorescens* (IISR-6) 10^8 cfu as seed treatment and spray at 60 DAS (T_4) (23.42%) and followed by *P. fluorescens* (IISR-6) 10^8 cfu as seed treatment + soil application of *T. harzianum* + *P. fluorescens* as spray at 60 DAS (T_8) (26.19%), *B. subtilis* as soil application and foliar spray at 60 DAS (T_7) (26.90%) and soil application of *B. subtilis* and *T. harzianum* + *P. fluorescens* as spray at 60 DAS (T_9) (27.88%). The minimum incidence of blight was found in spray of mancozeb @ 0.25% at 40, 50, 60 and 70 DAS (T_{11}) (21.66%) and followed by soil solarization + soil application of *T. harzianum* + spray of mancozeb @ 0.25% at 60 DAS (T_1) (24.99%) and vermicompost+ soil application of *T. harzianum* + spray of mancozeb @ 0.25% at 60 DAS (T_3) (25.63%). The maximum incidence of blight was found in control (T_{10}) (42.54%). The data of yield also showed significant results. The maximum yield was found in spray of mancozeb @ 0.25% at 40, 50, 60 and 70 DAS (T_{11}) (419.7 kg/ha) and followed by vermicompost+

soil application of *T. harzianum* + spray of mancozeb @ 0.25% at 60 DAS (T_3) (295.67 kg/ha). The yield was low due to infestation of aphids in last stage of crop and incidence of powdery mildew disease in early stage (Table 46).

Out of eleven treatments evaluated at Jobner, the minimum wilt incidence (5.06 %) and blight incidence (6.67%) and maximum seed yield 259 kg/ha was recorded in the treatment where soil solarization and soil application of *Trichoderma* + FYM and spray with mancozeb @ 0.25% and it was closely followed by vermicompost + soil application of *Trichoderma* and spray with mancozeb @ 0.25% [wilt (6.82 %) and blight (7.33%) with the seed yield of 234 kg/ha]. Maximum disease incidence wilt (22.12 %) and blight (38.33 %) and lowest yield (163 kg/ha) was recorded in control. Out of eight entries of cumin CVT tested against wilt and powdery mildew, the minimum wilt incidence was recorded in CUM-3, CUM-6 and RZ-209 (0.74, 1.07 and 1.66%, respectively) and minimum powdery mildew disease incidence was recorded in CUM-3, CUM-2 and CUM-6 (16.25, 18.13 and 19.38 %, respectively). The local check resulted maximum disease incidence i.e. 14.13% wilt and 23.44% powdery mildew. Out of ten entries in IET tested against wilt and powdery mildew, the minimum wilt incidence was recorded in UC-225 and UC-331 (4.70 and 6.65%, respectively) and minimum powdery mildew disease incidence was recorded in UC-274, UC-225 and RZ-19 (3.13, 5.63 and 7.5%, respectively). The local check expressed maximum disease incidence i.e. 25.81% wilt and 26.88% powdery mildew.

Table 46. Management of wilt and blight disease in cumin at Jagudan

Treatment	Blight (PDI)	Wilt (PDI)	Yield (kg/ha)
Soil solarization + soil application of <i>T. harzianum</i> + spray mancozeb 0.25% (60 DAS)	17.92 (24.99)	30.75 (33.61)	205.00
FYM (5 t/ha)+ soil application of <i>T. harzianum</i> + spray mancozeb 0.25% (60 DAS)	27.25 (31.45)	32.33 (34.64)	200.67
Vermicompost (2 t/ha)+ soil application of <i>T. harzianum</i> + spray mancozeb 0.25% (60 DAS)	18.75 (25.63)	24.92 (29.92)	295.67
Neem cake (2 t/ha) + soil application of <i>T. harzianum</i> + spray mancozeb 0.25% (60 DAS)	23.75 (29.14)	32.17 (34.53)	206.67
Soil drench with carbendazim 0.1% + spray mancozeb 0.25% (60 DAS)	34.17 (35.75)	25.17 (30.09)	183.00
<i>P. fluorescens</i> (IISR-6) 10^8 cfu as seed treatment and spray (60 DAS)	28.33 (32.14)	15.83 (23.42)	154.67
<i>B. subtilis</i> as soil application and foliar spray (60 DAS)	32.75 (34.89)	20.58 (26.90)	175.00
<i>P. fluorescens</i> (IISR-6) 10^8 cfu as seed treatment + soil application of <i>T. harzianum</i> as spray	35.17 (36.35)	19.50 (26.19)	142.67
<i>B. subtilis</i> as soil application + soil application of <i>T. harzianum</i> + <i>P. fluorescens</i> as spray	30.08 (33.25)	21.92 (27.88)	156.00
Control	45.75 (42.54)	27.08 (31.33)	147.33
Spray mancozeb 0.25% (40, 50, 60 & 70 DAS)	13.67 (21.67)	26.25 (30.80)	419.67
Neem seed kernel extract	31.25 (33.97)	31.58 (34.17)	142.67
S.Em.±	1.27 (0.82)	1.27 (0.84)	6.90
CD(P=0.05)	3.72 (2.42)	3.74 (2.46)	20.24
CV(%)	7.79 (4.48)	8.60 (4.79)	5.90

7.8.2 Management of cumin wilt through biocontrol agents (Jagudan)

At Jagudan, the minimum incidence of wilt was found in *T. harzianum* @ 20 kg/ha + FYM @ 6 t/ha (T_6) (24.00%) followed by *T. harzianum* @ 20 kg/ha + FYM @ 3 t/ha (T_3) (26.72 %). The maximum wilt incidence was found in control treatment (T_{12}) (43.12%). Similarly the yield of different treatments showed significant results. The maximum yield was recorded in application of *T. harzianum* @ 20 kg/ha + FYM @ 6 t/ha (T_6) (195.28 kg/ha) followed by *T. harzianum* @ 20 kg/ha + FYM @ 3 t/ha (T_3), *T. harzianum* @ 10 kg/ha + vermicompost @ 3.2 t/ha (T_8), *T. harzianum* @ 10 kg/ha + vermicompost @ 1.6 t/ha (T_7), *T. harzianum* @ 10 kg/ha + FYM @ 3 t/ha (T_3), *T. harzianum* @ 10 kg/ha + FYM @ 6 t/ha (T_4), *T. harzianum* @ 20 kg/ha + vermicompost @ 3.2 t/ha (T_{10}) and *T. harzianum* @ 20 kg/ha + vermicompost @ 1.6 t/ha (T_9). The minimum yield was found in control treatment (T_{12}) (103.67 kg/ha). The lower yield was recorded in all treatments due to incidence of blight and powdery mildew and also the infestation of aphids in later stage. The data of yield also showed significant results. The maximum yield was found in *T. harzianum* @ 20 kg/ha + FYM @ 6 t/ha (T_6) (234.33 kg/ha) followed by *T. harzianum* @ 20 kg/ha + FYM @ 3 t/ha (T_3) (197.00 kg/ha). The yield was low due to infestation of aphids in last stage of crop and incidence of powdery mildew disease in early stage.

8. FENNEL

8.1 Genetic Resources

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

(Dholi, Hisar, Jagudan, Jobner and Kumarganj)

Out of forty five accessions tested at Dholi centre, thirteen accessions namely, RF-20, RF-2, RF-16, RF-11, RF-15, RF-33, RF-31, RF-14, RF-10, RF-21, JF-234 and HF-116 gave the maximum yield as compared to high yielding variety Rajendra Saurabh. RF-20 and RF-13 produced maximum yield (1.6 kg/5.4 m²) followed by RF-16 and RF-2 (1.55 kg/5.4 m²).

One hundred twenty two accessions of fennel were evaluated during 2007-2008 & 2008-2009 using PF-35, GF-1 and Local as checks at Hisar. The mean seed yield of the germplasm ranged from 1496 kg/ha (HF-140) to 2992 kg/ha (HF-107). On the basis of average umbels per plant and yield performance, forty eight lines gave higher seed yield than the highest yielding check PF-35. The most promising lines were HF-107, HF-116, HF-122, HF-123, HF-125, HF-129, HF-143, HF-163, HF-200 and HF-212. These lines were maintained by sib mating under muslin cloth and self seed of all the lines have been harvested.

Among the germplasm evaluated at Jagudan centre sixteen entries were dwarf type, having less than 180 cm plant height. Thirteen entries had more than 15 branches per plant and more than 52 umbels per plant and more than 26 umbellates per umbel. Fourteen entries were promising for more seeds per umbellate i.e. e" 60 seed per umbellate. Ten entries were

observed as more or less early maturity (d" 178 days). Seven entries has high test weight i.e. > 8 g. Twenty entries isolated as high yielder recorded more than 3148 kg/ha grain yield (Table 47). Germplasm was screened against blight disease during kharif and rabi season. The incidence of Ramularia blight ranged from 15.20 to 47.75%. and 19.50 to 42.20% during kharif and rabi season respectively. The minimum incidence was found in GF-2 (Check).

Out of 46 entries evaluated at Kumarganj during 2008-09, maximum seed yield of fennel (13.10 q/ha) was recorded in NDF-5 and NDF-46 followed by 12.50 q/ha in NDF-45. Increase in seed yield of NDF-5 and NDF-46 was recorded over 24.76% against GF-2 and 12.93% against RF-101 used as check respectively.

At Jobner, a wide range of variability was found for all the characters studied. Out of 76 accessions, 28 accessions were better than best check variety RF-125. Some of the promising accessions identified on the basis of yield per 5 plants were JF-29, NS-27, NS-11, NS-46, UF-102 SPS, NS-32, NS-21, NS-64, HF-104 SPS and NS-55. The germplasm of fennel maintained at various centres is given in Table 48.

8.2 Coordinated Varietal Trial

8.2.1 CVT – 2004 –Series V

(Dholi, Hisar, Jobner and Kumarganj)

Eight promising entries and two checks (one national and local check) were tested at Dholi centre. Among the genotype and check, none of the entries were found significant regarding number of branches per plant and yield per plot (kg/3m²) or per hectare (t/ha) as compared to local check variety Rajendra Saurabh. Between two checks local check Rajendra Saurabh gave the maximum number of branches per plant (11.50), number of umbels per plant (72.50), number of umbellets per umbel (41.00), number of grains per umbellets (42.17), and yield per plot (1.58 kg/ 9 m²) or yield per hectare (1.76 t/ha) as compared to national check variety GF-2. Among the entries, genotype NDF-5 produced the maximum number of branches per plant (12.67), number of umbels per plant (114.33), number of umbellets per umbel (54.17), number of grains per umbellets (51.67) and yield per plot (1.87 kg/ 9 m²) or yield per hectare (2.08 t/ha) followed by genotype J.F-376.

At Hisar, out of 13 entries of fennel evaluated in coordinated varietal trial during 2008-2009. The maximum seed yield was recorded as 1923 kg/ha in FNL-24 followed by FNL -36 (1898 kg/ha), FNL -25 (1885 kg/ha) and FNL -26 (1842 kg/ha), respectively.

Twelve entries were evaluated in CVT at Jobner and the analysis of variance revealed significant differences among the entries for all the traits including seed yield. The seed yield ranged from 1075.56 to 1880.00 kg/ha. Of the fourteen entries evaluated, entry FNL-16 recorded maximum seed yield of 2128.89 kg/ha followed by FNL-15 (2066.67 kg/ha), FNL-22 (1808.89 kg/ha), FNL-21 (1764.44 kg/ha) and FNL-17 (1684.44 kg/ha), while lowest seed yield of 1253.33 kg/ha was recorded in FNL-14.

Table 47. Performance of fennel germplasm accessions at Jagudan

Character	Range	GF-2	Desirable value	No. of Entries	Promising entries identified
Dwarf (Plant height in cm)	110-195	170	<180	16	JF-608, 391, 515, 531-1, 544, 619, PF-35 (Ch), JF-513-1, 575-9, Bulgaria, JF-499, 569, 516, 574, 493 and JF-532
More branches (Number of branches/plant)	6-17	9	>15	13	JF-351-5, 531-1, 494, 484, 679, 444-3, 406, 529-3, 376, 497, 637, 660 and JF-588
More umbels (No. of umbels/plant)	15-77	36	<52	13	JF-497, 515, 478, 456-2, 494, 484, 493, 442-1, 529-3, 588, 604-1, 485-1 and JF-473
More umbellates (No. of umbellates/umbel)	13-30	22	>26	13	JF-597, 672, 575-9, 545, 513-1, 619, 442-1, 608, 499, 544, 497-1, 676 and JF-351-5
More seeds (No. of seeds/umbel)	16-95	48	>60	14	JF-442-1, 674, 678, 531-1, 608, 544, 501-1, 680, 545, 493, 522-2, 532, 617 and JF-546
Early maturity (No. of days)	164-223	187	<178	10	JF-351-1-3, 472-2-3, 529-1, 536, 642, 673, 518-2, 527, 537 and JF-583
1000 Seed weight (g)	5.1-9	7.01	>8	7	JF-572, 391, 535-1, Germany, JF-575, 586-5 and JF-200
Grain yield (g/plant)	26-223	155	>170	20	JF-510-1, 484, 311, 473, 513-1, 576, 406, 608, 391, 532, 494, 548, 444-3, 680, 478, 420-3-2, 442-1, 472-2-2, Italy and JF-456-2
Projected yield (kg/ ha)	481-4130	2870	>3148	20 As above....

Table 48. Fennel germplasm collections maintained at various AICRPS centres

Centre	Indigenous	Exotic	Total
Dholi	45	-	45
Hisar	134	-	134
Jagudan	115	4	119
Jobner	261	20	281
Kumarganj	46	-	46
Total	601	24	625

Out of ten entries evaluated at Kumarganj, FNL-5 showed the maximum seed yield of 17.70 q/ha followed by 16.66 q/ha in FNL-11. FNL-22 showed maximum seed yield of 18.95 q/ha followed by FNL-20 out of ten entries (FNL-12 to FNL-23) over checks of GF-2 (1.179 q/ha).

8.2.2 Coordinated Varietal Trial – Transplant-early rabi (2006) (Jagudan and Hisar)

At Jagudan, the entry FNL-2 was found significantly superior for yield (2407 kg/ha) followed by FNL-1 (2225 kg/

ha), FNL-3 (2222 kg/ha), FNL-9 (2188 kg/ha) and FNL-4 (2131 kg/ha) than check GF-2, which were 16.19, 7.37, 7.25, 5.58 and 2.84 per cent higher over check, respectively. The pooled over three years data shown significant yield differences between the entries. But none of the entries were found significantly superior for yield over check. However, entry FNL-2 (JF-444-1) gave higher yield (2588 kg/ha) and was at par with FNL-3, FNL-4, GF-2(Ch) and FNL-1, which was 14.56 per cent higher over check GF-2.

Significant differences were obtained for all the parameters at Hisar during 2006-07 in CVT of transplanted fennel. Plant

height ranged from 113.0 to 133.3cm, number of branches 7.2 to 9.0, umbels per plant 24.2 to 36.6 and seeds per umbel 227.8 to 304.4. Maximum seed yield was recorded as 2138 kg/ha in FNL-6 which was statistically at par with FNL-1 and FNL-5. During 2007-08, the plant height ranged from 167.1 to 198.4 cm, number of branches 13.8 to 18.1, umbels per plant 131.9 to 206.8 and seeds per umbel 365.2 to 569.1. Maximum seed yield was recorded as 2088 kg/ha in FNL-9 which was statistically at par with FNL-3(2088 kg/ha) and FNL-5 (2088 kg/ha). During the third year also significant differences were obtained for all the parameters. Plant height ranged from 130.2 to 182.8, number of branches 14.8 to 19.5, umbels per plant 55.9 to 106.9 and seeds per umbel 714.1 to 928.5. Maximum seed yield was recorded as 2122 kg/ha in FNL-9 which was statistically at par with FNL- 3, FNL- 6 and FNL- 11 (Table 49). On the basis of average yield of three years (2006-2007 to 2008-2009) at Hisar the maximum seed yield was recorded as 2044 kg/ha in HF-125 (FNL-6) which

was 20.7% higher over local check followed by NDF-5 (16.3%) and HF-118 (15.8%) (Table 50).

8.2.3 CVT – 2007 –Series VI

(Jobner, Jagudan, Hisar and Kumarganj)

Fifteen entries were evaluated at Jobner and the analysis of variance revealed significant differences among the entries for all the traits including seed yield at Jobner centre. The seed yield ranged from 753.33 to 2460.00 kg/ha. Of the fifteen entries evaluated, entry FNL-25 recorded maximum seed yield of 2460.00 kg/ha followed by FNL-26 (2022.22 kg/ha), RF-125 check (1950.67 kg/ha), RF-178 (1786.67 kg/ha), FNL-36 (1626.67 kg/ha), FNL-30 (1526.67 kg/ha) and FNL-28 (1476.67 kg/ha), while lowest seed yield of 753.33 kg/ha was recorded in FNL-31 (Table 51).

The significant yield differences were observed among entries at Jagudan. But none of the entries were found

Table 49. Performance of CVT on transplanted fennel at Hisar (2008-2009)

Entries	Plant height (cm)	Branches per plant	Umbels per plant	Umbellets per umbel	Seeds per umbel	Seed yield (kg/ha)
FNL -1	138.1	15.9	81.7	32.7	710.9	1790
FNL -2	130.2	14.8	55.9	34.2	770.9	1448
FNL -3	141.3	18.6	87.4	38.9	928.5	1950
FNL -4	148.8	15.8	81.0	31.1	638.4	1537
FNL -5	157.0	17.9	94.9	32.7	714.1	1877
FNL -6	157.7	18.6	106.9	36.8	800.9	2008
FNL -7	182.8	17.6	86.3	36.4	877.2	1787
FNL -8	159.6	16.4	83.5	30.7	769.9	1672
FNL -9	150.4	19.5	126.6	37.8	851.7	2122
FNL -10	133.8	15.2	75.2	35.4	766.7	1786
FNL -11	168.4	17.7	114.9	35.5	781.2	2086
Local (C)	158.9	18.2	94.6	34.4	720.6	1810
CD (P=0.05)	9.2	1.1	8.8	1.5	63.3	179

Table 50. Yield performance of transplanted fennel under CVT at Hisar over three years

Entries	Seed yield (q/ha)				Increase over local check (%)
	2006-07	2007-08	2008-09	Mean	
FNL -1 (JF-376)	2032	1580	1790	1801	06.3
FNL -2 (JF-444-1)	1350	1250	1448	1349	-20.4
FNL -3 (JF-600)	1050	2038	1950	1679	-00.9
FNL -4 (JF-642)	1750	1885	1537	1724	01.8
FNL -5 (HF-118)	1975	2033	1877	1962	15.8
FNL -6 (HF-125)	2138	1987	2008	2044	20.7
FNL -7 (HF-107)	1788	1713	1787	1763	04.1
FNL -8 (HF-116)	1862	1505	1672	1680	-00.8
FNL -9 (NDF-5)	1700	2088	2122	1970	16.3
FNL -10 (NDF-6)	1254	1710	1786	1583	-06.6
FNL -11 NDF-12	1775	1790	2086	1884	11.2
Local (Check)-	1540	1733	1810	1694	-
CD (P=0.05)	173	186	179	-	-

Table 51. Performance of CVT fennel at Jobner

Entries	Days to flowering	Plant height (cm)	Branches per plant	Umbels per plant	Umbellets per umbel	Seeds per umbel	Test weight (g)	Seed yield (kg/ha)
FNL-25	106.00	106.33	6.27	14.33	19.67	310.33	6.75	2460.00
FNL-26	108.33	116.00	6.33	13.87	18.67	301.07	6.73	2022.00
FNL-27	106.33	105.27	6.13	13.07	20.73	281.33	6.51	1282.00
FNL-28	105.67	102.20	6.13	11.73	20.00	247.87	6.78	1476.67
FNL-29	106.67	101.53	5.40	9.87	20.80	307.07	7.45	1323.33
FNL-30	110.67	107.27	5.60	12.07	19.93	290.40	7.01	1526.67
FNL-31	105.33	109.00	6.13	10.40	20.87	224.33	6.45	753.33
FNL-32	108.33	108.47	6.13	10.27	19.67	242.13	5.98	1280.00
FNL-33	108.00	108.27	6.07	9.20	19.93	236.93	4.62	986.67
FNL-34	105.00	125.40	5.27	10.87	21.67	306.67	6.22	1346.67
FNL-35	104.67	104.40	6.40	11.87	19.60	301.20	7.01	1466.67
FNL-36	108.00	107.67	5.73	13.07	18.73	278.00	6.67	1626.67
RF-125 Check	109.67	90.87	6.13	14.80	19.20	306.80	6.71	1950.67
RF-178 Check	106.33	98.80	6.13	12.40	19.13	270.53	8.02	1786.67
Local Check	107.33	103.20	5.87	10.73	20.47	242.93	6.77	1116.67
CD (P=0.05)	NS	12.75	0.46	1.92	NS	56.38	0.24	302.62
CV (%)	1.69	7.17	4.61	9.62	7.41	12.19	2.12	12.11

significantly superior for yield over check. However, entry FNL-24 gave higher yield (970 kg/ha) than check GF-11, which was 38.72 per cent higher over check GF-11). The pooled over two years data shown significant yield differences due to entries. Entry FNL-29 had recorded superior yield (1574 kg/ha) and was at par with FNL-25 and FNL-28, which was 15.91 per cent higher over check GF-11.

At Kumarganj, FNL-31 was the highest seed yielder (1631 kg/ha) among 12 entries tested. FNL-22 was the highest seed yielder (1895 kg/ha) among all the entries tested.

8.3 Varietal Evaluation Trial

8.3.1 Initial evaluation trial

(Hisar, Jobner, Kumarganj and Jagudan)

The initial evaluation trial (IET) in fennel was conducted with ten accessions along with GF-2 as check during 2007-2008 and 2008-2009 at Hisar. The results indicated that HF-119 and HF-147 gave significantly better yield over GF-2 (check) showing 23.4 and 20.6% increase in yield, respectively. Hence, both these lines will be included in coordinated varietal trial for further evaluation (Table 52).

Twelve entries were evaluated in RBD with 3 replications in a plot size of 3 x 2.5 sq. m. at Jobner centre. The analysis of variance revealed significant differences among the entries for all the traits including seed yield. The seed yield ranged from

1231.11 to 2053.33 kg/ha. Of the twelve entries evaluated, entry NS-63 recorded maximum seed yield of 2053.33 kg/ha followed by NS-46 (1857.78 kg/ha), RF-125 check (1653.33 kg/ha), NS-3 (1484.44 kg/ha) and NS-32 (1466.67 kg/ha), while lowest seed yield of 1231.11 kg/ha was recorded in NS-37 and Local. Mean performance of the entries evaluated in IET over 2005-06 and 2007-08 revealed superior performance of NS-63 yielding 1974.57 kg/ha followed by NS-46 (1798.27 kg/ha), RF-125 check (1680.74 kg/ha) and RF-101 check (1491.98 kg/ha), while lowest mean seed yield of 1064.69 kg/ha was recorded in NS-37. NS-63 (UF-281) and NS-46 (UF-281) may be promoted to CVT (Tables 53 & 54).

The significant yield differences were observed among entries at Jagudan. But none of the entry was significantly superior over check GF-11. The pooled over two years data showed non significant yield differences due to entries. However, an entry JF-586-5 gave higher yield (1419 kg/ha) which was 1.01 per cent higher over check GF-11.

An initial evaluation trial was conducted at Kumarganj center with 10 promising lines. NDF-5 gave maximum seed yield of 12.84 q/ha followed by seed yield of 11.45 q/ha in NDF-33. In three years of study NDF-5 gave maximum seed yield of 8.64 q/h followed by NDF-6 (7.71 q/ha).

Table 52. Pooled yield of IET fennel at Hisar

Accession	Seed yield (kg/ha)			Increase over check (%)
	2007-2008	2008-2009	Mean	
HF-115	1804	1860	1832	11.16
HF-119	2017	2050	2033	23.39
HF-124	1960	1806	1883	14.26
HF-128	1863	1773	1818	10.31
HF-132	1753	1738	1745	05.92
HF-147	1988	1986	1987	20.57
HF-149	1860	1768	1814	10.10
HF-154	1867	1740	1803	09.43
HF-158	1768	1883	1825	10.77
GF-2 (Check)	1660	1636	1648	-
CD(P=0.05)	144	128	-	-

8.4 Quality evaluation trial

8.4.1 Quality evaluation in fennel

(Jobner)

Twelve entries of fennel under CVT were tested for volatile oil content at Jobner during Rabi 2007-08, which were analysed using Clevenger apparatus. The volatile oil content in the entries ranged from 1.60% to 2.20%. The maximum volatile oil of 2.20% was observed in FNL-15 followed by 2.13% in FNL-14, FNL-16, FNL-17 and Local, while, minimum of 1.60% in FNL-12. The entry FNL-15 ranked first in terms of volatile oil yield

(45.47 l/ha) followed by FNL-16 (45.35 l/ha), FNL-23 (36.52 l/ha), RF-125 (36.18 l/ha) and FNL-17 (35.88 l/ha). While lowest volatile oil yield of 24.75 l/ha was recorded in FNL-12.

Twelve entries of fennel under IET were tested for volatile oil content and the volatile oil content in the entries ranged from 2.37% to 3.20%. The maximum volatile oil of 3.20% was recorded in NS-63 followed by 2.93% in NS-37, 2.87% in NS-45 and 2.73% in NS-32, whereas minimum of 2.37% in NS-11. The entries NS-63, NS-46, RF-125 and NS-45 have shown better performance as compared to local check with respect to volatile oil yield in terms of litre per hectare.

Table 53. Performance of IET of fennel at Jobner

Entries	Days to flowering	Plant height (cm)	Branches per plant	Umbels per plant	Umbellets per umbel	Seeds per umbel	Test weight (g)	Seed yield (kg/ha)
NS-3	115.33	130.87	6.87	18.47	22.00	342.67	5.68	1484.44
NS-10	114.67	127.20	6.07	19.13	20.47	368.67	6.62	1337.78
NS-11	114.33	120.33	6.73	20.60	20.67	331.13	6.79	1342.22
NS-32	116.33	137.80	7.07	16.73	23.20	403.40	5.76	1466.67
NS-37	115.67	128.40	6.53	14.27	21.87	391.33	5.59	1231.11
NS-41	116.33	122.40	7.00	18.80	19.47	336.07	6.59	1240.00
NS-45	117.33	123.73	6.93	18.80	22.20	371.87	7.28	1368.89
NS-46	116.00	116.33	7.40	18.40	23.00	349.87	6.89	1857.78
NS-63	119.00	122.60	7.87	20.00	21.47	430.53	6.37	2053.33
RF-101 Check	114.33	132.20	7.00	17.00	19.47	345.47	6.23	1466.67
RF-125 check	114.33	124.00	7.27	18.33	19.27	319.80	5.33	1653.33
Local Check	114.33	132.07	6.20	15.60	21.93	324.93	5.72	1231.11
CD (P=0.05)	1.99	10.73	0.67	2.95	NS	63.46	0.22	290.06
CV (%)	1.02	5.01	5.72	9.66	9.08	10.42	2.09	11.59

Table 54. Pooled yield of fennel entries evaluated in IET at Jobner.

Entries	Yield (kg/ha)			
	2005-06	2006-07	2007-08	Mean
NS-63	1962.96	1907.41	2053.33	1974.57
NS-46	1694.44	1842.59	1857.78	1798.27
NS-10	1259.26	1398.10	1337.78	1331.71
NS-41	1166.67	1555.56	1240.00	1320.74
NS-32	907.41	1518.52	1466.67	1297.53
NS-3	1055.56	1351.85	1484.44	1297.28
NS-45	972.22	1074.07	1368.89	1138.39
NS-11	1212.96	833.33	1342.22	1129.50
NS-37	907.41	1055.56	1231.11	1064.69
RF-125 (Check)	1629.63	1759.26	1653.33	1680.74
RF-101 (Check)	1333.33	1675.93	1466.67	1491.98
Local Check	1074.07	1157.41	1231.11	1154.20
CD (P=0.05)	251.43	272.76	290.06	
CV (%)	10.40	12.74	11.59	

8.5 Nutrient Management Trial

8.5.1 Identification of drought/ alkalinity tolerance source in fennel (Kumarganj)

During 2008-09, ten genotypes of fennel was tested at Kumarganj with four levels of ESP, the highest mean seed yield of 42.17g/plant was recorded in FNL-12. Seed yield of 51.25 g/plant and 48.16 g/plant was recorded under 10 and 20 ESP levels in NDF-12.

8.5.2 Effect of bio-fertilizer, *Azospirillum* on fennel (Adaptive trial) (Dholi)

At Dholi all the 9 treatment combinations of bio-fertilizer *Azospirillum* gave significant effect regarding number of branches per plant, number of umbellets per umbel and yield per plot or per hectare as compared to control. Among the treatments of bio-fertilizer *Azospirillum*, application of inorganic nitrogen (100%) + FYM-5 t/ha + *Azospirillum* (T₁) produced maximum height of the plant (184.00), number of branches per plant (10.50), number of umbels per plant (79.00), number of umbellets per umbel (42.83), number of grains per umbellet (52.17) and yield per plot (1.38 kg/7.2 m²) or yield (1.92 t/ha) followed by inorganic nitrogen (75%) + FYM-5 t/ha + *Azospirillum* (T₂).

8.6 Role of rhizobacteria in growth promotion of fennel (Jagudan, Hisar and Raigarh)

Two different types of rhizobacteria and their methods of application with recommended dose of fertilizer were tested on fennel cv. GF 11 at Jagudan to evaluate the effect of rhizobacteria on growth, yield and quality of seed. Growth, yield attributes, yield and quality of fennel were not influenced

significantly by both the inoculants and its methods of application. But application of FK14 + FL18 as seed and soil inoculation recorded the higher growth and yield attributes as well as seed yield of fennel.

At Hisar significant differences were obtained for all the parameters except umbellets per umbel. The maximum seed yield (1973 kg/ha) was recorded with the application of *Trichoderma* MTCC- 5179, followed by rhizobacteria FK-14 (seed treatment) and rhizobacteria FL-18 (seed treatment + soil application) yielding 1962 kg/ha and 1917 kg/ha, respectively (Table 55).

At Raigarh, among the various treatments, maximum height (103.4 cm. and 104.3 cm) and yield (880 kg/ha and 910 kg/ha) of fennel crop was obtained in rhizobacteria FK 14 and FL 18 respectively when applied as seed treatment and soil application.

8.7 Survey and identification of disease causing organism in fennel and screening germplasm against diseases. (Dholi)

No disease incidence was recorded in the germplasm as well as in the surveyed area of Samastipur & Muzaffarpur districts by the Dholi centre.

9 FENUGREEK

9.1 Genetic Resources

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

(Dholi, Hisar, Jagudan, Jobner and Kumarganj)

Out of one hundred seventy one collection of fenugreek evaluated at Dholi, only twenty one accessions namely, Sel-37,

Table 55. Effect of rhizobacteria on growth and seed yield of fennel at Hisar

Treatment	Plant height (cm)	Branches per plant	Umbels per plant	Umbellets per umbel	Seeds per umbel	Seed yield (kg/ha)
Rhizobacteria FK 14 (seed treatment)	163.2	11.3	64.6	31.3	751.2	1962
Rhizobacteria FK 14 (seed treatment + soil application)	155.4	11.9	57.7	30.9	681.8	1483
Rhizobacteria FL 18 (seed treatment)	158.6	12.1	58.0	31.8	667.2	1505
Rhizobacteria FL 18 (seed treatment + soil application)	156.7	11.8	58.0	33.0	823.1	1917
Rhizobacteria FK 14+FL 18 (seed treatment)	152.7	11.2	65.8	30.0	600.6	1768
Rhizobacteria FK 14+FL 18 (seed + soil treatment)	149.8	11.8	68.2	31.3	586.4	1630
<i>Trichoderma</i> MTCC 5179 (recommended dose)	156.2	11.4	71.5	30.0	595.6	1973
Control	150.0	11.1	66.1	29.1	569.9	1510
CD (P=0.05)	16.2	0.5	8.0	NS	45.7	123

EC-57790, RM-70, RM-10, RM-185, RM-44, RM-28, J.Fenu-195, RM-90, RM-188, RM-186, H.M-291, H.M-144, H.M-103, UM-125, UM-86, J.Fenu-210, J.Fenu-58, GM-24, Sel-24 and UM-19 gave the maximum yield as compared to high yielding variety Rajendra Kanti. Among the promising accessions, selection-37 gave the maximum yield (0.90 kg/4.5 m²) followed by EC-57790 with 0.85 kg/4.52 m². The germplasm of fenugreek maintained in various AICRPS centres are given in Table 56.

Seventy six entries including GM-1 and GM-2 as checks were evaluated for different characters at Jagudan. Among them 10 entries were tall types having more than 71 cm plant height. Seven entries had recorded more or equal to 3.6 branches per plant. Eight entries were identified as high yielders i.e. more than 1017 kg/ha (Table 57). During the year, 35 entries were screened against powdery mildew disease under natural condition. The disease incidence ranged from 18.25 to 90.75%. None of the entries were found free from disease incidence. The minimum incidence was found in JFg-246 (18.25%)

followed by JFg-242 (25.50%) and GM-2 (Ch) (26.70%). Overall, the entire entries showed moderate to susceptible reaction. During the year, total 7 entries were selected from previous year screening and were again screened against powdery mildew disease under natural condition. The disease incidence ranged from 8.75 to 18%. The entry GM-1-2 and GM-2-2 was found < 10% incidence against powdery mildew disease. Overall, the entire entries showed more or less tolerant reaction to the disease.

Thirty one germplasm accession were evaluated along with four checks namely, RMT-1, RMT-143, RMT-303 and Local in augmented design at Jobner. A wide range of variability was found for all the characters studied. Out of 31 accessions, 6 accessions were better than best check variety RMT-303. These six promising accessions identified on the basis of yield per 5 plants were UM-345, UM-252, NC-2002-8, UM-354, UM-350, UM-349 and UM-342.

Table 56. Fenugreek germplasm collections under AICRPS centres

Centre	Indigenous	Exotic	Total
Dholi	171	-	171
Hisar	295	-	295
Jagudan	76	-	76
Jobner	353	12	365
Kumarganj	82	-	82
Total	977	12	989

Table 57. Promising germplasm accessions of fenugreek at Jagudan

Desirable character	Character	Range	GM-2 (C)	Desirable values	No. of Entry	Promising accession
Dwarf (Plant height in cm)	Plant height (cm) (Tall)	44-78	54	<71	10	JFg- 223, 204,263, 208, 225, 242, 267, 255, 226 and 205
More branches (No. of branches/plant)	No. of branches / plant (More branch)	2-4	2.6	>3.6	7	JFg-7, 196, 195, 239, 203, 208 and JFg- 226
More umbels (No. of umbels/plant)	No. of pods/plant (More pods)	9.6-29.8	13	>22	8	JFg-196, 195, 247, 203, 223, 204, 208 and JFg- 225
More umbellates (No. of umbellates/ umbel)	Length of pods (cm) (Long pods)	6.8-19.3	9.7	>9.3	8	GM-1©, GM-2©, JFg-180, 226,201, 220, 181 and JFg-236
More seeds (No. of seeds/umbel)	No. of seeds/pod (More seeds)	13.4-24.4	22.2	>21	10	JFg-235, 228, 247, 255, 249, GM-2©, JFg-180, 236, 266 and JFg-263
Early maturity (No. days)	Maturity days (Early)	89-113	92	<93	10	JFg-52, 262, 178, 179, 184, 201, Anantpur, JFg-80, 249 and GM-2©
Grain yield (g/plant)	Grain yield (g/plant) (High yield)	0.22-5.56	0.8	>3	8	JFg-266, 223, 208, 205, 239, 196, 237 and JFg- 226
Projected yield (kg/ ha)	Grain yield (kg ha ⁻¹)(High yield)	71-1819	260	>1017	8 As above

Out of 82 genotypes screened at Kumarganj, NDF-25 produced maximum seed yield of 25.30 q/ha followed by NDM-61 with a seed yield of 21.80 q/ha.

One hundred eighty accessions of fenugreek were evaluated at Hisar, along with Hisar Sonali and PEB as checks during 2007-2008 and 2008-2009. The mean seed yield of the germplasm material ranged from 977 kg/ha (HM-283-5) to 3029 kg/ha (HM-259). Seventy lines gave higher seed yield than the highest yielding check, Hisar Sonali. The most promising lines for seed yield were HM-208-1, HM-211, HM-211-1, HM-259, HM-259-1, HM-273, HM-280-1, HM-361, HM-426 and HM-453.

9.2 Coordinated Varietal Trial

9.2.2 CVT 2006

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

Twenty entries were at Jobner and the analysis of variance revealed significant differences among the entries for all the traits including seed yield. The seed yield ranged from 983.80 to 1789.35 kg/ha. Of the twenty entries evaluated, entry FGK-1 recorded maximum seed yield of 1789.35 kg/ha followed by FGK-16 (1675.46 kg/ha), RM-28 (1671.76 kg/ha), FGK-6 (1636.31 kg/ha), RMt-351 check (1554.63 kg/ha), FGK-7 (1538.89 kg/ha), RMt-1 check (1531.02 kg/ha), and FGK-9 (1448.61 kg/ha), while lowest yield of 983.80 kg/ha was recorded in FGK-10 (Table 58).

At Hisar significant differences were obtained for all the parameters. Plant height ranged from 110.9 to 145.3 cm,

pods per plant 82.0 to 120.4, length of pods 7.7 to 9.8 cm and seeds per pod 16.0 to 17.4. Maximum seed yield (2063 kg/ha) was recorded in FGK-20 followed by FGK-17 (2038 kg/ha) and FGK-21 (1980 kg/ha) (Table 59).

Pooled analysis of three years data at Kumarganj indicated that maximum seed yield of 18.35q/ha was recorded in FGK-12.

At Dholi, among three check, Rajendra Kanti gave the maximum number of pods per plant (41.67), number of grains per pod (16.60) and yield per plot 1.27 kg/7.2 m² or per hectare (1.76 t/ha) as compared to check J.Fg-244 and national check FGK-16 while check J.Fg-244 was found tall type (97.00 cm) with delayed maturity (142.00 days) as compared to local check Rajendra Kanti and national check FGK-16. All the entries were found non-significant regarding number of pods per plant, number of grains per pod as compared to local check variety Rajendra Kanti. However, all the entries were recorded significantly of delayed maturity as compared to local check variety Rajendra Kanti. Regarding Yield, only FGK-14 gave significantly more yield per plot (1.58 kg/7.2 m²) or per hectare (2.20 t/ha) as compare to local check variety Rajendra Kanti. The pooled analyses data indicated that among three check, local check Rajendra Kanti produced the maximum number of branches (6.47), number of pods per plant (43.40), length of pod (10.15 cm), number of grains per pod (15.98) and yield per plot (1.14 kg/7.2 m²) or per hectare (1.58 t/ha) and minimum height of the plant (67.61 cm) & early maturity (134.89 days) as compared to national check FGK-16 and check J.Fg-244 at Dholi.

Table 58. Performance of CVT fenugreek at Jobner

Entries	Days to flowering	Plant height (cm)	Branches per plant	Pods per plant	Pod length (cm)	Seeds per pod	Test weight (g)	Seed yield (kg/ha)
FGK-1	58.00	59.67	6.87	37.40	10.60	18.40	11.38	1789.35
FGK-2	52.33	54.30	5.53	27.20	10.07	15.93	11.02	1407.87
FGK-3	50.67	61.13	5.53	28.33	10.00	15.20	11.24	1392.59
FGK-4	55.00	58.40	6.13	28.40	11.63	16.00	8.44	1424.07
FGK-5	54.33	63.40	5.87	34.13	9.70	14.20	10.20	1393.52
FGK-6	55.00	64.37	5.93	34.07	10.90	17.40	10.60	1636.11
FGK-7	52.67	62.07	5.47	30.87	11.37	16.93	10.55	1538.89
FGK-8	56.67	51.13	6.60	28.67	10.63	15.73	8.41	1319.91
FGK-9	52.67	61.47	5.73	26.40	10.97	15.73	10.84	1448.61
FGK-10	54.67	55.60	5.73	25.07	10.47	13.33	10.77	983.80
FGK-11	53.33	56.33	5.93	24.00	11.97	15.00	10.56	1044.44
RM-18	55.33	60.67	5.93	31.87	10.50	15.53	9.42	1425.93
RM-28	58.67	56.73	5.73	34.53	10.27	16.87	11.07	1671.76
RM-70	59.00	56.27	5.73	28.87	10.43	13.60	11.37	1309.26
FGK-16	53.00	60.53	5.60	32.63	12.33	19.00	11.51	1675.46
JFg-244	53.67	59.20	5.47	26.73	10.57	15.07	11.76	1397.69
RMt-1 (Ch.)	55.67	62.93	5.47	31.20	10.40	17.47	11.07	1531.02
RMt-303 (Ch.)	53.33	59.07	6.07	37.80	10.33	16.67	11.07	1333.80
RMt-351	53.33	56.93	6.10	38.47	10.63	17.53	10.37	1554.63
Local Check	74.67	65.40	6.70	20.07	10.17	15.60	8.11	1188.89
CD (P=0.05)	2.03	5.36	0.50	6.28	1.02	1.20	0.25	192.65
CV (%)	2.21	5.47	5.15	12.52	5.78	4.53	1.47	8.19

Table 59. Performance of CVT in Fenugreek (2008-2009) at Hisar

Entries	Plant height (cm)	Branches per plant	Pods per plant	Length of pod (cm)	Seeds per pod	Seed yield (kg/ha)
FGK-1	127.1	6.6	92.1	8.5	16.4	1692
FGK-2	145.3	7.4	97.7	8.7	16.8	1810
FGK-3	124.7	7.8	82.0	8.3	16.7	1630
FGK-11	142.4	7.4	105.9	8.8	16.4	1665
FGK-17	131.0	6.9	114.2	8.1	16.6	2038
FGK-18	112.6	6.6	92.1	8.6	17.4	1720
FGK-19	110.9	7.2	110.9	7.8	16.0	1918
FGK-20	126.4	7.7	120.4	7.7	16.0	2063
FGK-21	120.5	6.9	108.2	8.5	17.2	1980
FGK-22	115.7	7.7	105.2	8.2	16.2	1844
CD (P=0.05)	9.0	0.4	34.2	0.5	0.8	146

During 2008-09, fourteen genotypes from other coordinating centers were evaluated at Guntur and the plant height, maximum plant height was recorded by FGK-22 (42.4 cm) which is significantly superior to check Lam Selection-I (34.5 cm). Minimum plant height was recorded by UM-363 (33.3 cm). Maximum number of branches was recorded in FGK-22, (5.7) which is significantly superior to the other check

Lam Selection-I (4.5). Minimum number of branches was recorded in UM-363 (3.8). Numbers of pods were maximum in FGK-22 (34.3) which is significantly superior to the check Lam Selection-I (23.1). Lowest number of pods was recorded in NDM-20 (37.5). Maximum pod length was recorded in FGK-22 (11.2 cm) followed by NDM-20 (11.0 cm) and FGK-18 (11.0 cm) which were on par with each other and significantly

superior to check Lam Selection-I (9.7 cm). Number of seeds per pod was more in FGK-22 (13.2) followed by FGK-20 (13.2) which was on par with each other and significantly superior to the check Lam Selection-I (10.2) which recorded the lowest. Among the twelve entries evaluated from different sub centers FGK-22 (466 kg/ha), FGK-18 (423 kg/ha), UM-361 (398 kg/ha) and FGK-19 (362 kg/ha) recorded significantly higher yield than the check LS-I (359 kg/ha). The three years pooled analysis of entries indicated that, among the ten entries evaluated for three years, LFC-84 recorded highest yield (793 kg/ha) followed by LFC-87 (742 kg/ha) which were on par with each other and significantly superior to the check Lam Selection-I (585 kg/ha).

At Jagudan, nonsignificant yield differences were observed among the entries. However, the entries FGK-18, FGK-3, FGK-2 and FGK-1, gave the highest yield (i.e., 989, 962, 909 and 861 kg/ha, respectively), which was 34.70, 26.11, 23.78 and 17.33% higher over check GM-2, respectively.

9.3 Varietal Evaluation Trial

9.3.1 Initial evaluation trial

(Hisar, Jagudan, Kumarganj and Jobner)

The initial evaluation trial (IET) in fenugreek was conducted with nine accessions along with Hisar Sonali as check during 2007-2008 to 2008-2009 at Hisar. The results indicated that maximum mean seed yield was recorded in HM-259 (3055 kg/ha) followed by HM-280-1 (2915 kg/ha) showing an increase of 30.3 and 24.3% over Hisar Sonali (check), respectively (Table 60). Both these lines i.e. HM-259 and HM-280-1 will be included in co-ordinated varietal trial for further evaluation.

At Jagudan JFg-269 and JFg-264 gave significantly higher yield (841 and 780 kg/ha respectively) than GM-2 which was 25.01 and 15.83 per cent higher over GM-2, respectively.

NDM-25 was the highest seed yielder (22.91 q/ha) followed by NDM-19 (20.41 q/ha) out of 10 promising lines tested at

Kumarganj. Three years pooled data revealed that NDM-25 gave highest seed yield of 23.83q/h followed by NDM-19 yielding 21.93 q/h of fenugreek seed yield.

Ten entries were evaluated at Jobner and the analysis of variance revealed significant differences among the entries for all the traits including seed yield. The seed yield ranged from 1074.07 to 1703.70 kg/ha. Of the 10 entries evaluated, entry UM-202 recorded maximum seed yield of 1703.70 kg/ha followed by UM-354 (1564.81 kg/ha), UM-353 (1388.89 kg/ha), UM-163 (1379.63 kg/ha) and UM-152 (1361.11 kg/ha), while lowest yield of 1074.07 kg/ha was recorded in Local check (Table 61). Mean performance of the entries evaluated in IET over 2006-07 and 2007-08 revealed superior performance of UM-202 yielding 1578.70 kg/ha followed by UM-454 (1532.41 kg/ha), RMT-303 check (1332.08 kg/ha) and RMT-1 check (1314.81 kg/ha), while lowest seed yield of 962.96 kg/ha was recorded in Local check.

9.4 Nutrient Management Trial

9.4.1 Effect of bio-fertilizer, *Azospirillum* on fenugreek (Adaptive trial)

(Dholi)

Application of inorganic nitrogen (100%) + *Azospirillum* + 5 t/ha FYM (T₁), inorganic nitrogen (75%) + *Azospirillum* + 5 t/ha FYM (T₂), inorganic nitrogen (50%) + *Azospirillum* + 5 t/ha FYM (T₃) and 100% inorganic nitrogen (T₈) gave significantly more yield as compared to control (T₁₀) at Dholi centre. Application of inorganic nitrogen (100%) + *Azospirillum* + 5 t/ha FYM (T₁) gave the maximum number of branches per plant (7.57), number of pods per plant (81.47) and yield per plot (1.10 kg/7.2 m²) or yield per hectare (2.44 t/ha) followed by inorganic nitrogen (75%) + *Azospirillum* + 5 t/ha FYM (T₂).

9.5 Effect of bio-regulators on fenugreek

(Jobner, Coimbatore and Dholi)

Table 60. Initial evaluation trial in fenugreek at Hisar

Accession number	Seed yield (kg /ha)			Increase over check (%)
	2007-2008	2008-2009	Mean	
HM-211	2960	2740	2850	21.5
HM-259	2850	3260	3055	30.3
HM-273	2640	2760	2700	15.1
HM-280-1	2940	2890	2915	24.3
HM-342	2530	2730	2630	12.2
HM-361	2760	3010	2885	23.0
HM-405	2450	2840	2645	12.8
HM-445	2620	2860	2740	16.8
HM-471	2645	2820	2732	16.5
Hisar Sonali (Check)	2360	2430	-	-
CD (P=0.05)	210	190	-	-

Table 61. Initial evaluation trial of fenugreek 2007-08 at Jobner

Entries	Days to flowering	Plant height (cm)	Branches per plant	Pods per plant	Pod length (cm)	Seeds per pod	Test weight(g)	Seed yield (kg/ha)
UM-152	55.33	66.13	5.40	35.00	10.20	17.47	11.79	1361.11
UM-202	58.33	62.00	5.47	46.40	10.40	18.13	13.27	1703.70
UM-134	54.33	60.27	5.57	37.40	9.83	15.33	9.82	1138.89
UM-189	59.00	62.60	6.43	42.40	10.60	17.73	10.02	1361.11
UM-163	54.67	62.97	5.30	40.20	10.00	17.60	10.44	1379.63
UM-353	54.67	63.20	5.67	41.27	10.57	16.87	10.01	1388.89
UM-354	56.33	68.14	6.27	42.40	10.73	16.87	11.76	1564.81
RMt-1 Ch.	54.33	56.70	6.03	39.20	10.50	17.47	11.13	1314.81
RMt-303 Ch.	52.67	63.00	6.10	42.93	10.27	17.80	10.82	1342.59
Local Check	71.00	63.73	6.63	39.07	10.17	17.87	9.27	1074.07
CD (P=0.05)	1.22	2.51	0.31	4.94	NS	1.25	0.34	252.76
CV (%)	1.24	2.33	3.04	7.10	4.77	4.19	1.84	10.82

An experiment on effect of bioregulators on fenugreek at Jobner indicated that application of NAA @ 50 ppm resulted in significantly higher seed yield of fenugreek and net returns over other treatments. Triacantanol 1.0 ml/l was also significantly superior over Triacantanol 0.5 ml/l and water spray. Data further indicated that with the increase in number of sprays, the seed yield and net returns also showed increasing trend but the significant response was observed only up to 2 sprays i.e. at 40 and 60 DAS. Significantly lower seed yield and net returns was recorded in the absolute control as compared to the mean of all other treatments. On the basis of three years experiment, it was concluded that two foliar spray of 50 ppm NAA at 40 and 60 DAS could be recommended for obtaining higher seed yield as well as net returns from fenugreek crop (Table 62).

At Coimbatore, during the third year of evaluation the grain yield varied from 277.8 kg/ha to 433.4 kg/ha among the treatments. The highest grain yield of 433.4 kg/ha was obtained in the treatment T₆ (Triacantanol 1.0 ml/l at 40, 60 & 80 days after sowing) followed by T₉, NAA 50 ppm at 40, 60 & 80 days after sowing (422.2 kg/ha) and T₅, Triacantanol 1.0ml/l at 40 & 60 days after sowing (411.2 kg/ha). The pooled analysis of three years data revealed that the grain yield/ha varied from 375.6 kg to 522.97 kg. The highest yield of 522.9 kg/ha was recorded by the treatment T₃ (Triacantanol 0.5ml/l at 40, 60 and 80 days after sowing). This was on par with the treatments T₄ (Triacantanol 1.0ml/l at 40 days after sowing), T₅ (Triacantanol 1.0ml/l at 40 and 60 days after sowing) and T₂ (Triacantanol 0.5ml /l at 40 and 60 days after sowing) The economics of cultivation in the present investigation showed that the

Table 62. Effect of bio-regulators on yield and yield attributes of fenugreek at Jobner

Treatment	Plant height (cm)	Branches/ plant	Pods/ plant	Seeds/ Spod	Seed yield (kg/ha)	Straw yield (kg/ha)	B:C ratio
Bio-regulators							
Triacantanol @ 0.5ml/litre	57.1	5.62	21.4	16.7	1357	3085	1.94
Triacantanol @ 1.0 ml/litre	59.0	5.84	22.8	16.7	1446	3239	2.09
NAA @ 50 ppm	59.2	5.82	23.5	16.8	1494	3381	2.25
Water spray	54.7	5.14	20.3	15.9	1169	2719	1.56
CD (p = 0.05)	1.9	0.19	0.6	0.5	47	121	0.08
Sprays							
One (40 DAS)	57.2	5.52	21.3	16.3	1305	3050	1.87
Two (40 & 60 DAS)	57.3	5.58	22.2	16.6	1386	3129	1.99
Three (40, 60 & 80 DAS)	58.0	5.71	22.5	16.6	1409	3138	1.99
CD (p = 0.05)	NS	0.17	NS	NS	41	NS	0.07
Control v/s Rest							
Control	54.6	5.00	19.0	15.5	1145	2557	1.55
Rest	57.5	5.61	22.0	16.5	1367	3106	1.96
CD (P = 0.05)	2.3	0.24	0.8	0.6	58	149	0.09

treatment combination T₃ recorded the highest grain yield (522.97 kg/ha) with a cost benefit ratio of 1: 1.7.

Effect of bio-regulators like Triacotanol, NAA, GA and water spray at one spray, two sprays and three sprays were tested for yield and yield contributing characters at Dholi. The experiment was conducted for three consecutive years (2006-07 to 2008-09). Application of bio-regulator viz., Triacotanol @ 0.5ml per liter of water, NAA @ 50 ppm, GA @ 50 ppm and water spray gave significant effect regarding yield and yield contributing characters. Spraying of Triacotanol @ 0.5ml per liter of water significantly increased the height of the plant, number of branches per plant, numbers of pods per plant, pod length, number of grains per pod and yield per plot or per hectare as compared to water spray. However, spraying of Triacotanol @ 0.5 ml per liter water gave the maximum plant height (80.47 cm), number of branches per plant (7.04) and number of grains per pods (16.90) followed by NAA @ 50 ppm i.e. height of the plant (75.68 cm), number of branches per plant (6.78) and number of grains per pod (16.76) while spraying of bio-regulator Triacotanol @ 0.5 ml per liter of water produced maximum number of pods per plant (49.09), pod length (10.82 cm) and yield per plot (1.30 kg/7.2 m²) or per hectare (1.86 t/ha) followed by application of GA @ 50 ppm i.e. number of pods per plant (46.60), pod length (10.74 cm) and yield per plot (1.29 kg/7.2 m²) or per hectare (1.78 t/ha). All the three spray viz., one spray (25 DAS), two sprays (25 & 45 DAS) and three sprays (25, 45 & 70 DAS), were found to have significant effect on yield and yield attributing characters. Three sprays (25, 45 & 70 DAS) gave significant effect as compares to one spray (25 DAS). However, three sprays (25, 45 & 70 DAS) gave the maximum plant height (79.92 cm), number of branches per plant (7.07), number of pods per plant (50.50), length of pod (11.03 cm), number of grains (17.70) and yield per plot (1.33 kg/7.2 m²) or per hectare (1.85 t/ha) followed by two sprays (25 & 45 DAS) i.e. height of the plant (75.86 cm), number of branches per plant (6.79), number of pod per plant (45.14), pod length (1.43 cm), number of grains (17.00) and yield per plot (1.25 kg/7.2 m²) or per hectare (1.73 t/ha). Interaction of bio-regulator X number of spray was found non-significant regarding yield and yield attributing characters. However, three spray (25, 45 & 70 DAS) of bio-regulators Triacotanol @ 0.5 ml per liter of water gave the maximum height of the plant (87.55 cm), number of branches per plant (7.67) and number of pods per plant (55.03) while three sprays (25, 45 & 70 DAS) of bio-regulator GA @ 50 ppm produced the maximum pod length (11.57 cm), number of grains per pod (18.44) and yield per plot (1.41 kg/7.2 m²) or per hectare (1.96 t/ha). So for cost: benefit ratio is concerned; three spray of Triacotanol @ 0.5 ml/l of water and GA @ 50 ppm gave the maximum return of Rs. 0.85 per unit cost (1:0.85).

9.6 Role of rhizobacteria in growth promotion of fenugreek

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

In the experiment conducted to assess the role of rhizobacteria on growth promotion of Fenugreek at Jobner indicated that out of eight treatments seed treatment and soil application with rhizobacteria strains FK -14 + FL-18 was

resulted highest yield (897 kg/ha) and biomass production (3.11 kg/ha) followed by seed treatment with FK -14 + FL-18 (seed yield 790 kg/ha) and seed and soil application with FL-18 (seed yield 780 kg/ha). Maximum number of nodules per plant (18), fresh and dry weight of nodules per plant (739 & 223 mg), root and shoot length (10.90 & 18.33 cm) was observed in seed treatment and soil application of bacterial strains FK -14 + FL-18. Soil population of rhizobacteria was also observed maximum in seed treatment and soil application with FK -14 + FL-18. The control was resulted in minimum growth parameters and yield (661 kg/ha). No root rot incidence was observed.

The effect of different rhizobacteria and its method of application was found to be non significant on ancillary characters, yield as well as quality of fenugreek at Jagudan. However, beneficial effect of rhizobacteria was observed in case of plant height, pod length, number of pods per plant, number of seeds per pod and seed yield.

The pooled analysis of the two years data at Guntur indicated that the treatments varied significantly in plant height, number of branches, number of pods per plant, pod length, number of seeds per pod and yield. Among the treatments, evaluated, maximum plant height (40.1 cm) was recorded in T-6 (seed treatment + soil application with FK 14 + FL 18) which is significantly superior to control (31.7 cm). Maximum number of branches was recorded in T-6 (seed treatment + soil application with FK 14 + FL 18) (6.1) which is significantly superior to the control (4.3). The treatment in T-6 (seed treatment + soil application with FK 14 + FL 18) recorded maximum number pods per plant (28.9) followed by T-2 (seed treatment + soil application with FK 14) (24.2), which were significantly superior to the control (19.4). Lowest number of pods was recorded in T-7 (seed treatment with *Trichoderma*) (18.9). Regarding pod length, the treatment T-6 (seed treatment + soil application with FK 14 + FL 18) recorded maximum (10.2) followed by T-5 (Seed treatment with FK 14 + FL 18) (10.0) which were significantly superior to control (8.9). Maximum number of seeds per pod was recorded in T-6 (seed treatment + soil application with FK 14 + FL 18) (11.8) which is significantly superior to the control (9.5) which is the lowest. Among the treatments evaluated, T-6 (seed treatment + soil application with FK 14 + FL 18) recorded maximum yield (419 kg/ha) followed by T-2 (seed treatment + soil application with FK 14) (398 kg/ha) which were on par with each other and significantly superior to control (323 kg/ha) (Table 63).

At Hisar, maximum seed yield (1827 kg/ha) was recorded with the application of rhizobacteria FL-18 (seed treatment + soil application) followed by rhizobacteria FK-14 + FL-18 (seed treatment + soil application) yielding 1824 kg/ha and *Trichoderma* MTCC- 5179 (1640 kg/ha).

At Dholi, seed treatment with rhizobacterial strain FL-18 gave the maximum plant height (77.70 cm), number of branches per plant (46.40), pod length (10.17 cm), number of seeds per pod (18.06), yield (1.80 t/ha) along with increase in yield over check (38.28%).

Seed treatment and soil application of rhizobacteria (FL-18 + FK-14) gave maximum growth in terms of maximum plant height (91.83 cm) length of pod (11.40 cm), number of grains/pod (17.97) and seed yield of 9.19 q/ha in T₆ treatment

Table 63. Effect of PGPR on growth and yield of fenugreek at Guntur (pooled data)

Treatment	Plant height (cm)	Number of branches	Number of pods/plant	Pod length (cm)	Number of seeds/ pod	Yield (kg/ha)
Seed treatment with FK14	34.8	4.6	22.6	9.2	10.6	368
Seed treatment + soil application with FK14	36.5	4.9	24.2	9.7	11.1	398
Seed treatment with FL18	32.5	4.3	20.9	8.7	9.8	336
Seed treatment + soil application with FL18	34.6	4.5	25.2	9.5	11.1	371
Seed treatment with FK 14 + FL 18	35.6	4.8	20.8	10.0	11.3	355
Seed treatment + soil application with FK 14 + FL 18	40.1	6.1	28.9	10.2	11.8	419
Seed treatment with <i>Trichoderma</i>	32.6	4.3	18.9	8.9	10.1	304
Control	31.7	4.3	19.4	8.9	9.5	323
CD (P=0.05)	3.3	0.7	2.9	0.8	1.0	39.5
CV(%)	8.0	12.8	11.0	7.2	8.3	9.4

at Kumarganj. Seed yield in T₆ was followed by seed yield of 8.85 q/ha in T₇ by treatment of *Trichoderma* (Table 64).

9.7 Survey and identification of disease causing organism in fenugreek and screening germplasm against diseases. (*Dholi and Jobner*)

At Dholi, no disease incidence was recorded in the germplasm as well as in the surveyed area of Samastipur and Muzaffarpur districts.

Out of twenty entries in CVT tested against powdery mildew and downy mildew, at Jobner the minimum downy mildew

incidence was recorded in FGK-2, FGK-1, RMt-351, FGK-11 and RM-18 (1.67, 3.33, 3.33, 9.17 and 9.17%, respectively) and minimum powdery mildew disease incidence was recorded in FGK-1, RMt-303 and FGK-11 (10, 14.17 and 15.83%, respectively). The local check resulted maximum disease incidence i.e. 25.81 % downy mildew and 26.88% powdery mildew. Out of ten entries of fenugreek IET tested against powdery mildew and downy mildew, the minimum downy mildew incidence was recorded in RMt-303 and UM-134 (16.66 and 18.05%, respectively) and minimum powdery mildew disease incidence was recorded in RMt-303 and UM-354 (9.72 and 13.89%, respectively). The local check resulted maximum disease incidence i.e. 47.22% downy mildew and 56.94 % powdery mildew.

Table 64. Effect of rhizobacteria on growth and yield of fenugreek at Kumarganj

Treatment	Plant height (cm)	Number of branches/ plant	Length of pods (cm)	Number of grains/ pod	Yield (kg/ha)
T ₁ . Seed treatment with rhizobacteria (FK-14)	84.97	3.40	10.93	17.17	689
T ₂ . Seed treatment and soil application with rhizobacteria (FK-14)	87.53	3.30	11.20	16.97	729
T ₃ . Seed treatment with rhizobacteria (FL-18)	88.40	3.30	11.40	16.77	767
T ₄ . Seed treatment and soil application with rhizobacteria (FL-18)	83.07	3.40	11.27	17.63	794
T ₅ . Seed treatment with rhizobacteria (FK-14 + FL -18)	76.07	3.30	11.07	17.07	711
T ₆ . Seed treatment and soil application with rhizobacteria (FK-14 + FL-18)	91.83	3.40	11.40	17.97	919
T ₇ . <i>Trichoderma</i> (MTCC 5179) recommended dose)	89.50	3.30	10.87	17.53	885
T ₈ . Control	74.07	3.10	10.67	16.27	554
SEm ±	1.59	0.15	0.18	0.31	023
CD (P=0.05)	4.82	0.45	0.54	0.95	071
CV(%)	3.26	0.87	2.82	3.18	538

LIST OF PUBLICATIONS

Coimbatore

1. Muthulakshmi,P, K., Rajamani, V. Prakasam and Samiyappan, R. 2008. Integrated disease management for coriander powdery mildew. National seminar on current scenario in production, processing and export of spices, 21-22 February 2008. Pp 62.
2. Muthulakshmi.P. Rajamani, K., Prakasam,V. and Samiyappan, R. 2008. Screening of turmeric germplasms against major diseases in turmeric and identification of resistant sources for the diseases. National seminar on current scenario in production, processing and export of spices, 21-22 February 2008. Pp.67.
3. Muthulakshmi.P,Rajamani, K.,Prakasam,V.and Samiyappan, R. 2008. Management of turmeric rhizome rot using ecofriendly biocontrol consortia. National seminar on current scenario in production, processing and export of spices, 21-22 February 2008. Pp 68.
4. Padmapriya. S., Chezhiyan, N., Rajamani, K., Sathiyamurthy,V.A and Kumanan, K., 2008. Influence of partial shade and integrated nutrient management of morphological parameters and yield of turmeric (*Curcuma longa* L.) National seminar on current scenario in production, processing and export of spices, 21-22 February 2008. Pp 22.
5. Padmapriya. S., Chezhiyan, N., Rajamani, K., Sathiyamurthy, V.A. and Kumanan K. 2008. Effect of shade, inorganic, organic and biofertilizers on yield parameters and quality of turmeric cultivar 147. National seminar on current scenario in production, processing and export of spices, 21-22 February 2008. Pp. 23.
6. Palanikumar. M., Rajamani K., Uma,D. Krishnasundar K., and M.Alagu Palamuthir Solai, M. 2008. Evaluation of fenugreek (*Trigonella foenum – graecum* L.) genotypes for higher diosgenin content. National seminar on current scenario in production, processing and export of spices, 21-22 February 2008. Pp 47.
7. Sathish. G., Paramaguru, P., Balakrishnamurthy, G., Subramanian, K.S., Rajamani, K. and Ponnusamy, V. 2008. Studies on effect of bioregulators on growth and yield of turmeric cv. BSR 2. National seminar on current scenario in production, processing and export of spices, 21-22 February 2008. Pp 25.
8. Sathish. G., Paramaguru, P. Balakrishnamurthy, G., Subramanian, K.S., Rajamani K. and Ponnusamy, V. 2008. Studies on effect of bioregulators on quality of turmeric cv. BSR 2. National seminar on current scenario in production, processing and export of spices, 21-22 February 2008 . Pp 26.
9. Shoba. N., Rajamani K., and Muthulakshmi, P. 2008. Studies on efficacy of *Azospirillum* in turmeric. National seminar on current scenario in production, processing and export of spices, 21-22 February 2008. Pp. 27.
10. Shoba. N., Rajamani, K. and Muthulakshmi, P. 2008. Studies on efficacy of *Azospirillum* in coriander. National seminar on current scenario in production, processing and export of spices, 21-22 February 2008. Pp 43.
11. Thondaiman. V., Rajamani, K., Shoba, N. and Muthulakshmi, P.2008. Effect of organic manures and bioregulators on growth and yield of turmeric. National seminar on current scenario in production, processing and export of spices, February 21-22.Pp 26.

Dholi

12. Singh, S.P, Chaudhary, R. and Mishra A.K. 2009. Effect of different combinations of organic manure on growth and yield of ginger. J. of Eco-friendly Agril. 4(1):22-24.

Guntur

13. Giridhar, K., Sarada, C. and Venkata Reddy, P. 2009. Pattern of morphological variation in coriander. National seminar on current trends and future prospects of spices with special reference to chillies, turmeric and seed spices, 24-25 March 2009.

14. Sarada, C. and Giridhar, K. 2009. Recent developments in production technology of seed spices National seminar on recent trends in research on spices and aromatic crops, 10-12 September 2009, Hisar.
15. Giridhar, K., Sarada, C., and Yallamanda Reddy, T. 2008. Efficacy of biofertilizers on the performance of coriander (*Coriandrum sativum*) in vertisols. Journal of Spices and Aromatic crops. Vol.17 (2): 98-102.
16. Giridhar, K., Sarada, C., and Yallamanda Reddy, T. 2008. Effect of bioregulators and their time of application on growth and yield of coriander (*Coriandrum sativum*). Journal of spices and Aromatic Crops Vol. 17(2): 183-186.
17. Giridhar, K., Sarada, C., and Yallamanda Reddy, T. 2008. Influence of micronutrients on growth and yield of coriander (*Coriandrum sativum*) in vertisols. Journal of Spices and Aromatic crops. Vol.17 (2):187-189.
18. Mahalakshmi, B.K., Giridhar, K., Sarada, C. and Naidu, T.C.M. 2009. Evaluation of coriander genotypes for drought tolerance. National seminar on current trends and future prospects of spices with special reference to chillies, turmeric and seed spices, 24-25 March 2009, Hisar.
19. Sarada, C., Giridhar, K. and Yallamanda Reddy, T. 2008. Climate modification for off season production of coriander initiatives R&D in horticultural crops. National seminar on new initiatives R&D in horticultural crops 26-29 November 2008 at OUAT, Bhubhaneshwar.
20. Sarada, C., Giridhar, K. & Yallamanda Reddy, T. 2008. Design and development of off-season production systems of coriander (*Coriandrum sativum* L.) for leaf, National seminar on new initiatives R&D in horticultural crops 26-29 November 2008 at OUAT, Bhubhaneshwar.
21. Sarada, C. Giridhar, K. and Venkata Reddy, P. 2009. Nutrient management in coriander. National seminar on current trends and future prospects of spices with special reference to chillies, turmeric and seed spices, 24-25 March 2009.
22. Sarada, C. Giridhar, K. and Venkata Reddy, P. 2009. Evaluation of coriander genotypes for suitability in Andhra Pradesh. National seminar on current trends and future prospects of spices with special reference to chillies, turmeric and seed spices. 24-25 March 2009.
23. Sarada, C. Giridhar, K. and Venkata Reddy, P. 2009. Evaluation of fenugreek (*Trigonella foenum-graecum*) genotypes for yield and diosgenin content in vertisols of Andhra Pradesh. National seminar on current trends and future prospects of spices with special reference to chillies, turmeric and seed spices, 24-25 March 2009.
24. Sarada, C., Giridhar, K., Venkata Reddy, P. 2009. Performance of coriander varieties under different dates of sowing. National seminar on current trends and future prospects of spices with special reference to chillies, turmeric and seed spices, 24-25 March 2009.
25. Sarada, C., Giridhar, K. 2008. Performance of coriander genotypes. Spice India.(21):18-19.
26. Sarada, C., Giridhar, K. and Rao, N.H.P. 2008. Studies on character association in fenugreek (*Trigonella foenum-graecum*). Journal of Spices and Aromatic Crops. .17(2): 82-84.
27. Sarada, C., and Giridhar, K. 2008. Threats in production of coriander. Journal of Spices and Aromatic Crops. 17 (2): 158-162.
28. Sarada, C., Giridhar, K. and Rao, N.H.P. 2008. Studies on genetic variability, heritability and genetic advance in fenugreek (*Trigonella foenum-graecum*). Journal of Spices and Aromatic Crops. .17 (2):163-166.

Hisar

29. Malik, T.P., Jitender Kumar and Tehlan, S.K. 2008. Effect of storage condition and packing on shelf life of coriander. National seminar on recent trends in research on spices and aromatic crops, 10-12 September 2009, Hisar. Pp.103.
30. Tehlan, S.K., Malik, T.P, Nandal, J.K. and Dahiya, M.S. 2008. The healing power of spices. National seminar on recent trends in research on spices and aromatic crops, 10-12 September 2009, Hisar. Pp.99.
31. Tehlan, S.K., Thakral, K.K., Malik, T.P. and Nandal, J.K. 2008. Screening of coriander accessions for growth and seed yield. National seminar on recent trends in research on spices and aromatic crops, 10-12 September 2009, Hisar. Pp14.
32. Tehlan, S.K., Thakral, K.K. and Nandal, J.K. 2009. Influence of Azospirillum, farm yard manure and nitrogen on growth and seed yield of coriander (*Coriandrum sativum* L). In: Proceedings Seminar on Prospects and problems in production, processing and marketing of medicinal and aromatic plants in Haryana pp.12-14.

33. Thakral, K.K., Tehlan, S.K., Bhatia, A.K. and Malik, T.P 2008. Response of bio-regulators in seed crop of coriander. National seminar on recent trends in research on spices and aromatic crops, 10-12 September 2009, Hisar. Pp.56.
34. Verma, S.S. and Tehlan, S.K. 2008. Seed production and seed testing procedures in seed spices. In Proceedings of National Symposium on Recent Trends in Research on Spices and Aromatic Plants, Hisar, Pp 116-122.

Jobner

35. Dhirendra Singh, Brijendra Pareek, E.V. Divakara Sastry and Sharma, K.C. 2009. Evaluation of half-sib progenies in population of fennel (*Foeniculum vulgare* Mill). Seminar on Recent Advances in Seed Spices, Gujarat, March 4-6, 2009. Pp. 33.
36. Divakara Sastry, E.V. and Dhirendra Singh. 2008. Research and strategies for increasing production of seed spices in Rajasthan. National workshop on spices and aromatic plants, February 6-7, 2008. Agricultural research Station, Rajasthan Agricultural University, Mandore, Rajasthan. Pp 5.
37. Divakara Sastry, E.V. and Sharma, M.M. 2008. Gamma ray induced variation in cumin. International seminar on induced mutagenesis in agriculture, Vienna. IAEA-CN-167-179P.
38. Divakara Sastry, E.V., Dhirendra Singh and Shyam Singh Rajput. 2009. Status of characterization and evaluation in coriander. National Seminar on Recent Advances in Seed Spices" CRSS, Gujarat, March 4-6, 2009. Pp. 5-6.
39. Divakara Sastry, E.V., Dhirendra Singh, S. S. Rajput. 2008. Plant breeding for organic agriculture. National Seminar on Biotechnology in Sustainable agriculture and environmental management. University of Rajasthan. November 7-8, 2008: Pp 12.
40. Divakara Sastry, E.V., Kailash Chandra, D. Singh and Sharma, 2009. Metroglyph analysis in fenugreek (*Trigonella foenum-graecum* L.). Strategies for seed spices improvement. Venkata Reddy, P., Uma Jyoti, K., Surya Kumari, S., Giridhar, K., Venkata Ramana, C., Sarada, C., and Vijaya Lakshmi, P. (Eds.). Souvenir and Abstracts. National Seminar on Spices- Current trends and future prospects of spices with special reference to chillies, turmeric and seed spices, Andhra Pradesh Horticultural University, Horticultural Research Station, Lam, Guntur, March, 2009. P-5, pp 32-33.
41. Divakara Sastry, E.V. 2008. Status of genetic resources in seed spices. Recent trends in research on spices and aromatic plants. Hisar, 10-12 November, 2008.
42. Divakara Sastry, E.V. 2009. Organic production of seed spices. National workshop on current trends and future prospects in production and export of spice crops with special reference to chillies. February 27-28, 2009. UAS, Dharwad.
43. Divakara Sastry, E.V. 2009. Strategies for seed spices improvement. Venkata Reddy, P., Uma Jyoti, K., Surya Kumari, S., Giridhar, K., Venkata Ramana, C., Sarada, C., and Vijaya Lakshmi, P. (Eds.). Souvenir and Abstracts. National Seminar on Spices- Current trends and future prospects of spices with special reference to chillies, turmeric and seed spices, Andhra Pradesh Horticultural University, Horticultural Research Station, Lam, Guntur, March, 2009. L-5, pp 15-17.
44. Divakara Sastry E.V., and Dhirendra Singh. 2008. Status of seed spices improvement in Rajasthan. In proceedings of national workshop on spices and aromatic plants. Solanki, Z.S. Parihar, G.N., Rathore, B.S. and Kumhar, S.R. (eds.). ARS, Mandore. Pp 31-37.
45. Divakara Sastry, E.V., Dhirendra Singh and Kayam Singh Shekhawat. 2008. Organic management of seed spices. In Souvenir and abstracts National workshop on organic spices (Commercial Perspectives of Organic Spices)" Orissa University of Agriculture and Technology, Regional Research and Technology Transfer Station, Smiliguda, Koraput Orissa), 14-15 December 2009. Pp 52-61.
46. Divakara Sastry, E.V. 2008. Status of genetic resources in seed spices. Recent trends in research on spices and aromatic plants (Tehlan, S.K., et al. eds.). CCS HAU, Hisar. Pp 1-15.
47. Divakara Sastry, E.V., M.L. Jakhar and Dhirendra Singh. 2009. Biotechnological interventions in seed spices improvement. Lead Papers, National seminar on biotechnological intervention for enhancing quality and improving yield in seed spices" held at NRCSS, Ajmer on 18th July 2009. Pp 31-37.
48. Sharma, K.C., Dhirendra Singh and Divakara Sastry, E.V. 2009. Estimate of heritability and genetic advance in fenugreek (*Trigonella foenum-graecum* L.). Seminar on recent advances in seed spices, Jagudan, Gujarat, March 4-6, 2009. Pp 41.
49. Thakral, K.K., Tehlan, S.K., Bhatia, A.K. and Malik, T.P 2008. Response of bio-regulators in seed crop of coriander. In: Abstract of National seminar on recent trends in research on spices and aromatic plants, Hisar. Pp.56.

Jagudan

50. Alanger, I., Mary V., Jiby, Anandaraj, M., Vemulapali Bhadramurthy, Patel, K.D. Patel, N.R., Jaiman, R.K. and Agalodiya, A.V. 2008. Occurrence and partial characterization of a phytoplasma associated with phyllody disease of fennel (*Foeniculum vulgare* Mill.). India. J. Phytopathol. 156: 758-761.
51. Kansara H.S., Patel K.D., Jaiman R.K., Patel N.R and Patel P.K., 2009. Management of powdery mildew in fenugreek Patel, N.R., Jaiman R.K., Patel K.D., Agalodiya, A.V. and Patel, P.K. 2008. Integrated management of coriander powdery mildew. J. Mycol. Pl. Pathol. 38(3): 643-644.
52. Patel, K.D., Vihol J.B., Jaiman R.K., Patel N.R., and Patel P.K., 2009. Influence of weather on development of blight in cumin caused by *Alternaria burnsii*. Seminar on recent advances in seed spices, Jagudan, Gujarat, March 4-6, 2009.
53. Patel N.R., Jaiman R.K., Patel K.D., Ravindrababu Y., Patel P.K. and Joshi D.K. 2009. Resistant sources for blight disease of cumin (*Cuminum cyminum* L.). Seminar on recent advances in seed spices, Jagudan, Gujarat, March 4-6, 2009.
54. Panchal, J.A., Patel K.D., Jaiman, R.K., Patel N.R., and Patel, P.K., 2009. Physiological studies of *Sclerotinia sclerotium* (Lib.) causing stem rot in fennel. Seminar on recent advances in seed spices, Jagudan, Gujarat, March 4-6, 2009. Paper presented in National Seminar held at CRSS, SDAU, Jagudan on 4-6 March-09.
55. Patel, K.D., Panchal, J.A., Jaiman, R.K., Patel, N.R., and Patel, P.K., 2009. Efficacy of plant extracts, biological agents and fungicides against *Sclerotinia sclerotium* (Lib.) incited stem rot in fennel. Seminar on recent advances in seed spices, Jagudan, Gujarat, March 4-6, 2009.
56. Patel, N.R., Kansara, H.S., Patel, K.D., Jaiman, R.K., and Patel, P.K., 2009. Effect of sowing date and weather on development of powdery mildew in fenugreek. Seminar on recent advances in seed spices, Jagudan, Gujarat, March 4-6, 2009.
57. Patel. G.M., Patel., D.G., Prajapati, D.B. and Patel, P.R. 2009. Genetic Variability and Correlation Studies in Fennel. Seminar on recent advances in seed spices, Jagudan, Gujarat, March 4-6, 2009.
58. Prajapati, D. B., Aglodia, A.V., Patel, G.M., Patel, N. R. and Patel, K.D. 2009. Gujarat Methi-2: A new fenugreek variety identified with better grain quality, high yield potential and disease resistance. Seminar on recent advances in seed spices, Jagudan, Gujarat, March 4-6, 2009.
59. Singh R.B., Patel K.D., Jaiman R.K., Patel N.R. and Patel P.K., 2009. Pathogenic potential and management of seed mycoflora of cumin (*Cuminum cyminum* L.). Paper presented in National Seminar held at CRSS, SDAU, Jagudan on 4-6 March-09.
60. Vihol, J.B., Patel K.D., Jaiman R.K., Patel N.R., and Patel P.K., (2009). Efficacy of plant extracts, biological agents and fungicides against *Alternaria burnsii* incited blight of cumin (*Cuminum cyminum* L.) Seminar on recent advances in seed spices, Jagudan, Gujarat, March 4-6, 2009.

Kumarganj

61. Dixit, J., Pandey, V.P. and Saxena, R.P. 2008. Performance of fennel genotypes and seed yield. National symposium on recent trends in development of spices and aromatic plants, C.C.S. Haryana Agriculture University, Hisar, 10-12 September 2008. Pp. 17.
62. Mudit Srivastava., Singh, A.K., Pandey, V.P. and Singh Abhishekh. P. 2009. Genotypic variability, heritability and genetic advance analysis in elite lines of turmeric (*Curcuma longa* L.). National seminar on emerging trends in plant sciences and urban medicines, Kumarganj, 17 -18 March 2009.
63. Pandey, V.P., Dixit, J. and Saxena, R.P. 2008. Evaluation of turmeric genotypes for fresh rhizome yield in Eastern U.P. National Symposium on recent trends in development of spices and aromatic plants, Hisar, 10-12 September 2008. Pp. 3.
64. Pandey, V.P., Kumar Rajesh., Singh, A.P. and Pandey, Vivek (2009). Evaluation of turmeric (*Curcuma longa*) germplasm for growth, yield and its attributing characters. National seminar on emerging trends in plant sciences and urban medicines. Kumarganj, 17-18 March 2009.
65. Singh, S.S., Dixit, J. Pandey, V.P. and Saxena, R.P. 2008. Response of turmeric to nitrogen, FYM and *Azospirillum*. National symposium on recent trends in development of spices and aromatic plants, Hisar, 10-12 September 2008. Pp. 29.

66. Singh, R.P., Pandey, V.P. and Tiwari, Tripti 2009. Evaluation of turmeric leaf oil for natural antioxidants at various stages of crop growth. . National seminar on emerging trends in plant sciences and urban medicines. Kumarganj, 17-18 March 2009.
67. Singh, A. P., Pandey, V.P., Solanky, S. S. and Srivastava, Mudit 2009. Stability analysis for yield and its attributing traits in turmeric (*C. longa*). National seminar on emerging trends in plant sciences and urban medicines. Kumarganj, 17-18 March 2009.
68. Upadyay, Preeti, Saxena, R.P. and Singh, R.B. 2008. Isolation of rhizosphere and soil mycoflora of fennel, presented in National symposium on recent trends in development of spices and aromatic plants, Hisar, 10-12 September 2008. Pp.108).

Mudigere

69. Jemla Naik, D., Thippesha, N. A. N., Reddy, and Chandra Naik, S. 2009. Studies on population dynamics of pepper mussel scale *Lepidosaphes piperis* Gr.(Diaspididae: Homoptera) and its management. J. Asian Hort.3(4) 267-270.
70. Jemla Naik, D. Thippesha, N. A. N., Reddy and Chandra Naik, K. S. 2008. Studies on population dynamics of small cardamom thrips, (*Sciothrips cardamomi*) Ramk. and effect of spray schedules against thrips, S. cardamomi Ramk, shoot and capsule borer, *Conogethes punctiferalis* Guen. in small cardamom. National symposium on recent trends in development of spices and aromatic plants, Hisar, 10-12 September 2008
71. Jemla Naik, D. Thippesha, D. Belavadi, V.V., Chandra Naik, K. S. and Shivakumar, K.V. 2008. Studies on ecological effect on small cardamom thrips, (*Sciothrips cardamomi* Ramk.) and Effect of spray schedules against thrips, S. cardamomi, shoot and capsule borer, *Conogethes punctiferalis* Guen. In small Cardamom. Presented Research papers paper in the Colemans National symposium on plant protection, GKVK Bangalore, 4- 6 December 2008.
72. Jemla Naik, D., Thippesha, N.A.N. Reddy, Belavadi, V.V., Rangaswamy S. D. and Venkatesha, J. 2008. Studies on population dynamics and management of small cardamom white fly, *Kanakarajiella cardamomi* (David and Subr.) (Hemiptera: Aleyrodidae) .National symposium on plant protection, GKVK, Bangalore, 4-6 December 2008.

Panniyur

73. Mammooty, K.P., Neema V.P. and Jayaraj, P. 2008. Diseases of black pepper In: Piperaceae Crops- technologies and future perspectives -Compilation of lead papers & extended summaries of the National Seminar on Piperaceae held from November 21-22, 2008 at IISR, Calicut. p. 148-157.
74. Neema, V.P 2008. Crop improvement in black pepper. In: Piperaceae Crops- technologies and future perspectives - Compilation of lead papers & extended summaries of the National Seminar on Piperaceae held from November 21-22, 2008 at IISR, Calicut. p. 56-63.
75. Vanaja, T., Neema, V.P., Mammooty, K.P and Rajesh, R. 2008. Development of a promising interspecific hybrid in black pepper for *Phytophthora* foot rot resistance. Euphytica .161: 437-445.

Pundibari

76. Debnath, A., Bandyopadhyay, S. and Dutta, S. 2009. Symptomatology variation of rhizome rot – wilt complex disease of ginger under terai agro ecological region of West Bengal. Environment and Ecology, 27 (1): 1 – 4.
77. Debnath, A., Bandyopadhyay, S. and Dutta, S. 2008. Symptomatology variation of rhizome rot – wilt complex disease of ginger under terai agro ecological region of West Bengal. National Workshop on Production, Processing and Marketing of Spices and Aromatic Plants held at Uttar Banga Krishi Viswa Viswavidyalaya, Pundibari, Coochbehar, W.B., during 16 – 17 January, 2008, pp. 45.

Pottangi

78. Behera, B., Mohanty, S. K., Mishra, A. and Dash, D. K. 2008. Impact of planting geometry on productivity and profitability of turmeric (*Cucuma longa*) and pigeonpea (*Cajanus cajan*) inter cropping under rainfed conditions. Journal of Spices and Aromatic Crops. 17(2): pp. 154-157.
79. Dash, D. K., Mishra, N. C. and Sahoo, B. K. 2008. Influence of nitrogen, Azospirillum sp. and farm yard manure on the yield, rhizome rot and quality of ginger (*Zingiber officinale* Rosc). Journal of Spices and Aromatic Crops. 17(2): pp. 177-179.
80. Mishra, A., Mohanty, S. K., Behera, B. and Dash, D. K. 2008. Field tolerance of ginger (*Zingiber officinale*) genotypes to soft rot under rainfed upland situation. Journal of Spices and Aromatic Crops. 17(2): pp. 202-204.

Pampadumpara

81. Geetha, K., Sivakumar, G. 2009. 50 years of cardamom research. Kerala Karshakan, 54(8): 10-11.

Peechiparai

82. Prem Joshua, J., Thangaselvabai, T., Richard Kennedy, R. and Jayasekhar, M. 2008. Studies on the effect of different spacings on yield and quality of pepper. National Seminar on Piperaceae crops-Technologies and future perspectives, IISR, Calicut, pp: 342.
83. Prem Joshua, J., Richard Kennedy, R. and Jayasekhar, M. 2009. PPI(C)-I Cinnamon-A new high yielding variety for lower elevations, Proceedings of Sixth All India Conference of SRF, pp: 126-127.
84. Richard Kennedy, R., Swaminathan, C. and Lakshmanan, V. 2008. Two variants of clove-king clove and liliput clove, National Seminar on current scenario in production, processing and export of Spices, TNAU, Yercaud, pp. 12.
85. Richard Kennedy, R., Swaminathan, C. Pugalandhi, L. Kumar, N. and Lakshmanan, V. 2008 Nutrient management in tree spices, National Seminar on current scenario in production, processing and export of Spices, TNAU, Yercaud, pp. 38.
86. Richard Kennedy, R., Swarnapirra, Prem Joshua, J., and Jayasekhar, M. 2008. Evaluation of Suitable standards for higher production of black pepper Cv. Panniyur-I under high rainfall zone of Kanyakumari District, National Seminar on Piperaceae crops-Technologies and future perspectives, IISR, Calicut, pp: 343.

Sirsi

87. Lokesh, M. S., 2008. Population density of black pepper vines in relation *Phytophthora* disease in arecanut cropping system. J. Asian Horticulture, 33: 180-182.
88. Lokesh, M. S., Shashidhara, S., Palakshappa, M. G. and Lingaraju, S, 2008. Integrated disease management of foot rot of black pepper caused by *Phytophthora capsici* Leon. Paper presented In: National Seminar on Piperaceae –Harnessing Agro Technologies for Accelerated Production of Economically Important Piper species, Indian Institute of Spices Research, Calicut, November 21-23. p. 351.
89. Lokesh, M. S. and Hemant G. Hegde, 2008. Organic farming in black pepper. Paper presented In: National Seminar on Piperaceae–Harnessing Agro Technologies for Accelerated Production of Economically Important *Piper* species, Indian Institute of Spices Research, Calicut, November 21-23. p. 348.
90. Lokesh, M. S. and Nagesh Naik, H., 2008. Role of growth promoting chemicals and bioagents on health of medicinally important black pepper (*Piper nigrum* L.) in Uttara Kannada. Paper presented In: National Seminar on Medicinal Plants Protection & Promotion, MM Arts & Science College, Sirsi, Uttara Kannada, Karnataka, October, 4-5.p.39.
91. Lokesh, M. S., Palakshappa, M.G., Mohan Kumar and Nagesh Naik, 2009. *Phytophthora* foot rot of black pepper (*Piper nigrum* L.) management with Potassium phosphonate and bioagent in arecanut cropping system. National workshop on current trends and future prospects in production and export of spice crops with special reference to chillies, University of Agricultural Sciences, Dharwad, Karnataka , February, 27-28.p107-109.
92. Lokesh, M. S., Palakshappa, M.G., Nagesh Naik and Mohan Kumar, 2009. Evaluation of black pepper cultivars to *Phytophthora* foot rot (*Phytophthora capsici* Leonion). National workshop on current trends and future prospects in production and export of spice crops with special reference to chillies, University of Agricultural Sciences, Dharwad, Karnataka, February, 27-28.p 43.
93. Lokesh, M. S., Palakshappa, M.G., Shashidhara, S., Hegde, R. V. and Lingaraju, S., 2009. Screening of seedlings of cultivated black pepper (*Piper nigrum* L.) varieties against *Phytophthora* foot rot (*Phytophthora capsici* Leonion). National workshop on current trends and future prospects in production and export of spice crops with special reference to chillies, University of Agricultural Sciences, Dharwad, Karnataka, February, 27-28.p 125.
94. Nagesh Naik H. and Lokesh, M. S., 2009. Exploration of genetic potential of black pepper (*Piper nigrum* L.). National workshop on current trends and future prospects in production and export of spice crops with special reference to chillies. University of Agricultural Sciences, Dharwad, Karnataka, February, 27-28.p 46.
95. Nagesh Naik, H. and Lokesh, M. S., 2008. Influence of organic and inorganic management practices in production of black pepper (*medicinal and spice valued crop*) in arecanut cropping system. National seminar on medicinal plants protection & promotion, MM Arts & Science College, Sirsi, Uttara Kannada, Karnataka, October, 4-5.p.37.

96. Nagesh Naik, H. and Lokesh, M. S., 2009. Nutrient management practices in production of black pepper in arecanut based cropping system. National workshop on current trends and future prospects in production and export of spice crops with special reference to chillies, University of Agricultural Sciences, Dharwad, Karnataka, February, 27-28.p 97.

Solan

97. Neerja Rana and B.N Korla. 2008. Quality attributes in spices- A Perspective. National workshop on spices and aromatic plants. Agricultural Research Station Mandor- Jodhpur February 6-7 2008.
98. Rajani Bala, B.N Korla and Neerja Rana. 2007. Evaluation of ginger clones for quality. Haryana Journal of Horticultural Sciences 36(1& 2): 198-199.

LIST OF RESEARCH PROGRAMMES

Project Code	Title	Centres
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/3.2	CVT 2000 – Series V	Chintapalle, Pampadumpara, Panniyur, Sirsi and Ambalavayal
PEP/CI/3.3	CVT 2006 – Series VI	Chintapalle, Dapoli and Panniyur, Pampadumpara, Pundibari, Sirsi , Yercaud / Pechiparai
PEP/CM/4	Nutrient Management Trial	
PEP/CM/4.4	Development of organic package for spices based cropping system – Observational trial	Chintapalle, Sirsi, Panniyur, and Dapoli
PEP/CM/4.5	Organic farming in black pepper - 2006	Panniyur, Dapoli, Pechiparai, Sirsi and Yercaud
PEP/CM/4.7	Rooting of orthotropic shoots in blackpepper	Dapoli, Panniyur, Pechiparai, Sirsi and Yercaud
PEP/CP/5	Disease Management Trial	
PEP/CP/5.1	Adaptive trial on management of <i>Phytophthora</i> foot rot of black pepper in farmers field	Chintapalle, Dapoli and Panniyur, Pampadumpara, Mudigere and Sirsi
PEP/CP/5.2	Trial on management of <i>Phytophthora</i> foot rot of black pepper in existing plantation	Chintapalle, Dapoli and Panniyur, Pampadumpara, Mudigere and Sirsi
PEP/CP/5.3	Trial on management of <i>Phytophthora</i> foot rot of black pepper in new plantation	Chintapalle, Dapoli, Panniyur, Pampadumpara, Pechiparai, Mudigere and Sirsi
PEP/CP/6	Pest Management Trial	
PEP/CP/6.1	Management of scale-insects of black pepper with organic products	Pampadumpara
PEP/CP/6.2	Management of <i>Erythrina</i> gall wasp. A popular standard of black pepper	Mudigere
CARDAMOM		
CAR/CI/1	Genetic Resources	
CAR/CI/1.1	Germplasm collection, characterization, evaluation and conservation	Mudigere and Pampadumpara

Project Code	Title	Centres
CAR/CI/2	Hybridization	
CAR/CI/2.1	Evaluation of OP progenies under intensive management	Mudigere
CAR/CI/2.2	Hybridization & selection in cardamom	Mudigere
CAR/CI/3	Coordinated Varietal Trial	
CAR/CI/3.5	CVT 2005-series V	Pampadumpara, Mudigere and Myladumpara
CAR/CI/3.6	CVT 2007/2009 -series VI	Mudigere, Pampadumpara, Sakleshpur and Myladumpara
CAR/CI/4	Varietal Evaluation Trial (VET)	
CAR/CI/4.1	Initial evaluation trial - I	Mudigere
CAR/CI/4.2	Initial evaluation trial - II	Mudigere
CAR/CP/6	Pest Management Trial	
CAR/CP/6.1	Bioecology of natural enemies of major pests of cardamom	Mudigere
CAR/CP/6.2	Estimation of quantitative and qualitative losses due to thrips damage in cardamom	Mudigere
CAR/CP/6.3	Management of shoot fly in cardamom	Mudigere
CAR/CP/6.4	Management of cardamom root grub through entomopathogenic nematodes	Pampadumpara
CAR/CP/6.5	Trial on management of panicle and clump rot of cardamom in existing plantation	Mudigere and Pampadumpara
CAR/CP/6.6	Trial on management of panicle and clump rot of cardamom in new plantation	Mudigere and Pampadumpara
GINGER		
GIN/CI/1	Genetic Resources	
GIN/CI/1.1	Germplasm collection, characterization, evaluation and conservation	Dholi, Kumarganj, Pottangi, Pundibari, Raigarh and Solan
GIN/CI/2	Coordinated Varietal Trial	
GIN/CI/2.2	CVT 2005 – Series VI	Solan
GIN/CI/2.3	CVT 2006 – Series VII	Kumarganj, Pottangi and Pundibari
GIN/CI/3	Varietal Evaluation Trial	
GIN/CI/3.1	Initial evaluation trial (IET 2006)	Raigarh, Solan, Pottangi and Dholi
GIN/CI/3.2	Comparative yield trial	Pottangi
GIN/CI/4	Quality Evaluation Trial	
GIN/CI/4.1	Evaluation of germplasm for quality	Solan
GIN/CI/4.2	Evaluation of germplasm from other centers	Solan
GIN/CM/5	Nutrient Management Trial	
GIN/CM/5.1	Effect of micronutrients on ginger	Pottangi

Project Code	Title	Centres
GIN/CM/5.2	Organic farming in ginger - 2006	Solan, Pundibari, Pottangi, Dholi and Kumarganj
GIN/CP/6	Disease Management Trial	
GIN/CP/6.1	Disease surveillance and etiology of rhizome rot in ginger	Solan and Dholi
GIN/CP/6.2	Biocontrol studies on rhizome rot of ginger	Pottangi
GIN/CP/6.5	Management of rhizome rot in ginger	Chintapalle, Sirsi , Mudigere and Dapoli
GIN/CP/6.6	Management of soft rot of ginger (Biofumigation using mustard)	Dholi, Solan, Chintapalle, Pundibari, Kumarganj and Raigarh
GIN/CP/6.7	Management of soft rot of ginger (Biofumigation using cabbage)	Dholi, Solan, Chintapalle, Pottangi, Kumarganj and Raigarh
GIN/CP/6.8	Management of bacterial wilt of ginger (Biofumigation using mustard)	Dholi, Solan and Pundibari
GIN/CP/6.9	Management of bacterial wilt of ginger (Biofumigation using cabbage)	Dholi, Solan and Pottangi
GIN/CM/5.3	Genotype X Environmental interaction a quality	Solan and Chintapalle
TURMERIC		
TUR/CI/1	Genetic Resources	
TUR/CI/1.1	Germplasm collection, characterization, evaluation and conservation	Coimbatore, Dholi, Jagtial, Kumarganj, Pottangi, Jagtial and Raigarh
TUR/CI/2	Coordinated varietal trial	
TUR/CI/2.2	CVT-2004-Series VI	Chintapalle, Coimbatore, Kumarganj, Pottangi, Jagtial and Raigarh
TUR/CI/3	Varietal evaluation trial	
TUR/CI/3.1	Comparative yield trial 2005-06	Jagtial and Pottangi
TUR/CI/3.2	Initial evaluation trial 2006	Kumarganj, Pottangi and Pundibari
TUR/CI/4	Quality evaluation trial	
TUR/CI/4.1	Quality evaluation of germplasm	Coimbatore
TUR/CM/5	Nutrient Management Trial	
TUR/CM/5.1	Effect of biofertilizer, <i>Azospirillum</i> on turmeric (Adaptive Trial)	Dholi
TUR/CM/5.2	Effect of organic farming in turmeric	Dholi
TUR/CM/5.3	Organic farming in turmeric	Coimbatore, Dholi, Jagtial, Pottangi, Pundibari and Kumarganj
TUR/CM/5.4	Efficacy of biocontrol agents for control of rhizome rot of turmeric	Pottangi
TUR/CM/5.5	Effect of micronutrients on turmeric	Pottangi
	Genotype x Environmental interaction on quality	Dholi, Chintapalle, Pottangi, Kumarganj, Pundibari, Jagtial, Coimbatore and Mizoram

Project Code	Title	Centres
TUR/CP/6	Disease Management Trial	
TUR/CP/6.1	Survey and identification of disease causing organisms in turmeric and screening of turmeric germplasm against diseases	Coimbatore, Pundibari, Raigarh and Dholi
	Management of foliar disease of turmeric	Dholi, Chintapalle, Pottangi, Kumarganj, Pundibari, Jagtial, Raigarh and Coimbatore
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
TSP/CI/2	Coordinated Varietal Trial	
TSP/CI/2.1	CVT 1992 - clove	Yercaud and Pechiparai
TSP/CI/2.2	CVT 2001- nutmeg	Dapoli and Pechiparai
TSP/CI/2.3	CVT 2001 - cassia	Pechiparai and Dapoli
TSP/CM/2	Propagation/Multiplication Trial	
TSP/CM/2.1	Softwood grafting in clove	Dapoli
TSP/CM/2.2	Post harvest technology studies in cinnamon	Dapoli and Pechiparai
	Management of die back and wilt disease of nutmeg	Dapoli
TSP/CP/3	Disease Management Trial	
TSP/CP/3.1	Survey for disease incidence in tree spices	Dapoli and Pechiparai
TSP/CP/3.2	Management of die back and wilt disease of nutmeg	Dapoli
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/2.2	CVT 2004 – Production of leafy type VI coriander during off-season	Coimbatore, Guntur and Hisar
COR/CI/2.3	CVT 2005 -VII	Jagudan, Jobner, Guntur, Hisar and Kumarganj
COR/CI/3	Varietal Evaluation Trial	
COR/CI/3.1	Initial evaluation trial	Hisar, Guntur, Jobner, Kumarganj and Jagudan
	Initial evaluation trail 2008	Jabalpur
COR/CI/4	Quality Evaluation Trial	

Project Code	Title	Centres
COR/CI/4.1	Quality evaluation in coriander	Jobner
COR/CM/5	Nutrient Management Trial	
COR/CM/5.1	Effect of biofertilizer, <i>Azospirillum</i> on coriander	Dholi
COR/CM/5.2	Effect of bio-regulators on coriander	Jobner
COR/CM/5.3	Identification of drought/ alkalinity tolerant source in coriander	Guntur , Coimbatore, Kumarganj and Jobner
COR/CM/5.	Production of leafy type of coriander in off season	Kumarganj, Coimbatore and Hisar
COR/CM/5.4	Role of rhizobacteria in growth promotion of coriander	Coimbatore, Guntur, Hisar, Jagudan and Raigarh (Closed)
COR/CP/6	Disease Management Trial	
COR/CP/6.1	Management of powdery mildew and stem gall in coriander	Coimbatore and Jobner
COR/CP/6.2	Survey to identify the disease incidence collection and identification of casual organism	Dholi
CUMIN		
CUM/CI/1	Genetic Resources	
CUM/CI/1.1	Germplasm collection, characterization, evaluation conservation and screening against diseases	Jagudan and Jobner
CUM/CI/2	Coordinated Varietal Trial	
CUM/CI/2.1	CVT 2005-Series VI	Jobner and Jagudan (Closed)
CUM/CI/3	Varietal Evaluation Trial	
CUM/CI/3.1	Initial evaluation trial	Jobner and Jagudan (Closed)
	Initial evaluation trial -2008	Jabalpur
CUM/CI/4	Quality Evaluation Trial	
CUM/CI/4.1	Quality evaluation in cumin	Jobner
CUM/CM/5	Nutrient management trial	
CUM/CM/5.1	Identification of drought tolerance	Jobner
CUM/CM/5.2	Role of rhizobacteria on growth and yield of cumin	Jagudan
CUM/CM/5.3	Effect of bioregulators on cumin	Jobner
CUM/CP/6	Disease Management Trial	
CUM/CP/6.1	Management of wilt and blight diseases in cumin	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

Project Code	Title	Centres
FNL/CI/2	Coordinated Varietal Trial	
FNL/CI/2.1	CVT – 2004 –Series	Jagudan, Jobner and Kumarganj
FNL/CI/2.2	CVT – Transplant early rabi 2006	Jagudan and Hisar
FNL/CI/2.3	CVT 2007 – Series VI	Jagudan, Jobner, Kumarganj and Hisar
FNL/CI/3	Varietal Evaluation Trial	
FNL/CI/3.1	Initial evaluation trial	Hisar, Jobner , Kumarganj and Jagudan
FNL/CI/3.2	Initial evaluation trial-2009	Jabalpur
FNL/CI/4	Quality evaluation trial	
FNL/CI/4.1	Quality evaluation in fennel	Jobner
FNL/CM/5	Nutrient Management Trial	
FNL/CM/5.1	Effect of biofertilizer, <i>Azospirillum</i> on fennel	Dholi
FNL/CM/5.2	Identification of drought/alkalinity tolerance source in fennel	Kumarganj
FNL/CM/5.3	Role of rhizobacteria on growth and yield of fennel	Jagudan, Raigasrh and Hisar
FNL/CP/6	Disease Management Trial	
FNL/CP/6.1	Survey, identification of disease causing organisms and survey of germplasm against disease	Dholi
FENUGREEK		
FGK/CI/1	Genetic Resources	
FGK/CI/1.1	Germplasm collection, characterization, evaluation conservation and screening against diseases	Dholi, Hisar, Jagudan, Jobner and Kumarganj
FGK/CI/2	Coordinated Varietal Trial	
FGK/CI/2.2	CVT 2005 – Series VI	Jobner, Kumarganj
FGK/CI/2.3	CVT 2006 –Series VII	Kumarganj, Guntur, Jagudan, Hisar
FGK/CI/3	Varietal Evaluation Trial	
FGK/CI/3.1	Initial evaluation trial	Guntur, Hisar, Jagudan , Kumarganj and Jobner
	Initial evaluation trial-2009	Jabalpur
FGK/CM/4	Nutrient Management Trial	
FGK/CM/4.2	Identification of drought/tolerance source in fenugreek	Jobner and Guntur
FGK/CM/4.3	Effect of bio-regulators on fenugreek	Jobner, Coimbatore, and Dholi (Closed)
FGK/CM/4.4	Role of rhizobacteria on growth and yield of fennel	Dholi, Guntur, Hisar, Jagudan and Kumarganj
FGK/CP/5	Disease Management Trial	
FGK/CP/5.1	Survey and identification of disease causing organisms and screening germplasm against disease	Dholi

STAFF POSITION

PROJECT COORDINATOR'S OFFICE

Project Coordinator	:	Dr M Anandaraj
Principal Scientist (Hort.)	:	Dr J Rema
Technical Information Officer	:	Dr Johny A Kallapurackal
Personal Assistant	:	Ms Alice Thomas
Supporting staff	:	Mr K Chandran

COORDINATING CENTRES

1. *Cardamom Research Station, KAU, Pampadumpara*

1. Breeder	:	Vacant (July 2006)
2. Agronomist (Hort.)	:	Dr K Geetha
3. Jr. Entomologist	:	Vacant
4. Farm Assistant (Sel. Gr.)	:	Mr C G Pradeep
5. Lab Assistant (Grade II)	:	Mr C S Manoj
6. Peon	:	Smt Radhamoney

2. *Pepper Research Station, KAU, Panniyur*

1. Pathologist (Assoc. Professor)	:	Dr K P Mammootty
2. Jr. Breeder (Asst. Professor)	:	Dr V P Neema
3. Jr. Pathologist	:	Vacant
4. Jr. Horticulturist (Agronomy)	:	Vacant
5. Farm Supervisor (Gr. II)	:	Mr K Lakshmanan
6. Farm Supervisor (Sr. Gr.)	:	Mr P P Muralidharan
7. Farm Supervisor (Gr. I)	:	Mr K A Kurien
8. Lab Assistant (Gr. III)	:	Ms Nirmala Chellath
9. Peon (Sel. Gr.)	:	K Rajeev

3. *Horticultural Research Station, UHS, Mudigere*

1. Pathologist	:	Dr S D Rangaswamy
2. Agronomist (Hort.)	:	Mr K M Devaraju
3. Breeder	:	Vacant
4. Jr. Entomologist	:	Dr D Jemla Naik
5. Technical Assistant	:	Mr Narayana

- | | | | |
|-----|--|---|--|
| 6. | Technical Assistant | : | Mr V Mallikarjunappa |
| | 7. Messenger | : | Ms Savithri |
| 4. | <i>Horticultural Research Station, UHS, Sirsi</i> | | |
| | 1. Jr. Pathologist (Assoc. Prof.) | : | Dr M S Lokesh |
| | 2. Jr. Horticulturist | : | Mr Nagesh Naik |
| | 3. Technical Assistant | : | Mr GV Heregowder |
| 5. | <i>Horticultural Research Station, TNAU, Yercaud</i> | | |
| | 1. Agronomist (Hort.) | : | Dr V Lakshmanan |
| | 2. Jr. Breeder (Hort.) | : | Dr R Richard Kennedy
(Posted at HRS Pechiparai) |
| | 3. Lab Assistant | : | Mr P Pappu |
| 6. | <i>Department of Spices & Plantation Crops, TNAU, Coimbatore</i> | | |
| | 1. Breeder (Horticulturist) | : | Dr N Shoba |
| | 2. Jr. Pathologist | : | Dr P Muthulakshmi |
| | 3. Agricultural Assistant | : | Mr R Swaminathan |
| 7. | <i>Horticultural Research Station, ANGRAU, Chintapalle</i> | | |
| | 1. Horticulturist | : | Sri K Ravindra Kumar |
| | 2. Junior Pathologist | : | Dr N Raja Kumar |
| | 3. Technical Assistant | : | Post filled on contract basis
from 26-5-2007 |
| 8. | <i>Regional Agricultural Research Station, ANGRAU, Jagtial</i> | | |
| | 1. Jr. Pathologist | : | Sri S Narasimha Rao |
| | 2. Jr. Horticulturist | : | Mrs K Uma Maheshwari |
| | 3. Technical Assistant | : | Post filled on contract basis |
| 9. | <i>Horticultural Research Station, ANGRAU, Guntur</i> | | |
| | 1. Horticulturist | : | Smt C Sarada |
| | 2. Jr. Breeder (Hort.) | : | Sri K Giridhar |
| | 3. Sub Assistant | : | Sri Shaik Jilani Bhasha |
| 10. | <i>Department of Vegetable Crops, Dr YSPUHF, Solan</i> | | |
| | 1. Breeder (Olericulturist) | : | Dr B N Korla |
| | 2. Jr. Pathologist | : | Dr N P Dohroo |
| | 3. Jr. Biochemist | : | Dr Neerja S Rana |
| | 4. Field Assistant | : | Mr Rajeshwar Chauhan |
| 11. | <i>High Altitude Research Station, OUAT, Pottangi</i> | | |
| | 1. Breeder | : | Vacant |
| | 2. Jr. Breeder | : | Mr D K Dash |

3. Technical Assistant : Mr L K Mishra
4. Technical Assistant : Vacant
12. *Department of Genetics and Plant Breeding, SKN College of Agriculture, RAJAU, Jobner*
1. Sr. Breeder : Dr EV D Sastry
2. Breeder : Dr Dharendra 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/Oleiculturist : Dr T P Malik
2. Assistant Scientist (VC) : Dr Suresh Tehlan
15. *Department of Horticulture, Tirhut College of Agriculture, RAU, Dholi*
1. Horticulturist : Dr S P Singh
2. Jr. Pathologist : Dr A K Mishra
3. Technical Assistant : Dr A N Mishra
16. *Department 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 V K Singh
17. *Department of Horticulture, UBKV, Pundibari*
1. Horticulturist : Vacant (Dr J C Jana, incharge)
2. Jr. Breeder : Dr N Bhowmik (Study leave)
3. Jr. Pathologist : Mr S Bandyopadhyay
4. Technical Assistant : Ms A Das
5. Technical Assistant : Mr B Dutta
18. *Department of Horticulture, KKV, Dapoli*
1. Horticulturist : Prof. R N Nawale
2. Jr. Pathologist : Prof U A Gadre
3. Jr. Breeder : Prof U B Pethe

- 4. Technical Assistant : Mr D D Bhandari
- 5. Technical Assistant : Mr A B Jadhav

19. *Regional Agricultural Research Station, IGAU, Raigarh*

- 1. Horticulturist : Vacant from 10-3-2008
- 2. Jr. Breeder : Vacant from 22-05-2007
- 3. Jr. Pathologist : Dr A K Singh
- 4. Technical Assistant : Mr D S Kshatri
- 5. Technical Assistant : Vacant

AICRPS - Budget Provision Centrewise and Head Wise Budget Provision -2008-09

(Rs. in lakhs)

Name of the centres	Pay and Allowances		TA		RC		Tech. A (ICAR)	Total RC (ICAR)	Equipments		Total		Grand Total
	Total	ICAR	Total	ICAR	Total	ICAR			Total	ICAR	ICAR Share	State Share	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(9)	(10)	(11)
Pampadumpara (KAU)	5.260	3.945	0.600	0.450	2.40	1.800	0.05	1.850	4.50	3.375	9.620	3.190	12.810
Panniyur (KAU)	5.508	4.131	0.800	0.600	3.20	2.400	0.05	2.450	4.000	3.000	10.181	3.377	13.558
Mudigere (UHS)	37.593	28.195	0.800	0.600	3.20	2.400		2.400	2.000	1.500	32.695	10.898	43.593
Sirsi (UHS)	8.863	6.647	0.400	0.300	1.60	1.200	0.05	1.250	3.5	2.625	10.822	3.591	14.413
Yercaud (TNAU)	8.313	6.235	0.400	0.300	1.60	1.200	0.05	1.250	2.500	1.875	9.660	3.203	12.863
Coimbatore (TNAU)	10.056	7.542	0.400	0.300	1.60	1.200	0.05	1.250	3.836	2.877	11.969	3.973	15.942
Chintapalli (APHU)	4.222	3.167	0.400	0.300	1.60	1.200	0.05	1.250	0.166	0.124	4.841	1.597	6.438
Jagtial (APHU)	3.056	2.292	0.400	0.300	1.60	1.200		1.200	3.668	2.751	6.543	2.181	8.724
Guntur (APAU)	5.663	4.247	0.400	0.300	1.60	1.200	0.1	1.300	1.836	1.377	7.224	2.375	9.599
Solan (YSPUHF)	13.116	9.837	0.600	0.450	2.40	1.800		1.800	2.233	1.675	13.762	4.587	18.349
Pottangi (OUAT)	16.307	12.230	0.400	0.300	1.60	1.200		1.200	1.845	1.384	15.114	5.038	20.152
Jobner (RAJAU)	12.489	9.367	1.000	0.750	4.00	3.000	0.15	3.150	3.668	2.751	16.018	5.289	21.307
Jagudan (GAU)	10.743	8.057	0.400	0.300	1.60	1.200	0.15	1.350	3.100	2.325	12.032	3.961	15.993
Hisar (HAU)	8.598	6.449	0.400	0.300	1.60	1.200	0.1	1.300	1.330	0.997	9.046	2.982	12.028
Dholi (RAU)	4.809	3.607	0.400	0.300	1.60	1.200	0.05	1.250	2.257	1.693	6.850	2.267	9.116
Kumarganj (NDUAT)	17.803	13.353	0.600	0.450	2.40	1.800		1.800	3.330	2.497	18.0995	6.033	24.133
Pundibari (UBKVV)	3.457	2.593	0.600	0.450	2.40	1.800	0.05	1.850	3.169	2.377	7.270	2.407	9.676
Dapoli (KKV)	12.469	9.352	0.600	0.450	2.40	1.800	0.05	1.850	3.330	2.497	14.149	4.700	18.849
Raigarh (IGKW)	12.089	9.067	0.600	0.450	2.40	1.800	0.05	1.850	3.066	2.300	13.667	4.539	18.205
Total	200.414	150.3125	10.200	7.650	40.800	30.600	1.000	31.600	53.334	40.000	229.5625	76.1870	305.748

AICRPS - Budget Provision

Centrewise and Head Wise Budget Provision -2008-09

(Rs. in lakhs)

Name of the centres	Pay and Allowances		TA		RC		Tech. A Total RC		Equipments		Total		Grand Total
	Total	ICAR	Total	ICAR	Total	ICAR	(ICAR)	(ICAR)	Total	(ICAR)	ICAR Share	State Share	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(9)	(10)	(11)
Ambalavayal(KAU)			0.150	0.1125	2.80	2.100		2.100			2.2125	0.7375	2.9500
Pechepari (TNAU)			0.150	0.1125	2.80	2.100		2.100			2.2125	0.7375	2.9500
Gangtok (ICRI)			0.150	0.1125	2.80	2.100		2.100			2.2125	0.7375	2.9500
Sakleshpur (ICRI)			0.150	0.1125	2.80	2.100		2.100			2.2125	0.7375	2.9500
Myladumpara (ICRI)			0.150	0.1125	2.80	2.100		2.100			2.2125	0.7375	2.9500
ICAR R C NEHR, Barapani			0.150	0.1125	1.80	1.350		1.350			1.4625	NIL	1.4625
ICAR R C NEHR, Mizoram			0.150	0.1125	1.80	1.350		1.350			1.4625	NIL	1.4625
ICAR R C NEHR, Gangtok			0.150	0.1125	1.80	1.350		1.350			1.4625	NIL	1.4625
Pasighat (CAU)			0.150	0.1125	0.80	0.600		0.600			0.7125	0.2375	0.9500
Pantnagar (GBPUAT)			0.150	0.1125	0.80	0.600		0.600			0.7125	0.2375	0.9500
Kanke (BIRSAU)			0.150	0.1125	0.80	0.600		0.600			0.7125	0.2375	0.9500
Kalyani (BCKV)			0.150	0.1125	0.80	0.600		0.600			0.7125	0.2375	0.9500
Udaipur (MPUAT)			0.150	0.1125	0.80	0.600		0.600			0.7125	0.2375	0.9500
Navasari (NAU)			0.150	0.1125	0.80	0.600		0.600			0.7125	0.2375	0.9500
Jabalpur (JNKV)			0.150	0.1125	0.80	0.600		0.600			0.7125	0.2375	0.9500
Total	200.747	150.3125	2.250	1.6875	25.00	18.750		18.750			20.4375	5.3500	25.7875
GRAND TOTAL			12.450	9.3375	65.800	49.350	1.000	50.350	53.334	40.000	250.000	81.5370	331.5355

Statement of fund released to AICRPS centres (2008-09)

Rs. in lakhs

Centre	Allocation 2008-09	I st half released	II nd half released	Technology Assessment	Additional fund released	Grand total
Pampadumpara (KAU)	9.620	3.098	3.097	0.050		9.620
Panniyur (KAU)	10.181	7.131		0.050		10.181
Mudigere (UAS-B)	32.695	10.398	7.797		13.00	32.695
Sirsi (UAS-D)	10.822	4.749	3.398	0.050		10.822
Yercaud (TNAU)	9.660	4.543	3.192	0.050		9.660
Coimbatore (TNAU)	11.969	4.646	4.396	0.050		11.969
Chintapalle (APHU)	4.841	3.509	1.158	0.050		4.841
Jagtial (APHU)	6.543	3.521	0.271			6.543
Guntur (APHU)	7.244	3.049	2.698	0.100		7.224
Solan (YSPUHF)	13.762	7.244	4.843			13.762
Pottangi (OUAT)	15.114	1.865	1.865		10.00	15.114
Jobner (RAJAU)	16.018	7.934	5.183	0.150		16.018
Jagudan (GAU)	12.032	4.954	4.603	0.150		12.032
Hisar (HAU)	9.046	4.625	1.324	0.100	2.00	9.046
Dholi (RAU)	6.850	3.204	1.903	0.050		6.850
Kumarganj (NDUAT)	18.0995	7.421	6.971		1.2105	18.0995
Pundibari (UBKVV)	7.270	4.843	Nil	0.050		7.270
Dapoli (KKV)	14.149	5.801	5.801	0.050		14.149
Raigarh (IGKVV)	13.667	5.659	5.658	0.050		13.667
Coopting/Voluntary Centers	20.4375		20.4375			20.4375
Total	250.00	98.194	84.5955	1.000	26.2105	250.00

Total amount received from council : Rs 250.00 L
Amount released : Rs 250.00 L

WEATHER DATA

Chintapalle

Month	Rainfall		Temperature		Relative Humidity	
	(mm)	Rainy days	(°C)		(%)	
			Max	Min	Max	Min
April '08	46.0	5.3	31.4	18.2	87.7	50.2
May	40.4	7.0	34.1	19.6	72.3	43.3
June	112.4	9.4	23.3	19.2	65.9	43.9
July	106.4	13.8	22.3	19.2	77.9	62.9
August	151.9	14.6	25.9	20.9	87.3	81.1
September	169.7	11.3	25.7	20.3	89.1	76.2
October	25.0	10.4	27.8	17.0	87.1	61.7
November	13.2	2.6	26.6	13.3	77.1	54.9
December	4.0	0.5	26.8	11.0	85.8	49.2
January'09	0.0	0.0	27.3	10.8	81.5	42.3
February	0.0	0.0	30.1	12.6	67.6	36.2
March	31.4	3.0	31.5	14.5	64.7	34.9

Coimbatore

Month	Rainfall		Temperature		Relative Humidity	
	(mm)	Rainy days	(°C)		(%)	
			Max	Min	Max	Min
April '08	51.6	3	34.2	22.6	89.0	43.0
May	42.0	2	35.0	23.0	85.0	44.0
June	21.4	2	32.0	23.6	77.0	51.0
July	27.8	3	31.3	23.1	82.0	54.0
August	66.3	4	31.8	22.7	88.0	54.0
September	26.3	4	31.5	21.7	84.0	52.0
October	312.9	14	30.8	22.0	91.0	62.0
November	43.6	5	28.4	20.8	91.0	55.0
December	11.1	1	28.6	19.2	90.0	51.0
January'09	0.0	0	30.0	18.7	90.0	39.0
February	0.0	0	33.5	19.2	82.0	28.0
March	101.8	3	34.6	21.4	83.0	34.0

Dapoli

Month	Rainfall		Temperature		Relative Humidity	
	(mm)	Rainy days	(°C)		(%)	
			Max	Min	Max	Min
April '08	0.0	0	32.5	19.8	93.0	59.2
May	6.0	1	33.3	22.7	88.4	61.0
June	990.8	23	29.3	24.0	93.0	88.5
July	729.0	30	28.5	24.4	93.2	87.8
August	670.9	16	28.0	23.0	97.2	94.5
September	608.2	14	29.2	23.6	97.2	87.7
October	10.1	2	32.3	19.6	94.7	64.5
November	0.0	0	33.4	17.1	94.0	49.0
December	0.0	0	32.7	15.4	96.0	46.2
January'09	0.0	0	31.9	13.0	96.5	44.5
February	0.0	0	32.8	12.6	94.0	50.0
March	0.0	0	33.6	16.3	89.0	55.7

Dholi

Month	Rainfall (mm)	Temperature (°C)		Relative Humidity (%)	
		Max	Min	Max	Min
		April '08	13.5	36.0	21.5
May	55.0	33.8	24.1	82.0	54.4
June	359.0	32.7	26.4	86.0	67.0
July	535.9	31.7	26.9	90.0	77.0
August	287.5	31.4	27.0	90.0	73.0
September	171.3	32.6	26.5	88.0	69.0
October	98.8	31.7	24.0	91.0	57.0
November	0.0	28.9	15.2	90.0	43.0
December	0.0	22.9	13.4	91.0	64.0
January'09	0.0	22.2	10.3	92.0	61.0
February	0.0	26.2	10.9	85.0	43.0
March	0.0	31.5	15.0	80.0	34.0

Guntur

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)	
			Max	Min	Max	Min
			June '08	109.6	9	36.8
July	244.6	14	34.0	23.1	78.6	55.1
August	329.6	11	31.4	22.0	85.9	68.4
September	32.4	3	33.0	22.1	79.6	60.3
October	26.6	3	32.9	20.0	84.2	54.2
November	102.0	3	31.4	17.3	81.3	54.7
December	0.0	0	30.5	15.5	96.2	67.2
January'09	0.0	0	31.7	18.5	94.0	69.2
February	0.0	0	34.8	19.7	94.2	51.9

Hisar

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)	
			Max	Min	Max	Min
			April '08	13.9	3	35.4
May	52.7	7	38.0	22.7	60.0	32.0
June	108.9	9	36.2	25.6	80.0	59.0
July	162.1	8	36.2	26.4	82.0	58.0
August	129.1	8	33.7	25.4	91.0	72.0
September	96.0	2	33.6	22.4	87.0	54.0
October	5.3	1	33.9	18.8	84.0	37.0
November	3.2	1	28.9	10.6	90.0	33.0
December	0.8	0	23.5	6.8	94.0	48.0
January'09	10.3	2	20.1	5.8	97.0	53.0
February	6.1	1	24.0	7.4	93.0	45.0
March	4.1	0	29.3	11.7	89.0	40.0

Jagtial

Month	Rainfall		Temperature		Relative Humidity	
	(mm)	Rainy days	(°C)		(%)	
			Max	Min	Max	Min
June '08	125.4	6	36.1	NA	67.7	49.8
July	184.2	10	32.7	NA	73.5	59.7
August	180.8	9	30.8	NA	74.4	66.2
September	71.6	6	32.1	NA	73.6	62.8
October	0.0	60	33.8	22.7	66.0	41.3
November	2.4	0	31.5	17.9	73.3	36.9
December	3.0	0	31.4	13.1	77.4	39.3
January'09	0.0	0	31.7	15.4	76.6	34.5
February	0.0	0	34.7	18.1	69.5	29.9
March	0.6	0	36.7	19.1	61.8	27.4
April	0.0	0	38.8	21.2	66.0	23.8
May	0.0	0	38.5	24.4	44.0	24.0

Jobner

Month	Rainfall		Temperature		Relative Humidity	
	(mm)		(°C)		(%)	
			Max	Min	Max	Min
April '08	25.3		35.7	18.3	56	29
May	12.4		39.5	24.6	47	22
June	44.1		35.9	26.1	71	48
July	109.0		34.4	25.9	76	55
August	71.0		32.4	23.9	79	51
September	29.4		35.4	27.7	67	39
October	4.0		35.3	16.0	65	27
November	0.0		29.8	09.7	64	23
December	0.0		26.3	07.6	75	29
January'09	0.0		23.2	06.1	78	36
February	0.0		27.4	08.6	69	27
March	4.8		31.4	13.4	57	21

Mudigere

Month	Rainfall		Temperature		Relative Humidity	
	(mm)	Rainy days	(°C)		(%)	
			Max	Min	Max	Min
April'08	17.4	3	31.6	19.0	90.0	80.0
May	99.8	6	31.6	18.6	89.9	80.2
June	611.6	25	26.9	17.2	89.0	79.3
July	623.4	25	25.9	16.9	91.9	87.6
August	858.4	20	26.0	17.2	90.6	82.4
September	307.0	13	26.1	17.5	90.7	16.1
October	279.1	14	26.5	17.3	91.3	86.9
November	21.6	2	26.9	17.1	91.4	86.7
December	0.0	0	26.9	15.8	86.2	75.0
January'09	0.0	0	25.9	15.0	72.2	58.5
February	0.0	0	26.9	15.8	83.0	61.8
March	174.8	7	81.0	48.2	31.4	18.4

Pampadumpara

Month	Rainfall (mm)	Rainy days	Temperature (°C)	
			Max	Min
January '08	0.4	1	28.0	13.0
February	13.2	3	28.0	14.0
March	165.2	10	28.0	14.0
April	52.8	7	31.5	17.0
May	15.0	2	28.5	16.0
June	218.7	2	27.0	16.5
July	313.0	17	27.0	16.0
August	367.8	18	27.5	16.5
September	200.4	12	28.0	16.0
October	285.6	13	29.5	17.0
November	78.8	4	28.0	14.0
December	31.2	5	24.5	13.0

Panniyur

Month	Rainfall		Temperature		Relative Humidity (%)
	(mm)	Rainy days	(°C)		
			Max	Min	
March '08	329.8	11	34.8	24.2	84.3
April	71.4	9	34.4	26.4	85.4
May	130.5	7	33.5	25.9	84.9
June	769.9	28	30.2	25.3	90.2
July	607.8	23	28.8	24.9	89.4
August	478.5	18	29.3	24.8	90.9
September	433.9	19	30.5	24.2	90.8
October	443.9	17	31.4	25.1	89.7
November	3.4	1	30.3	25.4	90.4
December	7.4	1	34.4	23.2	90.6
January '09	0.0	0	34.7	22.5	85.6
February	0.0	0	35.8	24.1	90.9

Pechiparai

Month	Total Rainfall		Temperature		Relative Humidity (%)
	(mm)	Rainy days	(°C)		
			Max	Min	
April '08	137.0	16	31.4	23.1	94.9
May	42.0	3	33.7	24.2	95.2
June	74.0	14	33.5	23.4	93.6
July	477.0	17	31.9	22.5	95.1
August	218.5	12	33.1	21.0	94.4
September	182.0	10	32.8	19.0	94.4
October	446.0	20	32.0	18.1	90.9
November	194.0	14	32.4	18.9	94.8
December	25.0	5	32.4	19.1	90.8
January '09	0.4	1	34.5	22.5	92.1
February	0.0	0	35.2	16.0	91.3
March	175.5	12	34.5	21.8	90.2

Pottangi

Month	Rainfall (mm)	Temperature (°C)		Relative Humidity (%)	
		Max	Min	Max	Min
		April '08	66	38	28
May	90.5	41	32	74	61
June	173	34	29	NA	NA
July	231	30	26	84	61
August	400	29	24	89	71
September	612	28	22	90	80
October	20	27	21	84	72
November	45	26	19	77	70
December	0	24	18	70	61
January'09	0	21	17	70	60
February	0	20	16	68	60
March	0	NA	NA	64	54

Pundibari

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)	
			Max	Min	Max	Min
			April '08	165.8	8	30.1
May	383.1	23	30.1	22.2	89	72
June	499.8	18	30.5	24.4	94	83
July	508.6	15	30.9	25.1	94	84
August	1090.8	25	30.7	24.6	95	88
September	377.6	12	31.7	24.4	95	82
October	239.6	7	31.1	20.8	91	71
November	0.0	0	27.5	14.2	89	54
December	0.0	0	24.6	14.0	94	67
January'09	0.0	0	23.5	11.9	94	63
February	0.0	0	27.7	13.0	90	53
March	36.60	7	31.1	14.8	83	44

Sirsi

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)	
			Max	Min	Max	Min
			April '08	0.0	0	33.9
May	34.4	1	32.6	82.4	54.7	21.3
June	584.6	23	27.5	89.9	79.9	21.2
July	483.3	23	27.0	90.6	80.8	21.3
August	645.2	18	26.5	90.8	83.1	20.8
September	182.6	16	27.8	89.7	79.3	20.6
October	26.2	3	29.8	86.0	70.4	19.3
November	14.8	2	29.8	80.4	63.5	15.7
December	13.2	1	30.0	77.6	47.7	14.8
January'09	0.0	0	30.5	84.0	60.7	14.0
February	0.0	0	33.0	79.8	29.1	15.3
March	21.8	4	34.5	89.0	66.0	19.2

Solán

Month	Rainfall (mm)	Temperature (°C)		Relative Humidity (%)
		Max	Min	
January'08	44.1	17.2	2.4	55
February	31.0	20.0	3.9	51
March	0.4	27.3	8.9	38
April	38.4	28.9	12.5	43
May	95.9	30.0	15.1	45
June	261.5	28.5	19.3	79
July	98.7	28.8	20.2	78
August	248.3	27.9	19.7	81
September	348.9	27.6	15.8	73
October	13.5	27.0	10.9	65
November	5.4	25.2	5.9	56
December	0.2	23.2	4.0	51

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