भाकृअनुप
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वार्षिक रिपोर्ट
Annual Report
2010-11

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

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Calicut - 673012, Kerala, India

ALL INDIA COORDINATED RESEARCH PROJECT ON SPICES

ANNUAL REPORT 2010-11

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परियोजना समन्वयक की रिपोर्ट

अखिल भारतीय समन्वित मसाला अनुसंधान परियोजना (ए आई सी आर पी एस) का मुख्यालय भारतीय मसाला फसल अनुसंधान संस्थान, कालिकट में स्थित है। यह परियोजना अपनी 13 अधिदेश फसलों जैसे, काली मिर्च, इलायची, कैसिया, दालचीनी, लौंग, धनिया, जीरा, सौंफ, मेथी, अदरक, बडी इलायची, जायफल तथा हल्दी पर शोध कार्य तथा समन्वय के लिए अधिकारित है। इस परियोजना के अन्तर्गत 34 केन्द्र है जो भारत के 21 विभिन्न राज्यों में 21 राज्य/केन्द्रीय कृषि विश्वविद्यालय/अनुसंधान संस्थानों के अन्तर्गत कार्यरत है। ए आई सी आर पी एस की बारहवीं कार्यशाला में लिये निर्णयानुसार, बीज मसालों पर विशेष कार्य करने के लिये एक स्वैच्छिक केन्द्र 11 वीं पंचवर्षीय योजना के अन्तर्गत बागवानी अनुसंधान क्षेत्र, पेरियकुलम इस परियोजना में सम्मिलित हुआ। वर्ष 2010-11 के लिये इस परियोजना का XI योजना का बजट 1400 लाख रूपये हैं इसमें आई सी ए आर 250 लाख रूपये का अंशदाता है।

राष्ट्रीय अनुसंधान केन्द्र (बीज मसाला) अजमेर में 5-6 जुलई 2010 को संपन्न हुई XXI वीं कार्यशाला के दौरान लिये गये निर्णयानुसार नये कार्यक्रमों को आरंभ किया गया। विभिन्न केन्द्रों में अधिदेश फसलों पर लगभग 100 अनुसंधान कार्यक्रमों को आयोजित किया गया। यह कार्यक्रम मुख्यतः आनुवंशिकी, फसल सुधार, फसल उत्पादन तथा फसल संरक्षण जैसे प्रमुख विभागों के अन्तर्गत आते हैं। अधिदेश फसलों पर कार्यों की प्रमुख उपलब्धि इस रिपोर्ट में प्रस्तुत की जा रही हैं।

काली मिर्च

काली मिर्च जननद्रव्यों को इकट्ठा करके लगभग सभी काली मिर्च पर कार्य करने वाले केन्द्रों में संरक्षण किया जा रहा है। काली मिर्च जननद्रव्य अनुरक्षण के लिये आर आर एस अम्बलवयल केन्द्र को वैकल्पिक अनुरक्षणशाला के रूप में स्थापना की गयी। पन्नियूर तथा चालक्कुडी में वर्ष 2010 के दौरान अनेक काली मिर्च अक्सेशनों का मूल्यांकन किया गया जिनमें से ICP- 48 तथा P-5 आशाजनक थे। यारकाड में दो अक्सेशन PN- 33 तथा 57 लगातार अच्छा प्रदर्शन कर रहे हैं। पन्नियूर में काली मिर्च की अन्तः प्रजाति संकर P6 x P 5 को विकसित किया गया जिसका उत्पादन हरी बेरी 5 कि. ग्राम/बेल है। पाम्पाडुमपारा तथा चिंतापल्ली में काली मिर्च की कल्टिवर्स प्रजाति परीक्षण (सी वी टी) में CUL 5308 की अधिकतम उपज अंकित की गयी। पन्नियूर में CUL. 5489 तथा CUL 5308 गत तीन वर्षों से आशाजनक है जबकि अम्बलवयल में पन्नियूर I की अधिकतम शुष्क बेरी उपज 1.89 किलोग्रम/बेल तत्पश्चात् PRS 21 में 1.01 कि. ग्राम/बेल अंकित की गयी। गत वर्ष काली मिर्च के विभिन्न केन्द्रों में काली मिर्च की कलम, आर्थोट्रोपिकल तथा रनर शूट को मूल्यांकन करने के लिये एक परीक्षण आरंभ किया गया तथा यह शोध कार्य प्रगति पर है। दापोली में काली मिर्च की आर्थोट्रोपिकल तनों में जडों के लिये एक तकनीक को मानकीकृत किया गया। इस में *प्स्यूडोमोनास फिलोरीसेन्स* 10^8 चूर्ण संरक्षण अथवा दो मिनट तक सामान्य शर्करा घोल से बिना पत्तियों का दो गांठ युक्त आर्थोट्रोपिकल तने को उपचारित करते है।

काली मिर्च में जड गलन रोग के लिये पोटैशियम फोस्फोनेट @ 0.3% का छिडकाव तथा एक किलो नीम केक के साथ *ट्राइकोडेरमा हरज़ियानम* को 50 ग्राम/बेल तथा बोर्डियो मिश्रण (1%) कोपर ओक्सिक्लोराइड को जडों के आस पास की मृदा को उपचारित करने से काली मिर्च के जड गलन रोग के प्रति प्रभावकारी एवं अल्पव्ययी प्रबन्धन की संस्तुति की गयी। काली मिर्च को उगाने वाले क्षेत्र मलनाड में *ईरिथ्रीना* को सहायक वृक्ष के रूप में उपयोग करते हैं। इस क्षेत्र में *ईरिथ्रीना* की मुख्यतः तीन उपजातियां *ई. इण्डिका, ई. फुसका* तथा *ई. सुबुमब्रान्स* पाई जाती है। इस वृक्ष पर गाल वास्प का संक्रमण एक गंभीर समस्या है। *ई. इण्डिका* तथा *ई. फुसका* पर इस रोगजनक का पूर्णतः क्षेत्र में असर अंकित किया गया जबकि *ई. सुबुमब्रान्स पर उसका प्रभाव अंकित नहीं किया गया।*

इलायची

मुडीगिरी में इलायची के खुली परागित संतति 21 C_8 में अधिकतम शुष्क कैप्स्यूल उपज (190.2 कि. ग्राम/हे) तत्पश्चात् 22 C_8 में (189.6 कि. ग्राम/हे) अंकित की गयी तथा क्लोन CL-722 (292.0 कि. ग्राम/हे) तथा PS -27 (262.00 कि. ग्राम/हे) शुष्क कैप्स्यूल उपज के लिये आशाजनक थे। पाम्पाडुमपारा

में कल्टीवर्स प्रजाति परीक्षण में PS -27 (386 ग्राम / पेड) की अधिकतम उपज अंकित की गयी। जल की मात्रा, सिंचाई का समय, फरटीगेशन की रिसावदार सिंचाई तथा जैविक खेती को मानकीकृत करने के लिये एक परीक्षण आरंभ किया गया जिसका कार्य प्रगति पर है। पाम्पाडुमपारा में इलायची तना एवं कैप्स्यूल भेदक तथा थ्रीप्स का क्वनालफोस (0.05%) को छः बार छिडकाव करके प्रभावकारी प्रबन्धन किया।

बडी इलायची

दार्जिलिंग के सुखिया पोखरी तथा रंग भंग, पश्चिम सिक्किम के हीगांव, दक्षिणी सिक्किम के रवंगला तथा नामची, उत्तर सिक्किम का डिज़ोनगो तथा असम लिंजीनी, पूर्वी सिक्किम का पैकयूंग क्षेत्र का सर्वेक्षण करके नौ जननद्रव्यों जैसे SCC 218 (हेरियो रामसे), SCC 219 (रोटो वरलेंजी), SCC 220 (रामसे), SCC 221 (वरलेंजी), SCC 222 (रामसे), SCC 223 (रामसे), SCC 224 (चिवैसी), SCC 225 (एलाइड जनरा), SCC 226 (हैरियो वरलैंगी) को एकीकृत करके कबी प्रक्षेत्र में रोपण किया। इन जननद्रव्यों को वर्णनकर्तानुसार चरित्रांकन किया गया। एन. बी. पी. जी. आर., नई दिल्ली से बडी इलायची के 48 अक्सेशनों के IC नंबर प्राप्त किये।

अदरक

अक्सेशन NDG-55 (कुमारगंज), GCP-32, GCP-14, GCP-33, GCP-54, GCP-01 (पुनडीबेरी) SG-26/04, SG-40/04, SG-8/04, SG-1029, SG-823 (सोलन) तथा RG-43 ,RG-18 (धोली) को अधिक उपज के लिये चिन्हित किया गया। पुनडीबेरी में अक्सेशन GCP-01, GCP-08 तथा GCP-51 वर्षभर रोगमुक्त रहे। सोलन में सी वी टी में दो क्षेत्रीय कल्टिवर्स SG-707 (179.99 ग्राम / पौधा) तथा SG-827 (164.23 ग्राम / पौधा) में अधिक उपज अंकित की गयी। अदरक की प्रजातियों का विभिन्न कशषि जलवायु क्षेत्रों में प्रदर्शन देखने के लिये परीक्षण किया गया। परिणामस्वरूप कल्याणी में अधिकतम औसत प्रकन्द उपज सुप्रभा (5.68 कि. ग्राम) तत्पश्चात् वरदा (4.616 कि. ग्राम) तथा गौरोबधन (4.309 कि. ग्राम) में अंकित की गयी। फासीघाट (अरूणाचल प्रदेश) में सुप्रिया एवं नदिया जबकि सोलन में हिमगिरी में अधिक उपज अंकित की गयी। सुप्रभा तथा महिमा रांची के लिये उपयुक्त थी। धोली में अदरक की जैविक प्रबन्धन परीक्षण करने पर ज्ञात हुआ कि एकीकृत उर्वरक (जैविक तथा अजैविक) तथा सम्पूर्ण अजैविक उर्वरकों की तुलना में पूर्णतः जैविक उर्वरकों को डालने पर अधिक उपज प्राप्त होती है। कुमारगंज में उर्वरकों की संस्तुत मात्रा का 50% (60:40:40 कि.ग्राम एन. पी. के. कि. ग्राम / है) + एफ वाइ एम का 50% (10 टन / है) + एज़ोस्पौरैलियम (5 कि. ग्राम / है) + बीज उपचारण *प्स्यूडोमोनास फिलोरीसेन्स* + *ट्राइकोडेरमा* (50 ग्राम / 3 मी^{2}) का उपयोग करने पर अधिकतम ताज़ा प्रकन्द उपज 62.37 कु. / है उपज प्राप्त हुई। जबकि 100% एफ.वाई.एम. (20टन / हे.) + बीज उपचारण तथा *प्स्यूडोमोनास फिलोरीसेन्स* + *ट्राइकोडेरमा* 50 ग्राम / 3 मी^{2} का उपयोग करने पर 44. 5 कु. / है. उपज प्राप्त हुई। चिन्तापल्ली में राइज़ोबैक्टीरिया अथवा मैटालैक्सिल, मैनकोज़ेब 72% WP (1.25 ग्राम / लि.) से प्रकन्द उपचारित करने पर मन्द गलन रोग का प्रभाव कम हुआ तथा उपज अधिक प्राप्त हुई।

हल्दी

कुमारगंज में जल्दी पकने वाले 29 जननद्रव्यों का मूल्यांकन करने पर NDH-79 (362.10 कु. / है.) तथा NDH-74 (352.47 कु. / है) अधिक आशावान थे। मध्यम अवधि में पकने वाले 74 जननद्रव्यों में से NDH-98 (421.60 कु. / है) तथा NDH-18 (नरेन्द्र हल्दी–1) (335.20 कु. / है) में अधिक उपज अंकित की गयी। विलम्ब से पकने वाली 36 प्रजातियों का आकलन करने पर, NDH-8 (375 कु. / है) तत्पश्चात् NDH-7 की 357.15 कु. / है. ताज़ा उपज प्राप्त हुई। जननद्रव्य अक्सेशन RH-24 तथा RH-17 (धोली) , CLI-317 (जगतियाल), IT-8, IT-3, IT-9, IT-41 (राइगढ), CHFT-8,CHFT-22, CHFT-30, CHFT-36 (फासी घाट), TCP-137, TCP-120 तथा TCP-46 (पुण्डीबेरी) को अधिक उपज के साथ आशाजनक अंकित किये गये। कुमारगंज में हल्दी की आई. ई. टी. में NDH-8 (346.33 कु. / है) तथा NDH-9 (336.66 कु. / है.) की अधिक उपज अंकित की गयी। हल्दी के सी. वी. टी. में TCP-70 ने पुण्डिबेरी, कुमारगंज तथा राइगढ में जबकि CL-101 तथा BSR-2 (13.25 कि. ग्राम/प्लोट) ने कोयम्बतूर में श्रेष्ठ प्रदर्शन किया। जीनोटाइप तथा पर्यावरण पारस्परिक अध्ययन में, हल्दी की प्रजाति VSR-II, दुगिराला तथा सुरन्जना ने कल्याणी में जबकि TCP-2 तथा नरेन्द्र हल्दी ने पुण्डिबेरी में श्रेष्ठ प्रदर्शन किया। कालिकट में अधिक उपज राजेन्द्र सोनिया तत्पश्चात् नरेन्द्र हल्दी में अंकित की गयी। चिन्तापल्ली में, अधिकतम शुष्क उपज (8.6 टन / है.) रोमा में तत्पश्चात् मेगा हल्दी में 36.3 टन / है. अंकित की गयी जबकि अधिकतम ताज़ा उपज राजेन्द्र सोनिया (36.3 टन / है) तत्पश्चात रोमा एवं सुरंजना (32 टन / हैक्टर) अंकित की गयी। राइगढ में सुरंजना अधिक उत्कृष्ठ थी। हल्दी का संसाधन परीक्षण करने पर यह ज्ञात हुआ कि परम्परागत गरम पानी विधि द्वारा प्रकन्दों को 40, 60 तथा 90 मिनट तक गरम करने पर प्रकन्द सूखने में 11 दिन का समय लेते है जबकि संशोधित गरम पानी में

60, 45 तथा 30 मिनट तक गरम करने पर क्रमशः 12, 23 तथा 24 दिन लगते है। गरम पानी विधि द्वारा प्रकन्दों को 40 मिनट तक गरम करने पर कुरकुमिन (5.91%) तथा आवश्यक तेल (3.6%) की अधिकतम मात्रा प्राप्त हुई। प्रकन्दों को संसाधन करने का समय बढाने से कुरकुमिन, स्टार्च, आवश्यक तेल एवं ओलिओरसिन की मात्रा कम हो गयी। जगतियाल में, हल्दी की रिसावदार सिंचाई के लिये जल की आवश्यकता का आकलन करने के लिये एक परीक्षण आयोजित किया गया। परिणामस्वरूप उपरी सतह की सिंचाई करने पर अधिकतम उपज (44.30 कि.ग्राम/60 पौधे) प्राप्त हुई। कोयम्बतूर तथा कामरपल्ली में सप्ताह में एक बार 100% उर्वरकों (एन पी के @ 150:60:108 कि.ग्राम / है.) डालने पर अधिकतम गुच्छ भार 432.44 ग्राम तथा उपज 9.24 कि.ग्राम/प्लोट प्राप्त हुई जबकि सूक्ष्म पोषण तत्वों का छिडकाव करने पर गुच्छ भार 341.7 कि. ग्राम तथा उपज 8.98 कि. ग्राम/प्लोट अंकित की गयी। हल्दी में पत्ती चित्ती रोग 0.1% को प्रोपीकोनाज़ोल को 45 तथा 90 दिन पर अथवा कार्बेन्डाज़िम + मेन्कोज़िब (0.1%) को 45 तथा 90 दिनों पर छिडकाव करने पर नियन्त्रित करने के लिये प्रभावकारी था। जगतियाल/कामरपल्ली में मेन्कोज़िब + कार्बेन्डाज़िम (0.1%) का छिडकाव पत्ती पर छाला के प्रबन्धन के लिये प्रभावकारी था।

वृक्ष मसाले

दापोली, येरकाड तथा पीचिपराइ केन्द्रों में वृक्ष मसाले जैसे जायफल, दालचीनी, कैसिया तथा लौंग को एकत्रित करके उनका चरित्रांकन, नामावली तथा अनुरक्षण किया जा रहा है। पीचिपराई में जायफल के अक्सेशन सं. Sel.4 में अधिकतम उपज 1005 फल/वृक्ष तथा ओलिओरेसिन 8.67% की मात्रा अंकित की गयी। दालचीनी के अक्सेशनों में Sel.65 ने श्रेष्ठ प्रदर्शन किया जिससे इसके पौधे की उंचाई 3.90 मी., तने की मोटाई 29.35 से. मी., पत्ती की उपज 7083 कि. ग्राम/वृक्ष तथा शुष्क छाल 620 ग्राम/वृक्ष अंकित की गयी। लौंग में Sel.13 की शुष्क उपज 3.70 कि. ग्राम/वृक्ष के साथ आशाजनक पाया गया। कैसिया पर सी. वी. टी. कार्य प्रगतिशील है।

जीरा

जोबनेर में, दो वर्ष के सी वी टी में मूल्यांकन करने पर पर CUM-13 को अधिक उपज (677. 61 कि. ग्राम/हेक्टर) तत्पश्चात् CUM-12 (595.14 कि. ग्राम/हेक्टर) में प्राप्त हुई। आई. ई. टी. में UC-339 (726.74 कि. ग्राम/हेक्टर) तथा UC-336 (671.88 कि. ग्राम/हेक्टर) को आशाजनक पाया गया। अतः इन को सी. वी. टी. के लिये संस्तुत किया गया। जगुदान में *ट्राइकोडरमा हर्ज़ियानम* को 20 कि. ग्राम/हेक्टर + एफ. वाई.एम. को 6 टन/है. (बी. सी. आर. 1:2.42) अथवा 1.20 कि. ग्राम/है. *ट्राइकोडरमा* + 3 टन/है. एफ. वाई.एम. (बी. सी. आर. 1:2.16) की दर से बुआई के समय उपचारित करने पर जीरा विल्ट का प्रभावकारी प्रबन्धन संस्तुत किया गया।

धनिया

कोयम्बतूर में 275 अक्सेशनों का मूल्यांकन करने पर CS 251 आशाजनक था। कुमारगंज में अक्सेशन, ND Cor-38 (18.45 कु./है.) तत्पश्चात् NDCor -2 (17.40 कु./है.) की अधिक बीज उपज प्राप्त हुई। गुंटूर में अधिकतम उपज अक्सेशन LCC-303 (1770.8 कि. ग्राम./है.) तत्पश्चात LCC-301 (1728.2 कि. ग्राम.), LCC-274 (1583 कि. ग्राम./है) तथा LCC-279 (1458 कि. ग्राम./है) की अंकित की गयी। धोली में अक्सेशन RD-420 तथा RD-395 अधिक उपज के लिये चिन्हित किये गये।

रिपोर्टाधीन काल में दो नये परीक्षण आरंभ किये गये जिनमें धनिया पत्ती प्रकार की प्रजाति की पहचान तथा धनिया पत्ती के उत्पादन में पोषण प्रबन्धन किया गया। सी. वी. टी. में जबलपुर तथा उदयपुर में COR-32, कुमारगंज में COR-25, राइगढ में COR-31, गुंटूर में COR-30, जोबनेर में COR-27 तथा अजमेर में COR-29 अक्सेशन आशाजनक थे। आई. ई. टी. में बीजों के लिये LCC -219, LCC-224 तथा LCC-229 आशाजनक थे। जोबनेर में, UD-794 तथा UD-663 आशाजनक थे तथा उनको सी. वी. टी. के लिये कर सकते है। जोबनेर में, सिंचाई आधारित खेती में जीनोटाइप UC-331, UC-274, तथा UC-225 को अधिक उपज के लिये चिन्हित किया गया जबकि UC-239, UC-274 तथा UC-225 कम नमी के लिये उपयुक्त थे। कोयम्बतूर में एकीकष्त पोषण पैकेज का उपयोग करने पर अधिक बीज उपज (1250 कि. ग्राम/है.) प्राप्त हुई। गुंटूर में 100% नाइट्रोजन + अज़ोस्पीरोलियम + 5 टन/है. की दर से एफ. वाई. एम. का उपयोग करने पर अधिक उपज (954 कि. ग्राम/हे.) अंकित की गयी। कोयम्बतूर में कोपर सल्फेट का 25 कि. ग्राम/हे. का मृदा में तथा ज़िंक सल्फेट (0.5%) को दो बार 45 तथा 60 दिनों पर छिडकाव करके उत्पादन बढा सकते है। राइज़ोबैक्ट्रिया की वृद्धि में भूमिका का कृषक खेतों पर उच्च स्तर पर प्रदर्शन किया गया। गुंटूर में, FK-14 तथा FL-18 में बीज उपचार तथा मृदा में उपचारण करने पर अधिकतम उपज (क्रमशः 1076 तथा 1037 कि. ग्राम/हे.) प्राप्त हुई जो कन्ट्रोल (851

कि. ग्राम / हे) की तुलना में अधिक थी। कोयम्बतूर में, ओफ सीज़न के दौरान धनिया पत्ती को 50% छाया के अन्दर उत्पादन करने के लिये तकनीक विकसित की गयी।

सौंफ

धोली में, जननद्रव्य अक्सेशन RF-14 तथा RF-20 को उपाजक के रूप में प्रतिवेदन किया गया। जोबनेर में, आई. ई. टी. में UF-157(2166.82 कि. ग्राम / हे.) तथा UF-278 (2137.63 कि. ग्राम / हे) उच्च उपज वाले पाये गये जिन्हें सी. वी. टी. के लिये उन्नति किया गया। जोबनेर में, सी. वी. टी. में FNL-43 (1904.22 कि. ग्राम / हे) तथा FNL-46 (1901.33 कि. ग्राम / हे.) उपज के आधार पर आशाजनक थे जबकि धोली में FNL-43 तथा FNL-41 आशाजनक थे।

मेथी

कुमारगंज में, मेथी के जननद्रव्यों की छान बीन करने पर NDM-37 में अधिकतम (23.70) तत्पश्चात् NDM-25 तथा NDM-48 (22.50 कु. / हे.) उपज प्राप्त हुई। गुंटूर में, अक्सेश्नों का मूल्यांकन करने पर, LFC-122 में अधिकतम उपज (1270 कि. ग्राम / हे) तत्पश्चात् LFC-78 (1145 कि. ग्राम / हे) अंकित की गयी। धोली में मेथी के अक्सेशन RM-201 में अधिक उपज 1.10 कि. ग्राम / 3.6 मी^{2} के साथ आशाजनक था। कुमारगंज में, आई. ई. टी. में NDM-61 तथा NDM-48 ने श्रेष्ठ प्रदर्शन किया। गुंटूर में, आई. ई. टी. में LFC-116, LFC-76, LFC-98 तथा LFC-93 कन्ट्रोल की तुलना में अधिक प्रतिभावान थे। जोबनेर में UM-126 (2595.61 कि. ग्राम / हे) तथा UM-222 (2419.22 कि. ग्राम / हे) अन्य प्रजातियों की तुलना में अधिक उपजवान थे। मेथी पर अनुसंधान करने वाले विभिन्न केन्द्रों पर सी. वी. टी. कार्य प्रगतिशील है। राइज़ोबैक्टीरिया की भूमिका की जांच करने के लिये उच्च स्तर पर कृषक खेतों पर परीक्षण हो रहा है। गुंटूर में, FK-14 तथा FL-18 में बीज तथा मृदा का उपचारण करने के पश्चात् लगभग समान उपज (क्रमशः 1.54 टन / हे. 1.51 टन / हे) प्राप्त हुई जो नियन्त्रण (1.33 टन / हे.) की तुलना में अधिक थी। सिंचाई आधारित क्षेत्रों में RMt-1, UM-29 तथा UM-13 पैदावार के लिये उपयुक्त है जबकि UM-36, UM-26 तथा UM-10 शुष्क वातावरण के लिये उपयुक्त है।

एम. आनन्दराज

PROJECT COORDINATOR'S REPORT

The All India Coordinated Research Project on Spices (AICRPS) is coordinating research in 13 spice crops namely, black pepper, cardamom, cassia, cinnamon, clove, coriander, cumin, fennel, fenugreek, ginger, large cardamom, nutmeg and turmeric, with its headquarter at Indian Institute of Spices Research, Calicut. AICRPS has at present 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. As per the decisions of the XXII AICRPs workshop, a new voluntary centre was added to take up specific work on seed spices at Horticultural Research Station Periyakulam during the XI plan period. The XI Plan budget of AICRPS is Rs. 1400 lakhs with Rs 250 lakhs (ICAR share) during 2010 - 11. 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 during 2010-11 in the mandate crops are presented in this report.

Black pepper

The germplasm of black pepper is collected and conserved in all the black pepper centres. An alternate repository of black pepper germplasm is being established at Regional Agricultural Research Station (RARS) of Kerala Agricultural University, Ambalavayal. Among the various accessions of black pepper germplasm evaluated at Panniyur, Chalakudy, ICP- 48 and P-5 were found to be promising. Two accessions PN- 33 & 57 continued to perform well at Yercaud. The intervarietal hybrid P6 x P 5 developed at Panniyur is promising with a green berry yield of 5 kg/vine. In a CVT trial in black pepper, Cul. 5308 recorded highest yield at Pampadumpara and Chintapalle. At Panniyur, Cul. 5489 and Cul. 5308 were promising during the last three years where as at Ambalavayal, Panniyur-1 recorded maximum dry weight of berries/standard (1.89 kg) followed by PRS-21(1.01 kg). A trial on evaluation of grafts, orthotropic and runner shoots of black pepper was initiated during the year and is in progress at various pepper centres. Standardized a technology for rooting of orthotropic shoots in black pepper at Dapoli, by treating the two node orthotropic cuttings without leaves either in *Pseudomonas fluorescens* -10 powder formulation or in common sugar (2%) solution for one minute. Application of potassium phosphonate @ 0.3% as spray and soil application of *Trichoderma harzianum* @ 50 g/vine with one kg of neem cake to the root zone and application of Bordeaux mixture 1% as spray and copper oxychloride @ 0.1% as drench is recommended for effective and economical management of foot rot disease of black pepper in the Konkan region. In black pepper growing tracts of Malanad region, three major species of *Erythrina* viz., *Erythrina indica*, *E. fusca* and *E. subumbrans* are being used as black pepper standards. The incidence of gall wasp, a serious pest attacking black pepper standards was recorded in two species, namely, *E. indica and E. fusca* in all the places and no incidence was reported on *Erythrina subumbrans.*

Cardamom

In cardamom, the open pollinated progenies 21C, recorded highest dry capsule yield (195 kg/ha) followed by 23C, (190.2 kg/ha) and 22C, (189.6 kg/ha) at Mudigere. In a CVT at Pampadumpara, PS -27 recorded highest yield (386 g/plant). At Mudigere, clone CL-722 (292.0 kg/ha) and PS-27 (262.00 kg/ha) were found promising for dry capsule yield. Experiments on standardizing water requirement and irrigation schedule, fertigation through drip irrigation and organic farming was initiated during the year and is in progress. Spraying six rounds of quinalphos (0.05%) was most effective for the management of cardamom shoot and capsule borer and cardamom thrips at Pampadumpara.

Large cardamom

Survey was conducted at Sukhia Pokhri and Rang bhang area of Darjeeling, Dentam and Hee-Gaon area of West Sikkim, Ravangla and Namchi area of South Sikkim, Dzongu area of North Sikkim and Assam lingzey, Pakyong area of East Sikkim and nine germplasm *viz.* SCC 218 (Hario Ramsey), SCC 219 (Rato Varlangey), SCC 220 (Ramsey), SCC 221 (Varlangey), SCC 222 (Asarey), SCC 223 (Ramsey), SCC 224 (Chivesey), SCC 225 (Allied

Genera), SCC 226 (Hario Varlangey) were collected and planted at Kabi farm. Characterizations of the collected germplasm were made as per descriptor obtained IC numbers for 48 accessions of large cardamom from, NBPGR, New Delhi

Ginger

Accessions NDG-55 (Kumarganj), GCP-32, GCP-14, GCP-33, GCP-54, GCP-01 (Pundibari) SG-26/04, SG-40/04, SG-8/04, SG-1029, SG-823 (Solan) and RG-43, RG-18 (Dholi) were identified as high yielders. At Pundibari, accession GCP-01, GCP-08 and GCP-51 recorded no pest or disease incidence during the year. In a CVT in ginger at Solan, two local entries namely, SG-707 (179.99 g/plant) and SG-827 (164.23 g/plant) recorded maximum yield. In an experiment to study the performance of ginger varieties in various agro climatic zones of the country, it was observed that the average yield of rhizome per plot was highest (5.682 kg) in Suprabha followed by Varada (4.616 kg) and Gorubathan (4.309 kg) at Kalyani. At Pasighat, (Arunachal Pradesh) the variety Surabhi and Nadia were found to be suitable where as at Solan, variety Himigiri recorded maximum yield. Suprabha and Mahima were suitable for Ranchi. In an organic management trial in ginger at Dholi, fully organic treatment gave maximum yield as compared to integrated fertilizer management (organic and inorganic) and fully inorganic. At Kumarganj, application of 50% recommended dose of fertilizer (60:40:40 kg NPK kg/ha) + 50% FYM (10 t/ha) + *Azosporillum* (5 kg/ha) + seed treatment and soil application of *Pseudomonas flourscens* + *Trichoderma* (50 g/3 m^2) gave maximum fresh rhizome yield of 6.23 t/ha of fresh ginger rhizomes followed by a yield of 44.5 t/ha in application of 100% FYM (20 t/ha) + seed treatment and soil application of *Pseudomonas fluorescens* + *Trichoderma* 50 g/3 m^2. At Chintapalle, soft rot incidence was less and yield was high when rhizomes were treated with rhizobacterial antagonist or with Metalaxyl, Mancozeb 72% WP (1.25 g/l).

Turmeric

Among the 29 early maturing germplasm evaluated at Kumarganj, NDH-79 (362.10 t/ha of fresh rhizome yield) and NDH-74 (352.47 t/ha) were found to be promising. Out of the 74 medium maturing germplasm, NDH-98 (421.60 t/ha) and NDH-18 (Narendra Haldi –1) (335.20 t/ha) were found to be superior for yield. Among the 36 late maturing varieties, NDH-8 gave maximum fresh yield of 375.0 q/ha followed by 357.15 q/ha in NDH-7. The germplasm accessions RH-24 and RH-17 (Dholi), CLI-317 (Jagtial), Raigarh, IT-8, IT-3, IT-9, IT-41 (Raigarh),CHFT-8,CHFT-22, CHFT-30, CHFT-36 (Pasighat), TCP-137, TCP-120 and TCP-46 (Pundibari) were reported to be promising with high yield. In an IET in turmeric at Kumarganj, NDH-8 (346.33 t/ha) and NDH-9 (336.66 t/ha) recorded high yield. In a CVT in turmeric, TCP-70 performed well at Pundibari, Kumarganj and Raigarh whereas, CL-101 and BSR-2 (13.25 kg/plot) were better performers at Coimbatore. In a Genotype and environment interaction study, the turmeric varieties BSR-II, Duggirala and Suranjana performed well at Kalyani, whereas at Pundibari TCP-2 and Narendra Haldi-1 performed well. At Calicut the maximum fresh yield was recorded in Rajendra Sonia followed by Narendra Haldi. Maximum dry yield was observed in Roma (8.6 t/ha) followed by Mega turmeric (6.3 t/ha) at Chintapalle where as highest fresh rhizome yield was recorded in Rajendra Sonia (36.3 t/ha) followed by Roma and Suranjana (32 t/ha). The variety Suranjana was found to be the best at Raigarh. In a processing experiment in turmeric it was observed that turmeric cured by traditional water boiling method for 40, 60, 90 min, took 11 days for drying while turmeric cured in improved water boiler for 60, 45 and 30 min took 12, 23 and 24 days. Maximum retention of curcumin (5.91%) and essential oil (3.6%) was obtained for rhizomes cured by water boiling method for 40 min. Increase in curing time resulted in significant reduction in curcumin, starch, essential oil and oleoresin content. In an experiment to standardize of water requirement for turmeric through drip irrigation at Jagtial, it was observed that surface irrigation recorded highest rhizome yield (44.30 kg/ 60 plants) followed by drip once in a day at 80% PE (42.80 kg/ 60 plants). Application of 100% recommended dose of fertilizer (NPK @ 150:60:108 kg/ha) through drip - weekly once recorded highest rhizome yield at Kammarpally and Coimbatore. Soil application of micro nutrients on turmeric produced highest clump weight of 432.44 g and highest yield of 9.24 kg per plot whereas foliar spray of micro nutrients on turmeric produced clump weight of 341.17 g and yield of 8.98 kg per plot at Pundibari. Foliar spray -

(propiconazole 0.1% on 45 and 90 days) or foliar spray with Carbendazim + Mancozeb (0.1%) on 45 and 90 days was effective for the control of leaf spot disease in turmeric. Foliar application of mancozeb + carbendazim (0.1%) was effective for the management of leaf blotch in turmeric at Jagtial/ Kammarpally.

Tree spices

The germplasm of tree spices which include nutmeg, cinnamon, cassia and clove are collected, maintained, characterized and catalogued at Dapoli and Yercaud/ Pechiparai centres. In nutmeg the accessions Sel.4 recorded the highest yield of 1005 fruits per tree and an oleoresin content of 8.67% at Pechiparai. Among the cinnamon accessions, Sel.65 performed well and attained a plant height of 3.90 m, stem girth of 29.35 cm, leaf yield of 7.83 kg/tree with a dry bark yield of 620 g/tree. In clove, Sel.13 was found to be promising with a dry yield of 3.70 kg/tree. A CVT on cassia is also in progress.

Cumin

Mean performance of the entries evaluated in CVT for two years at Jobner revealed superior performance of CUM-13 (677.61 kg/ha) followed by CUM-12 (595.14 kg/ha). UC-339 (726.74 kg/ha) and UC-336 (671.88 kg/ha) were found to be promising in an IET at Jobner and could be promoted to CVT. Application of *Trichoderma harzianium* @ 20 kg/ha + FYM @ 6 t/ha (BCR 1: 2.42) or *Trichoderma harzianium* @ 20kg/ha + FYM @ 3 t/ha (BCR 1: 2.16) at the time of sowing is recommended for the effective and economic management of cumin wilt at Jagudan.

Coriander

Among the 275 coriander accessions evaluated at Coimbatore, CS 251 was found to be promising for yield. At Kumarganj, coriander accession, ND Cor-38 gave maximum seed yield (18.45 q/ha) followed by NDCor -2 (17.40 q/ha). At Guntur, LCC-303 recorded highest yield per ha (1770.8 kg) followed by LCC-301 (1728.2 kg), LCC-274 (1583 kg/ha), and LCC-279 (1458 kg/ha). At Dholi, coriander accessions, RD-420 and RD-395 were identified as high yielders.

Two new experiments on leafy type coriander was initiated during this year for identifying varieties in leafy type coriander and another on nutrient management in off season coriander leaf production. In a CVT in coriander, the coriander (COR-32) was found to be promising at Jabalpur and Udaipur, COR-25 at Kumarganj, COR-31 at Raigarh, COR-30 at Guntur, COR-27 at Jobner, COR-29 at Ajmer. In an IET of coriander for seed purpose, LCC-219, LCC-224 and LCC-229 were found to be promising. At Jobner UD-794 and UD-663 were found to be promising and may be promoted to CVT. The cumin genotypes UC-331, UC-274 and UC-225 were identified as high yielder in irrigated conditions, while, UC-239, UC-274 and UC-225 were the best genotypes in limited moisture conditions at Jobner. Following integrated nutrient package for coriander gave highest coriander seed yield (1250 kg/ha) at Coimbatore. At Guntur, application of 100% N + *Azospirillum* + 5 t/ha FYM recorded maximum yield (954kg/h) in coriander. Application of micronutrients copper as copper sulphate (soil application) 25 kg ha^{-1} and foliar spray of zinc sulphate 0.5% (2 sprays-45 & 60 days of sowing) increased yield in coriander at Coimbatore. Large scale demonstration of the role of rhizobacteria in growth promotion of coriander is in progress in farmers plot. At Guntur, seed treatment and soil application with FK-14 and FL-18 recorded highest yields (1076 kg/ha & 1037 kg/ha respectively) which were on par with each other and significantly superior over control (851 kg/ha). A technology for production of leafy coriander under 50% shade during offseason was developed at Coimbatore.

Fennel

At Dholi, the germplasm accessions RF-14 and RF-20 were reported as yielders. Two fennel entries UF-157 (2166.82 kg/ha) and UF-278 (2137.63 kg/ha) were found to be high yielders in an IET at Jobner and may be promoted to CVT. In a CVT at Jobner, FNL-43 (1904.22 kg/ha) and FNL-46 (1901.33 kg/ha) were found to be promising based on the yield performance. At Dholi, FNL-43 and FNL-41 were found to be promising.

Fenugreek

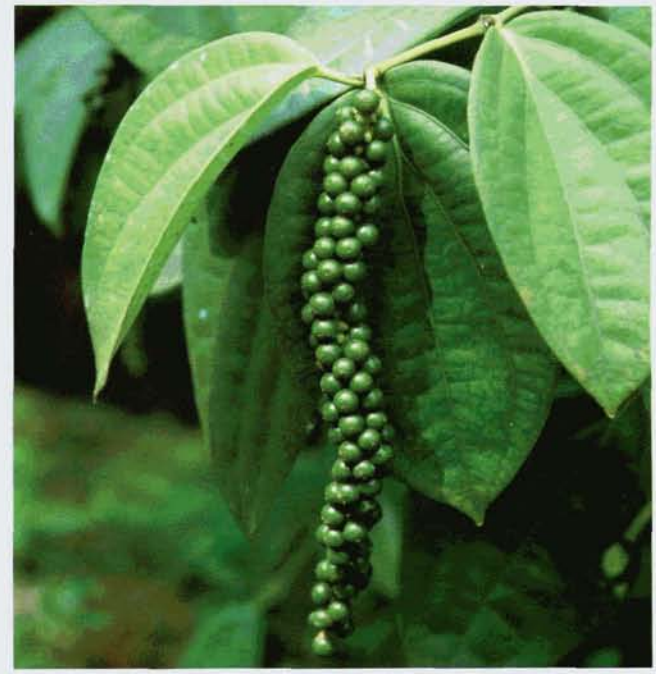
Out of 105 fenugreek germplasm screened at Kumarganj, NDM-37 gave maximum seed yield of 23.70 followed by NDM-25 and NDM-48 (22.50 q/ha). Among the accession evaluated at Guntur, LFC-122 recorded highest yield of (1270 kg/ha) followed by LFC-78 (1145 kg/ha). At Dholi, the fenugreek accession RM-201 was found to be promising with a yield of 1.10 kg/3.6 m^2. In an IET in fenugreek NDM-61 and NDM-48 were found t6o perform well at Kumarganj. In an IET at Guntur, LFC-116, LFC-76, LFC-98 and LFC-93 were found to be superior than the check. At Jobner

UM-126 (2595.61 kg/ha) and UM-222 (2419.22 kg/ha) were found to be superior to other varieties based on their yield performance. A CVT in fenugreek is in progress in various fenugreek growing centres. Large scale demonstration of the role of rhizobacterial in growth promotion of fenugreek was taken up in farmer's field. Seed treatment and soil application with FK-14 and seed treatment and soil application with FL-18 were on par with each other in leaf yields (1.54 t/ha &1.51 t/ha respectively) and superior over control (1.33 t/ha) at Guntur. RMt-1, UM-29, UM-13 were found suitable for growing in irrigated conditions. Similarly in drought conditions, UM-36, UM-26, UM-10 were found to be ideal. The salient findings under different projects during 2010-11 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, Dapoli, Panniyur, Pundibari, Sirsi, Ambalavayal & Yercaud)

Germplasm of black pepper is maintained in all the black pepper centres of AICRPS (Table 1). The germplasm maintained at each centre is evaluated every year.

Two collections of black pepper from Sindhudurg and Ratnagiri Districts were collected and added to the germplasm at Dapoli. At present total germplasm of black pepper consisting of 30 accessions have been maintained and are being evaluated.

At Panniyur centre, 227 cultivated types of black pepper and 72 wild types are being maintained. During 2010, the genotypes Angamaly, ICP-48 and Chalakudy were the top yielders. Angamaly ranked first with 3.4 kg berry yield and 1065 spikes/vine. Spike length (17.5 cm) and number of developed berries/spike (60.5) were more in ICP-48. The 100 berry weight was high for Josegiri (12 g/vine) and ICP-48 (11.8 g). The dry recovery percent was more for Alakodan (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	32	1	-	33
Panniyur	214	72	3	289
Pechiparai	12	1	-	13
Pundibari	21	4	-	25
Sirsi	125	1	1	127
Yercaud	127	10	-	137
Total	**589**	**89**	**4**	**682**

Table 2. Yield and attributing characters of promising germplasm lines maintained 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	3.400	1065	9.2	32.0	10.4	35
ICP-48	3.080	924	17.5	60.5	11.8	34
Chalakudy	2.800	780	11.9	31.6	10.9	30
Alakkodan	2.560	880	8.1	33.9	10.5	38
Karimunda	2.250	870	8.2	24.0	10.6	34
Josegiri II	2.200	290	8.9	18.5	12.2	37

Two new genotypes were collected by Pundibari centre from Terai region of West Bengal. The germplasm of pepper collected over the years are being maintained. Cuttings are also being prepared for multiplication, evaluation and distribution.

Out of 72 accessions maintained at HRS, Yercaud, berry set was observed only in 28 entries this year. The other accessions did not set berry due to heavy downpour during its flowering period. Acc. 57 and 33 continued to perform well at Yercaud.

PEP/CI/2 Hybridization Trial

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

(*Panniyur*)

Intervarietal hybridization is being carried out every year at Panniyur centre and the hybrid seeds obtained will be planted and evaluated. Among the intervarietal hybrids P6 x P 5 is found to be promising with a green berry yield of 5 kg/vine.

PEP/CI/3 Coordinated Varietal Trial (CVT)

PEP/CI/3.2 CVT 2000- Series V

(Chintapalle, Pampadumpara, Panniyur, Sirsi, Ambalavayal)

Among the 12 varieties evaluated at Chintapalle, maximum spike length was recorded in Panniyur-1 (16.1 cm) followed by HP-813 (15 cm). Good length of spikes was observed in Cul -5489 (14.9 cm) and Cul -5308 (12.8 cm). Significantly higher number of berries per spike was noticed in Panniyur-1 (92) followed by Cul-5308 (71). Significantly higher yield was recorded in accessions Cul-5308 (1861 g/vine) followed by Panniyur-1 (944 g/vine). In terms of fresh berry yields, Cul-1041 (723.5 g/vine) and HP-105 (756.2 g/vine) were on par with each other. Chilling injury was observed in Cul-1041 and HP-813 during the months of January and February and in severe cases vine death was also noticed due to cold injury.

During 2010-11, it was found that significant differences existed in all the traits except number of berries per spike at Pampadumpara. The accession CUL-5308 registered significantly higher yield (875.85 g) followed by HP-1411 (672.71 g). 100 berry weights was maximum in HP-105 (8.6 g) whereas, maximum was recorded in Panniyur-1 (14.33g) which was on par with all other varieties except HP-105, HP-813 and Karimunda.

During 2010, maximum green berry yield/vine was recorded by Cul. 5489 (2.150 kg/vine) followed by Cul. 5308 (1.410 kg/vine) at Panniyur. Cul. 5489 was significantly superior to all other cultures/varieties. The number of spikes/vine, spike, number of berries/spike, 100 berry weight and dry recovery percentage was more for Cul-5308 (Table 3).

Table 3. Performance of CVT-2000 black pepper at Panniyur

Varieties/ cultures	Green berry yield (kg/vine)	Number of spikes /vine	Spike length (cm)	Berries /spike	100 Berry weight (g)	Dry recovery (%)
Kalluvally- IV	1045	360	8.0	16	12.0	30
Karimunda- II	1270	545	7.9	12	10.3	30
Karimunda-III	1100	500	9.8	17	13.0	37
Cul. 5308	1410	395	10.0	32	14.0	40
Cul. 5489	2150	760	14.0	25	13.6	39
HP-34	515	105	8.0	18	11.0	38
HP-105	795	280	7.0	22	13.0	33
HP-813	900	485	8.1	17	12.0	38
HP-1411	1150	540	10.5	22	8.3	34
Karimunda OP	1215	375	9.9	14	9.6	36
Coll.1041	980	415	9.5	15	14.0	33
Panniyur -1	1250	405	14.2	14	13.9	35
Karimunda	1160	300	7.6	13	13.3	37
CD(P=0.05)	206	87	1.7	5.1	0.7	

At Sirsi, the vines attained maximum height in HP-105 (5.08 m) and HP-34 (5.0 m) followed by PRS–17 (4.8 m). Most of the entries initiated spiking and the yield was meager. However, significant differences were recorded in growth and yield parameters among the accessions. Spike length was maximum in Panniyur-1 (11.2 cm) followed by OP Karimunda (10.7 cm) and least in Col.1041 (5.1 cm). Total number of spikes and dry berry yield per vine was maximum in Paniyur-1 (243, 747g, respectively), followed by HP-105 (168, 573g, respectively) and PRS-17 (138, 490g, respectively).

Wet weight of berries/standard (kg), dry weight of berries/standard (kg), number of spikes/standard and number of berries/spike was significantly higher in Panniyur-1 compared to other genotypes at Ambalavayal. There was no significant difference among treatments for setting percentage. Hundred berry weights were significantly higher in PRS-21, Cul.5489 and Panniyur-1 and were significantly superior to other treatments.

PEP/CI/3.3 CVT 2006 – Series VI

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

During 2010-11, 100% survival was noticed in HB-20052, ACC-106, ACC-33, C-1090 and in Panniyur-1 at Chintapalle. Poor survival rates were recorded in ACC-53, ACC-57 and HP-39. Maximum plant height was recorded in Panniyur-8 (155.8 cm) followed by Panniyur-1 (132.5 cm). Highest number of branches was also recorded in Panniyur-8 followed by ACC-106 (6.6) and HP-39 (6.6).

The plant height varied from 1.23- 3.33 m in different varieties at Dapoli centre. C-1090 recorded significantly higher plant height (3.33 m) followed by Panniyur-1 (3.11 m) and PRS-64 (2.46 m). Panniyur-1 started bearing.

Observations on plant growth parameters showed that all the ten entries especially Panniyur-1, Accession-33, Accession-106, Accession-57 and HP-39 showed good growth and vigour in the field at Pampadumpara.

The trial was initiated during August, 2008 and it is the 2nd year of progress at Sirsi. Plants are in the initial growth stage. HB-20052 and Panniyur-1 attained the maximum height (2.3 m each) followed by Sirsi-1 (2.27 m) and PRS-88 (2.15 m).

At Yercaud, the trial was replanted on 7.3.2011. At Pechiparai, Acc. 53 recorded the maximum plant height of 4.67 m and dry yield of 1.15 kg/vine. The planting of cultures were completed in 2009 at Panniyur. The growth parameters were recorded.

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

(Ambalavayal, Panniyur, Sirsi, Yercaud, Thadiyankudassi)

An experiment on evaluation of grafts, orthotropic and runner shoots in black pepper was initiated during 2010-11 at Ambalavayal, Panniyur, Sirsi, Yercaud and Thadiyankudassi. At Yercaud, the rootstocks *viz.*, *P. colubrinum* and the improved varieties *viz.*, Sakthi and Thevam were replanted in the field. Grafting will be initiated after mass multiplication of the above rootstocks. However, the orthotropic and runner shoots were grafted on the native wild spp. of Yercaud locality and is under hardening. Similar work has been initiated at HRS, Thadiyankudisai.

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)

At Chintapalle, the vines which were given the inorganic treatments (recommended package of practices) showed maximum plant height (2.84 m), number of spikes (31), length of spike (10.02 cm) and highest fresh berry yield (714 g/vine) when compared to organic package..

At Sirsi, it was observed that during 2010-11, the vines treated according to the recommendations of package of practices were superior in its dry berry yield (1.17 kg/vine) to the vines treated with 100 percent organics (0.90 kg/vine) but, was not significant.

The recommended package recorded significantly higher green berry yield of 1.42 kg/vine compared to organic package which recorded green berry yield of 1.21 kg/vine at Panniyur. The spike yield (1.8 kg/vine) and number of spikes/vine (308) was also maximum for recommended package which was significantly superior to organic package.

At Dapoli, the vines treated with integrated package recorded maximum plant height (2.08 m/plant) followed by organic package (2.00 m/plant). Inorganic package recorded lesser plant height (1.54 m/plant). The experiment is at initial stage of growth and has not started flowering.

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

(Panniyur, Dapoli, Pechiparai, Sirsi & Yercaud)

During 2010, integrated treatment (T_2) resulted in higher green berry yield of 1.43 kg/vine which was significantly superior to both fully inorganic treatments (T_3) which recorded green berry yield of 1.13 kg/vine and fully organic treatment (T_1) which recorded green berry yield of 0.96 kg/vine at Panniyur centre. The spike yield (1.81 kg/vine) and number of spikes /vine (300 nos. /vine) was also maximum for integrated treatment which was significantly superior to other two treatments (Table 4).

At Dapoli, integrated package recorded maximum plant height (1.08 m/plant) followed by fully organic package (0.93 m/plant). Fully inorganic package recorded lesser plant height (0.74 m/plant).

This trial was imposed in established pepper vines at Pechiparai with three treatments *viz.*, 1) fully organic 2) integrated 3) fully inorganic. The highest yield of 3.78 kg/vine was recorded in the fully inorganic trial.

The vines with 100 percent inorganic and integrated treatments recorded significantly higher dry berry yield (1.10 kg/vine and 1.18 kg/vine, respectively) during 2010-11 compared to those with 100 percent organics (0.87 kg/vine) (Table 5) at Sirsi.

PEP/CP/5 Disease Management Trial

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

(Chintapalle, Panniyur, Pampadumpara, Mudigere, Sirsi)

The treatment T1 (potassium phosphonate and *T. harzianum)* was effective in controlling yellowing, defoliation and death of vines due to foot rot at Panniyur. The treatment also showed enhanced yield than control treatment. The control treatment showed higher rate of yellowing than others (Table 6).

Analysis of pooled data for 2006-2007, 2007-2008 and 2010-2011 (Table 7) at Pampadumpara showed that, among the five treatments, black pepper vines treated with the treatment T4 (consortium of bacteria + *Trichoderma harzianum*) before onset of monsoon (May last week), during monsoon (July first week) and after monsoon (September first week) recorded lesser DI (2.89), which was followed by T1 (Potassium phosphante 0.3% + soil application of *T. harzianum* (4.48 DI). Maximum dry berry yield was recorded for treatments T4 (*T. harzianum* + consortium of bacteria *ie.* 0.5 kg/vine), T2 (Bordeaux mixture spray and COC drench *ie.*, 0.48 kg/vine) and T1 (potassium phosphonate spray and soil application of *T. harzianum* ie., 0.48 kg/vine) and they were on par. They were significantly superior to T3 (Consortium of bacteria alone) and T5 (Control).

Table 4. Yield of black pepper in organic farming at Panniyur

Treatment	Spike yield (kg vine^{-1})	Number of spikes/vine	Green berry yield (kg vine^{-1})	Dry recovery (%)
T_1-Fully organic	1.22	174	0.96	35.05
T_2–Integrated	1.81	300	1.43	34.86
T_3–Fully inorganic	1.43	234	1.13	34.86
CD (P=0.05)	0.27	59	0.22	-
CV (%)	17	23	17	-
Sem	0.13	29	0.10	-

Table 5. Organic farming in black pepper in arecanut mixed cropping system at Sirsi

Treatment	Dry berry yield (kg/vine)				Mean
	2007-08	2008-09	2009-10	2010-11	
T_1 (100 % Organic)	1.01	0.86	1.01	0.87	0.94
T_2 (Integrated)	1.09	1.06	1.20	1.18	1.13
T_3 (100 % Inorganic)	1.02	0.92	0.94	1.10	1.00
SEm ±	0.71	0.42	0.14	0.11	
CD (P=0.05)	NS	NS	NS	0.24	

Table 6. Incidence of *Phytophthora* foot rot in black pepper at Panniyur

Treatment	Yellowing (PDI)	Defoliation (PDI)	Death of vines (%)	Yield (kg/vine)
T1 (Potassium phosphonate (0.3%) + *Trichoderma harzianum* (50 g/vine)	2.65	1.63	4.75	2.81
T2 (Bordeaux mixture + COC (0.2%))	2.95	2.31	6.00	2.51
T3 (Consortium of bacteria (50 g/vine)	3.49	3.27	8.50	2.01
T4 (*T. harzianum* + consortium of bacteria)	2.85	2.71	3.50	2.48
T5 (Control)	4.61	3.37	9.75	1.36
CD(P=0.05)	NS	NS	NS	0.941

Table 7. Effect of bio control agents and chemicals on the incidence of foot rot of black pepper in existing plantation at Pampadumpara (Pooled analysis of 2006-07, 2007-08, 2010-2011)

Treatment	Disease Incidence	Dry yield (kg/vine)
T1- Potassium phosphonate (0.3%) + *Trichoderma harzianum* (50 g/vine)	4.48	0.48
T2 - Bordeaux mixture 1% spray+ COC 0.2 % drench	7.36	0.48
T3 Consortium of bacteria (50 g/vine)	5.90	0.44
T4 - *Trichoderma harzianum* + Consortium of bacteria (50 g/vine)	2.89	0.51
T5 - Control	11.04	0.39
CD (P=0.05)	0.38	0.030

Table 8. Management of *Phytophthora* disease of black pepper in existing plantation at Sirsi (Pooled data from 2006 to 2010)

Treatment	Leaf infection (PDI)	Yellowing (PDI)	Defoliation (PDI)	Death of vines (%)	Green berry yield (kg/vine)	Projected yield (kg/ha)*	C:B ratio
T1. Potassium phosphonate (0.3 %) + *T. harzianum* MTCC 5179 50 g /vine with 1 kg of neem cake	10.99 (19.26)	10.78 (19.08)	9.35 (17.67)	5.15 (11.36)	1.20 (6.24)	451.35	1:8.37
T2. Bordeaux mixture (1%) +Copper oxychloride (0.1 % a.i.)	13.12 (21.11)	12.73 (20.74)	11.60 (19.57)	9.36 (15.49)	0.98 (5.64)	362.21	1:7.69
T3. Consortium of bacteria (IISR-6 & IISR 859)	22.21 (26.11)	20.13 (26.42)	19.88 (25.88)	19.05 (25.38)	0.77 (4.98)	257.95	1:3.95
T4. *T. harzianum* MTCC 5179 vine with 1 kg of neem cake + Consortium of bacteria (IISR-6 & IISR 859)	19.55 (26.22)	16.67 (23.91)	14.51 (22.02)	13.87 (21.37)	0.90 (5.38)	304.69	1:5.71
T5. Control	49.94 (44.96)	32.92 934.87)	30.91 (33.59)	38.95 (38.47)	0.58 (4.25)	168.61	
SEm ±	1.83 (1.11)	1.42 (0.86)	1.97 (1.26)	1.74 (1.32)	0.06 (0.19)	29.04	
CD @5 %	5.98 (3.62)	4.38 (2.64)	6.08 (3.88)	5.36 (4.08)	0.19 (0.60)	94.69	

Phytophthora disease incidence of black pepper with respect to leaf infection (%), collar infection (%), foliar yellowing (PDI) defoliation (PDI) and yield (both green berry kg vine^{-1} and projected yield kg ha^{-1}) were analyzed for each year i.e, 2006-07, 2007-08, 2008-09 and 2009-10 and pooled from 2006-07 to 2009-10 data separately at Sirsi. It was obvious from the pooled data that disease incidence in black pepper was least in combination of systemic fungicide and bioagent i.e., Potassium phosphonate (@ 0.3 per cent) as spraying (@ 2 l vine^{-1}) and drenching (3 l vine^{-1}) along with bioagent *Trichoderma harzianum* (MTCC 5179) 50 g with one kg of neem cake as soil application during first week of June and third week August and third round with second week of October 2009 to the root zone and high in C: B ratio (1:8.37) and it was followed by 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^{-1}) and drenching (@ 3 l vine^{-1}) and *Trichoderma 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 significantly superior in reduction of the disease and increase in C:B ration (1:5.71). 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. For the first time, in the present investigation, though the observations on leaf infection, was recorded, collar infection, foliar yellowing and defoliation of the vines were found as crucial stages which obviously led to death of vines. The application of treatments twice in a year i.e., once in the month of June and second in August and third in October helped in checking the spread of the disease and may be due to reduction in inoculum level. The vines which received the treatment combination of systemic fungicide and bioagents along with plant product neem cake, *i.e.* Potassium phosphonate as spray and drench followed by bioagents *T. harzianum* (MTCC-5179), and neem cake combated the disease significantly and brought down the incidence to a lowest level. This indicates there may be synergistic effect of treatment combination on subsiding of disease incidence. The present study also revealed that 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^{-1}) and drenching (@ 3 l vine^{-1}) and *Trichoderma 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 significantly superior in reduction of the disease. The present investigation on integrated disease management is practical oriented and showed that the components of IDM as eco-friendly, economically feasible and compatible. Thus, the present findings identified application of Potassium phosphonate (0.3 %) as spraying and drenching with soil application of *T. harzianum*(MTCC-5179), (50 g vine^{-1}) along with neem cake (1 kg vine^{-1}) as best treatment and it was followed by use of consortium of bacteria(IISR-6 and IISR 859) with *Trichoderma harzianum* (MTCC-5179) (50 g vine^{-1}) along with neem cake (1 kg vine^{-1}) for effective management of *Phytophthora* foot rot. It could be adopted easily by the farmers to protect the vines from the dreaded Phytophthora foot rot of black pepper (Table 8).

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

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

Varieties of black pepper exhibited significant difference to *Phytophthora* foot rot disease incidence and it was least in IISR Thevam (12.88 %) variety, followed by IISR Shakti (14.66%). The disease incidence was maximum in Panniyur-1 (17.32%). Among the treatments for the management of the disease, vines recorded least disease incidence (10.36%) wherein the vines were sprayed (2 l vine^{-1}) and drenched (3 l vine^{-1}) with consortium of bacteria (for growth, nematode and *Phytophthora* suppression (IISR 6 and IISR 859) and soil application with *Trichoderma harzianum* (MTCC 5179) @ 50 g per vine with one kg of neem cake to the root zone during pre monsoon (June 2010) and peak monsoon (Aug 2010). This was followed by vines treated with potassium phosphonate (@ 0.3 per cent) as spraying and drenching with incorporation of *Trichoderma harzianum* (MTCC 5179) @ 50 g per vine with one kg of neem cake to the root zone during pre monsoon (June 2010) and peak monsoon (August 2010) also exhibited less disease incidence (11.48%). However, all the treatments were significantly effective in combating the disease. Maximum incidences (24.81%) were observed in all the varieties of untreated check viz., IISR Thevam (17.77 %), IISR Shakti (23.33 %) and

Panniyur-1 (33.33%). Among the three varieties, IISR Thevam put forth good growth (0.49 m height) as compared to IISR Shakti (0.35 m height) and Panniyur -1 (0.21 m height). Black pepper vines treated with consortium of bacteria (for growth, nematode and *Phytophthora* suppression (IISR-6 and IISR-859) and soil application with *Trichoderma harzianum* (MTCC-5179) recorded maximum growth (0.51 m height) and it was significantly superior over other treatments. This was followed by vines treated with potassium phosphonate (@ 0.3 per cent) and incorporation of *Trichoderma harzianum* (MTCC- 5179) also recorded more height (0.41 m height). However, unprotected vines exhibited least growth (0.20 m height) viz., IISR Thevam (0.28 m height), IISR Shakti (0.20 m height) and Panniyur -1 (0.13 m height).

The experiment was started during 2008 at Chintapalle, Dapoli, Panniyur, Pampadumpara, Pechiparai, Mudigere and Sirsi. Since the establishment was poor replanting was taken up in most of the centres.

PEP/CP/6 Pest Management Trial

PEP/CP/6.2 Management of *Erythrina* gall wasp, a popular standard of black pepper

(Mudigere, Pampadumpara)

A survey has been conducted to ascertain the severity of gall wasp infestation in *Erythrina,* a popular standard of black pepper in different panchayats of Idukki District by Pampadumpara centre. Three types of *Erythrina* has been identified to be used as standard of pepper vines. They are black thorned, white thorned and thornless. A scale has been developed to measure the infestation of the gall wasp. The infestation was found severe in black thorned ones followed by white thorned ones. Thornless *Erythrina* were found to be more resistant to infestation. Chakkupallam, Erattyar, Kanchiyar and Kattappana panchayats recorded maximum infestation mainly in black thorned ones. Mudigere centre conducted survey in the n blackpepper growing tracts of Malnad region and observed thet three major species of *Erythrina* viz., *Erythrina indica*, *E. fusca* and *E. subumbrans* were used as standards. The species *Erythrina indica*, are used as standards in Coorg and all the three species in parts of Hassan, Chickamaglur and in Shimoga Districts. The incidence of pest was recorded in two species, *Erythrina indica*, *E. fusca* in all the places and there was no incidence on *Erythrina subumbrans* and was almost free from gall wasp . Further, that species was screened against gall wasp intensively both under field and polyhouse conditions and there was no incidence recorded

CARDAMOM

CAR/CI/1 Genetic Resources

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

(Mudigere, Pampadumpara)

The germplasm of cardamom conserved at various AICRPS centres are given in Table 9. Evaluation of germplasm at Pampadumpara indicated that , the yield performance was good and the highest fresh yield of capsules (6300 g plant^{-1}) and dry yield (1400 g plant^{-1}) of capsules was recorded in CRSP-84 followed by CRSP-26 with 4400 g plant^{-1} and 978 g plant^{-1} of fresh and dry yield, respectively. CRSP-61 recorded maximum 100 capsule volume (180 cc) and weight (115 g) followed by CRSP- 30 (175 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 (23.2%) 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-48 (52%) followed by CRSP-47 (45%). CRSP-44 was found to be susceptible to *azhukal* disease (40%). The capsule borer damage was recorded lowest for all the accessions.

Table 9. Cardamom germplasm collections of AICRPS centres

Centre	Indigenous		Total
	Cultivated	Wild and related sp.	
Mudigere	161	-	161
Pampadumpara	162	1	163
Total	323	1	324

At Mudigere, cardamom accessions were replanted during 2010 and the observation will be recorded from third year onward

CAR/CI/2 Hybridization

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

(Mudigere)

Thirty open pollinated progenies were evaluated for yield and yield attributing traits at Mudigere. Among the entries tested, entry 21C, recorded highest dry capsule yield (195 kg/ha) followed by 23C, (190.2 kg/ha) and 22C, (189.6 kg/ha). Genotypes M-2 was found tallest (286 cm), 22C8 recorded maximum number of bearing suckers/plant (12. 6) and 6C8 had longest panicle (52.3 cm). Number of capsules/panicle (49.0) was maximum in 4C8.

CAR/CI/2.2 Hybridization & selection in cardamom

(Mudigere)

A crossing block involving 5 elite clones of M-1, M-2, HS-1, Njallani 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 at Mudigere. Crossing programme will be taken up during 2011.

CAR/CI/3 Coordinated Varietal Trial

CAR/CI/3.5 CVT 2005-series V

(Pampadumpara, Mudigere, Myladumpara)

Yield attributing characters and incidence of pests were evaluated in seven promising cardamom accessions at Pampadumpara. Three varieties *viz.*, CL-722 (64.59), MCC-309 (57.83) and MCC-73 (57.73), registered more than 50 tillers per clump. Maximum 100 capsule volume was registered in Green gold (*Njallani*) (local check) (115 cc), followed by MHC-26 (113.33 cc), whereas maximum 100 capsule weight of 95g was recorded in PS -27 , MCC-246 and MHC-26. Highest fresh (3625.20 g plant^{-1}) and dry yield (816.13 g plant^{-1}) was recorded by PS-27similiar to the previous year's findings. Minimum thrips attack was found in PS-27, MCC-73, MCC-246 and Green gold (Njallani) (Table 10).

Table 10. Yield attributing characters of CVT 2005 cardamom accessions at Pampadumpara

Accession	Tiller height (cm)	004Eo. of tillers	Panicle length (cm)	100 Capsule weight (g)	100 Capsule volume (cc)	Number of seeds/capsule	Fresh weight (g/plant)	Dry weight (g/plant)	Dryage (%)	Thrips (%)	Capsule borer (%)	Azhukal (%)
CL-722	259.7	64.5	39.0	91.6	110.0	14.3	432.7	97.9	23.6	3.4	1.6	1.4
PS-27	250	47.6	55.0	95.0	105.0	14.0	3625.2	816.1	22.4	2.3	1.7	2.2
MCC-246	233.2	49.5	66.6	95.0	111.6	16.8	2126.6	445.4	21.2	2.7	1.4	1.3
MCC-309	208.4	57.8	55.6	86.6	106.6	12.8	1088.6	232.4	21.3	3.5	1.5	1.7
MCC-73	261.3	57.7	32.0	83.3	103.3	12.8	1755.9	367.1	21.5	2.5	1.8	1.3
MHC-26 (Green Gold (Njallani)	254.3	47.7	76.6	95.0	113.3	17.1	1489.0	303.6	20.4	2.9	1.5	1.8
Mean	253	42.3	44.6	91.6	115.0	16.3	1653.4	351.9	21.1	2.6	1.3	1.4
CD (P=0.05)	245.7	52.4	52.8	91.1	109.2	14.9	1738.8	373.5	21.7	2.8	1.5	1.6
	28.5	10.9	24.8	17.8	NS	NS	16.9	36.3	2.2	0.7	NS	NS

The field trial was continued during 2010-11 crop season 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 11) at Myladumpara. 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 1260 kg/ha was recorded in MHC-26 followed by MCC-73 (1050 kg/ha), MCC-246 (1128 kg/ha) and MCC-309 (984 kg/ha).

A CVT -2005 comprising of eight clones from different research center was initiated in 2005-06 in RCBD with 3 replications. Clone CL-722 was found superior for dry capsule yield (292.0 kg/ha) and significantly superior over checks (M-2 & M-1). Other entries which recorded high dry capsule yield were PS-27 (262.00 kg/ha).

Table 11. Performance of CVT 2005 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	63.8	244.2	20.9	40.5	62.8	22.6	8.1	1.26	126
MCC-73	56.0	227.1	21.6	34.1	57.4	19.6	7.0	1.05	105
MCC-246	58.6	259.6	21.9	37.1	56.0	21.3	8.0	1.12	1128
MCC-309	53.8	245.3	21.6	34.7	56.6	18.6	6.5	0.98	98
PS-27	42.1	212.5	21.8	26.5	36.6	17.5	7.4	0.74	741
CL-722	35.9	184.8	21.2	25.5	30.3	13.9	6.1	0.56	560
ICRI-2	53.3	242.0	21.8	34.8	55.8	18.2	6.5	0.92	92
MCC-260	51.1	217.8	20.7	32.8	53.3	17.4	6.4	0.90	90
CD (5%)	11.1	4.0	2.2	8.8	9.1	2.5	1.2	0.1	15

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

(Mudigere, Pampadumpara, Sakleshpur, Ambalavayal, Myladumpara)

The vegetative parameters were recorded at Pampadumpara and it was observed that tiller height, leaf length and leaf width was maximum in CRSP-158, PV-2, CRSP-19, and Green gold. CRSP-19 recorded maximum tiller height followed by PV-2. Leaf length and width of CRSP-19, CRSP-14 was comparable with Green gold and PV-2. Number of tillers was maximum in CRSP-19 which was on par with Green gold and PV-2. MCC-346 recorded highest value for 100 capsule volume and 100 capsule weight which was on par with PV-2 and Green gold (Table 12). Green gold (local check) and CRSP-158 yielded higher than other accessions (both in dry weight and fresh weight, length and width of CRSP-19, CRSP-14 was comparable with Green gold and PV-2. Thrips attack was minimum in all exotic accessions.

Growth characters such as total tillers, tiller height, number of leaves per tiller and number of vegetative buds per clump were recorded and analyzed at Sakleshpur. All the entries were found to be on par with respect to preliminary data on growth characters.

At Myladumpara significant difference was observed between the clones for total tillers, tiller height, number of leaves per tiller and number of vegetative buds per clump except for vegetative buds.

Observation on plant height and total number of suckers/plant was recorded. Entry IC-34987 (11.07) and CL-726 (11.47) recorded more number of suckers /plant than the checks M-2 (10.67 and GG (10.10)at Mudigere. The yield parameters will be recorded from third year onwards.

CAR/CI/4 Varietal Evaluation Trial (VET)

CAR/CI/4.1 Initial Evaluation Trial - I

(Mudigere)

IET-I was planted during 2009 at Mudigere and the observations on plant height and total number of suckers/plant were recorded. The entry 2-4-D11 (23.50) recorded more number of suckers/plant followed by 12-7-D11 and the yield traits will be recoded from third year onward.

CAR/CI/4.2 Initial Evaluation Trial - II

(Mudigere)

This trial has been planted during 2009 at Mudigere and the observations on plant height and total number of suckers /plant were recorded. The entry CL-720 (21.23) recorded more number of suckers/plant followed by HS-1 (16.89) and the yield traits will be recoded from third year onwards.

Table 12. Yield attributing characters in CVT 2009 cardamom accessions at Pampadumpara

Accession	Tiller height (cm)	Tillers/ clump (No.)	Leaf length (cm)	Leaf width (cm)	100 Capsule weight (g)	100 Capsule volume (cc)
IC 349545	98.32	5.67	50.78	8.44	9.43	13.42
IC 349651	87.00	3.34	41.22	6.22	1.00	1.00
IC 547167	126.33	20.22	53.00	9.33	9.41	12.33
IC 547185	98.55	3.22	44.00	7.50	1.00	1.00
CL 726	108.23	16.78	47.44	8.00	8.88	12.37
CL 691	118.90	15.00	52.00	8.22	8.22	11.53
PL NO 14 (CRSP 158)	150.47	23.22	57.55	10.55	9.45	13.58
CR 6 (CRSP -19)	214.20	10.67	59.67	10.78	9.96	13.50
MCC 346	104.90	17.33	49.89	10.44	10.32	14.11
SKP 104	92.43	9.67	41.44	7.83	9.18	12.35
SKP 164	108.00	13.00	40.44	7.22	9.18	13.70
GREEN GOLD (Njallani)	144.97	19.11	59.11	11.39	9.97	13.73
PV 2	167.23	20.66	62.45	11.67	10.17	13.63
Mean	124.58	13.68	50.69	9.05	8.17	11.25
CD(P=0.05)	20.40	7.61	7.18	1.65	0.66	1.27

CAR/CM/5 Nutrient Management Trial

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

(Mudigere)

An experiment was laid out at Mudigere centre to determine the response of cardamom to different levels of fertilizers and irrigation schedule during the year.

CAR/CM/5.2 Effect of fertigation on yield of cardamom through drips

(Mudigere, Pampadumpara)

Application of irrigation 9l/clump/day along with 100% recommended dose of fertilizer through drips recorded the highest capsule yield. (53.93 kg/ha) this was on par with irrigation 9l/clump/day with 75% recommended fertilizer dose (53.51 kg/ha). The least capsule yield was obtained with conventional method of irrigation. The supporting yield parameters also had similar tendency as that of yield obtained.

CAR/CM/5.3 Organic farming in cardamom

(Mudigere, Pampadumpara)

There was a significant difference among the treatments at Mudigere. Application of organics with biofertilizers was superior over organic treatments. Maximum capsule yield (105.5 kg/ha) was obtained with the application of FYM 30 t/ha along with the biofertilizers. This was followed by application of coffee pulp compost along with bio-fertilizers. The lowest yield (65.42 kg/ha) was recorded in application of Jeevamrutha with and without bio fertilizers. The supporting yield parameters also had similar tendency as that of yield obtained

CAR/CP/6 Pest and Disease Management Trial

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

(Mudigere, Pampadumpara)

Thrips and shoot and capsule borer are the important insect pest infesting cardamom. In order to effectively manage these pests, an experiment was initiated during 2010. At Pampadumpara, spraying Quinalphos @ 2ml/l was found to be the most significant treatment for the management of both pests when compared to all other treatments. The infestation levels were limited to 5%, 12% and 5% respectively in case of thrips, shoot and capsule borer. Acetamiprid @ 4g/l was found to be the next effective treatment against thrips (6.3%) followed by Methomyl and Thiamethaxam. Poneem a neem based formulation was found to be equally effective in management of all these infestations significantly, and was found to be a better alternative for the management of shoot and capsule borer.

The efficacy of five insecticides *viz.*, Thiamethoxam (1g) Methomyl (1.5g) Acetamiprid (0.4), and Imidachloroprid (0.5ml) and Ponneem (4 ml) were compared with Carbosulfan for the management of thrips and borers in cardamom plantation during 2010-11 at Mudigere. The damage of capsules by thrips and borers was low in all the treatments compared to untreated control. All the harvest indicated maximum damage with thrips compared to borers. Similar trend was noticed except in ponneem treatment, but ponneem treatment recorded significantly lower percent thrips and borer damage compare to control. Methomyl @ 1.5g was found effective for the control of thrips and capsule borer when compared to all the treatments including standard check.

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

(Pampadumpara)

All the five treatments were found to be effective in reducing the disease incidence compared to control at Pampadumpara. (Table 13). Minimum tiller infection was recorded for the treatment T3 (*Trichoderma harzianum* + consortium of bacteria @ 50 g/vine). Next best treatments were the treatments T1 (*T. harzianum* @ 50 g/vine) and T2 (Consortium of bacteria @ 50g/vine) and their effects were on par. The treatment T3 (*T. harzianum* + consortium of bacteria @ 50 g/vine) was found to be best treatment against panicle infection which was followed by the treatments T2, T1 and T5 (potassium phosphonate @0.3% spray and drench) and they were on par. The treatment T3 (*T. harzianum* + consortium of bacteria @ 50 g/vine) was found to be best treatment against capsule infection which was followed by the treatment T2 (consortium of bacteria @ 50 g/vine). Maximum yield of (0.68 kg dried capsule/plant) was recorded in treatment T3 which was on par

with the treatment T2 (consortium of bacteria @ 50 g/vine i.e., 0.67 kg dried capsule/plant). This was followed by the treatment T1 (*T. harzianum* @ 50 g/vine) *i.e.,* 0.63 kg dried capsule/plant). The yield of T1 (*T. harzianum* @ 50 g/vine) was on par with that of treatments T5 (potassium phosphonate (0.3%) spray and drench) and T4 (COC 0.3% drench).

CAR/CP/6.6 Trial on management of panicle rot and clump rot diseases of cardamom in new plantation (Final Report)

(Pampadumpara)

In the experiment all the treatments were found to be effective in reducing the disease incidence as compared to control at Pampadumpara (Table 14). In PV-2 the best treatment for tiller infection was T3 (*T. harzianum* + consortium of bacteria @ 50 g/plant) which was followed by T2 (consortium of bacteria @ 50 g/plant). Next best treatments compared to control were T1 (*T. harzianum* @ 50 g/plant) and T4 (COC 0.2% drench) and their effects were on par. The treatment T3 (*T. harzianum* + consortium of bacteria @ 50 g/plant) was found to be superior in reducing the panicle and capsule infection and was followed by the treatment T2. Highest yield was recorded for treatment T3 (*T. harzianum* + consortium of bacteria @ 50 g/plant i.e., 0.64 kg/plant). This was followed by the treatments T2 (consortium of bacteria @ 50 g/plant i.e., 0.60 kg/plant) and T1 and they were on par. In Green gold also same results were recorded. In this the best treatment against tiller infection, panicle infection and capsule infection are T3 (*T. harzianum* + consortium of bacteria @ 50 g/plant) and this was followed by the treatment T2 (consortium of bacteria @ 50 g/plant) Yield for the treatments T3 (*T. harzianum* + consortium of bacteria @ 50 g/plant i.e., 0.67 kg /plant), T2 (consortium of bacteria @ 50 g/plant i.e., 0.66 kg/plant), T5 (potassium phosphonate (0.3%) spray and drench i.e., 0.66 kg / plant) and T1 (*T. harzianum* @ 50 g/vine ie., 0.64 kg / plant) were on par and the treatments T3 (*T. harzianum* + consortium of bacteria @ 50 g/plant), T2 (consortium of bacteria @ 50 g/plant) and T5 (potassium phosphonate (0.3%) spray and drench) were significantly different from treatment T4 (COC 0.2% drench). All the five treatments were significantly superior to control in terms of yield.

Table 13. Effect of biocontrol agents and chemicals on the incidence of panicle and clump rot of cardamom in existing plantation at Pampadumpara (Pooled analysis of 2006-07. 2007-08 and 2010-2011)

Treatment	Tiller infection (%)	Panicle infection (%)	Capsule infection (%)	Dry yield (kg / plant)
T 1 - *Trichoderma harzianum*	5.55	5.04	4.45	
(50 g/vine)	(13.62)	(12.99)	(12.22)	0.63
T 2 - Consortium of bacteria	5.71	4.54	3.45	
(50 g/vine)	(13.8)	(12.31)	(10.71)	0.67
T 3 - *Trichoderma harzianum* +	2.2	2.26	2.76	
consortium of bacteria (50 g/vine)	(8.49)	(8.67)	(9.55)	0.68
T 4 - COC 0.3%	7.53	7.88	6.72	
drench	(15.95)	(16.29)	(15.03)	0.61
T 5 - Potassium phosphonate	6.98	6.78	6.63	
(0.3%) spray and drench	(15.31)	(15.08)	(14.95)	0.61
T 6 - Control	15.75	14.83	12.78	
	(23.38)	(19.9)	(20.94)	0.55
CD(0.05)	0.926	2.898	0.242	0.032

* Figures in parentheses indicate arcsine transformation

Table 14. Effect of bio control agents and chemicals on the incidence of panicle and clump rot of cardamom in new plantation at Pampadumpara (Pooled analysis of 2006-07, 2007-08 and 2010-2011)

Treatment	PV 2				Green Gold			
	Tiller infection	Panicle infection	Capsule infection	Dry yield (kg/plant)	Tiller infection	Panicle infection	Capsule infection	Dry yield (kg/plant)
T 1- *Trichoderma harzianum* (50 g/plant)	4.95 (12.87)	5.37 (13.43)	4.25 (11.92)	0.58	5.14 (13.14)	5.75 (13.89)	4.66 (12.52)	0.64
T 2 -Consortium of bacteria (50 g/plant)	3.76 (11.24)	4.135 (11.78)	3.37 (10.63)	0.60	3.75 (11.19)	4.7 (12.57)	3.07 (10.14)	0.66
T 3 -*Trichoderma harzianum* + Consortium of bacteria (50 g/plant)	1.57 (7.27)	2.41 (9.03)	2.42 (8.97)	0.64	1.75 (7.64)	2.67 (9.4)	2.07 (8.33)	0.67
T 4- COC 0.2 % drench	5.14 (13.09)	6.16 (14.38)	6.05 (14.26)	0.54	6.89 (15.23)	8.34 (16.78)	7.65 (16.07)	0.61
T 5 -Potassium phosphonate (0.3%) spray and drench	6.27 (14.54)	6.35 (14.61)	5.72 (13.85)	0.54	5.69 (13.81)	7.07 (15.45)	6.09(14.3)	0.66
T 6 -Control	14.21 (22.17)	14.55 (22.44)	13.47 (21.56)	0.41	14.3 (22.22)	14.95 (22.76)	13.70 (21.75)	0.51
CD(0.05)	0.248	0.245	0.255	0.035	0.252	0.241	0.143	0.035

LARGE CARDAMOM

LCA/CI Genetic Resources

LCA/CI Germplasm of large cardamom
(Gangtok)

Survey was made at Sukhia Pokhri and Rang Bhang area of Darjeeling, Dentam and Hee-Gaon area of West Sikkim, Ravangla and Namchi area of South Sikkim, Dzongu area of North Sikkim and Assam Lingzey, Pakyong area of East Sikkim for collection of germplasm. Six planting units of nine germplasm *viz*. SCC-218 (Hario Ramsey), SCC-219 (Rato Varlangey), SCC-220 (Ramsey), SCC-221 (Varlangey), SCC-222 (Asarey), SCC-223 (Ramsey), SCC-224 (Chivesey), SCC-225 (Allied Genera), SCC-226 (Hario Varlangey) were collected and planted at Kabi farm. Characterizations of the collected germplasm were made as per descriptor. IC numbers for 48 accessions of large cardamom was obtained from NBPGR, New Delhi.

LCA/CP Evolving disease and pest tolerant lines in large cardamom
(Gangtok)

The disease escapes plants of large cardamom were maintained in the research farm at Kabi.

LCA/CP Integrated pest and disease management in large cardamom
(Gangtok)

The trial in large cardamom was maintained at Singhik and data was recorded. Gap filling was done wherever required.

GINGER

GIN/CI/1 Genetic Resources

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

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

Germplasm of ginger is maintained in Dholi, Kumarganj, Pottangi, Pundibari, Raigarh, Solan centres of AICRPS (Table 15). Out of forty seven germplasm collected at Dholi, only fourteen accessions namely, RG-43, RG-18, RG-28, RG-21, RG-29, RG-34, RG-20, RG-5, RG-2, RG-1, RG-33, RG-4, RG-26, and RG-35 gave maximum yield (12.30 kg to 8 kg/7.2 m^2) as compared to check variety Nadia (7.90 kg/7.2 m^2). Among the promising accessions, RG-43 gave maximum yield (12.30 kg/7.2 m^2) followed by RG-18 *i.e.,* (12.00 kg/7.2 m^2).

Out of 61 germplasm evaluated at Kumarganj, NDG-55 produced 343.6 kg/ha fresh rhizomes of ginger followed by NDG-28 (141.1 kg/ha).

Fifty six germplasm of ginger were evaluated during 2010 -11 at Pundibari centre. GCP-49 recorded maximum plant height (111.27 cm) followed by GCP-33 (109.30 cm), whereas GCP-30 recorded the lowest plant height (37.50 cm). Maximum number of tillers was recorded in GCP-14 (59.33) followed by GCP-55 (52.67) and GCP-48 (52.00) whereas GCP-44 (5.67) recorded lowest numbers of tillers. Maximum disease incidence was recorded in the germplasm GCP-46 (90.00%) whereas lowest disease incidence was recorded in GCP-01, GCP-08 and GCP-51 (0.00%). Highest rhizome yield/plant was recorded in GCP-32 (974.33 g) followed by GCP-14 (734.67 g), GCP-33 (680.00 g), GCP-54 (563.33 g) and GCP-1 (556.33 g). Lowest rhizome yield/plant was recorded in GCP-16 (99.00 g).

Table 15. Ginger germplasm collection of AICRPS centres

Centre	Indigenous	Exotic	Total
Dholi	47	-	47
Kumarganj	61	-	61
Pottangi	174	3	177
Pundibari	56	-	56
Raigarh	44	-	44
Solan	231		231
Total	**613**	**3**	**616**

Two hundred and thirty one collections were evaluated under field conditions for rhizome yield and other horticultural traits at Solan. The yield of thirty promising lines varied from 170.21 g/plant (Panesh Local) to 282.35 g/plant (SG-26/04), whereas, the yield range of germplasm varied from 11.66 g/plant to 282.35 g/plant. Yield of five lines *viz.*, SG-26/04 (282.35 g/plant), SG-40/04 (268.64 g/plant), SG-8/04 (246.31 g/plant), SG-1029 (244.35 g/plant) and SG-823 (228.01 g/plant) excelled the check Himgiri which yielded 223.04 g/plant. Collection PLS-4 produced tallest tillers (87.25 cm) followed by SG- 15/04 (86.67 cm) and SG–1029 (86.24 cm). Rhizome length was maximum in SG-26/04 (20.22 cm) and breadth in SG-1029 (10.25 cm). The disease incidence varied from 2.50-19.00% in different lines with minimum incidence of 2.50% in Himgiri.

GIN/CI /2 Coordinated Varietial Trials

GIN/CI/2.3 CVT 2006 – Series VII

(Pundibari, Solan, Kumarganj)

Table 16. Growth performance of ginger under CVT 2006 at Pundibari

Entry	Plant height (cm)	Number of tillers	Number of leaves	Leaf length (cm)	Leaf breadth (cm)	Pseudostem girth (cm)	Rhizome yield/plot (kg/3m^2)	Disease Incidence	Projected yield (t/ha)	% Increase Over check (%)
IG-1	75.24	27.67	24.56	21.63	2.08	1.87	7.17	16.67	14.45	16.21
IG-3	77.01	32.22	23.44	20.80	2.04	2.05	5.17	40.00	10.42	
SG-827	85.14	38.45	19.67	20.80	2.59	2.09	5.33	45.00	10.75	
IG-2	71.20	26.11	20.00	19.43	2.12	1.86	9.03	6.67	18.21	46.35
PGS-8	55.14	14.11	19.67	21.41	1.91	2.01	10.07	16.67	20.31	63.21
V2E5-2	61.39	19.45	20.22	18.66	2.13	2.10	1.53	45.83	3.08	
GCP-5	86.35	18.67	18.89	19.62	2.04	1.99	8.07	22.50	16.26	30.79
GCP-31	81.64	25.89	27.33	20.18	2.61	2.23	9.10	28.33	18.35	47.49
NDG-1	68.23	75.22	26.33	18.33	1.46	1.69	5.23	23.33	10.55	
NDG-5	68.21	28.78	31.00	19.95	2.19	1.75	4.50	53.33	9.07	
ACC-578	73.90	19.78	26.56	20.78	2.30	1.83	6.77	39.17	13.64	9.72
Suprabha (check)	54.62	22.00	15.33	17.28	1.88	1.91	6.17	38.33	12.43	
Varada (check)	83.19	30.89	20.78	25.88	2.54	1.86	11.55	25.00	23.28	
SEm (±)	6.57	7.20	3.07	2.95	0.27	0.15	0.54	8.97	1.08	
CD (P=0.05)	13.57	14.86	6.34	6.10	0.55	0.32	1.11	18.52	2.24	

Amongst sixteen entries evaluated at Pundibari, the values of growth and yield parameters of thirteen entries namely, (IG-1, IG-3, SG-827, IG-2, PGS-8, V2E5-2, GCP-5, GCP-31, NDG-1, NDG-5, ACC-578, Suprabha and Varada) were recorded. Analysis of data showed that the genotype GCP-5 exhibited the highest plant height (86.35 cm) followed by SG-827 (85.14 cm). Suprabha (check) was the shortest in plant height (54.62 cm). Highest number of tillers/rhizome was recorded by NDG-1 (75.22) where as lowest was shown by PGS-8 (14.11). Varada (check) showed the highest yield per plot (11.55 kg) followed by PGS-8 (10.07 kg) and V2E5-2 recorded the lowest (1.53 kg). NDG-5 (53.33%) had the highest disease infestation whereas lowest PDI was recorded by IG-2 (6.67%) followed by IG-1 (16.67%). Highest projected yield was recorded by Varada (check) (23.28 ton/ha) followed by PGS-8 (20.31 ton/ha). The lowest yield was recorded by V2E5-2 (3.08 ton/ha) (Table 16).

At Solan, local entry SG-707 exhibited maximum rhizome yield of 179.99 g/plant followed by another local entry SG-827 (164.23 g/plant). These entries also recorded maximum rhizome length, breadth, leaves per tiller and tillers per plant. However, maximum tiller length was observed in NDG-2 (81.33 cm) and IG-2 (81.40 cm). Minimum yield of 54.22 g/plant was recorded in IG-3 followed by IG-1 (55.98 g/plant). The dry matter content and essential oil was maximum (21.50% and 2.00%) in SG-707 with 5% oleoresin and crude fiber. The disease incidence varied from 4.50-20.00% with minimum incidence in Varada.

Maximum fresh rhizome yield of 146.1 q/ha was recorded inV_2E_8-2 followed by 139.44 q/ha in NDG-5 (Table 17) at Kumarganj.

GIN/CI/3.2. Initial evaluation trial on ginger

(Raigarh, Solan)

Data presented in Table 18 revealed that nine genotypes including local check variety Nadia were tested under initial evaluation trial at Raigarh. All the entries were found non-significant regarding height of the plant and number of leaves. Genotypes RG-24, RG-30 and RG-32 were found to have significantly higher number of tillers per plant as compared to local check variety Nadia. All the entries recorded significantly higher yield as compared to check variety Nadia. Among the entries RG-32 gave the maximum number of branches per plant (15.80) and maximum yield per plot (4.38 kg/3m^2) or yield per hectare (13.15 t/ha) followed by RG-24 (4.00 kg/3m^2 or 12.07 t/ha).

Table 17. Yield of CVT ginger at Kumarganj

Entries	Yield (q/ha)
GCP-5	46.46
ACC-578	43.50
GCP-31	48.60
V.E.-2	146.10
NDG-1	49.00
NDG-2	46.00
NDG-5	139.44
SEM±	5.45
CD (0.05)	16.53
CV (%)	2.26

Table 18. Response of genotype under IET on ginger at Raigarh

Genotype	Height of plant (cm)	Number of tillers/ plant	Number of leaves/ tiller	Number of days to maturity	Yield per plot (kg/3m^2)	Yield (t/ha)	Increase in yield over check var.	
							t/ha	%
RG-7	42.60	12.20	16.53	239.66	2.23	6.70	2.20	48.88
RG-9	42.53	11.47	18.00	244.33	3.67	11.00	6.50	144.44
RG-13	44.26	13.53	18.53	247.00	3.03	9.10	4.60	102.22
RG-14	37.33	11.60	17.40	245.33	2.50	7.50	3.00	66.66
RG-24	43.26	15.26	16.73	247.66	4.00	12.07	7.57	168.22
RG-30	44.20	14.73	18.86	246.00	3.06	9.20	4.70	104.44
RG-32	46.13	15.80	18.40	243.66	4.38	13.15	8.65	192.22
RG-38	45.06	12.93	18.13	240.33	3.97	11.80	7.30	162.22
Nadia check	39.20	9.27	17.80	237.33	1.50	4.50	-	-
SEM (±)	3.31	1.21	1.22	1.83	0.22	0.66	-	-
CD (P=0.05)	NS	3.65	NS	5.51	0.66	2.00	-	-
CV (%)	13.42	16.26	11.94	1.30	12.17	12.25	-	-

At Solan, the average yield per plant varied from 59.06 g/plant to 223.04 g/plant. Local check variety Himgiri recorded maximum yield per plant and minimum disease incidence (2.50%). None of the genotypes recorded dry matter content and essential oil more than the check Himgiri which exhibited 19.20% and 2.00% dry matter content and essential oil, respectively. The crude fibre ranged from 3.03% to 5.80%.

GIN/C1/3.3 Genotype x Environment interaction on quality of ginger

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

At Chintapalle, only six varieties were recived from different centers. Narsipatnam was used as local check. Growth and yield parameters of seven varieties were recorded. Due to continuous rain fall very poor plant stand was recorded in all varieties. Maximum plant height was recorded in Narsipatnam (51.0 cm) followed by Varada (49.0cm). Himagiri produced maximum tillers (9.1) followed by Narsipatnam (8.6).Variety

Varada was recorded as highest yield (10.79 t/ha) of fresh rhizomes followed by variety Narsipatnam (9.77 t/ha) and the lowest yield was recorded in Suprabha (3.99 t/ha). All the genotypes were affected by soft rot and the disease incidence was observed from the month of August onwards.

Plant height, leaf length and leaf width were found to be non significant between varieties at Appangala whereas number of tillers and fresh yield (kg/bed) was significant between varieties. Suprabha recorded higher yield followed by Himagiri. Dry recovery, oil content and oleoresin per cent was found to be non significant. Dry recovery was higher in Himagiri, Mahima and Rejitha and least in Rio-de-gereio. Oil content ranged from 0.89 to 1.22% with a mean of 1.08 per cent. Oleoresin content ranged from 2.87 to 3.6 per cent with a mean of 3.07 per cent. Essential oil and oleoresin contents in these ranged from 0.9-1.2% and 2.8-3.6% respectively. The composition of 11 chief components representing 80-85% of essential oil was evaluated. Among the genotypes, not much change in composition of essential oil was observed. However, the contents of gingiberene and farnesene showed variations between 28.6-37.7% and 5.5-19.9% respectively; and bisabolenewas present in the oils of three genotypes. Pungent compounds in the ginger varieties were analysed by HPLC. The pungent compounds namely, 6-gingerol, 8-gingerol and 10-gingerol ranged from 1.0-1.4%, 0.09-0.29% and 0.01-0.3% respectively, contributing 1.3-1.7% of total gingerols. 10-Shogaol was not present in detectable levels, where as 6-shogaol and 8-shogaol were in the range 0.18-0.24% and 0.002-0.45% respectively. Suravi was superior among the varieties, with respect to quality traits, namely, essential oil and oleoresin contents, pungent compounds, and essential oil profile.

Total of ten ginger genotypes obtained from different centres were evaluated during 2010-11 at Barapani, Meghalaya. Among the genotypes evaluated, highest plant height was found in Suparbha (54.39 cm) followed by Varada (53.27 cm) with lowest crude fibre content (3.30%). Khasi Local showed comparable crude fibre content (3.40%). Highest dry recovery was recorded in V,S,-8 (23.51%) while lowest was recorded in Varada (17.71%) (Table 19).

Maximum plant height was recorded in Narsipatnam (51.0 cm) followed by Varada (49.0 cm). Himagiri produced maximum tillers (9.1) followed by Narsipatnam (8.6) at Chintapalli. Variety Varada was recorded as highest yielder

Table 19. Morphological and quality parameters under G x E interaction in ginger at Barapani

Genotype	Plant height (cm)	Leaf Length (cm)	Leaf Breadth (cm)	Stem diameter (mm)	No. of tillers	No. of leaves /plant	Yield / plant (g)	Yield/plot (kg)	Yield t/ha	Dry matter (%)	Crude fibre content (%)
Suprabha	54.39	19.90	2.58	7.33	6.33	62.42	255	5.10	14.45	20.76	4.68
Mahima	51.00	19.87	2.87	6.45	4.50	49.17	245	4.90	13.88	20.64	4.40
Himgiri	50.20	17.77	2.80	6.13	5.33	70.34	220	4.40	12.47	20.15	5.17
Varada	53.27	20.00	2.58	6.82	5.17	57.59	225	4.50	12.75	17.71	3.30
V3S1-8	49.85	13.25	2.85	6.98	3.5	45.00	228	4.56	12.92	23.51	4.90
Rejatha	44.0	17.0	2.75	5.33	6.5	49.00	55	1.10	3.12	19.50	4.80
Surachi	46.3	19.5	2.50	6.03	4.0	34.00	50	1.00	2.83	20.96	4.00
Suravi	53.0	25.0	2.70	5.67	10.0	82.00	210	4.20	11.90	21.71	5.77
Nadia	50.17	17.43	2.24	5.66	5.38	56.17	230	4.60	13.03	20.84	3.63
Khasi Local	35.33	11.67	2.34	4.38	4.67	38.25	105	2.10	5.95	22.02	3.40
SEm	3.26	1.37	0.11	0.35	0.65	5.53	15.78	0.30	0.38	0.65	0.30
CD (P=0.05)	9.77	4.11	0.32	1.06	1.96	16.28	47.31	0.88	1.15	1.94	0.90

(10.79 t/ha) of fresh rhizomes followed by variety Narsipatnam (9.77 t/ha) and lowest yield was recorded in Suprabha (3.99 t/ha). All the genotypes were affected by soft rot and the disease incidence was observed from the month of August onwards.

At Kanke, Varada recorded maximum average plant height 54.33 cm followed by Mahima 46.66 cm. Burdaman showed maximum leaf length 18.33 cm followed by V3S1-8-18.00 cm and maximum leaf width was in Suprabha 2.63 cm followed by Surabhi 2.50 cm. Suprabha showed maximum tillers 17.00 no. followed by Surabhi 14.66 no. As far as yield is concerned; the entry Surachi recorded the highest yield 5.300 kg per plot followed by Mahima 4.466 kg. Highest yield per ha was observed in Surachi (17.69 t/ha) followed by Mahima 14.88 t/ha. Rests are medium and poor yielder. In dry recovery, highest dry recovery of ginger rhizome was in Surachi (20.80%) followed by V3S1-8(21.20%). Pooled data of both the years (2009-10 and 2011-12) revealed that highest plant height was observed in Mahima (48.83 cm) which was closely followed by Varada (44.05 cm). Maximum leaf length was observed in Mahima (18.40 cm) followed by Burdaman (18.33 cm) and highest leaf breadth was observed in V3S1-8 (2.45 cm) followed by Rejatha (2.43 cm). Maximum number of tillers were observed in Surabhi (17.87 no.). Followed by Burdaman (17.15 no.). Highest rhizome yield of ginger per plot was in Suprabha (6.503 kg) followed by Mahima (5.484 kg). The highest yield per ha. was in Suprabha (21.67 tonnes/ha) followed by Mahima (18.27 tonnes/ha). Rest is medium and poor yielder. In dry recovery, Surachi gave highest recovery (20.90%) followed by Varada (21.43%).

Ten ginger genotypes including two local cv. were evaluated for the second year at Kalyani. Among the ten ginger genotypes evaluated, the average yield of rhizome per plot was highest (5.682 kg) in Suprabha followed by Varada (4.616 kg) and Gorubathan (4.309 kg), while minimum yield was in Himagiri (0.580 kg). Mahima also produced only 0.828 kg rhizome per plot.

The growth parameters, namely plant height, number of tillers, leaf length, leaf width, stem thickness and leaf area were taken after 120 days of planting at Mizoram. Top 5-7 leaves were chosen to measure the leaf length, leaf width and leaf area. Leaf area was highest for Himgiri which is at par with Nadia. However, plant height was maximum for Nadia followed by Himgiri and Nisapui. Maximum yield was recorded in Nadia followed by Himgiri and Nisapui (Local) (Table 20).

Table 20. Economic and yield traits of different ginger varieties at Mizoram.

Variety	Plant height (cm)	No. of tillers/ plant	Leaf length (cm)	Leaf width (cm)	Leaf area (cm^2)	Plant thickness (mm)	No. of leaves	Rhizome weight (g/ plant)	Yield (t/ ha)
Himgiri	45.9*	12.1	19.0	3.1	43.0*	6.9	14.1	105.5	17.60
Mahima	37.3	7.0	16.2	2.7	32.6	6.2	10.1	69.2	11.56
Nadia	46.5*	6.7	19.0	2.9	40.9*	7.2	13.3	108.3	18.07
Rejatha	35.6	6.4	15.0	2.7	30.3	6.1	9.5	44.2	7.37
Surabhi	34.3	14.3	15.0	2.8	31.1	4.9	9.1	51.0	8.52
Suprabha	34.1	13.0	15.1	2.8	31.0	6.0	8.9	52.9	8.85
Varda	38.4	5.1	16.5	2.6	31.7	6.0	10.4	68.7	11.47
Nisapui (Local)	41.8*	5.2	18.0	2.8	36.9	6.2	11.5	90.3	15.10
Mean	39.2	8.7	16.7	2.8	34.7	6.2	10.9	73.8	12.32
SEm	2.8	0.9	0.9	0.1	2.9	0.5	0.6	5.6	1.06
CD (P=0.05%)	8.4	2.9	2.8	0.4	8.9	1.5	1.8	17.1	3.22

Table 21. Morphological, yield and quality characters of ginger varieties at Pasighat

Variety	Plant height (cm)	No. of tillers	Leaf length (cm)	Leaf breadth (cm.)	Yield / plant (kg)	Yield /bed (kg)	Yield (t/ha)	Dry recovery (%)	Crude fibre (%)	Oleoresins (%)	Essential oil (%)
Mahima	56.39	14.40	23.00	2.53	0.22	8.90	29.67	22.50	3.30	4.35	4.20
Rejatha	53.21	10.33	21.27	2.38	0.17	6.66	22.20	20.47	3.93	4.45	4.70
Varada	56.01	12.07	23.71	2.66	0.18	7.29	24.30	19.77	3.63	7.00	5.30
Himgiri	50.29	11.67	20.42	2.68	0.15	5.95	19.84	19.07	5.93	4.23	5.05
Surabhi	50.65	15.67	21.68	2.61	0.27	10.80	36.00	22.93	4.07	9.40	5.90
Suruchi	48.00	11.33	19.76	2.58	0.20	7.99	26.62	23.10	3.73	10.63	6.00
Suprabha	47.99	16.40	21.27	2.23	0.26	10.25	34.15	20.43	4.43	8.77	5.70
V3S1-8	47.36	11.13	20.50	2.30	0.17	6.97	23.24	21.80	3.40	10.60	5.05
Nadia	59.16	15.07	22.33	2.67	0.26	10.34	34.47	22.10	7.47	5.12	5.20
GM	52.12	0.00	21.55	2.51	0.21	8.35	27.83	21.35	4.43	7.17	1.74
CD at 5%	3.68	2.21	NS	0.24	0.06	2.45	8.16	1.24	0.36	0.59	0.14
CV %	4.08	9.75	6.56	5.57	16.93	16.93	16.93	3.36	4.73	4.75	4.75
SEm±	1.23	0.74	NS	0.08	0.02	0.82	2.72	0.41	0.12	0.20	0.05

Growth, yield and quality parameters were studied among the nine varieties of ginger during 2010-11 at Pasighat, Arunachal Pradesh. The mean values of growth and yield pamameters showed that variety Nadia recorded maximum plant height (59.16 cm); Suprabha produced maximum number of tillers (16.40); Varada had maximum leaf area (23.71cm x 2.66cm) while variety Surabhi was recorded as highest yielder (10.80 kg/3m and 36.00 t/ha) of fresh rhizome followed by variety Nadia (10.34 3 m and 34.47 t/ha) and lowest yield was recorded in variety Himgiri (5.95 kg/3m and 19.84 t/ha). The mean values on quality parameters revealed that variety Suruchi had maximum dry recovery (23.10%) with maximum oleoresins (10.63%) and essential oil (6.00%) content while variety Nadia gave highest crude fibre (7.47%) content (Table 21).

Analysis of data from Pundibari showed that the genotype GCP-5 (86.30 cm) achieved highest plant height followed by IISR-Rejatha (79.87 cm) at Pundibari. IISR Mahima was the shortest in height (33.07 cm). Highest tiller number was recorded by the genotype Surabhi (34.60) where as lowest by IISR Mahima (8.39). IISR Mahima showed the highest clump weight (275.05 g) followed by GCP-5 (224.04 g) and Suprabha recorded the lowest clump weight (105.78 gm). Highest rhizome yield per plot was recorded by GCP-5 (6.02 Kg) followed by Surabhi (4.86 kg) and the lowest value was recorded by Suprabha (1.30 Kg). In respect of projected yield GCP-5 showed the highest value (12.14 t/ha) followed by Surabhi (9.80 t/ha) and lowest projected yield was recorded in Suprabha (2.62 t/ha). In respect of disease incidence IISR Varada (56.00%) recorded the highest value whereas GCP-5 (16.83%) recorded the lowest.

Yield per plant varied from 59.48 g/plant to 223.04 g/plant at Solan. Cultivar Himgiri recorded maximum yield followed by Local check SG-827 (164.23 g/plant). Disease incidence was also minimum (2.50%) in Himgiri, however, superior/comparable quality attributes *viz.* dry matter content, essential oil, oleoresin and crude fiber were exhibited by Varada and V3S1-8.

GIN/CI/4 Quality Evaluation Trial

GIN/CI/4.1 Evaluation of germplasm for quality

(Solan)

Twelve entries of CVT-2006 Series VI, 15 entries of IET-2006 and 10 entries of G X E interaction experiment and 30 best performing collections

were also analyzed for different quality attributes *viz.*, dry matter (%), essential oil (%), oleoresin (%) and crude fibre (%) at Solan. The dry matter contents and crude fibre % ranged between 15.60% (SG-1046)-19.20% (Himgiri) and 4.10% (SG-929) - 5.50% (SG-26/04), respectively. Essential oil and oleoresin contents varied from 1.05% (SG-865) to 2.00% (Himgiri, SG-40/04, SG-26/04) and 4.02% (SG-1032) to 6.50% (SG-26/04), respectively. Out of these 30 collections, SG-26/04 and SG-40/04 were found superior/comparable for dry matter, essential oil, oleoresin and crude fibre contents

GIN/CM/5 Nutrient Management Trial

GIN/CM/5.2 Organic farming in ginger - 2006

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

At Dholi, three treatments *i.e.*, fully organic (T_1- best organic nutrients combination (FYM, pongamia oil cake, sterameal, rock phosphate, neem oil cake, wood ASH) + *Azospirillum*, P-solublizers, *Pseudomonas fluorescens* and *Trichoderma* as seed treatment and soil application (50g/3m^2) with spray of BM (0.5%) and neem oil (0.5%) at 21 days interval from July-October for controlling disease and insect-pest), integrated nutrient management organic and inorganic (T_2- 20 t/ha FYM+1/2 NPK + solubilising bacteria, *P. fluorescens* and *Trichoderma* as seed treatment and soil application (50 g/3m^2) with spray or drenching with Mancozeb (Dithane M-45) and Malathion (0.1%) at 21 days interval from July-October for controlling disease and insect-pest) and fully inorganic (T_3 - recommended dose of N,P,K (80:50:80 kg/ha) drenching/spray with Mancozeb (Dithane M-45) and Malathion (0.1%) at 21 days interval from July-October for controlling diseases and insect-pest) were tested for obtaining higher yield. Among the treatments, fully organic (T_1) and integrated nutrient management (T_2) exhibited significantly better performance regarding height of the plant, number of tillers per plant, number of leaves per tiller, length of leaves, width of leaves, area of leaves, yield per plant, yield per plot and yield per hectare as compared to fully inorganic nutrient management. However, fully organic (T_1) as seed treatment and soil application showed better performance regarding height of the plant (42.28 cm), number of tillers per plant (20.14), number of leaves per tiller (22.45), length of leaves (15.85 cm) width of leaves (2.34 cm), area of leaves (37.18 cm^2), yield of rhizome per plant (0.10 kg), yield per plot (4.11 kg/3m^2) and yield per hectare (12.34 t/ha) followed by integrated nutrient management.

Application of organic nutrients on ginger (T_1) produced highest clump weight of 387.51 g and highest yield of 6.26 kg per plot at Pundibari. This treatment also produced highest oleoresin (3.65%). This treatment was followed by inorganic application on ginger (T_3) which produced clump weight of 225.11g and yield of 4.86 kg per plot.

Maximum yield was obtained at Raigarh in integrated nutrient (organic + inorganic) which gave an yield 12.46 t/ha.

At Kumarganj, application of 50% recommended dose of fertilizer (60:40:40 kg NPK kg/ha) + 50% FYM (10 t/ha) + *Azosporillum* (5 kg/ha) + seed treatment and soil application of *Pseudomonas flourscens* + *Trichoderma* (50 g/ m^2) gave maximum fresh rhizome yield of 62.37 q/ha of fresh ginger rhizomes followed by yield of 44.52 q/ha in application of 100% FYM (20 t/ha) + seed treatment and soil application of *P. flourscens* + *Trichoderma* 50 g/m^2 during 2010-11. Four years pooled data showed similar pattern showing maximum yield 49.45 q/ha by application of 50% recommended dose of fertilizer (60:40:40 kg NPK kg/ha) + 50% FYM (10 t/ha) + *Azosporillum* (5 kg/ha) + seed treatment and soil application of *P. flourscens* + *Trichoderma* (50 g/m^2 (Table 22).

GIN/CM/5.3 Nutrient supplementation though organic manures for growth and yield of ginger

(Dholi, Kumarganj)

Among the treatments evaluated at Dholi, only integrated nutrient management or INM (T_7) (30 t/ha FYM, N:P:K::80:50:80 kg/ha) gave significantly better performance regarding height of the plant, number of tillers per plant, yield per plot and projected yield (t/ha) as compared to absolute control (T_8) and other treatments. Among the treatments, integrated nutrients management or INM (T_7) (FYM-30 t/ha, N:P:K::80:50:80 kg/ha) gave the maximum plant height (48.73 cm), number of tillers per plant (30.93), yield per plot (4.33 kg/3m^2) or projected yield (13.00 t/ha) and increased the yield by 48.57 percent over absolute control (T_8) followed by FYM (100%) – 20 t/ha (T_1) (Table 23).

Table 22. Effect of fertilizers, FYM and bioagents on the yield of ginger at Kumarganj (Pooled analysis 2006-07 to 2010- 11)

Treatment	Yield q/ha				
	2006-07	2007-08	2008-09	2010-11	Mean
T1= 100 % Recommended dose of fertilizer	3.60	32.3	43.32	42.85	-
T2= 100 % Recommended dose of fertilizer + FYM (20 t/ha) + seed treatment and soil application of *Pseudomonas flourescens* and *Trichoderma* (50 g/m²)	3.90	54.1	45.23	44.52	36.93
T3= 50 % recommended dose of fertilizer + FYM (10 t/ha) + *Azospirillum* (5 kg/ha) + seed treatment and soil application of *P.flourescens* and *Trichoderma* (50 g/m²)	4.70	68.6	62.14	62.37	49.45
T4= 100 % FYM (20 t /ha + *Azospirillum* (5 kg/ha) + seed treatment and soil application of *P. flourescens* and *Trichoderma* (50 g/m²)	4.20	47.1	38.09	37.49	31.72
SEm ±		0.97	3.11	1.55	
CD (P=0.05)		2.89	9.25	4.62	
CV (%)		30.36	11.44	10.99	

Table 23. Effect of nutrient supplementation through organic manure on growth and yield of ginger at Dholi

Treatment	Height of the plant (cm)	No. of tillers per plant	No. of leaves per tiller	Yield per plot (Kg/3m²)	Yield (t/ha)	Increase in yield over control	
						(t/ha)	(%)
T_1	37.86	25.80	18.73	3.76	11.30	2.55	29.14
T_2	37.00	14.26	16.13	3.10	9.30	0.55	6.28
T_3	37.46	14.00	16.86	2.67	8.00	-	-
T_4	37.06	13.46	16.73	2.56	7.60	-	-
T_5	39.46	20.46	16.53	2.93	8.80	0.05	0.57
T_6	38.26	16.73	17.73	3.10	9.30	0.55	6.28
T_7	48.73	30.93	21.53	4.33	13.00	4.25	48.57
T_8	32.26	14.00	15.33	2.91	8.75	-	-
SEM (±)	2.76	1.42	1.24	0.28	0.85	-	
CD (P=0.05)	8.38	4.31	NS	0.85	2.58	-	-
CV (%)	12.42	13.16	12.36	15.30	15.50	-	-

T1= Vermicompost (100%) @ 20t/ha; T2= Vermicompost (100%) @ 5t/ha; T3=FYM (50%) + Vermicompost (50%); T4= FYM (25%) + Vermicompost (75 %); T5= FYM (75%) + Vermicompost (25%); T6= Recommended dose of fertilizer (chemical); T7= Recommended INM package of center; T8= Absolute control (no fertilizer or manure)

At Kumarganj, the recommended dose of fertilizer gave the maximum fresh rhizome yield of 134. 44 t/ha followed by recommended INM package of practices (122.21 t/ha).

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 15-45% in different ginger growing areas of the Himachal Pradesh. Bacterial wilt was found more predominating than soft rot 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 state were found to be associated with bacterial wilt disease caused by *Ralstonia solanacearum*. Bacterial wilt incidence of ginger ranged from 40-60% with mean disease incidence of 50%.

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

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

At Dholi, highest germination (69.50%), survival (65.50%) and lowest bacterial wilt incidence (PDI= 34.50) were recorded in the treatment (T_1), where soil bio-fumigation was done using mustard whereas highest yield (6.00 t/ha) was recorded in the treatment (T_4), where rhizome were treated by endophytic bacterial antagonist (IISR-GEB). Moreover, this treatment was found *at par* with treatment (T_1) in its effect on yield (Table 24).

At Solan, highest germination (95.33%) and minimum incidence of soft rot (2.51%) and leaf spot (7.25%) were obtained in rhizome treatment by metalaxyl + mancozeb followed by mustard biofumigation, though statistically different from each other. However, minimum incidence of bacterial wilt was obtained in mustard biofumigation (2.55%).

Among the five treatments evaluated at Chintapalle, ginger seed material treated with Metalaxyl, Mancozeb 72% W.P (1.25 g/l) recorded a germination count of 35.75 clumps out of 40 rhizomes planted, followed by rhizome treatment with rhizobacterial antagonist (34.50%). Rhizome treatment by Metalaxyl, Mancozeb 72% WP (1.25g/l) recorded lowest soft rot incidence (13.75%) followed by rhizome treatment by rhizobacterial antagonist (19.37%). Highest yield was recorded in case of rhizome treatment by rhizobacterial antagonist (3.14 kg/plot) followed by rhizome treatment by Metalaxyl, Mancozeb 72% WP (1.25g/l) (2.91 kg/ plot) while the control plots yielded 1.86 kg/bed.

Biofumigation using mustard (T_1) was the best treatment against soft rot disease of ginger (6.99% disease) at Pundibari. This treatment is closely followed by rhizome treatment with endophytic bacterial antagonist (T_4) which recorded 7.20% soft rot disease incidence. These two treatments are statistically at par with each other in respect of soft rot disease incidence. T_1 produced highest yield of 12.03 kg/plot followed by T_4 which recorded 11.75 kg /plot yield. Lowest yield of 8.43 kg/plot was obtained by T_5 (Control). Minimum and maximum bacterial wilt disease incidence of 10.05% and 19.43% respectively was recorded in T_1 and T_5 (control) respectively. T_2 recorded lowest leaf spot disease (PDI of 11.25) whereas highest leaf spot disease was found in T_3 (PDI of 17.00). No shoot borer incidence was found.

Table 24. Management of soft rot incidence of ginger at Dholi

Treatment	Germination (%)	Survival (%)	PDI (%)	Yield (kg/3m²)	Yield (t/ha)
T_1	69.50	65.50	34.50 (44.80)	1.79	5.96 (66.02)
T_2	53.00	51.50	42.50 (32.00)	1.51	5.04 (40.39)
T_3	57.00	51.00	44.00 (29.60)	1.39	4.65 (29.53)
T_4	63.50	61.00	39.00 (37.60)	1.80	6.00 (67.13)
T_5	47.50	37.50	62.50	1.08	3.59
CV	4.41	7.48	15.62	9.46	9.47
CD (5%)	3.94	6.14	10.95	0.22	0.74

T1 = Soil treatment by biofumigation using mustard;**T2** =Rhizome treatment by Metalaxyl Mancozeb 72% WP (1.25 g/l of commercial formulation); **T3** = Rhizome treatment by rhizobacterial antagonist (IISR-GRB); **T4** =Rhizome treatment by entophytic bacterial antagonist (IISR-GEB); **T5** =Absolute Control. **Note:** Data within parentheses corresponding PDI & Yield data represent % PDI decrease over control & % yield increase over control respectively.

At Kumarganj, minimum soft rot incidence of 40% was recorded in soil fumigation by mustard followed by 43.5% of soft rot by rhizome treatment with Metalaxyl-Mancozeb 72% WP against incidence of soft rot by 62.25 percent in control. Maximum yield of 27.49 q/ha was recorded in rhizome treatment by rhizobacterial antagonist IISR GRB followed by rhizome treatment with Metalaxyl-Mancozeb 72% WP. In three years pooled data, minimum disease incidence of 43.50% was observed in rhizome treatment by antagonist IISR-GRB with maximum fresh rhizome yield of 27.49 q/ha.

At Raigarh, among all the treatments, T1 (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 (16.72% and 18.39%, respectively as compared to control (40.73%) (Table 25).

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

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

At Dholi, maximum germination (96.50%), plant survival (88.50%), minimum soft rot incidence (PDI= 11.50) and highest yield (8.81 t/ha) were recorded over control in the treatment soil treatment by biofumigation using cabbage (T_1) (Table 26).

Table 25. Effect of biofumigation with mustard, fungicides and bioagents on the incidence of soft rot of ginger at Raigarh

Treatment	Average no. of sprouted rhizome (fifty)	Sprouted rhizomes (%)	Average survival plants/plot	Survival plants(%)	Per cent disease incidence	Average plot yield (kg)	Projected yield (t/ ha)
T_1	39.25	78.5	24.25	61.78	16.72	4.2	8.4
T_2	39.00	78.00	23.25	59.61	18.39	3.7	7.4
T_3	39.50	79.5	18.75	47.46	32.04	2.4	4.8
T_4	39.00	78.00	18.00	46.15	31.85	2.2	4.4
T_5	38.75	77.5	14.25	36.77	40.73	1.3	2.6
CD±at 5%			2.1		1.68		1.34
CV%			9.82		8.74		11.82

Note: T_1 = Soil treatment by biofumigation using cabbage; T_2 = Rhizome treatment by Metalaxyl Mancozeb 72% WP (1.25 g/l); T_3 = Rhizome treatment by rhizobacterial antagonist (IISR-GRB); T_4 = Rhizome treatment by endophytic bacterial antagonist (IISR-GEB); T_5 = Control.

Table 26. Effect of different treatments on soft rot of ginger at Dholi

Treatment	Germination(%)	Survival (%)	PDI (%)	Yield (kg/3m²)	Yield (t/ha)
T_1	96.50	88.50	11.50(80.99)	2.80	8.81(118.61)
T_2	86.50	81.50	18.50(69.42)	2.45	8.15(102.23)
T_3	66.00	59.00	41.00(32.23)	1.75	6.37(58.06)
T_4	74.50	66.50	33.50(44.63)	1.90	6.32(56.82)
T_5	52.50	39.50	60.50	1.21	4.03
CV	4.16	4.27	8.67	5.89	8.95
CD (5%)	4.82	4.41	4.41	0.18	0.93

Note: T_1 = Soil treatment by biofumigation using cabbage; T_2 = Rhizome treatment by Metalaxyl Mancozeb 72% WP (1.25 g/l); T_3 = Rhizome treatment by rhizobacterial antagonist (IISR-GRB); T_4 = Rhizome treatment by endophytic bacterial antagonist (IISR-GEB); T_5 = Control. **Note:** Data within parentheses corresponding PDI & Yield data represent % PDI decrease over control & % yield increase over control respectively.

At Solan, cabbage biofumigation gave highest germination (96.52%), yield (7.762 kg/plot) and minimum incidence of bacterial wilt. However, rhizome treatment by metalaxyl + mancozeb resulted in lowest incidence of soft rot (1.25%) and leaf spot (12.25%).

Among the five treatments, ginger seed material treated with rhizobacterial antagonist recorded germination count of 38.25 clumps out of 40 rhizomes planted followed by rhizome treatment with Metalaxyl, Mancozeb 72% W.P (1.25 g/l) (36.25) at Chintapalle. Rhizome treatment with Metalaxyl, Mancozeb 72% WP (1.25g/l) recorded lowest soft rot incidence (15.62%) followed by rhizome treatment by rhizobacterial antagonist (18.75 %). Highest yield of 2.96 kg/bed was recorded in case of rhizome treatment by metalaxyl, mancozeb 72% WP (1.25g/L) followed by rhizome treatment by rhizobacterial antagonist (2.85 kg/plot) while the control plots yielded 1.20 kg/bed.

Minimum soft rot incidence of 31.5 per cent was recorded on soil fumigation by cabbage (T1) followed by 47.75 per cent of soft rot by rhizome treatment with Metalaxyl-Mancozeb 72% WP (T2) at Kumarganj. Maximum fresh rhizome yield of 25.52 q/ha was recorded in soil fumigation by cabbage followed by 24.15 q/ha in rhizome treatment by rhizobacterial antagonist IISR GRB against 10.87 q/ha in control plots (Table 27).

Among the treatments evaluated at Raigarh, T_2 (rhizome treated by fungicides metalaxyl + mencozeb (72% WP) 1.25 g/liter and T_1 (soil treatment by bio fumigation using cabbage crop) were found effective against the disease and incidence was lowest (17.26 and 20.74 percent respectively) as compared to control (44.54) and gave an yield of 8.2 and 6.8 t/ha respectively.

At Pundibari, biofumigation using cabbage (T_1) is the best treatment in reducing soft rot disease of ginger (7.02% disease). This treatment is closely followed by rhizome treatment with Metalaxyl Mancozeb (T_2) which recorded 8.18% soft rot disease incidence. These two treatments are statistically at par with each other in respect of soft rot disease incidence. T_1 produced highest yield of 10.70 Kg/plot. Leaf spot disease incidence was found lowest in T_2 (13.75 PDI) and highest in T_2 (18.00 PDI). No shoot borer incidence was found.

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

(Dholi, Solan, Pundibari)

At Dholi, all the treatments showed significant effect on all the parameters recorded except reduction in disease incidence where treatments (T_1 & T_2) i.e., soil treatment by bio-fumigation using mustard and bleaching powder was found non-significant. Maximum germination (55.50%), maximum number of plant survived (50.50%) with lowest bacterial wilt incidence (PDI= 49.50) and highest rhizome yield (5.55 t/ha) were recorded over control under the treatment (T_3), where the rhizomes were solarized prior to planting.

Table 27. Effect of biofumigation with cabbage, fungicides and bioagents on incidence of soft rot of ginger at Kumarganj

Treatment	Germination (%)	Soft rot incidence	Yield (q/ha)	Percent disease control of soft root	Percent increase in yield over control
T_1= Soil fumigation using cabbage	63.5	31.50	25.52	48.78	134.77
T_2= Rhizome treatment by metlaxyl-mancozeb 75% W.P.	52.0	47.75	18.92	22.35	74.05
T_3 = Rhizome treatment by antagonist (IISR- GRB)	50.7	47.50	24.15	22.76	122.17
T_4 = Rhizome treatment by endophytic bacteria (IISR- GEB).	56.5	50.50	16.84	17.88	54.92
T_5= Absolute control	46.0	61.50	10.87	-	-
SEm ±	3.5	2.14	0.98		
CD (P= 0.05)	10.9	6.59	3.01		
CV (%)	13.2	8.96	10.10		

Mustard biofumigation resulted in highest germination per cent (97.22%) and yield (8.632 kg/plot), whereas lowest incidence of soft rot (3.25%) and bacterial wilt (2.12%) were recorded after rhizobacterial antagonist treatment at Solan.

At Pundibari, biofumigation using mustard (T_1) was the best treatment in reducing bacterial wilt disease of ginger (6.61% disease). This treatment was closely followed by rhizome treatment with rhizobacterial antagonist (T_4), rhizome treatment endophytic bacterial antagonist (T_5) and soil treatment by bleaching powder which recorded 6.97%, 7.42% and 7.53% bacterial wilt disease incidence respectively. These treatments were statistically at par with each other in respect of bacterial wilt disease incidence. T_1 produced highest yield of 10.35 kg/plot. Lowest yield of 5.63 kg/plot was obtained by T_6 (Control). Minimum and maximum soft rot disease incidence of 9.00% and 18.45% respectively was recorded in T_1 and T_6 (control) respectively. Highest leaf spot incidence was found in T_5 (16.00 PDI). No shoot borer incidence was found.

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

(Dholi, Solan, Ambalavayal, Pottangi, Pundibari)

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 yield where treatment (T2), soil treatment using bleaching powder was found non-significant in its effect over control. In this trial, the crop was found to be affected with only bacterial wilt incidence caused by *Ralstonia sp.* Highest yield (4.50 t/ha), germination (49.00%) and plant survival (47.00%) with lowest bacterial wilt incidence (PDI= 53.00) were recorded over control in the treatment (T_1) where soil treatment by biofumigation using cabbage was done.

At Solan, maximum germination and yield were obtained in cabbage biofumigation followed by rhizobacterial antagonist. Similarly, minimum incidence of soft rot and bacterial wilt were recorded in cabbage biofumigation followed by rhizobacterial antagonist treatment.

At Ambalavayal, there was no significant difference among treatments (soil treatment by biofumigation using cabbage (T_1), soil treatment using bleaching powder@10g/bed (T_2), rhizome treatment by heat (T_3), rhizome treatment by rhizobacterial antagonist (T_4), rhizome treatment by endophytic bacterial antagonist (T_5), absolute control (T_6) in germination percentage. The treatments T_1, T_2, T_3, T_4 and T_5 were on par with no soft rot incidence. The control plot was significantly inferior to other treatments and recorded 2.20% soft rot incidence. The treatments T_1, T_2, T_3, T_4 and T_5 were on par with no bacterial wilt incidence. The control plot was significantly inferior to other treatments and recorded 3.30% soft rot incidence. The treatments T_1, T_2, T_4 and T_5 were on par. The treatment T_5 recorded significantly higher yield than T_3 and T_6.

At Pundibari, biofumigation using cabbage (T_1) was the best treatment in reducing bacterial wilt disease of ginger (6.18% disease). This treatment was closely followed by soil application with bleaching powder (T_2) which recorded 7.45% bacterial wilt disease incidence. These two treatments are statistically at par with each other in respect of bacterial wilt disease incidence. T_1 produced highest yield of 12.13 kg/plot followed by T_2 which recorded 11.10 kg/plot yield. Lowest yield of 7.10 kg/plot was obtained by T_6 (Control). Minimum and maximum soft rot disease incidence of 9.60% and 18.15% respectively was recorded in T_1 and T_6 (control) respectively. Regarding leaf disease, minimum PDI of 10 and maximum PDI of 16.25 was recorded in T_4 and T_2 respectively. No shoot borer incidence was found.

TURMERIC

TUR/CI/1 Genetic Resources

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

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

The turmeric germplasm types maintained at various AICRPS centres are given in Table 28. At Coimbatore, the rhizome yield per plot ranged from 6.55 kg to 35.50 kg/plot. The mean yield recorded by the accessions was 19.26 kg/plot. Three checks were involved in the evaluation *viz*., CL 189 (CO1), CL 1 (BSR 1) and CL 2 (BSR 2). The yield /plot recorded by the checks were 16.700 kg, 13.200 kg and 15.400 kg respectively. Among the 275 lines evaluated 189 lines recorded higher yield than check 1 (CL 189), 253 genotypes recorded higher yield than check 2 (CL 1) and 231 genotypes recorded higher yield than Check 3 (CL 3). Out of 275 lines evaluated 140 lines recorded a higher yield than the mean yield of all the genotypes.

Ninety seven germplasm of turmeric were collected and evaluated for promising line with respect of yield at Dholi. Out of ninety seven germplasm, only ten accessions namely RH-24, RH-17, NDH-90, RH-408, RH-413, RH-412, RH-9/90, RH-409, RH-401 and RH-410 gave the maximum yield ranging from (38.00 kg to 31.00 kg/7.2m^2) as compared to high yielding variety RH-5 (30.00 kg/7.2m^2) and Rajendra Sonia (25.00 kg/7.2m^2). Among the ten promising accessions, RH-24 gave the maximum yield (38.00 kg/7.2m^2) followed by RH-17 (36.00 kg/7.2m^2).

During the year 2010-11, among the all germplasm lines tested, CLI-317 recorded highest rhizome yield (10.934 kg/3 sq. m) followed by No.5 (10.69 kg/3 sq. m) at Kammarpally.

At Kumarganj, 139 germplasm were sown in the field and evaluated. Among the 29 early maturing germplasm, NDH-79 gave highest yield of 362.10 q/ha of fresh rhizome yield followed by 352.47 q/ha in NDH-74.Evaluation of 74 medium maturing germplasm ,NDH-98 gave maximum fresh rhizome yield of 421.60 q /ha followed by NDH-18 (Narendra Haldi –1) yielding 335.20q /ha of fresh rhizomes. Among 36 late maturing varieties NDH-8 gave maximum fresh yield of 375.0 q/ha followed by 357.15 q/ha in NDH-7.

Forty two entries of turmeric were evaluated at Raigarh station for yield and its attributing characters along with the check Prabha during Kharif 2010-11. Among the entries, IT-8 (16.08 t/ha), IT-3 (13.10t/ha), IT-9 (14.24 t/ha), IT-41 (13.20 t/ha) and IT-38 (11.96 t/ha) were found significantly superior over the check Prabha (8.04 t/ha) in respect to yield.

Thirty five diverse genotypes of turmeric were collected from entire NE region and evaluated at the centre. Genotypes were evaluated in Randomized Block Design with three replications. Maximum fresh rhizome yield (16.75 kg/3m^2 and 55.82 t/ha) recorded in genotype CHFT-8 followed by genotype CHFT-22, CHFT-30 (12.21 kg/3m^2 and 40.71 t/ha) and CHFT-36 (11.66 kg/3m^2 and 38.85 t/ha) while lowest rhizome yield (4.16 kg/3m^2 and 13.87 t/ha) recorded in genotype CHFT-16. Genotypes CHFT-8, CHFT-22, CHFT-30 and CHFT-36 were significantly higher yielder as compared to local check Megha Turmeric-1 (9.41 kg/plot and 31.37 t/ha). These genotypes would be

Table 28. Turmeric germplasm collections in AICRPS centres

Centre	Indigenous		Total
	Cultivated	Wild and related sp.	
Coimbatore	277	7	284
Dholi	95	2	97
Kammarpally	298	-	298
Kumarganj	142	-	142
Pantnagar	20	-	20
Phasighat	45	2	47
Pottangi	199	-	199
Pundibari	152	18	170
Raigarh	42	-	42
Solan	131	-	131
Total	1401	29	1430

further evaluated in replicated yield trial in future..

A total of 185 turmeric germplasm were grown together for evaluation at Pundibari centre. TCP-20 was found to be the tallest culture (179.90 cm) where as TCP-40 was the dwarfest (53.83 cm). TCP-171 (4.67) recorded highest number of tillers. Similarly, highest numbers of leaves were found in TCP-28 (10.67) where as lowest numbers of leaves were found in genotype TCP-66 (6.00). Maximum pseudostem girth was recorded in TCP-20 (15.43 cm) whereas lowest pseudostem girth was recorded in genotype TCP-164 (5.97 cm). Longest leaf was found in genotype TCP-20 (85.70 cm), whereas shortest leaf was found in TCP-77 (35:73 cm) TCP-41 (8.93 cm). Rhizome yield of individual plant (clump weight) was maximum in TCP-137 (715.00 g). Considering plot yield and projected yield TCP-137 (54.43 tons/ha), TCP-168, TCP-176 (46.37 tons/ha) recorded significantly higher rhizome yield. A total of 14 genotypes out yielded the local check TCP-2 (30.24 t/ha).

TUR/CI/2 Coordinated varietal trial

TUR/CI/2.3 CVT 2009-Series VIII

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

At Chintapalle, among the 7 varieties evaluated for morphological characters, maximum plant height was recorded in TCP-129 (57.3 cm) followed by RH-50 and TCP-70. Maximum leaf area was recorded in TCP-129 followed by TCP-70. Maximum rhizome yield per plant was obtained in RH-80 (507/plant) followed by RH-50 (476 g/plant) and lowest values were recorded in Chintapalle local (177 g/plant). Maximum fresh rhizome yield was recorded in RH-80 (28.01 t/ha) followed by RH-50 (27.31 t/ha) and lowest yield were recorded in RH 13/90 (11.99 t/ha). Among the 7 genotypes evaluated, maximum dry recovery was observed in TCP-129 (25.8 %) followed by TCP-70 (23.9 %). Very low recovery % was observed in RH-50 (15.2 %). Maximum dry yield was recorded in RH-80 (5.4 t/ha) followed by TCP-129 and TCP-70 (5.1 t/ha) and lowest dry yield recorded in RH 13/90 i.e., 2.13 t/ha.

At Kammarpally, out of the seven genotypes tested, RH 9/90 has recorded more fresh rhizome yield (19.77 t/ha) followed by TCP-17 and (19.71 t/ha) and TCP-129 (19.71 t/ha) in comparison to the Duggirala Red (17.45 t/ha).

At Dholi, RH-5 was found superior over Rajendra Sonia regarding yield and yield parameters. Among all the entries and check, none of the entries was found significantly superior over local check Rajendra Haldi-5 regarding height of the plant, number of tillers per plant, number of leaves per tiller and yield per plot (kg/3m^2) and projected yield (t/ha). However, TCP-129 was a late maturing genotype (244.66 days) as compared to other genotypes and local check variety RH-5 and Rajendra Sonia. Minimum number of days (216.66 days) was taken by Rajendra Sonia.

Six genotypes (RH-9/90, RH-13/90, RH-80, RH-50 from Dholi and TCP-129, TCP-17 from Pundibari) along with two local checks (BSR 2 and CL 101) were evaluated at Coimbatore. The yield varied from 4.25 kg/plot to 16.0 kg/plot. The highest yield was recorded by CL-101(16.0 kg/plot) followed by BSR-2 (13.25 kg/plot.)

At Kumarganj, out of eight entries maximum yield of 309.99 q/ha was recorded in RH-80. Among the entries, maximum yield of 304.44 q /ha was recorded in TCP-70.

Analysis of data showed that TCP-129 recorded maximum plant height (112.54 cm) followed by TCP-70 (109.89 cm). TCP-2 recorded the lowest plant height (82.11 cm). TCP-2 showed the highest mean value for number of tillers/plant (2.67) while RH-80 recorded the lowest (2.11). In respect of number of leaves/plant, TCP-129 recorded the highest (8.89) and RH-13/90 recorded the lowest (7.67). For pseudostem girth, RH-9/90 recorded the highest (14.14 cm) while RH-13/90 showed the lowest (7.37 cm). In respect of leaf length, TCP-129 recorded the highest length (57.34 cm) and Rh-13/90 recorded the lowest (40.82 cm). TCP-129 recorded highest leaf breadth (13.09 cm) where as TCP-2 recorded lowest (9.78 cm). A wide range of variability was found among the genotypes for different yield characters. The highest mean value for clump weight/plant was recorded by TCP-129 (216.78 g) while RH-13/90 showed the lowest value for that trait (167.89 g). In respect of plot yield (kg/3m^2) and the projected yield (t/ha), TCP-70 recorded the highest mean value (7.48 kg and 15.08 t/ha, respectively), closely followed by TCP-2 (6.94 kg and 13.98 t/ha, respectively); the

genotype TCP-70 out yielded TCP-2, the local check.

Six genotypes of turmeric namely, RH-9/90, RH-13/90, RH-80, RH-50, TCP-129 and TCP-70 were received from different coodinating centres and evaluated in Randomized Block Design with three replication along with Local Check Megha Turmeric-1 during 2010-11 at Pasighat, Arunachal Pradedh. The mean values of growth and yield parameters of seven genotypes showed that genotype RH-13/90 recorded maximum plant height (91.77 cm) followed by TCP-129 (87.86 cm) while lowest plant height was recorded in TCP-70 (76.41cm). Genotype RH-9/90 produced maximum number of tillers (4.93) followed by RH-50 (3.73) where as least number of tillers was recorded in TCP-129 and Megha Turmeric-1(3.20). Number of leaves per tiller was highest in Megha Turmeric-1(11.33) followed by TCP-70 (10.67) where as lowest number of leaves per tiller was recorded in RH-13/90 (8.93). Highest fresh rhizome yield was recorded by RH-80 (11.50 kg/3m^2 and 38.40 t/ha) followed by RH-13/90 (9.84 kg/3m^2 and 32.8 t/ha) and RH-50 (9.49 kg/3m^2 and 31.64 t/ha). Out of these three genotypes only RH-50 gave significantly higher yield as compared with local check Megha Turmeric-1(9.41 kg/3m^2 and 31.37 t/ha). In terms of quality parameters RH-50 recorded the highest dry recovery (21.93%) while RH-13/90 had lowest dry recovery (19.32%). Highest curcumin content was observed in Megha Turmeric-1 (7.28%) where as least curcumin content was recorded in TCP-70 (4.59%). Maximum oleoresins content was recorded in RH-80 (11.54%) while Megha Turmeric-1 gave maximum essential oil content (6.26%).

The significant differences were observed for all the character except number of leaves per plant and number of days to maturity at Pantnagar. Maximum seed yield (26.97 t/ha) was recorded for RH-13/90, followed by local check Pant Pitabh (25.08 t/ha) and RH-9/90 (24.98 t/ha).

Six entries were evaluated under coordinated varietal trial during 2010-11 crop season with local check TCP-2 (Suranjana) at Raigarh. The entry TCP-70 was found the best which produced 15.63 t/ha yield and is significantly superior over the check.

Eight genotypes of turmeric including NVST-37 and Kesar as standard checks were evaluated in Randomized Block Design with three replications at Navsari. Significant differences existed among genotypes for the traits like green rhizome yield, breadth of rhizome, fingers/rhizome and weight of rhizome. NVST-37 recorded the highest rhizome yield (42.11 t/ha) followed by Kesar (25.56 t/ha) and TCP-70 (16.11 t/ha).

TUR/CI/3.2 Initial Evaluation Trial 2006

(Kumarganj, Pottangi & Pundibari)

Highest fresh rhizome yield of 333.33 q/ha was recorded in NDH-8 at Kumarganj, followed by fresh rhizome yield of 326.66 q/ha in NDH-7

Analysis of data at Pundibari, showed that TCP-57 recorded maximum plant height (109.71 cm) followed by TCP-128-1 (108.40 cm). ABN-01 recorded the lowest plant height (80.21 cm). ABN-01 showed the highest mean value for number of tillers/plant (3.22) while TCP-57 recorded the lowest (1.78). In respect of number of leaves/plant, TCP-54 recorded the highest (9.22) and TCP-97 recorded the lowest (7.89). For pseudostem girth, TCP-57 recorded the highest (13.99 cm) while TCP-139 showed the lowest (7.58 cm). In respect of leaf length, TCP-57 recorded the highest length (55.98 cm) and ABN-01 recorded the lowest (36.27 cm). TCP-139 recorded highest leaf breadth (13.14 cm) where as TCP-2 recorded lowest (9.93 cm). In respect of the trait weight of mother clump, TCP-64 recorded the highest value (109.45 g) and TCP-2 showed the lowest value for that trait (29.11 g). TCP-11 showed the highest value (7.13 cm) for the trait length of mother clump where as TCP-97 showed the lowest value (4.95 cm). In respect of number of clumps per mother rhizome, TCP-64 showed the highest and TCP-119 lowest value (2.22 and 1.00 respectively). In the trait number of primary fingers, TCP-64 recorded highest value (9.22) whereas TCP-2 recorded lowest value (4.45). TCP-129 achieved the highest weight of primary fingers (140.89 g) and TCP-140 showed the lowest value for the trait (74.00 g). In respect of length of primary fingers TCP-97 recorded the highest length of (11.52 cm) and TCP -2 recorded the lowest length (5.42 cm). TCP-64 showed the highest value and TCP-54 showed the lowest value (25.45 and 8.22 respectively) for the trait number of secondary fingers. In respect, weight of secondary fingers, TCP-64 recorded the highest weight (126.11 g) and TCP-54 lowest weight (26.33 g). TCP-160 showed the highest length of secondary fingers (5.89 cm) and TCP-2 showed the lowest length (3.82 cm) for that trait. The highest mean value for clump weight/plant was recorded by TCP-64 (382.22 g) while TCP-140 showed the

lowest value for that trait (137.33 g). In respect of plot yield (kg/3m^2) and the projected yield (t/ha), TCP-64 recorded the highest mean value (9.80 kg and 15.19 t/ha, respectively), closely followed by TCP-107 (6.83 kg and 12.43 t/ha, respectively); both the genotypes out yielded TCP-2, the local check.

TUR/CI/3.3 Initial Evaluation Trial 2010

(Pantnagar)

Ten genotypes of turmeric have been evaluated in RBD along with 2 checks at Pantnagar. Nine genotypes were at par regarding rhizome yield. However, genotype PT-5 yielded highest rhizome yield (38.27 t/ha) followed by PT-9 (37.60 t/ha).

TUR/C1/3.4 Initial Evaluation Trial 2009

(Dholi)

Sixteen genotype along with two checks RH-5 and Rajendra Sonia were tested for obtaining higher yield and quality of turmeric during 2010-2011 at Dholi. All the genotypes were found non-significant regarding yield and yield parameters. Among the genotypes and check, RH-17 gave the maximum yield 67.52 t/ha.

TUR/CI/3.5 Quality evaluation trial
TUR/CI/3.6 Genotype x Environmental interaction on quality

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

The experiment was conducted for three consecutive years from 2008-09 to 2010-11 at Dholi. Among the high yielding varieties of different state of India, Rajendra Sonia variety of Bihar gave the maximum projected yield (67.58 t/ha) followed by Narendra Haldi-1 (Variety of U.P) *i.e.*, projected yield (50.04 t/ha) and minimum projected yield (29.51 & 29.79 t/ha) was recorded with IISR Alleppy Supreme and IISR Kedaram respectively. But minimum percentage of dry recovery (25.90%) was observed in IISR-Alleppy Supreme followed by Roma (25.80%) and minimum dry recovery percentage was recorded in Rajendra Sonia (20.26%). However, among the varieties, all the varieties were significantly superior over Rajendra Sonia, Narendra Haldi-1 and BSR-2 regarding dry recovering percentage. However, IISR-Alleppy Supreme gave the maximum dry recovering percentage (25.90%) followed by Roma (25.80%) and minimum dry recovery percentage was found in Rajendra Sonia (20.26%).

Among the 12 varieties evaluated at Chintapalle, Roma recorded the maximum plant height (131.6 cm) followed by Rasmi (119.3 cm), IISR-Pratibha (113 cm), IISR Alleppy Supreme (113 cm) and Kedaram (113 cm). Maximum number of tillers were observed in case of Roma (4.6) and Rajendra Sonia (4 no). Roma (1116 sq.cm) recorded the maximum leaf area followed by Rasmi (919 sq, cm). In terms of quality parameters, Rajendra Sonia (576 g/plant) recorded the highest yield per plant, followed by Suranjana (543 g/plant). Highest yield recorded in Rajendra Sonia (36.3 t/ha) followed by Roma and Suranjana on par with each other in terms of fresh rhizome yield (32 t/ha). Whereas lowest yields recorded in case of Suranjana (14.2 t/ha). Maximum dry recovery observed in IISR-Pratibha (28.09%) followed by Mega turmeric,

Table 29. Yield observations in different varieties (G x E) during 2008-11 at Kumarganj

Entries	Yield (q/ha)				Per cent increase in yield over Narendra Haldi-1
	2008-09	2009-10	2010-11	Mean	
Rajendra Sonia	271.10	274.44	278.78	274.77	1.73
BSR-2	284.44	285.55	290.00	286.66	2.51
Suranjana TCP-2)	269.44	271.11	275.55	271.92	-
IISR-Kediram	261.66	262.22	269.99	264.62	-
IISR-Pratibha	207.77	212.22	225.55	215.18	-
IISR-Alleppy	219.44	218.89	228.88	222.40	-
Roma	266.66	268.86	275.55	270.35	-
Rasmi	269.33	271.09	277.77	272.73	-
Megha turmeric-1	253.88	254.44	266.11	258.14	-
CLI-317	189.99	201.11	213.23	201.47	-
Narendra haldi -1	273.33	272.22	293.33	279.62	-
SEM±	6.61	5.45	4.8		
CD (0.05)	19.51	16.10	14.23		
CV(%)	4.55	3.72	3.18		

Kedaram, Alleppy Supreme, Roma and Rasmi (26-27 %). Very low recovery % was obtained in BSR-2 (11.2 %). Maximum dryyield was reported in Roma (8.6 t/ha) followed by Mega turmeric (6.3 t/ha). NH-1, BSR-2, Rajendra Sonia, Suranjana and Chintapalle local having only 7 months duration.

At Kammarpally, among the eleven genotypes tested Suranjana recorded the highest fresh rhizome yield (21.27 t/ha) followed by CLI-317 (20.17 t/ha), and lowest yield was observed in Alleppy Supreme (17.53 t/ha).

Highest yield of fresh rhizome (293.33 q/ha) was recorded in NDH- 18 (Narendra Haldi-1) followed by BSR-2 (290.00 q/ha) at Kumarganj. None of the entries were superior over the check. BSR-2 also showed maximum increase of 2.51% in yield over the check (Table 29).

The genotype, Narendra Haldi-1 (118.96 cm) achieved highest plant height followed by IISR Kedaram (116.50 cm) at Pundibari white Rajendra Sonia was the shortest (83.06 cm). Highest tiller number was recorded by the genotype Roma (3.34) where as lowest by Megha Turmeric (2.22). IISR Alleppy Supreme showed the highest number of leaves (9.78). Rajendra Sonia recorded the lowest number of leaves (6.35). IISR Kedaram showed the highest clump weight (397.22 g) followed by Rasmi (323.89 g) and Rajendra Sonia recorded the lowest clump weight (149.33 g). Highest rhizome yield per plot was recorded by TCP-2 (11.77 Kg) followed by Narendra Haldi-1 (10.94 Kg) and the lowest value was recorded by IISR Kedaram (6.62 Kg). In respect to projected yield TCP-2 showed the highest value (23.73 t/ha) followed by Narendra Haldi-1 (22.05 t/ha) and lowest projected yield was recorded in IISR Kedaram (13.33 t/ha).

A total of eleven turmeric genotypes obtained from different Coordinating centres were evaluated during the year 2010-11 at Coimbatore. The rhizome yield of genotypes varied from 15.43 kg per plot (Suranjana) to 21.43 kg per plot (Duggirala) and 21.07 kg per plot (IISR Prathiba). The evaluation of genotypes for quality parameters is in progress.

In order to study the interaction of Genotype and Environment (GXE) on growth and quality characters, ten different varieties/genotypes of turmeric were evaluated at Barapani. BSR-2 produced the heaviest rhizomes per plant (716.67 g /plant) followed by Roma (533.33g/plant). Maximum yield was recorded in BSR-2 (32.22 t/ha) closely followed by RCT-1 (29.44 t/ha) and Kedaram (28.88t/ha). Dry matter recovery was highest in RCT-1 (22.02%) closely followed by Kedaram (21.83% each) and Rasmi (20.05%) while lowest recovery (12.70%) was in Narendra Haldi. Highest curcumin content was recorded in Megha Turmeric-1 (7.22%) while BSR-2 had lowest curcumin (3.70%) (Table 30).

Maximum yield was recorded for Narendra Haldi-1 followed by Suranjana, RCT-1, IISR Alleppy Supreme, BSR-2 and IISR Kedaram at Mizoram. Moreover, dry matter content was found to be highest in IISR Kedaram followed by Rashmi, IISR Pratibha, RCT-1 and Duggirala. The incidence of leaf spot was more acute than leaf blotch. The incidence of both diseases, leaf spot and leaf blotch,

Table 30. Morphological and quality parameters of turmeric under G x E at Barapani

Genotype	Plant height (cm)	Leaf area (cm)		Stem diameter (mm)	No. of tiller	No. of leaves	Yield/ plant (g)	Yield/ plot (kg)	Yield t/ha	Dry matter (%)	Curcumin content (%)
		Length	Breadth								
BSR-2	107.69	58.11	17.69	36.54	3.78	18.00	716.67	9.67	32.22	17.37	3.70
Rajendra Sonia	98.87	48.20	12.93	32.90	3.00	17.00	383.33	6.17	20.55	13.41	6.17
Alleppy Supreme	108.20	56.47	16.90	29.93	3.61	21.00	383.33	6.83	22.77	17.46	6.26
Narendra Haldi	100.43	49.50	14.87	27.35	2.50	17.33	383.33	6.17	20.55	12.70	6.17
Roma	106.73	57.53	17.62	35.01	3.67	21.00	533.33	7.00	23.33	19.85	6.84
Rasmi	112.70	59.20	17.13	28.62	4.83	20.67	300.00	8.00	26.66	20.05	5.00
Suranjana	98.80	54.03	15.23	30.11	2.77	16.67	466.67	7.58	25.68	15.10	5.12
Pratibha	110.87	57.17	16.90	32.96	3.83	21.67	416.67	6.17	20.55	18.32	6.86
Kedaram	120.03	58.93	17.37	36.38	4.33	26.33	433.33	8.67	28.88	21.83	6.35
RCT-1	115.50	58.43	18.12	34.25	3.33	19.00	500.00	8.83	29.44	22.02	7.22
SEm	3.82	3.05	0.86	1.85	0.66	2.04	20.33	0.68	2.28	1.07	0.20
CD (5%)	11.45	9.14	2.58	5.54	1.97	6.10	60.90	2.05	6.84	3.20	0.59

were noticed during September-October 2010. There is great loss in yield (4-85%) due to rhizome rot in various varieties over 2008-09 crop due to high rainfall, especially during maturity (November-December).

Among the entries evaluated at Raigarh, Suranjana found maximum Yielder variety 21.49 (t/ha) and found moderate resistant reaction against both the disease.

TUR/CI/4 Quality Evaluation

TUR/CI/4.1 Quality evaluation of germplasm

(Coimbatore)

34 turmeric germplasm lines were screened for yield and quality parameters at Coimbatore. All the genotypes recorded more than 25.0 kg per plot. The evaluation for quality parameters is in progress.

Twenty seven entries of turmeric obtained from other centres at Solan during 2010-11 were evaluated for quality parameters like curcumin content, oleoresin and essential oil. In twenty seven entries curcumin contents ranged from 2.48% (BSR-2) to 4.56% (IET RH-406). Oleoresin content varied from 6.70% (Pratibha) to 13.86% (IET RH-17). The essential oil contents varied from 3.75% (Pratibha) to 7.00% (IET RH-17, RH-401, RH-406, RH-410 and RH-411). Samples of ginger were not received from other AICRPS centers for quality analysis during 2010-11.

TUR/CM/5 Nutrient Management Trial

TUR/CM/5.2 Effect of organic farming in turmeric

(Dholi & Raigarh)

Maximum yield was obtained when integrated nutrient (organic + inorganic) gave maximum yield 20.50 t/ha at Raigarh.

TUR/CM/5.7 Standardization of fertigation in turmeric

(Coimbatore, Jagtial)

The trial was laid out for second year during 2010-11 with seven treatments at Coimbatore. Significant variation was observed between the treatments for growth and yield parameters. The plot yield of turmeric rhizome varied from 29.53 kg/10 m^2 plot (T1- Control -100% recommended dose of fertilizers (RDF) (NPK @ 150:60:108 kg/ha) through conventional method of application – (No drip) to 53.02 kg/plot (T2-100% RDF through drip –weekly once).

At Kammarpally, 100% RDF through drip, weekly once, recorded highest rhizome yield (23.14 t/ha) followed by 75% RDF through drip, weekly once treatment (22.66 t/ha) where as 50% RDF through drip- fortnightly once recorded lowest rhizome yield (20.59 t/ha).

TUR/CM/5.8 Effect of micronutrients on turmeric

(Dholi, Kumarganj, Pundibari)

At Dholi, among three doses of application *viz.*, zero level (Control), soil application of micro-nutrients @ 25 kg/ha and two foliar spray of micro-nutrients @ 0.5% at 60 and 90 days after sowing, soil application and foliar spray of micro-nutrients were found significant regarding all the characters as compared to control (Zero application) except height of the plant. However, soil application of micro-nutrients @ 25 kg/ha was recorded at par with two foliar applications of micro-nutrients @ 0.5% at 60 and 90 days after sowing regarding yield and yield attributing characters. Soil application of micro-nutrients @ 25 kg ha^{-1} gave the maximum number of branches per plant (4.15), number of leaves (11.75), area of leaves (734.23 cm^2), number of plants per plot (40.00 kg/$3m^2$) dry mater production (1.70 kg/$3m^2$), yield per plot (20.52 kg/$3m^2$) and projected yield (58.15 t/ha^{-1}) followed by two foliar application of micro-nutrients @ 0.5% at 60 and 90 days after sowing i.e., number of tiller per plant (3.93), number of leaves (11.42), area of leaves (683.75 cm^2), number of plant per plot (40.29 kg /$3m^2$), dry mater production (1.69 kg/$3m^2$) and projected yield (57.49 t/ha-1). Interaction effect of micro-nutrients and doses of application *i.e.*, soil application @ 25 kg/ha as well as foliar application of micro-nutrients @ 0.5% at 60 & 90 days after sowing were found non-significant regarding yield and yield attributing characters.

Maximum yield of 299.9 q/ha turmeric fresh rhizomes were recorded in soil application of zinc @25 kg/ha among all the treatments followed by 288.88 q /ha in foliar spray of iron (Fe_2SO_4) @ (0.5%) at 60 & 90 DAS at Kumarganj.

Analysis of data showed that soil application of boron (T_2) recorded maximum plant height (96.33 cm) at Pundibari. Soil application of iron (T_4) showed the highest mean value for number of tillers/plant (3.56). In respect of number of leaves/plant, soil application of boron (T_2) recorded

the highest (8.44). In respect of leaf length, soil application of boron (T_2) recorded the highest length (44.78 cm). Soil application of boron (T_2) recorded highest leaf breadth (11.09 cm). In respect of plant population 30 days after planting foliar spray of Boron (T_8) showed the highest mean value (40.00). A wide range of variability was found among the treatments for different yield characters. In respect of weight of mother clump, foliar spray of boron (T_8) recorded the highest value (64.22 g). Foliar spray of iron (T_7) achieved the highest weight of primary fingers (153.56 g). In respect, weight of secondary fingers, foliar spray of zinc (T_9) recorded the highest weight (144.33 g). In respect of plot yield (kg/3m^2) and the projected yield (t/ha), soil application of boron (T_2) recorded the highest mean value of 10.17 kg and 20.50 t/ha, respectively. Soil application of iron (T_4) recorded highest value for dry recovery of rhizome (18.50%) and curcumin level (5.80%).

TUR/CM/5.9 Standardization of processing in turmeric

(Calicut, Coimbatore)

Experiments on curing of turmeric (variety Prathiba) were done during April 2010 by improved steam boiling and conventional water boiling methods at Calicut. Cured turmeric was dried in cemented yard and the maximum ambient temperature obtained during the day was 38°C. Turmeric cured by traditional water boiling method for 40, 60, 90 min, took 11 days for drying while turmeric cured in improved water boiler for 60, 45 and 30 min took 12, 23 and 24 days. Maximum retention of curcumin (5.91%) and essential oil (3.6%) was obtained for rhizomes cured by water boiling method for 40 min. Increase in curing time resulted in significant reduction in curcumin, starch, essential oil and oleoresin content. Slicing of rhizomes to 5 mm thickness and drying without curing, significantly reduced the drying time (9 days). However there was significant reduction in quality in terms of curcumin (5.71%) and essential oil (3.07%) contents.

The trial was conducted for the second year during 2010-11 with eight treatments at Coimbatore. In all the eight treatments the initial weight of the sample taken for the experiment is 2.0 kg. The trial is in progress.

TUR/CM/5.11 Mechanical harvesting in turmeric (Observational trial)

(Coimbatore)

An observational trial on mechanical harvesting in turmeric was conducted for the second during 2010-11 with four treatments at Coimbatore. The time taken by the tractor mounted harvester is less when compared to power tiller mounted harvester. The trial is in progress.

TUR/CP/5 Disease Management Trial

TUR/CP/5.1 Survey and identification of disease causing organisms in turmeric and screening of turmeric germplasm against diseases

(Coimbatore, Pundibari, Raigarh & Dholi)

A field survey on turmeric diseases was conducted in different turmeric growing districts of Tamil Nadu *viz.,* Coimbatore, Erode, Salem, Namakkal and Tiruppur districts during 2010-2011. In Coimbatore district, totally 11 places were surveyed with different cropping pattern. In the case of leaf spot, the maximum intensity was noticed at Mettupalayam (54.20 PDI) and the minimum intensity was recorded at Thennamanallur (28.20PDI). For the leaf blotch, the maximum intensity of 28.32 PDI was noticed at Narasipuram and minimum at Sundarapuri (12.03 PDI). The rhizome rot incidence ranged from 8.00-16.00 %. In Erode district, totally 17 places were surveyed with different cropping pattern. Among the places surveyed, the maximum leaf spot intensity of 56.60 PDI was recorded at Palaiyur and minimum at Ganapathypalayam (28.00 PDI). The leaf blotch intensity was maximum (36.00 PDI) at Kasipalayam and minimum at Ganapathypalayam (14.0 PDI). The rhizome rot incidence ranged from 10.00 to 30.00 %. The maximum rot incidence was observed at Palaiyur (30%). In Salem district, totally 5 places were surveyed. The maximum leaf spot intensity of 48.32 PDI was recorded at Manakadu and the minimum intensity was recorded at Vazhapadi (32.20 PDI). The leaf blotch intensity was maximum at Yethapur (26.67 PDI) and minimum at Selliyampalayam (20.21 PDI). The rhizome rot incidence ranged from 10.00-12.00%. In Namakkal ditrict, the maximum leaf spot intensity was observed at Rasipuram (42.30 PDI) and minimum at Nasianur (28.32 PDI). The leaf blotch intensity was minimum at Nasianur (18.67 PDI) and maximum at Rasipuram (24.67 PDI). In Tiruppur district, maximum leaf spot intensity of 44.00 PDI was observed at Thekkalur and minimum at Perumanallur (28.20 PDI). In the case of leaf blotch, the maximum intensity of 63.13

PDI was observed at Kunnathur and minimum at Thekkalur (24.60 PDI). The rhizome rot incidence ranged from 10.0 to 12.00 %. 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.

A survey was conducted 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 asses the severity of different diseases of turmeric in this area. 12 well distributed locations within those places were selected for the survey. In each location the survey was done in at least 2 different places. 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 II block (average 36.08%) followed by Coochbehar I block (average 32.07%) and Dinhata (average 29.89%). Regarding leaf spot of turmeric it was found that disease severity is highest in Coochbehar II block (average 40%) which is followed by Coochbehar I block (average 35.13%) and Dinhata (average 32.11%). 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, 4, 5, 7, 12, 20, 25, 34, 55, 62, 70, 88, 96, 111, 126, 135, 172, 186, 200, 211, 235, etc. and moderately resistant germplasm (PDI ranging from 11 – 20) are TCP 8, 36, 50, 67, 74, 95, 124, 149, 202, 234, etc. The germplasm found to be resistant (PDI ranging from 1 – 10) against leaf spot disease are TCP 3, 14, 24, 63, 93, 101, 115, 130, 165, 176, 186, 200, 202, 234, 265, etc. whereas moderately resistant germplasm (PDI ranging from 11 – 20) against this disease are TCP 2, 7, 14, 28, 63, 71, 121, 137, 168, 90, 177, 226, 232, 245, 266, 270, etc.

At Dholi, the turmeric crops cultivated by farmer were found to be affected by leaf spot caused by *Colletotrichum capsici* in Vaishali district of Bihar. *Colletorichum* leaf spot incidence of turmeric was found 15 to 45% with mean disease incidence of 24%. Among 97germplasm of turmeric screened against the disease under natural condition, 29 and 38 numbers of germplasm were found to be resistant and moderately resistant against *Taphrina* leaf spot respectively.

TUR/CP/5.2 Management of foliar disease of turmeric

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

An experiment was conducted to access the effect of rhizome treatment and spray of standing crop at different days of interval with different fungicides against foliar disease. For leaf spot disease caused by *Taphrina maculans,* all the treatments gave significant effect on all the parameters recorded and analyzed over control except germination of rhizome, where treatments (T_5, T_6 & T_7) i.e., Foliar spray with Hexaconazole (0.1%), Propiconazole (0.1%)and Tricyclazole (0.1%) was done at 45 and 90 DAP. Highest rhizome germination (99.33%) was recorded in treatment (T_1), where rhizome treatment as well as foliar spray was done with Hexaconazole (0.1%) at 45 and 90 DAP. Highest yield (43.70 t/ha) with lowest leaf spot incidence (PDI= 6.66) were recorded in treatment (T_8), where foliar spray of crop was done by Carbanzim + Mancozeb (0.1%) at 45 and 90 DAP.

Among the treatments, 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 (60.58%) followed by fhizome treatment with carbendazim + mancozeb (0.1%) + foliar spray of carbendazim + mancozeb (0.1%) on 45 and 90 DAP in case of leaf spot.(57.42 %). 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 (60.45 %) followed by foliar spray of carbendazim + mancozeb (0.1%) on 45 and 90 DAP (50.35%).

Minimum incidence of leaf blotch disease (17.84 %, PDI) was recorded in rhizome treatment with hexaconazole (0.1%) + foliar spray with hexaconazole (0.1%) on 45 and 90 DAS followed leaf blotch incidence of 22.06 % foliar spray of carbendazim + mancozeb (0.1%) on 45 and 90 DAS against the control of 32.0 % at Kumarganj. Minimum incidence of Leaf spot was observed by rhizome treatment and foliar spray of propaconazole (0.1%) at 45 & 90 DAS followed by

16.22 % of leaf spot in rhizome treatment with tricyclazole (0.1%) and foliar spray of tricyclazole (0.1%) at 45 & 90 DAS against control values of 30.00. rhizome treatment with carbendazim + mancozeb (0.1%) on 45 and 90 DAS was at par with tricyclazole (0.1%) treatment. Maximum fresh rhizome yield of 378.88 was recorded in foliar spray of tricyclazole (0.1%) at 45 And 90 DAS. Fresh yield recorded in rhizome treatment with Hexaconazole (0.1%) and foliar spray with hexaconazole at 45 and 90 DAS was at par with tricyclazole treatment.Observation on three years pooled data shows that minimum leaf spot disease was 17. 39 per cent in seed treatment and foliar spray with hexaconazole (0.1%) on 45 and 90 days followed by 20.06 % in foliar spray with Carbendazim and mancozeb (0.1%) on 45 and 90 DAS. Minimum leaf spot diseases of 10.86 per cent were recorded in seed treatment and foliar spray with Propaconazole (0.1%) on 45 and 90 days. Maximum yield of 261.65 q/ha in seed treatment and foliar spray with Hexaconazole (0.1%) on 45 and 90 days. Yield observed in foliar spray with Tricyclazole (0.1%) on 45 and 90 DAS was at par with above treatment.

Rhizome treatment as well as foliar spray with Carbendazim + Mancozeb at 45 and 90 days after planting (T_4) was found to be the best treatment for controlling both leaf blotch and leaf spot disease of turmeric at Pundibari. This treatment was closely followed by rhizome treatment as well as foliar spray with propiconazole (T_2) and 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_2 produced lowest percent disease index of 22.63 and 27.74 in case of leaf blotch and leaf spot respectively. This treatment also produced the highest yield of 9.40 Kg/plot (18.95 t/ha) among all the treatments.

No significant effect of fungicides on rhizome germination and significant effect on disease index and yield were observed at Kammarpally. Rhizomes treated with carbedazim + mancozeb (0.1%) + foliar spray of carbedazim + mancozeb (0.1%) on 45 and 90 recorded the highest germination (89.30%) which was followed by propiconazole (0.1% + foliar spray of propiconazole (0.1%) on 45 and 90 DAP (85.73%) and lowest rhizome germination was observed in rhizome treated with tricyclozole (0.1% + foliar spray of tricyclozole (0.1%) on 45 and 90 DAP (79.06%). Lowest leaf spot disease index was recorded in rhizome treated with propiconazole (0.1%) + foliar spray of propiconazole (0.1%) on 45 and 90 DAP (25.50%) which was followed by foliar spray of propiconazole (0.1%) on 45 and 90 DAP (26.12%) but both were on par with each other. The next best treatment was rhizome treated with carbedazim + mancozeb (0.1%) + foliar spray of carbedazim + mancozeb (0.1%) on 45 and 90 DAP (26.73%). While in case of leaf blotch, the lowest disease index was recorded in foliar spray of carbedazim + mancozeb (0.1%) on 45 and 90 DAP (17.06%) which was followed by rhizomes treated with carbedazim + mancozeb (0.1%) + foliar spray of carbedazim + mancozeb (0.1%) on 45 and 90 DAP (17.42%). More fresh rhizome yield was recorded in rhizomes treated with carbedazim + mancozeb (0.1%) + foliar spray of carbedazim + mancozeb (0.1%) on 45 and 90 DAP (20.257 t/ha) which was followed by rhizome treated with propiconazole (0.1%) + foliar spray of propiconazole (0.1%) on 45 and 90 DAP (19.094 t/ha).

At Raigarh, minimum disease intensity 23.66 percent and maximum yield 12.40 t/ ha was found when rhizome treated with carbendazim + mancozeb (1:1) and spray (0.1%) after 45 and 90 DAS after planting followed by rhizome treated with trycyclazole (0.1%) and spray (0.1%) after 45 and 90 DAS after planting with 27.12 disease intensity and 10.55 t /ha yield.

At Coimbatore, leaf spot intensity was less in treatment T6-foliar spray with propiconazone (0.1%) on 45 and 90 days (14.00 PDI) followed by T8-foliar spray with carbendazim + mancozeb (0.1%) on 45 and 90 days (16.67 PDI) which was on par with T6 and followed by T4-rhizome treatment with carbendazim + mancozeb (0.1%) + foliar spray on 45 and 90 days (21.33 PDI) as compared to control (64.67 PDI). In the case of leaf blotch, the lowest disease intensity of 16.67 PDI was recorded in T6 treatment which was on par with T8 (18.00 PDI) followed by T8 (21.33 PDI). Rhizome rot was absent in all the treatments. The rhizome yield was recorded for all the treatments. Among the nine treatments, the highest yield was recorded in the T6 (foliar spray with propiconazone (0.1%) on 45 and 90 days) treatment (43.47 t/ha) followed by T8 (foliar spray with carbendazim + mancozeb (0.1%)

on 45 and 90 days) treatment (38.67 t/ha). The maximum CB ratio of 1:4.96 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: 4.44. The pooled mean of three years data revealed that T6 (foliar spray – propiconazole (0.1%) on 45 and 90 days) was the best treatment in reducing the leaf spot intensity to 19.33 PDI and leaf blotch intensity to 13.34 as compared to untreated control (61.56 PDI). This treatment was on par with T8 treatment (foliar spray with carbendazim + mancozeb (0.1%) on 45 and 90 days.). The T6 treatment also recorded the maximum yield of 38.92 t/ha with the highest C: B ratio of1:4.60 followed by T8 treatment with yield of 34.44 t/ha and the CB ratio of 1:3.92 as compared to control (23.51 t/ha).

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)

Clove

The germplasm of tree spices are maintained at Dapoli, Pechiparai and Yercaud centres (Table 31). The germplasm of clove consisting of two accessions *viz.* IISR Calicut type and Kallar type have been maintained at Dapoli, and are being evaluated for growth and yield performance. From the germplasm of clove planted during the year 1996-97, five promising genotypes namely, Selection-1-27, Selection -2-36, Selection-3-40, Selection-4-42, Selection -5-49 were selected. The plant height varied from 5.40 to 7.45 m., girth from 29.00 to 33.00 cm and spread varied from 2.45m to 8.40m. Die back symptoms were observed on clove genotypes during the year. Defoliation and die back of young shoots was observed and only 18 plants from genotype block recovered.

This trial was initiated with an objective to collect, maintain, characterize and catalogue the germplasm of clove. Among the 24 accessions maintained at Pechiparai, SA-13, SA-8 and SA-1 were identified as the promising accessions with regard to their yield performance (Table 32)

Table 31. Tree spices germplasm collections at AICRPS centres

Crop/Centre	Indigenous/ Cultivated
Clove	
Dapoli	2
Pechiparai	24
Yercaud	13
Total	**39**
Nutmeg	
Dapoli	88
Pechiparai	24
Total	**112**
Cinnamon	
Dapoli	13
Pechiparai	14
Yercaud	16
Cassia	
Dapoli	06
Pechiparai	04
Total	**53**

Table 32. Performance of clove accessions at Pechiparai/ Yercaud

Accession	Year of planting	Tree height (m)	Stem girth (cm)	Leaf length (cm)	Leaf breadth (cm)	Dry flower bud yield (kg/tree)	Clove bud oil (%)	Oleoresin content (%)
SA 1	1996	7.45	31.75	13.50	5.50	2.90	2.00	2.20
SA 2	1996	7.80	35.00	13.80	4.70	2.13	2.05	2.11
SA 3	1996	6.86	28.75	12.50	4.92	1.90	2.00	2.13
SA 4	1996	6.50	27.90	13.50	4.80	1.30	2.11	2.24
SA 5	1996	7.30	28.45	12.00	4.50	1.86	2.10	2.16
SA 6	1996	7.33	32.10	13.90	4.90	2.00	2.20	2.30
SA 7	1996	7.86	33.70	14.30	4.60	2.50	1.95	2.05
SA 8	1996	6.67	30.00	14.60	4.32	3.25	2.30	2.50
SA 9	1996	6.34	29.15	12.40	4.70	3.00	1.92	1.86
SA 10	1996	6.90	37.00	12.20	4.40	2.50	1.75	1.73
SA 11	1996	5.87	21.85	14.40	4.20	2.45	2.31	2.25
SA 12	1996	6.00	29.20	14.30	4.70	2.20	2.56	2.16
SA 13	1996	8.15	38.55	13.70	4.55	3.70	2.78	2.56
SA 14	1996	6.50	27.00	13.16	4.12	2.60	1.80	1.70
SA 15	2000	5.80	22.55	11.50	4.00	0.75	1.65	1.68
SA 16	2000	5.25	22.36	10.78	3.16	0.80	1.60	1.50
SA 17	2000	5.79	23.45	13.00	4.30	0.75	1.54	1.56
SA 18	2000	5.00	17.83	9.88	2.76	—	—	—
SA 19	2001	3.58	12.85	9.80	3.20	—	—	—
SA 20	2001	3.00	10.65	7.80	2.90	—	—	—
SA 21	2001	2.75	11.70	10.20	3.10	—	—	—
SA 22	2006	1.95	3.50	9.80	3.30	—	—	—
SA 23	2007	1.55	3.50	7.60	2.70	—	—	—
SA 24	2008	1.56	2.95	7.50	2.30	—	—	—
Local check	1996	6.25	28.50	12.51	4.34	1.00	1.50	1.50
SED		0.12	0.60	0.13	0.05	0.06	0.05	0.06
CD (P=0.05		0.23	1.21	0.25	0.10	0.14	0.11	0.11

Nutmeg

One promising collection of nutmeg genotype from Ratnagiri District was collected and added in the germplasm for evaluation. At present total germplasm of nutmeg consisting of 87 accessions have been maintained and are being evaluated at Dapoli centre. From the germplasm collections planted during the year 1996-97 fifteen promising types have been identified and selected during the year for further evaluation. Cumulative yield of four years ranged from 317-972 fruits and potential yield of 63- 194 fruits. B- 38 (194), B-9 (171), 9/20 -21 (169), and 9/79-31 (152) showed higher potential yield. These genotypes are further evaluated for yield and fruit characters.

At Pechiparai, the nutmeg selections Sel. 4, Sel. 2, Sel. 6 and Sel. 1 were identified as promising entries

Cinnamon

Two collections of cinnamon (*C. verum*) from Ratnagiri District were collected and added in the germplasm for evaluation. At present total germplasm of cinnamon consisting of 13 accessions have been maintained and are being evaluated. The data on growth parameters did not differ significantly in different genotypes. The plant height ranged from 3.56 – 4.61 m, the girth 20.00 – 25.44 cm, the spread 3.23 – 4.47 m. and the regenerated shoots 4.06-5.71.

Morphological characteristics yield and yield attributing traits are being evaluated to identify

promising accessions at Pechiparai. A high yielding selection from Nagercoil was added to the germplasm this year. Among the accessions, Sel.65 performed well and gave a dry bark yield of 620 g /tree and leaf yield of 6.8 kg/tree (Table 33).

TSP/CI/2 Coordinated Varietal Trial
TSP/CI/2.1 CVT 1992 – clove
(Yercaud, Pechiparai)

Clove

Nine genotypes collected from IISR, Calicut is being maintained at Pechiparai station and the growth parameters were evaluated. Among the genotypes Sel.3 was found to be promising in terms of yield characters (1515.19 kg/tree) (Table 34).

Table 33. Performance of cinnamon at Pechiparai

Accession	Tree height (cm)	Rejuvenation growth (120 days)	Stem girth (cm)	Leaf yield (kg/plant)	Bark yield (g/plant)
Sel.5	2.95	2.00	16.60	3.5	286.50
Sel.44	3.00	3.26	16.15	3.8	396.15
Sel.53	2.94	2.33	12.69	4.2	187.41
Sel.63	2.85	2.13	14.87	4.8	300.01
Sel.65	4.14	4.16	25.80	6.8	620.00
Sel.139	2.85	2.55	17.40	4.3	455.76
Sel.203	2.75	2.88	12.88	4.9	235.75
Sel.310	3.33	3.73	17.90	4.2	405.50
Sel.312	3.96	3.81	18.15	5.2	512.90
Konkan Taj	3.22	2.33	14.90	4.8	282.00
Bhavani	2.65	2.30	15.68	4.5	300.15
Pechiparai local (CV 12)	2.90	1.95	19.55	6.3	328.00
SED	0.26	0.06	0.77	0.28	12.11
CD(P=0.05)	0.47	0.13	1.65	0.61	25.09
CV (%)	9.81	6.22	5.51	7.64	7.27

Table 34. Performance of CVT clove at Pechiparai

	Yield/kg/tree (dry)						
Accession	2006	2007	2008	2009	2010	Pooled mean	Yield (Kg/ha) (dry)
SA 3	1.59	1.70	2.50	3.00	3.33	2.42	672.03
SA 4	0.40	1.50	1.80	1.40	1.76	1.38	383.64
SA 5	1.26	1.50	2.00	1.10	1.00	1.37	380.86
SA 6	1.12	1.40	1.80	2.40	2.50	1.84	511.52
SA 7	1.05	1.40	2.40	2.30	2.30	1.09	303.02
SA 8	1.33	1.60	2.30	2.50	2.31	2.00	556.00
SA 9	0.60	1.20	1.90	1.50	1.30	1.30	361.40
SA 10	1.25	1.40	1.70	1.90	1.83	1.61	447.58
SA 11	0.46	1.20	1.80	1.90	1.90	1.83	508.74
SA 12	1.26	1.40	2.10	2.40	2.05	1.84	511.52
Local check	1.22	1.30	1.45	1.80	1.95	1.54	428.12
SED	0.01	0.02	0.01	0.05	0.14	0.02	0.65
CD (P=0.05)	0.03	0.03	0.03	0.11	0.29	0.04	1.36
CV (%)	1.66	1.31	0.88	3.10	8.73	1.31	0.17

TSP/CI/2.2 CVT 2001- nutmeg

(Dapoli, Pechiparai)

At Dapoli, significant difference was observed only in girth and the other parameters *viz.* height, number of branches and spread did not show any significant differences among the different genotypes. The plant height ranged from 0.73 – 1.43 m., the girth 10.17 – 19.17 cm. and the spread 0.53 – 1.88 m.

Six accessions were collected from IISR, Calicut and are being maintained and evaluated along with a local check. Among the accessions A9/150 has recorded the highest plant height of 1.10 m, stem girth of 11.30 cm and maximum number of shoots recorded were 18.00 (Table 35).

Table 35. Yield performance of CVT nutmeg at Pechiparai

Accession	Plant height (m)	Stem girth (cm)	No. of branches
A9/4	1.00	9.65	5.25
A9/20	0.93	11.05	14.56
A9/25	0.85	8.11	13.05
A9/71	0.91	6.92	13.25
A9/150	1.10	11.30	18.00
M.L.	0.92	7.35	7.36
Local check	0.83	6.20	3.12
SED	0.03	0.10	0.07
CD(P=0.05)	0.06	0.21	0.16
CV (%)	10.89	2.07	1.25

TSP/CI/2.3 CVT 2001 - Cassia

(Pechiparai, Dapoli)

Four genotypes collected from IISR, Calicut along with local check is being evaluated at Pechiparai. Among the four selections, D3 was found to be promising with plant height of 5.05 m, stem girth of 40 cm, the leaf yield of 390 g/tree, and bark yield of 213.0 g/tree (Table 36).

At Dapoli, the data on growth parameters viz. height, number of regenerated shoots and spread did not differ significantly in different genotypes. The genotype KKVCTSH recorded significantly higher girth (32.03 cm) followed by KKVCTSH (31.63 cm). The oil percentage in leaf varied from 6.16-7.44 %. The genotype KKVCTSH and KKVCTSH recorded higher oil percentage 7.44 % and 7.36 % respectively than other genotype.

Table 36. Growth and yield performance of CVT cassia at Pechiparai

Accession	Plant height (m)	Stem girth (cm)	Leaf yield (g/tree)	Bark yield (g/tree)
C1	2.50	22.30	287.15	190.25
D1	2.45	23.14	300.55	200.00
D3	5.05	40.00	390.00	213.00
D5	2.66	30.06	350.00	199.13
Local check	2.10	19.33	260.12	188.56
SED	0.15	0.02	15.83	0.29
CD (P=0.05)	0.03	0.05	34.49	0.64
CV (%)	0.72	8.12	6.94	0.21

TSP/CM/2.2 Post harvest technology studies in cinnamon

(Dapoli, Pechiparai, Sirsi)

At Dapoli, the experiment was laid out in factorial randomised block design with twelve treatment combinations. Two genotypes *viz.* Konkan Tej and ACC-11 were selected for experiment. Two lengths of stem *viz.* 50 & 100 cms were selected for bark extraction as per treatment details. Three sizes of stem *viz.* 1-2, 2-3, and 5-6 cms, were used as per details mentioned in the experiment.

Effect of genotypes on bark thickness and quill weight

It was observed from the pooled results that there were no significant differences in bark thickness before drying, bark thickness after drying, quill fresh weight, quill dry weight among different genotypes. No significant differences between yield of two genotypes i.e. Konkan Tej and ACC-111 after selection certain length and certain thickness of stem of bark extraction.

Effect of length of stem on bark thickness and quill weight

No significant differences in bark thickness before drying, bark thickness after drying, quill fresh weight, quill dry weight among different length of cinnamon stem selected for bark extraction. This indicates that length of stem of cinnamon had no direct relation with yield of cinnamon bark (Table 37).

Effect of thickness of stem on bark thickness and quill weight

Significantly highest bark thickness before drying 1.14 mm., bark thickness after drying 0.82 mm,

quill fresh weight 111.21 g & quill dry weight 56.64 g were recorded in T_3 treatment (5- 6 cm thickness of stem) (Table 37). This might be due to more maturity of stem is related with more thickness and more weight of bark in cinnamon.

Effect of G x L

It was observed from pooled results of interaction effect regarding genotype and length of stem that there were no significant differences for bark thickness before drying and bark thickness after drying. But quill fresh weight and quill dry weight showed significant differences due to interaction effect of G x L. (Table 38). The G_1L_3 (Konkan Tej with 100 cm. length of stem) interaction, recorded significantly as high as 126.33 g and 65.93 g quill fresh weight and quill dry weight respectively which was at par with G_2L_3 which recorded 124.05 g (quill fresh weight) and 61.92 g (quill dry weight) respectively. This might be due to interaction effect of higher length of stem (100 cm) with genotypes (G_1 & G_2).

Effect of G x T

It was observed that interaction effect of genotype and thickness of stem produced significant difference in bark thickness before drying, bark thickness after drying, quill fresh weight, quill dry weight of cinnamon. Significantly maximum bark thickness before drying was recorded in treatment combination G_2T_3 i.e. 1.72 mm which was at par with 1.70 mm (treatment combination G_1T_3). Significantly maximum bark thickness after drying (1.28 cm), quill fresh weight (172.49 g) and quill dry weight (89.26 g) were recorded in treatment combination G_1T_3 which were followed by G_2T_3 treatment combination i.e. 1.17 mm bark thickness after drying, 161.15 g quill fresh weight and 80.67 quill dry weight of cinnamon. Also interestingly significantly low bark thickness before drying (1.00 mm), bark thickness after drying (0.69 mm) quill fresh weight 58.12 g, quill dry weight 26.72 g, were recorded in G_1T_1 treatment combinations which were also at par with G_2T_1 treatment combinations (Table 38). The higher values of bark thickness & quill weight in T_3 treatment combinations indicated dominant and profound effect of thickness of stem on interaction effects with genotypes. (G x T interactions).

Effect of L x T

It was observed from pooled results of interaction effects of length of stem & thickness of stem in cinnamon, there were significant differences in bark thickness before drying, bark thickness after drying, quill fresh weight, quill dry weight of cinnamon. Significantly maximum bark thickness before drying (1.72 mm), bark thickness after drying (1.24 mm) quill fresh weight (214.22 g), quill dry weight (109.03 g) were observed in treatment combination L_3T_3 which was at par with L_1T_3 for bark thickness before drying (1.70 mm), bark thickness after drying (1.20 mm) and quill fresh weight (119.42 g) (Table 38). This might be profound and dominant effect of higher thickness of stem on length of stem in cinnamon.

Effect of interaction of G x Lx T

The pooled mean interactions effect of genotype, length and thickness of stem in cinnamon are presented in Table 39. The results indicate that there were significant differences in bark thickness before drying, bark thickness after drying, quill fresh weight, quill dry weight as affected by interaction effect of genotype, length of stem and thickness of stem in cinnamon. Significantly maximum bark thickness before drying (1.74 mm) was recorded in treatment combination $G_2L_1T_3$, which was at par with $G_1L_2T_3$ (1.72 mm), G2L2T3 (1.71 mm) and $G_1L_1T_3$ (1.67 mm). The treatment combination $G_1L_2T_3$ produced significantly highest bark thickness after drying (1.33 mm) quill fresh weight (223.31 g) quill dry weight (117.28 g) respectively. Significantly low bark thickness before drying (1.00 mm) quill fresh weight (49.13 g) and quill dry weight (22.92g) were recorded in treatment combination $G_1L_1T_1$ which was at par with treatment combination $G_2L_1T_1$. Significantly low bark thickness after drying (0.65 mm) was recorded in treatment combination $G_1L_2T_1$ which was at par with $G_2L_2T_1$ treatment combination 0.70 mm. Significantly higher yield of G x L x T indicate profound, dominant and major role of thickness of stem selected for coppicing on thickness of bark and quill weight in cinnamon. The data regarding oil percentage of different thickness of stem in Konkan Tej & ACC-11 genotypes are presented in Table 40. It was observed that oil percentage was higher in thicker stem in both the genotypes. Higher oil percentage was observed 5-6 cm. thick stem i.e. Konkan Tej (3%) and ACC-11 (2.50%) respectively. The data regarding economics of bark extraction in cinnamon are presented in Table 41. It was observed from the table that treatment T_3 (5-6 cm thickness stem of cinnamon) resulted highest net profit (Rs.670/-). Hence for getting highest cinnamon bark yield 5-6 cm thick stem for bark extraction in cinnamon is recommended.

Table 37. Effect of genotype, length (cm) and thickness (cm) of stem on bark thickness before dry, bark thickness after drying, quill fresh weight, quill dry weight of cinnamon (Pooled of 2008-09, 2009-10, 2010-11) at Dapoli.

Treatment	Bark thickness before drying (mm)	Bark thickness after drying (mm)	Quill fresh weight (g)	Quill dry weight (g)
Genotype (G)				
G1	1.29	0.92	104.20	53.35
G2	1.31	0.89	102.68	51.80
S.Em.±	0.016	0.037	5.374	3.70
C.D. 5%	NS	NS	NS	NS
Length of stem (L)				
L1	1.31	0.91	81.69	41.22
L2	1.29	0.90	125.19	63.93
S.Em.±	0.0034	0.029	5.473	3.435
C.D. 5%	NS	NS	NS	NS
Thickness of stem (T)				
T1	0.67	0.47	39.74	18.82
T2	0.79	0.53	55.93	29.69
T3	1.14	0.82	111.21	56.64
S.Em.±	0.018	0.019	2.255	1.643
C.D. 5%	0.110	0.115	13.718	9.995

G_1 - Konkan Tej ; G_2 Acc-11; L_1 - 50 cm length of stem; L_2 -100 cm length of stem;T_1 – 1-2 cm thickness of stem; T_2 - 2 -3 cm thickness of stem; T_3 5-6 cm thickness of stem.

Table 38. Effect of G x L, G x T and L x T on fresh bark thickness before drying, bark thickness after drying, quill fresh weight and quill dry weight of cinnamon (Pooled of 2008-09, 2009-10, 2010-11) at Dapoli

Treatment Combination	Bark thickness before drying (mm)	Bark thickness after drying (mm)	Quill fresh weight (g)	Quill dry weight (g)
G x L				
G1L1	1.28	0.93	82.07	40.76
G1L2	1.30	0.92	126.33	65.93
G2L1	1.33	0.90	81.32	41.68
G2L2	1.28	0.87	124.05	61.92
S.Em.±	0.035	0.028	3.427	1.724
C.D. 5%	N.S.	N.S.	14.20	5.966
G x T				
G1T1	1.00	0.69	58.12	26.72
G1T2	1.17	0.80	81.99	44.06
G1T3	1.70	1.28	172.49	89.26
G2T1	1.00	0.71	61.10	29.73
G2T2	1.19	0.78	85.79	45.01
G2T3	1.72	1.17	161.15	80.67
S.Em.±	0.026	0.037	3.871	2.553
C.D. 5%	0.088	0.130	13.395	8.833
L X T				
L1T1	1.00	0.72	50.62	23.40
L1T2	1.22	0.82	75.04	39.37
L1T3	1.70	1.20	119.42	60.90
L2T1	1.00	0.68	68.60	33.05
L2T2	1.15	0.76	92.75	49.71
L2T3	1.72	1.24	214.22	109.03
S.Em.±	0.034	0.02	3.52	2.18
C.D. 5%	0.118	0.07	12.19	7.53

G_1- Konkan Tej; G_2 – Acc-11; L_1 – 50 cm length of stem; L_2 – 100 cm length of stem;T_1 – 1-2 cm thickness of stem; T_2 – 2 - 3 cm thickness of stem;T_3 – 5-6 cm thickness of stem

Table 39. Effect of interaction on bark thickness before drying, bark thickness after drying, quill fresh weight, quill dry weight of cinnamon (Pooled of 2008-09, 2009-10, 2010-11) at Dapoli

Treatment Combinations	Bark thickness before drying (mm)	Bark thickness after drying (mm)	Quill fresh weight (g)	Quill dry weight (g)
$G_1L_1T_1$	1.00	0.73	49.13	22.92
$G_1L_1T_2$	1.18	0.83	75.41	38.13
$G_1L_1T_3$	1.67	1.24	121.67	61.23
$G_1L_2T_1$	1.00	0.65	67.10	30.91
$G_1L_2T_2$	1.17	0.77	88.57	50.00
$G_1L_2T_3$	1.72	1.33	223.31	117.28
$G_2L_1T_1$	1.01	0.72	52.10	23.87
$G_2L_1T_2$	1.26	0.81	74.67	40.62
$G_2L_1T_3$	1.74	1.17	117.18	60.56
$G_2L_2T_1$	1.01	0.70	70.10	35.59
$G_2L_2T_2$	1.13	0.76	96.92	49.41
$G_2L_2T_3$	1.71	1.16	205.13	100.77
S.Em.±	0.047	0.040	5.6196	3.3097
C.D. 5%	0.138	0.118	16.479	9.705

G_1 - Konkan Tej ; G_2 – Acc-11; L_1 - 50 cm length of stem; L_2 - 100 cm length of stem; T_1 – 1-2 cm thickness of stem; T_2 – 2 -3 cm thickness of stem; T_3 – 5-6 cm thickness of stem.

Table 40. Oil percentage in different thickness of stem in cinnamon

Genotype	Oil Percentage		
Stem thickness	**1-2 cm**	**2-3 cm**	**5-6 cm**
Konkan Tej	2.78	2.80	3.00
ACC – 11	2.35	2.40	2.50

Table 41. Cost of production of 10 kg cinnamon bark (cost in Rs) at Dapoli

Particulars	Cinnamon bark extraction cost (Rs)		
	1-2 cm stem thickness	2-3 cm stem thickness	5-6 cm stem thickness
Material cost	1460	1430	1285
Labour cost	550	515	425
Other cost	310	135	120
Total cost	2320	2080	1830
Net return by selling of produce	2500	2500	2500
C : B ratio	1.08	1.20	1.36
Net profit per 10 kg Cinnamon bark	180	420	670

Significant difference was noticed in genotype, length, thickness and G x L and L x T interactions in cinnamon at Pechiparai. Among the genotypes, G1 recorded significantly higher mean dry weight of quills (130g). Among the lengths tried the L2 recorded the higher mean dry weight (82g). The interaction effect also follows the 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. Among 3 genotypes tried for processing studies, significant difference was observed among the treatments with respect to the characters *viz*. bark thickness, bark fresh weight, bark dry weight and bark dry recovery percent. Mean dry bark yield recorded in 50 cm stem shoots with 1-2 cm., 2-3 cm. and 5-6 cm diameter of G_1 genotype was 22.70g., 33.60g. and 50g., respectively and its dry recovery percent was 49.15, 49.20 and 52., respectively. There was increase in fresh as well as dry bark yield with increasing the thickness and the length of the stem shoot. However, the increment was proportionately more in 50 cm shoots in all the treatments where, the maximum value of 22.70g, 33.60g and 50g was recorded in the shoots of 1-2 cm, 2-3 cm and 5-6 cm diameter, respectively of G_1 genotype. Bark dry yield recovery varied between 44.20 percent and 53.70 percent (G_1 genotype having 100 cm length and 1-2 cm diameter) with significant difference among some of them (Table 42). The genotype, length and thickness did not influence significantly the content of essential oil.

Table 42: Influence of shoot length and thickness on bark yield characters of cinnamon (2010-11) at Pechiparai

Treatment	Fresh bark thickness (mm)	Dry bark thickness (mm)	Fresh bark weight (g)	Dry bark weight (g)	Dry bark recovery (%)
$G_1L_1D_1$	0.78	0.53	38.40	17.00	44.20
$G_1L_1D_2$	1.10	0.76	83.00	40.90	49.30
$G_1L_1D_3$	1.50	1.08	98.60	47.00	47.70
$G_1L_2D_1$	0.75	0.37	52.75	26.25	53.70
$G_1L_2D_2$	0.90	0.64	100.30	46.15	46.00
$G_1L_2D_3$	1.46	1.12	164.60	79.50	48.30
$G_2L_1D_1$	0.80	0.51	46.20	22.70	49.15
$G_2L_1D_2$	0.97	0.72	68.30	33.60	49.20
$G_2L_1D_3$	1.43	1.02	96.15	50.00	52.00
$G_2L_2D_1$	0.81	0.36	62.80	29.20	47.15
$G_2L_2D_2$	0.89	0.62	93.00	46.30	49.80
$G_2L_2D_3$	1.34	1.07	168.40	80.20	47.60
$G_3L_1D_1$	0.72	0.46	36.20	17.05	48.50
$G_3L_1D_2$	0.96	0.68	40.30	19.35	48.20
$G_3L_1D_3$	1.63	1.08	51.90	25.80	49.30
$G_3L_2D_1$	0.73	0.29	60.30	31.80	44.20
$G_3L_2D_2$	0.88	0.64	116.50	50.50	47.30
$G_3L_2D_3$	1.28	0.98	167.75	83.05	46.20
Sem±	0.04	0.02	1.79	0.93	1.42
CD (P=0.05)	0.08	0.04	3.78	1.96	3.00
CV (%)	5.31	3.76	2.95	3.16	4.16

G = Genotype (G_1, G_2, G_3); L = Length of stem shoot (L_1 = 50 cm & L_2 = 100 cm); D = Shoot diameter (D_1 = 1-2 cm; D_2 = 2-3 cm; D_3 = 5-6 cm).

TSP/CI/3 Disease Management Trial

TSP/CP/3.1 Management of die back and wilt disease of nutmeg

(Dapoli)

Profile soil and surface soil analyses of germplasm block of nutmeg at Bhatye, Ratnagiri, Maharashtra were carried out at 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 & Kumarganj)

Among the 275 coriander accessions evaluated at Coimbatore, the coriander grain yield ranged from 25g per plot to 90g per plot. The average mean yield is 44g per plot. Out of 275 collections evaluated, 113 genotypes recorded a yield higher than the mean yield. The highest mean coriander yield was registered by the accession CS-251 (90g per plot). Three checks were involved in the evaluation (CS-111, CS-49 and CS-82). The grain yield of the check lines were 55g for CS-111 and CS-82 and 40g for CS-49 respectively. Powdery mildew intensity was noticed in all the accessions. The PDI ranged from 17.5 PDI to 67.50 PDI. The accessions viz., CS 169, 175, 261 and 265 recorded the least disease intensity of 17.5 PDI. The other accessions *viz*., CS 62, 74, 75, 80, 90, 167, 171 and 270 recorded the minimum disease intensity of 20.50 PDI. The accessions viz., CS 61, 73, 87, 95, 98, 159, 170, 263, 225, 245, 268 and 272 recorded the disease intensity of 22.5 PDI. The germplasm conserved at various AICRPS centres is given in Table 43.

Table 43. Coriander germplasm collection at AICRPS centres

Centre	Indigenous		Total
	Cultivated	Wild and related sp.	
Coimbatore	275	-	275
Dholi	143	-	143
Guntur	309	-	309
Hisar	266	-	266
Jagudan	74	21 (Exotic)	95
Jobner	753	102	855
Kumarganj	102	-	102
Pantnagar	30	-	30
Solan	92	-	92
Total	**2044**	**123**	**2167**

One hundred forty three germplasm of coriander were collected and evaluated for promising line with respect two yields at Dholi. Fourteen accessions namely, RD-420, RD-395, RD-387, RD-419, RD-400, JCO-32, RD-389, RD-396, RD-378, UD-73, UD-241, UD-303, JCO-72 and JCO-115 gave the maximum yield ranging from (1.35 to 1.15 kg/3.6m^2) as compared to high yielding varieties Rajendra Swati (0.85 kg/5.4m^2) and Pant Haritima (0.90 kg/5.4m^2). Among the promising accessions, RD-420 and RD-395 gave the maximum yield (1.35 kg/5.4m^2) followed by RD-387, RD-419, RD-400 and JCO-132 i.e., (1.20 kg/5.4m^2).

During 2010-11, ninety five entries were evaluated at Guntur. Among the entries evaluated, LCC-209 recorded highest single plant yield (3.5 g/plant) followed by LCC-224 (2.9 g), CS-23 (2.6 g), LCC-205 (2.56 g), LCC-236 (2.38 g), LCC-197 (2.36 g), LCC-245 (2.3g) and CS-7 (2.1g) which were significantly superior to the best check Swathi (1.26 g).

One hundred forty three 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 2010-2011 at Hisar. The mean seed yield of the germplasm material ranged from 15.4 g/plant (DH-315, DH-286) to 45.6 g/plant (DH-281). Seventy one lines gave higher seed yield than the highest yielding check, Hisar Anand. The most promising lines for seed yield were DH-237-2, DH-244, DH-244-2, DH-254, DH-277, DH-278, DH-279, DH-280-1, DH-281, DH-287, DH-294, DH-318, DH-393-1 and DH-393-2. These lines were maintained by sib mating under muslin cloth and self seed of all the lines have been harvested.

At Jagudan, 95 entries were raised and evaluated with GCori-1 and GCori-2 as checks for different yield attributes. Among them eight entries was dwarf type, having less than 52 cm plant height. Two entries had more branches i.e. more than 8.0 branches per plant. The higher umbels per plant were recorded by entry JCr-376 i.e. e"19. Five entries recorded equal or more than 5.5 umbellate per umbel. The entry JCr-380 was promising for

more seeds per umbel i.e. > 60 seed per umbel. The entry JCr-393 was as early maturity type (< 100 days). Two entries found bold seeded has high test weight i.e. > 17 g. Five entries (UD-100, JCr-327, Lam-6, Lam-69 and Lam-73) identified as high yielders recorded more than 1389 kgha^{-1} grain yield. During the year, total 74 (72+2) entries of Jagudan centre, were screened for the resistance against powdery mildew disease under natural condition. The incidence of powdery mildew ranged from 10.25% to 40.25%. None of the entries were found resistant against the disease.

Two hundred thirty germplasm accession of coriander were evaluated along with nine checks namely, RCr-20, RCr-41, RCr-435, RCr-436, RCr-446, RCr-480, RCr-684, RCr-728 and Local in augmented design in one row plots of 3 x 0.3 sq.m size 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.

Hundred and two germplasm were evaluated at Kumarganj. NDCor-38 gave the maximum seed yield of 18.45 q/ha followed by NDCor -2 with seed yield of 17.40 q/ha.

Multilocation evaluation of coriander genotypes

In the multilocation evaluation of coriander genotypes ninety germplasm lines (Guntur – 60 & Coimbatore- 30) of coriander were evaluated for the second year during 2010 -11 along with two checks. The single plant yield varied from 14.15g to 38.40 g. The highest yield was recorded by the line LCC-209 (38.40g per plant) followed by CS-3 (36.54g per plant) more than the checks. Among the genotypes evaluated eighty four genotypes out yielded the local check CO (CR)- 4 and forty seven genotypes out yield of the check Sudha. With regard to the screening for powdery mildew disease incidence in the coriander germplasm accessions, the entries LCC-226 and LCC-245 recorded the least disease intensity of 18.80 PDI (Grade 1) followed by the entries *viz.*, LCC-198, 199,208,211,216 and 222 which recorded less disease intensity of 20.20 PDI.

Fifteen germplasm were tested in six blocks with three checks at Kumarganj. None of the germplasm was disease free for stem gall and powdery mildew disease under field conditions. No significant difference was obtained for yield.

COR/CI/2.4 CVT 2009-VIII

(Jagudan, Jobner, Guntur, Hisar, Kumarganj)

The yield differences among the entries were significant at Jagudan. The entries COR-32 and COR- 30 gave significantly highest yield (i.e., 1880 and 1803 kgha^{-1}), which was 16.34 and 11.57% higher over check G Cori 2, respectively during 2010-11. The pooled over two year's data shown significant differences for yield. The entry COR 32 gave 2487 kgha^{-1} yield, which was 26.24 per cent higher over check G Cori 2 (Table 44).

Table 44. Yield performance of CVT coriander at Jagudan (Pooled)

Entry	Projected Yield (kgha^{-1})		Mean	% Increase over check
	2009-10	2010-11		
COR-25	2336	1077	1707	-
COR-26	2355	1151	1753	-
COR-27	2791	1725	2258	14.62
COR-28	2112	972	1542	-
COR-29	2948	1710	2329	18.22
COR-30	2718	1803	2261	14.75
COR-31	2071	1611	1841	-
COR-32	3094	1880	2487	26.24
COR-33	1694	1550	1622	-
COR-34	1765	1049	1407	-
COR-35	1637	0	819	-
GCr-2 (Check)	2324	1616	1970	-
Hisar Anand(N check)	-	1562	-	-
RCr-728(Check)	-	1502	-	-
S.Em.±	180	94	-	-
C.D. at 5%	530	274	-	
C.V.%	13.49	11.89	-	-

During 2010-11 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, maximum plant height was recorded in COR-27 (75.87cm) followed by COR-31 (74.33 cm) which were on par with each other and significantly superior to the check Sudha (65.33 cm). Maximum number of primary branches was recorded in COR-30 (5.4) which was significantly superior to the check Sudha (3.4). Regarding number of secondary branches, maximum number were recorded with COR-30 (18.73) followed by COR-31(16.33) which were found superior to the check Sudha (13.73). COR-29 (53.3 days) was earliest to reach the fifty percent flowering while COR-31 (65.3 days) took maximum number of days to reach fifty percent flowering. Regarding number of umbels per plant, maximum number was recorded with COR-31 (26.43) which was found superior to the check Sudha (15.87). Maximum number of umbellets per umbel were recorded in COR-31 (8.57) followed by COR-29 (7.37) which were on par with each other and significantly superior to the check Sudha (6.87). Maximum number of seeds per umbel were recorded in COR-31 (46.17) followed by COR-28 (44.83) which were on par with each other and significantly superior to the check Sudha (34.57). Among the entries evaluated, COR-31 (1319 kg/ha), COR-30 (1037 kg/ha) and COR-28 (1041 kg/ha), recorded significantly higher yield than checks Sudha (829 kg/ha), local (284 kg/ha) and national check Hisar Anand (621 kg/ha).

Among all the entries COR-25 gave the maximum yield of 19.44 q/ha at Kumarganj. A yield of 20.31 q/ha was recorded in Kumarganj selection used as check (Table 45).

COR/CI/2.5 Coordinated Varietal Trial 2009

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

Among the promising entries and check, COR-34 and COR-33 recorded significantly higher plant height (147.46 & 137.63 cm) respectively as compared to national check variety Hisar Anand at Dholi. However, none of the entries was found

Table 45. Yield and ancillary observations in coordinated varietal trial on coriander during 2010-11 at Kumarganj

Entries	Plant height (cm)	No. of branches/ plant	No. of umbels/ plant	No. of umbellets/ umbel	No. of seeds / umbel	Yield (kg/plot)	Yield(q/ha)	% increase in yield over check K. selection
Cor-31	104.83	6.17	98.40	8.30	42.63	0.825	17.12	-
Hisar Anand (check)	108.30	5.73	103.40	7.40	43.50	0.925	19.27	-
Cor-30	131.20	6.30	108.93	6.40	43.83	0.875	18.22	-
Cor-33	139.97	5.97	106.50	5.87	45.97	0.900	18.74	-
Cor-29	145.07	5.97	106.73	6.53	45.50	0.916	19.09	-
Cor-32	146.07	5.30	107.50	7.07	41.30	0.941	19.61	-
Cor-28	139.20	5.40	100.83	6.07	45.40	0.850	17.87	-
Cor-26	139.93	5.97	100.40	6.97	46.50	0.950	19.79	2.69
Cor-25	136.40	6.17	108.73	6.30	44.17	0.933	19.44	0.88
Cor-35	141.77	5.97	109.83	7.10	39.50	0.928	18.92	-
Cor-27	138.53	5.97	108.07	6.93	43.63	0.891	18.57	-
Cor-34	138.73	6.07	112.17	8.30	39.73	0.958	19.96	3.58
K. selection (Ch.)	144.07	6.30	113.93	8.63	45.17	0.975	20.31	5.39
RCR-728	136.53	5.63	100.50	7.30	39.50	0.875	18.22	-
SEM±	1.18	0.2	1.04	0.22	0.90	0.02	0.42	-
CD(0.05)	3.43	0.6	3.02	0.64	2.63	0.06	1.21	
CV(%)	1.51	6.3	1.69	5.40	3.62	3.81	3.82	-

significantly superior over local check variety Rajendra Swati regarding number of primary branches per plant, number of secondary branches per plant, number of umbels per plant, number of umbellets per umbel, number of grains per umbellet and yield per plot or projected yield per hectare. While local check variety Rajendra Swati was found significantly early 50% flowering (79.33 DAS) as compared to entries COR-27, COR-28, COR-29, COR-31, COR-33, COR-34, COR-35 and Hisar Anand.

Significant differences were obtained for all the parameters. Plant height ranged from 95.3 to 126.1, number of branches 6.1 to 10.8, umbels per plant 47.7 to 107.8 and seeds per umbel 23.6 to 38. Maximum seed yield (2126 kg/ha) was recorded in COR-32 followed by COR-31 (2091 kg/ha) and COR-27 (1876 kg/ha). Among the genotypes tested at Jabalpur, COR- 33 gave maximum height (121.46 cm) and no of primary branches (9.26). Whereas COR-32 gave maximum number of secondary branches (13.33), umbels/plant (28.83), umbellets/umbel (10.26) and yield (2.35 kg/plot & 2.446 t/ha).

Fourteen entries were evaluated in RBD with 3 replications in a plot size of 3 x 2.4 sq. m. accommodating eight rows spaced 30 cm apart with plant to plant distance 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 948.15 to 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), Hisar Anand NC (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 (Table 46).

Table 46. Coordinated Varietal Trial of coriander 2009-10 at Jobner

Entry	Days to flowering	Plant height (cm)	Branches / plant	Umbels /plant	Umbellets/ umbel	Seeds/ umbel	Test weight (g)	Volatile oil content (%)	Seed yield (kg/ha)
COR-25	56.67	76.40	5.80	21.53	5.20	33.40	12.34	0.30	1389.35
COR-26	55.00	73.73	5.60	20.73	5.13	34.87	12.32	0.30	1349.07
COR-27	62.00	104.33	5.87	28.47	6.40	38.47	11.73	0.43	1557.41
COR-28	79.67	117.27	5.67	20.20	4.87	31.67	9.49	0.30	1172.22
COR-29	55.00	77.73	5.33	18.80	5.07	24.53	14.62	0.43	948.15
COR-30	56.33	83.40	5.93	22.67	4.67	23.27	14.14	0.30	1139.81
COR-31	63.67	116.60	6.47	30.07	6.60	37.13	10.24	0.43	1601.85
COR-32	69.67	109.00	5.87	27.07	5.67	25.40	12.01	0.30	1540.28
COR-33	73.00	116.27	6.00	22.13	5.20	27.47	8.32	0.30	1509.72
COR-34	69.00	126.93	6.93	29.53	4.93	29.43	8.55	0.47	1535.65
COR-35	85.67	117.87	6.40	20.20	5.60	32.20	6.21	0.30	1149.07
Hisar Anand NC	68.33	111.13	5.40	22.47	5.87	25.53	9.24	0.30	1487.04
RCr-435 Check	68.67	126.20	5.47	24.13	7.00	38.13	9.58	0.43	1496.76
Local Check	68.00	113.80	5.53	19.93	5.47	24.67	9.03	0.30	1064.35
CD at 5%	4.60	12.14	0.74	4.37	0.69	5.15	0.49	0.05	162.00
CV (%)	4.12	6.89	7.47	11.12	7.39	10.09	2.79	8.56	7.13

Significant differences were obtained for all the character at Pantnagar. Maximum seed yield (2295.67 kg/ha) was recorded for Cor-28 followed by Cor-33 (2236.33 kg/ha) and Cor-31 (2044.00 kg/ha).

Among the 13 entries evaluated at Raigarh, COR-31(1267.36kg/ha) was found significantly superior over all the checks ICS-1(LC), Hisar Anand and RCor- 728 with yield 850.69, 562.50 and 232.64 kg/ha, respectively.

Fourteen genotypes including Hisar Anand, Rajasthan Coriander -728 (National Checks) and Gujarat Coriander-2 (Local Check) were evaluated in Randomized Block Design with three replications at Navsari during Rabi-2010-11. Observations were recorded on days to 50% flowering, plant height (cm), no. of primary branches/plant, no. of secondary branches/plant, umbellate per plant, umbellate/umbel, no. of seeds/umbel and seed yield (kg/ha). Significant difference among genotypes was observed for all the traits except for plant height, umbellate/umbel and seeds/umbel. For seed yield, Cor-27 was the highest yielding genotype (1034.81 kg/ha) followed by GCr-2 (1030.61 kg/ha) and Cor-29 (951.95 kg/ha). None of the genotype had significantly out yielded the check Hisar Anand and GCr-2 while among eleven tested genotypes except COR-28, COR-33 and COR-35 the remaining genotypes were significantly superior over RCr-728. COR-29 was earliest to flower (43.67 days) followed by COR-25 and COR-30 (both with 45.67 days). For no. of primary branches/plant, GCr-2 registered the highest primary branches/plant (7.87) followed by COR-25 and COR-33 (both with 7.40 no. of primary branches/plant). Among eleven tested genotypes, none of the genotype was significantly superior over Hisar Anand and GCr-2. GCr-2 recorded the highest no. of secondary branches/plant (25.20) followed by COR-35 (23.67) and COR-34 (21.87). None of the genotype was significantly superior over GCr-2. COR-30 manifested the highest no. of umbellate/plant followed by COR-29 (18.80) and RCr-728 (18.27). None of the genotypes significantly out yielded the check GCr-2 and RCr-728 while COR-29, COR-30 and RCr-728 were significantly superior over Hisar Anand.

The trial was conducted with leafy coriander genotypes from TNAU, Coimbatore and APHU, Guntur (three each) and one genotype from NRCSS, Ajmer with two checks. The leaf yield of the genotypes varied from 2.15 kg per plot (4.8m^2) to 3.62 kg per plot. The highest yield was recorded by the genotype ACr-1 followed by CS-1(3.53 kg per plot) which were higher than both the check (Table 47).

Table 47. Mean performance of coriander (leafy type during off season) CVT 2010 genotypes – 2010-11 at Coimbatore

Genotype	Days to germination	Plant height (cm)	No. of leaves	Plot yield ($10m^2$) kg
ACr-1	10	23.05	7.20	3.62
CS-1	10	23.69	6.20	3.53
CS-11	10	22.69	6.07	2.59
CS-38	11	22.93	6.80	2.52
LCC-234	11	21.95	5.20	2.15
LCC-242	11	21.57	5.47	3.38
LCC-244	11	22.07	5.40	2.75
CO(CR)1	9	23.07	6.20	3.42
Sadhana (check)	10	22.86	6.80	3.24
SED	0.66	1.44	0.39	0.19
CD (P=0.05)	1.41	3.05	0.83	0.42

COR/CI/3 Varietal Evaluation Trial

COR/CI/3.1 Initial evaluation trial 2010

(Dholi, Kumarganj, Jobner, Jagudan, Hisar)

Eight promising entries and two checks (Pant Haritima and Rajendra Swati) were tested at Dholi under Initial evaluation trial during 2010-2011. Among the two check varieties, Pant Haritima was found at par with check variety Rajendra Swati regarding height of the plant, number of branches per plant, number of umbellets per plant, number of umbellets per umbel and number of grains per umbel. However, local check Rajendra Swati produced significantly higher yield per plot (0.92 kg m^{-2}) or projected yield per hectare (1.71 t ha^{-1}) as compared to check variety Pant Haritima. Among the promising entries and two checks, all the entries were found non significant as compared to check varieties Rajendra Swati regarding all characters except yield per plot or projected yield per hectare. However, RD-377 gave significantly higher yield (1.22 kg/4.8m^2) or projected yield per hectare (2.28 t/ha) as compared to check variety Rajendra Swati (0.92 kg/4.8 m^2 or 1.71 t/ha).

At Kumarganj, highest yield of 17.87 q/ha was recorded in NDCor-10 followed by yield of 17.53 q/ha in NDCor–38 showing a maximum per cent increase of 4.01 in NDCor-10 over the check Hisar Anand.

The entries tested at Jagudan were found nonsignificant for yield. However, the entries JCr 389 and JCr 401 gave 1898 and 1871 $kgha^{-1}$ yield, which was 20.60 and 18.84 per cent higher over check G Cori 2, respectively.The pooled over three years data shown significant differences for yield. An entry JCr- 404 gave 1857 $kgha^{-1}$ yield, which was 17.77 per cent higher over check G Cori 2.

The initial evaluation trial (IET) in coriander was conducted with ten accessions along with Hisar Anand as check during 2010-2011 in plots measuring 3.0 x 2.0 m at Hisar. The results indicated that DH-281 and DH-314 gave significantly better yield over Hisar Anand (check) showing 23.5 and 20.3% increase in yield, respectively.

Ten genotypes of coriander have been evaluated in RBD along with 2 checks for seed purpose at Pantnagar. Only one genotype PD (S)-21(seed yield - 1910.13 kg/ha) was superior over best check *ie* Pant Haritima.

Ten promising coriander accessions from germplasm entries were tested in RBD. Replicated thrice with Sudha as check at Guntur. All entries evaluated differed significantly in all the yield attributes studied. Among the entries, number of primary branches were maximum in the LCC-225 (5.0) followed by LCC-229 (4.4) which were on par with each other and significantly superior to the check Sudha (2.86). Regarding number of secondary branches, maximum number were recorded in LCC-229 (15.4) followed by LCC-224 (14.7) and LCC-224 (14.4) which were on par with each other and significantly superior to the check Sudha (11.13). Maximum number of umbels were recorded in LCC-229 (20.4) followed by LCC-219 (20.3) which were on par with each other and significantly superior to the check Sudha (13.7). Regarding number of umbellets per umbel, maximum number were recorded with LCC-219 (8.8) followed by LCC-229 (8.4) and LCC-225 (7.96) which were on par with each other and significantly superior to the check Sudha (6.86). Regarding number of seeds per umbel, maximum number were recorded in LCC-219 (46.9) followed by LCC-226 (45.2) and LCC-213 (44.8) which were on par with each other and significantly superior to the check Sudha (35.9). Among the twelve entries tested, LCC-219 recorded significantly highest yield of 1684kg/ha followed by LCC-224 with 1357kg/ha and LCC-229 with 1315 kg/ha which were superior over check Sudha (1055 kg/ha).

Ten entries were evaluated in RBD with 3 replications in a plot size of 3 x 2.4 sq. m. 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 1212.96 to 2004.63 kg/ha. Of the ten entries evaluated, UD-794 recorded maximum seed yield of 2004.96 kg/ha followed by UD-706 (1745.37 kg/ha), UD-663 (1724.07 kg/ha), RCr-435 check (1644.44 kg/ha) and UD-563 (1635.19 kg/ha, while lowest seed yield of 1212.96 kg/ha was recorded in local check.

Mean performance of the entries evaluated in IET over 2008-09 and 2009-10 revealed superior

performance of UD-794 yielding 1712.97 kg/ha followed by UD-663 (1702.32 kg/ha), RCr-435 check (1500.46 kg/ha), UD-556 (1437.04 kg/ha) and RCr-436 check (1341.44 kg/ha), while lowest seed yield of 1039.35 kg/ha was recorded in local check.

IET Coriander

Ten entries of coriander under IET were tested for volatile oil content during Rabi 2009-10, which was analyzed using Clevenger apparatus at Jobner. The volatile oil content in the entries ranged from 0.30% to 0.43%. The maximum volatile oil of 0.43% was observed in UD-365, UD-663 and RCr-435 check followed by 0.40% in UD-706, 0.33% in UD-794 and RCr-436, while minimum of 0.30% was recorded in UD-562, Ud-563 and UD-737. The entry UD-663 ranked first in terms of volatile oil yield (7.47 l/ha) followed by RCr-435 check (7.13 l/ha)), UD-706 (6.98 l/ha), UD-565 (6.92 l/ha) and UD-794 (6.68 l/ha). While lowest volatile oil yield of 3.64 l/ha was recorded in Local Check. On the basis of two years data (2008-09 and 2009-10), the highest mean volatile oil content of 0.43% was recorded in RCr-435 check followed by 0.42% in UD-565 and UD-663, O.37% in UD-794 and RCr-436 Check and 0.35% in UD-562, UD-706 and UD-563, whereas minimum 0.27% was recorded in UD-737. The maximum mean volatile oil yield in terms of litre per ha. was observed in UD-663 (7.09 l/ha) followed by RCr-435 check (6.48 l/ha), UD-794 (6.28 l/ha) and minimum in Local check (3.27 l/ha) (Table 48).

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 2009-10, which was analyzed using Clevenger apparatus. The volatile oil content in the entries ranged from 0.30% to 0.47%. The maximum volatile oil of 0.47% was observed in COR-34 followed by 0.43% in COR-27, COR-29, COR-31 and RCr-435, while minimum of 0.30% was recorded in rest of the entries. The entry COR-34 ranked first in terms of 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). While lowest volatile oil yield of 3.19 l/ha was recorded in Local Check (Table 49).

Table 48. Mean volatile oil content of entries of coriander IET in 2008-09 and 2009-10 at Jobner

Entries	Seed Yield (Kg/ha)			Volatile Oil Content (%)			Volatile oil yield (l/ha)
	2008-09	2009-10	Mean	2008-09	2009-10	Mean	
UD-562	750	1375.00	1062.50	0.4	0.30	0.35	3.72
UD-563	879.63	1635.19	1257.41	0.4	0.30	0.35	4.40
UD-565	1277.78	1596.30	1437.04	0.4	0.43	0.42	5.99
UD-663	1680.56	1724.07	1702.32	0.4	0.43	0.42	7.09
UD-706	717.59	1745.37	1231.48	0.3	0.40	0.35	4.31
UD-737	1379.63	1221.30	1300.47	0.23	0.30	0.27	3.45
UD-794	1421.3	2004.63	1712.97	0.4	0.33	0.37	6.28
RCr-435 Check	1356.48	1644.44	1500.46	0.43	0.43	0.43	6.48
RCr-436 Check	1245.37	1437.50	1341.44	0.4	0.33	0.37	4.92
Local Check	865.74	1212.96	1039.35	0.33	0.30	0.32	3.27
CD at 5 %	202.35	252.46		0.05	0.06		
CV (%)	10.43	9.44		8.55	10.38		

Table 49. Volatile oil content of entries of coriander CVT in 2009-10 at Jobner

Entry	Seed yield (kg/ha)	Volatile oil (%)	Volatile oil yield (l/ha)
COR-25	1389.35	0.30	4.17
COR-26	1349.07	0.30	4.05
COR-27	1557.41	0.43	6.75
COR-28	1172.22	0.30	3.52
COR-29	948.15	0.43	4.11
COR-30	1139.81	0.30	3.42
COR-31	1601.85	0.43	6.94
COR-32	1540.28	0.30	4.62
COR-33	1509.72	0.30	4.53
COR-34	1535.65	0.47	7.17
COR-35	1149.07	0.30	3.45
Hisar Anand NC	1487.04	0.30	4.46
RCr-435 Check	1496.76	0.43	6.49
Local Check	1064.35	0.30	3.19
CD at 5%	162.00	0.05	
CV (%)	7.13	8.56	

COR/CM/5 Production of leafy type of coriander in off season

(Kumarganj, Coimbatore)

The study on production of leafy type coriander in off season (summer) was taken up in 2010-2011 under different shade levels with four different leafy genotypes at Coimbatore. Among the three shade levels, 50% shade resulted in higher leaf yield followed by 25% shade. Among the genotypes East West (6.76 kg/10m^2) recorded the highest leaf yield followed by CS 11 (6.47 kg/10 m^2). Significant difference was observed for all the parameters among the genotypes, shade levels and the interaction effect. Early germination (7days) was observed by the genotype East West under 50% and 75% shade levels. The days taken for harvest varied from 35 to 42 days. Late harvest was observed in the genotype East West under 50% shade. In the case of number of compound leaves per plant, it varied from 5.00 to 7.20. The highest number of compound leaves per plant was observed by the genotype East West (7.20) under 50% shades. Regarding the leaf yield per plot, it varied from 4.00 kg to 6.76 kg. The highest leaf yield was recorded by all the genotypes under 50% shades. Among the genotypes the highest leaf yield per plot was recorded by the genotype East West (6.76 kg) followed by CS 11 (6.40 kg per plot). Germination of seeds was very poor at Kumarganj.

COR/CM/5.4 Role of rhizobacteria in growth promotion of coriander

(Hisar and Jagudan)

This is the third year of experiment in which two types of rhizobacteria (FK14 & FL18) 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 nonsignificant except number of umbels per plant and umbellates per umbel. The maximum number of umbel per plant was recorded when coriander received rhizobacteria FK14 as seed and soil inoculation and was at par with RDF alone, FK14 as seed inoculation, FK14+FL 18 as seed inoculation and soil inoculation and *Trichoderma* application. Whereas umbellates per umbel was the maximum under *Trichoderma* application and was at par with FK 14 as seed inoculation, RDF alone as well as FK 14 and FL 18 as seed and soil inoculation. In general, growth and yield attributes as well as seed yield were higher when crop received only recommended dose of fertilizer.

COR/CM/5.6 Nutrient supplementation though organic manures for growth and yield of coriander

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

A trial on nutrient supplementation through organic manures for growth and yield of coriander was taken up for the second time during 2010-2011 with eight treatments at Coimbatore. Significant difference was observed for all the growth and yield parameters studied between the treatments. Among the eight treatments of study, the treatment, T_7 (Recommended Integrated nutrient package) has recorded the highest coriander seed yield (1250 kg/ha) followed by treatment T_6 (RDF alone-Chemical fertilizers) (944.43 kg/ha).

All the treatments gave significant effect regarding number of primary branches per plant, number of umbellets per umbel, number of grains per umbel and yield per plot or projected yield per hectare as compared to absolute control (T_8) at Dholi. However, all the treatments were found significant effect regarding height of the plant and number of secondary branches per plant and number of umbels per plant as compared to absolute control (T_8) except treatment (T_2) vermicompost (100%) @ 5 t/ha. While treatment (T_4) FYM (25%) + vermicompost (75%) was not found significant superior as compared to absolute control regarding number of secondary branches per plant as compared to absolute control. Among the treatment, recommended dose of integrated nutrient management (INM) (T_7) gave maximum height of the plant (138.46 cm), number of primary branches per plant (8.60), number of secondary branches per plant (15.73), number of umbels per plant (53.67), number of umbellets per umbel (6.80), number of grains per umbel (56.13), and yield per plot (1.45 kg/6.0 m^2) or projected yield (2.17 t/ha) followed by recommended dose of fertilizers (RDF) alone (T_6) i.e., plant height (135.07 cm), number of primary branches per plant (7.93), number of secondary branches per plant (15.60), number of umbels per plant (45.93), number of umbellets per umbel (6.20), number of grains per umbel (51.20) and yield per plot (1.28 kg/6m^2) or projected yield per hectare (1.93 t/ha).

Maximum seed yield was recorded with the application of recommended INM (2086 kg/ha) followed by application of vermicompost (100%) @ 5t/ha (1844 kg/ha) and RDF (1795 kg/ha) at Hisar.

At Guntur, maximum plant height was recorded in T-7 (INM - 100% N + *Azospirillum* + 5 t/ha FYM) (64.6 cm) followed by T 4 (FYM 25% + Vermicompost(VC) 75%) (64.1 cm) which were on par with each other and significantly superior to the absolute control (58.0 cm). Maximum number of primary branches were recorded in T 7 (INM - 100% N + *Azospirillum* + 5 t/ha FYM) (3.8) followed by T 4 (FYM 25% + VC 75%) (3.6) and T5 (FYM 75% + VC 25%) which were on par with each other and significantly superior to the absolute control (2.8). Similarly, maximum number of secondary branches were recorded in T 7 (INM - 100% N + *Azospirillum* + 5 t/ha FYM) (14.0) followed by T 6 (FYM 50% + VC 50%) (13.5) which were on par with each other and significantly superior to the absolute control (11.8). Maximum number of umbels were recorded in T 7 (INM - 100% N + *Azospirillum* + 5 t/ha FYM) (22.1) followed by T 3 (FYM 50% + VC 50%) (19.1) which were significantly superior to the absolute control (14.8). Regarding number of umbellets per umbel, T-7 (INM - 100% N + *Azospirillum* + 5 t/ha FYM) (7.4) followed by T 3 (FYM 50% + VC 50%) (7.36) which were on par with each other and significantly superior to the absolute control (6.7). Maximum number of seeds per umbel were recorded in T 7 (INM - 100% N + *Azospirillum* + 5 t/ha FYM) (48.0) followed by T 4 (FYM 25% + VC 75%) (19.9) which were on par with each other and significantly superior to the absolute control (38.4). Regarding days to 50% flowering, none of the treatments were significantly different from the control. Regarding maturity, T-7 (INM - 100% N + *Azospirillum* + 5 t/ha FYM) (87.7 days) matured significantly earlier than control (89.7 days). Among the treatments evaluated, T7 (100% N + *Azospirillum* + 5 t/ha FYM) recorded maximum yield (954.86 kg/h) followed by T3 (FYM 50% + VC 50%) (798.6 kg/ha) and T2 (VC 5 t/ha) (711.8 kg/ha) significantly superior than control (479 kg/ha).

At Kumarganj, recommended dose of fertilizer (60:30:30 kg NPK/ha) gave the maximum yield of 17.29 q/ha of coriander seeds followed by recommended integrated nutrient management practice producing 15.97 q/ha of coriander seeds

Table 50. Effect of nutrient supplementation through organic manures on the growth and yield of coriander during 2010-11 at Kumarganj.

Treatment	Plant height (cm)	No. of branches/ plant	No. of umbels/ plant	No. of umbellets /umbel	No. of seeds /umbel	Yield kg/plant	Yield q/ha
T_1=FYM (100%) @ 10t/ha	114.00	4.99	97.78	5.78	39.17	0.750	15.62
T_2= Vermi compost (100%) @ 5 t/ha	114.57	4.95	100.55	5.89	39.40	0.743	15.41
T_3= FYM (50%) + vermi compost (50%)	117.63	5.03	102.11	6.11	39.99	0.670	13.95
T_4=FYM (25%)+ vermi compost (75%)	119.67	4.97	104.78	6.56	43.11	0.753	15.69
T_5= FYM (75%)+ vermi compost (25%)	117.18	5.08	103.88	5.78	41.08	0.680	14.31
T_6=RDF alone chemical fertilizer	122.54	5.25	106.22	7.44	46.22	0.830	17.29
T_7=Recommended INM package of the centre	121.45	5.13	105.78	7.10	44.89	0.766	15.97
T_8= Absolute control	112.66	4.77	96.22	5.44	36.55	0.610	12.70
sem ±	0.62	0.07	0.48	0.19	0.39	0.01	0.22
CD (0.05)	1.87	0.22	1.47	0.57	1.18	0.03	0.65
CV%	0.91	2.55	0.82	5.23	1.63	2.29	2.47

against control of 12.70 q/ha. Minimum stem gall disease of 11.66 % (PDI) was recorded in FYM (75%) + vermi compost (25%) and powdery mildew 40% in RDF alone chemical fertilizer (Table 50).

COR/CM/5.7 Effect of micronutrients on yield of coriander

(Coimbatore, Dholi)

A study on the effect of micronutrient on the yield of coriander (variety CO (CR) 4) at Coimbatore, revealed that the treatments differed significantly for growth and yield parameters. Among the twelve treatments imposed, the highest coriander seed yield was obtained in the treatment T_7 (copper as copper sulphate (soil application) 25 kg ha^{-1}) (900 kg/ha) followed by T_2 (0.5% foliar spray of zinc sulphate (2 sprays-45 & 60 days of sowing) with a yield of 894.33 kg/ha (Table 51).

Four micro-nutrients viz., zinc sulphate, ferrous sulphate, copper sulphate and manganese sulphate, all the micro-nutrients gave the significant effect regarding number of umbels per plant. However, ferrous sulphate (F_2) produced the maximum number of umbels per plant (48.77) followed by manganese sulphate (F_4) i.e., (48.17). Regarding yield, all the micro-nutrient gave the significant effect. Among the micro-nutrients, ferrous sulphate (F_2) produced the maximum yield per plot (1.09 kg/$6m^{-1}$) or projected yield per hectare (1.64 t/ha) followed by Zinc sulphate (F_1) and Copper sulphate (F_3) i.e., yield per plot (0.94 kg/$6m^{-1}$) or projected yield per hectare (1.42 t/ha). Three doses of micro-nutrients viz; zero level (Control), soil application of micro-nutrients @ 25 kg/ha and two foliar spray of micro-nutrients @0.5% at 45 and 60 days after sowing, soil application and foliar application were found significantly regarding all the character as

Table 51. Effect of micronutrient on yield of coriander (2009-10) at Coimbatore

Treatment	Plant height (cm)	No. of primary branches	No. of secondary branches	No. of umbels /plant	No. of umbellets / umbel	No. of seeds / umbel	Seed yield /plot (g) (4 x 2.7 m^2)
T_1	52.11	8.00	11.67	21.22	5.22	27.44	627.66
T_2	52.88	6.11	12.56	24.89	5.33	37.67	894.33
T_3	60.36	6.44	12.78	30.00	5.78	30.77	594.33
T_4	54.04	6.44	12.44	26.67	5.67	29.67	827.66
T_5	55.14	6.11	13.11	25.33	5.78	31.22	716.67
T_6	61.43	6.00	12.11	29.56	5.56	33.78	605.67
T_7	55.21	6.11	13.11	30.33	6.11	34.11	900.00
T_8	53.77	6.00	13.89	26.33	5.67	30.11	850.00
T_9	60.77	5.22	11.44	22.33	5.44	25.33	661.00
T_{10}	51.17	6.67	12.22	23.67	6.33	27.56	716.67
T_{11}	55.88	6.22	12.33	27.89	6.00	30.33	705.67
T_{12}	55.32	6.78	12.89	24.78	5.56	27.67	683.33
SED	Mn- 2.009	Mn - 0.230	Mn - 0.451	Mn -0.945	Mn -0.204	**Mn -1.106**	**Mn -7.903**
	MnL -1.740	MnL -0.199	MnL - 0.390	MnL -0.818	MnL -0.176	**MnL -0.958**	**MnL -6.84**
	Mn MnL-3.480	Mn MnL-0.399	Mn MnL- 0.781	Mn MnL-1.63	Mn MnL-0.35	**Mn MnL-1.916**	**Mn MnL-13.68**
CD (P=0.05)	Mn -4.167	Mn - 0.477	Mn - 0.935	Mn -1.960	Mn -0.423	**Mn -2.295**	**Mn - 16.39**
	MnL -3.609	MnL -0.413	MnL -0.810	MnL -1.698	MnL -0.366	**MnL -.987**	**MnL - 14.19**
	Mn MnL-7.218	Mn MnL-0.827	Mn MnL-1.620	Mn MnL-3.39	Mn MnL-0.73	**Mn MnL-3.975**	**Mn MnL-28.39**

T1 - Zinc as Zinc sulphate (Soil application) 25 kg ha^{-1}, T2 -0.5 % foliar spray of zinc sulphate (2 sprays-45 & 60 days of sowing), T3 – Control, T4- Iron as Ferrous sulphate (Soil application) 25 kg ha^{-1}, T5 - 0.5% foliar spray of ferrous sulphate (2 sprays-45 & 60 days of sowing), T6- Control, T7 - Copper as Copper sulphate (Soil application) 25 kg ha^{-1}, T8 - 0.5% foliar spray of copper sulphate (2 sprays-45 & 60 days of sowing), T9 – Control, T10 - Manganese as manganese sulphate (Soil application) 25 kg ha^{-1}, T11 - 0.5% foliar spray of manganese sulphate (2 sprays-45 & 60 days of sowing), T12- Control.

compared to zero level (Control). However, soil application of the micro-nutrients @25.0 kg/ha gave the maximum plant height (124.86 cm), number of primary branches per plant (7.33), number of secondary branches per plant (16.92), number of umbels per plant (53.28), number of umbellets per umbel (6.51), number of grains per umbel (39.67) and yield per plot (1.16 kg/6m^2) or projected yield per hectare (1.75 t/ha) followed by two foliar application of micro-nutrients @0.5% at 45 and 60 days after sowing i.e., height of the plant (123.44 cm), number of primary branches per plant (7.03), number of secondary branches per plant (16.16), number of umbels per plant (52.56), number of umbellets per umbel (6.05), number of grains per umbel (40.10) and yield per plot (0.98 kg/6m^2) or projected yield per hectare (1.48 t/ha).Interaction effect of micro-nutrients and doses of micro-nutrients i.e., soil application as well as foliar applications of micro-nutrients were found non-significant effect regarding all the character of yield and yield parameters.

COR/CM/5.8 Irrigation management for sustainable coriander production

(Guntur)

During 2010-11, three methods were tried i.e. irrigation through raingun, sprinkler, and flooding. Among the methods of irrigation, irrigation through Raingun recorded higher yields (1272.6kg/ha). However, among the irrigation schedules, irrigation at 30 and 45 DAS recorded highest yield (1517 kg/ha) followed by irrigation at 30 DAS (1176 kg/ha).Among the interactions irrigation at 30 and 45 DAS through flooding recorded higher yields (2191 kg/ha).

COR/CM/5.9 Nutrient management in off season coriander leaf production

(Periyakulam, Coimbatore, Guntur)

A study on nutrient management in off-season production of coriander leaf was initiated at Coimbatore, during 2010 -11 with nine different treatments replicated thrice.the days taken for germination did not exhibit any significant variation among the treatments. Significant variation was noticed for the leaf yield among the treatments. The leaf yield varied from 9.71 kg per plot (10m^2) to 14.74 kg per plot. The highest yield was recorded by the treatment T_8 (45:40:20 NPK + spraying with GA 10 ppm at 20 DAS) followed by the treatment T_4(30:40:20 NPK + spraying with GA 5ppm at 20 DAS) (Table 52).

COR/CP/6 Disease Management Trial

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

(Dholi)

At Dholi, out of 143 germplasm, 45 and 58 germplasm were found Highly resistant and resistant against stem gall disease under natural.

Table 52. Effect of nutrient on off season coriander leaf production (2010-11) at Coimbatore

Treatment	Days to germination	Plant height (cm)	Days to 50% flowering	No. Primary branches	No. of Secondary branches	Yield /plot (4 x 2.4 m) (kg)
T_1- Control	10	27.71	35	3.0	8.0	7.89
T_2- 30:40:20 NPK	10	29.57	38	4.0	9.0	9.71
T_3- 45:40:20 NPK	11	28.49	38	4.0	9.0	11.28
T_4- 30:40:20 NPK + GA 5ppm at 20 DAS	10	30.45	40	4.0	12.5	14.46
T_5-30:40:20 NPK + GA 10ppm at 20 DAS	10	28.27	42	4.0	11.0	13.72
T_6-30:40:20 NPK + GA 15ppm at 20 DAS	10	28.87	42	5.0	12.0	13.92
T_7-45:40:20 NPK + GA 5ppm at 20 DAS	10	23.63	40	5.0	11.0	13.07
T_8-45:40:20 NPK + GA 10ppm at 20 DAS	10	23.31	40	4.0	12.0	14.74
T_9-45:40:20 NPK + GA 15ppm at 20 DAS	10	29.66	40	4.0	12.0	12.87
SED	0.645	1.78	2.53	0.26	0.69	0.81
CD (P=0.05)	1.368	3.77	5.37	0.57	1.47	1.71

Coriander cultivated field surveyed under Samastipur and Muzaffarpur districts of state were found to be infested with stem gall disease caused by *Protomyces macrospores*.

COR/CM/ Management of stem gall disease of coriander

(Dholi, Pantnagar, Jabalpur, Udaipur, Raigarh & Kumarganj)

A field trial was conducted o of stem gall disease of coriander to see the effect of different fungicides and bio-control agents on control of stem gall disease of coriander at Dholi. All the treatments were found to have statistically significant effect on reduction of stem gall incidence and increasing yield over control except disease severity which was not significantly influenced by treatments (T_1 & T_2) i.e., seed treatment as well as spray by IISR *Trichoderma* and *Pseudomonas* formulation (@0.40%) at 45, 60 and 75 DAP. Highest yield (2.28t/ha) with lowest PDI (15.00%) was recorded in treatment (T_2) where seeds were treated with Propiconazole (@0.20%) prior to sowing and also the crop was sprayed at 45, 60 and 75 DAP (@0.20%).

At Pantnagar, the highest seed yield was recorded in T4 treatment (i.e., seed treatment with blitox @ 0.20) + spray at 45, 60 & 75 DAP (@0.20) followed by T6 treatment i.e., Seed treatment with propinazole (@0.20%) + spray at 45, 60 & 75 DAP (0.20%) indicate best suited treatment to control stem gall of coriander under *tari* region conditions.

At Raigarh, minimum disease incidence (8.1%) was recorded when seed were treated with Hexaconazole (@0.20%) + its spray at 45, 60 & 75 DAP which were at par with seed treated with Propiconazole (@0.20%) + spray at 45, 60 & 75 DAP (@ 0.20%) (9.0%). The respective maximum yield were 7.7 q/ha and 7.5 q/ha.

Stem gall disease was first observed in T5 treatment (S T with Hexaconazole (@ 0.20 %) + spray at 40, 60 & 75 DAP (@ 0.20 %) on 5.2.2011 at Kumarganj. Minimum stem gall disease of 44.16 (PDI) was recorded in seed treatment with Hexaconazole @ 0.2 % and foliar spray of Hexaconazole (0.2%) at 45, 60 and 90 DAP with maximum seed yield of 18.95 q/ha followed by 48.33 % stem gall disease by treatment of seeds with propaconazole @ 0.2% with foliar spray at 45, 60 and 90 DAP against the control of 81.66 % of stem gall disease. Minimum incidence of powdery mildew disease was also in seeds with propaconazole @ 0.2% with foliar spray at 45,60 and 90 DAP followed by seed treatment with Hexaconazole @ 0.2 % and foliar spray of Hexaconazole (0.2%) at 45,60 and 90 DAP. Maximum seed yield of 18.94 q/ha was recorded in S T with Propiconazole (@ 0.20 %) + spray at 40, 60 & 75 DAP (@ 0.20 %) followed by 18.39 q/ha in S T with Hexaconazole (@ 0.20 %) + spray at 40, 60 & 75 DAP (@ 0.20 %).

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

(Coimbatore, Guntur, Hisar, Jagudan, Raigarh)

A study on large scale demonstration of the role of r*hizobacteria* in growth promotion of coriander with the variety CO (CR) 4 at Coimbatore revealed that all the three treatments were significantly different for all the growth and yield parameters studied. Among the three treatments, the treatment T_1 (rhizobacteria FK 14 + FL 18 (seed treatment-600g per ha + soil application - 800g per ac) recorded the highest seed yield of 522.22 kg/ha followed by T_2 (rhizobacteria FL 18 (seed treatment + soil application) 466.66 kg/ha.

At Guntur, during 2010-11, three treatments with rhizobacteria were evaluated in large-scale plots in farmers' fields. Among the treatments evaluated, the seed treatment and soil application of FK14 resulted significantly superior leaf yield (1076 t/ha) over control (851 t/ha) which was on par with seed treatment and soil application with FK14 + FK 18 (1037 t/ha).

The significant differences were obtained for all the parameters at Hisar. The maximum seed yield (1696 kg/ ha) was recorded with the application of rhizobacteria FL-18 (seed treatment + soil application) followed by *Trichoderma* MTCC-5179 (1568 kg/ha).

COR/CP/1.1 Screening of coriander entries against powdery mildew disease

(Jagudan & Jobner)

A total one hundred seventy two (170+2) entries were screened under natural condition at Jagudan. None of the entries were found free from the

powdery mildew incidence. Out of one hundred nine (107+2) entries of Jagudan centre, the minimum incidence was noticed in Jcr-328 (34.00%). The range was between 34.00 to 78.80%.

Out of twenty three entries of Guntur, the minimum incidence was found in LCC-261 (38.75%). The range was from 38.75 to 76.00%. Out of twenty entries of Kumargunj, the minimum incidence was found in NDCor-61(37.50%) and the range was between 37.50 to 60.50%. Out of twenty entries of Jobner, the minimum incidence was recorded in UD-173 (40.00%) and range from 40.00 to 68.75%.

Fourteen entries under CVT were screened against powdery mildew disease at Jobner. None of the entries were found immune and resistant to powdery mildew. Entries COR-25, COR-31 & COR-34 were observed moderately resistant and COR-27, COR-28, COR-29, COR-32, COR-33 & RCr-435 were found susceptible whereas, COR-26, COR-30, Hisar Anand, COR- 35 & Local were found highly susceptible to powdery mildew disease.Ten entries of coriander (IET) were screened against powdery mildew. None of entries were found resistant against powery mildew.Entries UD-562, UD-563, UD-565,UD-663,UD-706 & UD-794 were observed resistant,UD-737,RCr-435,RCr-436 were susceptible and Local check was observed highly susceptible.

CUMIN

CUM/CI/1 Genetic Resources

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

(Jagudan and Jobner)

The germplasm of cumin maintained at Jobner and Jagudan is given in Table 53. At Jagudan, 218 genotypes of cumin were compared with check GC-4 during *rabi* season 2010-11. Among them ten entries observed dwarf type, having less than 28.6 cm plant height. Two entries had more branches i.e. equal 7.0 branches per plant. The more than 40 umbels per plant were recorded by 2 entries. Six entries recorded more than 6.0 Umbellates per umbel. Four entries were promising for more seeds per umbelt. i.e. e" 7.0 seed per umbelt. Nine entries observed more or less early maturity (d" 92 days). Three entries were bold seeded having equal or more than 4.70 gm test weight. Six entries isolated as high yielder recorded more than 800 kgha grain yield.

***Alternaria* blight disease (Caused by *Alternaria burnsii*)** Total one hundred twenty (217+3) entries were screened for the resistance against blight disease. None of the entries was found free from blight disease incidence. The minimum incidence was noticed in GC-4 (33.50%) followed by JC-2002-37, JC-2002-56, JC-2000-53 and JC-2000-47.

Table 53. Cumin germplasm collection under AICRPS centres

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

Powdery mildew disease (Caused by: *Erysiphe polygoni*) incidence ranged from 33.50 to 100.00 per cent total one hundred twenty (217+3) entries were screened for the resistance against powdery mildew disease under natural condition. The incidence was reported moderately to highly susceptible and it was ranged between 36.40 to 85.75 %. The minimum incidence was found in JC-2000-65 (36.40%) followed by JC-2000-54, JC-2000-47, JC-99-2, JC-95-27, JC-95-31, JC-2002-33,CUM-10 and JC-2002-29.

Wilt disease (Caused by: *Fusarium oxysporum* f. sp. *cumini*) Total two hundred thirty three (230+3) entries were screened under wilt sick plot condition, GC-4 was showed minimum wilt incidence (45.75%) followed by GC-3. The wilt disease incidence ranged between 45.75 to 100.00 per cent.

CUM/CI/2 Coordinated Varietal Trial

CUM/CI/2.2 CVT - 2009

(Jobner and Jagudan)

At Jobner, ten entries were evaluated in RBD with 4 replications in a plot size of 3 x 2.4 sq. m. accommodating eight rows spaced 30 cm apart with plant to plant distance of 5 cm maintained by thinning. 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.

At Jagudan, the yield differences among the entries were significant. None of the entries gave the higher yield over check GC-4, GC-3 and GC-2.

CUM/CI/ Coordinated Varietal Trial – 2009

(Jobner, Jagudan, Ajmer, Jabalpur)

Five genotypes along with one Check GC-4 were

tested for their performance at Jabalpur condition. Cumin is not a suitable crop for Jabalpur. The germination of all the genotypes was very poor (10-20%). However maximum plant height (37.78 cm), number of umbel/ plant (9.00), number of umbellets / umbel (3.92) and yield/plot (48.50 g) and yield / ha (47.99kg/ ha) was obtained from CUM 11.

CUM/CI/3 Varietal Evaluation Trial

CUM/CI/3.3 Initial evaluation trial -2009

(Jobner)

Twelve entries were evaluated in RBD with 4 replications in a plot size of 3 x 2.4 sq. m. accommodating eight rows spaced 30 cm apart with plant to plant distance of 5 cm maintained by thinning. The analysis of variance revealed significant differences among the entries for all the traits including seed yield. The seed yield ranged from 351.04 to 720.49 kg/ha. Of the twelve entries evaluated, UC-339 recorded maximum seed yield of 720.49 kg/ha followed by UC-336 (640.97), UC-293 (625.69 kg/ha) and UC-292 (575.00 kg/ha), while lowest seed yield of 351.04 kg/ha was recorded in Local check .

At Jagudan, the yield differences among the entries were significant. None of the entries gave the higher yield over check GC-4. The entries viz., JC-95-103 and JC-96-127 gave 1028 and 877 kg per ha yield which was 69.6 and 44.7 per cent higher than GC-2.

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

(Jagudan)

At Jagudan, 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 FK14 and FL18 applied as seed and soil inoculation recorded the maximum growth and yield attributes as well as seed yield of cumin.

CUM/CP/6 Disease Management Trial

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

(Jobner)

A field experiment with eleven treatments in RBD was conducted; each treatment was replicated three times. The plot size 4 x 2.5 m accommodating eight rows spaced 30 cm apart with intra row spacing of 10 cm maintained by thinning. Out of eleven treatments, the minimum wilt incidence (5.57 %) and blight incidence (4.13%) was recorded in the treatment where soil solarization and soil application of *Trichoderma* + FYM and spray with Mancozeb @ 0.25% with maximum seed yield 351.33 kg/ha, was recorded, it was closely followed by vermicompost + soil application of *Trichoderma* and spray with mancozeb @ 0.25% wilt (6.87 %) and blight (4.86%) with the seed yield of 251 kg/ha. The control resulted maximum disease incidence wilt (26.35 %) and blight (24.57 %) with lowest yield (97.67 kg/ha) as compared to all other treatments. 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, treatment Soil drench 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 followed by vermicompost (2 t/ha) + *Trichoderma* + spray with mancozeb 0.25% (60 DAS) with B:C ratio of 1.34.

At Jagudan, the data revealed that the incidence of blight and wilt disease was moderate. The results of the different treatments were found significant. The minimum incidence of blight was found in spray of mancozeb @ 0.25% at 40, 50, 60 & 70 DAS (T11) (24.58%) and it was at par with the treatment of Soil solarization + soil application of *Trichoderma harzianum* + spray mancozeb @ 0.25% at 60 DAS (T1) (26.19%), FYM + soil application of *T. harzianum* + spray mancozeb @ 0.25% at 60 DAS (T2) (26.48%) and vermicompost + soil application of *T. harzianum* + spray mancozeb @ 0.25% at 60 DAS (T3)(27.53%). The significantly minimum incidence of wilt disease was found in soil solarization+ soil application of *T. harzianum* + spray mancozeb @ 0.25% at 60 DAS (T1) (18.06%) and followed by FYM + soil application of *T. harzianum*+ spray mancozeb @ 0.25% at 60 DAS (T2) (20.73%), *Pseudomonas fluorescence* (IISR-6)10^{9} cfu as seed treatment + soil application of *T. harzianum* + *P. harzianum* + *P. fluorescence* as spray (T9) (22.70%). The data of yield also showed significant results. The maximum yield was found in spray of mancozeb @ 0.25% at 40, 50, 60 & 70 DAS (T_{11}) (434.17 kg/ha) and it was at par with the treatment of soil solarization + soil application of *T. harzianum* + spray mancozeb @ 0.25% at 60 DAS (T_{1}) (418.89 kg/ha), *P.*

fluorescence (IISR-6)10⁸ cfu as seed treatment + soil application of *T. harzianum* + *P. fluorescence.* as spray (T_1) (406.67 kg/ha) and FYM (5 ton/ha)+ soil application of *T. harzianum* + spray mancozeb 0.25% (60 DAS) (T_2) (402.50 kg/ha).

CUM/CP/6.1 Management of cumin wilts through biocontrol agents

(Jobner)

A field experiment with twelve treatments in RBD was conducted. Each treatment was replicated three times. The plot size 4 x 2.5 m accommodating eight rows spaced 30 cm apart with intra row spacing of 10 cm maintained by thinning. All the treatments were found significantly superior over control. Application of *Trichoderma harzianum* @10 Kg/ha + FYM @ 3 ton/ha resulted minimum wilt incidence (18.05%) and maximum seed yield (537 kg/ha) and B:C ratio (2.92). It was at par with application of *T .harzianum* @ 10 kg/ha + vermi-compost @ 3.2 ton/ha exhibited 18.12% wilt incidence, seed yield 527 kg/ha and B:C. ratio 2.24. Both the treatments also exhibited higher percentage of volatile oil (4.13%). Control gave maximum wilt incidence (66.60%) and minimum seed yield (197 kg/ha).

CUM/CP/6.2 Survey for identification of yellowing causing organisms in cumin

(Jobner, Jagudan, Jobner)

Survey was conducted in different cumin growing areas of North Gujarat. The range of yellowing was 4.0 – 15.0. No organism was isolated from infected plant samples collected from different villages of North Gujarat

FENNEL

FNL/CI/1 Genetic Resources

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

(Dholi, Hisar, Jagudan, Jobner & Kumarganj)

The germplasm of fennel maintained at various AICRPS centres are given in Table 54.

Fifty six collection of fennel were tested for promising line in respect of yield at Dholi. Out of fifty six collection or accession, only five accession namely, RF-14, RF-20, RF-15, RF-5 and HF-125 gave the maximum yield ranging from (0.95 to 0.80 kg/5.4m^2) as compared to high yielding variety GF-2 check (0.72 kg/5.4m^2) use as check. Among promising line RF-14 gave the maximum yield (0.95 kg/5.4m^2) followed by RF-20 (0.90 kg/5.4m^2).

At Hisar, eighty-three accessions of fennel were evaluated during 2010-2011 in two row plots of 3.0 m length each using GF-2 and HF-33 as checks. The mean seed yield of the germplasm ranged from 106 g/plant (HF-195) to 466 g/plant (HF-151). The most promising lines were HF-142, HF-144, HF-145, HF-148, HF-151, HF-168, HF-170, HF-212 and HF-213. These lines were maintained by sib mating under muslin cloth and self seed of all the lines have been harvested.

During the kharif and *rabi* season, the 124 and 16 indigenous and 3 and 1 exotic entries of fennel were evaluated for different yield attributes with five checks i.e. PF-35, GF-1, GF-2, GF-11 and GF-12, respectively at Jagudan. Among them nine entries observed as dwarf type, having less than 125 cm plant height. Eight entries had good branches i.e. more than 13 branches per plant. More than 52 umbels per plant were recorded by 3 entries. Six entries recorded more than 81 umbellates per umbel. Three entries were promising for more seeds per umbellate i.e. e" 70 seed per umbellate. Eight entries observed more or less early maturity (< 130 days) types. Seven entries has high test weight i.e. > 10 g. Five entries were high yielder which recorded more than 4960 kgha-1 grain yield.

Out of 70 germplasm at Kumargang, NDF-46 showed maximum seed yield of 13.50 q /ha followed by 13.30 q /ha in NDF-5.

Multilocational trial on fennel

(Kumarganj, Jagudan)

Fifteen germplasm of fennel were tested in six blocks with three checks at Kumarganj. Maximum seed yield of 11.50 q/ha was recorded in NDM-6 followed by the field of 11.30 q/ha JF-499 (11.30 q/ha). None of the germplasm was disease free for powdery mildew under field conditions.

At Jagudan, one hundred fifty one entries (150+1) were screened against *Ramularia* blight diseases during *rabi* season. All screened entries were free from disease during ensuing crop season.

Table 54. Fennel germplasm collections maintained at various AICRPS centres

Centre	Indigenous	Exotic	Total
Dholi	56	-	56
Guntur	2	-	2
Hisar	138	-	138
Jagudan	129	2	131
Jobner	261	20	281
Kumarganj	70	-	70
Pantnagar	2	-	2
Total	658	22	680

FNL/CI/2 Coordinated Varietal Trial
FNL/CI/2.3 CVT 2007 – Series VI
(Jagudan, Jobner, Kumarganj, Hisar)

At Jobner, twelve entries were evaluated in RBD with 3 replications in a plot size of 4 x 2.5 sq. m. accommodating five rows spaced 50 cm apart with intra row spacing of 20 cm maintained by thinning. The analysis of variance revealed significant differences among the entries for all the traits including seed yield. The seed yield ranged from 669.78 to 1817.33 kg/ha. Of the twelve entries evaluated, entry FNL-26 recorded maximum seed yield of 1817.33 kg/ha followed by FNL-25 (1694.22 kg/ha), RF-125 check (1607.56 kg/ha), FNL-36 (1501.78 kg/ha), FNL-29 (1434.67 kg/ha), FNL-35 (1428.00 kg/ha) and FNL-27 (1391.11 kg/ha), while lowest seed yield of 669.78 kg/ha was recorded in FNL-33. Mean performance of the entries evaluated in CVT over 2007-08 to 2009-10 revealed superior performance of FNL-26 yielding 2187.18 kg/ha followed by FNL-25 (2164.06 kg/ha), FNL-24 (2032.41 kg/ha), RF-178 check (1786.67 kg/ha), RF-125 check (1779.12 kg/ha) and FNL-30 (1730.93 kg/ha), while lowest seed yield of 1214.19 kg/ha was recorded in FNL-33 (Table 55).

At Kumarganj, NDM –25 (check) gave the maximum seed yield of 19.27 q/ha. Among other entries, FGK-31 gave seed yield of 17.28 q/ha. None of the entries were found free from powdery mildew disease.

FNL/CI Coordinated Varietal Trial - 2009
(Ajmer, Dholi, Hisar, Jabalpur, Jagudan, Jobner, Kumarganj, Pantnagar, Udaipur, Raigarh)

At Dholi, ten promising entries and four checks (Three national checks and one local check) were tested under co-ordinated varietal trial during 2010-2011. Between four checks, local check Rajendra Saurabh was found significantly superior regarding number of umbels per plant (54.67), number of umbellets per umbel (41.83) and number of grains per umbellet (35.00) as compared to other national check variety. Rajendra Saurabh gave the maximum yield (0.72 kg/7.2m^2) or projected yield (895.83kg/ha) followed by national check variety RF-205 N.C i.e., yield per plot (0.67 kg/7.2m^2) or projected yield per hectare (833.33 kg/ha).

Among the promising entries and four check, entry FNL-43 recorded significantly more number of primary branches per plant, number of umbels per plant, number of umbellets per umbel, number of grains per umbellet and yield per plot or projected yield per hectare as compared to best check

Table 55. CVT of fennel during 2007-08 to 2009-10 (Pooled over three years) at Jobner

Entry	Seed Yield (kg/ha)				
	2007-08	2008-09	2009-10	Total	Mean
FNL-24	-	2032.41	-	2032.41	2032.41
FNL-25	2460.00	2337.96	1694.22	6492.18	2164.06
FNL-26	2022.00	2722.22	1817.33	6561.55	2187.18
FNL-27	1282.00	2138.89	1391.11	4812.00	1604.00
FNL-28	1476.67	2203.70	1316.00	4996.37	1665.46
FNL-29	1323.33	1875.00	1434.67	4633.00	1544.33
FNL-30	1526.67	1935.19	-	3461.86	1730.93
FNL-31	753.33	2231.48	-	2984.81	1492.41
FNL-32	1280.00	2125.00	1009.78	4414.78	1471.59
FNL-33	986.67	1986.11	669.78	3642.56	1214.19
FNL-34	1346.67	1736.11	1001.78	4084.56	1361.52
FNL-35	1466.67	1740.74	1428.00	4635.41	1545.14
FNL-36	1626.67	1828.70	1501.78	4957.15	1652.38
Local Check	1116.67	1731.48	1209.33	4057.48	1352.49
RF-125 Check	1950.67	-	1607.56	3558.23	1779.12
RF-178 Check	1786.67	-	-	1786.67	1786.67
CD at 5%	**302.62**	**251.69**	**229.16**		
CV (%)	**12.11**	**7.45**	**10.35**		

Rajendra Saurabh. Among the promising entries, FNL-43 gave the maximum primary branches per plant (12.67), number of secondary branches per plant (26.16), number of umbels per plant (67.50), number of umbellets per umbel (59.83), number of grains per umbellet (43.00) and yield per plot (1.43 kg/7.2m^2) or projected yield (1791.67 kg/ha) followed by FNL-41 i.e., number of primary branches per plant (9.00), number of umbels per plant (55.67), number of umbellets per umbel (47.33), number of grains per umbellet (31.17) and yield per plot (1.07 kg/7.2m^2) or projected yield per hectare (1333.33 kg/ha).

Significant differences were obtained for all the parameters at Hisar. Plant height ranged from 123.4 to 164.4, number of branches 8.1 to 9.4, umbels per plant 28.6 to 58.6, umbellate per umbel 29.3 to 36.9 and seeds per umbel 332.4 to 671.6 Maximum seed yield was recorded as 1923 kg/ha in FNL-41 followed by FNL-37(1887kg/ha) and FNL-42(1867kg/ha), respectively.

Thirteen genotypes were tested under Jabalpur condition, and observed that FNL-46 gave the maximum plant height (153.20 cm) and primary branches (11.53), whereas, FNL-40 gave maximum no. of umbels / plant (25.56), umbellets/ umbel (38.16) and yield (2.375 Kg / plot and 2.633 t/ha). FNL-37, FNL-38, FNL-41, FNL-43, FNL-44, GF-11 and RF-101 are at par with each other.

Significant yield differences were observed among entries at Jagudan. However, an entry FNL-40 gave higher yield (i.e., 1196 kg ha^{-1}) than both the checks GF-11, RF-101 and RF-205, which was 3.11, 6.39 and 8.61 per cent higher, respectively. The pooled over two year's data shown significant differences for yield. Entry FNL-40 gave 1315 kgha^{-1} yield, which was 12.11 and 8.05 per cent higher over check GF-1 and GF-12 Jagudan.

Fourteen entries were evaluated in RBD with 3 replications in a plot size of 4 x 2.5 sq. m. accommodating five rows spaced 50 cm apart with intra row spacing of 20 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 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.

At Kumarganj, NDF-5 (Check) gave the maximum seed yield of 15.62 q/ha. Among entries FNL-44 gave maximum seed yield of 14.85 q/ha followed by 14.65 q/ha of seed yield in FNL-43.

The significant differences were observed for all the characters at Pantnagar. Highest seed yield (2998.67 kg/ha) was recorded in FNL-44, followed by local check Pant Madhurika (2832.00 kg/ha) and FNL – 42 (2721.00 kg/ha).

Twelve entries were evaluated along with the three checks for yield and its related characters at Raigarh. Among the entries, entry FNL-40 with yield 1061.67 kg/ha was found significantly superior over the checks i.e. RF-101 (877.00 kg/ha), RF-205 (473.33 kg/ha) and GF-11 (437.67 kg/ha). The entry FNL-39 (680.00 kg/ha) and FNL-41 (680.00 kg/ha) were also good yielders.

FNL/CI/3 Varietal Evaluation Trial

FNL/CI/3.1 Initial evaluation trial

(Hisar, Jobner, Kumarganj, Jagudan)

The initial evaluation trial (IET) in fennel was conducted with ten accessions along with HF-33 as check during 2010-2011 in plots measuring 3.0 x 2.4 m at Hisar. The results indicated that HF-151 and HF-212 gave significantly better yield over GF-2 (check) showing 31.25 and 19.02 % increase in yield, respectively.

At Jobner, 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.

At Kumarganj, NDF-46 gave the maximum yield of 13.54 q/ha over control of 10.58q/ha.

Significant yield differences were observed among entries at Jagudan. The entries JF 671-1, JF 674-1 and JF 671-2 gave the significantly superior yield (i.e., 1256, 1246 and 1243 kgha^{-1}), which 3.43, 2.67 and 2.36 per cent higher was over check GF-11, respectively. The pooled over two years data shown significant differences for yield. An entries JF 671-1, JF 671-2 and JF 674-1 gave 1194, 1187 and 1182 kgha^{-1} yield, which was 13.28, 12.62 and 12.14 per cent higher over check GF-11.

FNL/CI/4 Quality evaluation trial

FNL/CI/4.1 Quality evaluation in fennel

(Jobner)

CVT – 2007

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 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 minimum 1.87% was recorded in RF-178. The maximum mean volatile oil yield in terms of litre per ha was observed in FNL-26 (63.14 l\ha) followed by FNL-25 (56.99 l\ha), FNL-24 (48.17 l\ha) and minimum in FNL-33 (28.33 l\ha). FNL-26 and FNL-25 were identified as higher yielders for further evaluation.

CVT – 2009

Fourteen entries of fennel under CVT (new) 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 2.30% to 3.107%. 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 NC, 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 Fennel

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/5.2 Identification of drought/ alkalinity tolerance source in fennel

(Kumarganj)

At Kumarganj, NDF–12 showed maximum alkalinity tolerance (42.05) at 10, 20 and 30 ESP among 10 entries tested.

FENUGREEK

FGK/CI/1 Genetic Resources

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

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

One hundred seventy six collection of fenugreek germplasm were tested for promising line in respect of yield and yield attributing characters at Dholi. Among one hundred seventy seven collection of fenugreek germplasm, only seven accessions namely, RM-201, RM-190, RM-70, RM-12, RM-10, RM-44 and RM-28 gave the maximum yield ranging from (1.10 to 0.90 kg/5.4m^2). Among the promising accessions RM-201 gave the maximum yield (1.10 kg/5.4m^2) followed by RM-190, RM-70 & RM-12 i.e., (1.00 kg/5.4m^2). The germplasm of fenugreek conserved at various centres is given in Table 56.

Table 56. Fenugreek germplasm collections under AICRPS centres

Centre	Indigenous	Exotic	Total
Dholi	176	-	176
Guntur	123	-	123
Hisar	310	-	310
Jagudan	74	-	74
Jobner	353	12	365
Kumarganj	105	-	105
Pantnagar	20	-	20
Total	1161	12	1173

One hundred eighty six accessions of fenugreek were evaluated at Hisar along with Hisar Sonali, Hisar Suvarna and Hisar Mukta as checks during 2010-2011. The seed yield of the germplasm ranged from 7.5 g/plant (HM-478) to 23.6 g/plant (HM-392). The most promising lines for seed yield were HM-381, HM-392, HM-396, HM-401, HM-411, HM-424, HM-425, HM-443, HM-452, HM-456, HM-460, HM-466, HM-483 and HM-490.

At Jagudan, 75 entries including GM-2 as check were evaluated for different characters. Among them 12 entries (JFg- 180, 198,205,236,238,239, 240,243,244,266, 267 and GM-2) were found to be dwarf types having less than 55 cm plant height. Nine entries (JFg-15, 80, 52, 184, 185, 194, 195 201 and Kasuri Methi) had recorded more or equal to 6.5 branches per plant. Seven entries (Anantpur, JFg-15, 178, 185, 205, 265, 266 and JFg- 267) were found equal or more than 35 pods per plant. Long pod length i.e. ≥11.0 cm was recorded in entry JFg-208. More seed per pod i.e. ≥23.0 was found in 12 entries (JFg-207,209, 226, 228, 237, 241, 250,262 268, 267 and GM-1 and Kasuri Methi). JFg-52, 184 and 265 were early maturing types (before 90 days). Nine entries were bold seeded having equal or more test weight i.e. ≥12.50. Nine entries (JFg-15, 80, 52, 148, 221, 224, 244, GM-1 and JFg- 269) were high yielders (>3000 kg/ha).

During the year, total 84 (83+1) entries were screened against powdery mildew disease under natural condition. None of the entries were found free from the incidence of powdery mildew. The minimum incidence was noticed in JFg-195 (18.75%) and followed by JFg-224 (19.20%). The incidence ranged was between 18.75 to 42.50 %.Maximum yields of 29.90 q/ha was recorded in NDM-19 followed by 23.70 q/ha of seed yield in NDM –37 at Kumarganj.

Among the fifty eight entries entries evaluated at Guntur during 2010-11, LFC-97 recorded highest yield (3.91g/plant) followed by LFC-78 (3.46 g/plant), LFC-107 (3.43 g/plant), LFC-84 (3.21 g/plant), LFC-101 (3.13 g/plant), LFC-77 (3.11 g/plant), LFC-110 (3.03g/plant), and LFC-106 (3g/plant) which were significantly superior to the check APHUM-1 (1.96 g/plant).

During 2010-11, fifty five entries were evaluated at Jobner. Among the fifty five entries evaluated, LFC-84 recorded highest yield (2.17 g/plant) followed by UM-1 (1.81 g/plant), JFG-241 (1.78 g/plant), JFG-219 (1.65 g/plant), JFG-249 (1.41 g/plant), UM-10 (1.33g/plant) and UM-2 (1.32 g/plant) which were significantly superior to the best checkGM-2 (0.9 g/plant).

FGK/CI/2 Coordinated Varietal Trial

FGK/C1 Coordinated Variety Trial 2009 Series VII

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

Coimbatore

Thirteen fenugreek genotypes along with two checks were evaluated for the second time during 2010-11 at Coimbatore. The genotypes varied significantly in the grain yield per plot and grain yield per ha. Among the thirteen fenugreek genotypes along with two checks evaluated, the CVT line FGK-30 recorded the highest grain yield of 514.33 kg/ha followed by FGK-31 of 422.23 kg/ha.

At Dholi, among two check i.e., national check Hisar Sonali and local check Rajendra Kanti, Rajendra Kanti as local check was found significantly superior regarding number of secondary branches per plant (11.96), number of pods per plant (68.63) and yield per plot (0.98 kg/5.4m^2) or projected yield per hectare (1.64 t/ha) as compared to national check Hisar Sonali while Rajendra Kanti as local check was recorded at par with national check Hisar Sonali regarding number of primary branches, number of grains per pod and 1000-grains weight. However, Rajendra Kanti as local check was found significantly early 50% flowering (73.33 DAS) and early 50% maturity (137.33 DAS) as compared to national check Hisar Sonali. None of the entries were found significantly superior over local check variety Rajendra Kanti regarding number of primary branches per plant, number of secondary branches per plant, number of pods per plant, number of grains per pod, 1000-grain weight and yield per plot or projected yield per hectare. However, among the entries, Rajendra Kanti was found significantly 50% early flowering (73.33 DAS) and early 50% maturity (137 DAS) as compared to genotypes namely, FGK-35, FGK-36, FGK-37 and FGK-31 while rest entries viz; FGK-26, FGK-27, FGK-28, FGK-29, FGK-30, FGK-32, FGK-33, FGK-34 and FGK-38 were at par with Rajendra Kanti regarding early 50% flowering and early 50% maturity.

Among the thirteen entries evaluated at Guntur FGK-30 (1006 kg/ha), FGK-27 (937 kg/ha), and FGK-31 (854 kg/ha) recorded significantly higher yield than the check LS-1 (611 kg/ha), Local (260 kg/ha) and Hisar Sonali (409 kg/ha).

Among the fifteen genotypes of fenugreek tested at Jabalpur, FGK-27 gave maximum plant height (35.85 cm) and no of primary branches (6.46). FGK-28 showed maximum number of pod/plant (70.67), pod length (35.8 cm), no. of seeds per pod (14.90) and yield (1.080 kg/plot)

At Jagudan, significant yield differences were observed among the entries. None of the entries gave significantly higher yield over checks H.Sonali and GM-2. However the entry FGK-27 produced maximum yield i.e.1974 kgha^{-1} which was 8.62 and 15.69 per cent higher over checks H. Sonali and GM-2. The pooled over two years data showed that entry FGK-35 gave 1938 kgha-1 yield, which was 21.89 and 17.67 per cent higher over check GM-2 and RMT-361.

Sixteen entries were evaluated in RBD with 3 replications in a plot size of 3 x 2.4 sq. m. 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 1414.35 to 2080.56 kg/ha. Of the sixteen entries evaluated, entry FGK-37 recorded maximum seed yield of 2080.56 kg/ha followed by FGK-30 (2039.35 kg/ha), FGK-31 (2032.41 kg/ha) and FGK-34 (2018.52 kg/ha), while lowest yield of 1414.35 kg/ha was recorded in Local check.

Seed yield of NDM-25 and Hisar sonali were maximum (19.27 and 17.70 q /ha 17.70 q/ha respectively) at Kumarganj. None of the entries out yielded the check NDM-25 and Hisar sonali.

Significant differences were observed for all the characters except number of secondary branches per plant and seeds per pod at Pantnagar. Maximum seed yield (3093.00 kg/ha) was recorded in local check-Pant Ragini, followed by RMT-361 (2987.33 kg/ha) and FGK-35 (2859.67kg/ha).

Sixteen entries were evaluated at Raigarh for yield and its related characters along with three checks. Among the entries, FGK-27 (606.01 kg/ha), gave the highest yield and among the checks RMt-361 (737.50 kg/ha) gave the highest yield. No entry was found superior to check.

FGK/CI/3 Varietal Evaluation Trial

FGK/CI/3.2 Initial evaluation trial 2009

(Jabalpur, Kumarganj)

Maximum seed yield of 20.31 q/ha was recorded in NDM-61 followed by in 20.13 q/ha in NDM-48 at Kumarganj.

At Jagudan, the entry, JFg-245 gave higher yield (1973 kg/ha) than GM-2 which was 14.64 per cent higher over GM-2. The pooled over three years data showed that entry JFg-245 and JFg-269 gave 1503 and 1494 kgha-1 yield, which was 8.99 and 8.36 per cent higher over check GM-2.

FGK/CI/3.3 Initial evaluation trial 2009

(Jobner)

Fourteen entries were evaluated in RBD with 3 replications in a plot size of 3 x 2.4 sq.m. accommodating four 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 1464.35 to 2163.43 kg/ha. Entry UM-126 recorded maximum seed yield of 2163.43 kg/ha followed by UM-222 (2088.43 kg/ha), RMt-351 check (1919.91 kg/ha), RMt-1 check (1897.22 kg/ha) and UM-124 (1873.15 kg/ha), while lowest yield of 1464.35 kg/ha was recorded in Local check. (Table 57)

FGK/CI/3.4 Initial evaluation trial 2010

(Dholi & Hisar)

At Dholi, eight promising entries and two check Hisar Sonali and Rajendra Kanti were tested under initial evaluation trial during 2001-2011. Among two checks i.e., Hisar Sonali and Rajendra Kanti, check variety, Rajendra Kanti was found significantly higher regarding height of the plant (74.80 cm) and number of primary branches per plant (8.43) as compared to check variety Hisar Sonali while Rajendra Kanti check variety was at par with Hisar Sonali check variety regarding number of pods per plant and yield per plot or projected yield per hectare. However, Rajendra Kanti was early maturing (134.33 DAS) as compared to check variety Hisar Sonali i.e., 142.33 days after sowing. None of the entries were found significantly superior over check variety Rajendra Kanti regarding number of primary branches per plant and length of pod while genotype RM-191 was recorded significantly higher plant height (98.03 cm) as compared to check variety Rajendra Kanti (74.80 cm). RM-188, RM-194 and RM-197 produced significantly higher yield as compared to

Table 57. Initial Evaluation Trial of fenugreek 2009-10 at Jobner

Entries	Days to flowering	Plant height (cm)	Branches per plant	Pods per plant	Pod length (cm)	Seeds per pod	Test wt. (g)	Seed Yield (kg\ha)
UM-100	50.67	78.13	5.93	37.67	12.10	15.47	11.78	1528.24
UM-124	48.33	95.27	4.80	39.33	11.07	17.33	11.94	1873.15
UM-126	48.33	113.00	5.67	41.07	10.60	18.07	10.34	2163.43
UM-136	46.67	103.00	5.60	34.73	9.97	17.00	12.25	1661.11
UM-137	45.00	107.67	5.00	31.80	10.43	17.00	12.45	1770.83
UM-140	46.67	107.00	5.33	35.47	8.97	14.47	10.24	1640.28
UM-193	49.00	108.13	5.73	33.93	10.30	14.67	12.44	1795.83
UM-222	48.33	104.60	5.93	41.73	11.07	17.80	11.22	2088.43
UM-228	46.33	104.40	5.40	39.60	9.90	14.53	11.22	1766.20
UM-325	51.00	112.87	5.93	38.67	9.70	15.07	12.08	1872.69
RMt-1 C	50.33	105.87	6.00	39.13	10.17	16.60	12.07	1897.22
RMt-305 C	43.33	54.73	6.27	35.87	11.10	15.93	13.11	1716.67
RMt-351 C	51.00	93.13	6.00	36.20	9.87	15.27	11.31	1919.91
Local Check	59.00	91.27	5.47	31.27	11.37	14.40	10.11	1464.35
CD at 5%	1.87	10.74	0.81	4.78	1.34	2.00	0.33	316.68
CV%	2.29	6.50	8.51	7.72	7.64	7.45	1.70	10.50

check variety Rajendra Kanti. Regarding maturity, RM-185, RM-188, RM-190, RM-191, RM-197 and check variety Hisar sonali were late maturing types as compared to check variety Rajendra Kanti. Among the eight entries, RM-188 gave the maximum projected yield (2.12 t/ha) followed by RM-194 i.e., projected yield (1.81 t/ha).

The initial evaluation trial (IET) in fenugreek was conducted at Hisar with nine accessions along with Hisar Sonali as check during 2010- 2011 in plots measuring 3.0 x 1.2 m. The results indicated that maximum mean seed yield was recorded in HM-425 (3210 kg /ha) followed by HM-257 (3024 kg/ha) showing an increase of 31.6 and 23.9% over Hisar Sonali (check), respectively.

Among the twelve entries tested, LFC-116 recorded significantly highest yield of 774 kg/ha followed by LFC-93 with 760 kg/ha and LFC-76 with 729 kg/ha which were superior over check LS-1 (548 kg/ha) and PEB (427 kg/ha) at Dholi.

FGK/CM/4.4 Role of rhizobacteria in growth promotion of fenugreek

(Hisar & Jagudan)

Significant differences were obtained for all the parameters at Hisar. Maximum seed yield (1833.1 kg/ha) was recorded with the application of rhizobacteria FL-14 +FL-18 (seed treatment + soil application) followed by *Trichoderma* MTCC-5179 (1764.7 kg/ha) producing 11.71 and 7.54 per cent higher yield over the control (Table 58).

At Jagudan, all the growth and yield attributes were not influenced significantly due to different strains of *Rhizobacteria.* However, application of RDF i.e. 40 + 20 Kg NP/ha recorded significantly higher seed yield of fenugreek. Thus, rhizobacteria was not effective for improving the yield of fenugreek.

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

(Jagudan, Jobner, Guntur, Hisar & Kumarganj)

Field demonstration in farmers field at Kumarganj, indicated that seed treatment and soil application of rhizobacteria FK-18 and FK-14 increased the seed yield in the entire farmers field and gave 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 (Tables 59, 60).

Table 58. Effect of rhizobacteria on growth and seed yield of fenugreek during 2010-11 at Hisar

Treatments	Plant height (cm)	Branches per plant	Pods per plant	Pod length (cm)	Seeds Per pod	Seed yield (kg/ha)
Rhizobacteria FK 14+FL 18 (Seed + Soil treatment)	116.6	6.0	107.6	8.8	17.9	1833.1
TrichodermaMTCC 5179 (Recommended dose)	111.2	5.8	101.2	8.8	17.4	1764.7
Control	107.0	5.4	097.3	8.4	15.5	1641.0
CD at 5 %	8.3	0.4	4.1	0.3	0.5	153

Table 59. Yield and ancillary characters at farmers field (FLD) on large scale demonstration of effect of rhizobacteria on growth promotion of fenugreek at Kumarganj

Sl. No.	Farmers Name / Best treatment	Yield (q/ha)	Plant height (cm)	No of branches /plant	Length of pod (cm)	No grain /pod
1.	Sri Rakesh Kumar DubeyGram & Post Kehraye, Vikas Khand –Sohawal Pirkholli, Faizabad					
	ST+SAFK-14+FL-18	1676	94.10	8.36	11.65	16.20
	Appl of *Trichoderma*	1520	82.30	3.80	10.85	15.69
	Farmers Practice	1425	72.20	3.0	10.65	13.35
2.	Sri Sanjay Kumar chaubeyLaharpur Post BarwaVikas Khand-Sohawal,Faizabad					
	ST+SAFK-14+FL-18	1670	90.30	3.75	11.45	16.10
	Appl of *Trichoderma*	1535	81.16	3.70	10.45	16.65
	Farmers Practice	1440	70.15	3.0	9.65	13.65
3.	Sri Subhash s/o Durga PrasadFaizabad					
	ST+SAFK-14+FL-18	1620	91.60	3.75	10.65	15.00
	Appl of *Trichoderma*	1540	82.16	3.65	10.16	14.65
	Farmers Practice	1450	71.60	3.10	9.45	12.75
4.	Sri Sureshwar Dutt PandeyDharamdaspur, Mashoda Faizabad					
	ST+SAFK-14+FL-18	1490	90.30	3.50	10.00	15.63
	Appl of *Trichoderma*	1385	76.45	3.0	9.16	16.00
	Farmers Practice	1265	65.25	2.85	8.45	14.26
5.	Sri Umesh PathakKumarganj, Faizabad					
	ST+SAFK-14+FL-18	1640	94.15	3.80	11.38	15.85
	Appl of *Trichoderma*	1530	85.25	3.65	10.45	15.30
	Farmers Practice	1460	70.45	3.10	9.16	13.30
6.	Sri Onkar SinghMau Atwari, Rani bazar, Sultanpur					
	ST+SAFK-14+FL-18	1520	91.30	3.80	11.60	16.65
	Appl of *Trichoderma*	1380	88.30	3.70	10.45	16.25
	Farmers Practice	1290	78.60	3.10	10.00	13.75
7.	Sri Rakesh Kumar SinghMuzaid, Belsar, Distt Gonda					
	ST+SAFK-14+FL-18	1520	91.30	3.80	11.60	16.65
	Appl of *Trichoderma*	1380	88.30	3.70	10.45	15.26
	Farmers Practice	1290	98.60	3.10	10.00	13.75
8.	Sri Janardan PrasadNababganj gird, Nababganj , Gonda					
	ST+SAFK-14+FL-18	1635	88.30	3.75	10.65	16.00
	Appl of *Trichoderma*	1380	88.30	3.70	10.45	15.26
	Farmers Practice	1365	65.80	3.00	9.00	13.65
.9.	Sri RohitNear Engg College, Ambedkar nagar					
	ST+SAFK-14+FL-18	1680	93.30	3.86	10.75	15.69
	Appl of *Trichoderma*	15.50	88.60	3.10	9.65	14.63
	Farmers Practice	1485	75.45	3.00	8.80	13.00
10.	Sri Radhey Shyam MishraMathura Bazar, Balrampur					
	ST+SAFK-14+FL-18	1635	90.60	3.65	11.00	16.75
	Appl of *Trichoderma*	1540	85.45	3.10	10.65	15.00
	Farmers Practice	1470	77.30	3.00	9.65	13.35

Appl = Application of ;ST = Seed treatment ;SA = Soil application;Farmers practice: Broadcasting of seeds

Table 60. Yield of fenugreek on FLD on large scale demonstration of effect of rhizobacteria on growth promotion at Kumarganj

Sl. No.	Name of Farmers	Seed treatment and soil application of FL-18, FK-14	Application of Trichoderma MTCC 5179	Farmers Practice	% increase in yield over seed treatment & soil appl. of FL-18, FK-14	% increase in yield over application of Trichoderma MTCC 5179
1.	Sri Rakesh Kumar Dubey	1676	1520	1425	17.61	5.55
2.	Sri Sanjay Kumar Chaubey	1670	1535	1440	15.79	6.59
3.	Sri Subhash S/o shri Durga Prasad	1620	1540	1450	11.72	6.20
4.	Sri Sureshwar Dutt Pandey	1490	1385	1265	17.78	9.48
5.	Sri Umesh Pathak	1640	1530	1425	15.08	7.36
6.	Sri Onkar Singh	1690	1550	1460	15.75	6.16
7.	Sri Rakesh Kumar Singh	1520	1380	1290	17.82	6.79
8.	Sri Janardan Prasad	1635	1490	1365	19.78	9.15
9.	Sri Rohit	1680	1550	1485	13.13	4.37
10.	Sri Radhey Shyam Mishra	1635	1540	1470	11.22	4.76

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35. Nagesh Naik, Lokesh, M. S. and Hegde, H. G. 2010. Use of bio fertilizers in the production of black pepper (*Piper nigrum* L) in mixed cropping system. Paper presented in International Conference on Coconut Biodiversity for Prosperity, 25 to 28 October 2010, Central Plantation Crops Research Institute, Kasaragod, Kerala, p.107.

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LIST OF RESEARCH PROJECTS

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 & 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 & Ambalavayal
PEP/CI/3.3	CVT 2006 – Series VI	Chintapalle, Dapoli, Panniyur, Pampadumpara, Pundibari, Sirsi, Ambalavayal, Yercaud / Pechiparai
PEP/C1/3.4	Evaluation of grafts, orthotropic and runner shoots in black pepper	Ambalavayal, Panniyur, Sirsi Yercaud & Thadiyankudassi*
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
PEP/CM/4.5	Organic farming in black pepper - 2006	Panniyur, Dapoli, Pechiparai, Sirsi & 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
PEP/CP/5.2	Trial on management of *Phytophthora* foot rot of black pepper in existing plantation	Chintapalle, Dapoli , Panniyur, Pampadumpara, Mudigere & Sirsi
PEP/CP/5.3	Trial on management of *Phytophthora* foot rot of black pepper in new plantation	Chintapalle, Dapoli, Panniyur, Pampadumpara, Pechiparai, Mudigere & Sirsi
PEP/CP/6	Pest Management Trial	
PEP/CP/6.2	Management of *Erythrina* gall was, a popular standard of black pepper	Mudigere
CARDAMOM		
CAR/CI/1	Genetic Resources	
CAR/CI/1.1	Germplasm collection, characterization, evaluation and conservation	Mudigere & Pampadumpara
CAR/CI/2	Hybridization	
CAR/CI/2.1	Evaluation of OP progenies under intensive management	Mudigere
CAR/CI/2.2	Hybridization & selection in cardamom	Mudigere

* Testing Centre

Project Code	Title	Centres
CAR/CI/3	Coordinated Varietal Trial	
CAR/CI/3.5	CVT 2005-series V	Pampadumpara, Mudigere & Myladumpara
CAR/CI/3.6	CVT 2007/2009 -series VI	Mudigere, Pampadumpara, Sakleshpur, Ambalavayal & 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/CM/5.2	Effect of fertigation on yield of cardamom through drips	Mudigere & Pampadumpara
CAR/CM/5.3	Organic farming in cardamom	Mudigere & Pampadumpara
CAR/CP/6	Pest and Disease Management Trial	
CAR/CP/6.7	Evaluation of new insecticides/ biopesticide in cardamom againstthrips and shoot and capsule borer	Mudigere & Pampadumpara
CAR/CP/6.8	Comparison of effect of chemical treatments as well as biocontrol agents against pseudostems rot of cardamom	Pampadumpara & Mudigere
LARGE CARDAMOM		
LCA/CI	Germplasm of large cardamom	Gangtok
LCA/CI	Initial Evaluation Trial	Gangtok
LCA/CP	Evolving disease & pest tolerant lines in large cardamom	Gangtok
LCA/CP	Integrated pest and disease management in large cardamom	Gangtok
GINGER		
GIN/CI/1	Genetic Resources	
GIN/CI/1.1	Germplasm collection, characterization, evaluation and conservation	Dholi, Kumarganj, Pottangi, Pundibari, Raigarh & Solan
GIN/CI/2	Coordinated Varietal Trial	
GIN/CI/2.3	CVT 2006 – Series VII	Pottangi
GIN/CI/3	Varietal Evaluation Trial Initial evaluation trial-2010	Dholi
GIN/CI/3.2	Comparative yield trial	Pottangi
GIN/C1/3.3	Genotype X Environment interaction on quality of ginger	Appangala, Ambalavayal, Barapani, Calicut, Chintapalli, Dapoli, Dholi, Kanke,Kalyani, Mizoram, Navsari, Pantnagar,Pasighat, Pottangi, Pundibari, Raigarh & 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	Solan
GIN/CM/5	Nutrient Management Trial	
GIN/CM/5.2	Organic farming in ginger - 2006	Solan, Pundibari, Pottangi, Dholi & Kumarganj

Project Code	Title	Centres
GIN/CM/5.3	Nutrient supplementation though organic manures for growth and yield of ginger	Dholi & Kumarganj
GIN/CP/6	Disease Management Trial	
GIN/CP/6.1	Disease surveillance and etiology of rhizome rot in ginger	Solan & 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 & Dapoli
GIN/CP/6.6	Management of soft rot of ginger (Biofumigation using Mustard)	Dholi, Solan, Chintapalle, Pundibari, Kumarganj & Raigarh
GIN/CP/6.7	Management of soft rot of ginger (Biofumigation using cabbage)	Dholi, Solan, Chintapalle, Pottangi, Kumarganj, Ambalavayal & Raigarh
GIN/CP/6.8	Management of bacterial wilt of ginger (Biofumigation using mustard)	Dholi, Solan & Pundibari
GIN/CP/6.9	Management of bacterial wilt of ginger (Biofumigation using cabbage)	Dholi, Solan, Ambalavayal & Pottangi
TURMERIC		
TUR/CI/1	Genetic Resources	
TUR/CI/1.1	Germplasm collection, characterization, evaluation and conservation	Coimbatore, Dholi, Jagtial, Kumarganj, Pottangi, & Raigarh
TUR/CI/2	Coordinated varietal trial	
TUR/C1/2.4	Coordinated Varietal Trial - 2009	Ambalavayal, Chintapalle, , Jagtial, Dholi,Coimbatore, Kumarganj, Pottangi Pundibari, Pasighat, Pantnagar, Raigarh & Navsari
TUR/CI/3	Varietal evaluation trial	
TUR/CI/3.2	Initial Evaluation Trial 2006	Kumarganj, Pottangi & Pundibari
TUR/CI/3.3	Initial Evaluation Trial 2010	Pantnagar
TUR/C1/3.4	Initial Evaluation Trial 2009	Dholi
TUR/CI/3.5	Genotype x Environmental interaction on quality	Dholi, Chintapalle, Jagtial, Pottangi, Kumarganj, Pundibari, Coimbatore & Mizoram
TUR/CI/4	Quality Evaluation	
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/5.4	Efficacy of biocontrol agents for control of rhizome rot of turmeric	Pottangi
TUR/CM/5.5	Standardization of water requirement for turmeric through drip irrigation	Coimbatore, Dholi, Jagtial, Kumarganj, Raigarh, Guntur & Pottangi
TUR/CM/5.6	Standardization of fertigation in turmeric	Coimbatore & Jagtial
TUR/CM/5.7	Effect of micronutrients on turmeric	Dholi, Kumarganj & Pundibari
TUR/CM/6	Post Harvest Technology	
TUR/CM/6.1	Standardization of processing in turmeric	Calicut & Coimbatore

Project Code	Title	Centres
TUR/CM/6.2	Mechanical harvesting in turmeric (Observational trial)	Coimbatore
TUR/CP/7	Disease Management Trial	
TUR/CP/7.1	Survey and identification of disease causing organisms in turmeric and screening of turmeric germplasm against diseases	Coimbatore, Pundibari, Raigarh & Dholi
TUR/CP/7.2	Management of foliar disease of turmeric	Dholi, Chintapalle, Pottangi, Kumarganj, Pundibari, Jagtial, Raigarh & 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 & Pechiparai
TSP/CI/2.3	CVT 2001 – cassia	Pechiparai & Dapoli
TSP/CM/2	Propagation/Multiplication Trial	
TSP/CM/2.1	Softwood grafting in clove	Dapoli
TSP/CM/2.2	Post harvest technology studies in cinnamon	Dapoli & Pechiparai
TSP/CI/3	Disease Management Trial	
TSP/CP/3.1	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 & 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 & Udaipur
COR/CI/2.6	Coordinated varietal trial on coriander (Leafy type during off season) CVT 2010	Guntur, Ajmer, Coimbatore & Periyakulam*
COR/CI/3	Varietal Evaluation Trial	
COR/CI/3.1	Initial evaluation trial 2010	Dholi
COR/CI/3.2	Initial evaluation trial 2010 (Leaf purpose)	Pantnagar
COR/CI/3.3	Initial Evaluation Trial 2010 (Seed purpose)	Pantnagar
COR/CI/4	Quality Evaluation Trial	
COR/CI/4.1	Quality evaluation in coriander	Jobner
COR/CM/5	Nutrient Management Trial	
COR/CM/5.3	Identification of drought/ alkalinity tolerant source in coriander	Guntur , Coimbatore, Kumarganj & Jobner

Project Code	Title	Centres
COR/CM/5.4	Production of leafy type of coriander in off season	Kumarganj
COR/CM/5.4	Role of rhizobacteria in growth promotion of coriander	Hisar & Jagudan
COR/CM/5.6	Nutrient supplementation though organic manures for growth and yield of coriander	Coimbatore, Dholi, Hisar, Jagudan, Jobner, Kumarganj & Raigarh
COR/CM/5.7	Effect of micronutrients on yield of coriander	Coimbatore & Dholi
COR/CM/5.8	Irrigation management for sustainable coriander production	Guntur
COR/CM/5.9	Nutrient management in off season coriander leaf production	Periyakulam*, Guntur, Ajmer & Coimbatore
COR/CP/6	Disease Management Trial	
COR/CP/6.2	Survey to identify the disease incidence collection and identification of casual organism	Dholi
COR/CM/6.3	Management of stem gall disease of coriander	Dholi, Pantnagar, Jabalpur, Udaipur, Kumarganj & Raigarh
COR/CM/6.4	Large Scale Demonstration of the role of *Rhizobacteria* in growth promotion of Coriander	Coimbatore, Guntur, Hisar, Jagudan & Raigarh
CUMIN		
CUM/CI/1	Genetic Resources	
CUM/CI/1.1	Germplasm collection, characterization, evaluation conservation and screening against diseases	Jagudan & Jobner
CUM/CI/2	Coordinated Varietal Trial	
CUM/C1/2.3	Coordinated Varietal Trial - 2009	Jobner, Jagudan, Ajmer & 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 & Jobner
CUM/CP/6	Disease Management Trial	
CUM/CP/6.1	Management of wilt and blight diseases in cumin	Jobner
CUM/CP/6.2	Survey for identification of yellowing causing organisms in cumin	Jobner, Jagudan & Ajmer

Project Code	Title	Centres
CUM/CM/6.3	Large scale demonstration of the role of Rhizobacteria in growth promotion of cumin	Jagudan & Jobner
FENNEL		
FEL/CI/1	Genetic Resources	
FNL/CI/1.1	Germplasm collection, characterization, evaluation, conservation and screening against diseases	Dholi, Hisar, Jagudan, Jobner & Kumarganj
FNL/CI/2	Coordinated Varietal Trial	
FNL/C1/2.4	Co-ordinated Varietal Trial - 2009-Series VII	Ajmer, Dholi, Hisar, Jabalpur, Jagudan, Jobner, Kumarganj, Pantnagar, Udaipur & Raigarh
FNL/CI/3	Varietal Evaluation Trial	
FNL/CI/3.1	Initial evaluation trial	Hisar, Jobner , Kumarganj & Jagudan
FNL/CI/3.2	Initial evaluation trial-2009	Jabalpur
FNL/CI/4	Quality evaluation trial	
FNL/CI/4.1	Quality evaluation in fennel	Jobner
FNL/CM/5	Nutrient Management Trial	
FNL/CM/5.2	Identification of drought/alkalinity tolerance source in fennel	Kumarganj
FNL/CM/5.3	Role of rhizobacteria on growth and yield of fennel	Jagudan, Raigarh & Hisar
FNL/CP/6	Disease Management Trial	
FNL/CP/6.1	Survey, identification of disease causing organisms and survey of germplasm against disease	Dholi
FNL/CM/6.2	Large scale demonstration of the role of Rhizobacteria in growth promotion of Fennel	Hisar, Jagudan, & Raigarh
FENUGREEK		
FGK/CI/1	Genetic Resources	
FGK/CI/1.1	Germplasm collection, characterization, evaluation conservation and screening against diseases	Dholi, Hisar, Jagudan, Jobner , Kumarganj & Guntur
FGK/CI/2	Coordinated Varietal Trial	
FGK/C1/2.1	Coordinated Variety Trial 2009 Series VIIAjmer, Coimbatore, Dholi, Guntur, Hisar,	Jabalpur, Jagudan, Jobner, Kumarganj, Pantnagar, Raigarh & Udaipur
FGK/CI/3	Varietal Evaluation Trial	
FGK/CI/3.2	Initial evaluation trial 2009	Jabalpur
FGK/CI/3.3	Initial evaluation trial 2009	Jobner
FGK/CI/3.4	Initial evaluatial trial 2010	Dholi

Project Code	Title	Centres
FGK/CM/4	Nutrient Management Trial	
FGK/CM/4.2	Identification of drought/tolerance source in fenugreek	Jobner & Guntur
FGK/CM/4.4	Role of rhizobacteria on growth and yield of fennel	Hisar & Jagudan
FGK/CM/4.5	Large scale demonstration of the role of Rhizobacteria in growth promotion of fenugreek	Jagudan, Jobner, Guntur, Hisar & 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

1. Project Coordinator : Dr M Anandaraj
2. Principal Scientist (Hort.) : Dr J Rema
3. Technical Information Officer : Dr Johny A Kallupurackal
4. Personal Assistant : Ms Alice Thomas
5. 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, Dr.YSR Horticultyural University, 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, Dr.YSR Horticultural University, Kammarapally (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, Dr.YSR Horticultyural University, 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. Horticulturist: Vacant
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 2010-11

ICAR Share (Rs. in lakhs)

Name of the centres	Pay and Allowances	TA	RC	Tech. Asstt.	Total RC	Equipments	Total
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Pampadumpara (KAU)	6.995	0.450	1.800	0.05	1.850	4.500	13.795
Panniyur (KAU)	4.106	0.600	2.400	0.05	2.450	3.750	10.906
Mudigere (UAS-B)	11.195	0.600	2.400	-	2.400	1.500	15.695
Sirsi (UAS-D)	6.697	0.300	1.200	0.05	1.250	2.625	10.872
Yercaud (TNAU)	6.285	0.300	1.200	0.05	1.250	1.875	9.710
Coimbatore (TNAU)	7.492	0.300	1.700	0.05	1.750	2.873	12.415
Chintapalli (APAU)	3.217	0.300	1.200	0.05	1.250	0.125	4.892
Jagtial (APAU)	4.242	0.300	1.200	-	1.200	2.749	8.491
Guntur (APAU)	4.297	0.300	1.700	0.10	1.800	1.350	7.747
Solan (YSPUHF)	8.787	0.450	1.800	-	1.800	1.675	12.712
Pottangi (OUAT)	2.130	0.300	1.200	-	1.200	1.350	4.980
Jobner (RAJAU)	10.367	0.750	4.500	0.15	4.650	2.749	18.516
Jagudan (GAU)	16.213	0.300	1.700	0.15	1.850	2.325	20.688
Hisar (HAU)	6.449	0.300	1.700	0.10	1.800	1.005	9.554
Dholi (RAU)	4.646	0.300	2.355	0.05	2.405	1.691	9.042
Kumarganj (NDUAT)	10.542	0.450	2.300	-	2.300	4.005	17.297
Pundibari(UBKVV)	5.783	0.450	1.800	0.05	1.850	2.373	10.456
Dapoli (KKV)	9.452	0.450	1.800	0.05	1.850	2.505	14.257
Raigarh (IGKVV)	9.0675	0.450	2.300	0.05	2.350	2.250	14.1175
APHU-Hyderabad	-	-	0.50	-	0.50	-	0.50
TNAU-Periyakulam	-	-	1.00	-	1.00	-	1.00
XXI & AICRPS Workshop	-	-	0.345	-	0.345	-	0.345
Total	137.9625	7.650	38.100	1.000	39.100	43.275	227.9875

AICRPS - BUDGET PROVISION

ALL INDIA COORDINATED RESEARCH PROJECT ON SPICES

CENTREWISE AND HEADWISE RE 2010-11

ICAR Share (Rs. in lakhs)

Name of the centres	Pay and Allowances	TA	RC	Tech. Asstt.	Total RC	Equipments	Total
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Ambalavayal(KAU)	-	0.1125	2.100	-	2.100	-	2.2125
Pechepari (TNAU)	-	0.1125	2.100	-	2.100	-	2.2125
Gangtok (ICRI)	-	0.1125	2.100	-	2.100	-	2.2125
Sakleshur (ICRI)	-	0.1125	2.100	-	2.100	-	2.2125
Myladumpara (ICRI)	-	0.1125	2.100	-	2.100	-	2.2125
ICAR R C NEHR, Barapani	-	0.1125	1.875	-	1.875	-	1.9875
ICAR R C NEHR, Mizoram	-	0.1125	1.875	-	1.875	-	1.9875
ICAR R C NEHR, Gangtok	-	0.1125	1.875	-	1.875	-	1.9875
Pasighat (CAU)	-	0.1125	0.600	-	0.600	-	0.7125
Pantnagar (GBPUAT)	-	0.1125	0.600	-	0.600	-	0.7125
Kanke (BIRSAAU)	-	0.1125	0.600	-	0.600	-	0.7125
Kalyani (BCKVV)	-	0.1125	0.600	-	0.600	-	0.7125
Udaipur (MPUAT)	-	0.1125	0.600	-	0.600	-	0.7125
Navasari (NAU)	-	0.1125	0.600	-	0.600	-	0.7125
Jabalpur (JNKV)	-	0.1125	0.600	-	0.600	-	0.7125
Total	-	1.6875	20.325	-	20.325	-	22.0125
Grand Total	137.9625	9.3375	58.425	1.000	59.425	43.275	250.000

STATEMENT OF FUND RELEASED TO AICRPS CENTRES 2010-11

(Rs. in lakhs)

Name of the centre	BE 2010-11	Amount Released		Non Recurring Contingency (Equipments)	Technology Assessment	* Additional Recurrring Contingency	Additional Pay & Allowances
		I Half	II Half				
Pampadumpara (KAU)	13.795	4.623	4.622	4.500	0.05	–	–
Panniyur (KAU)	10.906	7.106	–	3.750	0.05	–	–
Mudigere (UAS-B)	15.695	7.098	7.097	1.500		–	–
Sirsi (UAS-D)	10.872	4.099	4.098	2.625	0.05	–	–
Yercaud (TNAU)	9.710	3.893	3.892	1.875	0.05	–	–
Coimbatore (TNAU)	11.915	4.496	4.496	2.873	0.05	0.50	–
Chintapalli (APAU)	4.892	2.359	2.358	0.125	0.05	–	–
Jagtial (APAU)	8.491	2.871	2.871	2.749		–	–
Guntur (APAU)	7.247	2.899	2.898	1.350	0.10	0.50	–
Solan (YSPUHF)	12.712	5.519	5.518	1.675		–	–
Pottangi (OUAT)	4.980	1.815	1.815	1.350		–	–
Jobner (RAJAU)	17.016	7.059	7.058	2.749	0.15	1.50	–
Jagudan (GAU)	20.188	5.304	5.303	2.325	0.15	0.50	7.106
Hisar (HAU)	9.054	3.975	3.974	1.005	0.10	0.50	–
Dholi (RAU)	7.887	3.073	3.073	1.691	0.05	1.155	–
Kumarganj (NDUAT)	16.797	6.396	6.396	4.005		0.50	–
Pundibari(UBKVV)	10.456	4.017	4.016	2.373	0.05	–	–
Dapoli (KKV)	14.257	5.851	5.851	2.505	0.05	–	–
Raigarh (IGKVV)	13.6175	5.659	5.6585	2.250	0.05	0.50	–
Co-opting/Voluntary	22.0125	22.0125				–	–
APHU-Hyderabad						0.50	–
TNAU-Periyakulam						1.00	–
Reccuring (Reserve) Contingency/AICRPS Workshop	7.50					0.345	
Grand Total	250.000	110.1245	80.9945	43.275	1.00	7.500	7.106

Note: An amount of Rs. 7.106 Lakhs obtained as savings from Panniyur Centre has been released to Jagudan centre for meeting the expenditure requirement under Pay & Allowances.

* The reserve contingency of Rs. 7.50 Lakhs has been released for Rhizobacterial trails at seven centres viz., Coimbatore, Guntur, Jobner, Jagudan, Hisar, Kumarganj and Dapoli centres @ Rs. 50000 per centre and additional contingency of Rs. 1.155 Lakhs to Dholi, Rs. 1.00 Lakhs to Jobner, Rs. 50000 for APHU, Hyderabad and Rs. 1.00 Lakh for TNAU, Periyakulam centres. An amount of Rs. 34500 spent for XXI AICRPS Workshop.

WEATHER DATA

Ambalavayal

Month	Rainfall	Temperature (°C)		Relative Humidity (%)	
		Max.	Min.	Max.	Min.
January 2010	68.4	27.0	16.0	94.3	50.6
February	25.4	29.6	17.2	94.9	49.3
March	12.4	31.4	19.3	96.0	53.5
April	80.6	30.9	20.1	89.0	62.3
May	124.6	29.4	20.5	93.5	70.0
June	270.2	26.6	19.7	96.1	81.2
July	478.2	24.5	18.9	95.2	83.5
August	249.0	24.9	19.0	95.6	80.3
September	90.8	26.4	18.8	95.1	76.9
October	167.8	26.4	18.4	94.7	80.7
November	279.6	25.6	18.6	94.3	77.2
December	4.8	26.0	16.4	91.5	60.3

Barapani

Month	Rainfall	Temperature (°C)		Relative Humidity (%)	
		Max.	Min.	Max.	Min.
April 2010	110.9	29.4	17.3	67.3	54.7
May	207.8	28.4	17.6	79.1	67.5
June	586.6	27.8	19.7	89.4	76.0
July	419.7	28.4	20.3	88.4	77.3
August	389.1	28.5	20.1	88.7	74.3
September	344.3	27.3	19.0	88.8	78.2
October	408.3	26.3	15.6	88.3	74.8
November	22.6	25.4	12.9	84.7	67.1
December	4.7	20.4	7.5	83.5	57.0

Chintapalle

Month	Rainfall	Rainy days	Temperature ($_0$C)		Relative Humidity (%)	
			Max.	Min.	Max.	Min.
April 2010	54.2	6	33.7	20.2	66.3	43.4
May	139.2	8	31.9	21.4	54.2	66.3
June	169.0	9	30.0	22.4	62.1	73.8
July	256.8	17	25.9	21.9	79.5	86.2
August	167.4	12	26.4	21.0	80.9	85.4
September	206.0	14	26.8	21.0	77.2	87.6
October	164.0	11	26.1	19.5	75.7	84.8
November	34.6	4	25.6	17.3	70.8	89.9
December	63.0	5	24.2	12.0	56.4	89.3
January 2011	0	0	25.3	9.5	37.4	87.2
February	5.0	1	37.3	11.9	40.6	86.3
March	5.0	1	31.1	14.4	32.6	73.2

Coimbatore

Month	Rainfall	Rainy days	Temperature ($_0$C)		Relative Humidity (%)	
			Max.	Min.	Max.	Min.
April 2010	15.0	2	85	25.2	42	35.6
May	99.9	4	89	25.0	51	34.5
June	40.8	4	84	24.0	57	32.2
July	8.3	1	82	23.4	57	31.7
August	69.9	3	88	22.7	63	30.5
September	25.9	2	88	22.7	56	31.4
October	156.4	9	91	22.2	62	31.1
November	311.1	15	95	21.8	70	28.1
December	35.0	2	93	15.3	61	28.3
January 2011	0.4	-	89	19.0	44	30.1
February	125.6	3	89	18.4	40	31.6
March	23.6	1	88	20.7	35	33.5

Dapoli

Month	Rainfall	Rainy days	Temperature ($_0$C)		Relative Humidity (%)	
			Max.	Min.	Max.	Min.
April 2010	0.8	0	33.73	20.75	90	64.75
May	0.3	0	33.96	23.74	87.4	64.8
June	1181.8	25	29.68	23.45	96.75	81.25
July	1539.2	27	27.63	22.83	95.5	92.5
August	1036.6	32	27.66	22.82	97.2	91.2
September	746.8	19	29.53	22.65	96.75	84.5
October	1060.3	10	31.23	22.25	97	79
November	88.8	6	32.28	20.7	95.6	67.6
December	0.0	0	30.53	14	96	59.25
January 2011	0.0	0.0	32.32	11.36	96.6	62.8
February	0.0	0.0	32.13	12.88	96	52.75
March	0.0	0.0	35.45	14.6	92.5	56.5

Guntur

Month	Rainfall	Rainy days	Temperature (°C)		Relative Humidity (%)	
			Max.	Min.	Max.	Min.
June 2010	78.1	7	36.7	27.3	72.2	51.3
July	196.3	11	32.2	24.9	83.5	68.8
August	240.5	14	32.2	24.9	83	72.4
September	462.8	14	32.24	24.95	82.26	70.9
October	183.5	09	31.81	24.15	85.45	71.70
November	75.2	07	30.25	22.85	88.46	71.66
December	115.3	03	28.54	18.24	87.4	57.7
January 2011	0	0	30.61	16.48	89.1	48.81
February	0	0	32.41	18.21	87.93	47.96
March	0	0	35.99	21.12	82.29	46.52

Hisar

Month	Rainfall	Rainy days	Temperature (°C)		Relative Humidity (%)	
			Max.	Min.	Max.	Min.
April 2010	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 2011	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	31

Jobner

Month	Rainfall	Rainy days	Temperature (°C)		Relative Humidity (%)	
			Max.	Min.	Max.	Min.
April 2010	00	-	40.6	22.8	40	14
May	00	-	42.6	27.4	38	14
June	4.8	1	40.1	27.1	51	28
July	192.9	13	34.7	26.2	82	57
August	122.4	10	32.2	25.1	91	71
September	102.2	7	31.7	21.9	86	56
October	6.8	1	34.0	16.9	76	26
November	34.8	3	26.3	13.2	88	47
December	0.2	1	23.3	4.6	84	33
January 2011	00	-	19.6	4.3	87	35
February	34.6	3	24.9	9.1	88	37
March	00	-	33.0	12.1	73	17

Kammarpally

Month	Rainfall	Rainy days	Temperature (°C)		Relative Humidity (%)	
			Max.	Min.	Max.	Min.
January 2010	7.4	1	30.1	14.0	62.9	37.7
February	9.8	1	33.7	18.6	63.4	33.3
March	0.0	0	38.6	21.4	49.0	24.0
April	0.0	0	41.2	24.5	38.9	18.7
May	2.0	0	44.9	37.6	43.7	23.5
June	45.8	2	38.5	27.6	58.4	41.1
July	307.3	13	31.8	21.5	82.0	68.5
August	292.9	12	32.0	22.4	81.5	67.3
September	212.0	11	31.0	23.7	82.1	67.8
October	124.0	5	32.0	21.7	81.1	60.8
November	42.0	3	31.1	20.5	80.5	57.7
December	0.0	0	2.1	1.2	5.1	3.1

Kumarganj

Month	Rainfall	Rainy days	Temperature (°C)		Relative Humidity (%)	
			Max.	Min.	Max.	Min.
April 2010	0	0	41.3	20.5	51	27
May	24.7	3	39.5	25.2	64	35
June	37.3	4	39.2	27.2	68	45
July	204.3	14	34.8	26.5	82	76
August	241.3	15	32.5	26.2	91	76
September	149	9	32.0	24.8	92	73
October	31.7	4	32.2	21.3	88	63
November	1.2	0	28.7	15.5	88	59
December	0	0	25.3	7.1	90	54
January 11	1.3	0	19.5	4.6	98	58
February	8.9	1	25.3	8.6	87	51
March	5.1	1	31.9	12.8	70	31

Mizoram

Month	Rainfall	Rainy days	Temperature (°C)		Relative Humidity (%)	
			Max.	Min.	Max.	Min.
April 2010	597	12	21.3	28.2	70.4	85.1
May	385	17	21.3	31.3	83.8	90.5
June	340	22	20.6	31.3	83.3	96.1
July	401	24	22.0	31.7	82.2	94.0
August	693	27	23.3	31.4	82.2	92.9
September	431	22	23.1	30.7	83.1	92.3
October	136	8	23.0	30.6	79.1	88.5
November	15	3	19.1	27.8	70.0	84.8
December	31	2	15.9	25.8	50.6	69.9
January 2011	0	0	13.1	23.5	37.4	54.5
February	4	1	16.4	27.1	20.8	51.1
March	64	4	19.3	28.0	23.5	56.2

Pampadumpara

Month	Rainfall	Rainy days	Temperature ($_0$C)		Relative Humidity (%)	
			Max.	Min.	Max.	Min.
April 2010	121.1	6	30.1	20.1	92	52
May	100.7	7	27.8	20.0	93	70
June	268.0	19	24.7	18.7	96	81
July	397.3	24	22.9	17.9	98	88
August	234.4	23	22.7	18.1	98	90
September	150.4	14	24.2	18.4	94	80
October	257.2	19	24.4	18.0	96	79
November	320.8	16	23.6	17.8	95	80
December	45.4	7	23.2	16.4	95	75
January 2011	68.6	3	24.6	15.5	92	58
February	100.4	3	26.3	16.1	89	52
March	41.3	4	28.0	17.1	87	45

Panniyur

Month	Rainfall	Rainy days	Temperature ($_0$C)		Relative Humidity (%)
			Max.	Min.	
April 2010	117.9	11	35.45	27.21	92.6
May	234.2	12	34.17	26.70	93.67
June	509.8	21	31.20	25.50	92.3
July	1610.8	31	28.26	24.78	95.0
August	314.3	23	30.00	26.49	93.7
September	302.6	18	30.00	25.60	91.9
October	122.2	7	33.00	25.00	96.0
November	386.8	11	32.80	25.29	91.0
December	88.8	4	33.19	21.90	92.7
January 2011	21.4	1	33.25	23.29	87.5
February	-	-	34.71	24.50	90.1
March	-	-	36.58	23.29	87.2

Periyakulam

Month	Rainfall	Rainy days	Temperature ($_0$C)		Relative Humidity (%)
			Max.	Min.	
April 2010	44.2	9	38.10	32.42	48.98
May	128.6	6	36.66	28.20	55.10
June	20.2	13	34.90	27.26	55.96
July	52.0	9	33.64	26.20	52.61
August	8.4	4	34.00	26.56	52.29
September	136.6	10	32.88	25.60	62.00
October	164.4	11	31.71	25.23	62.77
November	330.4	19	29.29	23.21	71.13
December	64.2	9	28.74	22.25	68.12
January 2011	0.00	-	27.4	25.5	65.0
February	34.4	8	28.4	26.2	57.5
March	23.04	6	30.49	28.55	48.6

Pasighat

Month	Rainfall	Temperature (₀C)		Relative Humidity (%)
		Max.	Min.	
April 2010	650.7	26.7	19.3	80.3
May	534.7	27.9	21.1	81.3
June	1091.0	29.2	23.1	87.5
July	558.0	30.2	24.3	86.0
August	407.2	32.3	24.6	80.5
September	925.4	31.0	23.2	80.4
October	80.7	30.6	21.9	74.0
November	97.4	28.0	18.3	69.6
December	21.5	24.5	13.6	64.9
January 2011	51.9	22.1	12.0	72.1
February	43.7	24.8	14.7	71.9
March	309.1	26.6	16.5	73.0

Pundibari

Month	Rainfall	Rainy days	Temperature (₀C)		Relative Humidity (%)	
			Max.	Min.	Max.	Min.
April 2010	158.1	11	30.68	21.60	90.50	69.50
May	781.1	22	30.4	17.68	90.8	75.6
June	866.0	21	29.93	23.23	95.50	82.75
July	620.4	15	31.75	25.15	91.25	80.75
August	345.4	20	31.58	25.46	94.8	80.2
September	458.7	15	31.08	24.28	97.50	84.25
October	27.9	5	30.06	21.4	91.6	82.2
November	-	-	27.98	15.90	93.00	74.75
December	-	-	24.55	10.60	90.71	68.97
January 2011	2.8	1	19.97	8.29	91.55	70.55
February	9.8	1	26.11	12.80	90.71	58.14
March	9.9	2	29.08	15.30	89.39	51.81

Sirsi

Month	Rainfall	Rainy days	Temperature (₀C)		Relative Humidity (%)	
			Max.	Min.	Max.	Min.
April 2010	23.80	4	35.6	19.8	80.0	48.8
May	49.00	4	33.6	28.2	83.4	53.8
June	401.60	16	29.5	20.2	87.2	76.0
July	754.80	25	26.2	19.6	90.0	84.4
August	439.80	27	26.7	19.7	91.8	82.0
September	312.04	21	27.5	19.5	90.6	78.5
October	124.40	10	29.3	19.0	88.0	68.3
November	111.20	13	29.2	18.1	89.0	66.6
December	0.00	0	28.6	14.0	82.6	54.2
January 2011	0.00	0	30.4	9.7	74.5	31.4
February	0.00	0	31.6	10.8	74.7	31.3
March	23.40	2	35.00	15.70	77.00	47.00
Total Average	**2240.04**	**122**	**30.27**	**17.86**	**84.07**	**60.19**

Solan

Month	Rainfall	Rainy days	Temperature ($_0$C)		Relative Humidity (%)
			Max.	Min.	
January 2010	11.5	2	19.8	1.5	50
February	97.0	5	19.9	3.7	53
March	1.0	1	26.8	9.3	49
April	2.7	1	31.8	13.8	41
May	48.2	3	32.5	16.3	43
June	168.8	10	30.6	18.3	54
July	484.6	22	27.7	20.5	82
August	171.4	23	27.7	20.2	82
September	346.6	16	26.9	17.3	79
October	41.7	2	27.1	10.5	62
November	21.8	2	24.4	6.1	55
December	70.2	2	19.9	1.2	58

Udaipur

Month	Rainfall	Temperature ($_0$C)		Relative Humidity (%)	
		Max.	Min.	Max.	Min.
April 2010	0.0	39.4	22.9	40.1	14.8
May	0.0	41.2	27.6	38.8	21.7
June	35.1	38.1	26.7	59.8	33.9
July	321.1	37.8	24.5	86.3	70.6
August	323.4	30.5	23.7	91.0	75.8
September	113.5	31.0	20.7	86.1	57.8
October	0.0	34.0	18.2	74.5	34.4
November	77.6	28.5	16.0	82.7	66.9
December	2.4	25.0	8.3	88.7	55.9
January 2011	0.0	25.9	5.8	84.0	29.7
February	0.0	28.0	10.4	83.9	34.7
March	0.0	28.5	14.5	64.8	23.5

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