



वार्षिक रिपोर्ट Annual Report 2014-15



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

ICAR-Indian Institute of Spices Research
Kozhikode - 673012, Kerala, India



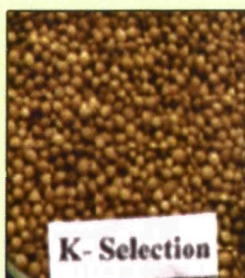
New Varieties



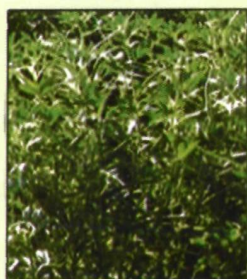
Cardamom - PV 3 (S 1)



Cardamom - Appangala 2
(IC 547167/NHY 35)



Coriander - Narendra
Dhania 2 (K-Selection)



Coriander - RCr-475 (UD 475)



Fenugreek - Lam Methi 3
(LFC-103)

**ICAR-ALL INDIA COORDINATED RESEARCH
PROJECT ON SPICES**

ANNUAL REPORT 2014 - 15



ICAR-All India Coordinated Research Project on Spices (ICAR-AICRPS)
Indian Institute of Spices Research
Kozhikode – 673 012, Kerala, India.

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कार्यकारी सारांश

अखिल भारतीय समन्वित मसाला फसल अनुसंधान परियोजना (AICRPS) का मुख्यालय भाकृअनुप-भारतीय मसाला फसल अनुसंधान संस्थान, कोषिकोड (केरल) में स्थित है। इस परियोजना के अन्तर्गत देश के 23 राज्यों में 38 केन्द्र (19 नियमित, 10 सहयोगी तथा 9 अवैतनिक केन्द्र) के अतिरिक्त परियोजना धन से कार्यान्वित 3 अन्य केन्द्र मसाला फसलों की खेती के लिये अनुकूल 12 विभिन्न कृषि जलवायु क्षेत्रों में स्थित हैं। इसकी प्रमुख अधिदेश फसलों जैसे काली मिर्च, छोटी इलायची, बड़ी इलायची, अदरक, हल्दी, दालचीनी, जायफल, लौंग, धनिया, जीरा, सौंफ, मेथी आदि हैं। वर्ष 2014-15 बजट में भारतीय कृषि अनुसंधान परिषद का आबंटन लगभग 462 लाख रुपये तथा राज्य का आबंटन 150.31 लाख रुपये था। विभिन्न केन्द्र में अधिदेश फसलों पर आनुवंशिक संसाधन, फसल सुधार, फसल प्रबन्धन, फसल संरक्षण, फसलोत्तर प्रौद्योगिकी पर कार्य करने वाले वैज्ञानिकों एवं तकनीकी कर्मचारियों द्वारा 86 परियोजनाओं के अन्तर्गत शोध कार्य प्रगति पर है।

नवीन कार्यक्रम

मसालों की बढ़ती मांग को देखते हुए उत्तर पूर्व राज्यों में मसाला अनुसंधान को बढ़ाने के लिये दो केन्द्र जैसे, नागालैंड तथा कहिकुची को सहयोगिता केन्द्र के रूप में स्थापित किया। तमिलनाडु के पेरियाकुलम में जीरा की खेती की संभावना को देखने के लिये परियोजना के अन्तर्गत एक कार्यक्रम आरंभ किया।

तमिलनाडु के कोल्ली तथा येरकाड पहाड़ों के पूर्वी तटों तथा उडीसा के कोरापुट जिले में कोफी बागों में (विशेषकर आदिवासी क्षेत्रों में) उत्पादन एवं आमदनी में वृद्धि के लिये उच्च उपज वाली काली मिर्च प्रजातियों की खेती करके कार्यक्रम शुरू किये।

हमने अरुणाचल प्रदेश एवं नागालैंड में रोग रहित सामग्रियों को उपलब्ध कराकर बड़ी इलायची के उत्पादन को बढ़ाने के लिये भी कार्यक्रम शुरू किये। तदनुसार विषाणु सूचक रोपण सामग्रियों के उत्पादन के लिये भारतीय कृषि अनुसंधान संस्थान के क्षेत्रीय केन्द्र कर्लिपोंग ने परियोजना रूप में इसका सहयोग किया तथा एकीकृत बागवानी विकास मिशन के अन्तर्गत सुपारी और मसाला विकास निदेशालय एवं स्पाइसेस बोर्ड में बड़ी मात्रा में उत्पादन एवं वितरण के लिये उपलब्ध होगा। अरुणाचल के अनजाउ जिला तथा नागालैंड के मोन जिले में बड़ी इलायची का उत्पादन करने वाले किसानों की समस्याओं को जानने के लिये सर्वेक्षण किया गया।

अखिल भारतीय समन्वित मसाला अनुसंधान परियोजना की 25 वीं कार्यशाला में विमोचन हेतु संस्तुत प्रजातियां

यु बी के वी, पुंडिबारी में आयोजित अखिल भारतीय समन्वित मसाला अनुसंधान परियोजना की 25 वीं कार्यशाला में मसालों की पांच उच्च उपज वाली प्रजातियों को विमोचित करने के लिये संस्तुत किया गया। इलायची की दो प्रजातियां भाकृअनुप-भा.म.फ.अनु.सं.के क्षेत्रीय स्टेशन अप्पंगला की अप्पंगला -2 (कट्टे विषाणु प्रतिरोधक पहला संकर) तथा इलायची अनुसंधान क्षेत्र, पाम्पाडुमपारा की पी वी -3 (शुष्कता के प्रति मध्यम प्रतिरोधक), धनिया की दो प्रजातियां, प्रथम एस के एन कोलेज ओफ एग्रिकल्चर (आर ए यु), जोबनर की Rcr 475 (बुशी तथा सीधा खड़ा हुआ प्रकार) तथा द्वितीय एन डी यु ए एवं टी, कुमारगंज की नरेन्द्र धनिया 2 (दो लक्षित प्रजाति) तथा बागवानी अनुसंधान क्षेत्र, डा. वाई एस आर एच यु, गुंटूर की मेथी की उच्च उपज वाली एक प्रजाति LFC 103 (सिचाई तथा वर्षा आधारित खेती करने के लिये अनुकूल प्रजाति) आदि को संस्तुत किया गया।

काली मिर्च

गत वर्ष काली मिर्च के 99 अक्सेशनों अखिल भारतीय समन्वित मसाला अनुसंधान परियोजना के विभिन्न काली मिर्च केन्द्रों के काली मिर्च जननद्रव्यशाला में सम्मिलित किया गया। कुछ विशिष्ट प्रकार जैसे उच्च उपज वाली करिमुंडा, बालनकोट्टा तथा अरकुलमुंडा को संचित करके जननद्रव्यशाला में सम्मिलित किया गया।

येरकाड में जर्मप्लासम मूल्यांकन परीक्षण पी एन 57 (4.08 कि. ग्राम / बेल) की अधिकतम उपज अंकित की गयी। पन्नियूर में, संकर पी आर एस 160 तथा पी आर एस 161 की अधिकतम हरी बेरी की उपज क्रमशः 4.2 कि. ग्राम / बेल तथा 4 कि. ग्राम / बेल के साथ आशाजनक थी।

चिंतापल्ली में जैविक खेती परीक्षण में ज्ञात हुआ कि जैविक पोषण (1.831 कि. ग्राम / बेल) के साथ उपचारित बेलों की अपेक्षा अजैविक उर्वरक से उपचारित बेलों में अधिकतम उपज (2.51 कि. ग्राम / बेल) अंकित की गयी। पन्नियूर में किये गये ड्रिप सिंचाई परीक्षण से यह ज्ञात हुआ कि 50% आर डी एफ 8 लिटर पानी से ड्रिप सिंचाई करने पर अच्छी उपज (4.89 कि. ग्राम / बेल) प्राप्त हुई।

सिरसी में काली मिर्च के फाइटोफथोरा खुर गलन के प्रबन्धन के लिये किये गये परीक्षण में आई आई एस आर थेवम की अधिकतम वृद्धि (2.49 एम) तथा सांख्यिकीय दृष्टि से आई आई



एस आर शक्ति (2.09 एम) में अधिक जबकि पन्नीयूर में न्यूनतम रोग आपतन पन्नीयूर-1 (11.1 %) में अंकित किया। आई आई एस आर थेवम में न्यूनतम रोग आपतन तथा ट्राइकोडेरमा हरज़ियानम (50 ग्राम प्रति बेल की दर से) के साथ पोटेथियम फोस्फोनट (0.3 %) का छिड़काव पाम्पाडुमपारा में उत्तम था।

काली मिर्च के सहायक वृक्ष एरिथ्रिना गाल वास्प के प्रति सह्य एरिथ्रिना सुबुम्बान्स मुडिगरे में बहुगुणित करके किसानों तथा संस्थानों को दिया जा रहा है।

छोटी इलायची

मुडिगरे तथा पाम्पाडुमपारा केन्द्रों में कुल 309 जर्मप्लासम अक्सेशनों का संरक्षण किया जा रहा है। इलायची के आशाजनक प्रकारों का मूल्यांकन करने पर, पी एस 27 में टिल्लरों की संख्या (21.56). टिल्लरों में पुष्प गुच्छ (1) एवं फलदार टिल्लर (2.33 की दक्षता अंकित की गयी।

मुडिगरे में छोटी इलायची में फर्टिगेशन परीक्षण करने पर ज्ञात हुआ कि 100% आर डी एफ के साथ 9 लिटर / गुच्छ / दिन की दर से ड्रिप सिंचाई करने पर अधिकतम कैप्सूल उपज (207.41 कि. ग्राम / हेक्टेयर) तथा 75% RDF के साथ 9 लिटर / गुच्छ / दिन की दर से सिंचाई करने पर अधिकतम उपज (201.23 कि. ग्राम हेक्टेयर) प्राप्त हुई।

मुडिगरे में जैव उर्वरक के साथ जैविक खाद का प्रयोग करने पर केवल जैविक खाद डालने की अपेक्षा अधिक उपज अंकित की गई। पाम्पाडुमपारा में जीवामृता + अज़ोस्फिरिल्ला (10 ग्राम / गुच्छ) + फोस्फेट लेयक जीवाणु (10 ग्राम / गुच्छ) + ट्राइकोडेरमा (10 ग्राम / गुच्छ) डालने पर उच्चतम उपज (220.27 ग्राम / पौधे) तथा शुष्क कैप्सूल उपज (42.89 ग्राम / पौधे) अंकित की गयी।

पाम्पाडुमपारा में कारबेन्डाज़िम 2 ग्राम / लिटर की दर से पत्तों पर छिड़काव तथा पौधों के आधारिय भाग पर डालने से तना गलन रोग आपतन (13.67%) कम अंकित किया गया।

बड़ी इलायची

बड़ी इलायची के 271 जर्मप्लासम अक्सेशनों को आई सी ए आर तथा आई सी आर आई, गांगटोक केन्द्रों में संरक्षित किया जा रहा है।

अरुणाचल के अनजाउ जिले तथा नागालैंड के मोन जिले में बड़ी इलायची किसानों की समस्याओं का पता लगाने के लिये सर्वेक्षण किया गया।

उत्तर सिक्किम के सिंहिक के बड़ी इलायची बागों में

फाइटोसैनिटेशन का अंगीकरण तथा जैव कारकों का प्रयोग करने पर कीट बाधा (प्ररोह मक्खी तथा कैटरपिल्लर) तथा रोग (ब्लाइट, चिरके तथा फूरके) को नियन्त्रण करने में अच्छा परिणाम प्राप्त हुआ।

अदरक

नागालैंड के दस मोटे प्रकार के तथा एक विशिष्ट काले रंग के अदरक को संचित किया। जमैकन अदरक एवं सिंगपूर अदरक को क्रमशः केरल तथा तमिलनाडु के स्थानीय किसानों के खेतों से संचित किया गया।

सोलन में एक सौ तिरासी अदरक संग्रहों को प्रकन्द उपज तथा अन्य बागवानी विशेषताओं के लिये मूल्यांकन किया गया। इस उपज में 100.63 कुन्टल / हेक्टेयर (एस जी -865) से 141.20 कुन्टल / हेक्टेयर (एस जी - 857) का अन्तर, जबकि कुमारगंज में एन डी जी - 55 (317.80 कुन्टल / हेक्टेयर) की अधिकतम उपज तत्पश्चात् एनडीजी - 28 (138.30 कुन्टल / हेक्टेयर) तथा एनडीजी - 6 (132.40 कुन्टल / हेक्टेयर) थी।

ज़िंक स्रोत के संबन्ध का परीक्षण करने पर, पुंडिबारी में महिमा प्रजाति की उच्चतम साफ उपज 4.68 कि. ग्राम / प्लोट (9.43 टन / हेक्टेयर) तथा उच्चतम शुष्क उपज 1.21 कि. ग्राम / प्लोट प्राप्त हुई।

पुंडिबारी और सोलन में हेक्ज़ाकोनाज़ोल (0.1%) को रोग आपतन के समय तथा फिर दो बार 20 दिनों के अन्तराल में पत्तों पर छिड़काव पूर्ण दाग रोग नियन्त्रण के लिये प्रभावी था। लेकिन धोली में प्रोपिकोनाज़ोल (0.1%) को रोग आपतन के समय तथा फिर दो बार पहले छिड़काव के बाद 20 दिनों के अन्तराल में पत्तों पर छिड़कने पर रोग आपतन कम अंकित किया गया।

हल्दी

नागालैंड तथा अरुणाचल प्रदेश की तीन कुरकुमा स्पीसीस को संचित किया तथा जमैकन हल्दी को केरल के स्थानीय किसानों के खेत से संचित किया जा रहा है।

एन डी एच 98 हल्दी की सी वी टी में अधिकतम प्रकन्द की उपज पासीघाट में (36.41 टन / हेक्टेयर), चिन्तापल्ली में (590 ग्राम / पौधे), कुमारगंज में (31.66 टन / हेक्टेयर) तथा रायगढ़ में (16.67 टन / हेक्टेयर) अंकित किया गया।

ड्रिप सिंचाई परीक्षण में, दिन में एक बार 80% पी ई की ड्रिप सिंचाई करने पर अधिकतम प्रकन्द उपज कम्मरपल्ली (38.32 कि. ग्राम / प्लोट), गुंटूर तथा कोयम्बतूर में (51.1 टन / हेक्टेयर) जबकि पुंडिबारी में 5 से. मी. 0.90 आई डब्ल्यू / सी पी ई



की सिंचाई करने पर अधिकतम प्रकन्द उपज (11.40 कि. ग्राम / प्लोट) अंकित की गयी।

कोयम्बतोर में सह्य प्रकारों द्वारा पर्ण रोग का प्रबन्धन करने के लिये किये गये परीक्षण में सी एल -32 तथा सी एल -34 में क्रमशः पर्ण दाग एवं पर्ण ब्लोच का कम आपतन अंकित किया गया। धोली में एन डी एच -128 तथा कुमारगंज में सी एल-34 में दोनों रोगों का आपतन कम अंकित किया। पुंडिबारी में टी सी पी 129 में दोनों पर्ण रोगों का कम आपतन अंकित किया गया।

वृक्ष मसाले

जायफल, कैसिया, दालचीनी तथा लौंग के जननद्रव्यों का संकलन करके पीचिपारै एवं दापोली में अनुरक्षण किया जा रहा है। इस वर्ष नागरकोइल के सिम्पसन तथा राजन एस्टेट से बौना लौंग, किंग लौंग तथा अधिक मोटे मदगास्कर लौंग (पहली बार) को संचित करके जननद्रव्य संकलन में सम्मिलित किया। केरल कृषि विश्वविद्यालय, त्रिशूर के परियोजना केन्द्र द्वारा जायफल संकलन का सर्वेक्षण आयोजित किया तथा विशिष्ट संकलन जैसे वृक्षों का आकार, शाखाओं की रीति, पत्तों का आकार, लिंग रूप, फल, जावित्री तथा केरनल चरित्र उपज जैविक एवं अजैविक प्रतिक्रिया आदि के लिये सर्वेक्षण किया गया। पत्तनमतिट्टा, कोट्टयम, एरणकुलम, त्रिशूर, मलप्पुरम, पालघाट तथा कोषिककोड से 15 विभिन्न अक्सेशनों को संकलित किया गया।

दापोली में आयोजित एक जायफल जननद्रव्य मूल्यांकन में औसत शुष्क फलों की उपज जीनोटाइप DBSKVMF 29 (1505 ग्राम) तथा शुष्क जावित्री की उपज (315 ग्राम) अंकित की गयी। यह जीनोटाइप फलों का वजन, नट का वजन तथा जावित्री का वजन के आधार पर आशाजनक था।

धनिया

कोयम्बतूर में धनिया के 70 जीनोटाइप में किये एम एल टी में जीनोटाइप के बीज उपज में 325 से 656 कि. ग्राम/हेक्टेयर का अन्तर तथा जीनोटाइप एल सी सी-168 अधिकतम बीज उपज (6.56 कुन्तल / हेक्टेयर) पंजीकृत किया। जो डी एच 246, एल सी सी 144, सी एस 66, एन डी 80 तथा एन डी 82 में अधिक थी। सी वी टी परीक्षण में जीनोटाइप एल सी सी -219 की कोयंबतोर में (573.20 कि.ग्राम / हेक्टेयर), गुणदूर में (12.95 कुन्तल / हेक्टेयर), जबलपुर में (4.143 कुन्तल / हेक्टेयर) तथा नवसारी में (11.04 कुन्तल/हेक्टेयर) अधिक उपज अंकित की गयी। जबकि जगुदान में जे सी आर 404 (17.40 कुन्तल / हेक्टेयर), जोबनर में जे सी आर 379 (23.47 कुन्तल / हेक्टेयर), कुमारगंज में एन डी सी ओ आर 10 (15.27 कुन्तल / हेक्टेयर) थी।

पी जी पी आर मूल्यांकन परीक्षण करने पर यह ज्ञात हुआ कि, एफ के 14 के साथ बीज उपचार के फलस्वरूप कोयम्बतूर में बीज उपजता बढ़ी तथा गुणदूर के अध्ययन से पता चला कि प्सूडोमोनास पुटिडा एफ के 14 तथा माक्रोबैक्टीरियम पाराओक्सिडन्स एफ एल 18 स्ट्रेन की उपज में वृद्धि ही नहीं बल्कि गुणदूर में धनिया की म्लानी का प्रबन्धन आशाजनक था।

कोयम्बतूर में धनिया के पाउडरी मिल्ड्यू के प्रबन्धन के लिये नये कवकनाशियों के प्रयोग की जांच के लिये एक परीक्षण किया गया। इस परीक्षण में पाउडरी मिल्ड्यू का आपतन प्रोपिकोनाज़ोल छिडकाव किये पौधों में कम (5.14 पी डी आई) तथा अधिक धान उपज 663.33 कि.ग्रा./हेक्टेयर अंकित किया तत्पश्चात् टेबुकोनाज़ोल, डिफेनकोनाज़ोल (11.67 पी डी आई) जबकि रोग आपतन का नियन्त्रण 5.56 कुन्तल/हेक्टेयर उपज के साथ 91.55 पी डी आई थी।

जीरा

जगुदान एवं जोबनर में जीरा के जननद्रव्य का संरक्षण किया जा रहा है। वर्तमान जननद्रव्य संकलन में 148 अक्सेशनें हैं जिनमें विदेश संकलन भी शामिल है।

जोबनर में सी वी टी परीक्षण में सी यू एम -23 की 6.37 कुन्तल / हेक्टेयर की अधिकतम बीज उपज अंकित की गयी तत्पश्चात् आर ज़ेड -345 चेक (6.33 कुन्तल/हेक्टेयर), सी यू एम -24(6.26 कुन्तल / हेक्टेयर) तथा सी यू एम-25(6.00 कुन्तल / हेक्टेयर) थी। जबकि निम्नतम बीज उपज सी यू एम -22 में 3.43 कुन्तल / हेक्टेयर अंकित की गयी।

सौंफ

एक सी वी टी में जबलपुर में ए जे एफ एन एल 2 (20.58 कुन्तल / हेक्टेयर), जगुदान में जे एफ - 674-1 (14.26 कुन्तल / हेक्टेयर), जोबनर में यू एफ 157 (24.05 कुन्तल / हेक्टेयर) अधिकतम थी।

जोबनर में आई ई टी के अन्तर्गत किये गये दस प्रविष्टियों में यू एफ - 286 ने 23.96 कुन्तल / हेक्टेयर की अधिकतम बीज उपज तत्पश्चात् यू एफ - 287(22.61 कुन्तल / हेक्टेयर) , यू एफ - 288(22.35 कुन्तल / हेक्टेयर), आर एफ - 205 चेक (21.48 कुन्तल / हेक्टेयर) तथा यू एफ - 283(20.64 कुन्तल / हेक्टेयर) थे जबकि निम्नतम बीज उपज 15.81 कुन्तल / हेक्टेयर यू एफ - 281 में अंकित की गयी। जगुदान में 3 साल से संचित आंकड़ों के आधार पर जे एफ - 576(14.36 कुन्तल / हेक्टेयर) तथा जे एफ -2012 - 9(14.01 कुन्तल / हेक्टेयर) में जी एफ -12 से अधिक बीज उपज प्राप्त हुई।



मेथी

एक सी वी टी में कोयम्बतूर जीनोटाइप एल एफ सी -98 में 4.31 कुन्टल / हेक्टेयर उपज के साथ अच्छा फल दिखाया जबकि गुण्डूर में यू एम-202 (16.69 कुन्टल / हेक्टेयर), यू एम-354 (16.27 कुन्टल / हेक्टेयर), एल एफ सी -98 (15.36 कुन्टल / हेक्टेयर) तथा ए एफ जी 5 (14.76 कुन्टल / हेक्टेयर) उन्नत उपज थी। ए एफ जी 5 (19.66 कुन्टल / हेक्टेयर), जे एफ जी 245 (18.88 कुन्टल / हेक्टेयर) तथा एन डी एम 69 (18.69 कुन्टल / हेक्टेयर) की जगुदान में अधिक उपज अंकित की गयी।

पी जी पी आर परीक्षण में प्स्यूडोमोनास पुटिडा एफ के 14 तथा माक्रोबैक्टीरियम पाराओक्सिडन्स एफ एल 18 स्ट्रेन को गुण्डूर में उपज बढ़ाने तथा शुष्क खुर गलन के प्रबन्धन में प्रभावी था।

गुणवत्ता युक्त रोपण सामग्रियों का उत्पादन एवं वितरण

आन्ध्र प्रदेश के आदिवासी क्षेत्रों में उच्च उपज तथा अधिक कुरकुमिन वाली हल्दी प्रजाति रोमा की लगभग 20 टन रोपण सामग्री का उत्पादन करके वितरण किया तथा मेघालया में 100 टन मेगा हल्दी वाणिज्यिक उपयोग के लिये उच्च गुणवत्ता वाले हल्दी क्षेत्र को स्थापित करने हेतु तैयार किया।

रोपण के लिये बीज सामग्रियों का वितरण

अखिल भारतीय समन्वित मसाला अनुसंधान परियोजना तथा सुपारी व मसाला विकास निदेशालय ने मिलकर 2.5 लाख काली मिर्च रोपण सामग्री, इलायची के 10,000 बीज पौधे / सकेर्स, हल्दी (आन्ध्र प्रदेश तथा मेघालया में उत्पादित रोमा तथा मेगा को मिलाकर) 148 टन बीज, अदरक के 20 टन बीज, जायफल के 600 कलमी पौधे तथा दालचीनी के 2500 एयर लेयर्स का वितरण किया गया।

बीज मसालों में जीरा, धनिया, सौंफ तथा मेथी प्रत्येक के 10 कुन्टल बीज सामग्रियों का उत्पादन एवं वितरण किया गया।

तकनीकियों का स्थानान्तरण

कृषकों को विकसित तकनीकियों से सीधे परिचित कराने के लिये विकसित तकनीकियों तथा प्रजातियों की प्रदर्शनी में सक्रिय रूप से भाग लिया। गत वर्ष में प्रदर्शित कुछ तकनीकियां निम्नलिखित हैं।

- ★ हल्दी की एकीकृत जैविक खेती (कम्मारपल्ली)
- ★ हल्दी का बीज उपचार (कम्मारपल्ली)
- ★ इलायची का संसाधन एवं ड्रिप सिंचाई (मुडिगरे)

- ★ अदरक का आशाजनक जीनोटाइप आई सी- 593889 (एस जी-26-04) (सोलन)
- ★ अदरक में मृदु गलन एवं जीवाणु म्लानी रोग नियन्त्रण के लिये कैबेज द्वारा बयोफमिगेशन (पुंडिबारी)
- ★ अनुकूल आई पी डी एम के अन्तर्गत पन्निचूर प्रजातियों का उत्पादन तथा अजैविक पद्धति से पन्निचूर प्रजातियों की उच्च उत्पादन क्षमता (पन्निचूर)।
- ★ बुश पेप्पर खेती (सिरसी)
- ★ अदरक एवं हल्दी की जैविक खेती पर खेतीगत प्रदर्शनी (पोट्टांगी)
- ★ काली मिर्च खेतों में ट्राइकोडेरमा विरिडे का प्रयोग (येरकाड)
- ★ हल्दी की सुगुणा प्रजाति पर खेतीगत प्रदर्शनी (गुण्डूर)
- ★ काली मिर्च एवं हल्दी का संसाधन, हल्दी एवं अदरक प्रो-ट्रै तकनीक, दालचीनी का छाल निकालना, मृदु लकड़ी की कलम बांधना तथा बुश पेप्पर तकनीकी (दापोली)
- ★ उच्च उपज वाली हल्दी प्रजाति सी ओ-2 की प्रदर्शनी (कोयम्बतूर)
- ★ धनिया (जी सी ओ आर-2) तथा सौंफ (जी एफ-12) की उच्च उपज वाली प्रजाति की प्रदर्शनी (जगुदान)

प्रशिक्षण, संगोष्ठी तथा प्रसार माध्यम (समाचार पत्र, आकाशवाणी में व्याख्यान तथा दूरदर्शन कार्यक्रम) से तकनीकी स्थानान्तरण।

सफल गाथा

काली मिर्च प्रतिरोधक रूट स्टोक -पाइपर कोलुब्रिनम पर कलम बांधकर, कवकनाशियों के प्रयोग को कम करके खेती करना फाइटोपथोरा खुर गलन रोग के प्रबन्धन के लिये एक कृषि अनुकूल मार्ग है। इस तकनीक का कर्नाटक के उत्तर कन्नडा जिले में लगभग 80 हेक्टेयर जगहों में विस्तार हुआ।

तमिलनाडु कृषि विश्वविद्यालय, तमिलनाडु, आन्ध्र प्रदेश महाराष्ट्र तथा उड़ीसा द्वारा अदरक एवं हल्दी में अधिक उत्तम सिंगल नोड के प्रोट्रे तकनीकी को कई किसानों के 20 एकड़ से अधिक खेतों में सफल रूप से कार्यान्वित किया तथा बीस से अधिक प्रशिक्षण कार्यक्रम भी आयोजित किये गये। यही कार्यक्रम तेलंगाना तथा आन्ध्र प्रदेश में चिन्तापल्ली तथा कम्मारपल्ली केन्द्रों द्वारा भी आयोजित किये गये।

केरल में संरक्षित अवस्था में अदरक की सिंगल बेड मृदा रहित खेती की गई।

आदिवासी कल्याण कार्यक्रम

पोट्टांगी, चिन्तापल्ली तथा रायगढ़ में आदिवासियों के लिये प्रशिक्षण आयोजित किये तथा किसानों के लिये रोपण सामग्रियों का वितरण भी किया गया।



उत्तर पूर्व क्षेत्रों में नवीन कार्यक्रम

नागालैंड में हल्दी की 24 प्रजातियां तथा अदरक की 8 प्रजातियों को पहली बार प्रयुक्त किया। केन्द्रीय बागवानी संस्थान तथा नागालैंड विश्वविद्यालय की अदरक एवं हल्दी के प्रो ट्रै तकनीकी का प्रशिक्षण दिया गया।

विभिन्न राज्यों के अखिल भारतीय समन्वित मसाला अनुसंधान परियोजना केन्द्रों द्वारा शुष्कता, पांस, रोग से प्रकोप आदि के संबन्ध में समय समय पर परामर्श दिये जा रहे हैं।

सहकारिता

भाकृअनुप- भारतीय मसाला फसल अनुसंधान संस्थान, राष्ट्रीय बीज मसाला अनुसंधान केन्द्र, अजमेर तथा राज्य कृषि विश्वविद्यालय के अतिरिक्त सुपारी व मसाला विकास निदेशालय, स्पाइसेस बोर्ड, केन्द्रीय बागवानी संस्थान के साथ भी सहयोगी कार्य

कर रहे हैं। असम के बागों तथा उड़ीसा के कोरापुट के कोफी कृषक संघ को भी काली मिर्च बागों के सुधार एवं स्थापना के लिये सहायता की है।

मूल्यांकन

केन्द्र द्वारा कार्यान्वित परियोजनाओं तथा कार्यक्रमों को परियोजना समन्वयक केन्द्र तथा प्रायोगिक प्रक्षेत्र में भ्रमण करके मूल्यांकन किये जाते हैं। गत वर्ष परियोजना समन्वयक ने 18 केन्द्रों का भ्रमण किया। जिनमें नियमित, सहयोगी, स्वैच्छिक तथा परियोजना केन्द्र भी शामिल थे। इनकी निगरानी केन्द्र द्वारा भेजे गये मासिक तथा वार्षिक प्रतिवेदनों के आधार पर की गयी तथा वार्षिक कार्यशाला का 25-27 सितम्बर 2014 में यूबीकेवी, पुंडिबारी में आयोजन किया गया। डा. एस. के. मल्होत्रा, बागवानी अयुक्त, तथा सहायक महानिदेशक (बागवानी विज्ञान) कार्यशाला में उपस्थित थे।



EXECUTIVE SUMMARY

All India Coordinated Research Project on Spices with its headquarters at ICAR-IISR, Kozhikode is a coordinating unit with 38 centres (19 regular, 10 co-opting and 9 voluntary centres) supplemented by 3 more centres through project mode funding, spreading over 12 agro climatic zones in 23 states of the country. Black Pepper, Small Cardamom, Large Cardamom, Ginger, Turmeric, Cinnamon, Nutmeg, Clove, Coriander, Cumin, Fennel and Fenugreek are the mandate crops. Annual budget for the year 2014-15 was Rs. 462 lakhs as ICAR share and 150.31 lakhs as state share. There are 86 projects handled by scientists and supported by technical staff working on the mandate crops in various aspects of genetic resources, crop improvement, crop management, crop protection and transfer of technology.

New Initiatives

To meet the increasing demand for hastening the spices research in the North East, 2 centres viz., Nagaland and Kahikuchi were started in co-opting mode. A project mode program was also undertaken to see the possibility of cultivating cumin in Periyakulam of Tamil Nadu.

We had initiated pepper intensification program in East coast at Kolli and Yercaud hills of Tamil Nadu and Koraput district in Orissa, by introducing high yielding black pepper varieties into coffee garden for increasing production and income, especially in Tribal areas.

We had also initiated intensification of large cardamom in Arunachal and Nagaland where disease free material will be introduced. Accordingly IARI Regional centre at Kalimpong was supported in project mode funding to generate virus indexed plant material and this will be made available to DASD under MIDH as well as Spices Board for further multiplication and distribution. We also surveyed Anjaw district in Arunachal and Mon district of Nagaland to

understand the problems of large cardamom farmers in the region.

Varieties recommended for release in 25th AICRPS workshop

Five high yielding varieties of spices were recommended for release in 25th AICRP on Spices workshop held at UBKV, Pundibari. Two cardamom varieties Appangala – 2 (First hybrid resistant to *Katte* virus) from ICAR-IISR Regional Station, Appangala and PV-3 (Moderately resistant to drought) from Cardamom Research Station, Pampadumpara, 2 coriander varieties RCr 475 (Bushy and erect plant type) from SKN college of Agriculture, (SKNAU) Jobner and Narendra Dhania 2 (Dual purpose variety) from NDUA&T, Kumarganj and a high yielding variety of fenugreek LFC-103 suitable for both irrigated and rainfed conditions from Horticulture Research Station, Dr. YSRHU, Guntur are the varieties recommended for release.

Black Pepper

During the year 99 accessions of black pepper were added to black pepper germplasm maintained at various black pepper centres of AICRPS. Some unique varieties like high yielding Karimunda, Balankotta and Arakalumunda were collected and added to the germplasm.

At Yercaud in a germplasm evaluation trial PN 57(4.08 kg vine⁻¹) recorded highest yield. At Panniyur, the hybrids PRS160 and PRS 161 were found to be promising with maximum green berry yield of 4.2 kg vine⁻¹ and 4 kg vine⁻¹ respectively.

As per the observations recorded in the organic farming trial at Chintapalle, vines treated with inorganic fertilizers have recorded higher yields (2.51 kg vine⁻¹) compared to vines treated with organic source of nutrients (1.831 kg vine⁻¹).



Drip irrigation trial at Panniyur revealed that application of 50% RDF with 8 l of water through drip help in obtaining good yield (4.89 kg vine⁻¹).

In a trial to manage *Phytophthora* foot rot of black pepper in new plantation at Sirsi, IISR Thevam recorded highest growth (2.49 m) and it was statistically on par with IISR Shakti (2.09 m) whereas in Panniyur minimum disease incidence was observed in Panniyur-1 (11.1%). IISR Thevam showed the least disease incidence and the treatment of potassium Phosphonate 0.3% spray along with the basal application of *Trichoderma harzianum* @ 50 g vine⁻¹ was the best at Pampadumpara.

Black pepper standard *Erythrina subumbrans* tolerant to *Erythrina* gall wasp is being multiplied at Mudigere and is distributing the material to the farmers and the institutions.

Small Cardamom

A total of 309 germplasm accessions are maintained at Mudigere and Pampadumpara centres. In evaluation of promising lines of cardamom, PS 27 performed well in terms of number of tillers (21.56), panicles per tiller (1) as well as productive tillers (2.33).

In an fertigation trial in small cardamom at Mudigere application of irrigation at 9 l/clump/day with 100% RDF through drip recorded the highest capsule yield (207.41 kg ha⁻¹) and this is on par with irrigation at 9 l/clump/day with 75% RDF (201.23 kg ha⁻¹).

Application of organics with bio-fertilizers recorded significantly higher yield at Mudigere than only organics. Application of Jeevamruta + *Azospirillum* (10 g clump⁻¹) + Phosphate solubilizing bacteria (10 g clump⁻¹) + *Trichoderma* (10 clump⁻¹) resulted in the highest fresh (220.27 g plant⁻¹) and dry capsule yield (42.89 g plant⁻¹) at Pampadumpara.

Lowest disease incidence (13.67 %) of pseudostem rot was observed in the application

of Carbendazim at 2g l⁻¹ as foliar spray as well as basal application at Pampadumpara.

Large Cardamom

In large cardamom 271 germplasm accessions are maintained at ICAR and ICRI, Gangtok centres.

A survey was undertaken in the Anjaw district in Arunachal and Mon district of Nagaland to understand the problems of large cardamom farmers in the region.

Adoption of phytosanitation and application of bioagents in large cardamom has resulted in controlling the incidence of pests (shoot fly and leaf caterpillar) and diseases (blight, chirke and foorkey) in farmers field at Singhik, North Sikkim.

Ginger

10 Bold types of ginger and one unique black ginger (*Kaempferia parviflora*) were collected from Nagaland. Jamaican & South African ginger (from Kerala) and Singapore ginger (from Tamil Nadu) were collected from local farmer's fields.

One hundred and eighty three ginger collections were evaluated for rhizome yield and other horticultural traits at Solan. The yield range varied from 100.63 q ha⁻¹ (SG-865) to 141.20 q ha⁻¹ (SG-857) whereas at Kumarganj NDG-55 (317.80 q ha⁻¹) recorded highest yield followed by NDG-28 (138.30 q ha⁻¹) and NDG-6 (132.40 q ha⁻¹).

In source sink relationship trial, variety Mahima produced the highest fresh yield of 4.68 kg plot⁻¹ (9.43 t ha⁻¹) and highest dry yield of 1.21 kg plot⁻¹ at Pundibari.

Foliar spray with Hexaconazole (0.1%) first at disease appearance and then 2 times at 20 days interval was found to be effective in controlling the leaf spot disease incidence at



Pundibari and Solan but at Dholi foliar spray of Propiconazole (0.1%) first at disease appearance and subsequently 2 sprays at 20 days interval after 1st spray recorded less disease incidence.

Turmeric

Three *Curcuma* species were collected from Nagaland and Arunachal Pradesh and Jamaican turmeric is collected from local farmer's field in Kerala.

NDH-98 recorded maximum rhizome yield at Pasighat (36.41 t ha⁻¹), Chintapalle (590.0 g plant⁻¹), Kumarganj (31.66 t ha⁻¹) and Raigarh (16.67 t ha⁻¹) in an turmeric CVT trial.

In an drip irrigation trial, drip once in a day at 80% PE recorded highest rhizome yield at Kammarpally (38.32 kg plot⁻¹), Guntur (51.1 t ha⁻¹) and also at Coimbatore whereas in Pundibari surface irrigation 5 cm at 0.90 IW/CPE recorded highest rhizome yield of 11.40 kg plot⁻¹.

Mechanical planting of turmeric was taken up as observational trial at Coimbatore.

In a trial to manage foliar diseases using tolerant lines at Coimbatore CL-32 and CL-34 recorded least incidence of leaf spot and leaf blotch respectively. At Dholi NDH – 128 and at Kumarganj CL-34 were least affected by both the diseases. At Pundibari TCP 129 recorded least incidence of both the foliar diseases.

Tree Spices

Germplasm of nutmeg, cassia, cinnamon and clove is maintained at Pechiparai and Dapoli. This year dwarf clove, king clove and extra bold Madagascar clove (for the first time) from Simpson and Rajan estates of Nagarcoil were collected and added to the germplasm.

Nutmeg collection survey was also conducted by project mode centre at KAU, Thrissur and unique collections in terms of tree shape, branching pattern, leaf size, sex form, fruit, mace and kernel characters, yield, reaction

to biotic and abiotic stress were looked into. 15 different accessions were located from Pathanamthitta, Kottayam, Ernakulam, Thrissur, Malappuram, Palakkad and Kozhikode.

In a nutmeg germplasm evaluation trial at Dapoli average dry nut yield (1505.0 g) and dry mace yield (315.0 g) was recorded in genotype DBSKKVMF 29 in years 2006 to 2014. The genotype DBSKKVMF 29 is found promising considering its fruit wt., nut wt. and mace wt.

Coriander

In an MLT of coriander at Coimbatore among 70 genotypes seed yield of genotypes varied from 325 to 656 kg ha⁻¹ and the genotype LCC-168 registered maximum seed yield (6.56 q ha⁻¹) which was on par with DH 246, LCC 144, CS 66, ND 80 and ND 82.

In a CVT trial genotype LCC 219 has recorded significantly higher yield at Coimbatore (573.20 kg ha⁻¹), Guntur (12.95 q ha⁻¹), Jabalpur (4.143 q ha⁻¹) and Navsari (11.04 q ha⁻¹) whereas JCr 404 (17.40 q ha⁻¹) at Jagudan, JCr 379 (23.47 q ha⁻¹) at Jobner, ND Cor 10 (15.27 q ha⁻¹) at Kumarganj.

PGPR evaluation trial revealed that seed treatment with FK 14 resulted in increasing the seed yield at Coimbatore and study at Guntur revealed that *Pseudomonas putida* FK14 and *Macrobacterium paraoxydans* FL18 strains found not only in improving the yield but also in management of wilt in coriander at Guntur.

A trial to test the efficacy of new generation fungicides for the management of coriander powdery mildew was laid out at Coimbatore. In this trail the incidence of powdery mildew was less (5.14 PDI) in propiconazole sprayed plants and these plants also recorded higher grain yield of 6.63 q ha⁻¹ and was followed by Tebuconazole, Difenconazole (11.67 PDI), while in control the disease incidence was 91.55 PDI with grain yield of 5.56 q ha⁻¹.





Cumin

Germplasm of cumin is maintained at Jagudan and Jobner, at present there are about 148 germplasm accessions including the exotic collections.

At Jobner in an CVT trial CUM-23 recorded maximum seed yield of 6.37 q ha⁻¹ followed by RZ-345 check (6.33 q ha⁻¹), CUM-24 (6.26 q ha⁻¹) and CUM-25 (6.00 q ha⁻¹), while lowest seed yield of 3.43 q ha⁻¹ was recorded in CUM-22.

Fennel

In a CVT trial the top yielders at various centres are as follows: AJ Fnl 2 (20.58 q ha⁻¹) at Jabalpur, JF -674-1 (14.26 q ha⁻¹) at Jagudan, UF 157 (24.05 q ha⁻¹) at Jobner.

Of the ten entries evaluated under IET at Jobner, entry UF-286 recorded maximum seed yield of 23.96 q ha⁻¹ followed by UF-287 (22.61 q ha⁻¹), UF-288 (22.35 q ha⁻¹), RF-205 check (21.48 q ha⁻¹) and UF-283 (20.64 q ha⁻¹) while lowest seed yield of 15.81 q ha⁻¹ was recorded in UF-281. In another IET 2012 at Jagudan pooled over data of 3 years indicated that the entries JF-576 (14.36 q ha⁻¹) and JF-2012-9 (14.01 q ha⁻¹) recorded significantly higher seed yield over GF-12.

Fenugreek

Fenugreek CVT 2012 revealed that at Coimbatore, genotype LFC-98 is performing good with seed yield of 4.31 q ha⁻¹ whereas at Guntur UM 202 (16.69 q ha⁻¹), UM 354 (16.27 q ha⁻¹), LFC 98 (15.36 q ha⁻¹) and AFg 5 (14.76 q ha⁻¹) recorded significantly higher yield. AFg 5 (19.66 q ha⁻¹), JFg 245 (18.88 q ha⁻¹) and NDM 69 (18.69 q ha⁻¹) recorded higher yield at Jagudan.

In a PGPR trial *Pseudomonas putida* FK14 and *Macrobacterium paraoxydans* FL18 strains found effective in increasing the yield as well as in management of dry root rot at Guntur.

Production and distribution of quality planting material

Produced and supplied about 20 t of pure seed material of high yielding high curcumin turmeric variety Roma in tribal areas of Andhra Pradesh and 100 t of Megha turmeric in Meghalaya for establishing areas of high quality turmeric for industrial use.

Distribution of Planting and seed material

The AICRPS centres along with DASD have multiplied and distributed 2.5 lakh rooted cuttings of black pepper, 10,000 seedlings/suckers of cardamom, 148 t of turmeric (includes Roma and Megha produced in Andhra Pradesh and Meghalaya), 20 t of ginger, 600 grafts of nutmeg and 2500 air layers of cinnamon.

In seed spices 10 quintals each of cumin, coriander, fennel and fenugreek seed material is produced and distributed.

Transfer of Technology

As “Seeing is believing” to make the technologies visible to farming sector scientists are actively involved in the demonstration of the technologies/varieties developed by the centre. Following are some of the technologies demonstrated during the year.

- ✓ Integrated organic farming in turmeric (Kammarpalli)
- ✓ Seed treatment in turmeric (Kammarpalli)
- ✓ Processing of cardamom and drip irrigation in cardamom (Mudigere)
- ✓ FLD on Promising Ginger genotype IC-593889 (SG-26-04) (Solan)
- ✓ Biofumigation using cabbage for the control of soft rot and bacterial wilt diseases in ginger (Pundibari)
- ✓ Yield potential of Panniyur varieties under proper IPDM and High yielding capacity of Panniyur varieties under abiotic stress (Panniyur)



- ✓ Bush pepper cultivation (Sirsi)
- ✓ FLD on ginger and turmeric organic cultivation (Pottangi)
- ✓ Use of *Trichoderma viride* in pepper cultivation (Yercaud)
- ✓ FLD on Suguna variety of turmeric (Guntur)
- ✓ Processing of black pepper and turmeric, Pro tray technology of turmeric and ginger, Cinnamon peeling, soft wood grafting and Bush pepper technology (Dapoli)
- ✓ Demonstration of high yielding Turmeric variety CO-2 (Coimbatore)
- ✓ Demonstration of high yielding varieties of coriander (GCor-2) and fennel (GF-12) (Jagudan)

Scientists are also involved in transfer of technology by conducting and attending as resource persons in trainings, seminar and also through media (news paper, radio talks and TV programs).

Success stories

Black Pepper grafted on resistant root stock - *Piper colubrinum* an eco friendly way to manage *Phytophthora* foot rot, reducing excessive use of fungicides. This grafted pepper cultivation is already spread to about 80 ha in Uttara Kannada district in Karnataka.

Highly efficient single node portray technology in ginger and turmeric, was successfully demonstrated in over 20 acres in farmers field and over 20 awareness and training programmes were conducted by TNAU in Tamil Nadu, Andhra Pradesh, Maharashtra and Orissa. A similar program was also done in Telangana and Andhra Pradesh conducted by Chintapalle and Kammarpalli centres respectively.

Single bud soilless cultivation of ginger under protected condition in Kerala.

Tribal welfare measures

Trainings at Pottangi, Chintapalle and Raigarh were conducted and distributed the planting material to the farmers.

New initiatives in North East

Introduced 24 varieties of Turmeric, 8 varieties of ginger to Nagaland. Training on portray technology of ginger and turmeric was given to Central Institute of Horticulture and Nagaland University.

Combating natural disasters and mitigating climate change

The AICRPS centres at various states have been providing periodical advisories regarding the drought, pest and disease outbreak.

Collaboration

In addition to IISR-Kozhikode, NRCSS-Ajmer and State Agricultural Universities we have collaboration with DASD, Spices Board, Central Institute of Horticulture. We also helped Amalgamated plantations in Assam and coffee planters association Koraput in Orissa for improving and establishing black pepper plantations and increasing the productivity in these regions.

Monitoring

Monitoring of projects and programs undertaken by the centres is done by Project Coordinator's visit to the centres and the experimental plots. This year Project Coordinator has visited 18 centres which includes regular, co-opting, voluntary and project mode centres. Monitoring was also done by monthly reports, annual report sent by the centres and annual workshop was conducted during 25th to 27th September 2014 at UBKV, Pundibari. Dr. S. K. Malhotra, Horticulture Commissioner and ADG (Hort.) was present during the workshop



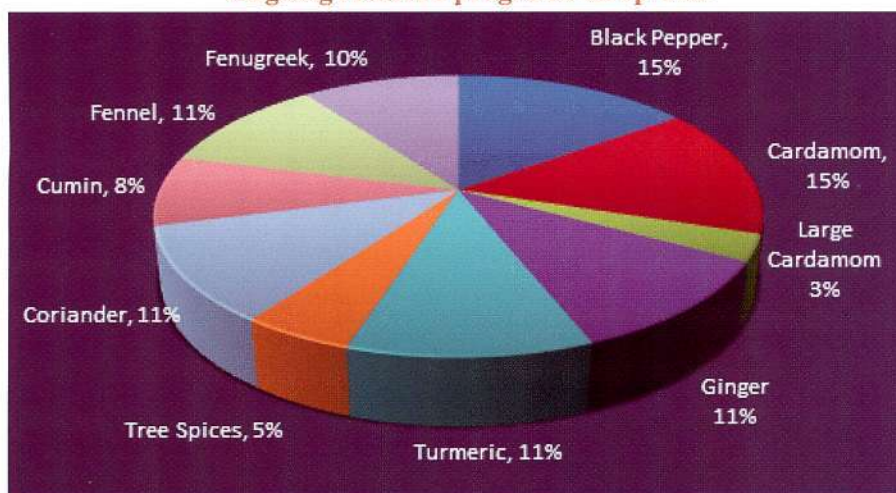
PROFILE OF AICRP ON SPICES

All India Coordinated Research Project on Spices (ICAR-AICRPS) is the largest spices research network in the country through which a nationwide collaborative and interdisciplinary research is being carried out, linking ICAR system with the State Agricultural Universities and central institutions. AICRPS was initiated in 1971 as All India Spices and Cashew nut Improvement Project (AISCIP). In 1986 it has become a full pledged coordinating unit for spices (major spices and seed spices) with its headquarters at Indian Institute of Spices Research, Kozhikode, Kerala. In VII plan (1986) it was having 12 centres and subsequently grew into 19 regular centres by the end of VIII Plan. AICRPS is working on 12 mandate crops viz., Black Pepper, Small Cardamom, Large Cardamom, Ginger, Turmeric, Nutmeg, Cinnamon, Clove, Coriander, Cumin, Fennel and Fenugreek. Presently research has extended to 10 co-opting centres and 9 voluntary centres also focusing the major agro climatic regions of the country. These centres are mostly located in State Agricultural Universities and some centres in ICAR Institutes and also Spices Board.

Mandates of the AICRPS are:

- To collect, conserve and study the biodiversity of spices in the country.
- Evolving high yielding climate resilient varieties, resistant/tolerant to pests and diseases.
- Multi-location testing of new varieties under varied agro ecological situations.
- Developing location specific varieties and standardizing agro technologies through integrated nutrient management for increasing sustainable productivity.
- Evolving suitable pests and disease management technologies through integrated pest and disease management.
- To act as an interface between ICAR/SAUs /Spices Board and DASD systems.
- Transfer of Technology through FLD's, Seminars, print and electronic media

Ongoing research programs-Crop wise



AICRPS centres, year of start and crops handled by the centre

Sl. No.	State	University	Centre	Year of start	Crops handled
Regular centres					
1	Andhra Pradesh	DrYSRHU	Chintapalle	1981	Black pepper, Ginger, Turmeric
2	Andhra Pradesh	DrYSRHU	Guntur	1975	Coriander, Fennel, Fenugreek
3	Bihar	RAU	Dholi	1993	Turmeric, Coriander, Fenugreek
4	Chhattisgarh	IGKV	Raigarh	1996	Coriander, Turmeric, Ginger
5	Gujarat	SKDAU	Jagudan	1975	Cumin, Coriander, Fennel, Fenugreek
6	Haryana	CCSHAU	Hisar	1993	Coriander, Fennel, Fenugreek
7	Himachal Pradesh	YSPUHF	Solan	1971	Ginger, Turmeric
8	Karnataka	UAHS	Mudigere	1971	Cardamom, Black pepper
9	Karnataka	UHS	Sirsi	1981	Black pepper, Turmeric, Ginger
10	Kerala	KAU	Panniyur	1971	Black pepper
11	Kerala	KAU	Pampadumpara	1971	Black pepper, Cardamom
12	Maharashtra	BSKKV	Dapoli	1995	Black pepper, Nutmeg, Clove, Cinnamon
13	Orissa	OUAT	Pottangi	1975	Turmeric, Ginger
14	Rajasthan	SKNAU	Jobner	1975	Cumin, Coriander, Fennel, Fenugreek
15	Telangana	SKLTSHU	Kamarpally	1986	Turmeric
16	Tamil Nadu	TNAU	Coimbatore	1975	Coriander, Fenugreek, Turmeric
17	Tamil Nadu	TNAU	Yercaud	1981	Clove, Nutmeg, Cinnamon, Black pepper
18	Uttar Pradesh	NDUAT	Kumarganj	1995	Turmeric, Ginger, Fennel, Coriander, Fenugreek
19	West Bengal	UBKV	Pundibari	1996	Black pepper, Turmeric, Ginger

Co-opting centres

1	Assam	AAU	Kahikuchi	2014	Black pepper, Turmeric, Nutmeg
2	Karnataka	ICRI	Sakaleshapura	2008	Cardamom
3	Kerala	KAU	Ambalavayal	2008	Black pepper, Ginger, Turmeric,
4	Kerala	ICRI	Myladumpara	2008	Cardamom
5	Meghalaya	ICAR RC NEHR	Barapani	2008	Ginger, Turmeric
6	Mizoram	ICAR RC NEHR	Mizoram	2008	Ginger, Turmeric
7	Nagaland	SASRD	Medziphema	2014	Black pepper, Ginger, Turmeric
8	Sikkim	ICRI	Gangtok	2008	Large Cardamom
9	Sikkim	ICAR RC NEHR	Sikkim	2008	Large Cardamom, Ginger, Turmeric
10	Tamil Nadu	TNAU	Pechiparai	2008	Black pepper, Cinnamon, Clove, Nutmeg

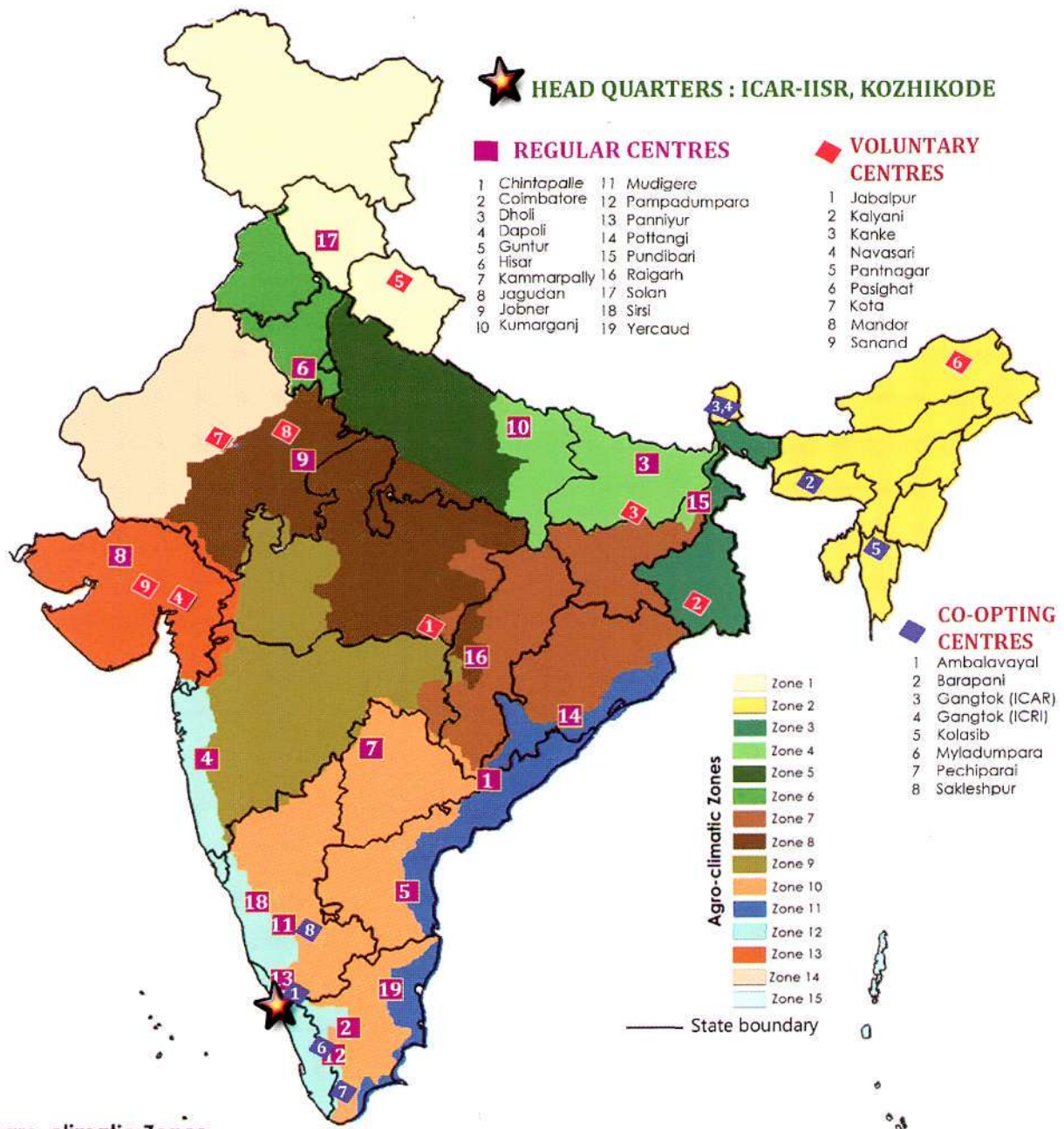
Voluntary centres

1	Arunachal Pradesh	CAU	Pasighat	2008	Large Cardamom, Ginger, Turmeric
2	Gujarat	NAU	Navasari	2008	Black pepper, Turmeric, Coriander
3	Gujarat	AAU	Sanand	2014	Cumin
4	Jharkhand	BIRSA AU	Kanke	2008	Ginger, Turmeric
5	Madhya Pradesh	JNKVV	Jabalpur	2008	Coriander, Fennel, Fenugreek
6	Rajasthan	AUK	Kota	2008	Coriander, Cumin, Fennel, Fenugreek
7	Rajasthan	AUJ	Mandoor	2014	Cumin
8	Uttarkhand	GBPUA&T	Pantnagar	2008	Turmeric, Coriander, Fennel, Fenugreek
9	West Bengal	BCKV	Kalyani	2008	Ginger, Turmeric



AGRO-CLIMATIC ZONES IN INDIA

CENTRES OF AICRP ON SPICES



Agro-climatic Zones

Zone 1 – W. Himalayan region
 Zone 2- E. Himalayan region
 Zone 3- L. Gangetic plain region
 Zone 4- M. Gangetic plain region
 Zone 5- U. Gangetic plain region

Zone 6- T. Gangetic plain region
 Zone 7-E. plateau and hills region
 Zone 8- C. Plateau and hills region
 Zone 9- W. Plateau hills region
 Zone 10- S. plateau and hills region

Zone 11- E. coast plains and hills region
 Zone 12- W. coast plains and ghat region
 Zone 13- Gujarat plains and hills region
 Zone 14- Western dry region
 Zone 15- Island region



TECHNICAL PROGRAMME (2014-15)

Project Code	Title	Centres
Black Pepper		
PEP/CI/1	Genetic Resources	
PEP/CI/1.1	Germplasm collection, characterization, evaluation and conservation	Ambalavayal, Chintapalle, Dapoli, Panniyur, Pundibari, Sirsi, Yercaud
PEP/CI/2	Hybridization trial	
PEP/CI/2.1	Inter-varietal hybridization to evolve high yielding varieties	Panniyur
PEP/CI/3	Coordinated Varietal Trial (CVT)	
PEP/CI/3.3	CVT 2006 Series VI	Chintapalle, Dapoli, Panniyur, Pampadumpara, Sirsi, Yercaud
PEP/CI/3.4	Evaluation of grafts, orthotropic and runner shoots in black pepper	Ambalavayal, Panniyur, Sirsi, Yercaud
PEP/CM/4	Nutrient Management Trial	
PEP/CM/4.4	Development of organic package for spices based cropping system-observational trial	Chintapalle, Dapoli, Panniyur, Sirsi
PEP/CM/4.5	Organic farming in black pepper-2006	Dapoli, Panniyur, Pechiparai, Sirsi, Yercaud
PEP/CM/4.6	Standardization of drip fertigation in black pepper	Panniyur
PEP/CM/4.7	Black pepper based mixed cropping system for sustainable productivity and food security	Ambalavayal, Sirsi, Panniyur, Dapoli
PEP/CP/5	Disease Management Trial	
PEP/CP/5.1	Adaptive trial on management of <i>Phytophthora</i> foot rot of black pepper in farmers field	Ambalavayal
PEP/CP/5.3	Trial on management of <i>Phytophthora</i> foot rot of black pepper in new plantation	Chintapalle, Mudigere, Dapoli, Sirsi, Panniyur, Pampadumpara
PEP/CP/5.4	Effectiveness of new molecules of fungi toxicants against <i>Phytophthora</i> foot rot of black pepper in existing plantation	Chintapalle, Mudigere, Sirsi
PEP/CP/5.6	Biological Management of Slow Decline in Black Pepper	Panniyur
PEP/CP/6	Pest Management Trial	
PEP/CP/6.2	Management of <i>Erythrina</i> gall wasp in a popular standard of black pepper	Mudigere, Pampadumpara
Small 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	Hybridization and selection in cardamom	Mudigere
CAR/CI/2.2	Evaluation of promising small cardamom (<i>Elettaria cardamom</i> L. Maton) cultivars/ varieties for organic cultivation in the high ranges of Idukki district	Pampadumpara
CAR/CI/3	Coordinated Varietal Trial	
CAR/CI/3.6	CVT 2007/2009-Series VI	Mudigere, Myladumpara, Pampadumpara
CAR/CI/3.7	CVT of drought tolerance in Cardamom – Series VII	Appangala, Mudigere, Sakaleshapura
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/CI/4.3	Initial Evaluation Trial – 2012	Pampadumpara
CAR/CM/5	Nutrient Management Trial	
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/CM/5.4	Liming in cardamom	Pampadumpara
CAR/CP/6	Pest and Disease Management Trial	
CAR/CP/6.7	Evaluation of new insecticides / biopesticides in cardamom against thrips and capsule borer	Mudigere, Pampadumpara
CAR/CP/6.8	Comparison of effect of chemical treatments as well as bio-control agents against pseudostem rot of cardamom	Pampadumpara
Large Cardamom		
LCA/CI/1.1	Germplasm collection and evaluation of large cardamom	ICAR Regional Station, Gangtok, ICRI Regional Research Station, Gangtok
LCA/CP/1.1	Evolving disease and pest tolerant lines in large cardamom	ICRI Regional Station, Gangtok
LCA/CP/1.2	Integrated pest and disease management in large cardamom	ICRI Regional Station, Gangtok
Ginger		
GIN/CI/1	Genetic Resources	
GIN/CI/1.1	Germplasm collection, characterization, evaluation and conservation	Dholi, Kammarpally, Kumarganj, Pundibari, Pottangi, Raigarh, Solan
GIN/CI/2	Coordinated Varietal Trial (CVT)	
GIN/CI/2.3	CVT 2013-Series VIII	IISR, Dholi, Pottangi, Pundibari, Solan



GIN/CI/3	Varietal Evaluation Trial	
GIN/CI/3.2	Initial Evaluation Trial – 2011	Pundibari, Solan
GIN/CI/3.3	Initial Evaluation Trial – 2012	Kumarganj, Pottangi
GIN/CI/4	Quality Evaluation Trial	
GIN/CI/4.1	Evaluation of germplasm for quality	Solan
GIN/CM/5	Nutrient Management Trial	
GIN/CM/5.4	Evaluation of herbicide for the effective control of weeds in ginger	Chintapalle
GIN/CM/5.5	Source sink relationship	IISR, Kanke, Mizoram, Pundibari, Solan
GIN/CP/6	Disease Management Trial	
GIN/CP/6.1	Disease surveillance and etiology of rhizome rot in ginger	Dholi
GIN/CP/6.10	Efficiency of different fungicides including new molecules against leaf spot disease of ginger	Dholi, Pundibari, Solan, Raigarh
Turmeric		
TUR/CI/1	Genetic Resources	
TUR/CI/1.1	Germplasm collection, characterization, evaluation and conservation	Coimbatore, Dholi, Kammarpally, Kumarganj, Pantnagar, Pasighat, Pottangi, Pundibari, Raigarh
TUR/CI/2	Coordinated Varietal Trial	
TUR/CI/2.5	CVT on Turmeric 2013	Chintapalle, Coimbatore, IISR, Kammarpally, Kumarganj, Pundibari, Pottangi, Raigarh
TUR/CI/3	Varietal Evaluation Trial	
TUR/CI/3.3	Initial Evaluation Trial 2010	Pantnagar, Raigarh
TUR/CI/3.5	Initial Evaluation Trial 2012	Dholi, Kumarganj
TUR/CM/5	Nutrient Management Trial	
TUR/CM/5.5	Standardization of water requirement for turmeric through drip irrigation	Coimbatore, Guntur, Kammarpally, Kumarganj, Pundibari
TUR/CM/5.9	Source sink relationship in turmeric	Coimbatore, IISR, Guntur
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 (Disease Surveillance)	Coimbatore, Pundibari, Dholi, Raigarh
TUR/CP/7.3	Assessment of fungicide and biological control agents against foliar disease of turmeric	Dholi, Raigarh
TUR/CP/7.4	Management of foliar diseases in turmeric using tolerant lines	Coimbatore, Dholi, Kumarganj, Pundibari, Raigarh



Tree Spices

TSP/CI/1	Genetic Resources	
TSP/CI/1.1	Germplasm collection, characterization, evaluation and conservation of clove, nutmeg and cinnamon	Dapoli, Pechiparai
TSP/CI/1.2	Collection of unique germplasm in tree spices	Dapoli, IISR, KAU, Pechiparai
TSP/CI/2	Coordinated Varietal Trial	
TSP/CI/2.2	CVT 2001-Nutmeg	Dapoli, Pechiparai
TSP/CI/2.3	CVT-2001-Cassia	Dapoli, Pechiparai

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/1.2	Multilocation evaluation of germplasm in coriander	Ajmer, Coimbatore, Guntur, Hisar
COR/CI/2	Coordinated Varietal Trial	
COR/CI/2.5	Coordinated Varietal Trial on coriander 2012-Series IX	Ajmer, Coimbatore, Dholi, Guntur, Hisar, Jabalpur, Jagudan, Jobner, Kumarganj, Navsari, Pantnagar, Kota
COR/CI/3	Varietal Evaluation Trial	
COR/CI/3.6	Initial Evaluation Trial 2012	Guntur, Jagudan, Kumarganj
COR/CI/3.7	Initial Evaluation in coriander	Dholi, Hisar
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	Jobner
COR/CM/5.8	Evaluation of PGPR bioformulation on coriander	Ajmer, Coimbatore, Guntur, Hisar, Jagudan, Raigarh
COR/CP/6	Disease Management Trial	
COR/CP/6.2	Survey to identify the disease incidence, collection and identification of causal organism in coriander	Dholi

Cumin

CUM/CI/1	Genetic Resources	
CUM/CI/1.1	Germplasm collection, characterization, evaluation, conservation and screening against diseases	Jagudan, Jobner, Mandor, Sanand
CUM/CI/1.2	Multilocation evaluation of cumin germplasm	Ajmer



CUM/CI/2	Coordinated Varietal Trial	
CUM/CI/2.4	Coordinated Varietal Trial – 2013	Ajmer, Jagudan, Jobner
CUM/CI/3	Varietal Evaluation Trial	
CUM/CI/3.4	IET on Cumin 2012	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/CP/6	Disease Management Trial	
CUM/CP/6.5	Management of blight and powdery mildew by spacing and potash application	Jagudan

Fennel

FNL/CI/1	Genetic Resources	
FNL/CI/1.1	Germplasm collection, characterization, evaluation, conservation and screening against diseases	Dholi, Hisar, Jagudan, Jobner, Kumarganj
FNL/CI/1.2	Multilocation evaluation of fennel germplasm	Ajmer, Jobner, Kumarganj
FNL/CI/2	Coordinated Varietal Trial	
FNL/CI/2.5	Coordinated Varietal Trial on Fennel 2012 Series VIII	Ajmer, Dholi, Hisar, Jabalpur, Jagudan, Jobner, Kumarganj, Pantnagar
FNL/CI/3	Varietal Evaluation Trial	
FNL/CI/3.3	Initial Evaluation Trial 2014	Jobner, Pantnagar, Hisar
FNL/CI/3.4	Initial Evaluation Trial 2012	Dholi, Jagudan, Kumarganj
FNL/CI/4	Quality Evaluation Trial	
FNL/CI/4.1	Quality Evaluation in Fennel	Jobner
FNL/CM/5	Nutrient Management Trial	
FNL/CM/5.3	Micro irrigation management in fennel	Jobner
FNL/CM/6.3	Evaluation of PGPR bioformulation in fennel	Hisar, Jagudan, Raigarh, Ajmer
FNL/CP/6	Pest Management Trial	
FNL/CP/6.2	Field evaluation of different insecticides/ botanicals against seed midge <i>Systole albipennis</i> Walker fennel	Jagudan, Jobner

Fenugreek

FGK/CI/1	Genetic Resources	
FGK/CI/1.1	Germplasm collection, characterization, evaluation, conservation and screening against diseases	Dholi, Guntur, Hisar, Jagudan, Jobner, Kumarganj
FGK/CI/1.2	Multilocation evaluation of fenugreek germplasm	Ajmer, Jobner, Hisar, Kumarganj



FGK/CI/2	Coordinated Varietal Trial	
FGK/CI/2.3	Coordinated Varietal Trial 2012 Series VIII	Ajmer, Coimbatore, Dholi, Guntur, Hisar, Jagudan, Jabalpur, Jobner, Kumarganj, Pantnagar, Navsari, Raigarh, Kota
FGK/CI/3	Varietal Evaluation Trial	
FGK/CI/3.4	Initial Evaluation Trial 2012	Guntur, Kumarganj, Jagudan, Jobner
FGK/CI/3.6	Initial Evaluation Trial on fenugreek	Dholi, Hisar
FGK/CM/5	Nutrient Management Trial	
FGK/CM/4.2	Identification of drought tolerance source in fenugreek	Jobner
FGK/CM/5.3	Micro irrigation management in fenugreek	Jobner
FGK/CM/5.8	Evaluation of PGPR bioformulation on fenugreek	Jagudan, Jobner, Guntur, Hisar, Kumarganj



I. BLACK PEPPER

Genetic Resources

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

(Centres: West coast plains and ghat region - Ambalavayal, Panniyur, Sirsi; East coast plains and hill region - Chintapalle; Western plateau and hills region - Dapoli; Middle Gangetic Plain Region - Pundibari; East coast plains and hill region - Yercaud)

Germplasm of black pepper maintained at various AICRPS centres (Table 1)

At present 232 cultivated types, 54 wild types and 3 exotic types of black pepper are being maintained at Panniyur. Fifty eight genotypes have been collected during 2014 from different pepper growing tracts of Kannur and Kasargod districts under a combined germplasm collection expedition with scientists from IISR and the cuttings were planted in the nursery for rooting.

In the current year, the genotypes PRS 64, PRS 154, PRS 137 and PRS 155 were the top yielders at Panniyur. PRS 64 recorded highest green berry yield of 4.73 kg and 1510 spikes/vine. Spike length was maximum in PRS 155 (15.9 cm). Number of developed berries / spike was more for PRS 137 (48.0). The 100 berry weight was high for PRS 154 (12.3 g.) and PRS 88 (11.4 g). The dry recovery (%) was more in PRS 154 and PRS 137 (36 %).

Twenty six new collections were made during the period from Sirsi centre. Totally, 165

germplasm accessions are being maintained at this station. Evaluation of these collections was made in the farmer's field. Species of *Piper i.e., Piper arborium* is collected and added to the germplasm.

At HRS, chintapalle, 26 germplasm lines were maintained, during 2014-15 among them Panniyur -1 and CU 5308 recorded the highest yield. Severe drought affected the crop during April, May, June and July months of 2014. HUDHUD cyclone hit the Visakhapatnam district on 12th October, 2014 destroyed the shade trees (Silver oak) and black pepper gardens. The catastrophic storms uprooted the silver oak trees and aggravated the *Phytophthora* foot rot disease resulted in very poor yield in east coast region.

At present 37 germplasm accessions are being maintained at Dapoli. This year 10 accessions have been added to the germplasm. Among the germplasm maintained plant height varied from 7.5 -1.1 m.

At Pundibari centre 31 germplasm are being maintained. In 2014 – 2015, one new genotype was collected from Terai region of West Bengal.

At Yercaud centre a total of 78 accessions are being maintained among them berry set was observed in 38 accessions. Out of those highest berry yield per vine was observed in PN 57(4.08 kg vine⁻¹), PN 33(3.54 kg vine⁻¹), PN 76(2.99 kg vine⁻¹), PN 90(3.07 kg vine⁻¹), PN 46(2.80 kg vine⁻¹) and PN 74(2.80 kg vine⁻¹).



Fig. 1: Promising germplasm accessions at Yercaud centre. a & b: High yielding accessions (PN-33 & PN-57); c & d: Accessions with long spike (PN-47 & PN-61)



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

Centres	Indigenous				Exotic	Total
	Cultivated		Wild and related species			
	Existing	Addition (April 2014 to March 2015)	Existing	Addition (April 2014 to March 2015)		
Ambalavayal	55	-	-	-	-	55
Chintapalle	38	-	-	-	-	38
Dapoli	36	10	1	-	-	47
Panniyur	232	58	54	-	3	347
Pechiparai	10	5	-	3	-	18
Pundibari	19	-	11	1	-	31
Sirsi	145	26	-	1	-	172
Yercaud	78	-	8	-	-	86
Total	613	99	74	5	3	794

Crop Improvement

PEP/CI/2 Hybridization trial

PEP/CI/2.1 Inter-variatal hybridization to evolve high yielding varieties

(Centre: West coast plains and ghat region - Panniyur)

At Panniyur centre, the hybrids PRS160 and PRS 161 were found to be promising with maximum green berry yield of 4.2 kg vine⁻¹ and 4 kg vine⁻¹ respectively. PRS 160 and PRS-161 recorded 560 and 472 number of spikes per vine respectively. Spike length was maximum in PRS 161 (20.1 cm).

To evolve varieties tolerant to biotic and abiotic stresses crosses between P 1 x PRS 4 and P 1 x PRS 64 were done successfully.

PEP/CI/3 Coordinated Varietal Trial (CVT)

PEP/CI/3.3 CVT 2006 Series VI

(Centres: East coast plains and hill region - Chintapalle; Western plateau and hills region - Dapoli; West coast plains and ghat region - Panniyur, Pampadumpara, Sirsi; East coast plains and hill region - Yercaud)

At Chintapalle centre among the 10 varieties maximum plant height was noticed in HB20052 (401.66 cm) and Panniyur-1 (306.66 cm). Variety C1090 recorded maximum fresh berry yield (2.06 kg) during the third year of bearing. All vines found susceptible to *Phytophthora*.

At Dapoli centre plant height varied from 2.23 – 4.32 m in different varieties. Highest plant height was recorded by Panniyur 1 and HB 20052 (4.32 m) followed by PRS 64 (3.92 m) and ACC No.106 (3.67 m).



Fig. 2: Variation in spike length in black pepper genotypes in an coordinated varietal trial at Dapoli



PRS 88 and HB 20052 recorded the highest green berry yield of 3.3 kg vine⁻¹ and 3.1 kg vine⁻¹ respectively at Panniyur centre and the highest plant height was recorded by HB 20052 and Panniyur 1 (3.8 m).

Among nine accessions tested the highest fresh weight (645g plant⁻¹) and dry weight (178 g plant⁻¹) was recorded by Panniyur 1 at Pampadumpara centre.

At Yercaud centre 9 entries have been planted during 2011 and the entries are in vegetative stage. One of the entries PRS 64 has started spiking.

PEP/CI/3.4 Evaluation of grafts, ortho-tropic and runner shoots in black pepper

(Centres: West coast plains and ghat region - Ambalavayal, Panniyur, Sirsi; East coast plains and hill region - Yercaud)

Panniyur -1 variety grafted on *Piper colubrinum* has recorded highest plant height (3.73 m) and green berry yield (2.57 kg) at Panniyur centre.

Field planting of grafts on *Erythrina indica* standards was done at Yercaud and the grafts are in vegetative stage.

Crop Management

PEP/CM/4 Nutrient Management Trial

PEP/CM/4.4 Development of organic package for spices based cropping system-observational trial

(Centres: East coast plains and hill region - Chintapalle; Western plateau and hills region - Dapoli; West coast plains and ghat region - Panniyur, Sirsi)

As per the observations recorded in the organic farming trial at Chintapalle, vines treated with inorganic fertilizers have recorded higher yields (2.51 kg vine⁻¹) compared to vines treated

with organic source of nutrients (1.831 kg vine⁻¹), but both are on par with each other in terms of plant height, number of spikes, spike length and fresh berry yield.

At Dapoli from pooled data it was concluded that for getting highest dry berry yield vines may be provided with recommended dose of fertilizers *i.e.* 30 kg F.Y.M + 150 g N + 75 g P₂O₅ + 150 g K₂O per vine/year from 3rd year onwards twice *i.e.* first in the month August and Second in the month of February.

Based on the trial conducted at Panniyur, it can be concluded that the recommended package involving Farm Yard Manure 10 kg, NPK 50:50:200g, recorded significantly higher yield (1.81 kg vine⁻¹) in pepper compared to other organic package (1.38 kg vine⁻¹). Higher oleoresin (8.12 %) content was recorded from organic treatment whereas piperine and volatile oil were similar in both treatments.

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

(Centres: Western plateau and hills region - Dapoli; West coast plains and ghat region - Panniyur, Sirsi; Southern plateau and hills region - Pechiparai; East coast plains and hill region -Yercaud)

From the trials conducted at Dapoli it was concluded that for getting highest dry berry yield of black pepper recommended dose (10 kg F.Y.M. + 150 g N + 75 g P₂O₅ + 150 g K₂O per vine/year from 3rd year onwards) be given twice to the vines *i.e.* first in the month of August and second in the month of February at the same time application of P-solubilizing bacteria and applying *Trichoderma* around the base of the vine @ 50g/vine and a foliar spray of Bordeaux mixture 1% and Quinolphos (0.05%) twice *i.e.* first application be given with onset of monsoon – June and second application during August (60 days after first) during rainy season is recommended.



Based on the trial conducted at Panniyur, it can be concluded that the integrated treatment involving Farm Yard Manure 10 kg, *Azospirillum* 50 g, Phosphobacteria 50 g, Bordeaux mixture 1%, *Trichoderma* 50 g, *Pseudomonas* 50 g, NPK 50:50:200 g, Copper Oxychloride 0.2%, Quinalphos 0.05%, recorded significantly higher yield in pepper compared to other treatments fully organic and fully inorganic.

EP/CM/4.6 Standardization of drip fertigation in black pepper

(Centre: West coast plains and ghat region - Panniyur)

The trial was started in 2012-13 at Panniyur. During 2014-15, T5 - (50 % RDF + 8

Note:

Treatments	Quantity / plant/ year
T1	Conventional irrigation @100 litres of water once in 10 days from February-April; 100 % RDF in 3 equal splits as basal 1 st in June, 2 nd in September and 3 rd in February
T2	Drip irrigation @ 8 litres of water daily from February-April; 100 % RDF in 3 equal splits as basal 1 st in June, 2 nd in September and 3 rd in February as fertigation in 12 splits (weekly intervals)
T3	Drip irrigation @ 8 litres of water daily from February-April; 100 % RDF in 3 equal splits as fertigation in 12 splits (weekly intervals) 1 st in June, 2 nd in September and 3 rd in February.
T4	Drip irrigation @ 8 litres of water daily from February -April; 75 % RDF in 3 equal splits as fertigation in 12 splits (weekly intervals) 1 st in June, 2 nd in September and 3 rd in February.
T5	Drip irrigation @ 8 litres of water daily from February -April; 50 RDF in 3 equal splits as fertigation in 12 splits (weekly intervals) 1 st in June, 2 nd in September and 3 rd in February.

litres drip) recorded maximum green berry yield of 4.89 kg vine⁻¹ followed by T4 (75 % RDF + 8 l drip) where yield recorded was 3.9 kg vine⁻¹ which was statistically on par with T5.

PEP/CM/4.7 Black pepper based mixed cropping system for sustainable productivity and food security

(Centres: West coast plains and ghat region - Ambalavayal, Sirsi, Panniyur; Western plateau and hills region - Dapoli)

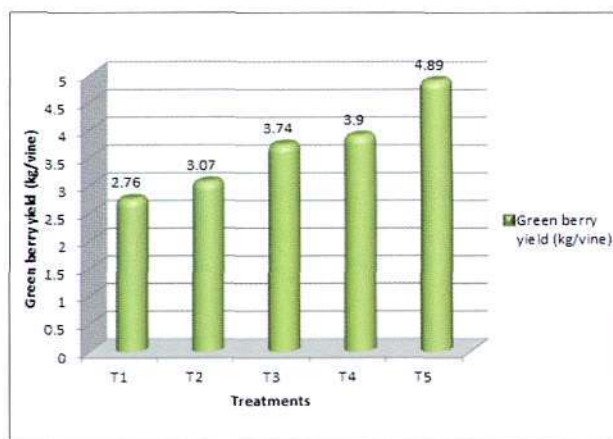


Fig. 3: Effect of different drip fertigation treatment on green berry yield of black pepper at Panniyur

The trial was started during 2013-14 at Panniyur. The intercrops and black pepper plants were planted during April-May and June-July 2014. Pepper plants are yet to establish and good yield was obtained from the intercrops in black pepper garden in the 1st year of planting. T1- Colocasia yielded 2.3 kg, T2- Arrow root(3.3 kg), T3- Elephant foot yam (12.4 kg), T4- Tapioca (8.2 kg) and T5- Greater yam(8.8 kg) from an inter space of 4 x 2 m between pepper plants.



Crop Protection

PEP/CP/5 Disease Management Trial

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

(Centres: East coast plains and hill region – Chintapalle; West coast plains and ghat region Mudigere, Sirsi, Panniyur, Pampadumpara; Western plateau and hills region - Dapoli)

This experiment was started during July 2008-09 at Horticultural Research station, Chintapalle. Three varieties *i.e.* IISR- Shakti, IISR- Thevam and Panniyur-5 each of 100 cuttings were brought from IISR, Calicut during the month July- 2008 and were planted in A4 block. The procured cuttings have not established properly resulting in the poor stand. This year crop is affected by *Hud Hud* cyclone.

At Mudigere experiment was initiated during 2007 and plants are not established properly. So replanting has to be taken up with IISR Shakti and IISR-Thevam plants.

Varietal reaction to the treatments with respect to the growth of the black pepper, IISR Thevam recorded highest growth (2.49 m) and it was statistically on par with IISR Shakti (2.09 m) and the least growth was noticed in Panniyur - 1 (1.99 m) at Sirsi. The potassium phosphonate @ 0.3% and incorporation of *Trichoderma harzianum* (MTCC 5179) also recorded more height.

At Panniyur soil application of *Trichoderma harzianum* (MTCC 5179) along with drenching and spraying with 0.3% potassium phosphonate recorded least disease incidence (7.4%) as against 38.9% disease intensity in control. With regard to varieties, minimum disease was recorded in Panniyur 1 (11.1%).

Of all the varieties tested IISR Thevam showed the least disease incidence and the treatment of potassium phosphonate 0.3% spray along with the basal application of *Trichoderma harzianum* @ 50 g vine⁻¹ was the best at Pampadumpara.

Survival and growth of black pepper cuttings of IISR- Shakti, IISR- Thevam and Panniyur-1 and of the standards (*Ailanthus malbarica*) were satisfactory at Dapoli. So far incidence of foot rot and leaf blight disease caused by *Phytophthora capsici* was not noticed during the period from 2010-11 to 2013-14.

PEP/CP/5.4 Effectiveness of new molecules of fungi toxicants against *Phytophthora* foot rot of black pepper in existing plantation

(Centres: East coast plains and hill region - Chintapalle, West coast plains and ghat region - Mudigere, Sirsi)

At Chintapalle spraying and drenching with 0.1 % of Fenamidon (10 %) + Mancozeb (50 %) (Sectin) + Soil application of *Trichoderma harzianum* (MTCC-5179) 50 g/vine with 1 kg neem cake resulted in reducing per cent yellowing (11.50 %), defoliation (13.98 %), death of vines (8.50 %) and recorded higher yield (3.02 kg vine⁻¹).

Spraying and drenching of 0.2 % Kocide 10 days after application of *T. harzianum* @ 50g + 1 kg Neem Cake vine⁻¹ was found more effective in reducing the disease incidence with higher yield of 482.50 g vine⁻¹ at Mudigere which was on par with spraying and drenching of 0.1% Sectin + *T. harzianum* (50 g) + Neem cake 1 kg vine⁻¹.

Spraying and drenching with 0.1% of Fenamidone (10 %) + Mancozeb (50 %) (Sectin) + Soil application of *T. harzianum* (MTCC 5179) 50 g vine⁻¹ with 1 kg neem cake resulted in less leaf infection (6.15 %), yellowing (7.59 PDI), defoliation (6.06 PDI) at Sirsi.



PEP/CP/5.6 Biological Management of Slow Decline in Black Pepper

(Centres: West coast plains and ghat region - Panniyur)

The experiment was started during 2013-14 at Panniyur. Among the various biocontrol agents tested, disease intensity was least recorded in soil application of *Trichoderma harzianum* + Neem cake @ 2 kg vine⁻¹ (17.5 %) followed by Soil application of *Trichoderma harzianum* followed by soil drenching with *P. fluorescens* @ 2 % (18.8 %) which were statistically on par with each other (Table 2).

PEP/CP/6 Pest Management Trial

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

(Centres: West coast plains and ghat region - Mudigere, Pampadumpara)

This project started in 2008 at Mudigere for management of *Erythrina* gall wasp. A survey was conducted in Hassan, Chikkamagaluru, Udupi, South – Canara, Coorg and North - Canara districts, where black pepper is a major crop and *Erythrina* used as standard. During the survey one of the *Erythrina* species free from gall – wasp observed in different plantation of Coorg, Hassan and Chikkamagaluru Dists. The *Erythrina* species free from gall – wasp identified and characterized as *Erythrina subumbrans* (Kassk.) Merrill. After this planting material of *Erythrina subumbrans* was distributed to farmers and institutions viz., IIHR, Bengaluru and IISR, Kozhikode.

Table 2: Effect of different biological management strategies on slow decline disease of Black pepper

Treatments	Disease intensity (%) with respect to yellowing in Black pepper				Average Disease intensity
	1 MAM	2 MAM	3 MAM	4 MAM	
T1 - Soil application of <i>Trichoderma harzianum</i> + Neem cake @ 2kg vine ⁻¹	15.0	15.0	15.0	25.0	17.5
T2 - Soil application of <i>Trichoderma harzianum</i> followed by soil drenching with <i>P. fluorescens</i> @ 2%	15.0	25.0	20.0	15.0	18.8
T3 - Soil application of <i>Pochonia chlamydosporia</i> followed by soil drenching with <i>P. fluorescens</i> @ 2%	15.0	26.3	20.0	30.0	22.8
T4 - Soil application of <i>Pochonia chlamydosporia</i> @ 50 g vine ⁻¹ followed by soil drenching with <i>P. fluorescens</i> @ 2%	20.0	35.0	20.0	18.8	23.4
T5 - Soil application with Cartap hydrochloride @ 15g vine ⁻¹	15.0	15.0	15.0	15.0	15.0
T6 - Soil drenching with Copper oxychloride @ 0.3% + Cartap hydrochloride @ 15 g vine ⁻¹	15.0	20.0	15.0	15.0	16.3
T7 - Control	25.0	47.5	40.0	32.5	36.3
CD @ 5%		7.5			

MAM - Months after cessation of monsoon



II. SMALL CARDAMOM

Genetic Resources

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

(Centres: West coast plains and ghat region - Mudigere, Pampadumpara)

Germplasm of small cardamom is maintained at Mudigere and Pampadumpara (Table 3)

At Mudigere centre 132 germplasm lines were replanted during 2010 and observations are recorded. Germplasm lines CL-726 and CL-691 found superior for important yield traits.

disease and also showed more tolerance to thrips (14.33% incidence).

Crop Improvement

CAR/CI/2 Hybridization

CAR/CI/2.1 Hybridization and selection in cardamom

(Centre: West coast plains and ghat region - Mudigere)

A crossing block of elite clones viz. M-1, M-2, HS-1, *Njallani* Gold, SKP-14, CL-726 and M-3 was established at a closer spacing of 6 x 3'

Table 3: Cardamom germplasm collections of AICRPS centres

Centre	Indigenous		Total
	Cultivated	Wild and related sp.	
Mudigere	132	Nil	132
Pampadumapra	177	Nil	177
Total	309	Nil	309



Fig. 4: Promising clones CL-726 and CL-691 from Mudigere centre

A total of 177 cardamom accessions are presently being conserved in the gene bank of Pampadumpara. Out of all the germplasm HY 14 registered maximum wet (356.6 g plant⁻¹) and dry capsule yield (72.32 g plant⁻¹). It has not registered any incidence or symptoms of *azhukal*

in order to generate all possible cross combinations through both random open pollination and hand pollination. All the clones were good general combiners and belong to Malabar type, while *Njallani* green gold is a *Vazhuka* type. Different F1 combinations were



produced by crossing seven improved elite genotypes in all possible combinations and the seedling are raised and evaluation will be done in the coming season.

CAR/CI/2.2 Evaluation of promising small cardamom (*Elettaria cardamom* L. Maton) cultivars/varieties for organic cultivation in the high ranges of Idukki district

(Centre: West coast plains and ghat region - Pampadumpara)

PS 27 performed well in terms of number of tillers (21.56), panicles per tiller (1) as well as productive tillers (2.33) whereas S-1 registered maximum tiller height (152.7 cm) followed by ICRI 2 (152.6 cm) and PV1 (152.2 cm). Yield data will be recorded in the ensuing season.

CAR/CI/3 Coordinated Varietal Trial

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

(Centres: West coast plains and ghat region - Mudigere, Myladumpara, Pampadumpara)

Among 13 genotypes evaluated at Mudigere, IC-346951 (330 kg ha⁻¹) recorded highest capsule yield followed by CL-726 (320 kg ha⁻¹) than the check GG (260 kg ha⁻¹).

At Myladumpara among the entries clone PL-14 has showed superiority in tiller height (289.9 cm), number of racemes per panicle (20), number of capsules per raceme (10.5) and yield (860.1 kg ha⁻¹). Whereas number of tillers per clump (61.9), number of bearing tillers (29.7) and number of panicles per clump (50) were more in CL-691. MCC-260 standard check showed highest oleoresin percentage (8.98 %) followed by IC - 349545 (8.84 %), SKP - 164 (8.65 %).

Maximum plant height was recorded by four accessions viz, PL 14 (207.88 cm), GG (222.22 cm), MCC 346 (211.22 cm) and PV2 (231.33 cm) at Pampadumpara. Highest yield was registered in case of PL-14 (361.54 g plant⁻¹)

and the lowest yield was obtained in SKP 104 (29.51 g plant⁻¹).



Fig. 5: Field view of coordinated varietal trial 2007/2009 of cardamom at Pampadumpara

CAR/CI/3.7 CVT of drought tolerance in Cardamom – Series VII

(Centres: West coast plains and ghats region – Appangala, Mudigere; Southern plateau and hills region - Sakaleshapura)

Selected clones are multiplied and trial will be taken up in Appangala, Mudigere and Sakaleshapura.

CAR/CI/4 Varietal Evaluation Trial (VET)

CAR/CI/4.1 Initial Evaluation Trial – I

(Centre: West coast plains and ghat region - Mudigere)

At Mudigere genotype HS-1 recorded highest plant height (310 cm), more number of suckers per plant (12.10) and yield (310 kg ha⁻¹) followed by Sel-800 (280 cm, 11.9 and 280 kg ha⁻¹ respectively).

CAR/CI/4.2 Initial Evaluation Trial – II

(Centre: West coast plains and ghat region - Mudigere)

Among the 10 genotypes evaluated at Mudigere, 2-5-D11 recorded highest yield (263 kg ha⁻¹) followed by GG (255 kg ha⁻¹).



CAR/CI/4.3 Initial Evaluation Trial – 2012

(Centre: West coast plains and ghat region - Pampadumpara)

During 2014-2015, maximum plant height was reported in PL No. 14 (282.99 cm) followed by HY 9 (240.23 cm). In case of number of tillers, HY 6 showed maximum (74.66) followed by *Njallani* (39.55). Among the accessions, BEP 2 and HY 6 showed the lowest borer infestation (1.66 %) followed by PV-1 (4.99 %). The incidence of clump rot was minimum in HY 9 and HY 6 (0.33 % and 0.55 % respectively).

Among the accessions studied PL NO.14 registered a maximum wet (266.10 g plant⁻¹) and dry yield (40.58 g plant⁻¹), HY 6 (192.89 g plant⁻¹) was the next best followed by S 1 (39.46 g plant⁻¹) whereas the dry weight was more in S-1 than HY 6. The accession HY 6 recorded the highest 100 capsule weight and 100 capsule volume (87.65 g and 95 ml). Regarding thrips infestation, BEP 2 showed higher tolerance (15.50 %), while *Njallani* reported maximum incidence of thrips (70.45 %). The capsule rot incidence was higher in *Njallani* (3.53 %) followed by PL. NO 14. There was no incidence of capsule rot in case of HY 6 and HY 9. These accessions have recorded the lowest incidence of borer (1.50 %) too. Among nine accessions evaluated, HY 6, HY 9 and PL. No.14 performed better than the rest of the accessions.

Crop Management

CAR/CM/5 Nutrient Management Trial

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

(Centres: West coast plains and ghat region - Mudigere, Pampadumpara)

At Mudigere effect of fertigation on yield of cardamom showed significant difference among the treatments. Application of irrigation 9

l/clump/day along with 100% Recommended dose of fertilizer through drips recorded the highest capsule yield (207.41 kg ha⁻¹) this was on par with irrigation 9 l/clump/day with 75% Rec. fertilizer dose (201.23 kg ha⁻¹). Conventional method of irrigation recorded 156.61 kg ha⁻¹.

The experiment was laid out in Pampadumpara and the observations on growth performances will be monitored from this season onwards.

CAR/CM/5.3 Organic farming in cardamom

(Centres: West coast plains and ghat region - Mudigere, Pampadumpara)

Significant differences were observed among the treatments at Mudigere centre. Application of organics with bio-fertilizers recorded significantly higher yield than only organics. Maximum dry capsule yield (252.77 kg ha⁻¹) was obtained with recommended package which was superior over all other treatments. Among the organics, application of vermicompost recorded the highest capsule yield (202.91 kg ha⁻¹) this is on par with FYM (193.71 kg ha⁻¹). Application of Jeevamrutha with and without bio fertilizers recorded less yield (170.68 kg ha⁻¹) and (188.87 kg ha⁻¹).

Application of Jeevamruta + *Azospirillum* (10 g clump⁻¹) + Phosphate solubilising bacteria (10 g clump⁻¹) + *Trichoderma* (10 clump⁻¹) resulted in the highest fresh (220.27 g plant⁻¹) and dry capsule yield (42.89 g plant⁻¹) at Pampadumpara.

CAR/CM/5.4 Liming in cardamom

(Centre: West coast plains and ghat region - Pampadumpara)

Application of Dolomite @ 2 kg plant⁻¹ was found to be the best treatment with highest fresh weight of 427 g plant⁻¹ at Pampadumpara. Next best treatment was found to be application of burnt lime @ 2 kg plant⁻¹ which was on par





Fig. 6: Organic farming in cardamom a. Field view of organic farming plot at Pampadumpara, b. Preparation of organic amendments

with ground lime stone @ 2 kg plant⁻¹ and the recovery percent was high for the application of burnt lime @ 2 kg plant⁻¹.

Crop Protection

CAR/CP/6 Pest and Disease Management Trial

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

(Centres: West coast plains and ghat region - Mudigere, Pampadumpara)

There were significant differences between the different treatments at Mudigere. At all the harvests it was observed that there was

maximum damage with thrips compared to borers. Thrips and capsule borer control was observed with use of methomyl @ 1.5 g l⁻¹ of water and acetamiprid @ 0.5 g and Imidacloprid @ 0.5 ml compared to standard practice (Carbosulfan 2 ml l⁻¹).

At Pampadumpara, lowest thrips infestation was reported in the plants treated with imidacloprid followed by carbosulfan and quinalphos. Shoot borer infestation was minimum in plants treated with poneem (3.16 %) and was followed by acetamiprid (4.03 %), quinalphos and carbosulfan.

Pooled analysis of 3 years showed that the most effective treatment against thrips was imidacloprid followed by quinalphos and carbosulfan. But for shoot borer infestation no significant differences were observed.

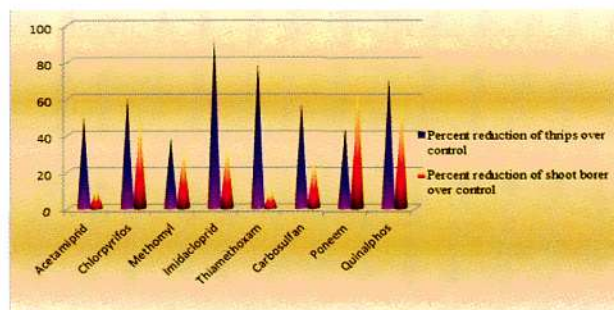


Fig. 7: Percent reduction of thrips and shoot borer infestation over control

CAR/CP/6.8 Comparison of effect of chemical treatments as well as bio-control agents against pseudostem rot of cardamom

(Centres: West coast plains and ghat region - Pampadumpara)

Lowest disease incidence (13.67 %) was observed in the application of Carbendazim at 2 g l⁻¹ as foliar spray as well as basal application at Pampadumpara.



III. LARGE CARDAMOM

Genetic Resources

LCA/CI/1.1 Germplasm collection and evaluation of large cardamom

(Centres: Eastern Himalayan Region - ICAR Regional Station, Gangtok, ICRI Regional Research Station, Gangtok)

A total of 271 germplasm of large cardamom is maintained at ICAR (RS), Gangtok and ICRI (RRS), Gangtok (Table 4)

ICAR RS, Gangtok is maintaing 7 different germplasm viz., Ramsey, Sawney, Dzongu Golsey, Varlangey, Seramney, Madhusai and Dudhe Golsai of large cardamom.

Survey was made at different area of North, East and West districts of Sikkim and Sukhia Pokhri, Darjeeling district of West Bengal for collection of germplasm by the scientists of ICRI Regional Station, Gangtok. Seven Germplasm accessions viz. SCC 255 (Golsey), SCC 256 (Seremna), SCC 258 (Ramsey), SCC 259 (Bada Ramsey), SCC 260 (Varlangey), SCC 261 (Golsey) and SCC 262 (Ramsey) were collected and planted under AICRPS at ICRI, RRS, Spices Board, Tadong, Gangtok research farm. Characterizations of the collected germplasm were made as per descriptor.

Table 4: Large cardamom collections maintained at AICRPS centres

Centre	Indigenous				Total
	Cultivated		Wild & related spices		
	Existing	Addition (April 2014 to March 2015)	Existing	Addition (April 2014 to March 2015)	
ICAR RS, Gangtok	7	NIL	NIL	NIL	7
ICRI RRS, Gangtok	245	08	11	NIL	264
Total	252	08	11	NIL	271



Fig. 8: Collection of germplasm from Sukhia Pokhri, Darjeeling district

Crop Protection

LCA/CP/1.1 Evolving disease and pest tolerant lines in large cardamom

(Centre: Eastern Himalayan Region - ICRI Regional Station, Gangtok)

Moderately tolerant and moderately susceptible germplasm accessions were planted in disease hot spot area (Kabi), North Sikkim for field evaluation. ICRI Sikkim 2 was taken as control.

LCA/CP/1.2 Integrated pest and disease management in large cardamom

(Centre: Eastern Himalayan Region - ICRI Regional Station Gangtok)

Lowest incidence of pest and diseases was observed in Phytosanitation and application of bio-agents plot than in that of control. Table 5 the incidence (%) of pests diseases

Table 5: Incidence (%) of pests and diseases in the field trial plots at Singhik, North Sikkim

Pests	Incidence % (Range / Mean)	
	Control	Phytosanitation and application of bio- agents
Shoot fly	20-25 (22.5)	5-10 (7.5)
Leaf caterpillar	10-15 (12.5)	2-5 (3.5)
Blight	30-45 (37.5)	10-15 (12.5)
Chirke	15-20 (17.5)	2-4 (3.0)
Foorkey	5-10 (7.5)	1-2 (1.5)



Fig. 9: Survey in the large cardamom area of Anjaw district of Arunachal



Fig.10 : AICRPS team interacting with Tribal cluster of Lungwah village at Indo Burma border of Mon district of Nagaland



IV. GINGER

Genetic Resources

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

(Centres: Middle Gangetic Plain Region - Dholi, Kumarganj, Pundibari; Southern plateau and hills region - Kammarpally; Eastern plateau and hills region - Pottangi, Raigarh; Western Himalayan Region - Solan)

Ginger germplasm maintained at different AICRPS centres (Table 6)



Fig. 11: Germplasm evaluation site of ginger at Solan

Out of fifty eight accessions evaluated at Dholi centre twelve accessions viz., RG-14, RG-

17, RG-19, RG-11, RG-29, RG-24, RG-32, RG-18, RG-37, RG-41, RG-38 and RG-10 were performed better with fresh rhizome yield ranging from 240 g to 350 g plant⁻¹. Among these 12 accessions RG-14 recorded the highest fresh rhizome yield (350 g plant⁻¹) followed by RG-17, RG-19, RG-11 i.e., fresh rhizome yield of 300 g plant⁻¹.

At Kumarganj centre 61 germplasm were evaluated this year and among them promising accessions in terms of yield are NDG-55 (31.78 t ha⁻¹) followed by NDG-28 (13.83 t ha⁻¹) and NDG-6 (13.24 t ha⁻¹). And also the germplasm is screened for soft rot disease and minimum disease incidence was recorded in NDG-15 (10.00%), NDG-4 (16.673%) and NDG-9 (23.0%).

Sixty two germplasm of ginger were evaluated at Pundibari centre. Highest rhizome yield plot⁻¹ was recorded in GCP-33 (16.57 kg plot⁻¹). Lowest rhizome yield plot⁻¹ was recorded in GCP-63 (1.35 kg plot⁻¹).

Ten accessions out of 173 accessions registered more than 10 kg/3m² fresh rhizome yield at Pottangi centre, and the plot yield ranged from 2.2 kg/3m² (PGS-34) to 19.0 kg/3m² (PGS-36) with the mean yield of 5.2 kg /3m². Highest

Table 6: Ginger germplasm collections in AICRPS centres

Centre	Indigenous				Exotic	Total
	Cultivated		Wild & related spp.			
	Existing	Addition (2014-15)	Existing	Addition (2014-15)		
Dholi	57	1	-	-	-	58
Kumarganj	61	-	-	-	-	61
Pundibari	61	1	-	-	-	62
Pottangi	128	20	2	-	3	153
Solan	231	-	-	-	-	231
Total	538	22	2	-	3	565



fresh rhizome yield was recorded in PGS-36 (19.0 kg/3 m²) followed by S-692 (16.5 kg/3 m²), Tura local (14.8 kg/3 m²), Tura Local-1 (14.3 kg/3 m²), S-642-1 (12.5 kg/3 m²), GCP-31 (12.0 kg/3 m²), PGCAL-1 (11.5 kg/3 m²).

Among the 183 ginger germplasm evaluated at Solan yield range varied from 10.06 t ha⁻¹ (SG-865) to 14.12 t ha⁻¹ (SG-857). Yield of three lines viz., SG-1134 (14.24 t ha⁻¹), SG-857 (14.12 t ha⁻¹) and SG-12-4 (13.44 t ha⁻¹) excelled the check Himagiri which yielded 12.40 t ha⁻¹. Rhizome rot disease incidence varied from 11.47-25.47% with 11.47% and 15.60 % in SG-12-4 and Himgiri, respectively.

Crop Improvement

GIN/CI/2 Coordinated Varietal Trial (CVT)

GIN/CI/2.3 CVT 2013-Series VIII

(Centres: West coast plains and ghat region - IISR; Middle gangetic plain region - Dholi, Pundibari; Eastern plateau and hills region - Pottangi; Western Himalayan Region - Solan)



Fig. 12: Field view of coordinated varietal trial of ginger at Pottangi

Ten accessions along with check IISR Varada were evaluated during 2014-15 for yield at IISR. Among the ginger accessions studied, maximum yield was recorded in GCP 49 followed by Acc. 219 and RG 3.

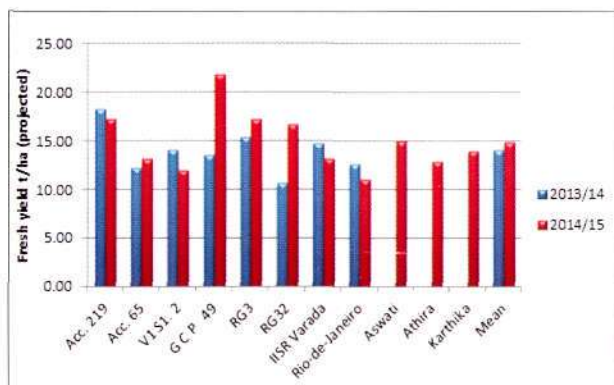


Fig.13: Performance of ginger entries in CVT at IISR

Among six entries and two check varieties evaluated at Dholi, two entries RG-32 and RG-3 gave significantly higher plant height (24.60 and 23.57 cm), number of leaves per tiller (17.25 and 16.67), yield per plot (2.58 and 2.47 kg/3 m²) and yield per hectare (8.61 and 8.22 t ha⁻¹) as compared to best local check variety Nadia and other promising entries. Percentage yield increase over check was 40.92 % in RG-32 and 34.53% in RG-3.

At Pundibari centre genotype GCP 49 registered highest yield (23.31 t ha⁻¹) followed by Karthika with a yield of 17.84 t ha⁻¹.

Out of 8 entries tested at Pottangi VIS1-2 (16.06 t ha⁻¹) was the top yielder with the yield advantages of 14.0 % than the national check Varada (13.81 t ha⁻¹) followed by GCP-49 (15.85 t ha⁻¹), RG-32 (15.47 t ha⁻¹) and Acc-65 (15.78 t ha⁻¹). Highest clump weight was observed in Suprabha (409.7g).

At Solan centre average yield varied from 6.78 t ha⁻¹ to 21.15 t ha⁻¹. Maximum yield was recorded by SG-26-04 (21.15 t ha⁻¹) followed by local check Himgiri 12.40 t ha⁻¹ and National check variety Varada 10.07 t ha⁻¹. The rhizome rot disease incidence varied from 10.50-25.39 % with minimum in SG-26-04.



Table 7: Projected yield of ginger genotypes in coordinated varietal trial (CVT-2013) at different AICRPS centres

Entries	Projected yield (t ha ⁻¹)			
	Dholi	Pottangi	Pundibari	Solan
ACC-65	5.44	12.65	08.51	8.12
ACC-219	4.78	07.92	05.82	6.78
V ₁ S ₁ -2	6.50	15.47	10.68	9.25
RG-3	8.22	11.77	11.30	9.95
RG-32	8.61	14.58	04.24	7.83
GCP-49	4.56	15.47	23.21	9.31
Varada (National check)	3.50	12.95	05.18	10.07
Local check/s	6.11	13.84	07.85	12.40
	(Nadia)	(Suprabha)	(GCP-5)	(Himgiri)
				21.15
				(SG-26-04)
Mean	5.96	13.08	09.59	10.54
S.Em (±)	0.29	6.26	2.78	6.09
CD (0.05)	0.88	22.34	6.34	5.24
CV (%)	8.49	10.15	15.34	11.22



Fig. 14: Rhizome of high yielding genotype SG-26-04 (SG-10-11-3) and check variety Himgiri at Solan

GIN/CI/3 Varietal Evaluation Trial

GIN/CI/3.2 Initial Evaluation Trial – 2011

(Centres: Middle Gangetic Plain Region - Pundibari; Western Himalayan Region - Solan)

At Solan, average yield of rhizome varied from 10.86 t ha⁻¹ to 21.15 t ha⁻¹. The genotype SG-26-04 recorded maximum yield 21.15 t ha⁻¹ followed by SG-08-04 (16.78 t ha⁻¹) and SG-908 (15.94 t ha⁻¹) whereas the check Himgiri yielded

12.40 t ha⁻¹. The rhizome rot disease incidence varied from 10.50-16.43 % with minimum in SG-26-04.

GIN/CI/3.3 Initial Evaluation Trial – 2012

(Centres: Middle Gangetic Plain Region - Kumarganj; Eastern plateau and hills region - Pottangi)

Seven entries of ginger were evaluated at Kumarganj on IET during the *kharif* season. The



maximum yield was recorded in Baidra sonth (31.77 t ha⁻¹) followed by NDG-28 (14.55 t ha⁻¹). Among the entries NDG-6 and NDG-28 were found moderately tolerant to soft rot.

At Pottangi centre among the 30 entries tested S-646 (23.68 t ha⁻¹) was the top yielder with the yield advantage of 50.6 % than the national check variety Varada (11.69 t ha⁻¹) followed by Zo-2 (23.24 t ha⁻¹), Suprabha (20.72 t ha⁻¹), V₁E₄-5 (20.42 t ha⁻¹) and V₁E₈-2 (20.28 t ha⁻¹). Project yield ranged from 11.69 t ha⁻¹ (Varada) to 23.68 t ha⁻¹ (S-646).

GIN/CI/4 Quality Evaluation Trial

GIN/CI/4.1 Evaluation of germplasm for quality

(Centre: Western Himalayan Region - Solan)

Forty six best performing genotypes were analyzed. Dry matter content (%) and crude fibre (%) ranged between 17.50 (SG-1118) to 24.28 (SG-247) and 4.10 (SG-30) to 5.37 (Himgiri), respectively. Essential oil (%) and oleoresin contents (%) varied from 0.83 (Surabhi) to 1.67 (SG-26-04) and 3.13 (SG-1045) to 4.58 (SG-857), respectively.

Crop Management

GIN/CM/5 Nutrient Management Trial

GIN/CM/5.4 Evaluation of herbicide for the effective control of weeds in ginger

(Centre: East coast plains and hill region - Chintapalle)

At Chintapalle an experiment was taken up to evaluate the effectiveness of herbicides for control of weeds in ginger and this revealed that maximum per plant yield (300.0 g plant⁻¹) was recorded in regular hand weeding and Oxyflurofen (Pre-emergent) 23.5% EC, 0.3 kg a.i./ha + Quazilofop ethyl (30 days of crop) 5% EC, 0.05 kg a.i./ha followed by hand weeding at 90 days (T9) of cropping. Maximum plot yield

and projected yield also recorded high in these 2 treatments 22.03 t ha⁻¹ and 21.67 t ha⁻¹ respectively.

GIN/CM/5.5 Source sink relationship

(Centres: West coast plains and ghat region - IISR; Middle Gangetic Plain Region - Kanke; Eastern Himalayan Region - Mizoram; Middle Gangetic Plain Region - Pundibari; Western Himalayan Region - Solan)

According to the analysis carried out at IISR, dry matter partitioning to shoot was maximum (50-55%) till 90 DAP in all varieties. Dry matter accumulation in rhizomes was maximum between 90 - 150 days after planting (DAP) in all varieties similar trend was noticed in all the centres. Rate of starch accumulation in rhizomes was also maximum during this period and the maximum starch content was obtained at harvest. Oil and oleoresin were maximum between 120-150 DAP and then declined. In general, Ranchi Local had the lowest oil and oleoresin content at all the places and Gorubathan had slightly higher oil and oleoresin compared to other varieties.

Four varieties viz. Mahima, GCP-5, Mizoram Local and prominent local variety (Ranchi Local) were evaluated for source sink relationship in ginger at Kanke, it was inferred from this trial that Mahima recorded maximum tillers (7.8) and highest fresh and dry weight of leaves (22.1 g and 4.46 g) while Ranchi local recorded maximum fresh and dry wt. of stem (46.08 g and 4.16 g), fresh and dry wt. of rhizome (122.5 g and 24.0 g) and maximum per plot yield of 4.9 kg. In terms of quality aspects essential oil content ranged from 0.82 (Ranchi local) to 1.02 % (Mizoram local). Oleoresin content was highest in Mizoram local (4.08 %). Less crude fibre was recorded by Mizoram local (3.65 %) followed by GCP-5 (3.98 %), Mahima (4.65 %) and Ranchi local (4.90 %).

At Pundibari in this trial the genotype Mahima produced the highest fresh yield of 4.68



kg plot⁻¹ (9.43 t ha⁻¹) and highest dry yield of 1.21 kg plot⁻¹.

Crop Protection

GIN/CP/6 Disease Management Trial

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

(Centre: Middle Gangetic Plain Region - Dholi)

From Dholi centre scientists surveyed in the Sheohar district of Bihar to record the severity of bacterial wilt and soft rot diseases. Bacterial wilt incidence ranged from 15 to 55 % with mean disease incidence of 22 %. Whereas soft rot disease ranged from 5 to 40 % with mean disease incidence of 22 %. *Phyllosticta* leaf spot disease incidence was also observed and disease incidence ranged from 0 to 45 % with mean of 24 %.

GIN/CP/6.10 Efficiency of different fungicides including new molecules against leaf spot disease of ginger

(Centres: Middle Gangetic Plain Region - Dholi, Pundibari; Western Himalayan Region - Solan; Eastern plateau and hills region - Raigarh)

Lowest disease incidence (PDI= 26.66) with highest yield (16.38 t ha⁻¹) over control (PDI = 55.55 & yield =11.50 t ha⁻¹) was recorded in foliar spray of Propiconazole (0.1%) was done first at disease appearance and subsequently 2

sprays at 20 days interval after 1st spray at Dholi.

Foliar spray with Hexaconazole (0.1%) first at disease appearance and then 2 times at 20 days interval is the best treatment for control of leaf spot disease at Pundibari, as it produced the lowest leaf spot disease incidence (PDI 17.48) and highest yield of 4.13 kg plot⁻¹ (8.33 t ha⁻¹) and was followed by foliar spray with Propiconazole (0.1%) first at disease appearance and then 2 times at 20 days interval which recorded the leaf spot PDI of 17.73 and yield of 3.93 kg plot⁻¹ (7.92 t ha⁻¹). Both the treatments reduced disease incidence by 43.70 % and 42.90 % respectively over control.

Minimum leaf spot incidence (8.46 %) was recorded in foliar spray with hexazonozole (0.1%) first at disease appearance and then 2 times at 20 days interval which also resulted in maximum percent disease control (80.93 %) followed by propiconazole, carbendazim + mancozeb and tricyclazole sprays, which were statistically at par with each other and gave 78.20, 73.69 and 73.51 per cent disease control, respectively. Hexaconazole spray also registered maximum yield (7.50 kg plot⁻¹) followed by sprays of propiconazole and carbendazim + mancozeb giving 6.75 and 6.25 kg plot⁻¹ respectively.

At Raigarh minimum disease intensity (18.63 %) and maximum yield (4.4 t ha⁻¹) was found with spray of Carbendazim:Mancozeb (0.1 %) first at disease appearance and then two times at 20 days interval.



V.TURMERIC

Genetic resources

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

(Centres: Southern plateau and hills region - Coimbatore, Kammarpally; Middle Gangetic Plain Region - Dholi, Kumarganj, Pundibari; Western Himalayan Region - Pantnagar; Eastern Himalayan Region - Pasighat; Eastern plateau and hills region - Pottangi, Raigarh)

Table 8 shows the turmeric germplasm conserved at various AICRPS centres

A total of 275 germplasm collections were evaluated at Coimbatore centre. The plant height of the genotypes ranged from 50.50 cm to 133.50 cm and the number of tillers per plant ranged between 1.00 and 8.10. Out of 275 genotypes 139 genotypes recorded significantly higher fresh rhizome yield plot⁻¹ (3 m²). The accession CL 101 recorded the highest fresh rhizome yield (13.27 kg plot⁻¹).



Fig. 15: Field view of germplasm evaluation at Coimbatore

At present, 182 germplasm collections are being maintained at TRS Kammarpally. Genotypes are grouped into long (8-9 months), medium (7-8 months) and short duration groups (6-7 months) based on duration. Variability was observed in diseases like Rhizome rot, *Colletotrichum* and *Taphrina* leaf blotch. During

the year 2014-15, among all germplasm lines tested, PTS-38 recorded highest rhizome yield (14.6 kg/3m²) followed by CLI-29 (14.3 kg/3m²) where as local check JTS -6 recorded 12.4 kg/3m².

At Dholi centre 92 accessions were evaluated for yield and other quality parameters among them 18 accessions performed better and the fresh rhizome yield ranged from 0.80 kg to 1.20 kg plant⁻¹. Among promising accessions, RH-2414 gave the highest yield of 1.20 kg plant⁻¹ followed by RH-50 and RH-441 (1.0 kg plant⁻¹).

In this cropping season 155 germplasm were evaluated at Kumarganj centre, among them in early maturity group NDH-74 (348.50 q ha⁻¹) and NDH-79 (345.30 q ha⁻¹), in medium maturity group NDH-98 (415.40 q ha⁻¹) and NDH-131 (333.60 q ha⁻¹) and NDH-8 (352.90 q ha⁻¹), NDH-7 (348.60 q ha) in late maturity group found promising in terms of yield. In terms of disease resistance minimum leaf blotch incidence was recorded in NDH-146 (20.16 %) followed by NDH-14 (22.53 %), NDH-55 (23.80 %), NDH-70 (25.71 %) and NDH-109 (26.53 %). Leaf spot disease was not observed in 2014-15.

At Pundibari centre 155 germplasm were evaluated. Rhizome yield was maximum in TCP-137 (735.00 g plant⁻¹). Considering plot yield and projected yield, TCP-15 (42.24 t ha⁻¹), TCP-28 (35.00 t ha⁻¹), TCP-46 (40.23 t ha⁻¹), TCP-90 (42.64 t ha⁻¹), TCP-137 (53.18 t ha⁻¹), TCP-162 (45.86 t ha⁻¹), TCP-165 (41.83 t ha⁻¹), TCP-168 (40.76 t ha⁻¹), TCP-176 (45.86 t ha⁻¹) recorded significantly higher rhizome yield (30-40 % increase over check variety TCP-2). A total of 17 genotypes out yielded the local check TCP-2 (31.37 t ha⁻¹).

Forty eight (46 Old +02 New) diverse genotypes of turmeric were evaluated at Pasighat centre with Megha Turmeric-1 as the check. Among the genotypes evaluated, maximum



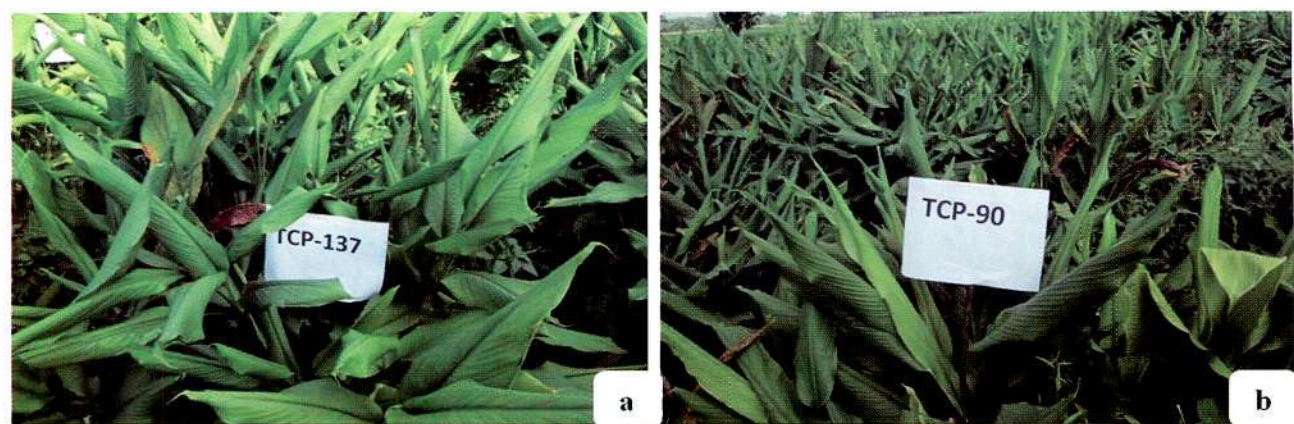


Fig. 16: Promising turmeric germplasm at Pundibari Centre. a. TCP 137 and b. TCP 90

rhizome yield was recorded in CHFT-8 (34.97 t ha⁻¹) followed by CHFT-24 (34.19 t ha⁻¹), CHFT-36 (33.74 t ha⁻¹), CHFT-1-1 (32.52 t ha⁻¹), CHFT-32 (31.08 t ha⁻¹), CHFT-30 (30.97 t ha⁻¹), CHFT-15 (29.42 t ha⁻¹) and CHFT-22 (29.30 t ha⁻¹) and these genotypes were significantly superior over rest of the genotypes.

152 *Curcuma longa*, 23 *Curcuma aromatic* and 4 *Curcuma amada* were evaluated at HARS, Pottangi. In *Curcuma longa* fresh rhizome yield ranged from 6.0 kg/3 m² to 20.3 kg/3m² with the mean of 12.7 kg/3m². High yielders were CLS-29 (20.3 kg/3m²), Kuchipudi (19.3 kg/3m²), VK-5 (19.0 kg/3m²) and PTS-33 (18.8 kg/3m²). In *Curcuma aromatica* the fresh

rhizome yield varied from 5.2 kg/3m² to 16.3 kg/3m².

At Raigarh centre 55 germplasm collections were evaluated. Germplasm was grouped into 2 groups based on site of selection and area of adaptability. From the first group the accessions IT 26 (4.850 kg plot⁻¹), IT 36 (4.73 kg plot⁻¹) and IT 23 (4.63 kg plot⁻¹) recorded highest yield of rhizome. These genotypes were found resistant to water logging. From the second group the accession RTC 12 (10.78 kg plot⁻¹) recorded highest rhizome yield followed by RTC 4 (8.63 kg plot⁻¹) and RTC 3 (6.98 kg plot⁻¹).

The promising genotype IT 2 released as

Table 8: Turmeric germplasm collections at various AICRPS centres

Centre	Indigenous			Exotic	Total
	Cultivated		Wild and related species	Existing	
	Existing	Addition (2014 -15)	Existing		
Coimbatore	266	-	7	2	275
Dholi	84	6	2	-	92
Kammarpally	182	-	-	-	182
Kumarganj	155	-	-	-	155
Pantnagar	36	-	-	-	36
Pasighat	61	2	2	-	65
Pottangi	155	-	24	-	179
Pundibari	200	-	3	-	203
Raigarh	42	13	-	-	55
Total	1181	21	38	2	1242



variety by name of Chhattisgarh Haldi 1 during 2014-15.

Crop Improvement

TUR/CI/2 Coordinated Varietal Trial

TUR/CI/2.5 CVT on Turmeric 2013

(Centres: East coast plains and hill region - Chintapalle; Southern plateau and hills region Coimbatore, Kammarpally; West coast plains and ghat region - IISR; Middle gangetic plain region - Kumarganj, Pundibari; Eastern plateau and hills region - Pottangi, Raigarh)

Out of 12 genotypes evaluated at Chintapalle PTS-55 recorded maximum plant height (127.33 cm) followed by PTS-12 (125.66 cm), PTS-8 (124.0 cm) both were on par. In terms of yield parameters, maximum rhizome yield per plant was observed in NDH-98 (590.0 g plant⁻¹) followed by NDH-8 (390.0 g plant⁻¹). Maximum fresh rhizome yield (33.03 t ha⁻¹) and dry recovery (23.4 %) was recorded by NDH-98. In terms of quality highest curcumin content was recorded by PTS-12 and Chintapalli local (5.3 %) and the essential oil content ranged from 6.1 % (NDH-79) to 7.0 % (Prathibha).

At Coimbatore centre among the genotypes tested, SLP 389/1 recorded more number of tillers per plant (8.53) and maximum plant height (92.73 cm). The fresh rhizome yield per plant was found to be high (911.67 g plant⁻¹) in the genotype SLP 389/1. The fresh rhizome yield per plot (9 m²) was significantly different in various genotypes which ranged from 20.41 kg in NDH 79 to 36.52 kg in SLP 389/1. Eight genotypes registered significantly higher values than the grand mean of 31.11 kg plot⁻¹. The projected rhizome yield per hectare ranged from 22.67 t ha⁻¹ (NDH 79) to 40.58 t ha⁻¹ (SLP 389/1) with a mean of 34.57 t ha⁻¹. The mean per cent incidence of leaf blotch disease varied between 3.34 % (Prathibha) and 32.51 % (BSR 2). Among the different genotypes the curing per cent ranged from 9.70 in the genotype TCP 64 to

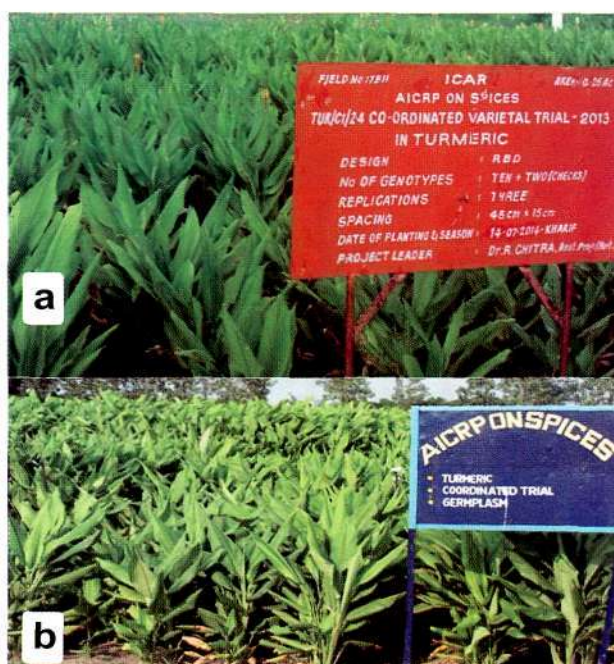


Fig. 17: Turmeric Coordinated Varietal Trial at (a) Coimbatore and (b) Pantnagar

21.60 in ACC 79. Curcumin content was highest in NDH-79, PTS-55 and Prathibha (5.3 %) whereas the essential oil content was highest in TCP-64 and IISR-48 (6.9 %).

Out of eleven genotypes tested at Kammarpally centre, NDH-79 recorded highest fresh rhizome yield (40.99 t ha⁻¹) followed by ACC-79 (36.68 t ha⁻¹) in comparison to JTS-6 local check variety (67.4 t ha⁻¹). Curcumin content ranged from 3.4 – 5.3 % and the highest was recorded in PTS-55 (5.3 %).

The experiment was laid out in IISR Experimental Farm, Peruvannamuzhi, Kerala with 10 different entries and a national check IISR Prathibha. The different accessions varied in plant morphological characteristics. Among the accessions studied, maximum yield was recorded in NDH 8 followed by Acc. 48.

NDH-98 recorded maximum yield (31.66 t ha⁻¹) followed by TCP-64 (29.44 t ha⁻¹) and NDH-8 (28.33 t ha⁻¹) at Kumarganj centre. Leaf blotch incidence was minimum in PTS-55 (18.12 %) followed by ACC-7 (21.44 %), TCP-



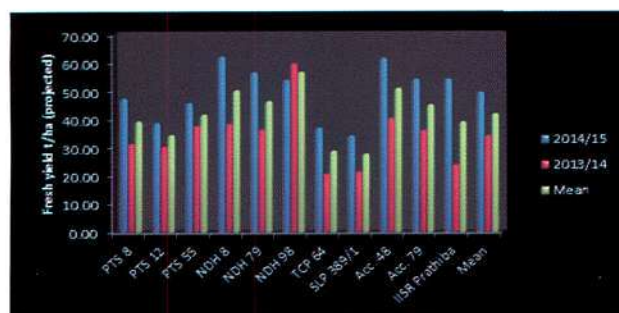


Fig. 18: Performance of turmeric entries in CVT at IISR

64 (21.77 %) and NDH-98 (25.53 %) whereas in case of leaf spot, minimum severity was found in PTS-55 (1.9 %) followed by PTS-12 (2.26 %), NDH-98 (3.03 %) and TCP-64 (3.9 %). Curcumin content varied from 3.5-5.4 %, highest was in SLP-389/7 IISR. ACC-48, PTS-55 and NDH-1 recorded the highest essential oil content of 7.0 %.

At Pundibari centre NDH-98 recorded highest yield of 15.65 kg plot⁻¹ (31.71 t ha⁻¹) followed by TCP 64 (10.06 kg plot⁻¹, 20.35 t ha⁻¹). Dry recovery (%) was highest in TCP 64 (34 %) and lowest was found in NDH-8 (24.33 %). PTS-12 recorded lowest incidence of leaf blotch disease followed by Prathibha (PDI 24.67). Lowest leaf spot disease incidence was observed in PTS-12 (PDI 4.29) followed by NDH 8 (PDI 4.59) and NDH 79 (PDI 5.89). In terms of quality PTS-12 and TCP-64 recorded highest curcumin content (5.3 %) followed by PTS-55 and Prathibha (5.1 %). Essential oil content varied from 6.1 % (NDH-79) to 7.0 % (Prathibha).

PTS-55 (25.85 t ha⁻¹) was the top yielder with yield advantage of 37.6 % at Pottangi centre. This was followed by NDH-98 (25.61 t ha⁻¹), PTS-12 (19.02 t ha⁻¹), NDH-8 (18.69 t ha⁻¹) and PTS-8 (17.02 t ha⁻¹). Maximum clump weight of 371.7 g was registered in NDH-98.

Among the 12 entries evaluated at Raigarh centre, NDH 98 (16.67 t ha⁻¹) recorded significantly higher rhizome yield over both checks Prathibha (8.67 t ha⁻¹) and IT 10 (12.28 t ha⁻¹). Curcumin content varied from 4.3 - 5.3%,

Prathibha variety recorded the highest curcumin content (5.3 %) as well as essential oil content (7.2 %).

TUR/CI/3 Varietal Evaluation Trial

TUR/CI/3.3 Initial Evaluation Trial 2010

(Centres: Western Himalayan Region–Pantnagar; Eastern plateau and hills region - Raigarh)

At Pantnagar 10 genotypes were tested along with 2 check varieties. Significant differences were observed for all the characters. Maximum fresh rhizome yield (35.83 t ha⁻¹) was recorded in PT-5, followed by PT-6 (29.80 t ha⁻¹). Yield increase was 30.43 % and 6.92 % in PT-5 and PT-6 respectively. Whereas in terms of curcumin content Pant Peetabh (check) showed the higher curcumin content 7.45 % followed by PT-9 (6.45 %).

At Raigarh centre, out of eight entries seven entries recorded significantly higher rhizome yield over local check IT 10 (2.6 kg). IT 7 (4.2 kg plot⁻¹) and IT 5 (3.8 kg plot⁻¹) recorded higher yield compared to both national (Narendra Haldi – 3 kg plot⁻¹) and local check (IT 10 – 2.6 kg plot⁻¹). All the entries were showed moderate resistance to *Colletotrichum* and *Taphrina* leaf spot.

TUR/CI/3.5 Initial Evaluation Trial 2012

(Centres: Middle Gangetic Plain Region - Dholi, Kumarganj)

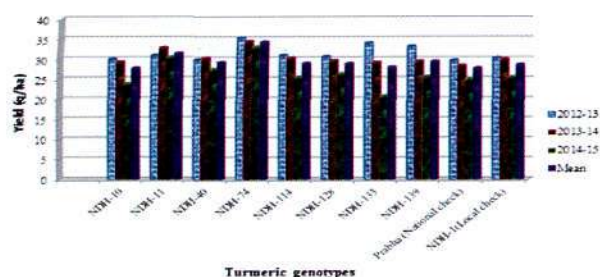
Among twelve entries along with local check variety Rajendra Sonia tested at Dholi, none of the entries was found significant superior regarding height of the plant, number of tillers per plant and number of leaves per tiller as compared to local check variety Rajendra Sonia. However, RH-7/80 gave significantly higher yield (53.95 t ha⁻¹) as compared to check variety Rajendra Sonia (40.83 t ha⁻¹) and other promising entries.



Table 9: Performance of turmeric entries in initial evaluation trial for the year 2014-15 at Dholi

Character Genotype	Height of the plant (cm)	No. of tillers per plant	No. of leaves per tiller	Yield per plot (kg/3m ²)	Yield (t/ha)	Increase in yield over check
RH-22	97.67	3.44	6.66	11.52	38.39	-
RH-24	103.11	3.67	6.11	12.75	42.49	4.07
RH-401	98.78	3.22	6.33	10.63	35.42	-
RH-406	100.67	3.55	6.66	11.88	39.61	-
RH-413	106.44	3.88	5.88	11.93	39.78	-
RH-415	99.11	4.11	5.89	11.59	38.62	-
RH-417	105.89	3.44	6.22	11.51	38.36	-
RH-421	96.67	3.89	6.00	10.65	35.51	-
RH-2/80	97.99	3.66	6.33	11.10	36.99	-
RH-7/80	106.77	4.11	5.77	16.18	53.95	31.13
RH-9/90	104.11	3.88	6.00	12.64	42.13	3.18
Rajendra SoniaL.C	106.33	4.33	6.22	12.25	40.83	-
SEM (±)	4.27	0.34	0.23	0.66	2.20	-
CD (P=0.05)	NS	NS	0.66	1.94	6.45	-
CV (%)	7.25	15.77	6.35	9.48	9.48	-

At Kumarganj maximum yield was obtained in NDH-74 (33.11 t ha⁻¹) followed by NDH-111 (30.55 t ha⁻¹) and NDH-40 (32.74 t ha⁻¹). Pooled data from 2012-15 showed that NDH-74 (34.29 t ha⁻¹) recorded highest yield followed by NDH-11 (31.48 t ha⁻¹). NDH-40 showed less severity of leaf blotch (10.67 %) and leaf spot (5.46 %). NDH-1 (check) and NDH-133 recorded the highest curcumin content of 5.2 % and the essential oil content was also highest in NDH-133 (7.0 %).

**Fig. 19: IET on turmeric (Pooled data) at Kumarganj centre during 2012-2015**

Crop Management

TUR/CM/5 Nutrient Management Trial

TUR/CM/5.5 Standardization of water requirement for turmeric through drip irrigation

(Centres: Southern plateau and hills region - Coimbatore, Kammarpally; East coast plains and hill region - Guntur; Middle Gangetic Plain Region - Kumarganj, Pundibari)

From drip irrigation trial at Coimbatore it was concluded that the drip irrigation daily at 80% PE can be recommended to enhance the productivity of turmeric.

Among the drip schedules tested at Guntur, drip irrigation once in a day at 80% PE (51.1 t ha⁻¹) recorded maximum yield followed by drip irrigation once in two days at 80% PE (50.4 t ha⁻¹) which were on par with each other



and significantly superior to surface irrigation at 5 cm, 0.9 IW/CPE (44.6 t ha⁻¹).

At Guntur drip once in a day at 80% PE treatment recorded highest rhizome yield (38.32 kg plot⁻¹) followed by drip once in 2 days at 80% PE treatment (37.21 kg plot⁻¹) where as drip once in 2 days at 50% PE treatment recorded lowest rhizome yield (23.34 kg plot⁻¹).

At Pundibari results revealed that application of surface irrigation 5cm and 0.90 IW/CPE ratios gave the highest yield of 20.91 t ha⁻¹ followed by drip once in 2 days at 40% PE (18.59 t ha⁻¹) which was also statistically at par with drip once in a day at 40% PE (17.36 t ha⁻¹), drip once in 2 days at 60% PE (17.26 t ha⁻¹) and drip once in a day at 60% (17.24 t ha⁻¹). The highest yield was recorded in the treatment of that application of surface irrigation 5cm and 0.90 IW/CPE ratios might be due to the production of the higher number of tillers per plant, moderate number of leaf number, leaf length and leaf breadth

During 2014-15, an experiment was conducted to study the rhizome bulking pattern of the five varieties i.e. BSR 2, Rajendra Sonia, Duggirala Red, Mydukur and Prathiba at Coimbatore. Fresh weight of whole rhizome increased considerably from September to February. Among the varieties evaluated, BSR 2 registered vigorous growth and the highest fresh rhizome weight (458.00 g plant⁻¹) followed by Mydukur (435.22 g plant⁻¹) which were significantly different from each other at 240 DAS.

The results showed that with respect to total dry matter accumulation, the local varieties performed better than the rest in all the places. Maximum dry matter accumulation period varied between locations. It was between 80 to 140 DAP at Kozhikode, 105-165 DAP at Dholi while it was after 180 DAP at Guntur. Accordingly, period of maximum dry matter partitioning to rhizomes also varied between locations. Starch accumulation followed similar pattern as that of dry matter accumulation. Oil and oleoresin were maximum at 105-150 DAP,

Best drip irrigation schedules which gave higher yields in different AICRPS centres

Coimbatore	Guntur	Kammarpally	Pundibari
Drip irrigation daily at 80% PE	Drip irrigation once in a day at 80% PE (51.1 t ha ⁻¹) and drip irrigation once in two days at 80% PE (50.4 t ha ⁻¹) which were on par with each other	Drip once in a day at 80% PE (38.32kg plot ⁻¹) and drip once in 2 days at 80% PE (37.21 kg plot ⁻¹)	Surface irrigation 5 cm and 0.90 IW/CPE ratio (20.91 t ha ⁻¹) and drip once in 2 days at 40% PE (18.59 t ha ⁻¹)

TUR/CM/5.9 Source sink relationship in turmeric

(Centres: Southern plateau and hills region – Coimbatore; West coast plains and ghat region - IISR, East coast plains and hill region - Guntur)

then started declining and stabilized at harvest. In general, IISR Prathibha followed by BSR-2 showed higher oil and oleoresin, closely followed by Rajendra Sonia in all the places.

Five varieties were sown in the first week of August evaluated for rhizome bulking with



periodical sampling at Guntur. Fresh weight of whole rhizome increased considerably from October to February. Among the five varieties evaluated, Mydukur was found to be vigorous in growth and recorded highest fresh rhizome weight (361.6 g plant⁻¹) followed BSR-2 (298.9 g plant⁻¹) which were significantly different from each other at harvest. In terms of quality aspects curcumin content ranged from 4.9-5.3 %, highest being recorded by Mydukur and Prathibha (5.3 %). Essential oil content ranged from 6.8 (Mydukur) to 7.2 % (Prathibha). Oleoresin content varied from 11.25 (Rajendra Sonia) – 12.45 % (Duggirala Red).

Crop Protection

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 (Disease Surveillance)

(Centres: Southern plateau and hills region – Coimbatore; Middle Gangetic Plain Region – Pundibari, Dholi; Eastern plateau and hills region - Raigarh)

By the scientists of Coimbatore centre a field survey was conducted in different turmeric growing areas of Tamil Nadu viz., Coimbatore and Erode dist. In case of leaf spot, maximum intensity was noticed at Avalpoondurai (32.9 PDI) and the minimum intensity was recorded at Kavunthampadi (2.8 PDI) and Thandukkara npalayam (1.00 PDI). For the leaf blotch, the maximum intensity of 76.6 PDI was noticed at Avalpoondurai and minimum at Kavunthampadi (15.6 PDI).

In the survey conducted by Pundibari it was found that leaf blotch disease severity was highest in Coochbehar II block (average 38.58 %) followed by Coochbehar I block (average 35.73 %) and Dinhata (average 34.33 %). Regarding leaf spot of turmeric it was found that disease severity was also highest in Coochbehar

II (average 34.00 %) which is followed by Dinhata (average 31.67 %) and Coochbehar I block (average 31.40 %). Screening of the collected germplasm was done against both leaf blotch and leaf spot diseases of turmeric. Germplasm TCP 1, 14, 18, 21, 43, 129, 153, 232, 248 were found tolerant against leaf blotch disease and the germplasm lines TCP 1, 5, 39, 42, 63, 65, 70, 85, 129, 136, 137, 153, 154, 163, 201 found tolerant against leaf spot disease.

Survey conducted by Dholi centre revealed that turmeric crop cultivated by farmers in Sheohar district of Bihar was found to be affected by *Colletotrichum* leaf spot in the range of 0 to 30 % with mean disease incidence of 11 % and also *Taphrina* leaf spot incidence ranged from 10 to 60 % with mean disease incidence of 37 %. Among 15+1 (Susceptible check var. Morangia) germplasm of turmeric screened against leaf spot & leaf blotch disease, two germplasm viz., RH-2 & RH-12 were found moderately resistant against both leaf spot as well as leaf blotch disease.

During the survey at Raigarh, it was found that 47.78 % of disease intensity of *Colletotrichum* leaf spot at Bhakurra village of Lailunga block and 39.76 percent disease intensity of *Taphrina* leaf blotch in Sohanpur village of Dharamjaigarh developmental block. In the germplasm evaluation none of the local entries found highly resistant or resistant against both the foliage diseases.

TUR/CP/7.3 Assessment of fungicide and biological control agents against foliar disease of turmeric

(Centres: Middle Gangetic Plain Region - Dholi; Eastern plateau and hills region - Raigarh)

Lowest incidence *Colletotrichum* leaf spot (PDI =6.67) and *Taphrina* leaf spot (PDI=11.67) were recorded in treatment where pre-planting treatment of rhizome and spraying of crop at 90, 105, 120 DAP was done with



Propiconazole (0.1 %) and Zineb (1 %) respectively over control (PDI = 23.33 and 55.0 respectively). Best treatment with respect to recording of highest yield (40.63 t ha^{-1}) over control (21.65 t ha^{-1}) was found in treatment where pre-planting treatment of rhizome and spraying of crop at 90, 105, 120 DAP was done with Zineb (0.1%) at Dholi.

At Raigarh minimum disease intensity 17.27 % and maximum yield 11.20 t ha^{-1} was recorded when rhizomes treated with Carbendazim + Mancozeb (0.1%) + Foliar spray of Carbendazim + Mancozeb (0.1%) on 45 and 90 days followed by Azystobin spray (0.1%) after 45, 75 and 105 DAP with minimum disease intensity of 20.26 and yield 10.30 t ha^{-1} . Both the treatments were statistically at par.

TUR/CP/7.4 Management of foliar diseases in turmeric using tolerant lines

(Centres: Southern plateau and hills region - Coimbatore; Middle Gangetic Plain Region - Dholi, Kumarganj, Pundibari; Eastern plateau and hills region - Raigarh)

A trial was conducted to screen the disease tolerant lines CL 32, CL 34, CL 52, CL 54 of Coimbatore centre, TCP 14, TCP 129, TCP

161 of Pundibari Centre, NDH 10, 40, 74, 128 of Kumaraganj and RH 406, RH 407 and RH 410 of Dholi centre along with susceptible check of each centre.

At Coimbatore all the disease tolerant lines of turmeric recorded 83.0 to 94.0 per cent sprouting. Among different lines, CL 32 registered highest sprouting (94.0 %). The disease tolerant lines recorded the least leaf spot incidence between 2.20 and 4.13 PDI where as the susceptible check BSR-2 registered the highest incidence of 11.97 PDI. The accession number viz., CL 32 recorded the least leaf spot intensity of 3.87 PDI. The disease tolerant lines recorded the leaf blotch incidence ranged from 3.08 to 28.26 PDI, while the maximum incidence was noticed in the susceptible check BSR-2 (44.96 PDI). The accessions CL 34, TCP 129 and NDH 40 recorded the least leaf blotch intensity of 3.08 PDI with maximum yield of 30.95, 28.44 and 29.00 t ha^{-1} respectively followed by RH 410 which recorded the disease intensity of 4.64 PDI with the yield of 28.06 t ha^{-1} .

Among the germplasm of turmeric screened against leaf spot and leaf blotch disease at Dholi, NDH-128 was found to have PDI of 18.33 and 0.00 in case of leaf spot and leaf blotch



Fig. 20: Leaf blotch tolerant lines a. TCP 129 & b. CL 34 in a trial on management of foliar diseases of turmeric using tolerant lines at Coimbatore



disease respectively with highest yield of 61.70 t ha⁻¹ against control (PDI= 25.0 and 58.33 for leaf spot and leaf blotch disease respectively and yield of 25.11 t ha⁻¹).

At Kumarganj, minimum leaf blotch severity was recorded in CL-34 (11.40 %) followed by CL-32 (25.17 %), TCP-161 (33.06 %) and NDH-128 (34.64 %) and the leaf spot severity was lowest in CL-34 (4.40 %) followed by NDH-128 (9.42 %), TCP-161 (12.45 %) and NDH-10 (12.47 %). The fresh weight of rhizome was highest in CL-34 (30.55 t ha⁻¹) in comparison

to NDH-10 (30.44 t ha⁻¹), TCP-161 (30.32 t ha⁻¹) and CL-52 (28.33 t ha⁻¹).

At Pundibari centre TCP 129 recorded lowest leaf blotch (PDI 11.18) and leaf spot (PDI 6.54) disease incidence. TCP 14 produced the second lowest leaf blotch disease incidence (PDI 12.03) and CL 52 produced second lowest leaf spot disease incidence (PDI 8.57). Highest yield of 11.00 kg plot⁻¹ (22.11 t ha⁻¹) was obtained by TCP 129 which is followed by TCP 14 with 8.37 kg plot⁻¹ (16.87 t ha⁻¹).

Table 10: Turmeric lines which showed highest degree of tolerance to foliar diseases at various AICRPS centres

Centre	Leaf blotch	Leaf spot
Coimbatore	CL 34, TCP 129, NDH 40	CL 32
Dholi	NDH 128	NDH 128
Kumarganj	CL 34, CL 32, TCP 161, NDH 128	CL 34, NDH 128, TCP 161, NDH-10
Pundibari	TCP 129, TCP 14	TCP 129, CL 52



Field view of mechanically planted of turmeric at Coimbatore



VI. TREE SPICES

Genetic Resources

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

(Centres: Western plateau and hills region - Dapoli; Southern plateau and hills region - Pechiparai)

Tree spices viz., clove, nutmeg, cinnamon and cassia germplasm maintained at various AICRPS centres (Table 11)

a. Nutmeg

Among the germplasm collections of Dapoli centre fifteen promising genotypes have been identified. Genotype DBSKKVMF 24 recorded maximum dry nut yield (1680.0 g) and dry mace yield (367.5 g) in year 2013 – 14. Average dry nut yield (1505.0 g) and dry mace yield (315.0 g) was recorded in genotype

DBSKKVMF 29 in years 2006 to 2014. The genotype DBSKKVMF 29 is found promising considering its fruit wt., nut wt. and mace wt.

Survey was undertaken by Pechiparai centre and collected bud sticks from Thadikarakonam and Black rock estate and efforts are made to procure the mini nutmeg from the grower. Among the 24 accessions maintained and evaluated at Pechiparai accession MF- 4 recorded maximum number of fruits (1020 fruits tree⁻¹) and single fruit weight (75.27 g). Local check recorded 117.30 number of fruits / tree and single fruit weight of 53.87g.

b. Clove

Among the germplasm of clove at Dapoli centre four promising genotypes were selected. The plant height varied from 5.0 to 7.0 m., girth ranged from 32 to 37 cm and spread varied from 3.60 m to 5.20 m.

Table 11: Tree spices germplasm collection at AICRPS centres

Crop/Centre	Indigenous		Total
	Cultivated		
	Existing	Addition (2014 -15)	
<i>Clove</i>			
Dapoli	2	-	02
Pechiparai	24	03	27
Yercaud	01	-	01
Total	27	03	30
<i>Nutmeg</i>			
Dapoli	89	5	94
Pechiparai	24	4	28
Total	113	9	122
<i>Cinnamon</i>			
Dapoli	11	-	11
Pechiparai	12	2	14
Yercaud	02	-	02
Total	25	2	27
<i>Cassia</i>			
Dapoli	6	-	6
Pechiparai	4	-	4
Total	10	-	10



Twenty four accessions are being maintained at Pechiparai. Two more types Madagascar clove and bush clove has been collected and added to the germplasm. Among the 24 accessions, SA-1 recorded the highest tree height of 8.43 m, followed by SA-2 (8.10 m) whereas local check recorded a tree height of 6.80 m. Dry bud yield was highest in SA- 3 (4.67 kg tree⁻¹) and local check recorded a flower yield of 2.15 kg tree⁻¹.

c. Cinnamon

Twelve accessions are being maintained at Pechiparai. Among these accessions, CV-5 has given the highest dry bark yield of 569.23 g per tree and local check recorded 272.85 g per tree. During this year a high yielding selection from Nagercoil was added to the germplasm.

TSP/CI/1.2 Collection of unique germplasm in tree spices

(Centres: Western plateau and hills region - Dapoli; West coast plains and ghat region - IISR, KAU; Southern plateau and hills region - Pechiparai)

Exhaustive survey to the Nutmeg growing tracts of Kerala was conducted by KAU, Thrissur centre. Districts surveyed include Pathanamthitta, Kottayam, Ernakulam, Thrissur, Malappuram, Palakkad and Kozhikode. Unique accessions of nutmeg were identified from these areas. Uniqueness with respect to tree shape,

branching pattern, leaf size, sex form, fruit, mace and kernel characters, yield, reaction to biotic and abiotic stress were looked into. 15 different accessions were located from these areas. Three uniform trees of each accession in the full bearing stage were tagged for recording observations. Observations were recorded from four sides of the tree. 20 samples were drawn for each observation, five each from one side. Flower count was recorded from 0.1m² area and fruit count from 1 m² area from all the four sides.

Crop Improvement

TSP/CI/2 Coordinated Varietal Trial

TSP/CI/2.2 CVT 2001-Nutmeg

(Centres: Western plateau and hills region - Dapoli; Southern plateau and hills region - Pechiparai)

No significant variation was observed for all parameters except no. of branches at Dapoli. Plant height ranged from 1.45 – 2.35 m., girth 16.17 - 23.33 cm and the spread was 0.90 – 2.10 m. Few plants from Acc.no. A 9/4, A 9/20 and A 9/150 started bearing

Six accessions collected from IISR, Kozhikode were evaluated along with a local check at Pechiparai. Among the accessions A9/150 has recorded highest plant height (3.00 m), stem girth (24.67cm), maximum number of branches (21.80) and number of fruits (56 per tree).



Fig. 21: Unique nutmeg accessions identified from Thrissur centre
a. Yellow mace type; b. Clustered fruit type; c. Monoecious type



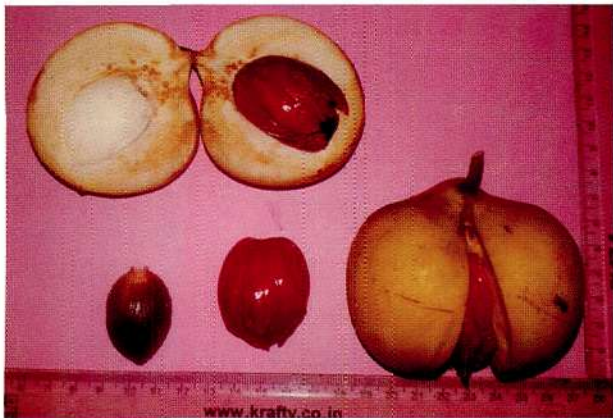


Fig. 22: Fruit, nut and mace of nutmeg genotype A 9/150 at Dapoli centre

TSP/CI/2.3 CVT-2001-Cassia

(Centres: *Western plateau and hills region - Dapoli; Southern plateau and hills region - Pechiparai*)

The genotype KKVCTSH2 recorded higher girth (47.63 cm) followed by KKVCTSH1 (42.88 cm). The oil percentage in leaf varied from 6.14 - 7.34 %. The genotype KKVCTSH1 and KKVCTSH2 recorded higher oil percentage 7.34 % and 7.12 % respectively. Treatment D5 record highest leaf area 98.64cm².

At Pechiparai centre 4 collections of cassia from IISR were evaluated along with local check. Among the four selections, D3 was found to be promising with plant height of 5.90m, stem girth of 40.79 cm, the leaf yield of 396.78 g tree⁻¹, and bark yield of 226.12 g tree⁻¹.

Table 12: Yield performance of Nutmeg accessions at Pechiparai in an CVT

Accessions	Plant height (m)	Stem girth (cm)	Number of branches	No. of fruits per tree
A9/4	3.05	23.16	7.12	20
A9/20	1.98	21.75	15.35	30
A9/25	2.50	19.25	13.99	29
A9/71	2.65	20.00	14.29	31
A9/150	3.00	24.67	21.80	56
M.L.	2.00	12.00	8.98	23
Local check	2.07	19.00	5.67	32
SED	0.35	0.88	2.39	4.88
CD (p=0.05)	0.61	1.42	6.79	9.02



VII. CORIANDER

Genetic Resources

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

(Centres: Southern plateau and hills region - Coimbatore; Middle Gangetic Plain Region - Dholi, Kumarganj; East coast plains and hill region - Guntur; Trans Gangetic Plain Region - Hisar; Gujarat plains and hills region - Jagudan; Central plateau and hills region - Jobner)

Coriander germplasm collection and conservation at different AICRPS centres (Table 13)



Fig. 23: Field view of coriander germplasm evaluation at Jobner

At Coimbatore 275 coriander germplasm were evaluated during *Rabi* season. Plant height at harvest varied significantly from 30.10 to 70.10 cm. Over all mean was 50.21cm, the genotype CS 105 recorded the highest plant height of 70.10 cm, when compared with check varieties, CS 49 (57.90cm), CS 82 (51.60cm) and CS 111 (48.40cm) and the genotype CS 230 recorded the lowest plant height (30.10cm). The number of umbels per plant varied from 7.30 to 29.30 and over all mean was 15.86. The maximum number of umbels per plant was recorded in CS 65 (29.30) and lowest was recorded in the genotype CS 110 (7.30) which was on par with CS 94, CS 96 and CS 100. The grain yield per plot (3 m²) ranged from 75.00 to 295.00 g plot⁻¹. The average mean yield was 157.55g per plot. Out of 275 collections evaluated, 112 genotypes recorded the maximum yield than the mean yield (157.55 g plot⁻¹).

Out of 149 accessions evaluated at Dholi, only twelve accessions namely RD-420, RD-404, RD-408, RD-413, RD-423, RD-397, RD-385, RD-424, RD-378, RD-394, RD-425 and RD-121 gave the highest yield ranging from 70 to 180 g per five plants as compared to best check variety Pant Haritima. Among twelve promising accessions, RD-420 gave the highest yield of 180 g per five plants followed by RD-404 (125g per five plants).

At Kumarganj centre 180 Germplasm accessions evaluated and among them NDCor-118 (15.35 q ha⁻¹), NDCor-102 (15.10 q ha⁻¹) and NDCor-119 (14.90 q ha⁻¹) were found promising in terms of yield in comparison to Hisar Anand (12.25 q ha⁻¹) and NDCor-2 (13.40 q ha⁻¹). NDCor-22, NDCor-51, NDCor-58, NDCor-96 and NDCor-97 were found moderately resistant to stem gall disease.

Sixty one germplasm lines were evaluated in Augmented Block Design with six checks at Guntur centre. Among the entries evaluated, LCC-291 (5.52 g plant⁻¹), LCC-304 (5.42 g plant⁻¹) and LCC-282 (5.21 g plant⁻¹) were found significantly superior in yield over the best check AD-1 (4.34 g plant⁻¹).

At Jagudan, 95 genotypes of coriander were evaluated for their yield and yield attributes. Among them 6 entries were of medium height type, having less than 80 cm plant height. Higher umbels per plant was recorded in 11 entries. 7 entries recorded > 7.4 umbellate per umbel. Four entries were found to be early type. 11 entries found high yielding (>16 g/plant).

Out of 368 accessions evaluated at Jobner, 13 accessions were better than best check variety RCr-684 (104.5 g) on the basis of seed yield per 5 plants. Promising accessions identified on the basis of seed yield per plant were UD-258 (158 g), UD-481 (137 g), UD-448 (135 g), UD-587 (126 g), UD-717 (125 g), UD-



324 (122 g), UD-480 (119 g), UD-280 (114 g), UD-449 (111 g), UD-484 (109 g), UD-705 (108 g), UD-20-130-278 (106 g) and UD-467 (105 g).

Screening of coriander germplasm against powdery mildew

At Coimbatore 275 coriander germplasm entries screened for the incidence of powdery mildew and the incidence was noticed in all the accessions. The PDI ranged from 12.50 PDI to 83.33 PDI. The accessions viz., CS 46, 58,105, 221 and 228 recorded the least disease intensity of 12.50 PDI with the highest yield range of 4.40 q ha⁻¹ to 6.60 q ha⁻¹. The highest intensity of powdery mildew was recorded in CS 67, 246 and 256 (83.33 PDI) with the yield range of 4.00 to 5.00 q ha⁻¹.

Out of 40 (39+1) entries screened under natural condition at Jagudan none of the entry was found free from powdery mildew incidence. Minimum incidence was noticed in JCr 342 (28.00 %) and the maximum disease intensity was recorded in the entry Lam-6 (65.75 %). The per cent disease intensity was ranged between 28.00 to 65.75 per cent.

COR/CI/1.2 Multilocation evaluation of germplasm in coriander

(Centres: Central plateau and hills region - Ajmer; Southern plateau and hills region -

Coimbatore; East coast plains and hill region – Guntur; Trans Gangetic Plain Region - Hisar)

At Ajmer trial was laid out with 60 genotypes and 5 checks. NDCor-14 recorded the highest seed yield of 9.33 g plant⁻¹ followed by JCr-389 (9.28 g plant⁻¹).

A trial on multi-location evaluation of coriander genotypes was laid out with 70 genotypes from seven centres (ten each) and two checks at Coimbatore centre. Plant height of genotypes varied from 29.57 to 69.33 cm. Maximum number of umbels per plant was recorded in GL 26P (24.10) which was on par with GL 20P and lowest was recorded in the genotype DH 252 (7.00) which was on par with DH 5, JCr 380 and ND 31. Highest number of seeds per plant was recorded in the genotype RD 391 (36.30) and the lowest was recorded in the genotype DH 36 (12.30). The seed yield varied from 3.25 to 6.56 q ha⁻¹ and the maximum seed yield was recorded in the genotype LCC 168 (6.56 q ha⁻¹) which was on par with DH 246, LCC 144, CS 66, ND 80 and ND 82 and better than the check variety CO 3 (5.74 q ha⁻¹).

Sixty germplasm lines from six centres along with seven checks were evaluated at Guntur centre. Among the entries evaluated, RD-387 (6.37 g plant⁻¹), NDC-14 (6.09 g plant⁻¹), NDC-31 (5.86 g plant⁻¹), LCC-144 (5.66 g plant⁻¹).

Table 13: Coriander germplasm collections at various AICRPS centres

Centre	Indigenous			Total
	Cultivated		Wild and related species	
	Existing	Addition (2014 -15)	Existing	
Coimbatore	275	-	-	275
Dholi	145	4	-	149
Guntur	310	-	-	310
Hisar	289	4	-	293
Jagudan	95	-	21 (Exotic)	116
Jobner	230	-	-	230
Kumarganj	170	-	-	170
Pantnagar	85	-	-	85
Total	1599	8	21	1628



¹), LCC-170 (5.66 g plant⁻¹) and DH-240 (5.49 g plant⁻¹) were found significantly superior in yield over the check AD-1 (4.50 g plant⁻¹).

Crop Improvement

COR/CI/2 Coordinated Varietal Trial

COR/CI/2.5 Coordinated Varietal Trial on coriander 2012-Series IX

(Centres: Central plateau and hills region - Ajmer, Jabalpur, Jobner; Southern plateau and hills region - Coimbatore; Middle Gangetic Plain Region - Dholi, Kumarganj; East coast plains and hill region - Guntur; Trans Gangetic Plain Region - Hisar; Gujarat plains and hills region - Jagudan, Navsari; Western Himalayan Region - Pantnagar; Western dry region - Kota)

Coordinated varietal trial of coriander was laid with 21 test entries and three checks in RBD at Ajmer. The best check was ACr-1 with 14.57 q ha⁻¹ seed yield followed by Hisar Anand (13.64 q ha⁻¹). The test entry Ajmer Coriander 2 (ACor-2) gave the highest seed yield (19.55 q ha⁻¹) followed by A Cor-3 (18.71 q ha⁻¹) and RD 385 (18.19 q ha⁻¹).

The experiment was conducted in Rabi 2014-15 with three replications at Jabalpur. Minimum days to 1st flowering was observed in RD 377 (47.33 days) and maximum in PD 11 (71 days). Maximum plant height (123.667 cm) was noted in JCr 404, and minimum was in PD 51 (46.30 cm). Maximum yield per hectare was recorded by LCC 219 (4.143 q ha⁻¹). Yield loss was due to winter rain at the time of maturity in Coriander.

Mean performance of the entries evaluated at Jobner in CVT of coriander over 2012-13 to 2014-15 revealed superior performance of JCr - 379 yielding 23.47 q ha⁻¹ followed by DH 306 (22.45 q ha⁻¹), RD 385 (21.97 q ha⁻¹), RD 377 (21.44 q ha⁻¹), ND Cor 10 (21.07 q ha⁻¹) and A Cor 2 (20.39 q ha⁻¹), while

lowest seed yield of 10.46 q ha⁻¹ was recorded in PD 7. Among the entries UD-794, DH-277 and JCr-379 found moderately resistant to powdery mildew.

The CVT trial was laid out with twenty genotypes including two national checks and one local check at Coimbatore centre. Highest number of umbels per plant was recorded by the genotype PD 11 (47.28) followed by RKD 39 (44.40) which were higher than check varieties CO (CR)-4 (26.96), RCr 728 (23.45) and ACr 1 (27.84). The seed yield per hectare differed significantly among the 20 genotypes tested, which ranged from 2.33 q ha⁻¹ (PD 7) to 5.73 q ha⁻¹ (LCC 219) with a mean of 3.39 q ha⁻¹. The genotype LCC 219 has recorded significantly higher yield when compared with Co (CR)-4 (3.79 q ha⁻¹) as local check and RCr-728 (3.98 q ha⁻¹) and ACr-1 (3.78 q ha⁻¹) as national checks.

After three year experimentation (2012-13 to 2014-15) at Dholi, among twenty one promising entries and three check varieties, three entries namely, RD 385, RD 377 and PD 7 were produced significantly higher yield (17.63, 16.90 and 16.42 q ha⁻¹ respectively) as compared to best check Rajendra Swati (10.33 q ha⁻¹) and other entries. Among best three entries, RD 385 recorded more yield (17.63 q ha⁻¹) and was at par with RD 377 and PD 7 (16.90 and 16.42 q ha⁻¹ respectively).

At Kumarganj maximum yield was recorded in A Cor 2 (15.23 q ha⁻¹) followed by PD 21 (14.40 q ha⁻¹) and ND Cor-1 (13.51 q ha⁻¹). Pooled analysis data from 2012-2015 resulted that ND Cor 10 (15.27 q ha⁻¹) followed by PD 21 (14.49 q ha⁻¹) recorded maximum yield. Stem gall severity has been recorded on the basis of gall formed per plant. The average number of galls were minimum in UD 794 (38.9 galls plant⁻¹) followed by DH 306 (39.6 galls plant⁻¹), LCC 242 (41.2 galls plant⁻¹) and ND Cor 28 (46.8 galls plant⁻¹).



Among the twenty one entries tested at Guntur, LCC 219 (13.52 q ha⁻¹) and LCC 224 (13.42 q ha⁻¹) recorded significantly higher yields than all other entries including best check AD-1 (10.79 q ha⁻¹). The pooled analysis indicated that among the ten entries tested, LCC 219 recorded highest yield of 12.95 q ha⁻¹ followed by LCC 224 (12.70 q ha⁻¹) and LCC 242 (11.40 q ha⁻¹) which were significantly superior to the best check AD-1 (10.58 q ha⁻¹).

At Hisar significant differences were obtained for all the parameters. Plant height ranged from 90.8 to 144.8 cm, number of branches 6.2 to 9.6, umbels per plant 32.8 to 82.6 and seeds per umbel 28.4 to 49.4. Maximum seed yield (22.96 q ha⁻¹) was recorded in ND Cor 10 followed by ND Cor 28 (22.32 q ha⁻¹) and DH-277 (18.99 q ha⁻¹).

In CVT at Jagudan, 3 years pooled data indicated that the yield differences among entries were significant. The entries JCr 404 (17.40 q ha⁻¹), JCr 379 (17.03 q ha⁻¹) and LCC 242 (16.93 q ha⁻¹) gave higher yield than best check GCr-2, which were 11.45, 9.10 and 8.43 per cent higher over check GCr-2 and 26.25, 23.58, 22.84 percent higher over national check Hisar Anand, respectively

Out of twenty three entries including check evaluated at Navsari, LCC 224 found significantly early flowering type (51.67 days) and also it has recorded more number of grains per umbel (39.93), seeds per plant (402.47) and yield (11.66 q ha⁻¹). LCC 219 was found promising for number of umbels per plant (18.93), number of grains per umbel (55.20), number of umbellate per umbel (6.87), seeds per plant (405.47) and yield was 11.04 q ha⁻¹.

Significant differences were obtained for all the parameters at Pantnagar. Maximum seed yield of 34.25 q ha⁻¹ was recorded in PD-21 followed by A Cor-2 and A Cor-3 (32.40 q ha⁻¹). 3 years pooled data showed that maximum seed yield (29.24 q ha⁻¹) was recorded in PD-21 and followed by PD-11 (19.24 q ha⁻¹).

During 2014-15 at Kota, RD 385 was found to be the best performing entry in terms of seed yield, yielding 15.10 q ha⁻¹ followed by DH 306 (14.93 q ha⁻¹) and DH 277 (14.76 q ha⁻¹). PD 51 was the lowest yielder with very poor seed setting. RKD 21 was the earliest in days to 50 % flowering (68 days) as well as maturity (103 days). PD 51 was the late flowering (118 days) and maturing type (138 days). RD 377 recorded the highest test weight of 19.34 g followed by JCr 379 (18.89 g) while PD 51 recorded the lowest test weight of 3.10 g.

COR/CI/3 Varietal Evaluation Trial

COR/CI/3.6 Initial Evaluation Trial 2012

(Centres: East coast plains and hill region - Guntur; Gujarat plains and hills region - Jagudan; Middle Gangetic Plain Region - Kumarganj)

Among the ten entries tested at Guntur, LCC-268 recorded highest yield (1360.7 kg ha⁻¹) followed by LCC-275 (1318.5 kg ha⁻¹) and LCC-276 (1312.5 kg ha⁻¹) which were significantly superior to the best check Suguna (1113.1 kg ha⁻¹). The pooled analysis indicated that among the ten entries tested, LCC-268 recorded highest yield (1293.9 kg ha⁻¹) followed by LCC-275 (1252.6 kg ha⁻¹) and LCC-276 (1243.9 kg ha⁻¹) which were significantly superior to the best check Suguna (1080.7 kg ha⁻¹).



Fig. 24: Field view of Initial Evaluation Trial of Coriander at Jobner



Table 14: Pooled analysis data of coriander yield in Initial Evaluation Trial 2012

Genotype	Guntur (kg ha ⁻¹)	Genotype	Jagudan (kg ha ⁻¹)	Genotype	Kumarganj (q ha ⁻¹)
LCC-246	957.7	JCr-377	1962	NDcor-86	15.07
LCC-256	1088.8	JCr-384	2131	NDcor-87	14.29
LCC-262	1086.9	JCr-387	1997	NDcor-88	13.08
LCC-268	1293.9	JCr-388	2029	NDcor-89	12.89
LCC-272	1100.2	JCr-389	2207	NDcor-92	13.18
LCC-275	1252.6	JCr-392	1917	NDcor-95	12.89
LCC-276	1243.9	JCr-395	1893	NDcor-96	11.27
Suguna (C)	1080.7	JCr-399	1803	NDcor-97	11.25
AD-1 (C)	974.1	JCr-401	2255	NDcor-100	14.57
Sudha (C)	973.6	GCr-2 (C)	2002	NDcor-101	14.18
				Hisar Anand (C)	11.89
CD (0.05)	77.3	CD (0.05)	168	CD (0.05)	1.52
CV	7.4	CV	7.28	CV	6.79

In IET at Jagudan, the pooled data of 3 years indicated that the yield differences among entries were significant. The entries JCr-389 (1660 kg ha⁻¹), JCr-401 (1644 kg ha⁻¹) and JCr-384 (1605 kg ha⁻¹) gave significantly higher seed yield over the check GCr-2, which were 13.25, 12.15 and 9.46 per cent higher than GCr-2, respectively.

Highest yield was obtained in NDCor-86 (15.83 q ha⁻¹) followed by NDCor-100 (14.58 q ha⁻¹) and NDCor-87 (14.51 q ha⁻¹) at Kumarganj. Pooled analysis data from 2012-2015 resulted that the maximum yield was recorded in NDCor-86 (15.07 q ha⁻¹) followed by NDCor-100 (14.56 q ha⁻¹) and NDCor-87 (14.29 q ha⁻¹). ND Cor-97 (15.0%), NDCor-96 (17.1%), NDCor-87 (17.5%) and NDCor-101 (18.9%) were found moderately resistant to stem gall.

COR/CI/3.7 Initial Evaluation in coriander

(Centre: Middle Gangetic Plain Region - Dholi)

Among eight promising entries and two check varieties evaluated at Dholi, RD-17 was

found significantly superior regarding number of primary branches per plant (11.55) and yield (22.77 q ha⁻¹) as compared to best check variety Hisar Anand (19.00 q ha⁻¹).

The initial evaluation trial (IET) in coriander was conducted with ten accessions along with Hisar Anand as check at Hisar during 2014-2015 in plots measuring 3.0 x 2.0 m. The results indicated that DH-208 and DH-312 gave significantly better yield over Hisar Anand (check) showing 20.7 and 19.9% increase in yield, respectively.

Crop Management

COR/CM/5 Nutrient management trial

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

(Centre: Central plateau and hills region - Jobner)

The genotypes UD 7, UD 563, UD 794, RCr 20, and RCr 436 were top yielders in normal conditions while RCr-20, UD 436, UD 706, UD



475 and UD 737 were top yielders in stress conditions. Based on stress indices UD 706 was found to be the desirable entry for drought conditions, followed by UD 13, UD 36, UD 475 and UD 109

Three years data indicated that the genotypes UD 563, UD 7, UD 794, UD 19 and UD 112 in normal while UD 112, RCr 436, RCr 20, RCr 684 and UD 475 were top yielders in stress conditions. Based on stress indices UD 706 was found to be the desirable entry for drought conditions, followed by UD 475, UD 22, UD 565 and UD 11.

COR/CM/5.8 Evaluation of PGPR bioformulation on coriander

(Centres: Central plateau and hills region - Ajmer; Southern plateau and hills region - Coimbatore; East coast plains and hill region - Guntur; Trans Gangetic Plain Region - Hisar; Gujarat plains and hills region - Jagudan; Eastern plateau and hills region - Raigarh)

Pooled analysis of 3 year data was done at Coimbatore and it revealed that plant height ranged from 39.90 cm to 42.59 cm. The highest plant height was registered by the treatment FL 18 seed treatment. The highest number of primary branches was registered by control. The highest number of secondary branches (9.04) was recorded by FK 14 seed treatment which was on par with the FL 18 seed treatment (9.00).

Number of umbels per plant (5.59) was higher in control. The seed yield per plot varied from 348.89 g in local variety to 496.66 g in FK 14 seed treatment.

Pseudomonas putida FK14 and *Macrobacterium paraoxydans* FL18 strains found not only in improving the yield but also in management of wilt in Coriander at Guntur.

Pooled result of 3 years shows that maximum seed yield of 9.1 and 9.5 q ha⁻¹ and maximum plant height (63.00 and 65.70 cm) were found when seeds were treated with *Rhizobacteria* FK 14 and FL 18 respectively. Both the treatments are statistically at par.

Crop Protection

COR/CP/6 Disease Management Trial

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

(Centre: Middle Gangetic Plain Region - Dholi)

Out of 149 germplasm tested at Dholi, 37 germplasm found highly resistant against stem gall disease under natural conditions. Coriander field surveyed under Sheohar districts were found to be infested with stem gall disease caused by *Protomyces macrospores*.



VIII. CUMIN

Genetic Resources

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

(Centres: Gujarat plains and hills region – Jagudan, Sanand; Central plateau and hills region – Jobner, Mandor)

Germplasm of cumin conserved at Jagudan, Jobner and Sanand (Table 15)

During the experimentation period, there was unseasonal rain after seed setting and maturing stage of the crop. Due to this whole crop became black and failed. The experiment considered as vitiated at Jagudan.

A wide range of variability was found for all the characters studied at Jobner. Out of 195 accessions, 21 accessions were better than best check variety RZ-341 (12.8 g) on the basis of seed yield per 5 plants. Promising accessions identified on the basis of seed yield per plant were JC-96-41 (19.5 g), JC-96-59 (17.5 g), Wt-12 (16.5 g), JC-96-30 (16.0 g), JC-96-60 (14.5 g), JC-96-1 (14.5 g), JC-95-24 (14 g), JC-95-32 (14 g), Wt-5 (14 g) and JC-95-104 (14 g).

At Sanand, 50 genotypes along with four checks, GC-2, GC-3, Gc-4 and RZ 209 were evaluated for agronomic, yield and yield attributing traits. Genotypes JC-95-55 (48.4 cm), JC-95-01 (46.8 cm) and JC-9-102 (46.8 cm) were found to be tall genotypes. JC-94-262, JC-95-100 and JC-94-276 were early in maturity 98, 99 and 100 days respectively. More number of

branches/plant was recorded in JC-95-24 (13.0), JC-95-75 (8.4) and JC-95-37(8.4). More number of umbels/plant was recorded in JC-95-75 (249.0), JC-95-34 (230.8) and JC-95-11(217.8). Maximum number of seeds/umbellet was recorded in JC-95-102 (8.4), JC-95-29 (8.4) and JC-95-100(8.0). The higher per plant yield was realized from JC-95-107(44.0 g). JC-95-75 (27.0 g) and JC-95-11 (22.8 g).



Fig. 25: Field view of GC-4 variety of cumin in vegetative stage at Sanand

Screening for resistance against *Alternaria* blight disease

Fifty three (51+2) entries of cumin were screened for the resistance against blight disease at Jagudan. Unseasonal rain at maturity stage resulted in failure of the crop. Minimum disease intensity was noticed in GC-4 (75.12 %) followed by Jc-99-12 (90.00 %). Disease incidence ranged from 75.12 to 100.00 per cent.

Screening for resistance against powdery mildew disease

Due to unseasonal rain there was total crop failure due to high intensity of blight at

Table 15: Cumin germplasm collections at various AICRPS centres

Centre	Indigenous	Exotic	Total
Jagudan	65	7	72
Jobner	70	6	76
Sanand	50	-	50
Total	135	13	198



Jagudan. So powdery mildew intensity was not considered.

Screening for resistance against wilt disease

At Jagudan 38 (35+3) entries of cumin were screened for the resistance against wilt disease under wilt sick plot condition. Overall wilt incidence was very high. Minimum disease intensity was noticed in GC-4 (41.75 %) and it was followed by GC-3 (48.50 %). Disease incidence ranged from 41.75 to 100.00 per cent.



Fig. 26: Field view of cumin experimentation at Mandor

CUM/CI/1.2 Multilocation evaluation of cumin germplasm

(Centre: Central plateau and hills region - Ajmer)

In an MLT at Ajmer 20 entries were tested along with 2 check varieties. Among the tested entries and check varieties days to 50% flowering ranged from 67 days (JC-95-110) to 78 days (GC-4) and minimum days to 50% flowering was taken by JC-95-110 (67 days). Whereas in case of seed yield per plant maximum seed yield per plant observed was 3.30 g plant⁻¹ by GC-4 (check). Low incidence of fusarium wilt

was noticed in 10 entries (ACU-1-2010, ACU-2-2007, ACU-3-2004, ACU-4-2001, ACU-5-2010, ACU-6-2010, ACU-7-2010, ACU-8-2010, ACU-9-2010, ACU-10-2010) and also in check variety GC-4 whereas alternaria blight incidence was high in all the entries.

Crop Improvement

CUM/CI/2 Coordinated Varietal Trial

CUM/CI/2.4 Coordinated Varietal Trial - 2013

(Centres: Central plateau and hills region - Ajmer; Gujarat plains and hills region - Jagudan; Central plateau and hills region - Jobner)

This trial is started in the year 2013-14 and is in the 2nd year of progress.

Coordinated varietal trial of cumin was laid out with 6 test entries and two checks in RBD at Ajmer. Among the entries and check varieties tested GC 4 (national check) recorded the highest yield of 671.30 kg ha⁻¹ followed by CUM-25 (623.03 kg ha⁻¹) which were on par with each other.

At Jagudan during the experimentation due to unseasonal rain, it has affected the crop and whole crop failed.

At Jobner in Rabi 2014-15, ten entries were evaluated in RBD with 3 replications in a plot size of 3 x 2.4 sq. m. The seed yield ranged from 343.40 to 637.15 kg ha⁻¹. Of the ten entries evaluated, CUM-23 recorded maximum seed yield of 637.15 kg ha⁻¹ followed by RZ-345 check (633.33 kg ha⁻¹), CUM-24 (626.04 kg ha⁻¹) and CUM-25 (600.00 kg ha⁻¹), while lowest seed yield of 343.40 kg ha⁻¹ was recorded in CUM-22. In terms of disease incidence national check GC-4 was found to be resistant to wilt disease and among the entries all the entries were susceptible to wilt and blight disease.



Table 16: Performance of cumin entries in coordinated varietal trial 2013

Entries	Seed yield (kg ha ⁻¹)	
	Ajmer	Jobner
CUM-20	446.60	509.03
CUM-21	508.89	537.85
CUM-22	520.89	343.40
CUM-23	542.95	637.15
CUM-24	599.25	626.04
CUM-25	623.03	600.00
GC-4 (National check)	476.25	522.92
Local check	671.30 (RZ 209)	508.68 (RZ-19)
Local check		572.57 (RZ-223)
Local check		633.33 (RZ-345)
Mean	548.64	549.10
CD (0.05)	72.52	88.40
CV (%)	13.07	11.09

CUM/CI/3 Varietal Evaluation Trial

CUM/CI/3.4 IET on Cumin 2012

(Centre: Central plateau and hills region - Jobner)

This trial started in the year 2013-14 and is in the 2nd year of progress. Seed yield ranged from 197.22 to 432.99 kg ha⁻¹. Of the ten entries evaluated, UC-260 recorded maximum seed yield of 432.99 kg ha⁻¹ followed by UC-238 (359.72 kg ha⁻¹), UC-242 (352.43 kg ha⁻¹) and UC-265 (322.92 kg ha⁻¹), while lowest seed yield of 197.22 kg ha⁻¹ was recorded in local check. Entries were tested against wilt and blight disease and none of entries was found resistant against wilt disease. Entries UC-234, UC-238, UC-265, RZ-19 and local were observed moderately resistant against blight disease.

Crop management

CUM/CM/5 Nutrient Management Trial

CUM/CM/5.1 Identification of drought tolerance

(Centre: Central plateau and hills region - Jobner)

At Jobner 30 genotypes were screened for drought tolerance, among the genotypes screened UC 238, UC 339, UC 293, RZ 223 and RZ 209 in normal conditions while UC 250, UC 245, UC 247, UC 257 and UC 249 in stress conditions were top yielders. Based on stress indices UC 250 was found to be the desirable entry for drought conditions, followed by UC 247, UC 249, UC 234, UC 238 and UC 257.

Crop Protection

CUM/CP/6 Disease Management Trial

CUM/CP/6.5 Management of blight and powdery mildew by spacing and potash application

(Centre: Gujarat plains and hills region - Jagudan)

During the experimentation period, there was unseasonal rain after seed setting and maturing stage of crop. So whole crop turned black and there was crop failure. The experiment considered as vitiated.



IX. FENNEL

Genetic Resources

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

(Centres: Middle Gangetic Plain Region - Dholi, Kumarganj; Trans Gangetic Plain Region - Hisar; Gujarat plains and hills region - Jagudan; Central plateau and hills region - Jobner)

Table 17 shows the germplasm collection and maintained at various AICRPS centres

Out of sixty one accessions evaluated at Dholi, only 16 accessions namely, RF-59, RF-58, RF-33, RF-38, RF-68, RF-29, RF-65, RF-19, RF-31, JP-494, JF-303, HF-116, RF-27, NDF-6, JF-376 and RF-5 gave the highest yield ranging from 80.00 to 115.92 g per plant as compared to the best check variety GF-11(78.50g per plant). Among sixteen promising accessions, RF-59 produced the highest seed yield of 115.92 g per plant followed by RF-58 (107.18 g per plant).

At Kumarganj, 140 germplasm accessions of fennel were evaluated and among them NDF-46 (12.65 q ha⁻¹) was found to be promising followed by NDF-5 (12.50 q ha⁻¹) and NDF-84 (12.30 q ha⁻¹) in comparison to GF-2 and

RF-101. Incidence of powdery mildew was observed in the month of April and May. Maximum incidence was found in HF-121 (86.6%) and HF-123 (80.0%) whereas minimum incidence was observed in RF-101, RF-117 and RF-110.

During the *kharif* season, 136 indigenous and 2 exotic entries of fennel were evaluated for different yield attributes with two checks *i.e.* GF-2 and GF-12, at Jagudan. Among them eight entries observed dwarf type, having < 150 cm plant height. Seven entries had good branches *i.e.* > 17 branches per plant. 10 entries recorded > 60 umbels per plant. Twelve entries were promising for more seeds per umbellate *i.e.* > 43 seed per umbellate. Seven entries observed early maturing (< 207 days). Thirteen entries isolated as high yielders which recorded >192 g plant⁻¹ grain yield.

A wide range of variability was found for all the characters studied at Jobner. Out of 254 accessions, 36 accessions were better than best check variety RF-178 (107.72 g) on the basis of seed yield per 5 plants. Promising accessions identified on the basis of seed yield per plant were UF-175 (242.50 g), UF-193 (205.52 g), UF-58 (180 g), UF-230 (165.82 g), UF-198 (159.26 g), UF-200 (156.44 g), UF-194 (154.65 g), UF-154 (149.84 g) and UF-185 (143.26 g).

Table 17: Germplasm collection of fennel in various AICRPS centres

Centre	Indigenous		Total
	Cultivated		
	Existing	Addition (2014 -15)	
Dholi	57	4	61
Guntur	2	-	2
Hisar	154	6	160
Jagudan	128	-	128
Jobner	137	-	137
Kumarganj	140	-	140
Pantnagar	21	-	21
Total	639	10	649



Screening for resistance against *Ramularia* blight disease (Caused by: *Ramularia foeniculi*)

During *kharif* season, total 31 entries of fennel were screened under natural conditions at Jagudan for incidence of *Ramularia* blight disease. None of the entry was found free from the *Ramularia* blight. Minimum intensity of disease was noticed in JF-672 (31.19 %) and it was followed by JF-675 (33.54 %), JF-671-1 (34.68 %), JF-675-1 (35.58 %) and JF-671-3 (38.21%). The per cent disease intensity ranged from 31.19 to 72.26 %.

During *rabi* season, total sixty two (60 +2) entries of fennel were screened under natural conditions at Jagudan. None of the entries were found free from the *Ramularia* blight intensity. The minimum intensity of *Ramularia* blight was noticed in JF-672 (29.25 %) and it was followed by JF-671-2 (35.12 %), JF-671-3 (35.18 %), JF-675 (35.18 %) and JF-675-1 (35.20 %). The per cent disease intensity was ranged between 29.25 and 69.24 per cent

FNL/CI/1.2 Multilocation evaluation of fennel germplasm

(Centres: Central plateau and hills region - Ajmer, Jobner; Middle Gangetic Plain Region - Kumarganj)

At Ajmer among the accessions tested AF-1 registered the highest yield of 486 g plant⁻¹ followed by RF-125 (386 g plant⁻¹).

At Jobner out of 52 accessions, only 4 accessions were found better than best check variety NC-1 (83.13 g). Some of the promising accessions identified on the basis of yield per 5 plants were GKKB-170 (105.00 g), RF-38 (101.53 g), HF-136 (98.05 g), SKCU-09-20 (94.16 g), RF-63 (82.56 g), RF-57 (78.71 g), RF-62 (75.99 g), GK/RM/AK-27 (75.15 g) and NDF-44 (74.71 g) and HF-133 (74.09 g).

In an MLT at Kumarganj maximum yield was recorded in JF-625 (12.30 q ha⁻¹) followed by

RF-15 (12.10 q ha⁻¹) and NDF-37 (11.70 q ha⁻¹). Pooled data of 3 years showed that maximum seed yield was observed in JF-625 (12.73 q ha⁻¹) followed by RF-15 (12.67 q ha⁻¹) and RF-38 (12.43 q ha⁻¹). Powdery mildew infestation was recorded highest in HF-141 (80.0 %) and lowest in HF-132 (10.0 %). Whereas GK/RM/AK-24 and HF-138 were found resistant against powdery mildew.

Crop Improvement

FNL/CI/2 Coordinated Varietal Trial

FNL/CI/2.5 Coordinated Varietal Trial on Fennel 2012 Series VIII

(Centres: Central plateau and hills region - Ajmer, Jabalpur, Jobner; Middle Gangetic Plain Region-Dholi, Kumarganj; Trans Gangetic Plain Region-Hisar; Gujarat plains and hills region - Jagudan; Western Himalayan Region - Pantnagar)



Fig. 27: Field view of coordinated varietal trial of fennel at Jobner

At Ajmer all the tested entries showed significant differences with respect to growth and yield characters. With respect to plant height NDF 45 and NDF 46 recorded the highest plant height of 190 and 185 cm respectively. More number of umbels per plant was recorded in HF 119 and AF-05-1-3 (71.13 and 68.67 respectively). Whereas test weight was



maximum in JF-671-1 and JF-674-1 (6.5 and 6.22 g respectively). AF 05-1-3 recorded the highest yield of 17.52 q ha⁻¹ followed by AF 1 (check) i. e., 16.54 q ha⁻¹.

Twelve genotypes of fennel were tested at Jabalpur. Among the genotypes AJ Fnl 2 (85.76 days) exhibited early flowering. Maximum number of branches (7.74), Number of umbel / plant (29.433) and yield (20.58 q ha⁻¹) was recorded in RF 205.

The analysis of variance revealed significant differences among the entries for all the traits including seed yield at Jobner. Seed yield ranged from 17.07 to 23.74 q ha⁻¹. Of the fourteen entries evaluated, entry HF 119 recorded maximum seed yield of 23.74 q ha⁻¹ followed by UF 278 (23.59 q ha⁻¹), UF 157 (23.57 q ha⁻¹), AF 05-1-3 (22.79 q ha⁻¹), JF-674-1 (22.31 q ha⁻¹), RF-143 S/check (21.07 q ha⁻¹) and JF-671-1 (20.85 q ha⁻¹), while lowest seed yield of 17.07 q ha⁻¹ was recorded in NDF 45. Mean performance of the entries evaluated in CVT of fennel over 2012-13 to 2014-15 revealed superior performance of UF 157 yielding 24.05 q ha⁻¹ followed by AjFnl 2 (23.73 q ha⁻¹), AF 05-1-3 (22.17 q ha⁻¹), UF 278 (21.96 q ha⁻¹) and RF-281 check (21.76 q ha⁻¹), while lowest seed yield of 16.49 q ha⁻¹ was recorded in NDF 46.

After three years experimentation (2012-13 to 2014-15) at Dholi, among ten entries and three check varieties, all entries were found non-significant regarding yield and yield parameters as compared to best check variety Rajendra Saurabh.

Out of 13 entries evaluated at Kumarganj, maximum yield was recorded in AJFnl - 2 (12.36 q ha⁻¹) followed by NDF-45 (12.08 q ha⁻¹) and NDF-46 (11.94 q ha⁻¹). Three years pooled data showed that maximum seed yield was recorded in AJFnl - 2 (12.87 q ha⁻¹) followed by AF 05-1-3 (12.28 q ha⁻¹) and NDF-46 (12.21 q ha⁻¹). Lowest powdery mildew severity was found in AJFnl-2 (20.0 %).

At Hisar plant height ranged from 128.4 to 182.6 cm, number of branches 8.7 to 10.2, umbels per plant 32.4 to 46.4, umbellate per umbel 26.7 to 44.6 and seeds per umbel 398.6 to 682.9. Maximum seed yield recorded was 22.86 q ha⁻¹ in NDF 46 followed by NDF 45 (21.95 q ha⁻¹) and AF-05-1-3 (18.68 q ha⁻¹).

In CVT at Jagudan, the pooled over three year data indicate that the entries JF -674-1 (14.26 q ha⁻¹) and JF-671-1 (13.96 q ha⁻¹) recorded higher seed yield over GF-12, which were 13.78 and 11.41 percent higher than best check GF-12.

Significant differences were observed for all the characters except umbellate per umbel at Pantnagar. Highest yield (26.62 q ha⁻¹) was recorded in JF-671-1 followed by HF 119 (25.13 q ha⁻¹). On the basis of three year data maximum seed yield (27.70 q ha⁻¹) was recorded in HF-119 and followed by RF-205 national check (25.68 q ha⁻¹).

FNL/CI/3 Varietal Evaluation Trial

FNL/CI/3.3 Initial Evaluation Trial 2014

(Centre: Central plateau and hills region - Jobner; Western Himalayan Region - Pantnagar; Trans Gangetic Plain Region - Hisar)

The trial is in the 1st year of progress. In *rabi* 2014-15, ten entries were evaluated at Jobner. The analysis of variance revealed significant differences among the entries for all the traits including seed yield. Seed yield ranged from 15.81 to 23.96 q ha⁻¹. Of the ten entries evaluated, entry UF-286 recorded maximum seed yield of 23.96 q ha⁻¹ followed by UF-287 (22.61 q ha⁻¹), UF-288 (22.35 q ha⁻¹), RF-205 check (21.48 q ha⁻¹), and UF-283 (20.64 q ha⁻¹), while lowest seed yield of 15.81 q ha⁻¹ was recorded in UF-281.

Among the 10 entries tested at Pantnagar maximum seed yield (25.12 q ha⁻¹) was recorded



in PF-5, followed by PF-7 (24.16 q ha⁻¹).

At Hisar 10 entries were tested and the results indicated maximum seed yield (21.65 q ha⁻¹) was recorded in HF-179 followed by HF-146 (19.72 q ha⁻¹) showing an increase of 21.6 and 19.7 % over HF-33 (check), respectively.

FNL/CI/3.4 Initial Evaluation Trial 2012

(Centre: Middle Gangetic Plain Region - Dholi, Kumarganj; Gujarat plains and hills region - Jagudan)

Among 9 entries and 2 checks evaluated at Dholi, 4 entries namely, RF-15, RF-68, RF-16 and RF-62 produced significantly higher yield (20.12, 18.85, 16.82 and 16.81 q ha⁻¹ respectively) as compared to best check variety GF-11 (14.60 q ha⁻¹). Among four high yielding entries, RF-15 gave the highest number of primary branches per plant (13.33), number of umbellets per umbel (83.68), number of grains per umbellet (42.22) and yield (20.12 q ha⁻¹) followed by RF-68 i.e., number of primary

branches per plant (12.89), number of umbels per plant (72.16), number of umbellets per umbel (41.78), number of grains per umbellet (42.44) and yield (18.85 q ha⁻¹).

At Kumarganj maximum yield was recorded in NDF-51 (13.54 q ha⁻¹) followed by NDF-67 (13.54 q ha⁻¹) and NDF-52 (12.70 q ha⁻¹). Pooled data of 3 years showed that maximum seed yield was registered by NDF-51 (13.69 q ha⁻¹) followed by NDF-67 (13.05 q ha⁻¹) and NDF-52 (12.75 q ha⁻¹). Powdery mildew of fennel was appeared in 2nd week of April. The severity was found minimum (2.5 %) in NDF-51 and NDF-63 (5.0%). The maximum severity was observed in NDF-69 (75%) followed by NDF-73 (63.3%) and NDF-66 (62.5%).

In IET at Jagudan, the pooled over three year data indicated that the entries JF-576 (14.36 q ha⁻¹) and JF-2012-9 (14.01 q ha⁻¹) gave significantly higher seed yield over GF-12, which were 14.95 and 12.20 percent higher than best check GF-12.

Table 18: Performance of Fennel entries in IET at Kumarganj (3 years pooled data)

Sl. No	Genotype	Yield (q ha ⁻¹)			Mean yield (q ha ⁻¹)
		2012-13	2013-14	2014-15	
1	NDF-51	13.74	14.01	13.33	13.69
2	NDF-52	12.8	13.08	12.36	12.75
3	NDF-53	12.56	12.7	12.08	12.45
4	NDF-59	12.15	12.28	11.73	12.05
5	NDF-63	12.25	12.63	11.87	12.25
6	NDF-66	12.49	12.42	11.94	12.28
7	NDF-67	13.12	13.19	12.84	13.05
8	NDF-69	12.39	12.56	11.73	12.23
9	NDF-70	12.87	12.91	12.22	12.67
10	NDF-73	12.7	12.8	11.87	12.46
11	RF-101(Ch)	11.04	11.11	10.2	10.78
SEm (±)		0.67			
CD (%)		0.19			
CV (%)		0.94			



Crop Management

FNL/CM/5 Nutrient Management Trial

FNL/CM/5.3 Micro irrigation management in fennel

(Centres: Central plateau and hills region - Jobner)

The results showed that drip irrigation at different IW/CPE ratios significantly increased growth parameters, yield attributes, yields, economics, water use efficiency, water saving and yield increase over surface irrigation at IW/CPE ratio 1.0 (control). The results further revealed that the drip irrigation at an IW/CPE ratio 0.8 with paired row planting, being at par with 0.8 IW/CPE ratio in normal row planting and drip irrigation at 1.0 IW/CPE ratio in normal and paired row planting, recorded significantly higher plant height (124.57 cm), number of branches/plant (6.32), umbels/plant (31.80), umbellets/umbel (23.51), seeds/umbel (453.9), test weight (5.71 g), seed yield (31.26 q ha⁻¹), straw yield (73.72 q ha⁻¹), net returns (Rs 200860/ha) and B:C ratio (6.98) over 0.4 and 0.6 IW/CPE ratios with normal and paired row planting. Similarly, drip irrigation at an IW/CPE ratio 0.6 with paired row planting, being at par with 0.6 IW/CPE ratio in normal row planting, also significantly increased the above parameters over 0.4 IW/CPE ratio with normal as well as paired row planting. The paired row planting at 0.4 IW/CPE ratio also significantly increased the all parameters over normal row planting at the same drip irrigation level. However, the drip irrigation at higher level of 1.0 IW/CPE ratio could not bring significant increase over irrigation at 0.8 IW/CPE ratio.

The results further indicated that water use efficiency and water saving progressively decreased with increasing levels of drip irrigation from IW/CPE ratio 0.4 to 1.0, however, per cent yield was increased progressively with increase in drip irrigation levels. Drip irrigation

at 0.8 IW/CPE ratio with paired row planting, remained comparable to drip irrigation at 1.0 IW/CPE ratio, recorded higher water use efficiency (6.96 kg/ha-mm), water saving (18.9 %) and yield increase (107.4 %) over surface irrigation at 1.0 IW/CPE ratio (control).

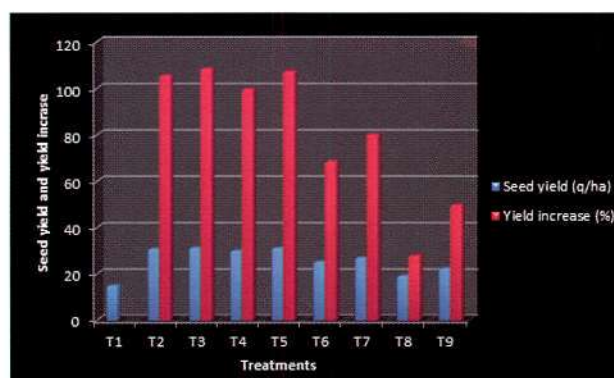


Fig. 28: Effect of different irrigation schedule on seed yield (q ha⁻¹) and yield increase (%) in fennel

- T1 - Surface irrigation IW/CPE 1.0 (Normal row)
- T2 - Drip IW/CPE 1.0 (Normal row)
- T3 - Drip IW/CPE 1.0 (Paired row)
- T4 - Drip IW/CPE 0.8 (Normal row)
- T5 - Drip IW/CPE 0.8 (Paired row)
- T6 - Drip IW/CPE 0.6 (Normal row)
- T7 - Drip IW/CPE 0.6 (Paired row)
- T8 - Drip IW/CPE 0.4 (Normal row)
- T9 - Drip IW/CPE 0.4 (Paired row)

FNL/CM/6.3 Evaluation of PGPR bioformulation in fennel

(Centres: Trans Gangetic Plain Region - Hisar; Gujarat plains and hills region - Jagudan; Eastern plateau and hills region - Raigarh; Central plateau and hills region - Ajmer)

At Raigarh pooled data of 3 years shows that maximum seed yield of 8.90 and 9.70 q ha⁻¹ and maximum plant height (154.96 and 160.16 cm) was registered when seeds were treated with *Rhizobacteria* FK 14 and FL 18 respectively. Both the treatments found statistically at par.



Crop Protection

FNL/CP/6 Pest Management Trial

FNL/CP/6.2 Field evaluation of different insecticides/botanicals against seed midge *Systole albipennis* Walker fennel

(Centre: Gujarat plains and hills region – Jagudan; Central plateau and hills region – Jobner)

At Jobner, minimum (14.90 %) seed midge infestation and maximum seed yield 24.53 q ha⁻¹ was recorded with spray of Acetamiprid 20 SP @ 0.004 % and was followed by Thiamethoxam 25 WG @ 0.0084 % which

resulted in 16.75 % seed midge infestation and 22.53 q ha⁻¹ seed yield. Control (No treatment) resulted maximum (24.08%) seed midge infestation and minimum 14.64 q ha⁻¹ seed yield. Pooled data of three years revealed that out of nine treatments minimum (14.45 %) seed midge infestation and maximum seed yield 22.50 q ha⁻¹ was recorded with spray of Acetamiprid 20 SP @ 0.004 % with highest B: C ratio 9.20 and it was at par with Thiamethoxam 25 WG @ 0.0084 % resulted 16.10 % seed midge infestation and 20.91 q ha⁻¹ seed yield and B: C ratio 8.28. Control resulted in maximum (25.72%) seed midge infestation and minimum 14.56 q ha⁻¹ seed yield with 5.80 B: C ratio



X. FENUGREEK

Genetic Resources

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

(Centres: Middle Gangetic Plain Region - Dholi, Kumarganj; East coast plains and hill region-Guntur; Trans Gangetic Plain Region-Hisar; Gujarat plains and hills region-Jagudan; Central plateau and hills region-Jobner)

Germplasm of fenugreek maintained at various AICRPS centres (Table 19)

Among 168 accessions of fenugreek evaluated at Dholi, only seventeen accessions namely RM-197, RM-16 (IC-590122), UM-361, RM-198, (IC-590126), RM-112, RM-205, RM-186, (IC-590108), RM-185 (IC-590104), RM-192 (IC-590124), RM-191 (IC-590098), RM-196 (IC-590105), HM-10, UM-66 and RM-144 (IC-590121) gave the highest yield ranging from 32.50 to 54.15 g per five plant as compared to best check variety Rajendra Kanti (30.00 g per five plant). Among best 17 accessions, RM-197 produced the highest yield of 54.15 g per five plants followed by RM-16 (IC-590122) i.e., 52.00 g per five plants.

At Guntur centre 124 germplasm lines along with four checks were evaluated in

Augmented Block Design. The first five promising entries for yield were LFC-18 (7.56 g plant⁻¹), LFC-19 (7.08 g plant⁻¹), LFC-123 (6.87 g plant⁻¹), LFC-78 (6.70 g plant⁻¹) and LFC-34 (6.44 g plant⁻¹) which were significantly superior to the check APHU Methi-1 (2.22 g plant⁻¹).

At Jagudan 75 entries including GM-2 as check were evaluated for different characters. Among them 10 entries were found tall types having > 72.0 cm plant height. 11 entries recorded > 6.7 branches per plant. 12 entries recorded > 30 pods per plant. More seeds per pod i.e. > 17.2 found in 10 entries. 11 entries were found early maturing (100 days), bold seeded having equal or more test weight i.e. > 12.60 and found promising for yield which recorded > 6.0 g plant⁻¹.

348 germplasm accessions were evaluated along with three checks namely RMt-1, RMt-361 and local at Jobner. A wide range of variability was found for all the characters studied. Out of 348 accessions, 26 accessions were better than best check variety RMt-143 (40.97 g). Some of the promising accessions identified on the basis of yield per 5 plants were UM-27 (71.00 g.), UM-378 (54.60 g.), UM-274 (52.31 g.), UM-220 (51.24 g.), UM-218 (51.20 g.), UM-161 (49.39 g.), UM-230 (48.62 g.), UM-223 (48.26 g.) and UM-229 (48.03 g).

Table 19: Germplasm collection of fenugreek in various AICRPS centres

Centre	Indigenous		Total
	Existing	Addition (2014 -15)	
Dholi	167	4	171
Guntur	124	-	124
Hisar	363	10	373
Jagudan	75	-	75
Jobner	348	-	348
Kumarganj	176	-	176
Pantnagar	65	-	65
Total	1318	14	1332



187 germplasm accessions were evaluated at Kumarganj centre and the entries found promising are NDM-19 (15.30 q ha⁻¹) and, NDM-18 (15.10 q ha⁻¹) in comparison to Hisar Sonali (11.40 q ha⁻¹). *Cercospora* leaf spot incidence was 30.0 to 86.3 % at the time of flowering and pod formation stage in all genotypes due to heavy rainfall in February and March.

FGK/CI/1.2 Multilocation evaluation of fenugreek germplasm

(Centres: Central plateau and hills region - Ajmer, Jobner; Trans Gangetic Plain Region - Hisar; Middle Gangetic Plain Region - Kumarganj)

Fifty genotypes with five checks were evaluated at Ajmer among the genotypes tested AM-298 recorded the highest seed yield per plant (7.95 g plant⁻¹) followed by AM-293 (7.4 g plant⁻¹).

Seventy (70) germplasm accessions from different parts of country were evaluated along with four checks namely NC-1, NC-2, RMt-1 and RMt-365 at Jobner. Out of 74 accessions, 14 accessions were found better than best check variety NC-2. Some of the promising accessions identified on the basis of yield per 5 plants were J.Fg.201, HM-278, J.Fg.219, NDM-72, AM-298, AM-297, HM-280, HM-282, J.Fg.266, AM-295, J.Fg.-15, NDM-61, J.Fg.250 and RM-194.

Forty accessions of fenugreek were evaluated under multilocation testing along with Hisar Sonali and Hisar Suvarna as checks at Hisar. The seed yield of the germplasm material ranged from 14.3 g plant⁻¹ (JFg-219) to 26.7 g plant⁻¹ (HM-281). The most promising lines for seed yield were HM-273, HM-278, HM-281, RM-30, RM-28, AM-295 and NDM-43.

At Kumarganj maximum yield has been recorded by NDM-95 (8.8 q ha⁻¹) followed by AM-293 (8.5 q ha⁻¹). Pooled data analysis (2012-15) showed that the genotype NDM-95 recorded highest seed yield (8.9 q ha⁻¹) followed by NDM-

108 (8.8 q ha⁻¹) and NDM-90 (8.7 q ha⁻¹). Minimum *Cercospora* leaf spot infection was observed in NDM-110 (20.0%) followed by PEB (25%), NDM-81 (30%) and AM-305 (35%) whereas as maximum intensity was observed in JEG-240, AM-273, JFG-13 and AM-301.

Crop Improvement

FGK/CI/2 Coordinated Varietal Trial

FGK/CI/2.3 Coordinated Varietal Trial 2012 Series VIII

(Centres: Central plateau and hills region - Ajmer, Jabalpur, Jobner; Southern plateau and hills region - Coimbatore; Middle Gangetic Plain Region - Dholi, Kumarganj; East coast plains and hill region - Guntur; Trans Gangetic Plain Region - Hisar; Gujarat plains and hills region - Jagudan, Navsari; Western Himalayan Region - Pantnagar; Eastern plateau and hills region - Raigarh; Western dry region - Kota)



Fig. 29: Field view of fenugreek CVT at Kota and Pantnagar



At Ajmer highest yield was recorded for AFG 5 (25.69 q ha⁻¹) followed by LFC 98 (22.01 q ha⁻¹). Among the checks the highest yielder was recorded by AFG-3 with 21.66 q ha⁻¹ seed yield.

At Jabalpur, early flowering among the genotypes was observed in the genotype NDM 69 (42.3 days) and also this genotype gave maximum pod length (11.1 cm) and number of branch (5.4) whereas maximum yield was obtained by UM 354 (27.20 q ha⁻¹).

The analysis of variance revealed significant differences among the entries for all the traits including seed yield at Jobner. The seed yield ranged from 20.00 to 30.18 q ha⁻¹. Of the eighteen entries evaluated, entry NDM 69 recorded maximum seed yield of 30.18 q ha⁻¹ followed by RMt-361 check (28.10 q ha⁻¹), Hisar Sonali Check (28.03 q ha⁻¹), UM 202 (26.62 q ha⁻¹) and JFg 266 (26.18 q ha⁻¹), while lowest yield of 20.00 q ha⁻¹ was recorded in Rm 188. Entries JFg 245, JFg 266 and AFG 6 were found to be moderately resistant against powdery mildew disease.

Fourteen fenugreek genotypes along with three checks were evaluated at Coimbatore. The genotype LFC 98 recorded the highest seed yield of 4.31 q ha⁻¹ as compared to Hisar Sonali and Rmt-362 (national check) which recorded the seed yield of 3.02 q ha⁻¹ and 3.12 q ha⁻¹ respectively.

Three years (2012-13 to 2014-15) pooled data from Dholi shows that among 14 entries and 3 check varieties, 3 entries namely – NDM 69, RM 194 and AFG 6 gave significantly higher yield (18.51, 17.77 and 17.64 q ha⁻¹ respectively) as compared to best check variety Rajendra Kanti (15.67 q ha⁻¹). Among best three entries, NDM 69 produced the highest number of primary branches per plant (9.31) and seed yield (18.51 q ha⁻¹) followed by RM 194 *i.e.*, number of primary branches per plant (9.20) and yield (17.77 q ha⁻¹).

Highest yield at Kumarganj centre was obtained in RM 188 (13.29 q ha⁻¹) followed by

JFg 245 (12.98 q ha⁻¹) and UM 202 (12.84 q ha⁻¹). Three years pooled data showed highest seed yield in JFg 245 (14.02 q ha⁻¹) followed by UM 202 (14.00 q ha⁻¹) and AFG 5 (13.88 q ha⁻¹). Due to heavy rainfall in March, 2015 *Cercospora* leaf spot infection increased rapidly and caused heavy yield loss. Minimum leaf spot intensity of 18.69 % was recorded in RM-361(Ch) followed by LFC 98 (21.85%), UM 202 (24.03%), JFg 245 (24.48%) and AFG 5 (25.60%).

At Guntur among the seventeen entries evaluated, UM 202 (16.69 q ha⁻¹), UM 354 (16.27 q ha⁻¹), LFC 98 (15.36 q ha⁻¹) and AFG 5 (14.76 q ha⁻¹) recorded significantly higher yield than check APHU Methi -1 (13.64 q ha⁻¹). The pooled analysis indicated that among the seventeen entries tested, UM 202 (16.40 q ha⁻¹), UM 354 (15.79 q ha⁻¹) and LFC 98 (15.28 q ha⁻¹) recorded significantly higher yield than check APHU Methi -1 (13.19 q ha⁻¹).

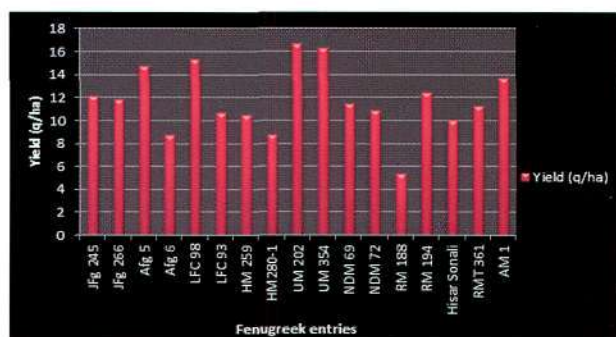


Fig. 30: Performance of different fenugreek entries (pooled data of 3 years) in coordinated varietal trial at Guntur

At Hisar significant differences were obtained for all the parameters. Plant height ranged from 106.7 to 123.5 cm, pods per plant 90.1 to 104.8, length of pods 7.3 to 8.9 and seeds per pod 14.8 to 18.1. Maximum seed yield (23.84 q ha⁻¹) was recorded in LFC 93 followed by HM 259 (22.77 q ha⁻¹) and UM 354 (20.47 q ha⁻¹).

Three years mean data at Jagudan shows that the entries AFG 5 (19.66 q ha⁻¹), JFg 245 (18.88 q ha⁻¹) and NDM 69 (18.69 q ha⁻¹) recorded higher yield over best check GM-2 and



which were 16.24, 11.65 and 10.53 per cent more over best check GM-2.

Out of 16 entries evaluated at Navsari, UM 354 (13.58 q ha⁻¹), AFg 5 (13.45 q ha⁻¹), AFg 6 (12.46 q ha⁻¹) and LFC 98 (12.34 q ha⁻¹) recorded higher seed yield over national as well as local check. All these four high yielding entries were also found significantly superior in performance for number of pods per plant and number of seeds per pod over both the checks. At

Pantnagar significant differences were observed for all the character except for number of primary branches per plant, number of secondary branches per plant and days to maturity. Maximum seed yield (24.30 q ha⁻¹) was recorded in UM-354, followed by RMt-361 (23.98 q ha⁻¹). On the basis of 3 years pooled data maximum yield was recorded in local check Pant Ragini (23.41 q ha⁻¹) followed by UM-354 (23.24 q ha⁻¹).

Entry UM 354 (9.16 q ha⁻¹) recorded higher seed yield followed by entry AFg 5 (2.04 q ha⁻¹) and LFC 98 (2.03 q ha⁻¹) at Raigarh and showed moderate resistant to powdery mildew disease.

At Kota the seed yield of fenugreek ranged from 8.33 – 16.67 q ha⁻¹. During the third and final year of evaluation, Hisar Sonali (NC) was found to be the best performing entry in terms of seed yield, yielding 16.67 q ha⁻¹ followed by JFg 245 (15.63 q ha⁻¹) and UM 202 (13.72 q ha⁻¹). JFg 245 (15.63 q ha⁻¹) showed 25 % higher yield over the check RMt 361. The mean days to flowering ranged from 61 days (RMt 361) to 69 days (Hisar Sonali); days to maturity from 125 days (RMt - 361) to 133 days (Hisar Sonali); plant height ranged from 74.93 cm (HM 259) to 88.60 cm (AFg 6); pods per plant from 8.20 (JFg 266) to 11.67 (RM 194); pod length from 6.20 cm (JFg 245) to 6.93 cm (UM 202); seeds per pod from 13.23 (JFg 266) to 22 (RM 194) and test weight from 10.99 g (HM 259) to 13.29 g (LFC 98 and RM 188).

FGK/CI/3 Varietal Evaluation Trial

FGK/CI/3.4 Initial Evaluation Trial 2012

(Centres: East coast plains and hill region - Guntur; Middle Gangetic Plain Region - Kumarganj; Gujarat plains and hills region - Jagudan; Central plateau and hills region - Jobner)

Among the nine germplasm lines tested at Guntur, five entries *i.e.* LFC-78 (12.41 q ha⁻¹), LFC-90 (12.40 q ha⁻¹), LFC-118 (12.38 q ha⁻¹), LFC-72 (12.37 q ha⁻¹) and LFC-85 (12.31 q ha⁻¹) were found to be significantly superior to the best check APHU Methi-1 (10.69 q ha⁻¹). Pooled analysis indicated that among the ten entries tested, LFC-90 (11.63 q ha⁻¹), LFC-72 (11.54 q ha⁻¹), LFC-78 (11.53 q ha⁻¹), LFC-118 (11.52 q ha⁻¹) and LFC-85 (11.43 q ha⁻¹) were found to be significantly superior to the best check APHU Methi-1 (9.92 q ha⁻¹).

Ten entries were evaluated at Kumarganj and among them NDM-79 (14.58 q ha⁻¹) followed by NDM-82 (13.47 q ha⁻¹) and NDM-81 (13.33 q ha⁻¹) found to be high yielding. Three year pooled data showed maximum seed yield in NDM-79 (16.30 q ha⁻¹) followed by NDM-82 (15.30 q ha⁻¹) and NDM-81 (15.01 q ha⁻¹). *Cercospora* leaf spot was found minimum in NDM-82 (25.85 %) and maximum in NDM-107 (65.01%).



Fig. 31: Yield performance of fenugreek entries in initial evaluation trial at Kumarganj centre



At Jagudan pooled data of three years indicated that entry JFg-268 (18.65 q ha⁻¹) gave significantly higher yield over check GM-2 (16.87 q ha⁻¹) followed by JFg-224 (18.17 q ha⁻¹) which were 11.88 and 8.97 per cent higher over the check GM-2, respectively.

The seed yield ranged from 21.41 to 33.93 q ha⁻¹ at Jobner. Of the ten entries evaluated, entry UM-221 recorded maximum seed yield of 33.93 q ha⁻¹ followed by UM-294 (30.46 q ha⁻¹), UM-161 (28.28 q ha⁻¹) and RMT-305 check (28.14 q ha⁻¹), while lowest yield of 21.41 q ha⁻¹ was recorded in Local check. Mean performance of the entries evaluated in IET of fenugreek over 2012-13 to 2014-15 revealed superior performance of UM-221 yielding 26.76 q ha⁻¹ followed by UM-161 (26.56 q ha⁻¹), UM-294 (26.32 q ha⁻¹) and UM-28 (24.08 q ha⁻¹), while lowest seed yield of 19.14 q ha⁻¹ was recorded in Local check. Entries UM-161, UM-347 and UM-379 were observed moderately resistant against powdery mildew disease.

FGK/CI/3.6 Initial Evaluation Trial on fenugreek

(Centre: Middle Gangetic Plain Region – Dholi; Trans Gangetic Plain Region - Hisar)

Among 8 promising entries and 2 check varieties tested at Dholi, RM-204 gave significantly higher number of pods per plant and yield per hectare (21.11 q ha⁻¹) as compared to check variety Rajendra Kanti (17.00 q ha⁻¹).

The initial evaluation trial (IET) in fenugreek was conducted with eight accessions along with Hisar Sonali and Hisar Suvarna as check during 2014-15 in plots measuring 3.0 x 1.2 m at Hisar. The results indicated that maximum mean seed yield was recorded in HM-273 (26.96 q ha⁻¹) followed by HM-355 (26.80 q ha⁻¹) showing an increase of 14.9 and 14.2 % over Hisar Sonali (check), respectively.

Crop Management

FGK/CM/5 Nutrient Management Trial

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

(Centre: Central plateau and hills region - Jobner)

Thirty genotypes were evaluated for drought tolerance in fenugreek at Jobner. Three years data indicated that the genotypes UM 112, UM 100, UM 118, UM 163 and UM 302 in normal while UM 112, UM 124, UM 302, UM 163 and UM 118 in stress conditions were top yielders. Based on stress indices UM 140 was found to be the desirable entry for drought conditions, followed by UM 124, UM 126, UM 321 and UM 116.

FGK/CM/5.3 Micro irrigation management in fenugreek

(Centre: Central plateau and hills region - Jobner)

The results showed that drip irrigation at different IW/CPE ratios, except 0.4 IW/CPE ratios with normal and paired row planting, significantly increased growth parameters, yield attributes, yields, economics, water use efficiency, water saving and yield increase over surface irrigation at IW/CPE ratio 1.0 (control). The results further revealed that the drip irrigation at an IW/CPE ratio 0.6 with paired row planting, being at par with 0.6 IW/CPE ratio in normal row planting and drip irrigation at 0.8 and 1.0 IW/CPE ratio in normal and paired row planting, recorded significantly higher plant height (103.07 cm), number of branches/plant (5.45), pods/plant (30.38), seeds/pod (16.60), pod length (12.03 cm), test weight (13.32), seed yield (18.77 q/ha), straw yield (47.27 q ha⁻¹), net returns (Rs 45952/ha) and B:C ratio (2.57) over 0.4 IW/CPE ratio with normal and paired row planting and surface irrigation at IW/CPE ratio



1.0. However, the drip irrigation at higher level of 1.0 and 0.8 IW/CPE ratio could not bring significant increase over irrigation at 0.6 IW/CPE ratio.

The results further indicated that water use efficiency and water saving progressively decreased with increasing levels of drip irrigation from IW/CPE ratio 0.4 to 1.0, however, per cent yield was increased progressively with increase in drip irrigation levels. Drip irrigation at 0.6 IW/CPE ratio with paired row planting, remained comparable to drip irrigation at 1.0 and 0.8 IW/CPE ratio, recorded higher water use efficiency (6.74 kg/ha-mm), water saving (35.3 %) and yield increase (49.3 %) over surface

irrigation at 1.0 IW/CPE ratio (control) (Fig. 32).

FGK/CM/5.8 Evaluation of PGPR bioformulation on fenugreek

(Centres: Gujarat plains and hills region - Jagudan; Central plateau and hills region - Jobner; East coast plains and hill region - Guntur; Trans Gangetic Plain Region - Hisar; Middle Gangetic Plain Region - Kumarganj)

Pseudomonas putida FK14 and *Macrobacterium paraoxydans* FL18 strains found not only in improving the yield but also in management of dry root rot in fenugreek at Guntur.

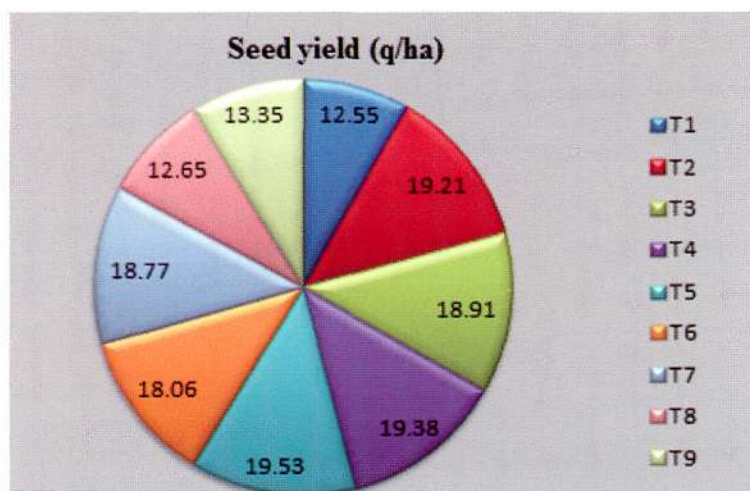


Fig. 32: Seed yield of fenugreek as affected by different irrigation schedule

Note:

- T1 - Surface irrigation at 1.0 IW/CPE ratio
- T2 - Drip irrigation at 1.0 IW/CPE ratio with normal row planting
- T3 - Drip irrigation at 1.0 IW/CPE ratio with paired row planting
- T4 - Drip irrigation at 0.8 IW/CPE ratio with normal row planting
- T5 - Drip irrigation at 0.8 IW/CPE ratio with paired row planting
- T6 - Drip irrigation at 0.6 IW/CPE ratio with normal row planting
- T7 - Drip irrigation at 0.6 IW/CPE ratio with paired row planting
- T8 - Drip irrigation at 0.4 IW/CPE ratio with normal row planting
- T9 - Drip irrigation at 0.4 IW/CPE ratio with paired row planting



XI. MONITORING

Monitoring and reviewing of the centres was done by Project Coordinator visiting the centre and also through e-mail and phone. Monthly progress report and budget utilization

certificates sent from the centres were reviewed critically and suggestions were given to carry out the research activities in the centre

Project Coordinator visited the following centres during the period from 1st April 2014 to 31st March 2015

Sl. No.	Date	Centre visited
1.	26.04.2014 to 27.04.2014	CRSS, Jagudan (Regular centre)
2.	06.05.2014, 25.06.2014 & 02.03.2015	KAU, Vellanikkara (Project mode centre)
3.	18.05.2014 to 21.05.2014	Birsa Agril. University, Kanke (Voluntary centre)
4.	22.05.2014 to 23.05.2014	BCKV, Kalyani (Voluntary centre)
5.	26.05.2014 to 29.05.2014	N.M. College of Agriculture, Navsari (Voluntary centre)
6.	22.07.2014 to 23.07.2014	TRS, Kammarpally (Regular centre)
7.	23.07.2014 to 25.07.2014	HRS, Chintapalli (Regular centre)
8.	26.08.2014 to 29.08.2014	HRS, Sirsi (Regular centre) & Farmers field
9.	22.09.2014 to 30.09.2014	UBKV, Pundibari (Organized 25 th AICRPS workshop)
10.	15.10.2014, 18.11.2014 & 24.01.2015	RARS, Ambalavayal (Co-opting centre) & Farmers plots
11.	07.11.2014 to 08.11.2014 & 04.03.2015 to 05.03.2015	TNAU, Coimbatore (Regular centre)
12.	26.11.2014 to 28.11.2014 & 09.03.2015 to 11.03.2015	HRS, Yercaud (Regular centre)
13.	29.12.2014 to 31.12.2014	PRS, Panniyur (Regular centre)
14.	07.01.2015 to 11.01.2015	SKN College of Agriculture, Jobner (Regular centre)
15.	28.01.2015 to 31.01.2015	HRS, Pechiparai (Co-opting centre) & Pepper plantation in Marthandam
16.	19.02.2015	AICRPS centre Appangala (IISR Regional Station)
17.	24.02.2015 to 01.03.2015	SASRD, Nagaland (Co-opting centre)
18.	21.03.2015 to 29.03.2015	CAU, Pasighat (Voluntary centre), Surveyed the large cardamom plantations in Arunachal Pradesh and Nagaland & AICRPS New Co-opting centre Kahikuchi



Project Coordinator visit to centres



XII. ANNUAL WORKSHOP OF AICRPS

The 25th Workshop of All India Coordinated Research Project on Spices was conducted during 25-27 September 2014 under the guidance of Dr. S. K. Malhotra, Hon. Assistant Director General (Horticultural Science), ICAR and Horticultural Commissioner, New Delhi in the august presence of Prof. B. Bandopadhyay, Hon. Vice Chancellor, Uttar Banga Krishi Viswavidyalaya, Pundibari.



Inauguration of the annual group meeting

Luminaries like Dr. M. Anandaraj, Director, ICAR-Indian Institute of Spices Research, Kozhikode; Dr. Homey Cheriyan, Director, Directorate of Arecanut and Spices Development, Kozhikode; Dr. Debasis Mazumdar, Director of Research, Uttar Banga Krishi Viswavidyalaya, Pundibari; Dr. J. P. Singh, Director of Research, GB Pant University of Agriculture and Technology, Pantnagar; Dr. James George, Project coordinator, AICRP on tuber crops; Dr. J. Suresh, Professor & Head, Dept. of Spices and Plantation Crops, TNAU, Coimbatore; Dr. John Zachariah, Head, Division of Crop Production; Dr. B. Sasikumar, Head, Division of Crop improvement and Biotechnology, Dr. S. J. Ankegowda, Head, IISR Regional Station, Appangala from ICAR-Indian Institute of Spices Research; Dr. Gopal Lal, Principal Scientist and Dr. R. Kakani, Principal Scientist from NRC for Seed Spices and Dr.

Apurba Kr Choudhury, Dean, Faculty of Agriculture, UBKV, Pundibari were present to help and guide through the proceedings.

In the inaugural session the Project Coordinator presented the action taken report (ATR) on the recommendations of previous meeting and that was approved by the workshop. There were 6 technical sessions under genetic resources, crop improvement, crop management, crop protection, varietal release and transfer of technology where there were 49 presentations by various workers. The projects were discussed thoroughly suggestions were given and also new projects were approved in the workshop.

Important highlights

In addition to general recommendations, some important decisions taken were

1. Catalogues of evaluated spices will be prepared.
2. Trait specific collections will be taken up and this year special drive for bold vegetable type gingers will be taken up in North Eastern Region, wilt resistance in cumin
3. Large cardamom research will be intensified and the centres like ICRI (Spices Board) centre at Sikkim and Munnar (as 30% seed set was noticed in Munnar in large cardamom) UBKV (at Kalimpong), IARI Res. station at Kalimpong (For Virus indexing), ICAR Res Complex at Sikkim, SAARD Nagaland, Pasighat centres will work together as a team to multiply disease free varieties with wide adaptability, introduce and evaluate them to the respective regions (outside Sikkim), develop organic packages and observe for alternate pollinators (like honey bees). This is essentially to develop organic package for large cardamom and to grow it out of Sikkim.



4. Unique high yielding Nutmeg genotypes from farmer's gardens will be multiplied and evaluated in all tree spice centres.
5. Since the some AICRPS trials are effectively $G \times E$ trials, in different agro climatic regions, the 3 year replication wise, year wise data available, along with agro climatic data (climate, soil and rainfall conditions) will be analyzed to identify climate resilient varieties.
6. All nurseries of AICRP Centres will be accredited for production of nucleus (Breeder seed) planting materials

Some important new Projects initiated from this year are – Bio efficacy of new molecules against cumin aphids; Management of powdery mildew of coriander; Eco-friendly management of stem gall of coriander

A new experiment on developing organic package (Involving permissible micro nutrients in organic system) for production of ginger and turmeric decided in the network project on Organic Horticulture at IISR will also be conducted by AICRP centres at Meghalaya, Nagaland, Sikkim (NEH centres), Pottangi, Chintapalli and Raigarh centres (tribal areas). A demo trial on tractor based turmeric planter will be taken up.

Three other projects were recommended by the workshop, to be taken in a project mode for next 3 years with additional contingency of Rs 1 lakh/year. They are:

1. Evaluation of large cardamom genotypes lines at Kalimpong centre as satellite centre of UBKV, Pundibari
2. Chemo-profiling of Released varieties of Seed spices cumin, coriander, fennel and fenugreek at SDAU, Jagudan
3. Evaluation of cumin genotypes in Ramanad District of Tamil Nadu by TNAU centre at Periyakulam



Presentation and discussion during the meeting

Transfer of technology

Eight technologies for 12 states were recommended for release.

1. Control of rhizome rot of ginger by biofumigation with Cabbage and/or Mustard for Kerala, Odisha, Himachal Pradesh, Andhra Pradesh, Chhattisgarh, Bihar, West Bengal.
2. Integrated nutrient management in ginger for Bihar with Cost: Benefit ratio 1:3.
3. Management of Stem gall of coriander with new molecules in Uttar Pradesh and Chhattisgarh.
4. Nutrient management in off – season coriander leaf production in Tamil Nadu with 25% yield increase.
5. Application of PGPR (FK-14 (*Pseudomonas putida*) or FL-18 (*Macrobacterium paraoxydans*) or combination of both) in Fenugreek, Coriander and Fennel in Andhra Pradesh, Rajasthan, Gujarat, Chhattisgarh, Haryana and Uttar Pradesh conditions.
6. Standardization of water management of turmeric through drip irrigation for Tamil Nadu which saves 40% water.
7. Integrated nutrient management in black pepper for Kerala.



8. Use of micronutrients (Ferrus sulphate @ 0.5 % at 60 and 90 days of planting) for higher yield on turmeric for Iron deficient regions of Bihar.

Many booklets and pamphlets on AICRP technologies in local languages published were released during the inaugural session. They are - Protray Nursery and Production Technology of Turmeric (English), Turmeric production technology (English), Nutmeg cultivation practices (Tamil), Clove (Tamil) for Tamil

Nadu; Ginger cultivation practices (Telugu), Black pepper cultivation practices (Telugu) for Andhra Pradesh; Turmeric cultivation practices (Telugu) for Telangana; Black pepper cultivation practices (Odiya), Black pepper cultivation practices (English), Off-season coriander (Odiya) for Odisha; Success story on black pepper grafting e- Publication in CD (Kannada), for arecanut based *Phytophthora* hot spot regions of Karnataka

Release of varieties

Five varieties 2 in small cardamom one from Pampadumpara, KAU and another from IISR 2 in coriander released for Uttar Pradesh and Rajasthan respectively and 1 in fenugreek for Andhra Pradesh and Telangana were recommended for release.

The workshop came to an end on 27th September 2014, during the plenary session ADG (Hort.) has complemented for the work done in the AICRPS and also emphasized that much can be done as there will be continuous scope for improvement.



Release of publications during the 25th AICRPS Workshop



Awarding "Best AICRPS Centre" award to CRSS, Jagudan



XIII. POPULARIZATION OF TECHNOLOGY

Scientists of AICRPS centres are involved in technology demonstration by conducting FLD's to make the technologies developed by the centre visible to the farmers. Following are the technologies demonstrated in the year 2014-15:

- Integrated organic farming in turmeric and Seed treatment in turmeric (Kammarpally)
- Demonstration of promising ginger genotype IC-593889 (SG-26-04) (Solan)
- Processing of cardamom and drip irrigation in cardamom (Mudigere)
- Biofumigation using cabbage for the control of soft rot and bacterial wilt diseases in ginger (Pundibari)
- Yield potential of Panniyur varieties under proper IPDM and High yielding capacity of Panniyur varieties under abiotic stress (Panniyur)
- Bush pepper cultivation (Sirsi)
- FLD on organic cultivation of ginger and turmeric (Pottangi)
- Integrated Nutrient Management (Raigarh)
- FLD on Suguna variety of coriander (Guntur)
- Technique of removing cinnamon bark, Protray techniques of raising ginger and turmeric, Processing of black pepper, Processing of turmeric, Soft wood grafting in nutmeg, Bush pepper technology (Dapoli)
- FLD – High yielding turmeric variety CO-2 (Coimbatore)
- Use of *Trichoderma viridae* in pepper cultivation (Yercaud)
- Demonstration of high yielding varieties of coriander (GCor-2) and fennel (GF-12) (Jagudan)
- FLD on spraying Tricyclazole (0.1%) on 45 & 90 DAP to control leaf spot of turmeric (Dholi)



FLD on Suguna variety of coriander



Demonstration of cinnamon bark peeling



Portray technology of turmeric



FLD on Co-2 variety of turmeric



XIV. SUCCESS STORIES

BLACK PEPPER GRAFTED ON *PIPER COLUBRINUM*- AN ECO FRIENDLY WAY TO MANAGE *PHYTOPHTHORA* FOOT ROT

There is continuous decrease in black pepper productivity due to old and senile plantations and the prevalence of *phytophthora* disease. To overcome this problem steps undertaken are

1. Introduction of high yielding varieties and cultivation of black pepper in non traditional areas
2. Following of good irrigation management and crop protection measure
3. Grafting black pepper on resistant rootstock *Piper colubrinum*

Introduction of high yielding varieties and cultivation of black pepper in nontraditional areas

In this regard introduced high yielding varieties of black pepper to Kolli hills in Tamil Nadu, Koraput region of Pottangi and tea estates of Assam. This will help in cultivation of black pepper in nontraditional areas and which leads in increasing the productivity.

Need for this technology

- Sirsi and surrounding areas of Uttara Kannada district in Karnataka are bestowed with prestige natural resource of water, soil and tropical climate and in this region Arecanut - Pepper cropping system is the most important cropping pattern.
- Arecanut and black pepper growing areas in this region are waterlogged and also this area is the hot-spot of *Phytophthora*. Due to this farmers are losing their crop and if at all crop is there yield level is very low. To overcome this disease farmer has to use more fungicides and that leads to polluting the soil, water bodies and ultimately leads to environment pollution.
- To overcome this problem in Black pepper – Arecanut cropping system a technology of grafting the pepper on resistant rootstock *Piper colubrinum* is developed.



Grafted plant in field



Crop stand in the field



Advantages of this technology

- Foot rot disease can be easily controlled as the rootstock is resistant to disease
- Eco-friendly: This technique reduces the chemical application for control of foot rot disease; cost of production of black pepper is also considerably reduced
- Replanting with new rooted cuttings is very low or nil as there is no death of vines due to foot rot disease.

Mr. N. D. Hegde of Uttara Kannada dist. was the first to adopt this technology in his farm. From the last two years, commercial scale nursery is developed with the assistance from the Department of Horticulture, Govt. of Karnataka. This grafted pepper cultivation is already spread to about 80 ha in Uttara Kannada district. In 2011-12 the University of Agricultural Sciences, Dharwad, Karnataka has recognized him for his innovativeness in grafted pepper cultivation and also he was awarded as the 'Best Innovative Farmer' during the March 2014 in the Pusa Krishi Vigyan Mela by ICAR, New Delhi. His farm has become a regular study tour spot for the farmers of Karnataka, Goa and Kerala wherein he shares his experiences with the visiting farmers' groups. Scientists at Sirsi centre are actively involved in providing advisories to him and also they are involved in popularization of this technology among the farmers.



Flowering in grafted plants



Receiving the "Best Innovative Farmer Award"



RAPID MULTIPLICATION OF TURMERIC THROUGH SINGLE BUD RHIZOME TECHNOLOGY

Constraints in conventional method of propagation

- Less availability of quality planting material
- Heavy requirement of planting material (seed rhizome) per ha (2.5 t ha^{-1})
- High cost of planting material (Rs. 75,000 to Rs. 1,00,000/ha)
- Only 80 % crop establishment.

Need for single bud rhizome method

Characters	Direct planting method	Transplanting method
Propagation through	Whole Rhizome	Rhizome single bud
Seed rate	2500 kg/ha	750 kg/ha
Cost of planting material	Rs. 30,000	Rs. 9,000
Crop establishment	75 - 80%	95 -100 %
Rhizome development	Starts from 5 MAP	Starts from 2 MAP
Productivity	30-32 tonnes/ha	40-42 tonnes/ha

Cost of seedling production (1500 portrays/ha)	Cost (Rs.) per ha
1. Portray (Rs.4/No.)	6,000.00
2. Cost of growing media	2,500.00
3. Cost of rhizome (750 kg @ Rs.10/kg)	7,500.00
4. Labour charge	2,500.00
Total	18,500.00
B) Cost of seed rhizome (2500 kg/ha)	25,000.00
Benefit from transplant production	6,500.00
Benefit cost ratio	1.35



This portray technology is transferred to large number of farmers in Tamil Nadu by the scientists of Coimbatore centre. This technology is taken up by about 20 farmers and in an area of 50 acres in the last 6 months and also this technology has become popular among the farmers of Andhra Pradesh.

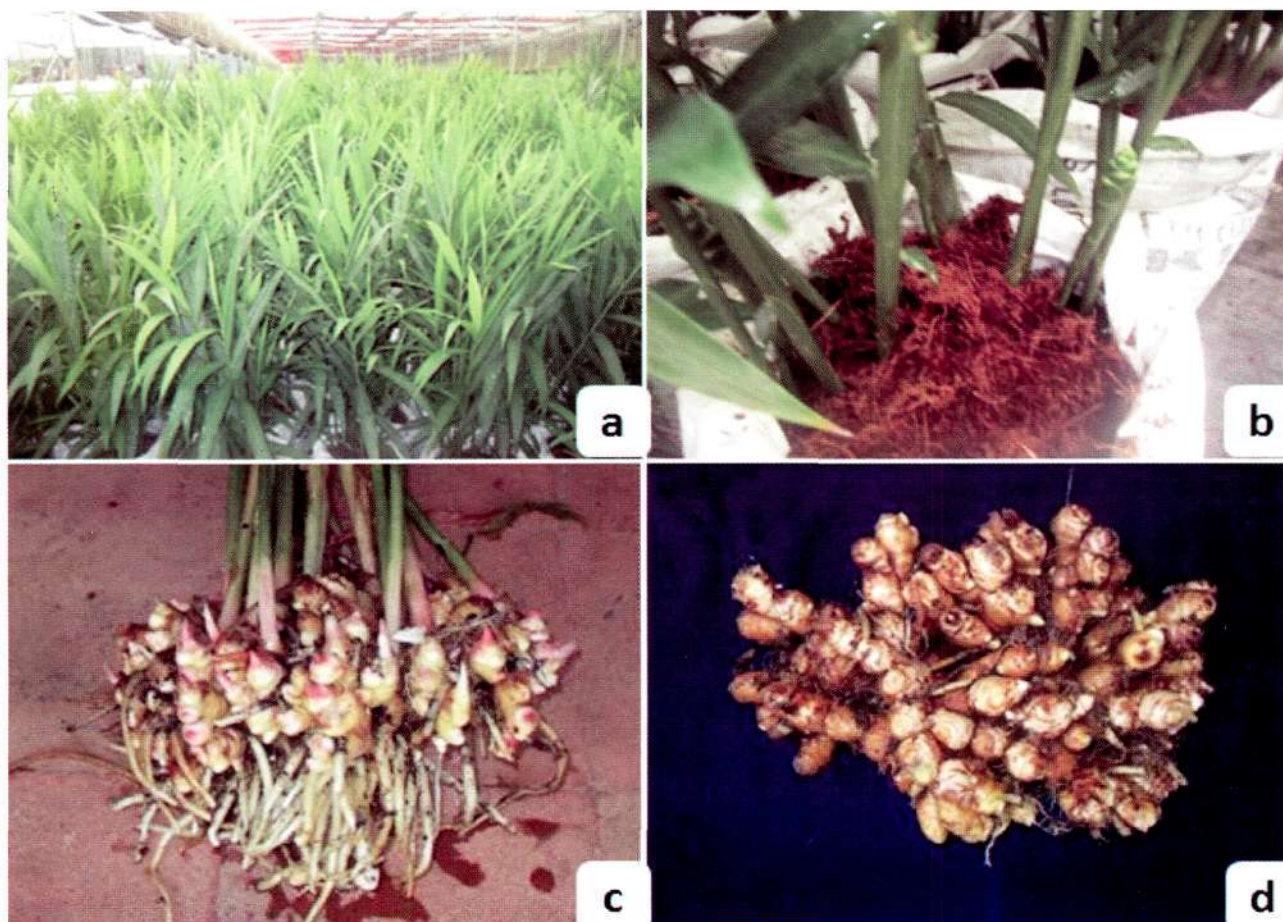


SOILLESS SINGLE NODE GINGER CULTIVATION IN POLYHOUSE

An experiment on soil less ginger cultivation by using coir pith in polyhouse was laid out in a farmer field at Adivaram in Kozhikode in a PPP mode. 5 varieties of ginger were cultivated (Maran and Himachal in large quantity and other 3 varieties Athira, Karthika and Aswathy in small quantity) in polyhouse in an area of 1200 sq. mt. ginger is cultivated in 6,156 bags. About 17 treatments were imposed viz., use of different types of rhizomes (small, medium and big) and use of bioinoculants and PGPR's. Fertilizers and irrigation was given

through fertigation system. In this the results were found promising and use of bioinoculants recorded higher yield compared to the treatments without use of bioinoculants. Healthy rhizomes were harvested and the rhizome yield per bag varied from 400 to 1600 g.

This technology helps in production of healthy disease free planting material and also here single node rhizomes were planted so the recovery was higher.



Soilless ginger cultivation in polyhouse. a. 4 months old ginger plants
b. Tiller development in coir pith, c. Rhizome development after 6 months
d. Rhizome weighing 1.4 kg



POPULARIZATION AND SPREAD OF GUJARAT CUMIN 4: A VARIETY OF CUMIN

Major problem in cumin cultivation is incidence of *Fusarium* wilt and almost all the varieties are susceptible to this disease. GC – 4 variety of cumin was released by Jagudan centre which is high yielding as well as resistant to *Fusarium* wilt. This variety is popular in the cumin cultivating areas of Gujarat and Rajasthan. It covers an area of 90 and 60 per cent in Gujarat and Rajasthan respectively. After release of this variety, significant increase in the area, production and productivity is realized at national level.



Field view of GC-4 variety of cumin

SUCCESSFUL GINGER CULTIVATION IN COIMBATORE

Ginger requires a warm humid climate and is not most commonly cultivated in Tamil Nadu. In an attempt to grow ginger in Tamil Nadu it is cultivated in Coimbatore farmer's field. A farmer received a yield of 15 t ha⁻¹. In ginger the soil borne rhizome rot is one of the

major diseases and in this context growing ginger in non traditional areas where the disease is not present will help to get better yield of fungicide free produced. Scientists from Coimbatore centre are actively involved in giving advisories to these farmers.



Ginger cultivation in Coimbatore



XV. UNIQUE GERMPLASM COLLECTION (2014-15)



Wild *Piper* sp.



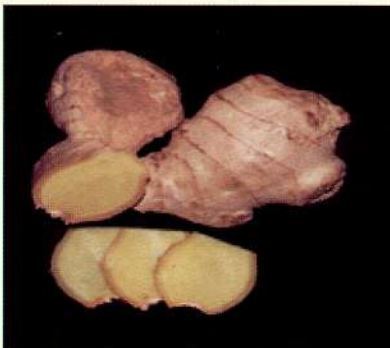
Arakalumunda



Karimunda



Black ginger
(*Kaempferia parviflora*)



Extra Bold Singapore Ginger



Finger like ginger



Jamaican ginger and turmeric



XVI. PUBLICATIONS

Research publications

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Sirsi

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XVII. STAFF POSITION

PROJECT COORDINATOR'S OFFICE

- | | |
|-----------------------------|---|
| 1. Project Coordinator | : Dr. K. Nirmal Babu |
| 2. Scientist (SPMAP) | : Dr. C. K. Thankamani (till 08.10.2014)
Ms. H. J. Akshitha (From 08.11.2014 to till date) |
| 3. Scientist (SPMAP) | : Vacant |
| 4. Technical Officer | : Dr. Utpala Parthasarathy |
| 5. Personal Assistant | : Ms. Alice Thomas (till 30.11.2014 and then vacant) |
| 6. Skilled Supporting Staff | : Sh. K. Chandran Nair |

COORDINATING CENTRES

1. Cardamom Research Station (KAU), Pampadumpara

- | | |
|---|---------------------|
| 1. Assistant Professor (Ag. Entomology) | : Dr. K. B. Deepthy |
| 2. Associate Professor (Agron/Hort.) | : Vacant |
| 3. Assistant Professor (Pl. Breeding) | : Vacant |
| 4. Laboratory Assistant Gr. II | : Mr. Anil Kumar |
| 5. Peon | : Mr. Shinoj Antony |

2. Pepper Research Station (KAU), Panniyur

- | | |
|--|--|
| 1. Asst. Professor/ Jr. Breeder (Pl. Breeding) | : Dr. P. M. Ajith |
| 2. Asst Professor (Plant Pathology) | : Dr. C. R. Rini |
| 3. Asst. Professor (Agron / Hort) | : Smt. Anupama. T. V (till 21.8.14 now on study leave) |
| 4. Asst. Professor (Pl. Pathology) | : Vacant |
| 5. Farm Superintendent | : Sh. K. Lakshmanan |
| 6. Farm Manager Gr I | : Sh. P. P. Muralidharan |
| 7. Farm Manager Gr II | : Sh. P. Krishnan |
| 8. Lab Asst. Gr.III | : Sh. K. Rajeev |
| 9. Peon Gr II | : Sh. Mohanan Valayangatan |

3. Horticultural Research Station (UAHS), ZAHRS, Mudigere

- | | |
|--|----------------------|
| 1. Associate Professor (Agronomy) | : Dr. K. M. Devaraju |
| 2. Associate Professor (Plant Breeding) | : Dr. H.B. Dinesh |
| 3. Associate Professor (Plant Pathology) | : Dr. H. Manjunatha |
| 4. Associate Professor (Entomology) | : Ms. A. Asma |
| 5. Technical Assistant | : Mr. Mahadevappa |
| 6. Technical Assistant | : Smt. H. R. Manjula |
| 7. Messenger | : Ms. Savithri |

4. Horticultural Research Station(UHS), Sirsi

- | | |
|--|--------------------------|
| 1. Associate Professor (Hort.) | : Dr. Laxminarayan Hegde |
| 2. Associate Professor (Plant Pathology) | : Dr. M. J. Manju |
| 3. Technical Assistant | : Sh. B. B. Doddamani |



5. Horticultural Research Station (TNAU), Yercaud

- | | |
|------------------------|--|
| 1. Agronomist (Hort.) | : Dr. K. Nageswari |
| 2. Jr. Breeder (Hort.) | : Dr. J. Prem Joshua
(Posted at HRS Pechiparai) |
| 3. Lab Assistant | : Sh. P. Pappa |

6. Department of Spices & Plantation Crops (TNAU), Coimbatore

- | | |
|--------------------------------|----------------------|
| 1. Breeder (Horticulture) | : Dr. R Chitra |
| 2. Jr. Pathologist (Pathology) | : Dr. C. Ushamalini |
| 3. Agricultural Assistant | : Th. R. Swaminathan |

7. Turmeric Research Station (SKLTSHU), Kammarpally

- | | |
|------------------------|-----------------------|
| 1. Jr. Pathologist | : Vacant |
| 2. Jr. Horticulturist | : Dr. M. Hanuman Naik |
| 3. Technical Assistant | : Sh. T. Pullaiah |

8. Horticultural Research Station (Dr.YSRHU), Chintapalle

- | | |
|------------------------------------|---|
| 1. Senior Scientist (Horticulture) | : Dr. C. Chandrasekhara Rao |
| 2. Scientist (Plant Pathology) | : Vacant |
| 3. Technical Assistant | : Vacant from 25.01.2012 onwards
(Engaged outsourcing) |

9. Horticultural Research Station (Dr.YSRHU), Guntur

- | | |
|-------------------------------|---------------------------|
| 1. Jr. Breeder (Horticulture) | : Dr. K. Giridhar |
| 2. Horticulturist | : Dr. S. Suryakumari |
| 3. Technical Assistant | : Sh. Shaik Jilani Bhasha |

10. Department of Vegetable Crops (Dr. YSPUHF), Solan

- | | |
|----------------------------------|-------------------------|
| 1. Professor (Vegetable Science) | : Dr. Happy Dev Sharma |
| 2. Jr. Pathologist | : Dr. Meenu Gupta |
| 3. Jr. Biochemist | : Dr. Vipin Sharma |
| 4. Field Assistant | : Sh. Chunni Lal Sharma |

11. High Altitude Research Station (OUAT), Pottangi

- | | |
|------------------------------------|----------------------|
| 1. Sr. Breeder & Officer-in-charge | : Dr. Parshuram Sial |
| 2. Breeder | : Vacant |
| 3. Technical Assistant | : Sh. L. K. Mishra |
| 4. Technical Assistant | : Vacant |

12. Department of Genetics and Plant Breeding, SKN College of Agriculture (SKNAU), Jobner

- | | |
|-------------------------------|-----------------------------|
| 1. Sr. Breeder | : Dr. Dharendra Singh |
| 2. Breeder | : Vacant |
| 3. Senior Pathologist | : Dr. Kayam Singh Shekhawat |
| 4. Asst. Biochemist | : Dr. Girish Kumar Mittal |
| 5. Agronomist | : Dr. A. C. Shivran |
| 6. Senior Technical Assistant | : Dr. S. S. Rajput |
| 7. Junior Technical Assistant | : Sh. S. R. Kumawat |



13. Centre for Research on Seed Spices (SDAU), Jagudan

- | | |
|--|------------------------|
| 1. Assoc. Research Scientist (Pl. Path.) | : Dr. K. D. Patel |
| 2. Asst. Research Scientist (Pl. Br.) | : Prof. D. G. Patel |
| 3. Agril. Asst. (HG) | : Kum. Rekha Chaudhari |

14. Department of Vegetable Crops (CCS HAU), Hisar

- | | |
|----------------------------------|---------------------|
| 1. Junior Pathologist | : Dr. Suresh Tehlan |
| 2. Horticulturist (Olericulture) | : Dr. T. P. Malik |

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. V. P. Pandey |
| 2. Jr. Breeder | : Vacant |
| 3. Jr. Pathologist | : Dr. R. S. Mishra |
| 4. Tech. Asst. | : Sh. R. K. Gupta |
| 5. Tech. Asst. | : Sh. Vinod Singh |

17. Department of Horticulture (UBKV), Pundibari

- | | |
|------------------------|------------------------------|
| 1. Horticulturist | : Vacant |
| 2. Jr. Pathologist | : Dr. (Mrs.) Anamika Debnath |
| 3. Jr. Breeder | : Dr. Soumendra Chakraborty |
| 4. Technical Assistant | : Sh. Murari Krishna Roy |
| 5. Technical Assistant | : Sh. Samsul Haque |

18. Department of Horticulture (Dr. BSKKV), Dapoli

- | | |
|------------------------|--------------------------|
| 1. Horticulturist | : Dr. Gargi, D. Shrike |
| 2. Jr. Pathologist | : Prof. Uttam, K. Sawant |
| 3. Jr. Breeder | : Prof. U. B. Pethe |
| 4. Technical Assistant | : Sh. D. D. Bhandari |
| 5. Technical Assistant | : Sh. G. D. Bandre |

19. College of Agriculture and Research Station (IGKV), Raigarh

- | | |
|------------------------|--------------------------------------|
| 1. Horticulturist | : Vacant |
| 2. Jr. Breeder | : Dr. Shrikant Laxmikant Swargaonkar |
| 3. Jr. Pathologist | : Dr. Ajit Kumar Singh |
| 4. Technical Assistant | : Sh. D. S. Kshatriya |
| 5. Technical Assistant | : Vacant |



XVIII. AICRPS CENTREWISE BUDGET 2014-15

Name of the centres	Pay and Allowances		TA		RC		Tech-A		Total RC		Work		Total		Grand Total
	Total	ICAR	Total	ICAR	Total	ICAR	Total	ICAR	Total	ICAR	Total	ICAR	ICAR share	State share	
Regular Centres	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)				(9)	(10)	(11)	
Pampadumpara (KAU)	9.62	7.22	0.50	0.375	1.50	1.125	0.10	1.225				8.82	2.90	11.72	
Panniyur (KAU)	27.94	20.96	1.00	0.75	3.00	2.25	0.10	2.35				24.06	7.98	32.04	
Mudigere (UAHS)	40.45	30.34	1.00	0.75	3.00	2.25	0.10	2.35				33.44	11.11	44.55	
Sirsi (UHS)	30.13	22.60	1.00	0.75	3.00	2.25	0.10	2.35				25.70	8.53	34.23	
Yercaud (TNAU)	22.93	17.20	0.50	0.375	1.50	1.125	0.10	1.225				18.80	6.23	25.03	
Coimbatore (TNAU)	22.94	17.21	1.00	0.75	3.00	2.25	0.10	2.35				20.31	6.73	27.04	
Chintapalle (Dr YSRHU)	12.57	9.43	0.50	0.375	1.50	1.125	0.10	1.225				11.03	3.64	14.67	
Kamarpally (SKLTSHU)	4.29	3.22	0.50	0.375	1.50	1.125	0.10	1.225				4.82	1.57	6.39	
Guntur (Dr YSRHU)	30.52	22.89	1.00	0.75	3.00	2.25	0.20	2.45				26.09	8.66	34.52	
Solan (YSPUHF)	26.09	19.57	1.50	1.125	4.50	3.375	0.10	3.475				24.17	8.02	32.19	
Pottangi (OUAT)									13.33	9.74		9.74	3.59	13.33	
Jobner (SKNAU)	64.18	48.14	2.00	1.50	6.00	4.50	0.10	4.60				54.24	18.04	72.28	
Jagudan (GAU)	20.40	15.30	1.00	0.75	3.00	2.25	0.10	2.35				18.40	6.10	24.50	
Hisar (HAU)	35.10	26.33	1.00	0.75	3.00	2.25	0.10	2.35				29.63	9.81	39.10	
Dholi (RAU)	26.36	19.77	1.00	0.75	3.00	2.25	0.10	2.35				22.87	7.59	30.46	
Kumarganj (NDUAT)	44.36	33.27	1.00	0.75	3.00	2.25	0.10	2.35				36.37	12.09	48.46	
Pundibari (UBKV)	25.89	19.42	1.00	0.75	3.00	2.25	0.10	2.35				22.52	7.47	29.99	
Dapoli (KKV)	15.64	11.73	1.50	1.125	4.50	3.375	0.10	3.475				16.33	5.41	21.74	
Raigarh (IGKV)	21.65	16.24	1.00	0.75	3.00	2.25	0.10	2.35			13.33	29.34	9.74	39.08	
Reserve contingency/ Technology Assessment/AICRPS Workshop						0.87		0.87				0.87		0.87	
Total	481.33	361.04	18.00	13.50	54.00	41.37	1.90	43.27	26.66	19.74	437.55	145.21	582.76		



Name of the centres	Pay and Allowances		TA		RC		Tech-A	Total RC	Work	ICAR share	State share	Grand Total
	(1)	(2)	(3)	(4)	(5)	(6)						
Coopting Centres							(7)	(8)		(9)	(10)	(11)
Ambalavayal (KAU)	-	-	-	-	-	-	-	-	-	-	-	-
Peechiparai (TNAU)	-	-	0.67	0.50	5.33	4.00	-	4.00	-	4.50	1.50	6.00
Gangtok (ICRI)	-	-	0.33	0.33	0.33	0.33	-	0.33	-	0.66	-	0.66
Sakleshpur (ICRI)	-	-	0.33	0.33	0.33	0.33	-	0.33	-	0.66	-	0.66
Myladumpara (ICRI)	-	-	0.33	0.33	0.33	0.33	-	0.33	-	0.66	-	0.66
ICAR RC NEHR,												
Barapani	-	-	-	-	0.35	0.35	-	0.35	-	0.35	-	0.35
ICAR RC NEHR,												
Mizoram	-	-	0.50	0.50	0.50	0.50	-	0.50	-	1.00	-	1.00
ICAR RC NEHR,												
Gangtok	-	-	-	-	-	-	-	-	-	-	-	-
Voluntary centres												
Pantnagar (GBPUAT)	-	-	0.66	0.50	2.66	2.00	-	2.00	-	2.50	0.80	3.30
Pasighat (CAU)	-	-	0.50	0.50	4.00	4.00	-	4.00	-	4.50	-	4.50
Kanke (BIRSAU)	-	-	0.66	0.35	2.66	0.35	-	0.35	-	0.70	0.24	0.94
Kalyani (BCKVV)	-	-	-	-	-	-	-	-	-	-	-	-
Kota (AUK)	-	-	0.66	0.50	2.66	2.00	-	2.00	-	2.50	0.80	3.30
Navasari (NAU)	-	-	0.66	0.50	2.66	0.42	-	0.42	-	0.92	0.30	1.22
Jabalpur (JNKV)	-	-	0.66	0.50	2.66	2.00	-	2.00	-	2.50	0.80	3.30
Mandor (AUJ)	-	-	-	-	1.00	1.00	-	1.00	-	1.00	0.33	1.33
Sanand (AAU)	-	-	-	-	1.00	1.00	-	1.00	-	1.00	0.33	1.33
Project mode funding												
Trichur (KAU)	-	-	-	-	1.00	1.00	-	1.00	-	1.00	-	1.00
Periyakulam (TNAU)	-	-	-	-	-	-	-	-	-	-	-	-
Total	-	-	5.96	4.84	27.47	19.61	-	19.61	-	24.45	5.10	29.55
Grand Total	481.33	361.04	23.96	18.34	81.47	60.98	1.90	62.88	26.66	19.74	462.00	612.31





XIX. WEATHER DATA

Chintapalle

Coimbatore

Month/ Year	Rainfall (mm)	No. of Rainy Days	Temperature (°C)		RH (%)	Rainfall (mm)	No. of Rainy Days	Temperature (°C)		RH (%)	
			Max.	Min.				Max.	Min.	I	II
April'14	7.8	2	37.47	27.2	94.96	18.5	4	30.1	23.11	83.93	57.18
May	21.61	10	34.98	25.4	94.5	299.5	11	26.81	20.55	93.32	80.71
June	25.84	25	31.52	25.72	94.5	91.4	15	23.96	19.16	93.3	89.8
July	37.39	31	29.58	24.87	94.45	517.9	25	20.63	17.46	97	90.38
Aug.	39.16	28	29.42	24.74	94	478.9	25	21.4	17.42	94.61	91.53
Sept.	16.74	20	30.74	24.47	90.4	148.8	16	22.98	18.38	95.06	94.43
Oct.	16.62	18	32.66	25.65	92.81	349.0	18	22.95	18.63	97.09	96.23
Nov.	13.38	10	33.93	24.22	93.13	114.6	12	22.32	17.97	94.93	93.53
Dec.	23.5	3	33.74	23.9	93.54	35.0	7	21.08	17.06	96.29	96.09
Jan.'15	23.8	1	33.88	22.17	93.71	Nil	Nil	20.55	17.34	96.03	96.26
Feb	-	-	-	-	-	Nil	Nil	22.34	18.73	91.68	94.96
March	-	-	-	-	-	36.4	4	30.1	23.11	92.42	95.74

Coimbatore

Yercaud

Month/ Year	Rainfall (mm)	No. of Rainy Days	Temperature (°C)		RH (%)		Rainfall (mm)	No. of Rainy Days	Temperature (°C)		RH (%)
			Max.	Min.	I	II			Max.	Min.	
April'14	17.4	1	36.3	24.9	81	39	34.5	5	27.7	18.7	29.5
May	125.8	5	34.3	24.4	85	52	107.0	10	26.9	18.8	55.6
June	10.6	1	32.8	24.3	79	53	92.5	4	26.9	19.5	69.0
July	41.2	5	30.7	23.3	78	60	41.0	3	24.8	17.9	75.0
Aug.	75.8	7	30.6	23.1	84	59	153.7	16	23.8	17.3	79.0
Sept.	90.4	5	31.9	22.6	85	55	170.2	12	23.3	17.0	77.0
Oct.	352.1	15	30.1	22.5	93	68	172	21	22.6	16.8	86.0
Nov.	3.4	0	29.5	21.3	90	58	54.5	5	21.8	15.0	85.3
Dec.	16.3	3	28.8	21.0	89	59	35.3	5	19.1	15.5	90.3
Jan.'15	0.0	0	30.1	19.5	86	47	0	0	20.7	13.7	84.91
Feb.	0.0	0	32.2	20.0	80	35	0	0	20.0	16.9	59.7
March	3.7	0	34.5	23.1	80	35	47	3	19.2	18.7	73.5

Mudigere

Sirsi

Month/ Year	Rainfall (mm)	No. of Rainy Days	Temperature (°C)		RH (%)		Rainfall (mm)	No. of Rainy Days	Temperature (°C)		RH (%)	
			Max.	Min.	I	II			Max.	Min.	I	II
April'14	188.7	12	31.41	18.78	87.26	78.90	36.8	3	35.1	21.1	82.5	70.0
May	265.6	11	31.53	18.53	86.96	74.54	107.6	7	32.5	22.1	81	74.0
June	306.4	17	28.25	17.80	84.63	73.60	333.6	12	29.5	21.5	88.5	84.0
July	1185.4	31	26.40	17.19	84.54	72.38	1016.4	25	26.7	20.9	90	89
Aug.	542.60	29	26.29	17.35	88.22	76.90	699.5	25	26.5	21	90	72.5
Sept.	365.40	22	27.41	18.75	90.63	80.70	196.6	12	27.6	20.5	87.5	69.0
Oct.	88.00	10	26.46	18.01	90.38	81.70	98.0	8	33	20	72	69
Nov.	12.00	2	26.96	17.41	84.03	73.46	36	3	29	12	58	59
Dec.	19.00	3	26.80	14.91	84.70	74.29	5.2	2	22	8	58	54
Jan.'15	-	-	-	-	-	-	0.0	0	18	8	46	47
Feb	-	-	-	-	-	-	4.0	2	26	12	42	40



Chintapalle

Month/ Year	Rainfall (mm)	No. of Rainy Days	Temperature (°C)		RH (%)		Rainfall (mm)	No. of Rainy Days	Temperature (°C)		RH (%)
			Max.	Min.	I	II			Max.	Min.	
April' 14	40.2	5.0	33.39	18.23	67.23	64.00	0.0	0.0	38.9	25.4	85.4
May	90.2	5.0	32.29	19.80	80.74	80.67	80.8	3	40.6	27.8	79.0
June	54.8	4.0	31.80	22.86	86.20	85.03	8.3	1	39.8	25.4	62.5
July	140.0	14.0	26.54	21.64	90.61	91.67	149.0	9.0	34.4	20.1	74.8
Aug.	233.2	15.0	26.87	21.35	90.19	91.16	130.6	8.0	34.19	19.7	82.7
Sept.	139.0	10.0	27.16	21.30	89.53	88.20	228.4	9.0	32.7	18.7	89.3
Oct.	259.4	10.0	27.38	18.32	91.45	91.29	133.0	5.0	31.8	17.0	93.3
Nov.	4.0	1.0	26.83	14.08	90.56	91.66	45.2	3.0	30.6	21.5	95.8
Dec.	0.0	0.0	25.32	10.12	89.54	91.12	0.0	0.0	29.8	18.4	89.5
Jan.' 15	9.0	1.0	25.19	7.96	89.83	90.64	0.0	0.0	29.9	17.6	92.6
Feb.	8.0	1.0	27.89	10.32	87.67	88.07	0.0	0.0	32.1	19.5	94.5
March	98.4	7.0	29.38	15.61	87.00	91.09	0.0	0.0	35.6	24.1	92.3

Guntur

Dapoli

Month/ Year	Rainfall (mm)	Temperature (°C)	RH (%)		Rainfall (mm)	No. of Rainy Days	Temperature (°C)		RH (%)	
			I	II			Max.	Min.	I	II
April' 14	5.02	33.53	20.70	88.00	40.0	3	42.5	26.5	76.0	58.0
May	6.51	33.39	23.79	82.07	63.0	12	43.0	28.5	73.0	57.0
June	8.36	31.99	25.29	87.39	99.0	8	39.5	27.5	73.0	60.0
July	9.23	28.39	23.72	95.14	329.7	20	38.5	25.5	86.0	64.0
Aug.	6.03	28.29	23.86	94.79	380.9	20	34.5	23.5	88.0	70.0
Sept.	4.98	29.68	23.40	92.96	157.0	10	30.5	19.5	84.0	69.0
Oct.	2.47	32.58	21.26	91.14	314.2	5	29.5	17.5	81.0	68.0
Nov.	2.33	33.19	18.00	88.61	9.0	1	24.5	15.5	80.0	65.0
Dec.	2.63	31.63	15.50	86.09	21.0	1	23.5	9.5	79.0	60.0
Jan. ' 15	2.85	30.35	12.99	86.51	7.0	1	25.5	10.5	79.0	59.0
Feb.	3.53	31.79	13.29	88.96	Nil	-	28.5	15.5	73.0	57.0
March	4.38	33.26	18.58	87.64	Nil	-	31.5	22.5	71.0	53.0

Pottangi

Jagudan

Month/ Year	Rainfall (mm)	No. of Rainy Days	Temperature (°C)		RH (%)		Rainfall (mm)	No. of Rainy Days	Temperature (°C)		RH (%)	
			Max.	Min.	I	II			Max.	Min.	I	II
April' 14	0.0	0	39.59	20.66	67.5	41.7	0.0	0.0	35.3	22.2	84.0	42.0
May	6.8	2	42.01	25.84	51.6	32.4	0.0	0.0	34.9	25.8	83.0	56.0
June	0.0	0	40.69	28.41	82.0	69.25	36.0	5.0	33.7	27.9	80.0	63.5
July	455.0	12	35.28	25.94	93.0	85.4	719.0	14.0	30.8	25.8	90	79.6
Aug.	125.0	10	33.43	25.67	89.25	75.75	324.0	17.0	30.3	25.1	93.2	79.5
Sept.	388.8	9	33.51	23.57	87.5	73.0	379.0	17.0	31.3	24.5	92.5	60.0
Oct.	0.0	0	35.64	25.17	86.2	76.2	0.0	0.0	35.9	22.4	83.2	39.6
Nov.	0.0	0	32.93	20.09	87.0	72.0	67.0	3.0	33.9	20.5	83.2	41.2
Dec.	0.0	0	27.6	11.83	-	-	0.0	0.0	30.0	13.9	76.5	41.0
Jan.' 15	9.9	2	26.67	9.72	-	-	0.0	0.0	28.9	12.9	79.5	36.8
Feb.	15.2	1	31.86	12.54	-	-	0.0	0.0	30.9	14.1	83.4	38.9
March	0.0	0	34.34	17.23	-	-	10.0	2.0	32.5	18.2	85.5	44.8

Navsari



Jobner**Jabalpur**

Month/ Year	Rainfall (mm)	No. of Rainy Days	Temperature (°C)		RH (%)		Rainfall (mm)	No. of Rainy Days	Temperature (°C)		RH (%)	
			Max.	Min.	I	II			Max.	Min.	I	II
April '14	6.4	1	36.6	17.0	61	25	-	-	-	-	-	-
May	21.2	2	39.2	22.9	55	21	-	-	-	-	-	-
June	Nil	Nil	41.8	28.3	51	28	159.4	7	39.6	26.8	58	33
July	131.2	11	35.4	25.7	78	56	316.5	18	32.7	24.9	62	64
Aug.	48.8	4	32.9	24.1	84	63	241.7	11	31.0	24.3	86	67
Sept.	76.6	6	32.8	22.0	82	54	199.0	14	31.5	23.1	89	61
Oct.	17.0	2	34.4	17.4	76	32	041.6	3	31.2	18.8	88	46
Nov.	Nil	Nil	29.3	10.9	70	31	000.0	00	29.9	12.2	84	25
Dec.	Nil	Nil	23.9	5.4	87	38	004.8	1	24.6	07.7	87	35
Jan. '15	10.2	1	21.5	6.2	88	47	058.7	7	21.2	08.6	89	53
Feb.	4.0	1	27.2	10.3	81	36	020.6	2	27.5	11.0	86	41
March	18.2	1	29.2	14.3	73	34	091.0	7	29.4	14.6	84	39

Solan**Hisar**

Month/ Year	Rainfall (mm)	Temperature (°C)		RH (%)	Rainfall (mm)	No. of Rainy Days	Temperature (°C)		RH (%)	
		Max.	Min.				Max.	Min.	I	II
April '14	57.6	26.3	10.4	52	16.4	3	34.1	17.1	72	35
May	51.2	30.0	14.4	57	56.5	3	38.4	22.2	66	30
June	101.8	32.6	17.8	58	71.6	4	41.0	26.3	61	34
July	361.0	28.1	19.2	76	73.1	4	37.4	27.5	77	51
Aug.	83.8	28.8	18.6	72	34.2	2	36.4	26.3	80	52
Sept.	129.4	27.9	16.1	71	81.5	4	34.7	23.8	84	52
Oct.	15.7	25.7	10.3	60	21.3	2	33.2	18.5	84	39
Nov.	0.0	23.6	05.7	49	0.0	0	28.2	10.2	84	32
Dec.	75.6	19.7	02.4	58	9.0	1	19.5	6.0	96	61
Jan. '15	49.4	17.1	02.6	63	2.0	4	16.2	6.0	97	73
Feb.	-	-	-	-	15.4	2	23.5	9.6	91	54
March	-	-	-	-	12.2	5	26.5	12.4	92	54

Dholi**Kanke**

Month/ Year	Rainfall (mm)	No. of Rainy Days	Temperature (°C)		RH (%)		Rainfall (mm)	No. of Rainy Days	Temperature (°C)		RH (%)	
			Max.	Min.	I	II			Max.	Min.	I	II
April '14	Nil	Nil	36.7	18.5	86.8	68.6	2.0	0	35.4	18.3	83.4	66.1
May	51.4	3	37.1	23.6	87.5	51.4	55.7	5	35.6	21.0	82.0	58.7
June	148.6	6	35.3	26.2	92.5	63.8	101.2	6	34.1	23.2	83.8	59.8
July	384.8	8	32.2	25.9	92.5	78.0	206.6	14	30.5	22.9	83.4	72.7
Aug.	402.2	9	31.8	26.2	94.3	79.4	195.3	16	29.7	22.7	82.4	72.6
Sept.	236.4	5	32.2	25.2	96.2	78.6	179.2	10	29.8	21.3	82.8	72.6
Oct.	104.4	2	31.4	20.9	96.0	77.5	39.4	3	28.6	17.3	81.3	69.1
Nov.	Nil	0	28.5	13.2	99.1	79.9	0.0	0	25.6	8.8	81.9	66.8
Dec.	Nil	0	29.6	10.4	99.6	89.3	0.0	0	21.5	4.3	82.1	69.1
Jan. '15	6.4	2	19.1	10.0	99.3	87.1	22.2	2	21.2	7.7	82.5	71.5
Feb.	11.0	1	25.1	12.0	99.4	76.8	8.1	1	26.8	12.7	83.2	66.9
March	10.4	2	29.1	16.1	94.0	62.9	4.1	1	28.9	16.0	82.4	61.9



Pundibari

Month/ Year	Rainfall (mm)	Temperature (°C)		RH (%)		Rainfall (mm)	Temperature (°C)		RH (%)	
		Max.	Min.	I	II		Max.	Min.	I	II
April'14	9.4	33.9	20.2	80	47	0.0	34.74	23.35	90.06	57.23
May	547.4	31.7	22.8	90	69	44.5	43.40	26.46	88.83	71.93
June	689.0	31.7	25.4	94	77	172	43.81	26.00	95.33	76.80
July	232.8	32.9	26.5	92	74	253.4	32.47	25.75	96.96	82.95
Aug.	479.8	31.0	25.8	94	84	361.1	32.07	24.69	93.67	85.35
Sept.	523.0	31.3	24.6	95	78	179.1	31.03	27.98	97.60	82.50
Oct.	3.8	31.8	21.4	90	66	77	30.31	21.97	93.70	85.00
Nov.	0.0	29.2	17.3	92	56	0.0	29.47	14.98	95.00	57.78
Dec.	0.0	25.0	12.6	95	58	0.0	24.27	11.16	97.20	63.00
Jan.'15	21.8	23.3	11.5	95	58	1.2	25.16	14.37	95.65	58.35
Feb.	56.8	25.3	12.9	94	54	7.3	28.74	14.42	86.98	55.58
March	102.8	29.0	17.2	86	50	21.2	32.50	18.33	99.67	63.50

Kalyani

Mizoram

Month/ Year	Rainfall (mm)	No. of Rainy Days	Temperature (°C)		RH (%)		Rainfall (mm)	Temperature (°C)		RH (%)	
			Max.	Min.	I	II		Max.	Min.	I	II
April'14	93.30	6	32.54	23.05	71	41	6.17	30.8	15.1	61.0	47.2
May	473.90	17	30.96	22.51	75	43	33.95	29.2	17.6	78.1	62.0
June	334.30	19	31.03	24.28	65	42	85.48	28.6	19.3	89.1	76.9
July	954.90	23	31.55	24.13	63	35	16.95	29.1	20.0	87.7	71.8
Aug.	349.70	21	30.12	22.82	68	31	120.3	27.9	19.2	87.8	75.9
Sept.	596.70	19	29.77	22.81	76	29	112.42	27.3	18.1	87.9	74.0
Oct.	62.70	4	30.31	21.85	57	22	48.97	27.3	14.7	84.9	66.2
Nov.	3.80	1	26.64	18.97	65	22	0.93	24.0	10.8	85.6	59.0
Dec.	0.00	0	24.47	30.24	59	24	0.7	22.4	7.0	81.9	52.8
Jan.'15	16.40	2	24.54	13.00	73	26	7.9	21.6	6.6	82.6	55.3
Feb.	34.20	2	26.52	15.98	64	32	4.3	22.3	6.7	80.5	44.0

Barapani

Gangtok

Month/ Year	ICRI, Kabi farm				ICRI, Pangthang farm			
	Max (°C)	Min (°C)	Rainfall (mm)	No. of rainy days	Max (°C)	Min (°C)	Rainfall (mm)	No. of rainy days
April '14	22.9	7.3	259.5	16	17.4	9.2	295.0	13
May	24.1	10.7	930.0	24	18.8	11.1	640.0	23
June	26.0	13.0	673.9	24	20.5	13.6	864.0	24
July	25.8	13.9	727.7	27	20.6	13.9	766	25
Aug.	24.3	14.8	823.6	29	19.3	4.9	771.0	30
Sept.	23.5	15.1	371.1	24	18.6	12.3	563.0	24
Oct.	21.0	15.2	82.7	4	16.7	10.1	76.0	6
Nov.	17.3	11.1	10.6	1	12.9	8.2	6.0	1
Dec.	13.9	8.5	9.2	1	10.9	9.5	8.0	1
Jan. '15	14.1	9.2	11.1	1	9.2	4.2	10.0	2
Feb.	16.9	9.8	14.7	3	11.2	6.1	21.0	4
March	21.6	11.8	140.8	10	11.8	8.2	136	6





Pasighat

Month/Year	Rainfall (mm)	Temperature (°C)		Relative Humidity (%)
		Max.	Min.	
April' 14	68.90	27.40	23.39	73.05
May	514.60	28.79	24.921	84.98
June	493.50	32.22	28.11	84.45
July	312.5	31.58	28.69	83.64
Aug.	1003.00	28.40	26.80	92.15
Sept.	385.90	30.93	29.55	83.24
Oct.	385.90	31.00	29.70	83.10
Nov.	21.50	29.00	25.37	67.35
Dec.	0.00	25.80	22.30	68.15



Large Cardamom Cultivation in Arunachal



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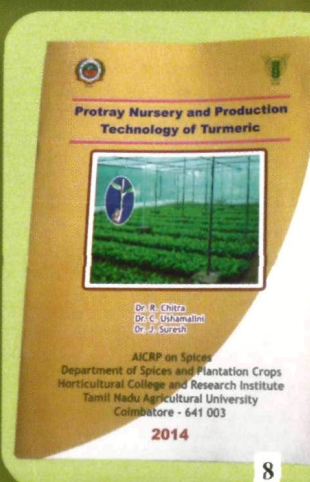
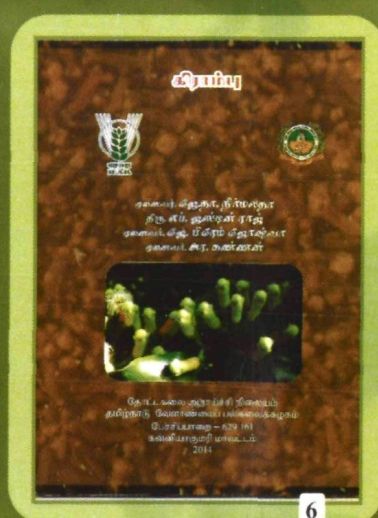
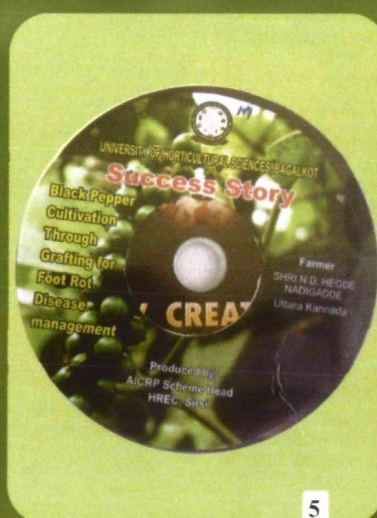


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Publications released during 25th AICRPS workshop



1. & 2. Black Pepper and Ginger Cultivation Practices (Telugu)
3. Black Pepper Cultivation Practices (Odiya & English), Off-season Coriander (Odiya) & Organic Chilli Cultivation (Odiya)
4. & 6. Nutmeg & Clove Cultivation Practices (Tamil)
5. e- Publication - Success Story On Black Pepper Grafting (Kannada)
7. Turmeric Cultivation Practices (Telugu)
8. Protray Nursery and Production Technology of Turmeric (English)
9. Turmeric Production Technology (English)



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