



वार्षिक रिपोर्ट Annual Report 2013 - 14

बोटपड

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

**ALL INDIA COORDINATED RESEARCH
PROJECT ON SPICES**

ANNUAL REPORT 2013– 14



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Indian Institute of Spices Research

(Indian Council of Agricultural Research)

Kozhikode – 673 012, Kerala, India

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कार्यकारी सारांश

अखिल भारतीय समन्वित मसाला फसल अनुसंधान परियोजना (ऋक्वडव्) का मुख्यालय भारतीय मसाला फसल अनुसंधान संस्थान, कोषिकोड (केरल) में स्थित है। इस परियोजना के अन्तर्गत भारत के २१ राज्यों में मसालों के लिये अनुकूल विभिन्न कृषि जलवायु क्षेत्रों में १२ प्रमुख मसालों (११ नियमित, ८ सहयोगी तथा ७ अवैतनिक केन्द्रों) पर केन्द्रित हैं। अधिदेश फसलों पर शोध कार्य करने वाले केन्द्रों की संख्या काली मिर्च (१० केन्द्र), छोटी इलायची (४ केन्द्र), बड़ी इलायची (२ केन्द्र), अदरक (१४ केन्द्र), हल्दी (१३ केन्द्र), धनिया (१२ केन्द्र), जीरा (५ केन्द्र), सौंफ (१ केन्द्र), मेथी (११ केन्द्र), वृक्ष मसाले जैसे जायफल, लौंग, दालचीनी (प्रत्येक के ३ केन्द्र) हैं। वर्ष २०१३-१४ बजट में भारतीय कृषि अनुसंधान परिषद का आबंटन लगभग ३९६ लाख रुपये थे। 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 १२ परियोजनाओं का कार्यक्रम गतिमान है।

काली मिर्च

द्युगत वर्ष २० अक्सेशनों को पन्त्रियूर, अम्बलावयल, चिन्तापल्ली, दापोली, पेचीपराई, पुंडिबारी, सिरसी तथा येरकाड केन्द्रों की काली मिर्च जननद्रव्यशाला में सम्मिलित किये गये। पन्त्रियूर में काली मिर्च के प्राथमिक मूल्यांकन में कल्टिवार पीआरएस ६४ ने ३.११ कि. ग्राम प्रति बेल हरी बरी की उपज तथा १०४५ स्पाइक प्रति बेल के साथ सर्वश्रेष्ठ अंकित किया गया।

सिरसी में, पाइपर नाइग्रम पर आई आई एस आर शक्ति की पैबंद पन्त्रियूर ६ की बेल ने उच्चतम ऊंचाई अंकित की। पन्त्रियूर काली मिर्च में साप्ताहिक अंतराल में ५० S आर डी एफ ड्रिप (८१) फेर्टि गेशन परीक्षण में २५ S पानी की बचत में उच्चतम स्पाइक उत्पादन अंकित किया गया (प्रति बेल ५.४३ कि. ग्राम)।

शोध उपलब्धियां

नये कार्यक्रम

राजस्थान और गुजरात के कृषकों की बीज मसालों की आवश्यकता की पूर्ति के लिए, मन्दोर और सानन्द में दो केन्द्रों की स्थापना की गयी है और उनमें जीरा जननद्रव्य का मूल्यांकन शुरू किया गया है। कच्चे अदरक का महत्व समझकर हमने उत्तर पूर्व से इसका संग्रहण करने का काम प्रारंभ किया है और नागालैंड से ७ नये संग्रहण कर लिया है। इसके अतिरिक्त आई आई एस आर के १० नेपाल संग्रहण प्रवर्धन और मूल्यांकन के लिए उत्तर पूर्व के ४ केन्द्रों में परिचित किया गया है।

अखिल भारतीय समन्वित मसाला अनुसंधान परियोजना की २४वीं कार्यशाला में विमोचित करने के लिये संस्तुत प्रजातियां

सी आर एस एस, जगुदान में आयोजित २४ वीं कार्यशाला में डॉ. वाई एस आर एच यू, कम्मारपल्ली द्वारा विकसित हल्दी की सुधारित प्रजाति डुगिराला लाल (जेटीएस-६), आई आई एस आर, कोषिकोड की जायफल प्रजाति केरलाश्री, डॉ. वाई एस

आर एच यू, गुण्टूर की धनिया की गैर मौसम प्रजाति एल सी सी २३४, और सी सी एस एच ए यू की मेथी प्रजाति एच एम ३४८ को विमोचित करने को संस्तुत किया गया।

सिरसी में काली मिर्च की सहिष्णु प्रजातियों (आई आई एस आर शक्ति तथा आई आई एस आर थेवम) में फाइटोफथोरा प्रकन्द गलन रोग आपतन में कमी (क्रमशः ११.७३ तथा १४.१५) अंकित की गयी। काली मिर्च बेल जीवाणुओं के संघटक (आई आई एस आर ६ तथा आई आई एस आर ८५९) का २१ / बेल की दर से छिडकाव तथा ३१ प्रति बेल की दर से इंचिंग के साथ प्रति बेल ५० ग्राम की दर से ट्राइकोडेरमा हर्जियानम (एम टी सी सी ५१७९) तथा मृदा में १ कि. ग्राम नीम केक को वर्षा के पूर्व (जून २०१३) तथा वर्षा के बाद (अगस्त २०१३) उपचारित करने पर सबसे कम रोग आपतन और पन्त्रियूर १ के समान पौधों की ज्यादा लंबाई अंकित की गयी।

नवीन कवकनाशियों में ०.१ S फेनामिडोन (१० S) अ मैनकोज़ेब (५० S) (सेक्टिन) मात्र तथा फेनामिडोन (१० S) अ मैनकोज़ेब (५० S) (सेक्टिन) २१ / बेल की दर से छिडकाव तथा ३१ / बेल की दर से इंचिंग के साथ ट्राइकोडेरमा हर्जियानम (एम टी सी सी ५१७९) ५० ग्राम प्रति बेल के साथ के साथ मृदा में १ कि.ग्राम नीम केक को जून के पहले सप्ताह और अगस्त के तीसरे सप्ताह में उपचार





करने पर पत्तियों के रोग संक्रमण में (क्रमशः ७.७३ S तथा ६.१५ S), पीलापन में (क्रमशः ७.८८ तथा ७.५९ S) तथा पतझड़ और बेल की मृत्यु में (क्रमशः ८.५० तथा ६.०६) कमी देखी गयी।

इलायची

सकलेशपुर में किये गये एक अन्य सी वी टी अध्ययन में १५ अक्सेशन में आईसी ३४९८७ (८१६.२ ग्राम/पौधा) की उपज प्रति पौधा अधिकतम थी जबकि अर्पंगला आईसी ३४९५७ उपज ७३२.५ ग्राम/पौधा थी। मुडिगरे में १०० S संस्तुत मात्रा (१२५:१२५:२५० एन पी के कि.ग्राम/हेक्टर) उर्वरक डालने के साथ ९ लिटर/क्लंप/दिन ड्रिप सिंचाई करने पर अधिकतम कैप्सूल उपज (२२०.३५ कि. ग्राम/हेक्टर) अंकित की गयी जो संस्तुत मात्रा की ७५ S उर्वरक के साथ ९ लिटर/क्लंप/दिन सिंचाई करने के लगभग समान (२१५.२५ कि.ग्राम/हेक्टर) थी। इससे ४४ S पानी तथा २५५ उर्वरक की संस्तुत मात्रा को बचाया जा सकता है। पाम्पाडुम्पारा में किये एक सी वी टी में, जैविक खेती परीक्षण में, ३० टन एफ वाई एम अ संस्तुत एन पी के (१२५:१२५:२५० कि. ग्राम/हेक्टर) डालने से शुष्क कैप्सूल उपज (२५५ कि.ग्राम/हेक्टर) अंकित की गयी। इसी जगह में चूना का चूर्ण २ कि.ग्रा./पौधा की दर से उपयोग करने पर पैदावार में नियन्त्रण की अपेक्षा ६३ S अधिक उपज अंकित की गयी।

यही तना गलन के प्रबन्धन के लिए बाविस्टिन (०.२ S) का छिड़काव करने पर रोग के आपतन में कमी (१९.८ S) अंकित की गयी।

बड़ी इलायची

जननद्रव्य एकत्रित करने के लिए पश्चिम बंगाल के सुखिया पोखरी, डारजीलिंग तथा सिक्किम के दक्षिण और उत्तर जिलाओं में सर्वेक्षण किया गया। ए आई सी आर पी एस के अधीन कबी में स्थित परीक्षण खेत में तीन जननद्रव्य, यानी एस सी सी २४९ (जर्माले), एस सी सी २५० (वालंगे) तथा एस सी सी २५१ (वालंगे) को रोपण करके उनका चरित्रांकन किया गया। जैवकारकों (प्सूडोमोनास फ्लूरोसेंस अ बैसिलस सबटिलिस) ३ S द्वारा उपचार करने पर नियन्त्रण की अपेक्षा प्रत्येक ने म्लानी आपतन कम अंकित किया गया। अरुणाचल प्रदेश, नागालैंड और पश्चिम बंगाल में बड़ी इलायची की रोपण इकाइयाँ लगायी गयीं।

अदरक

नागालैंड के सात स्थानीय कल्चिवरों को इकट्ठा करके जननद्रव्य में शामिल किया गया। सोलन के के आई ई टी परीक्षण में अदरक

एसजी-२६-०४ (२११७ कि.ग्रा./हेक्टर), पुण्डिबारी की सीजीपी-४९ (१३२६ कि.ग्रा./हेक्टर), घोली की आरजी-१८ (२११९ कि.ग्रा./हेक्टर) और कुमारगंज की बैदा सोंत में (३३६६ कि.ग्रा./हेक्टर) अधिकतम उपज अंकित की गयी।

चिन्तापल्ली में एक जी - ई परीक्षण में नदिया प्रजाति में अधिकतम उपज (२२.७५ टन/हेक्टर), मिज़ोराम में हिमगिरी की (१६.७७ टन/हेक्टर), पासिघट में सुरभी की (२९.०९ टन/हेक्टर) तथा सोलान के एसजी-२६/०४ की (२१ टन/हेक्टर) उपज अंकित की गयी। बारापानी में सुरुची प्रजाति (१०.५ S) और पासिघट में सुरभी (८.५ S) में अधिकतम तेल की मात्रा अंकित की गयी।

धोली केन्द्र द्वारा बिहार के वैशाली जिले में किये गये पर ज्ञात हुआ कि रालस्टोनिया सोलानेसियारम जीवाणु द्वारा संक्रमित म्लानी रोग का आपतन (३० S) पाइथियम एफानिडमार्टम द्वारा संक्रमित मृदु गलन रोग के आपतन (१४ S) की अपेक्षा अधिक था।

अंबलवयल में गोभी आघारित जैव-धूमिकृत का उपयोग करने पर मृदा में मृदु गलन और पर्ण-चिन्ती रोग के आपतन क्रमशः (५६.०० S और १.०० S) कम तथा इन खेतों में प्रकन्द उपज (२० टन/हेक्टर) अधिक थी।

हल्दी

हल्दी जननद्रव्यों के संकलन एवं कंटोलिंग के बगैर विभिन्न केन्द्रों में जननद्रव्यों का मूल्यांकन भी किया गया। घोली में उपज के आधार पर आर एच २/८० (१७५ कि.ग्रा.), पासिघट में सी एच एफ टी ३६ (३५.५९ टन/हेक्टर), पोदटांगी में पीटीएस २१ (३४ टन/हेक्टर), पुण्डिबारी में टीसीपी १६८ (५४.५४/हेक्टर) और रायगढ़ में आईटी ४० (२२.५ टन/हेक्टर) की उच्चतम उपज प्राप्त हुई।

चिन्तापल्ली में सी वी टी अध्ययन में, हल्दी आर एच १३/९० की (४४ टन/हेक्टर), कोयम्बतूर में सीएल १०१ (४३.५७ टन/हेक्टर), धोली में आरएच ८० (६.७० टन/हेक्टर), कम्मारपल्ली में आरएच १/९० (३१ टन/हेक्टर), पोदटांगी में पीटीएस ५५ (१४.८ टन/हेक्टर), पुण्डिबारी में टीसीपी ७० और रायगढ़ में आरएच ५० (२१.९ टन/हेक्टर) की उच्चतम उपज प्राप्त हुई।

हल्दी एनडीएच ९८ की एक अलग सी वी टी में, चार केन्द्रों में उच्चतम उपज मिली, जैसे पासिघट में ३५ टन/हेक्टर, चिन्तापल्ली में ६२ टन/हेक्टर, पुण्डिबारी में ४७ टन/हेक्टर तथा कुमारगंज में ३० टन/हेक्टर, जबकि कोयम्बतूर में एसीसी ७९ में उच्चतम उपज रिकॉर्ड की गयी। हल्दी का यह अक्सेशन खेत में पर्णरोग-सहिष्णु भी है।







प्रविष्टि यूएफ-२३६ में १८४८.१५ कि.ग्रा./हैक्टर की उच्चतम उपज तत्पश्चात् यूएफ-१९१ (१६८५.१९ कि.ग्रा./हैक्टर) अंकित की गयी। कुमारगंज की उत्पाद सूचना के अनुसार एनडीएफ-३२ में (३९.५५ ग्राम/पौधा), एनडीएफ-३९ में (३८.१६ ग्राम/पौधा) और एनडीएफ-३९ में (३८.०९ग्राम/पौधा) १०,२०,३० और ४० ईएसएल स्तरों पर क्षारता-सहिष्णु अंकित किये गये।

जोडीकृत पंक्ति रोपण के साथ ०.८ आईडब्लियू/सीपीई के अनुपात में ड्रिप सिंचाई करने पर, जो रोपण में सामान्य पंक्ति सिंचाई ०.८ आईडब्लियू/सीपीई के लगभग समान थे, ०.६ और ०.४ आईडब्लियू/सीपीई की अपेक्षा ज्यादा सॉफ उत्पाद (३०.८० किं.ट/हैक्टर) अंकित किया गया।

रायगढ़ में बीजों में एफके १४ उपचार करने पर पी जी पी आर जैविक रूपीकरण का लाभदायक प्रभाव अंकित किया गया जबकि हिसार में स्थानीय लोकप्रिय प्रजाति एचएफ-३३ में १८०६.९ कि. ग्रा./हैक्टर उपज प्राप्त हुई। जगुदान में भी उपज गुणवत्ता तथा वृद्धि में महत्वपूर्ण अन्तर नहीं अंकित किया गया।

मेथी

वर्ष २०१२ में एक सी वी टी में विभिन्न अक्सेशनों के बीच उत्पाद ४८० कि.ग्राम/हैक्टर से २७५४ कि.ग्राम/हैक्टर तक का अन्तर देखा गया। रायगढ़ में अक्सेशन एफजीके ५२ में उच्चतम उत्पादन (१३६ कि.ग्राम/हैक्टर), कोयम्बतूर और उदयपूर में एफजीके ४४ में क्रमशः ४०८ और १४९३ कि.ग्राम/हैक्टर उत्पादन था। धौली में एफजीके ४९ में १८४८ कि.ग्राम/हैक्टर हिसार में एफजीके ४८ (२७५४ कि.ग्राम/हैक्टर) और कुमारगंज में एफजीके ४० में १४५८ कि.ग्राम/हैक्टर आशाजनक उपज मिली।

जगुदान में एक आई ई टी में संकलित दो साल के आंकड़ों में जे एफ जी-२६८ (१९८९ कि. ग्राम/हैक्टर) और जे एफ जी-२२४ (१९५४ कि.ग्राम/हैक्टर) में प्रमुख रूप से उच्च उत्पाद अंकित किया जो जीएम-२ चेक की अपेक्षा १०.६७ और ९.१३ प्रतिशत अधिक था। जोबनर में सामान्य और तनावपूर्ण स्थितियों में यूएम-१९२ अधिक उपज वाली थी। जूष्क अवस्थाओं में में आर एम टी-१, यू एम-१२४, यू एम-१४०, यू एम-२२८, यू एम-३५३, यू एम-३०४ और यू एम-३०२ बाँछित थी।

मेथी में किये गये पीजीपीआर परीक्षण में एफके१४ (प्यूडोमोनस पुटिडा) तथा एफएल१८ (माक्रोबैक्टीरियम पेराओक्सिडान्स) के संकलन ने गुण्डूर में १२३३.८ कि.ग्राम/हैक्टर उपज रिकॉर्ड किया, कुमारगंज और जोबनर में एफजीके-१४ अ एफएल-१८ के

जैवरूपीकरण ने क्रमशः उच्चतम उपज १५.८७ किं.ट/हैक्टर और १६६८.४१ कि.ग्राम/हैक्टर अंकित की जबकि हिसार में एफके-१४अ एफएल-१८ जैवरूपीकरण उपचार करने पर उच्चतम उपज (२०७०.५ कि.ग्राम/हैक्टर) अंकित की गयी। जगुदान में उपज में कोई महत्वपूर्ण अन्तर नहीं अंकित किया गया।

धनिया

कोयम्बतूर में स्थानीय जननद्रव्य मूल्यांकन में आरडी ४१० (७.५ ग्राम/पौधा), गुण्डूर में आरडी ३८७ (६.१३ ग्राम/पौधा) तथा जोबनर में वीडवी/जीएल-४९ आशाजनक थे। वर्ष २०१२ के दौरान किये गये सीवीटी में धनिया का उत्पादन ५५४.६ से १९१२ कि.ग्राम/हैक्टर था। समन्वय केन्द्रों में पहचान की गयी आशाजनक प्रविष्टियाँ गुण्डूर में सीओआर ४६ (१३०० कि.ग्राम/हैक्टर), कुमारगंज में सी ओ आर ४३ (१५५१ कि.ग्राम/हैक्टर), जगुदान में सी ओ आर ५६ (१४८९ टन/हैक्टर), रायगढ़ में सी ओ आर ५३ (१२०२ टन/हैक्टर), जोबनर में सी ओ आर ४४ (१६२२ कि.ग्रा./हैक्टर), नवसारी में सी ओ आर ५६ (१२२० कि.ग्राम/हैक्टर), कोयम्बतूर में सी ओ आर ४६ (५५४.६ कि.ग्राम/हैक्टर), हिसार में ओ आर ४३ (२२५६ कि.ग्राम/हैक्टर), उदयपूर में सी ओ आर ४४ (१९९८ कि.ग्राम/हैक्टर), जबलपुर में सी ओ आर ४८ (१५५३ कि.ग्राम/हैक्टर), हिसार में ओ आर ४९ और धौली में सी ओ आर ५० (१९९९ कि.ग्राम/हैक्टर) थीं।

बीज के उद्देश्य से (तीन वर्षों की अवधि में) हिसार में किये एक आई ई टी में डी एच-२८९ तथा डी एच-३१४ आशाजनक प्रविष्टियाँ थीं। जोबनर में शुरू हुए एक आई ई टी में यूडी १६९ (१२८४ कि.ग्राम/हैक्टर) की उच्चतम उपज अंकित की गयी। वर्ष २०१२ के दौरान जगुदान, गुण्डूर और कुमारगंज में की गयी नयी आई ई टी में जे सी आर ३८९ (१३८७ कि.ग्राम/हैक्टर), एल सी सी २६८ (१९२६ कि.ग्राम/हैक्टर) और एन डी कोर १०१ (१५६९ कि.ग्राम/हैक्टर) की उच्चतम उपज विभिन्न केन्द्रों में अंकित की गयी।

जोबनर में धनिया की शुष्क / क्षारता सहिष्णु की पहचान के लिए किये एक परीक्षण में जीनोटाइप आर सी आर-६८४ दोनों सामान्य तथा तनाव की स्थितियों में सर्वश्रेष्ठ उपज वाली अंकित की गयी। सूचकों के आधार पर शुष्क स्थितियों में यूडी-२२, यूडी-५६२, यूडी-८०१ और यूडी-८६ बाँछित थी।

धनिया में पी जी पी आर जैवरूपीकरण का मुख्य लाभदायक प्रयोजन बीजों को गुण्डूर में एफके १४ अ एफएल १८ को उपचार करने पर (१९१२ कि.ग्रा./हैक्टर), कोयम्बतूर में एफके १४ से उपचार करने पर (७३५ कि.ग्रा./हैक्टर) और रायगढ़ में एफएल १८ से उपचार करने पर (१२० कि.ग्रा./हैक्टर) प्राप्त हुई। हिसार में स्थानीय लोकप्रिय प्रजाति (हिसार आनन्द) की उच्चतम उपज



अंकित की गयी जबकि जगुदान में धनिया की वृद्धि और उपज में जैवरूपीकरण के उपयोग में कोई अन्तर नहीं था।

निरीक्षण

विभिन्न केन्द्रों की कार्यक्रम सामयिक रिपोर्टों (मासिक तथा अर्धवार्षिक) तथा समन्वयक द्वारा ए आई सी आर पी एस केन्द्रों तथा परीक्षण स्थलों का दौरा करके शोध कार्यों का निरीक्षण किया गया।

तकनीकियों का विस्तार

ए आई सी आर पी एस के वैज्ञानिकों तथा अन्य शोध कर्मों द्वारा अनेक कृषकों के खेतों में निम्न तकनीकियों को प्रदर्शित किया गया।

- प्रतिकूल मौसम में धनिया एलसीसी-२३४ (गुणदूर) के उत्पादन का अग्र पंक्ति प्रदर्शन।
- सौफ की उच्च उपज वाली प्रजाति जीएफ-१२ का प्रदर्शन (जगुदान)
- धनिया की उच्च उपज वाली प्रजाति जीकोर-२ का प्रदर्शन (जगुदान)
- धनिया की उच्च उपज वाली प्रजाति आरसीआर-४८० का प्रदर्शन (जोबनर)
- जीरा की उच्च उपज वाली प्रजाति आरसीआर-२२३ का प्रदर्शन (जोबनर)
- सौफ की उच्च उपज वाली प्रजाति आरएफ-१४३ का प्रदर्शन (जोबनर)
- एलसीसी-२३६ (सुगुणा) का बीजोत्पादन (गुणदूर)
- हल्दी की उच्च उपज वाली प्रजाति प्रतिभा को लोकप्रिय करना (गुणदूर)
- अदरक में प्रकन्द गलन का प्रबन्धन (रायगढ)
- हल्दी का रोगमुक्त सिंगल नोड पोरट्रे मल्टिप्लिकेशन (कोयम्बतूर)
- उच्च उपज वाली प्रजाति आरसीआर-४३६ की एफ एल डी (पंतनगर)
- गोभी आधारित जैव धूमिकरण करके अदरक में प्रकन्द गलन प्रबन्धन (रायगढ)
- जैवकारकों द्वारा बड़ी इलायची में म्लानी रोग का प्रबन्धन (आई सी आर आई, सिक्किम)

इनके अतिरिक्त कृषक अनुकूल तकनीकियों को लोकप्रिय बनाने के उद्देश्य

से कृषकों, विभागीय अधिकारियों से पारस्परिक संवाद तथा

आदि को शामिल करके २५ संगोष्ठियों, ४० कृषि मेलाओं, ५ टीवी प्रसारण, ११ रेडियो प्रसारण आदि में भाग लिया।

सफल गाथा

हल्दी का रोगमुक्त सिंगल नोड पोरट्रे मल्टिप्लिकेशन ३० प्रमुख किसानों को शामिल करके २० एकड़ से ज्यादा खेतों में विस्तार किया गया, जिससे तमिलनाडु और आन्ध्र प्रदेश के कृषक इस तकनीक से लाभान्वित हुये।

मध्यप्रदेश के पाँच जिलायें विदिषा, शाजापुर, सियोनी, गुना और राजगढ़ ओलाबारी से प्रभावित थे। इस अवस्था के लिये ए पी एच यू धनिया-१(एलसीसी-१७०) प्रजाति जो ए आई पी आर एस, एच आर एस द्वारा विकसित एवं विमोचित की गयी। कृषक गण भारी ओलाबारी के बावजूद ए पी एच यू धनिया-१(एलसीसी-१७०) का कम था।

उत्तर पूर्व में आदिवासी कल्याण योजनाएँ

आदिवासी क्षेत्रों में स्थित ए आई सी आर पी एस केन्द्रों द्वारा बढ़ती उपज और अच्छा लाभ उठाने हेतु सुघरी प्रजातियों के प्रवर्धन और वितरण में सक्रिय रूप से भाग लिया। उत्तर पूर्व में विभिन्न विषयों पर ३२ परीक्षण किये गये।

पोट्टांगी (उडीसा), चिन्तापल्ली (आन्ध्र प्रदेश) और तमिलनाडु की कोल्ली पहाडियों में काली मिर्च की सुघरी प्रजातियाँ रोपण की गयीं। अदरक और हल्दी की सुघरी प्रजातियाँ छत्तीसगढ़, झारखण्ड और नागालैंड में रोपित की गयीं।

सहकारिता

रिपोर्टाधीन अवधि के दौरान ए आई सी आर पी एस के केन्द्र डी आई एस डी और एन एच एम के सहयोग से काली मिर्च की ५ लाख रोगमुक्त रोपण सामग्रियों, ३०,००० वृक्ष मसाला ग्राफ्टों/पौधों, १०० टन अदरक, १५० टन हल्दी, ६० टन बीज मसालों का उत्पादन किया। विमोचित प्रजातियों, विशेषकर रोगों और कीटों के विरुद्ध प्रतिरोधक क्षमता वाली प्रजातियों को बीज प्रवर्धन कार्यक्रम में शामिल करने का प्रयास जारी है। रोग संक्रमण को कम करने के लिए मानक पौधशाला प्रक्रियाओं के पालन और स्वस्थ रोपण सामग्री के वितरण पर जोर दिया जा रहा है।





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 9 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), cumin (5 centres), fennel (9 centres), fenugreek (11 centres), tree spices viz. nutmeg, clove, cinnamon (3 centres each). The annual budget for the year, 2013-14 was around (Rs 396 lakhs) as ICAR share. There are 114 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

New initiatives

To meet the requirement of seed spices farmers in Rajasthan and Gujarat, two centres of seed spices in Mandor and Sanand has been started and initiated evaluation of cumin germplasm. Realising the importance of vegetable ginger, a new initiative to collect vegetable ginger from North East and 7 new collections were taken from Nagaland. In addition to this, 10 Nepal collections from IISR were introduced for multiplication and evaluation at 4 centres in North East.

Varieties recommended for release in 24th AICRPS workshop

Improved turmeric variety Duggirala red

(JTS-6) from Dr. YSRHU, Kammarpally, nutmeg Kerala Shree from IISR, Calicut, LCC 234 – coriander off season variety from Dr. YSRHU, Guntur, fenugreek variety HM 348 from CCSHAU, Hisar were recommended for release during the 24th Workshop held at CRSS, Jagudan.

Black pepper

During the year 20 more accessions were added to the germplasm of black pepper maintained at various centres viz. Panniyur, Ambalavayal, Chintapalle, Dapoli, Pechiparai, Pundibari, Sirsi and Yercaud. Preliminary evaluation of black pepper germplasm at Panniyur indicated that the cultivar PRS 64 ranked first with 3.11 kg green berry yield and 1045 spikes /vine.

At Sirsi grafts of Panniyur 1 runner shoots on *Piper nigrum* var IISR shakthi as rootstock recorded maximum height. Under drip fertigation experiment in black pepper at Panniyur, 50 % RDF through drip (81) at weekly interval recorded maximum spike yield (5.43 kg/vine) and saved 25 % water.

The black pepper tolerant varieties, IISR Shakti and IISR Thevam recorded significantly less disease incidence (11.73 and 14.15 respectively) of *Phytophthora* foot rot at Sirsi. Black pepper vines treated with consortium of bacteria (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 2013) and post monsoon (Aug 2013) recorded least disease incidence and recorded more plant height that was on par with Panniyur 1.

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 and third week August recorded statistically significant reduction in the disease with respect to leaf infection (7.73 and 6.15 %), reduced yellowing (7.88 and 7.59 %), least defoliation (8.05 and 6.06) and death of vines (4.24 and 4.86) respectively at Sirsi.

Cardamom

In a CVT at Sakaleshpur with 15 accessions, maximum per plant yield was recorded by IC 34987 (816.20 g/pl) whereas at Appangala, IC34957 recorded maximum yield (732.5 g/pl). At Mudigere irrigation (9 liters/clump/day) along with 100 % recommended dose (125:125:250 NPK kg ha⁻¹) of fertilizer through drip recorded the maximum capsule yield (220.35 kg ha⁻¹) that was on par with irrigation 9 liters/clump/day with 75 % recommended fertilizer dose (215.25 kg ha⁻¹) which saved 44 % water and 25 % recommended dose of fertilizer. In an organic farming trial at Pampadumpara, application of 30 t FYM+ recommended dose of NPK (125 :125 : 250 kg ha⁻¹) recorded maximum dry capsule yield (255 kg ha⁻¹). Application of ground lime stone @ 2 kg/plant in cardamom increased the yield by 63 % over control (without liming) at Pampadumpara.

For management of stem rot of cardamom at Pampadumpara spraying and basal application of bavistin 0.2 % resulted in less diseases incidence (19.8 %).

Large Cardamom

Survey was made at different area of Sukhia Pokhri, Darjeeling district of West Bengal and South and North district of North Sikkim for collection of germplasm. Six planting units of three germplasm viz. SCC 249 (Girmaley), SCC 250 (Varlangey) and SCC 251 (Varlangey), were collected and planted under AI-CRPS trial plot at Kabi farm and characterizations of

the collected germplasm were made as per descriptor.

Treating suckers with bio agents (*Pseudomonas fluorescens* + *Bacillus subtilis* 3 % each showed less incidence of blight as compared to control. Planting units of large cardamom were introduced into Arunachal Pradesh, Nagaland and West Bengal.

Ginger

Seven accessions of local types were collected from Nagaland and added to the germplasm. In an IET trial in ginger SG - 26 -04 at Solan (2117 kg ha⁻¹), GCP 49 (1326 kg ha⁻¹) at Pundibari, RG -18 (2119 kg ha⁻¹) at Dholi, Baidra Sonth (3366 kg ha⁻¹) at Kumarganj recorded maximum yield.

In a G x E trial in ginger, variety Nadia (2275 kg ha⁻¹) performed best at Chintapalle, Himgiri (1677 kg ha⁻¹) at Mizoram, Surabi (2909 kg ha⁻¹) at Pasighat, and SG-26/04 at Solan (2100 kg ha⁻¹). The variety Suruchi (10.5 %) at Barapani and Surabhi (8.5 %) at Pasighat recorded maximum oleoresin content.

Survey conducted in Vaishali district of Bihar by Dholi Centre indicated higher incidence of bacterial wilt caused by *Ralstonia solanacearum* (30 %) compared to soft rot(14 %) caused by *Pythium aphanidermatum*.

At Ambalavayal soft rot incidence and leaf spot incidence were found to be minimum in plots where the soil was bio-fumigated using cabbage (56.0 % and 1.0 % respectively) and rhizome yield was also higher in these plots (20.0 tha⁻¹).

Turmeric

Apart from collection (1225) and cataloguing of turmeric germplasm, evaluation of germplasm was carried out at various centres. Promising genotypes identified from germplasm based on yield were RH 2/80 (44.5 tha⁻¹) at Dholi, CHFT36 (35.59 t ha⁻¹) at Pasighat, PTS 21 (34 t ha⁻¹) at Pottangi, TCP 168 (54.54 t ha⁻¹) at Pundibari, and IT 40 (22.5 t ha⁻¹) at Raigarh.





In a CVT on turmeric RH 13/90 (44 t ha⁻¹) at Chintapalle, CL 101 (43.57 t ha⁻¹) at Coimbatore, RH 80 (6.70 t ha⁻¹) at Dholi, RH 9/90 (31 t ha⁻¹) at Kammarpally, PTS 55 (14.8 t ha⁻¹) at Pottangi, TCP 70 at Pundibari 26.21 t ha⁻¹ and RH 50 (21.9 t ha⁻¹) at Raigarh recorded maximum yield.

In another CVT on turmeric NDH 98 recorded maximum yield in four centres, 35 t ha⁻¹ at Pasighat, 62 t ha⁻¹ at Chintapalle, 47 t ha⁻¹ at Pundibari, 30 t ha⁻¹ Kumarganj whereas ACC 79 recorded maximum yield at Coimbatore. This accession is also field tolerant to leaf diseases of turmeric.

In a continued G x E interaction study turmeric varieties Roma (21 t ha⁻¹) at Pottangi, RH 9/90 (30 t ha⁻¹) at Kammarpally, RCT -1 (30 t ha⁻¹) at Mizoram, Megha Turmeric (46 t ha⁻¹) at Kalyani recorded maximum yield.

Integrated nutrient management registered maximum turmeric yield (17.52 t ha⁻¹ and 19.68 t ha⁻¹) at Pundibari and Raigarh respectively whereas organic management recorded maximum yield (27.2 t ha⁻¹) at Pottangi.

At Coimbatore, among the nine different treatments, the treatment single node cutting (5 g) planting in protray (1 month) recorded the highest yield (67.94 kg/plant) compared to control, primary full length rhizome (25-30 g) planted directly in the field which produced (43.77 kg/plot). Among the transplanted seedlings at Chintapalle, two node raised turmeric plants showed good growth and yield (26.57 t ha⁻¹) and on par with sowing of primary rhizomes directly in the field. By this method 350 kg of seed per acre is needed for planting compared to 1400 kg seed per acre in traditional practice of turmeric cultivation.

Tree Spices

The germplasm of the tree spices which include nutmeg, cinnamon, cassia and clove are collected, maintained, characterized and catalogued at Dapoli and at Pechiparai, three new collections were added at Pechiparai. The accession SA-13 of clove was significantly superior than other accessions and

recorded highest stem girth (39.78 cm), leaf length (13.70 cm) and leaf breadth (4.40 cm) and dry bud yield (4.50 kg/tree).

Among the nutmeg accessions evaluated at Pechiparai MF4 recorded maximum number of fruits/tree (1040), weight (75.24g), fruit weight maximum dry mace yield (418 kg/tree) and nutmeg oil (7.7 %). At Dapoli genotype DBSKKVMF 29 recorded maximum yield. Among twelve accessions of cinnamon, CV-5 recorded the highest dry bark yield (567.80 g) per tree whereas local check recorded less dry bark yield (272.80 g) per tree.

In a CVT at Pechiparai, among the six accessions of nutmeg, A9/150 recorded the maximum plant height (2.12m), stem girth (11.97 cm), number of branches (20.56), and recorded maximum number of fruits (32/tree). At Pechiparai among the cassia accessions D3 recorded maximum dry bark yield (226.12g per plant). In a CVT on cassia, at Dapoli the genotype KKVCTSH2 recorded higher girth (41.38 cm), oil percentage (7.34), followed by KKVCTSH 1 37.00 cm girth and (7.12 %) oil.

A mother garden was planted at Dapoli, Pechiparai (Coimbatore) and IISR with all the relevant varieties of cinnamon and nutmeg for future use as scion bank.

Cumin

Fifty accessions of seed spices were introduced and evaluated in new centres at Mandor and Sanand. At Jagudan in a new CVT the entries CUM-15 (623 kg ha⁻¹), CUM-16 (546 kg ha⁻¹) and CUM-18 (546 kg ha⁻¹) recorded the higher yield 17, 19 and 2.7 per cent higher over the best check GC-4.

At Jobner the results of pooled data indicated that the bio formulation FK 14+ FL 18 recorded significantly higher seed yield (279.61 kg ha⁻¹) over control and FK 14 and was comparable with FL 18. The cumin 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.



Fennel

The germplasm accessions RF 14 at Dholi, NDF 46, NDF 51 and NDF 84 at Kumarganj were reported as top yielders. In a CVT FNL 54 (2176 kg ha⁻¹) at Hisar, FNL 47 (1288 kg ha⁻¹) at Kumarganj, FNL 55 (1319 kg ha⁻¹) at Jagudan, FNL 52 (670 kg ha⁻¹) at Raigarh were found to be promising based on yield. In an IET at Jobner, entry UF-236 recorded maximum seed yield of 1848.15 kg ha⁻¹ followed by UF-191 (1685.19 kg ha⁻¹). In an initial evaluation trial (IET) in fennel at Hisar maximum seed yield was recorded in HF-151 (2107.4 kg ha⁻¹) followed by HF-212 (1979.8 kg ha⁻¹) showing an increase of 27.0 and 19.3 % over HF-33 (check). At Kumarganj as per yield data NDF-32 (39.55 g/plant), NDF-39 (38.16 g/plant) and NDF-31 (38.01 g/plant) were found to be alkalinity tolerant at 10, 20, 30 and 40 ESP levels.

Drip irrigation at 0.8 IW/CPE ratio with paired row planting, at par with irrigation at 0.8 IW/CPE ratio in normal row planting, recorded significantly higher fennel seed yield (30.80 t ha⁻¹) over irrigation at 0.4 and 0.6 IW/CPE ratios.

Beneficial effect of PGPR bioformulation was obtained in fennel by treating the seeds with FK14 (9.5 kg ha⁻¹) at Raigarh, whereas local popular variety HF-33 recorded maximum yield (1806.9 kg ha⁻¹) at Hisar and no significant difference in growth, yield and quality attributes in fennel was observed at Jagudan.

Fenugreek

In a CVT 2012 seed yield of different accessions varied from 408 kg ha⁻¹ to 2754 kg ha⁻¹. The accession FGK 52 recorded maximum seed yield (936 kg ha⁻¹) at Raigarh, FGK 44 at Coimbatore and Udaipur with a yield 408 kg ha⁻¹ and 1493 kg ha⁻¹ respectively, FGK 49 (1848 kg ha⁻¹) at Dholi, FGK 48 (2754 kg ha⁻¹) at Hisar, FGK 40 with a yield of 1458 kg ha⁻¹ at Kumarganj were also promising.

At Jagudan in an IET, the pooled over two year data revealed that entries JFg-268 (1981 kg ha⁻¹) and JFg-224 (1954 kg ha⁻¹) recorded significantly higher yield

over check GM-2, which were 10.67 and 9.13 per cent higher over the check GM-2. At Jobner UM-112 was top yielder in both normal and stress conditions. RMt-1, UM-124, UM-140, UM-228, UM-353, UM-304 and UM-302 were found to be the desirable entries for drought conditions.

In a PGPR trial in fenugreek, combination of FK14 (*Pseudomonas putida*) and FL18 (*Macrobacterium paraoxydans*) recorded maximum yield (1233.8 kg ha⁻¹) at Guntur, bio-formulation of FGK 14 + FL 18 recorded maximum yield (1587 kg ha⁻¹) and (1668.41 kg ha⁻¹) respectively at Kumarganj and Jobner whereas at Hisar maximum seed yield (2070.5 kg ha⁻¹) was recorded in a treatment bioformulation of FK 14 + FL 18 and no significant difference in between the treatment yield was observed at Jagudan.

Coriander

In a trial multilocation evaluation of germplasm, RD 410 at Coimbatore (7.5g/pl), RD-387(6.13g/pl) at Guntur and VDV/GL-49 at Jobner were promising. In the CVT trial initiated during 2012 the yield of coriander varied from 554.6 to 1912 kg ha⁻¹. Promising entries identified in coordinating centres were COR 46 at Guntur (1300 kg ha⁻¹), COR 43 at Kumarganj (1551 kg ha⁻¹), COR 56 (1481 kg ha⁻¹) at Jagudan, COR 53 (1202 kg ha⁻¹) at Raigarh, COR 44 (1622 kg ha⁻¹) at Jobner. COR 56 at Navsari (1220 kg ha⁻¹), COR 46 (554.6) at Coimbatore, COR 43 (2256 kg ha⁻¹) at Hisar, COR 44 at Udaipur (1198 kg ha⁻¹), COR 48 at Jabalpur (1533 kg ha⁻¹), COR 41 at Hisar and COR 50 (1919 kg ha⁻¹) at Dholi.

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 169 (1284 kg ha⁻¹) recorded maximum yield. New IET in coriander was initiated during 2012 at Jagudan, Guntur, Kumarganj and maximum yield was recorded by JCR 389 (1387 kg ha⁻¹), LCC 268 (1126 kg ha⁻¹), ND cor101 (1569 kg ha⁻¹) respectively at various centres.

In an experiment on identification of drought/alkalinity tolerant source in coriander at jobner, gen-





otype RCR-684 was top yielder in both normal and stress conditions. Based on the indices UD22, UD562, UD 801 and UD 86 were found to be the desirable entries for drought conditions.

Significant beneficial effect of PGPR bioformulations was obtained in coriander by treating the seeds with FK14 + FL18 (1192 kg ha⁻¹) at Guntur, seed treatment with FK 14 (735 kg ha⁻¹) at Coimbatore, seed treatment with FL18 at Raigarh (920 kg ha⁻¹), maximum yield (1764 kg ha⁻¹) was recorded by local popular variety (Hisar Anand) at Hisar, whereas the effect of bioformulations on growth and genotypes yield of coriander was not significant at Jagudan.

Monitoring

The programmes of various Centres were monitored by periodical reports (monthly and 6 monthly) and visits by the coordinator to the all the AICRPS centres and field visits to the experimental plots.

Transfer of Technology

The scientists of AICRPS among others are involved in the area of their operation focused in demonstration of the following technologies in many farmers field.

- FLD on off-season production of coriander LCC-234 (Guntur)
- Demonstrations of high yielding variety fennel GF-12 (Jagudan)
- Demonstrations of high yielding coriander variety GCor-2 (Jagudan)
- Demonstrations of high yielding coriander variety Rcr-480 (Jobner)
- Demonstrations of high yielding cumin variety Rcr-223 (Jobner)
- Demonstrations of high yielding fennel variety RF-143 (Jobner)
- Seed production LCC- 236 (Suguna) (Guntur)
- Popularization of high yielding turmeric variety Prathibha (Guntur)
- Management of rhizome rot of ginger (Raigarh)
- Disease free single node protrait multiplication of turmeric (Coimbatore)

- FLD on high yielding variety of RCr 436 (Pantnagar)
- Rhizome rot management in ginger by biofumigation using cabbage (Raigarh)
- Management of blight in large cardamom by bio control agents (ICRI, Sikkim)

In addition they are actively involved in interaction with farmers, departmental officers in 25 seminars, 40 Krishimelas, 5 TV shows and 11 Radio talks to popularize the farmer friendly technologies for higher returns.

Success story

The single node protrait multiplication of disease free seeds of turmeric was expanded to over 20 acres involving important farmers (30) who are happy with the technology in Tamil Nadu and Andhra Pradesh.

Five districts of Madhya pradesh viz., Vidisha, Shajapur, Seoni, Guna and Rajgarh have been severely affected by hailstorm. In contrast to the situation, APHU Dhania-1 (LCC-170) a variety developed and released through AICRPS, HRS, Lam was proved to be very successful. The farmers were amazed to see that in spite of heavy hailstorm, the damage caused to the APHU Dhania-1 (LCC-170) was very negligible.

Tribal welfare measures and new initiatives in North East.

The AICRPS centres located in tribal area are actively involved in multiplication and distribution of improved varieties for increased yield and better returns and 32 trials were under taken at North East during the current year.

Introduced released new varieties of black pepper to tribal areas at Pottangi (Odisha), Chintapalle (Andhra Pradesh) and Kolli hills in Tamil Nadu. Nucleus planting materials of improved varieties of ginger and turmeric were also introduced into Chattisgarh, Jharkhand and Nagaland.



Collaboration

During the year the AICRPS Centres were involved in production of disease free planting materials of (5 lakhs black pepper cuttings, 30,000 tree spices grafts/seedlings ,100 tons ginger, 150 tons turmeric, 60 tons seed spices) with the support from DASD under 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.





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 (AIC-SCIP) 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 mandates of the projects are:

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

Mandate crops and the centres of AICRPS

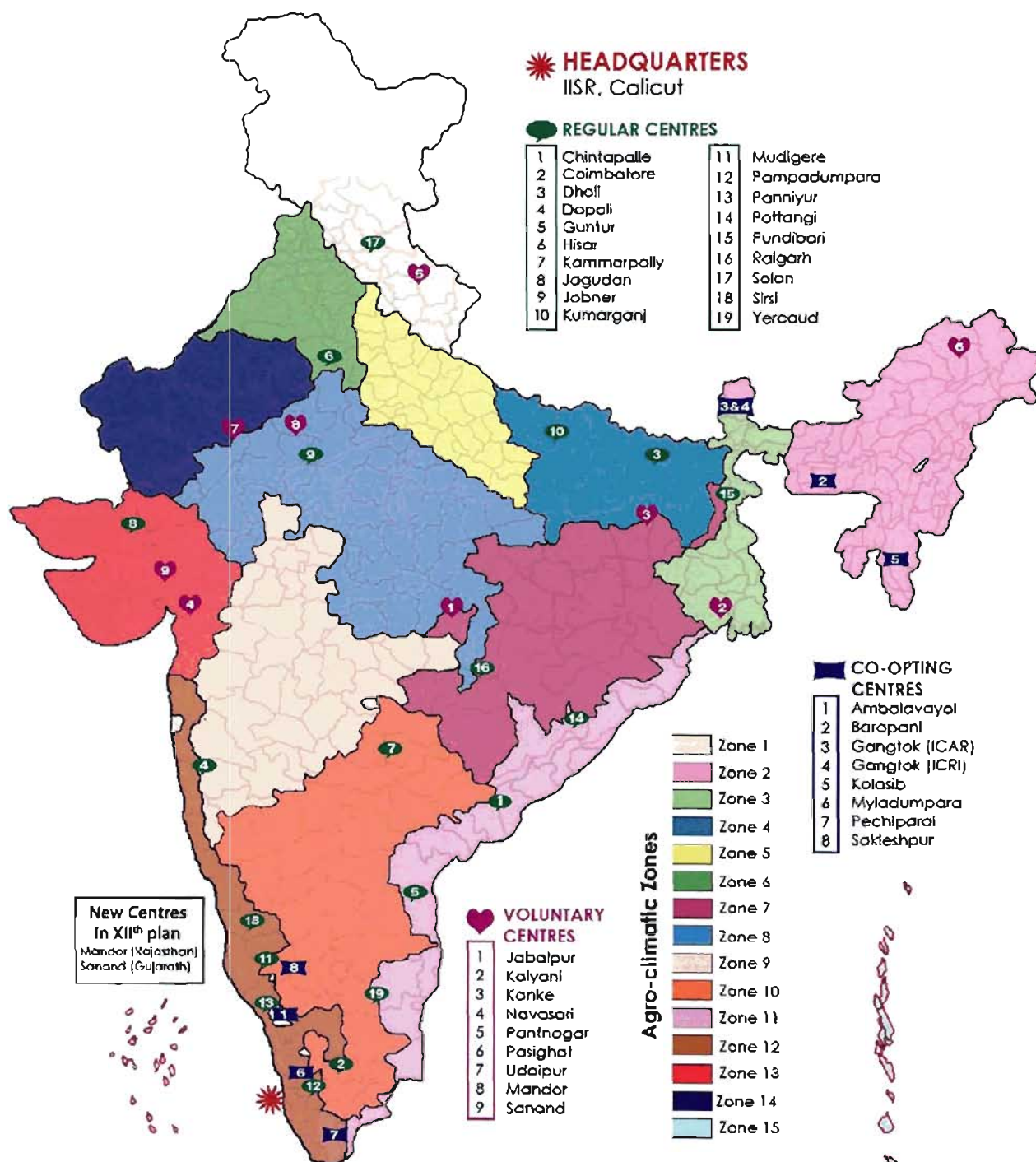
Sl. NO.	Crop	No. of Centres	Centres
1	Black pepper	10	Ambalavayal, Chintapalle, Dapoli, Kalyani, Pampadumpara, Panniyur, Pundibari, Sirsi, Yercaud, Pechiparai
2	Cardamom	4	Pampadumpara, Mudigere, Myladumpara, Sakleshpur
3	Large cardamom	2	Gangtok
4	Ginger	14	Ambalavayal, Barapani, Dholi, Calicut,* Kanke, Kalyani, Kumarganj, Mizoram, Pantnagar, Pasighat, Pottangi, Pundibari, Raigarh, Solan
5	Turmeric	13	Barapani, Calicut,* Coimbatore, Dholi, Kanke, Kumarganj, Pantnagar, Pasighat, Pottangi, Pundibari, Navsari Raigarh, Kammarpally, 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, Navsari
10	Cumin	5	Ajmer*, Jagudan, Jobner, Sanand, Mandour
11	Fennel	9	Ajmer, Dholi, Jabalpur, Jagudan, Jobner, Hisar, Kumarganj, Pantnagar, Udaipur
12	Fenugreek	12	Ajmer*, Coimbatore, Dholi, Guntur, Hisar, Jabalpur, Jagudan, Jobner, Kumarganj, Pantnagar, Raigarh, Udaipur

* IISR, Calicut and NRCSS, Ajmer undertake collaborative experiments



AICRP ON SPICES

CENTRES IN DIFFERENT AGRO-CLIMATIC ZONES



Agro-climatic Zones

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

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

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



I. Black pepper

PEP/CI/1 Genetic Resources

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

(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- Chintapalle*)



At present 262 cultivated types of black pepper and 54 wild types are being maintained at the Panniyur station (Table1). Fifteen new genotypes have been collected during 2013 from different pepper growing tracts of Kannur, Kasaragod and Thiruvananthapuram Districts. During the year 2013, the

genotypes PRS 64, PRS 154 and PRS 137 were the top yielders. PRS 64 ranked first with 3.11 kg green berry yield and 1050 spikes/vine. Spike length was maximum for PRS 155 (16.2 cm). Ambalavayal maintained 55 accessions in the black pepper germplasm.

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

Centre			Indigenous			Total
	Cultivated	Wild & related species			Exotic	
	Existing	Addition (April 2013 to March 2014)	Existing	Addition (April 2013 to March 2014)		
Chintapalle	38	-	-	-	-	38
Dapoli	34	2	1	-	-	37
Panniyur	262	15	54	-	-	331
Pechiparai	14	4	2	-	-	20
Pundibari	31	1	-	-		32
Sirsi	145	-	-	-	-	145
Yercaud	72	7	3	-	-	82
Ambalavayal	55	-	-	-	-	55
Total	651	29	60	-	-	740



In total, 145 germplasm accessions are being maintained at Sirsi. Under this project, a new experiment has been initiated to evaluate the performance of the new accessions collected (from the local source) and maintained in germplasm block. Fifteen (15) promising accessions were planted to the arecanut live standards which are in the initial stage of growth.

At Yercaud centre of TNAU, a total of 78 accessions in Black pepper are being maintained at germplasm conservatory. Among the 36 accessions evaluated, the accession PN 56 ($46.5/m^2$) and PN 70 ($44.5/m^2$) were found to be promising with respect to number of fruiting spikes per square meter.

The plant height varied from 2.21–3.81m in different varieties maintained at Dapoli centre. Panniyur 1 recorded maximum plant height (3.81 m) followed by PRS 64 (3.75 m) and HB 20052 (3.65m) and also recorded highest yield (77.80 g/plant) during the year 2013-14 (Fig 1).



Fig 1. Field view of Black pepper germplasm at Panniyur

At Pundibari 31 black pepper entries are being maintained in 2013 – 2014. One new entry of black pepper was collected during 2013 – 2014 from Terai region of West Bengal. At Pampadumpara 3 new black pepper germplasm was added during the year 2013-14 (Fig 2).



Neelamundi Benny
Olickal selection



Vattamundi Philip
Thomas selection



Benny 1 (Benny
Olickal)

Fig 2. New black pepper germplasm in Pampadumpara

Crop Improvement

PEP/CI/ Hybridization trial

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

(Centre: Panniyur)

During 2013-14, the hybrids PRS160 and PRS 161 have been found to be promising at Panniyur with maximum green berry yield of 3.5 kg/vine and 3.1 kg/vine respectively. Number of spikes /vine was 480 for PRS 160 and 325 for PRS 161 and PRS 161 recorded maximum spike length of 25.1 cm.

During 2013-14, the crosses PRS 4 x PRS 8 and P 1 x PRS 48 were successfully done to evolve varieties tolerant to biotic and abiotic stresses.





PEP/CI/3 Coordinated varietal Trial (CVT)

PEP/CI/3.2 CVT 2000-Series V

(Centres: Panniyur, Pampadumpara, Sirsi, Ambalavayal)

At Sirsi dry berry yield was the maximum in selection-2 (2.15 kg/vine) during the period and was significantly superior over others (Table 2). This was followed by Panniyur-1 (1.70 kg/vine) which was on par with, HP-105 (1.65 kg/vine), HP-34 (1.42 kg/vine).

PEP/CI/3.3 CVT 2006-Series VI

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

Among all the nine accessions tested at Pampadumpara, maximum dryweight of berries was recorded by Karimunda. Observations on plant growth parameters showed that maximum height was observed in the accessions ACC 7, CL-1090, HB-20052, Karimunda and Panniyur 1. At Panniyur during 2013, HB-20052 recorded the green berry yield of 2.9 kg/vine and was on par with ACC No.57 and C-1090 (2.2 kg/vine). The highest plant height was recorded by HB 20052 (3.2 m).

Table 2. Yield and yield attributing characters of Black pepper genotypes at Sirsi (2012-13)

Name of the Entries	Height of the vine (m)	No. of spikes/vine	Spike length (cm)	No. of berries/spike	Dry berry yield (g/vine)
HP-34	4.7	240	7.5	49	1.40
HP-105	5.5	308	6.4	48	1.65
OP K	3.8	248	10.4	34	0.60
HP-813	3.4	130	7.2	38	0.50
HP-1411	2.6	132	8.8	31	0.30
C-1041	2.8	163	7.0	26	0.78
P-24	3.5	154	7.2	26	0.75
PRS-17	4.9	228	6.4	39	1.28
PRS-21	1.7	11	7.7	30	0.45
PRS-22	2.9	74	5.2	29	0.48
C-5308	2.7	41	8.9	27	0.40
C-5489	3.1	71	9.8	37	0.35
Panniyur-1	5.3	388	11.3	70	1.70
Selection-2	5.0	458	10.5	50	2.15
CD (0.05)	0.67	58.55	0.42	4.47	0.29

At Ambalavayal Panniyur 1 recorded maximum yield (dry weight-1.70 kg/standard) followed by HP 1411 and HP 34 (1.57 kg and 1.27 kg respectively). PRS 17 recorded maximum 100 berry weight (13.3g) that was on par with Panniyur 1 and HP 1411(13). Cul 5489 and HP 105 had same 100 berry weight (12.00g) that was on par with Cul 5308 and OP Karimunda (11.67g).

At Sirsi among 11 entries, the height varied between 1.8 m to 3.3 m, maximum was in Sirsi-1 (3.3 m) followed by HB-20052 and PRS-88 (3.2 m each). Accession HB-20052 and PRS-64 initiated spikes and there were 15 and 25 numbers, respectively.



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 in 2011 and the crop is in vegetative phase only.

At Dapoli the data showed that the plant height varied from 2.21–3.81m in different varieties. Panniyur 1 recorded maximum plant height (3.81 m) followed by PRS 64 (3.75 m) and HB 20052 (3.65 m) and also recorded maximum yield (77.80 g/plant) in 2013-14.

Out of ten varieties of black pepper evaluated at HRS, Chintapalle (PRS-88, HB-20052 (Panniyur-8), Acc-33, Acc-53, Acc-57, Acc-106, C-1090, HP-39, Panniyur-1 and Karimunda) maximum plant height was noticed in Panniyur -8 (HB-20052) (301.66 cm) followed by Panniyur-1 (290.00 cm) and the lowest plant height was recorded by Acc-57, the differences were statistically significant.

The accession 53 recorded the maximum plant height of 4.99 m and dry berry yield of 1.58 kg/ vine at Pechiparai.

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

(Centres: Sirsi, Ambalavayal, Yercaud, Panniyur)

During the 2nd year of growth, the height of the rooted cuttings and the grafted vines attained between 0.68 m and 1.28 m at Sirsi. The maximum height was noticed in grafts of P-1 runner shoots on *Piper nigrum* var. IISR Shakti as rootstock (1.28 m) followed by grafts of Panniyur runner shoots on *Piper nigrum* var. IISR Thevam as rootstock (1.25 m).

The root stocks viz., *Piper colubrinum*, Shakti, Thevam were planted in tube pots and kept for hardening in mist chamber at Yercaud. Grafting will be done in June 2014 after receipt of the south west monsoon. The orthotropic shoots treated with IBA 1000 ppm were planted in poly bags and 85 % rooting was observed in the mist chamber. At Panniyur during 2013, maximum plant height (2.42 m) and green berry yield (1.63 kg) was recorded by runners of Panniyur grafted on *Piper colubrinum*.

At Ambalavayal the grafts, orthotropic shoots and runner shoots were planted in the main field.





Crop Management

PEP/CM/4 Nutrient management trial

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

(Centres: Chintapalle, Panniyur, Sirsi, Dapoli)

At Chintapalle two treatments inorganics and organics was imposed. Among the two treatments inorganic treatment (Recommended Package of Practices) showed maximum plant height (4.25 m), length of spikes (13.06 cm), maximum number of berries per spike (66) and fresh berry yield (3.86 kg/vine) compared to organic treatments.

During 2013-14, Recommended package recorded significantly higher green berry yield of (2.72 kg/vine) compared to organic package (1.68 kg/vine) at Panniyur. The spike yield (3.83 kg/vine) and number of spikes/vine (730) was also maximum for Recommended package which was significantly superior to organic package.

Dry berry yield of the vines treated with recommended package of practices was higher (1.20 kg/vine) at Sirsi compared to those of only organics (0.78 kg/vine). The B:C ratio was 1.48 : 1.00 for recommended Package of practices and 1.14 : 1.00 for organics respectively.

The treatment integrated package recorded maximum plant height (2.92 m/plant) followed by organic package (2.57 m/plant) at Dapoli.

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

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

During 2013-14, Recommended package recorded significantly higher green berry yield (2.72 kg/

vine) compared to organic package with green berry yield 1.68 kg/vine at Panniyur. The spike yield (3.83 kg/vine) and number of spikes/vine (730) was also maximum for Recommended package (T2) which was significantly superior to organic package.

The treatment integrated package recorded maximum plant height (3.11 m/plant) which was significantly superior over fully inorganic followed by fully organic package (2.53 m/plant) at Dapoli.

At Pechiparai significantly higher yield of 2.55 kg/vine was recorded by the integrated treatment (100 g *Azospirillum*+100 g N+ 40 kg P_2O_5 +140 kg K_2O +10 kg FYM per vine) followed by organic treatment (2.18 kg/vine).

The vines treated with 100 percent integrated methods recorded significantly higher dry berry yield (1.25 kg/vine) and B:C ratio 1.88 : 1.00 compared to those with 100 percent inorganics (0.97 kg/vine) with a B:C ratio 1.29 : 1.00 at Sirsi.

PEP/CM/4.6 Standardisation of drip fertigation

(Centre: Panniyur)

At Panniyur the trial was started in 2012-13 with five treatments. During 2013-14, 50 RDF + 8 l drip resulted in higher spike yield (7.75 kg/vine), green berry yield (5.43 kg/vine) and number of spikes/vine (1488 No./vine) which was on par with 75 RDF + 8 l drip and significantly superior to all other treatments.

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

The trial was initiated during 2013-14, and planting of intercrops completed.



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)

The trial was initiated at Ambalavayal 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, Chintapalle, Sirsi, Pampadumpara)

Survival and growth of black pepper cuttings of IISR-Shakthi, IISR-Thevam and Panniyur-1 and of the standards (*Ailanthus malabarica*) were satisfactory at Dapoli. Incidence of foot rot and leaf blight disease caused by *Phytophthora capsici* was not noticed during the year 2013.

The trial was started during 2011 at PRS, Panniyur. During 2013, application of consortium of bacteria (IISR-6 + IISR-859) recorded least disease incidence (33.3 %) and was on par with (Bordeaux mixture spray (1.0 %) + COC (0.1 %) drenching) and (*T. harzianum* (MTCC 5179) + consortium of bacteria (IISR-6 + IISR-859)) where PDI recorded was 37.0 % in both the treatments as against 63 % PDI in control.

At Chintapalle cuttings of IISR-Thevam and Panniyur-5 were multiplied in the shade net house and planted in July, 2011, plant stand is approximately 75.0 %. IISR-Shakti couldn't be rescued and they have procured from IISR-Kozhikode and are in multiplication stage.

At Sirsi, among the black pepper tolerant varieties, IISR Shakti and IISR Thevam showed tolerance and recorded significantly less disease of *Phytophthora* foot rot and were on par each other. Irrespective of varieties, black pepper vines treated with consortium of bacteria (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) and monsoon (Aug) recorded least disease incidence. Regarding height IISR Thevam recorded maximum and was statistically on par with IISR Shakti and Panniyur -1.

Statistical analysis of the data showed that among the three tested varieties, IISR Thevam showed the least disease incidence and the treatment Potassium phosphonate 0.3 % as spray and basal application of the biocontrol agent (*Trichoderma harzianum*) @ 50 g / vine was found the best at Pampadumpara.

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

(Centres: Sirsi, Chintapalle, 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 and third week August recorded statistically significant reduction in the disease with respect to leaf infection at Sirsi.

At Chintapalle spraying and drenching with 0.1 % of Fenamidone (10 %) + Mancozeb (50 %) coupled with soil application of *Trichoderma harzianum* (MTCC 5179) @ 50 g/vine with 1.0 kg neem cake recorded less yellowing (11.5 %), defoliation (13.98 %), death of vines (13.21 %) and recorded maximum yield (2.35kg/vine) that was on par with existing recommended practices for managing the foot rot





incidence i.e., Foliar application of Potassium Phosphonate (0.3 %) + Soil application of *Trichoderma harzianum* (MTCC-5179) @ 50 g/vine.

At Mudigere all the treatments were found effective in reducing the incidence of the disease compared to control. The treatment, spraying and drenching of 0.2 % Kocide 10 days after application of *T. harzianum* @ 50 g + 1 kg neem cake / vine was found more effective in reducing the disease incidence with maximum yield of 472.5 g / vine which was on par with spraying and drenching of 0.1 % Sectin + *T. harzianum* (50 g) + Neem cake 1 kg / vine.

PEP/CP/5.6 Biological Management of slow wilt in black pepper

(Centre: Panniyur)

The experiment was initiated during 2013 with the treatments, T1 – Soil application of *Trichoderma harzianum* + Neem cake @ 2 kg/vine, T2 – Soil application of *Trichoderma harzianum* followed by soil drenching with *P. fluorescens* @ 2 % ,T3 – Soil application of *Pochonia chlamydosporia* followed by soil drenching with *P. fluorescens* @ 2 % ,T4 – Soil application of *Pochonia chlamydosporia* @ 50 g/vine followed by soil drenching with *P. fluorescens* @ 2 % ,T5 – Soil application with Cartap hydrochloride @ 15g/vine, T6 – Soil drenching with Copper oxy chloride @ 0.3 % + Cartap hydrochloride @ 15g/vine, T7 – Control. All the treatments were imposed in the field.

PEP/CP/6 Pest management Trial

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

(Centre: Pampadumpara, Mudigere)

At Pampadumpara during the part of investigation it was observed that all the black thorned *Erythrina variegata* was badly affected by the insect damage. Farmers mostly preferred the black thorned type

due to its fast and luxuriant growth compared to the white thorned, *Erythrina type*. Introduction of the susceptible black thorned (*Erythrina variegata* L.) type into the locality was supposed to be one of the major reasons for the outbreak of gall wasp in large proportions. The white thorned type *Erythrina stricta* are also infested by this pest. Thorn less *Erythrina type*, *Erythrina subumbrans*, commonly known as seemamurukka in Kerala was completely devoid of infestation of *Erythrina* gall wasp (Fig 3). The tolerance of *Erythrina subumbrans* to gall wasp already confirmed at Mudigere centre.



Fig 3. Field view of *Erythrina subumbrans* tolerant to gall wasp



II. 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 177 cardamom accessions are presently conserved in the gene bank at Pampadumpara. Among them 73 cardamom accessions (CRSP 1-73) got IC numbers (547920 to 547992) from National Bureau of Plant Genetic Resources, New Delhi. Ten new additions were made to the germplasm during 2013-14 (Table 3). Perusal of yield data showed that among top 10 high yielding accessions, HY10 registered a maximum wet (1500.7 kg ha⁻¹) and dry yield (262.6 kg ha⁻¹) during the year 2013-2014 followed by MCC 18 and HY 13.

At Mudigere 132 cardamom lines have been replanted during 2010 and the observations on growth and yield parameters will be recorded after third year.

Table 3. Cardamom germplasm collections of AICRPS centres

Centre	Indigenous		Total
	Cultivated	Wild and related sp.	
Mudigere	132	-	132
Pampadumpara	177	-	177
Total	309	-	309



Fig 4. Cardamom accession reported to be tolerant to thrips

Crop Improvement

CAR/CI/2 Hybridization

CAR/CI/2.2 Hybridization and selection in cardamom

(Centre: *Mudigere*)

Different F1 combinations were produced by crossing seven improved elite genotypes in all possible combinations and the seedling will be raised and evaluated in the coming seasons.

CL-691, CL-726, CL-722 were promoted to CVT based on their yield performance in the IET and the entries are being evaluated in different location in order to assess their yield stability over different environmental conditions.

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

(Centre: *Mudigere, Pampadumpara, Myladumpara, Appangala*)

Among 13 genotypes evaluated at Mudigere, IC-346951 (310.0 kg ha⁻¹) recorded maximum dry





capsule yield followed by CL-726 (298.0 kg ha⁻¹) and IC-547167 (274.0 kg ha⁻¹).

At Pampadumpara significant differences existed for all the plant growth parameters viz., plant height, leaf length, leaf width and number of tillers per clump among the 13 accessions (IC 349545, IC 349651, IC 547167, IC 547185, CL 726, CL 691).

Among the entries, all growth parameters and yield per hectare (583.3 kg ha⁻¹) were superior in PL-14 (RRS, Pampadumpara) compared to other clones at Myladumpara. Incidence of thrips were recorded and the maximum thrips population was observed in PL-14 (RRS, Pampadumpara) & IC-349651 (RRS, Appangala) followed by ICRI-2. Minimum thrips incidence was observed in CL-691 and SKP-164.

Among the 13 entries in the coordinated varietal trial at Appangala IC 349545 recorded the maximum dry yield/ha (732.05 kg ha⁻¹) followed by IC 349651 (717.12 kg ha⁻¹) for a period of two years evaluation.

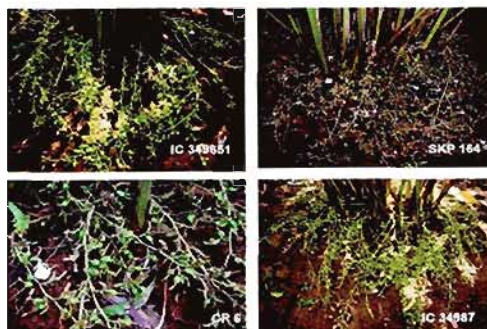


Fig 5. Promising cardamom accessions at Sakleshpur

At Sakleshpur significantly more capsules (3.6) were found in (IC 547185) followed by (IC 349651), (IC 547185) & T9 (MCC 346) (3.4) (Table 4). Yield was significantly more in IC 34987 (816.2) followed by T11 SKP164 (800.2) (Fig 5).

Maximum percentage (58.3 %) of bold capsules (capsules retained in 8 mm sieve) were found in (MCC 346) followed by SKP 164 (48.8 %) (Table 4). Least incidence of capsule borer (1.2 %) was observed in CL 726. Thrips incidence (0.8 %) was least in CL 691.

Table 4. Performance of cardamom accessions in a CVT at Sakleshpur (2013-2014)

Sl No	Genotype	No. of tillers	Height of Tiller (cm)	No. of leaves	No. of br. tiller	No. of panicle	Racemes/ panicle	No. of capsules/ raceme	(Yield kg ha ⁻¹)
1	IC 34987	31.7	241.7	14.9	18.5	29.9	21.7	3.1	816.2
2	IC 349651	27.5	211.7	13.3	16.6	27.4	20.2	3.4	718.2
3	IC 547167	27.9	230.1	14.3	17.0	27.4	20.1	3.1	670.8
4	IC 547185	23.9	232.1	14.1	12.7	22.1	19.2	3.6	603.0
5	CL 726	28.0	215.9	13.2	15.1	25.3	19.3	3.4	625.3
6	CL 691	25.3	200.4	14.6	13.9	24.5	19.4	3.0	557.2
7	PL.No.14	21.8	229.5	15.0	11.5	19.7	19.7	3.3	483.7
8	CR 6	24.0	250.8	15.9	13.9	23.5	18.7	3.2	554.3
9	MCC 346	28.3	265.3	15.6	16.5	29.2	19.5	3.4	719.7
10	SKP 104	25.9	255.5	14.8	16.1	29.7	20.7	3.1	755.5
11	SKP 164	30.3	221.7	14.9	18.5	31.3	20.9	3.1	800.2
12	MCC 260	19.7	204.7	15.2	10.9	18.9	18.3	3.3	422.8
13	Control	26.4	212.9	14.0	14.2	24.7	18.3	3.1	537.8
14	ICRI 3	27.3	204.9	14.1	16.7	27.6	20.5	3.3	708.0
	CV (%)	13.18	12.07	10.76	14.72	11.76	6.03	8.69	11.90
	CD (0.05)	5.81	45.98	2.63	3.74	5.09	2.00	0.47	28.00



CAR/CI/4 Varietal Evaluation Trial (VET)

CAR/CI/4.1 Initial Evaluation Trial-1 2009

(Centre: *Mudigere*)

This experiment was initiated at Mudigere during 2009 and the entry Darmala (268.4 cm) was found tallest followed by CL-728 (259.4 cm). Total number of suckers/plant was recorded more in valley No.1 (21.4) followed by CL-720 (17.50).

CAR/CI/4.2 Initial evaluation trial –II 2009

(Centre: *Mudigere*)

Among the 10 genotypes evaluated at Mudigere, more plant height was found in 2-4-D11 (278.5 cm) and more total number of suckers/plant was observed in another clone 2-5-D11 (23.0) followed by 12-7-D11(21.5).

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 Management

CAR/CM/5 Nutrient management Trial

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

(Centres: *Mudigere, Pampadumpara*)

Experiment showed significant difference among the treatments. Application of irrigation 9 lt./clump/day along with 100 % Recommended dose of

fertilizer through drips recorded the highest capsule yield (220.35 kg ha⁻¹) that was on par with irrigation 9 lt./clump/day with 75 % Recommended fertilizer dose (215.25 kg ha⁻¹). The conventional method of irrigation recorded an yield (160.57 kg ha⁻¹) in this experiment. Water (44 %) and 25 % of recommended dose of fertilizer was saved through drip fertigation.

At Pampadumpara the experiment is in progress.

CAR/CM/5.3: Effect of different organics on yield and quality of cardamom

(Centre: *Mudigere*)

Application of organics with bio-fertilizers recorded significantly higher yield than only organics.

The maximum dry capsule yield (255.66 kg ha⁻¹) was obtained with Recommended package (T9) FYM (30 t ha⁻¹) + NPK 125:125:250 kg ha⁻¹ that was on par with the treatment *Azospirillum* (10g/clump) + PSB (10g/clump) + *Trichoderma* (10g/clump) (245.81 kg ha⁻¹) (Table 5). Marginal improvement in soil N.P.K. was observed. Quality parameters was not influenced by the application of organics.



**Table 5. Yield and Yield attributing characters as influenced by organics at Mudigere**

Treatment	No. of bearing suckers/clump	No. Panicles/clump	Panicle Length (cm)	Capsules / Panicle	(Yield kg ha ⁻¹)
T1	182.6	242.7	355	150	195.66
T2	190.5	230.0	350	125	190.75
T3	161.6	210.0	340	165	201.33
T4	164.4	190.0	340	125	173.67
T5	180.0	250.0	210	175	245.81
T6	170.0	245.0	365	165	235.47
T7	150.0	240.0	350	175	236.65
T8	140.0	225.0	345	130	191.32
T9	190.0	245.0	345	195	255.66
SEm ±	0.99	1.86	1.72	0.43	3.66
CD (0.5)	3.28	5.12	N.S	0.75	9.98
CV (%)	15.55	15.85	15.19	15.0	11.35

Evaluation of the effect of different organic amendments on growth and yield of cardamom variety PV 2 at Pampadumpara was not significant. However highest fresh (276.28 kg ha⁻¹) and dry capsule yield (52.35 kg ha⁻¹) was realized with the combined application of Jeevamitha 20 litres per clump; 10g *Azospirillum*/clump; 10g PSB/clump and *Trichoderma* 10g/clump followed by the application of Jeevamritha 20 litres/clump.

CAR/CM/5.4: Liming in Cardamom

(Centre: Pampadumpara)

Maximum fresh (1340.14 kg ha⁻¹) and dry yield (285.34 kg ha⁻¹) of cardamom was observed for the treatment application of dolomite @ (T4) 2 kg plant⁻¹ with 62.5 % increase in dry yield over control (Fig 6) followed by application of dolomite @ 1 kg plant⁻¹.

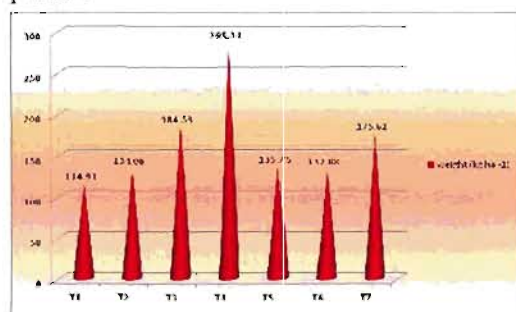


Fig 6. Effect of different liming materials on yield of cardamom

Disease Management

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

(Centre: Pampadumpara)

Lowest disease incidence in cardamom at Pampadumpara was observed in the treatment T1 (Bavistin (2g/l) applied as foliar spray as well as basal application. Highest incidence of fusarium rot was observed in control plants (Fig 7).

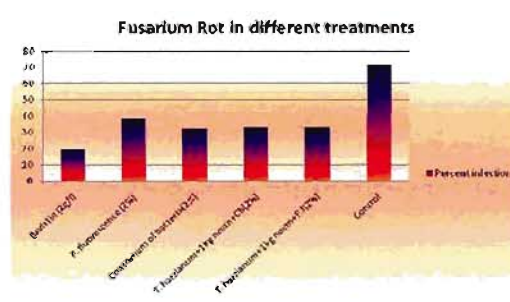


Fig 7. Effect of chemical as well as bio-control agents against Pseudostem rot of cardamom

All the treatments were found effective in reducing the rot compared to control at Mudigere. The minimum tiller infection (7.05 %) with significantly higher yield (688 g / plant) was recorded by spraying of 0.2 % Bavistin followed by application of *T. harzianum* with neem cake and spraying of 0.2 % *Pseudomonas fluorescens*.



III. Large Cardamom

LCA/CI/1 Genetic Resources

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

(Centre: Eastern Himalayan region; ICRI Regional Research Station (Gangtok)



Fig 8. Germplasm collection at Singhik at Sikkim

Germplasm of Large Cardamom maintained at ICRI Regional Research Station, Gangtok is shown in Table 6.

Survey was made at different areas of Sukhia Pokhri, Darjeeling district of West Bengal and South and North district of North Sikkim for collection of germplasm (Fig 8). Six planting units of three germ-

plasm viz. SCC 249 (Gimnaley), SCC 250 (Varlangey) and SCC 251 (Varlangey), were collected and planted under AICRPS trial plot at Kabi farm. Characterizations of the collected germplasm were made as per descriptor. Monitored, maintained and recorded data from AICRPS trial plot located at Singhik, Mangan, North Sikkim.

Table 6. Large cardamom collections maintained at ICRI Regional Research station, Gangtok

Centre	Indigenous				Exotic		Total
	Cultivated		Wild & related species		Addition (April 2013. to March 2014)		
	Existing				Existing		
		Addition (April 2013 to March 2014)	Existing	Addition (April 2013. to March 2014)			
ICRI,RRS, Gangtok	237	03	11	NIL	NIL	NIL	251
ICAR (Gangtok)	7	-	-				7
Total	244						258





Few germplasms of large cardamom have been newly collected and being maintained at the ICAR Research complex centre, Gangtok. At present 7 different germplasms viz., Ramsey, Sawney, Dzongu Golsey, Varlangey, Seramney, Madhusai and Dudhe Golsai are being maintained.

Disease Management

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

(Centre: ICRI Regional Research Station (Gangtok))

Incidence of pests and diseases was recorded in trial plots in farmer's fields at Singhik, North Sikkim. Treating suckers with the bioagents (PF + BS, 3 % each) showed less incidence of blight as compared to control. Based on this, a recommendation was brought out for disease management in nursery and new field planting by treating with bioagents.

Moderately tolerant and moderately susceptible germplasm accessions against blight were planted in disease hot spot area (Kabi) for field evaluation with ICRI Sikkim 2 as control. There were seven treatments, with three replications having a plot size of 12 plants and the trial is in progress.

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 as T₁ Control, T₂ Phytosanitation and application of bio- agents in Exploded Block Design (EBD), with 20 plants in each treatment. Targeted pests and diseases were leaf caterpillar (*Artana chorista*), Shoot fly (*Merchlorops dimorphus*), *Colletotrichum* blight and Chirke and foorkey (viral diseases).

Treatment imposed and data recorded as per the technical programme. It was observed that the incidence of the pests and diseases was less in treated plots than in control plot.

Intergrated Management of insect pests and diseases in Large cardamom

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

A comparison of integration of developed technologies for controlling pest and diseases with farmers practice was done at ICAR Research complex for NEH Region, Gangtok (Table 8). In general pest and diseases incidence was less in plots in which integrated technologies was applied compared to farmers practice.



Table 7. Evaluation of management strategies for controlling of insect pests and diseases in large cardamom.

Treatment	Practices adopted	Incidence of insect pests (%)	Disease incidence (%)
Plot-1: Management strategies adopted through integration of all developed technologies	<ul style="list-style-type: none"> Collection and destruction of damaged leaves, shoots and plants due to attack of insect pests and diseases. Four Spraying of neem oil 0.15EC @ 3 ml/l at 20 days interval from June onwards. Four Spraying of Copper oxychloride @ 2.5 g/l at 20 days interval June onwards. After harvest cleaning of plantation, collection and destruction of infested leaves, shoots and plants. Application of manure (vermicompost 100 g + poultry manure 400 g + 1kg FYM) per plant after harvest. Life saving irrigation at 30 days interval till March. 	Stem borer - 5.00. Shoot fly - 8.75 Leaf eating caterpillar -3.75	<i>Colletotrichum</i> leaf blight-15.00 Foorkey-3.75 Chirkey-5.00
Plot-2 : Farmer's practice.	Cleaning of base of the plants during harvest	Stem borer- 17.50 Shoot fly- 22.50 Leaf eating caterpillar-16.25	<i>Collectotrichum</i> leaf blight-71.25 Foorkey-16.25 Chirkey-27.50

Data are mean of total 80 plants (20 from each four sub-plots)





IV. 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*)



Fig 9. Field view of ginger at Ambalavayal

Germplasm of ginger maintained at various centres is shown in Table 8. Out of fifty seven accessions evaluated at Dholi, only eleven accessions namely RG-18, RG-30, RG-54, RG-14, RG-28, RG-37, RG-34, RG-29, RG-17, RG-19 and RG-24 recorded the maximum yield ranging from (0.90 kg plant⁻¹ to 0.29 kg plant⁻¹) as compared to check variety Nadia (0.267kg plant⁻¹) (Table 8). Among eleven promising lines, RG-18 produced maximum yield per plant (0.90 kg) followed by RG-30 i.e., 0.880 kg per plant.

Table 8. Ginger germplasm collection of AI-CRPS centres

Centre	Indigenous	Exotic	Total
Dholi	57	-	57
Kumarganj	61	-	61
Pottangi	128	-	128
Pundibari	61	-	61
Raigarh	231	-	231
Solan	231	-	231
Total	769	-	769

Out of 61 germplasm of ginger evaluated at Kumarganj, promising lines identified were NDG-55 (33.6 t ha⁻¹) and NDG-6 (13.5 t ha⁻¹) with respect to yield. NDG-6 and NDG-7 were observed as soft rot tolerant germplasm accessions.

Two hundred and thirty one ginger collections were evaluated for rhizome yield and other horticultural traits at Solan. The yield range of 21 best genotypes varied from 11.4 t ha⁻¹ (SG-1045) to 16.1 t ha⁻¹ (SG-857). Yield of three lines viz., SG-857 (16.1 t ha⁻¹), SG-12-04 (14.50 t ha⁻¹) and SG-1134 (13.8 t ha⁻¹) excelled the check Himgiri which yielded (12.2 t ha⁻¹). The rhizome rot disease incidence varied from 10.00-27.41 % with 10.00 % and 14.50 % in SG-857 and Himgiri, respectively.

Out of 128 ginger germplasm studied at Pottangi, 55 accessions recorded more than 10 kg/3m² fresh rhizome yield, the range of plot yield being 5.4 kg (PGS-31) to 21.3 kg/3 m² (Renga Local-2). Other promising accessions are wild Ginger-1 (14.8 kg/3m²), S-554 (14.4 kg/3m²), V2E4-5 (13.6 kg/3m²), PGS-58 (13.6 kg/3m²), PGS-83 (13.5 kg/3 m²) and China (13.5 kg/3m²) etc.

At Pundibari sixty one entries of ginger were



evaluated in 2013 – 2014 for identification of promising entry(s) for lower gangetic plain agro-climatic region.

Two new entries of ginger were collected in 2013 – 2014. Germplasm evaluation revealed that highest rhizome yield/plot was recorded by GCP-33 (16.20 kg) and lowest rhizome yield / plot was recorded by GCP-10 (1.20 kg).

Three different germplasm of ginger viz., Bhaishhe, Garubathani and Majaole have been collected and cultivated around 1 ha for multiplication at ICAR Research Complex for NE region at Gangtok.

Crop Improvement

IN/CI/2 Coordinated Varietal Trial

GIN/CI/2. Coordinated Varietal Trial (CVT-2013) of Ginger

(Centres: Solan, Pottangi, Dholi, Pundibari, IISR)

At Solan average yield varied from 6.2 t ha⁻¹ to 21.7 t ha⁻¹. The local check genotype SG-26-04 recorded maximum yield (21.1 t ha⁻¹) followed by local check variety Himgiri (12.2 t ha⁻¹) and National check variety Varada (10.2 t ha⁻¹). The rhizome rot disease incidence varied from 9.75-25.22 % with minimum in SG-26-04.

Out of 8 entries tested in RBD with 3 replications during Kharif 2013 at Pottangi, it was found that the entry VISI-2 (16.6 t ha⁻¹) was the top yielder with the yield advantages of 11.94 % than the national check variety Varada (14.6 t ha⁻¹) followed by RG-32 (16.3 t ha⁻¹), GCP-49 (16.2 t ha⁻¹) and Acc-65 (15.7 t ha⁻¹).

At Dholi among six promising entries and two checks (National check Varada & local check Nadia), two entries RG-3 and RG-32 recorded significantly higher plant height (51.53 & 47.07cm), number of tillers per plant (27.30 & 24.50), number of leaves per

tiller (19.03 & 17.37), delayed maturity (235.33 & 236.67 days) and yield per hectare (11.38 & 10.44 t ha⁻¹) as compared to best check variety Nadia.

In coordinated varietal trial on ginger at Pundibari – 2013, the genotype GCP-49 recorded the maximum yield of 26.5 t ha⁻¹ followed by VISI-2 with a yield of 12.4 t ha⁻¹ in 2013-14.

The seven AICRPS test accessions along with check IISR Rejatha were evaluated at IISR during 2013-14 for the yield. Among the ginger accessions studied, maximum yield (14.9 t ha⁻¹) was recorded in (Acc. 219) followed by RG 3 (11 t ha⁻¹).

At Raigarh in a CVT trial 2013 maximum yield in ginger was recorded by the entry ACC-48 (17.28) and found to be moderately resistant to both the diseases. The local check used in the Trial IT-10 also registered same yield (17.4 t ha⁻¹) and was moderately resistant to both the diseases.

GIN/CI/3.2 Initial evaluation trial 2011

(Centres: Solan, Pundibari, Dholi)

Average yield of ginger at Solan varied from 10.1 t ha⁻¹ to 21.1 t ha⁻¹. The genotype SG-26-04 recorded maximum yield (21.1 t ha⁻¹) followed by SG-08-04 (17.2) and SG-908 (16.1 t ha⁻¹) whereas the check Himgiri yielded 12.2 t ha⁻¹. The rhizome rot disease incidence varied from 9.75-19.85 % with minimum in SG-26-04.

In initial evaluation trial of ginger 2011 at Pundibari, pooled analysis for three years shown that maximum yield (14.8 t ha⁻¹) was registered by GCP-49 followed by GCP-8 (11.9 t ha⁻¹).

Among nine promising entries and one check variety Nadia evaluated at Dholi, RG-18 registered significantly higher yield (21.1 t ha⁻¹) and percent increased yield over the check variety Nadia was (29.2).

At Kumarganj 7 entries of ginger were evaluated in IET during the kharif season. The maximum yield was recorded by Baidra sonth (33.6 t ha⁻¹) fol-





lowed by NDG-28 (15.3 t ha⁻¹) and NDG-6 (14.8 t ha⁻¹). NDG-6 was also observed as soft rot tolerant entry in the trial.

GIN/CI/3.3 - Initial Evaluation Trial 2013

(Centre: Pottangi)

Out of 18 entries tested in RBD with 3 replications at Pottangi, the entry V1E4-5 (21.6 t ha⁻¹) was the top yielder with the yield advantage of 44.2 % than the national check variety Varada (12.1 t ha⁻¹) followed by S-642 (19.7 t ha⁻¹), PGS-58 (18.3 t ha⁻¹) (Fig 10). Maximum rhizome weight was observed in V1E4-5 (351.7g). The weight of rhizomes varied from 161.7g (Kg-49) to 351.7g (V1E4-5) with a mean value of 251.1g.

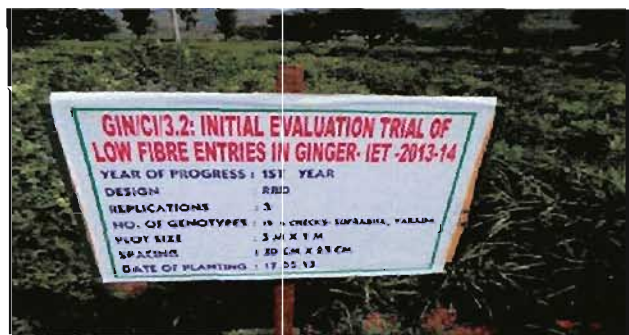


Fig 10. Field view of Ginger IET at Pottangi

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

(Centres: *Western Himalayan region-Solan; Eastern himalayan region-Pasighat, Mizoram, Barapani; Lower gangetic plain - Pundibari, Kalyani; East cost plains and hills region - Chintapalle; Eastern plateau and hills region-Pottangi*)

Growth, yield and quality parameters were studied among the nine varieties of ginger in RBD with three replications during 2009-10 to 2012-13 at Pasighat, Arunachal Pradesh (Table 9). Pooled analysis of the data over four years revealed that maximum rhizome yield was observed in the variety Surabhi (0.23kg/plant, 8.73 kg/3m², 29.0 t ha⁻¹), while lowest

rhizome yield was recorded in variety Rejatha (0.13 kg/plant, 4.98kg/3m², 16.5 t ha⁻¹). The variety Suruchi recorded higher dry recovery of rhizome (22.77 %) whereas lowest dry recovery was observed in Himgiri (19.29 %). The variety Mahima showed lowest crude fibre content (3.32 %), minimum essential oil (1.63 %) where as highest crude fibre was noticed in the variety Nadia (6.22 %). The maximum oleoresin content was observed in V3S1-8 (9.81 %), and it was statistically at par with variety Suruchi (9.51 %) while lowest oleoresin content was recorded in the variety Himgiri (5.03 %).

At Solan average yield of ginger varied from 8 t ha⁻¹ to 21 t ha⁻¹. The local check SG-26-04 recorded maximum yield (21 t ha⁻¹) followed by Himgiri (12 t ha⁻¹). The rhizome rot disease incidence varied from 9.75-19.55 % with minimum in SG-26-04.

It was concluded from the four years data (2009-2012) that the clone V1E8-2 (19.6 t ha⁻¹) was the highest yielder among all the entries followed by V3S1-8(18.8 t ha⁻¹) and NDG-2(18.0 t ha⁻¹) at Pottangi.

At Chintapalle, during the year 2013-14, observations revealed that Nadia recorded maximum plant height (53.00 cm), yield (33.7 t ha⁻¹) followed by Varada (24.7 t ha⁻¹) and lowest yield was recorded by Himgiri (7.4 t ha⁻¹). All the genotypes were susceptible for ginger rhizome rot disease and the symptoms were visible from the month of August.

The maximum yield was recorded by Himgiri (16 t ha⁻¹) followed by Nadia (14 t ha⁻¹) and Mahima (13 t ha⁻¹). Plant height was highest for Nisapui (Local) (44.7 cm) followed by varada (41.8) and Nadia (39.3) at Mizoram.



Table 9. Performance of Ginger varieties under G x E interaction at Pasighat (2009-2013)

Varieties	Plant height (cm)	Number of tillers /plant	Leaf length (cm)	Leaf breadth (cm)	Yield/ plant (kg)	Yield/ bed (kg/ 3m ²)	Pro- jected yield (t ha ⁻¹)	Dry re-covery (%)	Crude fibre (%)	Oleo- resin (%)	Oil (%)
Suprabha	48.65	12.50	20.22	2.38	0.18	6.73	22.43	19.99	4.50	8.33	1.81
Suruchi	55.76	11.63	20.08	2.55	0.17	6.12	20.38	22.77	3.83	9.51	1.98
Surabhi	52.63	12.90	22.11	2.54	0.23	8.73	29.09	22.20	4.05	9.25	1.94
V3S1-8	48.40	10.00	19.09	2.48	0.15	5.53	18.43	20.93	3.54	9.81	1.75
Himgiri	50.85	9.95	20.18	2.56	0.14	5.31	17.70	19.29	5.38	5.03	1.65
Varada	50.98	9.67	21.27	2.46	0.15	5.68	18.92	19.62	3.87	6.81	1.72
Mahima	55.40	10.13	21.81	2.55	0.16	6.05	20.14	21.71	3.32	5.13	1.63
Rejatha	51.10	9.87	20.13	2.36	0.13	4.98	16.59	20.40	3.96	5.73	1.72
Nadia	60.04	10.93	21.59	2.54	0.20	7.67	25.55	21.90	6.22	6.11	1.72
GM	52.65	10.84	20.72	2.49	0.17	6.31	21.03	20.98	4.30	7.30	1.77
CV (%)	3.21	4.01	3.63	2.05	7.68	6.75	6.76	1.37	2.25	3.12	2.19
SEm±	0.98	0.25	0.43	0.03	0.01	0.25	0.82	0.17	0.06	0.13	0.02
CD (0.05)	2.93	0.75	1.30	0.09	0.02	0.74	2.46	0.50	0.17	0.39	0.07

GIN/CI/4 Quality Evaluation Trial

GIN/CI/4.1 Evaluation of germplasm for quality

(Centre: *Solan*)

Main objective of the trial is to identify high yielding and good quality genotypes for further promotion in IET and CVT. Forty six best performing genotypes of ginger was analyzed at Solan. The dry matter content (%) and crude fibre (%) ranged between 17.75 (SG-1118) to 24.15 (SG-247) and 4.10 (SG-04-04) to 5.31 (Himgiri), respectively. Essential oil (%) and oleoresin contents (%) varied from 0.70 (Varada) to 1.66 (SG-26-04) and 3.02 (SG-929) to 4.48 (SG-857) respectively. The high yielding genotype SG-26-04 was found superior/ comparable for dry matter content, essential oil, oleoresin and crude fibre contents to the check Himgiri.

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)

At Dholi among seven treatment and one control, FYM (100 %) 20 t ha⁻¹ and integrated nutrient management (FYM-30 t ha⁻¹, N:P:K:80:50:80 kg ha⁻¹) recorded significantly higher yield compared to control (9.29 t ha⁻¹) in which recommended dose of INM @FYM-30 t ha⁻¹, N:P:K:80:50:80 kg ha⁻¹ registered the maximum yield (16.10 t ha⁻¹). Regarding cost benefit ratio, recommended dose of INM recorded the maximum return Rs.3.00 per unit cost





(1:3.00) followed by FYM-100 % @20 t ha⁻¹ with a 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*)

During the year 2013-14, observations revealed that, maximum per plant yield (518.3 g/plant) was recorded by application of Oxyfluorfen 0.3kg a.i./ha as pre emergent spray, followed by Quazilofop ethyl (30 days of crop) 0.05 kg a.i./ha that was on par with weed free check.

Disease Management

GIN/CP/6 Disease Management Trial

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

(Centres: Dholi, Ambalavayal, Pampadumpara)

A survey was conducted at Vaishali district of Bihar, to record severity of bacterial wilt and soft rot incidence at Dholi. Bacterial wilt incidence of ginger ranged from 5 to 60 % with mean disease incidence of 30 % whereas soft rot disease ranged from 0 to 25 % with mean disease incidence of 14 %. The crop was also found to be infected with *Phyllosticta* leaf spot disease incidence in the range of 0 to 35 % with mean disease incidence of 23 %.

At Ambalavayal germination percentage was higher when ginger rhizomes were treated in metalaxyl mancozeb 72 % WP (72.00 %) and it was least when the soil was biofumigated (54.00 %) (Fig 9). But soft rot incidence and leaf spot incidence were found to be minimum in plots where the soil was bio-fumigated using cabbage (56.0 % and 1.00 % respectively) and rhizome yield was also higher in these plots (20.0 t ha⁻¹).

Minimum soft rot incidence was recorded for rhizome treatment by IISR-GRB followed by soil fumigation using cabbage at Pampadumpara (Fig 11). Maximum yield was recorded by soil fumigation using cabbage followed by rhizome treatment by Metalaxyl-Mancozeb 75 % wettable powder.

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

(Centre: Pundibari, Ambalavayal, Pampadumpara)

At Pampadumpara minimum bacterial wilt incidence was recorded for rhizome treatment by heat followed by soil treatment with bleaching powder. Highest yield was recorded by soil fumigation using cabbage followed by soil treatment with bleaching powder (Fig 12).

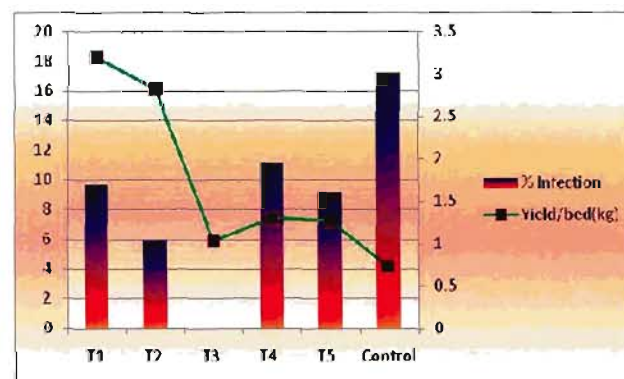


Fig 11. Bacterial wilt incidence in ginger as influenced by different treatments

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)

In efficacy of different fungicides against leaf spot disease of ginger trial in 2013-14 at Pundibari, it was found that foliar spray with hexaconazole (0.1 %) first at disease appearance and then 2 times at 20 days interval was the best treatment as it produced the lowest leaf spot disease severity (PDI 10.22) and high-



est yield of 7.58 kg/plot (15.27 t ha⁻¹). Same treatment reduced the disease incidence to 69.49 % compared to control.

At Dholi lowest disease (PDI 22.77) with maximum yield (21.89 t ha⁻¹) over control (PDI 51.11 with a yield (10.99 t ha⁻¹) was recorded by the treatment where foliar spray with Carbendazim + Mancozeb (0.1 %) was given first at the appearance of disease and subsequently 2 sprays at 20 days interval after 1st spray.

The highest germination of ginger was found in foliar spray with COC (0.1 %) T₄ followed by fo-

liar spray with Tricyclazole (0.1 %) T₆ and foliar spray with Carbendazim + mancozeb T₃ which were statistically at par with each other at Solan (Table 10). Minimum leaf spot incidence was recorded in spraying of Hexaconazole (0.1 %) T₇ which also resulted in maximum (83 %) disease control followed by propiconazole T₅, (Carbendazim+Mancozeb) T₃ and Tricyclazole T₆ which were statistically at par with each other and recorded 78.81, 76.97 and 76.76 per cent disease control, respectively. Foliar spray with hexaconazole (0.1 %) gave maximum yield (7.50 kg/ plot) followed by propiconazole and (Carbendazim+Mancozeb) giving 6.75 and 6.25 kg/ plot, respectively.

Table 10. Effect of different treatments on leaf spot disease of ginger at Solan (2013-2014)

Treatments	Germination (%)	Leaf spot (PDI)	% reduction over control	Yield (kg/plot)	Projected yield (t ha ⁻¹)
T ₁	89.88	18.69 (24.57)	50.37	4.75	9.54
T ₂	89.25	11.57 (20.84)	69.27	5.50	11.05
T ₃	90.50	8.67 (18.52)	76.97	6.25	12.56
T ₄	91.37	15.57 (23.40)	58.65	5.50	11.05
T ₅	90.25	7.98 (17.34)	78.81	6.75	13.56
T ₆	90.63	8.75 (18.64)	76.76	6.00	12.06
T ₇	90.00	6.37 (17.39)	83.08	7.50	15.07
T ₈	85.67	37.66 (34.37)	-	4.68	9.40
CD (0.05)	4.76	3.57	-	3.05	-

Figures in parentheses are square root transformed values





V. Turmeric



Fig 12. Evaluation of germplasm at Coimbatore

TUR/CI/I Genetic Resources

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

(Centre: Coimbatore, Dholi, Kumarganj, Pottangi, Pundibari, Kammarpally, Raigarh, Pasighat)

The germplasm of turmeric conserved at

various centres is given in Table 11. At Coimbatore among the 275 genotypes evaluated, 22 genotypes recorded higher yield than the check genotypes (Fig 12). The accession CL 39 recorded the highest fresh rhizome yield (15.60 kg / plot). Among the 41 genotypes, 21 high yielding genotypes were identified. Fresh rhizome yield per plot (3 m²) of short duration types ranged from 4.96 kg to 18.80 kg with duration of 210 days.

Table 11. Turmeric germplasm collections in AICRPS centres

Centre	Indigenous		Total
	Cultivated	Wild and related sp.	
Coimbatore	275	-	275
Dholi	86	-	86
Kammarpally	220	-	220
Kumarganj	155	-	155
Pasighat	46	-	46
Pottangi	179	-	179
Pundibari	200	22	200
Raigarh	42	-	42
Total	1203	22	1203



Out of eighty six accessions of turmeric were collected and evaluated at Dholi, eight accessions namely, RH-2/80, RH-81, RH-24, RH-434, RH-406, RH-7, RH-411 and RH-401 recorded the maximum yield ranging from (1.75 kg per plant to 1.55 kg per plant) as compared to the best check variety Rajendra Sonia (1.25 kg per plant). Among eight promising lines, RH-2/80 recorded the maximum yield (1.75 kg plant) followed by RH-24 (1.65 kg plant⁻¹).

At Pasighat forty six (38 Old + 08 New) diverse genotypes of turmeric were collected from entire NE region and evaluated in Randomized Complete Block Design with three replications along with check variety Megha Turmeric-1 during 2013-14. Among the genotypes evaluated, maximum rhizome yield was recorded by CHFT-36 (35.5 t ha⁻¹) followed by CHFT-8 (35.1 t ha⁻¹), CHFT-1-1 (34.2 t ha⁻¹) and CHFT-24 (34.0 t ha⁻¹) and lowest rhizome yield was recorded by genotype CHFT-20 (17.21 t ha⁻¹) with the overall mean value of (23.51 t ha⁻¹).

At present, 220 genotypes/germplasm collections are being maintained at TRS Kammarpally. During the year 2013-14, among the all germplasm lines tested, JTS-6 (Selection of Duggirala Red) recorded highest rhizome yield (15.4 kg/3m²) followed by CLI-316 (13.1 kg/3m²).

At Kumarganj 155 germplasm of turmeric have been evaluated and categorised into early NDH-74 (35.0 t ha⁻¹), NDH-79 (35.0 t ha⁻¹), medium NDH-98 (42.1 t ha⁻¹), NDH-131 (33.4 t ha⁻¹) and late group maturity NDH-8 (35.3 t ha⁻¹) and NDH-7 (35.0 t ha⁻¹). Maximum yield was obtained in NDH74 (34.4 t/ha) followed by NDH-111 (32.8 t ha⁻¹) and NDH-40 (30.3 t ha⁻¹). Leaf spot severity was found lowest in NDH-10 (2.3 %) followed by NDH-133 (2.6 %) and NDH-128 (3.36 %).

Among 179 turmeric accessions evaluated in 2013-14 at HARS, Pottangi, 152 were *Curcuma longa*, 23 were *Curcuma aromatica* and 4 were *Curcuma amada*. Out of 152 *Curcuma longa* accessions 111 entries recorded more than 10 kg/3m² fresh rhizome yield and 23 entries yielded more than 15 kg/3m². Among the tested germplasm maximum yield was

recorded by CLS 29 (19.6 kg/3m²) followed by Kuchipudi (18.6 kg/3m²).

At Pundibari 200 turmeric germplasms were maintained in 2013 – 2014 and six new collections were made in 2013 – 2014. Out of 155 turmeric germplasms were screened, maximum rhizome weight (715.00g), highest yield was noticed in TCP-137 (54.43 t ha⁻¹) followed by TCP 15 (50.4 t ha⁻¹), TCP-168 (46.37 t ha⁻¹) and TCP-176 (46.37 t ha⁻¹).

Among the entries evaluated at Raigarh, IT-40 (22.5 t ha⁻¹) followed by IT-37 (22.1 t ha⁻¹) were found to be good yielders as compared to check Prabha (14.8 t ha⁻¹) and Narendra Haldi (19.5 t ha⁻¹).

ATICAR research complex at Sikkim, Megha Turmeric-1 had been cultivated in an area around 0.5 ha. The performance of the variety in Sikkim was very good.

Crop Improvement

TUR/CI/2 Coordinated Varietal Trial

TUR/CI/2.4 Coordinated Varietal Trial – 2012

(Centres: Chintapalle, Coimbatore, Dholi, Kammarpally, Pottangi, Pundibari, Raigarh, Kumarganj, Pasighat, Pantnagar, Navsari)

At Coimbatore among the six genotypes evaluated CL101 recorded maximum plot yield (17.13 kg) and the genotype TCP-129 recorded the lowest plot yield (9.57 kg).

At Chintapalle maximum rhizome yield per plant and maximum fresh rhizome yield was noticed in RH-13/90 (595.4 g/plant) followed by RH-9/90 (500.0 g/plant) and lowest yield was observed in TCP-70 (282.1 g/plant). Regarding the dry recovery maximum recorded by TCP-129 (25.8 %) followed by TCP-70 (23.9 %). Low recovery was observed in RH-50 (15.2 %). Maximum dry yield was recorded





by RH-13/90 (7.85 t ha⁻¹) followed by RH-80 (7.4 t ha⁻¹) and lowest dry yield was recorded by TCP-70.



Fig 13. Trial on CVT of Turmeric at Pasighat

At Raigarh seven entries were evaluated under coordinated varietal trial. The entry RH-50 recorded maximum yield (21.89 t ha⁻¹) and was moderately resistant to *Colletotrichum* leaf spot and susceptible to leaf spot. The check TCP-2 registered a yield (19.6 t ha⁻¹).

At Pasighat genotype RH-9/90 registered significantly higher rhizome yield (45.2 t ha⁻¹) as compared with local check variety Megha Turmeric-I (37.4 t ha⁻¹). However, genotype RH-13/90 yielded 39.7 t ha⁻¹ and found at par with check Megha Turmeric-I. Lowest yield was recorded in RH-80 (25.9 t ha⁻¹) with the overall mean value of 34.70 (Fig 13).

For fresh rhizome yield no significant difference was observed among all tested eight entries at Navsari and the genotype RH-9/90 recorded maximum yield (22.2 t ha⁻¹) followed by RH-13/90 (20.9 t ha⁻¹).

TUR/CI/2.5 Co-ordinated Varietal Trial - 2013-2014

(Centres: Pasighat, Coimbatore, Chintapalle, Pottangi, Pundibari, Kammarpally, Kumarganj, Raigarh)

Ten turmeric genotypes namely Acc. 48, Acc. 79, SLP 389/1 (IISR), NDH 8, NDH 79, NDH 98 (Kumarganj), TCP 64 (Pundibari), PTS 12, PTS 8, PTS 55 (Pottangi) were evaluated in Randomized Block Design with three replications along with National Check, Prathiba and Local Check, Megha Turmeric-I during 2013 -14 at Pasighat, Arunachal Pradesh. Data revealed that NDH-98 recorded maximum rhizome yield (35.6 t ha⁻¹) followed by NDH-79 (35.5 t ha⁻¹), which were significantly superior over National Check Prathiba (21.4 t ha⁻¹) and Local check Megha Turmeric-I (22.8 t ha⁻¹). Lowest rhizome yield was recorded in genotype TCP-64 (15.2 t ha⁻¹) with general mean value of 25.06.

At Coimbatore out of ten turmeric genotypes projected rhizome yield per hectare differed significantly among the ten genotypes tested, which ranged from 17.5 t ha⁻¹ (Prathiba) to 24.2 t ha⁻¹ (ACC 79) with a mean of 21.6 t ha⁻¹.

Out of 12 entries, maximum yield was noticed in NDH-98 (30.9 t ha⁻¹) followed by NDH-I (26.5 t ha⁻¹) and NDH-79 (25.9 t ha⁻¹) at Kumarganj. In the case of foliar diseases minimum leaf blotch incidence was observed in NDH-8 (9.0 %) followed by ACC-48 (14.5 %) and ACC-74 (14.4 %), but in the case of leaf spot severity minimum PDI was in TCP-64 (2.0 %) followed by PTS-12 (2.3 %) and PTS -55 (3.5 %) (Fig 14).



Fig 14. NDH-98 tolerant to foliar diseases in turmeric at Kumarganj



Among the 12 genotypes evaluated during the year 2013-14 at Chintapalle maximum fresh rhizome yield was recorded by NDH-98 (62.0 t ha⁻¹), NDH-79 (51.4 t ha⁻¹) and NDH-8 (47.70 t ha⁻¹) over the other entries.

Among the 12 entries evaluated at Pottangi in RBD with 3 replications, the entry PTS-55 (26.9 t ha⁻¹) was the top yielder with the yield advantages of 40.5 % than the national check variety Pratibha (16.0 t ha⁻¹) followed by NDH-98 (26.2 t ha⁻¹). The range of projected yield was from 68.1t ha⁻¹ to 26.9 t ha⁻¹ with mean of 16.3 t ha⁻¹. The maximum rhizome weight was observed in NDH-79 (371.7g).

In a coordinated varietal trial on turmeric at Pundibari 2013, the lowest leaf blotch disease severity of 20.00 was found in TCP 64 followed by NDH 98 (PDI 24.44). The lowest leaf spot disease severity was found in TCP 64 and NDH 98 with a PDI 2.96. NDH-98 recorded maximum yield of 23.50 kg/plot (47.3 t ha⁻¹) followed by TCP 64 (12 kg/plot, 24.1 t ha⁻¹) in 2013-14.

During the year 2013-14, out of eleven (11) genotypes tested at Kammarpally, NDH-790 recorded highest fresh rhizome yield (27.7 t ha⁻¹) followed by ACC-79 (24.2 t ha⁻¹) in comparison to JTS-6 (Selection of Duggirala red), a local check variety (35.6 t ha⁻¹).

Genotype NDH-98 (32.9 t ha⁻¹) significantly superior over both the checks for number of fingers (27.6), rhizome breadth (21.1 cm), rhizome length (19.7 cm), rhizome weight (63.6 g) and leaf length (59.5 cm) at Navsari. NDH-79 (24.5 t ha⁻¹), PTS-55 (24.0 t ha⁻¹) and PTS-8 (23.5 t ha⁻¹) were also found promising for green rhizome yield and other related characters.

At Raigarh the entry evaluated in the CVT trial, maximum yield of turmeric was noticed in the entry ACC-48 (17.28) and found moderately resistant to both the diseases. The local check used in the Trial IT-10 also gave similar yield (17.4 t ha⁻¹) and moderately resistant to both the diseases.

The experiment was laid out in IISR Experimental Farm, Peruvannamuzhi, Kerala with 10 different entries and a national check IISR Prathiba. The different accessions varied in plant morphological characteristics. Among the accessions studied, maximum (43.4 t ha⁻¹) yield was recorded in (NDH 98) followed by Acc. 48(39.2 t ha⁻¹).

TUR/CI/3.5 Initial evaluation trial 2012

(Centre: *Dholi, Kumarganj*)

In a IET, maximum yield was obtained in NDH - 74 (34.4 t ha⁻¹) followed by NDH-11(32.8 t ha⁻¹) and NDH - 40 (30.3 t ha⁻¹) at Kumarganj. Leaf spot severity was found lowest in NDH-10 (2.3 %) followed by NDH-133 (2.6 %) and NDH-128 (3.36 %).

TUR/CI/3.6 Initial evaluation trial-2013

(Centres: *Pottangi*)

It was revealed from the analyzed data on turmeric at Pottangi that the entry CLS-38 (37.8 t ha⁻¹) was the top yielder with the yield advantages of 42.6 % than the Local check variety Roma (21.6 t ha⁻¹) followed by PTS-42 (23.6 t ha⁻¹) and PTS-18(23.0 t ha⁻¹). Maximum rhizome yield per plant was noticed in PTS-57 (51.0 g).

TUR/CI/3.4 Genotype x Environmental interaction on quality

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

At Pottangi it was noticed from the analyzed data of 5 years that the top three highest fresh rhizome yielders were Roma (21.2 t ha⁻¹), Surangana TCP-II (19.7 t ha⁻¹) and Pratibha(18.6 t ha⁻¹) at HARS, Pottangi. The dry recovery per cent of above genotypes was 26.2 %, 22.2 % and 22.4 %, respectively. The curcumin per cent was ranged from 4.4 % to 6.4 % of tested among the entries.





The maximum yield of turmeric at Mizoram was recorded by RCT-1 (30.6 t ha⁻¹), followed by BSR-2 (28.7 t ha⁻¹) and Duggirala Red (26.3 t ha⁻¹). Moreover, dry matter content was found to be highest in RCT-1 (21.16 %) followed by Kedaram (17.06 %), and IISR Alleppy supreme (16.86). The incidence of leaf spot (*Colletotrichum curcumae* and *C. capsici*) was more acute than leaf blotch (*Taphrina maculans*). Narendra Haldi-1 and Rajendra Sonia showed tolerance to leaf spot. Similarly RCT-1, IISR Alleppy supreme, IISR Kedaram, IISR Prathiba, Duggirala, Roma and Rashmi showed tolerance towards leaf blotch.

At Kalyani Prathibha recorded maximum yield per plant (0.500 kg/plant) and also the projected yield per hectare (46.0 t ha⁻¹). The other genotypes namely Duggirala (0.433 kg/plant and 37.8 t ha⁻¹), Rajendra Sonia (0.393 kg/plant and 36.1 t ha⁻¹) and BSR-2 (0.393 kg/plant and 36.1 t ha⁻¹) were also recorded higher yield (Table 12).

Table 12. GxE interaction on growth and yield of Turmeric at Kalyani (2013-2014)

Genotypes	Plant height (cm)	No. of tillers/clump	Average yield / plant (kg)	Projected yield (t/ha)
Roma	1.47	3.53	0.307	28.21
Rajendra sonia	1.50	2.53	0.393	36.19
Duggirala	1.51	2.93	0.433	39.87
IISR Alleppey supreme	1.53	2.87	0.387	35.57
CIL-317	1.57	3.73	0.367	33.73
NH-1	1.45	2.93	0.267	24.53
Suranjana	1.70	3.0	0.340	31.28
BSR-2	1.67	2.87	0.393	36.17
IISR Prathiba	1.58	3.4	0.500	46.00
IISR Kedaram	1.47	3.53	0.215	19.78
Rashmi	1.44	2.53	0.293	26.99
Megha Turmeric	1.52	2.6	0.373	34.35
Krishnanagar(local cv.)	1.14	3.93	0.353	32.51
S Em (±)	0.15	0.04	0.04	3.74
CD (0.05)	0.46	0.11	0.11	10.93

Crop Management

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

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

At Coimbatore a trial was laid out to standardize the irrigation requirement in turmeric with seven treatments with varying levels of irrigation during



2013-14 (Fig 15). The rhizome yield per plot (15 m²) ranged from 46.95 kg to 64.20 kg with a mean of 58.10 kg. Among the various treatments, the treatment (Drip once in a day at 80 % PE) recorded the significantly higher yield which was on par with the treatment (Drip once in 2 days at 80 % PE) (63.11 kg) when compared to control (Surface irrigation, 5cm, 0.09 IW/CPE ratio) (46.95 kg) (Fig 15).



Fig 15. Field view of drip irrigation experiment in turmeric at Coimbatore

The pooled data of the 2011-14 at Kumarganj showed that yield and yield attributes of turmeric was highest in surface irrigation 5cm, 0.90 IW/CPE ratio (63.4 t ha⁻¹ fresh rhizome) followed by drip once in two days at 80 % PE (60.2 t ha⁻¹) and drip once in a day at 80 % PE (56 t ha⁻¹ fresh rhizome).

At Kammarpally during the year 2013-14, among all the treatments tested drip once in a day at 80 % Pan Evaporation (PE) treatment recorded significantly maximum rhizome yield (37.1kg/plot) followed by drip once in 2 days at 80 % PE treatment (33.2 kg/plot) whereas drip once in 2 days at 50 % PE treatment recorded lowest rhizome yield (23.4 kg/plot).

Among the drip schedules tested at Guntur (Table 13) drip irrigation once in a day at 80 % PE (49.9 t ha⁻¹) recorded maximum yield followed by drip irrigation once in two days at 80 % PE (49.5 t ha⁻¹) which were on par with each other and significantly

superior to surface irrigation at 5 cm, 0.9 IW/CPE (45.0 t ha⁻¹).

In drip irrigation trial of turmeric at Pundibari, the results for 2013-14 revealed that drip once in 2 days at 80 % PE recorded highest plant height (132.86 cm) and maximum rhizome yield per plot(10.57 kg).

Table 13. Effect of drip irrigation treatment on yield of turmeric at Guntur (2013-2014)

Treatment	Name of the treatment	Yield
T1	Surface irrigation, 5 cm, 0.90 IW/CPE	45.0
T2	Drip once in a day at 80 % PE	49.9
T3	Drip once in two days at 80 % PE	49.5
T4	Drip once in a day at 60 % PE	42.1
T5	Drip once in two days at 60 % PE	39.8
T6	Drip once in a day at 40 % PE	38.8
T7	Drip once in two days at 40 % PE	37.9
CD (0.05)		3.9
CV (%)		5.1

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

(Centres: Coimbatore, Chintapalle)

At Coimbatore a trial to standardize the size of the planting material and to study the effect of the seedling on growth and yield parameters was laid out with nine different treatments. Among the different treatments, the treatmentsingle node cutting (5 g) planting in protray (1 month) recorded the highest yield (67.94 kg) compared to control primary full length rhizome (25-30 g) planting directly in the field (43.77 kg).





At Chintapalle, experimental values revealed that, maximum fresh rhizome yield was recorded in mother rhizome pieces (31.87 t ha⁻¹) followed by planting primary full length rhizome (22-25 g) directly in the field (27.47 t ha⁻¹). Among the transplanted seedlings, two node raised turmeric plants showed good growth and yield (26.57) and on par with sowing of primary rhizomes directly in the field. Based on these experimental results farmers can cultivate the turmeric with two node raised seedlings with 350 kg of turmeric seed per acre instead of 1400 kg per acre in traditional practice.

TUR/CM/5.9 Source Sink Relationship in Turmeric

(Centres: Coimbatore, Guntur)

A new trial on source sink relationship in turmeric was initiated at Coimbatore during 2013. One genotype received from IISR, Calicut (Prathibha) along with one local check (BSR-2) was planted during June, 2013. Among the varieties, Prathiba recorded the highest dry weight of stem (0.70 g), rhizome (3.43 g) and root (0.48 g) per plant respectively. Regarding the yield parameters, BSR-2 recorded the highest rhizome yield per plant (0.388 g) when compared to Prathibha (0.352 g). However, Prathibha had more core diameter (1.12 cm) compared to BSR-2 (1.08 cm).

At Guntur during 2013-14 kharif season, two varieties viz. Mydukur and Prathibha, were sown in the first week of July and evaluated for rhizome bulking with periodical monthly sampling. Fresh weight of whole rhizome increased considerably from September to February. Among the two varieties evaluated Mydukur was found to be vigorous in growth and recorded highest fresh rhizome weight at 315 days after sowing (632 g/plant) followed by Prathibha (312 g/plant) which were significantly different from each other. Vigorous bulking was observed from 135 DAS and continued till the end of the season. Further, accumulation of fresh weight followed polynomial regression for both the varieties (Fig 16,17).



Fig 16. Mydukur vs Prathibha in source-sink relationship trial at Guntur (190 DAS)

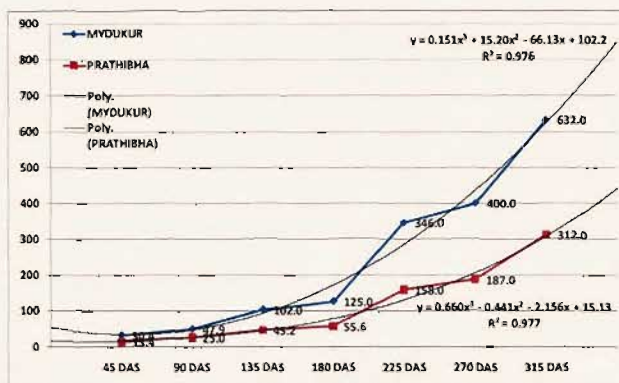


Fig 17. Changes in fresh rhizome bulking (fresh weight) in the two varieties of turmeric at Guntur

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 and Thiruppur



districts during the year 2013-2014. Among the 7 places surveyed in Erode district, the maximum leaf spot intensity of 45.0 PDI, higher rhizome rot incidence was recorded at Gobichettipalayam and minimum at Ayyampalayam (23.10 PDI). The leaf blotch intensity was maximum (40.0 PDI) at Kanjikovil and minimum at Ayyansalai (5.65 PDI).

In Coimbatore, Tiruppur and Salem districts, totally eight places were surveyed with different cropping pattern. In the case of leaf spot and leaf blotch the maximum intensity was noticed at Veerapandi (23.60 PDI, 48.0 PDI respectively) and the minimum intensity was recorded at Thandukkaranpalayam (1.00 PDI and 5.20 PDI respectively). The higher incidence of leaf blotch was noticed in the cultivation of PTS 8 when compared to the cultivation of Erode and Salem local.

Germplasm screening

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 2013-14 at Coimbatore. The accessions viz., CL 32, 33, 52, 54 recorded the least leaf spot intensity of 9.03 PDI with the yield of 15.40, 46.20, 23.98, 19.9 t ha⁻¹ respectively and rhizome rot incident was absent among the germplasm tested.

The accessions CL.54 recorded the least leaf blotch disease intensity of 4.52 PDI followed by CL 51 and CL 52 which recorded the disease intensity of 6.45 PDI and yield 23.2 t ha⁻¹.

Among 108 germplasm of turmeric screened under natural condition against diseases at Dholi, 22 & 6 nos. of germplasm were found 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* leaf spot incidence in the range of 10 to 50 % with mean disease incidence of 28 %. *Taphrina* leaf spot incidence of turmeric ranged from 5 to 20 % with mean disease incidence of 10 %.

TUR/CP/7.2 Management of foliar diseases in turmeric using tolerant lines

(Centre: Kumarganj)

At Kumarganj experiment has been conducted for screening foliar diseases of turmeric. The genotypes TCP-14, TCP-129, NDH-10 and NDH-128 were found to be resistant against leaf spot and CL-54, TCP-14, TCP-129, TCP-161, NDH-10, NDH-40 and NDH-128 were found to be moderately resistant against leaf blotch of turmeric.

TUR/CP/7.3 Fungicide Management of foliar disease turmeric by new molecules.

(Centre: Dholi)

At Dholi lowest disease viz., *Colletotrichum* leaf spot (PDI -5.0), *Taphrina* leaf spot (PDI-1.67) and maximum yield was recorded in the treatment where pre-planting treatment of rhizome and spraying of crop at 90, 105, 120 DAP with Dithane Z-78 (0.1 %) whereas control recorded more disease incidence (PDI 50.0 & 15.0 respectively).

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

(Centre: Pundibari, Coimbatore, Kumarganj)

A new trial on Management of foliar diseases in turmeric using tolerant lines (CL 32, CL 34, CL 52, CL 54 (from Coimbatore), RH 406, RH 407, RH 410 (from Dholi), TCP 14, TCP 129, TCP 161 (from Pundibari) and TCP 2, Local check was initiated at Pundibari. The result revealed that TCP 129 recorded lowest leaf blotch (PDI 11.11), leaf spot (PDI 6.58) disease severity) and the highest yield (27.6 t ha⁻¹) among the 11 germplasm tested including the local check. Over all 4 germplasm produced lower leaf blotch disease severity and 6 germplasm produced lower leaf spot disease severity than local check (TCP 2). The lowest yield of 4.27 kg/plot (8.60 t ha⁻¹) was recorded by RH 410.





lower leaf spot disease severity than local check (TCP 2). The lowest yield of 4.27 kg/plot (8.60 t ha⁻¹) was recorded by RH 410.

Among the different lines tested at Coimbatore, the accession number viz., CL 32 recorded the least leaf spot intensity of 6.36 PDI with maximum yield 37.3 t ha⁻¹ followed by CL 34 (6.90 PDI) with maximum yield of 37.9 t ha⁻¹. The highest leaf spot intensity of 14.32 PDI was recorded by TCP 161 with the yield of 29.6 t ha⁻¹.

Similarly, disease tolerant lines showed the least leaf blotch incidence ranged between 8.10 to 2.80 PDI when compared to the susceptible check BSR-2 (13.78 PDI). The accessions CL 34 recorded the least leaf blotch intensity of 2.80 PDI with maximum yield of 37.9 t ha⁻¹ followed by CL 52 which recorded the disease intensity of 3.74 PDI with the yield of 33.7 t ha⁻¹.



VI. Tree Spices



Fig 18. SA 13 - A high yielding accession of clove and CV 5 - A promising cinnamon accession from Pechiparai

TSP/C1/1 Genetic Resources

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

(Centres: *Dapoli, Pechiparai*)

a) Nutmeg

The germ plasm of tree spices are maintained at Dapoli, Pechiparai and Yercaud (Table 14). At Dapoli among the germplasm collections of nutmeg average no. of fruit of four years ranged from 69-199. Average dry nut yield (1706.90g) and dry mace yield (473.20g) was recorded in genotype DBSKKVMF 29 in years 2006 to 2013 and found promising. During 2013-14 a new accession seed less nutmeg was collected by Pampadumpara Centre (Fig 19).

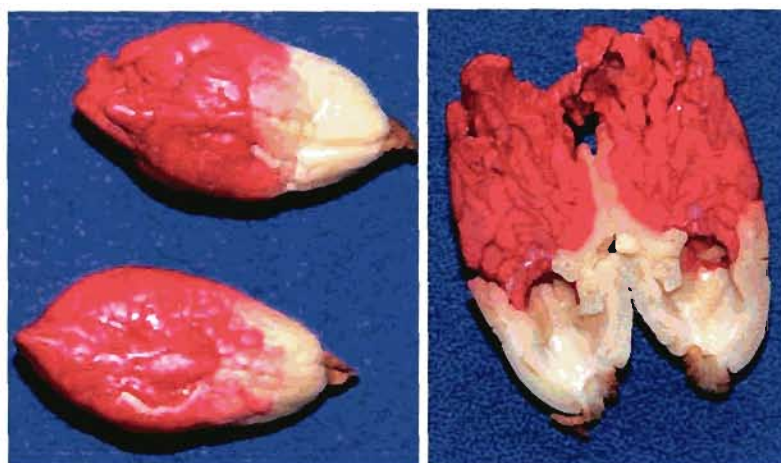


Fig 19 . Nutmeg (seed less) collected by Pampadumpara centre



**Table 14. Tree spices germplasm collections at AICRPS centres**

Crop/Centre	Indigenous/ cultivated	Total
<i>Clove</i>		
Dapoli	4	4
Pechiparai	24	24
Yercaud	1	1
Total	29	29
<i>Nutmeg</i>		
Dapoli	15	15
Pechiparai	26	26
Yercaud	1	1
Total	42	42
<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



Fig 20. A close up view of fruit and mace of MF-4 Nutmeg at Pechiparai



Out of 24 Nutmeg accessions at Pechiparai, the accession MF- 4 (Fig 20) recorded maximum number of fruits of 1040 fruits /tree. The dry mace yield recorded per tree was 418 g. Local check recorded 116.37 number of fruits /tree and single fruit weight was 53.87g and the mace yield was 118g.

b) Clove

At Pechiparai 24 clove accessions are being maintained. Two more types a dwarf clove and a king clove has been identified from Black Rock estate and efforts are made to procure the seeds from the grower.

Among the germplasm of clove planted during the year 1996-97 at Dapoli four promising genotypes were selected. The plant height varied from 4.65 to 6.50 m., girth ranged from 31.00 to 35.00 cm and spread varied from 3.45 m to 5.15 m.

c) Cinnamon

In cinnamon, 12 accessions are being maintained including the local check at Pechiparai. During this year a high yielding selection from Nagercoil was added to the germplasm the accession CV5 recorded maximum dry bark yield (567.80 g/pl) (Fig 18).

The data on growth parameters of cinnamon did not differ significantly in different genotypes at Dapoli. The plant height ranged from 3.92 - 4.95 m, the girth 22.40 - 27.97 cm, the spread 3.58 - 4.92 m and the regenerated shoots were 4.47 - 6.23.

Crop Improvement

TSP/CI/2 Coordinated Varietal Trial

TSP/CI/2.1 Coordinated Varietal Trial 1999 - Clove

(Centre: Pechiparai)

At Pechiparai, the accession SA-13 was significantly superior than other accessions and recorded

highest stem girth (39.78 cm), leaf length (13.70 cm) and leaf breadth (4.40 cm) (Table 15). Dry bud yield was highest in SA-13 (4.50 kg/tree). The local check recorded a flower yield of 2.13 kg/tree. The accession SA-13 recorded the maximum clove bud oil (6.78 %) whereas the local check recorded clove bud oil content of 1.50 %

TSP/CI/2.2 CVT 2001- Nutmeg

(Centres : Dapoli, Pechiparai)

At Dapoli there was no significant variation was observed for all the parameters except no. of branches in evaluated eight accessions. The plant height ranged from 1.10 – 2.33 m., the girth 15.67 - 21.83 cm and the spread 0.61 – 1.81 m. Few plants from Acc. no. A 9/4, A 9/20 and A 9/150 started bearing.

Six accessions were collected from IISR, Calicut and are being maintained and evaluated along with a local check at Pechiparai (Fig 21). Among the accessions A9/150 recorded the highest plant height of 2.56 m, stem girth (11.99 cm) and maximum number of branches recorded was 20.56.



Fig 21. Field view of Nutmeg CVT Trial at Pechiparai





TSP/CI/2.3 Coordinated Varietal Trial 2001- Cassia

(Centre: *Pechiparai, Dapoli*)

In cassia there was no significant difference with regard to plant height, girth and no. of branches at Dapoli. The genotype KKVCTSH2 recorded maximum girth (41.38 cm) followed by KKVCTSH1 (37.00 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. Accession D5 recorded maximum leaf area 98.64cm².

Four genotypes collected from IISR, Calicut along with local check is being maintained at Pechiparai and growth parameters were studied (Table 15). Among the four selections D3 recorded maximum yield (226.12g/tree) (Fig 22).



Fig 22. Field view of Cassia in a CVT trial at Pechiparai

Table 15. Growth and yield performance of Cassia at Pechiparai

Accessions	Plant height (m.)	Stem girth (cm)	Leaf yield (g/tree ⁻¹)	Bark yield (g/tree ⁻¹)
C1	3.00	22.57	280.80	197.90
D1	2.70	23.58	315.89	225.65
D3	5.90	40.79	396.78	226.12
D5	2.79	30.69	358.23	210.49
Local check	2.80	20.63	278.97	197.78
SEm (±)	0.16	0.04	14.13	0.33
CD (0.05)	0.24	0.06	29.48	0.68





sign at Ajmer. The trial was initiated on 13.11.2013. On 28.02.2014 there was a severe hail storm which damaged the coriander crop more than 85 per cent, thus only days to 50 per cent flowering was recorded. Thus trial may be treated as failed.

One hundred forty accessions of coriander were evaluated in two row plots of 3.0 meter length each using Hisar Sugandh, Hisar Bhumit and Hisar Anand as checks during 2013-2014. The mean seed yield of the germplasm material ranged from 27.2 g/plant (DH-336) to 80.8 g/plant (DH-281). The most promising lines for seed yield were DH-208, DH-213, DH-279, DH-280, DH-281, DH-283, DH-312, DH-315, DH-344, and DH-349.

During the reporting year, 95 genotypes of coriander were evaluated for their yield and yield attributes at Jagudan. Among them, 9 entries found high yielder (>14 g/plant).

Screening for resistance against Powdery mildew disease

Total seventy one (69+2) entries of coriander were screened under natural condition at Jagudan. None of the entry was found free from the Powdery mildew incidence. The minimum incidence was noticed in JCr-397 (11.50 %) followed by JCr-396 (18.50 %) and categorized as moderately resistant. The per cent disease intensity was ranged between 11.50 and 82.00 per cent.

Out of 131 accessions evaluated at Jobner, 10 accessions were better than best check variety RCr-728 (39.25 g). Promising accessions identified on the basis of seed yield per 5 plants were UD-347(66 g), UD-795 (63 g), UD-403 (50 g), UD-792 (45 g), UD-285 (44 g), UD-665 (43 g), UD-733 (41 g), UD-144 (41 g), UD-179 (40 g) and UD-316 (40 g). There was 50 % damage in the trial due to hailstorm.

Among 170 germplasm accessions evaluated at Kumarganj and promising accessions identified were NDCor-102 (14.71 t ha⁻¹), NDCor-51 (14.15 t ha⁻¹) and NDCor-53 (14.06 t ha⁻¹) in comparison to Hisar Anand (11.70 t ha⁻¹) and Pant Haritima (12.30 t ha⁻¹).

NDCor-22, ND Cor-51, NDCor-58, NDCor-96 and NDCor-97 were found to be moderately resistant entry for stem gall disease.

At Coimbatore among the 275 germplasm entries of coriander screened the accessions viz., CS 16, 18, 29, 37, 46, 58, 66, 70, 94, 105, 134, 216, 225 and 245 recorded the least disease intensity of 14.50 - 15.60 PDI with the highest yield of 440 - 660 kg ha⁻¹. The highest intensity of Powdery mildew was recorded in CS 109 with the lowest yield of 253 kg ha⁻¹.

COR/CI/1.2 Multilocal Evaluation of germplasm

(Centres: Coimbatore, Guntur, Hisar, Ajmer)

At Coimbatore a trial on multi-location evaluation of coriander genotypes was laid out with 70 genotypes from ten centres (ten each) and five checks during 2013 - 2014 (Fig 23). Among the genotypes, RD-410 recorded highest seed yield per plant (7.50 g) and JCr-401 recorded highest incidence of Powdery mildew (19.50 %). Observations for twelve qualitative traits taken from five randomly selected plants of 73 different coriander genotypes indicated that four traits did not show any difference between genotypes. Among the traits that were showing variations viz., most of the genotypes possessed a particular variant phenotype. Cluster analysis was performed on Jaccard's similarity coefficient matrices calculated from morphological markers to generate a dendrogram of 73 coriander genotypes. The genetic similarity coefficients for 73 coriander genotypes obtained with morphological markers ranged from 38.00 to 68.00 per cent.

Among the sixty entries evaluated at Guntur with seven checks during 2013-14, RD-387 (6.13 g/plant), NDC-14 (5.77 g/plant), NDC-31 (5.75 g/plant), LCC-170 (5.59 g/plant), 37-P (5.39 g/plant) and LCC-144 (5.39 g/plant) were found significantly superior in yield over the check Sudha (4.26 g/plant).

At Ajmer 60 germplasm lines of coriander was sown in six blocks with five checks in Augmented Block design. On 28.02.2014 there was a severe hail



storm which damaged the coriander crop more than 85 per cent, thus only days to 50 per cent flowering was recorded and the trial may be treated as failed (Fig 24).

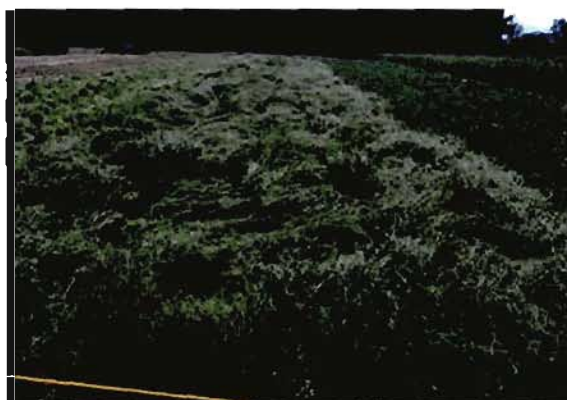


Fig 24. Hailstorm damage in coriander crop at Ajmer

Sixty (60) germplasm accession of different parts of country were evaluated at Jobner along with four checks namely NC-1, NC-2, RCr-435 and RCr-436. Out of 60 accessions, 13 accessions were better than best check variety NC-1 (24.14g), on the basis of seed yield per 5 plants. Some of the promising accessions identified on the basis of yield per 5 plants were VDV/GL-49 (42 g), JCor-406 (38 g), JCor-389 (34 g), JCor-405 (32 g), JCor-404 (30 g), DH-254 (29 g) and DH-259 (27 g). There was 50 % damage in the trial due to hailstorm.

At Kumarganj maximum yield was recorded in DH-239 (12.90 t ha⁻¹) followed by CH-65 (12.82 t ha⁻¹) and DH-258 (12.80 t ha⁻¹).

Crop Improvement

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-Navsari, Jagudan; Western Himalayan region- Pantnagar; Middle gangetic plain region-Dholi; East cost plains and hills region-Gun-*

tur, Ajmer; Central plateau and hills region-Jabalpur; Upper gangetic plain region- Kumarganj)

The trial was conducted including twenty one test entries along with three checks in three replications at Udaipur and the entry COR – 44 was found to be the best with seed yield, 1198 kg ha⁻¹ followed by COR – 41 (1024 kg ha⁻¹) and COR 47 (967 kg ha⁻¹). COR - 51 was the lowest yielder, late entry type (120 days to 50 % flowering) with lowest test weight of 2.13.

In a CVT at Jagudan the entries COR-56 (1481 kg ha⁻¹), COR-48 (1455 kg ha⁻¹) and COR-55 (1405 kg ha⁻¹) recorded higher yield than best check GCr-2, which were 13.23, 11.24 and 7.38 percent higher over check GCr-2, 28.34, 26.08 and 21.08 percent higher over National check Hisar Anand, respectively.

Of the twenty one entries evaluated at Navsari, COR-55 recorded maximum seed yield of 2587.96 kg ha⁻¹ followed by COR-43 (2537.04 kg ha⁻¹), COR-41 (2462.96 kg ha⁻¹), COR-40 (2226.85 kg ha⁻¹), COR-54 (2194.44 kg ha⁻¹) and COR-44 (2180.56 kg ha⁻¹), while lowest seed yield of 1185.19 kg ha⁻¹ was recorded by COR-37.

At Pantnagar significant differences were obtained for all the growth parameters evaluated. Maximum seed yield (3194.45 kg ha⁻¹) was recorded in Pant Haritima followed by Cor-49 (3125.0 kg ha⁻¹) (Table 17).

Among twenty one entries and three checks evaluated at Dholi, only four entries namely - COR-50, COR-53, COR-54 and COR-44 produced significantly more yield (1916.67, 1666.67, 1555.55 and 766.67 kg ha⁻¹ respectively) as compared to best check variety Rajendra Swati (527.79 kg ha⁻¹). However, among five high yielding entries, COR-50 recorded the maximum yield (1919.67 kg ha⁻¹) followed by COR-53 i.e., 1666.67 kg ha⁻¹.

During 2013-14, twenty one coded entries from different coordinating centres were evaluated at Guntur in RBD replicated thrice along with three





checks. Among the entries evaluated, COR-46 (1300.1 kg ha⁻¹) and COR-47 (1302.2 kg ha⁻¹) recorded significantly higher yields than all other entries including best check AD-1 (1061 kg ha⁻¹).

At Ajmer coordinated varietal trial of coriander was laid with 21 test entries and three checks in RBD. The trial was initiated on 7.11.2013. On 28.02.2014 there was a severe hail storm which damaged the coriander crop more than 85 per cent, thus only days to 50 per cent flowering was recorded. The trial may be treated as failed.

The significant differences were obtained for all the parameters at Hisar. Plant height ranged from 85.2 to 147.4, number of branches 5.8 to 9.2, umbels per plant 23.8 to 82.3 and seeds per umbel 22.2 to 48.5. Maximum seed yield (2256.8 kg ha⁻¹) was recorded in COR- 43 followed by COR-42 (2121 kg ha⁻¹) and COR-41 (1970.4 kg ha⁻¹).

Among twenty one entries and three checks evaluated at Dholi, COR-50 recorded the maximum yield (1919.67 kg ha⁻¹) followed by COR-53 (1666.67 kg ha⁻¹).

Table 17. Coordinated Varietal Trial - Coriander at Pantnagar (2012)

Genotype	Character								
	Days to 50 % flowering	Plant height (cm)	No. of primary branches per plant	No. of secondary branches per plant	Umbels per plant	Umbel-lets per umbel	Seeds per umbel	Days to maturity	Seed yield (kg ha ⁻¹)
Cor-36	79.00	80.33	4.60	10.47	19.47	4.60	6.00	136.67	1736.11
Cor-37	82.67	86.87	4.93	11.13	19.93	4.67	5.20	138.00	1851.85
Cor-38	86.67	137.33	5.33	11.27	33.13	5.47	10.33	148.00	2245.37
Cor-39	89.67	136.27	5.20	10.20	30.73	6.13	6.93	152.33	1203.70
Cor-40	82.67	128.93	5.13	11.80	44.60	5.60	5.73	147.33	2268.52
Cor-41	81.67	137.00	5.20	12.80	41.27	6.13	7.00	148.67	2291.67
Cor-42	90.00	128.93	5.13	10.67	28.73	6.33	7.80	147.33	2476.85
Cor-43	86.33	130.20	4.93	9.33	29.47	5.93	7.87	146.00	2037.04
Cor-44	82.33	118.27	6.13	13.27	39.53	5.80	9.53	142.67	2893.52
Cor-45	81.33	125.40	5.80	14.07	34.40	6.93	10.07	144.67	2708.34
Cor-46	79.33	91.87	5.20	13.07	23.67	4.80	5.27	140.67	1620.37
Cor-47	79.67	91.40	4.93	10.80	19.20	4.60	4.60	145.33	1666.67
Cor-48	82.33	90.93	5.00	11.53	20.40	5.00	4.80	139.67	1689.82
Cor-49	91.00	137.33	5.13	12.27	29.00	5.47	9.40	151.00	3125.00
Cor-50	105.67	139.67	6.53	13.73	41.47	7.60	10.53	151.33	2986.11
Cor-51	119.33	149.67	9.53	29.67	101.20	5.87	6.20	160.67	2546.30
Cor-52	89.33	131.87	5.67	14.07	42.27	6.13	8.60	150.00	2939.82
Cor-53	86.00	131.20	5.53	10.20	33.07	5.47	6.67	144.00	2152.78
Cor-54	84.00	130.67	5.40	11.00	30.73	6.53	7.73	146.67	2175.93
Cor-55	85.00	126.33	5.07	12.13	21.60	5.53	5.67	146.67	1805.56
Cor-56	81.33	112.40	5.13	11.27	27.00	5.40	6.07	144.00	1921.30
Hisar Anand (N. Check)	84.67	126.27	5.07	11.13	32.20	5.93	5.40	146.00	2083.34
Rcr728 (N. Check)	89.67	131.73	5.87	13.13	39.47	5.93	9.67	149.67	2569.45
Pant Haritima (N. Check)	90.67	139.27	5.80	11.87	35.67	6.07	9.40	150.33	3194.45
CD (0.05)	5.26	15.04	0.88	3.66	12.28	1.19	1.85	6.33	401.39
CV (%)	3.68	7.47	9.67	17.78	21.91	12.61	15.32	2.63	10.83



At Jobner the seed yield ranged from 564.81 to 1622.69 kg ha⁻¹. Of the twenty four entries evaluated, COR-44 recorded maximum seed yield of 1622.69 kg ha⁻¹ followed by COR-54 (1606.48 kg ha⁻¹), COR-53 (1513.89 kg ha⁻¹), while lowest seed yield of 564.81 kg ha⁻¹ was recorded in COR-50. Entry COR-51 was very late flowering and no seed set was observed in this entry. Twenty one (CVT) entries of coriander were screened against Powdery mildew at Jobner. Entries COR-46, COR-47 and COR-48 was found resistant, whereas COR-36, COR-37, COR-39 and COR-43 were found moderately resistant to Powdery mildew. There was about 50 % damage in the trial due to hailstorm.

Maximum number of branches (10.11) and number of umbel was found in COR51 but no formation of seeds like last year was observed at Jabalpur (Fig 25). Maximum yield was found in COR-48 (1534 kg ha⁻¹).



Fig 25. CVT of Coriander at Jabalpur

The significant differences were obtained for all the parameters at Hisar. Plant height ranged from 85.2 to 147.4, number of branches 5.8 to 9.2, umbels per plant 23.8 to 82.3 and seeds per umbel 22.2 to 48.5. Maximum seed yield (2256.8 kg ha⁻¹) was recorded in COR- 43 followed by COR-42 (2121 kg ha⁻¹) and COR-41 (1970.4 kg ha⁻¹).

At Kumarganj the maximum yield was recorded in Cor-43(15.51 t ha⁻¹) followed by Cor-449 (15.20 t ha⁻¹) and Cor-42 (14.02 t ha⁻¹). Cor-42, Cor-43, Cor-48, Cor-49, Cor-52, Cor-53, Cor-54 and Cor-55

has been found moderately resistant against the stem gall incidence.

Twenty entries were evaluated at Raigarh including three checks for yield and its related characters. Among the entries, COR-53(12.02 kg ha⁻¹) was found significantly superior over national check Hisar Anand and Rcr- 725 followed by ICS-1 local check (957.6 kg ha⁻¹).

At Coimbatore the coordinated varietal trial on coriander 2012-IX series was conducted for second year during 2013-14. The genotype Cor-46 has recorded significantly the highest yield when compared with Co (CR)-4 (361.11 kg ha⁻¹) as local check and RCr-728 (380.00 kg ha⁻¹) and Acr-1 (360.00 kg ha⁻¹) as national checks (Fig 26).



Fig 26. Trial on CVT of Coriander at Coimbatore

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 2013-2014 in plots measuring 3.0 x 2.0 m (Table 18). The results indicated that DH-281 and DH-314 recorded significantly better yield over Hisar Anand (check) showing 23.9 and 19.4 % increase in yield respectively.



Table 18. Initial Evaluation Trial (IET) in Coriander at Hisar

Sl. No.	Accession number	2010-11	2011-2012	2012-13	2013-14	Mean	Increase over check (%)
1.	DH-244	1820	1842	1855	1865	1846	10.5
2.	DH-279	1890	1926	1908	1932	1914	14.6
3.	DH-281	2065	2083	2034	2094	2069	23.9
4.	DH-289	1910	1945	1935	1940	1933	15.7
5.	DH-310	1865	1894	1873	1884	1879	12.5
6.	DH-314	2012	1995	1877	1986	1968	17.8
7.	DH-318	1985	2015	1968	2008	1994	19.4
8.	DH-340	1924	1983	1967	1978	1963	17.5
9.	DH-393-1	1880	1892	1857	1884	1878	12.5
10.	Hisar Anand	1684	1654	1666	1676	1670	-
C D (0.05)		94.9	64.9	73.2	82.4	-	-

COR/CI/3.2 Initial evaluation trial -2011

(Centre: Jobner)

Out of the ten entries evaluated at Jobner during Rabi 2013-14, UD-139 recorded maximum seed

yield of 1328.70 kg ha⁻¹ followed by UD-169 (1284.72 kg ha⁻¹) while lowest seed yield of 752.31 kg ha⁻¹ was recorded in RCr-436. There was 50 % damage in the trial due to hailstorm. Out of Ten (IET) entries of coriander were screened, entry UD-123 was found to be resistant to Powdery mildew Table 19.

Table 19. Screening of coriander (IET) entries against Powdery mildew disease (2012-13) at Jobner

Entries	Powdery mildew (PDI)	Disease reaction
UD-61	75.83	Highly Susceptible
UD-82	51.66	Susceptible
UD-123	14.16	Resistant
UD-139	90	Highly Susceptible
UD-169	87.5	Highly Susceptible
UD-307	73.33	Highly Susceptible
UD-411	62.5	Highly Susceptible
RCR-436	39.16	Moderately Susceptible
RCR-728	40	Moderately Susceptible
LOCAL	60.83	Highly Susceptible



COR/CI/3.6 Initial evaluation trial 2012-13

(Centre: Jagudan, Guntur, Kumarganj)

Eight entries were tested in RBD replicated thrice along with two checks at Guntur. Among the ten entries tested, LCC-268 recorded maximum yield (1326 kg ha⁻¹) followed by LCC-275 (1306 kg ha⁻¹) and LCC-276 (1305 kg ha⁻¹) which were significantly superior to the best check Suguna (1116 kg ha⁻¹).

At Kumarganj highest yield was obtained in NDCor 86 (15.69 t ha⁻¹) followed by NDCor-100 (14.37 t ha⁻¹) and NDCor-87 (14.32 t ha⁻¹). The accessions NDCor 97(15.0 %), NDCor-96 (17.1 %), NDCor-87 (17.5 %) and NDCor-101(18.9 %) were found moderately resistant against stem gall severity. At Jagudan the pooled over two years data indicated that yield differences among the entries were not significant

COR/CI/ 3.7 Initial evaluation trial on coriander

(Centre: Dholi)

At Dholi among eight promising entries, only two entries namely- RD-417 and RD-416 recorded significantly higher yield per hectare (1777.78 kg) and 1633.33 kg respectively) as compared to best check variety Rajendra Swati (1144.45 kg ha⁻¹) and other promising lines. Between two high yielding promising entries, RD-417 was recorded maximum yield (1777.78 kg ha⁻¹) followed by RD-416 (1633.33 kg ha⁻¹).

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 initiated to identify drought tolerant source in coriander by selecting thirty genotypes from germplasm in coriander at Jobner. Among the genotypes RCR-684 as top yielder in both normal and stress conditions. Based on the indices UD 22, UD 562, UD 801, and UD 86 were found to be the desirable entries for drought conditions. The hailstorm damage was about 50 %.

As per yield data NDCor- 37 (26.99 g/plant) and NDCor-36 (26.60 g/plant) were found to be alkalinity tolerant at 10, 20, 30 and 40 ESP levels at Kumarganj.

COR/CM/6.5 Evaluation of PGPR bio-formulation of coriander

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

During 2013-14 rabi season, three different treatment combinations of PGPR bio-formulations were evaluated with four replications in Randomized Block Design at Guntur (Table 20). Among the treatments evaluated, T-3 seed treatment with combination of FK14 (*Pseudomonas putida*) and FL18 (*Macrobacterium paraoxydans*) recorded maximum yield (1191.9 kg ha⁻¹) followed by T-1 seed treatment with FK-14 (*Pseudomonas putida*) (1186.7 kg ha⁻¹) which were on par with each other and significantly superior to untreated control (APHU Dhanial-1) (1104.5 kg ha⁻¹) and untreated local check Sudha (1008.0 kg ha⁻¹). The pooled result indicated that seed treated with bio-formulations were on par with each other and recorded significantly higher yield over untreated control (940.7 kg ha⁻¹).

Table 20. Effect of bioformulations on yield of coriander at Guntur

Treatment	Yield (kg ha ⁻¹)
T 1 – Bio-formulation of FK14	1186.7
T 2 – Bio-formulation of FL18	1138.9
T 3 – Bio-formulation of FK14+FL18	1244.0
T 4 – Control (without PGPR)	1104.5
T 5 – Sudha	1008.0
CD (0.05)	129.2
CV (%)	7.4





At Coimbatore among the four treatments, the treatment - bioformulation of FK 14 seed treatment recorded the highest number of umbels per plant (21.33) followed by – local popular variety CO (CR)-4 (18.11). Regarding the seed yield, the treatment - bioformulation of FK 14 seed treatment recorded the highest seed yield of (735 kg ha⁻¹) followed by - bioformulation of FK 14 + FL 18 seed treatment (700 kg ha⁻¹).

Maximum seed yield (1764.6 kg ha⁻¹) was recorded in treatment T5 - Local popular variety (Hisar Anand), at Hisar followed by T2 - bioformulation of FL 18 (1675.6 kg ha⁻¹) and T3 - bioformulation of FK 14+ FL 18 (1638.3 kg ha⁻¹)

Maximum height of the plants (84.4 cm) and number of primary branches (8.3) of coriander was recorded by combination of FK14 + FL 18 at Ajmer. Due to hail storm on 28th Feb 2014, crop was severely damaged, stems, umbel and umbellets were broken down to soil. Therefore, no observations were recorded for yield and yield attributing characters.

At Raigarh maximum seed yield of 8.7 and 9.20 t ha⁻¹ and maximum plant height (66.00 and 64.90 cm) were found in the treatment when seeds were treated with Rhizobacteria FK 14 and FL 18 respectively and both the treatments were on par.

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.

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

(Centre: Dholi)

Out of 142 germplasm, all the germplasm

were found highly susceptible against stem gall disease under natural condition at Dholi. A survey in the cultivated coriander fields at Vaishali districts of Bihar was found to be infested with stem gall disease caused by *Protomyces macrospores* (Fig 27).

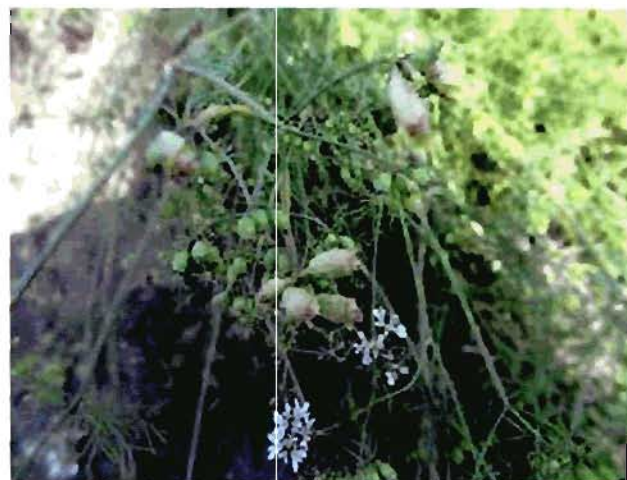
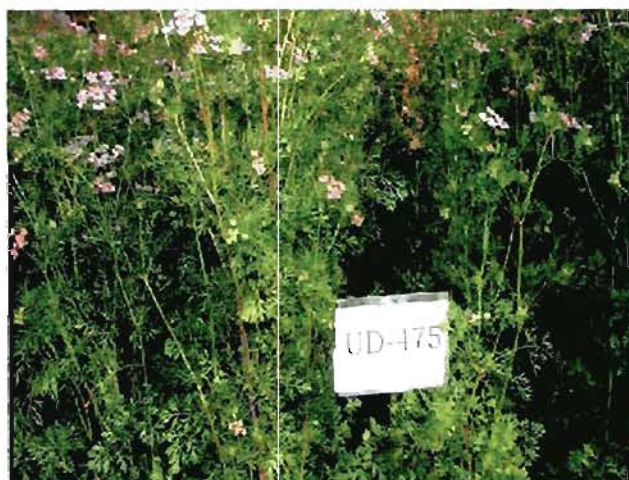


Fig 27. Stem gall disease in coriander



VIII. Cumin

Genetic Resources

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

(Centres: Jagudan, Jobner, Sanand, Mandor)



Fig 28. Germplasm evaluation of cumin at Jobner

The cumin germplasm maintained at various centres of AICRPS are given in Table 21. During the reporting year, 2014, genotypes of cumin were sown for evaluation for their yield and yield attributes at Jagudan (Table 21). Among them ten entries were dwarf type, having less than 26.0 cm plant height. Six entries had more branches i.e. more than 5.5 branches per

plant. The higher umbellets per plant were recorded in thirteen entries. Eight entries recorded more than 6.0 umbellets per umbel. Ten entries were recorded more number of seeds per umbellets as well as umbel. Ten genotypes were observed bold seeded. Eight entries recorded higher seed yield per plant.

Table 21. Cumin germplasm collection maintained at AICRPS centres

Centre	Indigenous	Exotic	Total
Jagudan	65	7	65
Jobner	70	6	70
Total	135	13	135

Screening for resistance against *Alternaria* blight disease

Total sixty (59+1) entries of cumin were screened for the resistance against blight disease at

Jagudan. Overall blight incidence was rated on high to very high. The minimum disease intensity was noticed in GC-4 (48.25 %) followed by JC-99-11 (55.25 %) and JC-99-17 (55.50 %). The blight disease incidence ranged from 48.25 to 100.00 per cent.





Screening for resistance against Powdery mildew disease

Total sixty (59+1) entries of cumin were screened for the resistance against Powdery mildew disease. Overall Powdery mildew incidence was rated on low to very low. The minimum disease intensity was noticed (10 %) in nine genotypes. The Powdery mildew disease incidence ranged from 10.00 to 20.26 per cent.

Screening for resistance against wilt disease

Total sixty three (63) entries of cumin were screened for the resistance against wilt disease under wilt sick plot conditions. Overall wilt incidence was very high. The minimum disease intensity was noticed in GC-4 (39.25 %) and it was followed by GC-3 (45.25 %), JC-2010-4 (50.25 %) and JC-2010-9 (50.75 %). The wilt disease incidence ranged from 39.25 to 100.00 per cent.

At Jobner one hundred and eight (108) germplasm accessions were evaluated along with six checks namely RZ-19, RZ-209, RZ-223, RZ-341, RZ-345 and Local in augmented design in one row plot of 3 x 0.3 sq.m. size (Fig 28). The trial was initiated on 25.11.2013. There was 80-90 % damage in the trial due to hailstorm. Mean seed yield per 5 plant was 2.84 g with the range of 1.03g (UC-268) to 7.56 g (UC-198). Out of 108 accessions, 15 accessions were better

than best check variety RZ-209 (3.89 g). Some of the promising accessions identified on the basis of seed yield per 5 plants were UC-198 (7.56 g), UC-224 (7.3 g), UC-225 (6.54 g), UC-287 (6.19 g), UC-242 (6.02 g), UC-126 (5.84 g), UC-217 (5.77 g), UC-236 (5.68 g), UC-348 (5.44 g) and UC-229 (5.35 g).

Total 50 lines of cumin germplasm received from SDAU, Jagudan was sown in rabi 2013-14 season at Sanand along with Gujarat Cumin – 2, (GC-2), GC-3, GC-4 and Rajasthan Ziru-9(RZ-9). Vegetative growth of crop up to flowering is good.

A total of 87 genotypes tested (20 received from NRCS, Ajmer and 67 from AICRPS, SKN College of Agriculture, Jobner against three checks viz. RZ19/RZ 209 and GC 4. The genotype JC-95-14 recorded numerically higher seed yield over the best check at Mandor.

CUM/CI/1.2 Multiflocation evaluation of cumin germplasm

(Centres: Ajmer)

Twenty germplasm lines of cumin were sown in six blocks with five checks in Augmented Block design at Ajmer. The trial was initiated on 20.11.2013. On 28.02.2014 there was a severe hail storm which damaged the coriander crop more than 90 per cent, thus only days to 50 per cent flowering was recorded. Thus trial may be treated as failed (Fig 29).



Fig 29. Field view of cumin trials before and after hailstorm at NRCSS, Ajmer



CUM/CI/2 Coordinated Varietal Trial

CUM/CI/2.4 Coordinated Varietal Trial – 2013

(Centres: *Jagudan, Jobner, Ajmer*)

A new CVT on cumin 2013 was initiated with six entries from three centres Jagudan, Jobner and Ajmer. The yield differences among the entries were significant at Jagudan. The entries CUM-15 (623 kg ha⁻¹), CUM-16 (546 kg ha⁻¹) and CUM-18 (546 kg ha⁻¹) recorded the higher yield over the best check GC-4, which were 17.19, 2.7 and 2.7 per cent higher over check GC-4 respectively.

The trial was started in the year 2013-14 at Jobner and is in the 1st year of progress. In rabi 2013-14, ten entries were evaluated in RBD with 3 replications in a plot size of 3 x 2.4 sq. m. accommodating eight rows spaced 30 cm apart with plant to plant distance of 5 cm maintained by thinning. The trial was initiated on 24.11.2013. There was 90-100 % damage in the trial due to hailstorm.

The coordinated varietal trial of cumin was laid with 06 test entries and two checks in RBD at Ajmer. The trial was initiated on 17.11.2013. On 28.02.2014 there was a severe hail storm which damaged the cumin crop more than 85 per cent, thus only days to 50 per cent flowering was recorded. All other observations recorded were based on the plant population which survived after the hailstorm.

CUM/CI/3 Varietal Evaluation Trial

CUM/CI/3.4: Initial Evaluation Trial 2012

(Centres: *Jagudan, Jobner*)

At Jagudan in IET, the yield differences among the entries were found significant. The entries JC-2010-2 (673 kg ha⁻¹), JC-2000-57 (660 kg ha⁻¹), JC-2000-28 (617 kg ha⁻¹) and JC-2010-3 (617 kg ha⁻¹) recorded the higher yield over check GC-4, which were

9.58, 7.53, 0.53 and 0.53 per cent higher than GC-4, respectively.

The trial is started in the year 2012-13 and is in the 2nd year of progress at Jobner. In rabi 2013-14, ten (10) entries were evaluated in RBD with 3 replications in a plot size of 3 x 2.4 sq. m. accommodating eight rows spaced 30 cm apart with plant to plant distance of 5 cm maintained by thinning. The trial was initiated on 25.11.2013. There was 80-90 % damage in the trial due to hailstorm.

Crop Management

CUM/CM/5 Nutrient Management-Trial

CUM/CM/5.1 Identification of drought tolerance

(Centre: *Jobner*)

An experiment was conducted to identify drought tolerance in cumin. Thirty genotypes were randomly selected from the germplasm being maintained at Jobner. These lines were sown on 21.11.2012 in two environments namely irrigated (full supplement of irrigations given) and drought (staggered irrigations (half of that given in irrigated treatment)). The entries were sown in RBD with three replications in each environment. The trial was poor due to heavy hailstorm damage 90-100 %.

CUM/CM/6.4 Evaluation of PGPR bioformulation on Cumin

(Centres: *Jagudan, Ajmer*)

At Jobner the results of pooled data indicated that bioformulation treatments significantly improved yield of cumin over control. The bioformulation FK 14+ FL 18 recorded significantly higher seed yield (279.61 kg ha⁻¹) over control and FK 14 and was comparable with FL 18. Bioformulation treatment with FK 14 & FL 18 also recorded significant improvement in





yield of cumin over untreated control. The yield was also significantly higher in untreated control over local control variety.

Different growth and yield attributes, yield as well as volatile oil content of cumin were not influenced significantly due to various inoculants at Jagudan.

At Ajmer the treatment Bioformulation recorded minimum days for germination and maximum height. However the crop was severely damaged and stems, umbel, umbellets were broken down to the soil. Therefore, no observations were recorded for yield and yield attributing characters.

Disease Management

CUM/CP/6 Disease Management Trial

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

(Centre: Jobner)

A survey was conducted in different cumin growing areas in Rajasthan, infected plants were collected, isolations were made to isolate yellowing causing organisms. None of biotic agents was isolated from infected plant samples. A preliminary experiment was conducted on yellowing of cumin and results revealed that the application of NAA, ZnSO₄ and Tetracycline hydrochloride was found effective against yellowing in cumin. In this year trial was failed due to high incidence of wilt and blight.

CUM/CP/ 6.3 Management of blight and Powdery mildew by spacing and potash application

(Centre: 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 (Table 22). The application of potash either 10 kg or 20 kg reduced the per cent disease intensity of blight and Powdery mildew diseases.

Table 22. Effect of spacing and potash application on yield of cumin at Jagudan (2013-14)

Treatment Details		Blight (PDI)	PM (PDI)	Yield (kg ha ⁻¹)	1000-seed weight (g)
A	Main Plot Treatments: Spacing				
	Broadcasting	**57.36 (69.69)	**21.18 (13.20)	252	3.85
	30 X 10 cm	48.41 (55.79)	19.81 (11.51)	309	3.93
	45 X 10 cm	40.72 (42.67)	18.95 (10.57)	378	4.63
	S.Em. ±	1.12	0.54	3.75	-
	CD (0.05)	3.40	NS	11.33	-
	Sub – Plot Treatments: Dose of Potash				
B	0 kg	**49.40 (57.39)	**20.45 (12.36)	287	3.90
	10kg	49.16 (56.67)	19.79 (11.52)	307	4.09
	20kg	47.93 (54.09)	19.69 (11.39)	345	4.41
	SEm ±	1.12	0.54	3.75	-
	CD (0.05)	NS	NS	11.33	-
	S × K	NS	NS	NS	-
	CV (%)	12.30	10.25	14.42	-

** Arc sine transformation, Figures in the parenthesis are original, PM - Powdery mildew.



CUM/CP/6.6 Crop Protection Schedule in cumin

(Centre : Jagudan)

A total of ten crop protection schedules including untreated control were evaluated at Jagudan during 2013-14 to manage important pests and diseases in cumin.

Treatment	Protection schedules in cumin
T ₁	<p>Grow sorghum as previous crop</p> <p>Seed treatment with Garlic extract 5 % @ 10 ml/kg seed</p> <p>Spray the crop with Garlic extract 5% at 40, 50, 60 and 70 DAG</p> <p>Spray the crop with Achook @ 3 ml/lit. at 60 and 70 DAG</p> <p>Installation of yellow sticky traps @ 10/ha</p>
T ₂	<p>Grow sorghum as previous crop</p> <p>Seed treatment with <i>Pseudomonas flourescens</i> 10g/kg seed</p> <p>Spray the crop with <i>P. flourescens</i> 10⁸ at 40, 50, 60 and 70 DAG</p> <p>Spray the crop with <i>Verticilium lecanii</i> 1.15WP 4 g/litre at 60 and 70 DAG</p> <p>Installation of yellow sticky traps @ 10/ha</p>
T ₃	<p>Grow sorghum as previous crop</p> <p>Seed treatment with Mancozeb @ 3g/kg seed</p> <p>Seed treatment with Imidacloprid 70WS @ 10g/ kg seed</p> <p>Spray the crop with Mancozeb 75WP 0.2 % at 40, 50 and 60 DAG</p> <p>Dusting of Sulphur dust @ 25 kg ha⁻¹ at 50 and 60 DAG</p> <p>Spray the crop with Dimethoate 30EC @ 0.03 % at 50 DAG</p> <p>Spray the crop with Imidacloprid 17.8SL @0.005 % at 60 DAG</p> <p>Installation of yellow sticky traps @ 10/ha</p>
T ₄	<p>Grow sorghum as previous crop</p> <p>Seed treatment with Mancozeb @ 3g/kg seed</p> <p>Seed treatment with Imidacloprid 70WS @ 10 g/ kg seed</p> <p>Spray the crop with Mancozeb 75WP 0.2 % at 40 and 50 DAG</p> <p>Spray the crop with <i>Difconazole</i> 25EC 0.01 % at 60 DAG</p> <p>Spray the crop with Dimethoate 30EC@ 0.03 % at 50 DAG</p> <p>Spray the crop with Carbosulfan 25EC @ 0.05 % at 60 DAG</p> <p>Installation of yellow sticky traps @ 10/ha</p>
T ₅	<p>Grow sorghum as previous crop</p> <p>Seed treatment with Mancozeb @ 3g/kg seed</p> <p>Seed treatment with Imidacloprid 70WS @ 10g/ kg seed</p> <p>Spray the crop with Mancozeb 75WP @ 0.2 % at 40 and 50 DAG</p> <p>Spray the crop with Zineb 68 % + Hexaconazole 4 % @ 0.2 % at 60 DAG</p> <p>Spray the crop with Dimethoate 30EC@ 0.03 % at 50 DAG</p> <p>Spray the crop with Thiamethoxam 25WG @ 0.0084 % at 60 DAG</p> <p>Installation of yellow sticky traps @ 10/ha</p>





T ₆	<p>Grow sorghum as previous crop</p> <p>Seed treatment with Mancozeb @ 3g/kg seed</p> <p>Seed treatment with Imidacloprid 70WS @ 10 g/ kg seed</p> <p>Spray the crop with Mancozeb 75WP @ 0.2 % at 40 and 50 DAG</p> <p>Spray the crop with Difenconazole 25EC@ 0.01 % at 60 DAG</p> <p>Spray the crop with Thiamethoxam 25WG @ 0.0084 % at 50 DAG</p> <p>Spray the crop with Carbosulfan 25EC @ 0.05 % at 60 DAG</p> <p>Installation of yellow sticky traps @ 10/ha</p>
T ₇	<p>Grow sorghum as previous crop</p> <p>Seed treatment with Mancozeb @ 3g/kg seed</p> <p>Seed treatment with Imidacloprid 70WS @ 10 g/ kg seed</p> <p>Spray the crop with Mancozeb75WP@ 0.2 % at 40 and 50 DAG</p> <p>Spray the crop with Difenconazole 25EC @ 0.01 % at 60 DAG</p> <p>Spray the crop with Thiamethoxam²5WG@ 0.0084 % at 50 DAG</p> <p>Spray the crop with Imidacloprid 17.8SL @ 0.005 % at 60 DAG</p> <p>Installation of yellow sticky traps @ 10/ha</p>
T ₈	<p>Grow sorghum as previous crop</p> <p>Seed treatment with Mancozeb @ 3g/kg seed</p> <p>Seed treatment with Imidacloprid 70 WS @ 10 g/ kg seed</p> <p>Spray the crop with Mancozeb75WP@ 0.2 % at 40 and 50 DAG</p> <p>Spray the crop with Zineb 68 % + Hexaconazole 4 % @ 0.2 % at 60 DAG</p> <p>Spray the crop with Imidacloprid 17.8SL@ 0.005 % at 50 DAG</p> <p>Spray the crop with Carbosulfan 25EC @ 0.05 % at 60 DAG</p> <p>Installation of yellow sticky traps @ 10/ha</p>
T ₉	<p>Grow sorghum as previous crop</p> <p>Seed treatment with Mancozeb @ 3g/kg seed</p> <p>Seed treatment with Imidacloprid 70WS @ 10g/ kg seed</p> <p>Spray the crop with Mancozeb 75WP 0.2 % at 40 and 50 DAG</p> <p>Spray the crop with Zineb 68 % + Hexaconazole 4 % @ 0.2 % at 60 DAG</p> <p>Spray the crop with Acetamiprid 20SP@ 0.004 % at 50 DAG</p> <p>Spray the crop with Thiamethoxam 25WG @ 0.0084 % at 60 DAG</p> <p>Installation of yellow sticky traps @ 10/ha</p>
T ₁₀	Untreated Control

DAG (DAYS AFTER GERMINATION)

Disease management

It was observed that the least intensity of blight disease was noticed in T₁ and it was followed by T₅, T₄, T₆ and T₉. The maximum blight disease intensity was recorded in untreated control (T₁₀ (66.42 %). As far as Powdery mildew is concerned, all the treatments

were significantly superior over control except T₁ and T₂. The minimum Powdery mildew intensity had registered in T₅ followed by T₈ and T₉. The maximum Powdery mildew intensity was recorded in untreated control (T₁₀ (49.65 %). As far as wilt of cumin is concerned, there were no-significant differences among the treatments. However, the minimum wilt percent



percent had exhibited in T_2 followed by T_6 . The maximum wilt per cent was recorded in untreated control (T_{10} (19.43 %).

Pest management

The treatments of T_7 (6.40 %) and T_6 (7.27 %) registered the least per cent umbels infested by cumin aphid at 7 days after second spray. Mean population of thrips had registered the least in T_7 (0.27/ 5 plants) followed by T_6 (0.94/ 5plants). It can also be seen from the results that T_1 , T_2 , T_6 , T_{10} and T_7 were proved safer

insecticides to the coccinellid beetles. Mean population of coccinellids had registered 2.60, 2.56, 2.56, 2.56 and 2.53 per plant, respectively.

Seed yield

Effect of different treatments on yield was not significant. However, T_7 had obtained the maximum seed yield of cumin (249 kg ha⁻¹) followed by the treatments of T_3 (241 kg ha⁻¹) and T_6 (222 kg ha⁻¹) as compared to untreated control (122 kg ha⁻¹).





IX. Fennel

FNL/CI/1 Genetic Resources

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

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



Fig 30. Field view of Fennel at Jabalpur

The germplasm of fennel is maintained at Dholi, Jagudan, Hisar, Jobner and Kumarganj of AICRPS (Table 23).

Out of fifty seven accessions of fennel evaluated at Dholi, only eleven accessions namely, RF-14, RF-5, RF-67, RF-2, RF-63, RF-58, RF-9, RF-23, RF-

57, RF-18 and RF-31 recorded the maximum yield ranging from 150 g to 100 g per plant as compared to the best check variety Rajendra Saurabh (84 g plant⁻¹). Among promising accessions, RF-14 produced maximum yield 150g per plant followed by RF-5, 118 g per plant.

Table 23. Fennel germplasm collections maintained at various AICRPS centres

Centre	Indigenous	Exotic	Total
Dholi	57	-	57
Guntur	2	-	2
Hisar	142	-	142
Jagudan	128	-	128
Jobner	137	-	137
Kumarganj	140	-	140
Total	606	-	606

During the kharif season, the 136 indigenous and 2 exotic entries of fennel were evaluated for different yield attributes with two checks GF-2 and GF-12, respectively at Jagudan. Among them seven entries observed on dwarf type, having less than 140

cm plant height. Nine entries had good branches more than 14 branches per plant. The more than 60 umbels per plant were recorded by 7 entries. Eight entries recorded more than 50 per umbel. Fifteen entries were promising for more seeds per umbelate i.e. > 40 seeds.



Seven entries observed more or less early maturity (< 210 days). Eleven entries isolated as high yielder recorded more than 205 g/plant grain yield.

Ramularia blight disease (Caused by *Ramularia foeniculi*)

During kharif season, total forty four (43 +1) entries of fennel were screened under natural conditions. None of the entry was found free from the *Ramularia* blight intensity. The minimum intensity of *Ramularia* blight was noticed in JF-2012-8 (45.00 %) and it was followed by JF-2012-11 (45.46 %) and JF-2012-6 (48.14 %). The per cent disease intensity was ranged between 45.00 and 90.01 per cent.

During rabi season, total fifty nine (58 +1) entries of fennel were screened under natural conditions. None of the entry was found free from the *Ramularia* blight intensity. The minimum intensity was noticed in JF-609 (40.21 %) followed by JF-588 (42.31 %) and JF-609 (40.21 %). The per cent disease intensity was ranged between 40.21 and 80.63 per cent.

One hundred and forty (140) germplasm accessions of fennel were evaluated at Kumarganj and promising entries were NDF-46 (13.75 t ha⁻¹), NDF-5 (13.70 t ha⁻¹) and NDF-84 (13.60 t ha⁻¹) in comparison to GF-2 and RF-101. Only minor incidence of Powdery mildew was observed during the month of April.

In rabi 2013-14, one hundred thirty seven (137) S7 progeny and 120 F1's (Top Crosses) of fennel were grown in augmented design in one row plots of 3 x 0.45 sq.m. size at Jobner. The trial was initiated on 25.10.2013. Single plant from each row of a plot from S7 progeny was maintained by bagging with muslin cloth and on maturity seeds were harvested separately to obtain the selfed seeds for next generation. The performance of top crosses was affected by the hailstorm.

Multilocation Trial

(Centres: *Hisar, Ajmer, Jobner, Kumarganj*)

At Ajmer 50 germplasm lines of fennel was sown with five checks in Augmented Block design. The trial was initiated on 25.11.2013. On 28.02.2014 there was a severe hail storm which damaged the fennel crop more than 85 per cent, thus days to 50 per cent flowering only was recorded. Thus trial may be considered as failed.

Forty one (41) germplasm accessions of different parts of country were evaluated along with four checks namely NC-1, NC-2, RF-143, RF-281 in augmented design in one row plot of 3 x 0.3 sq.m. size at Jobner. There was 50 % damage in the trial due to hailstorm. Some of the promising accessions identified on the basis of yield per 5 plants were RF-15 (180 g), HF-137 (136 g), RF-16 (136 g), GK/RM/AK-19 (126 g), GK/RM/AK-27 (126 g), GK/RM/AK-7 (89 g) and GK/RM/AK-7 (89 g).

At Kumarganj maximum yield was recorded in RF-15 (13.0 t ha⁻¹) followed by JF625 (13.00 t ha⁻¹) and NDF-42 (12.80 t ha⁻¹). Infection of Powdery mildew was recorded 5.0 to 15.78 % in most of the entries.

Crop Improvement

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 and three check varieties, all the entries was found non-significant regarding yield and yield parameters as compared to local check variety Rajendra Saurabh with a yield (1541.67 kg ha⁻¹).

The significant differences were observed for all the characters except umbellets per umbel at Pant-





nagar (Table 24). Highest yield (2754.63 kg ha⁻¹) was recorded in FNL-51 followed by FNL -55 (2615.74 kg ha⁻¹).

Table 24. Performance of Fennel genotypes in a CVT 2012 at Pantnagar

Genotype	Character							
	Days to 50 % flower- ing	Plant height (cm)	No. of primary branches per plant	No. of secondary branches per plant	Umbels per plant	Umbellets per umbel	Days to maturity	Seed yield (kg ha ⁻¹)
FNL-47	119.67	140.47	9.87	20.80	48.53	24.40	195.67	1736.11
FNL-48	115.00	139.20	10.27	23.53	47.27	29.07	200.00	2199.08
FNL-49	109.67	145.30	8.20	18.93	48.53	23.73	191.00	2268.52
FNL-50	113.00	140.80	8.40	17.20	41.80	25.80	198.33	2500.00
FNL-51	113.00	150.13	9.33	18.73	46.60	26.80	193.00	2754.63
FNL-52	114.67	144.80	9.87	21.47	51.80	24.53	197.33	2430.56
FNL-53	113.67	147.93	9.07	17.47	40.00	24.47	192.00	2407.41
FNL-54	112.33	157.60	11.27	26.80	56.93	21.40	198.33	2129.63
FNL-55	107.67	113.93	6.07	12.40	30.00	22.47	183.67	2615.74
FNL-56	107.67	119.53	6.33	12.27	30.00	26.40	186.67	2476.85
Rf. 101 (N. Check)	110.67	122.00	7.90	20.67	50.40	25.00	186.00	2592.60
Rf. 205 (N. C)	111.33	113.93	8.13	15.80	35.47	25.40	187.67	2430.56
Pant Madhurika (L. C)	111.33	142.53	7.73	15.27	31.93	24.73	184.00	2500.00
CD (0.05)	2.45	18.71	2.59	7.26	14.89	NS	7.65	238.89
CV (%)	1.30	8.12	17.75	23.22	20.54	16.71	2.37	5.95

Out of 13 entries evaluated at Kumarganj, maximum yield was recorded in FNL- 47(12.88 kg ha⁻¹) followed by FNL-53 (12.70 kg ha⁻¹) and FNL -54(12.54 kg ha⁻¹). infection of Powdery mildew ranged from 5.0 to 15.78 % in FNL-51, FNL-53 and FNL-55.

At Ajmer coordinated varietal trial of fennel was laid with 10 test entries and three checks in RBD. On 28.02.2014 there was a severe hail storm which damaged the fennel crop severely, later efforts were made to recover the crop by providing extra irrigation.

As the data recorded is not to true representative, the trial may be considered as failed (Fig 31).

The data revealed that maximum plant height (161.3 cm) was noted in FNL 47 and early flowering was found in FNL 49 (84.33 days) at Jabalpur (Fig 30). Maximum number of branches (7.77) and number of umbels /plant (30.22) was observed in NC 2 where as the maximum yield was recorded in FNL 47 (0.600 g/ plot & 8.88 q/h).





Fig 31. Hailstorm damage in fennel crop at Ajmer

In a 2012 CVT, at Jagudan the pooled over two years data indicated that the entries FNL-55 (1319 kg ha⁻¹), FNL-47 (1288 kg ha⁻¹), FNL-56 (1265 kg ha⁻¹) and FNL-48 (1240 kg ha⁻¹) recorded significantly higher seed yield over GF-12, which were 15.24, 12.46, 10.44 and 8.28 percent higher than the best check GF-12.

Out of, fourteen (14) entries evaluated at Jobner entry FNL-47 recorded maximum seed yield of 1729.63 kg ha⁻¹ followed by FNL-48 (1722.22 kg ha⁻¹), RF-281 check (1703.70 kg ha⁻¹), NC-2 (1737.04 kg ha⁻¹) while lowest seed yield of 929.63 kg ha⁻¹ was recorded in FNL-51. There was 50 % damage in the trial due to hailstorm. Fourteen (CVT) entries of fennel were screened against *Ramularia* blight disease. Entries FNL-47, FNL-48, FNL-52 and FNL-54 were observed resistant against the disease.

Significant differences was obtained for all the parameters at Hisar. Plant height ranged from 131.9 to 188.7, number of branches 8.8 to 10.8, umbels per plant 26.4 to 43.8, umbellets per umbel 25.2 to 33.2 and seeds per umbel 340.1 to 581.7 Maximum seed yield was recorded by FNL-54 (2176.6 kg ha⁻¹) followed by FNL-53 (2062.3 kg ha⁻¹) and FNL-51 (1865.5 kg ha⁻¹) respectively.

At Raigarh thirteen entries were evaluated including three checks for yield and its related characters at the station. Among the entries, entry FNL-52 recorded a yield (670 kg ha⁻¹) where as check variety RF-205 (776.66 kg ha⁻¹), RF-101 (686.66 kg ha⁻¹) recorded maximum yield (Fig 32).



Fig 32. Field view of CVT fennel at Raigarh

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, 2011-12, 2012-13 and 2013-14 in plots measuring 3.0 x 2.4 m. The results indicated that maximum seed yield was recorded in HF-151 (2107.4 kg ha⁻¹) followed by HF-212 (1979.8 kg ha⁻¹) showing an increase of 27.0 and 19.3 % 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 3rd year of progress at Jobner. In rabi 2013-14, ten entries were evaluated in RBD with 3 replications in a plot size of 3 x 3 sq. m. The seed yield ranged from 1214.81 to 1848.15 kg ha⁻¹. Of the ten entries evaluated, at Jobner entry UF-236 recorded maximum seed yield of 1848.15 kg ha⁻¹ followed by UF-191 (1685.19 kg ha⁻¹), RF-205 check (1431.48 kg ha⁻¹), and UF-161 check (1368.52 kg ha⁻¹), while lowest seed yield of 1214.81 kg ha⁻¹ was recorded in UF-168. There was 50 % damage in the trial due to hailstorm. Ten (IET) entries of fennel were screened against *Ramularia* blight disease. No disease was found in IET entry UF-191, where as UF-53, UF-135, UF-149, UF- 161, UF-168 and UF-236 were observed resistant entries against *Ramularia* blight.

FNL/CI/3.4 Initial evaluation trial 2012

(Centres: Jagudan, Kumarganj, Dholi, Pantnagar)

At Kumarganj out of ten entries, maximum yield was recorded in NDF-51(14.01t ha⁻¹) followed by NDF-67 (13.19 t ha⁻¹) and NDF-52(13.08 t ha⁻¹).

At Jagudan the pooled over two years data indicated that the entries JF-576 (1270 kg ha⁻¹), JF-2012-9 (1247 kg ha⁻¹) and JF-500-1(1234 kg ha⁻¹) recorded higher seed yield over GF-12, which were 11.21, 9.19 and 8.01 percent higher than best check GF-12.

Among nine entries and two check variety GF-11 and Rajendra Saurabh evaluated at Dholi, two entries namely RF-15 and RF-68 were found significant regarding yield and between two best entries RF-15 and RF-68, RF-15 recorded the maximum number of primary branches per plant (13.33), number of umbels per plant (92.67), number of umbellets per umbel (45.33), number of grains per umbellets (46.33) and yield per hectare (2408.35 kg) as compared to RF-68, (2225.93 kg per hectare).

Crop Management

Nutrient Management Trial

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

(Centre: Kumarganj)

At Kumarganj as per yield data NDF- 32 (39.55 g/plant), NDF-39 (38.16g/plant) and NDF-31 (38.01g/plant) were found to be alkalinity tolerant at 10, 20, 30 and 40 ESP levels.

FNL/CM/5.3 Micro irrigation management in fennel

(Centre:Jobner)

In fennel Drip irrigation at 0.8 IW/CPE ratio with paired row planting, was at par with irrigation at 0.8 IW/CPE ratio in normal row planting, and recorded significantly higher seed yield (30.80 t ha⁻¹) compared to irrigation at 0.4 and 0.6 IW/CPE ratio in normal planting as well as paired row planting and surface irrigation at 1.0 IW/CPE ratio.

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, Jobner)

During kharif 2013-14, a total of eight insecticides / botanicals were evaluated at Jagudan against seed wasp, *Systole albipennis* Walker infesting fennel. Among them, the damage due to seed wasp was recorded the least (2.33 %) in the treatment of Thiamethoxam 25WG @ 0.0084 %



vest (3.27 %)(Table 25). Thiamethoxam 25WG @ 0.0084 % recorded highest seed yield of fennel (2778 kg ha⁻¹) followed by the treatments Acetamiprid 20SP@ 0.004 % (2521 kg ha⁻¹) and Acephate 75SP @0.075 % (2382 kg ha⁻¹).

An experiment on field evaluation of insecticides / botanicals against seed midge infesting fennel was started in the year 2012-13 at Jobner (Table 25). The experiment consisted of nine treatments were evaluated in RBD with 3 replications . Out of nine treatments minimum (17.80 %) seed midge infestation

and maximum seed yield (1980 kg ha⁻¹) was recorded by spraying Acetamiprid 20 SP @ 0.004 % followed by Achook 3ml/lit with seed midge in festation (19.79 %) and seed yield (1866.66 kg ha⁻¹). in the year 2012-13 at Jobner (Table 25). The experiment consisted of nine treatments were evaluated in RBD with 3 replications . Out of nine treatments minimum (17.80 %) seed midge infestation and maximum seed yield (1980 kg ha⁻¹) was recorded by spraying Acetamiprid 20 SP @ 0.004 % followed by Achook 3ml/lit with seed midge in festation (19.79 %) and seed yield (1866.66 kg ha⁻¹).

Table 25. Field evaluation of insecticides / botanicals against seed midge infesting fennel at Jobner

Treatment	Seed Midge Infestation (%)	Yield (kg ha ⁻¹)
NSKE 5 %	21.99	1689.33
Cartap hydrochloride 50 SP @ 0.15 %	20.96	1720.00
Spinosad45Sc @ 0.01 %	24.83	1644.00
Abamectin 19EC @ 2ml/lit.	20.12	1733.33
Achook 3 ml/lit.	19.76	1866.66
Acetamiprid20SP @ 0.004 %	17.80	1980.00
Thiamethoxam ² 5WG @ 0.0084 %	21.23	1702.22
Acephate75SP @ 0.075 %	22.87	1680.00
Check	29.26	1444.44
CD (0.05)	4.11	232.74
CV (%)	10.76	7.83

FNL/CP/6.3 Evaluation of PGPR bioformulation on fennel

(Centres: Hisar, Raigarh, Ajmer, Jagudan)

At Hisar maximum seed yield (1806.9 kg ha⁻¹) was recorded in the treatment - Local popular variety (HF-33), followed by - Bioformulation of FK 14 (1747.2 kg ha⁻¹) and - Bioformulation of FK 14+ FL 18 (1709.0 kg ha⁻¹)

At Raigarh maximum seed yield of 8.5 and 9.5 t ha⁻¹ and maximum plant height (158.12 and 163.42 cm) were found in the treatment when seeds

were treated with rhizobacteria FK 14 and FL 18 respectively.

At Jagudan various PGPR treatments were not significantly influenced growth, yield and quality attributes as well as seed yield of fennel.

The experiment was conducted at the farm field of NRC on Seed Spices, Tabiji, Ajmer during 2013-14. The crops were sown on 20th Nov 2013. It was observed that the PGPR coated treatments germinated earlier than the control treatments. Bioformulation FK14+FL18 recorded maximum height (186.75 cm) and primary branches (9.85) followed by the control.





X. Fenugreek

FGK/CI/1 Genetic Resources.

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 26). Among one hundred sixty four accessions evaluated at Dholi, only twelve accessions recorded the maximum yield ranging from (160g per five plant) to 120g per five plant

as compared to check variety Rajendra Kanti and Hisar Sonali (112 & 110g per five plant respectively). Among promising accessions, RM-194 (IC-590120) produced maximum yield 160g per five plant followed by RM-187, (155g per five plant.)

Table 26. Fenugreek germplasm collections under AICRPS centres

Centre	Indigenous	Exotic	Total
Dholi	164	-	164
Guntur	124	-	124
Hisar	196	-	196
Jagudan	75	-	75
Jobner	32	-	32
Kumarganj	176	-	176
Total	767		767

At Jobner Thirty two (32) germplasm accession were evaluated along with three checks namely RMT-1, RMT-305, RMT-351 and RMT-361 in augmented design in one row plot of 3 x 0.3 sq. m. size. Out of 32 accessions, some of the promising accessions identified on the basis of yield per 5 plants were UM-398, UM-383, UM-411, UM-400 and UM-385. There was

10-15 % damage in the trial due to hailstorm.

At Kumarganj 176 germplasm accessions of fenugreek evaluated and promising accession identified was NDM-19 (17.40 t ha⁻¹) and NDM-18(17.20 t ha⁻¹) in comparison to Hisar sonali (12.50 t ha⁻¹).



During the year 2013-14, hundred and twenty four germplasm lines along with four checks were evaluated in Augmented Block Design at Guntur. The first five promising entries for yield LFC-18 (7.01 g/plant), LFC-19 (6.59 g/plant), LFC-123 (6.435 g/plant), LFC-78 (6.41 g/plant) and LFC-34 (6.15 g/plant) were significantly superior over the check APHU Methi-1 (1.80 g/plant).

At Jagudan during the reporting year, 75 entries including GM-1 and GM-2 as check were evaluated for different characters. Among them 11 entries were found tall types having more than 66.0 cm plant height and eight entries recorded more than 6.2 branches per plant. Twelve entries were found bold seeded having equal or more test weight i.e. > 12.50. Ten entries found promising for yield more than 4.75 g/plant.

FGK/C1/1.2 Multilocation Trial on Fenugreek - 2012-13

(Centre: Ajmer, Jobner, Kumarganj)

Sixty germplasm lines of coriander was sown in six blocks with five checks in Augmented Block design at Ajmer. The seeds were sown on 13.11.2013. The data recorded for agro-morphological traits are not true representative due to crop damage by hail storm on 28-2-14.

Out of 40 accessions evaluated at Jobner 12 accessions were better than best check variety RMT-365 (34.60 g) on the basis of seed yield per 5 plants. Some of the promising accessions identified on the basis of seed yield per 5 plants were NDM-69 (54 g), NDM-72 (54 g), HM-277 (48 g), HM-273 (45 g), HM-281 (45 g), NDM-67 (45 g) and AM-301 (41 g). There was 10-15 % damage in the trial due to hail-storm.

At Kumarganj maximum yield was recorded by AM-302 (8.9 t ha⁻¹) followed by HM-283 (8.8 t ha⁻¹) and NDM-90 (8.8 t ha⁻¹).

Crop Improvement

FGK/C1/2 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, Udaipur)

Out of fourteen fenugreek evaluated at Coimbatore the genotype FGK 44 recorded the highest seed yield of (408.71 kg ha⁻¹) as compared to CO-2 (local check) and Hisar Sonali, RMT-362 (national check) which recorded the seed yield of 314.48 kg ha⁻¹, 347.23 kg ha⁻¹ and 359.33 kg ha⁻¹ respectively.

At Ajmer coordinated varietal trial of fenugreek was laid with 14 test entries and three checks in RBD. On 28.02.2014 there was a severe hail storm which damaged the fenugreek crop up to 60 percent, but later the crop recovered due to extra irrigation provided. The test entry FGK-45 recorded the highest seed yield (1282 kg ha⁻¹) followed by FGK-48.

Among fourteen promising entries and three checks evaluated at Dholi, two promising entries namely FGK-49 and FGK-52 recorded significantly higher yield 1848.89 and 1726.11 kg ha⁻¹ respectively as compared to the best check variety Rajendra Kanti (1564 kg ha⁻¹) (Fig 33).



Fig 33. Field view of CVT on Fenugreek at Dholi





At Hisar plant height ranged from 98.5 to 131.9 cm, pods per plant 67.3 to 107.2, length of pods 7.9 to 9.6 and seeds per pod 14.4 to 18.7. Maximum seed yield (2754.7 kg ha⁻¹) was recorded in FGK-48 followed by FGK-43 (2741.7 kg ha⁻¹) and Hisar Sonali (2299 kg ha⁻¹).

As per two year's pooled data at Jagudan the entries FGK-41 (2045 kg ha⁻¹), FGK-39 (2020 kg ha⁻¹), FGK-49 (1939 kg ha⁻¹) and FGK-48 (1886 kg ha⁻¹) recorded higher yield over best check GM-2, RMT-361 and Hisar Sonali, which were 16.86, 15.40, 10.77 and 7.77 per cent more over best check GM-2.

At Kumarganj highest yield was obtained in FGK-40 (14.58 t ha⁻¹) followed by FGK-47 (14.37 t ha⁻¹) and FGK-44 (14.23 t ha⁻¹).

During the second year of evaluation, at Udaipur FGK - 44 was found to be the best performing entry in terms of seed yield (1493 kg ha⁻¹), which was 21 %, higher yield over the best check NC - 2 followed by FGK - 46 (1337 kg ha⁻¹).

At Raigarh seventeen entries were evaluated including four checks for yield and its related characters among the entry FGK-52 (936.32 kg ha⁻¹) recorded the maximum yield followed by FGK-48 (936.32 kg ha⁻¹).

There was no significant influence of various genotypes on number of branches, No. of pods and yield of fenugreek was observed at Jabalpur.

Out of, eighteen (18) entries were evaluated in RBD with 3 replications in a plot size of 3 x 2.4 sq. m. at Jobner entry FGK-43 recorded maximum seed yield of 2011.57 kg ha⁻¹ followed by NC-1 (1967.59 kg ha⁻¹), while lowest yield of 1027.78 kg ha⁻¹ was recorded in FGK-42. There was 10-15 % damage in the trial due to hailstorm.

Out of sixteen entries at Navsari FGK-41 (1432.10 kg ha⁻¹), FGK-48 (1296.30 kg ha⁻¹) and FGK-42 (1271.60 kg ha⁻¹) recorded significantly higher seed yield over both the checks.

Among the seventeen entries evaluated at Guntur, FGK-47 (1660.9 kg ha⁻¹), FGK-48 (1618.6 kg ha⁻¹), FGK-41 (1617.2 kg ha⁻¹) and FGK-43 (1558.1 kg ha⁻¹) recorded significantly higher yields than check APHU Methi -1 (1319.9 kg ha⁻¹).

FGK/CI/3. Varietal Evaluation Trial

FGK/CI/3.4 Initial evaluation trial 2010

(Centres: *Hisar, Pantnagar*)

The initial evaluation trial (IET) in fenugreek for leaf purposes was conducted at Hisar with nine accessions along with Hisar Sonali as check during 2012-2013. Maximum leaf yield was recorded in HM-348 (7458 kg /ha after one cutting and 13208 kg ha⁻¹ after two cuttings followed by HM-355 (6250 kg ha⁻¹ after one cutting & 11832 kg ha⁻¹ after two cuttings) along with seed yield of 1641 & 824 kg ha⁻¹ (HM -348) and 1437 & 707 kg ha⁻¹ (HM-355), respectively.

The significant differences were observed for all the character except pod length at Pantnagar. Maximum seed yield (2981.48 kg ha⁻¹) was recorded in PM (C)-1, followed by Pant Ragani as local check (2518.52 kg ha⁻¹).

FGK/CI/3.5 Initial evaluation trial 2012

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

During 2013-14, seven promising germplasm lines were evaluated in RBD replicated thrice along with two checks at Guntur. Among the nine entries tested, five entries i.e. LFC-90 (1151.8 kg ha⁻¹), LFC-72 (1144.2 kg ha⁻¹), LFC-118 (1142.9 kg ha⁻¹), LFC-78 (1141.8 kg ha⁻¹) and LFC-85 (11136.8 kg ha⁻¹) were found to be significantly superior to the best check APHU Methi-1 (991.8 kg ha⁻¹).

At Kumarganj 10 entries were evaluated and promising with respect to yield were NDM-79 (1694 kg ha⁻¹) followed by NDM-82 (1579 kg ha⁻¹) and NDM-107(1569 kg ha⁻¹).



Pooled over two year data in IET indicated significant difference among the entries at Jagudan. The entries JFg-268 (1981 kg ha⁻¹) and JFg-224 (1954 kg ha⁻¹) recorded significantly higher yield over check GM-2, which were 10.67 and 9.13 per cent higher over the check GM-2.

FGK/CI/3.6 Initial evaluation trial on fenugreek

(Centre: Dholi)

At Dholi among eight promising entries, only two entries viz., RM-204 and RM-170 recorded the maximum yield per hectare (1669.89 kg and 1423.34 kg ha⁻¹) as compared to the best check variety Rajendra Kanti (1026.67 kg ha⁻¹). Between high yielding entries, RM-204 recorded the maximum number of primary branches per plant (14.22), number of pods per plant (67.11) and yield per hectare (1668.89 kg ha⁻¹) followed by RM-170 with a yield per hectare (1423.34 kg ha⁻¹).

Crop Management

FGK/CM/4 Nutrient Management Trial

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

(Centre: Jobner)

At Jobner an experiment was conducted to identify drought tolerance in fenugreek. Thirty genotypes were sown on 12.11.2013 in two environments namely irrigated (full supplement of irrigations given) and drought (staggered irrigations (half of that given in irrigated treatment)). The seeds of entries were sown in RBD with three replications in each environment. Among the genotypes UM-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, RMt-1, UM-124, UM-

140, UM-228, UM-353, UM-304 and UM-302 were found to be the desirable entries for drought conditions.

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

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

During 2013-14 rabi season, three different treatment combinations of PGPR bio-formulations were evaluated and combination of FK 14 + FL 18 recorded maximum yield at Guntur, Kumarganj, Jobner and Hisar. Among the bio-formulations tested at Guntur, maximum yield was recorded in seed treated with combination of FK 14 (*Pseudomonas putida*) and FL 18 (*Macrobacterium paraoxydans*) (1233.8 kg ha⁻¹) followed by FK-14 (*Pseudomonas putida*) (1220.5 kg ha⁻¹) and FL 18 (*Macrobacterium paraoxydans*) (1216.9 kg ha⁻¹) which were on par with each other and significantly superior to untreated control (1108.6 kg ha⁻¹) and untreated local check LS-1 (991.8 kg ha⁻¹).

Pooled analysis data from 2011-14 at Kumarganj revealed that maximum yield (15.87 t ha⁻¹) in the treatment bio-formulation of FK 14 + FL 18 followed by bio-formulation of FK 14 (14.70 t ha⁻¹) and bio-formulation of FL 18 (13.69 kg ha⁻¹).

At Hisar maximum seed yield of fenugreek (2070.5 kg/ha) was recorded in the treatment bioformulation of FK 14 + FL 18 followed by treatment T₃ – Hisar Sonali, local variety (2045.0 kg ha⁻¹).

Bioformulation FK 14 + FL 18 recorded significantly higher seed yield (1668.41 kg ha⁻¹) over control and was comparable with FK 14 and FL 18 at Jobner. bioformulation treatment with FK 14 & FL 18 also recorded significant improvement in yield of fenugreek over untreated control.

At Jagudan response of fenugreek to various PGPR treatment did not emerge any positive effect on growth and yield characters and seed as well as straw yield.





XI. Monitoring

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 advice was given for the proper implementation of the projects.

Project Coordinator visited the following Centres during the period from 1st April 2013 to 31st March 2014

1	28-5-2013 to 29-5-2013	AICRPS co opting Centre at ICAR Research Complex , Barapani
2	18-6-2013 to 22-6-2013	AICRPS Centre at Jagudan, Gujarat
3	17-7-2014 to 19-7-2014	AICRPS Centre at TNAU, Coimbatore
4	4-8-2014 to 8-8-2014	AICRPS Centre at Dapoli
5	26-9-2013 to 27-9-2013	AICRPS Res Centre, ND University, Kumarganj.
6.	21-10-2013 to 27-10-2014	AICRPS Centre SDAU, Jagudan
7.	16-11-2013	KAU, Thrissur
8.	18-11-2013	TNAU, Coimbatore
9.	18-12-2013	KAU, Ambalavayal
10.	20-12-2013	KAU, Panniyur
11.	22-12-2013 to 23-12-2013	IGKV, Raigarh
12.	29-12-2013	TNAU, Coimbatore
13.	30-12-2013 to 31-12-2013	Dept. of Horticulture, Kolli Hills
14.	30-1-2014 to 2-2-2014	AICRPS Centre at Pottangi and Farmers gardens
15.	26-2-2014	AICRPS Centre, Hisar
16.	12-14 March 2014	IISR, Appangala Sakleshpur (ICRI), Mudigere and farmers fields



Fig 34. Demonstration of protrait technology in farmer's plot



Fig 35. Field visit at Sakleshpur (Cardamom plot)



XII. Annual Group Meeting

The National group meeting (XXIV Workshop) of All India Coordinated Research project on spices (AICRPS) was held at CRSS, Jagudan during 24-26th October 2013.



Fig 36. Plenary Session – 24th AICRPS Workshop at CRSS, Jagudan



Fig 37. Release of publications

The workshop was inaugurated by Hon'ble Vice Chancellor, Dr. K. Sreedharan, CRSS, SDAU and Dr. S. K. Malhotra, ADG (Hort.), ICAR, New Delhi by lighting the lamp. Dr. K. Nirmal Babu, Project Coordinator, AICRPS, presented the action taken report for 2012-13 and highlighted the AICRP's contribution, thrust areas for XII plan and 15 pamphlets on important technologies developed by AICRPS were released.

The ADG (Horticulture), Dr. S. K. Malhotra in his presidential address mentioned that AICRPS is a unique system where a lot of location specific technologies can be generated. He urged the scientists from all the centres to submit projects and to participate actively in generation and dissemination of technologies. He emphasized to develop suitable cropping systems models for spices, and to study Genotype x Environmental interaction in other spices crops.

During the plenary session Dr. N. K. Krishnakumar, DDG(Hort.), ICAR, New Delhi in his introductory remarks opined to distribute quality planting material of large cardamom free from 'Chirke' disease, to standardize protected cultivation for seed spices, testing of thrips resistant cardamom genotypes at different AICRPS centres, formulation of

common plant protection schedule for thrips, collection of unique germplasm for evaluation and urged to emphasize on micro irrigation, micronutrient requirements and organic spices production. Mr. Gaurang Patel, Chairman, APMC, Unja, opined that efforts should be made to multiply the high yielding varieties of seed spices and the same should be available to the farmers.

Dr. M. Anandaraj, Director, IISR, Kozhikode and Dr. Balrajsingh, Director, NRCSS, Ajmer were also expressed their opinion in the plenary session. Four improved varieties in turmeric, nutmeg, coriander and fenugreek respectively were recommended to release and technologies on protrait cultivation of turmeric recommended to transfer during the annual group meeting. The proceedings of different sessions were presented which was approved by the group meeting.

The Hon'ble Vice chancellor, Dr. K. Sreedharan, CRSS, SDAU, congratulated the AICRPS scientists for their good achievements. He addressed them to work for value addition, medicinal and aromatic aspects of spices and eradication of malnutrition in India.





XIII. Popularization of Technologies

Sl. No	Technology demonstrated	Details of the technology	Farmers name and place of demonstration
1	FLD on off-season production of coriander (Guntur)	Off-season production under shadenet 75%	1. Sh. Durga Prasad, Kadiapu lanka, East Godavari District.
2	Demonstrations of high yielding variety GF-12 Fennel. (Jagudan)	T1 –GF-12 T2 - GF-11 (control)	1. Mahendiali Habibali Dedhrotia, Manipura Ta. Kadi Dist. Mehsana 2. Patel Jashwantbhai M. Dhanaj Ta. Kalol Dist. Gandhinagar
3	Demonstrations of high yielding Coriander variety GCor-2, (Jagudan)	T1 – GCor-2 T2 - GCor-1 (control)	1. Patel Ramilaben D. Manipura, Ta. Kadi, Dist. Mehsana 2. Patel Rasikbhai Ranchhodbhai Agol, Ta. Kadi, Dist. Mehsana
4	Demonstrations of high yielding Coriander variety Rcr-480 , (Jobner)	T1 – Rcr-480 T2 – Local check (control)	1. Sh. Jagdish Prasad Chowdhary Bobas Tehsil: Sambhar Distt.: Jaipur 2. Sh. Girdhari Doomara C/o Officer Incharge ARSS, Tabiji, Ajmer 3. Sh. Shyam Singh Dodiya C/o Officer Incharge ARSS, Tabiji, Ajmer 4. Sh. Rustam Alipura C/o Officer Incharge ARSS, Tabiji, Ajmer
5	Demonstrations of high yielding Cumin variety Rcr-223 (Jobner)	T1 – Rcr-223 T2 – Local check (control)	1. Sh. Rajendra Bhanvari Bhavariyon ki Dhani Post: Borunda Teh.: BilaraSambhar Disst. Jodhpur 2. Sh. Narayan Nandi II C/O Officer Incharge ARSS Tabiji, Ajmer
6	Demonstrations of high yielding fennel variety RF-143 (Jobner)	T1 – RF-143 T2 – Local check (control)	1. Sh. Mohan Lal Sharma Vill. & Post: Hingota Teh.: Gangapur city Distt.: Sawai Madho Pur 2. Sh.Sangrama Singh Karad Sanrakshak Bhartiya Kisan Sangh, Rajasthan State
7	Popularization of high yielding variety Prathibha	T1 – Prathibha T2 – Mydkur (control)	Field visit to Prathibha Turmeric cultivators 1. Sh. Chandra Sekhar Azad in Gundimeda, 2. Sh.Ramesh in Morampudi 3. Sh. A.Sambi Reddy 4. Sh. Raghava Reddy of Kunchanapalli in Krishna district



XIV. Publications

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Technical Programme (2013-14)

BLACK PEPPER		
Project Code	Title	Centres
PEP/CI/1	Genetic Resources	
PEP/CI/1.1	Germplasm collection, characterization, evaluation and conservation	Chintapalle, 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 & Ambalavayal
PEP/CI/3.3	CVT 2006 – Series VI	Chintapalle, Dapoli, Panniyur, Pampadumpara, Sirsi & Yercaud
PEP/CI/3.4	Evaluation of grafts, orthotropic and runner shoots in black pepper	Ambalavayal, Panniyur, Sirsi & Yercaud
PEP/CM/4	Nutrient Management Trial	
PEP/CM/4.4	Development of organic package for spices based cropping system – Observational trial	Chintapalle, 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/CM/4.7	Black pepper based mixed cropping system for sustainable productivity and food security	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	Chintapalle, Dapoli, Panniyur, Pampadumpara, & Sirsi
PEP/CP/5.3	Trial on management of <i>Phytophthora</i> foot rot of black pepper in new plantation	Chintapalle, Mudigere, Dapoli, Sirsi, panniyur & Pampadumpara
PEP/CP/5.4	Effectiveness of new molecules of fungi toxicants against <i>Phytophthora</i> foot rot of black pepper in existing plantation	Sirsi, Mudigere & Chintapalle
PEP/CP/5.6	Biological Management of slow wilt in black pepper	Panniyur
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.	Panniyur, Dapoli, Pechiparai, Sirsi & Yercaud
CAR/CI/3	Coordinated Varietal Trial	
CAR/CI/3.5	CVT 2005-Series V	Mudigere & Pampadumpara
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	
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 2013 ginger	IISR, Dholi, Pottangi, Pudibari & Solan
GIN/CI/3	Varietal Evaluation Trial	
GIN/CI/3.2	Initial evaluation trial -2011	Pundibari & solan
GIN/CI/3.3	Initial evaluation trial -2012	Kumarganj
GIN/CI/3.5	Genotype x Environment interaction on quality of ginger	Barapani, Chintapalle, 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 Centres	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 weeds in ginger	Chintapalle
GIN/CM/5.5	Source Sink Relationship in ginger	Mizoram, Kanki, Solan, Pudibari & IISR
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 (Biofumigation using cabbage)	Pundibari, Ambalavayal & 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, Kammarpally, Kumarganj, Pottangi Raigarh, Pundibari, Kammarpally & Pasighat
TUR/CI/2	Coordinated varietal trial	
TUR/CI/2.4	CVT on turmeric 2009	Pottangi, Kumarganj, Chintapalle, Coimbatore, Dholi, Kamarpally, Pundibari, Raigarh, Pasighat, Pantnagar & Navsari
TUR/CI/2.5	CVT on turmeric 2013	Pasighat, Coimbatore, Chintapalle, Pottangi, Pundiabari, Kammarpally, Kumarganj & Raigarh
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/3.6	Initial Evaluation Trial 2013	
TUR/CI/3.4	Genotype x Environmental interaction on quality	Kammarpally, Raigarh, Pottangi, Mizoram, Kalyani & Barapani
TUR/CM/5	Nutrient Management Trial	Pottangi
TUR/CM/5		
TUR/CM/5.5	Standardization of water requirement for turmeric through drip irrigation	Coimbatore, Kammarpally, Kumarganj, Pundibari & Guntur
TUR/CM/5.8	Studies on the effect of rhizome size and nursery on growth and yield of turmeric	Chintapalle & Coimbatore
TUR/CM/5.9	Source Sink Relationship in turmeric	Coimbatore & Guntur





TUR/CP/7	Disease Management Trial	
TUR/CP/ 7.1	Survey and identification of disease causing organisms in turmeric and screening of turmeric germplasm against diseases	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
TUR/CP/ 7.4	Management of foliar diseases in turmeric using tolerant lines	Pundibari, Coimbatore & Kumarganj
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/3.4	Initial Evaluation Trial 2011	Jobner
COR/CI/3.6	Initial Evaluation Trial 2012	Jagudan, Kumarganj & Guntur
COR/CI/3.7	IET on coriander	Dholi
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 and identification of causal organism	Dholi
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/2.4	Coordinated Varietal Trial - 2013	Jagudan, Jobner, Ajmer
CUM/CI/3	Varietal Evaluation Trial	
CUM/CI/3.4	IET on cumin 2012	Jobner
CUM/CI/4	Quality Evaluation Trial	
CUM/CI/4.1	Quality evaluation in cumin	Jobner
CUM/CM/5	Nutrient management trial	
CUM/CM/5.1	Identification of drought tolerance	Jobner
CUM/CP/6	Disease Management Trial	
CUM/CP/6.2	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 of Blight and Powdery mildew by spacing and potash application	Jagudan
CUM/CP/ 6.6	Crop Protection Schedule in cumin	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/CM/5	Nutrient Management Trial	
FNL/CI/5.2	Identification of drought/alkalinity tolerance source in fennel	Kumarganj
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 & Jobner
FNL/CP/6.3	Evaluation of PGPR bioformulation on fennel	Hisar, Jagudan, Raigarh & Ajmer
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
FNL/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, Navsari & Raigarh
FGK/CI/3	Varietal Evaluation Trial	
FGK/CI/3.4	Initial evaluation trial 2010	Hisar & Pantnagar
FGK/CI/3.5	Initial evaluation trial 2012	Guntur, Kumarganj, Jagudan & Jobner
FGK/CI/3.6	Initial evaluation trial on fenugreek	Dholi





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



XVI. STAFF POSITION

PROJECT COORDINATOR'S OFFICE

- | | |
|-----------------------------------|----------------------------|
| 1. Project Coordinator | : Dr. K. Nirmal Babu |
| 2. Principal Scientist (Agronomy) | : Dr. C.K. Thankamani |
| 3. Chief Technical Officer | : Dr. Utpala Parthasarathy |
| 4. Personal Assistant | : Ms. Alice Thomas |
| 5. Skilled Supporting staff | : Mr. K. Chandran Nair |

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. C.S. Manoj |
| 4. Peon | : Mrs. Radhamani |

2. Pepper Research Station, KAU, Panniyur

- | | |
|---|-------------------------|
| 1. Assistant Professor/Jr. Breeder (Pl. Breeding) | : Dr. P.M. Ajith |
| 2. Assistant Professor (Pl.Pathology) | : Dr. Rini C. R |
| 3. Assistant Professor(Horticulture) | : Smt. Anupama T. V |
| 4. Assistant Professor (Pl. Pathology) | : Dr. Heera G |
| (Under LWA on medical grounds from October 2 till date) | |
| 5. Junior Technical Assistant | : Mr. K. Lakshmanan |
| 6. Junior Technical Assistant. | : Mr. P.P. Muralidharan |
| 7. Junior Technical Assistant | : Mr. P. Krishnan |
| 8. Peon | : K. Rajeev |

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. Peon | : Ms. Savithri |





4. Horticultural Research Station, UHS, Sirsi

- | | |
|--------------------------|----------------------|
| 1. Junior Horticulturist | : Mr. Nagesh Naik |
| 2. Technical Assistant | : Mr. B.B. Doddamani |

5. Horticultural Research Station, TNAU, Yercaud

- | | |
|----------------------------|---|
| 1. Professor & Head | : Dr. K. Nageswari
(from 3-12-2012 to till date) |
| 2. Junior. Breeder (Hort.) | : Dr. J Prem Joshua
(Posted at HRS Pechiparai) |
| 3. Technical | : Mr. P Pappu |

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

- | | |
|-------------------------------|------------------------|
| 1. Breeder (Assoc. Professor) | : Dr. R. Chitra |
| 2. Junior Pathologist | : Dr. D. Saravanakumar |
| 3. Agriculture Assistant | : Th. R. Swaminathan |

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

- | | |
|------------------------------------|---|
| 1. Senior Scientist (Horticulture) | : Dr. C. Chandrasekhara Rao |
| 2. Scientist (Plant Pathology): | : Vacant from 02.09.2012 onwards |
| 3. Technical Assistant: | : Vacant from 25.01.2012 onwards
(Engaged outsourcing) |

8. Turmeric Research Station, Dr.YSR Horticultural University, Kammarpally (Jagtial)

- | | |
|--------------------------|-------------------------|
| 1. Junior Pathologist | : Vacant |
| 2. Junior Horticulturist | : Mrs. K. Uma Maheswari |
| 3. Technical Assistant | : Mr. K. Venkanna |

9. Horticultural Research Station, Dr.YSR Horticultural University, Guntur

- | | |
|------------------------|----------------------|
| 1. Junior Breeder | : Dr. K. Giridhar |
| 2. Horticulturist | : Dr. S. Suryakumari |
| 3. Technical Assistant | : Mr. Saik J. B |



10. Department of Vegetable Crops, Dr YSPUHF, Solan

- | | | |
|----|---|------------------------|
| 1. | Professor (Vegetable Science) & PI/
Senior Breeder | : Dr. Happy Dev Sharma |
| 2. | Junior Pathologist | : Dr. Meenu Gupta |
| 3. | Junior Biochemist | : Dr. Vipin Sharma |
| 4. | Junior Technical Assistant | : Mr. Rajeswar Chauhan |

11. High Altitude Research Station, OUAT, Pottangi

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

13. Main Spices Research Station, SDAU, Jagudan

- | | | |
|----|--|----------------------|
| 1. | Research Scientist (Pl. Path.) | : Dr. K. D. Patel, |
| 2. | Assistant Research Scientist (Pl. Br.) | : Prof. D. G. Patel |
| 3. | Agriculture Assistant (HG) | : Sh.S. R. Chaudhari |

14. Department of Vegetable Crops, CCS HAU, Hisar

- | | | |
|----|------------------------------|---------------------|
| 1. | Scientist (VC) | : Dr. Suresh Tehlan |
| 2. | Horticulturist/Oleoculturist | : Dr. T P. Malik |

15. Department of Horticulture, Tirhut College of Agriculture, RAU, Dholi

- | | | |
|----|----------------|------------------|
| 1. | Horticulturist | : Dr. S. P Singh |
|----|----------------|------------------|





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|------------------------|--------------------|
| 2. Junior 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. Junior Breeder | : Dr. V. B. Singh |
| 3. Junior Pathologist | : Dr. R. S. Mishra |
| 4. Technical Assistant | : Sri. R. K. Gupta |
| 5. Technical Assistant | : Sri. V. K. Singh |

17. Department of Horticulture, UBKV, Pundibari

- | | |
|------------------------|------------------------|
| 1. Horticulturist | : Vacant |
| 2. Junior Pathologist | : Mr. S. Bandyopadhyay |
| 3. Technical Assistant | : Mr. B. Dutta |
| 4. Technical Assistant | : Ms. Anupama Das |

18. Department of Horticulture, KKV, Dapoli

- | | |
|------------------------|-----------------------|
| 1. Horticulturist | : Dr. Gargi D. Shrike |
| 2. Junior Pathologist | : Vacant |
| 3. Junior 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 |
| 2. Junior Breeder | : Smt. Roshni Bhagat |
| 3. Junior Pathologist | : Dr. A. K. Singh |
| 4. Technical Assistant | : Mr. D. S. Kshatriya |
| 5. Technical Assistant | : Vacant |
- (From commencement of the project)



XVII. AICRPS Centrewise Budget 2013-14

(Rs. in lakhs)

Name of the centres	Pay and Allowances		TA		RC		Tech-A		Total RC		Equipment		Total		Grand Total
	Total	ICAR	Total	ICAR	Total	ICAR	Total	ICAR	Total	ICAR	Total	ICAR	State share	(10)	(11)
Regular centres	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)					(9)		
Pampadumpara (KAU)	11.234	8.425	0.94	0.70	2.66	2.00	0.10	2.10					11.225	3.709	14.934
Panniyur (KAU)	35.368	26.526	1.88	1.40	5.33	4.00	0.10	4.10					32.025	10.652	42.678
Mudigere (UHS)	39.213	29.410	1.40	1.05	4.00	3.00	0.10	3.10					33.560	11.153	44.713
Sirsi (UHS)	11.935	8.951	0.47	0.35	1.33	1.00		1.00					10.301	3.434	13.735
Yercaud (TNAU)	9.251	6.938	0.47	0.35	1.33	1.00		1.00					8.288	2.763	11.051
Coimbatore (TNAU)	18.439	13.829	0.94	0.70	2.66	2.00	0.10	2.10					16.628	5.510	22.139
Chintapalle (Dr YSPHU)	11.408	8.556	0.47	0.35	1.33	1.00	0.10	1.10		13.333	10.00		20.005	6.635	26.641
Kamarpally (Dr YSPHU)	8.558	6.419	0.47	0.35	1.33	1.00		1.00					7.769	2.589	10.358
Guntur (Dr YSPHU)	24.879	18.659	0.94	0.70	2.66	2.00	0.20	2.20					21.559	7.120	28.679
Solan (YSPUHF)	16.172	12.129	1.40	1.05	4.00	3.00		3.00					16.179	5.393	21.572
Pottangi (OUAT)	9.250	6.938	0.47	0.35	1.33	1.00		1.00		13.333	10.00		18.288	6.095	24.383
Jobner (RAJAU)	35.457	26.593	1.88	1.40	5.33	4.00	0.30	4.30					32.293	10.674	42.967
Jagudan (GAU)	11.000	8.250	0.94	0.70	2.66	2.00	0.30	2.30					11.250	3.650	14.900
Hisar (HAU)	18.322	13.741	0.94	0.70	2.66	2.00	0.20	2.20					16.641	5.480	22.121
Dholi (RAU)	11.000	8.250	0.94	0.70	2.66	2.00	0.10	2.10					11.050	3.650	14.700
Kumarganj (NDUAT)	19.023	14.267	1.40	1.05	4.00	3.00	0.10	3.10					18.417	6.106	24.523
Pundibari (UBKVV)	11.847	8.885	0.47	0.35	1.33	1.00	0.10	1.10					10.335	3.412	13.747
Dapoli (KKV)	13.100	9.825	1.40	1.05	4.00	3.00	0.10	3.10					13.975	4.625	18.600
Raigarh (IGKVV)	1.137	0.853	0.47	0.35	6.66	5.00	0.10	5.10		13.333	10.00		16.303	5.397	21.700
Reserve contingency/ Technology Assessment/ AICRPS Workshop						0.567							0.567		0.567
Total	316.592	237.445	18.29	13.65	57.26	43.57	2.00	45.00	45.00	30.00	40.00	326.658	108.047	434.708	



Name of the centres	Pay and Allowances		TA		RC		Tech. A	Total RC	Eqp	ICAR	ICAR share	State share	Grand Total
	(1)	(2)	(3)	(4)	(5)	(6)							
Coopting centres													
Ambalavayal (KAU)			0.47	0.35	3.30	2.48		2.48			2.830	0.940	3.770
Pechiparai (TNAU)			0.47	0.35	3.30	2.48		2.48			2.830	0.940	3.770
Gangtok (ICRI)			0.35	0.35	3.30	2.48		2.48			2.830		2.830
Sakleshpur (ICRI)			0.35	0.35	3.30	2.48		2.48			2.830		2.830
Myladumpara (ICRI)			0.35	0.35	3.30	2.48		2.48			2.830		2.830
ICAR RC NEHR, Barapani			0.35	0.35	5.08	3.81		3.81		10.00	14.160		14.160
ICAR RC NEHR, Mizoram			0.35	0.35	3.23	2.42		2.42		10.00	12.770		12.770
ICAR RC NEHR, Gangtok			0.35	0.35	4.18	3.13		3.13		10.00	13.480		13.480
Voluntary centres													
Pasighat (CAU)			0.35	0.35	2.61	1.96		1.96			2.300		2.300
Pantnagar (CBPUAT)			0.47	0.35	2.91	2.18		2.18			2.530	0.850	3.380
Kanke (BIRSAU)			0.47	0.35	0.97	0.73		0.73			1.075	0.360	1.435
Kalyani (BCKVV)			0.47	0.35	0.97	0.73		0.73			1.075	0.360	1.435
Udaipur (MPUAT)			0.47	0.35	2.15	1.61		1.61			1.962	0.660	2.622
Navasari (NAU)			0.47	0.35	1.44	1.08		1.08			1.430	0.480	1.911
Jabalpur (JNKV)			0.47	0.35	2.75	2.06		2.06			2.410	0.810	3.222
Mandor (AU)					1.33	1.00		1.00			1.000	0.330	1.330
Sanand (AAU)					1.33	1.00		1.00			1.000	0.330	1.330
Total			6.21	5.25	45.45	34.09		34.09		30.000	69.342	6.060	75.405
Grand Total	316.592	237.445	24.500	18.900	102.707	77.660	2.000	79.093	40.000	60.000	396.000	114.107	510.113



XVIII. Weather Data

Chintapalle

Month & year	Rain fall (mm)	Rainy days	Temperature (°C)		RH (%)	
	Actual	Actual	Max.	Min.	Max.	Min.
April 2013	45.4	4.0	31.80	18.50	64.60	48.10
May	38.4	4.0	34.25	22.38	63.03	41.83
June	68.2	11.0	27.30	21.76	82.63	71.93
July	213.8	11.0	25.09	21.58	86.29	78.77
August	122.4	10.0	26.06	21.54	84.67	79.16
September	102.0	10.0	27.26	20.30	88.96	77.90
October	316.6	11.0	25.87	19.90	88.00	83.03
November	21.4	2.0	26.06	14.56	83.46	71.06
December	0.0	0.0	24.90	10.69	84.83	60.19
January 2014	0.0	0.0	25.35	12.27	89.41	62.64
February	0.0	0.0	27.25	10.89	78.96	53.46
March	32.0	3.0	30.09	15.41	75.03	55.19

Coimbatore

Month & year	Rain fall (mm)	Temperature (°C)		RH (%)	
		Max.	Min.	Max.	Min.
April 13	46.8	35.9	22.8	86	42
May	14.8	35.4	24.5	82	45
June	54.5	30.6	24.5	80	57
July	21.9	30.1	23.3	79	61
August	27.3	31.3	23.2	86	55
September	46.5	31.2	22.6	85	58
October	141.2	31.5	22.6	88	57
November	57.9	29.8	21.7	89	59
December	24.8	29.2	22.3	88	51
January 2014	0.0	30.1	19.8	84	42
February	0.2	32.4	20.4	79	39
March	-	34.2	22.8	80	37



**Dapoli**

Month & year	Rain fall (mm)	Rainy days	Temperature ($^{\circ}\text{C}$)		RH (%)	
	Actual		Max.	Min.	Max.	Min.
April 2013	0.0	0.0	32.3	19.7	86.2	66.6
May	4.1	0.0	33.3	23.2	86.0	70.4
June	1713.2	24.0	29.1	23.8	94.1	94.1
July	1763.7	30.0	26.9	23.5	95.7	93.6
August	609.4	29.0	27.9	23.8	93.5	87.3
September	282.6	18.0	28.9	23.2	93.4	89.0
October	365.4	9.0	31.0	23.0	91.5	78.8
November	0.0	0.0	32.6	18.1	91.9	55.0
December	9.6	1.0	31.5	14.2	89.1	63.0
January 2014	0.0	0.0	30.1	14.5	91.9	61.6
February	0.0	0.0	30.5	14.7	89.2	62.9

Dholi

Month & year	Rain fall (mm)	Temperature ($^{\circ}\text{C}$)		RH (%)	
		Max.	Min.	Max.	Min.
April 2013	13.2 (1)	35.3	20.6	78	43
May	100.1 (5)	35.4	24.5	82	58
June	235.8 (9)	33.5	26.4	88	71
July	45.4 (7)	33.5	26.8	89	69
August	127.7 (10)	32.8	26.0	89	68
September	111.1 (3)	34.0	25.8	88	63
October	285.0 (6)	30.2	22.5	91	67
November	0.0 (0)	27.8	14.0	90	46
December	0.0 (0)	23.5	10.5	91	55
January 2014	9.5 (1)	19.4	9.53	90	68
February	32.4 (3)	22.3	10.7	90	60
March	4.2	29.9	15.3	83.2	40.7



Guntur

Month & year	Rain fall (mm)	Temperature ($^{\circ}\text{C}$)		RH (%)	
		Max.	Min.	Max.	Min.
April 13	12.0	38.0	25.9	87.2	41.3
May	68.4	41.1	28.3	77.4	35.7
June	88.5	36.1	26.2	77.7	47.8
July	138.3	32.7	25.4	82.6	61.5
August	238.5	30.0	23.3	82.5	61.0
September	222.2	32.2	24.7	91.0	70.0
October	287.0	29.1	23.0	87.0	71.0
November	40.4	29.1	20.3	89.0	61.0
December	0.0	27.6	15.5	86.0	47.0
January 2014	0.0	28.9	17.4	98.0	53.0
February	46.0	30.9	18.5	96.0	54.0
March	0.0	34.6	21.7	91.0	44.0

Solan

Month & year	Rain fall (mm)	Rainy days	Temperature ($^{\circ}\text{C}$)		RH (%)
			Max.	Min.	
April 2013	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 2014	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



**Jagudan**

Month & year	Rain fall (mm)	Temperature ($^{\circ}\text{C}$)		RH (%)	
		Max.	Min.	Min.	
April 2013	7.4	19.32	39.11	74.71	
May	-	22.92	42.54	86.28	
Jun	86.2	24.71	39.60	90.14	
July	668.6	18.71	39.11	94.85	
August	117.8	22.42	32.95	94.00	
September	148.4	22.14	36.97	94.00	
October	64.2	18.50	35.50	93.42	
November	-	16.5	35.00	80.70	
December	-	10.70	30.17	87.20	
January 2014	-	7.98	26.32	86.71	
February	-	11.28	30.42	86.28	
March	-	14.25	38.04	76.14	

Jobner

Month & year	Rain fall (mm)	Temperature ($^{\circ}\text{C}$)		RH (%)	
		Max.	Min.	Min.	Min.
April 2013	002.6	36.5	18.5	63.0	19.8
May	-	41.5	25.1	45.0	17.3
June	027.8	38.4	27.5	70.0	41.2
July	138.0	33.2	25.6	89.0	67.6
August	184.8	31.0	23.8	91.2	73.7
September	020.8	43.5	22.1	81.5	48.2
October	008.4	32.3	17.8	82.2	39.6
November	005.2	22.3	10.5	82.5	28.0
December	-	24.3	7.8	83.7	34.3
January 2014	013.8	20.1	5.9	89.0	46.8
February	013.6	23.3	8.0	87.7	35.5
March	014.4	12.5	10.7	81.6	29.6



Kumarganj

Month & year	Rain fall (mm)	Rainy days	Temperature ($^{\circ}\text{C}$)		RH (%)	
			Max.	Min.	Max.	Min.
April 2013	00.0	0	36.8	18.8	71.3	35.3
May	00.0	0	40.3	24.2	69.3	35.8
Jun	577.9	12	33.1	25.1	86.5	65.6
July	145.1	14	33.0	26.5	86.0	68.7
August	207.7	18	33.3	25.6	86.0	65.8
September	124.4	6	33.9	25.2	85.5	61.1
October	6.7	3	30.0	21.4	86.1	67.2
November	00.0	0	27.3	12.3	87.5	51.2
December	0.4	1	24.1	8.3	85.5	55.0
January 2014	64.3	3	17.9	7.7	94.5	69.8
February	25.1	6	23.0	9.8	87.3	55.9
March	15.3	2	29.6	12.9	75.0	43.9

Panniyur

Month & year	Rain fall (mm)	Temperature ($^{\circ}\text{C}$)		RH (%)
		Max.	Min.	
April 2013	3.40	37.04	26.55	90.3
May	162.70	35.6	27.2	90.3
June	1457.00	29.1	24.6	93.3
July	1332.00	28.3	24.4	93.09
August	496.30	29.5	24.9	93.1
September	277.60	31.01	25.08	94.46
October	281.50	31.74	24.87	93.29
November	93.80	34.17	24.82	94.1
December	11.60	34.42	22.21	93.54
January 2014	-	35.13	22.68	93.58
February	0.60	35.34	23.27	93.78
March	-	37.57	24.72	93.9



**Pampadumpara**

Month & year	Rain Fall (total in mm)	Temperature ($^{\circ}\text{C}$)		RH (%)	
		Max.	Min.	Max.	Min.
April 13	5	30.14	23.25	91.33	85.83
May	8	28.11	21.17	94.31	91.83
June	23	22.91	17.10	95.8	94.4
July	29	21.38	16.85	93.61	93.83
August	20	22.30	16.76	95.93	91.37
September	18	25.37	18.49	95.2	82.5
October	12	25.62	16.88	93.03	78.48
November	9	25.09	18.59	92.5	78.36
December	5	23.37	17.02	90.16	77
January 14	-	23.20	15.18	88.9	75.73
February	1	26.76	18.61	83.64	58.83
March	3	25.90	18.91	77.25	61.96

Pundibari

Month & year	Rain fall (mm)	Temperature ($^{\circ}\text{C}$)		RH (%)	
		Max.	Min.	Max.	Min.
April 2013	122.50	30.33	20.15	96.03	53.57
May	251.00	30.44	23.08	98.84	70.81
June	404.00	32.30	25.38	98.10	74.33
July	757.50	31.74	25.86	99.00	77.16
August	343.05	32.02	25.32	97.22	75.74
September	404.00	31.81	24.61	96.00	75.00
October	169.00	29.09	21.08	91.06	72.58
November	2.00	27.88	14.22	83.50	48.97
December	0.00	23.56	11.71	71.58	57.77
January 2014	0.00	22.06	10.68	66.52	51.81
February	19.50	22.18	11.13	62.36	50.64
March	14.50	28.48	15.33	68.00	54.84



Mudigere

Month & year	Rainfall (mm)	Rainy days	Temperature ($^{\circ}\text{C}$)		RH (%)	
			Max.	Min.	Max.	Min.
April 2013	56.8	03	31.41	18.78	87.26	78.9
May	201.7	09	31.53	18.62	87.06	74.54
June	615.7	27	27.73	17.78	82.48	73.9
July	1039.2	31	26.40	17.19	84.54	72.38
August	567.6	26	26.08	17.62	87.38	76.38
September	329.6	24	26.56	18.15	87.60	77.9
October	63.3	11	26.16	17.90	91.58	89.0
November	50.2	06	26.06	17.36	85.96	76.03
December	36.0	03	26.74	14.98	85.83	75.29
January 2014	-	-	26.90	14.62	74.09	63.25
February	-	-	27.12	15.16	72.57	60.53
March	-	-	-	-	-	-

Sirsi

Month & year	Rain fall (mm)	Temperature ($^{\circ}\text{C}$)		RH (%)	
		Max.	Min.	Max.	Min.
April 13	21.6	34.9	20.1	90.8	73.6
May	79.2	33.0	22.3	91.8	88.5
June	534.3	27.0	20.8	91.0	86.4
July	1220.2	25.3	21.0	94.4	90.0
August	432.5	26.4	20.7	92.6	84.4
September	229.9	28.4	20.1	92.4	77.4
October	94.2	29.1	20.4	94.3	72.4
November	17.0	30.3	15.5	84.3	58.5
December	0.0	30.1	13.4	81.8	64.0
January 2014	0.0	30.8	15.5	92.7	91.0
February	0.0	32.1	14.8	91.1	48.1
March	0.0	33.9	17.7	85.0	47.0



**Yercaud**

Month	Rainfall (mm)	Rainy days	Temperature (°C)		RH (%)
			Max.	Min.	
April 2013	96.5	4	28.0	18.3	77.1
May	140	4	27.8	20.0	73.8
June	140.5	9	23.9	17.0	88.3
July	177.0	16	22.4	16.3	94.9
August	232.9	14	22.4	16.8	93.3
September	367.5	15	23.0	17.0	85.8
October	187.0	13	24.1	14.1	86.6
November	107.0	8	21.6	15.8	89.2
December	58.5	6	19.0	17.2	74.0
January 2014	0	0	21.5	13.0	75.0
February	6.5	1	23.8	15.2	74.2
March	0	0	27.4	15.0	57.0

Mizoram

Month & year	Rain fall (mm)	Rainy days	Temperature (°C)		RH (%)	
			Max.	Min.	Max.	Min.
April 13	104.8	5	32.30	20.80	73	43
May	831.5	23	29.50	21.17	95	72
Jun	322.6	18	31.92	23.75	92	74
July	454.6	26	30.62	23.88	94	80
August	717.1	27	29.88	22.26	98	77
September	561.3	18	30.15	22.47	98	81
October	107.1	8	28.66	22.22	96	71
November	0	0	27.79	18.78	90	52
December	0	0	23.59	16.16	82	48
January 2014	0	0	24.33	14.96	79	40
February	25.6	4	26.23	15.29	79	31
March	-	-	-	-	-	-



Pasighat

Month	Temperature ($^{\circ}\text{C}$)		RH (%)	Rainfall (mm)
	Max.	Min.		
April 2013	32.8	18.0	59.8	0.0
May	30.3	18.4	75.6	154.3
June	31.8	27.9	77.9	525.9
July	29.3	23.2	83.0	907.7
August	28.6	23.0	81.1	403.9
September	30.4	23.0	73.5	456.2
October	26.0	20.2	77.0	222.9
November	22.3	15.9	68.6	23.0
December	17.1	13.4	68.2	4.3

Kalyani

Months	Rain fall (mm)	Temperature ($^{\circ}\text{C}$)		RH (%)	
		Max.	Min.	Max.	Min.
April 2013	117	36.7	23.46	90.3	47.2
May	200.57	35.6	25.35	92.8	73.9
June	182.4	33.7	25.1	94.1	79.8
July	251.1	32.6	25.3	95.1	81.9
August	362.7	31.6	24.34	96.77	83.52
September	231.0	32.0	24.5	95.6	81.5
October	331.7	30.32	22.63	97.6	81
November	0.0	29.11	15.9	95	54.1
December	0.0	26	12.7	97.2	57
January 2014	0.0	23.6	12.4	95	61.4
February	16.8	24.4	12.4	86	52.9
March	0.0	30.3	16.4	99.6	58.5



**Gangtok**

Month	Rainfall mm	Rainy days	ICRI, Kabi farm	
			Max 0C	Min 0C
April 2013	411.8	4	18.9	10.0
May	342.7	2	22.5	13.0
June	778	4	18.1	11.1
July	622.5	-	18.8	10.2
August	428.1	-	20.7	12.9
September	345.3	1	19.3	12.5
October	247.4	1	20.7	16.0
November	4.0	-	20.0	6.1
December	-	-	12.0	6.0
January 2014	-	-	11.6	7.3
February	34.2	3	12.5	3.1
March	-	-	-	-

Sikkim

Months	Rain fall (mm)	Rainy days	ICRI, Pangthang farm	
			Max 0C	Min 0C
April 2013	300	1	12.2	4.1
May	275	2	15.3	9.2
June	453	-	15.4	8.4
July	545	3	14.2	10.3
August	644	1	20.4	12.2
September	545	3	17.2	10.4
October	304	2	16.6	12.0
November	120	2	10.2	6.5
December	15.4	-	9.4	2.7
January 2014	30.0	-	7.6	4.1
February	-	-	10.3	5.8
March	-	-	-	-



Pechiparai

Month & year	Rainfall	Rainy days	Temperature (°C)		RH (%)
	mm		Max.	Min.	
April 2013	30.0	2	34.50	27.50	77.00
May	-	-	34.00	27.50	80.50
June	40.00	4	34.50	24.50	80.45
July	130.00	8	33.50	30.50	82.00
August	90.00	13	33.50	27.50	88.00
September	29.00	6	33.00	26.20	72.00
October	80.00	11	34.00	24.50	82.00
November	151.00	18	31.00	21.20	77.50
December	70.00	30	32.50	21.81	79.00
January 2014	15.00	7	32.50	21.33	83.00
February	30.00	10	33.00	21.50	79.90
March	56.00	10	34.00	21.56	87.00





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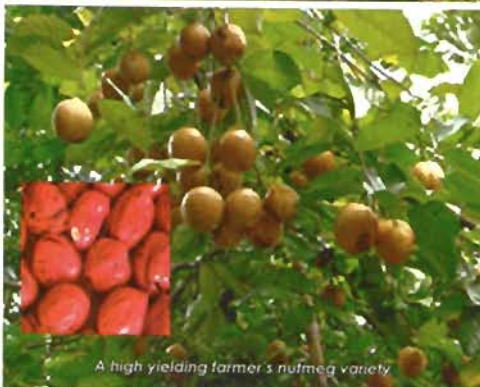
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