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Annual Report
2009-10

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

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भारतीय मसाला फसल अनुसंधान संस्थान

(भारतीय कृषि अनुसंधान परिषद)

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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

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CONTENTS

परियोजना समन्वयक की रिपोर्ट

शोध कर्मियों की इक्कीसवीं राष्ट्रीय समूह बैठक अखिल भारतीय समन्वित मसाला अनुसंधान परियोजना

अखिल भारतीय समन्वित मसाला अनुसंधान परियोजना (ए आई सी आर पी एस) अपने मुख्यालय भारतीय मसाला फसल अनुसंधान संस्थान, कालिकट सहित 13 अधिदेश मसाला फसलों जैसे, काली मिर्च, इलायची, कैसिया, दालचीनी, लौंग, जायफल, घनिया, जीरा, सौंफ, मेथी, अदरक, हल्दी तथा बडी इलायची में शोध कार्यों और अनुसंधान समन्वय करने के लिए अधिकारित है। ए आई सी आर पी एस के कुल 34 केन्द्र है जो भारत के 21 राज्यों में 21राज्य/केन्द्रीय कृषि विश्वविद्यालय (राज्य कृषि विश्वविद्यालय)/शोध संस्थानों के अन्तर्गत कार्यरत है। इन केन्द्रों में 19 नियमित, 8 सहयोजित तथा 7 स्वैच्छिक केन्द्र हैं। वर्ष 2009-10 में ए आई सी आर पी एस की ग्यारहवीं योजना का बजट 1400 लाख रूपये है जिसमें भारतीय कृषि अनुसंधान परिषद का अंश 250 लाख रूपए है। एन. बी. पी. जी. आर. नई दिल्ली तथा एन आर सी एस एस, अजमेर में जननद्रव्य पर ब्रेनस्टोमिंग सत्र में लिये गये निर्णय के अनुसार ए आई सी आर पी एस के विभिन्न केन्द्रों में संयुक्त रूप से जननद्रव्य का बहुस्थानीय परीक्षण किया गया। तमिलनाडु कृषि विश्वविद्यालय, कोयम्बतोर में 6-8 जून 2009 में बीसवीं ए आई सी आर पी एस कार्यशाला में लिये निर्णय के अनुसार प्रस्तुत वर्ष फेरटिगेशन, यांत्रिक फसल कटाई, तथा हल्दी के संसाधन हेतू संशोधित उबालने की यूनिट आरम्भ की गयी। अधिदेश मसाला फसलों के लगभग 100 शोध कार्यक्रम विभिन्न केन्द्रों में आयोजित किये जा रहे हैं। यह कार्यक्रम आनुवांशिकी, फसल सुधार, फसल उत्पादन तथा फसल संरक्षण जैसे प्रमुख विभागों के अन्तर्गत चल रहे हैं। वर्ष 2009-10 में विभिन्न परियोजनाओं के अन्तर्गत अधिदेश फसलों की प्रमुख उपलब्धियां इस रिपोर्ट में प्रस्तुत की जा रही हैं।

काली मिर्च

काली मिर्च जननद्रव्य, विदेशी, वन्य तथा अन्य संबन्धित उपजातियों को ए आई सी आर पी एस के विभिन्न केन्द्रों में अनुरक्षण किया जा रहा हैं। जननद्रव्य परिरक्षण के लिये अम्बलवयल केन्द्र को एक वैकल्पिक केन्द्र के रूप में पहचान की गयी। जननद्रव्यों के चरित्रांकन के फलस्वरूप अधिक उपज वाले अक्सेशनों की पहचान की गयी। चिन्तापल्ली में मूल्यांकन किये 22 अक्सेशनों में पन्नियूर -I में अधिकतम उपज (7.6 कि. ग्राम/बेल) तत्पश्चात् नीलमुंडी (6.84 कि. ग्राम/बेल) प्राप्त हुयी । वर्ष 2009 में पन्नियूर, अंगमाली तथा चालक्कुडी में जननद्रव्य अक्सेशनों का मूल्यांकन करने पर यह ज्ञात हुआ कि अक्सेशन आई सी पी 48 तथा वट्टमुंडा में 3 कि. ग्राम हरी उपज/बेल अन्य की अपेक्षा अधिक आशाजनक थे। पन्नियूर में काली मिर्च में सी वी टी में अधिकतम हरी बेरी उपज/बेल सी यू एल-1041 (2.5 कि. ग्राम/बेल) तत्पश्चात् सी यू एल-5489 (2 कि. ग्राम/बेल) में अंकित की गई। वही सिरसी में, शुष्क बेरी की उपजता पन्नियूर. में (963 ग्राम/बेल) तत्पश्चात् एच पी. 105 (747 ग्राम/बेल) थी। अम्बलवयल में अधिकतम स्थापना का प्रतिशत पी आर एस- 22 में तत्पश्चात् कल्टिवर 5489, सी ओ एल एल 1041 तथा करिमुंडा ओ पी (98%) था। काली मिर्च के अन्तर प्रजातीय संकरजों में पी. 6 x पी.5 (5 कि. ग्राम हरी उपज/बेल) अधिक आशाजनक था। उर्वरक परीक्षणों में, सिरसी में पूर्णतः जैविक (1.01 कि. ग्राम/बेल) तथा पूर्णतः अजैविक (0.94 कि. ग्राम/बेल) की तुलना में एकीकृत विधियों द्वारा उपचारित काली मिर्च बेलों में अधिक शुष्क उपजता (1.20 कि. ग्राम/बेल) अंकित की गयी। वही पीचिपराई में, पूर्णतः अजैविक परीक्षण में अधिकतम उपजता 3.78 कि. ग्राम/बेल तथा एकीकृत विधियों में इसके समकक्ष उपज 3.54 कि. ग्राम/बेल अंकित की गयी। काली मिर्च में कृषक परंपरागत विधियों की तुलना में पोटैशियम फोस्फोनेट + *ट्राइकोडेरमा हरज़ियानम* तथा बोर्डियो मिश्रण + सी ओ सी डालने पर खुर गलन का आपतन क्रमशः 70.47 तथा 56.85 प्रतिशत कम था। इस वर्ष काली मिर्च की सहिष्णु/प्रतिरोधक रूट स्टोक जैसे आई आई एस आर थेवम, आई आई एस आर शक्ति तथा *पाइपर कोलुब्रिनम* पर कलम बांधना आरंभ किया। ओरथेट्रोपिक के अलावा काली मिर्च की आरोही प्ररोहों का भी मूल्यांकन किया जा रहा हैं।

इलायची

पाम्पाडुमपारा में वर्ष 2009-10 में इलायची जननद्रव्य का मूल्यांकन करने पर अधितम उपजता सी आर एस पी.147 (1055 ग्राम शुष्क कैप्स्यूल/पौधे) में अंकित की गयी। विभिन्न अक्सेशनों में, पी वी- 2 को अधिकतम शुष्क फलों के प्रतिशत (23.4%) के लिये पंजीकृत किया। प्रविष्टियों की दक्षता की सी वी टी में मूल्यांकन करने पर एस के पी. 170 अन्य प्रविष्टियों की तुलना में उत्तम थी तथा यह इस वर्ष सकलेशपुर केन्द्र से विमोचन हेतू प्रस्तावित है। मुडिगरे केन्द्र में, खुले परागित संतति 23 सी 8 में अधिकतम उपजता (221 कि. ग्राम/हेक्टर) अंकित की गयी। पाम्पाडुमपारा में, इलायची की सी वी टी में अधिकतम शुष्क उपजता पी एस-27 (1016.58 ग्राम/पौधा) तत्पश्चात् एम एच

सी-26 (335.42 ग्राम/पौधा) अंकित की गयी। थ्रिप्स द्वारा होने वाली हानि में 26 से 48% का अन्तर था। सबसे कम थ्रिप्स द्वारा हानि सी एल-722 में तथा अधिकतम एम सी सी-246 में अंकित की गयी। आशुकाल रोगों के कारण होने वाली अधिकतम हानि एम सी सी-246 एवं जी जी में तथा सबसे कम हानि एम सी सी-309 में थी। कैप्स्यूल बेधक के कारण होने वाली हानि का प्रतिशत सबसे कम एम एच सी-26 एवं सी एल-722 में तथा अधिकतम एम सी सी-73 तथा जी जी में थी। मुडिगरे में इलायची के उपरोक्त सी वी टी में क्लोन सी एल-722 की शुष्क कैप्स्यूल उपज (341.00 कि. ग्राम/हेक्टर) अंकित की।

बडी इलायची

बडी इलायची पर अनुसंधान कार्य वर्ष 2009-10 में आई सी आर आई, स्पाइसेस बोर्ड तथा आई सी ए आर, आर सी एन ई एच आर, गांगटोक, सिक्किम में शुरू किया। उत्तर सिक्किम के मध्य सिंगहिक, सेन्टम तथा नंग ग्राम में सर्वेक्षण आयोजित किया तथा बडी इलायची के पांच अक्सेशनों जैसे एस सी सी 213 (गोलसे), एस सी सी 214 (गोलसे), एस सी सी 215 (गोलसे), एस सी सी 216 (रमला) तथा एस सी सी 217 (रमला) को जननद्रव्य में शामिल किया। संचित किये जननद्रव्य को विवर्णक के आधार पर चरित्रांकन किया।

अदरक

धोली केन्द्र में, अदरक के आशाजनक अक्सेशनों का मूल्यांकन करने पर यह ज्ञात हुआ कि आर जी 14 तथा आर जी 24 में अधिकतम उपज (8.00 कि. ग्राम/7.2 मीटर) तत्पश्चात् आर जी 13 (7.30 कि. ग्राम/7.2 मीटर) प्राप्त हुई। पुंडिबारी में, अधिकतम राइसोम उपज/पौधे जी सी पी 1 में (672.33 ग्राम) अंकित की गई। पुंडिबारी में, जननद्रव्य अक्सेशनों के मूल्यांकन में, जी सी पी-29, जी सी पी-50, तथा जी सी पी-52 में कोई रोग समस्या नहीं थी जबकि सोलन में एस जी-785 अक्सेशन में रोग आपतन 5.5% अंकित किया। धोली में आई ई टी में, नियन्त्रण प्रजाति नदिया (17.81 टन/ हेक्टर) की तुलना में आर जी-3 की उपज 21.34 टन/हेक्टर अधिक होने के कारण इस को आशाजनक अक्सेशन के रूप में सी वी टी में बढावा दिया। फासीघट में, अदरक के जीन प्रकार पर पारिस्थितिक प्रभाव के अध्ययन पर यह ज्ञात हुआ कि सुरभि प्रजाति में अधिकतम साफ प्रकन्द उपज (32.60 टन/हेक्टर) तत्पश्चात् नदिया प्रजाति (21.13 टन/हेक्टर) में अंकित की गयी। धोली केन्द्र में, अदरक में पूर्णतः जैविक उर्वरकों को डालने पर अधिकतम उपज (12.90 टन/हेक्टर) तत्पश्चात् एकीकृत उर्वरक डालने पर (11.62 टन/हेक्टर) प्राप्त हुयी। धोली तथा कुमारगंज में गोभी द्वारा जैविक धूम्रीकरण करके मृदा को उपचारित करने पर अदरक की अधिकतम उपज एवं मृदा गलन रोग का आपतन कम अंकित किया।

हल्दी

पुंडिबारी केन्द्र में, हल्दी के 180 अक्सेशनों का मूल्यांकन करने पर, टी सी पी-88, टी सी पी-36 तथा टी सी पी-2` उपज की दृष्टि से आशाजनक थे। जगतियाल में, जे टी एस -315 तथा जे टी एस -14 को आशाजनक रूप में अंकित किया। चिंतापल्ली में, हल्दी के सी वी टी में, पी टी एस- 39 की अधिकतम उपज (36.37 टन/हेक्टर) अंकित की गई जबकि राइगढ में नरेन्द्र हल्दी -1 की अधिकतम उपज (21.49 टन/हेक्टर) प्राप्त हुई। पुंडिबारी में किये गये हल्दी के आई ई टी पर टी सी पी-129 में अधिकतम उपज (21.24 टन/हेक्टर) अंकित की गई। धोली में राजेन्द्र सोनिया, चिन्तापल्ली में रोमा, कन्के में सुप्रभा, पुंडिबारी में नरेन्द्र हल्दी, मिज़ोरम में आई आई एस आर प्रतिभा, रोमा तथा आर सी टी-1 अन्य प्रजातियों की अपेक्षा श्रेष्ठ तथा ये प्रजातियां इन स्थानों के लिये उत्तम है। धोली में, एकीकृत उर्वरक डालने पर अधिकतम उपज (54.93 टन/हेक्टर) तत्पश्चात् पूर्णतः जैविक खाद (50.30 टन/हेक्टर) प्राप्त हुई। एकीकृत उर्वरक प्रबन्धन के लागत : लाभ के अनुपात में अधिकतम लाभ 4.4 रू./यूनिट लागत (1:4.46) तत्पश्चात् पूर्णतः अजैविक 3.80 रू./यूनिट लागत (1:3.80) है। एक पखवाडे के अन्तराल में 100% संस्तुत मात्रा का उर्वरक ड्रिप सिंचाई द्वारा डालने पर हल्दी की अधिकतम उपज (39.34 कि. ग्राम/प्लोट) प्राप्त हुई। हल्दी के यांत्रिक फसलन से यह ज्ञात होता है कि पावर टिल्लर माउंटेड हारवेस्टर की अपेक्षा ट्राक्टर माउंटेड हारवेस्टर द्वारा फसलन में कम समय लगता है। पावर टिल्लर माउंटेड हारवेस्टर एवं मैनुअल फसलन की तुलना में ट्राक्टर माउंटेड हारवेस्टर फसलन में प्रकन्दों की हानि कम (1.7%) तथा लागत भी कम लगती है।

वृक्ष मसाले

धापोली, येरकाड एवं पीचिपराई केन्द्रों में, वृक्ष मसालों जैसे लौंगद्व जायफल तथा दालचीनी के जननद्रव्यों का अनुरक्षण किया जा रहा है। पीचिपराइ में कैसिया के चार चयनों का सी वी टी मूल्यांकन करने पर, डी 3 आशाजनक था।

धनिया

इस वर्ष सभी बीज मसालों, जैसे धनिया, जीरा, सौंफ तथा मेथी के जननद्रव्यों का बहुस्थनीय मूल्यांकन प्रारंभ किया। कोयम्बतोर में, धनिये के 275 अक्सेशनों का मूल्यांकन करने पर उपजता 360 कि. ग्राम/ हेक्टर से 1080 कि. ग्राम/हेक्टर तक अंकित की गयी। धनिये की अधिकतम औसत उपजता अक्सेशन सी एस-121

(1080 कि. ग्राम/हेक्टर) में अंकित की गयी। धोली एवं राइगढ में धनिया सी ओ आर-31 पर किये सी वी टी तथा गुंटूर में, सी ओ आर-30 आशाजनक थे। गुंटूर में, एल सी सी-200 (594 कि. ग्राम/ हेक्टर) तथा एल सी सी-143 (547 कि. ग्राम/हेक्टर) में नियन्त्रण साधना (484 कि. ग्राम/हेक्टर) की अपेक्षा अधिक उपज अंकित की गयी तथा यह शुष्क स्थिति में खेती करने के लिये उपयुक्त है। जोबनर में, धनिया जीन प्रकार, यू डी- 510 सिंचाई आधारित खेती जबकि यू डी- 277 तथा यू डी-324 शुष्क हालत में खेती के लिये अधिक उपयुक्त है। धनिया की बुआई के 30 तथा 60 दिनों बाद सिंचाई करने पर अधिकतम उपज (995 कि. ग्राम/हेक्टर) तत्पश्चात् गुंटूर में, 30 तथा 45 दिनों बाद सिंचाई करने पर (883 कि. ग्राम/हेक्टर) प्राप्त हुई। धनिया की सी आर आर-34 में अधिक बाव्यशील तेल (7.17 ली. /हेक्टर) तत्पश्चात् सी ओ आर -31 (6.94 ली/हेक्टर), सी ओ आर-27 (6.75 ली/हेक्टर) तथा आर सी आर -435 (6.49 ली/हेक्टर) की मात्रा अंकित की गयी।

जीरा

जीरे के जीन प्रकारों में, यु सी – 239, यु सी – 274 तथा यु सी – 225 को सीमित आर्द्रता वाले स्थानों में पैदावार के लिये उपयुक्त है। जोबनर में, जीरे के सी यु एम-13 में अधिकतम बीज उपजता (667.71 कि. ग्राम/ हेक्टर) अंकित की गयी वही जी सी- 4 (4.45%) तथा सी यु एम - 11 (4. 2%) में अधिक बाष्पशील तेल की मात्रा अंकित की गयी।

सौंफ

धोली में, सौंफ के तिरपन संग्रहों का मूल्यांकन करने पर आर एफ-31 में अधिकतम उपज (1.05 कि. ग्राम/5.4मी^{2}) तत्पश्चात् आर एफ-21 (1.00 कि. ग्राम/ 5.4 मी) अंकित की गयी। राइगढ में, सी वी टी परीक्षण में एफ एन एल 40 में अधिकतम उपज (1216.67 कि. ग्राम/ हेक्टर) प्राप्त हुई। जोबनर केन्द्र में दो प्रविष्टियों, एफ एन एल -26 तथा एफ एन एल -25 को आशाजनक रूप में पहचान की तथा उन्हें प्रचारित करने के लिये प्रस्तावित किया। अधिकतम औसत बाव्यशील तेल की मात्रा; (2.89%) एफ एन एल 26 तत्पश्चात् एफ एन एल 30 (2.78%) में प्राप्त हुई।

मेथी

धोली में, मेथी के एक सौ सतावन जननद्रव्य संग्रहों का मूल्यांकन करने पर, आर एम-190 में अधिकतम उपज (0.92 कि. ग्राम/4.5 मी.) तत्पश्चात् आर एम 191 में (0.91 कि. ग्राम/4.5 मी.) प्राप्त हुई। जगुदान में, पाउडरी मिल्ड्यू के प्रति विवक्तीकरण करने पर यह ज्ञात हुआ कि कोई भी प्रविष्टी पाउडरी मिल्ड्यू मुक्त नहीं थी तथा इसका आपतन 24.0 से 84.75 % था। विवक्तीकरण किये अक्सेशनों में, जे एफ जी 212 (24. 50%) तत्पश्चात् जे एफ जी 217 (28%) में कम रोग हानि अंकित की गई। कोयम्बतोर में, तेरह मेथी जीन प्रकारों के मूल्यांकन करने पर सी वी टी पंक्तियों में एफ जी के -28 में अधिकतम उपज (348.33 कि. ग्राम/हेक्टर) तत्पश्चात् एफ जी के-34 एवं एच एम-57 (335.00 कि. ग्राम/हेक्टर) में अंकित की गयी। राइगढ एवं जबलपुर में, अक्सेशनें एफ जी के-27 तथा एफ जी के 28 अन्य प्रकारों की अपेक्षा अधिक श्रेष्ठ थे। जोबनर में, आई ई टी में यु एम-126 (2163.43 कि. ग्राम /हेक्टर) की अधिकतम बीज उपजता अंकित की गयी।

इस वर्ष बीज मसाले जैसे धनिया, जीरा, सौंफ तथा मेथी में राइज़ोबैक्टीरिया पर उच्च स्तर पर परीक्षण प्रारंभ किया। मेथी में, राइज़ोबैक्टीरिया का बीज उपचारित करने तथा मृदा में डालने पर यह ज्ञात हुआ कि एफ के 14 + एफ एल 18 को बीज उपचार एवं मृदा में डालने के फलस्वरूप अधिक उपज (1800 कि. ग्राम/हेक्टर) प्राप्त हुयी तत्पश्चात् एफ एल -18 में सिर्फ बीज उपचारण के पश्चात् (बीज उपजता 1630 कि. ग्राम/हेक्टर) प्राप्त हुई। इस रिपोर्ट में वर्ष 2009-10 में विभिन्न परियोजनाओं के अन्तर्गत प्राप्त प्रमुख उपलब्धियां प्रस्तुत 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 namely, black pepper, cardamom, cinnamon, clove, coriander, cumin, fennel, fenugreek, ginger, large cardamom, nutmeg and turmeric, with its headquarter at Indian Institute of Spices Research, Calicut. AICRPS at present has 34 centers which include 19 regular, 8 co opting and 7 voluntary centres 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 (ICAR share) with Rs 250 lakhs during 2009 - 10.

In pursuance of the decisions of the brainstorming session on germplasm held at NBPGR, New Delhi and at NRCSS, Ajmer multilocation testing of germplasm were taken up at various AICRPS centres in a collaborative mode. Based on the decisions of XX AICRPS workshop held at Tamil Nadu Agricultural College, Coimbatore during 6-8 June 2009, new programmes on fertigation, mechanical harvesting and processing of turmeric with the improved boiling unit were initiated during the year. About 100 research programmes covering the mandate spice crops are being conducted at various centres. These programmes are carried out under the major disciplines of genetic resources, crop improvement, crop production and crop protection. The salient findings in the mandate crops are presented in this report.

BLACK PEPPER

Black pepper germplasm consisting of cultivated, exotic and wild and related species are maintained under different AICRPS centres. Ambalavayal centre has been identified as an alternate centre for germplasm conservation. The characterization of germplasm resulted in identification of high yielding accessions. Among 22 accessions evaluated at Chintapalle, Panniyur-1 recorded highest fresh yield of 7.6 kg/vine followed by Neelamundi (6.84 kg/vine). Among the germplasm accessions evaluated at Panniyur, Angamaly, Chalakudy, ICP-48 and Vattamunda were promising during the year 2009 with a yield more than 3 kg green/ vine. In a CVT in black pepper at Panniyur maximum green berry yield/vine was recorded by Cul. 1041 (2.5 kg/vine) followed by Cul. 5489 (2 kg/vine) whereas at Sirsi dry berry yield was maximum in Paniyur-1 (963 g/ ine) followed by HP-105 (747 g/vine). At Ambalavayal maximum setting percentage was observed in PRS-22, followed by Cul. 5489, Coll. 1041, Karimunda OP (98%). Among the intervarietal hybrids in black pepper, P-6 x P-5 was found to be promising with green berry yield of 5 kg/vine. In a fertilizer trial, black pepper vines treated with the integrated methods recorded significantly higher dry berry yield (1.20 kg/vine) compared to those with fully organics (1.01 kg/vine) and fully inorganic (0.94 kg/vine) methods at Sirsi, where as at Pechiparai, the highest yield of 3.78 kg/vine was recorded in the fully inorganic trial and it was on par with integrated which recorded an yield of 3.54 kg/vine. In black pepper, application of potassium phosphonate + *Trichoderma harzianum* and Bordeaux mixture + COC reduced foot rot incidence by 70.47 and 56.85 per cent respectively, compared to farmers' practice. Grafting of black pepper on tolerant /resistant rootstocks like IISR-Thevam, IISR-Shakthi and *Piper colubrinum* was initiated this year. Besides, the performance of orthotropic and runner shoots are also being evaluated in black pepper.

CARDAMOM

Among the germplasm evaluated during 2009-10 in cardamom at Pampadumpara, highest yield was recorded in CRSP-147 (1055 g dry capsules/plant). PV-2 registered the highest drying percentage (23.4%) among the accessions. The performance of the entry, SKP-170 was superior to other entries evaluated in a CVT, and is being proposed for release from Sakleshpur centre this year. The open pollinated progeny $23C_8$ recorded highest yield (221 kg/ha) in cardamom at Mudigere. In a CVT in cardamom at Pampadumpara, highest dry yield was recorded in PS-27(1016.58 g/plant) followed by MHC-26 (335.42 g/plant). The damage caused by thrips ranged from 26 to 48%. Thrips attack was the lowest for CL-722 and highest for MCC- 246. The damage due to azhukal disease was highest for MCC-246 and GG and lowest for MCC-309. The percentage loss due to capsule borer was least for MHC-26 and CL-722 and highest for MCC- 3 and GG. At Mudigere the cardamom, clone CL-722 was found superior for dry capsule yield (341.00 kg/ha) in the above CVT trial.

LARGE CARDAMOM

Research programmes on large cardamom was initiated during 2009-10 at Indian Cardamom Research Institute (Spices Board), and ICAR RCNEHR located at Gangtok, Sikkim. Surveys were conducted in the Middle Singhik, Sentam and Nung village of North Sikkim and five accessions of large cardamom *viz.* SCC-213 (Golsey), SCC-214 (Golsey), SCC-215 (Golsey), SCC-216 (Ramla) and SCC-217 (Ramla) were added to the germplasm. Characterizations of the collected germplasm were carried out based on the descriptor.

GINGER

Among the promising accession of ginger evaluated at Dholi, RG-14 and RG-24 gave maximum yield (8.00 kg/7.2m^2) followed by RG-13 (7.30 kg/ 7.2m^2). At Pundibari, highest rhizome yield/plant was recorded in GCP-1 (672.33 g). No disease incidence was recorded in the germplasm accessions GCP-29, GCP-50 and GCP-52 evaluated at Pundibari were as accession SG-785 showed 5.5% disease incidence at Solan. In an IET at Dholi, RG-3 was found to be a promising accession with a yield of 21.34 t/ha as compared to check variety Nadia (17.81 t/ha) and could be promoted to CVT. In a trial to study the influence of environment on genotypes of ginger it was observed that the variety Surabhi recorded highest yield (32.60 t/ha) of fresh rhizome followed by variety Nadia (21.13 t/ha) at Pasighat. In ginger application of fully organic fertilizers gave highest yield (12.90 t/ha) followed by integrated fertilizer (11.62 t/ha) at Dholi centre. Ginger planted in soil treated by biofumigation using cabbage gave highest yield and registered lowest incidence of soft rot at Dholi and Kumarganj.

TURMERIC

Among the 180 accessions of turmeric evaluated at Pundibari centre, TCP-88, TCP-36 and TCP-25 were found to be promising with respect to yield. At Jagtial, JTS-315 and JTS-14 were found to be promising. In a CVT of turmeric at Chintapalle, PTS-39 recorded maximum yield of 36.37 t/ha where as at Raigarh, Narendra Haldi-1 gave the highest yield of 21.49 t/ha. TCP-129 recorded the highest yield (21.24 t/ha) in an IET on turmeric at Pundibari. The performance of the varieties Rajendra Sonia at Dholi, Roma at Chintapalle, Suprabha at Kanke, Narendra Haldi at Pundibari, Duggirala, IISR Pratibha, Roma and RCT-1 in Mizoram were superior to other varieties and these varieties are suitable for cultivation in the respective these locations. At Dholi, application of integrated fertilizer resulted in maximum yield of 54.93 t/ha followed by fully organic (50.30 t/ha). The cost : benefit ratio of integrated fertilizer management gave the maximum return of Rs. 4.46 per unit cost (1:4.46) followed by fully inorganic *i.e.*, Rs. 3.80 per unit cost (1:3.80). Application of 100% of the recommended dose of fertilizer of turmeric through drip irrigation at fortnightly interval gave highest yield (39.34 kg/plot). Mechanical harvesting of turmeric indicated that the time taken for harvesting by the tractor mounted harvester is less when compared to power tiller mounted harvester. The percentage of damaged rhizome is also minimum (1.7%) and cost for operating the tractor mounted harvester was low in comparison with power tiller mounted harvester and manual harvesting.

TREE SPICES

Tree spices namely, clove, numeg and cinnamon germplasm are maintained at Dapoli, Yercaud and Pechiparai centre. Among the four selections of cassia evaluated in a CVT, D-3 was found to be promising at Pechiparai.

CORIANDER

Multilocational evaluation of germplasm was initiated during this year in seed spices namely, coriander, cumin, fennel and fenugreek. Among the 275 coriander accessions evaluated at Coimbatore, the grain yield ranged from 360 kg/ha to 1080 kg/ha. The highest mean coriander yield was registered by the accession CS-121 (1080 kg/ha). In a CVT on coriander COR-31 at Dholi and Raigarh and COR-30 at Guntur were identified as promising. At Guntur, LCC-200 (594 kg/ha)) and LCC-143 (547 kg/ha) recorded significantly higher yield than the best check Sadhana (484 kg/ha) and were found suitable for growing under drought conditions. At Jobner, the coriander genotype, UD-510 was found suitable for growing under irrigated conditions while UD-277 and UD-324 were suitable for drought conditions. Irrigation in coriander at 30 and 60 DAS recorded highest yield (995 kg/ha) followed by irrigation at 30 and 45 DAS (883 kg/ha) at Guntur. The coriander entry COR-34 recorded a high volatile oil yield (7.17 l/ha) followed by COR-31 (6.94 l/ha), COR-27 (6.75 l/ha), and RCr-435 (6.49 l/ha).

CUMIN

Cumin genotypes, UC-239, UC-274 and UC-225 were identified suitable for growing under limited moisture conditions. The cumin entry, CUM-13 recorded maximum seed yield of 667.71 kg/ha at Jobner.

The entries GC-4 (4.45%) and CUM-11 (4.2%) recorded very high volatile oil at Jobner.

FENNEL

Among the fifty three collections of fennel evaluated at Dholi, RF-31 produced maximum yield (1.05 kg/ 5.4m^2) followed by RF-21 (1.00 kg/5.4m$^{2)}$. The fennel entry FNL-40 gave maximum yield of 1216.67 kg/ha in a CVT trial at Raigarh. Two entries FNL-26 and FNL-25 were identified as promising and proposed for release *from Jobner centre. The highest mean volatile oil* content of 2.89% was recorded in FNL-26 followed by 2.78% in FNL-30 at Jobner.

FENUGREEK

Among the one hundred seventy seven collection of fenugreek germplasm evaluated at Dholi, RM-190 gave a maximum yield of 0.92 kg/4.5 m^2 followed by RM-191 (0.91 kg/4.5 m^2). None of the entries screened against powdery mildew at Jagudan were found to be free from the incidence of powdery mildew and the incidence ranged between 24.50 to 84.75%. Among the accessions screened, minimum disease incidence was noticed in JFG-212 (24.50%) followed by JFG-217 (28%). Among the thirteen fenugreek genotypes evaluated at Coimbatore, the CVT line FGK-28 recorded the highest grain yield of 348.33 kg/ha followed by FGK-34 & HM-57 of 335.00 kg/ha. At Raigarh and Jabalpur, accessions FGK-27 and FGK-8 performed better than other lines. At Jobner the entry UM-126 recorded maximum seed yield of 2163.43 kg/ha in an IET. Large scale demonstration on application of rhizobacteria in seed spices namely, coriander, cumin, fennel and fenugreek were under taken this year. In the demonstration in fenugreek, it was observed that, seed treatment and soil application with the rizobacteria FK-14 + FL-18 , resulted in a very high yield of 1800 kg/ha followed by seed treatment with FL-18 alone (seed yield 1630 kg/ha). The salient findings under different projects during 2009-10 are presented in this report.

M. Anandaraj

PROGRESS OF WORK AND ACHIEVEMENTS

BLACK PEPPER

PEP/CI/1 Genetic Resources

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

(Chintapalle, Panniyur, Pundibari, Sirsi, Ambalavayal, Dapoli, Yercaud)

Germplasm of black pepper is maintained in all the pepper centres of AICRPS (Table 1). The germplasm maintained at each centre is evaluated every year. Among 20 accessions evaluated at Chintapalle centre, Panniyur-1 recorded maximum number of spikes (1496) per vine followed by Vellanamban (1430). Maximum spike length was recorded in Malamundi (13.1 cm) followed by Panniyur-1 (12.6 cm) and Panniyur-2 (12.4 cm). Narayakkodi recorded maximum number of berries per spike (87). Among 20 accessions evaluated Panniyur-1 recorded highest fresh yield of 7.6 kg/vine followed by Neelamundi (6.84 kg/vine). Panniyur-1 recorded maximum dry berry yield (2.51 kg/vine) followed by Neelamundi (2.19 kg/vine). All the accessions were susceptible to *Phytophthora* foot rot disease.

Two collections of black pepper from Raigarh and Ratnagiri Districts were collected and added to the germplasm at Dapoli centre. At present 91 accessions of black pepper are maintained and are being evaluated.

At present 227 cultivated types of black pepper and 72 wild types are being maintained at Panniyur centre.

During 2009-10, the genotypes Angamaly, ICP-48 and Chalakudy were top yielders (green berry yield > 3.5 kg/vine). Angamali ranked first with 4.3 kg berry yield and 1302 spikes/vine. Spike length was maximum for Veluthanamban and ICP-48 (17.4 and 17.3 cm). The number of developed berries/spike were also more for Veluthanamban and ICP-48 (64.4 and 62.8) respectively. 100 berry weight was more for Josegiri, Thekkanmavu and Veluthanamban (>12 g/vine). The dry recovery percentage was more for Alakodan (40) and Josegiri (38) (Table 2).

Table 1. Black pepper germplasm collections maintained at various AICRPS centres

Centre	Indigenous		Exotic	Total
	Cultivated	Wild and related sp.		
Chintapalle	58	-	-	58
Dapoli	85	6	-	91
Panniyur	224	72	3	299
Pechiparai	12	1	-	13
Pundibari	21	4	-	25
Sirsi	125	1	1	127
Yercaud	127	10	-	137
Total	**652**	**94**	**4**	**750**

Table 2. Yield and attributing characters of promising germplasm lines at Panniyur

Cultivar	Green berry yield (kg/vine)	Number of spikes/vine	Spike length (cm)	Number of developed berries/spike	100 Berry weight (g)	Dry recovery (%)
Angamaly	4.300	1302	9.0	31.6	10.6	36
ICP-48	4.000	110	17.3	62.8	12.0	34
Chalakudy	3.700	854	12.0	32.5	11.0	30
Alakkodan	3.150	939	8.0	34.6	10.6	40
Karimunda(Chit)	3.020	1209	8.4	25.8	10.7	33
Josegiri II	2.600	302	9.0	20.7	12.8	38
Veluthanamban	2.490	805	17.4	64.4	12.5	25
Thekkanmavu	2.450	888	10.0	22.0	12.6	33
Palulutta	2.360	520	10.0	40.0	12.0	28
Karimunda	2.200	865	10.0	14.8	11.0	36

At Pundibari, 25 black pepper entries are being maintained. Three new entries of black pepper were collected during 2009 - 2010 from Terai region of West Bengal.

One new accession has been added during the year and a total of 127 germplasm are maintained at Sirsi. Promising five accessions were characterized according to the standard descriptor. Six promising accessions including Panniyur-1 are under evaluation trial since 2004-05. Among them, Panniyur-1 continued to record maximum dry berry yield (2.75 kg/vine) followed by Sirsi-1 (Acc. 91) and Ademane pepper (Acc. 53) (2.60 kg/vine and 2.38 kg/vine, respectively) during 2009-10 with significant difference (Table 3).

At Yercaud, berry set was observed in seventy two accessions of which Acc. 57 recorded the highest value of 12.8 kg and 4.10 kg of green and dry berry yield respectively. The Acc. 33 recorded 12.8 and 3.3 kg of green and dry berry yield respectively and highest value for spike length (12.8 cm) and number of berries (72).

PEP/CI/2 Hybridization Trial

PEP/CI/2.1 Intervarietal hybridization to evolve high yielding varieties

(Panniyur)

To evolve black pepper varieties with high yield, pest and disease resistance and other favourable traits intervarietal hybridization was carried out in black pepper at Panniyur. Intervarietal hybridization is being carried out every year and the hybrid seeds obtained were planted and evaluated. Among the intervarietal hybrids P-6 x P-5 was found promising with green berry yield of 5 kg/vine. Number of spikes/vine and spike length were 845 and 11 cm respectively.

Table 3. Yield performance of black pepper accessions (2006-07 to 2009-2010) at Sirsi

Sl No	Accession	Dry berry yield (kg/vine)				
		2006-07	2007-08	2008-09	2009-10	Mean
1	Sirsi -1	3.15	1.71	1.5 0	2.60	2.24
2	Ademane Pepper	2.08	1.86	2.50	2.38	2.21
3	Malligesara	1.78	1.67	1.60	1.10	1.54
4	Uddakare	2.00	2.00	1.78	1.80	1.90
5	Kudragutta	2.38	2.05	1.79	1.98	2.05
6	Panniyur-1	2.33	2.63	2.60	2.75	2.58
	SEm ±	0.07	0.17	0.18	0.24	
	CD (P=0.05)	0.21	0.51	0.53	0.52	
	CV (%)	11.18	17.34	18.30	16.30	

Note: @ 1375 vines/ha

PEP/CI/3 Coordinated Varietal Trial (CVT)

PEP/CI/3.2 CVT 2000 – Series V

(Chintapalle, Pampadumpara, Panniyur, Sirsi, Ambalavayal)

The experiment was started during 2002 with 12 black pepper entries and three replications to evaluate the performance of released varieties as well as promising selections of black pepper. Among the 12 varieties evaluated at Chintapalle, HP-813 recorded maximum plant height (4.52 m) followed by Cul-1041 (4.5 m) whereas Cul-5308 recorded the lowest plant height (3.071 m). Maximum length of spikes was observed in Cul-5308 (10.75 cm) followed by Panniyur-1 (9.64 cm). The number of berries per spike was 63 in Panniyur-1 followed by 61 in HP-105 variety. In terms of fresh yield, Panniyur-1 recorded the highest yield (505 g/vine) which was followed by Cul-5308 (490.2 g/vine) (Table 4).

Among the twelve accessions evaluated at Pampadumpara, significant differences was observed for all the traits. In general, the yield performance was very low and Cul. 5308 registered the highest yield (875.55 g/plant) followed by HP-1411 (748.77 g/plant). All the accessions except Cul. 5308 (527 g/plant) recorded less than 500 g of dry berry yield per plant. Less than 100 g of dry weight per plant was recorded in HP-105 (44.5 g) and HP-34 (66.89 g). Number of berries per spike ranged from 27.11 in PRS-21 to 56.33 in HP-1411. Least 100 berry volume was recorded in PRS-22 (19.0 cc) followed by HP-34 (21.0 cc) whereas maximum was recorded in Pan-1 (37.0 cc). Hundred berry weight was lowest in HP-105 (8.6 g) and maximum in Pan-1 (14.32 g).

During 2009, the maximum green berry yield/vine was recorded by Cul. 5489 (2.520 kg/vine) followed by Cul. 5308 (1.550 kg/vine) at Panniyur. Cul. 5489 was significantly superior to all other cultures/varieties. The number of spikes/vine was also maximum for Cul. 5489 (850) and was significantly superior to all other cultures. The maximum spike length was recorded by Cul. 5489 (3.7 cm) and Panniyur-1(13.3 cm) and were on par. The number of berries/spike was more for Cul. 5308 (29.7) and was significantly superior. 100 Berry weight was more for Cul. 5489 (13.67g) and Panniyur-1. The dry recovery percentage was more for Cul. 5308 and Cul. 5489 (41 and 40) respectively (Table 5).

At Sirsi, the growth of the vine was maximum in HP-34 and HP-105 (4.9 m each) followed by OP Karimunda and PRS-17 (4.6 m each). Most of the entries initiated spiking with a meager yield. Spike length was maximum in OP Karimunda (11.4 cm) and least in PRS-17 (4.0 cm). Dry berry yield was maximum in Panniyur-1 (963 g/vine) followed by HP-105 (747 g/vine) and HP-34 (383 g/vine).

Among different cultivars of pepper evaluated at Ambalavayal, Panniyur-1 showed the highest wet weight

Table 4. Performance of CVT black pepper at Chintapalle

Variety	Plant height (m)	Length of spike (cm)	Berries/spike	Fresh berry yield (g)
Cul-1041	4.5	7.7	44.7	211.5
Karimunda OP	3.3	7.4	34.6	111.1
Cul-5489	3.9	8.4	26.8	64.6
PRS-17	3.1	9.5	38.1	37.4
PRS-21	3.1	7.3	32.4	23.7
PRS-22	4.1	7.1	28.4	24.8
HP-34	3.5	6.1	25.3	22.4
Cul-5308	3.0	10.7	70.6	490.2
HP-105	3.9	9.4	61.5	355.1
HP-1411	4.1	8.5	46.1	245.4
HP-813	4.5	9.2	41.2	394.5
Panniyur-1	4.1	9.6	63.2	505.1
SEm±	0.36	0.26	2.02	24.61
CD (P=0.05)	NS	0.77	5.99	72.66
CV (%)	16.58	5.35	8.21	20.57

Table 5. Performance of CVT-2000 black pepper at Panniyur

Varieties/cultures	Green berry yield (g/vine)	No. of spikes /vine	Spike length (cm)	Berries/ spike	100 Berry wt (g)	Dry recovery (%)
Kalluvally-IV	1180	380	8.0	16.7	11.67	30
Karimunda-II	1320	565	8.0	12.0	10.33	31
Karimunda-III	1200	540	10.0	17.0	11.67	38
Cul-5308	1550	425	10.0	29.7	13.33	41
Cul-5489	2520	850	13.7	25.0	13.67	40
HP-34	560	110	8.3	16.7	10.67	39
HP-105	840	300	9.0	12.0	12.67	34
HP-813	970	508	8.0	11.7	10.67	39
HP-1411	1420	690	10.7	23.7	8.33	34
Karimunda OP	1270	405	10.7	14.3	9.67	37
Coll.1041	1027	440	9.3	13.7	11.67	34
Panniyur-1	1127	390	13.3	21.3	13.67	34
Karimunda	1210	315	8.7	13.3	13.3	38
CD(P=0.05)	378	63	1.3	1.9	0.95	
CV (%)	18	8	7.7	6.4	5	
SEm	129	22	0.44	0.65	0.33	

of berries/standard (4.22 kg) followed by Cul-5489 (3.13 kg). Lowest wet weight was recorded in PRS-22 (0.26 kg). Among the different cultivars of pepper, Panniyur-1 showed the maximum dry weight of berries/ standard (1.81 kg) followed by PRS-21 (1.58 kg). Lowest dry weight was recorded in PRS-22 (0.18 kg). Among the thirteen cultivars, PRS-22 recorded the maximum number of spikes/standard (530.50) followed by HP-34 (447.17) and Cul. 5308 (408.30). Lowest number of spikes was recorded in the cultivar, PRS-22. Panniyur-1 produced the longest spike (15.92 cm) followed by Cul. 5489 (13.88 cm) and Karimunda OP (13.23 cm) and lowest spike length was recorded in PRS-17 (7.73 cm). Maximum setting percentage was shown by PRS-22, followed by Cul. 5489, Coll. 1041, Karimunda OP (98%). Minimum setting percentage was recorded in Cul. 5308 (90%). Panniyur-1 recorded the highest number of berries/spike (89.26) followed by Cul. 5489 (73.22) and HP-105 (57.31). Lowest number of berries/ spike was recorded in Karimunda (local check). PRS-17 recorded the highest hundred berry weight (14.87 g) followed by Panniyur-1 (13.92 g) while lowest was recorded in the cultivar PRS-21 (8.50 g). Maximum berry volume was shown by PRS-17(26.33 cc) followed by Panniyur-1 (26.02 cc). Minimum berry volume was recorded in PRS-21 (15.00 cc).

PEP/CI/3.3 CVT 2006 – Series VI

(Chintapalle, Dapoli, Panniyur, Pampadumpara, Sirsi, Ambalavayal, Yercaud/Pechiparai)

Among the 10 varieties (HB-20052, PRS-88, Acc No.53, Acc. No.106, Acc Nos.33, Acc No. 57, C-1090, HP-39, Panniyur-1 and local) evaluated at Chintapalle, HB-20052 (Panniyur-8) recorded the maximum plant height (73.6 cm) followed by Panniyur-1 (70.1 cm) at the centre. Slow growth was observed in ACC- 57 variety.

At Dapoli, the plant height varied from 0.45-2.14 m in different varieties. Panniyur-1 recorded significantly higher plant height (2.14 m) followed by Acc. 33 (1.42 m) and Acc. 106 (1.36 m).

Among the ten entries evaluated at Pampadumpara, Acc. 57 and Acc. 106 from Sirsi have shown 100 per cent survival. Good plant growth was observed in Acc. 57 and Acc. 33 of Yercaud and sufficient growth was observed with Panniyur-1 and Karimunda.

At Paniyur, Yercaud and Sirsi also the experiment was laid out and all the plants have established.

PEP/CM/4.7 Rooting of orthotropic shoots of black pepper

(Ambalavayal, Panniyur, Dapoli, Yercaud)

At Dapoli, the orthotropic shoot cutting showed rooting success and the percentage success in various treatments is presented in (Tables 6, 7, 8). Three node cutting (N2) was found to be 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*-10^8) was significantly superior (92.88%) to rest of the treatments followed by treatments with common sugar 2% (73.32%) and IBA 1000 ppm (68.44%). The interaction effect was found to be significant. The rooting success ranged from 56.00% to 97.33%. The treatment combination N2H3 recorded maximum rooting success (97.33%) followed by N1H3 (94.66%) which were on par with each other.

At Yercaud, the treatment with two nodal cuttings dipped in IBA 1000 ppm resulted in highest percentage of rooting (85%), number of leaves (7) and fresh and dry weight of leaves.

Table 6. Effect of number of node of black pepper cutting on rooting success at Dapoli

Sl. No.	Treatment	Mean rooting success (%)
1	N1 (Two node cutting)	72.33 (59.56)
2	N2 (Three node cutting)	76.33 (62.71)
3	N3 (Five node cutting)	71.66 (58.25)
	SEm ±	0.84
	CD(P=0.05)	2.47

Figures in parenthesis are arcsine transformation

Table 7. Effect of rooting hormone/solution on rooting success of black pepper at Dapoli

Sl. No.	Treatment	Mean rooting success (%)
1	Common sugar 2% (H1)	73.32 (58.94)
2	IBA (H2)	68.44 (55.86)
3	PGPR (H3)	92.88 (75.63)
4	Without hormone (H0)	59.11 (50.27)
	SEm.±	0.98
	CD(P=0.05)	2.86

Figures in parenthesis are arcsine transformation

Table 8. Effect of interaction on rooting success of black pepper at Dapoli

Sl. No.	Treatment	Success (%)
1	$N_1 H_0$	56.00 (48.46)
2	$N_1 H_1$	74.66 (59.80)
3	$N_1 H_2$	64.00 (53.15)
4	$N_1 H_3$	94.66 (76.83)
5	$N_2 H_0$	61.33 (51.56)
6	$N_2 H_1$	74.66 (59.80)
7	$N_2 H_2$	72.00 (58.05)
8	$N_2 H_3$	97.33 (81.43)
9	$N_3 H_0$	60.00 (50.78)
10	$N_3 H_1$	70.66 (57.22)
11	$N_3 H_2$	69.33 (56.38)
12	$N_3 H_3$	86.66 (68.63)
SEm ±		1.69
CD(P=0.05)		4.95

(Figures in parenthesis are arcsine transformation)

PEP/C1/3.4 Evaluation of grafts, orthotropic and runner shoots in black pepper

(Ambalavayal, Panniyur, Sirsi, Yercaud)

Planting materials of the rootstocks of pepper variety Shakti and Thevam and *Piper colubrinum* varieties required for planting are being multiplied and the proposed experiment will be initiated during 2010-11 at various centres.

PEP/CM/4 Nutrient Management Trial

PEP/CM/4.4 Development of organic package for spices based cropping system – Observational trial

(Chintapalle, Sirsi, Panniyur, Dapoli, Yercaud)

Among the two treatments, maximum plant height (2.68 m), no. of spikes (6.7) and highest fresh berry yield (154 g/vine) was observed in inorganic treatment at Chintapalle.

The trial was initiated during 2005-06 at Sirsi. It was observed that for the last four years, there were no significant differences in dry berry yield among the treatments except in 2007-08.

During 2009-10, recommended package of practice (Farmyard manure 10 kg; NPK 50:50:200 g as urea, rockphosphate and muriate of potash) recorded significantly higher green berry yield of 1.38 kg/vine compared to organic package (T_1) which recorded

green berry yield of 1.14 kg/vine at Panniyur. The spike yield (1.75 kg/vine) and number of spikes/vine (309 / vine) was also maximum for recommended package (T_2) which was significantly superior to organic package (Farm Yard Manure 10 kg; neem cake 1 kg; vermicompost 1 kg).

At Dapoli integrated package recorded maximum plant height (1.55 m/plant) followed by organic package (1.50 m/plant). Inorganic package recorded lesser plant height (1.20 m/plant).

Application of FYM 10 kg + Azospirillum 50 g + phosphobacteria 50 g + VAM 200 g recorded the highest yield (13.2 kg and 3.8 kg of green and dry berry yield respectively) at Yercaud.

PEP/CM/4.5 Organic farming in black pepper – 2006

(Panniyur, Dapoli, Pechiparai, Sirsi, Yercaud)

The trial was started in 2006 at Panniyur and during 2009-10, integrated treatment (Farm Yard Manure 10 kg; phosphobacteria 50 g; Bordeaux mixture 1%; *Trichoderma* 50 g; *Pseudomonas* 50 g; NPK 50:50:200 g as urea, rockphosphate and muriate of potash; copper oxychloride 0.2%; quinalphos 0.05%) resulted in higher green berry yield of 1.56 kg/vine which was significantly superior to both fully inorganic treatment (Bordeaux mixture 1%; NPK 50:50:200g as urea, rockphosphate and muriate of potash; copper oxychloride 0.2%; quinalphos 0.05%) which recorded green berry yield of 1.29 kg/vine and fully organic treatment (Farm Yard Manure 10 kg; Azospirillum 50 g; phosphobacteria 50 g; Bordeaux mixture 1%; neem oil 0.5%; *Trichoderma* 50 g; *Pseudomonas* 50 g) which recorded green berry yield of 1.13 kg/vine. Green berry yields of fully inorganic treatment and fully organic treatment were on par. The spike yield (1.98 kg/vine) and number of spikes/vine (283 was also maximum for integrated treatment which was significantly superior to other two treatments (Table 9).

A new trial on organic farming was initiated with fully organic, integrated and inorganic treatments at Dapoli with the black pepper variety Panniyur-1 planted on *Thespesia populnea* standard. The growth of the vine is satisfactory.

The trial was initiated during 2006-07 at Sirsi. There was no significant differences among the treatments after three years in growth. However, the vines treated with the integrated methods recorded higher dry berry yield (1.20 kg/vine) compared to those with fully organic (1.01 kg/vine) and fully inorganic (0.94 kg/vine) methods during 2009-10 .

Integrated farming recorded maximum yield of green and dry berry yield (13.2 kg and 3.6 kg/vine respectively) against inorganic (11.8 kg and 3.2 kg) and organic (11.2 kg and 2.80 kg/vine) treatment at Yercaud.

PEP/CP/5 Disease Management Trial

PEP/CP/5.1 Adaptive trial on management of *Phytophthora* foot rot of black pepper in farmers field

(Ambalavayal , Sirsi, Dapoli, Mudigere)

A field experiment on management of foot rot of black pepper was carried out by applying fungicides, bioagents and plant product like neem cake in farmer's garden at Hosabale village, Sirsi Taluka of Uttara Kannada district of Karnataka during 2006-07 to 2009-10 for four years. The objective was to understand the efficacy of potassium phosphonate and *Trichoderma harzianum* (MTCC-5179) combination on the disease management. The vines were cultivated in arecanut garden as mixed crop where the vines were trained to arecanut standards. The fungicides, *viz.* potassium phosphonate (0.3%), Bordeaux mixture (1%), copper oxychloride (0.2%) were applied as spraying (@ 2 l^{-vine}) and drenching (@ 3 l^{-vine}) along with biocontrol agents *T. harzianum* (MTCC-5179). The treatments were compared with the farmers' practice where in Bordeaux

Table 9. Yield data for organic farming in black pepper during 2009-2010 at Panniyur

Treatment	Spike yield (kg $vine^{-1}$)	No. of spikes $vine^{-1}$	Green berry yield (kg $vine^{-1}$)	Dry recovery (%)
T_1-Fully Organic	1.44	212	1.13	34.85
T_2-Integrated	1.98	283	1.56	35.48
T_3-Fully Inorganic	1.63	242	1.29	34.21
CD (P=0.05)	0.308	40	0.243	
CV (%)	17	15	17	
SEm	0.150	19	0.118	

mixture (1%) was taken up as spraying once after the disease appearance and only to affected vines. *Phytophthora* foot rot was least on black pepper vines where application of potassium phosphonate (@ 0.3%) as spraying (@ 2 l^{-vine}) and drenching (@ 3 l^{-vine}) and soil application of *T. harzianum* (MTCC-5179) @ 50 g per vine with one kg of neem cake to the root zone was given during pre monsoon (June 2009) and peak monsoon (August 2009) and post monsoon (October 2009). The vines protected by application of 1% Bordeaux mixture and drenching copper oxychloride (@ 0.1 per cent a.i.) during June, August and October 2009 revealed less foliar yellowing (12.96 PDI), low defoliation (12.96 PDI), less death of vines (16.67%) and more yield (0.83 kg^{-vine} green berry yield and 341.79 kg^{-ha} projected yield). Farmers practice where 1% Bordeaux mixture was applied to the foliage after appearance of the disease registered maximum leaf yellowing (30.09 PDI) and maximum defoliation (31.02 PDI), maximum death of vines (33.33%) and lowest yield (0.0.56 kg^{-vine} green berry yield and 229.23 kg^{-ha} projected yield). Pooled data of four years (2006-07 to 2009-10) (Table 10) showed that *Phytophthora* foot rot incidence was least on black pepper vines where in disease incidence was minimum with foliar yellowing (11.74 PDI), least defoliation (12.35 PDI), minimum death of vines (6.63 %), highest yield (1.12 kg^{-vine} green berry yield and 371.26 kg^{-ha} projected yield) and highest cost benefit ratio (1:2.35) due to protection of vines to foliage and root zone with application of potassium phosphonate (@ 0.3 %) as spraying (@ 2 l^{-vine}) and drenching (@ 3 l^{-vine}) and soil application of *T. harzianum* (MTCC-5179) @ 50 g per vine with one kg of neem cake to the root zone during premonsoon (June) and peak monsoon (August) and post monsoon (October). The above treatments were compared with the farmers practice where in only affected vines were applied with 1% Bordeaux mixture to the foliage after appearance the disease. Those vines recorded maximum leaf yellowing (38.98 PDI) and maximum defoliation (39.83 PDI), maximum death of vines (28.40%) and lowest yield (0.81 kg^{-vine} green berry yield and 242.49 kg^{-ha} projected yield). In the present investigation of field trial on integrated disease management of *Phytophthora* foot rot of black pepper, with various treatments or their interactions revealed a positive effect on significant reduction in disease intensity on treated vines. Application of potassium phosphonate (0.3%) as

Table 10. Management of *Phytophthora* foot rot disease in black pepper (adaptive trial) Pooled (2006-07, 2007-08, 2008-09 and 2009-10) at Sirsi

Treatment	Foliar yellowing (PDI)	Defoliation (PDI)	Death of vines(%)	Green berry yield (kg/vine)	Projected yield (kg/ha)	Cost : Benefit ratio
T1- Potassium phosphonate (0.3 %) + *Trichoderma harzianum* (MTCC- 5179)+ 1 kg neem cake	11.74 (19.99)*	12.35 (20.56)	6.63 (12.93)	1.12 (5.99)	371.26	1:2.35
T2- Bordeaux mixture (1 %) spraying + Copper oxychloride (0.1 % a.i.) drenching	15.26 (22.97)	16.13 (23.61)	11.35 (19.20)	1.03 (5.72)	324.12	1:2.15
T3- Farmers, practice Bordeaux mixture (1%) as spraying once after the disease appearance and only to affected vines	38.98 (38.51)	39.83 (39.05)	28.40 (31.73)	0.81 (5.03)	242.49	-
SEm ±	1.13 (2.46)	2.85 (1.57)	2.28 (1.91)	0.03 (0.10)	15.83	
CD (P=0.05)	14.30 (8.51)	9.86 (5.44)	7.87 (5.80)	0.10 (0.31)	62.16	

*arc sin transformed values **33 per cent dryage

spraying and drenching with soil application of *T. harzianum* (MTCC-5179)(50 g vine^{-1}) along with neem cake (1 kg vine^{-1}) is the best treatment which could be adopted easily by the farmers to protect the vines from the *Phytophthora* foot rot of black pepper.

The data on disease incidence and dry berry yield at Dapoli indicated that potassium phosphonate +Bordeaux mixture + COC were equally efficant in reducing foot rot incidence by 70.47 and 56.85 per cent respectively, compared to farmers' practice. Incidence of leaf blight was minimum (3.35 PDI) with the treatment of potassium phosphonate + *T. harzianum* with 68.69 per cent disease reduction compared to farmers' practice and was significantly superior to rest of the treatments. It was followed by Bordeaux mixture + COC (4.78 PDI) with 55.33 per cent disease reduction and was significantly superior to farmers' practice. Maximum dry berry yield (0.916 kg/vine) was recorded by potassium phosphonate + *T. harzianum* and was significantly superior to rest of the treatments with 11.44 per cent increase in dry berry yield compared to farmers' practice. Though Bordeaux mixture + COC was significantly superior to farmers' practice in reducing foot rot and leaf blight incidence, increase in yield was only 2.55 per cent (Table 11).

At Mudigere, both the treatments (T_1 & $T_{2)}$ were found effective in reducing the incidence of foot rot disease as compared to farmers practice (T_3). Minimum leaf yellowing (6.25%), foliage infection of 6.75% was observed in T_2 (1% BM + 0.3% COC drenching and spraying). The maximum canopy diameter of 3.67 m and yield of 464 g/vine was recorded in T_2 which was followed by T_1 (potassium phosphonate (0.3%) + *Trichoderma harzianum*) (Table 12).

PEP/CP/5.2 Trial on management of *Phytophthora* foot rot of black pepper in existing plantation

(Chintapalle, Dapoli, Panniyur, Mudigere, Sirsi)

This experiment was started during the year 2007-08 at Chintapalle. The observations revealed that, among the five treatments, black pepper vines treated with potassium phosphonate (0.3%) + *T. harzianum* before

Table 11. Management of *Phytophthora* foot rot disease in black pepper (adaptive trial) Pooled (2006-07, 2007-08, 2008-09 and 2009-10) at Dapoli

Treatment	Foot rot (PDI)		Leaf blight (PDI)		Dry berry yield(kg/vine)	
	Pooled mean	% Reduction	Pooled mean	% Reduction	Pooled mean	% Increase
Potassium phosphonate + *Trichoderma harzianum*	4.42 (6.62)* a	70.47	3.35 (9.61)a	68.69	0.916a	11.44
Bordeaux mixture + COC	6.46 (9.79)a	56.85	4.78 (11.97)b	55.33	0.843b	02.55
Farmers' practice	14.97 (22.75)b	—	10.70 (18.33)c	—	0.822b	—

* Figures in parentheses indicate arcsine transformation.

Table 12. Effect of bio-control agent and chemicals on the incidence of foot rot in black pepper at Mudigere

Treatment	Leaf yellowing (%)	Foliage infection (%)	Defoliation (%)	Canopy size (m)	Yield / vine (g)
T_1-Potassium phosphonate (0.3%) + *Trichoderma harzianum*	6.70	7.50	9.0	3.20	445
T_2-Bordeaux mixture spray (1.0%)–COC (0.3 %) drench	6.25	6.75	11.0	3.67	464
T_3-Farmer's practice	7.50	8.50	22.0	2.80	407

onset of monsoon (May 2nd fortnight), during monsoon (July 1st week) and after monsoon (September 1st fortnight) recorded lesser grade for yellowing (0. 56), defoliation (0.51) and mortality of vines (15.00%) and more yield/vine (1.68 kg) followed by Bordeaux mixture spray (1.0%) - COC (0.1%) drenching with yellowing (0.94), defoliation (0.78) and mortality of vines (21.25%) and yield/vine (1.31 kg) as compared to the control with a grade of 1.44 for yellowing, 1.63 for defoliation and 31.25% of vine mortality and low yield/vine (0.70 kg).

At Dapoli, minimum percent incidence of foot rot (4.17 PDI) was observed in the vines treated with potassium phosphonate @ 0.3% as spray and soil application of *T. harzianum* @ 50 g/vine with one kg of neem cake to the root zone. It was closely followed by *T. harzianum* + consortium of bacteria (8.34 PDI) and Bordeaux mixture 1% as spray and copper oxychloride @ 0.1% as drench (8.34 PDI). Application of consortium of bacteria alone was found to be less effective with 16.67 PDI and was on par with control. It was synergistic when applied with *T. harzianum* in reducing *Phytophthora* infections in black pepper. Potassium phosphonate @ 0.3% as spray and soil application of *T. harzianum* @ 50 g/vine with one kg of neem cake to the root zone, Bordeaux mixture 1% as spray and copper oxychloride @ 0.1% as drench, and *T. harzianum* + consortium of bacteria were at par with leaf blight incidence ranging between 7.12 and 9.36%. They were significantly superior to consortium of bacteria (for growth, and nematode and *Phytophthora* suppression) alone and control. Maximum dry berry yield (0.910 kg/vine) was recorded by potassium phosphonate @ 0.3% as spray and soil application of *T. harzianum* @ 50 g/vine with one kg of neem cake to the root zone and was significantly superior to rest of the treatments except Bordeaux mixture 1% as spray and copper oxychloride @ 0.1% as drench (Table 13).

There was no significant difference between treatments for disease incidence and yield at Panniyur. The control plot showed more yellowing, defoliation and death of vine.

At Mudigere all the treatments were effective in reducing the disease incidence of footrot (leaf yellowing, defoliation and death of vine) and increasing the canopy size and yield as compared to control. The minimum leaf yellowing of 5.5% was recorded in T_2 (Bordeaux mixture spray (1%)-COC (0.2%) drench) (1% Bordeaux mixture + 0.2% COC drench) followed by T_1 (potassium phosphonate (0.3%) + *T. harzianum*) as compared to other treatments. The minimum defoliation

Table 13. Management of *Phytophthora* foot rot disease in black pepper- existing plantation at Dapoli

Treatment	Foot rot(PDI)		Leaf blight(PDI)		Dry berry yield(kg/vine)	
	2009-10	Reduction over control (%)	2009-10	Reduction over control (%)	2009-10	Increase over control (%)
Potassium phosphonate (0.3%) + *T. harzianum* (50 g/vine)	4.17 (6.02)*a	85.70	7.12 (15.47)a	68.07	0.910a	42.19
Bordeaux mixture 1% spray + COC 0.2 % drench	8.34 (12.09)a	71.41	7.63 (16.02)ab	65.78	0.870b	35.94
Consortium of bacteria (50 g/vine)	16.67 (24.10)ab	42.85	11.90 (20.08)c	46.64	0.730d	14.06
T. harzianum + consortium of bacteria (50 g/vine)	8.34 (12.05)a	71.41	9.36 (17.77)b	58.03	0.820c	28.13
Control	29.17 (32.47)b	-	22.30 (28.13)d	-	0.640e	-
SEm+	05.88		0.71			
CD (P=0.05)	18.12		2.09			

* Figures in parentheses indicate arcsine transformation
** Means with common letters are at par.

(6.2%) and death of vine was recorded in T_2 followed by T_4 (Consortium of bacteria + *T. harzianum*) (6.4 %) as compared to control (8.35%). The maximum canopy size (3.58 m.) and yield/vine (682.5 g) were recorded in T_3 (Consortium of bacteria) followed by T_4 (677.5 g/ vine) as compared to control.

At Sirsi, black pepper vines showed least *Phytophthora* foot rot incidence when vines were treated with a combination of systemic fungicide and bioagent i.e., 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 and third round during second week of October to the root zone. Treated vines exhibited significantly least leaf infection (7.88 PDI), least yellowing (13.94 PDI), least defoliation (11.51 PDI), least death of vines (5.45 %) and highest yield (1.49 kg^{-vine} green berry yield and 596.88 kg^{-ha} projected yield). Recommend chemical check with application of 1% Bordeaux mixture as spraying (@ 2 l^{-vine}) and copper oxychloride (0.1 % a.i.) drenching thrice in the months of June, August and October 2009 was also significantly effective in combating the disease where the vines recorded less leaf infection (9.09 PDI), less yellowing (13.94 PDI), less defoliation (13.94 PDI), less death of vines (12.73 %) and more yield (1.14 kg^{-vine} green berry yield and 454.72 kg^{-ha} projected yield). Combination of bioagents application *i.e.*, consortium of bacteria @ 10^8 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 in the months of June, August and October 2009 was significantly superior in reduction of the disease *i.e.*, less leaf infection (18.79 PDI), less yellowing (20.00 PDI), less defoliation (21.21 PDI), less death of vines (18.18%) and more yield (0.93 kg^{-vine} green berry yield and 373.36 kg^{-ha} projected yield) in comparison with application of vines with only consortium of bacteria @ 10^8 cfu/g (for growth, nematode and *Phytophthora* suppression –IISR-6 & IISR 859) as spraying (@ 2 l^{-vine}) and drenching (@ 3 l^{-vine}) where the disease incidence was more i.e., more leaf infection.(21.21 .00 PDI), more yellowing (27.27 PDI), more defoliation (29.69 PDI), more death of vines (27.27%) and less yield (0.78 kg^{-vine} green berry yield and 313.60 kg^{-ha} projected yield). However, unprotected vines against the disease in control showed peak incidence of leaf infection (40.60 PDI), maximum yellowing (41.21 PDI), maximum defoliation (44.84 PDI), maximum death of vines (49.09%). and least yield (0.40 kg^{-vine} green berry yield and 160.80 kg^{-ha} projected yield).

PEP/CP/5.3 Trial on management of *Phytophthora* foot rot of black pepper in new plantation

(Chintapalle, Dapoli, Panniyur, Pampadumpara, Pechiparai, Mudigere, Sirsi)

This experiment was started during July 2008-09 at various pepper centres of AICRPS. Three varieties i.e. IISR- Shakti, IISR- Thevam and Panniyur-5 cuttings were planted. The plants have established.

CARDAMOM

CAR/CI/1 Genetic Resources

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

(Mudigere, Pampadumpara)

The germplasm of cardamom maintained at various centres are given in Table 14.

Table 14. Cardamom germplasm collections of AICRPS centres

Centre	Indigenous		Total
	Cultivated	Wild and related sp.	
Mudigere	161	-	161
Pampadumpara	160	1	161
Total	321	1	322

A total of 16 cardamom accessions are presently conserved in the gene bank at Pampadumpara which includes superior genotypes with special characters *viz.*, high yield, tolerance to biotic and abiotic stress conditions and good quality capsules possessing boldness, parrot green colour, superior aroma as well as flavour. Among them IC numbers (547920 to 547992) were obtained from National Bureau of Plant Genetic Resources, New Delhi for 73 cardamom accessions (CRSP 1-73). In general, the yield performance was very low and the highest fresh yield of capsules (1110 g plant^{-1}) and dry yield (211 g plant^{-1}) of capsules was recorded in CRSP-147 followed by CRSP-145 with 758.8 g plant^{-1} and 144 g plant^{-1} of fresh and dry yield, respectively. CRSP-87 recorded maximum 100 capsule volume (230 cc) and weight (105 g) followed by CRSP-100 (210 cc and 100 g) suggesting higher boldness and liter weight of capsules. These two attributes determines the market price of cardamom. Dryage percentage of CRSP-158 was found to be highest (23.4%) confirming its superiority in recovery percentage than all other accessions under study. CRSP-158 was also found to be tolerant to thrips. Thrips infestation was highest in CRSP-84 (44%) followed by CRSP-82 (40%). CRSP-121 was found to be susceptible to azhukal disease (10%). The capsule borer damage was less in all the accessions.

Among the 132 germplasm lines evaluated at Mudigere, ten lines were found better for yield and yield attributing traits. The germplasm line P-3 was the tallest (228.5 cm), P-3 and CL-730 were found superior for

number of bearing suckers (13.6), and the highest panicle length of 49 cm was recorded by entry P-3 and more number of capsules per panicle and green capsule yield/plant (422 g) was recorded in CL-730.

CAR/CI/2 Hybridization

CAR/CI/2.1 Evaluation of OP progenies under intensive management

(Mudigere)

Thirty open pollinated progenies were planted during 2000 at Mudigere and evaluated for yield and yield parameters. Entry $23C_8$ yielded highest (221 kg/ha) followed by $21C_8$ (210 kg/ha, $22C_8$ (209.50 kg/ha), $14C_8$ (202 kg/ha), $24C_{18}$ (208 kg/ha). Genotypes M-2 was found tallest (311.33 cm), $22C_8$ and $23C_8$ had maximum number of bearing suckers (13.33 & 13.70), $6C_8$ had longest panicle (68.70 cm) and number of capsules/plant (58.50) was maximum in $4C_8$ (Table 15).

CAR/CI/2.2 Hybridization and selection in cardamom

(Mudigere)

A crossing block involving 5 elite clones of M-1, M-2, HS-1, Nejllani Gold and CL-726 was established at a closer spacing of 6 x 3' in order to generate all possible cross combinations through both random open pollination and hand pollination. All the clones were good general combiners and belong to Malabar type, while Nejllani green gold is a Vazhuka type.

CAR/CI/3 Coordinated Varietal Trial

CAR/CI/3.5 CVT 2005-series V

(Pampadumpara, Mudigere, Myladumpara)

A total of seven accessions namely, MCC-73, MCC-309, MCC-246, MHC-26 (ICRI, Myladumpara), CL-722 (RARS, Mudigree), PS-27 (CRS, Pampadumpara) and

Table15. Performance of OP progenies under intensive management at Mudigere

Clones	Plant height (cm)	Suckers/ plant	Bearing suckers/plant	Panicles/ plant	Panicle length (cm)	Capsules/ panicle	Inter-nodes/ panicle	Dry capsule yield (kg/ha)
$1C_8$	220.25	23.60	13.00	22.50	40.00	43.00	17.00	145.80
$2C_8$	250.00	21.66	10.00	22.50	55.21	45.20	18.00	150.20
$3C_8$	285.00	31.30	12.00	21.00	52.65	51.00	19.00	142.50
$4C_8$	310.00	24.25	9.00	18.20	59.00	58.50	20.50	155.90
$5C_8$	309.67	22.60	8.00	15.80	42.55	42.00	18.60	150.40
$6C_8$	285.00	18.75	9.00	25.60	68.70	60.10	22.80	186.00
$7C_8$	262.00	30.00	12.20	18.25	60.75	58.00	22.00	191.00
$8C_8$	225.00	20.00	8.20	12.50	32.56	35.00	16.00	145.00
$9C_8$	280.50	21.00	7.50	11.00	38.90	37.00	17.50	122.20
$10C_8$	265.30	18.33	10.00	19.30	56.22	57.20	21.00	156.50
$11C_8$	272.00	13.33	11.00	12.70	58.96	55.00	20.10	135.80
$12C_8$	250.33	18.00	9.00	10.60	41.33	33.00	16.50	140.00
$13C_8$	260.33	22.66	10.00	26.00	55.00	45.10	21.00	192.40
$14C_8$	195.00	23.33	11.25	30.00	62.99	42.00	22.50	202.00
$15C_8$	268.33	18.33	7.00	18.87	33.41	30.12	18.00	175.50
$16C_8$	302.50	26.00	12.25	22.33	42.56	40.51	20.08	142.00
$17C_8$	283.90	16.00	11.00	20.33	50.11	41.00	21.69	175.60
$18C_8$	289.43	16.66	10.50	29.00	58.23	36100	19.67	139.50
$19C_8$	265.00	13.50	11.00	26.82	42.25	32.40	17.54	140.00
$20C_8$	255.40	13.00	11.30	18.33	38.50	34.45	18.00	179.30
$21C_8$	262.60	16.33	12.50	28.33	50.20	33.08	20.00	210.20
$22C_8$	258.44	19.50	13.30	31.66	54.41	45.40	19.00	209.50
$23C_8$	268.30	18.66	13.70	25.44	47.25	53.50	17.00	220.10
$24C_8$	222.00	18.00	12.66	17.00	40.12	37.20	16.00	208.00
$25C_8$	294.50	10.70	6.33	10.12	47.30	33.45	17.50	140.00
$26C_8$	260.40	22.00	10.87	21.33	32.67	32.00	16.00	146.20
$27C_8$	232.22	16.00	8.66	19.67	48.00	35.70	19.00	188.20
$28C_8$	268.70	12.25	10.00	13.45	51.25	30.12	18.88	130.50
$29C_8$	252.67	12.00	9.50	15.33	36.00	37.44	18.22	158.80
$30C_8$	210.00	13.00	8.80	18.44	40.50	35.00	16.22	154.20
M-1	269.60	15.75	11.00	12.67	38.90	28.80	15.00	144.50
M-2	311.33	11.00	4.66	19.87	43.60	42.00	16.10	153.00
Mean	262.15	19.02	10.31	20.08	47.92	41.65	18.84	164.44

Green Gold (check) were raised in three replications in randomized block design during October 2005 at Pampadumpara. Significant variations existed in all accessions for the eight characters studied (Tables 16,17). Plant height was highest in MCC-309 (261.3 cm) and lowest in CL-722 (208.44 cm). Three varieties viz., MCC-73 (62.8), CL-722 (55.9) and MCC-309 (55.9) registered more than 50 tillers per clump. The panicle length ranged from 31.0 cm in MCC-73 to 45.7 cm in MCC-246. Maximum 100 capsule volume was registered in MCC-246 (178.3 cc) followed by MHC-26 (170.8 cc), whereas maximum 100 capsule weight was recorded in PS-27 (88.3 g) and minimum in MCC-309 (73.3 g). MCC-246 (5.67%) recorded higher capsule rot infection than the check whereas MCC-309 (1.33) registered the least. Infestation by thrips was found to be low in CL-722 (26.0%). Highest fresh (1566.93 g plant^{-1}) and dry yield (338.86 g plant^{-1}) was observed in PS-27 which was found to be significantly superior than other accessions. MHC-26 and MCC-246 recorded more dry yield than the check Greengold. The number of seeds per capsule was observed to be higher in PS-27 (17.17) followed by MH-26 (16.83) and MCC-246 (16.33).

At Mudigere clone CL-722 was found superior for dry capsule yield (341 kg/ha) and significantly superior over checks (M-2 & M-1). Other entries which recorded

Table 16. Yield attributing characters of CVT cardamom accessions at Pampadumpara

Accession	Plant height (cm)	Tillers/ clump	Panicle length (cm)	100 Capsule volume (cc)	100 Capsule weight (g)	No. of seeds/ capsule
MCC-73	259.78	62.78	31.00	145.83	81.67	14.33
Green Gold	250.00	45.89	39.00	166.67	87.50	14.00
MHC-26	233.22	47.22	33.22	170.83	82.50	16.83
CL-722	208.44	55.89	34.78	160.00	82.50	12.83
MCC-309	261.33	55.89	39.56	129.17	73.33	12.83
PS-27	254.33	46.00	32.00	155.00	88.33	17.17
MCC-246	*253.00*	*40.44*	*45.67*	*178.33*	*86.67*	*16.33*
Mean	245.73	50.59	36.46	157.98	83.21	14.90
CD (P=0.05)	28.5	9.94	NS	19.25	NS	NS

Table 17. Yield and pest incidence of CVT cardamom accessions at Pampadumpara

Accession	Fresh weight (g/plant)	Dry weight (g/plant)	Thrips (%)	Capsule borer (%)	Azhukal (%)
MCC-73	304.81	74.39	32.67	4.00	3.00
Green Gold	424.35	99.95	41.33	4.00	4.67
MHC-26	555.00	111.81	33.33	1.00	1.67
CL-722	163.08	37.22	26.00	1.00	2.00
MCC-309	388.35	81.77	30.67	3.00	1.33
PS-27	1566.93	338.86	37.33	3.00	2.33
MCC-246	493.13	105.67	47.33	3.00	5.67
Mean	556.52	121.38	35.52	2.71	2.95
CD (P=0.05)	571.91	142.45	2.10	1.22	1.66

high dry capsule yield were PS-27 (298.005 kg/ha), MCC-309 (310.00 kg/ha) and MCC-246 (318.00 kg/ha). Entry MCC-246 recorded highest plant height of 285.90 cm. Number of bearing suckers was maximum in PS-27 (13.50). MCC-246 had maximum panicle number (65.20) and longest panicle length (51.20 cm) and maximum number of capsules/panicle (20.70) was recorded in CL-722 (Table 18).

Table 18. Performance of CVT-2005 at Mudigere

Sl. No.	Clone	Plant height (cm)	Suckers/ plant	Bearing suckers/ plant	Panicle/ plant	Panicle length (cm)	Capsules/ panicle	Internodes/ panicle	Dry capsule yield (kg/ha)
1	MCC-73	230.00	18.20	9.00	45.40	35.00	16.00	9.50	198.60
2	MCC-246	285.90	20.20	13.20	65.20	50.33	15.20	19.25	318.00
3	MCC-309	245.70	20.50	12.60	62.00	45.20	17.20	15.20	310.00
4	MHC-26	232.12	17.50	12.00	56.00	44.00	19.10	16.20	259.00
5	PS-27	235.70	19.50	13.50	52.80	42.72	18.00	18.50	298.00
6	CL-722	220.90	20.20	12.00	60.20	51.20	18.90	20.10	341.00
7	M-1	210.20	1820	10.00	45.33	36.00	20.70	14.90	195.30
8	M-2	256.70	18.00	11.00	48.70	42.43	16.00	16.50	210.00
Mean		239.65	24.42	11.66	54.45	43.36	17.62	16.26	266.25
CD (P=0.05)		23.00	2.50	2.95	5.68	2.42	2.65	2.80	48.95
CV (%)		9.25	11.50	20.80	8.90	14.20	13.85	13.70	24.23

The field trial was continued during 2009-10 crop season at Myladumpara and 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 second stabilized yield were recorded and analyzed statistically (Table 19). Significant differences could be observed between the clones for all the characters except for the number of leaves per tiller. As in the previous years, performance of PS-27 and CL-722 with regard to yield was inferior when compared to other clones. The highest yield of 1400 kg/ha was recorded in MHC-26 followed by MCC-73 (1247 kg/ha), MCC-246 (1235 kg/ha) and MCC-309 (1103 kg/ha).

CAR/CI/3.6 CVT 2007/2009 - series VI

(Mudigere, Pampadumpara, Sakleshpur, Ambalavayal, Myladumpara)

The trial was laid out at Myladumpara during 2009 planting season incorporating a total of thirteen entries from Appangala (IC-349545, IC-349651, IC-547167, IC-547185), Mudigere (CL-726, CL-691), Saklespur (SKP-104, SKP-164), Pampadumpara (CR-6, PL-14) and Myladumpara (MCC-346, MCC-260 (local check), ICRI-2 (standard check)) centres. The trial was laid out in randomized block design (RBD) with three replications and 12 plants per plot adopting a spacing of 3 m x 3 m. During 2009-10 season, data on growth characters such as total tillers, tiller height, number of leaves per tiller and number of vegetative buds per clump were recorded and analyzed (Table 20). All the entries were found to be on par with respect to preliminary data on growth characters.

Table 20. CVT on cardamom (2009 series) at Myladumpara

Clone	Tillers/ clump	Tiller height (cm)	Leaves/ tiller	Vegetative buds/ clump
IC-349545	9.08	117.94	10.55	3.67
IC-349651	10.10	119.49	10.06	4.20
IC-547167	9.50	115.49	11.59	4.21
IC-547185	11.72	113.88	10.16	3.78
CL-726	9.27	110.25	8.94	4.11
CL-691	10.53	119.61	9.88	3.87
SKP-104	9.44	112.79	9.10	3.85
SKP-164	10.92	115.27	10.32	3.61
MCC-346	12.61	121.71	11.83	4.89
PL-14	10.49	112.98	9.61	3.07
CR-6	9.16	109.77	9.67	4.08
MCC-260	11.21	115.16	10.22	4.81
ICRI-2	10.72	113.47	10.71	3.44
CD (P=0.05)	NS	NS	NS	NS

The experiment was laid out during 2009 at Mudigere. Observation on different quantitative yield parameters will be recorded from third year onwards.

CAR/CI/4 Varietal Evaluation Trial

CAR/CI/4.1 Initial Evaluation Trial - I

(Mudigere)

A new experiment was laid out during 2009 and the observations on different quantitative traits will be recoded from third year onwards.

Table 19. CVT-2005 on 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	83.09	255.91	19.35	44.91	75.90	20.99	7.70	1.400	1400
MCC-73	72.46	242.20	20.14	38.48	69.96	18.18	7.17	1.247	1247
MCC-246	76.19	275.32	20.11	41.69	67.44	19.76	7.90	1.235	1235
MCC-309	70.29	258.99	19.91	40.75	68.35	17.33	6.39	1.103	1103
PS-27	55.01	229.45	19.95	29.96	44.83	16.28	6.13	0.857	857
CL-722	46.71	203.03	19.26	25.18	36.97	13.09	6.00	0.653	653
ICRI-2	69.25	260.14	20.30	38.78	64.72	16.82	6.42	1.057	1057
MCC-260	67.21	237.10	19.52	37.14	63.13	16.20	6.25	1.030	1030
CD (P=0.05)	14.02	8.01	NS	7.68	11.13	2.23	1.12	0.191	190.90

CAR/CI/4.2 Initial Evaluation Trial - II

(Mudigere)

A new experiment was laid out during 2009 and the observations on different quantitative traits will be recoded from third year onwards.

CAR/CM/5 Nutrient Management Trial

CAR/CM/5.1 Effect of different irrigation schedule and fertilizers on yield of cardamom

(Mudigere)

The experiment was initiated during 2008. The drip irrigation facilities were installed for implementing the main plot treatments. The main and sub plots treatments will be imposed during December 2010.

CAR/CP/6 Pest and Disease Management Trial

CAR/CP/6.5 Trial on management of panicle and clump rot of cardamom in existing plantation

(Mudigere, Pampadumpara)

All the treatments were effective in reducing the disease incidence as compared to control at Mudigere (Table 21). Minimum tiller infection of 2.32 was recorded in T_5 and panicle infection of 2.52 PDI was recorded in T_4. With regard to foliage infection, the minimum leaf spot of 2.85 PDI was recorded in T_5 and leaf blotch in T_4 (3.5 PDI). Maximum yield of 318 kg/ha was recorded in T_4 which was followed by T_3 (295 kg/ha) as compared to control.

CAR/CP/6.6 Trial on management of panicle and clump rot of cardamom in new plantation

(Mudigere, Pampadumpara)

All the treatments were effective in reducing the disease incidence as compared to control at Mudigere. The maximum plant height of 185.3 cm was obtained in the COC 0.3% drenched Nellani Green Gold plants. The maximum tiller production and minimum foliage infection was recorded in COC (0.0%) drenched plants as compared to other treatments.

CAR/CP/6.7 Evaluation of new insecticides/ biopesticide in cardamom against thrips and shoot and capsule borer

(Mudigere, Pampadumpara)

Among the different pest species infesting cardamom, thrips and shoot and capsule borer are one of the most severe pests. To manage these pests, at present farmers adopt conventional insecticides and the indiscriminate use of insecticides adversely affect the quality of the produce and fetches lower prices in National/International market. Hence to develop safe and alternative eco friendly management strategies for the effective management of these pests an experiment was initiated during 2009. At Mudigere, spraying methomyl @ 1.5 ml and spray with quinalphos @ 2 ml was found to be effective and significant when compared to all the other treatments (Table 22).

At Pampadumpara the experiment was laid out in December 2009 and spraying was taken up as per schedule.

Table 21. Effect of bio-control agents and chemicals on the incidence of major diseases in cardamom at Mudigere

Treatment	Tiller infection	Panicle infection	Leaf spot	Leaf blotch	Yield kg/ha
T_1 - *T. harzianum*	2.80	3.30	3.22	3.72	232
T_2 - Consortium of bacteria	2.70	3.27	2.93	3.65	245
T3 - *T. harzianum* + Consortium of bacteria	2.77	3.20	3.27	4.20	295
T_4 - COC (0.3%) drenching,	2.57	2.52	3.07	3.50	318
T_5 - Potassium phosphonate (0.3%) spray and drench,	2.32	2.77	2.85	3.80	217
T_6 - Control.	3.30	4.00	3.77	4.40	231
CD (P=0.05)	0.56	0.82	0.64	0.89	38.25
CV (%)	13.74	16.91	13.48	15.18	9.61

Table 22. Management of thrips and shoot and capsule borer in cardamom at Mudigere

Sl. No.	Treatment	Dosages	Damage in I harvest (%)		Damage in II harvest (%)		Damage in III harvest (%)		Mean damage (%)	
			Thrips	Borer	Thrips	Borer	Thrips	Borer	Thrips	Borer
1	Imidacloprid	0.5 ml	5.21	3.29	4.65	1.18	11.27	0.53	7.04	1.66
2	Methomyl	1.5 ml	5.17	2.96	2.82	1.90	9.18	1.13	5.72	1.63
3	Acetamiprid	0.4 g	3.05	2.40	3.27	1.18	14.15	1.28	6.97	1.62
4	Quinalphos**	2 ml	4.77	2.11	2.59	1.02	8.79	0.86	5.38	1.33
5	Carbosulfan	2 ml	4.61	3.09	3.43	0.61	8.06	0.29	5.36	1.33
6	Check Mudigere*		4.47	2.38	3.87	0.99	12.90	1.64	7.08	1.67
7	Control		5.50	4.65	5.20	2.17	14.00	2.16	8.23	2.99
	CD (P=0.05)		4.86	4.05	2.94	1.77	12.58	1.38		

*Carbosulfan-Phosalone-Phosalone.** Kerala practices- Six rounds of spray at 15-20 days interval

LARGE CARDAMOM

LCA/C1 Genetic Resources

LCA/C1.1 Collection, conservation, characterization and evaluation of large cardamom germplasm

(Gangtok)

A survey was conducted at Mangan, Singhik and Dzongu area of North Sikkim. Six planting units of five germplasm viz. SCC-213 (Golsey), SCC-214 (Golsey), SCC-215 (Golsey), SCC-216 (Ramla) and SCC-217 (Ramla) were collected from Middle Singhik, Sentam and Nung village of North Sikkim area and planted at Kabi farm. Characterization of the germplasm were made as per descriptor (Table 23).

Table 23. Germplasm collection of large cardamom

Acc No.	Cultivar	Location	Age	Productive tiller/ clump	Spike/ clump	Capsule/ spike	Seeds/ capsule	Dry yields/ capsule (g)	Projected dry yields (kg/ha)
SCC-213	Golsey	Middle Singhik, N Sikkim	4	28	36	8	52	268	1072
SCC-214	Golsey	Singhik, N Sikkim	5	25	34	8	48	252	1008
SCC-215	Golsey	Sentam village N.Sikkim	4	29	38	9	47	280	1120
SCC-216	Ramla	Sentam village Singhik, N.Sikkim	6	33	44	8	44	320	1280
SCC-217	Ramla	Nung Dzongu N.Sikkim	5	43	78	8	49	470	1880

GINGER

GIN/CI/1 Genetic Resources

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

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

The germplasm of ginger maintained at various AICRPS centres is given in Table 24.

Table 24. Ginger germplasm collection of AICRPS centres

Centre	Indigenous	Exotic	Total
Dholi	49	-	49
Kumarganj	63	-	63
Pottangi	174	3	177
Pundibari	19	6	25
Raigarh	44	-	44
Solan	176	-	176
Total	525	9	534

Forty nine germplasm of ginger were collected and evaluated for promising line with respect to yield at Dholi. Out of forty nine germplasm, only eight accessions namely, RG-14, RG-24, RG-13, RG-7, RG-9, RG-30, RG-32, and RG-38 gave the maximum yield ranging from 6.00 kg/7.2 m^2 to 8.00 kg/7.2 m^2 as compared to check variety Nadia 5.00 kg/7.2 m^2. Among the eight promising accession, RG-14 and RG-24 gave maximum yield (8.00 kg/7.2 m^2) followed by RG-13 (7.30 kg/ 7.2 m^2).

Sixty three germplasm of ginger maintained at Kumarganj center were evaluated during 2009-10. The yield ranged from 14.3 q/ha (NDG-4) to 341.5 q/ha in NDG-55 (Badra Sonth). Maximum fresh rhizome yield was recorded in NDG-55 which was followed by NDG-28 (136.5 q/ha).

Fifty four germplasm of ginger were evaluated during 2009-10 at Pundibari centre. GCP-9 recorded maximum plant height (89.30 cm) followed by GCP-14 (83.70 cm), whereas GCP-31 recorded the lowest plant height (26.32 cm). Maximum number of tillers was recorded in GCP-28 (35.00) followed by GCP-52 (34.40) and GCP-9 (30.20) whereas GCP-16 (3.00) recorded lowest numbers of tillers. GCP-9 recorded maximum number of leaves (27.00) followed by GCP-1 (26.40), whereas GCP-24 (7.40) recorded lowest leaf number per plant. GCP-14 recorded the highest mean values for stem girth (3.22 cm) while GCP-31 recorded the lowest values for the same trait (1.66 cm). Maximum disease incidence was recorded in the germplasm, GCP-39, GCP-43 and GCP-47 (50 each) whereas lowest disease incidence was recorded in GCP-29, GCP-50 and GCP-52 (0%). Highest rhizome yield/plant was recorded in GCP-1 (672.33 g) followed by GCP-28 (502.00 g), GCP-48 (355.00 g) and GCP-9 (350.67). Lowest rhizome yield/plant was recorded in GCP-52 (80.00 g).

At Solan collection SG-962 produced tallest tiller followed by SG-9. Rhizome length was highest in SG-785. The yield of top ten collections varied from 3.00 to 5.20 kg/plot. Disease incidence varied from 10-15% in different lines while SG-785 showed minimum incidence of 5.5%.

GIN/CI/2 Coordinated Varietal Trial

GIN/CI/2.3 CVT 2006 (Final report)

(Solan)

The experiment was initiated in 2007 at Solan with 16 entries (one from Calicut; two each from Solan, Pundibari; three from Raigarh, Kumarganj and Pottangi including two checks *viz.*,Varada and Suprabha) including local check. During the reporting year (2009-10), the experiment was conducted only on twelve entries (Table 25). Analysis of variance showed that genotype

Table 25. Performance of CVT ginger at Solan

Collection	Survival (%)	Tiller length (cm)	Tillers	Leaves/ tiller	Rhizome length(cm)	Rhizome breadth(cm)	Yield/ plant(kg)
GCP-05	47.79	46.93	5.60	12.73	9.37	3.07	0.033
GCP-31	44.79	44.40	4.60	10.20	11.07	4.10	0.055
IG-1	22.91	50.80	5.73	12.47	9.07	3.67	0.039
IG-2	39.58	52.07	6.13	13.60	10.60	14.67	0.042
IG-3	45.00	52.67	5.80	13.20	10.20	4.40	0.057
NDG-1	48.95	46.93	6.93	12.07	10.80	4.33	0.058
NDG-2	47.91	47.93	6.13	13.13	9.60	4.73	0.044
NDG-5	22.91	43.40	5.17	9.52	8.87	4.07	0.041
SG-707	73.96	55.87	5.67	14.67	12.53	5.13	0.091
SG-827	67.79	55.40	4.20	12.50	12.40	4.23	0.072
Varada	9.37	47.50	4.27	10.00	10.33	5.00	0.037
Suprabha	19.67	43.33	5.93	12.47	9.87	4.20	0.061
SEm±	0.18	7.26	0.34	0.81	0.79	3.20	0.01
CD(P=0.05)	19.83	2.48	0.99	2.38	2.31	9.36	0.03

SG-707 exhibited maximum tiller and rhizome length. This genotype was also found at par with SG-827 for tiller length and SG-827, Varada, NDG-1 and IG-2 for rhizome length. Only three genotypes viz., SG-707, SG-827 and IG-2, differed significantly from others for yield per plant but found at par with each other. The disease incidence varied from 17-30 per cent with minimum incidence in SG-707.

GIN/CI/3.1 Initial Evaluation Trial 2006

(Raigarh, Dholi, Pottangi, Solan)

Pooled data (Table 26) showed that among the entries and local check Nadia, none of the entries were found significantly superior over check variety Nadia regarding height of the plant, number of tillers per plant, and number of leaves per tiller. But RG-3 gave significantly higher yield (21.34 t/ha) as compared to local check variety Nadia (17.81 t/ha).

GIN/CI/3.3 Genotype X Environment interaction on quality of ginger

(Appangala, Ambalavayal, Barapani, Calicut, Chintapalle, Dapoli, Dholi, Kanke, Kalyani, Mizoram, Navsari, Pantnagar, Pasighat, Pottangi, Pundibari, Raigarh, Solan)

Eight varieties of ginger namely, Suprabha, Suruchi, Surabhi, V3S1-8, Himgiri, Varada, Mahima and Rejatha were obtained from different coodinating centres and evaluated along with local check Nadia during 2009-10 at Pasighat. The observations were recorded on morphological, yield and quality parameters. The mean values of morphological and yield parameters showed that the variety Nadia recorded maximum plant height (74.0 cm.) and leaf area (19.83 cm x 2.50 cm) while variety Suruchi had maximum number of tillers (11.27). Variety Surabhi recorded highest yield (32.60 t/ha fresh rhizome) followed by variety Nadia (21.13 t/ha) and lowest yield was recorded in variety Rejatha (7.06 t/ha). The mean values in respect of quality parameters revealed that the variety Suruchi gave maximum dry matter (23.47%) and oleoresin (11.03%) content while variety Nadia, Suruchi and Rejatha had maximum crude fibre (7.90%), oleoresin (11.03%) and essential oil (2.20%) content, respectively.

Mahima recorded maximum plant height (35.36 cm) followed by Himagiri (29.99 cm). Surabhi and Suprabha dominated in the case of number of tillers (5.60 and 4.77 respectively). Varada recorded the best fresh yield per bed (6.32 kg) followed by Mahima (5.87 kg). In the case of dry recovery percentage Surabhi recorded maximum (28.93%) followed by Mahima (26.73%). Varada ranked 1st with 12.63 t/ha followed by Mahima with 11.73 t/ha at Appangala condition.

Ten ginger varieties obtained from different centres were evaluated during 2009-10 at Barapani, Meghalaya. All the genotypes were affected by soft rot. Highest yield was obtained in Nadia (8.55 t/ha). Among the genotypes evaluated highest plant height was recorded in Nadia (42 cm) with lowest crude fibre content (2.93%). Khasi local recorded highest crude fibre content (2.97%). Highest dry recovery was recorded in V_3S_1-8 (25.20%) while lowest was recorded in Varada (19.57%) (Table 27).

Table 26. Performance of initial evaluation trial on ginger (Pooled analysis 2006-07, 2008-09 and 2009-10) at Dholi

Genotype	Height of the plant(cm)	Tillers/ plant	Leaves/ tiller	Yield/plot	Yield (t/ha) (Kg/3m^2)	Increase in yield over check	
						t/ha	%
RG-1	41.62	14.50	14.09	4.55	15.18	-2.63	-14.76
RG-2	38.71	14.30	15.00	5.22	17.42	-0.39	-2.18
RG-3	39.13	16.65	16.20	6.40	21.34	3.53	19.82
RG-4	38.35	13.98	14.86	3.82	12.80	-5.01	-28.13
RG-8	39.56	13.94	15.14	4.68	15.61	-2.20	-12.35
RG-18	39.12	15.50	13.15	4.61	15.38	-2.43	-13.64
RG-20	36.30	14.71	14.83	4.16	13.87	-3.94	-22.12
RG-25	37.37	14.42	14.74	5.47	18.25	0.44	2.47
RG-29	37.16	13.21	14.05	4.51	15.04	-2.77	-15.55
RG-30	39.68	12.92	15.29	4.42	14.73	-3.08	-17.29
RG-34	39.01	15.44	14.86	4.23	14.12	-3.69	-20.71
RG-35	38.63	15.65	16.04	4.21	17.37	-0.44	-2.47
RG-43	43.36	17.80	17.00	5.95	19.84	2.03	11.39
Nadia (Local check)	41.29	14.16	16.34	5.34	17.81	-	-
SEm±	1.28	0.94	0.69	0.36	1.20	-	-
CD (P=0.05)	NS	NS	2.02	1.05	3.51	-	-
CV (%)	5.66	11.08	7.96	12.84	12.80	-	-

Table 27. Performance of different ginger varieties at Barapani

Variety	Plant height(cm)	Leaf area		Tillers	Yield/ plant (g)	Yield (t/ ha)	Dry recovery (%)	Fibre content (%)
		Length (cm)	Breath (cm)					
Suprabha	33.33	20.50	2.57	8.00	196.67	4.27	21.12	3.23
Mahima	32.67	19.67	2.53	5.67	129.00	3.55	21.65	3.60
Himgiri	23.25	18.25	2.60	4.50	70.00	0.66	20.00	5.00
Varada	34.50	22.33	2.67	4.17	121.33	3.06	19.57	3.40
V_3S_1-8	18.66	14.66	1.90	3.33	100.00	1.00	25.20	3.30
Rejatha	31.83	20.83	2.56	3.83	118.00	1.80	20.65	4.17
Surachi	29.17	20.33	2.53	6.83	121.33	1.66	21.96	4.25
Suravi	28.83	21.00	2.47	8.33	94.33	1.44	21.27	3.03
Nadia	42.00	20.67	2.77	4.67	176.00	8.55	21.34	2.93
Khasi Local	32.17	17.67	2.63	5.50	97.00	4.11	22.54	2.97
CD (P=0.05)	3.20	24.80	0.26	0.89	25.50	0.041	2.20	0.36

The trial would be initiated at Chintapalle, Dapoli, Ranchi, Pantnagar, Raigarh during 2010.

Leaf area was highest for Himgiri (45.4 cm^2) which was at par with Nadia (44.0 cm^2) and Nisapui-Local (39.1 cm^2) at Mizoram. The maximum yield was recorded for Nadia (194 q/ha) followed by Himgiri (186 q/ha), Nisapui-Local (160 q/ha), Mahima (122 q/ha) and Varada (122 q/ha).

Eight varieties were evaluated for various traits for economic importance at ICAR-RC-NEH Region, Kolasib. All the growth parameters, *i.e.* plant height, stem thickness, number of tillers, leaf length, leaf width and leaf area were taken after 120 days of planting. Leaf area was highest for Himgiri which was at par with Nadia and Nisapui (Local). The maximum yield was recorded for Nadia followed by Himgiri, Nisapui (Local), Mahima and Varada. (Table 28).

Table 28. Performance of ginger varieties at Mizoram

S. No.	Variety	Plant height (cm)	Tillers/ plant	Leaf length (cm)	Leaf width (cm)	Leaf area (cm^2)	Plant thickness (mm)	Leaves	Rhizome weight (g/plant)
1	Himgiri	48.5*	12.8	20.0	3.2	45.4*	7.3	14.9	111.5
2	Mahima	39.4	7.4	17.1	2.9	34.5	6.5	10.6	73.2
3	Nadia	50.0*	7.2	20.4	3.1	44.0*	7.8	14.3	116.5
4	Rejatha	38.0	6.8	16.0	2.9	32.3	6.5	10.1	47.2
5	Surabhi	36.6	15.3	16.0	3.0	33.2	5.2	9.7	54.5
6	Suprabha	35.9	13.7	16.0	2.9	32.8	6.3	9.4	56.0
7	Varada	40.9	5.5	17.6	2.7	34.1	6.4	11.1	73.5
8	Nisapui (Local)	44.4*	5.6	19.0	2.9	39.1	6.6	12.2	95.8
	Mean	41.7	9.3	17.8	2.9	36.9	6.6	11.5	78.5
	SEm±	2.8	1.0	0.9	0.1	3.3	0.5	0.6	6.4
	CD (P=0.05)	8.5	2.9	2.7	0.4	9.9	1.5	1.8	19.3

Growth and yield parameters of six varieties (Suprabha, Surabhi, IISR Varada, IISR Mahima, IISR Rejatha and GCP-5 Local check) were recorded at Pundibari. The mean values of growth and yield parameters of the different genotypes of ginger for 2009-10 showed highest rhizome yield in GCP-5 (5.69 kg) followed by IISR Mahima (4.01 kg) and the lowest value was recorded by Suprabha (1.50 kg). In respect of projected yield GCP-5 showed the highest value (11.48 t/ha) followed by IISR Mahima (6.45 t/ha) and lowest projected yield was recorded in Suprabha (3.02 t/ha). In respect of disease incidence IISR Varada recorded the highest value (37.50%) whereas IISR Mahima recorded the lowest (14.17%).

At Ranchi, Mahima recorded maximum plant height (51.00 cm) followed by Rejatha (40.69 cm). Suprabha showed maximum leaf length (18.58 cm) followed by Mahima (18.48 cm) and V_3S_1-8 showed maximum leaf breadth (2.51 cm) followed by Rejatha (2.43 cm). Highest fresh rhizome yield per ha was recorded by Suprabha (28.79 t/ha) followed by Mahima (21.67 t/ha) and highest dry recovery was observed in Suprabha (24%) followed by Mahima (23%). Yield of ginger was poor due to heavy drought at the time of planting and growth period.

At Solan yield per plot varied from 0.02 to 1.87 kg. Cultivar Himgiri differed significantly from all other cultivars and recorded maximum yield (1.867 kg) followed by SG-827 (local check). Himgiri showed minimum disease incidence of 16.5%.

GIN/CI/4.1 Evaluation of gemplasm for quality

(Solan)

At Solan different quality attributes viz. dry matter (%), essential oil (%) and oleoresin (%) were analyzed in ginger. The dry matter contents ranged between 17.7 and 27.3 per cent. Essential oil and oleoresin contents varied from1.0 to 1.5 and 2.49 to 4.70 per cent, respectively. Out of 34 collections, SG-962, SG-976, and 26/2004 were found superior for dry matter and essential oil content in comparison to check Himgiri.

GIN/CI/4.2 Evaluation of gemplasm from other centers for quality

(Solan)

Samples of ginger and turmeric were not received from other AICRPS centers for quality attributes during 2009-10.

GIN/CM/5 Nutrient Management Trial

GIN/CM/5.2 Organic farming in ginger – 2006

(Dholi, Solan, Pundibari, Pottangi, Kumarganj)

At Dholi, three treatments i.e. fully organic, integrated fertilizer management of organic and inorganic and fully inorganic were tested for obtaining higher yield during 2009-10. Among the treatments, fully organic (FYM, pongamia oil cake, sterameal, rock phosphate, neem oil cake, wood ash) + *Azospirillum*, P-solublizers, P. fluorescens and *Trichoderma* as seed treatment and soil application (50 g/3 m^2) with spray of Bordeaux ixture (0.5%) and neem oil (0.5%) at 21 days interval from July-October and integrated fertilizer management of

organic and inorganic (20 t FYM+ ½ N, P, K + P-solubilising bacteria *P. fluorescens* and *Trichoderma* as seed treatment and soil application (50 g/3 m^2) as spraying or drenching with mancozeb (Dithane M-45) and malathion (0.1%) at 21 days interval from July-October showed significantly better performance regarding height of the plant, number of leaves per tiller, length of leaves, width of leaves, area of leaves and yield per plot or per hectare as compared to fully inorganic (recommended dose of N,P,K, drenching/spray with mancozeb (Dithane M-45) and malathion (0.1%) at 21 days interval from July-October for controlling disease and insect-pest). However, fully organic showed better performance regarding height of the plant (51.97 cm), number of tillers per plant (17.23), number of leaves per tiller (18.22), length of leaves (19.28 cm), width of leaves (2.34 cm), area of leaves (45.32 cm^2), yield per plant (0.08 kg/plant) and yield per plot (3.87 kg/3 m^2), yield per hectare (12.90 t/ha) followed by integrated fertilizer management of organic and inorganic.

At Pundibari application of organic nutrients on ginger (FYM - 10 kg/3 m^2 + pongamia cake 250 g/3 m^2 +neem cake - 250 g/3 m^2 + sterameal 250 g/3 m^2 + rock phosphate 500 g/3 m^2 + wood ash 250 g/3 m^2), biofertilizers (*Azospirillum*, P-solubilizers) and *P. fluorescens* and *Trichoderma* as seed treatment and soil application @50 g/3 m^2 with spray/drench of Bordeaux Mixture @ 0.5% and neem oil @ 0.5% at 21 days interval from July to October for disease and pest control) produced highest clump weight of 294.21 g, highest yield of 4.61 kg/plot and highest oleoresin of 3.49% in 2009 – 2010. This treatment was followed by application of integrated nutrients on ginger (20 t/ha FYM, ½ N, P, K, P-solubilizers, *P. fluorescens* and *Trichoderma* as seed treatment and soil application @50 g/3 m^2 with spray/drench of Bordeaux Mixture @ 0.5% and malathion @ 0.1% at 21 days interval from July to October for disease and pest control) which produced clump weight of 262.99 g and yield of 3.55 kg per plot.

Effect of fertilizers, FYM and bioagents were studied in the trial of organic farming on ginger in four treatment and seven replications at Kumarganj. 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/m^2 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* @50 g/m^2 producing fresh rhizome yield of 45.23 q/ha. Pooled study indicated 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/m^2 with maximum increase in yield of 36.49% over control (Table 29).

GIN/CM/1.4 Effect of micronutrient on ginger (Final report)

(Kumarganj)

The objective of this experiment was to study foliar and soil application of zinc, iron and boron on the yield of fresh ginger rhizomes. The field experiment was conducted Kumarganj from 2001-2004 for a period of four years in F R B D in three replication in a plot size of 3 x 1 m^2 at a spacing of 30 x 20 cm with 27 treatments. Foliar application of zinc @ 0.5%, boron @ 0.2% and iron as ferrous sulphate @ 1.0% after 60 and 90 days of sowing and soil application of zinc @ 25 kg/ha, boron @10 kg/ha and ferrous sulphate @10 kg/ha alone or in combination with foliar application were tested. The soil was alkaline in nature having pH of 8.0. All agronomical practices were adopted for raising a good crop.

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 value 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 49.996 q/ha by foliar application of boron @ 0.2%. Low yield of ginger can be attributed to the incidence of rhizome rot diseases as 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.

GIN/CP/6 Disease Management Trial

GIN/CP/6.1 Disease surveillance and etiology of rhizome rot in ginger

(Solan, Dholi)

The incidence of rhizome rot ranged between 25 to 75% in different ginger growing areas of the Himachal

Table 29. Effect of fertilizers, FYM and bio-agent on the yield of ginger during 2006-07 to 2008-09 (Pooled) at Kumarganj

Sl. No.	Treatment	Yield q/ha 2006-07	2007-08	2008-09	Mean	Per cent increase in yield over control
1.	T_1- 100% recommended dose of fertilizer	3.60	32.3	43.32	33.07	-
2.	T_2- 100% recommended dose of fertilizer + FYM (20 t/ha) + seed treatment and soil application of *P. fluorescens* and *T. harzianum* (50 g/m^2)	3.90	54.1	45.23	34.41	4.05
3.	T_3- 50% recommended dose of fertilizer + FYM (10 t/ha) + *Azospirillum* (5 kg/ha) + seed treatment and soil application of *P. flourescens* and *T. harzianum* (50 g/m^2)	4.70	68.6	62.14	45.14	36.49
4	T_4- 100% FYM (20 t /ha) + *Azospirillum* (5 kg/ha) + seed treatment and soil application of *P. flourescens* and *T. harzianum* (50 g/m^2)	4.20	47.1	38.09	29.79	9.91
	SEM±		0.97	3.11		
	CD (P=0.05)		2.89	9.25		
	CV (%)		30.36	11.44		

Pradesh. Soft rot was found more predominating than bacterial wilt of ginger. Rhizome rot influenced germination and yield to a greater extent during this year.

Diseased rhizome of ginger collected from Samastipur and Muzaffarpur districts of Bihar were found to be associated with bacterial wilt disease caused by Ralstonia sp.

GIN/CP/6.5 Management of rhizome rot in ginger

(Chintapalle, Sirsi , Mudigere, Dapoli)

At Mudigere, germination and production of tillers were more in solarized plot, compared to non-solarized plot at Mudigere. Maximum germination (70.18%) and tiller production (98.2) was observed in T_4 (Mancozeb seed treatment and soil drench) which was followed by 66.48% germination and tiller production of 89.8 in T_3 (*T. harzianum* + application of bacterial consortium). Minimum incidence of 3.02% soft rot, 4.2% foliage disease and higher yield of 18.66 t/ha was recorded in T_4 as compared to other treatments. In non-solarized plot maximum germination (63.86%) was observed in T_4. Lesser incidence of soft rot (2.48%) and foliar disease (5.2%) was recorded in T_4 as compared to other treatments (Table 30)

GIN/CP/6.6 Management of soft rot of ginger (biofumigation using mustard)

(Dholi, Solan, Chintapalle, Pundibari, Kumarganj, Raigarh)

At Pundibari, biofumigation using mustard (T_1) was the best treatment against soft rot disease of ginger (8.34% disease). This treatment was closely followed by rhizome treatment with metalaxyl mancozeb (T_2) which recorded 10.49% 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 5.75 kg/plot followed by T_2 which recorded 5.15 kg/plot yield. Lowest yield of 3.08 kg/plot was obtained by T_5 (Control). Minimum and maximum bacterial wilt disease incidence of 10.56% and 24.11% respectively was recorded in T_1 and T_5 (control) respectively. T_2 recorded lowest leaf spot disease (PDI of 12.25).

At Dholi, treatment (T_2 - rhizome treatment by metalaxyl mancozeb 72% WP (1.25 g/l of commercial formulation) recorded maximum number of plant survived (39.00), minimum bacterial wilt incidence

Table 30. Effect of chemicals and bio-control agents on the incidence of rhizome rot in ginger at Mudigere

Treatment	Germination (%)		Tillers/ plot		Soft rot (%)		Foliar disease (%)		Yield (t/ha)	
	S	NS	S	NS	S	NS	S	NS	S	NS
T_1 *T. harzianum* seed treatment + soil application	60.04	59.38	93.8	83.4	3.46	2.66	4.8	5.6	11.37	10.06
T_2 Consortium of bacteria	63.96	62.86	83.6	76.5	3.82	3.98	4.4	5.2	10.00	10.50
T_3 *T. harzianum* + consortium of bacteria	66.48	58.64	89.8	86.60	4.32	4.40	5.6	5.8	10.03	14.50
T_4 Mancozeb seed treatment + soil drench	70.18	63.86	98.2	88.6	3.02	2.48	4.2	5.2	19.43	18.66
T_5 Control	54.20	50.48	61.6	85.2	7.6	5.98	6.6	9.0	9.06	9.73

S= Solarized, NS= Non-Solarized

(PDI= 61.00) giving highest yield (3.90 t/ha) followed the treatment (T_1- soil treatment by biofumigation using mustard (Table 31).

At Solan, soft rot incidence ranged from 30-45 % while bacterial incidence ranged from 10 to 20%. No incidence of shoot borer and leaf spot was recorded.

At Chintapalle, ginger seed material treated with rhizobacterial antagonist recorded germination count of 38.5 clumps out of 40 rhizomes planted, followed by rhizome treatment with metalaxyl mancozeb 72% WP (1.25 g/l) (37.25%). Rhizome treatment by metalaxyl mancozeb 72% WP (1.25g/l) recorded lowest soft rot incidence (14.75%) followed by rhizome treatment by rhizobacterial antagonist (17.75 %). Rhizome treatment by rhizobacterial antagonist is highly effective in managing leafspot (10.84%) followed by rhizome treatment with endophytic bacterial antagonist. Highest yield (2.57 kg/ plot) was recorded when rhizomes were treated with metalaxyl mancozeb 72% WP (1.25 g/l) followed by rhizomes treated with rhizobacterial antagonist (2.14 kg/plot).

At Kumarganj, significant decrease in percent disease incidence of soft rot was observed in rhizome treatment with metalaxyl + mancozeb (42.25% decrease in incidence of soft rot over control) followed by rhizome treatment by antagonist (IISR GEB) *i.e* 45.50%. The increase in yield of fresh rhizome 23.32 q/ha was maximum in this treatment (133.34% increase in fresh rhizome yield over control) followed by yield of 16.24 q/ha in soil fumigation with mustard showing an significant increase in yield of 62.56% over control.

Among all the treatments T_1 (soil treatment by bio fumigation using mustard crop) and T_2 (rhizome treated by fungicides metalaxyl + mancozeb (72% WP) 1.25 g/l) was found effective against the disease and incidence was lowest 11.28% and 14.98%, respectively as compared to control (28.92%) at Raigarh (Table 32).

Table 31. Effect of different treatments (bio-fumigation using mustard) on soft rot incidence of ginger at Dholi.

Treatment	Germination count (%)	Plant survived (%)	Bacterial wilt incidence (PDI)	Rhizome yield (kg/plot)	Rhizome yield (t/ha)
T_1	49.50	35.00	65.00(18.24)	1.12	3.72(95.79)
T_2	54.00	39.00	61.00(23.27)	1.22	3.90(105.26)
T_3	63.50	30.50	69.50(12.58)	0.91	3.02(58.95)
T_4	66.00	29.50	70.50(11.32)	0.88	2.93(54.21)
T_5	70.00	20.50	79.50	0.57	1.90
CD (P=0.05)	14.80	8.63	8.63	0.19	0.63
CV (%)	15.85	18.12	8.11	13.18	13.20

Note: T_1 - Soil treatment by bio-fumigation using mustard; T_2 - Rhizome treatment by metalaxyl mancozeb 72% WP (1.25 g/ l of commercial formulation); T_3 - Rhizome treatment by rhizobacterial antagonist (IISR-GRB); T_4 - Rhizome treatment by endophytic bacterial antagonist (IISR-GEB); T_5 - Absolute Control.

Table 32. Effect of treatment on management of soft rot of ginger at Raigarh

Treatment	Sprouted rhizomes (%)	Survival of plants/ plot	Survival (%)	Per cent disease incidence	Plot yield (Kg)	Projected yield (t/ ha)
Soil treatment by biofumigation using mustard crop	82.70	30.2	71.42	11.28	4.8	9.6
Rhizome treatment by metalaxyl + mancozeb 72% WP (1.25 g/l commercial formulation)	85.52	29.5	70.64	14.98	4.2	8.5
Rhizome treatment by rhizobacterial antagonist	82.50	26.5	62.41	20.09	3.3	6.6
Rhizome treatment by endophytic bacterial antagonist	83.12	26.4	63.52	19.60	2.9	5.9
Absolute control	83.08	22.5	54.16	28.92	1.9	3.8
CD (P=0.05)		1.8			0.6	

GIN/CP/6.7 Management of soft rot of ginger (biofumigation using cabbage)

(Dholi, Solan, Chintapalle, Pottangi, Kumarganj, Ambalavayal, Raigarh)

At Dholi, maximum plant survival (71%), minimum bacterial wilt incidence (PDI- 29.00) and highest yield (7.08 t/ha) was recorded in the treatment T_1 (soil treatment by biofumigation using cabbage. Next highest yield (6.50 t/ha) with plant survival (65.50%) and bacterial wilt incidence (PDI-34.50) was recorded in the treatment T_2 where the rhizome were treated by metalaxyl mancozeb 72% WP (1.25 g/l).

At Kumarganj significant reduction in the soft rot incidence was observed in all the treatments over control. However, maximum disease control was recorded in plots biofumigated with cabbage followed by seed rhizomes tested by fungal antagonist (IISR-GRB). Maximum significant increase in fresh rhizomes was observed in rhizomes treated with endophytic bacteria (IISR- GEB) (Table 33).

At Raigarh the treatments T_2 (rhizome treated by fungicides metalaxyl + mancozeb (72 % WP) 1.25 g/ liter and T_1 (soil treatment by biofumigation using cabbage crop) was found effective against the disease

Table 33. Effect of bio-fumigation with cabbage, fungicides and bio-agents on the incidence of soft rot disease and yield in ginger at Kumarganj

Sl No.	Treatment	Germination (%)	Soft rot incidence	Yield (q/ha)	Percent disease control of soft root	Percent increase in yield over control
1	T_1- Soil fumigation using mustard	71.5	31.25	22.65	47.69	117.78
2	T_2- Rhizome treatment by metlaxyl-mancozeb 75 % W.P.	70.0	48.00	14.15	19.66	36.05
3	T_3 - Rhizome treatment by antagonist (IISR- GRB)	72.0	45.75	23.73	23.43	12.81
4	T_4 - Rhizome treatment by endophytic bacteria (IISR- GEB).	62.5	49.25	15.66	16.73	50.57
5.	T_5- Absolute control	54.5	59.75	10.40	-	-
	SEm±		1.59	0.87		
	CD (P=0.05)		4.90	2.68		
	CV (%)		6.85	10.04		

and incidence was lowest 18.0% and 19.9% respectively as compared to control (29.19%) and these treatments gave an yield of 8.2 t/ha and 7.2 t/ha respectively.

GIN/CP/6.8 Management of bacterial wilt of ginger (biofumigation using mustard)

(Dholi, Solan, Pundibari)

At Dholi, all the treatment had significant effect on increase of germination percentage, reduction in disease incidence and increase in yield. Maximum plant survival (71.50%) with lowest bacterial wilt incidence (PDI= 28.50) and highest rhizome yield (7.83 t/ha) were recorded over control under the treatment (T_1) where the soil was biofumigated using mustard. Second highest yield (6.49 t/ha) with plant survival (65.00%) and bacterial wilt incidence (PDI= 35.00) were recorded over control in the treatment (T_5) where the rhizome were treated with endophytic bacterial antagonist (IISR-GEB) before planting. Both the treatments *viz.*, T_1 & T_5 were found to have significant different effect on survival of plant, PDI and yield of the crop (Table 34).

Due to severe drought in Himachal Pradesh during the year 2009, germination and yield were affected to a greater extent and accordingly non-significant results were obtained.

At Pundibari biofumigation using mustard (T_1) was the best treatment in reducing bacterial wilt disease of ginger (7.82% disease). This treatment was closely followed by soil application with bleaching powder (T_2) which recorded 9.74% 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 5.90 kg/plot followed by T_2 which recorded 5.57 kg/plot yield. Lowest yield of 3.85 kg/plot was obtained in T_6 (control). Minimum and maximum soft rot disease incidence of 9.11% and 19.57% respectively was recorded in T_1 and T_6 (control) respectively. Lowest leaf spot disease was found in T_6 (11.25 PDI) and highest leaf spot was found in T_2 (15.25 PDI). No shoot borer incidence was found.

GIN/CP/6.9 Management of bacterial wilt of ginger (biofumigation using cabbage)

(Solan, Ambalavayal, Pottangi)

An experiment on management of bacterial wilt of ginger was conducted to access the effect of bio-fumigation using cabbage, soil treatment using bleaching power and rhizome treatment by heat, rhizobacterial antagonist, endophytic bacterial antagonist on control of bacterial wilt disease of ginger. At Dholi all the treatments were found to have significant effect on all the parameters observed and analyzed except germination of rhizome over control. In this trial, the crop was found to be affected with only bacterial wilt incidence caused by *Ralstonia sp.* Highest yield (8.58 t/ha) and plant survival (77.50%) with lowest bacterial wilt incidence (PDI= 22.00) were recorded over control in the treatment (T_5) where ginger rhizome were treated by endophytic bacterial antagonist (IISR-GEB) over control. Second highest yield (6.92 t/ha), plant survival (63.50%) and bacterial wilt incidence (PDI= 36.50) over control were recorded in the treatment (T_2)- soil treatment using bleaching powder @10 g/bed.

Table 34. Effect of different treatments (bio-fumigation using mustard) on bacterial wilt incidence of ginger at Dholi

Treatment	Germination count (%)	Plant survived (%)	Bacterial wilt incidence (PDI)	Rhizome yield (kg/plot)	Rhizome yield (t/ha)
T_1 - Soil treatment by bio-fumigation using mustard	76.00	71.50	28.50 (57.14)	2.35	7.83 (136.55)
T_2 - Soil treatment using bleaching powder @ 10g/bed	67.00	57.50	42.50 (36.09)	1.88	6.25 (88.82)
T_3 - Rhizome treatment by heat	66.00	58.50	41.50 (37.59)	1.65	5.50 (66.16)
T_4 - Rhizome treatment by rhizobacterial antagonist (IISR-GRB)	61.50	59.00	41.00 (38.35)	1.71	5.68 (71.60)
T_5 - Rhizome treatment by endophytic bacterial antagonist (IISR-GEB)	77.50	65.00	35.00 (47.37)	2.00	6.49 (96.07)
T_6 - Absolute control	74.50	33.50	66.50	0.99	3.31
CD (P=0.05)	7.69	8.98	8.98	0.26	0.88
CV (%)	7.25	10.36	14.02	9.76	9.94

TURMERIC

TUR/CI/1 Genetic Resources

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

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

At Coimbatore along with the 271 turmeric germplasm types evaluated during 2008-09, four more collections from farmer's field at Annur and Sathyamangalam were added and all the 275 genotypes were evaluated during 2009-10. The rhizome yield per plot ranged from 1.8 kg to 13.50 kg/plot. The mean yield recorded by the accessions was 6.67 kg/plot. Among the 275 germplam evaluated 266 , 7 and 71 genotypes recorded higher yield than check CL-189 (3.60 kg), CL-1(10.5 kg) and check CL-2 (8.25 kg) respectively. The germplasm of turmeric maintained at various centres are given in Table 35.

Table 35. Turmeric germplasm collections in AICRPS centres

Centre	Indigenous		Total
	Cultivated	Wild and related sp.	
Coimbatore	273	2	275
Dholi	90	2	92
Jagtial	273	-	273
Kumarganj	130	-	130
Pantnagar	16	-	16
Pasighat	45	2	47
Pottangi	199	-	199
Pundibari	152	18	170
Raigarh	42	3	45
Solan	125	-	125
Total	1345	27	1372

Ninety two germplasm of turmeric were collected and evaluated at Dholi and only nine accessions namely, RH-80, RH-14, RH-413, RH-416, RH-9/90, RH-13/90, RH-50, RH-24 and RH-16 gave maximum yield ranging from 35.00 kg to 30.20 kg/7.2 m^2 as compared to high yielding check variety RH-5 (30.00/7.2 m^2) and Rajendra Sonia (28 kg/7.2 m^2). Among the nine promising accessions, RH-80 produced maximum yield 35 kg/7.2 m^2 followed by RH-14, RH-413, RH-416, RH-9/90 and RH-13/90 (32 kg/7.2 m^2).

At Kumarganj, 130 germplasm were screened for yield based on the days taken for maturity. Among the 31 early maturing germplasm, NDH-98 gave maximum

fresh rhizome yield of 421.30 q/ha. Among the 63 medium maturing germplasm screened, NDH-9 gave maximum fresh rhizome yield of 350 q/ha. Highest fresh rhizome yield of 355.40 q/ha was recorded in NDH-14 out of 36 late maturing germplasm screened.

Accession CLI-317 recorded highest rhizome yield (20.66 t/ha) followed by PTS-52 (17.99 t/ha) at Jagtial.

Forty two entries of turmeric were evaluated at Raigarh centre for yield and its attributing characters and among the entries, IT- 8 (15.578 t/ha), IT-9 (15.075 t/ha), IT-7 (12.563 t/ha) and IT-5/ IT-6/ IT-23 (12.060 t/ha) were found significantly superior over the check Prabha (10.05 t/ha) in respect to yield. The yield level ranged from 5.528 t/ha to 15.578 t/ha.

TUR/C1/2. Coordinated Varietal Trial

TUR/C1/2.1 Coordinated Varietal Trial-2004

(Kumarganj, Chintapalle, Jagtial)

In order to evaluate the performance of different cultivars/lines at different locations, a coordinated varietal trial was conducted at Kumarganj center from 2004 to 2009 for a period of five years in R B D in a plot size of 3 x 1 m^2 at a spacing of 30 x 20 cm in three replication. Sixteen entries were tested for their performance of yield and yield attributing character at this center. During the five years of study, among the sixteen entries highest yield of 281.11 q /ha fresh rhizome was recorded in entry IT-2 followed by Prabha (277.77 q/ha) as check variety. In three years of pooled yield data study NDH-9 produced maximum fresh rhizome yield of 298.38 q/ha followed by CL-101 yielding 277.53 q/ha which were on par with check Prabha.

Coordinated Varietal Trial was initiated at Chintapalle during 2004. Out of 13 promising turmeric cultivars tested, IT-3 recorded maximum plant height (144.4 cm) followed by TCP-52 (131.2 cm). PTS-39, IT-2, PTS-34, Chintapalle local were on par with each other in terms of number of tillers. PTS-39 recorded maximum leaf area (605.47 cm^2) followed by Chintapalle local (586.08 cm^2). Maximum yield per plant was obtained in PTS-39 (421.5 g/plant) followed by CL-101 (382.8 g/plant). PTS-39 recorded maximum yield (10.9 kg/bed) followed by TCP-52 and CL-101. TCP-82 and PTS-34 recorded lowest yield (Table 36).

Out of twelve cultures tested at Jagtial, IT-1 has recorded more fresh rhizome yield (23.91 t/ha) followed by PTS-59 (22.78 t/ha) in comparison to Duggirala red check variety (20.74 t/ha) (Table 37).

TUR/C1/2.2 Coordinated Varietal Trial-2009

(Ambalavayal, Chintapalle, Coimbatore, Dholi, Jagtial, Kumarganj, Pottangi, Pundibari, Pasighat, Pantnagar, Raigarh, Navsari)

A new CVT was initiated this year in Ambalavayal, Chintapalle, Coimbatore, Dholi, Jagtial, Kumarganj, Pottangi, Pundibari, Pasighat, Pantnagar, Raigarh and Navsari centres with 10 entries (8+2).

TUR/CI/3.1 Varietal Evaluation Trial

(Jagtial, Kumarganj)

During 2009-10, out of ten cultures tested at Jagtial, JTS-401 recorded more fresh rhizome yield (31.54 t/ha) followed by JTS-403 (31.44 t/ha) in comparison to Duggirala red check variety (27.39 t/ha).

Ten promising lines were evaluated at Kumarganj from 2004 - 2009 for a period of five years in R B D in a plot size of 3 x 1 m^2 at a spacing of 30 x 20 cm in three replication. None of the entries out yielded the yield performance of NDH–18 (360.05 q/ha). An increase in yield of 14.06 q/ha was observed in NDH-18 against check Prabha (312.15 q/ha) followed by an increase in yield of 9.02% in NDH-79.

TUR/CI/3.2 Initial Evaluation Trial 2006

(Kumarganj, Pottangi, Pundibari, Dholi)

Out of nine entries tested at Kumarganj, NDH-79 gave maximum fresh rhizome yield of 325.55 q/ha followed by NDH-7 (316.66 q/ha). Yield of all the entries was lower than NDH-18 (check) except NDH-79. The fresh rhizome yield of 304.44 q/ha was maximum in NDH-68 over Prabha (national check) (306.66 q/ha).

At Pundibari TCP-57 recorded maximum plant height (165.70 cm) followed by TCP-128-1 (152.68 cm). TCP-139 and TCP-64 showed the highest mean value

Table 36. Performance of CVT-2004 turmeric at Chintapalle

Entry	Plant height (cm)	Tillers/ plant	Leaf length (cm)	Leaf area (cm^2)	Leaf width (cm)	Rhizome yield/ plant(g)	Rhizome yield/ plot (kg)	Fresh rhizome yield (t/ha)
CL-147	128.8	2.8	60.0	487.37	15.2	215.2	5.5	18.65
TCP-82	68.6	2.4	38.3	231.28	11.1	184.6	4.8	15.50
PTS-39	129.5	4.2	64.8	605.47	18.4	421.5	10.9	36.37
IT-2	118.0	4.4	58.6	484.72	17.0	361.1	9.3	31.77
CL-101	127.9	3.6	62.6	485.16	16.1	382.8	9.9	33.23
TCP-52	131.2	3.7	61.4	560.28	17.3	259.4	6.7	22.90
IT-3	144.4	3.0	69.5	566.06	17.7	262.2	6.8	21.90
Acc.-360	121.4	3.6	60.7	421.8	15.9	188.6	4.9	17.23
PTS-34	120.2	4.2	56.7	449.82	15.5	182.3	4.7	15.93
Chintapalle Local	129.9	4.3	64.7	586.08	18.1	336.1	8.7	28.97
IT-1	118.9	3.1	59.6	511.29	17.2	281.0	7.3	23.23
TCP-11	118.0	3.6	58.9	571.02	17.5	316.2	8.2	28.13
NDH-9	126.6	2.8	67.3	568.92	17.1	301.5	7.8	25.70
SEm±	2.26	0.2	1.1	-	0.4	6.2	0.1	-
CD (P=0.05)	6.64	0.6	3.2	-	1.3	18.2	0.4	-
CV (%)	3.21	10.9	3.2	-	4.8	3.7	3.7	-

Table 37. Performance of CVT-2004 turmeric at Jagtial

Entry	Plant height (cm)	No. of leaves	No. of tillers	Leaf length (cm)	Leaf width (cm)	Clump weight (kg/plant)	No. of primary fingers	No. of secondary fingers	Length of mother rhizome (cm)	Width of mother rhizome (cm)	Weight of mother rhizome (g)	Fresh rhizome yield kg/3m^2	Fresh rhizome yield (t/ha)
IT-1	65.2	8.45	2.6	27.3	10.2	0.67	2.9	4.3	5.3	4.6	0.27	7.24	23.91
IT-2	66.1	8.26	2.8	23.9	10.5	0.66	3.1	3.8	6.2	5.2	0.15	6.56	21.67
IT-3	71.3	8.48	1.9	24.6	11.6	0.63	3.9	4.1	6.3	4.6	0.18	6.54	21.59
NDH-9	60.6	8.52	2.1	28.8	10.8	0.73	3.3	4.1	5.7	5.5	0.22	6.69	22.01
TCP-56	55.9	8.89	2.4	29.2	10.1	0.88	3.1	3.7	5.7	5.3	0.19	6.78	22.38
TCP-82	53.6	8.80	2.0	22.3	10.1	0.48	3.4	4.0	6.2	5.1	0.19	7.09	23.48
CL-101	64.0	8.30	1.9	24.4	9.9	0.51	3.6	4.3	5.2	5.2	0.19	6.23	20.55
CL-147	73.5	8.08	2.1	26.5	10.2	0.58	3.6	4.0	5.9	4.8	0.19	6.3	20.81
PTS-34	60.6	8.66	2.5	26.1	9.8	0.51	3.4	3.6	6.4	4.8	0.21	6.13	20.25
PTS-59	55.8	8.96	1.9	26.5	10.3	0.57	3.3	3.7	5.1	4.8	0.14	6.90	22.78
TCP-11	55.0	8.68	2.1	30.1	9.8	0.53	3.3	3.6	6.2	5.1	0.20	6.72	22.18
Duggirala Red	53.2	8.18	1.9	30.0	10.6	0.57	3.5	3.7	5.8	4.8	0.25	6.28	20.74
SEm+	2.84	0.04	0.19	1.59	0.249	0.030	0.27	0.27	0.33	0.275	0.011	0.064	0.211
CD (P=0.05)	8.38	0.14	0.569	4.53	0.735	0.089	NS	NS	NS	NS	0.032	0.624	0.624
CV (%)	8.03	10.97	15.18	9.90	4.16	8.54	14.09	11.09	9.77	9.49	9.41	1.674	1.674

for number of tillers/plant (3.33) while TCP-57 recorded the lowest (2.11). In respect to number of leaves/plant, ABN-01 recorded the highest (11.67) and TCP-84 recorded the lowest (9.78). For pseudostem girth, TCP-57 recorded the highest (14.32 cm) while TCP-72 showed the lowest (7.63 cm). In respect of leaf length, TCP-57 recorded the highest length (83.72 cm) and leaf breadth (16.31 cm).

All the genotype and check were found non-significant regarding height of the plant, number of tillers per plant and number of leaves per tiller at Dholi. Among the genotypes and check, RH-7/80 produced significantly higher yield 51.55 t/ha as compared to check and other genotypes. However, RH-17 and Rajendra Sonia was of early maturity type as compared to other genotypes.

TUR/CM/3.4 Genotype x environmental interaction on quality

(Dholi, Chintapalle, Pottangi, Kumarganj, Pundibari, Jagtial, Coimbatore, Mizoram, Barapani, Calicut)

Eleven prominent varieties of different states were tested under the agro-climatic condition of Bihar for obtaining higher yield and good quality of turmeric. Among prominent varieties, Rajendra Sonia produced significantly higher yield as compared to IISR-Alleppy Supreme, IISR-Kedarm, Suranjana (TCP-2), Roma, Pratibha and Narendra Haldi-1. The varieties namely, BSR-2, Rasmi and Megha turmeric were recorded at par with Rajendra Sonia. However, Rajendra Sonia gave highest yield of 55.28 t/ha followed by BSR-2 (48.33 t/ha). Rajendra Sonia was an early maturing type (228 days) as compared to other varieties.

Among the 11 varieties evaluated at Chintapalle, Rasmi recorded maximum plant height (125.3 cm) followed by IISR Pratibha (121.8 cm) and IISR Alleppy Supreme (120.4 cm). Maximum number of tillers was observed in case of Roma and Rajendra Sonia (4). Highest yield was recorded in Roma (36.23 t/ha) followed by Mega Turmeric (35.75 t/ha) where as lowest yields were recorded in case of Suranjana (14.2 t/ha).

At Kumarganj, maximum yield was recorded in variety BSR-2 (285.55 q/ha) followed by 274.44 q/ha in Rajendra Sonia while lowest yield was recorded in CLI-317 (201.11 q/ha).

Growth and yield parameters of eleven varieties were recorded at Pundibari. Megha Turmeric (135.17 cm) recorded highest plant height followed by Rasmi

(117.89 cm). Duggirala Red was the shortest (88.49 cm). Highest tiller number was recorded by the genotype IISR Pratibha (3.20) where as lowest by Rasmi (2.20). BSR-2 and TCP-2 showed the highest number of leaves (11.13). TCP-2 showed the highest clump weight (373.20 g) followed by IISR Kedaram (354.70 g). Highest rhizome yield per plot was recorded in Narendra Haldi-1 (13 kg) followed by TCP-2 (12 kg) and the lowest value was recorded by Duggirala Red (6 kg).

Among the eleven genotypes tested at Jagtial, Suranjana recorded the highest fresh rhizome yield (24.75 t/ha) followed by CLI-317 (24.09 t/ha), Roma and NH-1 and lowest yield was observed in Prathibha (20.6 t/ha).

At Coimbatore, significant variation was observed among the genotypes for growth and yield characters. The rhizome yield of genotypes varied from 194.04 g/ plant (Suranjana) to 329.32 g/plant (Roma). The highest yield per ha was recorded by Roma (47.79 t/ha) followed by Rajendra Sonia (46.65 t/ha), Megha turmeric (42.99 t/ ha) and BSR 2 (42.85 t/ha) (Table 38).

Highest yield was recorded for Duggirala (564 q/ha) which was at par with IISR Pratibha (512 q/ha), Roma (495 q/ha) and RCT-1 (490 q/ha) at Mizoram. Moreover dry matter content was found to be highest in Rashmi (23.7%) followed by Roma (22.9%), IISR Alleppy Supreme (22.0%), IISR Pratibha (21.9%), IISR Kedaram (21.9%) and RCT-1 (21.6%) (Table 39). Only two cultivars, *i.e.* Narendra Haldi-1 and Rajendra Sonia showed field level tolerance to leaf spot (*Colletotrichum curcuma* and *C. capsici*). However leaf blotch (*Taphrina maculans*) incidence was recorded in four genotypes namely, Suranjana, Narendra Haldi-1, BSR-2 and Rajendra Sonia.

At Barapani, Roma produced the heaviest rhizomes per plant (677.78 g/plant). Maximum yield was recorded in Narendra Haldi (30.88 t/ha) followed by Rajendra Sonia (27.55 t/ha). Dry matter recovery was highest in Pratibha (23.3%) followed by Rasmi and Kedaram (22.7% each) while lowest recovery (14.5%) was in Rajendra Sonia. Highest curcumin content was recorded in Megha Turmeric-1 (7.73%) while BSR-2 had lowest curcumin (3.65%).

Experiment was conducted under rainfed condition. Among the turmeric varieties tested at Calicut, Rajendra Sonia recorded the highest fresh yield (19.8 kg/3m^2 bed) followed by Suranjana TCP (19 kg) and Narendra Haldi-1(17.0 kg). The dry recovery (%) was maximum in Roma (22.2%), followed by Duggirala Red (22.0%) and Mega Turmeric-1 (20.2%). The dry yield per bed was higher in Duggirala Red (2.92 kg), followed by Suranjana TCP (2.79 kg) and Rajendra Sonia (2.57 kg).

Table 38. Genotype x environment interaction on quality of turmeric at Coimbatore

Genotype	Plant height (cm)	Tillers	Weight (g)			Yield /plant (g)	Yield (t/ha)
			Mother rhizome	Primary rhizome	Secondary rhizome		
IISR Alleppy Supreme	87.83	4.13	128.72	98.89	35.00	262.61	38.07
IISR Kedaram	91.88	3.53	107.24	127.18	33.89	268.31	38.90
IISR Prathiba	83.43	3.33	111.22	128.67	33.89	273.78	39.69
BSR- 2	70.11	3.80	83.33	157.23	55.00	295.56	42.85
Suranjana	78.05	3.40	48.94	94.54	50.56	194.04	28.13
Rajendra Sonia	60.62	3.27	102.86	191.11	27.78	321.75	46.65
Roma	93.39	4.60	70.00	200.42	58.89	329.31	47.74
Rasmi	73.09	4.47	63.89	96.42	90.56	250.87	36.37
Duggirala	82.55	3.27	84.31	140.00	56.67	280.98	40.74
Narendra Haldi	74.69	4.47	74.28	100.00	37.78	212.06	30.74
Megha turmeric	80.99	3.47	110.56	130.39	55.56	296.51	42.99
SED	4.99	0.23	5.89	8.90	3.14	17.42	2.52
CD (P= 0.05)	10.41	0.49	12.30	18.58	6.55	36.34	5.27

Table 39. Genotype x environment interaction on turmeric at Mizoram

Variety	Plant height (cm)	Leaf length (cm)	Leaf width (cm)	Plant thickness (mm)	Leaf area (cm^2)	Tillers/ plant	Rhizome wt (kg/ plant)	Dry matter (%)	Yield (q/ha)	Maturity (days)	Reaction to leaf spot	Reaction to leaf blotch
RCT-1	135.4	62.6	16.2	24.6	758	4.99	0.589	21.6*	490*	230	S	T
Suranjana	90.1	43.0	11.6	18.7	380	3.95	0.457	16.1	381	209	S	S
Narendra Haldi-1	106.0	47.4	11.5	18.1	410	4.24	0.362	10.7	302	206	T	S
IISR Alleppy Supreme	151.0	66.7	15.8	24.7	792	5.81	0.449	22.0*	374	227	S	T
IISR Kedaram	127.4	57.4	14.5	22.9	631	5.91	0.465	21.9*	388	229	S	T
IISR Pratibha	140.7	62.8	15.4	24.4	726	5.58	0.614	21.9*	512*	225	S	T
Duggirala	125.2	57.4	14.8	26.4	638	4.63	0.677	20.9*	564*	227	S	T
BSR-2	128.9	58.2	14.3	20.9	626	4.68	0.415	20.6	346	210	S	S
Rajendra Sonia	118.9	49.0	12.6	20.2	465	4.09	0.457	12.5	381	203	T	S
Roma	146.0	66.0	15.5	24.9	781	5.04	0.595	22.9*	495*	229	S	T
Rashmi	137.3	62.3	14.7	27.8	689	5.01	0.400	23.7*	333	228	S	T
Mean	127.9	57.5	14.3	23.0	627	4.90	0.498	19.5	415	220	-	-
SEm±	6.4	2.4	0.5	1.2	42	0.51	0.033	0.6	28	3	-	-
CD (P=0.05)	19.0	6.9	1.6	3.5	125	1.49	0.099	1.9	82	9	-	-

TUR/CI/4 Quality Evaluation Trial

TUR/CI/4.1 Quality evaluation of germplasm

(Coimbatore)

Screening of 26 turmeric germplasm lines at Coimbatore during 2009-2010 for rhizome yield and quality revealed that the rhizome yield varied from 2.23 kg/plot (CL-130) to 21.07 kg/plot (CL-56). The evaluation for quality parameters is in progress.

TUR/CM/5 Nutrient Management Trial

TUR/CM/5.2 Effect of organic farming in turmeric (Final Report)

(Dholi, Kumarganj)

Three treatments *i.e.*, fully organic (T_1), integrated fertilizer management of organic and inorganic (T_2) and fully inorganic (T_3) were tested for obtaining higher yield during 2009-10 at Dholi. Among the treatments, fully organic (T_1) and integrated fertilizer management of organic and inorganic (T_2) gave significantly better performance for all characters except height of the plant and number of tiller per plant as compared to fully inorganic (T_3). However, integrated fertilizer management (FYM-20 t/ha + ½ N, P,K + P-solublising bacteria, *P. fluorescens* and *T. harzianum* as seed treatment and soil application (50 g/3m^2)) resulted in maximum plant height (109.14 cm), number of leaves (9.85), and yield per plot or yield per hectare (13.14 kg/3m^2 or 43.81 t/ha) followed by fully organic (best organic nutrient combination (FYM, pongamia oil cake, rock phosphate, sterameal, wood ash, neem oil cake) + *Azospirillum*, P-solubilizers, *P. fluorescens* and *T. harzianum* as seed treatment and soil application) (Table 40).

Integrated approach of using 100, and 50% of recommended dose of fertilizers (100:80:80 NPK kg/ha) along with use of FYM (20 and 10 t/ha) and seed and soil application of *P. florescens* and *Trichoderma* 50 g/m^2 and *Azospirillum* (5 kg/ha) was used to study the effect on yield and NPK requirement of turmeric at Kumarganj for a period of three years (2006 - 2009) in RBD in a plot size of 3 x 1 m^2 at a spacing of 30 x 20 cm in three replication. An increase in 5.08% in yield of fresh rhizomes was observed by application of 100% FYM (20 t/ha) + *Azospirillum* (5 kg/ha) + seed treatment and soil application of *P. florescens* and *Trichoderma* (50 g/3 m^2).

Table 40. Response of organic nutrient on turmeric at Dholi

Treatment	Plant height (cm)	Tillers/plant	Leaves/tiller (kg/3 m²)	Yield/plot	Yield (t/ha)
T_1-Organic	101.17	4.14	9.66	11.79	39.28
T_2-Integrated	109.14	4.46	9.85	13.14	43.81
T_3-Inorganic	96.23	4.17	9.20	10.43	34.76
SEm±	2.42	0.26	0.15	0.41	1.35
CD (P=0.05)	7.46	NS	0.45	1.25	4.18
CV (%)	6.27	16.42	4.07	9.13	9.13

TUR/CM/5.1 Organic farming in turmeric (Final report)

(Dholi)

Experiment was conducted for three consecutive years (2007-08 to 2009-10) at Dholi, in randomized block design with seven replication. Turmeric variety, Rajendra Sonia was planted in a plot of size 3 X 1 m² at a spacing of 30 cm X 20 cm. Pooled mean of analyzed data (Table 41) showed that inorganic fertilizer management of organic and inorganic (T_2) *i.e.*, 20 t/ha FYM + ½ N,P,K, + P-solubizing bacteria, *P. fluorescens* and *Trichoderma* as seed treatment and soil application (50 g/3 m²) increased significantly height of the plant (121.18 cm) and number leaves (10.28) as compared to fully inorganic *i.e.*, recommended dose of N:P:K (150:60:120 kg/ha). Integrated fertilizer management *i.e.*, combination of organic and inorganic (T_2) and fully organic (T_1) *i.e.* best organic nutrients combination + *Azospirillum*, P-solobilizing bacteria, *P. fluorescens* and *Trichoderma* as seed treatment and soil application (50 g/3 m²) gave significantly higher yield (54.93 and 50.30 t/ha) as compared to fully inorganic (T3) treatment. However, integrated fertilizer management *i.e.*,

Table 41. Response of organic farming on turmeric at Dholi (Pooled analysis 2007-08 to 2009-10)

Treatment	Plant height (cm)	Tiller/ plant	Leaves/ tiller	Yield / plot (kg/3m²)	Yield (t/ha)	Gross income (Rs.)	Cost of cultivation (Rs.)	Net profit (Rs.)	Cost : benefit ratio
T_1- Organic	111.88	4.64	9.38	15.09	50.30	5,03,000	2,73,000	2,30,000	1:1.84
T_2-Integrate	121.18	4.86	10.28	16.48	54.93	5,49,300	1,22,897	4,26,403	1:4.46
T_3- Inorganic	99.55	4.08	8.25	12.90	43.00	4,30,000	1,13,132	3,16,868	1:380
SEm(±)	3.77	0.17	0.35	0.43	1.45	Selling rate :- Rs.1,000/- quintal			
CD(P=0.05)	14.80	NS	1.37	1.71	5.71	Cost of cultivation			
CV (%)	5.89	6.59	6.52	5.10	5.10	Seed cost @2500/quintal – 35 quintal; FYM – Rs.40/quintal			

A Pongamia oil cake – Rs.2,000/quintal
Neem oil cake – Rs.1,000/quintal
Sterameal – Rs.3,000/quintal
Rock phoshphate – Rs.3,000/quintal
Wood ash – Rs.500/quintal
BM - Rs.500/quintal
Azospirillum – Rs.300/kg
P-Solubilizing bacteria – Rs.400/kg
Pseudomonas fluorescens – Rs.300/kg
Trichorderma – Rs.300/kg

B Urea – Rs.276/50kg bag
S.S.P. – Rs.300/50kg bag
MOP – Rs.450/50kg bag
Fungicide – Rs.300/kg
Insecticide – Rs.300/lit.

combination of organic and inorganic (T_3) gave maximum yield (54.93 t/ha) followed by fully organic (50.30 t/ha). Integrated fertilizer management (T_3) gave more return (1:4.46) followed by fully inorganic (1:3.80).

Fourteen treatments including absolute control were tested for obtaining higher yield in turmeric during 2009-10. Turmeric variety Rajendra Sonia was planted in the plot size of 3.0 m X 1.0 m with a spacing of 30 cm X 20 cm at Dholi. All the treatment gave significantly more yield as compared to absolute control. Among the treatments, soil application of FYM-30 t/ha + 20 q/ha vermicompost + neem oil cake produced maximum plant height (101.53 cm), number of tillers per plant (4.80) and yield per plot (10.67 kg/3m^2) or per hectare (35.57 t/ha) as compared to other treatments and absolute control. However, soil application of FYM-30 t/ha + 20 q/ha vermicompost + 8 q/ha neem oil cake increased the yield (20.02 t/ha) 128.74% over control. The pooled analyzed data (Table 42) showed that all the treatment of organic fertilizers gave significant response as compared to absolute control regarding height of the plant and number of leaves per tiller. However, application of organic nutrients i.e., FYM – 10 t/ha + 10 q/ha vermicompost + 8 q/ha neem oil cake (T_3) was not found significantly superior over control (T_{14}) regarding number of tillers per plant and yield per plot or per hectare. Application of organic nutrients like FYM - 30 t/ha; 20 q/ha vermicompost + 8 q/ha neem oil cake (T_5) was found at par with application of organic nutrients *i.e.*, FYM – 30 t/ha + 15 q/ha vermicompost + 8 q/ha neem oil cake (T_8) regarding height of the plant, number of leaves per tillers and yield per plot or per hectare. However, application of organic nutrients *i.e.*, FYM – 30 t/ha + 20 q/ha vermicompost + 8 q/ha neem

Table 42. Response of organic farming on turmeric (Pooled analysis data from 2007-08 to 2009-10) at Dholi

Treatment	Plant height (cm)	Tiller/ plant	Leaves/ tiller	Yield/ plot (kg/3m^2)	Yield (t/ha)	Increase in yield over check t/ha	Increase in yield over check %	Gross income (Rs.)	Cost of cultivation (Rs.)	Net profit (Rs.)	Cost : benefit ratio
T_1	94.09	3.42	12.04	10.46	34.88	5.81	19.98	3,48,800	1,14,000	2,34,800	1:3.05
T_2	93.48	3.29	11.86	9.74	32.48	3.41	11.73	3,24,800	1,14,000	2,10,800	1:2.85
T_3	98.57	3.53	11.93	10.54	35.15	6.08	20.91	3,51,500	1,22,000	2,29,500	1:2.88
T_4	100.37	3.53	11.79	10.24	34.14	5.07	17.44	3,41,400	1,22,000	2,19,400	1:2.80
T_5	118.06	5.22	135.53	14.64	48.82	19.75	67.94	4,88,200	1,34,00	3,54,200	1:3.64
T_6	110.95	4.36	12.84	12.68	42.26	13.19	45.37	4,22,600	1,30,000	2,92,600	1:3.25
T_7	101.89	3.82	12.17	10.96	36.55	7.48	25.73	3,65,500	1,26,000	2,39,500	1:2.90
T_8	112.35	4.77	13.09	13.52	45.07	16.00	55.03	4,50,700	1,31,000	3,19,700	1:3.44
T_9	106.44	3.84	12.55	11.74	39.14	10.07	34.64	3,91,400	1,27,000	2,64,400	1:3.08
T_{10}	103.62	3.84	12.13	10.70	35.66	6.59	22.66	3,56,600	1,23,000	2,33,600	1:2.90
T_{11}	108.55	4.33	12.80	12.30	41.00	11.93	41.03	4,10,000	1,28,000	2,82,000	1:3.20
T_{12}	106.31	3.91	12.42	10.97	36.59	7.52	25.86	3,65,900	1,24,000	2,41,900	1:2.95
T_{13}	100.82	3.40	11.97	9.87	32.92	3.85	13.24	3,29,200	1,20,000	2,09,200	1:2.74
T_{14}	89.91	3.29	11.44	8.72	29.07	-	-	2,90,700	1,02,000	1,88,700	1:2.85
SEm ±	1.88	0.21	0.15	0.42	1.41	-	-	-	-	-	-
CD(P=0.05)	5.48	0.61	0.44	1.23	4.12	-	-	-	-	-	-
CV (%)	3.16	9.38	2.15	6.56	6.57	-	-	-	-	-	-

Note :A. Selling rate :- Rs.1,000/ quintal B. Cost of organic manure vermicompost @600/quintal, Neem oil cake @1000/quintal, FYM @40/ quintal, Seed cost @1200/quintal, General cultivation cost @60,000/hectare

T_1: FYM – 30 t/ha alone; T_2:Vermicompost 20 q/ha alone; T_3: FYM - 30 t/ha + 8 q/ha neem oil cake; T_4: Vermicompost - 20 q/ha + 8 q/ha neem oil cake; T_5: FYM - 30 t/ha + 20 q/ha vermicompost + 8 q/ha neem oil cake; T_6: FYM - 20 t/ha + 20 q/ha vermicompost + 8 q/ha neem oil cake; T_7: FYM - 10 t/ha + 20 q/ha vermicompost + 8 q/ha neem oil cake; T_8: FYM – 30 t/ha + 15 q/ha Vermicompost + 8 q/ha neem oil cake; T_9: FYM - 20 t/ha + 15 q/ha vermicompost + 8 q/ha neem oil cake; T_{10}: FYM - 10 t/ha + 15 q/ha vermicompost + 8 q/ha neem oil cake; T_{11}: FYM - 30 t/ha vermicompost + 8 q/ha neem oil cake; T_{12}: FYM – 20 t/ha + 10 q/ha vermicompost + 8 q/ha neem oil cake; T_{13}: FYM-10 t/ha + 10 q/ha vermicompost + 8 q/ha neem oil cake; T_{14}: Absolute control.

oil cake (T_5) was recorded at par with application of organic nutrients *i.e.*, FYM – 20 t/ha vermicompost + 8 q/ha neem oil cake (T_6), FYM – 10 t/ha + 20 q/ha vermicompost + 8 q/ha neem oil cake (T_7), FYM – 30 t/ha + 15 q/ha vermicompost + 8 q/ha neem oil cake (T_7), FYM – 30 t/ha + 15 q/ha vermicompost + 8 q/ha neem oil cake (T_8), FYM – 20 t/ha + 15 q/ha vermicompost + 8 q/ha neem oil cake (T_9) and FYM – 10 t/ha + 15 q/ha vermicompost + 8 q/ha neem oil cake (T_{10}) regarding number of tillers per plant. Among the application of organic nutrients, application of FYM – 30 t/ha + 20 q/ha vermicompost + 8 q/ha neem oil cake (T_5) gave the maximum height of the plant (118.06 cm), number of tiller per plant (5.22), number of leaves (13.53) and yield per plot (14.64 kg/3 m^2) or per hectare (48.82 t/ha) followed by application of FYM – 30 t/ha + 15 q/ha vermicompost + 8 q/ha neem oil cake (T_8) regarding height of the plant (112.35 cm), number of tillers per plant (4.77), number of leaves (13.09) and yield per plot (13.52 kg/3 m^2) or per hectare (45.07 t/ha). Application of organic nutrients FYM – 30 t/ha + 20 q/ha vermicompost + 8 q/ha neem oil cake (T_5) gave more return of Rs. 3.64 per unit cost (1:3.64) followed by application of FYM – 30 t/ha + 15 q/ha vermicompost + 8 q/ha neem oil cake (T8) *i.e.*, Rs. 3.44 per unit cost (1:3.44).

TUR/CM/5.1 Effect of bio-fertilizer *Azospirillum* on turmeric (Adoptive trial) (Final report)

(Dholi)

The experiment was conducted at Dholi during year 2007-08 to 2009-10 in randomized block design with eight treatments and four replications with a plot size 3.0 m X 1.0 m at spacing of 30 cm x 20 cm. with variety Rajendra Sonia. The pooled analysed data is presented in Table 43. Regarding yield per plot or per hectare, all the treatments gave significantly more yield over control and T_4 (FYM - 5 t/ha + *Azospirillum*) T_5 (FYM-5 t/ha alone). Among the treatments of bio-fertilizer, inorganic N (100%) + *Azospirillum* + 5 t/ha FYM gave maximum plant height (119.38 cm), number of tiller per plant (6.11), number of leaves per tiller (12.76) and yield per plot (16.98 kg/ha 3 m^2) or per hectare (56.61 t/ha) followed by application of inorganic N (75%) + *Azospirillum* + 5 t/ha FYM regarding height of the plant (117.21 cm), number of tillers per plant (5.33), number of leaves per tiller (12.46) and yield per plot (15.59 kg/3 m^2) or per hectare (51.97 t/ha). Application of inorganic N (100%) + *Azospirllum* + 5 t/ha FYM (T_1) gave the maximum return of Rs. 5.27 per unit cost (1:5.27) followed by application of inorganic N (75%) + *Azospirllum* + 5 t/ha FYM (T_2) *i.e.*, Rs. 4.86 per unit cost (1:4.86).

Table 43. Effect of biofertilizer *Azospirillum* on turmeric (Pooled analyzed data from 2007-08 to 2009-10) at Dholi

Treatment	Plant height (cm)	Tiller/ plant	Leaves/ tiller	Yield/ plot (kg/3m²)	Yield (t/ha)	Increase in yield over check t/ha	Increase in yield over check %	Gross income (Rs.)	Cost of cultivation (Rs.)	Net profit (Rs.)	Cost : benefit ratio
T_1	119.38	6.11	12.76	16.98	56.61	14.61	34.78	5,66,100	1,07,294	4,58,806	1:5.27
T_2	117.21	5.33	12.46	15.59	51.97	9.97	23.73	5,19,700	1,06,846	4,12,854	1:4.86
T_3	115.08	4.70	12.18	15.11	50.38	8.38	19.95	5,03,800	1,06,375	3,97,425	1:4.73
T_4	109.51	3.91	11.87	13.42	44.74	2.74	6.52	4,47,400	1,05,500	3,41,900	1:4.24
T_5	103.51	3.70	11.53	13.73	45.72	3.72	8.85	4,57,200	1,04,000	3,53,200	1:4.40
T_6	112.00	4.83	12.16	15.03	50.11	8.11	19.30	5,01,100	1,07,500	3,93,600	1:4.66
T_7	108.78	4.25	11.86	14.79	49.31	7.31	17.40	4,93,100	1,06,000	3,87,100	1:4.65
T_8	103.93	3.90	11.66	12.60	42.00	-	-	4,20,000	1,02,000	3,18,000	1:4.11
SEm±	1.63	0.19	0.12	0.42	1.42						
CD(P=0.05)	4.95	0.59	0.38	1.29	4.32						
CV (%)	2.54	7.42	1.80	5.03	5.06						

Note : A. Selling rate; Rs.1,000/- per quintal, B. Cost of fertilizer:Urea – Rs.276/50kg bag, *Azospirillum* – 300/kg, FYM – 40/quintal, Seed cost – @1200/quintal (35quintal Rs.42,000/ha), General cost – 60,000/ha

T_1: Inorganic N (100%) + *Azospirillum* + 5 t/ha FYM; T_2: Inorganic N (75%) + *Azospirillum* + 5 t/ha FYM; T_3: Inorganic N (50%) + *Azospirillum* + 5 t/ha FYM; T_4: 5t/ha FYM + *Azospirillum*; T_5: 5 t/ha FYM alone; T_6: 10 t/ha FYM + *Azospirillum*; T_7: 10 t/ha FYM alone; T_8: Control.

TUR/CM/5.3 Standardization of fertigation in turmeric

(Coimbatore, Jagtial)

Turmeric, being a crop with high water requirement, assured water supply is essential throughout its growth period of 9-10 months. Drip irrigation has emerged as one of the innovative approaches to precisely meet the water requirement of many crops. Fertigation through drip irrigation was found to improve the yield and quality of many horticultural crops. With this view, the present study was taken up in turmeric at Coimbatore and Jagtial. At Coimbatore, significant variation was observed between the treatments for growth and yield parameters. The plot yield of turmeric rhizome varied from 20.46 kg/plot (T_6-50% RDF (NPK@75:30:54kg/ha through drip - weekly once) to 39.34 kg/plot (T_3-100% RDF through drip- fortnightly once). The plot yield of turmeric rhizome in the control (100% recommended dose of fertilizers (RDF) (NPK @ 150:60:108kg/ha) through conventional method of application - no drip) is 29.00 kg/plot.

Among all the treatments tested application of 75% recommended dose of fertilizer(RDF) through drip-fortnightly once recorded highest rhizome yield (27.2 t/ha) followed by application of 100% RDF through drip- weekly once (26.80 t/ha) where as 50% RDF through drip- fortnightly once recorded lowest rhizome yield (23.5 t/ha) at Jagtial (Table 44).

TUR/CM/6 Processing & Harvesting

TUR/CM/6.1 Standardization of processing in turmeric

(Calicut, Coimbatore)

In turmeric fresh rhizomes are cured and processed to get the dried commercial product. In the traditional method of curing, fresh rhizomes are boiled in water just enough to immerse them. Copper/galvanized iron/earthen vessels are used for this purpose. The stage at which boiling is stopped largely influences color and aroma of the final product. Over cooking spoils color of the final product while under cooking renders dried product brittle. To avoid the above circumstances, improved method of curing and processing with the use of turmeric boiler (TNAU model) was adopted in the present study.

The trial was initiated with eight treatments with the variety BSR-2 at Coimbatore. In all the eight treatments the initial weight of the sample taken for the experiment was 2 kg at Coimbatore centre. The final weight was recorded after curing and drying. The final weight of the rhizome varied from 350 g to 475 g among the treatments. The final weight (475 g) of the

Table 44. Standardization of fertigation in turmeric at Jagtial

Treatment	Plant population at 30 DAP	Leaves at 150 DAP	Tillers	Leaf area (cm)	Plant height (cm)	Plant population at harvest (4 m x 3m²)	Fresh weight of rhizome (kg/3m²)	Fresh weight of rhizomes (t/ha)
Control-no drip	240.0	9.0	2.0	125.27	63.8	236.0	7.50	24.77
100% RDF through drip-weekly once	253.7	8.9	2.3	142.4	69.3	242.3	8.13	26.80
100% RDF through drip-fortnightly once	249.0	9.2	2.1	140.7	65.6	240.0	7.93	26.16
75% RDF through drip-weekly once	249.7	7.2	1.9	138.5	62.4	237.6	8.07	26.60
75% RDF through drip-fortnightly once	250.0	7.3	1.9	138.7	59.8	234.0	8.27	27.20
50% RDF through drip-weekly once	243.3	6.6	2.1	137.0	60.5	239.3	7.60	25.08
50% RDF through drip-fortnightly once	242.7	6.6	1.6	132.6	58.1	237.0	7.13	23.50
SEm+	2.8	0.5	0.1	2.4	1.7	0.1	0.13	
CD (P=0.05)	8.7	1.5	NS	7.6	5.4	0.4	1.40	
CV (%)	1.9	11.1	13.8	3.1	4.8	2.8	2.89	

rhizome was maximum in the treatment T_5 (improved processing for 20 minutes and drying (using TNAU model)). The percentage of dry rhizome recovery varied from 17.50% to 23.75% the highest dry rhizome recovery percentage was noticed in T_5 treatment. The time taken for drying varied from 147 h to 175 h between the treatments. More time (175 h) was taken by the treatment T_2 (traditional processing of rhizome boiling for 60 min and drying).

Variety Prathiba was used at Calicut and curing of turmeric was done between 9 AM to 3 PM. Initial moisture content of turmeric rhizomes were 78.89 per cent and dried to 10 percent after various initial pre-treatment like cooking of rhizomes in water, steam boiling of rhizomes by improved steam boiling, slicing and dipping in boiling water for 10 min. The cooked rhizomes were dried and it was found that rhizomes steamed for 60 min. took 12 days for drying and rhizomes cooked in boiling water for 40, 60, 90 min dried in 11 days. The rhizomes steamed for 30 min took longest time for drying *i.e.* 24 days. The sliced rhizomes dried in 9½ days. Rhizomes dipped in boiling water and dried took 13 days.

TUR/CM/6.2 Mechanical harvesting in turmeric (Observational trial)

(Coimbatore)

Harvesting of turmeric is labour intensive, requiring skilled labour to dig out the underground rhizome. The non-availability of skilled labour and the high wages demanded by them to harvest the crop, the higher field losses and damage to the crop by manual harvesting, necessitate the need to develop a suitable mechanical harvester for turmeric. Tamil Nadu Agricultural University has developed a tractor mounted and power tiller mounted mechanical harvester for turmeric. The main objective of this study is to know the efficiency of both the harvesters in comparison with the manual harvest on harvesting of turmeric rhizome.

The population maintained in T_1 (tractor mounted TNAU model harvester - width of each bed 120 cm; length of each bed 20m; space between two beds 30 cm) and T_3 (manual harvesting I: width of each bed 120cm; length of each bed 20m; space between two beds 30cm) is 480 plants and in T_2 (power tiller mounted TNAU model harvester – (width of each bed 75cm; length of each bed 20m; space between two beds 25cm) and T_4 (manual harvesting II: width of each bed 75cm; length of each bed 20m; space between two beds 25cm) were 300 plants. The time taken by the tractor mounted harvester is less when compared to power tiller mounted harvester. The percentage of damaged rhizome is also minimum (1.7%) in tractor mounted harvester. The cost for operating the tractor mounted harvester is also low in comparison with power tiller mounted harvester and manual harvesting.

TUR/CP/7 Disease Management Trial

TUR/CP/7.2 Survey and identification of disease causing organisms in turmeric and screening of turmeric germplasm against diseases

(Coimbatore, Pundibari, Raigarh, Dholi)

A field survey on incidence of major diseases of turmeric was conducted in turmeric growing areas of Coimbatore district during the year 2009-10 (Table 45). Totally 10 places of turmeric growing areas were surveyed. In all places of survey leaf spot, leaf blotch and rhizome rot were noticed. The maximum leaf spot

Table 45. Survey on turmeric diseases in different districts of Tamil Nadu

Disease	Coimbatore		Erode		Karur		Namakkal		Salem		Thirupur	
	Places surveyed	PDI	Places surveyed	PDI	Places surveyed	PDI	Places surveyed	PDI	Places surveyed	PDI	Places surveyed	PDI
Leaf spot (PDI)	10	26.0 to 42.0	15	10.0 to 32.0	5	12.0 to 32.0	5	12.0 to 20.0	16	12.0 to 32.0	10	8.0 to 28.0
Leaf blotch (PDI)	10	10.0 to 20.0	15	8.0 to 12.0	5	10.0 to 14.0	5	8.0 to 12.0	16	8.0 to 12.0	10	10.0 to 20.0
Rhizome rot (%)	10	8.0 to 10.0	15	8.0 to 12.0	5	8.0 to 12.0	5	8.0 to 12.0	16	4.0 to 12.0	10	8.0 to 12.0

disease intensity was noticed at Thondamuthur and Sennanur (42.0 PDI) and the minimum intensity of the disease was noticed at Narasipuram (26.0 PDI). In the case of leaf blotch, the maximum disease intensity of 20 PDI was noticed at Mathampatty and the minimum intensity of 10 PDI was at Boluvampatty. Rhizome rot disease incidence ranged from 8.0-10% in all areas surveyed.

In Erode district, survey was conducted in 15 places. The minimum leaf spot disease intensity was noticed at Lakampatty (10 PDI) and the maximum at Kadathur (32 PDI). In the case leaf blotch disease, the minimum intensity of 8 PDI was noticed at Kadathur and Lakampatty and the maximum at Kavundapadi (12 PDI). Rhizome rot incidence ranged from 8% to 12%. In Tirupur district, a total of 10 places were surveyed for the disease occurrence. The minimum intensity of leaf spot disease was noticed at Unity Nagar (8 PDI) and the maximum was noticed at Kunnathur (28 PDI). In the case of leaf blotch disease minimum intensity of 10 PDI was noticed at Unity Nagar and the maximum was noticed at Thekkalur (20 PDI). The rhizome rot disease incidence ranged from 8-12%. In Salem district, 16 places were surveyed. The minimum leaf spot disease intensity was noticed at Kothampadi (12 PDI) and the maximum of 32 PDI was noticed at Karipatty (Aathur). The leaf blotch disease intensity ranged from 8 – 12 PDI and the rhizome rot disease incidence ranged from 4% to 12%. In Namakkal district, the minimum disease intensity of leaf spot (12 PDI) was noticed at Pallipalayam and maximum was noticed at Attayampalayam (20 PDI). The leaf blotch disease intensity ranged from 8 - 12 PDI and the rhizome rot disease incidence ranged from 8% to 12%. In Karur district 5 places were surveyed. The minimum leaf spot disease intensity was noticed at Vengamedu (12 PDI) and the maximum was noticed at Velayuthampalayam (32 PDI). The leaf blotch disease intensity ranged from 10-14 PDI and the rhizome rot incidence ranged from 8 to 12%.

Highest incidence of leaf spot was observed in Coimbatore district (42 PDI) while the lowest incidence was noticed in Erode district (10 PDI). A similar trend of the highest leaf blotch disease incidence (20 PDI) was observed in Coimbatore district while the least incidence was noticed in Salem, Namakkal, Erode districts (8 PDI). The rhizome rot incidence varied from 4-12% in Coimbatore district. The leaf incidence was noticed in Erode and Salem districts.

In general, the leaf spot intensity was minimum in turmeric grown as pure crop when compared to mixed crop with chillies and other crops in all districts.

Germplasm screening

275 turmeric germplasm entries were screened against major diseases *viz.*, leaf spot, leaf blotch and rhizome rot disease during the year 2009-10 at Coimbatore. Leaf spot and leaf blotch disease intensity was noticed in all germplasm entries while the rhizome rot was found to be absent. The leaf spot disease intensity ranged from 16 PDI-64 PDI. The accessions *viz.*, CL-32, Cl- 1, 16, 25, 32, 33, 53, 54, 101, 231 recorded the least intensity of leaf spot disease (16 PDI). The other accessories *viz.*, CL- 34, 55, 125, 216, 233 recorded minimum intensity of 18 PDI. In the case of leaf blotch, the accessions *viz.*, CL 34, 54, 66 recorded minimum intensity of 10 PDI whereas the other accessions *viz.*, Cl-2, 15, 27, 28, 30, 31, 33, 36, 45, 60, 67, 68, 79, 82, 84, 123, 132, 136, 137, 152, 216, 228, 245, 246, 270 and 271 recorded minimum intensity of 12 PDI. In the other accessions, the leaf blotch intensity ranged from 14-30 PDI.

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.). Most of the area is covered with local varieties which are highly susceptible to leaf blotch disease and some of the area is highly susceptible to leaf spot disease too. In the survey it was found that leaf blotch disease severity was highest in Coochbehar I block (average 35.27%) followed by Coochbehar II block (average 34%) and Dinhata (average 32.67%). Regarding leaf spot of turmeric it was found that disease severity is highest in Coochbehar II block (average 34.75%) which is followed by Coochbehar I block (average 33.6%) and Dinhata (average 31.56%). Screening of the collected germplasm was done against both leaf blotch and leaf spot diseases of turmeric. The germplasm found to be resistant (PDI ranging from 1–10) against leaf blotch disease are TCP- 2, 3, 7, 12, 14, 62,117, 130, 140, 153. and moderately resistant germplasm (PDI ranging from 11 – 20) are TCP 50, 63, 78, 88, 90, 101, 124, 139. The germplasm found to be resistant (PDI ranging from 1 – 10) against leaf spot disease are TCP 3, 40, 115, 186 and 206 whereas moderately resistant germplasm (PDI ranging from 11 – 20) against this disease are TCP 2, 7, 14, 28, 71, 74, 90, 95, 121, 177.

At Raigarh, TCP-11 was found resistant to both the diseases. TCP -56 and TCP-82 was resistant to *Colletotrichum* leaf spot and *Taphrina* leaf spot respectively (Table 46).

Turmeric crop cultivated by farmer were found to be affected by leaf spot caused by Colletotrichum *capsici* during survey conducted in the Vaishali district of Bihar. Ninety two germplasm of turmeric were screened against different diseases under natural condition. During the observation period, the germplasm were found to be affected with varying degree of only leaf spot caused by *Taphrina maculans* (Table 47). Among the germplasm screened against leaf spot, four germplasm namely, Dehra Doon, PTS-39, PCT-62 & Neeli

Table 46. Performance of entries against leaf spot diseases at Raigarh

Scale	*Colletotrichum* leaf spot *(Colletotrichum capscii)*	*Taphrina* leaf spot *(Taphrina maculans)*
HR (0-1)	NIL	NIL
R (1.1-10)	TCP-11 TCP-56	TCP-11, TCP-82,
MR (10.1-20)	R-30, TCP-82 RH9/90, RH 13/90, TCP-1 IT-41, IT-1, IT-2, IT-3, IT-4, IT-6, IT-7, IT-10, IT26-, IT-17, Prabha, IT-11, NDH-9, PTS-52, IT-42	IT-1, IT-2, IT-3, NDH-14, NDH-18, PTS-39, TCP-56, RH 9/90, PTS-34, CL-147, RH 13/90, PTS-52, IT-28, IT-23, IT-18, IT-11, IT-9, IT-7, NDH-9, Prabha. IT-4, IT-5, IT-10, IT-12, IT-13, IT-14, IT-16, IT-17, IT-19, IT-20, IT-21, IT-33, IT-33, IT-35, IT-37, IT-38, IT-39, IT-40, IT-41, IT-42
S (20.1-50)	PTS-15, IT-5, IT-8,IT-12 IT-21 IT-27, IT13, IT-14, IT-15, IT-21, IT-9, IT-16, IT-18, IT-19, IT-20, IT-21, IT-22, IT-23, IT-24, IT-25, IT-26 IT-27, IT-28, IT-29, IT-30, IT-34, IT-35, IT-36, IT-37, IT-38, IT-39 IT-40 , TU-11, PTS-55, PTS-59, CL-147	IT-6, IT-8, IT-22, IT-24, IT-25, IT-26, IT-27, IT-29, IT-34, IT-31, IT-34, IT-31, IT-32, IT 15, IT-30
HS>50	NIL	NIL

Haldi were found to be highly resistant while 22 numbers of germplasm were found resistant against Taphrina leaf spot.

TUR/CP/6.3 Management of foliar disease in turmeric

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

At Dholi all the treatments gave significant effect on all the parameters recorded and analyzed except germination of rhizome. Highest number of rhizome germination (47.67%) and yield (37.72 t/ha) with lowest leaf spot incidence (PDI= 6.67) were recorded over control in the treatment (T_7) – foliar spray with Tricyclozole (0.1%) on 45 and 90 days after planting. Next highest number of rhizome germination (45.67%) and yield (35.34 t/ha) (PDI= 8.33) were recorded in the treatment (T_8) where the standing crop was sprayed with carbendazim + mancozeb (0.1%) on 45 and 90 days after planting (Table 47).

For control of leaf spot disease at Chintapalle, rhizome treatment with propiconazole (0.1%) + foliar spray of propiconazole (0.1%) on 45 and 90 DAP gave the maximum per cent disease reduction over control (68.05%) followed by rhizome treatment with tricyclazole (0.1%) + foliar spray of tricyclazole (0.1%) on 45 and 90 DAP was found to be effective. In the case of leaf blotch, rhizome treatment with carbendazim + mancozeb (0.1%) + foliar spray of carbendazim + mancozeb (0.1%) on 45 and 90 DAP gave the maximum per cent disease reduction over control (68.06%) followed by rhizome treatment with propiconazole (0.1%) + foliar spray of propiconazole (0.1%) on 45 and 90 DAP (53.29%).

There was a significant decrease in incidence of leaf blotch in all the treatments at Kumarganj. However, maximum disease control of 52.90% was observed in seed treatment of rhizome and foliar spray with hexaconazole (1.0%) at 45 and 90 DAS. The disease control in foliar spray with tricyclazole (1.0%) on 45 and 90 DAS was at par with above treatment. Significant disease control of leaf spot was observed at 64.51% in

Table 47. Effect of different fungicides on leaf spot incidence of turmeric at Dholi

Treatment	Germination (%)	PDI (%)	Yield (kg/plot)	Yield (t/ha)
T_1 - Rhizome treatment with hexaconazole (0.1%) + foliar spray with hexaconazole (0.1%) on 45 & 90 DAP	42.33	25.00(57.14)	9.40	31.31(24.80)
T_2 - Rhizome treatment with propiconazole (0.1%) + foliar spray with propiconazole (0.1%) on 45 & 90 DAP	40.33	35.00(40.00)	9.04	30.09(19.92)
T_3 - Rhizome treatment with tricyclozole (0.1%) + foliar spray with tricyclozole (0.1%) on 45 & 90 DAP	44.67	11.67(78.00)	10.03	33.42(33.20)
T_4 - Rhizome treatment with carbendazim + Mancozeb (0.1%) + foliar spray with carbendazim + mancozeb (0.1%) on 45 & 90 DAP	43.67	21.67(62.85)	9.84	32.78(30.65)
T_5 - Foliar spray with hexaconazole (0.1%) on 45 & 90 DAP	41.00	28.33(51.43)	8.92	29.70(18.37)
T_6 - Foliar spray with propiconazole (0.1%) on 45 & 90 DAP	42.66	31.67(45.71)	9.39	31.26(24.59)
T_7 - Foliar spray with tricyclozole (0.1%) on 45 & 90 DAP	47.67	6.67(88.57)	11.33	37.72(50.34)
T_8 - Foliar spray with carbendazim + mancozeb (0.1%) on 45 & 90 DAP	45.67	8.33(85.72)	10.61	35.34(40.85)
T_9 = Check	37.33	58.33	7.53	25.09
CD (P=0.05)	9.12	5.83	1.69	5.61
CV (%)	12.31	13.37	10.18	10.18

T_2 treatment i.e. seed treatment and foliar spray with propaconazole (1.0%) on 45 and 90 DAS followed by 55.04% disease control in foliar spray with carbendazim and mancozeb (1.0%) on 45 and 90 DAS. Significant increase of maximum fresh rhizome yield of 395.50 q/ha (118.41% over control) was recorded in seed treatment and foliar spray with hexaconazole (1.0%) on 45 & 90 DAS followed by 388.84 q/ha (114.73%) increase in yield in foliar spray with tricyclazole (1.%) on 45 & 90 DAS which was at par with above treatment. (Table 48).

Rhizome treatment as well as foliar spray with carbendazim + mancozeb at 45 and 90 days after planting (T_4) was the best treatment in controlling both leaf blotch and leaf spot disease of turmeric at Pundibari. 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, and T_8 in respect of disease intensity and yield. T_4 produced lowest percent disease index of 10.07 and 10.37 in case of leaf blotch and leaf spot respectively. This treatment also produced the highest yield of 8.69 kg/plot (17.51 t/ha) among all the treatments.

At Raigarh, minimum disease intensity (18.2 %) was found when rhizomes were treated with carbendazim + mancozeb (1:1) and sprayed (0.1%) after 45 and 90 days after planting (T4) followed by 32.66% disease intensity with foliar spray of carbendazim + mancozeb (0.1%) on 45 and 90 DAT (T_8). Both the treatments gave maximum yield 13.67 and 11.45 t/ha, respectively. These treatments were found statistically at par regarding the disease intensity and yield.

At Coimbatore, in all the treatments more than 70% of germination was recorded. The highest germination percentage of 85.71% was recorded in T3 (rhizome treatment with tricyclozole (0.1%)+ foliar spray-tricyclozole (0.1%) on 45 and 90 days) and T4 (rhizome treatment with carbendazim+ mancozeb (0.1%)+ foliar spray- carbendazim + mancozeb (0.1%) on 45 and 90 days) treatments (Table 49). Leaf spot intensity was less in treatments T6 (foliar spray with propiconazone (0.1%) on 45 and 90 days and T8 (foliar spray with carbendazim + mancozeb (0.1%) on 45 and 90 days (23.33 PDI) followed by T4 (rhizome treatment with carbendazim + mancozeb (0.1%) + foliar spray on 45 and 90 days (24.67 PDI) as compared to control (67.33 PDI). In the case of leaf blotch, the lowest intensity of 13.33 PDI was recorded in T4 treatment which was on par with T6 and T8. Rhizome rot was absent in all the treatments. The maximum rhizome yield was recorded

Table 48. Effect of fungicides on the incidence of foliar diseases on turmeric during 2009-10 at Kumarganj

Sl. No	Treatment	Percent disease index		Percent disease control		Estimated yield (t/ha)	% increase in yield over control
		Leaf blotch (PDI)	Leaf spot (PDI)	Leaf blotch	Leaf spot		
1	T_1- Seed treatment and foliar spray with hexaconazole (0.1%) on 45 and 90 days	16.53	21.72	52.90	31.48	395.5	118.41
2	T_2- Seed treatment and foliar spray with propaconazole (0.1%) on 45 and 90 days	25.01	11.25	28.74	64.51	237.53	31.17
3	T_3- Seed treatment and foliar spray with tricyclazole (0.1%) on 45 and 90 days	26.79	16.69	23.67	47.35	374.96	107.06
4	T_4- Seed treatment and foliar spray with carbendazim and mancozeb (0.1%) on 45 and 90 days	21.78	16.69	37.94	47.35	317.18	75.16
5	T_5- Foliar spray with hexaconazole (0.1%) on 45 and 90 DAS	28.21	20.01	19.62	36.87	372.18	105.65
6	T_6- Foliar spray with propaconazole (0.1%) on 45 and 90 DAS	20.27	17.86	42.25	43.65	372.40	105.65
7	T_7- Foliar spray with tricyclazole (0.1%) on 45 and 90 DAS	20.34	18.55	52.87	41.48	388.84	114.73
8	T_8- Foliar spray with carbendazim and mancozeb (0.1%) on 45 and 90 DAS	35.10	14.25	42.09	55.04	366.62	102.46
9.	T_9- Control	1.06	31.70	-	-	181.08	-
	SEm±	3.19	0.95				
	CD (P=0.05)	7.80	2.88				
	CV (%)		8.77				

in the T6 treatment (34 t/ha) followed by T8 (32.66 t/ha) and T4 (31.34 t/ha). The maximum CB ratio of 1:4.36 was recorded in the treatment T6 (foliar spray – propiconazole (0.1%)) followed by T8 (foliar spray with carbendazim + mancozeb (0.1%) which recorded the CB ratio of 1: 4.21 (Table 49).

Table 49. 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)	Percent reduction over control	Leaf blotch (PDI)	Percent reduction over control			
T1 - Rhizome treatment with hexaconazole (0.1%)+ foliar spray- hexaconazole (0.1%) on 45 and 90 days	80.95	32.00	52.47	22.0	35.29	10.83	21.66	2.46
T2 - Rhizome treatment with propiconazole (0.1%) + foliar spray- propiconazole (0.1%) on 45 and 90 days	79.99	31.33	53.46	25.3	25.59	13.33	26.66	3.11
T3 - Rhizome treatment with tricyclozole (0.1%)+ foliar spray- tricyclozole (0.1%) on 45 and 90 days	85.71	36.00	46.53	20.0	41.18	12.43	24.86	2.83
T4 - Rhizome treatment with carbendazim+ mancozeb (0.1%)+ foliar spray- carbendazim +mancozeb (0.1%) on 45 and 90 days	85.71	24.67	63.36	13.33	60.79	15.67	31.34	3.96
T5 - Foliar spray – hexaconazole (0.1%) on 45 and 90 days	77.14	34.00	49.50	26.67	21.56	12.33	24.66	2.95
T6- Foliar spray- propiconazole (0.1%) on 45 and 90 days	78.57	23.33	65.35	14.67	56.85	17.00	34.00	4.36
T7 - Foliar spray- tricyclozole (0.1%) on 45 and 90 days	80.09	36.67	45.54	29.33	13.74	11.07	22.14	2.49
T8 - Foliar spray- carbendazim+ mancozeb (0.1%) on 45 and 90 days	75.72	23.33	65.35	14.67	56.85	16.33	32.66	4.21
T9 – Check	76.67	67.33	-	34.0	-	10.00	20.00	-
SEd±		2.40		2.06			2.14	
CD (P=0.05)		5.09		4.38			4.55	
CV (%)		8.25		9.11			9.96	

TREE SPICES

TSP/CI/1 Genetic Resources

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

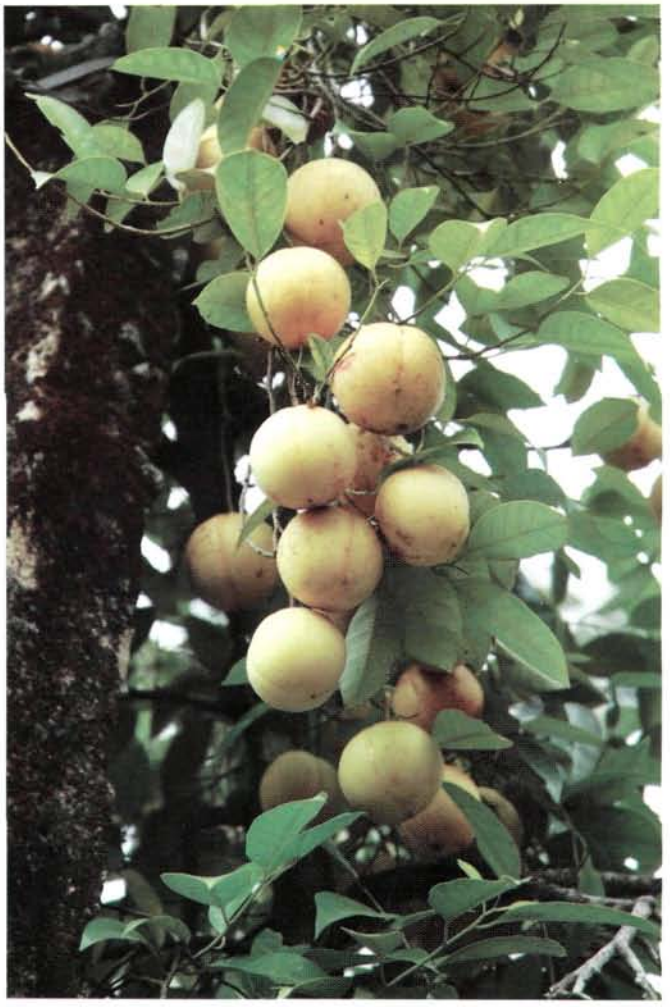
(Dapoli, Yercaud/Pechiparai)

Clove

The germplasm of tree spices are maintained at Dapoli, Pechiparai and Yercaud centres (Table 50). The germplasm of clove consisting of two accessions viz. IISR Calicut type and Kallar type have been maintained and are being evaluated for growth and yield performance at Dapoli. 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 plant height varied from 5.30 to 7.30 m., girth from 26.00 to 31.00 cm and spread varied from 2.42 m to 8.36 m. Selection 5-53 recorded maximum plant height (7.30 m), spread (8.36 m) and number of cloves/bunch (12/bunch). Selection 1-9 recorded the lowest plant height (5.30 m) and girth (26 cm). Selection 4-58 recorded early flowering (4th week of September) and other four selections recorded the flowering during 1st to 4th week of October (Table 51).

Table 50. 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	14
Yercaud	16
Cassia	
Dapoli	06
Pechiparai	04
Total	**53**



This trial was initiated at Pechiparai with an objective to collect, maintain, characterize and catalogue the germplasm of clove. Morphological characteristics yield and yield attributing traits are being evaluated to identify promising accessions. In clove 24 accessions are being maintained and during this year 2 more accessions were collected from Devagiri estate and Thadikarankonam

Table 51. Growth and yield performance of promising clove genotypes at Dapoli (2009-10)						
Selection	Height (m)	Girth (cm)	Spread (m)	No. of cloves/ bunch	Length of clove (cm)	Commencement of flowering
Selection -1-9	5.30	26	4.50	8	1.78	1st week of October
Selection -2 -46	5.50	29	7.79	7	1.92	3rd week of October
Selection -3 -55	6.50	31	8.33	8	1.78	2nd week of October
Selection -4 -58	6.0	29	2.42	9	1.84	4th week of September
Selection -5 -53	7.30	30	8.36	12	1.74	4th week of October
Mean	6.12	29	6.28	8.8	1.81	
Range	5.30-7.30	26-31	2.42-8.36	7-12	1.74-1.92	

among which Sel.13 performed well and gave an yield of 13.50 kg buds per tree. Among these 24 accessions the high yielding accessions alone were compared and analysis of the pooled mean data of three years indicate accessions SA-13, SA-1, SA-12 and SA-3 as promising (Table 52). These accessions can be forwarded to CVT.

Nutmeg

At present 98 nutmeg accessions are maintained and are being evaluated at Dapoli centre. From the germplasm collections planted during 1996-97, fifteen promising types have been identified and selected during the year for further evaluation. The data on growth and yield performance are presented in Table 53. The cumulative yield of four years ranged from 172-752 fruits. B- 38 (752), B-9 (684), 9/20 -21 (496), 9/20-41 (432) and 9/79-10 (428) were identified as high yielders. These genotypes are further evaluated for yield and fruit characters.

In nutmeg 24 accessions are being maintained at Pechiparai. During 2009-10 accessions from Maramala and Vellarada were added to the germplasm. Evaluation of germplasm has short listed the nutmeg selections Sel.2, Sel.4 and Sel.6 as promising entries (Tables 54 & 55).

Table 52. Yield performance of clove accession at Pechiparai (Pooled 2006-09)						
Accession	Yield/tree					Yield(Kg/ha)
	2006	2007	2008	2009	Pooled mean	
SA-1	5.10	7.92	10.32	8.00	7.84	2170.30
SA-2	4.32	4.08	4.68	6.20	4.82	1335.14
SA-3	4.98	5.60	7.60	9.00	5.47	1515.19
SA-4	1.20	4.64	5.40	4.30	3.89	1076.15
SA-5	3.8	4.58	5.91	3.26	4.39	1215.34
SA-6	3.37	4.27	5.30	7.20	5.04	1394.70
SA-7	3.15	6.15	7.12	6.90	5.83	1614.91
SA-8	4.0	5.70	6.80	7.50	6.38	1765.88
SA-9	1.80	3.74	5.70	4.50	3.94	1090.00
SA-10	3.75	4.32	5.10	5.70	4.72	1306.75
SA-11	1.39	3.58	5.50	5.80	4.07	1126.70
SA-12	3.80	4.22	6.20	7.20	5.36	1483.34
SA-13	6.72	9.08	12.75	13.50	10.51	2911.96
SA-14	3.20	4.06	5.00	5.60	4.47	1236.81
SA-15	1.95	1.72	2.20	0.75	1.66	458.44
SA-16	1.90	1.06	1.75	1.25	1.49	412.73
SA-17	1.00	1.14	2.10	1.75	1.50	414.81
SED	1.25	2.32	0.38	0.68	1.05	156.33
CD (P=0.05)	2.45	4.95	0.78	1.02	1.89	312.17

Table 53. Growth and yield performance of promising nutmeg at Dapoli

Genotype	Fruit weight (g)	Nut weight (g)		Mace weight (g)	
		Fresh	Dry	Fresh	Dry
9/4 - 58	60.10	8.0	5.32	3.8	1.10
9/4 - 59	76.15	12.5	5.45	5.5	1.40
9/4- 26	63.70	13.2	9.35	1.8	0.90
4/12 - 65	56.50	8.3	4.40	2.8	1.10
4/12 -15	58.33	10.1	6.73	3.6	1.20
9/20 – 21	52.10	7.3	4.90	2.5	0.90
9/20 -41	45.50	8.5	4.50	2.7	1.25
4/22 - 56	65.60	10.1	5.53	3.8	1.23
4/22 - 4	62.20	9.5	4.80	3.2	1.05
9/72 - 46	59.20	9.4	4.68	2.7	1.10
9/79 – 31	43.50	9.4	4.68	2.6	1.20
9/79- 10	62.70	9.8	4.00	2.6	0.90
B – 38	49.00	7.5	4.30	1.4	0.90
B– 9	92.50	18.7	12.10	6.3	2.80
B-39	51.00	7.7	4.50	1.3	0.70
Mean	59.87	10.7	5.68	3.1	1.18
Range	43.5-92.5	7.3-18.7	4.0-12.1	1.3-6.3	0.7-2.8

Table 54. Performance of nutmeg accessions at Pechiparai

Accession	Plant height (m)	Stem girth (cm)	Leaf length (cm)	Leaf breadth (cm)	No. of fruits/tree	Single fruit weight (g)	Fruit shape
Sel.1	6.74	46.23	14.20	4.50	538.35	73.60	Round
Sel.2	6.96	3.87	12.40	5.80	613.06	69.30	Round
Sel.3	4.47	29.13	12.40	5.10	246.87	90.58	Round
Sel.4	3.03	13.09	10.30	4.50	940.25	75.30	Pear
Sel.5	5.27	30.94	12.20	4.40	360.04	72.10	Round
Sel.6	6.51	35.77	13.70	5.70	330.95	120.30	Round
Sel.7	4.23	28.43	13.50	6.30	390.74	66.50	Round
Sel.8	5.14	30.51	12.00	4.10	360.50	63.10	Round
Sel.9	5.02	25.83	13.35	5.00	330.42	63.15	Pear
Sel.10	5.27	28.54	9.60	4.90	350.97	79.30	Pear
Sel.11	3.46	21.03	11.10	4.82	311.92	88.90	Round
Sel.12	3.47	30.01	13.50	6.20	201.06	62.00	Round
Sel.13	3.51	23.84	15.50	7.20	210.72	68.10	Round
Sel.14	4.06	23.87	15.40	5.10	211.26	70.06	Round
Sel.15	4.26	18.83	13.50	5.80	200.72	53.00	Round
Sel.16	3.25	22.66	13.60	4.90	170.95	74.30	Round
Sel.17	3.52	20.77	12.80	3.90	181.09	66.50	Round
Sel.18	3.27	19.30	13.40	4.60	175.47	68.70	Round
Sel.19	3.71	20.16	12.70	6.40	172.39	65.50	Round
Sel.20	3.43	17.92	13.10	4.90	53.12	70.60	Round
Sel.21	2.03	9.21	9.40	4.70	72.18	71.40	Round
Sel.22	1.22	7.71	12.20	4.60	-	-	-
Sel.23	0.92	4.31	13.30	4.90	-	-	-
Sel.24	0.84	3.93	13.70	5.20	-	-	-
SED	0.24	1.16	0.63	0.29	16.34	3.91	
CD(P=0.05)	0.48	2.33	1.26	0.59	32.89	7.88	
CV (%)	7.55	6.60	5.99	7.00	7.48	7.51	

Table 55. Yield performance of nutmeg accessions at Pechiparai

Accession	Fresh yield (kg/tree)				Fresh yield (kg/ha)			
	Total yield	Pericarp	Nut	Mace	Total yield	Pericarp	Nut	Mace
Sel.1	39.62	34.12	3.13	0.56	3763.70	3245.86	476.09	70.87
Sel.2	42.48	38.56	1.87	0.29	6170.00	2787.60	219.98	34.67
Sel.3	22.34	18.23	1.73	0.58	2995.81	2719.55	210.00	78.56
Sel.4	70.80	78.80	7.34	0.77	9996.35	3889.40	997.13	75.25
Sel.5	25.97	22.33	1.78	0.31	3657.48	3381.00	292.11	42.67
Sel.6	39.81	34.65	3.77	0.49	5773.15	5217.98	468.79	65.98
Sel.7	25.99	22.81	1.67	0.30	3780.00	3426.45	234.67	43.56
Sel.8	22.74	19.13	1.45	0.26	3204.90	2946.84	229.00	39.34
Sel.9	20.86	17.46	1.67	0.20	3103.23	2771.50	261.00	25.01
Sel.10	27.83	24.95	2.44	0.41	4014.15	3681.60	267.98	37.67
Sel.11	27.72	30.01	0.89	0.36	3989.54	3817.66	69.76	46.89
Sel.12	12.46	10.18	0.86	0.58	1703.54	1487.46	72.02	78.56
Sel.13	14.35	11.14	0.67	0.72	1987.98	1726.98	71.67	110.98
Sel.14	14.99	12.66	0.45	0.76	2050.00	1817.70	60.02	115.45
Sel.15	11.06	9.59	0.39	0.69	1489.34	1378.11	39.82	96.89
Sel.16	12.01	10.12	0.33	0.38	1639.57	1578.40	43.12	53.65
Sel.17	12.04	9.09	0.56	0.58	1567.21	1402.14	67.87	87.45
Sel.18	12.05	9.88	0.47	0.50	1543.65	1404.00	49.92	76.67
Sel.19	11.29	10.04.	0.32	0.47	1567.84	1469.11	38.54	62.87
Sel.20	4.10	-	-	-	-	-	-	-
Sel.21	5.10	-	-	-	-	-	-	-
SED	1.43	1.00	0.09	0.02	134.13	85.86	12.91	2.08
CD(P=0.05)	2.88	2.01	0.19	0.03	270.00	172.83	25.98	4.14
CV (%)	8.83	6.62	8.69	5.40	6.16	7.01	9.10	5.89

Cinnamon

At present the germplasm of cinnamon consisting of 13 accessions have been maintained and are being evaluated at Dapoli. The germplasm collections planted during 1996-97 were evaluated for growth parameters. The data on growth parameters did not differ significantly in different genotypes (Table 56). The plant height ranged from 3.51 to 4.40 m, the girth 18.11–23.24 cm, the spread 2.87–4.05 m, and the number of regenerated shoots from 3.49 to 5.79.

This trial was initiated during 1992 with an objective to collect, maintain, characterize and catalogue the germplasm of cinnamon at Pechiparai. 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 a bark yield of 580 g of dried bark/tree and leaf yield of 6.8 kg/tree.

TSP/CI/2 Coordinated Varietal Trial

TSP/CI/2.1 CVT 1992 – clove

(Yercaud/Pechiparai)

Nine genotypes collected from IISR, Calicut is being maintained at Pechiparai centre and growth parameters are studied. Among the types SA-3 was found to be promising in terms of yield characters (1515.19 kg/tree) (Table 57).

TSP/CI/2.2 CVT 2001- nutmeg

(Dapoli, Pechiparai)

At Dapoli there was only significant difference in girth and other parameters *viz.* height, number of branches and spread showed no significant difference in different genotypes. The plant height ranged from 0.70–1.38 m, girth 10.0–18.25 cm, and spread 0.37–1.93 m (Table 58).

Six genotypes collected from IISR, Calicut along with a local check is being maintained at Pechiparai centre

Table 56. Growth parameters of cinnamon genotypes planted at Dapoli

Accession	Average height (m)	Average girth (cm)	Number of regenerated shoots/ plant	Average spread (m)
A-55	4.40	22.00	4.10	3.15
A-44	3.81	22.50	5.79	4.05
A-53	3.87	18.11	3.69	2.87
A-63	4.04	20.33	5.18	3.28
A-65	3.91	23.22	3.81	2.89
A-189	3.62	18.50	5.33	3.22
A-203	3.72	23.44	2.92	3.83
A-310	3.58	18.67	3.49	3.39
A-312	3.51	21.11	4.56	3.30
Range	3.51-4.40	18.11-23.44	3.49-5.79	2.87-4.05
Mean	3.83	20.88	4.32	3.33
SEm±	0.286	1.608	0.648	0.485
CD (P=0.05)	NS	NS	NS	NS

Table 57. Performance of CVT clove at Pechiparai

Accession	Yield/tree (kg)					Yield
	2006	2007	2008	2009	Pooled mean	(kg/ha)
SA-3	4.78	4.98	7.60	9.00	5.47	1515.19
SA-4	1.20	4.64	5.40	4.30	3.89	1076.15
SA-5	3.80	4.58	5.91	3.26	4.39	1216.03
SA-6	3.37	4.27	5.30	7.20	5.04	1396.08
SA-7	3.15	4.15	7.12	6.90	5.83	1614.91
SA-8	4.00	4.70	6.80	7.50	6.38	1765.88
SA-9	1.80	3.74	5.70	4.50	3.94	1090.00
SA-10	3.75	4.32	5.10	5.70	4.72	1306.75
SA-11	1.39	3.58	5.50	5.80	4.07	1126.70
SA-12	3.80	4.22	6.200	7.20	5.36	1483.34
SED	0.08	0.26	0.27	0.18	0.55	54.89
CD (P=0.05)	0.17	0.54	0.56	0.39	1.16	115.33
CV (%)					13.72	5.97

Table 58. Growth performance of CVT nutmeg at Dapoli

Accession	Average height (m)	Average girth (cm)	Average no. of branches	Average spread (m)
A-9/4	0.70	10.0	3.33	0.67
A-9/20	1.22	11.72	3.00	0.83
A-9/25	0.90	10.50	2.67	0.94
A-9/71	1.38	18.25	7.17	1.44
A-9/150	1.12	16.17	4.33	1.93
Male	1.36	13.42	4.50	1.85
Konkan Sugandha	0.82	10.67	2.67	0.37
Shrivardhan Bold	1.19	11.25	6.17	0.49
Range	0.70-1.38	10.0 – 18.25	2.67 -7.17	0.37 – 1.93
Mean	1.084	12.75	4.23	1.065
SEm±	0.239	1.72	1.31	0.585
CD (P=0.05)	NS	5.22	NS	NS

and the growth parameters are studied (Table 59). Among the accessions A9/150 has recorded highest plant height (185 cm), stem girth (9.3 cm) and maximum number of shoots (15.6).

TSP/CI/2.3 CVT 2001 - cassia

(Pechiparai, Dapoli)

Four genotypes collected from IISR, Calicut along with local check is being maintained at Pechiparai station and growth parameters are studied (Table 60). The suitability of elite lines of CVT is being evaluated under this climatic zone for its yield and yield attributes. Among the four selections, D-3 was found to be promising with a leaf yield of 376.9 g/tree, stem girth of 24 cm and plant height of 4.5 m. The leaf yield of local check was 194.0 g/tree.

Table 59. Performance of CVT nutmeg at Pechiparai

Accession	Plant height (cm)	Stem girth (cm)	No. of branches
A9/4	98.45	9.03	4.45
A9/20	92.00	10.97	8.67
A9/25	80.22	7.93	7.64
A9/71	86.67	6.88	7.55
A9/150	185.00	9.30	15.60
Male	86.44	7.00	6.43
Local check	78.04	5.89	2.89
SED	15.86	1.13	1.21
CD(P=0.05)	32.01	1.78	2.23
CV (%)	21.22	5.89	8.95

Table 60. Growth and yield performance of CVT cassia at Pechiparai

Accession	Plant height (m)	Stem girth (cm)	Leaf yield (g/tree)
C-1	2.16	8.85	255.0
D-1	2.13	7.89	287.8
D-3	4.50	24.00	376.9
D-5	2.45	11.78	312.0
Local check	1.95	6.50	194.0
SED	0.34	0.56	50.12
CD (P=0.05)	0.77	1.14	132.01
CV (%)	16.18	6.15	15.88

At Dapoli, the data on growth parameters viz. height, branches and spread did not differ significantly in different genotypes. The genotype $KKVCTSH_2$ recorded significantly higher girth (31.0 cm) followed by KKVCTSH1 (30.63 cm). The leaf yield varied from 2.08 to 6.62 kg/plant. $KKVCTSH_1$ recorded maximum leaf yield (6.62 kg/plant). The oil percentage in leaf varied from 6.5 to 11.0%. The genotype $KKVCTSH_2$ and $KKVCTSH_1$ recorded higher oil percentage 11.0% and 10.4% respectively.

TSP/CM/2 Propagation/Multiplication Trial

TSP/CM/2.1 Softwood grafting in clove

(Dapoli)

The propagation trial on softwood grafting of clove on clove rootstock was initiated at Dapoli during last year. There was no success in softwood grafting of clove on clove rootstock.

TSP/CM/2.2 Post harvest technology studies in cinnamon

(Dapoli, Pechiparai)

At Dapoli, post harvest studies on extraction of bark in cinnamon were carried out during 2009-10. Bark could be extracted from the matured shoot having a thickness of 1.0-2.0 cm, 2.0-3.0 & 5.0-6.0 cm. The bark weight and thickness before drying (fresh) and after drying were found to be increased as the shoot thickness increased. The dry recovery percentage varied from 46.37 to 52.07% in the shoot length of 50 cm and 45.34 to 51.66% in the shoot length of 100 cm in genotype Konkan Tej variety. Similar trend was also observed in (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. 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 due to their easy peeling from the stem. The yield of dried bark varied from 26.62 to 58.15 g in shoot length of 50 cm having different thickness and 32.46 to 114.15 g in shoot length of 100 cm having different thickness in Konkan Tej variety. Similar yield trend was recorded in Acc. 11. (Table 61)

At Pechiparai significant difference was observed in genotype, length, thickness and G x L and L x T interactions. Among the genotypes G1 recorded significantly higher mean dry weight of quills (127 g). Among the lengths tried, L2 recorded higher mean dry weight (57.71 g) with respect to thickness. T3 recorded significantly more dry weight (50.61 g). The interaction

Table 61. Post harvest studies in cinnamon at Dapoli

Treatment	Konkan Tej (G1)						Acc. No 11 (G2)					
	Length of stem 50 cm (T1)/ Thickness of stem (TS)			Length of stem 100 cm (T2)/ Thickness of stem (TS)			Length of stem 50 cm (T1)/ Thickness of stem (TS)			Length of stem 100 cm (T2)/ Thickness of stem (TS)		
	TS1: 1.0-2.0 cm	TS2: 2.0-3.0 cm	TS3: 5.0-6.0 cm	TS1: 1.0 -2.0 cm	TS2: 2.0- 3.0cm	TS3: 5.0- 6.0 cm	TS1: 1.0-2.0 cm	TS2: 2.0- 3.0 cm	TS3: 5.0-6.0 cm	TS1: 1.0 -2.0 cm	TS2: 2.0- 3.0 cm	TS3: 5.0-6.0cm
Bark thickness (fresh) (mm)	1.00	1.24	1.75	1.00	1.00	1.70	1.00	1.25	1.73	1.00	1.00	1.67
Bark thickness (dry) (mm)	0.74	0.81	1.23	0.60	0.69	1.35	0.72	0.85	1.23	0.70	0.72	1.22
Fresh weight (g)	56.92	83.85	117.69	70.00	100.00	219.23	57.31	84.62	116.54	70.77	100	213.85
Dry weight (g)	26.62	43.31	58.15	32.46	50.00	114.15	26.46	42.62	58.00	33.15	51.31	110.38
Dry recovery (%)	46.94	51.65	49.41	46.37	50.00	52.07	46.17	50.37	49.77	46.84	51.31	51.62
Bark yield (g)	26.62	43.31	58.15	32.46	50.00	114.15	26.46	42.62	58	33.15	51.31	110.38

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.

TSP/CP/3 Disease Management Trial

TSP/CP/3.2 Management of die back 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. The trial on management of dieback and wilt disease of nutmeg was closed during this year and final report would be submitted.

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, Kumarganj)

Among the 275 coriander accessions evaluated during 2009-2010 at Coimbatore, the coriander grain yield ranged from 360 kg/ha to 1080 kg/ha with an average mean yield of 625.88 kg/ha. 125 genotypes recorded the yield higher than the mean yield. Highest mean coriander yield was registered by the accession CS-121 (1080 kg per ha). Incidence of powdery mildew disease was noticed in all the accessions. The PDI of powdery mildew ranged from 22.5 PDI to 62.5 PDI. The accessions *viz.*, CS-72, 84 and 103 recorded least disease intensity of 22.5 PDI. The other accessions *viz.*, CS-25, and 34 recorded minimum disease intensity of 25 PDI followed by CS- 39, 113, 126 and 170 which recorded 27.5 PDI. The germplasm of coriander conserved in various centres is given in Table 62.

Table 62. Coriander germplasm collection at AICRPS centres

Centre	Indigenous		Total
	Cultivated	Wild and related sp.	
Coimbatore	275	-	275
Dholi	114	1	115
Guntur	309	-	309
Hisar	261	-	261
Jagudan	74	21 (Exotic)	95
Jobner	753	102	855
Kumarganj	88	-	88
Pantnagar	20	-	20
Solan	92	-	92
Total	1986	124	2110

At Dholi, one hundred fifteen germplasm of coriander were collected and evaluated for getting promising line with respect to yield. Out of one hundred fifteen germplasm, only eleven accessions namely, RD-392, RD-385, RD-380, UD-435, RD-382, RD-379, RD-377, RD-393, RD-384, UD-90, and ND Cor-2 gave maximum yield as compared to high yielding check variety Rajendra Swati and Pant Haritima. Among promising accessions, RD-392 produced maximum yield (1.25 kg/4.8 m^2) followed by RD-385 (1.20 kg/4.8 m^2).

Sixty five entries were evaluated at Guntur during 2009-10, LCC-276 recorded highest single plant yield (4.87 g) followed by LCC-281 (4.05 g), LCC-249 (3.63 g), LCC-251 (3.62 g) and LCC-248 (3.56 g) and were significantly superior to the best check Sudha (1.79 g).

One hundred and thirty accessions of coriander were evaluated in two row plots of 3.0 meter length each using Hisar Anand, Narnaul Selection and Pant Haritima as checks during 2009-2010 at Hisar. The mean seed yield of the germplasm material ranged from 14.0 g/plant (DH-308) to 41.2 g/plant (DH-276-1). Twenty-two lines gave higher seed yield than the highest yielding check, Hisar Anand. The most promising lines for seed yield were DH-242-1, DH-276-1, DH-277, DH-294-1, DH-296, DH-297, DH-297-1, DH-298, DH-310, DH-355 and DH-356-1.

At Jagudan, 93 entries were raised and evaluated with G.Cori-1 and G.Cori-2 as checks for different yield attributes. Among them nine entries were dwarf types, having less than 75 cm plant height. Ten entries had more branches *i.e.* more than 8.5 branches per plant. The umbels per plant were recorded by 9 entries i.e. ≥ 45. Four entries recorded equal or more than 7 umbellate per umbel. Six entries were promising for more seeds per umbel *i.e.* > 60 seed per umbel. Twelve entries were early maturity (< 100 days) types. Twenty one entries were bold seeded(> 11 g), fourteen entries were high yielders (> 3000 kg ha^{-1} grain yield) (Table 63).

Three hundred sixty eight germplasm accessions were evaluated along with eight checks namely, RCr-

Table 63. Promising entries of germplasm conserved at Jagudan (2009-10)

Sl. No.	Character	Range	G.Co-2 (Check)	Desirable traits	No. of entries	Promising entries identified
1	Plant height (cm) (Dwarf)	67.4-110.4	91.2	<75	9	EC-357849, Egyptian, EC-343365, Lam-43, Dhana-41, JCr-372, Lam-87, JCr-342 & JCr-340
2	No. of branches/ plant(More branches)	4.8-9.2	7.8	≥8.5	10	EC-232669, JCr-391, JCr-393, JCr-389, Lam-45, Lam-69, JCr-387, JCr-390, JCr-384 & EC-363974
3	No. of umbels/plant (More umbels)	21.8-53	25.2	≥45	9	JCr-375, JCr-390, UD-100, JCr-397, Dhana-25, JCr-387, UD-273, Lam-44 & JCr-401
4	No. of umbellates/ umbel(More umbellates)	4.2-7.6	5	≥7	4	UD-51, EC-363971, Lam-4 & JCr-390
5	No. of seeds/umbel (More seeds)	28.4-87.8	34.6	>60	6	JCr-390, JCr-399, JCr-375, UD-51, EC-243366 & Lam-43
6	Maturity days (Early)	93-128	105	<100	12	Lam-5, JCr-330, Russian, EC-363974, JCr-383, JCr-333, JCr-32, EC-363971, UD-357, Dhana-25, JCr-283 & JCr-340
7	Test weight (g) (1000 seeds)	6.64-14.12	10.02	>11	21	JCr-329, UD-309, JCr-327, JCr-395, UD-357, JCr-328, Lam-6, JCr-403, UD-100, JCr-384, UD-79, JCr-283, UD-290, Dhana-157, Lam-5, EC-350691, UD-308, JCr-344, UD-217, JCr-381 & Lam-73
8	Grain yield (g plant $^{-1}$)	3.2-10.4	5.8	>9	14	Lam-23, JCr-375, Dhana-157, EC-363965, Dhana-25, JCr-387, Lam-44, JCr-390, UD-309, Lam-69, JCr-383, JCr-392, JCr-401 & UD-100
9	Grain yield (kg ha $^{-1}$)(High yield)	1067-3467	1933	>3000	14	....As above ....

20, RCr-41, RCr-435, RCr-436, RCr-446, RCr-480, RCr-684 and local in augmented design in one row plots of 3.0 x 0.3 m^2 size at Jobner. A wide range of variability was found for all the characters studied. Out of 368 accessions, 38 accessions were better than check variety RCr-480. Some of the promising accessions identified on the basis of yield per 5 plants were RCr-41 SPS, UD-457, UD-684-1, UD-587, UD-684-3, UD-785, UD-374 SPS, UD-454, UD-547, UD-783, Pant Haritma, UD-464, UD-477, UD-501, CS-2 SPS, UD-513, UD-744, UD-786, UD-494, DH-38 SPS, UD-787, UD-684-2 and UD-487.

Out of 88 germplasm screened at Kumarganj, NDCor-2 gave maximum seed yield of 18.5 q/ha followed by 17.2 q/ha in NDCor-38 against Hisar Anand (11.40 q/ha), K. selection (16.70 q/ha) and Pant Haritma (13.20 q/ha). The range of seed yield was 5.30 q/ha to 18.5 q/ha.

In rabi 2009-10, two hundred thirty (230) germplasm accession of coriander were evaluated along with nine checks at Jobner. A wide range of variability was found for all the characters studied. Out of 230 accessions, 23 accessions were better than best check variety RCr-728. Some of the promising accessions identified on the basis of yield per 5 plants were UD-309, UD-77, UD-225, UD-57, UD-247, UD-75, UD-410, UD-340, UD-87, UD-218, UD-409, UD-1, UD-259 and UD-292. In Rabi 2009-10, ninety (90) germplasm accession of coriander from different parts of the country were evaluated along with four checks namely Hisar Anand, RCr-435, RCr-436 and Local in augmented design in one row plots of 3 x 0.3 sq.m. size. A wide range of variability was found for all the characters studied. Out of 90 accessions, 23 accessions were better than best check variety RCr-435. Some of the promising accessions identified on the basis of yield per 5 plants

were UD-94, UD-228, UD-344, UD-86, UD-100, J.Cori-372, J.Cori-389, UD-13, UD-21, UD-119, UD-31, J.Cori-342, UD-7, UD-51, UD-56 and J. Cori-376.

Multilocational evaluation of coriander genotypes

Multilocational evaluation of ninety germplasm lines (Guntur (60) and Coimbatore (30)) of coriander were evaluated during 2009-10 along with two checks at Coimbatore. The single plant yield varied from 18.18 g to 48.00 g. The highest yield was recorded by the line CS-3 (48 g per plant) followed by LCC-241 (42.20 g per plant). Most of the genotypes obtained from Guntur recorded less than 50% disease incidence except for few genotypes (LCC-199, LCC-205, LCC-207, LCC-208 and LCC-214). With regard to the accessions from Coimbatore centre except for five lines (CS-1, CS-12, CS-14, CS-15 and CS-29) out of 30 lines evaluated recorded powdery mildew disease incidence less than 50%.

During 2009-10 multilocational evaluation of ninety five entries were evaluated at Guntur. Among the entries evaluated, LCC-223 recorded highest single plant yield (3.2 g) followed by LCC-208 (3.15 g), LCC-209 (3.02 g), CS-17 (2.92 g) and LCC-206 (2.90 g) which were significantly superior to check Sudha (1.01 g).

COR/CI/2 Coordinated Varietal Trial

COR/CI/2.6 CVT of coriander 2005 Series VI (Final report)

(Jobner, Kumarganj)

Fourteen entries were evaluated in RBD with 3 replications in a plot size of 3.0 x 2.4 m^2 accommodating eight rows spaced 30 cm apart with plant to plant distance of 10 cm maintained by thinning at Jobner. The analysis of variance revealed significant differences among the entries for all the traits including seed yield. The seed yield ranged from 324.44 to 1217.78 kg/ha. Of the fourteen entries evaluated, COR-1 recorded maximum seed yield of 1217.78 kg/ha followed by COR-2 (1251.12 kg/ha), COR-3 (1035.56 kg/ha), COR-8 (1017.78 kg/ha), RCr-435 (995.56 kg/ha), COR-19 (968.89 kg/ha) and COR-9 (808.89 kg/ha), while lowest seed yield of 324.44 kg/ha was recorded in COR-18 (Table 64). Mean performance of the entries evaluated in CVT over 2006-07 and 2008-09 revealed superior performance of COR-1 yielding 1168.01 kg/ha followed by COR-2 (914.26 kg/ha), RCr-435 check (823.267 kg/ha), COR-3 (815.63 kg/ha), COR-9 (757.58 kg/ha), RCr-684 check (724.89 kg/ha) and COR-8 (711.72 kg/ha), while lowest seed yield of 309.50 kg/ha was recorded in COR-11 (Table 65). UD-728 was found promising and ranked first over all the locations in the country and therefore may be release for national level.

Table 64. CVT of coriander 2008-09 at Jobner

Sl. No.	Entry	Days to flowering	Plant height (cm)	Branches/ plant	Umbels/ plant	Umbellets/ umbel	Seeds/ umbel	Test weight (g)	Seed yield (kg/ha)
1.	COR-1	75.00	88.93	9.33	34.40	5.80	43.07	9.61	1217.78
2.	COR-2	75.00	88.07	9.13	39.33	4.73	36.27	10.17	1151.11
3.	COR-3	75.67	89.67	9.07	30.27	5.00	41.80	10.42	1035.56
4.	COR-8	71.67	93.93	8.40	33.13	5.47	35.60	9.69	1017.78
5.	COR-9	71.33	89.00	8.00	29.67	5.53	35.67	10.05	808.89
6.	COR-15	61.67	62.67	5.40	26.27	4.67	23.47	11.68	631.11
7.	COR-16	61.33	65.20	5.87	19.33	5.13	29.33	12.28	426.67
8.	COR-18	63.33	63.80	5.40	19.80	4.87	23.07	14.42	324.44
9.	COR-19	64.00	68.33	5.73	23.20	5.13	27.87	12.76	968.89
10.	COR-20	69.33	55.40	5.73	26.13	4.87	25.80	14.13	592.89
11.	COR-21	74.33	69.40	7.07	20.60	5.60	30.40	10.36	537.78
12.	COR-22	68.00	58.13	6.20	22.40	4.67	20.20	14.35	511.11
13.	RCr-435 *(Check)*	64.67	82.20	7.67	32.40	5.67	39.00	10.99	995.56
14.	Local Check	66.33	90.73	7.20	31.47	5.20	36.73	10.43	755.56
	CD (P=0.05)	4.83	9.39	1.06	6.93	0.72	6.42	0.55	156.29
	CV (%)	4.19	7.35	8.86	14.89	8.33	11.94	2.84	11.88

Table 65. CVT of coriander (Pooled over three years) at Jobner

Sl.No.	Entry	Seed yield (kg/ha) 2006-07	2007-08	2008-09	Total	Mean
1	COR-1	1078.70	1207.56	1217.78	3504.04	1168.01
2	COR-2	847.22	744.44	1151.11	2742.77	914.26
3	COR-3	638.89	772.44	1035.56	2446.89	815.63
4	COR-4	578.70	285.78	-	864.48	432.24
5	COR-5	500.00	160.44	-	660.44	330.22
6	COR-6	527.78	368.00	-	895.78	447.89
7	COR-7	523.15	225.33	-	748.48	374.24
8	COR-8	875.00	548.44	-	1423.44	711.72
9	COR-9	1023.15	492.00	-	1515.15	757.58
10	COR-10	324.07	354.67	-	678.74	339.37
11	COR-11	208.33	410.67	-	619.00	309.50
12	COR-12	263.89	385.78	-	649.67	324.84
13	COR-15	875.00	352.44	533.33	1760.77	586.92
14	COR-16	504.63	169.33	453.33	1127.29	375.76
15	COR-17	458.33	249.33	-	707.66	353.83
16	RD-154	907.41	327.56	-	1234.97	617.49
17	RD-366	351.85	346.67	-	698.52	349.26
18	RCr-435 (Check)	722.22	752.00	995.56	2469.78	823.26
19	RCr-436 (Check)	476.85	400.89	-	877.74	438.87
20	RCr-684 (Check)	722.22	727.56	-	1449.78	724.89
21	Local (Check)	449.07	225.78	755.56	1430.41	476.80
	CD (P=0.05)	76.77	107.18	156.29		
	CV (%)	7.47	14.11	11.88		

Seventeen entries were tested for their performance of yield and yield attributing character at Kumarganj from 2005 - 2008 for a period of three years in R B D in a plot size of 2.00 x 2.40 m^2 at a spacing of 40 x 20 cm in three replication. Pooled analysis indicated that highest yield (18.28 q/ha) was obtained in COR-8 (NDCor-33) giving an increase of 37.03% of seed yield followed by yield of 17.91 q/ha in COR-1 (UD-728).

COR/CI/2.4 Coordinated Varietal Trial - 2009 - Series-VIII

(Ajmer, Dholi, Guntur, Hisar, Jabalpur, Jagudan, Jobner, Kumarganj, Navasari, Pantnagar, Raigarh, Udaipur)

At Ajmer a coordinated varietal trial was started during rabi season of 2009-10 to study the overall performance of different varieties. The maximum height was observed in COR-25, COR-26 and COR-29. COR-25, COR-26 and COR-29 exhibited early flowering while Cor-28 exhibited late flowering. Maximum yield was observed in COR-29 followed by COR-25, COR-26 and COR-30, which was at par to each other but higher than the yield of best check (Hisar Anand).

At Dholi, eleven coded promising entries and two checks (national check and local check) were tested under co-ordinated varietal trial. National check Hisar Anand and local check Rajendra Swati were found at par with each other regarding yield and yield attributing character except height of the plant. Among the promising entries, none of the entries was found significantly superior regarding number of umbellets per umbel, number of grains per umbellet, 1000-grain weight and yield per plot or per hectare as compared to national check Hisar Anand.

During 2009-10 rabi season, eleven genotypes of coriander from different coordinating centers were tested with Hisar Anand, Sudha and Local as checks in randomized block design with three replications at Guntur. Among the entries evaluated, COR-30 (820 kg/ha), COR-29 (808 kg/ha) COR-25 (762 kg/ha), COR-26 (754 kg/ha), recorded significantly higher yield than checks Sudha (644 kg/ha), local check (537 kg/ha) and national check Hisar Anand (447 kg/ha) (Table 66).

Table 66. CVT-2009 on coriander at Guntur

Sl. No.	Entry	Plant height (cm)	Primary branches	Secondary branches	Number of umbels	Number of umbellets/ umbel	Fruits/ umbel	Yield (kg/ha)	Oil (%)	Oil yield (l/ha)	Days to 50% flower-ing	Days to matu-rity
1	COR-25	64.9	5.5	15.6	26.5	7.2	41.6	762.3	0.43	3.31	55.3	98.3
2	COR-26	65.0	5.1	15.2	25.5	6.5	33.5	753.7	0.43	3.24	54.3	98.0
3	COR-27	62.3	4.9	12.7	21.2	5.7	32.5	430.6	0.35	1.52	60.3	106.0
4	COR-28	61.3	4.5	11.9	14.9	6.0	35.7	181.7	0.37	0.69	62.7	105.0
6	COR-30	68.9	5.7	13.2	26.6	6.1	36.9	820.2	0.43	3.54	54.3	97.3
7	COR-31	52.1	3.1	8.9	14.1	5.2	28.7	551.5	0.33	1.84	65.3	105.3
8	COR-32	60.5	5.0	11.9	21.8	6.0	27.7	467.3	0.32	1.48	62.7	106.3
9	COR-29	70.5	5.6	14.7	27.2	6.1	34.7	807.7	0.42	3.35	53.3	98.0
9	COR-33	56.0	4.5	10.1	17.3	5.8	32.7	456.2	0.27	1.19	64.0	104.7
10	COR-34	65.3	5.3	11.8	25.2	6.3	35.0	531.1	0.32	1.65	62.7	106.3
11	COR-35	51.1	4.7	9.3	16.8	5.6	27.7	239.2	0.33	0.78	63.0	109.3
12	Hisar Anand	60.7	4.1	11.5	23.4	4.7	25.0	446.5	0.22	0.97	65.3	111.7
13	Local	58.9	4.1	10.5	18.8	3.6	20.5	537.3	0.22	1.17	55.3	100.0
14	Sudha	59.3	4.7	15.7	22.9	5.4	23.7	644.1	0.37	2.36	55.7	100.7
	CD (P=0.05)	10.33	0.97	3.72	6.54	1.20	6.56	103.25	0.10	0.53	1.13	1.47
	CV (%)	10.04	12.05	17.90	18.02	12.46	12.52	11.27	17.65	16.27	1.13	0.85

At Hisar, significant differences were obtained for all the parameters. Plant height ranged from 95 to 125, number of branches 6.1 to 10.8, umbels per plant 48 to 108 and seeds per umbel 23.7 to 37.9. Maximum seed yield (2079 kg/ha) was recorded in COR-32 followed by COR-31 (2026 kg/ha) and COR-33 (1940 kg/ha) (Table 67).

Table 67. CVT 2009 in coriander at Hisar (2009-2010)

S.No.	Entry	Plant height (cm)	Branches/ plant	Umbels/ plant	Umbellets/ umbel	Seeds/ umbellet	Seeds/ umbel	Seed yield (kg/ha)
1.	COR-25	96	6.2	48	4.6	6.4	31.1	1376
2.	COR-26	98	6.1	59	4.9	6.3	33.0	1458
3.	COR-27	117	9.2	94	6.3	5.6	32.3	1923
4.	COR-28	115	8.9	80	5.9	5.8	35.8	1872
5.	COR-29	115	7.6	70	5.3	5.0	28.7	1678
6.	COR-30	103	6.2	58	4.8	5.0	23.7	1508
7.	COR-31	101	9.9	99	6.2	5.4	35.1	2026
8.	COR-32	125	10.8	108	5.7	5.4	31.1	2079
9.	COR-33	109	9.3	98	5.9	6.3	37.9	1940
10	COR-34	95	8.4	87	6.3	5.3	33.4	1881
11.	COR-35	117	6.5	68	5.4	6.1	34.3	1584
12.	Hisar Anand(Check)	109	7.8	78	5.9	5.9	34.7	1760
	CD (P=0.05)	7.0	0.5	9	0.3	0.3	3.0	120

Among the fifteen genotypes tested at Jabalpur maximum height of plant was observed in COR-34 (131.26 cm). Number of primary branches was maximum in COR-31(8.13) and minimum in COR-25(5.60). Maximum secondary branch was noted in Hisar Anand (13) and minimum in COR-30 (6.7). Number of umbels/plant was maximum in Hisar Anand (30.80) and minimum in COR-26 (17.80). Maximum number of umbellets/umbel (7.43) and yield/ha (18.75 q/ ha) was obtained in COR- 32.

The yield differences among the entries were significant at Jagudan. The entries COR-32 and COR-29 gave significantly highest yield (3094 and 2948 kgha^{-1} respectively), which was 33.13% and 26.84% higher over check G Cori-2, respectively.

At Kumarganj increase in seed yield of none of the entries were significant and was lower than that of Hisar Anand except in Cor-34 showing increase in yield of 0.84% (16.62 q/ha). Highest number of branches, and number of umbellets per umbel was recorded in COR-25.

COR/CI/3 Varietal Evaluation Trial

COR/CI/3.1 Initial evaluation trial 2008
(Kumarganj)

Ten promising lines from the germplasm were evaluated for their performance at Kumarganj, from 2006 - 2009 in R B D in a plot size of 2.0 x 2.4 m^2 at a spacing of 40 x 20 cm in three replication. NDCor-2 produced maximum seed yield of coriander during the three years of study showing an increase in yield of 52.22% over check Hisar Anand.

COR/CI/4 Quality Evaluation Trial

COR/CI/4.1 Quality evaluation in coriander
(Jobner)

CVT Coriander

Fourteen entries of coriander under CVT were tested for volatile oil content during rabi 2008-09, which was analyzed at Jobner. The volatile oil content in the entries ranged from 0.20% to 0.43%. The maximum volatile oil of 0.43% was observed in COR-1 followed by 0.40% in COR-2, COR-3, COR-8, COR-9 COR-15, COR-18 and RCr-435, while minimum of 0.20% was recorded in COR-22 and COR-16. The entry COR-1 ranked first in terms of volatile oil yield (5.24 l/ha) followed by COR-2 (4.60 l/ha), COR-3 (4.14 l/ha), COR-8 (4.07 l/ha) and RCr-435 (3.98 l/ha). While lowest volatile oil yield of 0.85 l/ha was recorded in COR-16 (Table 68).

Table 68. Volatile oil content of entries of coriander CVT in 2008-09 at Jobner

Sl. No.	Entry	Seed yield (kg/ha)	Volatile oil (%)	Volatile oil yield (l/ha)
1	COR-1	1217.78	0.43	5.24
2	COR-2	1151.11	0.40	4.60
3	COR-3	1035.56	0.40	4.14
4	COR-8	1017.78	0.40	4.07
5	COR-9	808.89	0.40	3.24
6	COR-15	631.11	0.40	2.52
7	COR-16	426.67	0.20	0.85
8	COR-18	324.44	0.40	1.30
9	COR-19	968.89	0.30	2.91
10	COR-20	592.89	0.30	1.78
11	COR-21	537.78	0.30	1.61
12	COR-22	511.11	0.20	1.02
13	RCr-435 Check	995.56	0.40	3.98
14	Local Check	755.56	0.33	2.49
CD (P=0.05)		156.29	0.04	
CV (%)		11.88	6.40	

IET coriander

Ten entries of coriander under IET were tested for volatile oil content during Rabi 2008-09. The volatile oil content in the entries ranged from 0.23% to 0.43%. The maximum volatile oil of 0.43% was observed in RCr-435 check followed by 0.40% in UD-562, UD-563, UD-565, UD-663, UD-794 and RCr-436, while minimum of 0.23% was recorded in UD-737. The entry UD-663 ranked first in terms of volatile oil yield (6.72 l/ha) followed by RCr-435 check (5.83 l/ha)), UD-794 (5.69 l/ha), UD-565 (5.11 l/ha) and RCr-436 (4.98 l/ha). While lowest volatile oil yield of 2.15 l/ha was recorded in UD-706.

COR/CM/5 Nutrient Management Trial

COR/CM/5.1 Effect of biofertilizer *Azospirillum* on coriander (Final report)
(Dholi)

The experiment was conducted at Dholi during year 2007-08 to 2009-10. The experiment was laid out in randomized block design with ten treatments and three replication. The pooled analyzed data (Table 69) showed

Table 69. Response of biofertilizer *Azospirillum* on coriander at Dholi (Pooled analysis 2007-08 to 2009-10)

Character Treatment	Plant height (cm)	Branches/ plant	Umbels/ plant	Umbellets/ umbel	Yield/ plot (kg/4.8 m^2)	Yield (t/ha)	Increase in yield over check t/ha	Increase in yield over check %	Gross income (Rs.)	Cost of cultivation (Rs.)	Net profit (Rs.)	Cost : benefit ratio
T_1	144.62	8.28	72.03	6.76	1.05	2.18	0.91	71.65	65,400	33,800	31,600	1:1.94
T_2	141.59	8.12	65.35	6.26	0.95	1.98	0.71	55.90	59,400	33,650	25,750	1:1.77
T_3	140.52	7.88	65.35	5.84	0.89	1.88	0.61	48.03	56,400	33,500	22,900	1:1.68
T_4	131.54	7.27	49.97	5.84	0.73	1.53	0.26	20.47	45,900	33,200	12,700	1:1.38
T_5	130.33	6.67	53.13	5.83	0.76	1.59	0.27	21.25	46.200	32,000	14,200	1:1.44
T_6	131.83	7.19	53.82	5.94	0.82	1.61	0.34	26.77	48,300	35,200	13,100	1:1.37
T_7	129.99	7.17	54.10	5.92	0.80	1.67	0.40	31.49	50,100	34,000	16,100	1:1.47
T_8	139.10	7.55	60.04	6.16	0.79	1.64	0.37	29.13	49,200	30,600	18,600	1:1.61
T_9	127.72	7.16	48.68	5.72	0.72	1.50	0.23	18.11	45,000	31,200	13,800	1:1.44
T_{10}	116.18	6.45	41.94	5.10	0.61	1.27	-	-	38,100	30,00	8,100	1:1.27
SEm(±)	4.77	0.65	2.46	0.22	0.04	0.10						
CD(P=0.05)	14.17	1.58	7.29	0.65	0.12	0.28						
CV (%)	6.19	12.49	7.52	6.48	8.35	9.92						

Note: A. Selling rate: Rs.3,000/- per quintal

B. Cost of fertilizer:

Azospirillum – Rs.1200/ha

FYM – Rs.40/quintal

Urea – Rs.276/50 kg bag

General cost – Rs. 30,000/ha

T_1- Inorganic N (100%) + FYM (5 t/ha) + *Azospirillum*; T_2- Inorganic N (75%) + FYM (5 t/ha) + *Azospirillum*; T_3- Inorganic N (50%) + FYM (5 t/ha) + *Azospirillum*; T_4- FYM (5 t/ha) + *Azospirillum*; T_5- FYM (5 t/ha) alone; T_6- FYM (10 t/ha) + *Azospirillum*; T_7- FYM (10 t/ha) alone; T_8- 100% inorganic nitrogen; T_9- *Azospirillum* @ 1.5 kg/ha; T_{10}- Control.

that all the treatments were statistically significant over control, (T_5) - FYM-5 t/ha alone, (T_7) - FYM-10 t/ha alone and (T_9) - *Azospirillum* @1.5 kg/hectare. Regarding number of branches per plant, inorganic N (100%) + *Azospirillum* + 5 t/ha FYM (T_1) and inorganic N (75%) + *Azospirillum* + 5 t/ha FYM (T_2) were found significant as compared to control. However, all the treatments were observed statistically significant over control and, Azospirillum @1.5 kg/ha alone (T_9) regarding number of umbels per plant and number of umbellets per umbel. While regarding number of grains per umbel, inorganic N (100%) *Azospirillum* + 5 t/ha FYM (T_1), inorganic N (75%) + *Azospirillum* + 5 t/ha FYM (T_2), inorganic N (50%) + *Azospirillum* + 5 t/ha FYM (T_3) and 100% inorganic nitrogen were observed significant as compared to control. However, all the treatments gave significantly more yield as compared to control, 5 t/ha FYM + *Azospirillum* (T_4) and *Azospirillum* @1.5 kg/ha alone (T_9). Among the treatments, application of inorganic N (100%) + Azospirillum + 5 t/ha FYM (T_1) gave the maximum height of the plant (144.62 cm), number of branches per plant (8.28), number of umbels per plant (72.03), number of umbellets per umbel (6.76), number of grains per umbel (54.64) and yield per plot (1.05 kg/4.8 m^2) or per hectare (2.18 t/ha) followed by inorganic N (75%) + *Azospirillum* + 5 t/ha FYM which gave plant height (141.59 cm), number of branches per plant (8.12), number of umbels per plant (65.35), number of umbellets per umbel (6.26), number of grains per umbel (45.72) and yield per plot (0.95 kg/4.8 m^2) or per hectare (1.98 t/ha). Cost : benefit ratio for, application of inorganic N (100%) + *Azospirillum* + 5 t/ha FYM (T_1) gave a maximum return of 1.94 per unit cost (1:1.94) followed by application of inorganic N (75%) + *Azospirillum* + 5 t/ha FYM (T_2) *i.e.*, Rs.1.77 per unit cost (1:1.77).

COR/CM/5.3 Identification of drought/ alkalinity tolerant source in coriander

(Guntur, Coimbatore, Kumarganj, Jobner)

During 2009-10, ten entries were selected from the germplasm based on the physiological drought parameters and further evaluated for their yield at Guntur. Among the entries evaluated, LCC-200 (659 kg/ha) recorded highest yield followed by LCC-143 (658 kg/ha) which were on par with each other and significantly superior to the check Sadhana (555 kg/ha). The yield evaluation trial was conducted for four years from 2006-2009. Among these four years, during 2007-08 and 2008-09, there was no rainfall after sowing thus offering the best test conditions as the crop was raised only on residual soil moisture. The pooled analysis of these two test years where there was no rainfall after sowing (2007-08 and 2009-10) indicated that LCC-200 (594 kg ha^{-1})) and LCC-143 (547 kg ha^{-1}) recorded significantly higher yield than the best check Sadhana (484 kg ha^{-1}) (Table 70).

The study of physiological parameters of forty germplasm lines revealed that high SLW was observed in LCC-229 (2.51 mg/cm^2), LCC-210 (2.44 mg/cm^2), LCC-187 (2.44 mg/cm^2), LCC-257 (2.38 mg/cm^2), LCC-184 (2.36 mg/cm^2) and LCC-200 (2.35 mg/cm^2). The SLW for checks was 2.09 mg/cm^2 for Sadhana, 1.73 mg/

Table 70. Identification of drought tolerance in coriander (Pooled analysis – 2007-08 to 2009-10) at Guntur

Sl. No.	Entry	Plant height (cm)	Primary branches	Secondary branches	Days to 50% flowering	Umbels/ plant	Umbellets/ umbel
1	LCC-143	56.6	3.9	9.7	51.3	15.6	4.7
2	LCC-150	53.5	3.9	8.1	47.7	14.7	4.5
3	LCC-159	51.2	3.5	7.1	49.7	12.2	4.6
4	LCC-164	55.8	3.9	9.5	52.0	15.9	5.3
5	LCC-183	52.8	3.5	6.6	50.7	10.0	4.6
6	LCC-184	41.2	2.8	6.3	50.7	11.1	3.9
7	LCC-187	53.3	3.6	8.4	49.8	11.9	4.9
8	LCC-200	49.0	3.5	9.1	50.8	16.2	5.2
9	Sadhana	51.9	3.1	7.3	51.2	12.8	4.7
10	Swathi	54.2	3.4	7.5	51.5	11.6	4.7
	CD (P=0.05)	6.0	0.7	1.4	1.5	2.2	0.6
	CV %	9.8	16.2	14.8	2.6	14.1	11.4

cm^2 for Sindhu, 1.98 mg/cm^2 for Swathi and 1.88 mg/cm^2 for Sudha. Similarly low SLW was recorded in LCC-245, LCC-246, LCC-248, LCC-250 and LCC-251 which are relatively drought susceptible. High RWC was recorded in LCC-262, Swathi, LCC-260, LCC-229 and LCC-170. High Water Potential (WP) was recorded in LCC-219, LCC-200, LCC-210, LCC-225 and LCC-260 where as low WP was recorded in LCC-251, LCC-150, LCC-143, LCC-248 and LCC-252.

In rabi 2008-09, forty two genotypes were evaluated in RBD with 3 replications in a plot size of 3.0 x 0.3 m^2 accommodating one row spaced 30 cm apart with intra row spacing of 10 cm maintained by thinning in irrigated as well as limited moisture condition at Jobner. Stress susceptibility index (SSI), Stress tolerance index (STI) and Stress tolerance (TOL) were calculated as per standard procedure. The analysis of variance revealed significant differences among the entries for all the traits including seed yield in irrigated as well as limited moisture condition experiment. The seed yield ranged from 7.71 to 30.18 g/5 plants in irrigated condition. The promising accessions identified were RCr-446, RCr-41, UD-374, RCr-435, RCr-684, UD-467, UD-488, UD-439, UD-274, UD-493, UD-476, UD-450 and UD-141, while it ranged from 2.94 to 14.36 g/5 plant in limited moisture condition. The promising accessions identified on the basis of yield are UD-143, RCr-684, RCr-480, UD-42, UD-490, UD-497, UD-274, RCr-41, UD-493, UD-115, UD-457, UD-119, UD-460 and UD-476. Stress susceptible index (SSI) for seed yield of coriander revealed that genotypes viz. UD-435, RCr-446, UD-450, RCr-436, UD-374, UD-467, UD-510, RCr-41, UD-10, UD-509, UD-277, UD-505, UD-137, UD-488, UD-322, UD-194, UD-258 and UD-481 were identified as tolerant to limited moisture condition. On the basis of stress tolerance (TOL), RCr-446, RCr-41, RCr-435, UD-374, UD-467, UD-450, RCr-436, UD-488, UD-10, UD-510, UD-509, UD-505, UD-194, UD-476, UD-137, UD-141 and UD-322 were identified as tolerant to limited moisture condition. On the basis of Stress tolerance index (STI), RCr-435, RCr-446, UD-450, RCr-436, UD-374, UD-467, UD-510, RCr-41, UD-10, UD-509, UD-277, UD-505, UD-137, UD-488, UD-322, UD-UD-194 and UD-258 were identified as tolerant to limited moisture condition. On the basis of over all ranking (SSI, TOL, STI), RCr-435, RCr-446, UD-450, UD-374, RCr-436, UD-467, RCr-41, UD-510, UD-10, UD-509, UD-488, UD-505, UD-137, UD-194, UD-277, UD-322, UD-481, UD-258, UD-483 and UD-141 were identified as tolerant to limited moisture condition.

At Kumarganj, maximum mean value of alkalinity tolerance was observed in ND Cor-15.

COR/CM/5.4 Role of rhizobacteria in growth promotion of coriander (Final report)

(Jagudan)

Two types of rhizobacteria (FK-14 & FL-18) and their methods of application with recommended dose of fertilizer were tested on coriander cv. GC-2 at Jagudan. The trial was laid out with an aim to determine the effect of rhizobacteria on growth, seed yield and quality of seed. Effect of different inoculation of rhizobacteria on growth and yield attributes as well as seed yield was non significant except number of umbels per plant and umbellates per umbel. The maximum number of umbel per plant was recorded when coriander received rhizobacteria FK-14 as seed and soil inoculation and it was at par with recommended dose of fertilizer (RDF) alone, FK-14 as seed inoculation, FK-14+FL-18 as seed inoculation and soil inoculation and *Trichoderma*. In general, growth and yield attributes as well as seed yield were higher when crop received only RDF (Table 71). Table 71.

COR/CM/5.5 Nutrient supplementation through organic manures for growth and yield of coriander

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

At Coimbatore, significant difference was observed between the treatments for all the growth and yield parameters studied. The seed yield per plot varied from 553.33 g to 816.67 g/plot. Among the eight treatments the treatment T_7 (recommended integrated nutrient package) has recorded the highest coriander seed yield (880 kg/ha) followed by treatment T_3 (FYM (50%) + vermicompost (50%) (816. 67 kg/ha). Both the treatments were on par (Table 72).

At Dholi, eight treatments including absolute control were tested for obtaining higher yield. Recommended dose of integrated fertilizer management (T_7) produced significantly higher yield per plot (1.60 kg/6 m^2) or hectare (2.6 t/ha) as compared to other treatment and absolute control.

Significant differences were obtained for all the parameters at Hisar. Maximum seed yield was recorded with the application of recommended INM of the centre (2138 kg/ha) followed by nitrogen supplemented with vermicompost (100%) -5 t/ha (1928 kg/ha) and recommended dose of fertilizer alone (1876 kg/ha) (Table 73).

Table 71. Role of rhizobacteria on growth and yield of coriander at Jagudan

Sl. No.	Treatment	Plant height (cm)	Branches/ plant	Umbels/ plant	Umbellates/ mainumbel	Seeds/ umbellates	Test weight (g)	Volatile oil content (%)	Yield (kg/ha^{-1})
1	FK-14 (seed inoculation)	93.6	5.7	57.3	6.6	6.7	13.82	0.42	2027
2	FK-14 (seed +soil inoculation)	84.6	6.2	67.7	5.6	7.0	13.75	0.40	1812
3	FL-18 (seed inoculation)	86.2	5.2	38.3	5.3	6.8	13.69	0.42	2095
4	FL-18 (seed +soil inoculation)	85.0	6.6	48.0	5.6	7.6	13.88	0.41	1801
5	FK-14+FL-18 (seed inoculation)	90.2	6.6	44.1	6.0	7.7	13.64	0.43	2008
6	FK-14 + FL-18 (seed +soil inoculation)	96.0	5.4	55.0	6.2	6.2	14.07	0.39	2190
7	*Trichoderma* (MTCC- 517)	91.0	6.9	53.2	7.6	8.6	13.99	0.43	1965
8	RDF	95.2	6.2	61.9	6.2	6.2	14.12	0.43	2191
	SEm ±	4.9	0.6	5.53	0.5	0.9	0.2	0.03	171
	CD (P=0.05)	NS	NS	16.77	1.4	NS	NS	NS	NS
	CV (%)	9.48	16.89	18.0	13.45	21.25	2.02	10.46	14.70

Table 72. Effect of organic manure on growth and yield of coriander (2009-10) at Coimbatore

Treatment	Plant height (cm)	Primary branches	Secondary branches	Umbels/ plant	Umbellets/ umbel	Seeds/ umbellets	Seed yield/ plot (g) (4 x 2.7 m^2)
T_1- FYM (100%) (10 t/ha)	65.18	4.67	9.89	31.33	6.22	31.78	616.67
T_2 - Vermicompost (100%) (5 t/ha)	71.12	4.67	10.78	32.00	5.22	31.78	613.33
T_3- FYM (50%) + vermicompost (50%)	64.76	5.67	12.78	36.00	6.89	36.33	816.67
T_4- FYM (25%) + vermicompost (75%)	66.81	6.33	12.89	42.56	6.78	37.11	706.67
T_5- FYM (75%) + vermicompost (25%)	61.92	5.11	11.89	37.00	6.44	35.33	593.33
T_6- RDF alone- chemical fertilizers	73.18	4.78	11.44	37.44	6.67	39.89	623.33
T_7 - Recommended INM package of the centre (FYM 5 t/ha + inorganic N 50% + *Azospirillum* 105 kg/ha (seed treatment)	53.23	4.56	10.89	32.11	5.78	33.33	880.00
T_8 - Absolute control	72.01	5.11	10.44	29.33	6.00	29.78	553.33
SED	1.04	0.33	0.74	2.30	0.41	2.29	45.14
CD (P= 0.05)	0.91	0.71	1.60	4.94	0.88	4.92	96.82

At Kumarganj highest and significant seed yield of coriander (17.149 q/ha) was recorded in recommended dose of chemical fertilizer (50:30:30 NPK/ha) followed by recommended INM package with an yield of 16.17 q/ha against the control yield of 12.18 q/ha. All the treatments showed significant increase in seed yield. Plant height, number of branches/plant, number of umbels/plant, number of umbellets/umbel significantly increased in recommended INM package of practices (Table 74).

Table 73. Effect of organic manures on growth and seed yield of coriander at Hisar

Sl. No.	Treatment	Plant height (cm)	Branches/ plant	Umbels/ plant	Number of umbellets/ umbel	Seeds/ umbellet	Seeds/ umbel	Seed yield (kg/ha)
1.	FYM (100%) @ 10 t/ha	107.5	8.3	90.5	6.3	5.7	36.6	1769
2.	Vermicompost (100%) – 5 t/ha	117.1	8.5	98.1	5.9	5.3	36.3	1928
3.	FYM (50%) + vermicompost (50%)	109.1	8.2	92.5	6.0	5.1	38.0	1783
4.	FYM (25%) + vermicompost (75%)	117.9	8.5	92.2	5.9	5.7	35.6	1848
5.	FYM (75%) + vermicompost (25%)	104.9	8.1	83.7	5.7	5.9	34.9	1738
6.	RDF alone	117.6	8.4	95.9	6.0	5.7	34.7	1876
7.	Recommended INM of the centre	120.4	8.6	100.9	6.1	5.6	36.6	2138
8.	Control	105.4	8.1	78.0	6.2	5.2	34.1	1689
	CD (P=0.05)		5.9	3.0	7.2	0.4	0.3	28

Table 74. Effect of nutrient supplementation through organic manures on the growth and yield of coriander at Kumarganj

Sl. No.	Treatment	Plant height (cm)	Branches/ plant	Umbels/ plant	Umbellets/ umbel	Seeds/ umbel	Yield (kg/plant)	Yield (q/ha)
1.	T_1 FYM (100%) @ 10 t/ha	106.16	5.4	99.4	5.4	40.4	0.726	15.13
2.	T_2 Vermicompost (100%) @ 5 t/ha	110.73	5.3	103.96	5.63	39.63	0.775	15.10
3.	T_3 FYM (50%)+ vermicompost (50%)	107.16	5.4	100.83	5.50	37.16	0.676	14.09
4.	T_4 FYM (25%)+ vermicompost (75%)	108.73	5.53	102.50	5.53	39.40	0.745	15.51
5.	T_5 YM (75%) + vermicompost (25%)	105.50	5.50	97.63	5.63	38.83	0.698	14.54
6.	T_6 RDF alone chemical fertilizer	112.83	5.50	106.83	6.30	42.40	0.82	17.14
7.	T_7 Recommended INM package of the centre	114.20	5.86	110.40	6.63	40.73	0.80	16.17
8.	T_8 Absolute control	95.40	5.10	93.16	5.1	35.83	0.625	12.81
	SEm±	11.86	0.16	11.83	0.145	0.47	0.14	0.30
	CD (P=0.05)	36.00	0.51	35.89	0.43	1.44	0.04	2.34
	CV (%)	19.87	5.39	20.98	0.49	2.09	3.4	2.16

COR/CM/5.6 Effect of micronutrients on yield of coriander

(Coimbatore, Dholi)

The seed yield varied from 420 g per plot to 786.67g per plot at Coimbatore. Among the twelve treatments imposed, the highest coriander seed yield was obtained in the treatment T_2 (0.5% foliar spray of zinc sulphate (2 sprays-45 & 60 days of sowing) (786.67 kg/ha) followed by T_{11} (0.5% foliar spray of manganese sulphate (2 sprays-45 & 60 days of sowing) (716.67 kg/ha)

whereas the seed yield observed in the control (T_{12}) was 493.33 g per plot.

At Dholi, the interaction of micronutrient X method of application was found non-significant regarding yield. Among the four micronutrients (four factor) *viz.*, zinc sulphate, ferrous sulphate, copper sulphate and managanese sulphate were found non-significant regarding yield. Among the three methods of application *viz.*, zero level, (control), soil application of micronutrient @25 kg/ha, foliar spray of micronutrient @0.5% at 45 and 60 days after sowing, soil application of micronutrient and foliar spray of micronutrient gave significantly more yield as compared to zero level of micronutrients. Foliar application of micronutrient @ 0.5% at 45 & 60 days after sowing gave maximum yield 2.89 t/ha followed by soil application of micro-nutrient @25 kg/ha *i.e.* 2.76 t/ha.

COR/CI/2.5 - Production of leafy type coriander in off-season (Final report)

(Guntur)

The present investigation was under taken to study the effect of different shade nets and genotypes suitable for summer season at Guntur for a period of three years from 2007-08 to 2009-10 during summer. The experiment was conducted in factorial RBD with three replications consisting of different levels of shade nets as one factor and genotypes as second factor. Six promising genotypes *viz.* LCC- 231, LCC- 234, LCC-242, LCC- 244 and Sadhana were valuated under open, 25%, 50% and 75% shade nets during summer season in FRBD with three replications. The pooled analysis of the three years data indicated that the genotypes under evaluation varied significantly for all the characters. Number of days taken for germination was more under open conditions than under shade net. Among the treatments days taken for germination was significantly less under 50% shade net (9.88 days) followed by 75% shade net (11.04 days). Sadhana (check) germinated earlier (11.20 days) and was on par with other genotypes. Number of leaves were significantly more under 50% and 75% shade net (6.11) than open conditions (4.41). Among the genotypes significantly more number of leaves were recorded in LCC-244 (6.43) being on par with LCC) 234 (6.12). With regard to yield (t/ha) significantly high yield was recorded with 50% shade net (3.59 (t/ha) followed by 35% shade net (3.01 (t/ha) than open conditions (0.51 t/ha). Among the genotypes significantly maximum yield was recorded in LCC-244 (3.18 t/ha) being on par with LCC-234 (2.89 t/ha) than check (1.87 t/ha). The pooled data pertaining to yield and other attributes indicated that off season coriander can be cultivated under 50% shade net with LCC -244 and LCC- 234 genotypes (Table 75).

Table 75. Effect of shade nets and genotypes on yield (t/ha) of coriander at Guntur

Genotype	Levels of shade				Mean
	0%	25%	50%	75%	
LCC-231	0.23	2.45	2.46	2.67	1.95
LCC-233	0.23	2.70	3.57	2.63	2.28
LCC-234	0.29	3.55	4.54	3.18	2.89
LCC-242	0.24	3.09	4.13	3.06	2.63
LCC-244	0.32	3.86	5.03	3.52	3.18
Sadhana	1.69	2.39	1.81	1.57	1.87
Mean	0.50	3.01	3.59	2.77	
	CD	CV			
Treatments	1.187	22.53			
Varieties	1.4537				
VT	2.9074				

COR/CM/5.7 Irrigation management for sustainable coriander production

(Guntur)

During 2009-10, three methods of irrigation were evaluated *i.e.* irrigation through raingun, sprinkler and flooding. Among the methods of irrigation, all were statistically at par. However, among the irrigation schedules, irrigation at 30 and 60 DAS recorded highest yield (995 kg/ha) followed by irrigation at 45 and 60 DAS (883 kg/ha) which were on par with each other and significantly superior to the control (611 kg/ha).

COR/CM/5.8 Large scale demonstration of the role of rhizobacteria in growth promotion of coriander

(Coimbatore, Guntur, Hisar, Jagudan, Raigarh)

The seed yield per plot varied from 846.25 kg/ha to 649.55 kg/ha at Coimbatore. Among the three treatments, the treatment T_1 (rhizobacteria FK-14 + FL-18 (seed treatment-600 g/ha + soil application – 800 g/acre) recorded the highest seed yield of 846.25 kg/ha followed by T_2 (rhizobacteria FL-18 (seed treatment + soil application) 715.00 kg/ha (Table 76).

Among the treatments evaluated at Guntur, the seed treatment and soil application of FK-14 + FL-18 resulted in significantly superior yield (1076 t/ha) over control (851 t/ha) which was on par with seed treatment and

Table 76. Effect of rhizobacteria on growth and yield parameters of coriander (2009-10) at Coimbatore

Treatment	Plant height (cm)	Primary branches	Secondary branches	Umbels/ plant	Umbellets/ umbel	Seeds/ umbel	Seed yield/ plot (g) (9 m^2)	Seed yield/ ha (kg)
T_1 - Rhizobacteria FK-14 + FL- 18 (seed treatment - 600 g/ ha + soil application – 800 g/acre)	72.06	7.50	16.90	42.40	6.60	39.10	770	846.25
T_2 - Rhizobacteria FL-18 (seed treatment + soil application)	53.21	7.60	14.20	39.30	6.10	28.90	650	715.00
T_3 - Control (farmers practice)	60.13	6.20	12.60	38.90	5.80	31.00	591	649.55
SED 2.46	0.31	0.71	1.69	0.36	1.91	0.20	18.85	
CD (P=0.05)	5.18	0.66	1.50	3.55	0.76	4.02	0.42	39.61

soil application with FK-14 alone (1037 t/ha). During 2009-10 rabi season, the experiment was conducted in ten different locations in farmers field consisting of seed treatment and soil application of FK-14 and seed treatment and soil application of FK-14 and FL-18. Among the treatments, maximum plant height was recorded in seed treatment and soil application of FK-14 and FL-18 (63.81 cm) followed by seed treatment and soil application of FK-14 (60.58 cm) which were on par with each other and significantly superior to the control (52.48 cm). Maximum numbers of primary branches were recorded in seed treatment and soil application of FK-14 and FL-18 (5.03) which was significantly superior to the control (3.91). Regarding number of umbels per plant, umbellets per umbel and seeds per umbel, seed treatment and soil application of FK- 14 and FL -18 (23.43, 6.0 and 27.29 respectively) and seed treatment and soil application of FK- 14 (21.32, 5.6, 23.47 respectively) were found superior to the control (1816, 4.8 and 19.54 respectively) (Table 77).

Significant differences were obtained for all the parameters at Hisar. Maximum seed yield (1731 kg/ha) was recorded with the application of rhizobacteria FL-18 (seed treatment + soil application) followed by *Trichoderma* MTCC- 5179 (1544 kg/ha) at Hisar.

COR/CP/6 Disease Management Trial

COR/CP/6.2 Survey to identify the disease incidence, collection and identification of casual organism

(Dholi)

Out of 115 germplasm, 53 and 12 numbers of germplasm were found highly resistant and resistant against stem gall disease under natural condition at Dholi. Coriander fields surveyed in Samastipur and Muzaffarpur districts of the State were found to be infested with stem gall disease caused by Protomyces macrosporus.

Table 77. Effect of rhizobacteria on growth and yield of coriander at Guntur

Treatment	Plant height (cm)	Primary branches	Secondary branches	Days to 50% flower	Days to maturity	Umbels	Umbellets/ umbel	Seed/ umbel	Yield (kg/ha)
Seed treatment+ soil application FK-14	60.58	4.64	7.08	54.3	98.8	21.32	5.6	23.47	1037
Seed treatment+ soil application FK-14 and FL-18	63.81	5.03	7.74	54.2	98.8	23.43	6.0	27.29	1076
Control	52.48	3.91	5.99	56.3	100.9	18.16	4.8	19.54	851
CD (P=0.05)	3.85	0.26	0.38	0.65	0.65	1.39	0.34	0.34	70.8

CUMIN

CUM/CI/1 Genetic Resources

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

(Jagudan, Jobner)

Germplasm of cumin is conserved at Jagudan and Jobner centers (Table 78). The germplasm conserved at Jagudan were compared with check GC-4 during rabi season 2009-10. Among them nineteen entries were dwarf types, having less than 28.6 cm plant height. Seventeen entries had good branches i.e. more or equal to 6.5 branches per plant. More than 40 umbels per plant were recorded by 18 entries. Two entries recorded more than 6 umbellates per umbel. Eleven entries were promising for more seeds per umbellate i.e. ≥ 7 seed per umbellate. Twenty two entries observed early maturity (≤ 95 days). Twelve entries were bold seeded having equal or more than 4.50 g test weight Eleven entries isolated as high yielder recorded more than 900 kgha^{-1} grain yield. The promising entries identified is given in (Table 79).

Table 78. Cumin germplasm collection maintained at AICRPS centres

Centre	Indigenous	Exotic	Total
Jagudan	207	7	214
Jobner	370	6	376
Total	577	13	590

Table 79. Promising entries of germplasm maintained at Jagudan

Character	Range	GC-4 (Check)	Desirable value	No. of entry	Promising entries identified
Plant height (cm) (Dwarf)	19.6-40.3	28.6	≤28.6	19	JC-95 -72, 96-7,8,99-3 ; 2000-4,9,11,20,21,27,28,29,31,40,47,53,56,61,72,2002-25,32
No. of branches/ plant (More branch type)	2.0-7.6	6.0	≥6.5	17	JC-94-167; 95-9,24,25,27,29,31,44,78,86,107,121,130; 96-3,6,34,45
No. of umbels/ plant (More umbels)	11.0-52.3	34.3	≥40	18	JC-94-61, 95 22,93,100,103,106,110,115,119,126,127, 128, 130, 138, 96-1,2,3,38
No. of umbellates/ umbel (More umbellate)	3.6-6.6	5.3	>6.0	2	JC-2000-29, 2000-56
No. of seeds/ umbellate(More seed)	3.6-7.3	5.3	>7.0	11	JC-95-29,32,93,102,116,125,129,96-3,9,16,18
Maturity days (Early maturing)	85-118	118	<95	22	JC-94-70,167,262; 95-10,96-4,5; 99-24,30,31,32,43; 2000-70;2002-12,14,15,16,17,20,21,23,24,29
Test weight (g)(Bold seeded)	2.56-5.02	4.46	<4.50	12	JC-95-9,10,12,96-6,7,16,18,23,49,99-44,45, 2002-4
Grain yield (kg ha^{-1})(High yield)	206-1000	994	>900	11	JC-94-61,95-17,27,86,107,108,110,128, 96-10,55,GC-4

Three hundred thirty two germplasm accessions were evaluated along with five checks namely, RZ-19, RZ-209, RZ-223, RZ-341 and local in augmented design at Jobner. Adequate variability was found for all the characters studied. Out of 344 accessions, 65 accessions were better than the best check variety RZ-209. Some of the promising accessions identified on the basis of yield per 5 plants were UC-292, UC-339, UC-272, UC-267, UC-293, JC-95-94, Wt-5, JC-95-92, JC-95-132, JC-95-21, JC-96-20, JC-95-76, JC-95-102, Wt-3, UC-19 and UC-336.

Multilocation evaluation of germplasm

A multilocational evaluation of cumin germplasm was carried out with 30 entries each from Jagudan, Jobner and Ajmer with four checks (two national checks, one as common check in group and one local check. Ninety germplasm accession of cumin from different parts of the country were evaluated along with four checks namely Hisar Anand, RCr-435, RCr-436 and Local in augmented design in one row plots of 3 x 0.3 sq.m. size. Limited range of variability was found for all the characters studied. Out of 90 accessions, 19 accessions were better than best check variety RZ-209. Some of the promising accessions identified on the basis of yield per 5 plants were C-08-19, UC-333, JC-188, C-08-33, JC-11, C-08-24, JC-94-167, C-08-42, JC-94-70, JC-262, JC-35, C-08-44, UC-285, JC-30and C-08-23.

CUM/CI/2 Coordinated Varietal Trial

CUM/CI/2.1 Coordinated Varietal Trial 2005 (Final report)

(Jobner)

Ten entries were evaluated at Jobner in RBD with 4 replications in a plot size of 3.0 x 2.4 m^2 accommodating eight rows spaced 30 cm apart with plant to plant distance of 5 cm. The analysis of variance revealed significant differences among the entries for all the traits including seed yield (Table 80). The seed yield ranged from 434.03 to 711.81 kg/ha. Of the ten entries evaluated, CUM-3 recorded maximum seed yield of 711.81 kg/ha followed by CUM-5 (673.61 kg/ha), CUM-2 (621.53 kg/ha), CUM-4 (618.06 kg/ha) and CUM-1 (600.69 kg/ha), while lowest seed yield of 434.03 kg/ha was recorded in RZ-209 check (Table 80). Mean performance of the entries evaluated in CVT over 2007-08 and 2008-09 revealed superior performance of CUM-3 (606.78 kg/ha) followed by CUM-5 (564.24 kg/ha), CUM-2 (502.61 kg/ha) and CUM-4 (489.59 kg/ha), while lowest seed yield of 381.95 kg/ha was recorded in local check (Table 80). UC-345 has been found promising and ranked first over the years (Table 81).

Table 80. CVT 2005 of cumin 2008-09 at Jobner

Sl. No.	Entry	Days to flowering	Plant height (cm)	Branches/ plant	Umbels/ plant	Umbellets/ umbel	Seeds/ umbel	Test weight (g)	Seed yield (kg/ha)
1	CUM-1	70.75	43.10	6.28	18.35	5.30	35.70	3.43	600.69
2	CUM-2	70.50	41.30	7.40	23.50	5.35	31.60	3.74	621.53
3	CUM-3	73.00	42.45	7.85	30.45	5.50	35.10	3.00	711.81
4	CUM-4	70.50	42.60	7.30	26.90	5.00	31.90	2.98	618.06
5	CUM-5	71.50	39.90	7.35	21.55	5.10	32.75	3.25	673.61
6	CUM-6	70.75	38.30	6.45	20.50	4.85	27.55	3.29	506.94
7	CUM-7	72.25	36.80	5.50	18.80	4.95	25.60	3.01	468.75
8	CUM-8	73.50	30.55	6.15	21.05	5.45	29.50	3.87	451.39
9	RZ-209 Check	73.00	39.95	6.75	18.70	5.15	31.60	4.19	434.03
10	Local Check	72.75	38.40	5.70	18.55	4.50	29.35	3.42	482.64
	CD (P=0.05)	1.94	2.97	0.83	3.79	0.52	4.57	0.31	69.38
	CV (%)	1.86	5.20	8.59	11.97	6.97	10.14	6.30	8.58

Table 81. Performance of cumin entries in CVT-2005 at Jobner (pooled over 2005-06 to 2008-09)

Sl. No.	Code No.	Entry	Days to flowering	Plant height (cm)	Branches/ plant	Umbels/ plant	Umbellets/ umbel	Seeds/ umbel	Test weight (g)	Seed Yield (kg/ha)
1	CUM-1	JC-95-12	77.75	35.50	6.08	19.51	5.15	29.07	3.33	427.43
2	CUM-2	JC-95-30	77.83	35.10	6.43	21.82	5.07	28.33	4.02	509.72
3	CUM-3	UC-345	78.92	36.40	6.72	26.35	5.03	30.75	3.47	607.06
4	CUM-4	UC-346	78.08	34.98	6.33	23.32	4.85	27.78	3.54	439.58
5	CUM-5	UC-347	79.25	34.53	6.03	22.32	4.75	27.07	3.94	546.41
6	CUM-6	UC-348	76.67	34.37	5.77	21.43	4.78	26.13	3.69	385.99
7	CUM-7	GC-3 Check	76.75	31.32	5.35	17.73	4.83	26.90	3.15	459.38
8	CUM-8	GC-4 Check	73.50	30.55	6.15	21.05	5.45	29.50	3.87	451.39
9	RZ-209 (Check)	RZ-209 Check	77.33	35.57	5.80	21.10	4.90	29.42	4.12	479.75
10	Local Check	Local Check	76.58	34.33	4.97	17.53	4.48	25.83	3.55	342.48

CUM/C1/2.2 Coordinated Varietal Trial – 2009

(Jobner, Jagudan, Ajmer, Jabalpur)

The trial is in the 1st year of progress. In rabi 2009-10, ten entries were evaluated in RBD with 4 replications at Jobner. The analysis of variance revealed significant differences among the entries for all the traits including seed yield. The seed yield ranged from 421.53 to 667.71 kg/ha. Of the ten entries evaluated, CUM-13 recorded maximum seed yield of 667.71 kg/ha followed by CUM-12 (618.75 kg/ha), RZ-223 check (616.67 kg/ha), RZ-345 check (608.68 kg/ha) and CUM-10 (558.76 kg/ha), while lowest seed yield of 421.53 kg/ha was recorded in GC-4 National check.

Seven genotypes of cumin were tested at Jabalpur. Out of the seven genotypes CUM-11 gave maximum plant height (43.91), number of secondary branches (9.83), number of umbels/plant (13.50), number of umbellate/umbel, and maximum yield/plant (101.66 g) and yield/ha (105.72 kg). Minimum plant height (37.90 cm), early flowering (63 days) and yield (25.0 g, 26.0 kg) were obtained by RZ-345. There was no significant effect of genotypes on number of primary branches and days to first flowering (Table 82).

At Ajmer, maximum height was observed in CUM-9 and CUM-13. The entries CUM-12 and CUM- 13 exhibited early flowering while all other entries were late flowering type. The maximum yield was observed in CUM-9 followed by CUM-11.

At Jagudan, the trial was vitiated due to poor germination and disease incidence.

CUM/CI/3. Initial evaluation trial

CUM/CI/3.3 Initial evaluation trial-2009 (Final report)

(Jobner)

At Jobner, ten entries were evaluated in RBD with 4 replications in a plot size of 3.0 x 2.4 m^2 accommodating eight rows spaced 30 cm apart with plant to plant distance of 5 cm maintained by thinning. Analysis of variance revealed significant differences among the entries for all the traits including seed yield. The seed yield ranged from 447.92 to 687.50 kg/ha. Of the ten entries evaluated, UC-299 recorded maximum seed yield of 687.50 kg/ha followed by UC-239 (663.19), UC-225 (631.94 kg/ha), RZ-223 check (576.39 kg/ha) and UC-274 (555.56 kg/ha) while lowest seed yield of 447.92 kg/ha was recorded in local check. Mean performance of the entries evaluated in IET over 2005-06 to 2008-09 revealed superior performance of UC-299 yielding 623.03 kg/ha followed by UC-239 (587.27 kg/ha), RZ-223 check (522.11 kg/ha), UC-225 (498.84 kg/ha) and UC-331 (470.14 kg/ha), while lowest seed yield of 355.21 kg/ha was recorded in Local check (Tables 83 & 84). UC-299 and UC-239 may be included in CVT.

CUM/CI/4 Quality Evaluation Trial

CUM/CI/4.1 Quality evaluation in cumin

(Jobner)

CVT entries

Ten entries of cumin under CVT were tested for volatile oil content during rabi 2008-09, which were analysed using Clevenger apparatus. The volatile oil

Table 82. Performance of CVT cumin at Jabalpur

Sl. No.	Genotype	Plant height	Primary branch	Secondary branch	Umbels/ plant	Umbellate/ umbel	Days to flowing	Yield/ plant(g)	Yield/ ha (kg)
1	RZ-345	37.90	5.10	8.93	10.13	4.2	63.0	25.00	26.00
2	CUM-13	39.96	4.16	7.66	11.50	4.2	63.3	48.33	50.26
3	CUM-09	40.32	3.86	6.26	11.13	4.0	64.3	63.33	65.86
4	CUM-12	39.38	5.13	7.20	12.86	5.2	65.0	98.33	102.26
5	CUM-10	40.42	4.36	6.66	13.06	5.4	66.6	101.66	105.72
6	CUM-11	43.91	4.86	9.83	13.50	5.6	66.0	101.66	105.72
7	GC-4 (Check)	40.40	4.23	7.60	10.03	4.2	63.6	25.00	26.00
	SEM+_	0.551	0.42	0.425	0.311	0.244	0.299	11.402	-
	CD (P=0.05)	1.697	NS	1.309	0.958	0.751	NS	35.130	36.53

Table 83. IET of cumin (2008-09) at Jobner

Sl. No.	Entry	Days to flowering	Plant height (cm)	Branches/ plant	Umbels/ plant	Umbellets/ umbel	Seeds/ umbel	Test weight (g)	Seed yield (kg/ha)
1	UC-225	65.25	39.70	6.08	20.65	5.10	32.00	3.97	631.94
2	UC-239	66.00	41.30	6.65	22.55	5.05	30.95	4.88	663.19
3	UC-273	63.25	42.40	6.65	25.55	5.40	29.85	4.64	531.25
4	UC-274	63.75	39.40	6.25	21.20	5.00	26.80	4.24	555.56
5	UC-299	64.75	43.00	7.10	25.65	5.30	30.55	4.33	687.50
6	UC-331	63.75	42.80	6.40	21.90	5.30	31.30	4.53	503.47
7	UC-334	69.25	43.00	6.60	22.80	4.80	32.60	4.23	534.72
8	RZ-223 (Check)	65.75	40.30	6.65	21.10	5.10	33.20	4.16	576.39
9	RZ-19 (Check)	67.00	42.00	6.55	19.45	5.00	30.90	4.16	510.42
10	Local (Check)	66.00	40.20	6.15	20.50	4.70	29.20	3.60	447.92
	CD (P=0.05)	1.37	4.78	0.45	3.84	0.38	2.60	0.29	94.55
	CV (%)	1.45	7.94	4.80	11.95	5.21	5.83	4.62	11.54

Table 84.Mean yield of cumin entries evaluated in IET at Jobner (pooled over three years)

Sl. No.	Entries	Yield (kg/ha) 2005-06	2007-08	2008-09	Mean
1	UC-225	503.47	361.11	631.94	498.84
2	UC-239	654.17	444.44	663.19	587.27
3	UC-273	338.19	270.83	531.25	380.09
4	UC-274	448.26	298.61	555.56	434.14
5	UC-299	692.01	489.58	687.50	623.03
6	UC-331	507.64	399.31	503.47	470.14
7	UC-334	499.65	321.18	534.72	451.85
8	RZ-223 Check	559.38	430.56	576.39	522.11
9	RZ-19 Check	541.32	322.92	510.42	458.22
10	Local Check	346.88	270.83	447.92	355.21
	CD (P=0.05)	105.76	63.42	94.55	
	CV (%)	14.32	12.10	11.54	

content in the entries ranged from 3.1% to 4.45%. The maximum volatile oil of 4.45% was observed in GC-4 (check) followed by 4.2% in CUM-11, 4.03% in CUM-9 and 3.83% in CUM-10 and minimum of 3.10% in Local check. The maximum volatile oil yield in terms of litre per ha was observed in CUM-10 (22.41 l/ha) followed by RZ-345 check (21.00 l/ha) and CUM-11 (20.39 l/ha), and minimum in CUM-13 (25.54 l/ha).

IET entries

The volatile oil content in the entries of IET cumin ranged from 2.58% to 3.10%. The maximum volatile oil of 3.10% was recorded in UC-259 followed by 3.03% in RZ-341 and Local check, 3.0% in UC-293 and UC-339, whereas minimum of 2.58% in RZ-19 check. Highest volatile oil yield was recorded in UC-339 (21.61 l/ha) followed by UC-293 (18.77 l/ha) and RZ-341 (16.94 l/ha) and minimum was recorded in Local check (10.62 l/ha).

CUM/CM/5 Nutrient management trial

CUM/CM/5.1 Identification of drought tolerance
(Jobner)

In rabi 2009-10, twenty genotypes were evaluated in irrigated as well as limited moisture condition. Results indicated non significant differences between the genotypes in both the environments, although the mean yield was higher in irrigated conditions (6.68 g per five plants). Among the genotypes UC-331 was the highest yielder in irrigated conditions while UC-274 was the highest yielder in limited moisture conditions. Based on the different drought indices (TOI, SSI and STI) CUM-7 was the best tolerant genotype followed by CUM-5 and CUM-4. RZ-19 was found to be least drought tolerant among the genotypes evaluated. The mean yield of cumin entries was higher in limited moisture conditions in both the years (2008-09 & 2009-10) in comparison to irrigated conditions. Similarly the average yield in both the environments was higher in the year 2009-10. Relative changes in the ranks of the genotypes over the years was noted. Based on average performance, UC-331 was the highest yielder, this was followed by UC-274 and UC-225 respectively in the irrigated conditions. While in limited moisture conditions, UC-239 followed by UC-274 and UC-225 were the best genotypes.

CUM/CM/5.2 Role of rhizobacteria on growth and yield of cumin
(Jagudan)

This is the third year of the experiment in which two different types of rhizobacteria and their methods of application with recommended dose of fertilizer were tested on cumin cv. GC-4 at Jagudan. The trial was laid out with an objective to study the effect of rhizobacteria on growth, yield and quality of seed. The growth and yield attributes as well as seed yield of cumin was not influenced significantly due to different strains of rhizobacteria and its method of application. However, strains FK-14 and FL-18 applied as seed and soil inoculation recorded the maximum growth and yield attributes as well as seed yield of cumin (Table 85).

CUM/CM/5.3 Effect of bioregulators 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. On the basis of first year (2007-08) experiment, application of bioregulators i.e. NAA and triacontanol resulted in significantly higher number of umbellets and seeds per umbel and seed yield of cumin over water spray while in second year

Table 85. Role of rhizobacteria on growth and yield of cumin at Jagudan

Sl. No.	Treatment	Plant height (cm)	Branches/ plant	Umbels/ plant	Umbel-lates/ main umbel	Seeds/ umbel-lates	Test weight (g)	Volatile oil content (%)	Yield (kg ha^{-1})	Increase over check %
1	FK-14 (seed inoculation)	25.4	3.2	16.8	4.8	4.9	3.69	3.87	498	-
2	FK-14 (seed + soil inoculation)	25.8	3.3	14.8	4.6	4.9	3.66	4.27	573	01
3	FL-18 (seed inoculation)	24.6	3.4	16.2	4.7	5.2	4.00	3.83	626	11
4	FL-18 (seed + soil inoculation)	26.0	3.4	17.9	4.6	4.3	3.97	4.00	561	-
5	FK-14+FL-18 (seed inoculation)	25.9	3.6	17.9	4.8	4.4	3.75	4.10	632	12
6	FK-14 + FL-18 (seed + soil inoculation)	25.1	3.2	16.8	5.0	4.2	4.04	4.10	561	-
7	*Trichoderma* (MTCC 517)	24.3	3.0	13.3	4.7	4.6	3.87	4.17	611	08
8	RDF	23.9	2.9	15.2	4.6	4.2	3.71	4.13	565	-
	SEm ±	-	0.6	0.2	1.4	0.3	0.28	0.17	0.13	42
	CD (P=0.05)	-	NS	NS	NS	NS	NS	NS	NS	NS
	CV %	-	4.4	10.7	15.0	11.2	10.72	7.87	5.45	12.70

(2008-09) application of bioregulators i.e. NAA and triacontanol resulted in significantly higher growth (plant height and branches per plant) yield attributes (umbels per plant, umbellets per umbel and seeds per umbel) and yields (biological and seed) over water spray (Tables 86 & 87). 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 recorded in the absolute control as compared to the mean of all other treatments.

Table 86. Effect of bioregulators on yield attributes of cumin at Jobner (2008-09)

Treatment	Plant height (cm)	Branches/ Plant	Umbels/ plant	Umbellets/ umbel	Seeds/ umbel	Test weight (g)	Volatile oil content (%)
Bio-regulators							
Triacontanol @ 0.5 ml/litre	41.0	5.3	17.6	4.78	30.9	4.85	3.12
Triacontanol @ 1.0 ml/litre	41.2	5.6	18.5	4.87	31.9	4.98	3.20
NAA @ 50 ppm	41.5	5.6	19.1	5.13	33.6	5.46	3.22
Water spray	39.6	4.9	14.8	4.62	29.7	4.76	3.50
CD (P = 0.05)	1.0	0.3	2.0	0.22	2.7	NS	NS
Sprays							
One (40 DAS)	40.5	5.3	16.8	4.78	31.5	4.88	3.13
Two (40 & 60 DAS)	41.0	5.4	17.7	4.87	31.6	5.23	3.16
Three (40, 60 & 80 DAS)	40.9	5.4	17.9	4.90	31.6	4.92	3.18
CD (P = 0.05)	NS	NS	NS	NS	NS	NS	NS
Control v/s Rest							
Control	39.0	5.6	14.5	4.40	28.1	4.51	2.90
Rest	40.8	5.4	17.5	4.85	31.5	4.97	3.14
CD (P = 0.05)	1.2	0.4	2.4	0.27	3.3	NS	NS

Table 87. Effect of bioregulators on seed yield of cumin at Jobner (2007-08 & 2008-09)

Treatment	Biological yield (kg/ha)			Seed yield (kg/ha)		
	2007-08	2008-09	Mean	2007-08	2008-09	Mean
Bio-regulators						
Triacontanol @ 0.5 ml/litre	1239	1759	1499	440	528	484
Triacontanol @ 1.0 ml/litre	1284	1910	1597	479	544	512
NAA @ 50 ppm	1286	1892	1589	503	551	527
Water spray	1233	1632	1433	399	405	402
CD (P = 0.05)	NS	193	-	39	60	-
Sprays						
One (40 DAS)	1233	1736	1485	443	484	464
Two (40 & 60 DAS)	1265	1823	1544	456	521	489
Three (40, 60 & 80 DAS)	1283	1836	1560	467	516	492
CD (P = 0.05)	NS	NS	-	NS	NS	-
Control v/s Rest						
Control	1236	1562	1399	401	389	395
Rest	1260	1798	1529	455	507	481
CD (P = 0.05)	NS	-	-	47	74	-

CUM/CP/6 Disease Management Trial

CUM/CP/6.1 Management of wilt and blight diseases in cumin

(Jobner)

The recommendations for management of wilt and blight disease in cumin based on the pooled data of three years was developed by Jobner centre. Based on yield, soil solarization + soil application of *Trichoderma* + FYM (5 t/ha) + spray with mancozeb 0.25% (60 DAS) was found to be superior among all the treatments followed by vermicompost (2 t/ha) + Trichoderma + spray with mancozeb 0.25% (60 DAS). Based on the B:C ratio, the soil drenching with carbendazim 0.1% + spray with mancozeb 0.25% (60 DAS) was found to be superior with highest B:C ratio (1.65:1) because of lowest treatment cost (Table 88).

Table 88. Management of wilt and blight in cumin (Pooled data of three years) at Jobner

Sl. No	Treatment	Wilt (%)				Blight (%)				Yield (kg/ha)		B:C ratio	
		2006-07	2007-08	2008-09	Pooled	2006-07	2007-08	2008-09	Pooled	2006-07	2007-08	2008-09	Pooled
1.	Soil solarization + soil application of *Trichoderma* + FYM (5 t/ha) + spray with mancozeb 0.25% (60 DAS)	5.67	5.06	5.57	5.43	4.67	6.67	4.13	5.16	294	258.67	351.33	301.33
2.	*Trichoderma* + FYM + spray with mancozeb 0.25% (60 DAS)	8.00	7.85	7.45	7.77	5.33	8.67	6.67	6.89	230	227.67	240.33	232.67
3.	Vermicompost (2t/ha) + *Trichoderma* + spray with mancozeb 0.25% (60 DAS)	7.00	6.82	6.87	6.90	5.30	7.33	4.86	5.83	235	234.33	251.00	240.11
4.	Neem cake (2 t/ha) + *Trichoderma* + spray with mancozeb 0.25% (60 DAS)	8.43	8.04	7.96	8.14	6.00	9.00	7.33	7.44	226	216.67	212.00	218.22
5.	Soil drench with carbendazim 0.1% + spray with mancozeb 0.25% (60 DAS)	7.26	10.10	9.02	8.79	5.67	8.33	6.47	6.82	234	230.33	230.00	231.44
6.	*Pseudomonas fluorescens* (IISR-6) 10^8 cfu as seed treatment and spray (60 DAS)	12.93	12.27	13.10	12.77	28.67	20.00	14.00	20.89	214	204.00	191.33	203.11
7.	*Bacillus subtilis* as soil application and foliar spray (60 DAS)	14.79	13.57	16.90	15.09	30.00	21.67	17.44	23.04	208	190.67	168.67	189.11
8.	*P. fluorescens* + *Trichoderma* as soil application + *P. fluorescens* (IISR-6) 10^8 cfu as spray (60 DAS)	12.26	15.54	14.63	14.14	30.67	22.00	19.68	24.12	212	200.00	191.00	201.00
9.	*B. subtilis* + *Trichoderma* as soil application + *P. fluorescens* (IISR-6) 10^8 cfu as spray (60 DAS)	12.38	16.00	19.87	16.08	33.33	24.33	19.96	25.87	212	200.67	164.33	192.33
10.	Seed treatment + spray with NSKE 5%	10.23	11.50	8.33	10.02	8.00	13.33	9.68	10.34	219	207.00	200.00	208.67
11.	Control	20.00	22.12	26.35	22.82	55.33	38.33	24.57	39.41	156	162.67	97.67	138.78
	CD (P = 0.05)	1.88	1.64	1.79	-	4.46	1.95	2.19	-	43.32	40.21	34.10	-
	CV (%)	10.44	5.02	5.65	-	13.83	5.07	7.69	-	13.02	14.10	10.56	-

FENNEL

FNL/CI/1 Genetic Resources

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

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

The germplasm of fennel maintained at various AICRPS centres are given in Table 89. Fifty four accessions of fennel were tested for yield at Dholi. Out of fifty four accessions, twelve accessions, namely, RF-31, RF-21, RF-23, RF-5, RF-11, RF-15, RF-16, RF-33, JF-444-1, GF-2, RF-10 and RF-38 gave the maximum yield ranging from 1.05 kg to 0.70 kg/5.4 m^2 as compared to high yielding variety Rajendra Saurabh (0.65 kg/5.4 m^2) used as check. Among the promising lines, RF-31 produced maximum yield (1.05 kg/5.4 m^2) followed by RF-21 (1.00 kg/5.4 m^2).

Table 89. Fennel germplasm collections maintained at various AICRPS centres

Centre	Indigenous	Exotic	Total
Dholi	54	-	54
Guntur	2	-	2
Hisar	134	-	134
Jagudan	129	2	131
Jobner	261	20	281
Kumarganj	49	-	49
Total	629	22	651

Ninety-six accessions of fennel were evaluated during 2009-2010 in two row plots of 3.0 m length each using GF-2 and HF-33 as checks at Hisar. The mean seed yield of the germplasm ranged from 108 g/plant (SEL-4) to 434 g/plant (HF-145). The most promising lines were HF-136, HF-141, HF-142, HF-145, HF-151, HF-152, HF-168, HF-169, HF-170, HF-212 and HF-213.

During kharif and rabi season, 125 and 16 indigenous and 2 and 1 exotic entries of fennel were evaluated for different yield attributes with four checks i.e. PF-35, GF-, GF-2 and GF-11, respectively at Jagudan and were classified based on various parameters (Table 90).

In rabi 2009-10, one hundred forty four S6 progeny of fennel were evaluated along with three checks namely, RF-101, RF-125, RF-143. Wide range of variability was found in the inbred lines which will be used for exploitation of heterosis in fennel.

Two hundred and fifty two germplasm accessions were evaluated along with five checks namely, RF-101, RF-125, RF-143, RF-178 and local in augmented design in one row plots of 3.0 x 0.45 m^2 size at Jobner. Wide range of variability was found for all the characters studied. Out of 252 accessions, 70 accessions were better than best check variety RF-178. Some of the promising accessions identified on the basis of yield per 5 plants were UF-42, UF-53, UF-117, UF-116, UF-40, UF-168, UF-7, UF-135, UF-33, UF-32, UF-132, UF-149, UF-79, UF-179, UF-119, UF-17, UF-11, UF-9, UF-143, UF-1, UF-167, UF-137, UF-157, UF-30, UF-128, UF-28, UF-146 and UF-164.

At Kumarganj, out of 49 germplasm screened, NDF-47 gave maximum seed yield of 10.45 q/ha. The yield of NDF-46, NDF-45 and NDF-44 was at par with NDF-47 with a seed yield of 10.35, 10.30, and 10.15 respectively, over control of 8.70 q/ha (GF-2) and 9.30 (RF-101). Seed yield ranged from 3.40 to 10.45 q/ha. A multilocational evaluation of germplasm was also carried out at the centre.

Fifty-eight germplasm maintained at Guntur were evaluated and LFC-122 recorded highest yield of 1.41 g followed by LFC-78 (1.26 g), LFC-114 (1.18 g), and LFC-102 (1.13) which are significantly superior to checks Lam Selection-1 (0.72 g), Hisar Sonali (0.62 g), LFC-84 (0.94 g) and Local (0.50 g).

Multilocational evaluation of fennel

A multilocational evaluation of germplasm with 90 germplasm accession of fennel from different parts of the country were evaluated at Jagudan along with four checks namely GF-11, RF-101, RF-125 and local in augmented design . A wide range of variability was found for all the characters studied. Out of 90 accessions, 12 accessions were better than best check variety GF-11.

Table 90. Germplasm of fennel found promising at Jagudan

Sl. No.	Character	Range	GF-2 (check)	Desirable character	No. of entries	Promising entries identified
1	Plant height (cm)(Dwarf)	120-210	154	<145	9	JF-673, JF-664, JF-642, JF-523, JF-522-2, JF-675, JF-546, JF-522 & JF-417
2	No. of branches/plant (More branches)	6-17	10	>13	5	JF-608, JF-532, JF-530, JF-677-1 & GF-11
3	No. of umbels/plant (More umbels)	11-65	52	>52	7	JF-478, JF-444-2, JF-550-1-1, JF-484,GF-12 & JF-660
4	No. of umbellates/ umbel (More umbellates)	20-120	36	≥80	12	JF-519, JF-671-1, JF-442-1, JF-674, JF-647, JF-522-1, JF-600, JF-494, JF-550-2-,JF-596, JF-676 & JF-679
5	No. of seeds/ umbellate (More seeds)	26-79	46	>60	16	JF-351-5, JF-522-2, JF-512-2, JF-497-, JF-501-2, JF-573, JF-676-1, JF-514-2, JF-518-2, JF-539-1, JF-675-1, JF-522, JF-494, JF-503, JF-550-2-2 & JF-671-2
6	Maturity days(Early)	189-252	231	<210	10	JF-664, JF-674-1, JF-660, JF-583, JF-600, JF-563, JF-533-2, JF-647, JF-642 & JF-609
7	1000 Seed weight (g)	4.9-11.3	8.2	>9	6	JF-533-2, JF-528, JF-351-1-3, JF-569, JF-493 & JF-679
8	Grain yield/plant (g) (High yield)	75-395	292	>300	17	JF-478, JF-550-1-1, JF-550-2-2, JF-484, JF-679-1, JF-531-1, JF-530, JF-456-2, JF-444-2, JF-473, JF-460, JF-485-1, JF-421, JF-548, JF-569, GF-12 & JF-494
9	Grain yield (kg ha^{-1}) (High yield)	1389-7315	5408	>5555	17	....As above....

Some of the promising accessions identified on the basis of yield per 5 plants were JF-442-3, JF-376, AF-04-32-2, AF-255, JF-351-1-3, JF-351-5, AF-12-01, JF-200, UF-5, JF-359-1 and AF-206.

FNL/CI/2 Coordinated Varietal Trial

FNL/C1/2.2 CVT-2004-Series V (Final Report)

(Kumarganj)

In order to evaluate the performance of different cultivars/lines at different location, a coordinated varietal trial was conducted at Kumarganj center. Entries from FNL -12 to FNL-21 were tested for their performance of yield and yield attributing character against FNL-22 (GF-2) and FNL-23 (RF-101) used as check at this center. The field experiment was conducted at Kumarganj from 2006 - 2009 for a period of three years in R B D in a plot size of 2.0 x 2.40 m^2 at a spacing of 60 x 40 cm in three replications. Evaluation of three years of mean values showed that yield of all the entries were below the check GF-2 but was significantly higher than the check RF-101. FNL-20 (NDF-29) produced mean seed yield of 12.77 q/ha showing an increase in seed yield of 60.45% over check RF-101 (7.89 q/ha).

FNL/C1/2.3 CVT-2007-Series VI

(Jobner, Kumarganj)

Fourteen entries were evaluated at Jobner in RBD with 3 replications in a plot size of 2.0 x 2.5 m^2 accommodating five rows spaced 50 cm apart with intra row spacing of 20 cm. The analysis of variance revealed significant differences among the entries for all the traits including seed yield. The seed yield ranged from 1731.48 to 2722.22 kg/ha. Of the fourteen entries evaluated, entry FNL-26 recorded maximum seed yield of 2722.22 kg/ha followed by FNL-25 (2337.96 kg/ha), FNL-31 (2231.48 kg/ha), FNL-28 (2203.70 kg/ha), FNL-27 (2138.89 kg/ha), FNL-32 (2125.00 kg/ha), and FNL-24 (2032.41 kg/ha), while lowest seed yield of 1731.48 kg/ha was recorded in local check. Mean performance of the entries evaluated in CVT over 2007-08 and

Table 91. CVT- 2007 of fennel at Jobner 2008-09

Sl. No.	Entries	Days to flowering	Plant height (cm)	Branches/ plant	Umbels/ plant	Umbellets/ umbel	Seeds/ umbel	Test weight (g)	Seed yield (kg/ha)
1.	FNL-24	93.00	146.87	6.13	18.87	22.53	472.67	7.88	2032.41
2.	FNL-25	92.33	174.47	7.20	23.20	28.67	584.93	6.46	2337.96
3.	FNL-26	90.33	148.73	7.07	23.80	28.13	604.67	7.01	2722.22
4.	FNL-27	90.00	138.20	5.73	12.27	29.40	609.67	7.10	2138.89
5.	FNL-28	89.00	138.27	6.87	18.80	29.33	538.93	8.50	2203.70
6.	FNL-29	89.33	149.33	6.53	15.87	26.67	558.13	6.43	1875.00
7.	FNL-30	90.33	142.87	5.80	19.33	23.47	460.67	6.62	1935.19
8.	FNL-31	89.33	152.07	6.67	21.87	27.13	443.00	7.61	2231.48
9.	FNL-32	89.67	157.33	6.20	16.20	27.73	780.80	7.15	2125.00
10.	FNL-33	89.00	151.80	6.47	19.27	24.87	606.67	7.22	1986.11
11.	FNL-34	94.33	180.07	6.53	12.87	25.53	520.53	5.65	1736.11
12.	FNL-35	96.00	159.27	5.20	11.27	25.13	417.33	7.62	1740.74
13.	FNL-36	91.67	164.93	6.53	15.33	27.73	545.27	5.61	1828.70
14.	Local check	89.00	149.67	5.60	11.60	21.87	394.20	6.84	1731.48
	CD (P=0.05)	3.16	14.43	0.92	3.38	3.99	109.46	0.32	251.69
	CV (%)	2.10	5.67	8.79	11.89	9.19	12.30	2.78	7.45

2008-09 revealed superior performance of FNL-25 yielding 2398.98 kg/ha followed by FNL-26 (2372.11 kg/ha), FNL-24 (2032.41 kg/ha), RF-125 check (1950.68 kg/ha), FNL-28 (1840.19 kg/ha), RF-178 check (1786.67 kg/ha) and FNL-30 (1730.93 kg/ha), while lowest seed yield of 1424.08 kg/ha was recorded in local check (Tables 91, 92).

At Kumarganj, significant differences between the yield of all the entries was observed. Significantly high yield of 8.57 q/ha was recorded in FNL-31 followed by 8.12 q/ha in FNL-35. (Table 93).

FNL/C1/2.4 Coordinated Varietal Trial - 2009 – Series VII

(Ajmer, Dholi, Hisar, Jabalpur, Jagudan, Jobner, Kumarganj, Pantnagar, Udaipur, Raigarh)

Coordinated varietal trial-2009 was started during rabi season of 2009-10 to study the overall performance of different varieties under Ajmer condition. The maximum plant height at maturity was recorded in FNL-39 followed by FNL-42, FNL-40 and FNL-45. In respect to days to 50% flowering and days to maturity, there is no significant difference, however, FNL-38 flowered little earlier and matured few days later as compared to other entries. The maximum yield was exhibited by FNL-38 which was higher over national and local checks. All other entries yielded less as compared to national checks (Table 94).

Table 92. Mean yield performance of fennel entries evaluated in CVT at Jobner

Sl. No.	Entries	Yield (kg/ha) 2007-08	2008-09	Mean
1	FNL-24	-	2032.41	2032.41
2	FNL-25	2460.00	2337.96	2398.98
3	FNL-26	2022.00	2722.22	2372.11
4	FNL-27	1282.00	2138.89	1710.45
5	FNL-28	1476.67	2203.70	1840.19
6	FNL-29	1323.33	1875.00	1599.17
7	FNL-30	1526.67	1935.19	1730.93
8	FNL-31	753.33	2231.48	1492.41
9	FNL-32	1280.00	2125.00	1702.50
10	FNL-33	986.67	1986.11	1486.39
11	FNL-34	1346.67	1736.11	1541.39
12	FNL-35	1466.67	1740.74	1603.71
13	FNL-36	1626.67	1828.70	1727.69
14	Local Check	1116.67	1731.48	1424.08
15	RF-125 (Check)	1950.67	-	1950.67
16	RF-178 (Check)	1786.67	-	1786.67
	CD (P=0.05)	302.62	251.69	
	CV (%)	12.11	7.45	

Table 93. Performance of CVT- 2007 fennel at Kumarganj

Sl. No	Entries	Plant height (cm)	No. of branches/ plant	No. of umbel/ plant	No. of umblets/ umbel	No. of grain/ umbels	Yield (q/ha)
1.	FNL-24	118.00	3.3	108.40	24.50	19.73	6.31
2.	FNL-25	124.06	3.06	106.50	23.40	20.16	6.73
3.	FNL-26	126.50	2.63	105.73	23.50	22.16	6.10
4.	FNL-27	113.73	3.3	109.06	25.40	15.16	7.08
5.	FNL-28	115.50	2.96	109.50	21.50	14.06	7.77
6.	FNL-29	111.73	2.63	111.14	20.73	17.50	6.04
7.	FNL-30	107.50	3.20	106.06	24.50	23.40	7.32
8.	FNL-31	115.83	2.63	105.16	25.40	23.73	8.57
9.	FNL-32	117.96	2.63	110.40	18.40	18.30	6.56
10.	FNL-33	107.26	3.20	113.50	21.16	22.83	7.39
11.	FNL-34	110.73	3.40	107.20	23.16	17.06	6.38
12.	FNL-35	121.40	2.63	109.40	25.40	20.50	8.12
13.	FNL-36	113.83	3.3	108.40	25.16	18.73	7.28
	SEm±	1.04	0.18	0.98	0.67	0.86	0.20
	CD (P=0.05)	3.04	0.55	2.87	1.98	2.52	0.59
	CV (%)	1.56	10.96	1.56	5.02	7.68	5.03

Table 94. Performance of CVT – 2009 fennel at Ajmer

Sl. No	Entries	Plant height at maturity	Primary branches/ plant	Secondary branches/ plant	Days to flower-ing	Days to matu-rity	Umbels/ plant	Umbellate/ umbel	Test weight (g)	Seeds/ umbel-late	Yield (kg/ha)
1	FNL-37	101.09	7.67	6.44	112	154	15.89	29.67	7.37	27.00	702.67
2	FNL-38	97.57	8.55	9.01	109	158	18.56	33.89	8.26	31.78	980.00
3	FNL-39	114.80	6.78	7.55	115	150	14.44	27.78	6.66	28.40	652.00
4	FNL-40	107.10	6.11	6.11	112	150	13.10	26.11	6.35	27.45	601.00
5	FNL-41	106.20	8.11	7.67	114	155	16.78	29.44	8.16	28.22	730.00
6	FNL-42	113.90	8.34	6.11	112	154	12.02	26.72	8.31	25.02	660.55
7	FNL-43	95.17	7.56	4.56	113	152	11.78	24.00	7.32	24.42	610.00
8	FNL-44	100.30	8.37	6.89	112	154	13.78	28.38	7.61	28.38	720.40
9	FNL-45	106.10	6.55	6.22	113	152	13.42	25.89	7.56	24.62	612.47
10	FNL-46	103.90	8.11	6.44	114	152	14.89	27.81	6.46	26.01	615.33
11	GF-11	98.70	8.55	7.22	117	155	15.33	28.66	7.86	29.44	740.00
12	RF-125	76.40	7.78	7.62	109	160	17.10	32.22	7.99	30.89	935.67
	S.Em	3.18	0.30	0.27	3.55	5.49	0.53	1.25	0.28	1.10	28.91
	CD (P=0.05)	9.32	0.89	0.80	NS	NS	1.56	3.67	0.82	3.23	84.80
	CV%	8.25	7.21	7.85	-	-	7.46	8.11	7.17	8.22	7.49

Among the promising entries and check evaluated at Dholi, entry FNL-41 recorded significantly more number of main branches per plant (11.50), as compared to local check Rajendra Saurabh (8.66). Entries FNL-41 and FNL-45 gave significantly more number of umbels per plant (86.00 & 77.33) over local check Rajendra Saurabh (60.16). However, promising entries FNL-43, FNL-45 and FNL-41 gave significantly higher yield (2106.48, 1851.85 & 1597.22 kg/ha respectively) as compared to local check Rajendra Saurabh (1365.74 kg/ha) (Table 95).

Significant differences were obtained for all the parameters studied in fennel entries at Hisar. Plant height ranged from 143.2 to 162.7, number of branches from 8.1 to 9.6, umbels per plant from 38.4 to 57.4, umbellate per umbel from 28.4 to 35.9 and seeds per umbel from 314.3 to 704.8. Maximum seed yield was recorded as 1876 kg/ha in FNL-41 followed by FNL-40 (1858 kg/ha) and FNL -44 (1794 kg/ha), respectively (Table 96).

Twelve genotypes of fennel were tested in Jabalpur condition. Out of twelve genotypes FNL-41 gave maximum plant height (157.93 cm), no. of primary branches (11.78) and no of secondary branches (15.96), but no. of umbels/plant and no. of umbellets/umbel was low and yielded 7.11 kg/ha. The genotype FNL-42 gave minimum plant height (136.90) but yielded maximum (16.03 kg/ha).

At Jagudan, significant yield differences were observed among entries. But none of the entries were found significantly superior for yield over check. However, an entry FNL-40 and FNL-42 gave higher yield (1434 and 1322 $kgha^{-1}$ respectively) than both the checks GF-11 & GF-12, which was 20.81 and 11.37 per cent higher over check GF-11, respectively

The trial is in the 1st year of progress at Jobner. The analysis of variance revealed significant differences among the entries for all the traits including seed yield. The seed yield ranged from 1115.56 to 1838.22 kg/ha. Of the fourteen entries evaluated, entry FNL-38 recorded maximum seed yield of 1838.22 kg/ha followed by FNL-43 (1724.44 kg/ha), FNL-41 (1592.89 kg/ha), RF-125 check (1436.00 kg/ha), RF-143 check (1426.67 kg/ha) and FNL-44 (1397.78 kg/ha), while lowest seed yield of 1115.56 kg/ha was recorded in FNL-45.

Table 95. Performance of CVT fennel at Dholi

Genotype	Plant height (cm)	Main branches/ plant	Secondary branches/ plant	Days to 50% flowering	Umbels/ plant	Umbellets/ umbel	Grains/ umbellet	Yield/ plot (kg/ 7.2 m^2)	Yield (t/ha)	Increase in yield over check t/ha	%
FNL – 37	135.16	9.16	10.33	132.66	80.00	32.66	28.00	0.48	671.29	-	-
FNL – 38	111.16	7.50	10.50	134.00	39.16	21.16	21.33	0.50	694.44	-	-
FNL – 39	140.83	8.33	16.00	134.33	63.16	25.16	26.00	0.70	972.22	-	-
FNL – 40	132.33	9.00	15.33	132.66	67.70	26.83	30.66	0.90	1249.99	-	-
FNL – 41	155.50	11.50	19.50	135.00	86.00	30.50	31.50	1.15	1597.22	231.48	16.94
FNL – 42	130.33	9.33	14.16	130.00	66.50	26.83	26.83	0.96	1342.58	-	-
FNL – 43	141.66	10.33	16.33	129.66	57.00	36.50	28.66	1.52	2106.48	740.74	54.24
FNL – 44	141.50	10.33	15.16	133.00	74.33	30.66	26.83	0.58	810.18	-	-
FNL – 45	134.16	9.66	18.33	133.66	77.33	28.83	26.16	1.33	1851.85	486.11	35.59
FNL – 46	142.00	10.33	17.66	131.66	50.66	25.66	28.66	0.96	1342.58	-	-
GF-11(N. check)	134.16	7.50	13.16	131.00	44.16	20.50	25.33	0.81	1134.25	-	-
Rajendra Sarubh (L. check)	141.66	8.66	17.00	130.00	60.16	33.33	26.66	0.98	1365.74	-	-
SEm(±)	8.45	0.68	1.68	1.37	4.90	2.71	1.69	0.06	77.48	-	-
CD(P=0.05)	NS	2.02	4.92	NS	14.38	7.97	4.95	0.16	227.26	-	-
CV (%)	10.70	12.78	18.14	1.80	13.30	16.67	10.75	10.63	10.63	-	-

Table 96. Performance of CVT-2009 fennel at Hisar

Sl. No.	Entry	Plant height (cm)	Branches/ plant	Umbels/ plant	Umbellate/ umbel	Seeds/ umbel	Seed yield (kg/ha)
1.	FNL -37	160.0	8.5	42.7	31.6	606.0	1610
2.	FNL -38	138.3	8.1	38.4	31.6	577.5	1418
3.	FNL -39	163.0	9.2	57.2	30.8	519.7	1714
4.	FNL -40	155.3	8.6	46.7	30.0	510.0	1858
5.	FNL -41	162.7	8.9	53.4	34.2	669.3	1876
6.	FNL -42	155.8	8.6	57.4	30.9	545.2	1490
7.	FNL -43	152.0	8.9	49.0	28.8	443.2	1627
8.	FNL -44	160.4	9.4	55.1	34.1	578.3	1794
9.	FNL -45	157.9	8.8	45.1	32.8	561.4	1412
10.	FNL -46	162.3	8.7	43.4	35.9	704.8	1459
11.	HF-33	151.7	9.1	51.8	32.0	519.5	1669
12.	GFII	143.2	8.6	44.9	30.5	314.3	1720
CD (P=0.05%)		3.8	0.4	8.5	3.6	34.9	59

Significant differences were observed for all the characters except umbels per plant and umbellets per umbel at Pantnagar. Highest yield (3472.17 kg/ha) was recorded in local check- Pant Madhurika, followed by FNL-43 (2815.98 kg/ha) and FNL- 41 (2731.86 kg/ha).

Twelve entries were evaluated along with the two checks for yield and other related characters at Raigarh during 2009-10. Among the entries, yield of entry FNL-40 (1216.67 kg/ha) was found significantly superior over both the checks GF-11(NC) and local check with yield 1066.67 kg/ha and 356.67 kg/ha, respectively. The entry FNL-39 (833.33 kg/ha), FNL-41 (783.33 kg/ha), FNL-45 (430.00 kg/ha), FNL-44 (382.33 kg/ha), FNL-37 (366.67 kg/ha) and FNL-46(366.67 kg/ha) were found superior over check GF-11 with yield of 356.67 kg/ha (Table 97).

Table 97. Yield and yield attributes of fennel entries under CVT-2009 at Raigarh

Sl. No.	Entry	Plant height (cm)	Umbel/ plant	Umbellate/ umbel	Yield (kg/plot)	Yield (kg/ha)
1	FNL-37	162.67	15.67	28.33	0.367	366.67
2	FNL-38	139.67	13.00	35.33	0.320	320.00
3	FNL-39	175.33	51.33	34.00	0.833	833.33
4	FNL-40	183.33	32.00	45.33	1.217	1216.67*
5	FNL-41	167.67	30.67	25.33	0.783	783.33
6	FNL-42	176.00	23.33	35.33	0.330	330.00
7	FNL-43	148.33	20.33	30.00	0.343	343.33
8	FNL-44	150.33	14.00	38.67	0.382	382.33
9	FNL-45	165.00	16.00	39.67	0.430	430.00
10	FNL-46	162.67	12.00	32.67	0.367	366.67
11	GF-11(NC)	158.00	16.00	34.00	0.357	356.67
12	Local check	192.67	9.00	41.67	1.067	1066.67
	Mean	165.14	21.11	35.03	0.566	566.31
	EMS					965.982
	CV (%)					5.49
	CD (P=0.05)					9.12

FNL/CI/3.1 Initial evaluation trial (Final report)

(Hisar, Jobner, Kumarganj, Jagudan)

The initial evaluation trial (IET) in fennel was conducted with ten accessions along with GF-2 as check during 2007-2008, 2008-2009 and 2009-10 in plots measuring 3.0 x 2.4 m at Hisar. The results indicated that HF-119 and HF-147 gave significantly better yield over GF-2 (check) showing 23.6 and 20.9% increase in yield, respectively (Table 98).

At Jobner, the trial is in the 2nd year of progress. The analysis of variance revealed significant differences among the entries for all the traits including seed yield. The seed yield ranged from 1107.56 to 2016.00 kg/ha. Of the ten entries evaluated, entry UF-157 recorded maximum seed yield of 2016.00 kg/ha followed by UF-278 (1884.00 kg/ha), RF-143 check (1814.22 kg/ha), UF-235 (1812.89 kg/ha), RF-101 check (1676.44 kg/ha) and UF-114 (1671.11 kg/ha), while lowest seed yield of 1107.56 kg/ha was recorded in UF-262. Mean performance of the entries evaluated in CVT over 2008-09 and 2009-10 revealed superior performance of UF-278 yielding 2150.89 kg/ha followed by UF-157 (2132.45 kg/ha), UF-235 (1919.78 kg/ha), RF-143 check (1876.00 kg/ha), RF-101 check (1724.89 kg/ha) and UF-270 (1698.23 kg/ha), while lowest seed yield of 1361.56 kg/ha was recorded in Local check.

Ten promising lines were evaluated in an IET at Kumarganj for a period of three years (2006 – 2009) in R B D in a plot size of 2.0 x 2.4 m^2 at a spacing of 40 x 20 cm in three replication. Three years pooled seed yield in fennel showed that NDF-5 produced maximum seed yield of 8.64 q/ha followed by NDF-6 (7.71q/ha) with an increase of 24.02% over GF-2 as check.

At Jagudan significant yield differences were observed among entries in IET. The entries JF 671-1, JF 671-2 and JF 674-1 gave significantly superior yield (1132, 1131 and 1118 $kgha^{-1}$ respectively), which was 26.81, 26.64 and 25.17 per cent higher over check GF-11, respectively (Table 99).

FNL/CI/3.2 Initial evaluation trial-2009

(Jabalpur, Kumarganj)

An initial evaluation trial was conducted at Kumarganj center with 9 promising lines. NDF-46 gave maximum seed yield of 11.11 q/ha followed by seed yield of 9.37 q/ha in NDF-45

FNL/CI/4 Quality evaluation trial

FNL/CI/4.1 Quality evaluation in fennel

(Jobner)

CVT Series VI

Fourteen entries of fennel under CVT 2007, were tested for volatile oil content during rabi 2009-10, which were analysed using Clevenger apparatus. The volatile oil content in the entries ranged from 2.17% to 2.97%. The maximum volatile oil of 2.97% was observed in FNL-27 followed by 2.83% in FNL-26, 2.80% in FNL-29, 2.77 in FNL-25, 2.57% in RF-125 check, while, minimum of 2.17% in FNL-35. The entry FNL-26 ranked first in terms of volatile oil yield (51.26 l/ha) followed by FNL-27 (43.51 l/ha), FNL-25 (43.23 l/ha), FNL-29 (42.37 l/ha) and RF-125 check (41.51 l/ha). While

Table 98. Initial evaluation trial in fennel at Hisar (Pooled over three years)

Sl. No.	Accession number	Seed yield (kg/ha)				Increase over check (%)
		2007-2008	2008-2009	2009-2010	Mean	
1.	HF-115	1804	1860	1840	1835	11.5
2.	HF-119	2017	2050	2038	2035	23.6
3.	HF-124	1960	1806	1894	1887	14.6
4.	HF-128	1863	1773	1806	1814	10.2
5.	HF-132	1753	1738	1776	1756	6.7
6.	HF-147	1988	1986	1996	1990	20.9
7.	HF-14 9	1860	1768	1740	1789	8.7
8.	HF-154	1867	1740	1792	1800	9.4
9.	HF-158	1768	1883	1821	1824	10.8
10.	GF-2 (Check)	1660	1636	1642	1646	11.5
	CD (P=0.05)	144	128	84	-	-

Table 99. Performance of IET fennel at Jagudan (2009-10)

Sl. No	Entry	50% Flowering	Plant height (cm) Up to M.U.	Plant height (cm) Up to Top	Branches/ plant	Umbels/ plant	Umbelt/ umbel	Seeds/ umbel-lete	Seeds/ umbel	Test wt. (m)	Vol. oil (%)	Yield/ plant (g)	Yield (kgha^{-1*}) %	Increse over check
1	JF-671-1	85	92.6	108.8	5.6	12.8	22.1	529.5	23.8	6.36	2.10	10.19	1132	26.81
2	JF-671-2	98	88.4	106.7	5.8	13.0	20.7	482.5	23.0	5.50	2.20	10.18	1131	26.64
3	JF-671-3	95	93.1	108.4	4.6	9.4	20.7	469.1	22.2	5.80	2.20	6.76	752	-
4	JF-671-4	86	95.7	113.3	5.1	10.7	18.1	371.0	20.2	6.20	2.30	6.54	727	-
5	JF-674-1	82	97.7	116.5	5.5	12.8	19.2	439.7	22.7	5.88	2.20	10.06	1118	25.17
6	JF-675-1	81	94.1	112.3	4.1	10.8	20.8	481.6	16.2	5.64	2.10	8.05	894	0.13
7	JF-676-1	79	93.3	113.7	5.0	11.3	21.2	521.8	24.0	5.64	2.10	7.27	808	-
8	JF-676-2	76	97.3	115.6	4.5	10.0	21.2	514.4	24.1	5.62	2.20	5.36	596	-
9	JF-681-1	83	93.8	113.7	4.7	13.1	18.7	427.4	22.8	5.66	2.30	8.50	944	5.74
10	GF-11(Ch)	75	95.7	113.2	4.7	12.4	18.0	395.3	21.9	5.44	2.10	8.03	893	-
	S.Em. ±	1	2.4	2.6	0.3	1.2	1.5	2.5	47.6	-	-	0.60	67	-
	CD (P=0.05)	4	7.1	NS	0.8	NS	NS	NS	NS	-	-	1.78	198	-
	CV%	2.96	4.38	3.97	9.49	17.92	13.18	19.34	17.79	-	-	12.80	12.80	-

* Yield kg/ha is calculated on basis of per plant yield

lowest volatile oil yield of 17.60 l/ha was recorded in FNL-33. On the basis of three years data (2007-08, 2008-09 and 2009-10), the highest mean volatile oil content of 2.89% was recorded in FNL-26 followed by 2.78% in FNL-30, 2.63% in FLN-25, whereas a minimum of 1.87% was recorded in RF-178. The maximum mean volatile oil yield was observed in FNL-26 (63.14 l/ha) followed by FNL-25 (56.99 l/ha), and FNL-24 (48.17 l/ha) and minimum in FNL-33 (28.33 l/ha).

CVT Series VII

The volatile oil content in the CVT-2009 entries ranged from 2.30% to 3.10%. The maximum volatile oil of 3.10% was observed in FNL-39 followed by 3.03% in RF-125 check, 2.80% in GF-11 2.77% in FNL-46 and FNL-37, while, minimum of 2.30% in local check. The entry FNL-38 ranked first in terms of volatile oil yield (47.18 l/ha) followed by FNL-43 (46.56 l/ha), RF-125 check (43.56 l/ha), FNL-39 (41.69 l/ha) and FNL-46 (39.68 l/ha). While lowest volatile oil yield of 26.40 l/ha was recorded in FNL-45.

IET

Ten entries of fennel under IET were tested for volatile oil content. The volatile oil content in the entries ranged from 2.00% to 2.37%. The maximum volatile oil of 2.37% was recorded in UF-114, UF-157, UF-262, RF-101 and RF-143 check, whereas minimum of 2.00% in UF-235. Highest volatile oil yield was recorded in UF-157 (47.71 l/ha) followed by RF-143 check (42.94 l/ha) and UF-278 (41.45 l/ha) and minimum was recorded in UF-262 (26.21 l/ha). On the basis of two years data (2008-09 and 2009-10), the highest mean volatile oil content of 2.42% was recorded in RF-143 check and RF-101 check followed by 2.35% in UF-278, 2.32% in UF-114 and UF-270 and 2.22% in UD-157, whereas minimum 2.12% was recorded in UF-189. The maximum mean volatile oil yield was observed in UF-278 (50.55 l/ha) followed by UF-157 (47.30 l/ha), RF-143 check (45.37 l/ha) and minimum in local check (29.73l/ha).

FNL/CM/5 Nutrient Management Trial

FNL/CM/5.1 Effect of biofertilizer, *Azospirillum* on fennel (Final report)

(Dholi)

The present study to determine the influence of inorganic and biofertilizer on grain yield of fennel (variety

Table 100. Effect of biofertillizer *Azospirillum* on fennel at Dholi (Pooled 2007-08 to 2009-2010)

Treatment	Plant height (cm)	Branches/ plant	Umbels/ plant	Umbellets/ umbel	Grains/ umbellet	Yield/plot (kg/7.2 m^2)	Yield (t/ha)	Increase yield in over check t/ha	Increase yield in over check %	Gross income (Rs.)	Cost of cultivation (Rs.)	Net profit (Rs.)	Cost : benefit ratio
T_1	169.32	9.36	65.65	49.42	46.14	1.18	1.63	0.80	96.38	97,000	38,800	58,200	1:2.50
T_2	156.00	8.05	61.71	43.72	40.54	1.04	1.45	0.62	74.69	87.000	38.650	48.350	1:2.25
T_3	157.47	7.69	57.06	40.19	38.63	0.94	1.31	0.48	57.83	78,600	38,500	40,100	1:2.04
T_4	144.65	6.31	46.55	30.63	31.91	0.80	1.12	0.29	34.93	67,200	38,200	29,000	1:1.76
T_5	143.54	6.21	46.33	34.09	31.57	0.73	1.01	0.18	21.68	60,600	37,000	23,600	1:1.64
T_6	151.08	6.85	50.55	33.72	32.37	0.78	1.10	0.27	32.53	66,000	40,200	25,800	1:1.64
T_7	150.29	6.56	50.26	32.92	30.54	0.83	1.15	0.32	38.55	69,000	39,000	30,000	1:1.77
T_8	149.65	7.64	55.31	34.86	35.26	0.85	1.19	0.36	43.37	71,400	35,600	35,800	1:2.00
T_9	141.08	6.17	41.78	29.14	28.20	0.69	0.95	0.12	14.45	57,000	36,200	20,800	1:1.57
T_{10}	131.00	5.39	39.22	26.13	25.61	0.59	0.83	-	-	49,800	35,000	14,800	1:1.42
SEm±	5.63	0.28	2.39	2.99	1.77	0.06	0.08						
CD (P=0.05)	16.75	0.85	7.12	8.89	5.26	0.17	0.26						
CV (%)	6.53	7.09	8.07	14.61	9.00	12.35	12.84						

Note. : A. Selling rate: Rs.6,000/- quintal

B. Cost of biofertilizer:

Azospirillum – Rs.1200/ha

FYM – Rs.40/quintal

Urea – Rs.276/50 kg bag

General cost – Rs.35,000/ha

T_1: Inorganic N (100%) + *Azospirillum* + 5t/ha FYM; T_2: Inorganic N (75%) + *Azospirillum* + 5 t/ha FYM; T_3: Inorganic N (50%) + *Azospirillum* + 5 t/ha FYM; T_4: 5 t/ha FYM + *Azospirillum*; T_5: 5 t/ha FYM alone; T_6: 10 t/ha FYM + *Azospirillum*; T_7: 10 t/ha FYM alone; T_8: 100% inorganic nitrogen; T_9: *Azospirillum* @1.5 kg/ha; T_{10}: Control.

Rajendra Saurabh) was conducted at Dholi, during 2007-08 to 2009-10 in an RBD with ten treatments and three replication. The pooled analyzed data is presented in Table 100. Treatments inorganic N (100%) + *Azospillum* + 5 t/ha FYM (T_1), inorganic N (75%) + *Azospirillum* + 5 t/ha FYM (T_2), inorganic N (50%) + *Azospirillum* + 5 t/ha FYM (T_3), FYM - 10t/ha + *Azospirillum* (T_6), FYM – 10 t/ha alone (T_7), 100% inorganic nitrogen (T_8) gave significantly higher yield as compared to control. The cost : benefit ratio for application of inorganic N (100%) + *Azospirillum* + 5 t/ha FYM was Rs.2.50 per unit cost (1:2.50) followed by Rs.2.25 per unit cost (1:2.25) in the application of inorganic N (75%) + *Azospirillum* + 5t/ha FYM (T_2).

FNL/CM/5.2 Identification of drought/alkalinity tolerance source in fennel (Final report)

(Kumarganj)

At Kumarganj, maximum mean tolerance to alkalinity of 41.66 was recorded in NDF-12 which also showed maximum tolerance at 10 ESP & 20 ESP levels (Table 101).

FNL/CM/5.3 Role of rhizobacteria on growth and yield of fennel (Final report)

(Jagudan, Hisar)

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. Yield and quality of fennel were not influenced significantly by the inoculants or its methods of application. But FK-14 + FL-18 with seed and soil inoculation recorded higher growth and yield attributes as well as seed yield of fennel. (Table 102).

Significant differences were obtained for all the parameters during 2009-10.. Pooled analysis of the data indicated that maximum seed yield (1964 kg/ha) was recorded with the application of *Trichoderma* MTCC-5179 (1964 kg/ha) followed by rhizobacteria FL-14 (seed treatment) and rhizobacteria FL-18 (seed treatment + soil application) yielding 1952 kg/ha and 1914 kg/ha, respectively (Table 103).

Table 101. Effect of ESP levels, varieties and interaction on seed yield of fennel (g/plant) during 2009-10 at Kumarganj

Varieties	ESP levels				Mean
	10	20	30	40	
NDF-11	49.10	45.23	37.35	26.66	39.58
NDF-12	50.70	48.03	37.33	30.61	41.66
NDF-13	44.25	41.45	36.66	26.08	37.06
NDF-14	46.58	43.41	36.00	29.58	38.89
NDF-15	46.25	45.41	30.95	26.33	37.23
NDF-16	49.28	46.50	35.58	28.00	39.84
NDF-17	39.25	36.25	27.75	21.50	31.18
NDF-18	40.50	36.75	28.91	27.00	33.29
NDF-19	47.08	45.45	34.41	28.83	38.94
NDF-20	46.91	45.16	36.58	29.41	39.51

FNL/CP/6 Disease Management Trial

FNL/CP/6.1 Survey, identification of disease causing organisms and survey of germplasm against disease

(Dholi)

No disease incidence was observed in the germplasm as well as in the surveyed area of Samastipur & Muzaffarpur districts under natural condition.

Table 102. Role of rhizobacteria on growth and yield of fennel at Jagudan

Sl. No.	Treatment	Plant height (cm)	Branches/ plant	Umbels/ plant	Umbellates/ main umbel	Seeds/ umbel lates	Test wt.(g)	Volatile oil content (%)	Yield (kg/ha^{-1})
1	FK-14 (seed inoculation)	115.7	5.30	26.2	24.9	25.4	5.14	1.933	1451
2	FK-14 (seed + soil inoculation)	113.0	5.97	27.3	25.8	26.3	5.36	1.793	1310
3	FL-18 (seed inoculation)	116.5	5.30	25.3	26.4	26.1	4.98	1.833	1343
4	FL-18 (seed + soil inoculation)	118.2	5.30	25.5	22.3	25.6	4.99	1.933	1553
5	FK-14 + FL-18 (seed inoculation)	116.5	5.63	25.4	22.8	25.5	4.93	1.800	1358
6	FK-14 + FL-18 (seed + soil inoculation)	114.8	5.87	27.3	25.5	24.5	5.67	1.867	1090
7	*Trichoderma* (MTCC- 517)	115.3	5.77	24.2	24.0	23.5	5.34	1.800	1142
8	RDF	116.6	6.30	25.9	25.2	24.2	5.45	1.767	1151
	SEm±	1.64	0.28	1.7	1.4	1.3	0.17	0.06	114
	CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS
	CV (%)	2.45	8.49	11.27	9.50	8.40	5.53	8.84	15.75

Table 103. Effect of rhizobacteria on growth and seed yield of fennel (Pooled data) at Hisar

Sl. No.	Treatment	Plant height (cm)	Branches/ plant	Umbels/ plant	Umbellets/ umbel	Seeds/ umbel	Seed yield (kg/ha)
1.	Rhizobacteria FK-14 (seed treatment)	163.9	11.6	66.6	31.6	731.7	1952
2.	Rhizobacteria FK-14 (seed treatment + soil inoculation)	155.4	11.7	58.1	30.5	630.1	1513
3.	Rhizobacteria FL-18 (seed treatment)	158.6	11.7	61.9	30.5	617.7	1562
4.	Rhizobacteria FL-18 (seed treatment + soil inoculation)	160.1	11.9	64.3	32.3	818.3	1914
5.	Rhizobacteria FK-14 + FL-18 (seed treatment)	154.7	11.7	67.0	30.2	597.6	1737
6.	Rhizobacteria FK-14 + FL-18 (seed + soil treatment)	153.0	11.6	67.9	31.3	580.5	1637
7.	*Trichoderma* MTCC -5179 (Recommended dose)	159.7	11.3	72.0	30.5	626.4	1964
8.	Control	151.4	11.1	61.9	28.9	566.1	1466
	CD (P=0.05)	11.2	0.5	6.7	1.7	43.1	115

FENUGREEK

FGK/CI/1 Genetic Resources

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

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

Germplasm of fenugreek is maintained in various AICRPS centres (Table 104). At Dholi, one hundred seventy seven collections of fenugreek germplasm were evaluated for yield and yield attributing character and eight accessions namely, RM-190, RM-191, RM-192, RM-188, RM-197, RM-194, RM-185 and RM-186 gave higher yield when compared to high yielding variety Rajendra Kanti and Hisar Sonali. Among the promising accessions, RM-190 gave maximum yield (0.92 kg/4.5 m^2) followed by RM-191 (0.91 kg/4.5 m^2). Selected eight promising accessions will be further tested under Initial Evaluation Trial for obtaining higher yield and quality aspect.

Table 104.Fenugreek germplasm collections under AICRPS centres

Centre	Indigenous	Exotic	Total
Dholi	176	-	176
Guntur	123	-	123
Hisar	295	-	295
Jagudan	74	-	74
Jobner	353	12	365
Kumarganj	85	-	85
Total	1106	12	1118

At Hisar, one hundred and eighty accessions of fenugreek were evaluated along with Hisar Sonali and PEB as checks during 2009-2010. The seed yield of the germplasm material ranged from 840 kg/ha (HM-401) to 2970 kg/ha (HM-277-1). The most promising lines for seed yield were HM-259-1, HM-271-12, HM-277-1, HM-280-1, HM-320, HM-321-1, HM-331, HM-338, HM-342-1, HM-357, HM-413, HM-441 and HM-468.

Seventy six accessions of fenugreek including GM-2 as check were evaluated for different characters at Jagudan. Among them two entries were of tall types, seven entries had more than 35 pods per plant, six entries were long pod types (>11.0 cm), five early maturing types and eight high yielders (Table 105).

Out of 85 germplasm screened at Kumarganj, NDM-79 showed maximum seed yield of 14.58 q/ha followed by seed yield of 14.45 q/ha in NDM-38 which was at

Table 105. Promising germplasm of fenugreek conserved at Jagudan

Sl. No.	Character	Range	GM-2 (C)	Desirable characters	No. of entries	Promising entries identified
1	Plant height (cm)(Tall)	42.0-71.3	53.3	<65.0	2	JFg- 203 and JFg-205
2	No. of branches /plant (More branch)	4.0-7.3	4.6	≤6.5	5	JFg-13, 178,180,184, and JFg- 196
3	No. of pods/plant (More pod type)	15.3-42.6	28.6	≤35	7	JFg-15, 184, 185, 262, 265, 266 and JFg- 267
4	Length of pods (cm) (Long pod type)	8.1-11.6	10.6	>11.0	6	JFg-207,208,209,240,262 and JFg-267
5	No. of seeds/pod (More seed type)	12.3-21.3	20.0	>20.5	7	JFg-234,235, 238, 240, 243 ,253 and JFg-261
6	Maturity days (Early)	71-116	94	<90	5	JFg-15,52, 184,201 and 262
7	Test weight (g) (Bold seeded)	2.0-14.21	12.43	>12.50	7	JFg-7,181,185,194,207,239 and JFg- 269
8	Grain yield (kg ha^{-1}) (High yield)	71-1819	260	>1017	8	JFg-7,181,185,194,207,239 and JFg- 269

par with NDM-99, against check Hisar Sonali (6.12 q/ha), PEB (7.16 q/ha). The yield ranged from 4.04 (NDM-20) to 14.58 q/ha.

Multilocational evaluation of fenugreek

30 entries each from Jagudan, Jobner and Hisar were raised and evaluated at various centres with four checks (two each *i.e.* national check and common check in group) in a multilocational mode to evaluate their performance.

At Guntur, during 2009-10, among the entries evaluated in a multilocational trial JFG-253 recorded highest yield (1.28 g/plant) followed by LFC-76 (1.27 g/plant), JFG-213 (1.00 g/plant), LFC-75 (0.98 g/plant), JFG-215 (0.95 g/plant) and LFC-84 (0.95 g/plant) which were significantly superior to the best check LS-1 (0.62 g/plant).

Ninety germplasm accession of fenugreek from different parts of the country were evaluated along with five checks namely, Hisar Sonali, GM-2, RMt-1, RMt-303 and local in augmented design in one row plots of 3 x 0.3 m^2 size at Jobner. A wide range of variability was found for all the characters studied. Out of 90 accessions, only one accession was better than the check variety RMt-1. Some of the promising accessions identified on the basis of yield per 5 plants were UM-56, HM-203, HM-253, UM-35, HM-201, HM-253-1, UM-20, HM-254, UM-34, HM-232, HM-242, UM-17 and UM-112.

FGK/CI/2 Coordinated Varietal Trial

FGK/CI/2.4 CVT 2005 Series VI - Final Report

(Jobner, Kumarganj)

Fourteen entries were evaluated in RBD with 3 replications in a plot size of 3 x 2.4 m^2 accommodating eight rows spaced 30 cm apart with intra row spacing of 10 cm maintained by thinning at Jobner. The analysis of variance revealed significant differences among the entries for all the traits including seed yield. The seed yield ranged from 1527.78 to 2250.00 kg/ha. Of the fourteen entries evaluated, entry FGK-1 recorded maximum seed yield of 2250.00 kg/ha followed by FGK-17 (2157.41 kg/ha), RMt-351 check (2060.19 kg/ha), RMt-303 check (2046.30 (kg/ha), FGK-18 (2032.41 kg/ha), FGK-2 and FGK-20 (2018.52 kg/ha), while lowest yield of 1527.78 kg/ha was recorded in local check (Table 106). Mean performance of the entries evaluated in CVT over 2006-07 to 2008-09 revealed superior performance of FGK-1 yielding 1863.43 kg/ha followed by RMt-351 check (1715.74 kg/ha), RMt-303 check (1631.33 kg/ha) and RMt-1 check (1587.50 kg/ha), while

Table 106. CVT-2005 of fenugreek at Jobner (2008-09)

Sl. No.	Entry	Days to flowering	Plant height (cm)	Branches/ plant	Pods/ plant	Pod length (cm)	Seeds/ pod	Test wt. (g)	Seed yield (kg/ha)
1	FGK-1	46.67	91.53	6.60	36.13	10.60	17.73	12.48	2250.00
2	FGK-2	47.00	79.33	6.53	35.47	10.40	16.40	13.11	2018.52
3	FGK-3	46.00	84.00	5.87	34.07	10.17	15.67	13.33	1972.22
4	FGK-11	46.00	89.40	6.07	26.00	11.23	15.73	16.11	1763.89
5	FGK-17	46.00	102.73	5.10	34.13	10.40	17.60	13.45	2157.41
6	FGK-18	46.00	90.73	5.60	34.67	10.90	17.00	13.07	2032.41
7	FGK-19	48.33	85.80	5.87	28.07	10.60	16.20	13.25	1916.67
8	FGK-20	46.67	87.47	5.53	30.33	10.03	16.53	13.28	2018.52
9	FGK-21	49.67	89.20	4.53	25.47	10.27	17.00	11.92	1953.70
10	FGK-22	45.33	92.73	4.73	25.53	11.07	15.40	13.44	1847.22
11	RMt-1 C	48.33	90.07	5.53	31.47	10.77	16.13	11.95	2000.00
12	RMt-303 C	46.33	95.20	5.20	30.80	10.27	17.07	11.75	2046.30
13	RMt-351 C	47.33	84.27	6.00	30.13	10.70	17.00	10.87	2060.19
14	Local Check	54.00	85.47	5.53	22.13	10.60	15.87	10.14	1527.78
	CD (P=0.05)	1.92	NS	0.85	4.94	NS	0.80	0.34	307.43
	CV (%)	2.45	8.14	9.18	9.85	6.49	2.92	1.60	9.45

lowest seed yield of 846.07 kg/ha was recorded in FGK-10 (Table 107).

UM-361 and HM-219 were found promising and ranked first over all the locations in the country, therefore may be release for national level.

At Kumarganj, sixteen entries were tested for their performance for yield and yield attributing characters from 2004 - 2008 in RBD in a plot size of 2.0 x 2.4 m^2 at a spacing of 60 x 40 cm in three replication. Evaluation of four years of mean values showed maximum seed yield in FGK-12 (RM-18) against check Hisar Sonali (10.61 q/ha) with an increase in yield of 60.45% over check.

FGK/C1/2.6 Coordinated Variety Trial - 2009 Series VII

(Ajmer, Coimbatore, Dholi, Guntur, Hisar, Jabalpur, Jagudan, Jobner, Kumarganj Pantnagar, Raigarh, Udaipur)

At Ajmer, thirteen genotypes were tested against two checks namely, Hisar Sonali and RMt-1. Among the test entries FGK-37 was the highest yielder with 1561.81 kg/ha seed yield followed by FGK-29 with 1071.18 kg/ha seed yield. Data on ancillary data are presented in Table 108.

The genotypes varied significantly in grain yield per plot and grain yield per ha at Coimbatore. The grain yield per plot varied from 276.67 g to 348.33 g. FGK-28 recorded the highest grain yield of 387.03 kg/ha followed by FGK-34 and HM-57 (372.22 kg/ha). The local check CO-2 recorded a grain yield of 351.86 kg/ha. This was on par with FGK-28 the highest grain yielder.

Thirteen promising entries and two check *viz.*, Hisar Sonali (national check) and Rajendra Kanti (local check) were evaluated at Dholi. Among two checks *i.e.*, Hisar Sonali (national check) and Rajendra Kanti (local check), Rajendra Kanti (local check) gave significantly higher yield (0.92 kg/5.4 m^2) as compared to national check Hisar Sonali (0.67 kg/5.40 m^2). None of the entries produced significantly higher yield per plot or per hectare as compared to local check Rajendra Kanti.

Table 107. CVT of fenugreek at Jobner (Pooled over three years)

Sl. No.	Entry	Seed yield (kg/ha) 2006-07	2007-08	2008-09	Total	Mean
1	FGK-1	1550.93	1789.35	2250.00	5590.28	1863.43
2	FGK-2	1245.37	1407.87	2018.52	4671.76	1557.25
3	FGK-3	1203.70	1392.59	1972.22	4568.51	1522.84
4	FGK-4	953.70	1424.07	-	2377.77	1188.89
5	FGK-5	1009.26	1393.52	-	2402.78	1201.39
6	FGK-6	1111.11	1636.11	-	2747.22	1373.61
7	FGK-7	1064.81	1538.89	-	2603.70	1301.85
8	FGK-8	1125.00	1319.91	-	2444.91	1222.46
9	FGK-9	1041.67	1448.61	-	2490.28	1245.14
10	FGK-10	708.33	983.80	-	1692.13	846.07
11	FGK-11	939.81	1044.44	-	1984.25	992.13
12	RM-18	1143.52	1425.93	-	2569.45	1284.73
13	RM-28	884.26	1671.76	-	2556.02	1278.01
14	RM-70	1537.04	1309.26	-	2846.30	1423.15
15	FGK-12	995.37	1675.46	-	2670.83	1335.42
16	JFg-244	990.74	1397.69	-	2388.43	1194.22
17	RMt-1 Check	1231.48	1531.02	2000.00	4762.50	1587.50
18	RMt-303 Check	1513.89	1333.80	2046.30	4893.99	1631.33
19	RMt-351 Check	1532.41	1554.63	2060.19	5147.23	1715.74
20	Local Check	851.85	1188.89	1527.78	3568.52	1189.51
	CD (P=0.05)	176.53	192.65	307.43		
	CV (%)	9.44	8.19	9.45		

Table 108. Performance of CVT-2009 fenugreek (2009-10) at Ajmer

Variety	Population/ row	Plant height	No. of primary branch	No. of secondary branch	Pod on main branch	Pod on primary branch	Pod on secondary branch	Pod length	Seed/ pod	Test wt. (g)	Yield (g/plot)	Yield (kg/ha)
FGK - 26	53.29	53.20	5.67	4.33	9.40	34.67	3.40	9.96	15.50	3.750	724.83	755.03
FGK - 27	45.13	49.87	5.87	3.93	9.47	33.13	3.67	10.56	15.52	3.588	764.00	795.83
FGK - 28	46.33	55.13	5.47	3.00	9.20	31.47	4.27	10.12	14.45	3.735	742.50	773.44
FGK - 29	54.08	50.13	5.20	2.53	9.20	37.93	6.00	8.72	14.82	4.085	1028.33	1071.18
FGK - 30	45.83	49.40	6.47	6.27	9.93	34.47	10.33	8.57	14.17	3.321	700.33	729.51
FGK - 31	60.42	45.47	6.47	3.53	10.53	44.53	7.93	9.45	14.67	3.392	312.50	325.52
FGK - 32	46.21	49.67	6.40	6.40	7.87	35.53	6.80	10.34	16.68	2.798	637.00	663.54
FGK - 33	59.04	45.73	6.33	2.33	9.60	32.13	3.93	8.87	14.10	3.291	731.83	762.33
FGK - 34	51.71	46.20	6.67	4.80	11.47	43.87	8.07	9.22	15.50	3.286	899.17	936.63
FGK - 35	54.50	42.20	5.60	3.67	9.60	24.80	8.67	11.37	15.50	3.245	714.17	743.92
FGK - 36	54.88	46.13	5.60	2.20	9.00	28.47	16.80	11.05	15.37	3.117	562.83	586.29
FGK - 37	69.71	48.80	4.27	2.07	9.53	34.80	5.93	10.33	16.45	3.261	1499.33	1561.81
FGK - 38	60.83	50.07	5.47	3.33	9.67	33.27	4.80	9.53	15.02	3.235	864.17	900.17
Hisar Sonali	54.00	45.40	6.00	3.73	9.13	38.93	9.73	9.38	15.78	3.036	673.83	701.91
RMt - 1	57.75	57.07	6.67	7.47	13.13	49.00	9.03	9.31	14.82	3.424	742.17	773.09
										CD	69.93	72.85
										CV(%)	9.36	9.36




Among the twelve entries evaluated from different sub centers at Guntur, FGK-31 (362 kg/ha), FGK-35 (311 kg/ha), FGK-26 (308 kg/ha), FGK-32 (292 kg/ha), FGK-36 (278 kg/ha), and FGK-37 (277 kg/ha) recorded significantly higher yield than the check LS-1 (196 kg/ha), local (177 kg/ha) and Hisar Sonali (162 kg/ha). Significant differences were observed among yield attributes and the genotypes. Among the genotypes, maximum plant height was recorded by FGK-31(41.67 cm), followed by FGK-26 (41.23 cm) and FGK-35 (40.27 cm) than check LS-1 (33.73 cm). Number of primary branches were significantly more than control, LS-1 (3.67) in FGK-37 (4.73), FGK–32 (4.47), FGK-36 (4.47) and FGK-35 (4.43) which were on par with each other and significantly superior to check. Significantly more number of pods were recorded in FGK-31 (16.93) followed by FGK-32 (15.3), FGK-35 (15.17), FGK-36 (14.43), FGK-37 (12.33) and FGK–27 (13.73) than check LS-1 (9.5). Pod length was significantly maximum in FGK-37 (15.37 cm) followed by FGK-31 (15.2 cm) and FGK-35 (15.1 cm), whereas number of seeds per pod were significantly more in FGK-33 (9.73), followed by FGK-31 (9.4), FGK-36 (9.1) and FGK-35 (8.9) than check LS-1 (7.57). Among the genotypes, FGK-26 came to flowering early (38.7 days) and matured early (79.7 days) and FGK- 37 was late to flower (44.3 days) while FGK- 32 (91.7 days) was late in maturity.

Significant differences were obtained for all the parameters at Hisar. Plant height ranged from 91 to 108, pods per plant from 80.6 to 112.5, length of pods from 8.0 to 8.9 and seeds per pod from 17.0 to 18.2. Maximum seed yield (2280 kg/ha) was recorded in FGK-31 followed by FGK-32 (2027 kg/ha) and FGK-37 (1980 kg/ha) (Table 109).

The experiment with the local genotype (JM- 131) was laid out for testing the performance in Jabalpur condition. It was observed that out of fifteen genotypes, FGK-28 performed better than other entries. FGK-28 recorded maximum plant height (74.18 cm), no of branches (14.24), days to maturity (122.33), number of pods/plant (35.63), pod length (14.06 cm), no of seeds/pod (20.56) and yield /ha (16.49 q). It also showed early flowering (48 days). Maximum test weight was recorded in FGK- 29 (14.69 q/ha). Lowest yield was obtained in FGK-26 (9.69 q/ha).

At Jagudan, significant yield differences were observed among the entries. None of the entries gave significantly higher yield over checks Hisar Sonali and GM-2. However, the entry FGK-27 produced maximum yield (1709 $kgha^{-1}$).

In rabi 2009-10, fourteen entries were evaluated at Jobner. The analysis of variance revealed significant differences among the entries for all the traits including seed yield. The seed yield ranged from 948.15 to

Table 109. Performance of CVT-2009 fenugreek (2009-2010) at Hisar

Sl. No.	Entry	Plant height (cm)	Branches/ plant	Pods/ plant	Length of pod (cm)	Seeds/ pod	Seed yield (kg/ha)
1.	FGK-26	103	6.8	87.0	8.7	17.8	1715
2.	FGK-27	82	7.0	93.1	8.6	17.1	1775
3.	FGK-28	92	6.8	98.0	8.4	17.2	1832
4.	FGK-29	85	6.3	88.1	8.0	17.0	1662
5.	FGK-30	92	6.6	90.3	8.2	17.1	1820
6.	FGK-31	113	7.3	112.5	8.7	18.2	2280
7.	FGK-32	107	7.2	108.1	8.8	18.0	2027
8.	FGK-33	95	6.3	80.6	8.0	17.0	1584
9.	FGK-34	98	7.1	101.4	8.5	18.0	1910
10.	FGK-35	92	6.5	90.3	8.6	17.0	1828
11.	FGK-36	94	6.5	89.7	8.1	17.4	1795
12.	FGK-37	112	6.7	105.2	8.9	18.2	1980
13.	FGK-38	91	6.4	100.1	8.2	17.4	1852
14.	HM-57	97	6.6	100.6	8.3	17.7	1887
15.	HM-103	108	7.0	103.5	8.5	18.2	1921
C.D. (P=0.05)		6.2	0.4	11.0	0.4	0.5	109

1601.85 kg/ha. Of the fourteen entries evaluated, COR-31 recorded maximum seed yield of 1601.85 kg/ha followed by COR-27 (1557.41 kg/ha), COR-32 (1540.28 kg/ha), COR-34 (1535.65 kg/ha), COR-33 (1509.72 kg/ha), RCr-435 check (1496.76 kg/ha), National check Hisar Anand (1487.04 kg/ha) and COR-25 (1389.35 kg/ha), while lowest seed yield of 948.15 kg/ha was recorded in COR-29.

At Raigarh, the local check gave higher yield than the national check (Hisar Sonali) with an yield of 97.22 and 86.81 kg/ha, respectively. Among the entries, FGK-27 (618.06 kg/ha) was the highest yielder.

(1660.49 kg/ha), RMt-303 check (1532.41 kg/ha) and UM-353 (1526.23 kg/ha), while lowest seed yield of 1208.33 kg/ha was recorded in local check. UM-202, UM-354 and UM-152 may be promoted to CVT (Tables 110 & 111)).

FGK/CM/4 Nutrient Management Trial

FGK/CM/4.2 Identification of drought tolerance source in fenugreek

(Jobner, Guntur)

In Rabi 2009-10, forty two genotypes were evaluated at Jobner in irrigated as well as limited moisture

Table 110. IET of fenugreek (2008-09) at Jobner

Sl. No.	Entry	Days to flowering	Plant height (cm)	Branches/ plant	Pods/ plant	Pod length (cm)	Seeds/ pod	Test wt. (g)	Seed yield (kg/ha)
1	UM-152	46.00	80.13	5.93	30.73	11.43	17.80	15.17	2527.78
2	UM-202	47.00	82.93	5.53	32.53	11.83	18.20	13.99	2532.41
3	UM-134	47.33	88.07	5.07	28.93	10.00	17.07	12.30	2175.93
4	UM-189	47.33	87.60	4.93	28.20	10.60	17.13	12.15	1879.63
5	UM-163	48.00	87.27	5.00	27.67	10.50	16.40	12.59	1791.67
6	UM-353	46.33	97.93	5.07	27.60	10.77	17.73	12.97	1995.37
7	UM-354	46.67	89.67	6.27	30.27	10.77	17.60	13.24	2444.44
8	RMt-1 Ch.	48.00	93.07	5.80	29.33	10.47	17.93	11.91	1856.48
9	RMt-303 Ch.	48.67	99.53	6.00	24.00	10.23	17.33	13.06	1949.07
10	Local Check	51.33	92.13	5.20	24.40	10.00	16.00	10.73	1699.07
	CD (P=0.05)	1.17	6.77	0.65	4.39	0.94	0.95	0.28	340.85
	CV (%)	1.46	4.50	7.07	9.23	5.25	3.27	1.32	9.75

FGK/CI/3 Initial Evaluation Trial

FGK/CI/3.1 Initial Evaluation Trial

(Jobner, Kumarganj)

Ten entries were evaluated in RBD with 3 replications in a plot size of 3.0 x 2.4 m^2 accommodating four rows spaced 30 cm apart with intra row spacing of 10 cm at Jobner. The analysis of variance revealed significant differences among the entries for all the traits including seed yield. The seed yield ranged from 1699.07 to 2532.41 kg/ha. Of the 10 entries evaluated, entry UM-202 recorded maximum seed yield of 2532.41 kg/ha followed by UM-152 (2527.78 kg/ha), UM-354 (2444.44 kg/ha), UM-134 (2175.93 kg/ha) and UM-353 (1995.37 kg/ha), while lowest yield of 1699.07 kg/ha was recorded in local check. Mean performance of the entries evaluated in IET over 2006-07 to 2008-09 revealed superior performance of UM-202 yielding 1896.60 kg/ha followed by UM-354 (1836.41 kg/ha), UM-152

Table 111. Mean yield (kg/ha) of fenugreek entries evaluated in IET (2006-07 to 2008-09) at Jobner

Sl. No.	Entry	Yield (kg/ha)			
		2006-07	2007-08	2008-09	Mean
1	UM-134	1194.44	1138.89	2175.93	1503.09
2	UM-152	1092.59	1361.11	2527.78	1660.49
3	UM-163	1027.78	1379.63	1791.67	1399.69
4	UM-189	824.07	1361.11	1879.63	1354.94
5	UM-202	1453.70	1703.70	2532.41	1896.60
6	UM-353	1194.44	1388.89	1995.37	1526.23
7	UM-354	1500.00	1564.81	2444.44	1836.42
8	RMt-1 Check	1314.81	1314.81	1856.48	1495.37
9	RMt-303 Ch.	1305.56	1342.59	1949.07	1532.41
10	Local Check	851.85	1074.07	1699.07	1208.33
	CD (P=0.05)	227.55	252.76	340.85	
	CV (%)	11.29	10.82	9.75	

condition and the results indicated significant difference between the genotypes in the irrigated conditions while in limited moisture conditions the differences were found to be non significant. Among the genotypes evaluated, UM-17 had the highest mean yield in both the environments. This was followed by UM-23 and UM-29 which were high yielding in irrigated conditions and UM-36 followed by UM-22 were having highest mean in limited moisture conditions. Based on different indices used to estimate the drought tolerance namely, TOL, SSI and STI, UM-11 followed by UM-33 were found to be most drought tolerant. UM-28 was the least tolerant among the genotypes tested. Comparison of seed yield over 2008-09 and 2009-2010 indicated that the average yield in both the years were nearly comparable in the limited moisuture condition, while the yields in the year 2008-09 were relatively higher in irrigated conditions. Over both the years UM-13 was the highest yielder in both the environments. This was followed by UM-17 and RMt-1 in irrigated conditions and UM-19 in limited moisture conditions.

FGK/CM/4. Effect of bio-fertilizer *Azospirillum* on fenugreek (Adoptive trail) (Final report)

(Dholi)

The present study was under taken to use the influence of inorganic and bio-fertilizer on grain yield of fenugreek (variety Rajendra Kanti) in calcareous soil during rabi season at Dholi during 2007-08 to 2009-10. The experiment was laid out with variety Rajendra Kanti in randomized block design with ten treatments and three replication. The individual plot size was 3.0 m X 1.5 m with spacing 30 cm X 10 cm. The pooled analyzed data showed all the treatments to have significant effect over control, *Azospirillum* @1.5 kg/ha alone (T9) regarding yield per plot and per hectare. Regarding number of branches per plant inorganic N (100%) + *Azospirillum* + 5 t/ha FYM (T_1), inorganic N (75%) + *Azospirillum* 5 t/ha FYM (T_2), inorganic N (50%) + *Azospirillum* + 5 t/ha FYM (T_3) and 100% inorganic nitrogen (T_8) were found significant as compared to control. However, all the treatments were significantly superior to control, FYM 5 t/ha + *Azospirillum* (T_4), FYM- 5 t/ha alone (T_5) and *Azospirillum* @ 1.5 kg/ha (T_9) regarding number of pods per plant. Non-significant effect was recorded regarding height of the plant, length of pods and number of grains per pod. Among the treatments, inorganic N (100%) + *Azospillum* + 5 t/ha FYM (T_1) gave maximum number of branches per plant (7.30), number of pods per plant (74.00) and yield per plot (1.18 kg/4.5m^2) or per hectare (2.62 t/ha) followed by inorganic N (75%) + *Azospirillum* + 5 t/ha FYM (T_2) i.e. number of branches per plant (7.00), number of pods per plant (69.67) and yield per plot (1.09 kg/4.5m^2) or per hectare (2.42 t/ha). Cost : benefit ratio of application of inorganic N (100%) + *Azospirillum* + 5 t/ha FYM (T_1) gave a maximum return of Rs. 2.35 per unit cost (1:2.35) followed by inorganic N (75%) + *Azospirrillum* + 5 t/ha FYM (T_2) i.e., Rs.2.17 per unit cost (1:2.17) (Table 112).

FGK/CM/4.3 Role of rhizobacteria in growth promotion of fenugreek (Final report)

(Dholi)

The present study was under taken at Dholi during 2007-2008 to 2009-2010 to understand the effect of biofertilizer on grain yield of fenugreek (variety Rajendra Kanti) in calcareous soil during rabi season. The experiment was laid out in randomized block design with eight treatments and three replication with variety Rajendra Kanti. The individual plot size was 3.0 m x 1.5 m and spacing was maintained at 30 cm x 10 cm. The pooled analysis indicated that all the treatments were significantly superior over control. Cost : benefit ratio of seed treatment with FL-18 (T_3) gave the maximum return of Rs.1.78 per unit cost (1:1.78) followed by seed treatment with FK-14 + soil application (T_2) *i.e.* Rs.1.42 per unit cost (1:1.42) (Table 113).

FGK/CM/4.4 Large scale demonstration of the role of rhizobacteria in growth promotion of fenugreek

(Jagudan, Jobner, Guntur, Hisar, Kumarganj)

Three large scale demonstrations were carried out at farmers field at different villages *viz.* Kalakh, Etawa junsia and Pachar (Sikar) by Jobner centre.

Village: Kalakh

Out of three treatments, seed treatment and soil application with FK-14 + FL-18 resulted in highest yield (2050 kg/ha) followed by seed treatment with FL-18 alone (seed yield 1870 kg/ha). The control recorded minimum seed yield (1680 kg/ha).

Village: Etawa Juncia

Out of three treatments, seed treatment and soil application with FK-14 + FL-18 gave an yield of 1800 kg/ha followed by seed treatment with FL-18 alone (1630 kg/ha).

Table 112. Response of bio-fertillizers *Azospirillum* on fenugreek at Dholi (Pooled mean 2007-08 to 2009-2010)

Treat ment	Plant height (cm)	Branches/ plant	Pods/ plant	Length of pod (cm)	Grains/ pod	Yield/plot (kg/4.5 m^2)	Yield (t/ha)	Increase in yield over check t/ha	Increase in yield over check %	Gross income (Rs.)	Cost of cultivation (Rs.)	Net profit (Rs.)	Cost : benefit ratio
T_1	88.75	7.30	74.00	10.14	16.50	1.18	2.62	1.25	91.24	78,600	33,500	45,100	1:2.35
T_2	90.25	7.00	69.67	10.01	16.83	1.09	2.42	1.05	76.64	72,600	33,428	39,172	1:2.17
T_3	88.04	6.86	65.41	10.21	16.18	1.03	2.29	0.92	67.15	68,700	33,350	35,350	1:2.06
T_4	80.96	5.93	48.73	9.56	16.25	0.81	1.80	0.43	31.38	54,000	33,200	20,800	1:1.63
T_5	83.98	6.01	47.59	9.87	16.22	0.84	1.89	0.52	37.95	56,700	32,000	24,700	1:1.77
T_6	82.24	5.88	51.89	9.91	16.15	0.83	1.86	0.49	35.76	55,800	35,200	20,600	1:1.59
T_7	80.90	6.09	49.14	9.72	16.18	0.82	1.85	0.48	35.03	55,500	34,000	21,500	1:1.63
T_8	84.67	6.20	57.66	10.31	16.33	0.95	2.02	0.65	47.44	60,600	30,300	30,300	1:2.00
T_9	84.96	5.59	42.92	9.57	15.40	0.76	1.69	0.32	23.35	50,700	31,200	19,500	1:1.63
T_{10}	78.34	5.37	41.18	8.98	14.40	0.61	1.37	-	-	41,100	30,000	11,100	1:1.37
SEm±	3.28	0.35	2.55	0.34	0.55	0.06	0.12						
CD (P=0.05)	NS	1.03	7.58	Ns	Ns	0.17	0.38						
CV (%)	6.74	9.65	8.07	6.13	6.03	11.21	11.26						

Note: A. Selling rate: Rs.3,000/- quintal

B. Cost of bio-fertilizer:

Azospirillum – Rs.1200/ha

FYM – Rs.40/quintal

Urea – Rs.276/50 kg bag

General cost – Rs.30,000/ha

T_1: Inorganic N (100%) + *Azospirillum* + 5 t/ha FYM; T_2: Inorganic N (75%) + *Azospirillum* + 5 t/ha FYM; T_3: Inorganic N (50%) + *Azospirillum* + 5 t/ha FYM; T_4: 5 t/ha FYM + *Azospirillum*; T_5: 5 t/ha alone; T_6: 10 t/ha FYM + *Azospirillum*; T_7: 10 t/ha FYM alone; T_8: 100% inorganic nitrogen; T_9: *Azospirillum* @1.5 kg/ha alone; T_{10}: Absolute control.

Table 113. Effect of rhizobacterial strains on yield and yield attributing character on fenugreek (Pooled 2007-08 to 2009-2010) at Dholi.

Character Treatment	Plant height	No. of branches/ plant	No. of pods/ plant	Pod length (cm)	No. of grains/ pod	Yield (kg/plot)	Yield (t/ha)	Increase in yield over check t/ha	Increase in yield over check %	Gross income (Rs.)	Cost of cultivation (Rs.)	Net profit (Rs.)	Cost : benefit ratio
T_1	62.07	5.25	35.51	9.49	14.91	0.95	1.65	0.35	26.92	49,500	34,000	15,500	1:1.40
T_2	78.63	6.64	50.26	10.123	17.88	1.06	1.85	0.55	42.30	55,500	39,000	16,500	1:1.42
T_3	80.37	7.21	50.72	11.33	18.53	1.14	2.00	0.70	53.85	60,000	34,000	26,000	1:1.78
T_4	76.82	6.27	44.55	10.11	17.23	1.03	1.78	0.48	36.92	53,400	39,000	14,400	1:1.37
T_5	72.52	5.92	37.63	9.51	16.05	0.99	1.72	0.42	32.30	51,600	38,000	13,600	1:1.35
T_6	70.08	5.84	36.56	9.39	16.51	0.97	1.67	0.37	28.46	50,100	48,000	2,100	1:1.40
T_7	69.31	5.30	32.01	9.28	16.01	0.93	1.61	0.31	23.85	48,300	39,000	9,300	1:1.23
T_8	58.68	4.89	26.80	8.74	14.06	0.73	1.30	-	-	39,000	30,000	9,000	1:1.30
SEm ±	1.85	0.20	1.10	0.21	0.31	0.02	0.05						
CD(P=0.05)	5.60	0.61	3.32	0.64	0.94	0.07	0.14						
CV (%)	4.50	5.97	4.83	3.76	3.28	4.35	4.69						

Note: A. Selling rate: Rs.3,000/- quintal

B. Cost of biofertilizer:

FK-14 strain- Rs.200/kg

FK-187 strain – Rs.200/kg

Trichoderma strain – Rs.200/kg

(Each strain 25kg/ha)

General cost Rs.30,000/ha

T_1: FK-14 - seed treatment; T_2: FK-14 - seed treatment + soil application; T_3: FL-18 - seed treatment; T_4: FL-18 - seed treatment + soil application; T_5: FK-14 + FL-18 - seed treatment; T_6: FK-14 + FL-18 - seed treatment + soil application; T_7: *Trichoderma* (MTCC 5179) - seed treatment + soil application; T_8: Control

Village: Pachar (Sikar)

Out of three treatments, seed treatment and soil application with FK-14 + FL-18 recorded highest yield (1400 kg/ha) followed by seed treatment with FL-18 alone (seed yield 1350 kg/ha). Minimum seed yield (1130 kg/ha) was obtained in control.

During 2009-10, three treatments with rhizobacteria were evaluated in farmers' field by Guntur centre. Among the treatments, maximum plant height was recorded in seed treatment and soil application of FK-14 (16.21 cm) followed by seed treatment and soil application of FK-14 and FL-18 (15.3 cm) which were on par with each other and significantly superior to the control (12.4 cm). Maximum numbers of leaves were recorded in seed treatment and soil application of FK-14 (12.6) followed by seed treatment and soil application of FK-14 and FL-18 (11.6) which was significantly superior to the control (10.7). Regarding green biomass and biomass also seed treatment and soil application of FK-14 recorded significantly more biomass (14.0 and 1.75 g/10 plant respectively) being on par with seed treatment and soil application of FK-14 and FL-18 (13.4 and 1.75 g/10 pl ant respectively) than control (12.5 and 1.5g/10 plant respectively). Among the treatments evaluated, the seed treatment and soil application of FK-14 + FL-18 yielded significantly superior leaf yield (1.57 t/ha) over control (1.33 t/ha) which was on par with seed treatment and soil application with FK-14 alone (1.51 t/ha) (Table 114).

Significant differences were obtained for all the parameters at Hisar. Maximum seed yield (1755 kg/ha) was recorded with the application of rhizobacteria FL-14 + FL-18 (seed treatment + soil application) followed by *Trichoderma* MTCC- 5179 (1669 kg/ha) (Table 115).

Field demonstration in 10 farmers field in 0.1 ha each was taken up in Kumarganj. Seed treatment and soil application of rhizobacteria FK-18 and FK-14 increased the seed yield in all the farmers field and gave the maximum growth in terms of plant height, length of pod, number of grains followed by application of *Trichoderma* over the farmer practice of seed broadcasting.

FGK/CP/5 Disease Management Trial

FGK/CP/5.1 Survey and identification of disease causing organisms and screening germplasm against disease

(Dholi)

Survey was conducted for identification of disease appearing in fenugreek in the Samastipur and Muzaffarpur districts of state. Disease was also recorded in the germplasm under natural condition.

Table 114. Yield and yield attributes of rhizobacteria treatment at Guntur

Sl. No.	Treatment	Plant height (cm)	Number of leaves	Green biomass (g/10 plants)	Biomass (g/10 plants)	Leaf yield (t/h)
1	Seed treatment + soil application with FK-14	16.2	12.6	14.3	1.75	1.51
2	Seed treatment + soil application with FK-14 + FL-18	15.3	11.6	13.4	1.75	1.57
3	Control	12.4	10.7	12.5	1.5	1.33
	CD (P=0.05)	1.2	0.46	0.52	0.21	0.12
	CV (%)	8.7	4.2	4.1	13.6	8.74

Table 115. Effect of rhizobacteria on growth and seed yield of fenugreek during 2009-10 at Hisar

Sl. No.	Treatment	Plant height (cm)	Branches/ plant	Pods/ plant	Pod length (cm)	Seeds/ pod	Seedyield (kg/ha)
1	Rhizobacteria FK-14 + FL-18 (seed + soil treatment)	69.6	6.6	60.8	8.9	18.2	1755
2	*Trichoderma* MTCC- 5179 (recommended dose)	63.5	5.5	55.3	8.1	17.8	1669
3	Control	65.8	5.3	45.4	8.5	16.1	1532
	CD (P=0.05)	1.4	0.4	1.1	0.1	0.4	126

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77. Gupta, M., Varsha Gangta and Dohroo, N. P. 2009. Morphological, pathological and physiological variability among *Pythium* isolates causing soft rot of ginger. Plant Disease Research 24(2): 103-108.

78. Gupta, M., Varsha Gangta and Dohroo, N. P. 2010. Biocontrol of ginger rhizome rot through fungal and bacterial antagonists. In: Souvenier and Abstracts of Annual Meeting of Indian Society of Plant Pathologists 26 February 2010, PAU, Ludhiana. PS-2.

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, Ambalavayal 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 , Ambalavayal and Yercaud / Pechiparai
PEP/C1/3.4	Evaluation of grafts, orthotropic and runner shoots in black pepper	Ambalavayal, Panniyur, Sirsi and Yercaud
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/CP/5	Disease Management Trial	
PEP/CP/5.1	Adaptive trial on management of *Phytophthora* foot rot of black pepper in farmers field	Ambalavayal (2009-10)
PEP/CP/5.2	Trial on management of *Phytophthora* foot rot of black pepper in existing plantation	Chintapalle, Dapoli and Panniyur, Pampadumpara, Mudigere and Sirsi
PEP/CP/5.3	Trial on management of *Phytophthora* foot rot of black pepper in new plantation	Chintapalle, Dapoli, Panniyur, Pampadumpara, Pechiparai, Mudigere and Sirsi
PEP/CP/6	Pest Management Trial	
PEP/CP/6.2	Management of *Erythrina* gall wasp, a popular standard of black pepper	Mudigere

Project Code	Title	Centres
CARDAMOM		
CAR/CI/1	**Genetic Resources**	
CAR/CI/1.1	Germplasm collection, characterization, evaluation and conservation	Mudigere and Pampadumpara
CAR/CI/2	**Hybridization**	
CAR/CI/2.1	Evaluation of OP progenies under intensive management	Mudigere
CAR/CI/2.2	Hybridization and 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, Ambalavayal 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/CM/5	**Nutrient Management Trial**	
CAR/CM/5.1	Effect of different irrigation schedule and fertilizers on yield of cardamom	Mudigere
CAR/CP/6	**Pest and Disease Management Trial**	
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
CAR/CP/6.7	Evaluation of new insecticides/biopesticide in cardamom against thrips and shoot and capsule borer	Mudigere and Pampadumpara
LARGE CARDAMOM		
LCA/CI	**Genetic Resources**	
LCA/CI.1	Germplasm of Large cardamom	Gangtok
LCA/CI/2	**Varietal Evaluation Trial**	
LCA/CI/2.2	Initial Evaluation Trial	Gangtok
GINGER		
GIN/CI/1	**Genetic Resources**	
GIN/CI/1.1	Germplasm collection, characterization, evaluation and conservation	Dholi, Kumarganj, Pottangi, Pundibari, Raigarh and Solan

Project Code	Title	Centres
GIN/CI/2	**Coordinated Varietal Trial**	
GIN/CI/2.2	CVT 2005 – Series VI	Solan, Pottangi and Pechiparai
GIN/CI/2.3	CVT 2006 – Series VII	Pottangi
GIN/CI/3	**Varietal Evaluation Trial**	
GIN/CI/3.2	Comparative yield trial	Pottangi
GIN/C1/3	Genotype X Environment interaction on quality of ginger	Appangala,Ambalavayal, Barapani, Calicut, Chintapalli, Dapoli, Dholi, Kanke, Kalyani, Mizoram, Navsari, Pantnagar, Pasighat, Pottangi, Pundibari, Raigarh and Solan
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 for quality	Solan
GIN/CM/5	**Nutrient Management Trial**	
GIN/CM/5.2	Organic farming in ginger - 2006	Solan, Pundibari, Pottangi, Dholi and Kumarganj
GIN/CM/5.3	Nutrient supplementation though organic manures for growth and yield of ginger	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, Ambalavayal 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, Ambalavayal and Pottangi
TURMERIC		
TUR/CI/1	**Genetic Resources**	
TUR/CI/1.1	*Germplasm collection, characterization,* evaluation and conservation	*Coimbatore, Dholi, Kumarganj, Pottangi,* Jagtial and Raigarh
TUR/CI/2	**Coordinated Varietal Trial**	
TUR/CI/2.3	CVT 2009-Series VIII	Ambalavayal

Project Code	Title	Centres
TUR/C1/2.4	Coordinated Varietal Trial - 2009	Ambalavayal, Chintapalle, Coimbatore, Dholi, Jagtial, Kumarganj, Pottangi, Pundibari, Pasighat, Pantnagar, Raigarh and Navsari
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/C1/3.3	Initial Evaluation Trial 2009	Dholi
TUR/CM/3.4	Genotype x Environmental interaction on quality	Dholi, Chintapalle, Pottangi, Kumarganj, Pundibari, Jagtial, Coimbatore and Mizoram
TUR/CI/4	**Quality Evaluation Trial**	
TUR/CI/4.1	Quality evaluation of germplasm	Coimbatore
TUR/CM/5	**Nutrient Management Trial**	
TUR/CM/5.2	Effect of organic farming in turmeric	Dholi
TUR/CM/5.3	Standardization of fertigation in turmeric	Coimbatore and Jagtial
TUR/CM/5.4	Effect of micronutrients on turmeric	Dholi, Kumarganj, Pundibari
TUR/CM/6	**Processing & Harvesting**	
TUR/CM/6.1	Standardization of processing in turmeric	Calicut and Coimbatore
TUR/CM/6.2	Mechanical harvesting in turmeric (Observational trial)	Coimbatore
TUR/CP/6	**Disease Management Trial**	
TUR/CP/6.1	Efficacy of biocontrol agents for control of rhizome rot of turmeric	Pottangi
TUR/CP/6.2	Survey and identification of disease causing organisms in turmeric and screening of turmeric germplasm against diseases	Coimbatore, Pundibari, Raigarh and Dholi
TUR/CP/6.3	Management of foliar diseases in 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/ Pechiparai
TSP/CI/2.2	CVT 2001- nutmeg	Dapoli and Pechiparai
TSP/CI/2.3	CVT 2001 - cassia	Pechiparai and Dapoli

Project Code	Title	Centres
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
TSP/CP/3	**Disease Management Trial**	
TSP/CP/3.2	Management of die back and wilt disease of nutmeg	Dapoli

CORIANDER

COR/CI/1	**Genetic Resources**	
COR/CI/1.1	Germplasm collection, description, characterization, evaluation, conservation and screening against diseases	Coimbatore, Dholi, Guntur, Hisar, Jagudan, Jobner and Kumarganj
COR/CI/2	**Coordinated Varietal Trial**	
COR/CI/2.4	Coordinated Varietal Trial - 2009 - Series-VIII	Ajmer, Dholi, Guntur, Hisar, Jabalpur, Jagudan, Jobner, Kumarganj, Navasari, Pantnagar, Raigarh and Udaipur
COR/CI/3	**Varietal Evaluation Trial**	
COR/CI/3.1	Initial evaluation trial 2008	Jabalpur
COR/CI/4	**Quality Evaluation Trial**	
COR/CI/4.1	Quality evaluation in coriander	Jobner
COR/CM/5	**Nutrient Management Trial**	
COR/CM/5.1	Effect of biofertilizer, *Azospirillum* on coriander	Dholi
COR/CM/5.2	Production of leafy type of coriander in off season	Kumarganj
COR/CM/5.3	Identification of drought/ alkalinity tolerant source in coriander	Guntur , Coimbatore, Kumarganj and Jobner
COR/CM/5.4	Role of rhizobacteria in growth promotion of coriander	Hisar and Jagudan
COR/CM/5.5	Nutrient supplementation though organic manures for growth and yield of coriander	Coimbatore, Dholi, Hisar, Jagudan, Jobner, Kumarganj and Raigarh
COR/CM/5.6	Effect of micronutrients on yield of coriander	Coimbatore & Dholi
COR/CM/5.7	Irrigation management for sustainable coriander production	Guntur
COR/CM/5.8	Large scale demonstration of the role of rhizobacteria in growth promotion of coriander	Coimbatore, Guntur, Hisar, Jagudan and Raigarh
COR/CP/6	**Disease Management Trial**	
COR/CP/6.2	Survey to identify the disease incidence collection and identification of casual organism	Dholi

Project Code	Title	Centres
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/C1/2.2	Coordinated Varietal Trial - 2009	Jobner, Jagudan, Ajmer and Jabalpur
CUM/CI/3	Varietal Evaluation Trial	
CUM/CI/3.2	Initial evaluation trial -2008	Jabalpur
CUM/CI/3.3	Initial evaluation trial-2009	Jobner
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/CM/5.4	Large scale demonstration of the role of rhizobacteria in growth promotion of cumin	Jagudan and Jobner
CUM/CP/6	Disease Management Trial	
CUM/CP/6.1	Management of wilt and blight diseases in cumin	Jobner
FENNEL		
FNL/CI/1	Genetic Resources	
FNL/CI/1.1	Germplasm collection, characterization, evaluation, conservation and screening against diseases	Dholi, Hisar, Jagudan, Jobner and Kumarganj
FNL/CI/2	Coordinated Varietal Trial	
FNL/CI/2.3	CVT 2007 – Series VI	Jagudan, Jobner, Kumarganj and Hisar
FNL/C1/2.4	Coordinated Varietal Trial - 2009 – Series VII	Ajmer, Dholi, Hisar, Jabalpur, Jagudan, Jobner, Kumarganj, Pantnagar, Udaipur and Raigarh
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

Project Code	Title	Centres
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, *Azospirillum* 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 and Hisar
FNL/CM/5.4	Large scale demonstration of the role of rhizobacteria in growth promotion of fennel	Hisar, Jagudan, and Raigarh
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/C1/2.1	Coordinated Variety Trial - 2009 Series VII	Ajmer, Coimbatore, Dholi, Guntur, Hisar, Jabalpur, Jagudan, Jobner, Kumarganj Pantnagar, Raigarh and Udaipur
FGK/CI/3	Varietal Evaluation Trial	
FGK/CI/3.2	Initial evaluation trial-2009	Jobner and Jabalpur
FGK/CM/4	Nutrient Management Trial	
FGK/CM/4.2	Identification of drought/tolerance source in fenugreek	Jobner and Guntur
FGK/CM/4.4	Large scale demonstration of the role of rhizobacteria in growth promotion of fenugreek	Jagudan, Jobner, Guntur, Hisar 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 Kallupurackal
Personal Assistant	:	Ms Alice Thomas
Supporting staff	:	Mr K Chandran

COORDINATING CENTRES

1. *Cardamom Research Station, KAU, Pampadumpara*

1. Breeder (Asst. Professor)	:	Dr Sanal Kumar P.
2. Agronomist (Hort.)	:	Dr G C Sreekala
3. Jr. Entomologist	:	Dr R Narayana
4. Farm Assistant (Sel. Gr.)	:	Mr C G Pradeep
5. Lab Assistant (Grade II)	:	Mr C S Manoj
6. Peon	:	Smt Radhamoni

2. *Pepper Research Station, KAU, Panniyur*

1. Pathologist (Assoc. Professor)	:	Vacant)
2. Jr. Breeder (Asst. Professor)	:	Dr V P Neema
3. Jr. Pathologist	:	Vacant
4. Jr. Horticulturist (Agronomy)	:	Dr D Jacob
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.)	:	Dr K M Devaraju
3. Breeder	:	Dr D Lakshmana

4. Jr. Entomologist	:	Dr D Jemla Naik
5. Technical Assistant	:	Vacant
6. Technical Assistant	:	Mr V Mallikarjunappa
7. Messenger	:	Ms Savithri

4. *Horticultural Research Station, UHS, Sirsi*

1. Jr. Pathologist	:	Dr M S Lokesh
2. Jr. Horticulturist	:	Mr Nagesh Naik
3. Technical Assistant	:	Mr B B Doddamani

5. *Horticultural Research Station, TNAU, Yercaud*

1. Agronomist (Hort.)	:	Dr V Lakshmanan
2. Jr. Breeder (Hort.)	:	Dr J Prem Joshua (Posted at HRS Pechiparai)
3. Lab Assistant	:	Mr P Pappu

6. *Department of Spices & Plantation Crops, TNAU, Coimbatore*

1. Breeder (Horticulturist)	:	Dr (Mrs) N. Shoba
2. Jr. Pathologist	:	Dr P Muthulakshmi
3. Agricultural Assistant	:	Mr R Swaminathan

7. *Horticultural Research Station, ANGRAU, Chintapalle*

1. Horticulturist	:	Sri K Ravindra Kumar
2. Junior Pathologist	:	Sri K Sesha Kiran
3. Technical Assistant	:	Post filled on contract basis

8. *Regional Agricultural Research Station, ANGRAU, Jagtial*

1. Jr. Pathologist	:	Sri S Narasimha Rao
2. Jr. Horticulturist	:	Mrs K Uma Maheswari
3. Technical Assistant	:	Post filled on contract basis

9. *Horticultural Research Station, ANGRAU, Guntur*

1. Horticulturist	:	Smt C Sarada
2. Jr. Breeder (Hort.)	:	Sri K Giridhar
3. Sub Assistant	:	Sri Shaik Jilani Bhasha

10. *Department of Vegetable Crops, Dr YSPUHF, Solan*

1. Breeder (Olericulturist)	:	Dr B N Korla
2. Jr. Pathologist	:	Vacant (Dr Ramesh Bhardwaj, in-charge)
3. Jr. Biochemist	:	Dr Neerja S Rana (Vacant from 19-8-2010)
4. Field Assistant	:	Mr Rajeshwar Chauhan

11. *High Altitude Research Station, OUAT, Pottangi*

1. Breeder	:	Vacant
2. Jr. Breeder	:	Mr D K Dash
3. Technical Assistant	:	Mr L K Mishra
4. Technical Assistant	:	Vacant

12. *Department of Genetics and Plant Breeding, SKN College of Agriculture, RAJAU, Jobner*

1. Sr. Breeder	:	Dr E V D Sastry
2. Breeder	:	Dr Dhirendra Singh
3. Jr. Agronomist	:	Dr N L Jat
4. Jr. Pathologist	:	Dr K S Shekhawat
5. Jr. Biochemist	:	Vacant
6. Technical Assistant	:	Dr S S Rajput
7. Technical Assistant	:	Mr S R Kumawat

13. *Main Spices Research Station, SDAU, Jagudan*

1. Pathologist	:	Dr K D Patel
2. Jr. Breeder	:	Mr G M Patel
3. Technical Assistant	:	Mr S R Chaudhari

14. *Department of Vegetable Crops, CCS HAU, Hisar*

1. Horticulturist/Oleoriculturist	:	Dr 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 VK Singh

17. *Department of Horticulture, UBKVV, Pundibari*

1. Horticulturist	:	Vacant (Dr J C Jana, in-charge)
2. Jr. Breeder	:	Dr N Bhowmik (Study leave) Dr B C Saha,in-charge

3.	Jr. Pathologist	:	Mr S Bandyopadhyay
4.	Technical Assistant	:	Ms Anupama Das
5.	Technical Assistant	:	Mr B Dutta

18. *Department of Horticulture, KKV, Dapoli*

1.	Horticulturist	:	Dr R G Khandekar
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 11-3-2008)
2.	Jr. Breeder	:	Smt. Roshni Bhagat
3.	Jr. Pathologist	:	Dr A K Singh
4.	Technical Assistant	:	Mr D S Kshatri
5.	Technical Assistant	:	Vacant (from commencement of the project)

AICRPS - BUDGET PROVISION

ALL INDIA COORDINATED RESEARCH PROJECT ON SPICES

CENTREWISE AND HEADWISE RE 2009-10

(Rs. in lakhs)

Name of the Centre	Pay and Allowances		TA		RC		Tech. A	Total RC	Equipments		Works		Total		Grand Total
	Total	ICAR	Total	ICAR	Total	ICAR*	ICAR	ICAR	Total	ICAR	Total	ICAR	ICAR	State	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	11	12	(13)	(14)	(15)
Pampadumpara (KAU)	3.711	2.783	0.600	0.450	2.400	1.800	0.05	1.850	4.500	3.375	-	-	8.458	2.803	11.261
Panniyur (KAU)	4.667	3.500	0.800	0.600	3.200	2.400	0.05	2.450	3.000	2.250	-	-	8.800	2.917	11.717
Mudigere (UHS)	16.813	12.610	0.800	0.600	3.200	2.400		2.400	2.000	1.500	-	-	17.110	5.703	22.813
Sirsi (UHS)	5.524	4.143	0.400	0.300	1.600	1.200	0.05	1.250	3.500	2.625	-	-	8.318	2.756	11.074
Yercaud (TNAU)	8.987	6.740	0.400	0.300	1.600	1.200	0.05	1.250	2.500	1.875	-	-	10.165	3.372	13.537
Coimbatore (TNAU)	8.000	6.000	0.400	0.300	2.267	1.700	0.05	1.750	3.833	2.875	-	-	10.925	3.625	14.550
Chintapalli (APHU)	4.713	3.535	0.400	0.300	1.600	1.200	0.05	1.250	0.167	0.125	-	-	5.210	1.720	6.930
Jagtial (APHU)	4.109	3.082	0.400	0.300	1.600	1.200		1.200	3.667	2.750	-	-	7.332	2.444	9.776
Guntur (APHU)	5.333	4.000	0.400	0.300	2.933	2.200	0.10	2.300	1.864	1.398	2.50	1.88	9.873	3.258	13.131
Solan (YSPUHF)	10.027	7.520	0.600	0.450	2.400	1.800		1.800	2.234	1.675	2.50	1.88	13.320	4.441	17.761
Pottangi (OUAT)	4.829	3.622	0.400	0.300	1.600	1.200		1.200	1.855	1.391	4.00	3.00	9.513	3.171	12.684
Jobner (RAJAU)	13.637	10.228	1.000	0.750	5.333	4.000	0.15	4.150	3.667	2.750	4.00	3.00	20.878	6.910	27.788
Jagudan (GAU)	15.517	11.638	0.400	0.300	4.267	3.200	0.15	3.350	3.100	2.325	-	-	17.613	5.821	23.434
Hisar (HAU)	8.749	6.562	0.400	0.300	3.600	2.700	0.10	2.800	1.330	0.998	-	-	10.660	3.519	14.179
Dholi (RAU)	8.541	6.4055	0.400	0.300	1.600	1.200	0.05	1.250	2.255	1.691	-	-	9.6465	3.199	12.846
Kumarganj (NDUAT)	15.063	11.297	0.600	0.450	3.067	2.300		2.300	4.330	3.248	-	-	17.295	5.764	23.059
Pundibari (UBKVV)	5.680	4.260	0.600	0.450	2.400	1.800	0.05	1.850	3.167	2.375	-	-	8.935	2.962	11.897
Dapoli (KKV)	17.800	13.350	0.600	0.450	2.400	1.800	0.05	1.850	3.330	2.498	-	-	18.148	6.032	24.180
Raigarh (IGKVV)	9.673	7.2545	0.600	0.450	3.733	2.800	0.05	2.850	3.034	2.276	-	-	12.8305	4.260	17.090
AICRPS Workshop	-	-	-	-	0.4575	0.4575	-	0.4575	-	-	-	-	0.4575	0.000	0.4575
TNAU	-	-	-	-	2.667	2.00	-	2.00	-	-	-	-	2.00	0.667	2.667
APHU	-	-	-	-	0.667	0.50	-	0.50	-	-	-	-	0.50	0.167	0.667
Total	171.373	128.530	10.200	7.650	54.591	41.0575	1.000	42.0575	53.333	40.00	13.00	9.75	227.9875	74.510	303.497

*Additional Recurring contigency of Rs 10.00 L Released to 7 AICRPS centres+TNAU+APHU

Continued..

AICRPS - BUDGET PROVISION

ALL INDIA COORDINATED RESEARCH PROJECT ON SPICES

CENTREWISE AND HEADWISE RE 2009-10

(Rs. in lakhs)

Name of the Centre	Pay and Allowances		TA		RC		Tech. A	Total RC	Equipments		Works		Total		Grand Total
	Total	ICAR	Total	ICAR	Total	ICAR*	ICAR	ICAR	Total	ICAR	Total	ICAR	ICAR	State	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	11	12	(13)	(14)	(15)
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	2.50	1.875	-	1.875	-	-	-	-	1.9875	-	1.9875
ICAR R C NEHR,	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mizoram	-	-	0.150	0.1125	2.50	1.875	-	1.875	-	-	-	-	1.9875	-	1.9875
ICAR R C NEHR, Sikkim			0.150	0.1125	2.50	1.875		1.875					1.9875	-	1.9875
Pasighat (CAU)	-	-	0.150	0.1125	0.80	0.600	-	0.600	-	-			0.7125	-	0.7125
Pantnagar (GBPUAT)	-	-	0.150	0.1125	0.80	0.600	-	0.600	-	-	-	-	0.7125	0.2375	0.9500
Kanke (BIRSAAU)	-	-	0.150	0.1125	0.80	0.600	-	0.600	-	-	-	-	0.7125	0.2375	0.9500
Kalyani (BCKVV)	-	-	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	-	-	2.250	1.6875	27.100	20.325	-	20.325	-	-	-	-	22.0125	7.3375	29.350
Grant Total	171.373	128.5300	12.450	9.3375	81.691	61.383	1.000	62.3825	53.333	40.00	13.0	9.75	250.000	81.848	332.847

STATEMENT OF FUND RELEASED TO AICRPS CENTERS 2009-10

(Rs. in Lakhs)

Name of the centre	Revised Estimate (Final)	Amount Released		Non Recurring Contingency	Works	Technology Assessment	Additional Recurring Contingency Realeased	Additional Pay & Allowances Released	Grand Total
	2009-10	I Half	II Half						
1	2	3	4	5	6	7	8	9	10
Pampadumpara (KAU)	8.458	2.516	2.517	3.375	-	0.050	-	-	8.458
Panniyur (KAU)	8.800	3.250	3.250	2.250	-	0.050	-	-	8.800
Mudigere (UHS)	17.110	7.805	7.805	1.500	-	-	-	-	17.110
Sirsi (UHS)	8.318	2.822	2.821	2.625	-	0.050	-	-	8.318
Yercaud (TNAU)	10.165	4.120	4.120	1.875	-	0.050	-	-	10.165
Coimbatore (TNAU)	10.925	3.750	3.750	2.875	-	0.050	0.50	-	10.925
Chintapalle (APHU)	5.210	2.517	2.518	0.125	-	0.050	-	-	5.210
Jagtial (APHU)	7.332	Nil	4.582	2.750	-	-	-	-	7.332
Guntur (APHU)	9.873	2.750	2.750	1.398	1.875	0.100	1.00	-	9.873
Solan (YSPUHF)	13.320	4.885	4.885	1.675	1.875	-	-	-	13.320
Pottangi (OUAT)	9.513	0.482	4.640	1.391	3.000	-	-	-	9.513
Jobner (RAJAU)	20.878	0.680	13.298	2.750	3.000	0.150	1.00	-	20.878
Jagudan (GAU)	17.613	5.069	5.069	2.325	-	0.150	2.00	3.000	17.613
Hisar (HAU)	10.660	1.100	6.962	0.998	-	0.100	1.50	-	10.660
Dholi (RAU)	9.6465	2.889	2.889	1.691	-	0.050	-	2.1275	9.6465
Kumarganj (NDUAT)	17.295	6.174	6.173	3.248	-	-	0.50	1.200	17.295
Pundibari (BCKVV)	8.935	3.250	3.260	2.375	-	0.050	-	-	8.935
Dapoli (KKV)	18.148	5.900	5.900	2.498	-	0.050	-	3.800	18.148
Raigarh (IGKVV)	12.8305	4.441	5.0635	2.276	-	0.050	1.00	-	12.8305
Co-opting/Voluntary	22.0125	22.0125	-	-	-	-	-	-	22.0125
APHU-Additional	0.500	-	-	-	-	-	0.50	-	0.500
TNAU-Additional	2.000	-	-	-	-	-	2.00	-	2.000
XXWS	0.4575	0.4575	-	-	-	-	-	-	0.4575
Grand Total	**250.00**	**86.870**	**92.2525**	**40.00**	**9.75**	**1.00**	**10.00**	**10.1275**	**250.00**

Total amount received from council = Rs 250.00 Lakhs
Amount released to centers = Rs 250.00 Lakhs

WEATHER DATA

Chintapalle

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)	
			Max	Min	Max	Min
April' 09	22.0	2	33.9	18.5	58.2	42.3
May	75.0	8	33.0	20.5	64.7	51.5
June	84.2	10	31.1	22.0	66.8	53.4
July	226.4	21	25.6	21.3	84.6	77.7
August	35.1	4	27.0	21.1	78.9	75.4
September	156.4	12	27.9	20.9	78.4	71.9
October	51.2	4	27.8	20.2	82.3	62.7
November	54.6	4	26.4	15.9	77.1	61.4
December	0	0	25.0	10.7	83.7	46.9
January' 10	41.2	3	25.2	11.2	83.7	47.8
February	1.4	1	28.7	11.7	69.3	41.8
March	61.6	4	32.1	16.6	68.0	38.0

Coimbatore

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)	
			Max	Min	Max	Min
April' 09	0.8	1	35.6	24.0	83	38
May	104.6	5	34.8	23.8	87	47
June	11.2	1	32.7	23.7	80	51
July	89.2	9	29.9	23.0	82	62
August	39.0	3	31.6	23.0	86	54
September	108.6	8	31.6	23.0	81	59
October	115.8	5	31.6	21.9	87	49
November	250.6	11	29.2	22.3	93	66
December	2.8	1	29.0	21.1	89	57
January'10	0.2	1	30.5	20.2	88	45
February	0.0	0	30.9	20.9	85	36
March	0.0	0	35.6	20.9	80	30

Dapoli

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)	
			Max	Min	Max	Min
April'09	1.0	1.0	32.8	20.1	88.2	61.1
May	2.8	1.0	33.4	21.3	87.5	64.5
June	117.1	7.0	32.7	23.8	90.5	68.1
July	1311.0	35.0	28.0	23.7	96.8	94.8
August	264.6	20.0	28.8	22.3	95.3	86.8
September	692.6	18.0	28.3	23.1	97.0	83.5
October	181.2	10.0	31.0	21.5	96.4	71.6
November	127.0	4.0	31.6	19.9	92.3	58.0
December	0.0	0.0	31.8	15.8	95.6	55.0
January'10	0.0	0.0	31.6	14.9	96.2	65.2
February	0.0	0.0	31.1	13.8	95.0	69.5
March	0.0	0.0	32.7	16.7	95.0	63.8

Dholi

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)	
			Max	Min	Max	Min
April' 09	0	-	37.0	20.6	65.5	41.5
May	7.0	-	34.5	23.5	78.7	52.4
June	2.6	-	37.0	26.3	81.5	51.8
July	3.0	-	34.5	27.0	85.5	62.9
August	9.9	-	32.7	26.0	90.4	72.4
September	3.9	-	33.6	25.8	89.0	67.2
October	1.3	-	32.0	20.6	88.7	51.0
November	0.0	-	28.9	15.2	88.3	43.8
December	0.2	-	24.3	9.7	89.6	42.6
January' 10	0.0	-	17.0	8.3	89.1	66.1
February	0.1	-	24.8	10.3	88.2	44.1
March	0.0	-	32.1	16.0	80.7	42.2

Guntur

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)	
			Max	Min	Max	Min
April' 09	0.0	0	39.8	24.5	85.0	44.0
May	68.9	3	40.6	26.4	82.8	40.1
June	7.7	1	39.7	26.1	71.6	38.8
July	29.8	4	36.7	25.7	76.0	50.9
August	240.6	10	35.8	23.5	83.3	60.1
September	143.0	8	34.4	23.6	84.0	61.7
October	22.4	2	33.5	21.7	83.2	57.7
November	123.0	5	30.0	19.9	90.1	73.1
December	9.4	1	29.5	18.1	88.0	55.4
January' 10	2.0	1	30.7	16.5	89.5	48.1
February	0	0	31.0	16.6	89.7	47.8
March	0	0	33.0	16.1	85.9	44.2

Hisar

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)	
			Max	Min	Max	Min
April' 09	24.9	1	35.8	17.3	62.5	29.8
May	38.2	2	40.8	23.7	54.7	25.5
June	29.4	4	41.5	25.2	54.7	25.1
July	92.4	5	36.7	26.4	77.7	57.8
August	14.0	2	38.0	26.8	76.0	49.7
September	239.9	5	34.4	22.5	88.5	51.1
October	0.0	0	33.4	15.5	84.1	29.3
November	0.0	0	27.1	9.9	91.1	41.2
December	0.0	0	23.1	4.9	89.6	36.6
January' 10	11.5	1	17.3	5.9	97.8	69.3
February	7.6	1	25.8	7.4	90.6	45.5
March	2.5	1	34.9	16.7	78.0	31.0

Jobner

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)	
			Max	Min	Max	Min
April' 09	0.0	-	37.8	18.6	44	17
May	37.6	3	41.2	25.7	49	19
June	6.8	2	40.3	25.6	52	26
July	67.2	2	35.9	25.5	74	53
August	50.0	6	34.6	25.0	78	51
September	19.2	2	36.8	22.3	69	34
October	-	-	34.1	16.3	64	32
November	1.2	1	28.0	10.3	67	30
December	-	-	24.9	06.8	71	29
January' 10	-	-	26.1	04.7	79	26
February	7.3	1	28.0	09.6	73	27
March	-	-	35.8	16.1	53	15

Kumarganj

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)	
			Max	Min	Max	Min
April' 09	1.3	0	40.7	20.5	54.3	22.2
May	38.0	4	37.9	24.4	69.5	38.9
June	31.6	1	40.2	26.5	66.4	38.3
July	239.5	10	34.3	27.2	80.8	63.3
August	265.8	17	33.0	26.1	89.4	71.8
September	309.7	10	32.8	24.9	90.4	71.1
October	133.2	2	33.4	18.0	86.8	56.6
November	3.2	1	27.3	12.2	86.6	45.2
December	6.6	1	24.6	7.1	86.9	45.3
January' 10	5.4	2	22.4	5.6	88.4	66.2
February	25.5	3	28.5	9.6	83.6	45.7
March	0.0	0	30.4	13.5	74.5	32.4

Mizoram

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)	
			Max	Min	Max	Min
April' 09	132	5	29.4	22.9	78.7	66.5
May	232	13	29.2	22.7	78.0	66.0
June	235	13	28.3	25.6	85.2	71.0
July	329	15	28.5	24.8	91.1	69.1
August	389	26	27.7	24.8	90.8	66.7
September	564	25	27.6	24.4	85.2	56.9
October	128	7	27.3	21.1	85.4	59.1
November	2	1	24.7	18.6	86.1	61.7
December	0	0	21.8	14.7	84.6	53.8
January'10	0	0	22.7	14.7	75.2	46.9
February	0	0	24.1	16.4	61.3	37.1
March	241	6	29.9	21.4	61.1	36.6

Mudigere

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)	
			Max	Min	Max	Min
April'09	73.4	4	29.8	16.4	84.5	77.8
May	116.1	8	31.1	18.4	89.9	82.7
June	230.2	16	27.2	17.0	89.7	83.8
July	1866.4	30	23.1	16.6	82.0	74.2
August	284.5	22	26.2	17.6	88.8	80.4
September	518.4	22	26.5	18.2	88.6	80.2
October	342.8	8	26.6	17.9	89.1	83.7
November	177.6	8	26.5	17.8	88.5	79.1
December	69.0	3	27.0	13.9	88.0	76.5
January' 10	-	-	26.3	14.6	67.9	58.9
February	-	-	27.0	16.5	83.2	66.3
March	-	-	30.8	17.0	89.8	82.8

Pampadumpara

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)	
			Max	Min	Max	Min
April' 09	62.2	3	28.9	19.1	89	52
May	58.2	8	27.9	19.3	95	65
June	184.7	13	24.3	18.3	96	77
July	407.2	24	21.9	18.0	98	90
August	101.0	14	24.0	18.2	97	81
September	183.4	17	24.0	18.3	97	80
October	131.2	9	25.7	18.2	94	64
November	260.8	11	24.0	18.3	96	78
December	28.3	5	23.5	16.9	94	74
January' 10	5.4	1	24.6	15.8	91	60
February	0.0	0	27.4	16.1	91	46
March	48.6	1	29.9	18.6	88	36

Panniyur

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)	
			Max	Min	Max	Min
April' 09	117.9	11	35.4	27.2	92.6	-
May	234.2	12	34.1	26.7	93.6	-
June	509.8	21	31.2	25.5	92.3	-
July	1610.8	31	28.2	24.7	95.0	-
August	314.3	23	30.0	26.4	93.7	-
September	302.6	18	30.0	25.6	91.9	-
October	122.2	7	33.0	25.0	96.0	-
November	386.8	11	32.8	25.2	91.0	-
December	88.8	4	33.1	21.9	92.7	-
January' 10	21.4	1	33.2	23.2	87.5	-
February	-	-	34.7	24.5	90.1	-
March	-	-	36.5	23.2	87.2	-

Pasighat

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)	
			Max	Min	Max	Min
April' 09	233.8	14	28.0	19.8	85.2	76.1
May	130.5	8	30.7	22.3	83.9	72.6
June	356.5	14	32.2	24.2	88.7	77.5
July	612.4	20	31.1	24.7	93.1	83.6
August	748.0	21	30.8	24.3	91.8	81.7
September	315.5	11	33.5	24.0	85.6	72.1
October	177.6	7	30.8	21.3	86.0	74.2
November	143.1	5	26.2	16.7	85.1	72.3
December	22.4	3	24.0	14.4	85.7	72.7
January' 10	0.3	0	25.1	12.0	82.4	64.3
February	39.3	6	24.1	14.8	82.1	69.9
March	63.8	16	26.1	17.0	82.5	72.0

Pechiparai

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)	
			Max	Min	Max	Min
April' 09	113	13	30.0	24.1	93.1	-
May	40	4	34.4	23.9	95.0	-
June	77	16	32.5	23.4	92.0	-
July	310	21	30.5	21.6	95.7	-
August	334	20	33.5	20.0	95.6	-
September	168	11	32.0	20.0	90.9	-
October	414	25	33.0	23.5	93.2	-
November	112	12	31.4	18.5	93.6	-
December	132	17	32.2	19.0	91.5	-
January'10	14	1	33.5	21.5	92.8	-
February	53	7	33.2	18.0	91.7	-
March	285	18	33.6	21.0	90.5	-

Pundibari

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)	
			Max	Min	Max	Min
April' 09	91.1	6	29.3	18.0	84	75
May	246.7	13	31.6	18.9	86	84
June	770.2	17	32.6	21.8	91	89
July	244.0	13	32.7	24.1	90	89
August	516.4	17	31.5	24.2	93	92
September	356.0	18	34.1	22.6	96	67
October	93.8	8	34.5	19.5	97	67
November	-	-	30.3	14.0	95	60
December	-	-	25.5	9.7	95	58
January' 10	-	-	24.8	8.8	98	61
February	-	-	27.9	9.0	95	57
March	241.9	10	30.1	16.9	94	51

Sirsi

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)	
			Max	Min	Max	Min
April, 09	11.8	2	34.9	20.5	84.0	44.0
May	18.8	4	33.5	21.9	81.0	50.0
June	209.4	11	28.8	19.9	88.8	75.8
July	1693.2	29	25.4	19.8	92.8	89.3
August	174.0	18	27.4	20.0	91.8	81.4
September	262.0	20	27.8	19.9	92.1	84.2
October	237.4	8	29.1	17.7	85.3	61.1
November	72.4	7	29.2	17.5	85.1	65.6
December	39.6	3	29.6	15.9	84.6	76.6
January' 10	9.8	3	29.6	14.7	91.7	87.8
February	0	0	32.7	15.3	90.0	89.3
March	0	0	34.90	17.71	88.92	86.59

Solan

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)	
			Max	Min	Max	Min
January' 09	21.3	-	21.0	2.3	64	-
February	29.3	-	22.5	3.0	51	-
March	43.2	-	24.9	8.4	51	-
April	26.5	-	28.8	16.6	53	-
May	30.2	-	30.8	15.9	49	-
June	37.3	-	33.3	18.5	45	-
July	183.1	-	29.0	19.5	70	-
August	67.5	-	28.4	18.8	75	-
September	408.0	-	21.1	15.6	77	-
October	2.2	-	26.2	9.7	60	-
November	14.7	-	22.2	5.0	56	-
December	0	-	19.2	1.9	51	-

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Agrisearch with a human touch

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