



वार्षिक रिपोर्ट Annual Report 2012-13



घोटपइ

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

Indian Institute of Spices Research
(*Indian Council of Agricultural Research*)
Kozhikode - 673012, Kerala, India





Published by

K. Nirmal Babu
Project Coordinator, Spices
All India Coordinated Research Project on Spices
(Indian Council of Agricultural Research)
Kozhikode – 673 012, Kerala, India
Phone: 0495 2731954, Fax: 0495 2731954
Email: aicrps@spices.res.in, aicrspices@gmail.com
Website: www.aicrps.res.in

Compiled by

C. K. Thankamani
Johny A. Kallupurackal

Hindi Translation

Rashid Pervez
N. Prasannakumari

Cover Design

A. Sudhakaran

Correct Citation

All India Coordinated Research Project on Spices, 2013
Annual Report, 2012-13
Indian Institute of Spices Research
Calicut, Kerala

Printed at

G.K. Printers, Kochi - 17



Contents

1	Executive summary (Hindi)	4
2	Executive summary (English)	10
3	Profile of AICRP on Spices	17
4	Experimental Results in Black pepper	20
5	Experimental Results in Cardamom	31
6	Experimental Results in Large Cardamom	39
7	Experimental Results in Ginger	41
8	Experimental Results in Turmeric	53
9	Experimental Results in Tree spices	68
10	Experimental Results in Coriander	75
11	Experimental Results in Cumin	87
12	Experimental Results in Fennel	93
13	Experimental Results in Fenugreek	100
14	Monitoring and meeting	109
15	Technologies recommended for transfer to extension agencies	111
16	Popularization of technologies	114
17	Publications	115
18	Technical Programme 2012-13	125
19	Staff position	132
20	Centerwise Budget 2012-13	136
21	Weather data	138
22	AICRPS centres	149

कार्यकारी सारांश

अखिल भारतीय समन्वित मसाला अनुसंधान परियोजना (ए आई सी आर पी एस) का मुख्यालय भारतीय मसाला फसल अनुसंधान संस्थान, कोषिकोड (केरल) में स्थित है। इस परियोजना के अन्तर्गत भारत के 21 राज्यों में मसालों के लिये अनुकूल विभिन्न कृषि जलवायु क्षेत्रों में 12 प्रमुख मसालों (19 नियमित, 8 सहयोगी तथा 7 अवैतनिक केन्द्र) पर केन्द्रित है। अधिदेश फसलों पर शोध कार्य करने वाले केन्द्रों की संख्या काली मिर्च (9 केन्द्र), छोटी इलायची (4 केन्द्र), बड़ी इलायची (2 केन्द्र), धनिया (12 केन्द्र), सौंफ (9 केन्द्र), मेथी (12 केन्द्र), वृक्ष मसाले जैसे जायफल, लौंग, दालचीनी (प्रत्येक के 3 केन्द्र) है। वर्ष 2012-13 बजट में भारतीय कृषि अनुसंधान परिषद की भागीदारी लगभग 625 लाख रुपये है। विभिन्न केन्द्रों में अधिदेश फसलों पर आनुवंशिक संसाधन, फसल सुधार, फसल उत्पादन, फसल संरक्षण, फसलोत्तर प्रौद्योगिकी एवं तकनीकियों की प्रदर्शनी पर कार्य करने वाले वैज्ञानिकों तकनीकी कर्मचारियों एवं सहायक कर्मचारियों द्वारा 97 परियोजनाओं का कार्यक्रम गतिमान है।

शोध उपलब्धियां

नये कार्यक्रम

इस वर्ष गरमी बाहुल क्षेत्रों का सर्वेक्षण करके तथा काली मिर्च के दो, इलायची का एक तथा जायफल का एक शुष्कता रोधी पौधों को संचित किया। किसानों के खेतों का सर्वेक्षण आयोजित करके काली मिर्च की 3, लौंग की 1 तथा जायफल की 6 प्रजातियों को उन्नत प्रजातियों के संकलन में संचित किया। विशिष्ट आशाजनक संकलनों को विशेषकर, वृक्ष मसालों को विशेष बाग में स्थापना के लिये रोपण किया। अदरक एवं हल्दी में केन्द्रीय जननद्रव्य शाला बनायी गयी जिससे विमोचित प्रजातियों को संभावित मिश्रण से बचाया जा सके। इन केन्द्रों तथा एन ए जी साइट के बीच जननद्रव्यों का अच्छा लेन देन है।

प्रजातियों की जल्दी पहचान करने के लिये प्रजाति विवरण की एक रूप रेखा तैयार की जा रही है जो रोपण सामग्रियों में अपमिश्रण की जांच करने में सहायक होगी। बीज मसालों के बीज गाव /क्लस्टर्स को प्रजातियों के मिश्रण से बचाने के लिये लोकप्रिय कर रहे है।

कम सिंचाई / फरटिगेशन परीक्षण के फलस्वरूप उच्च गुणवत्ता युक्त अधिक उपज, रोग आपतन में कमी, 30% कम जल का उपयोग तथा श्रमिकों में कमी अंकित की गयी।

23वीं ए आई सी आर पी कार्यशाला में विमोचित करने के लिये संस्तुत प्रजातियां

कोषिकोड में संपन्न हुई कार्यशाला में सकलेशपुर केन्द्र की इलायची की नयी प्रजाति आई सी आर आई-8, कुमारगंज की हल्दी प्रजाति एन डी एच-9, पीचिपराई से लौंग की पहली प्रजाति पी पी आई (सी एल) 1, हिसार तथा गुंदूर से धनिया की क्रमशः डी एच 220 तथा सुगुणा प्रजाति, हिसार तथा जोबनर से सौंफ की क्रमशः एच एफ 143 तथा आर एफ- 281 प्रजातियां, अजमेर तथा बिकानेर से क्रमशः अजमेर मेथी - 3, आर एम टी-365 हिसार से अजोवाइन प्रजाति हज 18 को विमोचित करने के लिये संस्तुत किया गया।

सहयोग

निजी संस्थाओं में अदरक की संरक्षित खेती की क्षमताओं का निरीक्षण किया जा रहा है।

डी ए एस डी तथा एन एच एम के सहयोग से रोग एवं कीट प्रतिरोधक प्रजातियों के बीज गुणन कार्यक्रम को विमोचित हो रहा है। रोग आपतन को कम करने के लिये स्वस्थ रोपण सामग्रियों का वितरण सुनिश्चित करने के लिये उत्तम कृषि पद्धतियों को अमल में लाया जा रहा है।

जैव प्रौद्योगिकी विभाग की मदद से अदरक एवं हल्दी की रोपण सामग्रियों को बहुगुणित करने हेतु सूक्ष्म प्रकन्दों को नागालैंड विश्वविद्यालय को स्थानान्तरित किया जा रहा है।





प्रबोधन

क्यू आर टी ने ए आई सी आर पी के सभी केन्द्रों के कार्यों का निरीक्षण किया तथा सदस्य गण कार्य पर संतुष्ट रहे। विभिन्न केन्द्रों के कार्य को 6 मासिक रिपोर्ट एवं केन्द्रों के खेत भ्रमण के अनुसार प्रबोधन किया गया।

काली मिर्च

प्रस्तुत वर्ष 65 से अधिक अक्सेशनों को विभिन्न केन्द्रों जैसे पन्नियूर, अम्बलवयल, चिन्तापल्ली, दापोली, पुंडिबारी, सिरसी तथा येरकाड में काली मिर्च जननद्रव्य में संरक्षित किया गया। पन्नियूर में काली मिर्च जननद्रव्य का प्राथमिक मूल्यांकन करने पर सूचित किया कि 57 कि. ग्राम हरे फल की उपज एवं 1045 स्पाइक / बेल के साथ कल्टिवार 64 प्रथम आयी। केरल सरकार ने इस वर्ष फाइटोफथोरा प्रतिरोधकता युक्त एक अन्तर प्रजातीय संकर पी 8 को विमोचित किया। फाइटोफथोरा के सह अक्सेशन 53 के अंगीकरण के लिये स्वीकृत किया गया तथा करनाटक क्षेत्र में किसानों की प्रजाति आदिमने पेप्पर के रूप में विमोचित किया गया। इस क्षेत्र में शुष्क फल की उपज क्रमशः राज्य की औसत उपज 1 कि. ग्राम / बेल / वर्ष तथा राष्ट्र की औसत उपज <1 कि. ग्राम / बेल / वर्ष की तुलना में दुगुना है।

अन्तर प्रजातीय संकरण में संकर पी आर एस 160 तथा पी आर एस 161 को आशाजनक देख लिया। काली मिर्च की सी वी टी परीक्षण में सी यु एल 5489 को उत्तम देख लिया तथा पन्नियूर में अधिकतम उपज 2.51 कि. ग्राम / बेल अंकित की। सिरसी में पाइपर नाइग्रम पर पन्नियूर 1 आरोही प्ररोह को कलम के रूप में तथा आई आई एस आर शक्ति प्रजाति को रूटस्टाक के रूप में लेकर कलम बांधने पर अधिकतम ऊंचाई अंकित की।

येरकाड में जैविक खेती के अन्तर्गत एफ वाई एम 10 कि. ग्राम, अज़ोस्फिरिल्लम 50 ग्राम, फोस्फोबैक्टीरिया 50 ग्राम तथा वी ए एम 200 ग्राम प्रति बेल को लगाने पर अधिकतम शुष्क फल उपज (4.78 कि. ग्राम / बेल) प्राप्त हुई। पन्नियूर में काली मिर्च पर 50 % आर डी एफ द्वारा साप्ताहिक अन्तराल में ड्रिप फर्टिगेशन (81) करने पर अधिकतम स्पाइक उपज (5.88 कि.ग्राम / बेल) अंकित की।

सिरसी में, काली मिर्च की सह प्रजातियां, आई आई एस आर शक्ति तथा आई आई एस आर थेवम ने फाइटोफथोरा खुर गलन रोग आपतन कम (क्रमशः 10.98 तथा 13.72) अंकित किया। काली मिर्च बेल जीवाणु संघ (1% की दर) के साथ (वृद्धि, सूत्रकृमि तथा फाइटोफथोरा दबाव आई आई एस आर 6 तथा आई आई एस आर 859) (प्रति बेल 21 की दर) में छिडककर उपचारित करने पर तथा (प्रति बेल 31 की दर) ड्रिपिंग एवं ट्राइकोडेरमा हर्ज़ियानम (एम टी सी सी 5179) के साथ प्रति बेल 50 ग्राम की दर में 1 कि. ग्राम नीम केक के साथ मूल क्षेत्र में मनसून के पहले (जून 2012) तथा मनसून के बाद (अगस्त 2012) को मृदा में लगाने पर रोग आपतन कम (10.45%) अंकित की। सिरसी में नये कवक विषाक्त अणुकणिकाओं को 0.1% की दर में फेनामिडोन (10%) + मेनकोज़ेब (50%) (सेक्टिन) अकेले तथा फेनामिडोन (10%) + मेनकोज़ेब (50%) (सेक्टिन) प्रति बेल 21 की दर में छिडककर तथा ड्रिपिंग प्रति बेल 31 की दर में जैव कारक ट्राइकोडेरमा हर्ज़ियानम (एम टी सी सी 5179) 50 ग्राम को 1 गि. ग्राम नीम केक के साथ मृदा में जून 2012 को पहले सप्ताह तथा अगस्त 2012 के तीसरे सप्ताह में अलग ही लगाने पर रोग में विशेषकर, पर्णों पर कीट बाधा (6.06% तथा 4.24%) में सांख्यिकीय दृष्टि से महत्वपूर्ण कमी, बेल के पीलापन की कमी (7.88 पी डी आई तथा 6.67 पी डी आई), सबसे कम पतझड़ (8.50 पी डी आई तथा 6.06 पी डी आई), बेलों की कम मृत्यु (7.27% तथा 4.86%) अंकित की तथा अधिकतम हरे फल उपज (2.93 कि. ग्राम / बेल तथा 3.16 कि . ग्राम / बेल) अंकित की।



इलायची

पाम्पाडुमपारा में किये गये सी वी टी में जीन प्रकार पी एस 27 ने अधिकतम उपज 597 ग्राम/ पौधा अंकित की जिसके पश्चात् एम एच सी 26 में 306 ग्राम/पौधा आता है तथा मुडिगरे में सी एल-722 (232 कि.ग्राम/हेक्टर) ने अधिकतम उपज अंकित की जिसके पश्चात् पी एस 27 (275.58 कि.ग्राम/हेक्टर) आता है। सकलेशपुर में किये अन्य सी वी टी के अनुसार प्रति पौधा अधिकतम उपज एस के पी 164 (1106.50 ग्राम/पौधा) अंकित की जबकि अप्पंगला में आई सी 349545 ने अधिकतम उपज (957 कि.ग्राम/ हेक्टर) अंकित की।

मुडिगरे में 100% संस्तुत मात्रा (125:125:250 एन पी के कि. ग्राम /हेक्टर) में उर्वरक लगाने के साथ 9 लिटर / क्लंप/दिन ड्रिप सिंचाई करने पर अधिकतम कैप्सूल उपज (205.35 कि. ग्राम/ हेक्टर) अंकित की जो संस्तुत मात्रा (199.25कि. ग्राम/ हेक्टर) 9 लिटर / क्लंप /दिन सिंचाई करने से काफी दूर है। पाम्पाडुमपारा में किये एक सी वी टी में, जैविक खेती परीक्षण में, 30 टन एफ वाई एम + संस्तुत एन पी के (125:125:250 कि. ग्राम/ हेक्टर) लगाने से शुष्क कैप्सूल उपज (250.65 कि. ग्राम/ हेक्टर) अंकित की जबकि जीवामृत + अज़ोस्फिरिल्लम (10 ग्राम/क्लंप) + 10 ग्राम पी एस बी /क्लंप + ट्राइकोडरमा 10 ग्राम / क्लंप लगाने पर अधिकतम कैप्सूल उपज (66.59 ग्राम / पौधा अंकित की। पाम्पाडुमपारा में नींबू चूर्ण 2 कि. ग्राम / पौधे की दर में इलायची को लगाने पर उपज में नियन्त्रण (नींबू रहित) से परे 208% वृद्धि हुई।

मुडिगरे में नये इलायची बाग में राइज़ोम एवं पनिकल गलन के प्रबन्धन के लिये कोप्पर ओक्सिक्लोराइड 0.3% छिडकना तथा ड्रिगिंग करने पर न्जल्लानी गोल्ड में पनिकल रोग बाधा कम तथा अधिकतम उपज (1085.30 कि. ग्राम) प्राप्त हुये जो ट्राइकोडरमा हरज़ियानम तथा जीवाणु संघ को मिलाकर लगाने से मिलने वाले फल से काफी अधिक है।

पानी का मीथोमिल (1.5 ग्राम / लिटर) तथा इमिडाक्लोप्रिड 0.5 मि. लिटर की दर में लगाने से मुडिगरे में थ्रिप्स तथा कैप्सूल बेधक का नियन्त्रण करने में प्रभावी फल देख लिया जबकि पाम्पाडुमपारा में इमिडाक्लोप्रिड लगाने से थ्रिप्स का आक्रमण सबसे कम हो गये। पाम्पाडुमपारा में पोनीम लगाने से प्ररोह बेधक का अच्छा प्रबन्धन देख लिया।

बडी इलायची

पश्चिम बंगाल के सिक्किम तथा डारजिलिंग पहाड़ों से कोलेटोटाइकम ग्लोयियोस्पोरियोयिड्स द्वारा होने वाले ब्लाइट रोग से बचे हुये चौदह अक्सेशनों को संचित किया। इन्हीं अक्सेशनों के प्रत्येक के छः यूनितों को आई सी आर आई रिसर्च फार्म, कबी में अतिरिक्त गुणन तथा मूल्यांकन के लिये रोपण किया गया।

सकेर्स को जैवकारकों (प्स्यूडोमोनास फ्लूरोसेंस + बासिलस सबटिलिस) को 3% द्वारा उपचार करने पर नियन्त्रण की अपेक्षा प्रत्येक ने ब्लाइट आपतन कम दिखा दिया।

आई सी ए आर, गैंगटोक में, मीली बग (नियन्त्रण के द्वारा 72.54% कमी) तथा एफिड्स (नियन्त्रण के द्वारा 79.76% कमी) का नियन्त्रण करने में पेट्रोलियम एग्रीस्प्रे 7 मि. लिटर / लिटर की दर में दो बार छिडकना प्रभावी देख लिया। लहसून की सता 10% को छिडकना या ड्रिगिंग दोनों करने से उसी क्षेत्र में नियन्त्रण (30.51%) की अपेक्षा ब्लाइट आपतन में कमी अंकित की।



अदरक

विभिन्न केन्द्रों के विभिन्न प्रजातियों की दक्षता का विभिन्न केन्द्रों में जी x ई की उपज में व्यापक अन्तर (4.5 टन/ हेक्टर से 34.38 टन/ हेक्टर) देख लिया। नदिया प्रजाति (22.75 टन/ हेक्टर) ने चिन्तापल्ली में उत्तम दक्षता प्रस्तुत की, जो मिसोराम की हिमगिरी में (15.43 टन/ हेक्टर) है, तथा वरदा ने कल्याणी में (34.83 टन/ हेक्टर), बारापानी में वी 3 एस 18 (4.5 टन/ हेक्टर), पुंडिबारी में जी सी पी -5 (11.48 टन/ हेक्टर), पासीघाट में सुरभि (23.34 टन/ हेक्टर), कंके में सुप्रभा (33.5 टन / हेक्टर) तथा सोलन में एस जी-26/04 (20 टन/ हेक्टर) आदि उत्तम उपज देने वाले थे। बारापानी की प्रजाति सुरुचि (10.5%) तथा पासीघाट में सुरभि (8.5%) ने अधिकतम ओलिओरसिन की मात्रा अंकित की। अधिकतम तेल की मात्रा बारापानी में महिमा (2.65%) में है जबकि सुरुचि ने पासीघाट में अधिकतम एसनशियल तेल (1.97 %) दिखा दी।

चिन्तापल्ली में कवक प्रबन्धन द्वारा अदरक की खेती खर्च को कम करने हेतु एक परीक्षण प्रारंभ किया। हेरबिसाइड ओक्सिफ्लूरोफेन 23.5% ई सी (0.3कि.ग्राम ए आई / हेक्टर) ने अधिकतम उपज (24.50 टन / हेक्टर) अंकित की जो कवक रहित परीक्षण (25.45 टन / हेक्टर) से काफी भिन्न है।

बिहार की वैशाली जिला में धोली केन्द्र द्वारा किये गये सर्वेक्षण से जीवाणुक म्लानी का आपतन (23.89%) सूचित किया जो पाइथियम एफानिडेरमाटम द्वारा होने वाले मृदु गलन (8.89%) की अपेक्षा अधिक है।

रालस्टोनिया सोलानसीरम (सरसों द्वारा बायोफिमिगेशन) के कारण अदरक में होने वाले मृदु गलन रोग प्रबन्धन पर परीक्षण करने पर इस वर्ष भी मेटालक्सिल मैन्कोज़ेब का प्रयोग करने पर प्रकन्द गलन का न्यूनतम आपतन (2.45%) अंकित की, जबकि अधिकतम उपज सरसों के बायोफिमिगेशन(15 टन /हेक्टर) द्वारा अंकित किया गया। कुमारगंज में, अधिकतम प्रकन्दों का अंकुरण, न्यूनतम मृदु गलन आपतन तथा अधिकतम उपज (21.2 टन /हेक्टर) मेटालक्सिल मैन्कोज़ेब का प्रयोग करने से अंकित की जिसके पश्चात् सरसों द्वारा बायोफिमिगेशन करने पर प्राप्त हुआ। अदरक (काबेज द्वारा बायोफिमिगेशन) के मृदु गलन का प्रबन्धन करने के लिये अन्य परीक्षण में अधिकतम उपज एवं न्यूनतम मृदु गलन आपतन सोलन, पुंडिबारी तथा अम्बलवयल में काबेज बायोफिमिगेशन करने पर देख ली जबकि कुमारगंज में प्रकन्दों के मेटालक्सिल मैन्कोज़ेब द्वारा उपचार करने पर अधिकतम उपज एवं न्यूनतम मृदु गलन आपतन अंकित किया।

अदरक में सरसों द्वारा बायोफिमिगेशन करने पर अधिकतम उपज (15 टन/हेक्टर) तथा कम जीवाणुक म्लानी आपतन (2.25%) देख ली जबकि, पुंडिबारी में काबेज बायोफिमिगेशन करने पर अधिकतम उपज एवं न्यूनतम जीवाणुक म्लानी आपतन (5.92%) प्राप्त हुई।

हल्दी

इस वर्ष तमिलनाडु में अधिक उपजवाले अक्सेशन सी एल 101 का विमोचन किया गया। हल्दी जननद्रव्यों का संकलन एवं केटलोगिंग से जननद्रव्यों का मूल्यांकन भी विभिन्न केन्द्रों में किया गया। धोली में उपज के आधार पर आर एच 427 (68.0 टन/ हेक्टर) सी एच एफ टी 36 (30.4 टन/हेक्टर) पासीघाट में, लाला दुग्गिराला 27.9 टन/हेक्टर) राइगढ में पहचान किया। कुमारगंज में एन डी एच-74 तथा एन डी एच-79 (क्रमशः 35 टन/हेक्टर) पहली पक्वता के अन्तर्गत आशाजनक पहचान की गयी। पहचान किये मध्यम पक्वता की प्राविष्टि में एन डी एच-98 (42 टन/हेक्टर) की पहचान की गयी तथा एन डी एच-7 (35 टन/हेक्टर) को देरी से पक जानेवाले वर्ग में पहचान की गयी।



हल्दी में एक सी वी टी करने पर चिंतापतली में आर एच 80 (42 टन/हेक्टर), कोयंबतोर में सी एल 101 (45.64 टन/हेक्टर), धोली में आर एच 80 (6.70 टन/हेक्टर) कम्मरपल्ली में आर एच 9/90 (31 टन/हेक्टर) पोटांगी में पी टी एस 55 (14.8 टन/हेक्टर) पुंडिबारी तथा राइगढ में टी सी पी 70 (क्रमशः 14.25 टन/हेक्टर, 17.46 टन/हेक्टर) पासीघाट में आर एच 50 (51 टन/हेक्टर) नवसारी में आर एच 9/90 (22.22 टन/हेक्टर) अधिकतम उपज अंकित की। हल्दी की आई ई टी में पन्तनगर में पी टी 5 ने 35.58 टन/हेक्टर अधिकतम उपज अंकित की जिसके पश्चात पी टी-6 (29.12 टन/हेक्टर) आता है।

जी x ई अन्तक्रिया अध्ययन में हल्दी प्रजाति पोटांगी में टी सी पी I (13.9 टन/हेक्टर) कामरपल्ली में आर एच 9/90 (30.3 टन/हेक्टर), मिज़ोरम में आर सी टी-1 (29 टन/हेक्टर), कल्याणी में मेगाटरमरिक (30.5 टन/हेक्टर) अधिकतम उपज अंकित की।

एकीकृत पोषण प्रबन्धन में क्रमशः पुंडिबारी तथा राइगढ में अधिकतम हल्दी उपज (17.52 टन/हेक्टर तथा 19.68 टन/हेक्टर) अंकित की जबकि जैविक प्रबन्धन में अधिकतम उपज (27.2 टन/हेक्टर) तथा 19.68 टन/हेक्टर अंकित की जबकि जैविक प्रबन्धन में अधिकतम उपज (27.2 टन/हेक्टर) पोटांगी में अंकित की।

ड्रिप सिंचाई द्वारा हल्दी की जल आवश्यकताओं का परीक्षण मानकीकरण में, दिन में एक बार 80% पी ई ड्रिप सिंचाई करने पर कोयंबतोर (64.2 कि ग्राम/ प्लोट) तथा कामरपल्ली (29.8 टन/हेक्टर) अधिकतम उपज अंकित की जबकि कुमारगंज में उपरितल सिंचाई 5 से. मी. आई। डब्ल्यू सी पी ई अनुपात 0.09 अधिकतम उपज (32 टन/हेक्टर) अंकित की ।

कोयंबतोर में फर्टिगेशन परीक्षण में, अधिकतम उपज (59.11 कि ग्राम/10m²) 100 % आर डी एफ द्वारा हफ्ते में एक बार ड्रिप सिंचाई उपचार करने पर अंकित की गयी।

बोने के 60 तथा 90 दिनों के बाद मृदा में सूक्ष्म पोषण 25 कि.ग्राम /हेक्टर की दर में तथा दो बार पत्तों पर सूक्ष्म पोषण 0.5% की दर में छिड़कने पर अधिक उपज 55.18, तथा 55.96 टन/हेक्टर प्राप्त हुई जो धोली में नियन्त्रण की तुलना में 43.99 टन/हेक्टर हैं जबकि पुंडिबारी में मृदा में बोरोन लगाने पर उपज 20.61 टन/हेक्टर अंकित की।

कोयंबतोर में मातृ प्रकन्दों (35-40 ग्राम) को सीधे खेत में रोपण करने से अधिकतम उपज (67.64 कि.ग्राम / प्लोट) अंकित की जिसके पश्चात मातृ प्रकन्दों को टुकड़े (10-15 ग्राम) करके खेत (4 टुकड़े) में रोपण करने पर 61.51 कि ग्राम /प्लोट आता है जबकि चिन्तापल्ली में अधिकतम साफ प्रकन्दों की उपज टी 9 मातृ प्रकन्दों (35-40 ग्राम) द्वारा सीधे खेत में रोपण करने से 28.53 टन/हेक्टर प्राप्त हुई जिसके पश्चात टी 7 प्राथमिक रूप से पूर्ण लंबाई के प्रकन्द 25-30 ग्राम सीधे खेत में रोपण (24.57 टन/हेक्टर) करने से प्राप्त हुई जो 2 नोडवाले अन्तरित बीजपौधे से भिन्न थी।

गुणवत्तावाली शुष्क हल्दी न्यूनतम हानी के साथ प्राप्त होने के लिए हल्दी को 60 मिनट भाप में पकाना पर्याप्त होता है तथा पानी में उबालकर जो खतरनाक है, सुखन के समय में कोई महत्वपूर्ण अन्तर नहीं होता है। सूखने की अपेक्षा इसी रीति में पत्तों पर प्रोपिकोनजोल (0.1%) को 45 तथा 50 दिनों में छिड़कना पर्ण दाग कम करने में (19.33 पी जी आई) तथा पर्ण ब्लोच कम करने में (13.34 पी जी आई) उत्तम उपचार है जो अनुपचारित नियन्त्रण 61.56 पीजी आई की तुलना में कोयंबतोर में अधिकतम उपज प्राप्त हुई। यहीं उपचार कुमारगंज में भी प्रभावी है तथा पर्ण दाग (28.40) एवं पर्ण ब्लोच (28.5) का न्यूनतम आपतन अंकित किया तथा हेक्साकोनाज़ोल उपचार में (0.10%) बोने के 45 तथा 90 दिनों में करने पर अधिकतम प्रकन्द उपज (15.16 टन/हेक्टर) अंकित की।



वृक्ष मसाले

वृक्ष मसाले जैसे जायफल, दालचीनी, कैसिया तथा लौंग के जननद्रव्यों का संकलन करके दापोली एवं पीचिपराई में अनुरक्षण चरित्रांकन तथा कैटलोगिंग किया जाता है। लौंग का अक्सेशन एस ए 13 पीचिपराई में उच्चतम हैं तथा अधिकतम ऊँचाई (8.43 मि), शुष्क मुकुलों की उपज (4.50 कि ग्राम / पेड) तथा मुकुलों का तेल लॉकल चैक की अपेक्षा 6.78% अंकित की गयी। पीचिपराई में जायफल के अक्सेशनों का मूल्यांकन करने पर एम एफ 4 ने अधिकतम फल/पेड (940-25), ऊँचाई, वज़न (75.30 ग्राम) तथा अधिकतम शुष्क जावित्री उपज (419.59कि ग्राम /पेड) अंकित की।

पीचिपराई में किये सी वी टी में लौंग के नौ जीन प्रकारों में एस ए 3 प्रकार ने शुष्क कली/ पेड (2.95/ पेड) की दृष्टि में आशाजनक देख लिया। जायफल के संबन्ध में छः अक्सेशनों में से ए 9/ 150 ने अधिकतम पौधों की ऊँचाई (2.12 मीटर) तना का व्यास 1.96 से मी. अंकित की तथा अधिकतम प्ररोहों 20.50 अंकित किया। पीचिपराई में दालचीनी अक्सेशनों में सी. वी 5 ने अधिकतम शुष्क छाल उपज 545 ग्राम / पौधा अंकित की। कैसिया में सी वी टी के अनुसार जीन प्रकार के के वी सी टी एस एच आई ने अधिकतम व्यास (36.25 से. मी.) अंकित किया तथा तेल प्रतिशत 7.34% हैं जिसके पश्चात् आता हैं के के वी सी टी एस एच2 ने (क्रमशः 35.50 से मी. तथा 7.12%) अंकित की।

जीरा

जगुदान में किये एक सी वी टी में सी यु एम-11, सी यु एम- 10 ने अधिक उपज (840,743 तथा 736 कि. ग्राम /हेक्टर) प्राप्त हुए। जो क्रमशः चैक की जी सी-2 से अधिकतम है। जबकि अजमेर की जीरा 10(486 कि. ग्राम /हेक्टर) अंकित की। तीन वर्ष के (2009-2012) औसत के अनुसार मध्यम बाष्पशील तेल अंकित किया जबकि सी यु एम 13 में मध्यम बाष्पशील तेल की मात्रा को अधिकतम (3.57%) देख लिया। जिसके पश्चात सी यु एम 9 (3.56%) तथा आर इज़ड 209 (3.43%) को अंकित किया।

सौफ

धोली में जननद्रव्य अक्सेशन आर एफ 27, कुमारगंज में एन डी एफ 46, एन डी एफ 51 तथा एम डी एफ 67 को श्रेष्ठ उत्पादक के रूप में अंकित किया गया। सौफ के दो उच्च उपजवाली प्रकार आई ई टी एच एफ 151 (2104 कि. ग्राम / हेक्टर) तथा एच एफ 212 (1987 कि ग्राम /हेक्टर) 27% तथा हिसार एच एफ-33 (चेक) के 14.9% सी वी टी को बढ़ा दिया। जोबनर में किये सी वी टी में एफ एन एल 43 (1825 कि ग्राम /हेक्टर) को उपज की दृष्टि से आशाजनक देखा गया। वर्ष 2012 में प्रारंभ किये गये सी वी टी परीक्षण में पन्तनगर एफ एन एल 51 (3043 कि ग्राम /हेक्टर) कुमारगंज, अजमेर तथा जबलपूर (उपज 1336 कि. ग्राम /हेक्टर), क्रमशः 4342 कि. ग्राम /हेक्टर, 1618 कि. ग्राम /हेक्टर) तथा जगुदान में (1299 कि. ग्राम / हेक्टर अंकित किया गया। पी जी पी आर बायोफोर्मुलेशन्स का अच्छा प्रभाव बीजों को एफ के 14 (1020 कि. ग्राम /हेक्टर) राइगढ में बीज उपचार द्वारा प्राप्त हैं। सौफ में गुणवत्ता मूल्यांकन परीक्षण करने पर अधिकतम बाष्पशील तेल 2.43% एफ एन एल 46 में अंकित किया। थियामीथोक्सम 25 WG 0.0084 % को बीज के वाष्प हानि कम (7.44%) करने में तीन या 7 दिनों के बाद छिडकने तथा उत्पादन में जगुदान में 2029 कि. ग्राम / हेक्टर उपज अंकित किया।



मेथी

अक्सेशन एफ जी के 48 में किये गये सी वी टी में अधिकतम उपज अजमेर (2295 कि. ग्राम / हेक्टर), पन्तनगर (1805 कि. ग्राम / हेक्टर), नवसारी (1104 कि. ग्राम/ हेक्टर), राइगढ (978 कि. ग्राम/ हेक्टर), अंकित की जबकि एफ जी के 49 ने अधिकतम उपज जगुदान (2049कि. ग्राम/ हेक्टर), उदयपुर (1562 कि. ग्राम/ हेक्टर) तथा धोली (1750 कि. ग्राम/ हेक्टर) अंकित की। इस परीक्षण में कुमारगंज के एफ जी के 39 ने कुमारगंज में 1492 कि. ग्राम/ हेक्टर के साथ आशाजनक देख लिया। जोबनर में किये गये आई ई टी में मेथी अक्सेशनों में तीन वर्ष की अवधि में उच्चतम दक्षता यू एम 126 (2376.92 कि. ग्राम/ हेक्टर) में देख ली। हिसार में किये गये आई ई टी में एच एम 425 (3015 कि. ग्राम/ हेक्टर) ने अधिकतम उपज अंकित की जिसके पश्चात् आता है एच एम 257 (2895 कि. ग्राम/ हेक्टर जबकि पी एम (सी) -1 (2798.99 कि. ग्राम/ हेक्टर पन्तनगर में उच्चतम उत्पादक है। जोबनर में मेथी अक्सेशनों यु एम 301 तथा यु एम 112 को शुष्क सह्य जीन प्रकार के रूप में पहचान किया गया। पी जी पी आर बायो फोर्मुलेशन्स का महत्वपूर्ण गुणदायी प्रभाव बीजों को एफ जी के 14 + एफ एल 18 उपचार करने पर गुंटूर, कुमारगंज तथा हिसार में क्रमशः 1117.5कि. ग्राम/ हेक्टर, 1591 कि. ग्राम/ हेक्टर, 1963 कि. ग्राम/ हेक्टर प्राप्त हुई।

धनिया

वर्ष 2012 में किये गये सी वी टी में धनिया की उपज में 1220 से 2868 कि. ग्राम/ हेक्टर अन्तर होते हैं, समन्वित केन्द्रों में पहचान किये अशाजनक प्रविष्टियां गुंटूर में सी ओ आर 46 (1233कि. ग्राम/ हेक्टर), अजमेर में सी ओ आर 44 (1589 कि. ग्राम/ हेक्टर), कुमारगंज में सी ओ आर 38 (1527 कि. ग्राम/ हेक्टर),नवसारी में सी ओ आर 56 (1220 कि. ग्राम/ हेक्टर), उदयपुर में सी ओ आर 48 (1423 कि. ग्राम/ हेक्टर), तथा जबलपुर में सी ओ आर 40 (2868 कि. ग्राम/ हेक्टर), हिसार में सी ओ आर 41 तथा धोली में सी ओ आर 54 (2105कि. ग्राम/ हेक्टर) थी।

पर्ण उपयोग के लिये धनिया की सी वी टी करने पर (तीन वर्ष के पौधों में) अधिकतम उपज कोयंबतोर में जीन प्रकार सी एस 38 (4.28 कि. ग्राम/ प्लोट) में अंकित की जबकि एल सी सी -232 ने अधिकतम हरे पर्ण उपज गुंटूर में 2.59 टन/ हेक्टर अंकित की। हिसार में धनिया के बीजों के लिये (तीन वर्ष से आधिक) आई ई टी करने पर डी एच -281 तथा डी एच 314 को आशाजनक देख लिया। जोबनर में शुरू किये आई ई टी में यू डी 123 (2071 कि. ग्राम/ हेक्टर) ने अधिकतम उपज अंकित की। धनिया के नये आई ई टी वर्ष 2012 में जगुदान, गुंटूर, कुमारगंज में प्रारंभ की तथा अधिकतम उपज विभिन्न केन्द्रों के क्रमशः जे सी आर 389 (1301कि. ग्राम/ हेक्टर), एल सी सी 268 (1174 कि. ग्राम/ हेक्टर), एन डी सी ओ आर 101 (1527 कि. ग्राम/ हेक्टर) में अंकित किया गया। जोबनर में गुणवत्ता मूल्यांकन परीक्षण में सी ओ आर 48 बाष्पशील तेल की मात्रा (0.6%) में पहले आया जिसके पश्चात् सी ओ आर 44 (0.58%) आता है। जोबनर में आई ई टी परीक्षण में अधिकतम बाष्पशील तेल 0.45% यु डी 411 में देख लिया जिसके पश्चात् 0.40% यु डी 61 तथा यु डी 82 आता है।

शुष्क सूचनाओं के आधार पर टी ओ एल, एस एस 1 तथा एस टी 1, यु डी 13, यु डी 112, यु डी 436 तथा आर सी आर - 684 को जोबनर में शुष्क आवस्था में भी वांछनीय देख लिया। एन डी सी ओ आर 37 (27.73 ग्राम / पौधा) तथा एन डी सी ओ आर 36 (27. 63 ग्राम / पौधा) को कुमारगंज में क्षारीय गुण में सह्य प्रकार पहचान किया गया।



धोली में 144 जननद्रव्य के अन्तर्गत 110 जननद्रव्यों के तना छेद रोग के प्रति स्वाभाविक अवस्था में अधिक प्रतिरोधक देखा गया तथा इस रोग से संबन्धित ओरगानिज़म को किसानों के प्लोट में प्रोटोमाइसेस माक्रोस्पोरा के रूप में पहचान किया गया।

एक परीक्षण में धनिया में जैविक खाद द्वारा पोषण देने पर एकीकृत पोषण प्रबन्धन ने राइगड तथा धोली (1610 कि. ग्राम/ हेक्टर अधिकतम उपज अंकित किया। गुंटूर में एन पी के 45: 40: 20 कि. ग्राम / हेक्टर + जी ए 10 पी पी एम बीज बोने के 20 दिन तक छिडकने से समयेतर में अधिकतम धनिया के पत्तों का उत्पादन अंकित किया जबकि कोयम्बतोर में एन पी के 30 :40 :20 कि. ग्राम / हेक्टर + जी ए 15 पी पी एम बुआई के 20 दिनों के बाद अधिकतम पर्ण की उपज पंजीकृत की। बायोफोर्मुलेशन एफ के 14 ने गुंटूर में अधिकतम उपज 1166.5 कि. ग्राम / हेक्टर, राईगड में 990 कि. ग्राम / हेक्टर, कोयम्बतोर में 700 कि. ग्राम / हेक्टर अंकित की जबकि स्थानीय कल्टिवार प्रजाति (हिसार आनन्द) का उत्पादन हिसार में अधिकतम उपज (1745 कि. ग्राम / हेक्टर) अंकित की तथा जगुदान एवं अजमेर में बायोफोर्मुलेशन डालने से कोई लाभकारी प्रभाव नहीं दिखाई पडा।

तेईसवीं कार्यशाला में विस्तार अभियन्ताओं को अन्तरित करने के लिये संस्तुत तकनीकियां

1. इलायची मूल छेदक के प्रबन्धन में एन्डोमोपाथोजनिक सूत्रकृमियों का प्रयोग । छोटी इलायची (पाम्पाडुमपारा)
2. जैविक उपजों के साथ काली मिर्च के शल्क कीटों का प्रबन्धन (पाम्पाडुमपारा)
3. **हल्दी के लिये फर्टिगेशन तकनीकी (कोयम्बतोर)**
4. **हल्दी में जैविक पोषण प्रबन्धन (धोली)**
5. **हल्दी में एकीकृत पोषण प्रबन्धन**
6. **धनिया में जैविक खाद द्वारा पोषण प्रदान (कोयम्बतोर एवं गुंटूर)**
7. **धनिया में सूक्ष्म पोषण अपेक्षार्ये (कोयम्बतोर)**
8. **धनिया में सूक्ष्म पोषण प्रवर्धन(गुंटूर)**
9. **धनिया में एकीकृत पोषण प्रबन्धन (धोली)**
10. **जीरा की ग्लानी तथा ब्लाइट रोग का प्रबन्धन (जगुदान)**
11. **मेथी में एकीकृत पोषण प्रबन्धन (धोली)**



I. Executive Summary

The All India Coordinated Research Project on Spices (AICRPS) located in Kerala with its head quarters at IISR, Kozhikode is giving emphasis on 12 major spices at (19 regular, 8 co opting and 7 voluntary centres) spread over 21 states of the country representing various agro climatic zones suitable for spices. The number of centres working in mandatory crops include black pepper (10 centres, small cardamom (4 centres), large cardamom (2 centres), Ginger (14 centres), Turmeric (13 centres), Coriander (12 centres), fennel (9 centres), fenugreek (11 centres), Tree spices nutmeg, clove, cinnamon (3 centres each). The annual budget for the year, 2012-13 was around (Rs 625 lakhs as ICAR share). There are 97 projects handled by scientists supported by technical /auxiliary staff working on major areas of genetic resources, crop improvement, crop production, crop protection, post harvest technology and technology demonstration.

Research achievements during the year

New initiatives

This being severe drought year severely drought effected areas were surveyed and 2 drought escapes in black pepper one in cardamom and 1 in nutmeg was collected. Collection surveys were also undertaken to collect promising farmers varieties and 3 of black pepper, 1 of clove and 6 of nutmeg were collected. The unique promising collections were planted in a separate plot to establish 'specialty gardens' especially in tree spices. The nucleus germplasm concept was introduced in ginger and turmeric so that the released varieties are maintained

with out possible mixup. There was a good exchange of germplasm between the centres and NAGSsites.

A draft varietal descriptor with pictorial diagrams for quick identification of varieties is being prepared which will help in checking adulteration in planting material. In seed spices seed village/ clusters are being popularized to avoid mixing up of varieties.

Micro irrigation/ fertigation experiments are yielding good results with increased yield in seed spices, saving about 30% water while reducing disease incidence and farm labour. Protected cultivation of bush peppers was initiated as it can form a important input in urban horticulture.

Varieties recommended for release in 23 AICRP workshops

Improved Cardamom variety ICRI-8 from Sakleshpur centre, NDH-9 Turmeric variety from Kumarganj, PPI (CL) 1, the first ever clove variety from Pechiparai, DH220 and Suguna coriander variety from Hisar and Guntur respectively, HF143 and RF281 fennel varieties from Hisar and Jobner respectively Ajmer fenugreek -3, RMT-365 fenugreek varieties from Ajmer and Bikaner respectively, Haj 18 Ajowain variety from Hisar recommended to release during the XXIII rd workshop held at Kozhikode.

Collaboration

Similar initiative in protected cultivation of ginger in private sector is being monitored for its efficacy.



In collaboration with DASD and NHM efforts are being made to include only released varieties, preferably with resistance to diseases and pests in the seed multiplication programme. The standard nursery practices were being enforced to ensure only healthy planting materials are distributed to minimize the disease spread.

Portray soil less propagation of micro rhizomes for multiplication of ginger and turmeric planting materials is being transferred to Nagaland University with the help of DBT.

Monitoring

The QRT has reviewed the work of all the AI-CRP centres and the members were appreciative of the work done. The programmes of various centers were monitored by 6 monthly reports and field visits to the centres.

Black pepper

During the year 65 more accessions were added to the germplasm of black pepper maintained at various centres viz. Panniyur, Amblavayal, Chintapally, Dapoli, Pechiparai, Pundibari, Sirsi and Yercaud. Preliminary evaluation of black pepper Germplasm at Panniyur indicated the cultivar PRS 64 ranked first with 2.57 kg green berry yield and 1045 spikes /vine. P8 an inter varietal hybrid with resistance to Phytophthora was released this year for Kerala state. Accession 53 with tolerance to Phytophthora, has been accepted for adoption and to release as a farmer's variety- 'Ademane Pepper' in the Karnataka region. Dry berry yield in this line is more than double when compared with the state average yield of 1 kg/vine/year and the national average yield of <1 kg/vine/year, respectively.

Under inter varietal hybridization the hybrids PRS 160 and PRS 161 have been found to be promising. In a CVT trial in black pepper cul 5489 was the best and recorded maximum yield 2.51 kg/vine at Panniyur. At Sirsi grafts of Panniyur 1 runner shoots on Piper nigrum var IISR shakthi as root-stock recorded maximum height.

Under organic farming at Yercaud application of FYM at 10 kg coupled with Azospirillum 50 g, Phosphobacteria 50 g and VAM 200 g per vine resulted in maximum dry berry yield (4.78 kg/vine). Under drip fertigation experiment in Black pepper at Panniyur, 50 % RDF through drip (81) at weekly interval recorded maximum spike yield (5.88 kg / vine).

At Sirsi, the black pepper tolerant varieties, IISR Shakti and IISR Thevam recorded significantly less disease incidence (10.98 and 13.72 respectively) of Phytophthora foot rot and were on par each other. Black pepper vines treated with consortium of bacteria (@1 %) (for growth, nematode and Phytophthora suppression IISR 6 and IISR 859) as spraying (@2l-vine) and drenching (@3l-vine) and soil application along with Trichoderma harzianum (MTCC 5179) @ 50 g per vine with one kg of neem cake to the root zone during pre monsoon (June 2012) and post monsoon (Aug 2012) recorded least disease incidence (10.45 %). Application of new fungi toxicant molecules @ 0.1 % Fenamidone (10 %) + Mancozeb (50 %) (Sectin) alone and Fenamidone (10 %) + Mancozeb (50 %) (Sectin) as spraying (@ 2 l-vine) and drenching (3 l-vine) along with bioagent Trichoderma harzianum (MTCC 5179) 50 g with one kg of neem cake as soil application separately during first week of June, 2012 and third week August, 2012 recorded statistically significant reduction in the disease with respect to leaf infection (6.06 % and 4.24 %), reduced yellowing of vines (7.88 PDI and 6.67PDI), least defoliation (8.50PDI and 6.06 PDI), least death of vines (7.27 % and 4.86%) and recorded highest green berry yield (2.93 kg/vine and 3.16 kg/vine) respectively at Sirsi.

Cardamom

In a CVT at Pampadumpara genotype PS 27 recorded maximum yield 597g/pl followed by MHC 26 306 g/pl and in Mudigere CL -722 (232 kg /ha) recorded maximum yield followed by PS 27(275.58 kg/ha). In another CVT at Sakaleshpur, maximum per plant yield was recorded by SKP 164 (1106.50 g/pl) whereas at Appangala IC349545 recorded maximum yield (957 kg/ha).



At Mudigere application of irrigation 9 liters/clump/day along with 100% recommended dose (125:125:250 NPK kg/ha) of fertilizer through drip recorded the maximum capsule yield (205.35 kg/ha) that was on par with irrigation 9 liters/clump/day with 75% recommended fertilizer dose (199.25 kg/ha). In a CVT, organic farming trial in the station, application of 30 t FYM+ recommended NPK (125 :125 :250 kg/ha) recorded maximum dry capsule yield (250.65 kg/ha) whereas application of Jeevamritha + Azospirillum (10 g/clump) + 10 g PSB/clump + Trichoderma 10g / clump resulted in the maximum dry capsule yield (66.59 g plant⁻¹) at Pampadumpara. Application of ground lime stone @ 2 kg/plant in cardamom increased the yield 208% over control (without liming) at Pampadumpara.

For management of rhizome and Panicle rot in new cardamom plantation at Mudigere, spraying and drenching of copper oxichloride 0.3 % resulted in less panicle infection and maximum yield (1085.30 kg) in Njallani gold that was on par with combined application of Trichoderma harzianum and consortium of bacteria.

Application of Methomyl (1.5 g/liter) of water and Imidacloprid @ 0.5 ml found to be effective to control thrips and capsule borer at Mudigere whereas application of Imidacloprid resulted in lowest thrips infestation at Pampadumpara. Effective management of shoot borer due to application of poneem was observed at Pampadumpara.

Large Cardamom

Fourteen disease escapes of blight caused by Colletotrichum gloeosporioides were collected from Sikkim and Darjeeling hills of west Bengal. Six units of each of these accessions were planted in ICRI Research farm at Kabi for further multiplication and evaluation.

Treating suckers with bio agents (Pseudomonas Fluorescens + Bascillus subtilis 3% each showed less incidence of blight as compared to control.

Two sprayings of Petroleum Servo Agrospray

@ 7 ml/L was effective to control the population of mealy bug (72.54 % population reduction over control) and aphids (79.76 % population reduction over control) at ICAR, Gangtok. Application of garlic bulb extract @10% both spray and drench showed less incidence of blight compared to control (30.51%)at the same station.

Ginger

Wide variation in yield (4.5 t/ha to 34.38 t/ha) was noticed in G x E interaction trial at various centres with different varieties performing better at different centres. Variety Nadia (22.75 t/ha) performed best at Chintapalli, Himgiri (15.43 t/ha) at Mizoram, Varada (34.83 t/ha) at Kalyani, V3S18 (4.5 t/ha) at Barapani, GCP-5 (11.48 t/ha) at Pundibari, Surabi (23.34 t/ha) at Pasighat, Suprabha (33.5 t/ha) at Kanke and SG-26/04 at Solan (20 t/ha) were the top yielders. The variety suruchi (10.5%) at Barapani and surabhi (8.5 %) at Pasighat recorded maximum oleoresin content. Maximum oil content was noticed in Mahima (2.65 %) at Barapani whereas suruchi registered maximum essential oil (1.97 %) at Pasighat.

In a trial nutrient management through organic manures for growth and yield of ginger, recommended nutrient application (120:80:80 NPK q/ha) registered maximum yield (135.0 q/ha) at Kuzmarganj.

A trial with the objective of reducing cost of cultivation in ginger by weed management was initiated at Chintapalli. Application of herbicide oxyflurofen 23.5 % EC (0.3 kg a. i/ha) recorded maximum yield (24.50 t/ha) that was on par with weed free check (25.45 t/ha).

Survey conducted in Vaishali district of Bihar by Dholi center indicated higher incidence of bacterial wilt (23.89 %) compared to soft rot(8.89 %) caused by Pythium aphanidermatum

In an experiment on management of soft rot of ginger caused by Ralstonia solanacearum, (bio-fumigation using mustard), this year also the ap-





plication of metalaxyl mancozeb recorded lowest rhizome rot incidence (2.45 %) whereas maximum yield was recorded by mustard biofumigation (15 t/ha). In Kumarganj, maximum rhizome germination, lowest soft rot incidence and maximum yield (21.2 t/ha) was recorded by Metalaxyl mancozeb followed by biofumigation using mustard. In another experiment management of soft rot of ginger (biofumigation using cabbage) maximum yield and lowest soft rot incidence was noticed due to cabbage biofumigation at Solan, Pundibari and Ambalavayal whereas in Kumarganj rhizome treatment with Metalaxyl mancozeb recorded maximum yield and lowest soft rot incidence.

Biofumigation using mustard in ginger resulted in maximum yield (15 t/ha) and low bacterial wilt incidence (2.25 %) whereas at Pundibari cabbage biofumigation resulted in maximum yield and lowest bacterial wilt incidence (5.92 %).

Turmeric

The accession CL 101 with high yield was released for Tamil Nadu this year. Apart from collection and cataloguing of turmeric germplasm, evaluation of germplasm was also carried out at various centres. Promising genotypes identified based on yield at Dholi was RH 427 (68.0 t/ha), CHFT36 (30.4 t/ha) at Pasighat, Duggirala red (27.9 t/ha) at Kammarapally, PTS 21 (24 t/ha) at Pottangi, TCP 168 (52.42t/ha) at Pundibari, IT 38 (13.72 t/ha) at Raigarh. At Kumarganj promising entries identified under early maturity group was NDH-74 and NDH-79 (35 t/ha respectively). In medium maturity entries identified was, NDH-98 (42 t/ha) and NDH-7(35 t/ha) was the entry identified in the late maturity group.

In a CVT on turmeric RH 80 (42 t/ha) at Chintapalli, CL I01 (45.64 t/ha) at Coimbatore, RH 80 (6.70 t/ha) at Dholi, RH 9/90 (31t/ha) at Kammarpally, PTS 55(14.8 t/ha) at Pottangi, TCP 70 at Pundibari and Raigarh (14.25 t/ha, 17.46 t/ha respectively), RH 50(51t/ha) at Pasighat, RH 9/90 (22.22 t/ha) at Navasari recorded maximum yield. In an IET on turmeric PT5 (35.58 t/ha) at Pantna-

gar recorded maximum yield (35.58 t/ha) followed by PT-6 (29.12 t/ha)

In G x E interaction study turmeric varieties TCP II (13.9 t/ha) at Pottangi, RH 9/90 (30.3 t/ha) at Kammarpally, RCT -1(29 t/ha) at Mizoram, Meghaturmeric (30.5 t/ha) at Kalyani recorded maximum yield.

Integrated nutrient management registered maximum turmeric yield (17.52 t/ha and 19.68 t/ha) at Pundibari and Raigarh respectively whereas organic management recorded maximum yield (27.2 t/ha) at Pottangi.

In a trial standardization of water requirement for turmeric through drip irrigation, drip irrigation once in a day at 80 % PE recorded maximum yield at Coimbatore (64.2kg/plot) and Kammarpally (29.8 t/ha) whereas at Kumarganj surface irrigation 5 cm, I/W CPE ratio 0.09 recorded maximum yield (32 t/ha).

In a fertigation trial in Coimbatore, maximum yield (59.11 kg per 10 m²) was recorded by the treatment 100% RDF through drip weekly once.

Soil application of micro-nutrients @25kg ha⁻¹ and two foliar sprays of micro-nutrients @0.5% at 60 and 90 days after sowing gave significantly higher yield 55.18, & 55.96 t ha⁻¹ compared to control at Dholi (43.99 t ha⁻¹) whereas soil application of Boron recorded the yield (20.61 t/ha) at Pundibari.

At Coimbatore, planting of mother rhizomes(35-40 g) directly planting into the field recorded maximum yield (67.64 kg/plot) followed by planting of mother rhizome pieces (10-15 g) in the field (4 pieces) 61.51 kg/plot whereas in Chintapalli maximum fresh rhizome yield was recorded by T9 mother rhizomes (35-40 g) directly planting into the field (28.53 t/ha) followed by T7 Primary full length rhizome 25-30g directly planting in the field (24.57 t/ha) that was on par with transplanted seedlings raised from 2 nodes.

Curing of turmeric for 60 min by steam cooking was considered optimum to produce quality



dried turmeric with minimum losses and also there was no significant difference in the drying time compared to that dried by water boiling process, which is very critical.

Foliar spray of Propiconazole (0.1%) on 45 and 50 days was the best treatment in reducing the leaf spot intensity (19.33 PDI) and leaf blotch intensity (13.34PDI) as compared to untreated control (61.56 PDI) and recorded maximum yield at Coimbatore. Same treatment was effective and recorded lowest incidence of leaf spot (28.40) and leaf blotch (28.5) and treatment Hexaconazole (0.10 %) at 45 and 90day of sowing recorded maximum rhizome yield (15.16 t/ha) at Kumaraganj.

Tree Spices

The germplasm of the tree spices which include nutmeg, cinnamon, cassia and clove are collected, maintained characterized and catalogued at Dapoli and Pechiparai. The accession SA-13 in clove at Pechiparai was superior and recorded maximum height (8.43m), dry bud yield (4.50 kg/ tree) and bud oil (6.78 %) compared to local check. Among the nutmeg accessions evaluated at Pechiparai MF4 recorded maximum number of fruits/tree (940.25), height, weight (75.30g) and maximum dry mace yield (419.59 kg/tree).

In a CVT at Pechiparai, out of nine geno types of clove , type SA3 was found to be promising in terms of dry buds/tree (2.95 kg/tree). In the case of nutmeg, among the six accessions A9/150 recorded the maximum plant height (2.12m), stem girth of 11.96 cm and recorded maximum number of shoots (20.50). At Pechiparai among the cinnamon accessions CV-5 recorded maximum dry bark yield 545g per plant. In a CVT on cassia, the genotype KKVCTSH1 recorded significantly maximum girth (36.25 cm) and oil percentage (7.34 %) followed by KKVCT SH2 (35.50 cm and 7.12 % respectively).

Cumin

In a CVT at Jagudan entries CUM-11, CUM-9 and CUM-10 gave higher yield (i.e.,840, 743 and

736 kgha-1), which was 47.37, 30.35 and 29.12 per cent higher over check GC-2 respectively where as at Ajmer the entry Cumin 10 (486 kg/ha) recorded maximum yield. Based on the pooled mean over three years (2009-2012), the mean volatile oil content was found to be highest in CUM 13 (3.57 %), followed by CUM 9 (3.56 %) and RZ 209 (3.43 %)

Fennel

The germplasm accession RF 27 at Dholi, NDF 46, NDF 51 and NDF 67 at Kumarganj were reported as top yielders. Two high yielding fennel entries in IET HF 151(2104 kg/ha) and HF 212 (1978 kg/ha) showing an increase of 27.1 and 14.9 % over HF-33 (check) at Hisar may be promoted to CVT. In a CVT at Jobner FNL 43 (1825 kg/ha) and FNL 52(1985 kg/ha) at Hisar were found to be promising based on yield. In a new CVT trial initiated during 2012, maximum yield was recorded by FNL51 (3043 kg/ha) at Pantnagar, FNL 47 at Kumarganj, Ajmer and Jabalpur (yield 1336 kg/ha, 4347 kg/ha, 1618 kg/ha respectively) and FNL 55 at Jagudan (1299 kg/ha). Significant beneficial effect of PGPR bioformulation was obtained in fennel by treating the seeds with FK14 (1020 kg/ha) at Raigarh. In a quality evaluation trial in fennel maximum volatile oil 2.43 % was recorded in FNL 26. Application of Thiamethoxam 25 WG@0.0084 % found to be effective for reducing the seed wasp damage (7.44 %) at three and seven days after spraying and at harvest and recorded a yield of 2029kg/ha at Jagudan.

Fenugreek

In a CVT accession FGK 48 recorded maximum yield at Ajmer (2295 kg/ha, Pantnagar (1805 kg/ha), Navasari (1104 kg/ha), Raigarh (978 kg/ha) whereas FGK 49 recorded maximum yield at Jagudan (2049 Kg/ha), Udaipur (1562 kg/ha) and Dholi (1750 kg/ha). FGK 39 with a yield of 1492 kg/ha at Kumaraganj was also promising in this trial. In an IET at Jobner superior performance of the fenugreek accession UM- 126 (2376.92 kg/ha) over a period of three years was observed. In another IET at Hisar HM 425 (3015 kg/ha) recorded maximum yield followed by HM 257(2895 kg/ha) where as PM (C) -1





2798.99 (kg/ha) was the top yielder at Pantnagar. In Jobner Fenugreek accessions UM 301 and UM 112 were identified as drought tolerant genotypes. Significant beneficial effect of PGPR bio formulations was obtained in fenugreek by treating the seeds with FGK 14 + FL 18 at Guntur, Kumarganj and Hisar 1117.5 kg/ha, 1591 kg/ha, 1963 kg/ha respectively.

Coriander

In the CVT initiated during 2012 the yield of coriander varied from 1220 to 2868 kg/ha, promising entries identified in coordinating centres were COR 46 at Guntur (1233 kg/ha), COR 44 (1589 kg/ha) at Ajmer, COR 38 at Kumarganj (1527 kg/ha), COR 56 at Navasari (1220 kg/ha), COR 48 at Udaipur (1423 kg/ha) and COR 40 at Jabalpur (2868 kg/ha), COR 41 at Hisar and COR 54 (2105 kg/ha) at Dholi.

In the CVT of coriander for leaf purpose (over a period of 3 years) maximum yield was recorded by the genotype CS 38 (4.28 kg per plot) at Coimbatore whereas LCC-232 recorded maximum green leaf yield 2.59 t/ha at Guntur. In an IET of coriander for seed purpose at Hisar (over a period of three years) DH-281 and DH 314 were the promising entries. In an IET started at Jobner UD 123 (2071 kg/ha) recorded maximum yield. New IET in coriander was initiated during 2012 at Jagudan, Guntur, Kumarganj and maximum yield was recorded by the JCR 389 (1301 kg/ha), LCC 268 (1174 kg/ha), ND cor 101 (1527 kg/ha) respectively at various centres. In a quality evaluation trial in coriander at Jobner entry COR -48 ranked first in terms of volatile oil content (0.6 %) followed by COR 44 (0.58 %). In an IET trial at Jobner maximum volatile oil of 0.45% was observed in UD 411 followed by 0.40% in UD 61 and UD 82. Based on drought indices TOL, SSI and STI UD 13, UD-112, UD-436 and RCr-684 were found to be the desirable entries for drought conditions at Jobner. ND cor 37 (27.73 g/pl) and ND cor 36 (27.63 g/pl) were the alkalinity tolerant lines identified at Kumarganj.

At Dholi out of 144 germplasm, 110 germplasm were found highly resistant against stem gall disease

under natural condition and organism associated with the disease identified were *Protomyces macrospora* in farmer's plot.

At Kumarganj and Dholi seed treatment of coriander with Propiconazole @ 0.2 % along with three foliar sprays was a technology to control stem gall disease in coriander whereas seed treatment with Hexaconazole @ 0.2 % along with three foliar sprays was the effective technology to control stem gall disease at Raigarh.

In a trial nutrient supplementation through organic manures in coriander, integrated nutrient management recorded maximum yield at Raigarh and Dholi (1610 kg/ha). At Guntur application of NPK 45:40:20 kg/ha + spraying with GA 10 ppm at 20 DAS recorded maximum coriander leaf production in off season whereas application of NPK 30:40:20 kg/ha + GA 15 ppm at 20 DAS registered maximum leaf yield at Coimbatore. The bioformulation FK14 recorded maximum yield 1166.5 kg/ha at Guntur, 990 kg/ha at Raigarh, 700 kg/ha at Coimbatore, whereas cultivation of local popular variety (Hisar Anand) recorded maximum yield (1745 kg/ha) at Hisar and no beneficial effect due to application of bio formulations was noticed on Jagudan and Ajmer.

Technologies recommended for transfer to extension agencies during the XXIIIrd Workshop.

1. Application of entomopathogenic nematodes in the management of cardamom root grub. Small cardamom (Pampadumpara)
2. Management of scale insects of black pepper with organic products (Pampadumpara)
3. Fertigation technology for turmeric (Coimbatore)
4. Organic nutrient management in turmeric (Dholi)
5. Integrated nutrient management in Turmeric
6. Nutrient supplementation through organic ma-



- nure in coriander (Coimbatore & Guntur) (Dholi)
7. Micronutrient requirement in coriander (Coimbatore)
 8. Promotion of micro irrigation in coriander (Guntur)
 9. Integrated nutrient management in coriander
 10. Management of cumin wilt and blight (Jagudan)
 11. Integrated nutrient management in Fenugreek (Dholi)



II. Profile of AICRP on Spices

The All India Coordinated Research Project on Spices (AICRPS) has its head quarters at Indian Institute of Spices Research (IISR), Calicut, Kerala. The AICRPS was originally initiated as a combined project of spices and cashew under the name All India Coordinated Spices and Cashew Improvement Project (AICSCIP) during 1971 (IV Plan) with its headquarters at Central Plantation Crops Research Institute (CPCRI), Kasaragod, Kerala. In order to intensify spices research and development, the AICSCIP was bifurcated into two separate projects one each for spices and cashew and the present AICRPS came into existence in 1986 with its headquarters at IISR, Calicut. The AICRPS which started with 14 centres in 12 states has now grown to 34 centres spread over 21 states of the country representing various agroclimatic zones suitable for spices cultivation. The main dates of the projects are:

- To evolve high yielding varieties, resistant/tolerant to pests and diseases and their multiplication testing.
- To develop agrotechnologies through integrat-

ed nutrient management for increasing sustainable productivity under various agro-ecological situations

- Evolving suitable pests and disease management technologies through integrated approaches.
- Collection, conservation and sustainable utilization of the biodiversity of spices in the country.
- To act as an interface between ICAR/SAUS'S/IISR, DASD systems.

The AICRPS is the largest spices research network in the country through which a nationwide collaborative and inter disciplinary research is being conducted linking Indian Institute of Spices Research Calicut , National Research Centre on Seed Spices (NRCSS), Ajmer , State Agricultural Universities, National Bureau of Plant Genetic Resources, New Delhi and Indian Cardamom Research Institute (Spices Board).

Mandate crops and the centres of AICRPS

Sl. No.	Crop	No. of Centres	Centres
1	Black pepper	10	Ambalavayal, Chintapalle, Dapoli, Kalyani, Pampadumpara, Panniyur, Pundibari , Sirsi, Yercaud , Pechiparai
2	Cardamom	4	Pampadumpara, Mudigere, Myladumpara, Sakleshpur
3	Large cardamom	2	Gangtok
4	Ginger	14	Ambalavayal, Barapani, Dholi, Calicut,* Kanke, Kalyani, Kumarganj, Mizoram, Navasari, Pantnagar, Pasighat, Pottangi, Pundibari, Raigarh, Solan

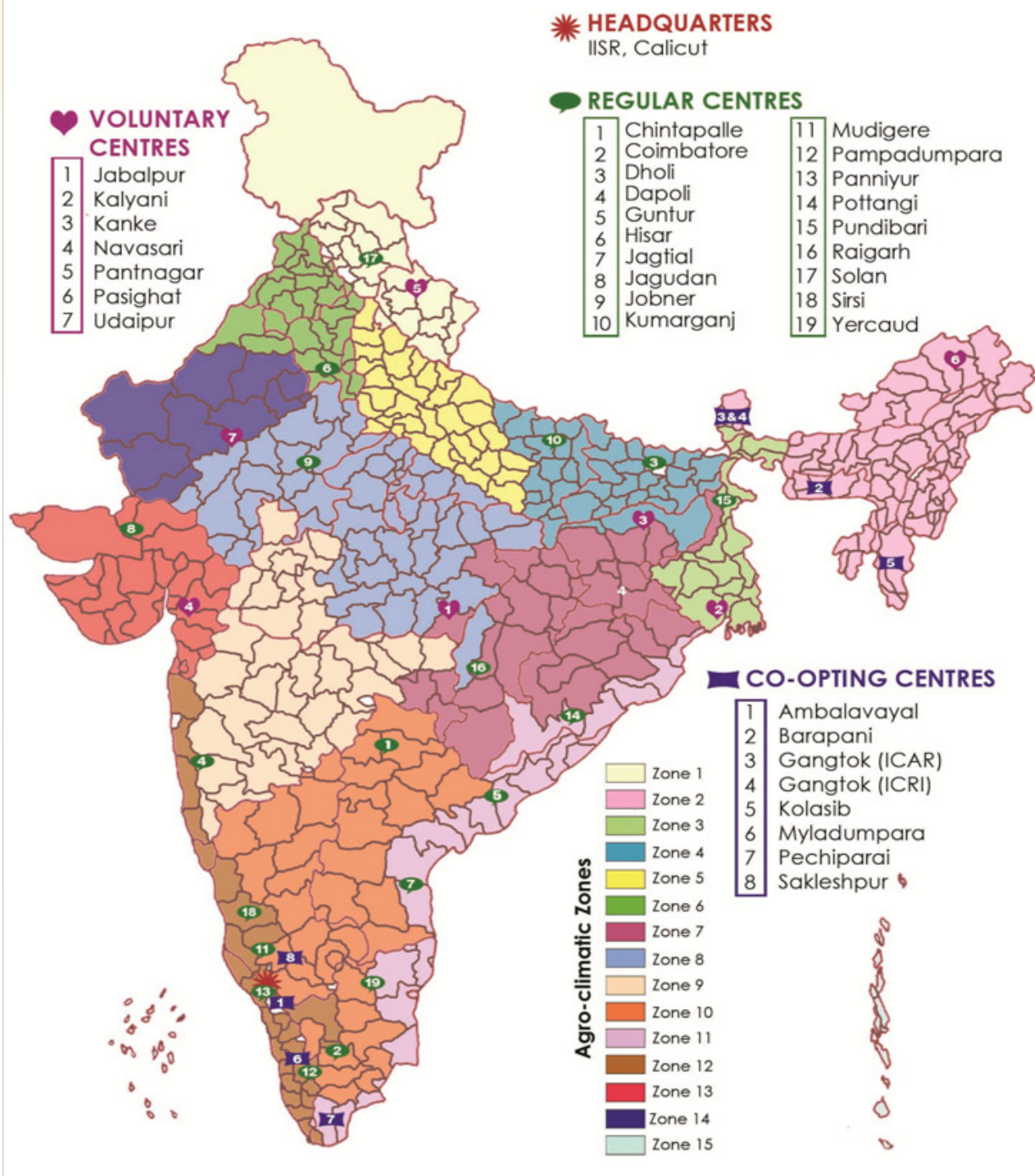


5	Turmeric	13	Barapani, Calicut,* Coimbatore, Dholi, Kanke, Kumarganj, Pantnagar, Pasighat, Pottangi, Pundibari, Navasari, Raigarh, Kamarpally, Mizoram
6	Clove	3	Dapoli, Yercaud, Pechiparai
7	Nutmeg	3	Dapoli, Yercaud, Pechiparai
8	Cinnamon	3	Dapoli, Yercaud, Pechiparai
9	Coriander	12	Ajmer,* Dholi, Guntur, Hisar, Jobner, Jagudan, Kumarganj, Raigarh, Coimbatore, Jabalpur, Pantnagar, Udaipur, Navasari
10	Cumin	2	Ajmer*, Jagudan, Jobner
11	Fennel	9	Ajmer, Dholi, Jabalpur, Jagudan, Jobner, Hisar, Kumarganj, Pantnagar, Udaipur
12	Fenugreek	11	Ajmer*, Coimbatore, Dholi, Guntur, Hisar, Jabalpur, Jagudan, Jobner, Kumarganj, Pantnagar, Raigarh, Udaipur

* IISR, Calicut and NRCSS, Ajmer undertake collaborative experiments



Agro-climatic region/ Zones in India CENTRES OF AICRP ON SPICES



III. Experimental results in Black pepper

BLACK PEPPER PEP/CI/1 Genetic resources

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



Fig 1. Promising genotype PRS 64 from Panniyur.

(Centres: West coast plains and ghat region: Panniyur, Ambalavayal, Sirsi, Yercaud, Pechiparai; Lower gangetic plain region: Pundibari; Western plateau and hills region-Dapoli; East cost plains and hills region- Chintapalli)

Black pepper germplasm maintained by all the pepper centres under AICRPS is given in (Table 1). The germplasm maintained at each centre is evaluated every year. At present 247 cultivated types of black pepper and 54 wild types are being maintained in Panniyur station. Fiftyone new genotypes (cultivars) have been collected during 2012 from Kasaragod, Kannur, Wayanad District and from Coorg. The genotypes PRS 64, PRS 154 and PRS 137 were the top yielders. PRS 64 is the most promising with high yield (2.57 kg green berry/vines) high spiking intensity (1045 spickes/vine). PRS 137 recorded the highest number of developed berries / spike (35) and the highest drying percentage (37 %).

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

Centre	Indigenous Cultivated Existing	Wild & related species			Total Exotic	
		Addition (April 2012 to March 2013)	Existing	Addition (April 2012 to March 2013)		
Chintapalli	38	-	-	-	-	38
Dapoli	34	2	1	-	-	37
Panniyur	193	51	54	-	3	301
Pechiparai	14	4	2	-	-	20
Pundibari	19	-	10	1	-	30
Sirsi	127	1	-	-	-	128
Yercaud	72	7	3	-	-	82
Total	493	65	70	1	3	632

Ambalavayal maintained 55 accessions in the black pepper germplasm.





At Sirsi 127 collections are being maintained and one new collection was added during 2012-13. Accession 53 (Ademane) has been accepted for adoption & to release as a farmer's variety – 'Ademane Pepper' in the Karnataka region. Totally, 128 germplasm accessions are being maintained at the station. Under this project, a new experiment has been initiated to evaluate the performance of the new accessions collected (from the local 63 accessions) and maintained in germplasm block. d Promising accessions 15 were planted to the arecanut live standards which are in the initial stage.



Fig 2. Ademane Pepper (Accn. 53) – A promising phytophthora tolerant Black pepper from Karnataka

Out of 72 accessions being maintained at HRS, Yercaud berry set was observed only in 29 entries during this year. The other accessions did not set berry. Acc. 57, 33 and 11 are continued to perform well at Yercaud.

Dapoli centre collected two promising black pepper local types. Total germplasm of black pepper consisting of 37 accessions has been maintained and are being evaluated.

At Pundibari 29 collections are being maintained and during 2012-13 one new collection was added from Terai region of West Bengal.

PEP/CI/ Hybridization trial

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

(Centre: Panniyur)

Among the intervarietal hybrids, P 6 x P 5 was found to be promising and has been released as Panniyur 8 by the Kerala State Variety Release Committee held on 15-7-13. Panniyur 8 has an average yield of 5760 kg green pepper /ha.



Fig.3 . P 8 - A Phytophthora tolerant Hybrid released for Kerala State.

During 2012-13, the hybrids PRS160 and PRS 161 have been found to be promising with maximum green berry yield of 3.2 kg/vine and 3.0 kg/vine respectively. Number of spikes /vine was 460 for PRS 160 and 294 for PRS 161. PRS 161 recorded maximum spike length of 27 cm. Number of well developed berries/spike was 101 for PRS 160 and 89 for PRS 161.



PEP/CI/3 Coordinated varietal Trial (CVT)

PEP/CI/3.2 CVT 2000-Series V

(Centres: Panniyur, Pampadumpara, Sirsi, Ambalavayal)

The trial was started during 2000 and concluded during 2012 at Panniyur. Pooled analysis of the yield and attributing data showed that PRS 108 (cul 5489) recorded the highest green berry yield of 2.51

kg/vine which was significantly superior to other entries followed by PRS 107(cul 5308) with 1.55 kg/vine (Table 2). PRS 108 recorded the highest number of spikes/vine (767) followed by HP 1411(557) which was on par with Col. 1041 (531). The highest number of berries/spike was recorded by PRS 108 and PRS 107(28 nos). Panniyur 1 recorded the maximum 100 berry weight (13.89 g) which was on par with PRS 108 (13.77g), PRS 107 (13.57g), Karimunda (12.78g) and Collection 1041(12.73g). The highest dry recovery per cent was recorded by PRS 107 (40.24).

Table 2. Green berry yield (kg) of Black pepper accessions under CVT 2000 (Pooled data) PRS, Panniyur

Cultivars/Varieties	2007-08	2008-09	2009-10	2010-11	2011-12	Pooled Mean
Kalluvally IV	1.02	1.54	1.180	1.045	1.043	1.17
Karimunda II	0.34	1.02	1.320	1.270	1.268	1.04
Karimunda III	0.59	1.25	1.200	1.100	1.112	1.05
PRS 107	1.51	1.85	1.550	1.410	1.423	1.55
PRS 108 (cul5489)	1.85	3.80	2.520	2.150	2.249	2.51
HP 34	0.93	1.50	0.560	0.515	0.522	0.81
HP 105	0.75	2.50	0.840	0.795	0.802	1.14
HP 813	0.63	1.28	0.970	0.900	0.912	0.94
HP 1411	0.96	1.35	1.420	1.150	1.122	1.20
Karimunda OP	1.75	1.57	1.270	1.215	1.219	1.40
Coll.1041	1.26	2.50	1.027	0.980	0.972	1.35
Panniyur 1	1.33	1.95	1.127	1.250	1.246	1.38
Karimunda	1.37	1.25	1.210	1.160	1.210	1.24
CD (0.05)						0.412

Five promising selections from PRS, Panniyur (PRS 17, PRS 21, PRS 22, CUL 5308, CUL 5489) and IISR, Kozhikode (HP 34, HP 105, HP 813, HP 1411, Coll 1041) were evaluated against the common varieties grown in this high ranges viz., Karimunda and Panniyur-1 at Pampadumpara. The

accession CUL 5308 registered significantly higher dry yield of black pepper per plant (766.51) followed by HP 1411 (527.92 g) and PRS 22 (408.43 g) (100 berry weight as well as volume was the highest with Karimunda (6.44 g and 13.47ml).



At Sirsi dry berry yield of Black pepper was the maximum in Selection-2(2.15 kg/vine) during the period and this was followed by Panniyur-1 (1.70 kg/vine). HP-105 (1.65 kg/vine), HP-34 (1.42 kg/vine) were on par with regard to yield. Spike length was maximum in Panniyur-1 (11.3 cm) followed by Selection-2 (10.5 cm) and OP Karimunda (10.4 cm) and the least spike length was noticed in PRS-22 (5.2 cm). Maximum number of spikes was recorded by Selection-2 (458) and fresh berries/spike by Panniyur-1 (70).

Panniyur 1 recorded highest yield (dry weight-1.70 kg/standard) at Ambalavayal followed by HP 1411 and HP 34 (1.57kg and 1.27kg) respectively. The wet weight of Panniyur 1 and HP 1411 was 4.47 kg and that of HP 34 was 2.97kg.

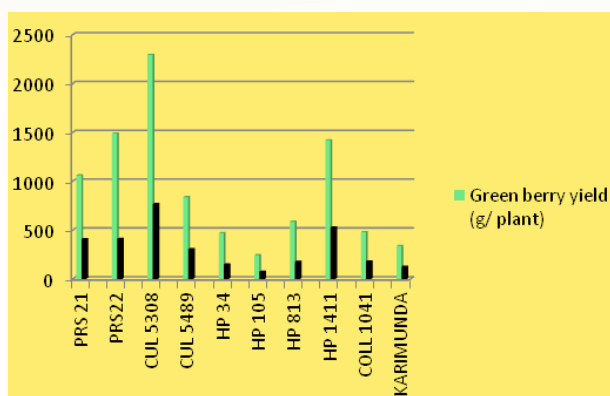


Fig 4. Fresh and dry yield of CVT2000 black pepper accessions at Pampadumpara

PEP/CI/3.3 CVT 2006-Series VI

(Pampadumpara, Panniyur, Sirsi, Yercaud, Dapoli, Chintapalli)

All the ten entries did not vary significantly for leaf length and internodal length at Pampadumpara. However the accessions Panniyur-1, Accession 33, Accession 57, Accession 106, and Karimunda showed good growth and vigour in the field.

During 2012, HB 20052 recorded maximum plant height (2.09) and green berry yield (1.8 kg/vine) followed by C- 1090 (1.35 kg/vine) at Pan-

niyur

At Sirsi the trial was initiated during August 2008, accession HB-20052 and PRS-64 which showed spike initiation with 15 and 25 numbers, respectively.

Varietal evaluation trial (CVT-2006) with nine black pepper varieties had been started in November 2008 at Dapoli. Panniyur 1 recorded significantly higher plant height (3.75 m) followed by C -1090 (3.70 m) and PRS 64 (3.50 m). The spiking has been started in Panniyur - 1, PRS 64, HB 20052, ACC 106 and ACC 33.

At Chintapalli maximum plant height was noticed in Panniyur-8 (HB20052) (291.34 cm) that was on par with Panniyur-1 (283.14 cm). Maximum number of sub-vines per plant was observed in HB 20052 (16.00) followed by ACC-33 (13.1) and Panniyur -1 (12.83).

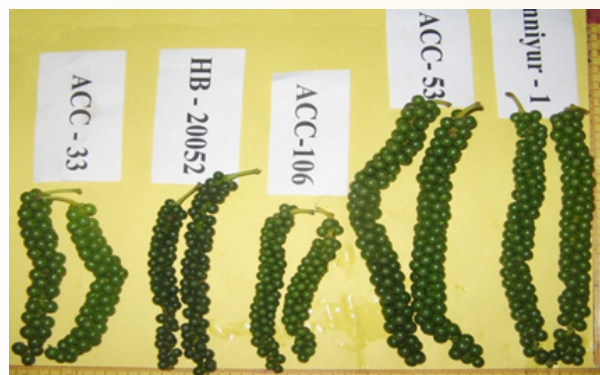


Fig 5. Spikes Variation in black pepper varietal trial in (CVT 2006) at Dapoli.

At Yercaud the Acc. No.57 and Acc. No.33 of TNAU – Yercaud Centre; Acc No. 53 (Ademane pepper) and Acc. No. 106 (Kudragutta pepper) collected from Sirsi centre of Karnataka; PRS 64 and HB 20052 of PRS – Panniyur along with Panniyur 1 were planted at Yercaud and crop is in initial phase only.

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



(Centres: Sirsi, Ambalavayal, Yercaud, Thadiyankudisai, Panniyur)

Grafts and the rooted plants were planted to the arecanut live standards during 2010-11 at Sirsi. The height of the rooted cuttings and the grafted vines ranged between 0.68 to 1.28 m in the 2nd year of growth. The maximum height was in grafts of P-1 runner shoots on *Piper nigrum* var. IISR Shakti as rootstocks (1.28 m) followed by grafts of P-1 runner shoots on *Piper nigrum* var. IISR Thevam as rootstocks (1.25 m).

Grafts, orthotropic shoots and runner shoots were planted in the main field at Ambalavayal.

The root stocks viz., *Piper Colubrinum*, Shakti, Thevam was established in ES12 for mass multiplication at Yercaud. However, grafting has been initiated using ortho, plagio shoots on wild black pepper.

At Panniyur during 2012-13, grafts of runners of Panniyur 1 on *Piper colubrinum* as root stock recorded the maximum plant height (1.29 m).

Three root stocks viz. *P.colubrianum*, IISR Sakthi and IISR Thevam with Scion as Panniyur-1 was planted in "D" block of HRS, Thadiyankudisai. The per cent establishment was higher in *P.colubrinum* x Panniyur -1 with five nodes runner (84%) followed by *P.colubrinum* x Panniyur -1 with three nodes runner (76%) and the least was observed in IISR Thevam x Panniyur-1 with 3 nodes of orthotropic shoots (44%). All the treatments are in vine stage and other characters are too early to report.

Crop Production

PEP/CM/4 Nutrient management trial

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

(Centres: Chintapalli, Panniyur, Sirsi, Dapo-

At Chintapalli two treatments inorganics and organics were imposed. Vines treated with inorganics (Recommended package of practices) showed maximum plant height (3.95 m), length of spikes (13.06 cm), maximum number of berries per spike (66) and fresh berry yield (4.01 kg/vine) compared to organic treatment of the vines.

During 2012-13, Recommended package (T2) recorded significantly higher green berry yield (1.94 kg/vine) compared to organic package (T1) which recorded green berry yield of (1.24 kg/vine) at Panniyur. The spike yield (2.34 kg/vine) and number of spikes/vine (451 No./vine) were also maximum for Recommended package (T2) which was significantly superior to organic package (T1).

At Sirsi dry berry yield of the black pepper vines treated with recommended package of practices was higher (1.20 kg/vine) compared to those of only organics (0.78 kg/vine). Maximum B: C ratio was observed for the treatment recommended package 1.48: 1.00 compared to the treatment in which organic package was given (1.14: 1.00).

Integrated package recorded maximum plant height (2.73 m/plant) followed by organic package (2.23 m/plant) at Dapoli.

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

(Centres: Panniyur, Dapoli, Pechiparai, Sirsi, Yercaud)

At Panniyur during 2012-13, integrated treatment (T2) resulted in higher green berry yield of 2.12 kg/vine which was significantly superior to both fully inorganic treatments (T3) which recorded green berry yield of 1.53 kg/vine and fully organic treatment (T1) which recorded green berry yield of 1.10 kg/vine. The spike yield (2.56 kg/vine) and number of spikes/vine (607 No. /vine) was also maximum for integrated treatment (T2) which was significantly superior to other two treatments.



The treatment integrated package recorded maximum plant height (2.63 m/plant) followed by fully organic package (2.15 m/plant) at Dapoli. The experiment is at initial growth stage and flowering is started in all blocks.

The trial was imposed in an established pepper garden at Pechiparai (Table 3). The treatment consisting of three types- integrated, fully inorganic and organic package. Ten vines were selected per treatment. The maximum yield of 3.95 kg/vine was recorded by the integrated treatment (100 g Azospirillum +100 g N + 40 g P₂O₅ + 140 gK₂O +10 kg FYM per vine).

Table 3 .Yield data of organic farming in black pepper at Pechiparai during 2012-13.

Treatments	Yield (kg/vine)	Cost benefit ratio
Fully organic	2.75	1:2.50
Integrated	3.95	1:3.0
Fully inorganic	3.18	1:2.70
CV (%)	0.03	--
CD	0.16	--

At Sirsi 2012-13, the vines treated with 100 percent integrated methods recorded significantly higher dry berry yield (1.25 kg/vine) compared to those with hundred percent inorganic (0.97 kg/vine) and 100 percent organics (0.88 kg/vine). Similarly, the B: C ratio was higher for integrated recommendation 1.88: 1.00 followed by inorganic recommendations 1.29: 1.00.

Application of FYM 10 kg coupled with Azospirillum 50 g, Phosphobacteria 50 g and VAM 200 g per vine resulted in long spike length (12.8 cm) with more number of berries (76) with maximum fresh berry yield (13.68 kg/vine) and dry berry yield (4.78 kg/vine) at Yercaud.

PEP/CM/4.6 Standardisation of drip fertigation

(Center: Panniyur)

The trial was started at Panniyur during 2012-13 with following treatments.

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 Ist in June, II nd in September and III rd in February
T2	Drip irrigation @ 8 litres of water daily from February –April; 100 RDF in 3 equal splits as basal Ist in June, II nd in September and III 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) Ist in June, II nd in September and III 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) Ist in June, II nd in September and III 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) Ist in June, II nd in September and III rd in February.

Number of spikes/ vine ranged from 939 in T1 to 1529 in T5. T5 (50% RDF through drip (8 l) weekly) recorded maximum spike yield (7.91 kg/vine) and green berry yield (5.88 kg/vine). The treatments T3 (100% RDF through drip (8 l) weekly) and T4 (75% RDF through drip (8 l) weekly) were on par with T5 with respect to number of spikes, spike yield and green berry yield. T1(100% RDF full as basin application + conventional irrigation (100 l/10 days in summer) and T2 (100% RDF 2/3 as basin + 1/3 through drip (8 l) weekly in summer) were on par for the given characters.



5.3 Disease Management

PEP/CP/5 Disease Management Trial

PEP/CP/5.1 Adaptive trials on management of Phytophthora foot rot of black pepper in farmer's field.

(Centre : *Ambalavayal*)

This trial was initiated with an objective of controlling Phytophthora foot rot disease of black pepper in farmer's field. Application of Potassium Phosphonate + Trichoderma harzianum was effective in controlling the disease.

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

(Centres: *Dapoli, Panniyur, Chintapalli, Sirsi, Pampadumpara*)

At Dapoli incidence of foot rot was not noticed during third year. The trial was started during 2011 at PRS, Panniyur. In all the three varieties, application of Potassium Phosphonate (0.3 %) + Trichoderma harzianum @ 50 g/vine recorded least disease intensity and good establishment of the vines.

The plants are in establishing stage at Panniyur. The application of Akomin potassium phosphonate and Trichoderma harzianum in Shakthi variety resulted in better plant height than the other treatments

Rooted cuttings of IISR Shakthi, IISR Thevam and Panniyur 5 were planted in the main field at Chintapalli. However due to transplantation shock and heavy down pour of rains immediately after planting, there was huge mortality of rooted cuttings (90 %). Some of the left over excess cuttings of IISR-Thevam and Panniyur-5 were multiplied in the shaded net house and planted in July, 2011 which has been survived and plant stand is approximately 75 % till on date. However, IISR-Shakti couldn't be

rescued and they have procured from IISR-Calicut and are in multiplication stage.

At Sirsi, among the black pepper tolerant varieties, IISR Shakti and IISR Thevam recorded significantly less disease incidence of Phytophthora foot rot (10.98 and 13.72 respectively) and were on par each other. But, Panniyur-1 recorded the highest disease incidence (22.75 %). Irrespective of varieties, black pepper vines treated with consortium of bacteria (@1 %) (for growth, nematode and Phytophthora suppression (IISR 6 and IISR 859) as spraying (@2l-vine) and drenching (@3l-vine) and soil application along with Trichoderma harzianum (MTCC 5179) @ 50 g per vine with one kg of neem cake to the root zone during pre monsoon (June 2012) and post monsoon (Aug 2012) recorded least disease incidence (10.45%). Black pepper variety IISR Thevam recorded maximum height (2.39 m) that was on par with IISR Shakti (209 m) and Panniyur -1 (1.99 m) .

The experiment was restarted during June 2010 at Pampadumpara. The three varieties of black pepper such as Panniyur-1, IISR-Shakthi and IISR-Thevam were planted in the field for the study during June 2010 at Pampadumpara and plants are in vegetative phase.

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

(Centres: *Sirsi, Chintapalli, Mudigere*)

Among the new fungi toxicant molecules @ 0.1 % Fenamidone (10 %) + Mancozeb (50 %) (Sectin) alone and Fenamidone (10 %) + Mancozeb (50 %) (Sectin) as spraying (@ 2 l-vine) and drenching (3 l-vine) along with bioagent Trichoderma harzianum (MTCC 5179) 50 g with one kg of neem cake as soil application separately during first week of June, 2012 and third week August, 2012 recorded lowest infection (6.06 % and 4.24 %), reduced yellowing of vines (7.88 PDI and 6.67PDI), least defoliation (8.50 PDI and 6.06 PDI), least death of vines (7.27 %



and 4.86 %) and highest green berry yield (2.93 kg/vine and 3.16 kg/vine) respectively at Sirsi.

At Horticultural Research Station Chintapalli the experiment was initiated during 2011-12. Application of Potassium Phosphonate (0.3 %) + Trichoderma harzianum (MTCC-5179) recorded less

yellowing and defoliation that was on par with spraying and drenching with 0.1 % of Fenamidon (10 %) + Mancozeb (50 %) (Sectin) + Soil application of T.harzianum (MTCC-5179) 50 g/vine with 1 kg neem cake and yield recorded was 2.92 kg/vine and 3.12 kg /vine respectively (Table 4).

Table 4. Effect of new molecules of fungitoxicants against Phytophthora foot rot of black pepper at Chintapalli

Treatments	Yellowing (%)	Defoliation (%)	Death of Vines (%)	Yield / vine (kg)
T1 Spraying and drenching with 0.1 % of Fenamidone (10 %) + Mancozeb (50 %) (Sectin)	16.20	21.32	13.11	1.8
T2 Spraying and drenching with 0.1 % of Fenamidon (10 %) + Mancozeb (50 %) (Sectin) + Soil application of T.harzianum (MTCC-5179) 50 g/vine with 1 kg neem cake	12.50	14.98	9.50	3.12
T3 Spraying and drenching with 0.2 % kocide + 10 days after soil application of T. harzianum (MTCC 5179) 50 g/vine with 1 kg neem cake.	17.30	17.45	14.21	2.45
T4 Potassium phosphonate (0.3%) + Trichoderma harzianum(MTCC-5179)	13.64	16.14	12.24	2.92
T5 Control	25.78	31.25	23.58	1.15
SEM	1.32	2.01	1.25	1.21
CV %	14.02	16.35	17.78	13.17
CD (0.05)	2.14	4.07	3.91	0.67

All the treatments were effective in reducing the incidence of the disease as compared to control at Mudigere. However, T3 (0.2 % Kocide spray & drench after 10 days of T. harzianum + Neem cake application) was found effective, which was on par with T2 (1 % Sectin spray & drench + T. harzianum + 1 kg Neem Cake).

The investigation was undertaken during 2011-12, in both black-pepper and betel vine growing areas of Karnataka at Mudigere. The incidence of pest was recorded on two species of Erythrina, viz., Erythrina indica, Erythrina fusca in all the places except on Erythrina subumbrans which was almost free from gall wasp. Further, that species was screened against this pest intensively both under field and poly house conditions and no incidence was recorded. Later sample has been sent for identification to Botanist and confirmed the identity of species.

PEP/CP/6 Pest management Trial

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

(Centres: Mudigere, Pampadumpara)



IV. Experimental Results in CARDAMOM

CAR/CI/1 Genetic resources

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

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

A total of 165 cardamom accessions are presently conserved in the gene bank at Pampadumpara among them 73 cardamom accessions (CRSP 1-73) were deposited at NAG centre and got IC numbers (547920 to 547992) from National Bureau of Plant Genetic Resources, New Delhi (Table 5). Two new additions

Chirackal, Malabar type with light green round heavier capsule and Sangharani Vazhukka type elongated capsule with medium size were added to the germplasm during the year 2012-13.

At Mudigere all the 132 lines have been replanted during the 2010 as the plantation (trial) was very old and the observations on different growth and yield parameters will be recorded from the third year after planting. Lines which found superior for important yield traits, for capsule yield are (CL-730, PDP-7, and D-4), panicle length (P-3, P-5, PDP-7, CL-730 and bearing suckers/plant (P-3, CL-730, PDP-7).

Table 5. Cardamom germplasm collections of AI-CRPS centres

Centre	Indigenous		Total
	Cultivated	Wild and related sp.	
Mudigere	132	-	132
Pampadumpara	165	2	165
Total	297	2	297



Fig.6 SANGHARANI - elongated capsule with medium size.





CHIRACKAL - light green round heavier capsule.

CAR/CI/3.5 CVT 2005 Series V

(Centre: Mudigere, Pampadumpara)

CVT -2005 trial comprising of evaluation of eight clones from different research center was initiated in 2005-06 in RCBD with 3 replications at Mudigere. Among the eight genotypes evaluated, PS-27 recorded maximum dry capsule yield (262.0 kg/ha) followed by CL-722 (232.0 kg/ha) and MCC-309 (202.0 kg/ha) than the best check M-1 (219 kg/ha). Over the years, genotype CL-722 (284.35 kg/ha) recorded highest yield followed by PS-27 (275.58 kg/ha) and MCC-309 (254.31 kg/ha) than the best check M1 (216.31 kg/ha).

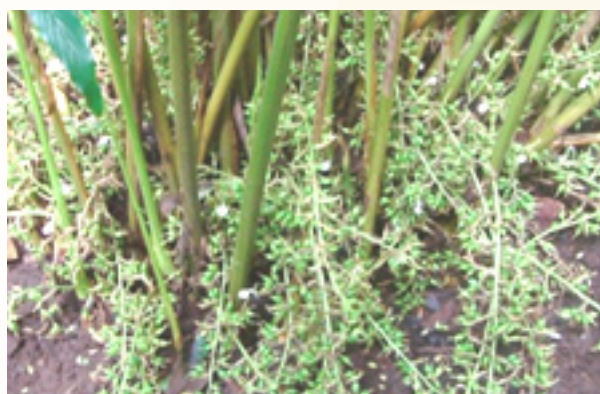


Fig 7. PS 27 promising variety of Cardamom in CVT

Crop Improvement

CAR/CI/2 Hybridization

CAR/CI/2.2 Hybridization and selection in cardamom

(Centre: Mudigere).

A crossing block involving elite clones of M-1, M-2, HS-1, Njallani Gold, SKP-14 and CL-726 was established at a closer spacing of 6 x 3' in order to generate all possible cross combinations through both random open pollination and hand pollination. All the clones were good general combiners and belong to Malabar type, while Njallani green gold is a Vazuka type. Thirty six new F1 combinations were produced by crossing six different improved/ elite genotypes in all possible combination and seedling will be raised and evaluated to identify the high yielding genotypes in coming years.

The accession PS 27 was found to be the most promising cultivar with maximum fresh weight (2805 g) and dry weight (597 g) of capsules per plant followed by MHC 26 at Pampadumpara.

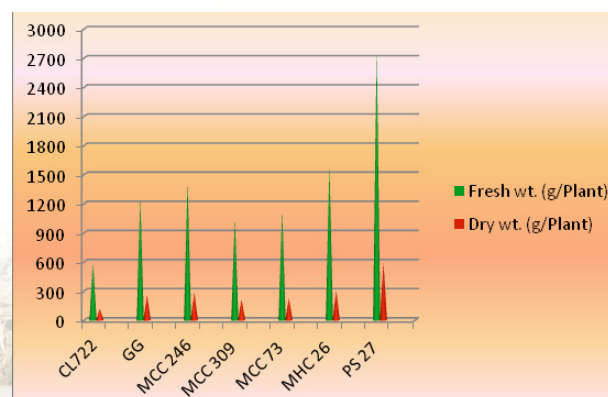


Fig 8. Fresh and dry yield of small cardamom accessions of CVT 2005 at Pampadumpara



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

(Centres: Mudigere, Pampadumpara, Myladumpara, Sakleshpur, Appangala)

This trial has been laid out during 2009 at Mudigere. Observation on plant height and total number of suckers/plant was recorded. Among the 13 entries evaluated IC-547185 (282.20 cm) found to be tallest followed by CL-726 (276.33 cm) and the entry IC-547167 (18.50) recorded more number of suckers/plant followed by IC-346951 (17.5) and the yield parameters will be recorded from third year onward.

In this trial IC 349545, IC 349651, IC 547167, IC 547185, CL 726, CL 691, PL NO 14 (CRSP 158), CR 6 (CRSP -19), MCC 346, SKP 104, SKP 164, PV 2 and Green gold (local check), a total of 13 accessions, are being evaluated for adaptability to high ranges of Idukki district.

At Pampadumpara Tiller height, leaf length and leaf width were maximum in PV 2 and Green gold and no significant differences were noticed between varieties for number of tillers per plant.

At Myladumpara during 2012-13 seasons, significant difference could be observed between the 13 clones for all the growth attributes. The production of panicles and yield was affected due to severe drought during the season.

Maximum yield was recorded by T11 (SKP 164) 1106.50 g followed by T1 (IC 34987) 1062.90 g at Sakleshpur. Maximum percentage (56.5 %) of bold capsules (capsules retained in 8 mm sieve) found in T9 (MCC 346) followed by SKP 164 (52.5 %). Least incidence of shoot borer was observed in SKP 104. Shoot fly incidence (2.6 %) was least in IC 547185.

Among the 13 entries in the coordinated varietal trial at Appangala IC 349545 recorded the max-

imum yield (957.87 kg/ha) followed by IC 547185 (870.34 kg/ha) during the year 2012-13.

CAR/CI/4 Varietal Evaluation Trial (VET)

CAR/CI/4.1 Initial Evaluation Trial-1 2009

(Centre: Mudigere)

At Mudigere out of 10 entries (7-24-D11, 2-4-D11, 2-5-D11, 12-7-D11, 7-12-D11, 26-16-D11, GG (ch), M-1 (ch), M-2 (ch), M-3 (ch), plant height was more in 2-4-D11 (285.90 cm) and total suckers /plant was recorded more by the entry 2-5-D11 (21.0) followed by 12-7-D11 (20.4).

CAR/CI/4.2 Initial evaluation trial -II 2009

(Centre: Mudigere)

The experiment was initiated during the year 2009 with thirteen entries at Mudigere and the entry Darmala (282.20 cm) was found to be tallest followed by CL-728 (256.9 cm). Total suckers/plant was observed more in valley no.1 (17.50) followed by CL-720 (16.50) than the best check M3 (15.0).

CAR/CI/4.3 Initial evaluation trial 2012

(Centre: Pampadumpara)

An experiment to initiate the performance of high yielding accessions viz. S1, Pl.No14, PV2, PV1, HY 9, BEP 2, PPK 2, HY 6 in comparison with Njalani (local check) was initiated at Pampadumpara during 2012 and plants are in vegetative stage.



CROP PRODUCTION

CAR/CM/5 Nutrient management Trial

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

(Centres: Mudigere, Pampadumpara)

Application of irrigation 9 liters/clump/day along with 100 % recommended dose of fertilizer through drips recorded the highest capsule yield (205.35 kg/ha) that was on par with irrigation 9 liters /clump/day with 75 % recommended fertilizer dose (199.25 kg/ha) and the least capsule yield was obtained with conventional method of irrigation (155.57 kg/ha) at Mudigere.

At Pampadumpara the experiment was started

during 2011 and the experiment is in progress.

CAR/CM/5.3 Organic farming in Cardamom

(Centre: Mudigere, Pampadumpara)

The experiment was initiated at Mudigere during 2010 with nine treatments to know the effect of different organics on yield and quality of cardamom. Application of organics with bio-fertilizers registered significantly higher yield than only organics but application of FYM(30 t/ha) + recommended NPK (125 :125 : 250 kg/ha) recorded maximum dry capsule yield (250.65 kg/ha) followed by application of FYM + Azospirillum (10 g/clump) + Phosphorus solubilising bacteria PSB (10 g/clump) + Trichoderma (10 g/clump) (Table 6). Marginal improvement in soil NPK content was observed due to the application of organics.

Table 6. Yield and Yield attributing characters as influenced by organics in cardamom at Mudigere

Treatments	No. of bearing suckers/clump	No. Panicles/clump	Panicle Length (cm)	Capsules / Panicle	Yield (kg/ha)
T1	36.52	48.55	71.00	30.00	190.66
T2	38.19	46.00	70.00	25.00	185.73
T3	32.33	42.00	68.00	33.00	199.86
T4	26.88	38.00	68.00	25.00	168.66
T5	36.00	50.00	42.00	35.00	240.21
T6	34.00	49.00	73.00	33.00	230.47
T7	30.00	48.00	70.00	35.00	231.55
T8	28.00	45.00	69.00	26.00	186.22
T9	38.00	49.00	69.02	39.00	250.65
SEm ±	0.99	1.86	1.72	0.43	3.66
C D (0.5)	3.28	5.12	N.S	0.75	9.28
CV %	15.55	15.85	15.19	15.0	11.35

At Pampadumpara evaluation of different organic amendments on growth and yield of cardamom variety PV 2 showed that application of Jee-

vamritha + Azospirillum (10 g/clump) + Phosphate solubilising bacteria (10 g/clump) + Trichoderma (10/ g clump) (T8) resulted in the maximum fresh



(315.73 g plant⁻¹) and dry capsule yield (66.59 g plant⁻¹), however the yield was on par with one time application of FYM @ 30 t ha⁻¹. Least incidence of Azhukal disease was observed with monthly basal application of Jeevamritha alone @ 20 L plant⁻¹.

CAR/CM/5.4: Liming in Cardamom

(Centre: Pampadumpara)

The experiment was started during 2011 at Pampadumpara in the variety PV 2. Application of ground lime stone @ 2 kg/plant in cardamom in June had increased the yield of cardamom (variety PV 2) 208 % over the control followed by dolomite @ 2 kg/plant.

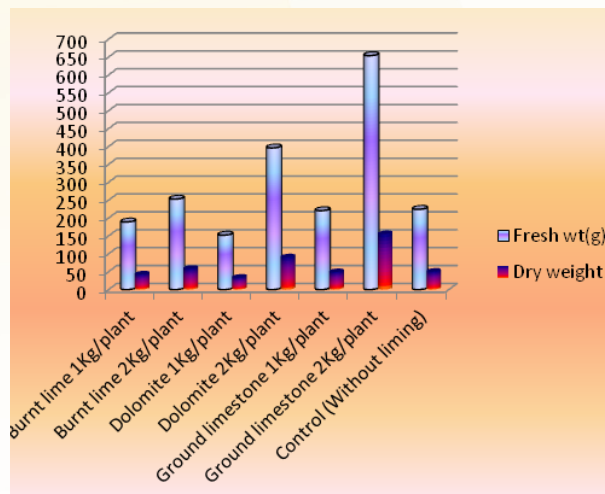


Fig 9. Effect of different liming materials on yield of cardamom

CAR/CP/6 Pest and disease management Trial

CAR/CP/6.4 Management of cardamom root grub through entomopathogenic nematodes

(Centre: Pampadumpara)

Experiment was conducted at CRS, Pampadumpara to evaluate the efficacy of two isolates of

Heterorhabditis sp. at two different concentrations and in combination with Imidacloprid (0.006 %) against cardamom root grub. Both the EPN concentrations @ 100IJ/grub or 200IJ/grub used in the study reduced the root grub population. The nematode was applied alone or in combination with Imidacloprid. A combined application of nematode and neonicotinoid is therefore suggested as a curative method in the management of cardamom root grub. Care should be taken to ensure adequate moisture content while applying EPN and application of EPN should be restricted to evening hours for better results.

CAR/CP/6.6: Management of rhizome and panicle rot in Cardamom (New plantation)

(Centre: Mudigere, Pampadumpara)

The experiment was initiated at Mudigere with six treatments (*Trichoderma harzianum*,

Consortium of bacteria (for growth, nematode, pythium suppression), *T. harzianum* + Consortium of bacteria, COC (0.2 %) drenching, Potassium Phosphonate (0.5 %) spray and drench, Control including three varieties during the year 2009. All the treatments were effective in enhancing the plant growth parameters compared to control. The maximum plant height (213.6 cm) and tillers (12.3) were recorded by T4 (spraying and drenching of COC (0.3 %) in Njallani green gold which was on par with T3 (Combined application of *T. harzianum* & Consortium of bacteria). The minimum disease incidence 3.0 % tiller and panicle infection and less incidence of foliar diseases were recorded by T3 and T4. with maximum yield (1085.3 kg/ha) and (1008.0 kg/ha) respectively.

Application of *Trichoderma harzianum* and consortium of bacteria @ 50 g/plant was found to be the best treatment against tiller, panicle and capsule infection of small cardamom varieties PV2 and Green gold at Pampadumpara.





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

(Centre: Mudigere, Pampadumpara)

All the harvests of cardamom at Mudigere indicated maximum damage with thrips compared to borers. Application of Methomyl@ 1.5gm per lit of water and Acetamiprid @0.5gm and Imidacloprid @ 0.5ml found to be effective to control thrips and capsule borer compared to Standard check (Mudigere practices).

At Pampadumpara minimum thrips infestation was recorded by the treatment T4 (Imidacloprid) with 5.89 % infestation followed by Thiamethoxam with lower infestation of 16.01 %. The treatment T8 (Quinalphos) was also effective in reducing thrips infestation (22.27 %) and was on par with the treatments T1 (Acetamiprid), T2 (Chlorpyrifos) and T5 (Carbosulfan). In the case of shoot borer attack, lowest infestation was recorded by the treatment T7 Poneem with 12.40 % infestation followed by the treatment T8 (Quinalphos) with a lower pest infestation of (15.36 %) and this treatment was on par with the treatment T2 (Chlorpyrifos) with 18.28 % borer attack.

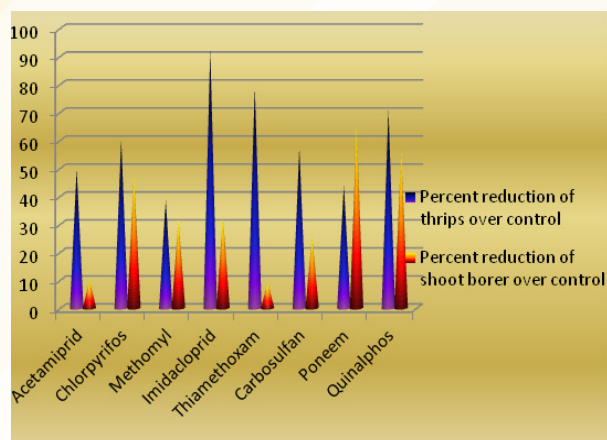


Fig 10. Percent reduction of thrips and shoot borer infestation over control at Pampadumpara.

CAR/CP/6.8 Comparison of effect of chemical treatments as well as bio-control agents against pseudo stem rots of cardamom

(Centre: Pampadumpara)

This experiment was started in 2011 at CRS, Pampadumpara using the cardamom variety Njalani. The treatments were imposed during first week of May 2013 and the trial is in progress.



V. Experimental Results in Large Cardamom

LCA/CI Genetic Resources

LCA/CI/1 Germplasm collection, characterization, evaluation and conservation

(Centre: Eastern Himalayan region Gangtok (ICRI))

Germplasm of Large Cardamom maintained at ICRI Regional Research Station, Gangtok is shown in Table 7. A Survey was conducted at different area of North Sikkim for collection of germplasms. Six planting units of six germplasms viz. SCC 239 (Golsey), SCC 240 (Golsey), SCC 241 (Golsey), SCC 242 (Ramsey), SCC 243 (Seremna) and SCC 246 (Ramsey) were collected and planted under AICRPS trial plot at Kabi farm. Characterizations of the collected



germplasm were made as per descriptor. SCC 242 Ramsay recorded more number of productive tillers (400, spike/clump (45), capsule /spike (15), seeds / capsule (50), dry yield/plant (675) and projected yield (2000 kg/ha).

Table 7. Large cardamom collections maintained at ICRI Regional Research station, Gangtok

Centre	Indigenous				Exi sting	Exotic Addition (April 2011. to March 2012)	Total
	Cultivated		Wild & related species				
	Existing	Addition (April 2011. to March 2012)	Existing (April 2011. to March 2012)	Addition			
ICRI,RRS, Gangtok	231	17	11	NIL	NIL	NIL	248



Disease Management

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

(Centre: ICRI regional research station (Gangtok))

Fourteen disease escapes (blight caused by *Colletotrichum gloeosporioides*) were collected from Sikkim and Darjeeling hills of West Bengal. Six units of each accession were planted in ICRI research farm at Kabi for further multiplication and evaluation. Established accessions are being planted in poly bags / pots for challenge inoculation with the pathogen. Incidence of pests and diseases was less in treated trial plots in farmer's fields at Singhik, North Sikkim. Treating suckers with bioagents (*Pseudomonas Fluorescens* + *Bacillus subtilis*, 3 % each) showed less incidence of blight as compared to control. Moderately tolerant and moderately susceptible germplasm accessions were planted in disease hot spot area (Kabi) for field evaluation ICRI Sikkim 2 as control.

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

(Centre: ICRI regional research station (Gangtok))

The experiment was started in 2011 in farmer's field at Singhik, North Sikkim with two treatments T1 Control and, T2 Phytosanitation and application of bio- agents. Targeted pests and diseases were leaf caterpillar (*Artona chorista*), shoot fly (*Merochlorops dimorphus*) *Colletotrichum* blight, chirke and foorkey (viral diseases). It was observed that the incidence of the pests and diseases was less in treated plot than in control plot.

Management of mealy bug and aphids

(Centre: Eastern Himalayan region –ICAR Research complex for NEH Region, Gangtok)

Six different biopesticides viz., Phytoneem @ 3 ml/L, Multineem @ 3 ml/L, *Bacillus thuringiensis* @ 2g/L, *Beauveria bassiana* @ 5 g/L, Petroleum Servo Agrospray @ 7 ml/L and Spinosad 45 SC 0.4 ml/L were evaluated against mealy bug and aphids in large cardamom. Among the biopesticides two sprayings of Petroleum Servo Agrospray @ 7 ml/L was found to be most effective to control the population of mealy bug (72.54 % population reduction over control) and aphids (79.76 % population reduction over control) followed by Spinosad 45 SC 0.4 ml/L (70.26 % population reduction over control) and (74.26 % population reduction over control) respectively.

Management of leaf blight caused by *Colletotrichum gloeosporioides*

Field experiment was conducted to study the effect of different organic treatments against *Colletotrichum gloeosporioides* the causal agent of Leaf blight in large cardamom. Among the treatments garlic bulb extract @10 % both spray and drench showed less incidence of disease (5.8 %) followed by ginger rhizome extract @ 10 % (drench and spray) with disease incidence of 11.11 compared to control (30.51 %).



Fig 11. Management of leaf blight using garlic extract



VI. Experimental Results in Ginger

GIN/CI/I Genetic Resources

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

(Centres: Middle gangetic plain-Dholi; Upper gangetic plain-Kumarganj; Western Himalayan region-Solan; Eastern plateau and hills region-Pottangi, Raigarh, Kanke; Lower gangetic plain region-Pundibari)

The ginger Germplasm maintained at various AICRPS centres are given in (Table 9) Fifty accessions of ginger were collected for screening

Table 8. Ginger germplasm collection of AICRPS centres

Centre	Indigenous	Exotic	Total
Dholi	50	-	50
Kumarganj	61	-	61
Pottangi	98	-	98
Pundibari	59	-	59
Raigarh	44	-	44
Solan	231	-	231
Total	543		543

of promising lines with respect to yield and other quality parameters at Dholi and only fifteen accessions namely RG-24, RG-22, RG-16, RG-34, RG-45, RG-18, RG-17, RG-30, RG-19, RG-20, RG-9, RG-44, RG-5, RG-14 and RG-25 registered the reasonable yield ranging from (0.35 to 0.17 kg/plant) as compared to high yielding variety Nadia used as check. Among the promising line RG-24 produced the maximum yield (0.35 kg/plant) followed by RG-22 i.e., 0.30 kg per plant.

Out of the 61 Germplasm of ginger evaluated at Kumarganj lines identified was NDG-55 (341.60 q/ha) and NDG-6 (137.80 q/ha). NDG-6 and NDG-7 with respect to yield were observed as soft rot tolerant germplasm accessions.

At Solan two hundred and thirty one ginger collections were evaluated for rhizome yield and other horticultural traits. Yield of three lines viz., SG-857 (185.20 q/ha), SG-12/04 (176.60 q/ha) and SG-1134 (175.80 q/ha) excelled the check Himgiri which yielded 151.50 q/ha. The rhizome rot disease incidence varied from 8.40-25.75 % with 9.80 % and 12.25 % in SG-857 and Himgiri, respectively.

Out of 59 germplasm evaluated at Pundibari highest rhizome yield/plant was recorded by GCP-23 (255.00 g) and lowest by GCP-10 (52.33 g).



Out of 98 ginger germplasm evaluated at Pottangi maximum fresh rhizome yield was recorded by three accessions Banspal (5.5 kg/3 m²), Singhjara (5.5 kg/3 m²), Zo-9 (5.5 kg/3 m²), V1E4-4 (5.5 kg/3 m²) followed by S-692 (5.3 kg/3 m²), Sargiguda (5.3 kg/3 m²) and Turia local (5.3 kg/3 m²).

Crop Improvement

GIN/CI/2 Coordinated Varietal Trial

GIN/CI/2.3 CVT 2006 - Series VII

(Centre: Pottangi, Pundibari, Kumarganj)

At Pottangi entry IG-2 (9.05 t/ha) was the top yielder with the yield advantages of 49.6% than the national check variety Mahima (6.05 t/ha) followed by V1S1-2 (7.5 t/ha) and GCP-31 (5.74 t/ha). Maximum tillers per clump were noticed in GCP-31 (7.8). The rotting and wilting per cent was low in V1S1-2 (Table 9)

Table 9. Performance of ginger genotypes in Coordinated Varietal Trial during kharif at Pottangi (2012-

Entries	Plot Yield (kg/3m ²)	Projected yield (t/ha)	Yield Adv. over NC (%)	Tillers/clump	Plant Height (cm)	Rot %	Wilt %
GCP 31	2.58	5.74	21.1	7.8	42.1	14.3	10.4
GCP 5	2.14	4.74		4.9	35.2	10.5	9.6
V1S1 -2	3.38	7.50	37.1	7.4	41.9	8.1	8.2
IG 3	2.27	5.03		4.7	46.5	13.1	8.6
IG 2	4.08	9.05	49.6	5.5	42.9	9.1	10.6
MAHIMA (NC)	2.73	6.05		6.5	44.1	3.7	3.8
SUPRABHA (LC)	2.81	6.25		6.1	36.4	10.0	10.4
S.Ed (±)	0.12	0.27		0.29	2.05	0.82	0.4
CD (0.05)	0.44	0.98		1.04	7.31	2.4	1.1
CV%	9.18	9.18		10.10	10.52	6.2	5.8

GIN/CI/3.2 Initial evaluation trial 2011

(Centres: Solan, Pundibari, Dholi)

At Solan the genotype SG-26/04 recorded maximum yield (203.00 q/ha) followed by SG-08/04 (191.60 q/ha) and the check Himgiri recorded less yield (151.50 q/ha). The rhizome rot disease incidence varied from 8.50 -14.65% with minimum in SG-26/04.

In IET, out of 11 genotype tested (GCP-1, GCP-8, GCP-9, GCP-12, GCP-14, GCP-28, GCP-33, GCP-45, GCP-48, GCP-49 and GCP-54. Gorubathan (Local Check), GCP-49 recorded the maximum projected yield (15.65 t/ha.) followed by GCP-8 (12.55 t/ha) at Pundibari.

Nine promising entries along with check variety Nadia were tested under initial evaluation trial. Promising entries RG-32 was found significantly more number of tillers per plant (26.06) as compared to check variety Nadia (22.27). All the en-



tries gave significantly higher yield per plot or per hectare except RG-14 as compared to check variety Nadia. However, among high yielding promising entries, RG-32 produced the highest yield per plot (7.92 kg/3m²) or 26.39 t/ha followed by entry RG-24 i.e., yield per plot (7.53 kg/3m²) or (25.11 t/ha) during 2012-13.

GIN/CI/3.3 - Initial Evaluation Trial 2012

(Centre: Kumarganj, Pottangi)

At Kumarganj seven entries of ginger were evaluated on IET during the kharif season. The Maximum yield 339.99 q/ha was recorded by bydra-sonth followed by NDG-28 (199.99 q/ha) and then NDG-6 (141.11 q/ha).

It is revealed from the analyzed data that the rhizome yield of the entry V1K1-1 (6.0 Kg/3m², 13.3 t/ha) was the highest followed by PGS-8 (5.5 Kg/3m², 12.2 t/ha), PGS-7 (5.5 Kg/3m², 12.2 t/ha) and Renga (5.5 Kg/3m², 12.2 t/ha) during 2012-13. The average of seven years data revealed that, VIE5 (21.4 t/ha) was the top yielder followed by PGS-8 (20.3 t/ha).

GIN/CI/3.5 Genotype X Environment interaction on quality of ginger

(Centres: Western Himalayan region-Solan; Eastern himalayan region-Pasighat, Mizoram, Barapani; Lower gangeticplain-Pundibari, Kalyani; East cost plains and hills region - Chintapalli; Eastern plateaue and

hills region-Pottangi)

At Solan average yield of ginger varied from 95.64 q/ha to 203.00 q/ha. Local check SG-26/04 recorded maximum yield 203.00 q/ha followed by Himgiri 151.50 q/ha. The rhizome rot disease incidence varied from 8.50 to 14.85 % with minimum in SG-26/04.

Maximum fresh rhizome yield of ginger was recorded by TCPPI (13.9 t/ha), followed by Roma (13.0 t/ha) and Pratibha(12.5 t/ha) at Pottangi.

At chinthapalli, out of the ten varieties allotted in this project received only 6 varieties from different centres and with local check Narsipatnam conducted the experiment in Randomized block design. During the year 2012-13, observations revealed that, Maximum plant height was recorded in Nadia (44.66 cm) followed by Varada (44.0 cm). Nadia produced maximum tillers (21) followed by Varada (19.3). Among the varieties, Nadia recorded maximum yield (22.75 t/ha) of fresh rhizomes followed by Varada (21.32 t/ha) and lowest yield was recorded in Himagiri (11.17 t/ha).

The maximum yield was registered by Himgiri (154.33 q/ha) followed by Nadia (131 q/ha) and the Mahima (125 q/ ha) at Mizoram.

At Kalyani in respect of yield per plant (kg) and projected yield (t/ha), Varada registered the maximum yield (34.38t/ha) followed by (Suruchi 31.62 t/ha), Suprabha (30.45 t/ha) and Gorubathan(30.15 t/ha) whereas lowest yield was recorded by Himgiri(14.84 t/ha) (Table11).

Table 10. Performance of ginger varieties at GXE interaction at Kalyani (2012-2013)

Genotypes	Plant height (cm)	No. of tillers/clump	Leaf area (cm s (kg) quare)	Average yield / plant	Projected yield (t/ha)
Himgiri	45.20	14.4	39.09	0.161	14.84
Mahima	47.0	9.57	38.74	0.177	16.13
Rejatha	49.60	12.43	40.09	0.167	15.40



Varada	50.57	12.57	37.75	0.376	34.38
Gorubathan (local cv.)	53.27	12.47	36.04	0.328	30.15
Suprabha	50.67	12.43	40.06	0.331	30.45
Suruchi	63.37	14.33	39.51	0.344	31.62
Surabhi	54.20	17.63	40.31	0.240	22.11
V3 S1 -8	55.67	11.90	40	0.212	25.91
Sambuk (local cv.)	52.20	14.53	39.57	0.193	17.79
S.Em.(±)	1.462	0.374	0.684	0.013	0.894
CD (0.05)	4.344	1.111	2.032	0.039	2.656

At Barapani maximum yield was noticed in V3S1-8 (4.5 t/ha) whereas variety Suruchi had maximum oleoresin content (10.50 %) and lowest was noticed in Mahima (3.90 %). The highest volatile oil content was noticed in Mahima (2.65 %) and lowest in Himgiri (1.73 %). Dry recovery percentage ranged from (17.10-29.91 %) and crude fiber content was (4.21-7.85 %).

In Genotype × Environment interactions, maximum projected yield was registered by GCP-5 (11.48 ton /ha) followed by IISR Varada (6.28 ton /ha) at Pundibari and the lowest yield was recorded by Suprabha (2.49 ton/ha).

At Kanke maximum yield per ha was noticed in

Suprabha (33.51 tonnes) followed by Suruchi (32.06 tonnes) and Himgiri (31.77 tonnes) whereas maximum dry recovery was observed in Varada (24.76 %) followed by Himgiri (24.39 %) and Mahima (23.23 %).

The variety Surabhi registered maximum rhizome yield (0.20 kg/plant, 7.01 kg/3m² and 23.34 t/ha) and that was statically on par with the check variety Nadia (0.20 kg/plant, 7.09 kg/3m² and 23.60 t/ha) at Pasighat (Table 11). The mean values on quality parameters revealed that variety Suruchi had maximum dry recovery (21.97 %) and essential oil (1.97 %) content. The variety Surabhi had maximum oleoresin (8.56 %) and lowest crude fibre (3.43 %) was noticed in Mahima.

Table 11. Performance of Ginger varieties under G x E interaction at Pasighat

Varieties	Plant height (cm.)	No of tillers	Leaf length (cm.)	Leaf breadth (cm.)	Yield /plant (kg)	Yield (t/ha)	Dry recovery (%)	Crude fibre (%)	Oleoresins (%)	Essential oil (%)
Suprabha	46.63	11.87	20.49	2.45	0.17	19.96	19.87	4.59	7.83	1.71
Suruchi	53.22	12.20	20.79	2.56	0.17	19.77	21.97	3.90	7.45	1.97
Surabhi	49.37	12.73	23.23	2.62	0.20	23.60	21.37	4.05	8.56	1.88
V3S1	50.09	11.27	18.66	2.55	0.13	15.70	19.97	3.75	8.43	1.76
Himgiri	49.63	10.33	21.00	2.51	0.15	19.38	19.67	4.67	6.00	1.75
Varada	46.76	11.00	21.10	2.34	0.16	19.67	19.40	3.97	6.76	1.76
Mahima	51.84	10.47	22.84	2.57	0.16	18.85	20.63	3.43	5.85	1.87
Rejatha	52.07	11.53	20.65	2.33	0.16	18.79	20.38	4.09	6.13	1.57



Nadia	52.98	11.27	21.65	2.72	0.20	23.34	21.60	4.02	7.13	1.72
GM 50.29	11.41	21.16	2.52	0.17	19.89	20.54	4.05	7.13	1.78	
SEm±	1.21	0.46	0.79	0.07	0.01	1.15	0.54	0.07	0.26	0.06
CD (0.05)	3.62	1.39	2.38	0.22	0.03	3.45	1.61	0.22	0.79	0.18

GIN/CI/4 Quality Evaluation Trial

GIN/CI/4.1 Evaluation of germplasm for quality

GIN/CI/4.1 Identification of high yielding and good quality genotypes for further promotion in IET and CVT

(Center: Solan)

Forty best performing collections were analyzed. The dry matter content (%) and crude fibre (%) ranged between 16.50 (Suprabha) to 23.50 (SG-1083) and 4.15 (SG-1134) to 5.32 (SG-603), respectively. Essential oil (%) and oleoresin contents (%) varied from 0.61 (Varada) to 1.93 (SG-857) and 3.12 (SG-40/04) to 5.26 (SG-1032), respectively. High yielding collection SG-26/04 was found superior/ comparable for dry matter content, essential oil, oleoresin and crude fibre contents to the check Himgiri.

GIN/CI/4.2 Evaluation of germplasm from other centres

(Center: Solan)

Eight samples of turmeric from one centre i.e. T.C.A., Dholi, Muzaffarpur (Bihar) were evaluated for quality parameters viz., dry matter (%), essential oil (%), oleoresin (%) and curcumin (%) in turmeric. However, samples of ginger were not received for analysis during the period under report.

Crop Management

GIN/CM/5 Nutrient management Trial

GIN/CM/5.3 Nutrient management through organic manures for growth and yield of ginger

(Centre: Kumarganj, Dholi)

Application of recommended dose of fertilizer (120:80:80) registered maximum rhizome yield (135.55 q/ha) at Kumarganj and the lowest rhizome yield 82.21q/ha was noticed in the treatment FYM (50 %) + vermicompost (50 % over the control (65.55 % q/ha).

At Dholi among seven treatment and one control, FYM (100%)-20t ha⁻¹ and integrated nutrient management (FYM-30 t ha⁻¹, N:P:K:80:50:80kg ha⁻¹) gave significant higher yield (14.15 & 16.10t ha⁻¹) respectively as compared to control (9.29 t ha⁻¹) in which recommended dose of INM @FYM-30 t ha⁻¹, N:P:K:80:50:80kg ha⁻¹ gave the maximum yield (16.10t ha⁻¹). Regarding cost benefit ratio is concerned, recommended dose of INM gave the maximum return Rs.3.00 per unit cost (1:3.00) followed by FYM-100% @20 t ha⁻¹ i.e., return Rs.2.72 per unit cost (1:2.72).

GIN/CM/ 5.4 Evaluation of herbicides for the control of weeds in Ginger (*Zingiber officinale rosc*)

(Centre: Chintapalli)



This trial was initiated during the year 2012-13 with the objective of reducing cost of cultivation in ginger with following treatments.

T1: Pendimethalin (Pre-emergent) 30% EC, 1.5 kg a.i./ha

T2: Oxyflurofen (Pre-emergent) 23.5% EC, 0.3 kg a.i./ha

T3:T1 followed by Quazilofop ethyl (30 days of crop) 5 % EC, 0.05 kg a.i./ha

T4:T1 followed by Propaquizafop (30 days of crop) 10 % EC, 0.05 kg a.i./ha

T5:T2 followed by Quazilofop ethyl (30 days of crop) 5 % EC, 0.05 kg a.i./ha

T6: T2 followed by Propaquizafop (30 days of crop)

10% EC, 0.05 kg a.i./ha

T7:T3 followed by hand weeding (90 days of crop)

T8: T4 followed by hand weeding (90 days of crop)

T9: T5 followed by hand weeding (90 days of crop)

T10:T6 followed by hand weeding (90 days of crop)

T11: Un weeded control

T12: Weed free check (Regular Hand weeding)

During the year 2012-13, predominance of weeds Cypress, Cynodan in ginger fields was observed. Maximum per plant yield (502 g/plant) and projected yield (24.50 t/ha) was recorded by T9 treatment i.e. application of Oxyflurofen 23.5 % E.C, 0.3 kg a.i./ha that was on par with T12 i.e weed free check (Table 12)

Table 12. The Effect of herbicides on growth and yield of ginger

Treatments	Plant height (cm)	No. of tillers/plant	Rhizome yield/plant (g)	Rhizome yield/plot (kg)	Fresh Rhizome Yield t/ha
T1	26.86	7.8	130.2	2.41	6.02
T2	28.46	9.1	146.4	2.73	6.82
T3	30.26	11.7	186.9	3.72	9.30
T4	31.06	11.1	180.0	3.52	8.80
T5	34.56	14.1	257.8	5.07	12.67
T6	35.15	14.2	224.5	4.42	11.05
T7	37.94	17.4	353.4	6.80	17.00
T8	35.43	16.3	345.6	6.44	16.10
T9	46.00	21.2	502.0	9.80	24.50
T10	40.93	19.7	428.5	8.24	20.60
T11	13.79	2.96	39.6	0.95	2.375
T12	43.80	22.6	511.2	10.18	25.45
SE (m)	0.949	0.748	8.198	0.131	--
CD (0.05%)	2.802	2.208	24.19	0.387	--
CV %	4.881	9.229	5.153	4.245	--



Disease Management

GIN/CP/6 Disease Management Trial

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

(Centre: Dholi)

A survey was conducted on the Vaishali district of Bihar to estimate the incidence of bacterial wilt and soft rot incidence in ginger by Dholi. The Bacterial wilt incidence was more compared to soft rot incidence and ranged from 5 to 45 % with mean disease incidence of 23.89 % whereas soft rot disease ranged from 0 to 20 % with mean disease incidence of (8.89 %). The crop was also found to be infected with *Phyllosticta* leaf spot disease which varied from 0 to 15 % with mean disease incidence of 5.56 %.

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

(Centres: Solan, Kumarganj)

At solan maximum germination (91.67 %) and minimum incidence of soft rot (2.45 %), bacterial wilt (1.56 %) and leaf spot (12.37 %) were noticed in rhizome treatment by Metalaxyl mancozeb, whereas maximum yield (151.20 q/ha) was noticed in the treatment biofumigation using mustard.

The result of experiment at Kumarganj showed that maximum rhizome germination (80 %) lowest soft rot incidence (21.2 %) and maximum yield (21.2t/ha) was recorded by the treatment Metalaxyl Mancozeb 75 % WP followed by soil fumigation with mustard.

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

(Centers: Solan, Kumarganj, Pundibari, Ambalavayal, Raigarh)

At Solan cabbage biofumigation registered maximum germination (90.67 %), yield (167.00 q/ha) and minimum incidence of bacterial wilt (1.25 %). It also resulted in lowest incidence of soft rot (2.56 %) and leaf spot (7.25 %).

Regarding 4 year's pooled results (2009-10 to 2012-13) biofumigation using cabbage (T1) recorded maximum yield of 14.15 t/ha with less soft rot disease of ginger (7.03 % disease) at Pundibari with an yield of 12.76 t/ha which was on par with rhizome treatment with Metalaxyl Mancozeb (T2) which recorded 9.54% soft rot disease incidence.

At Ambalavayal the germination percentage was considerably low (54.00 %) when the soil was biofumigated with cabbage and it was found to be higher when rhizomes were treated with Metalaxyl Mancozeb (72 %). Biofumigation using cabbage recorded maximum yield (20.0 t/ha), minimum soft rot (56 %) and leaf spot (1 %) incidence.



Fig.12 Management of soft rot of Ginger (bio-fumigation using cabbage)

All the treatment were effective against soft rot, at Kumarganj and maximum effect was noticed in rhizome treated by metalaxyl mancozeb with a soft rot incidence (22.7 %) and yield (3.0 kg/plot) followed by soil fumigation with cabbage and rhizome treated with antagonist bacteria.



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

(Centre: Solan)

An experiment on management of bacterial wilt of ginger was conducted at Solan with the treatments biofumigation using mustard, Soil treatment

by bleaching powder @10 g/bed , Rhizome treatment by heat (46-480C by solarization), Rhizome treatment by rhizobacterial antagonist, Rhizome treatment by endophytic bacterial antagonist and absolute control (Table 13). Mustard biofumigation resulted in maximum germination per cent in ginger (88.67 %), yield (150.0 q/ha) and lower incidence of bacterial wilt (2.25 %).

Table 13. Management of bacterial wilt of ginger (Biofumigation using mustard) at Solan

Treatment	Germination (%)	Soft rot (%)	Bacterial wilt (%)	Yield (q/ha)
T1	88.67 (8.23)	4.35 (0.67)	2.25 (0.34)	150.00
T2	84.77 (8.14)	6.60 (0.95)	3.50 (0.70)	130.00
T3	85.35 (8.28)	5.34 (0.82)	3.67 (0.78)	131.50
T4	83.54 (7.98)	6.70 (0.98)	5.57 (0.91)	140.00
T5	86.50 (8.16)	5.25 (0.80)	4.25 (0.82)	145.00
T6	75.66 (7.42)	12.50 (1.65)	6.50 (0.99)	111.50
CD(0.05)	(0.39)	(0.22)	(0.34)	06.60

Figures in parentheses are square root transformed values

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

(Centre: Pundibari, Ambalavayal, Pampadumpara)

At Pundibari pooled data (2009-10 to 2012-13)

revealed that biofumigation using cabbage (T1) was the promising treatment to reduce bacterial wilt disease of ginger (5.92 % disease) followed by soil treatment by bleaching powder (T2) which recorded bacterial wilt disease incidence 8.23 % with maximum yield (15.16 t/ha and 13.71 t/ha) respectively (Table14). No shoot borer incidence was noticed.

Table 14. Effect of biofumigation using cabbage on the incidence of softrot disease and yield at Pundibari (Pooled 2009 to 2013)

Treatments	Germination (%)	Soft rot (%)	Bacterial wilt (%)	Plot yield (kg)	Projected yield (t/ha)
T ₁	92.35	9.97 (18.41)	5.92 (14.08)	7.52	15.16
T ₂	87.03	12.55 (20.75)	8.23 (16.67)	6.80	13.71



T ₃	91.56	12.95 (21.09)	9.41 (17.86)	6.35	12.80
T ₄	86.72	12.06 (20.32)	8.54 (16.99)	6.16	12.42
T ₅	87.50	12.54 (20.74)	11.02 (19.39)	6.01	12.12
T ₆	85.63	19.19 (25.98)	22.11 (28.05)	3.82	7.70
SEm±	2.885	0.317	0.748	0.196	-
CD (0.0 5%)	8.695	0.955	2.254	0.592	-

(Figures in parenthesis are angular transformed value)

At Ambalavayal germination percentage was higher in the treatment where soil was biofumigated using cabbage (67 %). The plots in which rhizomes were treated with endophytic bacterial antagonist- GEB 18 recorded lower leaf spot and bacterial wilt incidence (1 % and 10 % respectively) as well as higher rhizome yield (23.00 t/ ha).

At Pampadumpara after the harvest of the produce in March 2013 the plant residue incorporated in soil and the beds kept for solarization for two months. The planting of ginger will be carried out in first week of June-2013.

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

(Centres: Middle gangetic plain region-Dholi; Lower gangetic plain region-Pundibari)

An experiment on efficiency of different fungicide against leaf spot disease of ginger including new molecules was initiated at Pundibari.

T1: Foliar spray with Mancozeb (0.3 %) first at disease appearance and then 2 times at 20 days interval

T2: Foliar spray with Carbendazim (0.1 %) first at disease appearance and then 2 times at 20 days interval

T3: Foliar spray with Carbendazim + Mancozeb (0.1%) first at disease appearance and then 2 times at 20 days interval.

T4: Foliar spray with Blitox (0.4 %) first at disease appearance and then 2 times at 20 days interval.

T5: Foliar spray with Propiconazole (0.1 %) first at disease appearance and then 2 times at 20 days interval.

T6: Foliar spray with Tricyclazole (0.1 %) first at disease appearance and then 2 times at 20 days interval.

T7: Foliar spray with Hexaconazole (0.1 %) first at disease appearance and then 2 times at 20 days interval

T8: Control.

From the Table 15 , it was found that Foliar spray with Propiconazole (0.1 %) first at disease appearance and then 2 times at 20 days interval (T5) was the best treatment with lowest PDI of 7.22 and maximum yield (8.80 kg/plot) followed by foliar spray with Hexaconazole (0.1 %) first at disease appearance and then 2 times at 20 days interval which recorded the leaf spot PDI of 8.89 and 10.00 and yield of 7.50 kg/plot and 7.25 kg respectively. T5, T7 and T4 reduced disease incidence of 81.43 %, 77.14 % and 74.29 % respectively over control.



Table 15. Effect of different treatments on leaf spot disease of ginger (2012-13)

Treatments	Germination	Leaf spot (PDI)	% reduction over control	Yield (kg/plot)	Project yield (t /ha)
T ₁	91.88	20.00 (26.57)	48.57	4.65	9.37
T ₂	91.25	17.78 (24.94)	54.28	5.80	11.70
T ₃	92.50	10.00 (18.43)	74.29	7.25	14.62
T ₄	93.75	16.67 (24.10)	57.14	5.40	10.89
T ₅	94.38	7.22 (15.59)	81.43	8.80	17.75
T ₆	95.63	12.22 (20.46)	68.58	6.70	13.51
T ₇	95.00	8.89 (17.35)	77.14	7.50	15.12
T ₈	92.50	38.89 (38.58)	-	3.65	7.36
SEm±	2.138	1.829	-	0.868	-
CD (0.05)	6.286	5.378	-	2.552	-

(Figures in parenthesis are angular transformed value)

A field trial on management of *Phyllosticta* leaf spot of ginger was conducted to see the effect of different fungicides on control of *Phyllosticta* leaf spot of ginger at Dholi. All the treatments were found to have statistically significant effect on decreasing *Phyllosticta* leaf spot disease and increasing yield over control.

Lowest disease (PDI 22.22) with maximum yield (19.24 t/ha) over control (PDI 48.89 & yield 10.88 t/ha) was recorded by the treatment foliar spray with Carbendazim + Mancozeb (0.1 %) first at the appearance of disease and subsequently 2 sprays at 20 days interval after 1st spray.



VII. Experimental Results in Turmeric

TUR/CI/I Genetic Resources and Crop Improvement

TUR/CI/1.1 Germplasm collection, char- acterization, evaluation and conservation

(Centre: Coimbatore, Dholi, Kumarganj, Pot-
tangi, Pundibari, Kammarapalli, Raigarh,
Pasighat)

The Turmeric germplasm maintained at vari-
ous AICRP centers are given in (Table 16). At Co-
imbatore a total of 275 germplasm collections were
planted during June 2012. The yield/plot (3 m²) re-
corded by the checks were CL 189 (CO1) 15.96, CL
1 (BSR 2) 8.64, 7.80 kg respectively. Among the 275
genotypes evaluated, 25 types recorded higher yield
than check 1 (CL 189), 195 genotypes recorded



higher yield than check 2 (CL 1) and 21 genotypes
recorded higher yield than Check 3 (CL 2). How-
ever 124 genotypes recorded higher yield than the
mean of all the genotypes.

Table 16. Turmeric germplasm collections in AICRPS centres

Centre	Indigenous		Total
	Cultivated	Wild and related sp.	
Coimbatore	275	-	275
Dholi	84	-	84
Kammarapally	220	-	220
Kumarganj	150	-	150
Pasighat	38	-	38
Pottangi	199	-	199
Pundibari	172	22	194
Raigarh	42	-	42
Total	1180	22	1172



Out of eighty four accessions of turmeric were collected and evaluated at Dholi only fourteen accession namely, RH-427, RH-426, RH-406, RH-413, RH-407, RH-24, RH-80, RH-6, RH-5/80, RH-2, RH-12, RH-401, RH-403 and RH-402 recorded maximum yield ranging from (1.70 to 1.2 kg per plant) as compared to local check variety Rajendra Sonali (1.00 kg per plant) and Rajendra Sonia (0.90 kg per plant). Among fourteen promising accessions, RH-427 registered the maximum yield (1.70 kg/plant) followed by RH-426 i.e., 1.60 kg per plant.

At Pasighat out of thirty eight diverse genotypes of turmeric were evaluated, only genotype CHFT-36 recorded significantly higher fresh rhizome yield (0.27 kg/plant, 10.83 kg/plot and 30.41 t/ha) as compared to the check variety Megha Turmeric-1 (0.24 kg/plant, 9.72 kg/plot and 32.37 t/ha) whereas highest curcumin content was observed in check variety Megha Turmeric-1 (7.21 %) followed by CHFT-17 (6.80 %) and CHFT-36 (6.77 %).

At present, 220 genotypes/germplasm collections are being maintained at TRS Kammarpally. During the year 2012-13, among the germplasm lines tested, Selection Duggirala Red recorded maximum rhizome yield (13.95 kg/3m²) followed by CLI-316 (12.95 kg/3m²).



Fig 12. Dugurala red a Promising turmeric variety from Kammarpally ready for release

der early maturity group was NDH-74 (352.7Q/ha) and NDH-79 (352.50Q/ha). In medium maturity entries identified was, NDH-98 (422.100Q/ha) and NDH-131(332.600 Q/ha). NDH-8(352.20Q/ha) and NDH-7(351.1Q/ha) was the entries identified in the late maturity group.

Among 162 turmeric accessions evaluated in 2012-13 at HARS, Pottangi, 141 were *Curcuma longa*, 17 were *Curcuma aromatic* and 4 were *Curcuma amada*. Out of 141 *Curcuma longa* accessions 29 entries recorded more than 7 kg/3m² fresh rhizome yield. The range in fresh rhizome yield in *C. longa* was varied from 2.0 kg/3 m² to 12.0 kg/3m². Maximum yield was recorded by PTS-21(12.0 kg/3m²), followed by CLS-28(11.3 kg/3m²), PTS-57(10.5 kg/3m²), CAM-2(10.0 kg/3m²).

194 cultures were maintained in at Pundibari and during the year four new collections were added. Out of 150 germplasm evaluated maximum plot yield and projected yield was recorded by TCP-168 (52.42 tons/ha) followed by TCP-90, and then TCP-170 (41.93 t/ha) . A total of 3 genotypes out yielded the local check TCP-2 (36.69 t/ha).

Forty two entries of turmeric were evaluated at Raigarh station for yield and its attributing characters along with the check Prabha during 2012-13 crop seasons. Among the entries, IT-8 (14.20 t/ha) followed by IT-38 (13.72 t/ha) were found good yielders as compared to check Prabha (12.09 t/ha).

TUR/CI/2 Coordinated Varietal Trial

TUR/CI/2.4 Coordinated Varietal Trial – 2009

(Centres: Chintapalli, Coimbatore, Dholi, Kammarapally, Pottangi, Pundibari, Raigarh, Kumarganj, Pasighat, Pantnagar, Navasari)

At Kumarganj 150 Germplasm of turmeric have been evaluated and promising entries identified un-

At Chintapalli, among the 7 varieties evaluated during the year 2012-13 for morphological charac-



ters, maximum plant height was recorded TCP-129 (92.80 cm) followed by TCP-70 (92.66 cm). Maximum leaf area is recorded in TCP-129 (935.8 sq.cm) followed by TCP-70 (9037 sq.cm). All accessions showed eight months duration.

In terms of yield parameters, maximum rhizome yield per plant was observed in RH-13/90 (595.3 g/plant) followed by RH-80 (538.3 g/plant) and lowest values recorded by TCP-70 (224.3 g/plant). Maximum fresh rhizome yield was recorded by RH 80 (42.0 t/ha) followed by RH 9/90 and RH-13/90 i.e, 37.40 and 35.50 t/ha respectively.

Among the 7 genotypes evaluated, maximum dry recovery observed in TCP-129 (25.8 %) followed by TCP-70 (23.9 %). Very low recovery was observed in RH-50 (15.2 %). Maximum dry yield observed in RH-80 (8.23 t/ha) followed by RH-9/90 (6.73 t/ha). Lowest dry yield recorded by TCP-70 and RH 50 and was on par with each other.

In the co-ordinated varietal trial 2009, six turmeric genotypes (RH-9/90, RH-13/90, RH-80, RH-50 from Dholi and TCP -129, TCP-17 from Pundibari) along with two local checks (BSR 2 and CL 101) were evaluated at Coimbatore. The yield varied from 16.96 to 22.82 kg/plot. The maximum yield was registered by CL 101 (22.82 kg/plot) followed by RH 80 (22.68 kg/plot).

At Dholi among the seven entries and one check Rajendra Sonia, RH-80 recorded significantly higher yield (61.70 t ha⁻¹) as compared to check variety Rajendra Sonia (51.02 t ha⁻¹).

Out of seven genotypes tested at Kammarpally, RH-9/90 recorded maximum fresh rhizome yield (31.0 t/ha) followed by RH-13/90 (30.6 t/ha) in comparison to Duggirala red check variety (40.0 t/ha).

At Pottangi it was revealed from the analyzed data that the maximum fresh rhizome yield was registered by PTS-55 (14.8 t/ha) followed by PTS-51 (12.2 t/ha) and PTS-34 (11.8 t/ha).

Among 10 genotypes only 7 [RH-13/90, RH-

50, RH-80, RH-9/90, TCP-129, TCP-70 & TCP-2 (Local check)] were tested and seed material of PTS-47, PTS-3 and National check (Pottangi) was not received. Maximum plot yield (kg/3m²) and the projected yield was registered by TCP-70 (7.07 kg and 14.25 t/ha) respectively and the lowest yield by RH-13/90(13 t/ha) at Pundibari.



Fig 13. Trial on CVT of Turmeric at Raigarh

At Raigarh out of six entries, the entry TCP-70 was found to be the best which produced 17.46 t/ha followed by the check TCP-2 Suranjana (13.46 t/ha).

Among Six genotypes of turmeric namely RH-9/90, RH-13/90, RH-80, RH-50, TCP-129 and TCP-70 were evaluated at Pasighat. Genotype RH-50 recorded maximum fresh rhizome yield (51.10 t/ha), which was significantly superior over rest of the genotypes including local check variety Megha Turmeric-1(32.37 t/ha). In terms of quality parameters, the genotype TCP-70 showed maximum dry recovery (24.97 %) and genotype RH-13/90 produced maximum oleoresin content (8.68 %). Check variety Megha Turmeric-1 recorded maximum curcumin (7.21 %) and essential oil (4.78 %) content.

Eight genotypes of turmeric including GNT-1 as local check and Kesar as national check were evaluated under coordinated variety trial in randomized block design with three replications during Kharif 2012-13 at Navasari. For fresh rhizome yield no significant difference was observed among all tested eight entries and the genotype RH-9/90 recorded maximum yield (22.22 t/ha) followed by RH-13/90 (20.93 t/ha).





TUR/CI/3 Varietal Evaluation Trial

TUR /CI/3.1 : Comparative Yield Trial

(Center:Pottangi)

It was revealed from the analyzed data that the fresh rhizome yield of VK-9 (16.8t/ ha) was the highest followed by PTS-53 (15.5 t/ha) and CLS-6 (15.5 t/ha).

TUR/CI/3.2 Initial Evaluation Trial (IET) -2006

(Centres: Pottangi, Kumarganj)

Out of 10 promising genotypes the Maximum yield was obtained in NDH-74 (353.33q/ha) followed by NDH-131(339.99q/ha) and NDH -139 (332.21q/ha).

It was revealed from the analyzed data that the fresh rhizome yield of 361 Gorakhpur local (11.5 t/ ha) was the highest yielder followed by Tu-4 (10.4 t/ ha) and GL Puram (9.6t/ha).

TUR/CI/3.3 Initial Evaluation Trial 2010

(Centre: Pantnagar, Raigarh)

Significant differences were observed for all the growth characters studied at Pantnagar . Maximum fresh rhizome yield (35.58 t/ha) was recorded by PT-5, followed by PT-6 (29.12 t/ha). On the basis of 3 year data of fresh rhizome yield, above two genotypes may be included in CVT 2013-14.



Fig 14.Promising turmeric varieties in IET at Pantnagar

The entries were selected on the basis of yield from the Turmeric genotype maintained at the station and evaluated for fresh rhizome yield during the crop season 2012-13 with the check Narendra Haldi. The entry IT-8 was found to be the best with fresh rhizome yield 15.49 t/ha.

TUR/CI/3.4 Initial Evaluation Trial 2012

(Centre: Dholi, Kumarganj)

At Dholi out of eleven promising entries (RH-22, RH 24, RH 401, RH 406, RH 413, RH 415, RH 417, RH 421, RH 2/80, RH 7/80, RH9/9 and Check Rajendra Sonia RH-7/80 and RH-413 recorded significantly higher yield (58.50 & 58.00 t ha-1) as compared to the check variety Rajendra Sonia (47.00 t ha-1).



Fig15. Field view of IET on turmeric at Dholi

Out of six entries and two checks (NDH 10, NDH 74, NDH 114, NDH 128, NDH 131, NDH 139, Prabha(Ch), NDH 1(ch) evaluated at Kumarganj maximum yield was registered by NDHm74 (353.33 q/ha) followed by NDH-131 (339.99 q/ha) and NDH -139 (332.21 q/ha).

TUR/CM/3.4 Genotype x Environmental interaction on quality

(Centres: Kammarpally, Pottangi, Mizoram, Kalyani, Raigarh, Barapani, Dholi)

During the year 2012-13, out of seven (7) genotypes tested at Kamarpalli, RH-9/90 recorded max-



imum fresh rhizome yield (30.3 t/ha) followed by RH-13/90 (29.7 t/ha) in comparison to Duggirala red check variety (43.6 t/ha).

At Pottangi maximum fresh rhizome yield was recorded by TCPII (13.9 t/ha), followed by Roma (13.0 t/ha) and Prathibha (12.5 t/ha).

Out of 11 varieties evaluated at Mizoram maximum yield was recorded by RCT-1(29 t/ha) followed by BSR-2 (28.8 t/ha), and IISR Kedaram (27.6 t/ha). Moreover dry matter content was found to be highest in Rashmi followed by Roma, and Duggirala Red (20.06). Only two cultivars, i.e. Narendra Haldi-1 and Rajendra Sonia showed field level

tolerance to leaf spot (*Colletotrichum curcumae* and *Colletotrichum capsici*). However leaf blotch (*Taphrina maculans*) incidence was recorded in four genotypes, namely Suranjana, Narendra Haldi-1, BSR-2 and Rajendra Sonia. Leaf spot and leaf blotch was found simultaneously in Suranjana and BSR-2.

At Kalyani out of thirteen genotypes, maximum yield of rhizome per plant (0.332 kg) and projected yield (30.54 t/ha) was recorded by Megha turmeric followed by Rajendra Sonia (0.323 kg/plant) and (29.75 t/ha) (Table 17). Lowest rhizome yield (0.159 kg/plant) and 14.68 t/ha projected yield was recorded by Krishnanagar local variety.

Table 17. GXE interaction on growth and yield of Turmeric at Kalyani (2012-2013)

Genotypes	Plant height (cm)	No. of tillers/ clump	Average yield / plant (kg)	Projected yield (t/ha)
Roma	1.11	2.67	0.280	25.76
Rajendra sonia	1.08	3.07	0.323	29.75
Duggirala	1.03	2.8	0.247	22.69
IISR Alleppy supreme	1.05	2.73	0.270	24.84
CIL-317	1.13	2.4	0.287	26.37
NH-1	1.10	2.33	0.277	25.45
Suranjana	1.0	2.03	0.290	26.68
BSR-2	0.99	1.8	0.223	20.55
IISR Pratibha	1.02	2.0	0.267	24.53
IISR kedaram	1.04	2.07	0.245	22.54
Rashmi	1.05	2.33	0.297	27.29
Megha turmeric	1.07	2.03	0.332	30.54
Krishnanagar(local cv.)	0.86	2.47	0.159	14.68
S.Em.(±)	0.049	0.168	0.009	0.833
CD(0.05)	NS	0.490	0.026	2.431

Out of 10 genotypes evaluated at Barapani maximum yield was recorded by V3S1-8 (4.5 t/ha). Maximum oleoresin content was recorded by Suruchi (10.50 %) and lowest by Mahima (3.90 %). The highest volatile oil content (2.65 %) was noticed in Mahima and lowest in Himgiri (1.73 %). Among the genotypes dry recovery percentage varies from (17.10 to 29.91 %) and crude fiber content ranged from (4.21to7.85 %).

At Dholi among eleven promising entries and one check variety Rajendra Sonia, RH-7/80 and RH-413 gave significant higher yield (58.50 & 58.00 t ha-1) as compared to check variety Rajendra Sonia (47.00 t ha-1).



Crop Management

TUR/CM/5 Nutrient Management Trial

TUR/CM/5.2 Effect of organic farming in Turmeric

(Centre: Pundibari, Pottangi, Raigarh)

At Pundibari application of integrated nutrient management in turmeric (T2) recorded, maximum clump weight (380.24 g), yield (8.76 kg / plot), curcumin (5.4 %) and oleoresin (12.11 %) content followed by application of fully organic inputs in turmeric (T1) which produced clump weight and plot yield 313.13 g and 7.20 kg/plot respectively.

At Pottangi results over the period of six years showed that there was significant difference among the three treatments for fresh rhizome yield. The highest rhizome yield of 27.2 t/ha was recorded by T3 (fully inorganic) with 22.1 % yield advantages over T1 (fully organic).

At Raigarh maximum yield (19.68 t/ha) was recorded by integrated nutrient management.

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

(Centre: Coimbatore, Kumarganj, Kammarpally, Guntur, pundibari)

A trial was laid out to standardize the irrigation requirement in turmeric with seven treatments with varying levels of irrigation during 2012-13 at Coimbatore. Significant variation was observed between the treatments for growth and yield characters. The plot yield of turmeric rhizome varied from 46.95 kg/plot to 64.20 kg/plot. The treatment T2-Drip once in a day at 80 % PE recorded the highest yield per plot which is more than the control- Surface irrigation, 5 cm, 0.09 IW/CPE ratios.

At Kumarganj yield and yield attributes was maximum in surface irrigation 5cm, 0.90 IW/CPE

ratio (32.0 kg/bed fresh rhizome) followed by drip once in two days at 80 %PE (30.33 kg/bed) and drip once in a day at 80 % PE (28.0 kg/bed fresh rhizome).

At Kammarpally Drip irrigation once in a day at 80 % PE recorded maximum rhizome yield (29.8 kg/plot) followed by Drip once in 2 days at 80 % PE (29.5 kg/plot) where as Drip once in 2 days at 40 % PE recorded lowest rhizome yield (21.4 kg/plot).

During 2012-13 kharif season, seven different treatment combinations were evaluated with three replications in Randomized Block Design at Guntur. Among the drip schedules tested, drip irrigation once in two days at 80 % PE recorded maximum yield (42.0 t/ha) followed by drip irrigation once in a day at 60 % PE (41.3 t/ha) and drip irrigation once in two days at 60 % PE (41.2 t/ha) which were on par with each other and significantly superior to surface irrigation at 5 cm, 0.9 IW/CPE (37.2 t/ha).



Fig 16. Standardization of water requirement in Turmeric through drip irrigation at Guntur

The experiment was conducted with 7 treatments with 3 replications at Pundibari. Highest tiller number and maximum rhizome yield was recorded by the surface irrigation, 5cm, and 0.90 IW/CRE ratios (20.30 t/ha).

TUR/CM/5.6 Standardization of fertigation in Turmeric

(Centre: Coimbatore)

The experiment was laid out at College orchard, Horticultural College & Research Institute, Coim-



batore for three years (2009-10, 2010-11 & 2011-12) in randomized block design with seven treatments replicated thrice. Each experimental plot measured 20 m length and 1 m width. Finger rhizomes of CL 101 turmeric weighing about 25 grams were selected, treated with copper oxy chloride 0.25 per cent for 20 minutes, shade dried and used for sowing. A spacing of 45 cm between rows 15 cm between plants were maintained. A venturi assembly was used for mixing fertilizer with irrigation water. Fertigation to individual plot in each replication was controlled by providing a manual regulating valve fixed to the lateral lines to ensure precise delivery of the required inputs thus enabling full control of experimental setup. Irrigation to the crop is given every day through drip. Fertigation was done once in a week or at fortnightly interval according to the treatment.

Regarding the rhizome yield per plot it varied from 44.22 kg per 10 m² to 59.11 kg per 10 m². The highest plot yield of 59.11 kg per 10 m² was registered by the treatment T2 – 100 % RDF through drip – weekly once. The treatment T2 was on par with the treatment T3 - 100 % RDF through drip – fortnightly once which registered a yield of 58.37 kg per 10 m². The plot yield recorded was high in all the treatment supplied with water soluble fertilizers through drip when compared to the conventional method of application.

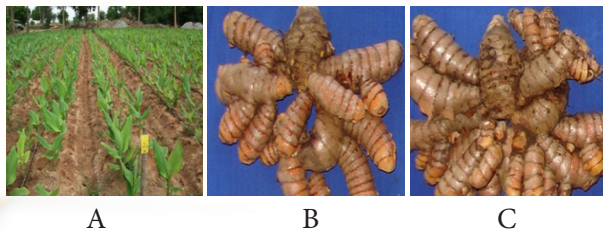


Table 18. Effect of micronutrients on yield of turmeric at Dholi (t/ha)

Micro-nutrients Treatment	Zinc sulphate	Ferrous sulphate	Boron	Manganese sulphate	Mean
No application or Control	43.76	43.90	44.55	43.75	43.99
Soil application @25kg/ha	57.74	54.66	54.56	53.75	55.18
Foliar spray @0.5% at 60 & 90 Days interval	56.00	60.39	53.63	53.83	55.96

- A: Filed view of Fertigation experiment in Turmeric at Coimbatore
- B: Recommended Dose of Fertilizer (100 %) through drip weekly once
- C: Application of 100% RDF through conventional method (no drip).

TUR/CM/5.7 Effect of micronutrients on turmeric

(Centres: Dholi, Pundibari)

This experiment was laid out to see the effect of micro-nutrients and standardized dose and method of application for healthy and economically good crop production turmeric at Bihar. Among four micro-nutrients viz; zinc sulphate, ferrous sulphate, borax, manganese sulphate with three method of application viz; zero level or control, soil application of micro-nutrients @25 kg ha⁻¹ and two foliar sprays of micro-nutrients @0.5 % at 60 and 90 days after sowing, effect of micro-nutrients were found non-significant regarding yield while method of application of micro-nutrients were recorded significant regarding the yield.

Soil application of micro-nutrients @25kg ha⁻¹ and two foliar sprays of micro-nutrients @0.5 % at 60 and 90 days after sowing registered the significantly higher yield 55.18 & 55.96 t ha⁻¹ respectively as compared to control (43.99 t ha⁻¹) (Table 19). Regarding cost benefit ratio, foliar sprays of micro-nutrients registered maximum return Rs.2.34 per unit cost (1: 2.34) followed by soil application of micro-nutrients i.e., return Rs.2.16 per unit cost (1: 2.16).



Mean	52.50	52.98	50.91	50.44	51.71
SEm+ -	1.12				
(Micro nutrient)					
SEm (Method)	0.97				
CD 0.05	2.86				

In micronutrient trial in turmeric, at Pundibari, soil application of Boron (T2) recorded the mean plot yield (10.22 kg) and projected yield (20.61 t/ha).

TUR/CM/5.8 Studies on the effect of rhizome size and nursery on growth and yield of turmeric

(Centres: Coimbatore, Chintapalli)

At Coimbatore the rhizome yield per plot (10 m²) varied from 39.33 kg to 67.94 kg per plot. The treatment T9- Mother rhizome pieces (35-40 g) directly planting in the field (1 month) recorded the maximum yield (67.94 kg/plot) followed by mother rhizome pieces having harvesting weight (10-15g) directly planting in the field (4 pieces) 61.51 kg/plot.

At Chintapalli, maximum fresh rhizome yield was recorded by mother rhizomes pieces (35-40g) T9 (28.53 t/ha) followed by T7 (24.57 t/ha). Among the transplanted seedlings, two node raised turmeric plants (T5) have shown good growth and yield (22.23 t/ha) and on par with T7 i.e. sowing of primary rhizomes directly in the field. Based on these experimental results farmers can cultivate the turmeric as two node raised seedlings and can reduce the requirement of seeds to 350 kg seed per acre instead of 1400 kg per acre in traditional practice.



Fig 17. Portray technology of production of planting materials in turmeric – saving huge quantities of planting materials

TUR/CM/6.1 Standardization of Processing in turmeric

(IISR)

Studies on curing of freshly harvested turmeric rhizomes (variety Prathiba) with an initial moisture content of 78.89 per cent were conducted during April 2010. The rhizomes were cured by cooking in boiling water for 45, 60 and 90 min, by steam cooking using TNAU model turmeric boiler (Viswanathan et al., 2002) for 30, 45 and 60 min, dipped the rhizomes in boiling water for 10 min and slicing the rhizomes manually to 3 mm thick. The rhizomes obtained from different curing methods were sun dried in cemented drying yard between 9 AM to 3 PM and the weight loss during drying was recorded periodically till the rhizomes obtained constant weight. The maximum ambient temperature recorded during the day was 37°C. The cured turmeric were analyzed for its biochemical qualities using standard procedure. The experiments were replicated thrice and quality parameters of turmeric rhizomes also determined.

It could be concluded from the study that slicing of turmeric rhizomes significantly reduced the drying time to 8.33 days (Table 20). Turmeric cured by traditional water boiling method for 45, 60, 90 min, took 10.33 days (mean) for complete drying. While turmeric cured by steam cooking for 30 min took 17.33, 45 min took 16 and for 60 min it took 11 days for drying. Reduction in essential oil and oleoresin curcumin, starch and drying time was observed with increased curing time. Maximum retention of essential oil (3.0) and curcumin (5.95%) was obtained for rhizomes cured by water boiling method for 45 min. Considering the advantages of steam cooking, curing of turmeric for 60 min by steam cooking was considered optimum to produce quality dried turmeric with minimum losses and also there was no significant difference in the drying time compared to that dried by water boiling process, which is very critical.



Table 19. Variation in drying time (days) of turmeric samples for three years at IISR

Treatments	2010-11	2011-12	2012-13	Mean
Cooking in boiling water boiling for 45 min	11	10	10	10.33
Cooking in boiling water boiling for 60 min	11	10	10	10.33
Cooking in boiling water boiling for 90 min	11	10	10	10.33
Improved steam cooking for 30 min in TNAU boiler	24	18	10	17.33
Improved steam cooking for 45 min in TNAU boiler	23	15	10	16.00
Steam cooking for 60 min in TNAU boiler	12	11	10	11.00
Improved steam cooking for 90 min in TNAU boiler		10	10	10.00
Dipping in boiling water for 10 min	13	12	13	12.67
Slicing to 3 mm thickness	9	8	8	8.33

Disease Management

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

(Centres: Coimbatore, Pundibari, Dholi, Raigarh)

A field survey on turmeric diseases was conducted in different turmeric growing districts of Tamil Nadu viz., Coimbatore, Erode, Salem districts during the year 2012-2013. In Coimbatore district, in total seven places were surveyed with different cropping pattern. In the case of leaf spot, the maximum intensity was noticed at Narasipuram (52.26 PDI) and the minimum intensity was recorded at

Vedapatti (32.32 PDI). The rhizome rot incidence was ranged from 8.00-16.00 %. The maximum rhizome rot incidence was recorded at sirumugai (16.00) and minimum incidence was recorded at Pethikuttai and Thondamuthur (6.00 %).

In Erode district, in total 13 places were surveyed with different cropping pattern. Among the places surveyed, the maximum leaf spot intensity of 52.14 PDI was recorded at Thalavadi and minimum at Sathyamangalam (28.21 PDI). The leaf blotch intensity was maximum (42.15 PDI) at Thalavadi and minimum at Kandikattuvalasu (24.15 PDI). The rhizome rot incidence ranged from 5.00 -14.00 %.

In Salem district, maximum leaf spot intensity of 47.12 PDI and leaf blotch 36.98 PDI was observed at Mettupalayam and minimum at Thammampatti (38.90 PDI). In the case of leaf blotch, the maximum intensity of 36.98 PDI was observed at Mettupalayam and minimum at Erumapatti (31.58 PDI).



A field trial was laid out with 275 turmeric germplasm to screen against foliar diseases viz., leaf spot, leaf blotch and rhizome rot diseases during the year 2012-13 at Coimbatore.

The accessions viz., CL 32, 33, 52 recorded the least leaf spot intensity of 16.00 PDI with the rhizome yield of 57.33, 54.00, 59.33 t/ha respectively. This was followed by CL 34, CL 54, CL 61 and CL 101 which recorded the leaf spot disease intensity of 18.00 PDI with the yield of 55.47, 57.33, 41.33, 60.67 t/ha respectively. The highest leaf spot disease intensity of 60.00 PDI was noticed in CL 12, CL 89, CL 108 and CL 266 with less rhizome yield ranged from 32.67 to 20.00.

The leaf blotch intensity ranged from 12.00 PDI - 48.00 PDI. The accessions CL.34 recorded the least leaf blotch disease intensity of 12.00 PDI with higher yield (55.47 t/ha) followed by CL 32 and CL 54 which recorded the disease intensity of 14.00 PDI and yield of 57.33 t/ha. The accession CL 101 recorded the disease intensity of 16.00 PDI with the maximum yield of 60.67 t/ha. The highest leaf blotch disease intensity of 48.00 PDI was recorded in CL 212 and CL 23 with less yield of 21.33 t/ha.

At Pundibari screening of the collected germplasm was done against both leaf blotch and leaf spot diseases of turmeric. The germplasm TCP 1, 2, 14, 29, 64, 70, 129, 161, etc. were found to be tolerant against both leaf blotch and leaf spot disease.

Among 110 germplasm of turmeric screened

under natural condition against diseases at Dholi 29,3 & 9 nos. of germplasm were found to be highly resistant, resistant & moderately Resistant respectively to both Taphrina & Colletotrichum leaf spot of turmeric. Turmeric crop cultivated by farmer were found to be affected by Colletotrichum Taphrina leaf spot incidence in the range of 10 to 60 % with mean disease incidence of 36.11 %. Leaf spot incidence of turmeric ranged from 0 to 30 % with mean disease incidence of 12.22 %.

In Kusmura village developmental block of Raigarh Colletotrichum leaf spot disease intensity (42.12 %) and taphrina leaf blotch (30.14 %) intensity was found. None of the local entries found highly resistant or resistant against both foliage diseases.

TUR/CP/7.2 Management of foliar diseases in turmeric

(Centre: Kumarganj)

At Kumarganj the effect of fungicides for management of foliar diseases showed that the foliar spray of Propiconazole @ 0.010 % at 45 and 90 DAS was found suitable with lowest incidence of leaf spot (28.40) and leaf blotch (28.50 %) as compared to control (Table 21). The effect of Hexaconazole was more or less similar. The fresh rhizome yield was recorded maximum (15.16 t/ha) in rhizome treatment+ foliar spray of Hexaconazole@0.10 % at 45 and 90DAS.

Table 21. Effect of fungicides on the incidence of foliar diseases of turmeric at Kumarganj (2012-13)

Treatments	Percent disease incidence		Percent disease control		yield (kg) /bed	Percent Increase in yield
	Leaf spot	Leaf Blotch	Leaf Spot	Leaf Blotch		
T1=ST+FS with Hexaconazole(@0.10%) at 45and 90DAS	30.10	29.44	41.02	39.67	7.58	51.6



T2=ST+FS with Propiconazole(@0.10%) at 45and 90DAS	28.40	28.50	44.37	41.59	7.13	42.6
T3=ST+FS with Tricyclazole(@0.10%) at 45and 90DAS	31.03	36.40	39.20	25.40	5.75	15.00
T4=ST+FS with Carbendazim+mancozeb(@0.10%) at 45and 90DAS	36.90	34.90	27.70	28.48	7.26	45.20
T5=FS with Hexaconazole(@0.10%) at 45and 90DAS	28.36	32.10	44.43	34.22	5.35	7.00
T6=FS with Propiconazole(@0.10%) at 45and 90DAS	25.65	29.20	49.74	40.16	6.43	28.60
T7=FS with Tricyclazole(@0.10%) at 45and 90DAS	37.80	31.10	25.94	36.27	6.63	32.60
T8=FS with Carbendazim+mancozeb(@0.10%) at 45and 90DAS	38.75	39.10	24.07	19.87	5.30	6.00
T9= Control	51.04	48.80	-	-	5.00	
SEM	2.41	2.03			0.47	
CD(0.05)	7.22	6.09			1.40	
CV%	10.80	9.20			11.63	

ST-Seed treatment, FS-Foliar spray

TUR/CP/7.3 Assessment of Fungicide & Biological control agents against foliar disease of turmeric.

(Centre: Dholi)

At Dholi Lowest disease viz., Colletotrichum leaf spot (PDI =6.67) & Taphrina leaf spot

(PDI=3.33) were recorded in the treatment where pre-planting treatment of rhizome and spraying of crop at 90, 105, 120 DAP with Propiconazole (0.1 %) over control (PDI = 58.33 & 18.33 respectively) which was on par with the treatment IISR Trichoderma liquid formulation (1 %) or IISR Pseudomonas talc formulation (1 %) was used with a yield (39.50 t/ha) while control has less yield (21.50 t/ha).



VIII. Experimental Results in Tree Spices

TSP/C1/1 Genetic Resources

TSP/C1/1.1 Germplasm collection, characterization, evaluation and conservation of clove, nutmeg, and cinnamon

(Centres: Dapoli, Pechiparai)

a. Clove

The germplasm of tree spices are maintained at Dapoli, Pechiparai and Yercaud (Table 22). The germ plasm of clove consisting of two accessions viz. IISR Calicut type and Kallar type have been maintained at Dapoli and are being evaluated for growth and yield performance. From the germplasm of clove planted during the year 1996-97, four promising genotypes were selected. The plant height varied from 4.60 to 6.00 m., girth ranged from 30.00 to 33.00 cm and spread varied from 3.36 m to 5.27 m.



Fig.18 Field view of clove and nutmeg germplasm maintained at Pechiparai

Table 21. Tree spices germplasm collections at AICRPS centres

Crop/Centre	Indigenous/ cultivated	Total
<i>Clove</i>		
Dapoli	2	2
Pechiparai	24	24
Yercaud	1	1
Total	27	27



<i>Nutmeg</i>		
Dapoli	88	88
Pechiparai	26	26
Yercaud	1	1
Total	115	115
<i>Cinnamon</i>		
Dapoli	11	11
Pechiparai	14	14
Yercaud	02	02
Total	27	27
<i>Cassia</i>		
Dapoli	06	06
Pechiparai	04	04
Total	10	10

At Pechiparai 24 accessions of clove are being maintained (Table 23). Among the 24 accessions, SA-13 recorded the highest tree height of 8.43 m, followed by SA-1(8.04) but local check recorded a tree height of 6.75 m. The accession SA-13 was significantly superior than other accessions and re-

corded highest stem girth (39.76 cm), leaf length (13.70 cm), leaf breadth (4.40 cm) and dry bud yield (4.50 kg/tree) and bud oil (6.78 %). The local check recorded dry bud yield (2.10 kg/tree) and clove bud oil content (1.50 %).

Table 22. Performance of Clove accessions at Pechiparai

Acc.	Tree height (m)	Stem girth (cm)	Leaf length (cm)	Leaf breadth (cm)	Dry Flower yield (kg/tree)	Clove bud oil (%)
SA- 1	8.04	35.78	13.50	5.50	2.70	6.13
SA -2	7.90	33.45	13.80	4.70	2.06	6.05
SA -3	6.92	28.93	12.50	4.92	1.23	6.00
SA -4	6.73	28.05	13.50	4.80	1.43	6.11
SA -5	7.95	28.76	12.00	4.50	1.08	6.10
SA -6	7.92	32.51	13.90	4.90	2.40	6.20
SA -7	7.96	33.97	14.30	4.60	2.30	5.95
SA -8	6.97	30.72	14.60	4.32	3.00	6.32
SA -9	6.87	29.85	12.40	4.70	1.50	5.90
SA -10	7.14	37.60	12.20	4.40	1.93	5.77
SA -11	6.34	21.94	14.40	4.20	1.80	6.37



SA -12	6.50	29.74	14.30	4.70	2.40	6.55
SA -13	8.43	39.76	13.70	4.40	4.50	6.78
SA -14	6.75	28.16	13.16	4.12	1.60	5.80
SA- 15	5.97	22.85	11.50	4.00	0.75	5.65
SA-16	5.63	22.78	10.78	3.16	1.25	5.60
SA -17	6.54	23.67	13.00	4.30	1.75	5.54
SA -18	5.75	17.99	9.88	2.76	--	--
SA -19	4.30	12.98	9.80	3.20	--	--
SA -20	3.75	11.32	7.80	2.90	--	--
SA -21	3.36	12.57	10.20	3.10	--	--
SA -22	2.65	3.85	9.80	3.30	--	--
SA -23	1.95	3.89	7.60	2.70	--	--
SA -24	1.68	3.75	7.50	2.30	--	--
Local check	6.75	28.96	7.75	3.60	2.10	1.50
SED	0.26	1.50	0.27	0.07	0.22	0.25
CD P (0.05)	0.54	3.26	0.56	0.16	0.46	0.52

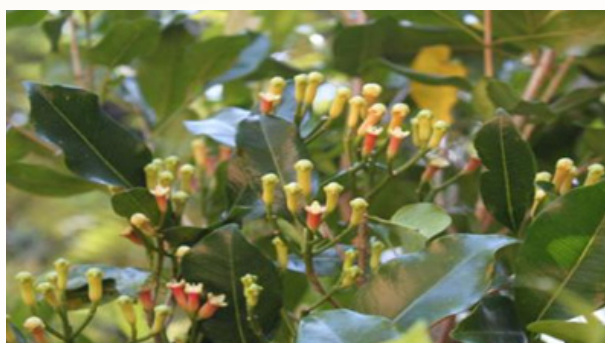


Fig 19. Promising accession of clove SA 13 at Pechiparai.

b. Nutmeg

(Centres : Dapoli, Pechiparai)

From the germplasm collections of nutmeg

planted during the year 1996 -97, fifteen promising genotypes have been identified at Dapoli (Table 23). Average number of fruits in different genotypes ranged from 55 - 198. The genotype number DBSKKVMF 28 (191), DBSKKVMF 21 (149), DBSKKVMF 16 (144 Av. No. of fruits) registered maximum average yield.

The genotype DBSKKVMF 17 recorded maximum dry nut yield (1117.25g) and dry mace yield (287 g) in the year 2011 - 12 (Table 24). Also average dry nut yield (1420.89 g) and dry mace yield (328.80 g) was recorded in genotype DBSKKVMF 29 in years 2006 to 2012. The genotype DBSKKVMF 29 is promising considering its fruit wt., nut wt. and mace wt. as yield contributing characters in nutmeg.

Table 23. Fruit characters of promising Nutmeg selections at Dapoli (2012-13).

Selection/ Genotype	Fruit wt. (g)	Nut wt. (g)		Mace wt. (g)		Yield (2011- 2012)	
		Fresh	Dry	Fresh	Dry	Dry nut (g)	Dry mace (g)
DBSKKVMF 16	60.10	8.0	5.32	3.8	1.10	1106.56	228.8
DBSKKVMF 17	76.15	12.50	5.45	5.5	1.4	1117.25	287
DBSKKVMF 18	63.70	13.25	9.35	1.80	0.90	233.75	22.5
DBSKKVMF 19	56.50	8.30	4.40	2.80	1.10	990	247.5
DBSKKVMF 20	58.33	10.1	6.73	3.63	1.20	336.5	60



DBSKKVMF 21	52.1	7.3	4.9	2.5	0.9	735	135
DBSKKVMF 22	45.5	8.5	4.5	2.70	1.25	495	137.5
DBSKKVMF 23	65.60	10.1	5.53	3.86	1.23	66.36	14.76
DBSKKVMF 24	62.20	9.5	4.8	3.2	1.05	480	105
DBSKKVMF 25	59.20	9.4	4.68	2.75	1.10	514.8	121
DBSKKVMF 26	43.5	9.4	4.68	2.6	1.2	374	96
DBSKKVMF 27	62.7	9.8	4.0	2.6	0.9	180	40.5
DBSKKVMF 28	49.0	7.5	4.3	1.4	0.9	645	135
DBSKKVMF 29	92.5	18.7	12.1	6.3	2.8	907.5	210
DBSKKVMF 30	51.0	7.7	4.5	1.3	0.7	450	70
Mean	59.87	10.70	5.68	3.12	1.18	575.45	127.37
Range	43.5-92.5	7.3-18.7	4.0-12.1	1.3-6.3	0.7-2.8	180-1117.25	60-287

In Nutmeg 24 accessions are maintained at Pechiparai, among which the accession MF- 4 recorded maximum number of fruits (940.25 fruits /tree) and the single fruit weight was also highest in MF-4 (75.30 g). The dry mace yield recorded per tree was (419.5g). Local check recorded 116.0 numbers of fruits /tree, single fruit weight was 53.91g and the mace yield was 120 g. During 2011-12 three accessions were added from Theni in addition to *Myristica bedomi* and *Myristica malabaricum*. The accessions were compared with local check for yield and quality.

At Dapoli 88 accessions of nutmeg are being maintained. One promising nutmeg type was collected during the year. From the germplasm collection 15 promising types have been identified and selected for further evaluation. The different genotypes showed potential yield of 18 – 225 fruits. These genotypes are being further evaluated for yield and fruit characters.

c. Cinnamon

At Dapoli germplasm of cinnamon consisting of 11 accessions which are maintained and being evaluated for growth and yield performance. Twelve accessions of cinnamon are being maintained at Pechiparai including the local check. During this year a high yielding selection from Nagercoil was added to the germplasm. Among twelve accessions, CV-5 recorded maximum dry bark yield (565.80g per tree) and local check recorded only (270.80 g per tree).



Fig 20 Promising accession Cinnamon –CV-5 at Pechiparai and its Quills

Crop Improvement

TSP/CI/2 Coordinated Varietal Trial

TSP/CI/2.1 Coordinated Varietal Trial 1999 - Clove

TSP/CI/2.1 CVT 1992-clove

(Centre: Pechiparai)

Nine genotypes collected from IISR, Calicut



is being maintained at Pechiparai and growth parameters were studied (Table 25). Among the accessions SA-3 was found to be promising in terms

of yield characters, dry buds /tree (2.95 kg) and recommended to state release.

Table 24. Performance of CVT Clove accessions at Pechiparai

Accessions	Yield/kg/tree (dry)						Pooled mean	Yield (Kg/ha) (dry)
	2006	2007	2008	2009	2010	2011		
SA- 3	1.59	1.70	2.50	3.00	3.33	2.95	2.46	681.42
SA -4	0.40	1.50	1.80	1.40	1.76	1.40	1.38	405.34
SA -5	1.26	1.50	2.00	1.10	1.00	1.92	1.46	404.42
SA -6	1.12	1.40	1.80	2.40	2.50	2.55	1.96	542.92
SA -7	1.05	1.40	2.40	2.30	2.30	2.60	2.22	614.94
SA -8	1.33	1.60	2.30	2.50	2.31	2.15	2.37	656.49
SA -9	0.60	1.20	1.90	1.50	1.30	2.14	1.66	459.82
SA -10	1.25	1.40	1.70	1.90	1.83	2.54	1.77	490.29
SA -11	0.46	1.20	1.80	1.90	1.90	2.57	1.64	452.28
SA -12	1.26	1.40	2.10	2.40	2.05	2.21	1.90	526.30
Local check.	1.22	1.30	1.45	1.80	1.95	2.65	1.72	476.44
SED	0.01	0.02	0.01	0.05	0.14	0.16	0.12	0.70
CD(0.05)	0.03	0.03	0.03	0.11	0.29	0.26	0.06	1.41
CV (%)	1.66	1.31	0.88	3.10	8.73	6.06	1.51	0.18

TSP/CI/2.2 CVT 2001- Nutmeg

Nutmeg

(Centres : Dapoli, Pechiparai)

CVT-2001 consisting of eight accessions, planted during 2003-04 was evaluated for growth parameters at Dapoli. Significant difference was observed in spread and other parameters viz. height, number of branches and girth did not showed significant differences among different genotypes. The plant height ranged from 0.73 – 1.70 m., the girth 9.33 – 20.50 cm and the spread 0.64 – 1.90 m and few plants from Acc. no. A 9/4, A 9/20 and A 9/150 started bearing.

At Pechiparai six accessions were collected from IISR, Calicut and are being maintained and evaluated along with a local check. Among the ac-

cessions A9/150 has recorded the maximum plant height of 2.12 m, stem girth of 11.96 cm and maximum number of shoots recorded was 20.50 .

TSP/CI/2 Coordinated varietal Trial

Coordinated Varietal Trial in Cassia (2001)

(Centre: Pechiparai, Dapoli)

Cassia

The growth parameters under CVT-2001 consisting of 6 accessions, planted during the year 2003-04 at Dapoli showed morphological variations (Table 26). There was only significant difference in girth and plant height did not showed significant differences among different genotypes. The



genotype KKVCTSH1 recorded significantly higher girth (36.25 cm) followed by KKVCTSH2 (35.50 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 than other genotypes.

Four genotypes collected from IISR, Calicut

along with local check is being maintained at Pechiparai and growth parameters are being studied. The suitability of elite lines of CVT is being evaluated under this climatic zone for its yield and yield attributes. Among the four selections at Pechiparai, D3 was found to be promising with plant height 5.84m, stem girth 40.00 cm, the leaf yield (390.7g/tree) and bark yield (226 g/tree) (Table 26).

Table 26. Growth and Yield Performance of Cassia at Pechiparai

Accessions	Plant height (m)	Stem girth (cm)	Leaf yield (g/tree)	Bark yield (g/tree)
C1	2.62	22.41	279.10	195.12
D1	2.56	23.20	313.67	215.00
D3	5.78	40.00	390.00	226.00
D5	2.68	30.17	352.00	200.45
Local check	2.22	19.50	278.64	190.60
SED	0.14	0.03	14.03	0.30
CD (0.05)	0.03	0.06	29.45	0.67
CV (%)	0.67	8.11	7.89	0.22



IX. Experimental Results in Coriander

COR/CI/I Genetic Resources and Crop Improvement

COR/CI/1.1 Germplasm collection, de- scription, characterization, evaluation, conservation and screening against dis- eases

(Centre: Middle gangetic plain region -Dholi; East cost plains and hills region –Guntur, Ajmer; Trans gangetic plain region-Hisar, Jobner, Gujarat plains and hills region- Jagudan; Upper gangetic plain region- maintenance at JobnerKumarganj, Coimbatore- Southern plateau and hill region)

The coriander germplasm maintained at various centers of AICRPS are given in (Table 27). Among the 275 coriander accessions evaluated at Coimbatore, 146 genotypes recorded the yield higher than the mean yield. Three checks were used in the evaluation (CS 111, CS 49 and CS 82) and yield of checks were 1.39, 1.64 and 1.25 g respectively. In the evaluation of 275 germplasm lines during 2012-13 seven lines recorded maximum yield than Check CS 111 with lowest incidence of powdery mildew.



Fig 21.A view of Coriander germplasm

Screening of germplasm accessions (275) against powdery mildew was done during Rabi 2012-13 at Coimbatore. Powdery Mildew intensity was noticed in all the accessions. The PDI ranged from 18.00 to 60.00. The accessions viz., CS 2, 25, 57, 61, 78, 101, 112, 121, 144, 180, 184, 186 and 211 recorded the least disease intensity of 18.00 to 20.00 PDI with the maximum yield (725-900 kg /ha). The maximum intensity of powdery mildew was noticed in CS 12 with the lowest yield of 175 kg /ha.



Table 26. Coriander germplasm collections at AICRPS centres

Centre	Indigenous		Total
	Cultivated	Wild and related sp.	
Coimbatore	275	-	275
Dholi	144	1	145
Guntur	305	-	305
Hisar	145	-	145
Jagudan	74	21 (Exotic)	95
Jobner	368	-	368
Kumarganj	165	-	165
Total	1476	22	1520

At Dholi out of one hundred forty five accessions, only ten accessions namely-, RD-41, RD-422, RD-399, RD-416, RD-412, RD-425, RD-395, RD-393, RD-385 and RD-382 registered the maximum yield ranging from 300 g per five plant to 105g per five plant as compared to check variety Rajendra Swati, Hisar Anand and Pant Haritima (90,94 & 96g per five plant). Among promising accessions, RD-41 recorded the maximum yield 300g per five plant followed by RD-422 i.e., 141g per five plant.

Among the sixty one germplasm entries evaluated at Guntur, in augmented Block Design, LCC-304 (5.67 g/plant), LCC-291 (5.65 g/plant), LCC-282 (5.51 g/plant), LCC-244 (5.11 g/plant) and LCC-260 (4.8 g/plant) were found significantly superior in yield over the best check Sudha (4.4 g/plant).

Out of one hundred forty five accessions of coriander were evaluated at Hisar using Hisar Sugandh, Hisar Bhumit and Hisar Anand as checks during 2012-2013. One hundred fifteen lines registered maximum seed yield than the check, Hisar Anand. The most promising lines for seed yield were DH-222, DH-229, DH-236, DH-239-2, DH-240, DH-277, DH-293-1, DH-298, DH-281, DH-302, and DH-306-1.

During the reporting year, 95 genotypes of coriander were evaluated for their yield and yield attributes at Jagudan. Among them, 13 entries were found high yielder (>1600 kg ha⁻¹). : During the reporting year, total forty two (40+2) entries were screened under natural condition. None of the entry was found free from the powdery mildew incidence. The minimum incidence was noticed in JCr 372 (17.26 %) followed by JCr-360 (22.14 %) and categorized as moderately resistant. The remaining entries fall under susceptible and highly susceptible categories. The per cent disease intensity was ranged between 17.26 and 100.00 per cent.

Three hundred and sixty eight lines of coriander were evaluated in augmented design at Jobner. Seed yield ranged from a minimum of 1.07 g/5 plants to 39.49 g/5 plants. The top ten high yielding entries were UD 171, UD 493, UD 563, UD 566, UD 571, UD 592, UD 601, UD 717 and UD 720.

Out of 165 germplasm accessions evaluated at Kumarganj and NDcor-38 (16.70 q/ha), NDcor-10 (16.50 q/ha) and NDcor-2(16.2 q/ha) found to be promising in respect to national check Hisar Anand(11.7 q/ha) and Pant Haritima (12.30 q/ha).

Coriander coordinated variety trial consisting



of 21 test entries and three check varieties namely Hisar Anand (National Check), RCr-728 (State Check) and ACr-1 (Local Check) at Ajmer. The plot size was kept as per previous plan i.e. 4 x 2.4 m. The trial was having general mean 11.48 q/ha with CD (5%) 2.54 and CV (%) 13.45. The best check was local check namely Hisar Anand having 14.33 q/ha seed yield. The highest yielding genotype was COR-44 (15.89 q/ha) followed by COR-53 (14.92 q/ha), COR-56 (14.81 q/ha) and COR-55 (14.80 q/ha), having 10.89, 4.12, 3.35 and 3.28 percent higher yield than national check, respectively.

COR/CI/1.2 Multilocal Evaluation of germplasm

(Centres: Coimbatore, Guntur, Hisar, Ajmer)

A trial on multilocation evaluation of coriander genotypes was laid out with 80 genotypes from ten centres (ten each) and five checks during 2012 – 2013 at Coimbatore. Among the genotypes ND-3 recorded maximum seed yield per plant (1.75g) and RD-410 registered maximum wilt incidence (32.50 %). The genotypes viz., GL-20P, GL-37P, GL-74P, GL-117P were free from wilt incidence.

Sixty germplasm lines from six centers were evaluated during 2012-13 in Augmented Block Design with seven checks at Guntur. Among the entries evaluated, RD-387 (5.88 g/plant), NDC-31 (4.55 g/plant), 37-P (4.26 g/plant), LCC-170 (4.09 g/plant) and DH-258 (3.73 g/plant) were found significantly superior in yield over the check Sudha (2.74 g/plant).

At Hisar eighty two accessions of coriander were evaluated using Hisar Sugandh, Hisar Bhumit and Hisar Anand as checks during 2012-2013. The seed yield of the germplasm material ranged from 22.0 g/plant (LCC-168) to 88.2 g/plant (DH-254). The most promising lines for seed yield were Jcr.-389, Jcr.-401, Jcr.-404, Jcr.-406, DH-244, DH-246, DH-254, RD-414, NDcr-10 and NDcr-82.

Total 60 germplasm lines were evaluated in Augmented Block Design with 5 check varieties namely Hisar Anand, Hisar sugandh, RCr-728, ACr-1 and RCr-436 in five blocks at Ajmer and maximum yield was recorded by the accession HC -258 (9.96 g/pl).

COR/CI/2 Coordinated Varietal Trial

COR/CI/2.5 Coordinated Varietal Trial – 2012 Series – IX

(Centres: Central plateau and Hills region- Jabalpur; Trans gangetic plain region- Udaipur Gujarat; plains and hills region- Navasari, Jagudan; Western Himalayan region- Pantnagar; Middle gangetic plain region- Dholi; East cost plains and hills region- Guntur, Ajmer; Central plateau and hills region- Jabalpur; Upper gangetic plain region- Kumarganj)

The CVT coriander Series IX was started in rabi, 2012-2013 with the objective of evaluation of coriander entries across the country for yield and its components. CVT trial consisting of 21 test entries and three check varieties namely Hisar Anand (National Check), RCr-728 (State Check) and ACr-1 (Local Check) was evaluated at Ajmer. The highest yielding genotype was COR-44 (15.89 q/ha) followed by COR-53 (14.92 q/ha), COR-56 (14.81 q/ha) and COR-55 (14.80 q/ha), having 10.89, 4.12, 3.35 and 3.28 percent higher yield than national check, respectively. The variety COR-51 was the late type which flowers in 115 days after sowing and no seed yield recorded in this entry due to increased temperature.

Among twenty one entries and three check varieties like- Rcr-728 NC, Hisar Anand NC and Rajendra Swati LC entries, COR-53 and COR-54 registered significantly higher yield (1750.kg ha⁻¹) and (2105.56 kg ha⁻¹) respectively compared to best check variety Rajendra Swati (1527 kg ha⁻¹) at



Dholi.

During 2012-13 seventeen coded entries (among 21 entries COR-49, COR-50, COR-51 and COR-52 could not be evaluated as they were received late) from different coordinating centres were evaluated, at Guntur COR-46 (1233 kg/ha) and COR-47 (1167 kg/ha) recorded significantly higher yield than all other entries including best check Sudha (1035).

At Kumarganj COR-38 (15.27 q/ha), COR-42 (15.10 q/ha) and COR-43 (15.06 q/ha) were identified as promising with respect to yield as well as tolerance to stem gall disease.

Out of twenty four genotypes including three checks were evaluated at Navasari, promising entries identified for seed yield were COR-56 (1220.25 kg/ha), COR-47 (1126.79 kg/ha), COR-46 (1109.63 kg/ha), COR-55 (1018.52 kg/ha) and COR-37 (996.67 kg/ha) compared to national checks viz., Hisar Anand and RCr-728.

Twenty three genotypes of coriander were tested in RBD with three replications during Rabi 2012 at Jabalpur. COR-40 recorded maximum Number of branches (13.633), No. of umbels (35.40) and yield (2.066 Kg/plot and 28.68 q/ha) that was on par with Hisar Anand and RCr 728.

At Udaipur during the first year of evaluation, COR-48 was found to be the best performing entry in terms of seed yield, yield 1423 kg/ha followed by COR - 46 (1354 kg/ha) and COR 36 (1215 kg/ha).

Out of 21 entries evaluated in co-ordinated varietal trial at Hisar, the maximum seed yield (2062 kg/ha) was recorded by COR-41 followed by COR-40 (1936 kg/ha) and COR-42 (1740 kg/ha).

At Raigarh among the entries, COR-53(1493.18 kg /ha) was found significantly superior over all the checks ICS-1(LC), Hisar Anand and Rcr- 725. Next best superior entries were COR-37 (1057.99 kg/ha) and COR-54 (1044.35 kg/ha).



Fig 22. Trial on CVT of Coriander at Raigarh

The seed yield ranged from 1185.19 to 2587.96 kg/ha at Jobner. Of the twenty one entries evaluated, COR-55 recorded maximum seed yield of 2587.96 kg/ha followed by COR-43 (2537.04 kg/ha), COR-41 (2462.96 kg/ha), COR-40 (2226.85 kg/ha), COR-54 (2194.44 kg/ha) and COR-44 (2180.56 kg/ha), while lowest seed yield of 1185.19 kg/ha was recorded by COR-37.

COR/CI/2.6 Coordinated varietal trial on coriander (Leaf type during off season) CVT-2010

(Centres: Coimbatore, Guntur, Ajmer, Periyakulam)

The coordinated varietal trial (leafy type) during off season – CVT 2010 was carried out for third year during 2012-13 at Coimbatore. Leafy coriander genotypes from TNAU, Coimbatore and APHU, Guntur (three each) and one genotype from NRC-SS, Ajmer with two checks were the entries. The maximum yield was recorded by the genotype CS 38 (4.28 kg per plot) followed by LCC 244 (4.23 kg per plot) which was higher than CO(CR)-4 as local check (3.29 kg/plot) and Sadhana as national check (2.79 kg/plot).

During 2011-12 summer seasons, seven genotypes from different coordinating centers were tried in RBD replicated thrice along with two checks at Guntur (Table. 28). Among the entries tested LCC-232 recorded maximum green leaf yield (2.59 t/ha) followed by CS-38 (2.46 t/ha) which were significantly superior to check Sadhana (1.68 t/ha).



Table 27. Performance of Coriander accessions (Leaf type) at Guntur

Name of the entry	Green leaf yield (t/ha)
Acr-1*	-
CS-1	1.48
CS-11	2.32
CS-38	2.46
LCC-232	2.59
LCC-242	1.88
LCC-244	1.64
Local	0.31
Sadhana	1.68
CD (p=0.05)	0.47
CV (%)	14.8

* The seed of entry Acr-1 was not received by the center.

A trial was initiated at Ajmer with nine entries including a local check (Dhani). The entries were harvested 35 days after sowing, as the flowering was started in all entries except local lines (ACr-1 and Dhani recorded maximum yield 1009.63 kg/ha) followed LCC 234 (929.63 kg/ha).

COR/CI/3 Varietal Evaluation Trial

COR/CI/3.1 Initial evaluation trial (2010)

(Centre: Hisar)

The initial evaluation trial (IET) in coriander was conducted with ten accessions along with Hisar Anand as check during 2012-2013 in plots measuring 3.0 x 2.0 m at Hisar (Table 29). DH-281 and DH-314 registered significantly better yield over Hisar Anand (check) showing 23.5 and 19.3 % increase in yield, respectively in comparison to control.

Table 28 . Initial evaluation trial (IET) in coriander at Hisar (2010-13)

Sl. No.	Accession number	2010-2011	2011-2012	2012-2013	Mean	% increase over check
1.	DH-244	1820	1842	1855	1839	10.3
2.	DH-279	1890	1926	1908	1908	14.4
3.	DH-281	2065	2083	2034	2061	23.5
4.	DH-289	1910	1945	1935	1930	15.7
5.	DH-310	1865	1894	1873	1877	12.5
6.	DH-314	2012	1995	1877	1961	17.6
7.	DH-318	1985	2015	1968	1989	19.3
8.	DH-340	1924	1983	1967	1958	10.3
9.	DH-393-1	1880	1892	1857	1876	12.5
10.	Hisar Anand	1684	1654	1666	1668	
C D (0.05)		94.9	64.9	73.2		

COR/CI/3.2 Initial evaluation trial -2011

(Centre: Jobner)

The trial is in the 1st year of progress. In rabi 2011-12, ten entries were evaluated in RBD with 3 replications in a plot size of 3 x 2.5 sq. m. accommodating five rows spaced 50 cm apart with intra row spacing of 20 cm maintained by thinning.

The analysis of variance revealed significant differences among the entries for all the traits including seed yield. The seed yield ranged from 1448.89 to 2306.67 kg/ha. Of the ten entries evaluated, entry UF-168 recorded maximum seed yield of 2306.67 kg/ha followed by UF-135 (2155.56 kg/ha), UF-149 (1922.22 kg/ha), RF-205 check (1797.78 kg/ha), UF-236 (1706.67 kg/ha) and UF-191 (1595.56 kg/ha), while lowest seed yield of 1448.89 kg/ha was recorded in Local Check.



COR/CI/3.3 Initial evaluation trial 2012-13

(Centre: Jagudan, Guntur, Kumarganj)

The trial started at Jagudan during the year 2012-13 with 10 entries JCr-377, JCr-384, JCr-387, JCr-388, JCr-389, JCr-392, JCr-395, JCr-399, JCr-401, GCr-2(Ch). The entry JCr-389 (1301 kg ha⁻¹) significantly yielded over the check GCr-2 followed by JCr-384(1244 kg ha⁻¹) and JCr-401(1238 kg ha⁻¹), which was 11.67, 6.78 and 6.27 per cent higher than GCr-2, respectively.

Among the eight entries evaluated at Guntur, LCC-268 recorded maximum yield of (1174 kg/ha) followed by LCC-275 (1133 kg/ha) and LCC-276 (1114 kg/ha) which were significantly superior to the best check APHU Dhania-1 (889 kg/ha).

Out of 11 entries tried at Kumarganj (NDcor 86, NDcor 87, NDcor 88, NDcor 89, NDcor 92, NDcor 95, NDcor 96, NDcor 97, NDcor 100 NDcor101 and Hisar Anand during the year 2012-13 maximum yield was obtained in NDCor 101 (15.27 q/ha) followed by NDCor-100 (14.75 q/ha) and NDCor-88 (14.31 q/ha).

COR/CI/4 Quality Evaluation Trial

COR/CI/4.1 Quality evaluation in coriander

(Centre: Jobner)

Twenty one entries of coriander under CVT were tested for volatile oil content during Rabi 2012-13, which was analyzed using Clevenger apparatus. The volatile oil content in the entries ranged from 0.30% to 0.60%. The maximum volatile oil of 0.60% was observed in COR-48 followed by 0.58% in COR-44, COR-46, and COR-47, while minimum of 0.30% was recorded in COR-54, RCr-728 N/Ch

and local Check. The entry COR-55 ranked first in terms of volatile oil yield (15.10 l/ha) followed by COR-43 (13.53 l/ha), COR-44 (12.72 l/ha), while lowest volatile oil yield of 4.94 l/ha was recorded in COR-local check and 5.06 l/ha in COR-36.

The experiment was initiated during the year 2011. Ten entries of coriander under IET were tested for volatile oil content during Rabi 2012-13, which was analyzed using Clevenger apparatus. The volatile oil content in the entries ranged from 0.58 % to 0.38%. On the basis of two years data (2011-12 and 2012-13), the highest mean volatile oil content of 0.45 % was recorded in UD-411 followed by 0.40 % in UD-61 and UD-82, whereas minimum 0.30 % was recorded in UD-123. The maximum mean volatile oil yield in terms of litre / ha was observed in UD-411 (7.67 l/ha) followed by UD-61 and UD-82 (7.28 l/ha) and minimum in Local check (4.50 l/ha).

Crop Management

COR/CM/5 Nutrient Management Trial

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

(Centres: Jobner, Kumarganj)

An experiment was conducted to identify drought tolerance of various entries in coriander. Thirty genotypes were randomly selected from the germplasm being maintained at Jobner and were sown in lines and maintained under two environments namely irrigated (full supplement of irrigations given) and drought staggered irrigations (half of that given in irrigated treatment) all around the experiment. Among the genotypes UD-112 was top yielder in both normal and stress conditions. There was good correspondence between the indices





namely TOL, SSI and STI. Based on these indices, UD 13, UD-112, UD-436 and RCr-684 were found to be the desirable entries for drought conditions.

COR/CM/5.4 Nutrient supplementation through organic manures for growth and yield of coriander

(Centre: Raigarh, Jobner)

At Raigarh a trial on nutrient supplementation through organic manures for growth and yield of coriander was taken up during 2012-13 with eight treatments. Maximum yield (11.3 q/ha) was obtained for the treatment application of recommended INM packages (10 t/ha FYM + 80 N: 60 P: 40 K) followed by recommended chemical fertilizer.

At Jobner the experiment was abandoned due to severe frost during the growth period of coriander.

COR/CM/5.6 Irrigation Management for sustainable coriander Production

(Centre: Guntur)

Irrigation in coriander is highly beneficial irrespective of the method of irrigation under rain fed conditions (Raingun, Sprinkler or Flooding). Irrigation at any of the stages (30 DAS, 45 DAS, 30 & 45 DAS or 30 & 60 DAS) is beneficial over no irrigation. In the case of irrigation schedules, irrigation at 30 & 60 DAS followed by irrigation at 30 & 45 DAS is highly beneficial. Irrigation with Raingun or Sprinkler at either 30 & 60 DAS or 30 & 45 DAS is highly beneficial. If water is available for only one irrigation, irrigation with Raingun/Sprinkler at 45 DAS is beneficial. Three hours operation of Sprinkler (18 lpm) or Raingun (152 lpm) is sufficient for single irrigation. Water savings is more in each irrigation in the case of Sprinkler (45.3 %) or Raingun (58.7 %) than flooding.



Fig.23 Irrigation in coriander using rain gun which saves 50% water

COR/CM/5.7 Nutrient management in off season coriander leaf production

(Centres: Guntur, Coimbatore, Periyakulam, Ajmer)

During 2011-12 summer season nine different treatment combinations were evaluated with three replications for the production of Coriander leaf at Guntur. Maximum yield was recorded by T 8 (45:40:20 NPK + spraying with GA 10 ppm at 20 DAS) (2.51 t/ha) followed by T9 (45: 40: 20 NPK + spraying with GA 15 ppm at 20 DAS) (2.42 t/ha) which were on par with each other and significantly superior to control (1.43 t/ha).

A study on nutrient management in off-season production of coriander leaf was taken up for third year at Coimbatore during 2012 -13 with nine different treatments replicated thrice. The leaf yield varied from 3.27 kg per plot (10 m²) to 5.87 kg per plot. The maximum yield (5.87 kg per plot) was recorded by the treatment T6 - 30: 40: 20 NPK + GA 15 ppm at 20 DAS followed by the treatment T4- 30: 40: 20 NPK + GA 5 ppm at 20 DAS (4.64 kg per plot).



Fig 24 Production of off season coriander



Variety CO(CR)-4 used for this study at periyakulam. In this experiment, nine treatments were imposed. The observations were recorded and analysed statistically. All the treatments were statistically significant. From the statistical analysis, it was found that the treatment T9 i.e., 45:40:20 NPK + Spraying with GA 15 ppm at recorded the highest values for the traits like plant height (29.18 cm), no. of leaves per plant (6.71), fresh plant weight

(8.89 g) yield per plot (2.67 kg/plot) and estimated yield (2.67 t/ha). The highest benefit cost ratio was recorded in the treatment T9 (1:3.49). The lowest cost benefit ratio was observed in control (1:2.62).

COR/CM/6.5 Evaluation of PGPR bioformulation of coriander

(Centre: Guntur, Coimbatore, Raigarh, Hisar, Jagudan, Ajmer,)

During 2012-13 rabi season, three different treatment combinations of PGPR bio-formulations were evaluated with four replications in Randomized Block Design at Guntur. Among the bio-formulations tested, seed treatment with FK-14 (*Pseudomonas putida*) recorded maximum yield (1166.5 kg/ha) followed by seed treatment with a combination of FK14 (*Pseudomonas putida*) and FL18 (*Macrobacterium paraoxydans*) (1117.5 kg/ha) which were on par with each other and significantly superior to untreated control (APHU Dhan-1) (1008.1 kg/ha) and untreated local check Sudha (809.1 kg/ha).

Among the four treatments, the treatment T1 - Bioformulation of FK 14 seed treatment recorded the maximum seed yield (700 kg/ha) followed by T3 - Bioformulation of FK 14 + FL 18 seed treatment (665.0 kg/ha) at Coimbatore.

At Raigarh maximum seed yield of 9.90 and 9.30 q/ha and maximum plant height (66.95 and 64.15 cm) were found when seeds were treated with Rhizobacteria FK 14 and FL 18 respectively and both the treatment were on par.

Maximum seed yield (1745kg/ ha) was recorded by the treatment T5 - Local popular variety (Hisar Anand), at Hisar followed by T2 - Bioformulation of FL 18 (1598 kg/ha) and T3 - Bioformulation of FK 14+ FL 18 (1565kg/ha).

The effect of different PGPR bioformulations on growth and yield attributing characters, yield and volatile oil content of coriander seed was not significant at Jagudan except plant height.

The experiment was conducted at the farm field of NRC on Seed Spices, Tabiji, Ajmer during 2012-13 and it was observed that the PGPR coated treatments germinated early than the control treatments. However there was no significant difference in yield among the various treatments.



Fig 25. Field view of Bio-formulations trial in Coriander at Guntur which increased yield by 15-30%

Disease management

COR/CP/6 Disease Management Trial

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

(Center: Dholi)

Out of 144 germplasm, 110 and 7 germplasm were found highly resistant and resistant against stem gall disease under natural condition at Dholi.





A survey in the cultivated coriander fields in Samastipur and Muzaffarpur districts of Bihar were found to be infested with stem gall disease caused by *Protomyces macrospores*.

COR/CP/6.3 Management of stem gall disease of coriander

(Centers: Kumarganj, Dholi, Raigarh)

At Kumarganj seed treated with Propiconazole @ 0.20 % along with three foliar sprays recorded less disease incidence and maximum yield (1.66 kg/plot). The seed treated with Hexaconazole @0.20 % with three foliar spray registered lowest disease incidence (10.0 %) and yield (1.30 kg/plot) followed by seed treated with Pseudomonas and blitox.

Seed treatment as well as spraying of crop with fungicide Propiconazole 0.2 % at 45.0 and 75 days after sowing registered lowest disease incidence (PDI=12.22), maximum disease reduction over control (79.40 %), yield (2.26t/ha) & yield increase over control was (121.57 %) at Dholi.

Fig 26 Field view of management of stem gall disease of coriander at Dholi

Minimum disease incidence (4.4 %) and maximum yield (9.9q/ha) was recorded when seeds were treated with Hexaconazole (@0.20 %) and its spray at 45, 60 & 75 days after sowing at Raigarh. The seed treatment with Propiconazole (@0.20 %) + spray at 45, 60 & 75 days after sowing (@0.20 %) was the next best treatment with a disease incidence of (6.20 %) and yield (8.6 q/ha).



X. Experimental Results in Cumin

Genetic Resources and Crop Improvement

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

(Centers: Jagudan)

The germplasm maintained at Cumin center are given in (Table 30). During the reporting year 207, genotypes of cumin were sown for evaluation for their yield at Jagudan. Among them, 10 entries found to be high yielder (>1100 kg ha⁻¹).

Screening

Total sixty three (60+3) entries of cumin were screened for the resistance against blight disease caused by (*Alternaria burnsii*). The minimum disease intensity was noticed in GC-4 (20.50 %) followed by white flower cumin (25.25 %) and GC-3 (25.75 %). The blight disease incidence ranged from 20.50 to 100.00 per cent.

Table 30. Cumin germplasm collection maintained at AICRPS centres

Centre	Indigenous	Exotic	Total
Jagudan	207	7	214
Jobner	303	6	309
Total	510	13	523



Fig.27 Field view of Cumin at Jagudan

Total sixty three (60+3) entries of cumin were screened for the resistance against powdery mildew disease caused by *Erysiphe polygoni*. Overall powdery mildew incidence was very low. The minimum disease intensity was noticed in JC-95-96 and JC-95-11 (1.00 %). The powdery mildew disease incidence ranged from 1.00 to 9.25 per cent.

Total One hundred eighty eight (186+2) entries of cumin were screened for the resistance against wilt disease caused by *Fusarium oxysporum* f. sp. *Cumini* under sick plot conditions. Overall wilt incidence was very high. The minimum disease intensity was noticed in IPS-3 (7.75 %). The wilt disease incidence ranged from 7.75 to 100.00 per cent.

Multilocation evaluation of Cumin Germplasm

(Centres: Ajmer)

Germplasm lines (RZ-209, GC-4, ACU-1-2010, ACU-2-2010, ACU-3-2010, ACU-4-2010,



ACU-5-2010, ACU-6-2010, ACU-7-2010, ACU-8-2010, ACU-9-2010, ACU-10-2010, RZ-209, GC-4, JC-95-10, JC-95-102, JC-95-110, JC-95-120, JC-95-129, JC-96-3, JC-96-7, JC-96-10, JC-96-16, JC-2000-29) were evaluated in Augmented Block Design with 2 check varieties (GC-4 and RZ-209). Maximum yield was recorded by GC-4 (51.70 g/plot)

CUM/CI/2 Coordinated Varietal Trial

CUM/CI/2.3 Coordinated Varietal Trial – 2009

(Centres: Ajmer, Jabalpur, Jagudan)

Cumin coordinated trial consisting of 05 test entries and two check varieties namely Gujarat Cumin-4 (National Check) and RZ-209 (State Check) was conducted at Regional Research Station of CAZRI at Jaisalmer(Ajmer). The plot size was kept as per previous plan i.e. 4 x 2.4 m. The trial was having general mean 424 Kg/ha with CD (5%) 96.0 and CV (%) 14.05. The best check was Gujarat Cumin-4 having seed yield of 548.6 kg/ha. The genotype CUM-10 (486.1 Kg/ha) was found at par with GC-4 (National check).

In a CVT, the yield differences among the entries were significant. None of the entries gave the higher yield over check GC-4. However the entries CUM-11, CUM-9 and CUM-10 gave higher yield (i.e.,840, 743 and 736 kg/ha-1), which was 47.37, 30.35 and 29.12 per cent higher over check GC-2 respectively. The pooled over three year data indicated none of the entry gave higher yield than the checks, GC-4. But the entries CUM-11 and CUM-10 yielded higher than check GC-2, which were 10.52 and 3.85 per cent higher than GC-2, respectively.

CUM/CI/3 Varietal Evaluation Trial

CUM/CI/3.3 Initial evaluation trial 2009

(Centre: Jobner, Jagudan)

Mean performance of the entries evaluated in IET over 2009-10 to 2011-12 at Jobner revealed superior performance of UC-339 yielding 640.51 kg/ha followed by UC-336 (578.94 kg/ha), Wt-5 (542.40 kg/ha), UC-293 (507.14 kg/ha), UC-272 (499.04 kg/ha) and UC-292 (498.88 kg/ha), while lowest mean seed yield of 345.49 kg/ha was registered by local check (Table 31). UC-339 and UC-336 may be promoted to CVT.

Table 30. Pooled mean seed yield of cumin IET over the years at Jobner (2009-2012)

Name of Entry	Seed Yield (kg/ha)			Total	Mean
	2009-10	2010-11	2011-12		
UC-259	387.85	463.89	206.48	1058.22	352.74
UC-267	529.17	692.01	266.20	1487.38	495.79
UC-272	449.65	710.42	337.04	1497.11	499.04
UC-292	575	593.4	328.24	1496.64	498.88
UC-293	625.69	596.18	299.54	1521.41	507.14
UC-336	640.97	702.78	393.06	1736.81	578.94
UC-339	720.49	732.99	468.06	1921.54	640.51
Wt-5	566.67	673.96	386.57	1627.20	542.40
RZ-19 Check	487.85	621.53	334.26	1443.64	481.21
RZ-223 Check	543.06	528.13	322.22	1393.41	464.47
RZ-341 Check	560.07	598.61	328.24	1486.92	495.64
Local Check	351.04	474.31	211.11	1036.46	345.49
CD (0.05)		98.67	101.20	65.49	
CV (%)		12.78	11.42	12.19	



At Jagudan, pooled over three year data indicated that none of the entry registered higher yield than the checks, GC-4. But the entries JC-2002-9 and JC-95-103 recorded maximum yield than check GC-2, which were 12.94 and 10.76 per cent higher than GC-2, respectively.

Crop Management

CUM/CM/5 Nutrient management trial

CUM/CM/6.4 Evaluation of PGPR bioformulation on Cumin

(Centre: Jagudan, Ajmer)

Different growth and yield attributes of cumin were not influenced significantly due to various inoculants at Jagudan (Table 33). The maximum seed yield (432 kg/plot) of cumin was noticed under the bioformulation of FK-14 that was on par with rest of the treatments. Similar trend was also observed in the case of volatile oil content.

Table 31. Evaluation of PGPR bioformulations on growth and yield of cumin at Jagudan

Treatment	Plant height (cm)	No. of branches/plant	No. of umbels/plant	No. of umbels/main umbel	No. of seeds/umbels	Test weight (g)	Volatile oil content (%)	Yield (kg/plot)
Bioformulation of FK-14	33.4	4.8	14.8	5.0	5.3	3.4	5.0	432
Bioformulation of FL-18	32.0	4.8	15.8	5.0	5.5	3.3	5.2	405
Bioformulations of FK-14 +FL-18	31.4	4.9	15.6	5.2	5.5	3.5	5.0	412
Control(without PGPR)	32.3	4.5	17.3	4.2	5.0	3.5	5.0	392
Local control(GC-2)	29.7	3.8	12.8	4.0	4.8	3.1	3.6	229
S.Em. ±	0.70	0.25	1.28	0.34	0.22	0.30	0.25	31
CD (0.05)	NS	NS	NS	NS	NS	NS	0.78	98
CV %	5.92	11.21	16.8	14.93	8.47	17.78	10.72	17

The experiment was conducted at the farm field of NRC on Seed Spices, Tabiji, and Ajmer during 2012-13. No significant difference of yield among the various treatments was observed. Wilt infestation observed in all the treatments during early stage of growth and later stage suffered with blight infestation.

Disease Management

CUM/CP/6 Disease Management Trial

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

(Centres: Jobner, Jagudan)



An experiment was initiated during the year 2009 to 2010 at Jobner to evaluate the effective dose of bio control agents for the management of wilt of cumin.

Pooled analysis of three years data given in (Table 34) revealed that the application of *Trichoderma harzianum* @10 kg/ha + FYM @ 3 t/ha resulted minimum wilt incidence (13.48 %) and maximum

seed yield (462 kg/ha) and B:C ratio (4.07) that was on par with application of *Trichoderma harzianum* @ 20 kg/ha + FYM @ 6 t/ha with wilt incidence (14.80 %) and seed yield (422 kg/ha) with B: C ratio 3.55 and *Trichoderma harzianum* @ 10 kg/ha + vermi compost @ 3.2 t/ha with wilt incidence (14.15 %), seed yield (414 kg/ha and B:C ratio (3.04). The control resulted in maximum wilt incidence.

Table 32. Management of cumin wilt through bio control agents (2009-2012) at Jobner (Pooled mean).

Treatments	Wilt (%)	Seed Yield (kg/ha)	B : C ratio
<i>Trichoderma harzianum</i> Talk base powder @ 10 kg/ha	13.20 (21.30)	340	3.26
<i>Trichoderma harzianum</i> Talk base powder @ 20 kg/ha	12.00 (20.24)	353	3.23
<i>Trichoderma harzianum</i> @ 10 kg/ha + FYM @ 3 ton /ha	5.4 (13.48)	462	4.07
<i>Trichoderma harzianum</i> @ 10 kg/ha + FYM @ 6 ton /ha	10.60 (19.02)	385	3.53
<i>Trichoderma harzianum</i> @ 20 kg/ha + FYM @ 3 ton /ha	9.80 (18.29)	386	3.39
<i>Trichoderma harzianum</i> @ 20 kg/ha + FYM @ 6 ton /ha	6.50 (14.80)	422	3.55
<i>Trichoderma harzianum</i> @ 10 kg/ha + Vermicompost@ 1.6 ton /ha	9.60 (18.04)	350	2.91
<i>Trichoderma harzianum</i> @ 10 kg/ha + Vermicompost@ 3.2 ton /ha	6.00 (14.15)	414	3.04
<i>Trichoderma harzianum</i> @ 20 kg/ha + Vermicompost@ 1.6 ton /ha	9.60 (18.09)	367	2.93
<i>Trichoderma harzianum</i> @ 20 kg/ha + Vermicompost@ 3.2 ton /ha	9.10 (17.60)	370	2.62
Bavistin Drenching @ 0.1% (Control)	6.60 (14.87)	406	3.81
Bavistin Seed Treatment	4.6 (12.39)	407	4.09
Control	41.00 (39.81)	258	2.44
CD(0.05)	3.60	48.44	
CV %	11.06	6.83	



CUM/CP/6.2 Survey for yellowing causing organism in cumin

(Centre: Jobner)

An experiment was conducted with eleven treatments for the management of yellowing in cumin. Soil application of zinc sulphate @25kg /ha + Foliar spray of Tetracycline 500 ppm at 60 and 80 days of sowing resulted minimum (0.92%) yellowing incidence.

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

(Center:Jagudan)

The crop sown by line sowing either 30 cm

or 45 cm showed its superiority over broadcasting method with respect to increasing overall yield and reducing per cent disease intensity of blight at Jagudan. Although both the row spacing were on par with each other. The application of potash either 10 kg or 20 kg reduced the per cent disease intensity of blight and increased the seed yield as compared to control. The powdery mildew incidence was not noticed during the experimentation period.



XI. Experimental Results in Fennel

FNL/CI/1 Genetic Resources and Crop Improvement

FNL/CI/1.1 Germplasm collection, char- acterizations, evaluation, conservation and screening against diseases

(Centres: Dholi, Jagudan, Hisar, Jobner & Kumarganj)

The germplasm of fennel is maintained at Dholi, Jagudan, Hisar, Jobner and Kumarganj of AI-CRPS (Table 35)

At Dholi Fifty six accession of fennel was tested for promising line in respect to yield of which seven accession namely, RF-27, RF-33, RF-23, RF-61, RF-69, RF-60 and RF-13 registered maximum



Fig 28. Field view of Fennel at Jagudan

yield ranging from 63g to 150 per plant , as compared to best check variety GF-2 i.e., 62g per plant. Among promising accessions, RF-27 recorded the maximum yield 150 g per plant followed by RF-33 i.e., 80 g per plant.

Table 33. Fennel germplasm collections maintained at various

Centre	Indigenous	Exotic	Total
Dholi	56	-	56
Guntur	2	-	2
Hisar	142	-	142
Jagudan	128	-	128
Jobner	368	-	368
Kumarganj	135	-	135
Total	831	-	831



During the reporting year, 128 genotypes of fennel were evaluated for their yield and yield attributes at Jagudan. Among them, 9 genotypes were identified as high yielding (2800 kg ha⁻¹) genotypes. During rabi season, total sixty two (60 + 2) entries were screened under natural conditions, one of the entry was found free from the disease. The minimum intensity was noticed in JF-512-2 and GF-12 (25.14 %) and categorized as moderately resistant. The per cent disease intensity was ranged between 25.14 to 65.36 per cent.

At Hisar one hundred forty two accessions of fennel were evaluated during 2012-2013 in two row plots of 3.0 m length each using GF-2 and HF-33 as checks. The mean seed yield of the germplasm ranged from 32.8 g/plant (HF-220) to 98.4 g/plant (HF-195). The most promising lines were HF-132, HF-148, HF-150, HF-154, HF-167, HF-169, HF-172, HF-179, HF-195, and HF-231.

In rabi 2012-13, one hundred forty four (144) S7 progeny of fennel were grown in augmented design in one row plots of 3 x 0.45 sq.m. size. Single plants from each row of a plot was maintained by bagging with muslin cloth and on maturity seeds were harvested separately to obtain the self seed for next generation.

One hundred and thirty five germplasm accessions of fennel were evaluated at Kumarganj and promising entries found to be NDF-46 (13.70 q/ha), NDF-51 (13.60 q/ha) and NDF-67 (13.15 q/ha) in comparison to GF-2 and RF-101.

Multilocation Trial

(Centres: Hisar, Ajmer)

At Hisar fifty accessions of fennel (viz. ten from Kumarganj, ten from Jagudan and ten from Hisar) were evaluated under multilocal testing in two row plots of 3.0 meter length each using GF-2, HF-33 and Raj-Saurabh as checks during 2012-2013. The seed yield of the germplasm material ranged from 23.6 g/plant (RF-16) to 92.4 g/plant (HF-132). The most promising lines for seed yield were NDF-

28, JF-421, JF-582, JF 676, HF-131, HF-132, HF-138, HF-140 and HF-141.

Total 50 germplasm lines were evaluated in Augmented Block Design with 5 check varieties namely AF-1, RF-125, RF-101, GF-2 and GF-12 in five blocks. At Ajmer, maximum yield recorded by HF-139 kg/plot.

FNL/CI/2.5 Coordinated varietal trial on fennel 2012 Series VIII (1st year).

(Centres: Dholi, Pantnagar, Kumarganj, Ajmer, Jabalpur, Jagudan, Jobner)

At Dholi among ten entries (FNL 47, FNL 48, FNL 49, FNL 50, FNL 51, FNL 52, FNL 53, FNL 54, FNL 55, FNL 56 and three checks viz; RF-101 NC, RF-205 NC and Rajendra Saurabh LC, none of the entries was found significant regarding number of umbels per plant, number of umbellets per umbel and yield per hectare as compared to best check variety Rajendra Saurabh.

At Pantnagar significant differences were observed for all the characters except umbellets per umbel. Maximum yield (3043.37 kg/ha) was recorded by FNL-51 followed by Rf 205 (2732.53 kg/ha).

Out of 13 entries tested at Kumarganj, maximum yield was recorded by FNL-47(13.36 q/ha) followed by FNL-48 (12.49 q/ha) and FNL-54(12.15 q/ha). Infection of powdery mildew was noticed which ranged from 13.23 to 15.78 % in FNL-5, FNL-53 and FNL-55.

A CVT trial consisting of 10 test entries and three checks (RF-101, RF-205 and AF-1) was initiated during the year 2012-13 at Ajmer. The best check was RF-205 (3501.39 kg/ha seed yield) and the genotype FNL-47 recorded maximum yield (4347.17 kg/ha).

Twelve genotypes of fennel were tested in Rabi 2012 in RBD with three replications at Jabalpur. FNL 47 recorded maximum number of umbellets / umbel (32.33) and yield (16.184 q/ha) and that was



on par with FNL 48 and RF 205.

Significant yield differences were observed among entries at Jagudan. The entries FNL-55, FNL-47 and FNL-56 recorded higher yield (1299, 1285 and 1221 kg ha⁻¹) than all the checks. which were 7.83 , 6.65 and 1.33 per cent higher than best check RF-205 , respectively.

The analysis of variance revealed significant differences among the entries for all the traits including seed yield at Jobner. The seed yield ranged from 2074.07 to 3425.93 kg/ha. Of the fourteen entries evaluated, entry FNL-49 recorded maximum seed yield of 3425.93 kg/ha followed by FNL-47 (3322.22 kg/ha), FNL-51 (3085.19 kg/ha), RF-205 N/check (2803.70 kg/ha) and RF-101 N/check (2781.48 kg/ha) while lowest seed yield of 2074.07 kg/ha was recorded in FNL-54.

FNL/CI/3 Varietal Evaluation Trial

FNL/CI/3.1 Initial Evaluation Trial 2010

(Centre: Hisar)

The initial evaluation trial (IET) in fennel was conducted with ten accessions along with HF-33 as check during 2010- 2011 to 2012-2013 in plots measuring 3.0 x 2.4 m. The results indicated maximum seed yield was recorded in HF-151 (2104 kg /ha) followed by HF-212 (1978 kg/ha) showing an increase of 27.1and 14.9% over HF-33 (check), from three years mean respectively.

FNL/CI/3.3 Initial Evaluation Trial - 2011

(Centre: Jobner, Dholi)

The trial is in the 2nd year of progress. In rabi 2012-13, ten entries were evaluated in RBD with 3 replications in a plot size of 3 x 3 sq. m. accommodating six rows spaced 50 cm apart with intra row spacing of 20 cm maintained by thinning. The trial was sown on 1.11.2012.

The analysis of variance revealed significant dif-

ferences among the entries for all the traits including seed yield. The seed yield ranged from 2322.22 to 3255.56 kg/ha. Of the ten entries evaluated, entry UF-149 recorded maximum seed yield of 3255.56 kg/ha followed by UF-191 (3251.85 kg/ha), UF-168 (3062.96 kg/ha), RF-205 check (2781.48 kg/ha), and RF-101 check 2770.37 kg/ha), while lowest seed yield of 2322.22 kg/ha was recorded in Local Check.

Mean performance of the entries evaluated in IET of fennel over 2011-12 and 2012-13 revealed superior performance of UF-168 yielding 2684.82 kg/ha followed by UF-149 (2588.89 kg/ha), UF-135 (2461.12 kg/ha), UF-191 (2423.71 kg/ha) and RF-205 check (2289.63 kg/ha), while lowest seed yield of 1885.56 kg/ha was recorded in Local check.

FNL/CI/3.4 Initial Evaluation Trial 2012

(Centres: Jagudan, Kumarganj, Dholi, Pantnagar)

Out of ten entries evaluated at Kumarganj (NDF 51, NDF 51, NDF 52, NDF 53, NDF 59, NDF 63, NDF 66, NDF 67, NDF 69, NDF 70, NDF 73, RF -101(check) maximum yield was recorded by NDF-51(13.74 q/ha) followed by NDF-67 (13.12 q/ha) and NDF-70(12.87 q/ha).

At Jagudan in IET, Ten entries were evaluated including checks GF-11 and GF-12. The entries JF-576 and JF-500-1 recorded significantly higher yield (1121 and 1120 kg/ha) which were 11.43 and 11.31 per cent higher than control.

Among nine entries and two checks i.e., GF-11 and Rajendra Saurabh evaluated at Dholi, RF-15 and RF-68 gave significantly higher yield 1388.89 & 1365 kg ha⁻¹ as compared to best check GF-11 (995.37kg ha⁻¹).

The significant differences were observed for all the characters expect days to maturity. Maximum yield (2786.80 kg/ha) was recorded in PF-5, followed by PF-10 (2463.50 kg/ha).



FNL/CI/4.1 Quality Evaluation in fennel

(Centre: Jobner)

Fourteen entries of fennel under CVT were tested for volatile oil content during Rabi 2010-11, which were analysed using Clevenger apparatus. The volatile oil content in the entries ranged from 1.90% to 2.43%. The maximum volatile oil of 2.43% was observed in FNL-26 followed by 2.33% in FNL-42, 2.30% in FNL-44, 2.23 in FNL-43 and RF-143 check, 2.17% in FNL-39 and FNL-45, while,

minimum of 1.90% in FNL-37. The entry FNL-46 ranked first in terms of volatile oil yield (57.55 l/ha) followed by FNL-44 (51.48 l/ha), FNL-45 (49.73 l/ha), FNL-42 (49.23 l/ha) and RF-143 check (47.62 l/ha) while lowest volatile oil yield of 35.73 l/ha was recorded in FNL-40 (Table 5 30).

Pooled analysis of volatile oil content (%) over three year period in CVT indicated that FNL 46 had the highest oil content (2.54%) over all the entries. This was followed by FNL 39 (2.48%) and RF 125 (2.43%)

Table 34. Volatile Oil Content In Fennel CVT (2011-12) at Jobnder

S. No.	Entry	Seed yield (kg/ha)	Volatile oil (%)	Volatile oil yield (l/ha)
1	FNL-37	1924.00	1.90	36.56
2	FNL-38	1882.67	2.10	39.54
3	FNL-39	1711.11	2.17	37.13
4	FNL-40	1701.33	2.10	35.73
5	FNL-41	1942.22	2.10	40.79
6	FNL-42	2112.89	2.33	49.23
7	FNL-43	2084.00	2.23	46.47
8	FNL-44	2238.22	2.30	51.48
9	FNL-45	2291.56	2.17	49.73
10	FNL-46	2368.44	2.43	57.55
11	GF-11 NC	1780.89	2.03	36.15
12	RF-125 Check	2061.78	2.13	43.92
13	RF-143 Check	2135.56	2.23	47.62
14	Local Check	1901.33	2.10	39.93
CD at 5%		332.63	0.20	
CV (%)		9.86	5.43	

Crop Management

Nutrient Management Trial

FNL/CM/5.2 Identification of drought/alkalinity sources in fennel

(Centre: Kumarganj)

As per yield data NDF- 32 (41.15g/ plant), NDF- 39 (39.39g/ plant) and NDF-40 (38.91g/ plant) were found to be alkalinity tolerant varieties

at 10,20,30 and 40 ESL levels at Kumarganj.

FNL/CM/5.3 Micro irrigation management in fennel

(Centre:Jobner)

Micro irrigation at 0.8 IW/CPE ratio with paired row planting recorded highest number of umbels per plant (34.80), number of umbellets per plant (22.49), number of seeds per umbel (442.16) and seed yield (33.50 q/ha) which was on par with irrigation at 1.0 IW/CPE ratio but significantly



higher over irrigation at 0.4 and 0.6 IW/CPE ratio in normal planting as well as paired row planting.



Fig 29. Micro irrigation in Fennel at Jobner

Disease Management

FNL/CP/6 Disease Management Trial

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

(Centre: Jagudan)

With a view to ascertain the efficacy of different insecticides as well as certain botanicals against seed wasp of fennel, a field experiment was under-

taken at Jagudan during kharif 2012-13. Among them, Thiamethoxam 25WG @ 0.0084 recorded the least (7.44 %) damage due to seed wasp at three and seven days after both the sprays and at the time of harvest. The plots sprayed with of Thiamethoxam 25WG @ 0.0084 % registered the maximum seed yield (2029 kg/ha) of fennel followed by Acetamidoprid 20SP@ 0.004 % (1906 kg/ha).

FNL/CP/6.3 Evaluation of PGPR bioformulation on Fennel

(Centers: Hisar, Raigarh, Ajmer, Jagudan)

At Hisar, the maximum seed yield (1754 kg/ha) was recorded by treatment T5 - Local popular variety (HF-33), followed by T1 - Bioformulation of FK 14 (1674 kg/ha) and T3 - Bioformulation of FK 14+ FL 18 (1625 kg/ha).

Maximum seed yield of 10.2 and 9.2 q/ha and maximum plant height (161.69 and 151.56 cm) were recorded when seeds were treated with rhizobacteria FK 14 and FL 18 respectively at Raigarh.

At Ajmer it was observed that PGPR coated treatments germinated earlier than the control treatments. However there was no significant difference of yield among the various treatments.

At Jagudan the effect of various treatments was not significant on growth, yield and quality of fennel except number of umbels per plant.



XII. Experimental Results in Fenugreek

FGK/CI/1 Genetic Resources and Crop Improvement

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

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

The germplasm of fenugreek conserved at various centres is given in (Table 35).

Out of one hundred sixty four collection of fenugreek germplasm maintained at Dholi, only fourteen accession namely, RM-204, RM-203, RM-186, RM-200, RM-189, RM-198, RM-70, RM-196, RM-28, RM-201, RM-188, RM-12, RM-190 and RM-18 registered the maximum yield ranging from 98g per five plant to 80g per five plant as compared to check variety Rajendra Kanti and Hisar Sonali (75 & 60g per five plant). Among promising accessions, RM-204 recorded the maximum yield 98g per five plant followed by RM-203 i.e., 96g per five plant.

Table 35. Fenugreek germplasm collections under AICRPS centres

Centre	Indigenous	Exotic	Total
Dholi	164	-	164
Guntur	124	-	124
Hisar	196	-	196
Jagudan	75	-	75
Jobner	348	-	348
Kumarganj	171	-	171
Total	1078	-	1078

At Hisar one hundred ninety- six accessions of fenugreek were evaluated along with Hisar Sonali, Hisar Suvarna and Hisar Mukta as checks during 2012-2013. The seed yield of the germplasm material ranged from 9.6 g/plant (HM-386) to 20.8 g/plant (HM-456). The most promising lines for seed

yield were HM-357, HM-389, HM-391, HM-392, HM-396, HM-401, HM-411, HM-436, HM-445, HM-449, HM-456, HM-460, HM-490, HM-501, HM-503 and HM-523.

Out of 111 accessions evaluated at Jobner , 37 accessions were better than best check variety RMt-



361 (41.67 g.). Some of the promising accessions identified on the basis of yield per 5 plants were LFC-91 (90 g), LFC-98 (90 g), and LFC-92 (83 g), LFC-47 (71 g), LFC-48 (67 g), LFC-35 (64 g), LFC-81 (63 g), LFC-110 (59 g), LFC-71 (58 g), LFC-44 (56 g), LFC-49 (56 g), LFC-103 (53 g), LFC-95 (55 g), LFC-1 (53 g), LFC-101 (53 g) and LFC-104 (53 g).

Out of 171 Germplasm of fenugreek were evaluated at Kumarganj suitable accession identified was NDM-69 (18.10q/ha) and NDM-72 (17.40q/ha) for cultivation.

At Guntur during the year 2012-13, hundred and twenty four germplasm lines along with four checks were evaluated in Augmented Block Design. LFC-6 (8.14 g/plant), LFC-67 (7.57 g/plant), LFC-50 (7.05 g/plant), LFC-48 (6.95 g/plant), LFC-45 (6.41 g/plant), LFC-7 (6.32 g/plant) and LFC-18 (5.82 g/plant) were significantly superior in yield to the check APHU Methi-1 (1.495 g/plant).

At Jagudan the 75 entries including GM-2 as check were evaluated for different characters. Short statured genotypes were also identified. More seed per pod >18.0 was found in 9 entries. The four entries were matured before 91 days. Six entries were found bold seeded having equal or more test weight >13.0. Ten entries found promising for yield, more than 2688 kg/ha.



Fig 30. Field gene bank of fenugreek showing Determinate type

Total sixty two (60+2) entries were screened under natural condition against Powdery Mildew Disease Caused by *Erysiphe polygoni* and *Leveillula taurica*. None of the entry was found free from the powdery mildew incidence. The minimum incidence were noticed in Jfg -245 (10.87 %) and categorized as moderately resistant. The per cent disease intensity was ranged between 10.87 and 85.85 per cent.

Multi-location Trial on Fenugreek - 2012-13

(Centre: Ajmer)

Total 50 germplasm lines were evaluated in Augmented Block Design with 5 check varieties namely Hisar Suvarna, Hisar Sonali, RMt-361, RMt-1 and AFG-3 in five blocks. Maximum yield (13.99 g/plant) was recorded by the accession AM-304.

FGK/CI/2 Coordinated Varietal Trial

FGK/C1/2.2 Coordinated varietal Trial 2012 Series VIII

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

At Ajmer significant yield difference were observed among the entries. The best check was AFG-3, local check having 19.66 q/ha seed yield. The highest yielding genotype was FGK-48 (22.95 q/ha) followed by FGK-47 (22.78 q/ha), FGK-50 (21.71 q/ha) and FGK-46 (21.40 q/ha), having 30.55, 29.58, 26.28 and 21.73 percent higher yield than national check, respectively

At Dholi fourteen entries and three checks i.e., RMt-361 NC, Hisar Sonali NC and Rajendra Kanti LC were evaluated. FGK-49 and FGK-52 recorded significantly more number of secondary branches per plant (48.80 & 47.68) and more yield 1750.00 kg ha⁻¹ by each entry as compared to best check variety Rajendra Kanti (1500 kg ha⁻¹).



The entries FGK-49 (2049 kgha-1) and FGK-48 (2040 kgha-1) recorded significantly higher yield over checks RMT-361, Hisar Sonali and GM-2, at Jagudan which was 19.55 and 19.01 per cent higher over best check GM-2, 27.99 and 27.41 per cent more over Hisar Sonali and 51.00 and 50.32 per cent higher than RMT-361, respectively.

At Kumarganj maximum yield was recorded by FGK-39 (14.92q/ha) followed by FGK-41 (14.85q/ha) and FGK-46 (14.79q/ha).

At Pantnagar significant difference was observed for all the characters except number of primary branches / plant and seeds per pod. Maximum seed yield (1805.56 kg/ha) was registered by FGK-48 and FGK-49, followed by FGK-45 (1698.145 kg/ha).

Eighteen entries were evaluated including four checks for yield and its related characters at Raigarh. Among the entry FGK-48 (978.08 kg/ha) recorded the maximum yield followed by FGK-52 (973.96 kg/ha).

At Jabalpur out of sixteen entries the genotype RMT 361 recorded maximum Number of pods/plant (78.36), Number of seeds /pod (26.20) and yield (21.097 q/ha). It was found that genotype FGK 48 and FGK 41 was on par with RMT 361.

Of the eighteen entries evaluated at Jobner, entry FGK-45 recorded maximum seed yield of 2291.67 kg/ha followed by FGK-50 (2236.11 kg/ha), FGK-49 (2194.44 kg/ha), FGK-47 (2106.48 kg/ha) and FGK-52 (1916.67 kg/ha), while lowest yield of 1379.63 kg/ha was recorded in FGK-51.

Table 36. Fenugreek seed yield and ancillary data recorded during 2012-13 in Coordinated Trial conducted at NRCSS Ajmer.

Name of entry	Days to 50 % flowering	Plant Height	Primary Branches per plant	Secondary Branches per plant	Pods per plant	Pod length (cm)	No. of seeds per pod	Test weight	Seed yield per plant (g)	Seed Yield (q/ha)
FGK-39	57.00	56.53	4.73	6.20	58.00	10.13	14.51	14.68	8.13	16.94
FGK-40	56.33	52.93	4.40	5.80	55.53	9.83	13.93	14.78	10.93	20.26
FGK - 41	56.00	56.93	5.40	5.33	59.93	10.37	14.96	15.65	7.27	20.36
FGK - 42	56.67	57.00	5.13	5.27	52.87	10.50	14.52	14.77	10.07	16.91
FGK - 43	56.67	51.07	4.27	4.73	52.76	8.90	12.85	14.24	10.15	16.87
FGK -44	55.67	53.87	4.07	5.20	56.56	9.67	14.37	14.60	7.99	14.88
FGK -45	56.00	51.53	4.73	4.73	53.87	9.40	13.59	14.48	6.35	16.61
FGK -46	57.67	45.70	3.47	3.93	50.40	9.67	13.99	14.04	8.41	21.40
FGK -47	56.67	49.27	4.20	5.00	50.80	9.23	12.48	14.60	13.58	22.78
FGK -48	57.00	51.33	4.33	5.40	56.73	8.97	13.25	13.84	12.57	22.95
FGK -49	56.67	51.47	4.80	5.13	53.80	9.07	14.59	15.07	9.93	14.53
FGK -50	57.00	44.67	4.07	4.20	48.93	9.50	14.04	16.47	9.30	21.71
FGK -51	56.67	51.47	3.47	5.33	42.53	10.63	14.37	16.52	11.41	15.35
FGK -52	56.00	49.80	3.60	3.93	49.40	10.03	13.04	17.25	7.83	12.96
H. Sonali (NC)	56.67	49.53	3.53	4.13	36.73	9.17	15.47	14.39	9.84	17.58
RMT-361 (C)	56.33	51.87	3.80	4.00	45.00	9.40	15.93	14.66	11.13	18.52
AFg-3 (C)	56.67	48.47	3.73	4.07	46.00	9.67	15.85	14.96	12.26	19.66
Mean	56.57	51.38	4.22	4.85	51.17	9.65	14.22	15.00	9.83	18.25
CD (0.05)	0.738	5.045	0.807	0.763	5.534	0.712	1.109	1.046	1.519	2.441
CV (%)	1.109	8.349	16.258	13.380	9.196	6.273	6.634	5.932	13.143	11.373



A total of sixteen entries including two checks were evaluated under coordinated Varietal Trial during Rabi 2012-13 at Navasari. FGK-48 (1104.94 kg/ha), FGK-42 (1080.25 kg/ha), FGK-41 (1030.86 kg/ha) and FGK-40 (975.31 kg/ha) recorded significantly higher yield over checks and observed early flowering except in the accession FGK 40.

At Udaipur the seed yield ranged from 902 - 1631 kg/ha. None of the tested entries were found to be higher in yield than the checks RMt - 361 and RMt - 1. However, FGK - 49 with the yield of 1562.50 kg/ha showed 26.76 per cent higher yield over the check Hisar Sonali followed by FGK - 48 (1475.69 kg/ha).

Among the seventeen entries evaluated, FGK-47 (1590.8 kg/ha), FGK-41 (1563 kg/ha), FGK-48 (1493.5 kg/ha) and FGK-43 (1490.1 kg/ha) recorded significantly higher yields than check APHU Methi -1 (1319.9 kg/ha) at Guntur. (Table 43).

Maximum seed yield (2271 kg/ha) was recorded in FGK-44 followed by FGK-48 (2262 kg/ha) and Hisar Sonali (2225 kg/ha) at Hisar.



Fig31.PMC flowering state in IET at Pantnagar

FGK/CI/3.Varietal Evaluation Trial FGK/CI/3.4 Initial Evaluation Trial 2010 (Centres: Hisar, Pantnagar)

The initial evaluation trial (IET) in fenugreek was conducted at Hisar with nine accessions along with Hisar Sonali as check during 2010 to 2013 in plots measuring 3.0 x 1.2 m. Maximum mean seed yield was recorded by HM-425 (3015 kg /ha) followed by HM-257 (2895 kg/ha) showing an increase of 26.7 and 21.6 % over Hisar Sonali (check), respectively (Table 38).

Table 37. Initial evaluation trial (IET 2010) Fenugreek at Hisar

Accession number	Seed yield (kg/ha)				% increase over check
	2010-11	2011-12	2012-13	Mean	
HM-247	2640	2720	2621	2660	11.8
HM-257	3024	2870	2790	2895	21.6
HM-259	2740	2630	2640	2670	12.2
HM-361	2910	2750	2690	2783	16.9
HM-414	2458	2320	2376	2385	00.2
HM-425	3210	2970	2864	3015	26.7
HM-426	2670	2458	2520	2549	07.1
HM-453	2864	2766	2690	2773	16.5
HM-460	2970	2810	2741	2840	19.3
Hisar Sonali(Ch.)	2440	2310	2390	2380	-
CD(0.05)	238.7	181.8	180	-	-



In an IET at Pantnagar in Fenugreek, the significant differences were observed for all the characters except number of primary branches and seeds per plant. Maximum yield (2798.99 kg/ha) was recorded by PM(C)-1, followed by Pant Ragani as local check (2395.83 kg/ha). On the basis of three years seed yield data, two genotypes PM(C) 1 and PM-6 may be included in CVT 2013-14.

FGK/CI/3.5 Initial Evaluation Trial 2012

(Centres: Guntur, Kumarganj, Jagudan, Jobner)

During 2011-12, ten promising germplasm lines (LFC 72, LFC78, LFC85, LFC90, LFC 116 and LFC 118) were evaluated in RBD, replicated thrice at Guntur. Among the entries tested, five entries i.e. LFC-72 (1082.3 kg/ha), LFC-78 (1078.1 kg/ha), LFC-85 (1062.8 kg/ha), LFC-90 (1097.6 kg/ha) and LFC-118 (1076.7 kg/ha) were found to be significantly superior in yield to the best check APHU Methi-1 (917.0 kg/ha).

Out of 10 entries (NDM 79, NDM 81, NDM 82, NDM 90, NDM 93, NDM 95, NDM 107, NDM 108, NDM 109, NDM 110 and Hisar sonali (ch)) evaluated at Kumarganj NDM-79 (17.40q/ha) found to be promising followed by NDM-82 (16.66 q/ha) and NDM-81(16.26 q/ha).

In IET, at Jagudan out of nine entries evaluated (JFg 148, JFg 224, JFg244, JFg 221, JFg 226, JFg 268, JFg 223, JFg 239, and GM-2(ch)) none of the entry recorded significantly superior yield than check GM-2. However the entries JFg-268 and JFg-224 recorded maximum yield (i.e. 2095 and 1991 kg/ha-1) which was 7.90 and 2.51 per cent higher over GM-2.

Of the ten entries evaluated at jobner, entry UM-161 recorded significantly higher seed yield of 2907.41 kg/ha followed by UM-294 (2865.74 kg/ha), UM-379 (2694.44 kg/ha), UM-221 (2638.89 kg/ha), UM-347 (2449.07 kg/ha) and RMT-351 check (2361.11 kg/ha), while lowest yield of 1527.78 kg/ha was recorded by RMT-305 check.

FGK/CM/4 Nutrient Management Trial

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

(Centre: Jobner)

Among the genotypes UM-118 was top yielder in both normal and stress conditions. There was good correspondence between the indices namely TOL, SSI and STI. Based on these indices, UM-118, UM-124, UM-144, UM-302 and RMT-361 were found to be the desirable entries for drought conditions.

FGK/CM/ 4.3 Micro irrigation management in fenugreek

(Centre: Jobner)

The results indicated that micro irrigation management in fenugreek resulted in significant improvement in yield attributes and yield of fenugreek over surface irrigation by check basin method at jobner. Micro irrigation at 0.6 IW/CPE ratio with paired row planting recorded higher number of pods per plant (31.93), number of seeds per pod (16.98), and seed yield (26.93 q/ha) which was on par with irrigation at 1.0 and 0.8 IW/CPE ratio but significantly higher over irrigation at 0.4 IW/CPE ratio in normal planting as well as paired row planting



Fig 32. Micro-irrigation in Fenugreek at Jobner



FGK/CM/4.5 Evaluation of PGPR bioformulations on seed spices

(Centres: Jobner, Guntur, Kumarganj, Hisar, Jagudan)

Effect of various treatments on growth characters and seed as well as straw yield of fenugreek were significant at Jagudan. Differences in yield attributes of fenugreek crop were not significant during the experimental period due to various treatments. Differences in yield seed pelleting with or without PGPR to GM 3 were on par (T1, T2, T3 and T4) and significantly higher than local control (GM2). Thus, slight beneficial effect of PGPR bioformulations was observed at Jagudan.

Among the bio-formulations tested, seed treatment with combination of FK14 (*Pseudomonas putida*) and FL18 (*Macrobacterium paraoxydans*)

(1117.5 kg/ha) followed by seed treatment with FK-14 (*Pseudomonas putida*) (1114.9 kg/ha) and seed treatment with FL18 (*Macrobacterium paraoxydans*) (1109.7 kg/ha) recorded maximum yield at Guntur and were on par with each other, and significantly superior to untreated control (1016 kg/ha) and untreated local check LS-1 (927.4 kg/ha).

At Kumarganj the treatment Bio-formulation of FGK-14 + FL-18 recorded maximum (15.91q/ha) followed by bio-formulation of FGK-14 (14.68q/ha) and bio-formulation of FL-18 (13.79 q/ha).

Significant differences were obtained for all the parameters except branches per plant and pod length at Hisar (Table 39). The maximum seed yield (1936 kg/ha) was recorded in treatment T3 - Bio-formulation of FK 14+ FL 18 followed by treatment T5 - Hisar Sonali, Local variety (1928 kg/ha).

Table 38. Effect of Rhizobacteria bioformulations (PGPR) on growth and seed yield of fenugreek at Hisar (2012-13)

Treatments	Plant height (cm)	Branches per plant	Pods per plant	Pod length (cm)	Seeds Per pod	Seed yield (kg/ha)
T1 – Biof. of FK 14	95.0	5.9	64.5	7.3	15.8	1910
T2 – Biof. of FL 18	92.1	5.7	66.5	7.4	15.2	1925
T3 – Biof. of FK 14+ FL 18	97.2	5.9	74.6	7.2	15.4	1936
T4 - Control	97.6	5.8	66.5	7.3	14.7	1814
T5 - Local variety	99.0	5.9	68.2	7.5	16.6	1928
C D (0.05)	4.5	NS	6.3	NS	0.4	87

The results of pooled mean at Jobner seed treatment with bioformulation FK 14 + FL 18, being on par with bioformulation FK 14 and FL 18, recorded significantly higher plant height, number of primary branches per plant, number of secondary branches per plant, number of pods per plant, pod length, number of seeds per pod, seed yield

(1792.46 kg/ha) and B:C ratio(2.20) over untreated control.



XIII. Monitoring and Meetings

The project coordinator monitored the working of various AICRPS centres by personal visit and by keeping constant touch with all the centres through phone and e-mail. Monthly progress report and budget utilization sent by various centres was reviewed critically and timely advise was given for the proper implementation of the projects.



Centres visited (April 2012-March 2013)

Sl. No.	Tour Details of Project Coordinator, AICRPS for the period 1-4-2012 to 31-3-2013	
1	08-06-2012 to 09-06-2012	PRS, Panniyur, CRC, Appangala
2	14-06-2012 to 16-06-2012	TNAU, Coimbatore
3	10-7-2012- to 11-7-2012	TNAU, Coimbatore
4	18-7-2012 to 19-7-2012	TNAU, Coimbatore
5	21-8-2012 to 22-8-2012	APHU, Hyderabad
6	05-09-2012 to 07-09-2012	AICRPS Center, Coimbatore
7	06-10-2012 to 09-10-2012	Rajasthan Agril. University, Jaipur
8	08-10-2012	NRCSS, Ajmer on 8th October
9	08-11-2012	AICRP Center, Hisar on 8th November
10	19-11-2012	AICRP Center, Panniyur
11	15-1-2013 to 17-1-2012	AICRPS regular Center at Pampadumpara AICRP voluntary center at ICRI, Myladumapara Idukki region - the most important pepper growing District in the country
12	31-1-2013 to 4th February	RAU, Jobner
13	11-2-2013 to 14-2-2013	AICRP Regular Centers at Guntur and Kammarapalli
14	26-02-2013	AICRP Regular Center at Jagudan
15	27-2-2013	Junagadh



XIV. Technologies recommended to Release

- 1. Application of entomopathogenic nematodes in the management of cardamom root grub. Small cardamom (Pampadumpara)**

Application of EPN *Heterorhabditis indica* @ 100 Infective Juvenile (IJ) grub was found to be effective in reducing the population of cardamom root grub. Care should be taken to ensure adequate moisture content in the soil while drenching EPN and application of EPN should be restricted to evening hours for better results.
- 2. Management of scale insects of black pepper with organic products (Pampadumpara)**

Scale insects of black pepper could be controlled by spraying neem formulation containing 1 % Azadirachtin @0.5 %, should be applied at fortnightly interval from September onwards (4 applications)
- 3. Fertigation technology for turmeric (Coimbatore)**

Application of NPK@150: 60:108 kg/ha with urea and potash as straight fertilizers and Phosphorus as water soluble fertilizer weekly once recorded a yield of 49.11 t/ha .
- 4. Organic Nutrient management in turmeric (Dholi)**

Soil application of FYM @30 t/ha + Vermi compost @20 q/ha + Neem oil cake @ 8 q/ha is recommended for higher yield (48.82 t/ha).
- 5. Integrated nutrient management in ?????**

Soil application of inorganic N @150 kg/ha + Azospirillum @1.5 kg/ha + FYM @5 t/ha is recommended for higher yield (56.6 t/ha).
- 6. Nutrient supplementation through organic manure in coriander (Coimbatore & Guntur)**

Use of FYM 5.0 t/ha + Vermi compost 2.5 t/ha or Vermi compost @ 5 t/ha or FYM 2.5 t/ha + Vermi compost 3.75 t/ha or FYM 10 t/ha is recommended to increase the seed yield of coriander.
- 7. Micronutrient requirement in coriander (Coimbatore)**

For the saline soils where there is zinc deficiency (less than 2 ppm) spraying of 0.5 % of zinc sulphate (2 spray- 45 and 60 days after sowing) is recommended for higher seed yield.
- 8. Promotion of micro irrigation in coriander (Guntur)**

Irrigation with Raingun or Sprinkler at either 30 & 60 DAS or 30 & 45 DAS is recommended to improve the productivity of coriander. If water is available for only one irrigation, irrigation with Raingun/Sprinkler at 45 DAS is beneficial and water saving is (58.7 %) and 45.3 % respectively.
- 9. Integrated nutrient management in coriander (Dholi)**



Soil application of inorganic N @ 33kg/ha + Azospirillum @1.5 kg/ha + FYM @ 5t/ha is recommended for higher yield (1.98 t/ha).

10. Management of cumin wilt and blight (Jagudan)

Seed treatment of *Pseudomonas fluorescens* @10 g/ kg seed + soil application of *Trichoderma harzianum* @2.5 kg/ha and *Pseudomonas fluorescens* (IISR 6) 108 cfu as a spray at 60 DAS is recommended.

11. Integrated nutrient management in Fenugreek (Dholi)

Soil application of inorganic N @13 kg/ha + Azospirillum @1.5 kg/ha + FYM @ 5t/ha is recommended for higher yield (2.29 t/ha).

Annual Group Meeting

The National group meeting (XXIII Workshop) of All India Coordinated Research Project on Spices (AICRPS) was held at Indian Institute of Spices Research, (IISR), Kozhikode during 29th September to 1st October 2012.



Dr. Umesh Srivastava, Asst. Director General, ICAR, New Delhi Inaugurating the 23rd AICRPS Workshop at Kozhikode

Dr. M. Anandaraj, Director, IISR, Kozhikode has given the welcome address and wanted the AICRPS which he coordinated for 6 years to develop location specific technologies which needed better visibility with an eye on commercialization.

Dr. V. A. Parthasarathy, Scientist Emeritus and former Director, IISR, Kozhikode in his presidential address stressed the need to concentrate on secondary agriculture to enhance productivity by at least 20% in the XII plan period. He requested the scientists to enhance the productivity by releasing new high yielding, climate resilient varieties and by crop intensification.

The National group meeting was inaugurated by Dr. Umesh Srivastava, Assistant Director General (Hort.), Indian Council of Agricultural Research (ICAR), New Delhi. In his inaugural address he stressed the need for concerted efforts to register unique and important genotypes and guard against bio piracy of spices germplasm. He also emphasized the importance of urban horticulture for food and nutritional security, varieties for different agro ecological zones of the country, varieties resistant to biotic and abiotic stress vis-à-vis climate change and use of safe green chemicals for crop disease management. He also opined that genetic basis of seed spices need to be widened and emphasis may be given for cost effective conservation of germplasm, cultivation of underutilized seed spices and enhancing the crop productivity by crop diversification.

Dr. Balraj Singh, Director, NRCSS, Ajmer emphasized the importance and recent advances in protected cultivation and its suitability for spices. Dr. K. Nirmal Babu, Project Coordinator (AICRPS) gave vote of thanks.

The deliberations of the annual group meeting were conducted in different technical sessions held from 29th to 1st October and the salient decisions, recommendations were presented during the plenary session held on 1st October 2012. The sessions dealt with aspects such as genetic resources, crop improvement, crop production, crop protection, variety release and transfer of technology. The technical sessions were chaired by eminent scientists in the respective fields. In plenary session Project co-ordinator Spices presented the technical programme for 2012-13 which was approved by the group meeting.



XV. Popularization of Technologies

S. No.	Technology Demonstrated	Details of the technology	Farmers name and place of demonstration
1.	FLD on micro-irrigation of Coriander using Raingun and Sprinklers	T1- Raingun irrigation @ 30 mm each twice at Flower initiation and grain filling. T2- Sprinkler irrigation @ 30 mm each twice at Flower initiation and grain filling. T3-Un-irrigated Control cv. Sudha	Sri Lakhma Reddy, Jonnalagadda, Guntur
2.	FLD on Organic farming of Coriander (grain) cv. Sudha.	T1- Organic farming T2- Chemical agriculture cv. Sudha	Sri Nannapaneni Srimannarayana, Bodipalem, Kakumanu Mandal, Guntur district.
3.	FLD on Organic farming of Coriander (leaf) cv. Sudha.	T1- Organic farming T2- Chemical agriculture cv. Sudha	Sri Upputuri Tribhujeswara Rao, Kakaravai, Vatsavai Mandal, Krishna district.
4.	FLD on Organic farming of Coriander (leaf) cv. Sindhu.	T1- Organic farming T2- Chemical agriculture cv. Sudha	Sri Edara Venkateswarlu, Doppalpudi, Kakumanu Mandal, Guntur district.
5.	FLD on Organic farming of Coriander (grain) cv. Sudha.	T1- Organic farming T2- Chemical agriculture cv. Sudha	Sri Chiriki Sathyanarayana, Chowdavaram, Vizag district.
6.	FLD on Intercropping in Bengal gram.	T1- 4 + 4 rows of Bengal gram + Coriander cv. Sudha T2- Bengal gram pure crop	Sri Tiyyagura Vekata Reddy, Tadikonda, Guntur district.



XVI. List of Publications

Coimbatore

Papers presented in conferences / seminars

Kumar, N. 2013. Spices Improvement: Aspect, achievements and issues. In: National seminar on Production, Productivity and quality of Spices at NRC on Spices, Ajmer on 2-3, February, 2013. Souvenir: 18-30.

Paramaguru, P., Jagadeeshkanth, R. and Shoba, N. 2012. Evaluation of turmeric genotypes for yield and curcumin content. In: 6th International Symposium on the family Zingiberaceae programme and abstracts on 10-13, September, 2012 at University of Calicut, Kerala. 34 p.

Subramanian, S. and Durgavathi, V. 2012. Evaluation of ginger genotypes under coconut ecosystem. In: 6th International Symposium on the family Zingiberaceae programme and abstracts on 10-13, September, 2012 at University of Calicut, Kerala. 54p.

Subramanian, S. and Gnanasekar, V. 2012. Effect of different seed rhizomes on growth, yield and quality of turmeric (*Curcuma longa* L) genotype CL 101 raised under in vivo conditions and standardization of in vitro multiplication. In: 6th International Symposium on the family Zingiberaceae programme and abstracts on 10-13, September, 2012 at University of Calicut, Kerala. 55p.

Shoba, N., Mikias Damtew. and Paramaguru, P.

2012. Identification of differentially expressed gene candidates under salt stress conditions in turmeric (*Curcuma longa* L.). In: 6th International Symposium on the family Zingiberaceae programme and abstracts on 10-13, September, 2012 at University of Calicut, Kerala. 53p.

Sharon Aravind., Shoba N., Paramaguru, P. and Subramanian, S. 2012. Study on performance of turmeric (*Curcuma longa* L) varieties for yield and quality. In: 6th International Symposium on the family Zingiberaceae programme and abstracts on 10-13, September, 2012 at University of Calicut, Kerala. 52p.

ii. Leaflet

Chitra, R. and Mohamed Yassin, M. 2012. Rapid multiplication of turmeric through

Single bud technology (Tamil).

iii. Booklet

Chitra, R. and Mohamed Yassin, M. 2012. Hi-Tech Cultivation of Turmeric (Tamil).

Subramanian, S., Mohanalakshmi, M., Bala-kumbagan, K., Paramaguru, P., and Kumar, N. 2012. Hi-Tech Production Technology of Ginger (Tamil).

iv. Popular article

Chitra, R., 2012. Cultivation aspects of Turmeric (Tamil) SPIC Pannai Cheithi bi-monthly April-May,





2012: 3-6.

Chitra, R., Mohanalakshmi, M., Subramanian, S. and Paramaguru, P. 2013. IPR issues in Spices Crops. In: Strategies and Issues: IPR in Horticultural Crops. Training manual: 24-27.

Dapoli

Khandekar, R. G., Pethe, U. B., Nawle, R. N., Gadre, U.A., Haldankar, P. M., Jadhav, B. B. and Anandraj, M. 2012 . Standardization of thickness and stem length for harvesting cinnamon (*Cinnamomum verum* J. Press) bark in two genotypes. *Journal of spices and aromatic crops* 21 (2): 164 – 168.

Khandekar, R.G., Pethe, U.B., Nawle, R.N., Gadre, U.A., Haldankar, P.M., Jadhav, B.B. and Anandraj, M. 2011 Orthotropic shoot propagation in black pepper (*Piper nigrum* L.) (2012). *Proceedings of SYM-SAC- VI symposium held at Univ. of Agril. Sci., Dharwad 8-10, Dec. 2011.*

Guntur

Surya Kumari, S., Srihari, D., Ravi Sanker, C., ChennaReddy, V. and SivaSanker A. Studies on Genetic Divergence, Heterosis and Combining Ability in Paprika (*Capsicum annuum* L.) accepted for Full length publication and Oral Presentation at XV Meeting on Capsicum and Eggplant to be organized by EUCARPIA from 2-4 September 2013 Torino, Italy.

Abstracts:

Vijaya Lakshmi, P., Vijaya Lakshmi, T., Surya Kumari, S., Rajani, A. and Naram naidu, L. 2012 New molecules of insecticides for the management of insect pests of chilli in Andhra Pradesh . *Proceedings of IV National Symposium on plant protection in Horticultural Crops – Emerging Challenges and sustainable pest management in Horticultural crops ,IIHR, Bangalore 25th to 28th April, 2012 .*

Vijaya Lakshmi, P., Vijaya Lakshmi, T., Surya Ku-

mari, S., Rajani, A. and Naram Naidu, L .*Impact of weather parameters on the population dynamics of major insect pests of chilli in Andhra Pradesh. Proceedings of IV National Symposium on plant protection in Horticultural Crops – Emerging Challenges and sustainable pest management in Horticultural crops, IIHR, Bangalore .25th to 28th April, 2012 .*

Author Poster presentation on “Comparative study on the performance of Coriander genotypes under receding soil moisture regimes in rainfed vertisols” at the National Symposium on Climate Change and Indian Agriculture: Slicing down the Uncertainties At CRIDA, Hyderabad.

Poster presentation on” Comparative study on the performance of Coriander genotypes under receding soil moisture regimes in rainfed vertisols” at the National Symposium on Climate Change and Indian Agriculture: Slicing down the Uncertainties. At CRIDA, Hyderabad on 21-1-13.

Hisar

Papers presented in conferences / seminars

Tehlan, S. K., Nandal, J. K. and Dahiya, M. S. 2012. Present status, production constraints and future research priorities of seed spices in India. *Proceedings of Seminar on “New Perspectives in Aromatic and Medicinal Plants” Hisar: 122-124*

Tehlan, S. K., Sandooja, J.K., Nandal, J.K., Sharma, N. K. and Dahiya, M. S. 2012. Influence of storage environment and varieties on self life of coriander leaves. In *proceedings of Seminar on “New Perspectives in Aromatic and Medicinal Plants” Hisar: 122-124*

Shetty, A. A., Rana, M. K. and Tehlan, S. K. 2012. Effect of gibberellic acid on yield and seed quality of Ajowain. *Proceedings of Seminar on “New Perspectives in Aromatic and Medicinal Plants”, Hisar: 105-109.*



Nandal, J. K., Tehlan, S. K. and Bamal, J. S. 2012. Effect of method of sowing, nitrogen levels, cuttings of leaves on growth and seed yield of coriander. Proceedings of Seminar on “New Perspectives in Aromatic and Medicinal Plants” Hisar: 117-121.

Dahiya, M. S., Yadav, A. C., Dudi, B. S. and Tehlan, S. K. 2012. Response of phosphorus and spacing on seed yield of fenugreek. Proceedings of Seminar on “New Perspectives in Aromatic and Medicinal Plants” (Feb, 2012), Hisar: 125-126.

Dahiya, M. S., Dudi, B. S., Tehlan, S. K. and Nandal, J. K. 2012. Effect of nitrogen and spacing on seed yield of onion. Proceedings of Seminar on “New Perspectives in Aromatic and Medicinal Plants” (Feb, 2012), Hisar: 133-134.

Nandal, J.K., Tehlan, S.K., Dahiya, M.S. and Bamal, J. S. 2012. Response of spacing and seed rate in nursery on growth and green chilli yield. Proceedings of Seminar on “New Perspectives in Aromatic and Medicinal Plants” (Feb, 2012), Hisar: 129-132.

Kumar, A., Tehlan, S. K. and Nandal, J.K. 2012. Studies on viability and vigour in coriander seeds stored under ambient conditions. Proceedings of Seminar on “New Perspectives in Aromatic and Medicinal Plants” (Feb, 2012), Hisar: 135-138.

Tehlan, S. K. and Thakral, K.K. 2012. Hisar Bhoomiti: A leafy type variety of coriander (Abstract). “National seminar on Sustainable Agriculture and Food Security: Challenges in Changing Climate” (March, 2012), Hisar: 298-299.

Dahiya, O. S., MOR, V. S., Punia, R. C. and Tehlan, S. K. 2012. Effect of Rhizobacteria on seed quality of fennel. “National seminar on Sustainable Agriculture and Food Security: Challenges in Changing Climate” (March, 2012), Hisar: 295-296.

Punia, R. C., Kumar, A., Tehlan, S. K. and Dahiya, O. S. 2012. Effect of organic manures on seed quality of coriander. “National seminar on Sustainable Agriculture and Food Security: Challenges in Changing Climate” (March, 2012), Hisar: 296-297.

Deswal, D.P., MOR, V.S., Tehlan, S.K. and Sheokand, R.N. 2012. Assessment of field emergence and seed storability through different vigour tests in fenugreek. “National seminar on Sustainable Agriculture and Food Security: Challenges in Changing Climate” (March, 2012), Hisar: 297-298.

Nandal, J. K. and Tehlan, S. K. 2012. Studies on seed quality and its deterioration during storage in tomato. “National Seed Congress-2012: Quality Seed for Food Security” (Jan., 2012), Chandigarh: 297-298.

Malik, T. P. and Tehlan, S. K. 2012. Growth and seed yield of fennel as influenced by rhizobacteria. Hortiflora Research Spectrum. 1(2): 181-183

Jagudan

Research Article

Ravindrababu, Y., Prajapati, D. B. and Patel, K. P. 2013. Characterization and Evaluation of indigenous ajwain (*Trachyspermum ammi*) germplasms under North Gujarat condition. International Seed Spices Journal: 38 (1) 13-16.

Panchal, J. A., Patel, K. D., Jaiman, R. K. and Patel, N. R. 2012. Physiological Studies of Sclerotinia sclerotiorum Causing Stem Rot of Fennel (*Foeniculum vulgare* Mill.). Environment & Ecology. 30 (3A): 764-769.

Patel, N. R., Patel, K. D., Jaiman, R. K. and Agalodiya, A. V. 2012. Scheduling of fungicidal sprays for the management of powdery mildew. International J. Seed Spices. 2(1): 69-76.

Prajapati, B. G., Patel D. G. and Agalodiya, A.V. 2013. Relative susceptibility of coriander genotypes against coriander aphid, *Hydaphis coriandrai* (Das) under north Gujarat condition Proceedings of National Seminar on “Production, Productivity and Quality of Spices” held during March 2-3, 2012 at Jaipur:17-18.

Papers presented in conferences / seminars





Prgalodiya, A. V., Patel, N. R., Sutariya, D. A. and Patel, J. B. 2012. Seed Spices Research in Gujarat Present Status, Impact and Strategies - a lead paper presented and Proceedings of National Seminar on "Production, Productivity and Quality of Spices", Jaipur, Rajasthan, India during February, 2-3, 2012.

Patel, N. R., Jaiman, R. K., Patel, K. D. and Agalodiya, A. V. 2012. Screening of cumin (*Cuminum cyminum* L.) genotypes for resistance against various diseases - Proceedings of National Seminar on "Production, Productivity and Quality of Spices", Jaipur, Rajasthan, India during February, 2-3, 2012.

Patel, K. D. Patel, N. R., Jaiman, R. K. and Agalodiya, A. V. 2012. Field Screening of Fenugreek genotypes against Powdery Mildew disease - Proceedings of National Seminar on "Production, Productivity and Quality of Spices" Jaipur, Rajasthan, India during February, 2-3, 2012.

Dimple Sutariya Patel, M. B., Patel, N. R. and Agalodiya, A. V. 2012. Seed village concept- A case study- Proceedings of National Seminar on "Production, Productivity and Quality of Spices", Jaipur, Rajasthan, India during February, 2-3, 2012.

Patel, N. R., Jaiman, R. K. Patel, K. D. and Agalodiya, A. V. 2012. Field screening of coriander genotypes against powdery mildew - Proceedings of 34th Annual Conference & Symposium of ISMPP on the theme "Crop Disease Management: Advances and Challenges" during the technical session III, organized by ISMPP and Navsari Agricultural University, Navsari, Gujarat during January 21-23, 2013 at NAU, Navsari, Gujarat.

Gujarati articles/ leaflets/ folders:

Bij Masala Pako man Pak Sanrakshan

Bij Masala Pako ni Nikaslakshi Khetpadhatio

Jobner

Reaserach articles

Shivran, A. C., Divakara Sastry, E. V., Kayam Singh Shekhawat, Mittal, G. K. and Rajput, S. S. 2012. Effect of plant growth promoting rhizobacteria on growth and yield of cumin (*Cuminum cyminum* L.). *International J Seed Spices* 2(2): 30-33.

Shivran, A. C. and Jat, N. L. 2012. Effect of bioregulators and their time of application on yield of coriander (*Coriandrum sativum*). *Crop Improvement Special issue*: 673-674.

Kumar, M., Shivran, A. C., Chouhan, Rekha. Meena, K. S. and Verma, K. C. 2013. Effect of row ratio and sulfur levels on yield attributes, seed yield and quality in castor- mungbean intercropping system under dryland conditions. *Environment and Ecology*, 31(3C) : 1061-1064.

Shivran, A. C., Shekhawat, K. S., Sastry, E. V. D. and Rajput, S. S. 2013. Effect of plant growth promoting rhizobacteria (PGPR) coated bioformulations on fenugreek. *International Journal of Seed Spices*, 3(1): 16-19.

Ram, L., Shekhawat, K.S., Khokhar, M.K., Gupta, R. and Meena, R. K. 2012. Deteriorative effect of seed mycoflora of ajwain on seed germination, seedling vigour and on oil content of seeds. *Green Farming*: 3 (5): 579-582.

Ram, L., Khokhar, M.K., Nema, R., Shekhawat, K.S., and Gupta, R. 2012. Management of pathogenic seed Mycoflora of Ajwain through Fungicidal seed Treatments. *Jour. Pl. Sci. Res.* 28(2): 77-79.

Papers presented in conferences / seminars

Jeetarwal, Rajesh Chand, Divakara Sastry, E. V. and Shyam Singh. 2013. Genetic variability analysis in inbreds of Fennel (*Foeniculum vulgare* Mill.). National Seminar on Production & Quality of Spices, Book of Abstracts. Published by National Research Centre on Seed Spices, Tabiji, Ajmer. 39p.

Shekhawat, K. S., Divakara Sastry, E. V., Shivran, A.



C. and. Rajput, S. S. 2013. Management of cumin wilt through bioagents under field condition. National Seminar on Production & Quality of Spices, Book of Abstracts. Published by National Research Centre on Seed Spices, Tabiji, Ajmer.148p.

Shivran, A. C., Divakara Sastry, E. V., Kayam Singh Shekhawat, Mittal, G. K. and Rajput, S. S. 2013. Role of plant growth promoting rhizobacteria coated bioformulation on cumin. National Seminar on Production & Quality of Spices, Book of Abstracts. Published by National Research Centre on Seed Spices, Tabiji, Ajmer. 55p.

Shivran, A. C., Kayam Singh Shekhawat, Divakara Sastry, E. V. and. Rajput, S. S 2013. Role of plant growth promoting rhizobacteria coated bioformulation on fenugreek. National Seminar on Production & Quality of Spices, Book of Abstracts. Published by National Research Centre on Seed Spices, Tabiji, Ajmer. 57p.

Shivran, A. C. and Jat, N. L. 2012. Yield of cumin (*Cuminum cyminum*) influenced by bioregulators and their time of application. Abstract of symposium on Managing stress in drylands under climate change scenarios held from December 1-2, 2012, at Jodhpur: 170-171.

Sastry, E. V. D., Shekhawat, K. S., Shivran, A. C., Rajput, S. S. and Mittal, G. K. 2013. Crop improvement strategies in seed spices for higher productivity and quality. National seminar on production, productivity and quality of spices held at Jaipur from Feb., 2-3, 2013: -60-71.

TRAINING MANUAL

Sastry, E. V. D., Singh, D., Shekhawat, K. S., Shivran, A. C., Rajput, S. S. and Kumawat, S. R. 2012. Training manual for state level seed spices seminar held at AICRP on spices, Jobner from 21-22, Feb., 2012.

Kumarganj

Pandey, V. P., Saxena, R. P, Yadava, G. C, Yadava, P. S. and Kumar, A. 2011. Yield Performance of Initial

Evaluation Trial in Turmeric in Eastern U.P. Alumni Meet and National Seminar on 'New Vistas of R & D in Agriculture and Allied Sectors': 54.

Mudigere

Lakshmana, D., JemlaNaik, D., Madaiahand, D, K. and Devaraju, M. 2012. Performance of Promising indigenous clones of cardamom under hill zone of Karnataka. Journal Asian Horticulture. Accepted.

Rangaswamy, S. D. 2012. Cardamom Research at RHR&EC, Mudigere, p. 89-91, The Capsule – Golden Jubilee Souvenir, CRS, Appangala.

Pampadumpara

Maya, T., Kuriakose, K. P., Dhanya, M. K. and Deepthy, K. B. 2012. Three decades of cardamom research at CRS, Pampadumpara, The Capsule-Golden Jubilee Souvenir, Indian Institute of Spices Research, Calicut: 93-101.

Murugan, M. and Ravi, R. 2012. Climate change challenges small cardamom research: The Capsule-Golden Jubilee Souvenir, Indian Institute of Spices Research, Calicut: 69-73

Murugan, M., Shetty, P. K., Anandhi, A. and Ravi, R 2013. Present and Future Climate change in Indian Cardamom Hills: Implications for Cardamom Production and Sustainability. British Journal of Environment & Climate Change, 2(4) : 368-390.

Murugan, M., Shetty, P. K, Raju Ravi, Aavudai Anandhi and Arulappan Joseph Rajkumar (2012). Climate change and crop yields in the Indian Cardamom Hills, 1978-2007 CE. Climatic Change,110: 737-753, Springer, USA.

Murugan, M., Bijoy, K. Panigrahy., Shetty, P. K, Alappan Subbiah and Raju Ravi 2012. Effect of Heavy metal and Nutrient Uptake by soils in Indian Cardamom Hills: Journal of Soil Science and Environmental Management, Vol. 3(8):196-206.

Narayana, R, Dhanya, M. K. and Nisha, M. S 2012.





Effects of organic inputs and bio control agents on the microflora and nematodes in rhizosphere of cardamom, proceeding of 24th Kerala congress 46-47.

Sivakumar, G., Josephraj Kumar, A. and Dhanya, M. K. 2012, Evaluation of bacterial antagonists for the management of rhizome rot of cardamom (*Elettaria cardamomum* Maton), *Journal of Spices and Aromatic crops* 21(1): 9-15

Papers presented in conferences / seminars

Dhanya, M. K., Sivakumar, G., Maya, T., Deepthy, K.B., Kuriakose, K. P. and Narayana, R. 2012. Eco friendly management of foot rot of blackpepper (*Piper nigrum* L.) caused by *Phytophthora capsici* Leon. - PLACROSYM XX, Coimbatore: 95p.

Dhanya, M. K., Narayana, R., Umamaheswaran, K., Deepthy, K. B. and Maya, T. 2012. Banana bract mosaic virus, a new threat to small cardamom (*Elettaria cardamomum* Maton) PLACROSYM XX, Coimbatore: 104p.

Popular articles

Sivakumar, G., Dhanya, A., M. K. and Joseph Rajkumar, A. 2012. Bacterial Consortium - A novel Approach for the Management of Rhizome Rot of Small Cardamom. *Spice India*: 9-10.

Maya, T., Sreekala, G. S., Geetha, K., Kuriakose, K. P., Dhanya, M. K. and Deepthy, K. B. 2012. Evaluation of promising small cardamom (*Elettaria cardamom* Maton) accessions in the cardamom hill reserves, Abstract of Papers, PLACROSYM XX December 12-15, 2012. UPASI, Tamilnadu.

Pundibari

Bandyopadhyay, S. and Khalko, S. 2012. An Approach for the management of rhizome rot complex of ginger. *International Symposium on Food Security Dilemma: Plant Health and Climate Change Issues* held at Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia. 7-9 December. p 182.

Bandyopadhyay, S. and Bhattacharya, P. M. 2013. Survey of different diseases of ginger and finding etiology of rhizome rot complex disease of ginger. *National Symposium on recent trends in Plant and Microbial Research*, Siliguri, West Bengal. 22-23 March, 2013.

Bandyopadhyay, S. and Bhattacharya P. M. (2012). Management of rhizome rot of ginger using physical, chemical and biological methods. *J Mycol Pl Pathol*. 42 (3): 314-316.

Sirsi

Lokesh, M. S., Patil, S. V., Gurumurthy, S. B., Nagesh Naik and Palakshappa, M. G. 2012, *Phytophthora* foot rot (*Phytophthora capsici* Leonian.) of black pepper management through fungi toxicant and consortium in Western Ghats of Karnataka. *International Journal of Plant Protection Muzaffarnagar Hind Agricultural Research and Training Institute, Hindi Agri- Horticultural*.

Lokesh, M. S., Patil, S. V., Gurumurthy S. B., Palakshappa M. G. and Anandaraj. M 2012, Efficacy of Solarization and antagonistic organisms for management of rhizome rot of ginger in Karnataka. *International Journal of Plant Protection* 5(2):195-200

Lokesh, M. S., Survyararayanan, V., Patil, S. V., Gurumurthy, S. B., Palakshappa, M. G. and Manjunath, G. O. 2012. Documentation and management of anthracnose- A new nursery disease of *Garcinia indica* Choice in Karnataka. *International Journal of Plant Protection* 5(2):275-277

Lokesh M. S., Survyararayanan V., Patil .S. V., Gurumurthy. S. B., Palakshappa M. G. and Anandaraj. M., 2012, Evaluation of combination of potassium phosphonate and *Trichoderma harzianum* on management of *Phytophthora* foot rot of black pepper (*Piper nigrum* L.) under arecanut cropping system. *International Journal of Plant Protection* 5(2): 356-360.

Dr. Nagesh Naik and Dr. Lokesh, M. S - 'Evaluation of promising black pepper (*Piper nigrum* L.) genotypes for disease tolerance and high yield in areca-



nut (*Areca catechu* L.) mixed system of cultivation'. [Article submitted to publish in 'Journal of Asian Horticulture']

Solan

Dev, H. and Sharma, V. 2012. Production technology of ginger under changing climate. In: Vegetable production under changing climate scenario (Ed) under ICAR, CAFT, Hort (Veg), Department of Vegetable Science, Dr YSP UHF, Nauni, Solan, 44-52.

Dev, H. and Sharma, V. 2012. Production technology of turmeric under changing climate. In: Vegetable production under changing climate scenario (Ed) under ICAR, CAFT, Hort (Veg), Department of Vegetable Science, Dr YSP UHF, Nauni, Solan, 53-58.

Dohroo, N. P. and Meenu Gupta 2012. Effect of bio-agents on management of rhizome diseases, plant growth parameters and nematode population in ginger. *Agric. Sci. Digest* (Accepted)

Gupta Meenu., Bharat, N., Chauhan, A. and Vikram, A. 2013. First report of bacterial leaf spot of coriander caused by *Pseudomonas syringae* pv. *coriandricola* in India. *Plant Disease* 97(3): 418.

Gupta Meenu, M. L., Bhardwaj and Vikram, Amit 2012. Studies on microbial population dynamics in solar solarized soils. *Crop Improvement Special Issue*. 989- 90.

Gupta, Meenu 2012. Eco-friendly techniques for the management of diseases of spice crops. In: Vegetable production under changing climate scenario (Ed) under ICAR, CAFT, Hort (Veg), Department of Vegetable Science, Dr YSP UHF, Nauni, Solan-173 230 (HP) p. 159-66.

Sharma, R.C. and Gupta, Meenu 2012. Biotic factors and their management under changing climate. In: Vegetable production under changing climate scenario (Ed) under ICAR, CAFT, Hort (Veg), Dep of Vegetable Science, Dr YSP UHF, Nauni, Solan. p. 124-30.

Sharma, V. and Dev, H. 2012. Biochemical constituents and quality attributes in spices. In: Vegetable production under changing climate scenario (Ed) under ICAR, CAFT, Hort (Veg), Department of Vegetable Science, Dr YSP UHF, Nauni, Solan. 218-22.

Sharma, V. and Dev, H. 2012. Techniques of quality analysis in spices. In: Vegetable production under changing climate scenario (Ed) under ICAR, CAFT, Hort (Veg), Dep of Vegetable Science, Dr YSP UHF, Nauni, Solan . 223-27.



XVII. Technical Programme (2012-13)

BLACK PEPPER		
Project Code	Title	Centres
PEP/CI/1	Genetic Resources	
PEP/CI/1.1	Germplasm collection, characterization, evaluation and conservation	Chintapalli, Dapoli, Panniyur, Pundibari, Sirsi, Ambalavayal , Pechiparai & 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/3.2	CVT 2000 – Series V	Pampadumpara, Panniyur, Sirsi and Ambalavayal
PEP/CI/3.3	CVT 2006 – Series VI	Chintapalli, Dapoli, Panniyur, Pampadumpara, Sirsi , Yercaud
PEP/CI/3.4	Evaluation of grafts, orthotropic and runner shoots in black pepper	Ambalavayal, Panniyur, Sirsi Yercaud & Thadiyankudasai*
PEP/CM/4	Nutrient Management Trial	
PEP/CM/4.4	Development of organic package for spices based cropping system – Observational trial	Chintapalli, Sirsi, Panniyur, & Dapoli
PEP/CM/4.5	Organic farming in black pepper - 2006	Panniyur, Dapoli, Pechiparai, Sirsi & Yercaud
PEP/CM/4.6	Standardisation of drip fertigation in black pepper	Panniyur
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/5.2	Trial on management of <i>Phytophthora</i> foot rot of black pepper in existing plantation	Chintapalli, Dapoli, Panniyur, Pampadumpara, & Sirsi
PEP/CP/5.3	Trial on management of <i>Phytophthora</i> foot rot of black pepper in new plantation	Chintapalli, 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	Sirsi, Mudigere & Chintapalli
PEP/CP/5.7	Evaluation of New insecticides/Bio pesticides against Pepper Mussel Scale, <i>Lepidosaphis piperis</i>	Mudigere



PEP/CP/6	Pest Management Trial	
PEP/CP/6.2	Management of <i>Erythrina</i> gall wasp, a popular standard of black pepper	Mudigere, Pampadumpara
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	Hybridisation 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.	Mudigere, Pampadumpara
CAR/CI/3	Coordinated Varietal Trial	
CAR/CI/3.5	CVT 2005-Series V	Mudigere, Pampadumpara
CAR/CI/3.6	CVT 2007/2009 -Series VI	Mudigere, Pampadumpara, Sakleshpur, Appangala & Myladumpara
CAR/CI/3.7	CVT of drought tolerance in Cardamom -Series VII	Appangala, Mudigere, Sakleshpur
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/5.1	Effect of different irrigation schedule and fertilizers on yield of cardamom	Mudigere
CAR/CM/5.2	Effect of fertigation on yield of cardamom through drips	Mudigere & Pampadumpara
CAR/CM/5.3	Organic farming in cardamom	Mudigere & Pampadumpara
CAR/CM/5.4	Liming in Cardamom	Pampadumpara
CAR/CP/6	Pest and Disease Management Trial	Pampadumpara
CAR/CP/6.4	Management of cardamom root grub through entomopathogenic nematodes	Pampadumpara
CAR/CP/6.6:	Management of rhizome and panicle rot in Cardamom (New plantation)	Mudigere & Pampadumpara





CAR/CP/6.7	Evaluation of new insecticides/biopesticides in cardamom against thrips and capsule borer	Pampadumpara & Mudigere
CAR/CP/6.8	Comparison of effect of chemical treatments as well as bio-control agents against pseudostem rots of cardamom	Pampadumpara
LARGE CARDAMOM		
LCA/CI/1	Germplasm collection and evaluation of large Cardamom	Gangtok, Gangtok (ICAR)
LCA/CP/1.1	Evolving disease & pest tolerant lines in large Cardamom	Gangtok
LCA/CP/1.2	Integrated pest and disease management in large cardamom	Gangtok
GINGER		
GIN/CI/1	Genetic Resources	
GIN/CI/1.1	Germplasm collection, characterization, evaluation and conservation	Dholi, Kumarganj, Pottangi, Pundibari & Solan
GIN/CI/2	Coordinated Varietal Trial	
GIN/CI/2.3	CVT 2006 – Series VII	Pottangi
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
GIN/CI/3.5	Genotype X Environment interaction on quality of ginger	Barapani, Chintapalli, Kanke, Kalyani, Mizoram, Pasighat, Pottangi, Pundibari, & Solan
GIN/CI/4.1	Evaluation of germplasm for quality	Solan
GIN/CI/4.2	Evaluation of germplasm from other centers	Solan
GIN/CM/5	Nutrient Management Trial	
GIN/CM/5.3	Nutrient supplementation through organic manures for growth and yield of ginger	Kumarganj
GIN/CM/5.4	Evaluation of herbicide for the effective control of weed in ginger	Chintapalli
GIN/CP/6	Disease Management Trial	
GIN/CP/6.	Disease surveillance and etiology of rhizome rot in ginger	Dholi
GIN/CP/6.6	Management of soft rot of ginger (Biofumigation using mustard)	Solan, Kumarganj
GIN/CP/6.7	Management of soft rot of ginger (Biofumigation using cabbage)	Ambalavayal, Pundibari Pampadumpara, Solan & Kumarganj
GIN/CP/6.8	Management of bacterial wilt of ginger (Biofumigation using mustard)	solan
GIN/CP/6.9	Management of bacterial wilt of ginger	Pundibari, Ambalavayal &



	(Biofumigation using cabbage)	Pampadumpara
GIN/CP/6.10	Efficiency of different fungicide against leaf spot disease of ginger including new molecules	Dholi & Pundibari
TURMERIC		
TUR/CI/1	Genetic Resources	
TUR/CI/1.1	Germplasm collection, characterization, evaluation and conservation	Coimbatore, Dholi, Kamarapalli, Kumarganj, Pottangi Raigarh, Pundibari, Kammarpally & Pasighat
TUR/CI/2	Coordinated varietal trial	
TUR/CI/2.4	CVT on Turmeric 2009	Pottangi, Kumarganj, Chintapalli, Coimbatore, Dholi, Kamarpally, Pundibari, Raigarh, Pasighat, Pantnagar, Navasari
TUR/CI/3	Varietal evaluation trial	
TUR/CI/3.3	Initial Evaluation Trial 2010	Pantnagar
TUR/CI/3.5	Initial Evaluation Trial 2012	Dholi & Kumarganj
TUR/CI/3.4	Genotype x Environmental interaction on quality	Kammarpally, Raigarh, Pottangi, Mizoram, Kalyani & Barapani
TUR/CM/5	Nutrient Management Trial	
TUR/CM/5		
TUR/CM/5.5	Standardization of water requirement for turmeric through drip irrigation	Coimbatore, Kammarapally, Kumarganj, Pundibari & Guntur
TUR/CM/5.6	Standardization of fertigation in turmeric	Coimbatore
TUR/CM/5.7	Effect of micronutrients on turmeric	Dholi, & Pundibari
TUR/CM/5.8	Studies on the effect of rhizome size and nursery on growth and yield of turmeric	Chintapalle, Coimbatore
TUR/CM/6	Post Harvest Technology	
TUR/CM/6.1	Standardization of Processing in turmeric	IISR
TUR/CP/7	Disease Management Trial	
TUR/CP/7.1	Survey and identification of disease causing organisms in turmeric and screening of turmeric germplasm against diseases	Coimbatore, Pundibari, Dholi, Raigarh
TUR/CP/7.2	Management of foliar diseases in turmeric	Kumarganj
TUR/CP/7.3	Fungicidal management of foliage diseases of turmeric by new molecules	Dholi
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/2	Coordinated Varietal Trial	
TSP/CI/2.1	CVT 1992 – clove	Pechiparai
TSP/CI/2.2	CVT 2001- nutmeg	Dapoli & Pechiparai
TSP/CI/2.3	CVT 2001 – cassia	Pechiparai & Dapoli
CORIANDER		
COR/CI/1	Genetic Resources	
COR/CI/1.1	Germplasm collection, description, characterization, evaluation, conservation and screening against diseases	Coimbatore, Dholi, Guntur, Hisar, Jagudan, Jobner & Kumarganj, Ajmer
COR/CI/1.2	Multilocation Evaluation of germplasm	Coimbatore, Hisar , Ajmer & Guntur
COR/CI/2	Coordinated Varietal Trial	
COR/CI/2.5	Coordinated varietal trial on coriander 2012- Series IX	Ajmer, Dholi, Guntur, Hisar, Jabalpur, Jagudan. Jobner, Kumarganj, Navasri, Pantnagar, Udaipur.
COR/CI/2.6	Coordinated varietal trial on coriander (Leafy type during off season) CVT 2010	Guntur, Ajmer, Coimbatore & Periyakulam**
COR/CI/3	Varietal Evaluation Trial	
COR/CI/3.1	IET on coriander 2010	Hisar
COR/CI/3.4	Initial Evaluation Trial 2011	Jobner
COR/CI/3.6	Initial Evaluation Trial 2012	Jagudan, Kumarganj & Guntur
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/5.4	Nutrient supplementation through organic manures for growth and yield of coriander	Jobner & Raigarh
COR/CM/5.6	Irrigation Management for sustainable coriander Production	Guntur
COR/CM/5.7	Nutrient management in off season coriander leaf production	Periyakulam, Guntur, Ajmer & Coimbatore
COR/CP/6	Disease Management Trial	
COR/CP/6.2	Survey to identify the disease incidence, collection	Dholi



	and identification of casual organism	
COR/CP/6.3	Management of stem gall disease of coriander	Dholi, Kumarganj & Raigarh
COR/CP/6.5	Evaluation of PGPR bioformulation on Coriander	Coimbatore, Guntur, Hisar, Jagudan, Raigarh & Ajmer
CUMIN		
CUM/CI/1	Genetic Resources	
CUM/CI/1.1	Germplasm collection, characterization, evaluation conservation and screening against diseases	Jagudan & Jobner
CUM/CI/1.2	Multilocation Evaluation of germplasm	Ajmer
CUM/CI/2	Coordinated Varietal Trial	
CUM/CI/2.3	Coordinated Varietal Trial - 2009	Jobner, Jagudan, Ajmer & Jabalpur
CUM/CI/3	Varietal Evaluation Trial	
CUM/CI/3.3	IET on cumin 2009	Jobner & Jagudan
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/6.2	Survey for identification of yellowing causing organisms in cumin	Jobner
CUM/CP/6.4	Evaluation of PGPR bioformulation on Cumin	Jagudan, Jobner & Ajmer
CUM/CP/6.5	Management on blight and powdery mildew by spacing and potash application	Jagudan
FENNEL		
FEL/CI/1	Genetic Resources	
FNL/CI/1.1	Germplasm collection, characterization, evaluation, conservation and screening against diseases	Dholi, Hisar, Jagudan, Jobner & Kumarganj
FNL/CI/1.2	Multilocation Evaluation of Germplasm	Hisar & Ajmer
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/3.1	Initial evaluation trial 2010	Hisar
FNL/CI/3.3	Initial evaluation trial 2011	Jobner
FNL/CI/3.4	Initial evaluation trial 2012	Jagudan, Dholi & Kumarganj
FNL/CI/4	Quality Evaluation Trial	



FNL/CI/4.1	Quality evaluation in fennel	Jobner
FNL/CI/5.2	Identification of drought/alkalinity tolerance source in fennel	Kumarganj
FNL/CM/5	Nutrient Management Trial	
FNL/CM/5.3	Micro irrigation management in Fennel	Jobner
FNL/CP/6	Disease Management Trial	
FNL/CP/6.2	Field evaluation of different insecticides / botanicals against seed midge <i>Systole albipennis</i> walker fennel	Jagudan
FNL/CP/6.3	Evaluation of PGPR bioformulation on Fennel	Hisar, Jagudan, Raigarh & Ajmer
FNL/CP/6.2	Field evaluation of different insecticides/botanicals against seed midge <i>Systole albipennis</i> walker fennel	Jagudan
FENUGREEK		
FGK/CI/1	Genetic Resources	
FGK/CI/1.1	Germplasm collection, characterization, evaluation conservation and screening against diseases	Dholi, Hisar, Jagudan, Jobner, Kumarganj, Guntur
FGK/CI/1.2	Multilocation Evaluation of Germplasm	Ajmer
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, Navasari, Raigarh.
FGK/CI/3	Varietal Evaluation Trial	
FGK/CI/3.2	Initial evaluation trial 2009	Jobner
FGK/CI/3.4	Initial evaluation trial 2010	Hisar & Pantnagar
FGK/CI/3.5	Initial evaluation trial 2012	Guntur, Kumarganj, Jagudan & Jobner
FGK/CM/4	Nutrient Management Trial	
FGK/CM/4.2	Identification of drought/tolerance source in fenugreek	Jobner
FGK/CM/4.3	Microirrigation management in Fenugreek	Jobner
FGK/CM/4.5	Evaluation of PGPR bioformulation on Fenugreek	Jagudan, Jobner, Guntur, Hisar & Kumarganj



XVIII. Staff Position

PROJECT COORDINATOR'S OFFICE

1. Project Coordinator: Dr. K. Nirmal Babu
2. Principal Scientist (Agronomy.): C.K. Thankamani
3. Technical Information Officer: Dr Johny A Kal-lupurackal
4. Personal Assistant: Ms Alice Thomas
5. Supporting staff: Mr. M. Koru
3. Asst. Professor(Horticulture) : Smt Anupama T V
4. Asst. Professor (Pl.Pathology): Dr Heera G (Under LWA on medical grounds from October 2 till date)
5. Farm Manager Gr I: Mr K Lakshmanan
6. Farm Manager.Gr II: Mr P P Muralidharan
7. Farm Officer Sel Gr: Mr P Krishnan
8. Farm Supervisor (Gr. II): Ms Nirmala Chellath
9. Farm Supervisor (Sr. Gr.): K Rajeev

COORDINATING CENTRES

1. Cardamom Research Station, KAU, Pampadumpara

1. Assistant Professor (Agron./ Horti.) : Dr Maya.T
2. Assistant Professor (Ag. Entomology): Dr Deepthy K B
3. Laboratory Assistant Gr. II: Mr. Anil Kumar
4. Peon : Mr. Shinoj Antony

2. Pepper Research Station, KAU, Panniyur

1. Asst Professor(Pl. Breeding): Dr P M Ajith
2. Asst Professor (Pl.Pathology) : Dr Rini CR

3. Horticultural Research Station, ZAHRS, Mudigere

1. Professor (Plant Pathology): Dr. S D Rangaswamy
2. Associate Professor (Agronomy: Dr K M Devaraju
3. Associate Professor (Plant Breeding): Dr D Lakshmana.
4. Technical Assistant: Mr Mahadevappa
5. Technical Assistant: Smt H R Manjula
6. Messenger: Ms Savithri

4. Horticultural Research Station, UHS, Sirsi

1. Jr. Pathologist: Dr M S Lokesh





2. Jr. Horticulturist: Mr Nagesh Naik
3. Technical Assistant: Mr B B Doddamani

5. Horticultural Research Station, TNAU, Yercaud

1. Prof. & Head: Dr K Nageswari (from 3-12-2012 to till date)
2. Agronomist (Hort.): Dr R Arulmozhiyan up to 3.12.2012
3. Jr. Breeder (Hort.) : Dr J Prem Joshua (Posted at HRS Pechiparai)
4. Lab Assistant: Mr P Pappu

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

1. Breeder (Assoc. Professor) : Dr R Chitra
2. Jr. Pathologist : Dr D Saravanakumar
3. Agrl. Assistant: Th. R Swaminathan

7. Horticultural Research Station, Dr.YSR Horticulturyal University, Chintapalle

1. Senior Scientist (Horticulture): Sri K Ravindra Kumar
2. Scientist (Plant Pathology): Vacant from 02.09.2012 onwards
3. Technical Assistant: Vacant from 25.01.2012 onwards (Post filled on contract basis)

8. Regional Agricultural Research Station, Dr.YSR Horticultural University, Kammarapally (Jagtial)

1. Jr. Pathologist: Vacant
2. Jr. Horticulturist: Mrs K Uma Maheswari
3. Technical Assistant: Vacant

10. Horticultural Research Station, Dr.YSR Horticulturyal University, Guntur

1. Jr. Breeder: Dr K Giridhar

2. Horticulturist: Dr S Suryakumari

11. Department of Vegetable Crops, Dr YSPUHF, Solan

1. Professor (Vegetable Science) &PI/ Sr. Breeder AICRP (Spices): Dr. Happy Dev Sharma
2. Jr. Pathologist: Dr Meenu Gupta
3. Jr. Biochemist: Dr Vipin Sharma
4. Field Assistant: Mr 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: Mr L K Mishra
4. Technical Assistant: Vacant

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

1. Sr. Breeder: Dr E V D Sastry
2. Pathologist: Dr Kayam Singh Shekhawat
3. Biochemist: Dr Girish Kumar Mittal,
4. Asst. Agronomist: Dr A C Shivran
5. Technical Assistant: Dr S S Rajput
6. Technical Assistant: Mr S R Kumawat

13. Main Spices Research Station, SDAU, Jagudan

1. Research Scientist (Pl. Path.): Dr K. D. Patel,
2. Asstt. Research Scientist (Pl. Br.): Prof. D G Patel
3. Agril.Asstt. (HG): Sh.S.R.Chaudhari

14. Department of Vegetable Crops, CCS HAU, Hisar

1. Assistant Scientist (VC) : Dr Suresh Tehlan
2. Horticulturist/Oleoriculturist : 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: Dr V B Singh
3. Jr. Pathologist: Dr R S Mishra (1-9-2012)
4. Tech. Asstt.: Sri R K Gupta
5. Tech.Asstt.: Sri V K Singh

17. Department of Horticulture, UBKVV, Pundibari

1. Horticulturist: Vacant
(Dr J C Jana, in-charge from 20.11.2003 to till date)
2. Jr. Breeder: Dr N Bhowmik (Study leave)
(Dr B C Saha, in-charge from 20th May, 2009 to

till date)

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

18. Department of Horticulture, KKV, Dapoli

1. Horticulturist: Dr P B Sanap
2. Jr. Pathologist: Prof U A Gadre
3. Jr. Breeder: Prof U B Pethe
4. Technical Assistant: Mr D D Bhandari
5. Technical Assistant: Mr G D Bandre

19. Regional Agricultural Research Station, IGAU, Raigarh

1. Horticulturist: Vacant (from 11-3-2008) 13.07.2007?
2. Jr. Breeder: Smt. Roshni Bhagat
3. Jr. Pathologist: Dr A K Singh
4. Technical Assistant: Mr D S Kshatri
5. Technical Assistant: Vacant
(From commencement of the project)



XIX. Centerwise Budget 2012-13

Name of the centres	Pay and Allowances		TA (3)	TA (4)	RC (5)	Tech. A (7)	Total RC (8)	Eqp	ICAR (9)	ICAR share (10)	Total (11)
	(1)	(2)									
Pampadumpara (KAU)	34.873	26.155	0.900	0.675	4.00	0.1	3.100	1.33	1.00	30.930	41.200
Panniyur (KAU)	80.000	60.000	1.200	0.900	5.33	0.1	4.100	1.3	1.00	66.000	88.000
Mudigere (UHS)	56.626	42.470	1.200	0.900	5.33	0.1	4.000	1.3	1.00	48.370	64.493
Sirsi (UHS)	51.133	38.350	0.600	0.450	2.66	0.1	2.100	1.3	1.00	41.900	55.866
Yercaud (TNAU)	60.640	45.480	0.600	0.450	2.66	0.1	2.100	1.3	1.00	49.030	65.373
Coimbatore (TNAU)	36.173	27.130	0.600	0.450	2.66	0.1	2.100	1.3	1.00	30.680	40.906
Chintapalli (Dr. YSPHU)	16.706	12.530	0.600	0.450	2.66	0.1	2.100	1.3	1.00	16.080	21.440
Kamarpally (Dr. YSPHU)	6.066	4.550	0.600	0.450	2.66	0.1	2.000	1.3	1.00	8.000	10.666
Guntur (Dr. YSPHU)	26.026	19.520	0.600	0.450	2.66	0.2	2.200	1.3	1.00	23.170	30.893
Solan (YSPUHE)	10.433	7.825	0.900	0.675	4.00	0.1	3.000	1.3	1.00	12.500	16.666
Pottangi (QUAT)	26.826	20.120	0.266	0.200	2.71	0.1	2.000	1.3	1.00	23.320	31.093
Jobner (RAJAU)	71.273	53.455	1.500	1.125	6.66	0.3	5.300	1.3	1.00	60.880	81.173
Jagudan (GAU)	32.506	24.380	0.600	0.450	2.66	0.3	2.300	1.3	1.00	28.130	37.506
Hisar (HAU)	27.880	20.910	0.600	0.450	2.66	0.2	2.200	1.3	1.00	24.560	32.746
Dholi (RAU)	24.086	18.065	0.600	0.450	2.66	0.1	2.0325	1.3	1.00	21.6475	28.863
Kumarganj (NDUAT)	30.153	22.615	0.900	0.675	4.00	0.1	3.000	1.3	1.00	27.290	36.386
Pundibari (UBKVV)	5.766	4.325	0.900	0.675	4.00	0.1	3.100	1.3	1.00	9.100	12.133
Dapoli (KKV)	75.140	56.355	0.900	0.675	4.00	0.1	3.100	1.3	1.00	61.130	81.506
Raigarh (IGKVV)	11.686	8.765	0.900	0.555	4.00	0.1	3.100	1.3	1.00	13.420	17.893
Technology Assessment/ AICRPS Workshop					0.5175		0.5175			0.5175	0.5175
Reserve contingency							1.00			1.00	1.330
Total	683.992	513.00	14.966	11.105	67.970	2.00	54.55	25.33	19.00	597.655	796.650

Recurring contingency @Rs 1.00 L per scientist per year. For cooping centers Rs 2.10 L for recurring contingency / technical assistance per year/center. For voluntary centers Rs 0.60L for contingency per year(ICAR Share) per center.Travelling allowance fixed is @Rs 0.225(ICAR share)per scientist/center. An amount of Rs 2.00 L allotted for technology assessment programme and Rs 0.50 L for AICRPS workshop contingency.



XX. Weather Data

Chintapalli

Month & year	Rainfall (mm.)	Rainy days	Temperature (°C)		RH (%)	
	Actual	Actual	Max.	Min.	Max.	Min.
May 2012	41.4	5.0	33.1	20.1	65.4	44.3
June	49.0	8.0	30.3	22.2	70.8	63.1
July	179.1	18.0	25.8	21.7	83.8	75.6
August	195.4	17.0	25.6	21.0	81.2	79.3
September	254.4	17.0	26.3	20.6	86.5	84.1
October	107.3	7.0	27.2	17.1	83.3	77.2
November	316.8	5.0	25.1	14.8	87.8	64.3
December	0.0	0.0	26.9	11.3	87.0	52.5
January 2013	4.0	1.0	26.4	11.9	87.5	51.3
February	7.4	1.0	28.0	12.7	76.5	59.7
March	0.0	0.0	31.2	13.6	64.0	47.8
April	45.4	4.0	31.8	18.5	64.6	48.1

Coimbatore

Month & year	Rain Fall (mm)	Temperature °C		RH (%)	
		Max.	Min.	Max.	Min.
April 2012	78.4	35.3	24.0	86	43
May	25.6	34.5	24.1	87	49
June	11.1	32.4	23.8	78	49
July	27.5	31.3	23.6	79	52
August	28.3	31.2	23.0	83	55
September	6.1	32.4	22.6	84	50
October	165.2	30.6	22.3	87	59
November	22.4	30.7	20.5	89	48
December	6.9	30.5	20.3	85	43
January 2013	-	31.6	19.0	85	35
February	99.8	31.9	20.7	82	38
March	-	34.2	22.8	80	37



Dapoli

Month & year	Rain fall (mm)	Rainy Days	Temperature(°C)		RH (%)	
			Max	Min	Max.	Min.
April 2012	0.0	0.0	32.5	22.0	85.7	72.7
May	0.0	19.0	32.5	22.1	85.2	72.6
June	933.8	29.0	30.5	23.7	93.7	82.8
July	1107.9	28.0	28.5	23.9	96.1	90.1
August	866.3	19.0	28.2	24.0	95.6	90.0
September	493.0	5.0	28.5	23.2	94.5	87.7
October	253.0	0.0	32.0	21.4	88.7	65.4
November	0.0	0.0	32.1	16.9	90.4	50.4
December	0.0	0.0	32.1	14.9	90.8	45.4
January 2013	0.0	0.0	31.2	12.2	93.5	46.9
February	0.0	0.0	31.8	15.0	94.0	51.9
March	0.0	100.0	33.6	16.7	92.9	62.6

Dholi

Month & year	Rainfall (mm)	Temperature (°C)		RH (%)	
		Max.	Min.	Max.	Min.
April 2012	0.4	3.61	20.7	77	39
May	1.1	38.5	24.5	74	45
June	2.9	37.85	26.8	84	51
July	8.8	33.14	26.3	90	72
August	4.2	33	26	89	73
September	5.36	32.7	25.48	90	69
October	4.60	31.20	20.8	89	59
November	0	28.69	13.93	90	49
December	0	20.85	9.7	93	67
January 13	0.4	19.2	7.3	92	65
February	1.1	24.8	11.5	93	60
March	0.0	30.8	16.0	88	50



Solan

Month & year	Rainfall (mm)	Rainy days	Temperature (°C)		RH (%)
			Max.	Min.	
April 2012	55.8	11	26.7	11.6	50
May	2.6	03	32.2	15.3	40
June	19.3	04	34.1	18.8	48
July	316.1	17	28.8	19.5	71
August	269.8	21	27.0	18.8	84
September	111.8	10	27.7	15.9	75
October	3.5	02	26.0	8.2	52
November	3.9	01	22.4	4.2	47
December	18.4	03	19.6	2.1	48
January 2013	113.6	03	17.6	1.1	56
February	184.3	11	17.8	4.5	64
March	85.6	06	25.2	8.3	53

Guntur

Month & year	Rainfall (mm)	Mean temperature (°C)		RH (%)	
		Max.	Min.	Max.	Min.
June 12	133.6	38.94	27.5	71.6	45.2
July	225.5	32.9	25.2	87.3	68.2
August	156.6	33.20	24.6	88.4	65.1
September	213.4	32.38	24.86	88.6	70.3
October	105.4	31.46	23.10	91.6	66.3
November	210.6	30.35	19.34	93.2	61.2
December	0	30.55	18.34	94.9	56.0
January 2013	0	31.1	18.14	96.6	51.6
February	115	31.42	19.24	94.9	53.1
March	0	34.94	21.63	93.16	44.26



Hisar

Month & year	Total rainfall (mm)	Total rainy days	Temperature (°C)		RH (%)	
			Max.	Min.	Morn.	Even.
April 2012	24.9	1	35.8	17.3	62.5	29.8
May	38.2	2	40.8	23.7	54.7	25.5
June	29.4	4	41.5	25.2	54.7	25.1
July	92.4	5	36.7	26.4	77.7	57.8
August	14.0	2	38.0	26.8	76.0	49.7
September	239.9	5	34.4	22.5	88.5	51.1
October	5.4	1	32.4	15.1	85	37
November	0.0	0	27.4	9.2	92	38
December	4.4	1	20.8	6.0	93	58
January 2013	43.0	2	17.6	4.2	95	58
February	32.7	6	21.5	8.9	96	60
March	31.1	2	28.4	12.0	92	47

Jagudan

Month & year	Rain fall (mm)	Temperature °C		RH (%)
		Min.	Max.	Max.
April 2012	1.0	20.50	39.83	87.05
May		24.44	41.23	89.56
Jun	37.2	26.67	39.68	93.24
July	30.06	25.32	35.59	85.05
August	43.4	23.61	33.41	89.85
September	71	22.94	32.73	92.28
October		19.7	35.86	73.28
November		12.75	33.02	76.31
December		10.49	28.69	67.56
January 2013		8.92	28.12	64.08
February 2013	22	11.03	30.07	62.98
March 2013		16.88	36.41	70.8



Jobner

Month & year	Rainfall (mm)	Temperature ⁰ C		RH (%)	
		Max.	Min.	Max.	Min.
April 2012	007.8	35.9	19.1	53.6	21.8
May	007.8	40.1	22.4	48.5	21.5
June	000.6	39.9	28.3	49.8	25.5
July	012.6	37.8	27.6	69.0	44.8
August	451.0	30.0	24.4	93.3	77.5
September	068.6	32.5	22.7	86.6	56.3
October	001.4	33.3	14.8	73.4	27.6
November	-	28.4	9.0	80.0	28.8
December	-	24.9	2.7	84.5	34.0
January 2013	-	21.6	4.6	89.6	37.0
February	022.4	23.7	9.5	87.3	42.8
March	-	32.5	13.8	76.5	20.8
April	002.6	36.5	18.5	63.0	19.8

Pampadumpara

Month & year	Rain Fall (total in mm)	Temperature (°C)		RH (%)	
		Max.	Min.	Max.	Min.
April 12	88.4	32	17	90.57	50.47
May	81.2	29	17	92.97	66.12
June	176.2	28	17	95.63	79.16
July	210.6	26.5	16.5	97.16	80.06
August	228.8	26.5	17.0	97.1	83.6
September	111.3	29	17	94.43	75.42
October	231.0	30.0	16.5	94.3	55.22
November	109.1	29	14	89.23	58.06
December	2.4	24.5	16.1	95.4	60.11
January13	--	--	--	--	--
February	0	26.97	13.82	88.20	70.82
March	36.6	28.03	18.21	92.87	88.10



Kumarganj

Month & year	Rain fall (mm)	No. of Rainy days	Temperature (°C)		RH (%)	
			Max.	Min.	Max.	Min.
April 2012	0	0	38.0	16.7	57.5	25.1
May	0	0	41.2	22.6	48.7	17.8
June	22.5	1	41.16	28.0	63.2	29.9
July	282.5	15	33.4	26.6	88.0	70.4
August	284.4	14	32.0	26.2	91.1	82.4
September	203.0	11	31.6	24.9	89.2	73.8
October	0	0	32.1	18.9	88.1	52.6
November	0	0	28.4	10.6	86.0	47.2
December	0	0	21.8	7.6	86.8	51.4
January 2013	3.2	1	18.7	5.3	94.7	57.2
February	82.6	7	24.0	9.7	89.3	55.7
March	0	0	31.1	13.7	79.5	37.9

Panniyur

Month & year	Rain fall (mm)	Temperature (°C)		RH (%)
		Max	Min	
April 2012	48.2	36.02	90.76	90.76
May	68.0	35.11	92.93	92.93
June	688.1	29.43	88.03	88.03
July	584.6	29.05	91.84	91.84
August	911.8	28.74	93.96	93.96
September	360.1	30.44	92.60	92.60
October	182.9	32.80	91.97	91.97
November	107.0	32.45	91.96	91.96
December	2.2	34.89	92.48	92.48
January 2013	0	34.27	92.03	92.03
February	27.0	35.50	93.53	93.53
March	46.1	36.52	91.83	91.83



Mudigere

Month & year	Rainfall (mm)	Rainy days (Nos.)	Temperature (°C)		RH (%)	
			Max	Min	Max	Mini
April 2012	278.6	15	31.51	18.31	87.26	79.43
May	113.2	5	31.41	18.43	86.67	74.12
June	341.6	17	27.73	17.78	85.86	75.20
July	617.2	25	26.40	17.00	84.54	72.38
August	800.9	23	26.19	17.48	88.80	79.74
September	216.6	10	26.58	26.58	87.60	77.90
October	47.4	3	26.16	18.00	91.16	84.32
November	66.2	2	26.60	17.35	85.96	75.63
December	NIL	NIL	26.60	14.80	85.16	74.45
January 2013	06.0	1	26.90	14.66	74.09	63.25
February	60.4	4	28.23	15.25	72.78	59.60
March	24.8	1	31.77	18.80	81.96	24.66

Sirsi

Months & year	Rain fall (mm)	Temperature (°C)		RH (%)	
		Max	Min	Max	Min
April 12	130.6	34.00	21.20	93.24	70.27
May	5.0	32.23	21.82	89.09	68.70
June	244.0	28.65	21.25	90.67	75.63
July	572.4	26.35	21.34	93.35	84.15
August	685.0	26.85	21.00	93.78	82.51
September	208.6	28.00	20.18	94.13	80.93
October	33.4	30.03	19.31	91.31	77.87
November	64.6	29.92	17.00	85.98	59.66
December	2.0	30.94	15.53	83.48	52.33
January 2013	48.6	31.7	14.1	83.1	63.1
February	10.4	32.8	16.0	88.7	86.1
March	0	34.1	18.6	86.0	41.0



Yercaud

Month & year	Rainfall (mm)	Temperature (°C)		RH (%)
		Max.		Min.
April 2012	27.5	27.2	41.8	17.5
May	163.0	25.8	43.0	20.4
June	124.5	22.3	45.0	18.9
July	230.0	21.3	50.0	18.3
August	173.0	20.5	60.0	18.2
September	115.0	20.9	65.0	17.6
October	239.5	21.3	70.0	17.7
November	264.0	20.8	70.4	15.4
December	56.5	20.6	82.5	14.4
January 2013	0	22.4	66.7	13.9
February	11.0	23.8	66.1	15.4
March	0.5	26.3	48.9	17.1

Raigarh

Months & year	Rain fall (mm)	Temperature (°C)		RH (%)	
		Max	Min	Max	Min
April 12	74.46	28.02	24.28	97.16	86.95
May	89.84	28.99	24.21	95.99	84.19
June	69.18	28.99	25.24	28.99	25.24
July	37.08	29.45	20.25	92.51	64.68
August	--	31.24	14.42	85.28	51.75
September	--	24.67	12.60	87.89	47.24
October	--	24.93	10.78	87.22	39.79
November	16.51	28.6	16.13	88.38	47.69
December	40.13	35.13	19.62	80.19	31.15
January 2013	--	36.56	26.71	72.42	29.28
February	--	41.42	26.74	66.64	21.92
March	116.20	35.63	27.78	78.65	52.31



Pundibari

Month & year	Rainfall (mm)	Temperature (⁰ C)		R H (%)	
		Max	Min	Max	Min
April 2012	133.60	31.1	20.40	77.53	64.37
May	347.50	32.71	23.06	78.84	70.35
June	967.00	32.43	24.63	91.00	85.33
July	739.80	31.42	25.68	90.16	84.03
August	423.40	33.19	25.94	86.00	79.00
September	650.50	31.5	24.90	89.07	85.80
October	127.60	30.90	20.00	76.74	84.26
November	0.00	29.13	13.33	78.57	81.97
December	0.00	25.13	11.16	92.55	86.61
January 2013	0.00	23.71	7.32	92.10	76.16
February	19.10	28.39	11.93	78.64	55.54
March	1.90	32.10	16.65	55.39	38.16

Ambalavayal

Month & year	Rain Fall (mm)	Temperature (⁰ c)		RH (%)	
		Max	Min.	Max.	Min.
April 2012	167.0	30.1	19.0	93.7	66.0
May	89.6	29.4	19.9	93.5	71.7
June	185.2	26.1	18.6	95.5	80.7
July	129.6	25.5	18.4	96.3	81.1
August	348.2	25.0	18.3	95.9	84.5
September	170.0	26.3	17.9	92.9	75.9
October	80.8	27.7	18.2	93.0	68.7
November	124.4	27.2	16.6	92.0	67.6
December	9.0	27.9	15.8	91.2	58.7
January 2013	0.0	29.4	15.3	93.9	52.9
February	7.6	30.0	16.9	95.3	52.2
March	139.0	30.3	18.6	94.2	59.0



Barapani

Month & year	Rainfall (mm)	Temperature (°C)		R H (%)	
		Max	Min	Max	Min
April 2012	173.60	27.80	15.72	75.00	57.16
May	251.20	29.35	18.70	80.30	70.20
June	301.40	28.30	19.37	88.75	74.55
July	301.20	28.90	20.35	87.32	72.74
August	412.20	28.62	18.65	83.81	69.34
September	331.40	27.43	19.07	90.03	75.55
October 2	251.50	26.38	14.59	82.32	68.12
November	30.00	23.65	9.65	84.18	52.58
December	0.00	21.00	7.23	81.93	48.45
January 2013	0.00	20.60	4.52	81.73	46.05
February	10.2	25.3	8.5	70.9	48.4
March	46.1	27.9	12.5	77.9	54.1
April	179.7	28.2	14.9	79.7	64.4

Mizoram

Month&year	Rainfall (mm)	No. of rainy days	Temperature (°C)		RH (%)	
			Max	Min	Max	Min
April 12	647.50	24	28.41	19.81	80	55
May	268.40	16	31.82	22.34	86	64
Jun	471.90	20	30.57	22.86	95	78
July	312.00	20	30.39	23.72	96	80
August	515.00	24	30.76	23.40	96	79
September	526.50	17	30.33	23.28	97	80
October	180.20	12	29.85	22.10	95	74
November	24.80	04	26.72	18.60	88	71
December	0.00	00	24.62	14.16	84	61
January 2013	0.00	00	23.00	12.45	83	57
February	5.10	01	28.88	17.70	64	40
March	7.8	02	31.34	20.73	58	31



Navasari

Month	Rain fall (mm)	Rainy days	Temperature		RH (%)	
			Max	Min	Max	Min
January	0.0	0	31.3	15.5	81	34
February	0.0	0	33.0	15.0	82	29
March	0.0	0	35.7	19.6	82	30
April	0.0	0	38.0	22.9	68	31
May	0.0	0	33.7	26.8	83	60
June	47.0	5	33.2	27.5	84	65
July	1051.2	26	29.5	25.4	89	83
August	196.8	10	30.1	26.0	87	74
September	240.0	6	32.4	25.3	77	66
October	840.0	2	33.9	21.2	85	47
November	19.2	2	32.2	19.5	76	43
December	0.0	0	31.2	16.3	80	36



XX. AICRPS Ceners

HEADQUARTERS:

Project Coordinator (Spices)

All India Coordinated Research Project on Spices

Indian Institute of Spices Research, Calicut-673 012, Kerala Phone: Off. (0495) 2731794

Fax: 0091-495-2731794 E-mail: aicrps@spices.res.in, pcspices@yahoo.com

		Telephone	Fax/E. mail
	Andhra Pradesh		
1	Horticultural Research Station (Andhra Pradesh Horticultural University), CHINTAPALLE - 531 111, Dist. Visakhapatnam, Andhra Pradesh	08937-238057 (O)	Fax: 08937-238057 ravikhorti@gmail.com seshakiran@hotmail.com chinmi102@yahoo.com
2	Horticultural Research Station (Andhra Pradesh Horticultural University), GUNTUR – 522 034, Andhra Pradesh	0863-2524017 /2524644(O)	Fax: 0863-2524073 gkalidasu@yahoo.com aphuhrslam@gmail.com surya.surepeddi@gmail.com naramlnaidu@gmail.com rajanhortico@gmail.com
3	Turmeric Research Station (Andhra Pradesh Horticultural University), Experimental Farm, KAMMARPALLY -503 308, Nizamabad Dist., Andhra Pradesh (Lr.No.25/TRS/KMP/Res/10 Dated 12.7.2010)	08463-272026 (O)	Fax: 08463-272026 headhrs_kammarpalli@drysru.edu.in uma_kudiri@rediffmail.com umavarma2007@gmail.com umavarma2007@hotmail.com
	Bihar		
4	Department of Horticulture Tirhut College of Agriculture (Rajendra Agrl. University) DHOLI -843 121, Musaffarpur, Bihar	0621-2293227(O)	Fax: 0621-2293227 spicestcadholi@yahoo.com ashim_sigatoka@yahoo.com
	Chhattisgarh		
5	Regional Agril. Research Station (Indira Gandhi Agrl. University), Boirdadar Farm, RAIGARH – 496 001 Dist. Chattisgarh	07762-222402/215235 (O)	Fax: 07762- 222402 /215235 singh_ajit8@yahoo.co.in singh_ajit8@rediffmail.com
	Gujarat		
6	Main Spices Research Station (Sardarkurshinagar Dantiwada Agricultural University) JAGUDAN – 382 710 Dist. Mehsana, Gujarat	02762-285337 (O)	Fax: 02762-285337 crss_jagudan@ymail.com ava.1952@yahoo.com kdpatel_1954@yahoo.com dgpateljagudan@yahoo.co.in



	Haryana		
7	Department of Vegetable Crops (Chaudharay Charan Singh Haryana Agril. University) HISAR – 1 25 004, Haryana, Himachal Pradesh	01662-289207 (O)	Fax: 01662-234952/284306 aicrpspices@hau.ernet.in tpmalik@yahoo.com maliktp@hau.ernet.in sktehlant07@gmail.com
8	Department of Vegetable Crops (Dr YS Parmar Univ. of Horticulture & Forestry), Nauni, SOLAN -173 230, Himachal Pradesh	01792-252329 (O)	Fax: 01792- 252329 happydev21@yahoo.in vgcuhf@yahoo.com solanspices@yahoo.com meenugupta1@gmail.com vipinsharma43@yahoo.com
	Karnataka		
9	Zonal Agricultural and Horticultural Research Station (University of Agricultural and Horticultural Sciences, Shimoga),* MUDIGERE -577 132, Dist. Chickmangalur, Karnataka (UHS, Bagalkot has transferred to UAHS, Shimoga w.e.f. 21-9-2012 vide Lr. No. DR/UAHSS/SO/GV/2012-13 dated 7-1-2013)*	08263-228146/ 228246/ 228135	Fax: 08263-228403 rangaswamysd@gmail.com kmdevaraju@gmail.com mudigere@rediffmail.com lakshmanad@rediffmail.com djn97@rediffmail.com
10	Horticultural Research Station AICRP on Spices, (University of Horticultural Sciences, Bagalkot) SIRSI -581 401, Dist. Uttara Kannada, Karnataka	08384-226797 (O)	Fax: 083840- 226797 ars_sirsipepper@rediffmail.com lokeshsirsi@rediffmail.com nageshnaikkagal@gmail.com
	Kerala		
11	Cardamom Research Station (Kerala Agricultural University) PAMPADUMPARA -685 553 Dist. Idukki, Kerala	(04868) 236263 (O)	Fax: 04868- 236263 crspam@kau.in mayahortti@gmail.com deepthyagri@yahoo.co.in sidharthanbiju@yahoo.com
12	Pepper Research Station (Kerala Agricultural University) PANNIYUR , PB No.113 Kanjirangadu (P.O) Karimbam (Via), Taliparamba -670 142, Dist. Cannanore, Kerala.	0460-2227287 (O)	Fax: 0460-2227287 ajith.pm@kau.in prspanniyur@kau.in heera.g@kau.in crrini@gmail.com anupama.tv@kau.in
	Maharashtra		
13	Department of Horticulture (Konkan Krishi Vidyapeeth) DAPOLI – 415 712 Dist. Ratnagiri, Maharashtra	02358-280244 (O) 02358-282563/282868	Fax: 02358-282074/282414 prakashsanap09@gmail.com rgk.bsckv@rediffmail.com guanantan@gmail.com gadredapoli@rediffmail.com udaykumar_pethe@rediffmail.com



	Orissa		
14	High Altitude Research Station (Orissa Univ. of Agrl. & Technology), POTTANGI -764 039 Dist. Koraput, Orissa	06853-252565 (O)	Fax: 06853-223348 dash.manas61@gmail.com parsuramsial@gmail.com
	Rajasthan		
15	Dept. of Genetics & Plant Breeding, SKN College of Agriculture (Rajasthan Agricultural University), JOBNER -303 329 Dist. Jaipur, Rajasthan	01425-254036/ 254041/ (O)	Fax: 01425-254022 evdsastry@yahoo.com evdsastry@gmail.com kssjobner@gmail.com acs_shivran@rediffmail.com mittalgkumar@gmail.com
	Tamil Nadu		
16	Horticultural Research Station YERCAUD – 636 602 Dist. Salem, Tamil Nadu	04281-222456/ 222234/ 222387 (O)	Fax: 04281- 222234/222387 hrrsyed@tnau.ac.in arulmozhiyan@yahoo.co.in
17	Dept. of Spices & Plantation Crops, Horticultural College and Research Institute (Tamil Nadu Agricultural University), COIMBATORE – 641 003, Tamil Nadu	0422-6611284/ 2430781(O)	Fax: 0422-6611371 /2430781 paramagurup@yahoo.co.in chitra.varadharaj@gmail.com spices@tnau.ac.in agrisara@rediffmail.com
	Tamil Nadu Agricultural university Faculty of Horticulture, Horticultural College & Research institute, Coimbatore -641003	0422-6611270/6611371	Fax: 0422-2430781 deanhortcbe@tnau.ac.in kumarhort@yahoo.com
	Uttar Pradesh		
18	Department of Vegetable Science (Narendra Dev University of Agril. & Technology), Narendra Nagar Post, KUMARGANJ , Faizabad-224 229, Uttar Pradesh	05270-262076	Fax: (05270) 262097/262331 nduat@up.nic.in yppandeyuat2012@gmail.com drramsumanmishra@gmail.com raviprakashsaxena@gmail.com dchfnduat2@gmail.com
	West Bengal		
19	Department of Horticulture (Uttar Banga Krishi Viswa Vidyalaya, North Bengal Campus PUNDIBARI P.O, Dist. Cooch Behar, West Bengal – 736 165	03582-270588 (O)	Fax: 03582-270143 (F) pundibari@rediffmail.com , pundibari@yahoo.co.in
	CO-OPTING CENTERS		
	Karnataka		
1	The Scientist-in-charge Regional Research Station Spices Board (Govt. of India) Donigal Post, SAKLESHPUR Karnataka – 573 134	08173-244281 (O)	Fax: 08173- 244124 cardamom@sancharnet.in sk9bhat@yahoo.com
	Kerala		





2	The Associate Director Regional Agricultural Research Station (Kerala Agril. University) AMBALAVAYAL –673 593 Dist. Wynad, Kerala	04936-260421/ 260561 / 260777 (O)	Fax: 04936-260421 menon_r15@yahoo.com adramb@kau.in, rarsamb@kau.in
3	The Director Indian Cardamom Research Institute MYLADUMPARA , Kailasanadu Idukki Dist., Kerala – 685 553 Meghalaya	04868-237206/ 237207 (O)	Fax: 04868-237285 mrs44545@gmail.com icrimyla@yahoo.com kalyanidhanapal@yahoo.com
4	The Principal Scientist & Head ICAR Research Complex for NEH Region, Umroi Road, Ri-bhoi- 793103, BARAPANI , (Umiam), Meghalaya Mizoram	0364-2570257 /2570678(O)	Telefax: 0364-2570257 /2570678 amithnath2005@gmail.com akjhaicar@gmail.com akjhaicar@rediffmail.com akjhaicar@yahoo.com
5	The Joint Director ICAR Research Complex for NEH Region, Mizoram Centre , KOLASIB -796081, Mizoram Sikkim	03837-220041 / 220056 (O)	Fax: 03837-220560 jdicarmizoram@gmail.com bksinghkushinagar@yahoo.co.in kapicar@yahoo.com
6	The Dy. Director (Res.) ICRI Regional Station (Spices Board), Yakthung, Tadong, GANGTOK -737 102, Sikkim	03592- 231307/237301/(O)	Fax: 03592-231307/237301 rrspicesgtk@yahoo.com guptau07@yahoo.com
7	Joint Director ICAR Res. Complex For NEH Region, Regional Station, Sikkim Center , Tadong, GANGTOK -737 102, Sikkim Tamil Nadu	03592- 231030//232125 (O)	Fax: 03592-231238 hricar@gmail.com drhkhalita@yahoo.co.in
8	The Professor & Head Horticultural Research Station (Tamil Nadu Agricultural University) PECHIPARAI – 629 161 Kanyakumari Dist., Tamil Nadu VOLUNTARY CENTRES Arunachal Pradesh	04652-281191(O)	hrrsppi@tnau.ac.in hrrspp_ngc@sancharnet.in joshua.prem@rediffmail.com
1	The Dean Central Agricultural University College of Horticulture & Forestry PASIGHAT -791 102, Arunachal Pradesh Gujarat	(0368)2224887	Fax: 0368-2225066 chfdeanpsg@yahoo.com chf_dean@yahoo.com vikaschf@gmail.com rkdubey@gmail.com rksdubey@yahoo.co.in



2	The Director of Research & Dean Faculty of PG Studies Directorate of Research N.M. College of Agriculture Navsari Agricultural University NAVASARI -396 450, Gujarat	(02637) 283160 / 282771-75 - Ex.132 (O)	Fax: 02637-283452 /282765 nau_dr@yahoo.com rtdesai1951@yahoo.com ritesh147@gmail.com
	Jharkhand		
3	The Director, Research BIRSA Agricultural University Kanke, RANCHI -834 006, Jharkhand	(0651) 2450610/ 2451011/ 2450678(O)	Fax: 0651-2451011 rnrayranchi@gmail.com msanyat@gmail.com drsanyat@rediffmail.com
	Madhya Pradesh		
4	The Sr. Scientist/Head (Hort.): Department of Horticulture, College of Agriculture, Jawaharlal Nehru Krishi Vishwavidyalaya, JABALPUR -482 004, Madhya Pradesh	(0761)2680771/ 2681773 Extn: 345(O)/ (0761)6456625/ 2681710	Fax: 0761-2681074/2681236 /2681389 niganakjnau@rediffmail drsjnavv@sancharr arnet_sst_drsinkvv@yahoo.com drswa_pansengupta@gmail.com drmaiduak@gmail.com
	Rajasthan		
5	The Director of Research Maharana Pratap University of Agriculture & Technology, RCA Campus, UDAIPUR -31001, Rajasthan	(0294)2417334/ 2420447 (0744)2844369	Fax: 0294-2420447 0744-2844306 dr@mpuat.ac.in arskota@hotmail.com
	Associate Professor Agricultural Research Station (MPUA&T) Ummedganj Farm, Post Box No.7, GPO Nayapura, Kota-324001	(0744) 2844369 (O)	Fax: arskota@hotmail.com
	Uttarakhand		
6	Professor & Joint Director/Director Govind Ballabh Pant University of Agriculture & Technology , College of Agriculture , PANTNAGAR -263 145, Dist. Udham Singh Nagar, Uttarakhand	(05944) 210149 (O)/ (05944)233363 (O)	Fax: 05944- 233608/233473 j.gautam56@yahoo.com m_des@guuat.ernet.in dheer_singh72@yahoo.com
	West Bengal		
7	The Director of Research Bidhan Chandra Krishi Vishwa Vidhyalay, Directorate of Research Faculty of Horticulture, Kalyani, P.O. KALYANI -741 235, Nadia, West Bengal	(033) 25828407 (O) 03473- 2222269/70 03473-222659	Fax: 033-25828407/ 03473-222275/73/77 drbckv@vsnl.net ; chatterjeeranabir@yahoo.co.in



