



वार्षिक रिपोर्ट **Annual Report** **2015 - 16**



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



ICAR-Indian Institute of Spices Research
Kozhikode - 673 012, Kerala, India

New Varieties



Coriander - Susthira



Fenugreek -
Narendra Methi 2



Fenugreek -
RMt 354



Fennel - RF 157

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

ANNUAL REPORT 2015-16



ICAR-All India Coordinated Research Project on Spices (ICAR-AICRPS)

Indian Institute of Spices Research
Kozhikode – 673 012, Kerala, India.

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Correct Citation

Muhammed Nissar, V. A. and Akshitha, H. J. (Eds) (2016)
Annual Report 2015-16, ICAR-All India Coordinated Research Project on Spices,
ICAR-IISR, Kozhikode, Kerala, India, 120p.
June 2016

Printed at

Modern Graphics, Kochi

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कार्यकारी सारांश

भाकृअनुप- अखिल भारतीय समन्वित मसाला अनुसंधान परियोजना देश के 24 राज्यों में 38 केन्द्रों (19 नियमित, 10 सहयोगी तथा 9 अवैतनिक केन्द्रों) के अतिरिक्त पांच अन्य केन्द्र में विभिन्न कृषि जलवायु क्षेत्रों में कार्यान्वित एक समन्वयन इकाई है। इसकी प्रमुख अधिदेश फसलें काली मिर्च, बडी इलायची, छोटी इलायची, अदरक, हल्दी, दालचीनी, जायफल, लौंग, धनिया, जीरा, सौंफ, मेथी आदि है। वर्ष 2015-16 की वार्षिक बजट में भारतीय कृषि अनुसंधान परिषद का आबंटन 504 लाख रुपए थे।

नवीन कार्यक्रम

दक्षिण भारत के बंगलूरु में बीज मसालों की खेती की संभावना को देखने के लिए परियोजना के अन्तर्गत एक कार्यक्रम आरंभ किया था जहां बीज मसाले जैसे धनिया, सौंफ तथा मेथी को उगाया गया। उसी जगह जीरा के पुष्पण एवं बीज सज्जा का निरीक्षण भी किया गया।

भारतीय कृषि अनुसंधान परिषद की नीति के अनुसार सारी कार्यशालाओं तथा ए आई सी आर पी एस की वार्षिक प्रतिवेदन को सम्बन्धित वेब साइट पर रूपांकित करें। इस वेब साइट से केन्द्र की मासिक, त्रैमासिक, वार्षिक प्रतिवेदन, बजट तथा उपयोग को अपलोड करें।

अखिल भारतीय समन्वित मसाला अनुसंधान परियोजना की 26 वीं कार्यशाला में विमोचन हेतु संस्तुत प्रजातियां

भाकृअनुप-भारतीय मसाला फसल अनुसंधान संस्थान, कोषिककोड में आयोजित अखिल भारतीय समन्वित मसाला अनुसंधान परियोजना की 26 वीं कार्यशाला में पांच उच्च उपज वाली प्रजातियों को विमोचित करने के लिए संस्तुत किया गया। धनिया की एक प्रजाति बागवानी अनुसंधान स्टेशन (डा.वाई एस आर एच यु) गुंटूर की उच्च उपज वाली, वर्षा आधारित एवं सिंचित अवस्था के लिए अनुकूल एवं उन्नत एसनशियल तेल वाली **एल सी सी 219 (सुस्थिरा)**

को आन्ध्र प्रदेश, तेलंगाना तथा तमिलनाडु में विमोचित करने के लिए संस्तुत किया गया। भाकृअनुप- राष्ट्रीय बीज मसाला अनुसंधान केन्द्र, अजमेर द्वारा विकसित उन्नत एसनशियल तेल वाली तथा रामुलारिया ब्लाइट के प्रतिरोधक सौंफ की दो प्रजातियां **अजमेर फेन्नल -2 (ए एफ-2)** को राष्ट्रीय स्तर पर विमोचित करने के लिए संस्तुत किया गया तथा करण नरेन्द्रा कृषि विश्वविद्यालय, जोबनर, राजस्थान द्वारा विकसित उन्नत उपज क्षमता वाली एवं उत्तम बीज गुणवत्ता वाली प्रजाति **आर एफ-157** को राजस्थान, गुजरात तथा हरियाणा में विमोचित करने के लिए संस्तुत किया गया। मेथी की दो प्रजातियां श्री करन नरेन्द्र कृषि विश्वविद्यालय, जोबनर, राजस्थान तथा नरेन्द्र देव कृषि एवं तकनीकी विश्वविद्यालय कुमारगंज द्वारा विकसित उन्नत उपज क्षमता तथा पाउडरी मिल्ड्यू एवं डाउनी मिल्ड्यू के प्रति मध्यम प्रतिरोधक **आर एम टी -354** तथा **नरेन्द्र मेथी 2 (एन डी एम 69)** को कार्यशाला में विमोचित करने के लिए संस्तुत किया गया।

काली मिर्च

गत वर्ष काली मिर्च के 45 अक्सेशनों को अखिल भारतीय समन्वित मसाला अनुसंधान परियोजना के विभिन्न केन्द्रों के काली मिर्च जननद्रव्यशाला में अनुरक्षित किया गया। काली मिर्च के मोटे बेरी वाले कुछ विशिष्ट प्रकार-{ट्टाणी} पेप्पर तथा अण्डाकार के अन्य जीन प्रकार *करिविलंची* को संचित करके जननद्रव्यशाला में सम्मिलित किया गया।

सिरसी में, बेलों को 100 प्रतिशत अजैविक (0.97 कि. ग्राम प्रति बेल) एवं 100 प्रतिशत जैविक (0.88 कि. ग्राम प्रति बेल) के उपचार की अपेक्षा 100 प्रतिशत एकीकृत प्रणाली से उपचारित करने पर शुष्क बेरी की उपज (1.25 कि. ग्राम प्रति बेल) अंकित की गयी।

अम्बलवयल में काली मिर्च आधारित अन्तःफसल प्रणाली पर किये गये अध्ययन में यह देखा कि फसलें जैसे टपियोका, एरोरूट, जर्मीकन्द, कोलोकैसिया तथा ग्रेटर याम काली

मिर्च बागों में अन्तरफसल के लिए उचित है। जिसके द्वारा लाभ बढ़ा।

सिरसी के वर्तमान बाग में *फाइटोपथोरा* खुर गलन के प्रति कवक विषाक्त के नये अणुओं के प्रभाव का मूल्यांकन परीक्षण में सेक्टिन 0.1% की दर में 21 प्रति बेल की दर से छिड़काव तथा ड्रिगिंग करने (3 लिटर प्रति बेल) के साथ जैव कारक *ट्राइकोडेरमा हरज़ियानम* 50 ग्राम के साथ एक कि. ग्राम नीम केक को मृदा में दो बार डालने पर रोगों के प्रति अन्य उपचारों की अपेक्षा आशावान थे।

छोटी इलायची

मुडिगरे तथा पाम्पाडुमपारा केन्द्रों में कुल 309 जर्मप्लासम अक्सेशनों का संरक्षण किया जा रहा है। मुडिगरे में इलायची के आशाजनक प्रकारों का मूल्यांकन करने पर, आई सी - 346951 (387 कि. ग्राम / हेक्टेयर) में उच्चतम कैप्सूल की मात्रा अंकित की गयी तत्पश्चात् सी एल -726 (340 कि. ग्राम / हेक्टेयर)।

पाम्पाडुमपारा में विभिन्न लाइमिंग के प्रभाव का अध्ययन के लिए परीक्षण करने पर, डोलोमाइट प्रति पौधे 2 कि. ग्राम की दर से डालने पर पी वी 2 प्रजाति में उच्चतम नमी (2667.427 ग्राम / पौधे) तथा शुष्क कैप्सूल (941 ग्राम / पौधे) के साथ उत्तम उपचार थे। अन्य उपचारों की अपेक्षा इस उपचार में कीट एवं रोग आपतन कम अंकित किया गया।

मुडिगरे में *प्स्यूडोस्टम* गलन के प्रति रासायनिक उपचार एवं जैव नियन्त्रण कारकों के प्रभाव की तुलना के लिए परीक्षण करने पर बाविस्टिन 0.2 % डालने पर 645.54 ग्राम प्रति पौधे की उच्च उपज के साथ न्यूनतम टिल्लर बाधा (5.80%) अंकित की गयी तत्पश्चात् टी. *हरज़ियानम* के साथ नीम केक तथा 0.2 % *प्स्यूडोमोनास फ्लूरोसन्ट* का छिड़काव था।

बड़ी इलायची

बड़ी इलायची के 292 जर्मप्लासम अक्सेशनों को आई सी ए आर तथा आई सी आर आई, गेंगटोक केन्द्रों में संरक्षित किया जा रहा है। सिक्किम के उत्तर पूर्व एवं पश्चिम जिलों

के विभिन्न क्षेत्रों तथा अरुणाचल प्रदेश के सियांग जिले में एक्सप्लोरेशन ट्रिप्स किया गया तथा वहां से बड़ी इलायची के पन्द्रह अक्सेशनों को आई सी आर आई क्षेत्रीय स्टेशन सिक्किम द्वारा संचित किया गया।

आई सी ए आर रिसर्च कोम्प्लक्स, सिक्किम केन्द्र तटांग में पहली बार बड़ी इलायची की मीली बग आक्रमण को अंकित किया गया। यह देखा जाता है कि कीट बाधा की व्याप्ति अधिकांशतः संचित पानी तथा अन्तर्पोषण के पहले कीट बाधा द्वारा होती है। कीट बाधित पौधों से क्रोलेर्स के द्वारा अन्य पौधों में होती है।

अदरक

केरल में किसानों के खेतों से उच्च उपज वाली अदरक अक्सेशन आनच्चुवडन तथा एक विशिष्ट लाल अदरक को संचित किया गया।

कुछ विशिष्ट प्रकार जैसे उच्च उपज वाली करिमुंडा, बालनकोट्टा तथा अरकुलमुंडा को संचित करके जननद्रव्यशाला में सम्मिलित किया गया।

पुंडिबारी केन्द्र में प्रति खेत उच्चतम प्रकन्द उपज जी सी पी -33 (7.55 कि. ग्राम) में अंकित किया गया। जहां निम्नतम प्रकन्द उपज प्रति खेत जी सी पी -60 (1.38 कि. ग्राम प्रति खेत) में अंकित की गयी। अधिकतम रोग आपतन जर्मप्लासम जी सी पी -21 (50.33%) में तत्पश्चात् जी सी पी -22(50.22%) तथा निम्नतम रोग आपतन जी सी पी -27 (9.81%) में अंकित किया गया।

सोलन केन्द्र में, अदरक के 55 श्रेष्ठ जीन प्रकारों को गुणवत्ता के लिए विश्लेषण किया गया। अदरक के शुष्क उपज (%) तथा कूड फाईबर (%) में क्रमशः 15.33 (अक्से. 578) से 24.31 (एस जी -247) तथा 3.90 (रांची लोकल) से 5.62 (हिमगिरि) अन्तर। एसनशियल तेल (%) तथा ओलिओरसिन की मात्राओं (%) में क्रमशः 0.72 (वरदा) से 1.670 (एस जी -857) तथा 3.180 (एस जी-1124) से 4.737 (एस जी-908) का अन्तर था। उच्च उपज वाले जीन प्रकार एस जी -26-04

(गिरिगंगा) को शुष्क उपज, एसनशियल तेल, ओलिओरेसिन तथा कूड फाईबर की दृष्टि से हिमगिरि चैक की अपेक्षा उच्चतम/तुलनीय था। अदरक में सिंक संबन्ध के स्रोत पर परीक्षण 4 विभिन्न केन्द्रों की चार प्रजातियों जैसे आई आई एस आर महिमा, जी सी पी 5 (गोरुबथने), मिज़ोरम लोकल तथा रांची लोकल पर किया गया। परिणामस्वरूप, सभी स्थानों में सभी प्रजातियों पर लगभग समान दक्षता अंकित की गयी। सामान्यतया, प्रति पौधे की प्रकन्द उपज इन जगहों की स्थानीय प्रजाति से उन्नत तत्पश्चात् आई आई एस आर महिमा की थी। तेल तथा ओलिओरेसिन की मात्राएं सभी स्थानों में अन्य प्रजातियों की अपेक्षा जी सी पी 5 में अधिक थी। अर्थात् आई आई एस आर महिमा उपज के लिए तथा जी सी पी 5 गुणवत्ता के लिए एक सुस्थिर प्रजाति है।

पोटांगी में जीवाणु म्लानी के प्रबन्धन के लिए किये गये परीक्षण में, कम गलन आपतन (8.6%) तथा उन्नत साफ प्रकन्द उपज (17.4 टन/हेक्टेयर) रासायनिक उपचारों में (मेंकोज़ेब 3 ग्राम प्रति लिटर कारबेन्डाज़िम 1 ग्राम प्रति लिटर तथा स्ट्रेप्टोसाइक्लिन 1 ग्राम प्रति लिटर की दर के साथ प्रकन्द उपचार तथा बुआई के 45 तथा 90 दिनों के बाद छिड़काव करने पर) में था।

हल्दी

एक सी वी टी में एन डी एच -98 ने कुमारगंज (30.88 टन/ हेक्टेयर), पासीघाट (22.64 टन/ हेक्टेयर) तथा नवसारी (33.46 टन/ हेक्टेयर) में उन्नत साफ प्रकन्द उपज अंकित की गयी। जबकि पी टी एस 12 (455.6ग्राम/ पौधे), एन डी एच 8 (28.04 टन/ हेक्टेयर) तथा पी टी एस -8 (35.08 टन/ हेक्टेयर) क्रमशः कोयंबतोर, काम्मारपल्ली तथा पुंडिबारी में उच्चतम उपज थी।

सोलन में, प्रकन्द उपज एवं अन्य बागवानी परीक्षण के लिए 133 हल्दी संचयनों का मूल्यांकन किया गया। उपज का अन्तर 180.07 कुन्तल /हेक्टेयर (बीडीजेआर-1292) से 411.98 कुन्तल /हेक्टेयर (एस टी -907) था। तीन प्रकारों जैसे एस टी 907 (411.98 कुन्तल /हेक्टेयर) एस टी -12एम (376.76 कुन्तल /हेक्टेयर) तथा पी सी टी -53 (372.07 कुन्तल /

हेक्टेयर) की उपज चैक पालम लालिमा तथा पालम पीताम्बर से अधिक थी जिसकी उपज क्रमशः 331.75 कुन्तल / हेक्टेयर तथा 367.04 कुन्तल /हेक्टेयर थी। कुरकुमिन की मात्रा में पी सी टी -14 में उच्चतम मूल्य 6.30% के साथ 1.53-6.30% थे। चैक प्रजाति पालम लालिमा तथा पालम पीताम्बर में क्रमशः 3.57% तथा 2.98% थी।

हल्दी के सोर्स सिंक संबन्ध पर दक्षिण, उत्तर तथा उत्तर पूर्व राज्यों के 6 विभिन्न केन्द्रों में निम्न प्रजातियों जैसे आई आई एस आर प्रतिभा, राजेन्द्र सोनिया, दुगिराला लाल, मिदुकर तथा बी एस आर -2 के साथ परीक्षण आयोजित किया। परिणामस्वरूप, बुआई के 60 दिनों के बाद पत्ते में अधिकतम विभाजन प्रतिशत तत्पश्चात् तने जबकि बुआई के 120 दिनों के बाद प्रकन्द में अधिकतम विभाजन प्रतिशत था। समान अवस्थाएं लगभग सभी केन्द्रों में थी। सभी केन्द्रों में इन प्रजातियों में से बुआई के 120 दिनों के बाद प्रकन्द का विभाजन राजेन्द्र सोनिया में अधिकतम तत्पश्चात् आई आई एस आर प्रतिभा में था। गुणवत्ता के अनुसार कोयम्बतूर में सभी प्रजातियों में तेल तथा ओलिओरेसिन का स्तर समान थे, जबकि आई आई एस आर प्रतिभा तथा राजेन्द्र सोनिया का स्तर गुंटूर में अधिकतम था। तेल तथा ओलिओरेसिन की मात्रा आई आई एस आर तथा धोली की अपेक्षा गुंटूर तथा कोयम्बतोर दोनों में समान थी। राजेन्द्र सोनिया, प्रतिभा तथा बी एस आर -2 में तेल तथा ओलिओरेसिन की मात्राएं आई आई एस आर तथा धोली दोनों में समान थीं। बारापानी में आई आई एस आर प्रतिभा के लिए उच्चतम तेल एवं ओलिओरेसिन जबकि, अन्य सभी प्रजातियों में तेल मात्राएं समान थी। लेकिन ओलिओरेसिन की मात्रा में प्रजाति के अनुसार अन्तर था। सामान्यतया, विभिन्न कृषि जलवायु परिस्थितियों के अनुसार आई आई एस आर प्रतिभा में उन्नत तेल एवं ओलिओरेसिन की मात्रा थी। उपज के अनुसार भी, इस प्रजाति की सभी स्थानों में अच्छी दक्षता अंकित की गई।

पुंडिबारी में किये गये सूक्ष्मपोषण प्रबन्धन परीक्षण में, मृदा में बोरॉन (बोराक्स के रूप में) प्रति हेक्टेयर 25 कि. ग्राम डालने पर उच्चतम उपज (22.45 टन/हेक्टेयर) प्राप्त हुई जो सांख्यिकीय दृष्टि से बोरॉन (बोराक्स के रूप में) बुआई के

60 तथा 90 दिनों के बाद (21.36 टन/हेक्टेयर) 0.5% की दर से पत्तों पर छिड़कने पर प्राप्त उपज से काफी अधिक थी। मृदा में आयरन (एफ ई 2 एस ओ 4 के रूप में) 25 कि. ग्राम /हेक्टेयर की दर से (19.90 टन/हेक्टेयर) उपचार करने पर हल्दी प्रकन्द की अधिकतम उपज अंकित की गयी, जबकि निम्नतम उपज नियन्त्रित खेतों में (14.45टन/हेक्टेयर) अंकित की गयी।

कुमारगंज में पर्ण रोगों के कृषि पारिस्थितिक प्रबन्धन परीक्षण किया तथा न्यूनतम पर्ण ब्लोच आपतन पत्तों पर एग्रिमोने तेल 1.0% (25.07%) की दर से पत्तों पर छिड़क कर उपचार करने से प्राप्त हुई तत्पश्चात् महुआ तेल (28.7%) तथा जत्रोफा तेल (32.6%)। एग्रिमोने तेल की तुलना में यह प्रोपिकोनाज़ोल से अधिक थी।

वृक्ष मसाले

जायफल (122), कैसिया (10), दालचीनी (27) तथा लौंग (30) के जर्मप्लासम को पीचिपराई, दापोली तथा येरकाड केन्द्रों में संरक्षित किया जा रहा है।

जायफल के विशेष प्रकार का सर्वेक्षण केरल कृषि विश्वविद्यालय, त्रिश्शूर के परियोजना केन्द्र में हो रहा है तथा 14 नये अक्सेशनों को इस वर्ष केरल के विभिन्न जिलों में चिह्नित किया गया। दापोली में संरक्षित जायफल जर्मप्लासम में चार वर्ष के फलों की संख्या के औसत में 73-226 का अन्तर था। फलों की उन्नत औसत संख्या डी बी एसके के वी एम एफ 28 (226), डी बी एस के के वी एम एफ 24 (172) तथा डी बी एस के के वी एम एफ 19 (163) जीन प्रकार में अंकित की गयी। जीन प्रकार डी बी एस के के वी एम एफ 24 से अधिकतम शुष्क नट की उपज (1464.0 ग्राम) तथा शुष्क जावित्री की उपज (320.25 ग्राम) अंकित की गयी। औसत शुष्क नट की उपज (1376.0 ग्राम) तथा शुष्क जावित्री की उपज (288.0 ग्राम) जीन प्रकार डी बी एस के के वी एम एफ में अंकित की गयी। जीन प्रकार डी बी एस के के वी एम एफ 29 को अपने फलों का वज़न, नट का वज़न तथा जावित्री वज़न की दृष्टि से आशाजनक था। पीचीपाराई में जायफल अक्सेशन एम एफ 4 की संख्या में फल (1150 फल/वृक्ष) तथा एक फल का

वज़न (108.0 ग्राम) तथा जावित्री की उपज (440.50 ग्राम / वृक्ष) अंकित की गयी।

पीचीपाराई में संरक्षित 24 लौंग अक्सेशनों में से अक्सेशन एस ए -3 ने अधिकतम पर्ण लंबाई (16.50 से. मी.) पर्ण चौड़ाई (6.20 से. मी.) तथा शुष्क मुकुलों की उपज (5.50 कि. ग्राम / वृक्ष) अंकित की गयी। साधारण चैक ने शुष्क उपज मुकुल की उपज 3.00 कि. ग्राम / वृक्ष अंकित की गयी।

पीचीपरीई में, दालचीनी के अक्सेशन सी वी-5 ने अधिकतम पौधों की ऊंचाई (6.69 मीटर), तना परिधि (29.10 से. मी.), पर्ण उपज (8.90कि. ग्राम / पौधे तथा शुष्क छाल की उपज (625.00 ग्राम / प्रति पौधे) अंकित की गयी।

धनिया

कोयम्बतूर में धनिया के जीनोटाइप एल सी सी 168 (900 कि. ग्राम/ हेक्टर) तथा आर सी सी -12-11 (893.33 कि. ग्राम/ हेक्टेयर) तथा कुमारगंज में एन डी धनिया -94 (12.80 कुन्टल / हेक्टेयर), एन डी धनिया -90 (12.80 कुन्टल / हेक्टेयर) तथा एल सी सी -241 (12.35 कुन्टल / हेक्टेयर) पर किये बहुस्थानीय मूल्यांकन परीक्षण में अधिकतम बीज उपज अंकित की गयी।

समन्वित प्रजाति परीक्षण में, अधिकतम बीज उपज जोबनर में आर सी आर-436 (17.36 कुन्टल / हेक्टेयर), सी ओ आर -110 (15.82 कुन्टल / हेक्टेयर), सी ओ आर -96 (15.53 कुन्टल / हेक्टेयर) तथा सी ओ आर -95 (15.26 कुन्टल / हेक्टेयर), हिसार में सी ओ आर-114 (21.49 कुन्टल / हेक्टेयर) तत्पश्चात् सी ओ आर 115 (20.68 कुन्टल / हेक्टेयर), कोयम्बतूर में सी ओ आर-106 (6.40 कुन्टल / हेक्टेयर), जबलपुर में सी ओ आर-118 (25.30 कुन्टल / हेक्टेयर), कुमारगंज में सी ओ आर-119 (17.08 कुन्टल / हेक्टेयर) तत्पश्चात् सी ओ आर-98 (16.66 कुन्टल / हेक्टेयर), सी ओ आर-110 (16.04 कुन्टल / हेक्टेयर), सी ओ आर-111 (15.76 कुन्टल / हेक्टेयर) तथा सी ओ आर-114 (15.62 कुन्टल / हेक्टेयर), गुंटूर में सी ओ आर-108 (11.91 कुन्टल

/ हेक्टेयर), सी ओ आर-107 (13.42 कुन्टल / हेक्टेयर), सी ओ आर-104 (11.42 कुन्टल / हेक्टेयर), सी ओ आर-106 (9.95 कुन्टल / हेक्टेयर), सी ओ आर-120 (9.73 कुन्टल / हेक्टेयर) तथा सी ओ आर-98 (9.63 कुन्टल / हेक्टेयर), जगुदान में सी ओ आर-95 (14.14 कुन्टल / हेक्टेयर), सी ओ आर-96 (13.89 कुन्टल / हेक्टेयर) तथा सी ओ आर-98 (13.87 कुन्टल / हेक्टेयर) तथा नवसारी में सी ओ आर-99 (15.09 कुन्टल / हेक्टेयर), सी ओ आर-100 (14.50 कुन्टल / हेक्टेयर), सी ओ आर-95 (14.35 कुन्टल / हेक्टेयर) तथा सी ओ आर-105 (13.95 कुन्टल / हेक्टेयर) में अंकित की गयी।

मधु मक्खियों के आकर्षक हेतु सिट्रोनेल्ला तेल (10 मि. लि./ लि.), गुड़ (25 ग्राम / लि.) तथा गन्ना जूस (50 मि. लि / लि.) को गुंटूर में धनिया में इपयोग करने से बढ़िया परागण द्वारा उपज में (23-32%) महत्वपूर्ण वृद्धि अंकित की गयी।

कोयम्बतूर में धनिया के पाउडरी मिल्ड्यू के प्रति नये कवकनाशियों के मूल्यांकन अध्ययन करने पर प्रोपिकोनाज़ोल का छिड़काव करने पर अधिकतम नियन्त्रण था। हेक्साकोनाज़ोल 5% एस सी 0.1 की दर से तथा प्रोपिकोनाज़ोल 25% ई सी 0.1 % की दर से जोबनर में तथा राईगड में वेटबिल सल्फर 0.2% डालने पर उत्तम नियन्त्रण में आशावान थे।

जीरा

जीरा का जर्मप्लासम जगुदान, जोबनर तथा सानन्द में संरक्षित किया जा रहा है तथा वर्तमान में यहां लगभग 340 अक्सेशनें जिसमें विदेशी संचयन भी शामिल हैं।

जगुदान में क्युमिन की अठारह प्रजातियों को अल्टरनेरिया ब्लाइट रोग तथा पाउडरी मिल्ड्यू के प्रति छानबीन की गयी। परिणामस्वरूप, न्यूनतम ब्लाइट रोग जी सी-3 (5.7%) में तत्पश्चात् जी सी -4 (10.1%), जबकि न्यूनतम पाउडरी मिल्ड्यू का आपतन जे सी -2010-1(3.5%) में अंकित किया गया।

सौंफ

प्रस्तुत वर्ष सी वी टी में उत्तम दक्षता प्रजातियां जबलपुर की आर एफ-205 (16.42 कुन्टल / हेक्टेयर), जोबनर के आर एफ-143 (29.29 कुन्टल / हेक्टेयर), धोली की आर एफ-88 (18.51 कुन्टल / हेक्टेयर), कुमारगंज की एफ एन एल-86 (15.62 कुन्टल / हेक्टेयर), हिसार की एफ एन एल -84 (20.91 कुन्टल / हेक्टेयर) तथा एफ एन एल -83 (20.33 कुन्टल / हेक्टेयर), जगुदान की एफ एन एल -77 (15.42 कुन्टल / हेक्टेयर) तथा अजमेर की एफ एन एल 81 (30.48 कुन्टल / हेक्टेयर) आदि थी।

जगुदान में सौंफ के बीज उपज में विभिन्न सूक्ष्म पोषण उपचारों का महत्वपूर्ण प्रभाव देखा गया। अन्य उपचारों के सिवा अयरन 3.0 कि. ग्राम अ ज़िक1.5 कि. ग्राम/ हेक्टेयर के साथ एफ वाई एम 200 कि. ग्राम / हेक्टेयर की दर से संस्तुत मात्रा के उर्वरक भी डालने पर बीज उपज में उन्नत वृद्धि प्राप्त हुई, लेकिन यह संस्तुत मात्रा के उर्वरक अ200 कि. ग्राम एफ वाई एम 1.5 कि.ग्राम ज़िक प्रति हेक्टेयर की दर से उन्नत करके संस्तुत मात्रा में उर्वरक अ 200 कि. ग्राम 3.0 कि. ग्राम आयरन उपचार से प्राप्त उपज काफी कम थी।

मेथी

मेथी के लिए एक सी वी टी करने पर, उच्चतम बीज उपज कोयम्बतूर में एफ जी के 86 (4.29 कुन्टल / हेक्टेयर) में, जबलपुर में आर एम टी 361 (25.30 कुन्टल / हेक्टेयर), जोबनर में एफ जी के -88 (22.91 कुन्टल / हेक्टेयर) , अजमेर में एफ जी के 85 (21.33 कुन्टल / हेक्टेयर) तथा एफ जी के -86 (21.17 कुन्टल / हेक्टेयर), एफ जी के -82 (135 कुन्टल / हेक्टेयर) एफ जी के -79 (12.49 कुन्टल / हेक्टेयर), कुमारगंज में एफ जी के - 81 (12.14 कुन्टल / हेक्टेयर) तथा एफ जी के -84 (12.01 कुन्टल / हेक्टेयर) हिसार सोनाली में (22.63 कुन्टल / हेक्टेयर) में अंकित की गयी तत्पश्चात् हिसार में एफ जी के -89 (22.55 कुन्टल / हेक्टेयर) तथा एफ जी के -83 (20.49 कुन्टल / हेक्टेयर)

तथा नवसारी में एफ जी के -87 (13.45 कुन्टल / हेक्टेयर), एफ जी के -89 (13.33 कुन्टल / हेक्टेयर) थी।

जोबनर में, मेथी के पाउडरी मिल्ड्यू के लिए जांच किये अठारह प्रजातियों में एफ जी के -79 तथा एफ जी के -83 को सामान्यतया पाउडरी मिल्ड्यू रोग के प्रतिरोधक थे। यु एम-398 तथा यु एम -415 को जांच किये दस आई ई टी में से सामान्य प्रतिरोधक अंकित किया गया। एक सौ इक्कीस जर्मप्सालम में से बत्तीस प्रविष्टियों को रोग के प्रति सामान्यतया प्रतिरोधक के रूप में पहचान की गयी।

गुणवत्ता युक्त रोपण सामग्रियों का उत्पादन एवं वितरण

दस लाख काली मिर्च, 15 टन हल्दी तथा 5 टन अदरक एवं 30000 वृक्ष मसालों का वितरण किया गया। जीरा, धनिया, सौंफ, मेथी आदि के 10 कुन्टल को सुपारी व मसाला विकास निदेशालय की सहायता से वितरण किया गया।

तकनीकी स्थानान्तरण

विभिन्न केन्द्रों के वैज्ञानिकों ने नवीन तकनीकियों को लोकप्रिय करने के लिए परिश्रम किया क्योंकि अनुसंधान की उपलब्धियों को किसानों तक पहुंचाने पर ही अनुसंधान सार्थक होता है। प्रस्तुत वर्ष प्रदर्शित कुछ नवीन तकनीकियां निम्न प्रकार है।

- ❖ वयनाडु के आदिवासी किसानों एवं विशेषज्ञों के लिए अदरक की प्रोट्रे प्रवर्धन तकनीकी की प्रदर्शनी (अखिल भारतीय समन्वित मसाला अनुसंधान परियोजना का मुख्यालय, कोषिकोड)।
- ❖ उच्च उपज वाली हल्दी प्रजाति सी ओ 2 (कोयम्बतूर) पर खेतीगत प्रदर्शनी।
- ❖ दालचीनी के छाल को निकालना, अदरक एवं हल्दी की प्रो ट्रे प्रवर्धन, काली मिर्च का संसाधन, हल्दी का संसाधन, जायफल एवं कोकुम में मृदु काठ ग्राफिटिंग, बुश पेप्पर उत्पादन तकनीकी पर प्रदर्शनी (दापोली)।

- ❖ कवगनाशियों द्वारा पर्ण दाग रोग प्रबन्धन पर खेती गत प्रदर्शनी (धोली)।
- ❖ उच्च उपज वाली उच्च तेल वाली धनिया प्रजाति सुगुणा पर खेती गत प्रदर्शनी (एल सी सी -236) (गुंटूर)।
- ❖ जीरा, धनिया तथा सौंफ के उच्च उपज वाली प्रजातियों के रोग प्रबन्धन तकनीकियों पर खेती गत प्रदर्शनी (जगुदान)।
- ❖ मेथी, जीरा तथा सौंफ में एच वाई वी तथा नवीन तकनीकियों पर खेती गत प्रदर्शनी (जोबनर)।
- ❖ हल्दी के लिए प्रो ट्रे प्रवर्धन तकनीकी (कामरापल्ली)।
- ❖ इलायची में ड्रिप सिंचाई का प्रयोग (मुडिगरे)।
- ❖ इलायची में मूल भेदक का प्रबन्धन (पाम्पाडुमपारा)।
- ❖ आई पी डी एम के अन्तर्गत पन्नियूर प्रजातियों की उत्पादन क्षमता तथा एबयोटिक स्ट्रेस के अन्तर्गत पन्नियूर प्रजातियों की उच्च उत्पादन क्षमता (पन्नियूर)।
- ❖ अदरक की जैविक खेती पर खेती गत प्रदर्शनी (पोट्टांगी)।
- ❖ अदरक के मृदु गलन तथा जीवाणु म्लानी रोग नियन्त्रण के लिए कैबेज द्वारा बायोफ्यूमिगेशन (पुंडिबारी)।
- ❖ बुश पेप्पर खेती (सिरसी)।
- ❖ चैक सी वी हिमगिरी के साथ अदरक के आशाजनक जीनोटाइप आई सी -593889 (एस जी-26-04) पर खेती गत प्रदर्शनी (सोलन)।

उपरोक्त खेती गत प्रदर्शनियों के अलावा, वैज्ञानिकों ने प्रशिक्षण तथा संगोष्ठी आयोजित करके तथा प्रसार माध्यम (समाचार पत्र, आकाशवाणी में व्याख्यान तथा दूरदर्शन कार्यक्रम) से तकनीकियों को अधिक लोकप्रिय बनाया।

सफल गाथा

श्री श्रीधर भट्ट, सिरसी, कर्नाटक के किसान ने अपने पाच एकड़ भूमि में काली मिर्च के बीस स्थानीय जीनोटाइप का संरक्षण किया है। सभी जीनोटाइप उपज देने वाले तथा उस क्षेत्र में अच्छी तरह लोकप्रिय भी है। इन सभी जीनोटाइपों को वैज्ञानिकों ने वैज्ञानिक स्तर पर अध्ययन किया। संचित प्रजातियों में पर्ण रचना, उपज, बेरी का गुण तथा कीट एवं रोग प्रतिरोधकता की दृष्टि से अन्तर था। उनके संचयनों से दो उच्च उपज वाली प्रजातियों (स्वर्णवल्ली सूर्या तथा स्वर्णवल्ली शालमला) को संचित करके उनका अध्ययन किया गया। लगभग 22 जीनोटाइप की पहचान की गयी तथा उनकी वृद्धि एवं उत्पादन क्षमता का अध्ययन किया जा रहा है।

अखिल भारतीय समन्वित मसाला अनुसंधान परियोजना के सिरसी केन्द्र के वैज्ञानिकों से संपर्क करके फसल से संबन्धित सभी तकनीकी जानकारियां अर्जित कीं। वह काली मिर्च की खेती पिछले तीन दशकों से कर रहे हैं। यहां लगभग 1600 बेल है, जिनमें 1100 पुरानी बेल है। ये कई प्रजातियों की है जिसे श्री भट्ट ने तिरपु करे, करी मल्लिशरा, बिलिमल्लिसरा, पन्नियूर -1 से संचित किया है। यह सच है कि स्थानीय प्रजातियां कम उपज वाली होती है, लेकिन श्री भट्ट का विश्वास है कि नवीन कृषि तकनीकियों द्वारा उपज को बढ़ा सकते हैं तथा उनका यह भी मानना है कि स्थानीय प्रजातियां कीट एवं रोग प्रतिरोधक है। उनका नाम प्लान्ट जीनोम सेवियर पुरस्कार के लिए संस्तुत किया गया है।

आदिवासी कल्याण उपाय

पोट्टांगी, चिंतापल्ली तथा राइगड क्षेत्र में आदिवासी किसानों के लिए प्रशिक्षण आयोजित करने के अलावा मसालों की गुणवत्ता रोपण सामग्रियों का वितरण किया गया।

उत्तर पूर्व में नयी पहल

असम (उत्तर पूर्व क्षेत्र) में असम कृषि विश्वविद्यालय एवं आई आई एस आर, कोषिकोड के साथ मिलकर काली मिर्च की उत्पादन तकनीकी पर दो दिवसीय प्रशिक्षण कार्यक्रम 22-23 मई 2015 को पेपर मित्रा के रूप में आयोजित किया।

सहयोग

भाकृअनुप-भारतीय मसाला फसल अनुसंधान संस्थान, कोषिकोड ने राष्ट्रीय बीज मसाला अनुसंधान केन्द्र, अजमेर तथा राज्य कृषि विश्वविद्यालयों के अलावा सुपारी व मसाला विकास निदेशालय, स्पाइसेस बोर्ड, केन्द्रीय बागवानी संस्थान, राष्ट्रीय नवोत्पाद संगठन के साथ सहयोगी कार्य कर रहे हैं। हम गिरिजन विकास, आन्ध्र प्रदेश का एक एन जी ओ के साथ मिलकर आदिवासी क्षेत्रों में अदरक एवं हल्दी की खेती /उत्पादन के लिए मदद कर रहे हैं।

निरीक्षण

केन्द्रों द्वारा संचालित परियोजनाओं तथा कार्यक्रमों का प्रबोधन परियोजना समन्वयक एवं परियोजना समन्वयक यूनिट के वैज्ञानिकों ने केन्द्रों तथा प्रायोगिक क्षेत्रों का भ्रमण करके किया। इस वर्ष 14 केन्द्रों का भ्रमण किया जिनमें नियमित, सहकारी तथा परियोजना स्तर के केन्द्र भी शामिल हैं। यह निरीक्षण केन्द्रों द्वारा भेजी गयी मासिक रिपोर्ट, वार्षिक रिपोर्ट द्वारा भी किया जाता है तथा वार्षिक कार्यशाला 5-7 अक्टूबर 2015 को भाकृअनुप-भारतीय मसाला फसल अनुसंधान संस्थान, कोषिकोड में आयोजित की गयी।

Executive Summary

ICAR-All India Coordinated Research Project on Spices is a coordinating unit with 38 centres (19 regular, 10 co-opting and 9 voluntary centres) supplemented by five more in project mode funding, spreading over various agro climatic zones in 24 states of the country. Black Pepper, Large Cardamom, Small Cardamom, Ginger, Turmeric, Cinnamon, Nutmeg, Clove, Coriander, Cumin, Fennel and Fenugreek are the mandate crops. Annual budget for the year 2015/16 was Rs. 504 lakhs as ICAR share.

New Initiatives

To know the suitability of seed spices cultivation in South India under Bengaluru conditions a project mode program was undertaken where seed spices such as coriander, fennel and fenugreek were grown. In the same area flowering and seed set in cumin was also observed.

In tune with the ICAR policy of digitization and maintenance of records all the workshop proceedings and Annual Reports of AICRPS are digitized and made available in the AICRPS website. A user friendly web based online reporting system is started for reporting/submitted of monthly, quarterly, annual reports, budget details and utilization certificate from the centres.

Varieties recommended for release in 26th AICRPS workshop

Five high yielding varieties of spices were recommended for release in XXVI AICRP on Spices workshop held at ICAR-IISR, Kozhikode. One coriander variety- **LCC 219 (Susthira)** from Horticultural Research Station

(DrYSRHU), Guntur with high yield, suitable to rainfed and irrigated conditions with high essential oil content was recommended for release in Andhra Pradesh, Telangana and Tamil Nadu. Two fennel varieties **Ajmer Fennel-2 (AF-2)** developed by ICAR-NRCSS, Ajmer with high essential oil content and moderate resistance to *Ramularia* blight is recommended for release at national level and **RF-157** developed by Sri Karan Narendra Agricultural University, Jobner, Rajasthan with high yield potential and better seed quality is recommended for release in Rajasthan, Gujarat and Haryana. Two fenugreek varieties **RMt-354** with high yield potential and moderate resistance to powdery mildew and downy mildew and **Narendra Methi 2 (NDM 69)** developed by Sri Karan Narendra Agriculture University, Jobner, Rajasthan and Narendra Dev University of Agriculture and Technology, Kumarganj respectively also recommended for release in the workshop.

Black Pepper

During the year, 45 accessions of black pepper were added to black pepper germplasm maintained at various centres of AICRPS. Some unique black pepper accessions with extra bold berries –‘Pattani pepper’ and another genotype with oval shaped berries resembling ‘*Karivilanchi*’ were collected and added to the germplasm.

At Sirsi, the vines treated with 100 per cent integrated methods recorded significantly higher dry berry yield (1.25 kg vine⁻¹) compared to those with 100 per cent inorganic (0.97 kg vine⁻¹) and 100 per cent organics (0.88 kg vine⁻¹).

A study at Ambalavayal on black pepper based mixed cropping system showed that crops such as tapioca, arrowroot, elephant foot yam, colocasia and greater yam are suited as intercrops in juvenile black pepper garden which have evidently added to the income generated.

In an experiment to evaluate the effectiveness of new molecules of fungi toxicants against *Phytophthora* foot rot in existing plantation at Sirsi, Sectin @ 0.1 % as spraying (@ 2 l vine⁻¹) and drenching (3 l vine⁻¹) along with bioagent *Trichoderma harzianum* 50 g with one kg of neem cake as soil application two times in a season found superior than other treatments with respect to leaf infection.

Small Cardamom

A total of 309 germplasm accessions are maintained at Mudigere and Pampadumpara centres. In a trial to evaluate promising lines of cardamom at Mudigere, IC-346951 (387 kg ha⁻¹) recorded highest capsule yield followed by CL-726 (340 kg ha⁻¹).

In an experiment at Pampadumpara to study the effect of different liming materials, application of dolomite @ 2 kg plant⁻¹ was found to be the best treatment with highest wet (2667.427 g plant⁻¹) and dry capsule (941 g plant⁻¹) yield in PV2 variety. The incidence of pest and disease in this treatment was less compared to other treatments.

In a trial to compare the effect of chemical treatments and bio-control agents against pseudostem rot at Mudigere, the minimum tiller infection of (5.80 %) with higher yield of 645.54 g plant⁻¹ was recorded with the application of 0.2 % Bavistin which is followed by the application of *T. harzianum* with Neem cake and spraying of 0.2 % *Pseudomonas fluorescens*.

Large Cardamom

In large cardamom 292 germplasm accessions are maintained at ICAR and ICRI, Gangtok centres. Exploration trips were made to different areas of East and West districts of Sikkim and Siang Dist. of Arunachal Pradesh and collected fifteen accessions of large cardamom by ICRI Regional Station, Sikkim.

Mealy bug infestation has been observed for the first time in large cardamom at ICAR Research Complex, Sikkim Centre, Tadong. It is found that spreading of the pest is mostly by irrigation water, re-use of previously infested plots for transplanting and through movement of crawlers from infested plants to other plants.

Ginger

A high yielding ginger accession 'Aanachuvadana' and a unique red ginger were collected from farmer's field at Kerala.

At Pundibari centre, highest rhizome yield per plot was recorded in GCP-33 (7.55 kg) whereas the lowest rhizome yield per plot was recorded in GCP-60 (1.38 kg plot⁻¹). Maximum disease incidence was recorded in the germplasm GCP- 21 (50.33 %) followed by GCP-22 (50.00%) whereas lowest disease incidence was recorded in GCP-27 (9.81%).

At Solan centre, 55 best performing genotypes of ginger were analyzed for quality. The dry matter content (%) and crude fibre (%) of ginger ranged between 15.33 (Acc. 578) to 24.31 (SG-247) and 3.90 (Ranchi Local) to 5.62 (Himgiri), respectively. Essential oil (%) and oleoresin contents (%) varied from 0.720 (Varada) to 1.670 (SG-857) and 3.180 (SG-1124) to 4.737 (SG-908), respectively. The high yielding genotype SG-26-04 (Giriganga) was found superior / comparable for dry matter

content, essential oil, oleoresin and crude fibre contents to the check Himgiri.

The experiment on source sink relationship in ginger is being carried out in 4 different centres with four varieties *viz.* IISR Mahima, GCP 5 (Gorubathane), Mizoram Local and Ranchi Local. Results indicated that partitioning efficiency remained almost same in all varieties in all places. In general, rhizome yield per plant was higher in local variety of the place followed by IISR Mahima. Oil and oleoresin contents were higher in GCP 5 compared to other varieties in all the places. Results indicate that IISR Mahima could be a stable variety for yield and GCP 5 for quality.

In a trial for management of bacterial wilt in ginger at Pottangi, the low rot incidence (8.6 %) and high fresh rhizome yield (17.4 t ha⁻¹) was found in the chemical treatment (rhizome treatment with mancozeb @ 3g l⁻¹ along with carbendazim @ 1g l⁻¹ and streptomycin @ 1g l⁻¹ and foliar spray at 45 DAS and 90 DAS).

Turmeric

NDH-98 recorded highest fresh rhizome yield at Kumarganj (30.88 t ha⁻¹), Pasighat (22.64 t ha⁻¹) and Navsari (33.46 t ha⁻¹) in a CVT whereas PTS 12 (455.6 g plant⁻¹), NDH 8 (28.04 t ha⁻¹) and PTS-8 (35.08 t ha⁻¹) were the top yielders at Coimbatore, Kammarpally and Pundibari respectively.

At Solan, 133 turmeric collections were evaluated for rhizome yield and other horticultural traits. The yield range varied from 180.07 q ha⁻¹ (BDJR-1292) to 411.98 q ha⁻¹ (ST-907). Yield of three lines *viz.*, ST-907 (411.98 q ha⁻¹), ST-12M (376.76 q ha⁻¹) and PCT-53 (372.07 q ha⁻¹) excelled over the checks Palam Lalima and Palam Pitamber which yielded 331.75 q ha⁻¹ and 367.04 q ha⁻¹,

respectively. The curcumin content varied from 1.53-6.30 % with the highest value of 6.30 % in PCT-14 whereas, 3.57 % and 2.98 % in the check varieties Palam Lalima and Palam Pitamber, respectively.

The experiment on source sink relationship in turmeric is being carried out in 6 different centres spread over South, North and North Eastern states with the following varieties *viz.*, IISR Prathibha, Rajendra Sonia, Duggirala Red, Mydukur and BSR-2. The results showed that at 60 days after planting (DAP), leaf showed maximum partitioning percentage followed by stem while at 120 DAP, rhizomes showed the highest partitioning percentage. Similar trend was noticed in almost all the centres. Among the varieties partitioning to rhizomes was maximum in Rajendra Sonia followed by IISR Prathibha in general at 120 DAP in all the centres. With respect to quality, all the varieties had similar oil and oleoresin levels at Coimbatore while IISR Prathibha & R. Sonia had maximum at Guntur. Oil and oleoresin contents were similar in both Guntur and Coimbatore but less compared to IISR & Dholi. Rajendra Sonia, Prathibha and BSR 2 had the similar oil and oleoresin contents at both IISR and Dholi. IISR Prathibha had the highest oil and oleoresin at Barapani while all the other varieties had similar oil levels but oleoresin content varied among the varieties. In general, IISR Prathibha showed higher oil and oleoresin content among varieties under different agro climatic conditions. Yield wise also, this variety performed well in all the locations.

In a micro nutrient management trial at Pundibari, soil application of boron (as borax) @ 25 kg ha⁻¹ gave the highest yield (22.45 t ha⁻¹) which was statistically *on par* with foliar spray of boron (as borax) @ 0.5 % after 60 and 90 days of planting (21.36 t ha⁻¹). Higher yield of

turmeric rhizome was also recorded in the treatment of soil application of iron (as Fe_2SO_4) @ 25 kg ha^{-1} (19.90 t ha^{-1}) whereas the lowest yield was recorded in the control plot (14.45 t ha^{-1}).

A trial on ecofriendly management of foliar diseases was undertaken at Kumarganj and the minimum leaf blotch incidence was observed in foliar spray of Argimone oil @ 1.0 % (25.07 %) followed by Mahuwa oil (28.7 %) and Jatropha oil (32.6 %). In case of Argimone oil, it was *at par* with Propiconazole.

Tree Spices

Germplasm of nutmeg (122), cassia (10), cinnamon (27) and clove (30) are maintained at Pechiparai, Dapoli and Yercaud centres.

Survey for unique accessions of nutmeg is conducted by project mode centre at KAU, Thrissur and 14 new accessions have been identified from various districts of Kerala during this year. Among the nutmeg germplasm maintained at Dapoli, average number of fruit for four years ranged from 73-226. The higher average number of fruits is recorded in genotypes DBSKKVMF 28 (226), DBSKKVMF 24 (172) and DBSKKVMF 19 (163). The genotype DBSKKVMF 24 recorded maximum dry nut yield (1464.0 g) and dry mace yield (320.25 g). Average dry nut yield (1376.0 g) and dry mace yield (288.0 g) was recorded in genotype DBSKKVMF 28. The genotype DBSKKVMF 29 is found to be promising considering its fruit weight, nut weight and mace weight. At Pechiparai, the Nutmeg accession MF- 4 recorded maximum number of fruits (1150 fruits /tree) and single fruit weight (108.0 g) and the mace yield (440.50 g tree^{-1}).

Among the 24 clove accessions, maintained at Pechiparai, the accession SA-3 recorded the

highest leaf length (16.50 cm) leaf breadth (6.20 cm) and dry bud yield (5.50 kg tree^{-1}). The local check recorded dry bud yield of 3.00 kg tree^{-1} .

In case of cinnamon, the accession CV-5 recorded maximum plant height (6.69 m), stem girth (29.10 cm), leaf yield (8.90 kg plant^{-1}) and dry bark yield (625.00 g plant^{-1}) at Pechiparai.

Coriander

In a multi-location evaluation of coriander maximum seed yield was recorded in the genotype LCC 168 (900 kg ha^{-1}) and RCC-12-11 (893.33 kg ha^{-1}) at Coimbatore and NDCor-94 (12.80 q ha^{-1}), NDCor-90 (12.0 q ha^{-1}) and LCC-241 (12.35 q ha^{-1}) at Kumarganj.

In an Coordinated Varietal Trial, maximum seed yield was recorded in the entries RCr-436 (17.36 q ha^{-1}), COR-110 (15.82 q ha^{-1}), COR-96 (15.53 q ha^{-1}) and COR-95 (15.26 q ha^{-1}) at Jobner, COR- 114 (21.49 q ha^{-1}) followed by COR-115 (20.68 q ha^{-1}) at Hisar, COR 106 (6.40 q ha^{-1}) at Coimbatore, COR 118 (25.30 q ha^{-1}) at Jabalpur, COR-119 (17.08 q ha^{-1}) followed by COR-98 (16.66 q ha^{-1}), COR-110 (16.04 q ha^{-1}), COR-111 (15.76 q ha^{-1}) and COR-114 (15.62 q ha^{-1}) at Kumarganj, COR-108 (11.91 q ha^{-1}), COR-107 (13.42 q ha^{-1}), COR-104 (11.42 q ha^{-1}), COR-106 (9.95 q ha^{-1}), COR-120 (9.73 q ha^{-1}) and COR-98 (9.63 q ha^{-1}) at Guntur, COR-95 (14.14 q ha^{-1}), COR-96 (13.89 q ha^{-1}) and COR-98 (13.87 q ha^{-1}) at Jagudan and COR-99 (15.09 q ha^{-1}), COR-100 (14.50 q ha^{-1}), COR-95 (14.35 q ha^{-1}) and COR-105 (13.95 q ha^{-1}) at Navsari.

In a study to evaluate new generation fungicides against powdery mildew in coriander at Coimbatore, spraying of Propiconazole found to give maximum level of control whereas Hexaconazole 5% SC @ 0.1 and Propiconazole 25% EC @ 0.1% at Jobner

and wettable sulphur 0.2% at Raigarh were found to be best controlling agents.

Cumin

Germplasm of cumin is maintained at Jagudan Jobner and Sanand, at present there are about 340 accessions including the exotic collections.

Total eighteen entries of cumin were screened for the resistance against *Alternaria* blight disease and powdery mildew at Jagudan. The minimum blight disease intensity was noticed in GC-3 (5.7 %) followed by GC-4 (10.1 %), while the minimum powdery mildew disease intensity was noticed in JC-2010-1 (3.5 %).

Fennel

The best performed entries in the CVT during the year were RF 205 (16.42 q ha⁻¹) at Jabalpur, RF-143 (29.29 q ha⁻¹) at Jobner, RF-88 (18.51 q ha⁻¹) at Dholi, FNL-86 (15.62 q ha⁻¹) at Kumarganj. FNL-84 (20.91 q ha⁻¹) and FNL-83 (20.33 q ha⁻¹) at Hisar, FNL-77 (15.42 q ha⁻¹) at Jagudan and FNL 81 (30.48 q ha⁻¹) at Ajmer.

The seed yield of fennel was found to be influenced significantly with different micronutrient treatments at Jagudan. Application of 3.0 kg Fe + 1.5 kg Zn ha⁻¹ enriched with FYM @ 200 kg ha⁻¹ along with recommended dose of fertilizer produced significantly higher seed yield over rest of the treatments, but it was *at par* with treatments of recommended dose of fertilizer + 200 kg FYM enriched with 1.5 kg Zn ha⁻¹ and recommended dose of fertilizer + 200 kg enriched with 3.0 kg Fe ha⁻¹.

Fenugreek

In a CVT for fenugreek, the highest seed yield was recorded in FGK 86 (4.29 q ha⁻¹) at Coimbatore, Rmt 361 (25.30 q ha⁻¹) at Jabalpur

and FGK 88 (22.91 q ha⁻¹) at Jobner, FGK 85 (21.33 q ha⁻¹) and FGK 86 (21.17 q ha⁻¹) at Ajmer, FGK 82 (13.5 q ha⁻¹) followed by FGK 79 (12.49 q ha⁻¹), FGK 81 (12.14 q ha⁻¹) and FGK 84 (12.01 q ha⁻¹) at Kumarganj, Hisar Sonali (22.63 q ha⁻¹) followed by FGK 89 (22.55 q ha⁻¹) and FGK 83 (20.49 q ha⁻¹) at Hisar and FGK 87 (13.45 q ha⁻¹), FGK 89 (13.33 q ha⁻¹) at Navsari.

Among eighteen (CVT) entries of fenugreek screened against powdery mildew at Jobner, the entries FGK 79 and FGK 83 were observed as moderately resistant against powdery mildew disease whereas the entries UM 398 and UM 415 were observed as moderately resistant amongst the ten IET entries tested. Thirty two entries among the one hundred and twenty one germplasm accessions were also identified as moderately resistant lines against the disease.

Production and distribution of quality planting material

10 lakhs of black pepper, 15 t of turmeric, 5 t of ginger and 30000 tree spices planting material were distributed. 10 quintals each of cumin, coriander, fennel, fenugreek seed material was distributed along with DASD.

Transfer of Technology

The scientists of various centres have taken earnest effort to popularize the latest technologies as the research is meaningful only when it is reached to farmers and they are benefited out of that. Following are some of the technologies demonstrated during the year.

- ❖ Demonstration of Ginger protrait propagation for tribal farmers and resource persons at Wayanad (AICRP Head Quarter, Kozhikode)

- ❖ FLD on high yielding turmeric variety CO 2 (Coimbatore)
- ❖ Demonstration of Technique of removing bark of cinnamon, Pro tray propagation technique for ginger and turmeric, Processing of black pepper , Processing of turmeric Soft wood grafting technique in nutmeg and kokum, Bush pepper production technology (Dapoli)
- ❖ FLD on management of leaf spot disease through fungicide application (Dholi)
- ❖ FLD on high yielding high oil content coriander variety Suguna (LCC-236) (Guntur)
- ❖ FLD on disease management technologies and high yielding varieties of cumin, coriander and fennel (Jagudan)
- ❖ FLD on HYV and advance technologies in fenugreek, cumin and fennel (Jobner)
- ❖ Pro-tray propagation technique for turmeric (Kammarppally)
- ❖ Adoption of drip irrigation in cardamom (Mudigere)
- ❖ Root grub management in Cardamom (Pampadumpara)
- ❖ Yield potential of Panniyur varieties under proper IPDM and High yielding capacity of Panniyur varieties under abiotic stress (Panniyur)
- ❖ FLD on organic cultivation of ginger (Pottangi)
- ❖ Biofumigation using cabbage for the control of soft rot and bacterial wilt diseases in ginger (Pundibari)
- ❖ Bush pepper cultivation (Sirsi)
- ❖ FLD on promising Ginger genotype IC-593889 (SG-26-04) along with check cv. Himgiri (Solan)

Apart from the above field level demonstrations, the scientists were made technologies more popular by conducting and attending as resource persons in trainings, seminar and also through various media (newspaper, radio talks and TV programs).

Success stories

Mr. Shridhar Bhat farmer from Sirsi, Karnataka has conserved more than twenty local genotypes of black pepper in an area of five acres. All the genotypes are yielding and are very well adopted in that area. All these genotypes are studied scientifically by the scientists. Varieties collected are varying in their leaf structure, yield, berry quality and resistance to pests and diseases. From his collections, two good yielding varieties (Swaranavalli Surya and Swaranavalli Shalmala) have been selected and studies are been taken up. About 22 genotypes have been identified and are being studied for their growth and yield potentials. These genotypes are collected and added to the black pepper germplasm of Sirsi centre.

He is in contact with scientists of AICRPS centre at Sirsi and getting all the technical information regarding the crop. He has been cultivating pepper from last three decades; there are about 1600 vines. There are many varieties which Mr. Bhat has collected including Thirapu kare, Kari mallisara, Bilimallisara, Panniyur-1. It is true that the local varieties are low yielding, but Mr. Bhat believes that yields can be increased with

improved agro-techniques, and also he says that local varieties are resistant to pest and diseases. His name is recommended for the 'Plant Genome Saviour Award'.

Tribal welfare measures

Quality planting materials of spices were distributed to the tribal farmers of Pottangi, Chintapalle and Raigarh area apart from conducting trainings.

New Initiatives in North East

To train the people working in black pepper plantation in the North East about the Nursery and High Production technology in Black Pepper a two days training program "Pepper Mitra" was conducted on 22nd and 23rd May 2015 in collaboration with Assam Agriculture University and IISR, Kozhikode at Kahikuchi, Assam (North East region).

Collaboration

In addition to IISR-Kozhikode, NRCSS-Ajmer and State Agricultural Universities we have collaboration with DASD, Spices Board and National Innovation Foundation. We are also helping Girijana Vikasa an NGO from Andhra Pradesh for growing/production of ginger and turmeric in tribal areas.

Monitoring

Projects and programs undertaken by the centres are monitored through visits of Project Coordinator and Scientists from PC unit's to various centres and experimental plots. In this year visits taken up to 14 centres which includes regular, co-opting, voluntary and project mode centres. Monitoring was also done by monthly reports, annual report sent by the centres. Annual workshop was conducted during 5th to 7th October 2015 at ICAR-IISR, Kozhikode.

Profile of AICRP on Spices

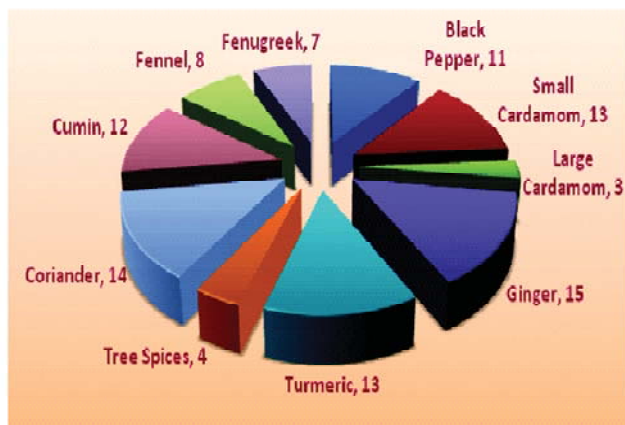
All India Coordinated Research Project on Spices (ICAR-AICRPS) is the largest spices research network in the country through which a nationwide collaborative and interdisciplinary research is being carried out, linking ICAR system with the State Agricultural Universities and central institutions. AICRPS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

focusing the major agro climatic regions of the country. These centres are mostly located in State Agricultural Universities and some centres in ICAR Institutes and also Spices Board.

Mandates of the AICRPS are:

- ❖ Evolving high yielding, high quality varieties suitable for various agro-ecological situations and that are tolerant/resistant to biotic and abiotic stresses to mitigate climate change
- ❖ Development of location specific green agro technologies for improved production with water and nutrient management, organic farming, ecologically sound control measures against pests and through mechanisation for production of quality clean spices and spice products.
- ❖ Facilitate faster adoption of proven technologies/varieties developed through technology dissemination, Field Level Demonstrations and attract youth to agriculture and agro enterprise.
- ❖ Working as an interface between State Agricultural Universities (SAUs) and Indian Council of Agricultural Research (ICAR).
- ❖ Spread the cultivation of spices to non traditional areas, North East and tribal areas for increased production. Tribal empowerment and identification of most suitable areas (crop mapping) for each of the crop.

Ongoing research programs-Crop wise

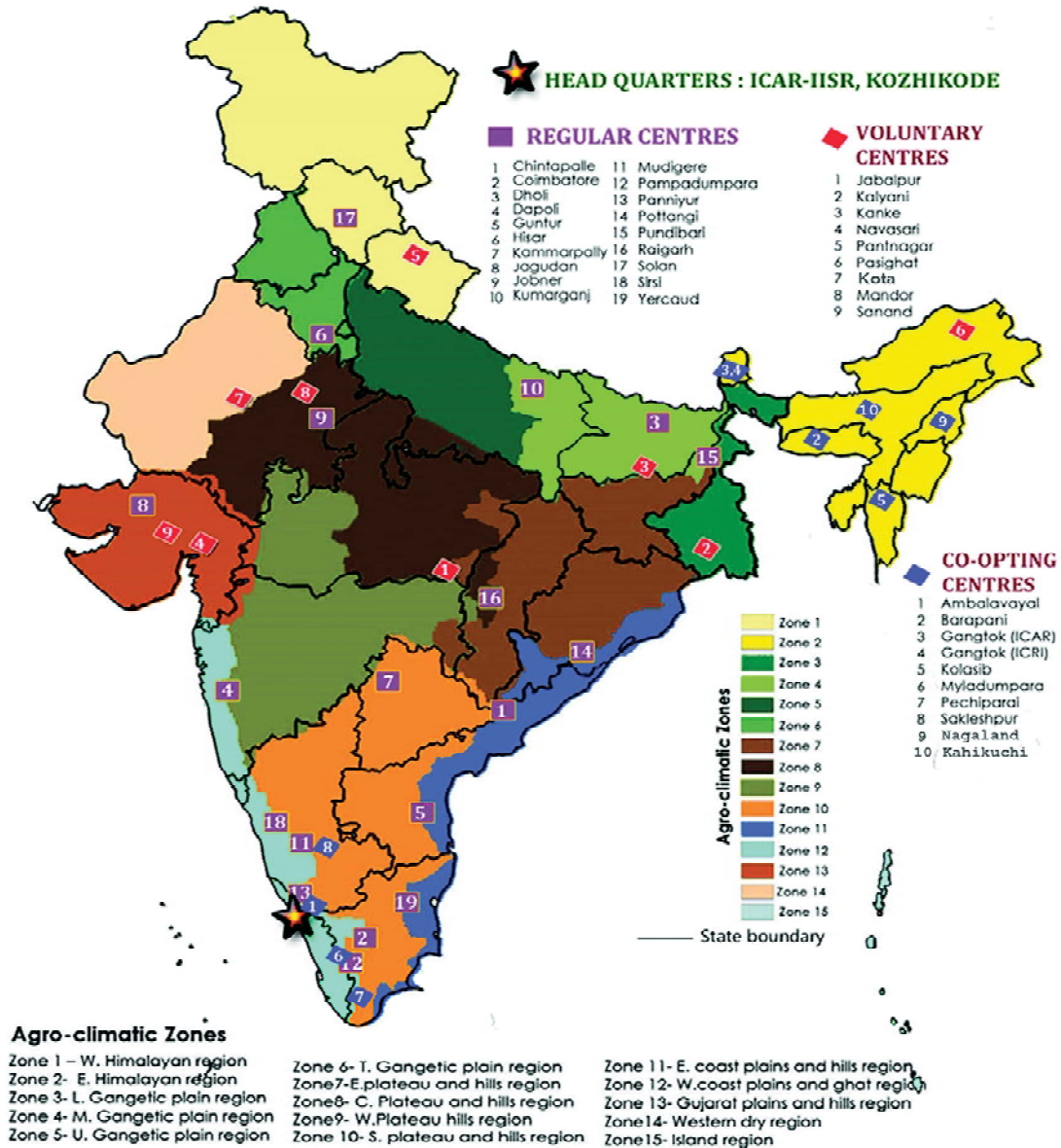


AICRPS centres, year of start and crops handled by the centre

Sl. No.	State	University	Centre	Year of start	Crops handled
Regular centres					
1	Andhra Pradesh	DrYSRHU	Chintapalle	1981	Black pepper, Ginger, Turmeric
2	Andhra Pradesh	DrYSRHU	Guntur	1975	Coriander, Fennel, Fenugreek
3	Bihar	RAU	Dholi	1993	Turmeric, Coriander, Fenugreek
4	Chhattisgarh	IGKV	Raigarh	1996	Coriander, Turmeric, Ginger
5	Gujarat	SDAU	Jagudan	1975	Cumin, Coriander, Fennel, Fenugreek
6	Haryana	CCSHAU	Hisar	1993	Coriander, Fennel, Fenugreek
7	Himachal Pradesh	YSPUHF	Solan	1971	Ginger, Turmeric
8	Karnataka	UAHS	Mudigere	1971	Cardamom, Black pepper
9	Karnataka	UHS	Sirsi	1981	Black pepper, Turmeric, Ginger
10	Kerala	KAU	Panniyur	1971	Black pepper
11	Kerala	KAU	Pampadumpara	1971	Black pepper, Cardamom
12	Maharashtra	BSKKV	Dapoli	1995	Black pepper, Nutmeg, Clove, Cinnamon
13	Orissa	OUAT	Pottangi	1975	Turmeric, Ginger
14	Rajasthan	SKNAU	Jobner	1975	Cumin, Coriander, Fennel, Fenugreek
15	Telangana	SKLTSHU	Kamarpally	1986	Turmeric
16	Tamil Nadu	TNAU	Coimbatore	1975	Coriander, Fenugreek, Turmeric
17	Tamil Nadu	TNAU	Yercaud	1981	Clove, Nutmeg, Cinnamon, Black pepper
18	Uttar Pradesh	NDUAT	Kumarganj	1995	Turmeric, Ginger, Fennel, Coriander, Fenugreek
19	West Bengal	UBKV	Pundibari	1996	Black pepper, Turmeric, Ginger
Co-opting centres					
1	Assam	AAU	Kahikuchi	2014	Black pepper, Turmeric, Nutmeg
2	Karnataka	ICRI	Sakaleshapura	2008	Cardamom
3	Kerala	KAU	Ambalavayal	2008	Black pepper, Ginger, Turmeric,
4	Kerala	ICRI	Myladumpara	2008	Cardamom
5	Meghalaya	ICAR RC NEHR	Barapani	2008	Ginger, Turmeric
6	Mizoram	ICAR RC NEHR	Mizoram	2008	Ginger, Turmeric
7	Nagaland	SASRD	Medziphema	2014	Black pepper, Ginger, Turmeric
8	Sikkim	ICRI	Gangtok	2008	Large Cardamom
9	Sikkim	ICAR RC NEHR	Sikkim	2008	Large Cardamom, Ginger, Turmeric
10	Tamil Nadu	TNAU	Pechiparai	2008	Black pepper, Cinnamon, Clove, Nutmeg
Voluntary centres					
1	Arunachal Pradesh	CAU	Pasighat	2008	Large Cardamom, Ginger, Turmeric
2	Gujarat	NAU	Navasari	2008	Black pepper, Turmeric, Coriander
3	Gujarat	AAU	Sanand	2014	Cumin
4	Jharkhand	BIRSA AU	Kanke	2008	Ginger, Turmeric
5	Madhya Pradesh	JNKVV	Jabalpur	2008	Coriander, Fennel, Fenugreek
6	Rajasthan	AUK	Kota	2008	Coriander, Cumin, Fennel, Fenugreek
7	Rajasthan	AUJ	Mandor	2014	Cumin
8	Uttarkhand	GBPUA&T	Pantnagar	2008	Turmeric, Coriander, Fennel, Fenugreek
9	West Bengal	BCKV	Kalyani	2008	Ginger, Turmeric

Agro-climatic zones in India

CENTRES OF AICRP ON SPICES



Technical Programme (2015-16)

Project Code	Title	Centres
Black Pepper		
PEP/CI/1	Genetic Resources	
PEP/CI/1.1	Germplasm collection, characterization, evaluation and conservation	Ambalavayal, Chintapalle, Dapoli, Panniyur, Pundibari, Sirsi, Yercaud
PEP/CI/2	Hybridization trial	
PEP/CI/2.1	Inter-varietal hybridization to evolve high yielding varieties	Panniyur
PEP/CI/3	Coordinated Varietal Trial (CVT)	
PEP/CI/3.3	CVT 2006 Series VI	Chintapalle, Dapoli, Panniyur, Pampadumpara, Sirsi, Yercaud
PEP/CI/3.4	Evaluation of grafts, orthotropic and runner shoots in black pepper	Ambalavayal, Panniyur, Sirsi, Yercaud
PEP/CI/3.5	CVT 2015 on Farmers varieties of black pepper – Series VII	Chintapalle, Sirsi, Panniyur, Dapoli, Yercaud
PEP/CM/4	Nutrient Management Trial	
PEP/CM/4.6	Standardization of drip fertigation in black pepper	Panniyur
PEP/CM/4.7	Black pepper based mixed cropping system for sustainable productivity and food security	Ambalavayal, Sirsi, Panniyur, Dapoli
PEP/CP/5	Disease Management Trial	
PEP/CP/5.3	Trial on management of <i>Phytophthora</i> foot rot of black pepper in new plantation	Chintapalle, Mudigere, Dapoli, Sirsi, Panniyur
PEP/CP/5.4	Effectiveness of new molecules of fungi toxicants against <i>Phytophthora</i> foot rot of black pepper in existing plantation	Chintapalle, Mudigere, Sirsi
PEP/CP/5.6	Biological Management of Slow Decline in Black Pepper	Panniyur
PEP/CP/5.7	Studies on management of <i>Phytophthora</i> causing foot rot in black pepper	Panniyur, Sirsi, Dapoli, Mudigere
PEP/CP/5.8	Management of <i>Phytophthora</i> foot rot by mulching	Sirsi

Small cardamom

CAR/CI/1	Genetic Resources	
CAR/CI/1.1	Germplasm collection, characterization, evaluation and conservation	Mudigere, Pampadumpara
CAR/CI/2	Hybridization	
CAR/CI/2.1	Hybridization and selection in cardamom	Mudigere
CAR/CI/2.2	Evaluation of promising small cardamom (<i>Elettaria cardamom</i> L. Maton) cultivars/varieties for organic cultivation in the high ranges of Idukki district	Pampadumpara
CAR/CI/3	Coordinated Varietal Trial	
CAR/CI/3.6	CVT 2007/2009-Series VI	Mudigere, Myladumpara, Pampadumpara
CAR/CI/3.7	CVT of drought tolerance in Cardamom – Series VII	Appangala, Mudigere, Sakaleshapura, Pampadumpara, Myladumpara
CAR/CI/3.8	CVT 2015 on Farmers varieties of cardamom-Series VIII	Appangala, Mudigere, Pampadumpara, Myladumpara
CAR/CI/4	Varietal Evaluation Trial (VET)	
CAR/CI/4.1	Initial Evaluation Trial – I	Mudigere
CAR/CI/4.2	Initial Evaluation Trial – II	Mudigere
CAR/CI/4.3	Initial Evaluation Trial – 2012	Pampadumpara
CAR/CM/5	Nutrient Management Trial	
CAR/CM/5.2	Effect of fertigation on yield of cardamom through drips	Mudigere, Pampadumpara
CAR/CM/5.3	Organic farming in cardamom	Mudigere, Pampadumpara
CAR/CM/5.4	Liming in cardamom	Pampadumpara
CAR/CP/6	Pest and Disease Management Trial	
CAR/CP/6.7	Evaluation of new insecticides / biopesticides in cardamom against thrips and capsule borer	Mudigere, Pampadumpara
CAR/CP/6.8	Comparison of effect of chemical treatments as well as bio-control agents against pseudostem rot of cardamom	Mudigere

Large Cardamom

LCA/CI/1.1	Germplasm collection and evaluation of large cardamom	ICAR Regional Station, Gangtok, ICRI Regional Research Station, Gangtok
LCA/CP/1.1	Evolving disease and pest tolerant lines in large cardamom	ICAR Regional Station, Gangtok, ICRI Regional Research Station, Gangtok
LCA/CP/1.2	Integrated pest and disease management in large cardamom	ICAR Regional Station, Gangtok, ICRI Regional Research Station, Gangtok

Ginger

GIN/CI/1	Genetic Resources	
GIN/CI/1.1	Germplasm collection, characterization, evaluation and conservation	Dholi, Kammarpally, Kumarganj, Pundibari, Pottangi, Raigarh, Solan
GIN/CI/2	Coordinated Varietal Trial (CVT)	
GIN/CI/2.3	CVT 2013-Series VIII	IISR, Dholi, Pottangi, Pundibari, Solan
GIN/CI/2.4	CVT 2015-Series IX	IISR, Dholi, Pottangi, Pundibari, Kalyani, Solan, Nagaland
GIN/CI/3	Varietal Evaluation Trial	
GIN/CI/3.3	Initial Evaluation Trial – 2013	Pottangi, Dholi
GIN/CI/3.5	Initial Evaluation Trial - 2015	Kumarganj
GIN/CI/4	Quality Evaluation Trial	
GIN/CI/4.1	Evaluation of germplasm for quality	Solan
GIN/CI/4.2	Evaluation of germplasm from other centres	Solan
GIN/CM/5	Nutrient Management Trial	
GIN/CM/5.4	Evaluation of herbicide for the effective control of weeds in ginger	Chintapalle
GIN/CM/5.5	Source sink relationship	IISR, Kanke, Mizoram, Pundibari, Solan, Barapani
GIN/CM/5.6	Organic production of ginger	Barapani, Mizoram
GIN/CM/5.7	Effect of micronutrients on growth and yield of ginger (Demonstration trial)	Pottangi, Chintapalle
GIN/CM/5.8	Effect of organic manures and bio-fertilizers on partitioning of dry matter in ginger	Dholi
GIN/CP/6	Disease Management Trial	
GIN/CP/6.1	Disease surveillance and etiology of rhizome rot in ginger	Dholi
GIN/CP/6.10	Efficiency of different fungicides including new molecules against leaf spot disease of ginger	Solan, Raigarh
GIN/CP/6.11	Eco-friendly management of rhizome rot of ginger	Kumarganj
GIN/CP/6.12	Field screening of different varieties of ginger against leaf spot and rhizome rot	Dapoli

Turmeric

TUR/CI/1	Genetic Resources	
TUR/CI/1.1	Germplasm collection, characterization, evaluation and conservation	Barapani, Coimbatore, Dholi, Kammarpally, Kumarganj, Pantnagar, Pasighat, Pottangi, Pundibari, Raigarh, Solan
TUR/CI/2	Coordinated Varietal Trial	
TUR/CI/2.5	CVT on Turmeric 2013	Chintapalle, Coimbatore, IISR, Kammarpally, Kumarganj, Pundibari, Pottangi, Raigarh, Navsari, Pasighat
TUR/CI/3	Varietal Evaluation Trial	
TUR/CI/3.6	Initial Evaluation Trial 2013	Pottangi
TUR/CI/3.7	Initial Evaluation Trial 2015	Kumarganj
TUR/CM/5	Nutrient Management Trial	
TUR/CM/5.9	Source sink relationship in turmeric	Coimbatore, IISR, Guntur, Kammarpally, Dholi, Barapani
TUR/CM/5.10	Organic production of turmeric	Barapani, Mizoram
TUR/CM/5.11	Screening of post-emergent herbicides for selectivity in turmeric	Guntur
TUR/CM/5.12	Mechanical planting in turmeric (Observational trial)	Coimbatore
TUR/CM/5.13	Comparative performance of turmeric entries under polyhouse and field conditions	Raigarh
TUR/CP/7	Disease Management Trial	
TUR/CP/7.1	Survey and identification of disease causing organisms in turmeric and screening of turmeric germplasm against diseases (Disease Surveillance)	Coimbatore, Pundibari, Dholi, Raigarh
TUR/CP/7.3	Assessment of fungicide and biological control agents against foliar disease of turmeric	Raigarh, Coimbatore
TUR/CP/7.4	Management of foliar diseases in turmeric using tolerant lines	Coimbatore, Dholi, Kumarganj, Pundibari, Raigarh, Kammarapally, Solan, Guntur
TUR/CP/7.5	Eco-friendly management of foliar diseases of turmeric	Kumarganj
TUR/CP/7.6	Field screening of different varieties of turmeric against leaf spot and rhizome rot	Dapoli

Tree Spices

TSP/CI/1	Genetic Resources	
TSP/CI/1.1	Germplasm collection, characterization, evaluation and conservation of clove, nutmeg and cinnamon	Dapoli, Pechiparai

TSP/CI/1.2	Collection of unique germplasm in tree spices	Dapoli, IISR, KAU, Pechiparai
TSP/CI/2	Coordinated Varietal Trial	
TSP/CI/2.2	CVT 2001-Nutmeg	Dapoli, Pechiparai
TSP/CI/2.3	CVT-2001-Cassia	Dapoli, Pechiparai
Coriander		
COR/CI/1	Genetic Resources	
COR/CI/1.1	Germplasm collection, description, characterization, evaluation, conservation and screening against diseases	Coimbatore, Dholi, Guntur, Hisar, Jagudan, Jobner, Kumarganj
COR/CI/1.3	Identification of drought/alkalinity tolerant source in coriander	Jobner
COR/CI/1.4	Multilocation evaluation of coriander germplasm - 2015	Ajmer, Guntur, Coimbatore, Dholi, Hisar, Jobner, Jagudan, Kota, Kumarganj, Raigarh
COR/CI/2	Coordinated Varietal Trial	
COR/CI/2.6	Coordinated Varietal Trial on coriander 2015-Series IX	Ajmer, Coimbatore, Dholi, Guntur, Hisar, Jabalpur, Jagudan, Jobner, Kumarganj, Navsari, Pantnagar, Kota, Raigarh
COR/CI/3	Varietal Evaluation Trial	
COR/CI/3.7	Initial Evaluation in coriander	Hisar, Jobner
COR/CI/3.8	Initial Evaluation Trial 2015	Guntur, Jagudan, Kumarganj, Dholi, Raigarh
COR/CI/4	Quality Evaluation Trial	
COR/CI/4.1	Quality Evaluation in coriander	Jobner
COR/CM/5	Nutrient management trial	
COR/CM/5.5	Response of coriander varieties to various levels of fertility under multicut management practice	Jagudan
COR/CM/5.6	Effect of using varying levels of NPK and bio-fertilizers on growth and yield of coriander	Dholi
COR/CM/5.7	Standardization of drip irrigation and fertigation in coriander	Jobner, Guntur, Kumarganj
COR/CM/5.9	Comparative performance of coriander entries under polyhouse, field and selfing net	Raigarh
COR/CP/6	Disease Management Trial	
COR/CP/6.2	Survey to identify the disease incidence, collection and identification of causal organism in coriander	Dholi

COR/CP/6.4	Studies on the management of coriander powdery mildew using new generation fungicides (Observational trial)	Coimbatore, Raigarh, Jobner, Jagudan and Kumarganj
COR/CP/6.5	Eco-friendly management of stem gall of coriander (Observational trial)	Kumarganj
COR/CP/6.6	Integrated management of stem gall disease of coriander	Dholi

Cumin

CUM/CI/1	Genetic Resources	
CUM/CI/1.1	Germplasm collection, characterization, evaluation, conservation and screening against diseases	Jagudan, Jobner, Mandor, Sanand
CUM/CI/1.2	Multilocation evaluation of cumin germplasm	Ajmer
CUM/CI/1.3	Identification of drought tolerance	Jobner
CUM/CI/2	Coordinated Varietal Trial	
CUM/CI/2.4	Coordinated Varietal Trial – 2013	Ajmer, Jagudan, Jobner
CUM/CI/3	Varietal Evaluation Trial	
CUM/CI/3.4	IET on Cumin 2012	Jobner
CUM/CI/3.5	IET on Cumin 2013	Jagudan
CUM/CI/4	Quality Evaluation Trial	
CUM/CI/4.1	Quality Evaluation in Cumin	Jobner
Project Mode	Performance evaluation of Cumin genotypes for Tamil Nadu conditions	Periyakulam
CUM/CM/5	Nutrient Management Trial	
CUM/CM/5.2	Organic nutrient and disease management in cumin	Jobner
CUM/CM/5.3	Response of sulphur and bio regulators on yield and quality of cumin	Mandor
CUM/CM/5.4	Standardization of drip irrigation and fertigation in cumin	Jobner, Jagudan, Mandor
CUM/CP/6	Disease Management Trial	
CUM/CP/6.5	Management of blight and powdery mildew by spacing and potash application	Jagudan
CUM/CP/6.6	Bio-efficacy of newer molecules of insecticides against cumin aphid	Jagudan, Jobner, Ajmer
CUM/CP/6.7	Management of powdery mildew in cumin through new chemicals	Jobner

Fennel

FNL/CI/1	Genetic Resources	
FNL/CI/1.1	Germplasm collection, characterization, evaluation, conservation and screening against diseases	Dholi, Hisar, Jagudan, Jobner, Kumarganj
FNL/CI/1.2	Multilocation evaluation of fennel germplasm	Ajmer, Jobner, Kumarganj, Hisar
FNL/CI/2	Coordinated Varietal Trial	
FNL/CI/2.6	Coordinated Varietal Trial on Fennel 2015 Series – Series IX	Ajmer, Dholi, Hisar, Jabalpur, Jagudan, Jobner, Kumarganj, Pantnagar
FNL/CI/3	Varietal Evaluation Trial	
FNL/CI/3.4	Initial Evaluation Trial 2014	Jobner, Pantnagar, Hisar
FNL/CI/3.5	Initial Evaluation Trial 2015	Jagudan, Kumarganj, Dholi
FNL/CI/4	Quality Evaluation Trial	
FNL/CI/4.1	Quality Evaluation in Fennel	Jobner
FNL/CM/5	Nutrient Management Trial	
FNL/CM/5.4	Effect of ferrous and zinc enriched FYM on yield and quality of fennel	Jagudan
FNL/CM/5.5	Standardization of drip fertigation in fennel	Jobner

Fenugreek

FGK/CI/1	Genetic Resources	
FGK/CI/1.1	Germplasm collection, characterization, evaluation, conservation and screening against diseases	Dholi, Guntur, Hisar, Jagudan, Jobner, Kumarganj
FGK/CI/1.2	Multilocation evaluation of fenugreek germplasm	Ajmer, Jobner, Hisar, Kumarganj
FGK/CI/1.3	Identification of drought tolerance source in fenugreek	Jobner
FGK/CI/2	Coordinated Varietal Trial	
FGK/CI/2.4	Coordinated Varietal Trial of fenugreek 2015 – Series IX	Ajmer, Coimbatore, Dholi, Guntur, Hisar, Jagudan, Jabalpur, Jobner, Kumarganj, Pantnagar, Navsari, Raigarh, Kota
FGK/CI/3	Varietal Evaluation Trial	
FGK/CI/3.6	Initial Evaluation Trial 2014	Dholi, Hisar
FGK/CI/3.7	Chemo-profiling for identification of industrial types among the released varieties of fenugreek	Ajmer, Coimbatore, Guntur, Dholi, Hisar, Jobner, Kumarganj
FGK/CI/3.8	Initial Evaluation Trial 2015	Guntur, Kumarganj, Jagudan, Jobner

I. BLACK PEPPER

Genetic Resources

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

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

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

At present 290 cultivated types, 54 wild types and 3 exotic types of black pepper are being maintained at Panniyur station. The survey was carried out, 9 new genotypes were collected and added to the germplasm during the year. The genotypes PRS 64, PRS 154 and PRS 137 were the top yielders. PRS 64 ranked first with 4.29 kg green berry yield and 1480 spikes/vine. Spike length was maximum for PRS 155 (15.1 cm). The number of developed berries / spike was more for PRS 137 (49.0).

The 100 berry weight was high for PRS 154 (12.1 g.). The dry recovery % was more in PRS 154 and PRS 137 (36%).

Thirty six new collections are made during the year by Sirsi centre. Totally, 209 germplasm accessions are being maintained at this station. Out of these, 110 accessions are from the local source (Uttara Kannada and neighbouring districts in Karnataka) and the remaining 99 are from other centres *viz.*, IISR and Panniyur. New collections like Vijay hybrid (KAU), Malbar (Sagar), Thekkan, Zionmundi, Kampkal, PRS 160, PRS 161, Dadshet-1 to 5, Dundkal-1 to 2 were added to the existing collection. Six related species of *Piper viz.*, *P. colubrinum*, *P. arborium*, *P. chaba*, *P. longum*, *P. attenuatum*, *P. hymenophyllum* collected and maintained.

Among 24 accessions evaluated at Chintapalle, Panniyur-1 recorded the highest fresh berry yield of 1.43 kg dry pepper/vine.

At present 47 germplasm accessions are being maintained at Dapoli. This year 10 accessions



Fig. 1: Black Pepper germplasm conservation site at a. Dapoli and b. Sirsi

have been added to the germplasm. Among the germplasm maintained plant height varied from 1.35 -7.7 m.

At Pundibari, 31 accessions of black pepper are being maintained.

Berry set was observed only in 22 accessions among the 72 accessions maintained at Yercaud due to uneven distribution of rainfall. Among the 22 accessions, the spike length was highest (14.5 cm) in the accession PN 33 and the shortest spikes (7.8 cm) were observed in PN 64. The mean number of berries per spike

Crop Improvement

PEP/CI/2 Hybridization trial

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

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

At Panniyur centre, the hybrids PRS 160 and PRS 161 were found to be promising with

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

Centres	Indigenous				Exotic	Total
	Cultivated		Wild and related species			
	Existing	Addition (April 2015 to March 2016)	Existing	Addition (April 2015 to March 2016)		
Ambalavayal	30	-	-	-	-	30
Chintapalle	38	-	-	-	-	38
Dapoli	47	-	-	-	-	47
Panniyur	281	9	54	-	3	347
Pechiparai	15	-	3	-	-	18
Pundibari	19	-	11	1	-	31
Sirsi	173	36	-	-	-	209
Yercaud	134	-	3	-	-	137
Total	737	45	71	1	3	857

ranged from 65 (PN 33) to 18.9 (PN 64). The 100 green berry weight ranged from 9.71 g (PN 57) to 20.62 g (PN 83) and dry berry weight ranged from 3.31 g (PN 48) to 6.36 g (PN 64). The highest green berry yield of 3.25 kg per vine was recorded in PN 33 whereas the lowest green berry yield was recorded in PN 83 (0.20 kg vine⁻¹). The highest dry berry yield (1.073 kg vine⁻¹) was observed in PN 33 and the lowest dry berry yield (0.125 kg vine⁻¹) was recorded in PN 53.

mean green berry yield of 4.35 kg vine⁻¹ and 3.99 kg vine⁻¹ respectively. Number of spikes / vine was 489 and 463 for PRS 160 and PRS 161 respectively. Spike length was maximum for PRS 161 (20.0 cm). The hybrid seedlings of PRS 4 x PRS 8, P 1 x PRS 78 and P1 x PRS 48 were planted in the field. During the year cross between P1 x PRS 64 and P1 x PRS 4 were carried out.



Fig. 2: Variability in spike length among the black pepper germplasm maintained at Ambalavayal

PEP/CI/3 Coordinated Varietal Trial (CVT)

PEP/CI/3.3 CVT 2006 Series VI

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

At Chintapalle maximum plant height was noticed in Panniyur -8 (HB20052) (435.20 cm) followed by Panniyur-1 (334.51 cm). Maximum number of branches per plant was observed in ACC-33(21.12) followed by C-1090 (12.78), Panniyur – 1 (12.33) and ACC106 (12.11), which were on par. Early spike initiation was observed in Panniyur -8 and 1. Highest fresh berry yields recorded in Panniyur – 1 (967.96 g) followed by ACC 33 (617.37 g). All vines are susceptible to *Phytophthora* foot rot disease.

At Panniyur station, HB 20052 and Acc. No 53 recorded the highest green berry yield of 3.0



Fig. 3: Spikes of promising hybrid PRS 160

kg vine⁻¹ and 2.97 kg vine⁻¹ respectively. The highest plant height was recorded for HP 39 and Panniyur 1 (4.7 m).

Among 11 entries, the height varied between 3.8 m and 6.2 m at Sirsi. Maximum plant height was in Panniyur-1 and Accession-33. HB 20052 and PRS-88 initiated spikes and there were 40.0 and 46.0 numbers, respectively.

At Dapoli, the plant height varied from 2.46 – 4.46 m in different varieties. HB 20052 recorded higher plant height (4.46 m) followed by Panniyur 1 (4.43 m) and PRS 64 (4.03 m). Highest yield was obtained in Panniyur 1 (90.25 g pl⁻¹).

Among nine accessions tested the highest fresh weight (1920 g pl⁻¹) and dry weight (640.31 g pl⁻¹) was recorded by HB 20052 at Pampadumpara centre

Table 2: Yield data of promising new hybrids at PRS, Panniyur during 2015-16

Variety/ Hybrid	Green berry yield (kg/vine)	Spikes/vine	Spike length (cm)	Developed berries /spike	100 Berry weight (g)	Drying %
PRS 160	4.35	489	14.7	101	11.7	33
PRS 161	3.99	463	20	98	14.5	35



Fig. 4: General view of CVT black pepper at Sirsi

At Yercaud centre 9 entries have been planted during 2011 and the spiking observed only in PRS 64 (150 g vine⁻¹ of green berry) and IISR Shakthi (215 g vine⁻¹ of green berry).

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

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

Highest plant height (4.54 m) and green berry yield (3.60 kg) were recorded by runners of Panniyur-1 grafted on *Piper colubrinum* at Panniyur.

The grafts were planted on *Erythrina indica* standards at Yercaud and the plants are in vegetative stage.

As per the decision of the workshop, replanting was taken up with new grafts during Sep. 2015 as there was higher mortality of grafted plants.

PEP/CI/3.5 CVT 2015 on Farmers varieties of black pepper – Series VII

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

Panniyur, Pampadumpara, Sirsi; East coast plains and hill region - Yercaud)

This trial is in collaboration with National Innovation Foundation. 3 farmer varieties of black pepper *viz.*, Zion Mundi, Pepper Thekken and Kumpukkal along with a local check and national check Panniyur-1 are included in the trial. Planting material is received by the centres from NIF and planting will be taken up.

Crop Management

PEP/CM/4 Nutrient Management Trial

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

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

The trial is continuing at Panniyur from 2012-13 onwards. During 2015-16, T₅ (50 RDF + 8 l drip) recorded comparatively higher green berry yield of 2.34 kg/vine. It was followed by T₃ (100 RDF + 8 l drip) with 2.29 kg/vine. Observations on disease intensity showed that in T₂ (100% RDF 2/3 as basin+ 1/3 through drip (8 l weekly in summer), the disease was significantly low (13.4%), followed by T₁ (100% RDF full as basin application + conventional irrigation) and T₅ (50% RDF through drip (8 l weekly) with disease intensity 21.2 % and 22.2% respectively

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

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

At Ambalavayal, tapioca (465.6 kg ha⁻¹) recorded maximum yield among the intercrops followed by arrowroot and elephant foot yam with 169.6 kg ha⁻¹ and 110



Fig. 5: Field view of black pepper based mixed cropping system in Dapoli

kg ha⁻¹ yield respectively. The lowest yield was recorded by greater yam (28 kg ha⁻¹). This study shows that crops such as tapioca, arrowroot, elephant foot yam, colocasia and greater yam are suited to intercropping in juvenile black pepper garden which have evidently added to the income generated. However, it was also realized that better returns were obtained from tapioca compared to other tuber crops grown.

The trial was started during 2013-14 at Panniyur. The black pepper plants are in the vegetative stage and not yet started yielding. During 2015-16, good yield was obtained from the intercrops in black pepper garden except arrowroot and tapioca. Colocasia (T₁) yielded 3.0 kg, Elephant foot yam (T₃) – 7.99 kg, Greater yam (T₅) – 6.5 kg and Pineapple – 3.5 kg from the interspaces of 4 x 2 m spacing between black pepper. Due to severe wild animal attack, tapioca and arrowroot were lost completely.

At Dapoli, the inter space of 3 X 1 m is utilized for planting different tuber crops like colocasia, arrow root, elephant foot yam, tapioca and greater yam. Pineapple was planted as border crop in colocasia, arrow root, elephant foot yam, and tapioca as mixed crops. No yield obtained in pineapple and

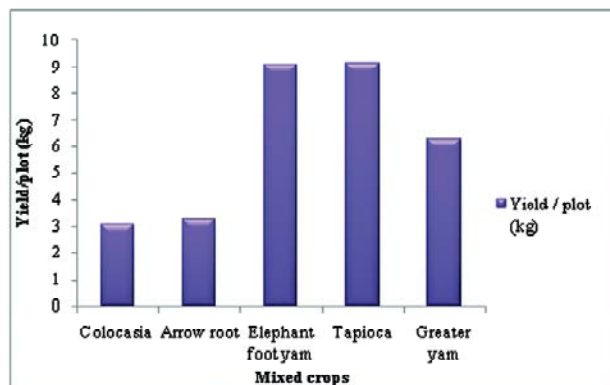


Fig. 6: Yield of mixed crops in black pepper based mixed cropping system at Dapoli.

black pepper is in pre-bearing stage. The yield obtained per ha was in colocasia 3.08 tons, arrow root 3.29 tons, elephant foot yam 9.10 tons, tapioca 9.11 tons and greater yam 6.30 tons, respectively.

Crop Protection

PEP/CP/5 Disease Management Trial

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

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

At Chintapalle it was observed that application of *Trichoderma* (MTCC 5179) + consortium of bacteria (IISR-6 + IISR-859) was recorded lesser incidence of yellowing and defoliation and higher yield while compare with remaining treatments in all three varieties of Black pepper. Among three varieties tested IISR Shakti recorded lowest yellowing and defoliation.

At Mudigere Plants are not established properly and the experiment was vitiated.

At Sirsi, the experiment was carried out consecutively for three years to study the

Table 3: Pooled data (2012-13 to 2014-15) of *Phytophthora* foot rot intensity in Black pepper in new plantation at PRS, Panniyur

Treatments (Sub Plot)		Percent Disease Intensity – (Pooled Results 2012-13 to 2014-15)			
		IISR-Sakthi (V ₁)	IISR-Thevam (V ₂)	Panniyur 1 (V ₃)	Treatment Mean
T ₁	Potassium phosphonate (0.3%) + <i>Trichoderma harzianum</i>	16.66 (18.61)	25.93 (24.88)	5.54 (11.16)	16.04(18.22)
T ₂	Bordeaux mixture spray (1.0 %) + COC (0.1 %) drenching	25.92 (24.88)	12.96 (21.01)	12.94 (16.42)	17.27 (20.77)
T ₃	Consortium of bacteria (IISR-6 and IISR- 859)	9.24 (14.05)	24.05 (29.14)	27.76 (31.33)	20.35 (24.84)
T ₄	<i>T. harzianum</i> + consortium of bacteria	14.79 (22.34)	33.31(34.09)	12.94 (20.39)	20.35 (25.61)
T ₅	Control	44.44 (41.55)	38.88 (38.30)	40.71 (39.36)	41.34 (39.74)
Variety mean		22.21 (24.28)	27.02 (29.49)	19.98 (23.73)	
CD @ 5%		Main Treatments			2.48
		Sub Treatments			3.24
		Main x Sub			5.62

efficacy of tolerant varieties in combination with fungicides and bioagents against *Phytophthora* foot rot disease of black pepper in a newly established arecanut garden. Among the *Phytophthora* tolerant varieties, IISR Shakti recorded significantly less disease intensity followed by IISR Thevam. Other popularly cultivating variety Panniyur-1 recorded slightly higher disease intensity. Irrespective of varieties, black pepper vines treated with consortium of bacteria @ 1% as spray (2 l vine⁻¹) and drenching (3 l vine⁻¹) and soil application of *Trichoderma harzianum* @ 50 g per vine with one kg of neem cake to the root recorded less disease intensity. However, all the treatments except control were significantly effective in reducing the disease. Varietal response to the treatments with

respect to the growth of the black pepper, IISR Thevam recorded highest growth and it was statistically *on par* with IISR Shakti and the least growth was noticed in Panniyur-1.

At Panniyur significant reduction in *Phytophthora* foot rot incidence was observed with all the treatments when compared to control. Pooled analysis of the three year data (Table 3) revealed that, irrespective of the varieties, plants treated with *T. harzianum* (MTCC 5179) @ 50 g vine⁻¹ along with drenching and spraying with 0.3% Potassium phosphonate recorded least disease intensity (16.04 %) which was statistically *on par* with the recommended practice of Bordeaux mixture spray (1.0 %) + COC (0.2 %) drenching which recorded disease intensity of

17.27 %. Application of consortium of bacteria alone and in combination with *T. harzianum* also recorded significantly less disease (20.35%) than the control plants where disease intensity recorded was 41.34 %. Among the black pepper varieties, Panniyur 1 recorded least disease severity (19.98 %) followed by IISR Shakthi (22.21 %) and was *on par* with each other.

At Dapoli centre, there was no incidence of foot rot disease (*Phytophthora capsici*) in the period from 2010-11 to 2015-16. So far, survival and growth of black pepper cuttings of IISR- Shakthi, IISR- Thevam and Panniyur-1 and of the standards Maharukh (*Ailanthus malbarica*) were satisfactory.

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

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

At Chintapalle, spraying and drenching with 0.1 % of Fenamidone(10%) + Mancozeb (50%) alone and 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 lesser incidence of leaf yellowing, defoliation and vine mortality. 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 is comparable with the existing recommended practice 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 Sirsi, the new molecules Sectin @ 0.1 % as spraying (@ 2 l vine⁻¹) and drenching (3 l vine⁻¹)

¹) along with bioagent *Trichoderma harzianum* 50 g with one kg of neem cake as soil application two times in a season found superior than other treatments with respect to leaf infection. Treatment with recommended check wherein vines were protected with Potassium phosphonate (@ 0.3 per cent) as spraying and drenching along with bioagent *Trichoderma harzianum* 50 g with one kg of neem cake as soil application also recorded lower leaf infection, yellowing of vines, lower defoliation and less death of vines.

At Mudigere, all the treatments were found effective in reducing the incidence of the disease compared to control. The treatment T₃ *i.e.*, Spraying and drenching of 0.2 % Kocide 10 days after application of *T. harzianum* @ 50 g + 1 kg Neem Cake vine⁻¹ was found more effective in reducing the disease incidence with higher yield of 456.7 g vine⁻¹, Which was *on par* with T₂ *i.e.*, Spraying and drenching of 0.1 % Sectin + *T. harzianum* (50 g) + Neem cake 1 kg vine⁻¹.

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

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

The experiment was started during 2013-14 at Panniyur. All the treatments were significantly superior to control in reducing yellowing due to slow decline disease in black pepper. Among the various biocontrol agents tested, intensity of disease was minimum recorded (7.5 %) in T₁ (*Trichoderma viride* + Neem cake @ 2 kg vine⁻¹). Similar result was recorded in T₃ (*Pochonia chlamydosporia* multiplied in partially decomposed farm yard manure and applied @ 2 kg vine⁻¹ and drenched with *P. fluorescens* @ 2 %). This was followed by T₂ the application of *T. viride* + soil drenching with *P. fluorescens* (11.9 %) and T₄ – *Pochonia chlamydosporia* @ 50 g vine⁻¹ (14.4 %) and were *on par*. The effect of these treatments

Table 4. Effect of different treatment on incidence of slow decline disease in Black pepper at Panniyur

Treatments	Disease intensity (%) with respect to yellowing in Black pepper				Average Disease intensity
	1 MAM*	2 MAM	3 MAM	4 MAM	
T ₁	10.0	5.0	10.0	5.0	7.5 (15.7)
T ₂	5.0	22.5	10.0	10.0	11.9 (19.5)
T ₃	5.0	10.0	10.0	5.0	7.5 (15.7)
T ₄	5.0	16.3	20.0	16.3	14.4 (21.8)
T ₅	15.0	10.0	10.0	5.0	10.0 (18.1)
T ₆	12.5	10.0	5.0	10.0	9.4 (17.6)
T ₇	13.8	25.0	25.0	35.0	24.7 (29.5)
CD @ 5%					7.18

*MAM – Months after monsoon

Figures in parenthesis are arc sin transformed values

T₁ Soil application of *Trichoderma viride* + Neem cake @ 2 kg vine⁻¹

T₂ Soil application of *Trichoderma viride* followed by soil drenching with *P. fluorescens* @ 2%

T₃ Soil application of *Pochonia chlamydosporia* (multiplied in partially decomposed FYM @ 2 kg vine⁻¹) followed by soil drenching with *P. fluorescens* @ 2%

T₄ Soil application of *Pochonia chlamydosporia* @ 50 g vine⁻¹ followed by soil drenching with *P. fluorescens* @ 2%

T₅ Soil application with Cartap hydrochloride @ 15 g vine⁻¹

T₆ Soil drenching with Copper oxy chloride @ 0.3% + Cartap hydrochloride @ 15g vine⁻¹

T₇ Control

was also statistically *on par* with T₅ and T₆ where chemical control measures were applied.

PEP/CP/5.7 Studies on management of *Phytophthora* causing foot rot on black pepper

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

At Dapoli, the Treatment T₄ *i.e.*, application of fungicide (Fosetyl Al) amended fertilizer briquettes (0.3 %) found to be effective with

minimum PDI of 10.92 % and about 54.97 per cent disease control.

PEP/CP/5.8 Management of *Phytophthora* foot rot by mulching

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

This trial started in 2015-16 with 7 treatments which includes mulching the black pepper vine base with different mulching materials such as soft grass/dried leaves, soil, banana sheath, polyethylene mulch and control *i.e.*, without mulch. These treatments are imposed in the field.

II. Small Cardamom

Genetic Resources

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

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

Germplasm of small cardamom is maintained at Mudigere and Pampadumpara (Table 5)

A total of 177 cardamom accessions are being conserved in the gene bank of Pampadumpara. Among them, 73 cardamom accessions (CRSP 1-73) were deposited at the NAG centre and they are given with IC numbers (547920 to 547992) from the National Bureau of Plant Genetic Resources, New Delhi. Perusal of the yield data of the germplasm collection as well as the top ten high yielding accessions, HY 14 has superior performance with regard to biometric and yield characters. The incidence of pest insects and diseases was also less in the accession (HY14).

Table 5: Cardamom germplasm collections of AICRPS centres

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



Fig. 7: Small cardamom germplasm conservation site at Pampadumpara

Crop Improvement

CAR/CI/2 Hybridization

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

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

PV1 had reported the highest number of tillers and number of capsules per panicle as well as panicles per clump whereas PV2 showed maximum plant height. The incidence of stem borers was higher in GG than other types studied. Plant height varied significantly among the tested varieties. Plant height was maximum for PV2 and minimum for S1. PV1 recorded the highest fresh (2823.93 g plant⁻¹) and dry (449.12 g plant⁻¹) yield followed by ICRI-2 and both were significant over others. The occurrence of pests such as thrips (3.34 %), stem borers (0.78%) and

azhukal disease incidence (0.51%) were lesser in PV1 compared to other varieties. The pest and disease incidence was more in PV2 even though its yield potentials are comparable.

CAR/CI/3 Coordinated Varietal Trial

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

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

Among 12 genotypes evaluated at Mudigere IC-346951 (387 kg ha⁻¹) recorded highest capsule yields followed by CL-726 (340 kg ha⁻¹) than the check GG (310 kg ha⁻¹).

At Myladumpara, among the genotypes tested the clone PL-14 performed better with regard to yield (980 kg/ha), tiller height and number of racemes/panicle. The clone CL-691 performed better with regard to number of bearing tillers and number of panicles/clump (Table 6).

At Pampadumpara, PV 2 (3.33 %) has recorded maximum plant height (303.2 cm), leaf length (66.4 cm), leaf width (12.8 cm) and internodal length (11.2 cm) followed by MCC 346. The maximum number of panicles (21.407) and panicle length (52.723 cm) was observed in MCC 346. Number of capsules / panicle was more in IC547167 (19). Accession

Table 6: Pooled data (2011-2015) on growth and yield attributes in coordinated varietal trial at Myladumpara

Clone	Tillers/clump	Tiller height (cm)	Leaves/tallest tiller	Vegetative buds/clump	No. of bearing tillers	No. of panicles/clump	No. of racemes/panicles	No. of capsules/raceme	Yield (kg/ha)
IC -349545	36.4	175	13.3	2.5	14.5	23.6	6.1	5.1	640.0
IC -349651	34.3	202.1	10.2	2.3	25.1	18.9	12.5	5.6	560.2
IC -547167	40	182.1	12.9	2.9	17.9	23.5	11.6	6.2	657.3
IC -547185	55.2	234.4	13.2	3.6	26.2	35.6	15.5	6.0	648.5
CL - 726	57.6	200.5	13.4	2.8	27.5	36.1	13.6	6.8	580.3
CL - 691	61.9	226.5	12.8	3.2	29.7	40.0	14.8	7.2	630.1
IC 585012	52.6	217.5	13.4	2.3	20.8	28.3	14.1	6.0	580.4
IC 585037	60.6	211.6	13.0	2.7	21.0	31.1	14.1	7.2	560.0
IC 584837	49.6	279.9	14.2	2.1	22.3	33.3	16.2	8.6	744.1
PL - 14	52.4	289.8	13.8	2.7	21.1	31.7	20.0	9.5	980.1
CR - 6	50.2	261.8	13.0	2.2	21.7	31.7	18.7	7.0	744.3
IC 584985	34.6	238.2	14.0	2.8	20.1	28.7	19.8	9.1	890.8
IC 584790	46.1	198.5	14.2	1.6	26.5	26.1	10.7	6.9	640.0
CV(%)	19.8	15.9	7.7	8.8	18.5	19.6	19.6	19.1	18.9

SKP104 recorded the lowest growth parameters, but the incidence of stem borer was less in that accession. Stem borer incidence and variability was higher among the types evaluated. Significant and comparable variations have been recorded for all biometric characters. Maximum fresh (1693 g plant⁻¹) and dry weight (282. g plant⁻¹) of capsules was recorded by IC547167 followed by PV 2. The incidence of thrips and stem borers was more for the accession GG followed by SKP 104, PL NO 14 and CL 691. The lowest wet and dry yield was registered in IC547185 which is significantly inferior to all others.

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

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

Selected clones IC 349537, IC 584058, GG×NKE-12, IC 584078, CL 668, HS 1, Appangala 1 and IC 584090 are multiplied in Appangala and the material is distributed to other centres for taking up the trial.

CAR/CI/3.8 CVT 2015 on Farmers varieties of cardamom-Series VIII

(Centres: West coast plains and ghats region – Appangala, Mudigere, Myladumpara, Pampadumpara)

This trial started in 2015. This is in collaboration with National Innovation Foundation. Eight farmers varieties viz., Pappalu, Arjun, Elarajan, Thiruthali, Wonder Cardamom, Njallani, Panikulangara green bold no.1, Patchaikai along with nation check green gold and a local check are included in the trial. Planting of these varieties was taken up.

CAR/CI/4 Varietal Evaluation Trial (VET)

CAR/CI/4.1 Initial Evaluation Trial – I

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

At Mudigere, entry HS-1 (355 kg ha⁻¹) has recorded higher yields followed by CL-691 (340 kg ha⁻¹). Total number of suckers per plant was recorded more in HS-1 (13.52) followed by Sel-800 (12.45).

CAR/CI/4.2 Initial Evaluation Trial – II

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

Among the 10 genotypes evaluated at Mudigere, maximum plant height was found in 2-4-D11 (265.59 cm) and more number of suckers per plant was observed in 2-5-D11 (15.68) followed by 2-4-D11 (14.56). Maximum yield was observed in 2-5-D11 (294 kg ha⁻¹) followed by 2-4-D11 (289 kg ha⁻¹).

Crop Management

CAR/CM/5 Nutrient Management Trial

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

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

At Mudigere, experiment showed significant difference among the treatments. Application of irrigation 9 lt./clump/day along with 100% Rec. dose of fertilizer through drips recorded the highest capsule yield (368.52 kg ha⁻¹) this was on par with irrigation 9 lt./clump/day with 75% Rec. fertilizer dose (362.63 kg ha⁻¹). The conventional method of irrigation recorded 318.75 kg ha⁻¹. The supporting yield parameters also had similar tendency as that of yield obtained.

CAR/CM/5.3 Organic farming in cardamom

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

Significant difference among the treatments was found at Mudigere centre. Application of organics with bio-fertilizers gave significantly higher yield than only organics. The maximum dry capsule yield (358.97 kg ha⁻¹) was obtained with recommended package which is superior over all other treatments. Among organics, application of *Jeevamrutha* recorded the highest capsule yield (320.65 kg ha⁻¹) which is on par with Vermicompost (310.76 kg ha⁻¹) & FYM (302.06 kg ha⁻¹). Significant improvement in soil N.P.K. content was observed. Quality parameter did not change as influenced by the organics.

At Pampadumpara, application of *Jeevamrutha* plus *Azospirillum* (10 g clump⁻¹) as well as PSB (10 g clump⁻¹) and *Trichoderma* (10 g clump⁻¹) resulted increased height of tillers and panicle length/clump, the number of borer infested tillers was also found to be lower (1.7 %). There was no significant difference with respect to number of capsules per panicle among the treatments application of *Jeevamrutha* + *Azospirillum* (10 g clump⁻¹) + PSB (10 g clump⁻¹) + *Trichoderma* (10 g clump⁻¹) resulted in highest fresh yield (2393.6 g plant⁻¹) which was *on par* with application of recommended dose of CPC 15 t ha⁻¹ (2392.904 g plant⁻¹). The incidence of thrips and *azhukal* disease was also less in this treatment. There was no significant difference among treatments with regard to 100 capsule weight and stem borer incidence level.

CAR/CM/5.4 Liming in cardamom

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

Application of dolomite @ 2 kg plant⁻¹ was found to be the best treatment with highest

wet (2667.427 g plant⁻¹) and dry capsule (941 g plant⁻¹) yield. The incidence of pest and disease in this treatment was less compared to other treatments. The effect of liming on dry weight of capsule was found to be non-significant. The next best treatment was the application of burnt lime @ 1 kg plant⁻¹ which was *on par* with the application of waste lime @ 2 kg plant⁻¹.

Crop Protection

CAR/CP/6 Pest and Disease Management Trial

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

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

The treatments were significantly influenced the total healthy capsules in all the treatment compared to untreated control at Mudigere. All the harvests indicated maximum damage with thrips compared to borers. As a consequence of thrips and capsule borer control with methomyl@ 1.5g per lit of water and acetamiprid @0.5g and Imidacloprid @ 0.5ml found to be effective and superior of over standard check Mudigere practices.

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

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

At Mudigere, all the treatments were found effective compared to control. The minimum tiller infection of 5.80% with higher yield of 645.54 g plant⁻¹ was recorded in T₁ *i.e.* spraying of 0.2 % Bavistin which is followed by T₅ *i.e.*, application of *T. harzianum* with Neem cake and spraying of 0.2 % *Pseudomonas fluorescens*.

III. Large Cardamom

Genetic Resources

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

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

A total of 292 germplasm accessions of large cardamom are maintained at ICAR (RS), Gangtok and ICRI (RRS), Gangtok (Table 7)

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

Survey was made at different areas of East and West districts of Sikkim and Siang Dist. of Arunachal Pradesh for collection of germplasm by the scientists of ICRI Regional Station, Gangtok. Fifteen Germplasm accessions viz. SCC 264 (Disease escape of Sawney), SCC 265 (High yielding Madhusey), SCC 266 (High yielding Seremna), SCC 286 (Golsey with bigger capsules), SCC 288

(Golsey), SCC 289 (Green golsey), SCC 291 (Golsey), SCC 292 (Golsey), SCC 296 (Frost tolerant Varlangey) and five wild species of *Amomum* were collected and planted under AICRPS at ICRI, RRS, Spices Board, Tadong, Gangtok research farm. Characterizations of the collected germplasm were made as per descriptor.

Quality Analysis of large cardamom varieties

In this study the volatile oil profile of the four popular varieties of the crop namely Sawney, Varlangey, Ramla and Ramsey were studied in detail. The capsules contained 58.1- 68.1 % seeds and 1.19-2.87 % essential oil. By GC-MS analysis 23 constituents of the oil were identified with 1, 8- cineole as the chief component. Major constituents of the oil were α - pinene (1.67-6.45 %), β - pinene (3.95 - 11.08 %), 1, 8- cineole (63.19-73.37 %) and α -terpineol (5.58-7.64 %). The oil contained high level of 1, 8- cineole when compared to small cardamom (*Elettaria cardamomum*) but α -terpinyl acetate, the chief component of small cardamom oil was found in trace amount in large cardamom.

Table 7: Large cardamom collections maintained at AICRPS centres

Centres	Indigenous				Total
	Cultivated		Wild and related species		
	Existing	Addition (April 2015 to March 2016)	Existing	Addition (April 2015 to March 2016)	
ICAR RS, Gangtok	7	NIL	NIL	NIL	7
ICRI RRS, Gangtok	255	15	11	4	285
Total	262	15	11	4	292



Fig.8 Golsey (Ht. >6 ft.) and Rengka (spikes in the pseudo stem) cultivar from Arunachal Pradesh

Crop Protection

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

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

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

with three replications having a plot size of 12 plants.

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

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

It was observed that the incidence of the pests and diseases were less where the Phytosanitation and application of bio-agents was followed than that of control.

Table 8: Incidence (%) of pests and diseases in the field trial plots at Singhik, North Sikkim

Pests	Incidence %	
	Control	Phytosanitation and application of bio- agents,
Shoot fly	12.3	8.5
Leaf caterpillar	6.0	1.0
Blight	10.2	5.1
Chirke	2.3	1.2
Foorkey	3.0	1.0

IV. Ginger

Genetic Resources

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

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

Ginger germplasm maintained at different AICRPS centres (Table 9)

At Dholi, 68 accessions of ginger were collected and evaluated for promising line in respect of yield and quality parameters. Out of 68 accessions, only eleven accessions namely RG-52, RG-41, RG-11, RG-17, RG-54, RG-24, RG-1, RG-39, RG-70, RG-14 and RG-19 were recorded higher yield ranging from 100 to 260 g per plant and 2.5 to 6.34 kg/7.2 m² as compared to check variety Nadia *i.e.*, 900 g per plant and 2.28 kg/ 7.2 m². Among eleven promising accessions, RG-52 gave the highest fresh rhizome yield (260 g plant⁻¹ and 6.34 kg/ 7.2m²) followed by RG-41 *i.e.*, fresh rhizome yield of 220 g plant⁻¹ and 6.34 kg/7.2 m². All the accessions and check varieties did not perform well in respect of growth, tillering and yield as compared to average yield due to low rainfall and high temperature during crop period.

At Kumarganj, total 61 germplasms were collected over the period and are maintained at the station. Out of 61 accessions evaluated, NDG-55 (445g plant⁻¹) recorded higher yield followed by NDG-28 (140 g plant⁻¹) and NDG-6 (138 g plant⁻¹). Germplasm of ginger has been screened against soft rot and in the

germplasm accessions NDG-5, NDG-6 and NDG-18 there was no disease incidence.

At Pundibari centre, highest rhizome yield/ plot was recorded in GCP-33 (7.55 kg) whereas the lowest rhizome yield / plot was recorded in GCP-60 (1.38 kg plot⁻¹). Maximum disease incidence was recorded in the germplasm GCP- 21 (50.33%) followed by GCP-22 (50.00 %) whereas lowest disease incidence was recorded in GCP-27 (9.81 %).

Out of 173 genotypes at Pottangi, four accessions gave more than 10 kg/3m² fresh rhizome yield and 109 entries yielded more than 5 kg/3m². The range of plot yield being 1.0 kg (Wild ginger) to 18.8 kg/3 m² (Zo-9-1) with the mean yield of 5.7 kg /3 m² in tested germplasm during *Kharif* 2015-16. The highest fresh rhizome yield was recorded by Zo-9-1 (18.8 kg/3 m²) followed by Phiringia (16.57 kg/ 3 m²), Tura local (11.0 kg/3 m²), PGCAL-1 (10.43 kg/3 m²) *etc.*

At Raigarh, out of 35 newly collected germplasm of Ginger only 14 germplasm survived while other 21 germplasm were found highly susceptible to rhizome rot. It was observed that four germplasm (IG 3, IG 9, IG 4 & IG 1 respectively) of Ginger recorded higher rhizome yield over national check Suprabha.

One hundred and eighty three ginger collections were evaluated for rhizome yield and other horticultural traits at Solan. The yield range varied from 99.21 q ha⁻¹ (SG-865) to 134.99 q ha⁻¹ (SG-1134). Yield of five lines *viz.*, SG-1134 (134.99 q ha⁻¹), SG-247 (133.43 q ha⁻¹), SG-1083 (132.44 q ha⁻¹), SG BDJR 1088 (132.19 q ha⁻¹) and SG-857 (131.20 q ha⁻¹)

Table 9: Ginger germplasm collections in AICRPS centres

Centres	Indigenous				Exotic	Total
	Cultivated		Wild and related species			
	Existing	Addition (2015 to 2016)	Existing	Addition (2015 to 2016)		
Dholi	58	3	-	-	-	61
Kumarganj	61	-	-	-	-	61
Pundibari	62	5	-	-	-	67
Pottangi	148	-	2	-	3	153
Solan	231	-	-	-	-	231
Total	560	8	2	-	3	573

excelled the check Himgiri which yielded 120.66 q ha⁻¹. The rhizome rot disease incidence varied from 10.95-23.65 % with 10.95 % and 15.79 % in SG-857 and Himgiri, respectively.

Crop Improvement

GIN/CI/2 Coordinated Varietal Trial (CVT)

GIN/CI/2.3 CVT 2013-Series VIII

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

Ten AICRPS test accessions along with check IISR Rejatha were evaluated during 2015-16 for yield at IISR. Among the ginger accessions studied, maximum yield was recorded in Acc. 65 (31.00 t ha⁻¹) followed by V₁S₁-2 (25.85 t ha⁻¹).

Among six entries and two check varieties tested at Dholi, none of the entries was found significantly superior regarding yield and

yield parameters as compared to local check variety Nadia. All the entries and check varieties did not perform well due to very low rainfall and high temperature.

At Pundibari centre the genotype GCP- 49 showed the highest yield 19.78 t ha⁻¹ followed by Aswathy with a yield of 15.50 t ha⁻¹ in 2015-16. Highest disease incidence was found in genotype ACC 65 (52.50 %) and lowest found in genotype GCP-49 (15.83 %).

Out of 8 entries tested at Pottangi, the entry V₁S₁-2 (14.3 t ha⁻¹) was the top yielder with the yield advantage of 12.6 % than the national check variety Varada (12.7 t ha⁻¹) followed by GCP-49 (14.1 t ha⁻¹), RG-32 (13.9 t ha⁻¹) and Karthika (13.2 t ha⁻¹). The highest clump weight was observed in Suprabha (345.2 g).

Average yield varied from 6.84 t ha⁻¹ to 18.0 t ha⁻¹ at Solan Centre. The local check genotype SG-26-04 (Giriganga) recorded maximum yield of 18.0 t ha⁻¹ followed by local check variety Himgiri 12.06 t ha⁻¹ and National check variety Varada 8.36 t ha⁻¹. The rhizome rot

disease incidence varied from 9.47-23.78 % with minimum incidence in SG-26-04 (Giriganga).

GIN/CI/2.4 CVT 2015-Series IX

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

The experiment was laid out during July 2015 at IISR Experimental Farm, Peruvannamuzhi, Kerala with seven different entries and a national check IISR Varada. Among the ginger accessions studied, maximum yield was recorded in Acc. 247 (28.78 t ha⁻¹) followed

by SE 8681 (23.80 t ha⁻¹) and Acc. 578 (23.79 t ha⁻¹).

At Dholi centre, six entries and two checks *i.e.*, one national check Varada and other local check Nadia were tested under coordinated varietal trial. Between two checks, local check Nadia was found significantly superior regarding yield and yield parameter over national check variety Varada. Among six entries and two checks, none of the entries was found significantly better yield and yield parameters as compared to local check Nadia.

At Pundibari, genotype SE-8681 showed the highest projected yield (8.87 t ha⁻¹), followed by SE HP-9 (7.80 t ha⁻¹). Lowest yield was recorded in SG-26-04 (4.49 t ha⁻¹). Analysis of data showed the highest disease incidence in

Table. 10: Projected yield of ginger genotypes in Coordinated Varietal Trail (CVT 2015) in different AICRPS centres

Entries	Projected yield (t ha ⁻¹)				
	Dholi	Pundibari	Pottangi	Solan	Nagaland
ACC-247	0.42	5.24	3.2	8.18	16.20
ACC-578	0.41	8.16	3.4	4.99	5.64
SE HP 9	0.29	7.11	7.6	5.16	12.66
SE-86 40	0.34	6.79	8.5	5.51	9.18
SE-86 81	0.43	8.87	7.9	6.10	19.14
SE-86 131	0.48	5.44	7.1	5.54	17.64
SG-26-04		4.49	4.7	18.02	20.58
Varada (NC)	0.27	6.99	7.1	8.36	
Local check	3.40	6.55	4.0	12.06	26.46
	(Nadia)	(GCP 5)	(Suprabha)	(Himgiri)	(Nadia)
Mean	0.75	6.67	5.94	8.21	15.93
SEm±	0.02	0.627	0.4	0.39	
CD (@ 5%)	0.06	1.895	1.5	1.18	
CV (%)	4.83	16.36	15.1	8.62	

the variety Varada (29.55 %) and lowest incidence in the genotype ACC-578 (5.71 %).

At Pottangi, the entry SE-8640 (8.5 t ha⁻¹) was the top yielder with the yield advantage of 20.2% than the national check variety Varada (7.1 t ha⁻¹) followed by SE-8681 (7.9 t ha⁻¹) and SEHP-9 (7.6 t ha⁻¹). The highest clump weight was observed in SE8681 (196.7 g).

At Solan centre, average yield varied from 4.99 t ha⁻¹ to 18.02 t ha⁻¹. The genotype SG-26-04 recorded maximum yield of 18.02 t ha⁻¹ followed by local check variety Himgiri 12.06 t ha⁻¹ and National check variety Varada 8.36 t ha⁻¹. The rhizome rot disease incidence varied from 9.47-22.12 % with minimum in SG-26-04.

At Nagaland, highest yield was obtained in local check Nadia (26.46 t ha⁻¹). Among the entries SG-26-04 was the highest yielder (20.58 t ha⁻¹) followed by SE-86 81 (19.14 t ha⁻¹).

GIN/CI/3 Varietal Evaluation Trial

GIN/CI/3.3 Initial Evaluation Trial – 2013

(Centres: Eastern plateau and hills region – Pottangi; Middle Gangetic Plain Region – Dholi)

At Pottangi centre, the entry S-646 (20.1 t ha⁻¹) was the top yielder with the yield advantage of 62.3 % than the national check variety Varada (12.4 t ha⁻¹) followed by Zo-2 (17.5 t ha⁻¹), V₁E₄-5 (17.0 t ha⁻¹), V₁E₈-2 (16.1 t ha⁻¹), V₃S₁-8 (16.9 t ha⁻¹), V₁S₁-8 (16.9 t ha⁻¹) and V₁K₁-1 (16.4 t ha⁻¹).

At Dholi centre, nine promising entries and one check variety Nadia were tested under initial evaluation trial (3rd year). Among nine entries, RG-17, RG-30 and RG-45 gave significantly higher number of leaves per tiller (23.67, 23.00 and 22.33 respectively) as compared to check variety Nadia (19.67).

However, RG-30 and RG-1 recorded significantly higher yield (12.87 and 11.43 t ha⁻¹ respectively) as compared to check variety Nadia (9.60 t ha⁻¹).

GIN/CI/3.5 Initial Evaluation Trial – 2015

(Centre: Middle Gangetic Plain Region – Kumarganj)

Seven entries were tested at Kumarganj under IET and maximum yield was recorded in NDG-9 (13.66 t ha⁻¹) followed by NDG-59 (13.44 t ha⁻¹) and NDG-56 (12.99 t ha⁻¹). The soft rot incidence was lowest in NDG -59 (16.18%) and highest in local clone (49.32%).

GIN/CI/4 Quality Evaluation Trial

GIN/CI/4.1 Evaluation of germplasm for quality

(Centre: Western Himalayan Region - Solan)

In Quality evaluation of Ginger: Fifty five best performing genotypes were analyzed. The dry matter content (%) and crude fibre (%) ranged between 15.333 (Acc 578) to 24.313 (SG-247) and 3.900 (Ranchi Local) to 5.623 (Himgiri), respectively. Essential oil (%) and oleoresin contents (%) varied from 0.720 (Varada) to 1.670 (SG-857) and 3.180 (SG-1124) to 4.737 (SG-908), respectively. The high yielding genotype SG-26-04 (Giriganga) was found superior/ comparable for dry matter content, essential oil, oleoresin and crude fibre contents to the check Himgiri.

GIN/CI/4.2 Evaluation of germplasm from other centres

(Centre: Western Himalayan Region - Solan)

Four ginger samples from other centres were evaluated for quality. The quality evaluation data is presented under respective experiments.

Crop Management

GIN/CM/5 Nutrient Management Trial

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

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

Oxyflurofen was selected as best pre-emergent herbicide in this experiment compared to pendimethalene. But one has to spray the Oxyflurofen chemical 2nd day after sowing the rhizomes and concentration should not exceed 500 ml/ha, otherwise it will cause phytotoxicity to the ginger plants. Oxyflurofen controls all kinds of weeds up to 60 days, where as Pendimethalene controls up to 25-30 days only.

GIN/CM/5.5 Source sink relationship

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

The experiment on source sink relationship in ginger is being carried out in 4 different centres with four varieties viz. IISR Mahima, GCP 5 (Gorubathane), Mizoram Local and Ranchi Local. Results indicated that partitioning efficiency remained almost same in all varieties in all places. In general, rhizome yield per plant was higher in local variety of the place followed by IISR Mahima. Oil and oleoresin contents were higher in GCP 5 compared to other varieties in all the places. Results indicate that IISR Mahima could be a stable variety for yield and GCP 5 for quality.

At Kanke centre, Ranchi local recorded maximum tillers per plant (4.2), highest fresh

and dry weight of leaves per plant (12.82 g, 1.32 g) as well as fresh and dry weight of stem per plant respectively (18.5 g, 2.09 g), fresh and dry wt. of rhizome respectively (89.76 g, 14.44 g) Maximum per plot yield of 3.92 kg recorded in Mahima and lowest per plot yield 2.50 kg in Mizoram local with rhizome fresh weight & dry weight per plant of 16.7 g and 2.36 g. Among the genotypes (Mahima, Ranchi local, GCP 5, Mizoram local) the genotype Mizoram local recorded highest essential oil and oleoresin content (1.02 & 4.08 % respectively).

At Mizoram, maximum number of tillers/plant was observed in IISR Mahima (3.67) at 60 DAP and in IISR Mahima (5.00) and Mizoram Local (5.00) in 120 DAP. Leaf area/plant (cm²) was found to be highest in Mizoram Local (152.67) at 60 days after planting, whereas IISR Mahima (272.33 cm²) recorded highest leaf area/plant at 120DAP. Total dry weight/plant (g) was maximum in Gorubathane (13.90 and 31.70 g) both at 60 and 120 DAP. Rhizome dry weight (g) was highest in Mizoram Local (13.77 and 23.67 g) both at 60 and 120 days after planting.

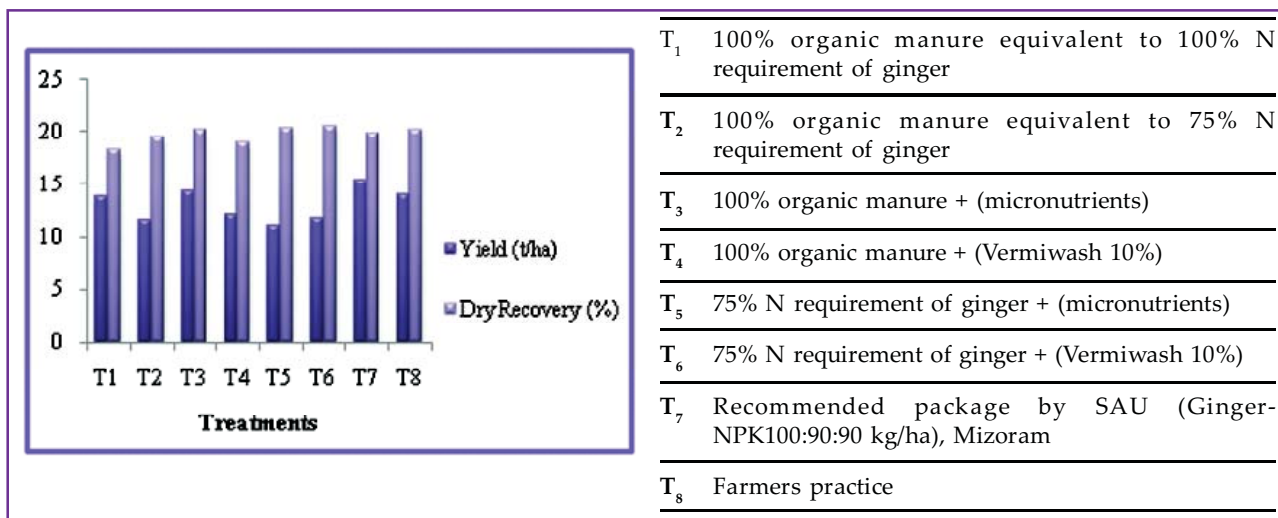
At Pundibari the genotype Mizoram Local produced the highest fresh yield of 6.06 kg plot⁻¹ (12.22 t ha⁻¹) and highest dry yield of 1.44 kg plot⁻¹.

At Barapani, the genotype Nadia produced the highest fresh rhizome weight of 562.88 g per plant followed by Himgiri (433.54 g plant⁻¹).

GIN/CM/5.6 Organic production of ginger

(Centres: Eastern Himalayan Region – Mizoram, Barapani)

At Mizoram, the maximum yield was recorded for T₇ (Recommended package by



T ₁	100% organic manure equivalent to 100% N requirement of ginger
T ₂	100% organic manure equivalent to 75% N requirement of ginger
T ₃	100% organic manure + (micronutrients)
T ₄	100% organic manure + (Vermiwash 10%)
T ₅	75% N requirement of ginger + (micronutrients)
T ₆	75% N requirement of ginger + (Vermiwash 10%)
T ₇	Recommended package by SAU (Ginger-NPK100:90:90 kg/ha), Mizoram
T ₈	Farmers practice

Fig. 9: Yield (t/ha) and dry recovery (%) as influenced by different organic production practices at Mizoram

SAU; NPK100:90:90 kg ha⁻¹), with a yield of 15.28 t ha⁻¹, followed by T₃ (100 % organic manure + micronutrients) with a yield of 14.23 t ha⁻¹, T₈ (Farmers practice) with a yield of 14.09 t ha⁻¹. Dry recovery was found to be highest in T₆ (75% N requirement of ginger + Vermiwash 10 %) with dry recovery of 20.40% followed by T₅ (75% N requirement of ginger + micronutrients) with 20.30 % dry recovery and T₈ (dry recovery 20.20 %). The maximum fresh weight of clump was recorded for T₇ (111.90 g plant⁻¹), followed by T₆ (106.13 g plant⁻¹) and T₂ (105.50 g plant⁻¹).

GIN/CM/5.7 Effect of micronutrients on growth and yield of ginger (Demonstration trial)

(Centres: East coast plains and hill region – Chintapalle; Eastern plateau and hills region - Pottangi)

There were 2 treatments T₁ is recommended package of practice and T₂ is recommended package of practice + IISR micronutrient formulation.

At Pottangi, significant differences were observed among the two treatments for fresh

rhizome yield of Ginger. Application of recommended packages along with IISR-Micronutrients produced the highest fresh rhizome yield of 19.8 t ha⁻¹, 20.4 t ha⁻¹ and 21.5 t ha⁻¹ in Suprabha, Suravi and Varada, respectively.

Crop Protection

GIN/CP/6 Disease Management Trial

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

(Centre: Middle Gangetic Plain Region - Dholi)

Diseased rhizomes of ginger collected from Darbhanga districts of Bihar were found to be infected with Bacterial wilt and Soft rot diseases. Bacterial wilt incidence ranged from 0 to 45% with mean disease incidence of 20 %. Whereas Soft rot disease incidence ranged from 0 to 30% with mean disease incidence of 11%. The crop was also found to be infected with *Phyllosticta* leaf spot disease incidence in the range of 5 to 40% with mean disease incidence of 14%.



Fig. 10: Symptom of *Phyllosticta* leaf spot of ginger

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

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

At Solan, highest germination of ginger rhizomes was found in foliar spray with carbendazim + mancozeb (T_3) followed by foliar spray with copper oxychloride (T_4) and foliar spray with tricyclazole (T_6). Minimum leaf spot incidence was recorded in hexaconazole foliar spray (T_7) which also resulted in maximum disease control followed by propiconazole (T_5), carbendazim + mancozeb (T_3) and tricyclazole (T_6) sprays, which were statistically at par with each other and gave 71.50, 67.40 and 66.26 per cent disease control, respectively. Hexaconazole sprays (T_7) also gave maximum yield (9.75 t ha⁻¹) followed by sprays of propiconazole (T_5) and carbendazim + mancozeb (T_3) which yielded 8.62 and 7.87 t ha⁻¹, respectively.

Minimum disease intensity 14.24 and maximum yield 5.8 t ha⁻¹ was recorded with spray of Carbendazim:Mancozeb (0.1%) at first appearance of the disease with two sprays at 20 days interval at Raigarh. The next best treatment was Tricyclazole (0.1%) and

Hexaconazole (0.1%) spray at first appearance of disease followed by 2 sprays at 20 days interval

GIN/CP/6.11 Eco-friendly management of rhizome rot of ginger

(Centres: Middle Gangetic Plain Region – Kumarganj)

Observations on percent disease severity of soft rot of ginger at Kumarganj showed that lowest disease incidence was found in soil solarization + plastic mulching + rhizome treatment with 2% neem oil (41.06) followed by soil solarization + plastic mulching (47.70) and soil solarization + rhizome treatment with 2% neem oil (50.43) as compared to control (77.89). The maximum yield was recorded in soil solarization + plastic mulching + rhizome treatment with 2% neem oil (3.35 t ha⁻¹) and minimum in plastic mulching (14.62 t ha⁻¹) in comparison to control (11.34 t ha⁻¹).

GIN/CP/6.12 Field screening of different varieties of ginger against leaf spot and rhizome rot

(Centre: Western plateau and hills region – Dapoli)

Ten varieties viz., IISR-Varada, IISR-Rejatha, IISR-Mahima, Athira, Suruchi, Suravi, Suprabha, Himgiri, V₃E₈ 2 and V₃S₁ 8 were screened against leaf spot and rhizome rot diseases. Out of ten varieties screened IISR Rejatha and IISR Mahima were found to be resistant (R) to leaf spot (*Phyllosticta zingiberi*) and rhizome rot (*Pythium aphanidermatum*) whereas Athira variety was susceptible to leaf spot (*Phyllosticta zingiberi*). Other varieties were found to be moderately resistant.

V. Turmeric

Genetic resources

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

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

Table 11 shows the turmeric germplasm conserved at various AICRPS centres

A total of 275 germplasm collections were planted and 55 high yielding accessions were evaluated at Coimbatore. The plant height of the genotypes ranged from 35.77 cm to 95.20 cm and the number of tillers per plant ranged between 1.33 and 4.33. The fresh rhizome yield per plot (3m²) significantly ranged from 7.80 kg (CL 88) to 14.00 kg (CL 100) with a mean of 10.65 kg. The genotype CL 100 had the highest fresh rhizome yield per plot which was *on par* with CL 269 (13.30 kg) and CL 122 (12.80 kg).

One hundred and eighty two germplasm collections are being maintained at TRS Kammarpally. The Genotypes are grouped into long (8-9 Months), medium (7-8 Months), short duration (6-7 Months) based on duration of the culture. Among all the germplasm lines tested, Co. 1 recorded highest fresh rhizome yield (12.8 kg/3m²) followed by CLI-325 (9.62 kg/3m²) where as local check JTS -6 yielded (2.83 kg/3m²). Poor yield was due to severe drought conditions in the district

Ninety four accessions of turmeric were collected and evaluated for promising lines with respect to yield and quality parameters at Dholi. Out of ninety four accessions, only ten accessions namely - RH-50, RH-438, RH-2, RH-80, RH-441, RH-2/80, RH-431, RH-9/90, RH-7/80 and RH-416 gave better performance and showing fresh rhizome yield ranging from 1.20 to 0.75 kg per plant as compared to best check variety Rajendra Sonali *i.e.*, 0.70 kg per plant. Among ten promising accessions, RH-50 recorded higher fresh rhizome yield per plant (1.20 kg) and per plot (29.96 kg 7.2 m²) followed by RH-438 (1.05 kg plant⁻¹ and 28.98 kg 7.2m² respectively). The growth and yield was reduced drastically due to low rainfall and high temperature during the crop period.



Fig. 11: Field view of turmeric germplasm conservation site at Dholi

At Kumarganj 160 germplasm were evaluated and NDH-74 (260 g plant⁻¹) and NDH-79 (269 g plant⁻¹) in early maturing entries, NDH-98 (315 g plant⁻¹), NDH-131 (265 g plant⁻¹) and NDH-134 (260 g plant⁻¹) in medium and NDH-8 (265 g plant⁻¹), NDH-7 (260 g plant⁻¹) in late maturity turmeric accession were found promising. Leaf blotch severity was found minimum in NDH-53 (14.07 %) followed by

NDH-11 (18.51 %), NDH-17 (18.88 %), NDH-18 (19.05 %), NDH-25 (19.75 %), and NDH-22 (22.22 %). Leaf spot of turmeric has not been observed in 2015-16.

A total of 186 turmeric germplasm were grown together for evaluation in 2015-2016 at Pundibari centre. TCP-165 and TCP -223 (159.00 cm) were found to be tallest whereas TCP-96 was the dwarf (83.3cm). TCP-41 (14.98) recorded highest number of tillers. TCP-62 showed lowest number of tillers (1.23). Rhizome yield of individual plant (clump weight) was maximum in TCP-200 (864.00 g). Lowest yield was recorded in TCP-5 (184.5 g). A total of 21 germplasm recorded significantly higher rhizome yield (29 - 86%) increase over check variety TCP-2. Highest leaf spot was found in TCP 178 (PDI 48.51) and lowest was in TCP-39, TCP-54, TCP-96, TCP-129, TCP-136, TCP-153, TCP-163, TCP-202 where the PDI was 7.41. Highest leaf blotch was found in TCP 197 (PDI - 40.74) and minimum was in TCP-17, TCP-44, TCP-48, TCP-55, TCP-67, TCP-129, TCP-153, TCP-161, TCP-176 and TCP-184 where the PDI was 7.41.

At Solan, 133 turmeric collections were evaluated for rhizome yield and other horticultural traits. The yield range varied from 18.0 t ha⁻¹ (BDJR-1292) to 41.19 t ha⁻¹ (ST-907). Yield of three lines *viz.*, ST-907 (41.19 t ha⁻¹), ST-12M (37.67 t ha⁻¹) and PCT-53 (37.20 t ha⁻¹) excelled the checks Palam Lalima and Palam Pitamber which yielded 33.17 t ha⁻¹ and 36.70 t ha⁻¹ respectively. The curcumin content varied from 1.53-6.30 % with 6.30% in PCT-14 whereas, 3.57 % and 2.98 % in Palam Lalima and Palam Pitamber, respectively.

Forty nine (48 Old +01 New) diverse genotypes of turmeric collected from entire

NE region were evaluated at Pasighat along with check variety Megha Turmeric-1 during 2015-16. Among the genotypes evaluated, maximum rhizome yield was recorded in CHFT-8 (17.54 t ha⁻¹), which was statistically *at par* with CHFT-36 (15.54 t ha⁻¹), CHFT-24 (15.43 t ha⁻¹) and CHFT-15 (13.65 t ha⁻¹). Lowest rhizome yield was recorded in genotype CHFT-28 (7.44 t ha⁻¹).

Among 179 turmeric accessions evaluated in 2015-16 at HARS, Pottangi, 152 were *Curcuma longa*, 23 were *Curcuma aromatica* and 4 were *Curcuma amada*. Out of 152 *Curcuma longa* accessions 20 accessions gave more than 10 kg/3m² fresh rhizome yield and 104 entries yielded more than 5 kg/3m². The range in fresh rhizome yield in *C. longa* varied from 1.2 kg/3m² to 14.1 kg/3m² with the mean of 6.5 kg/3m² among tested germplasm. High yielding accessions were CLS-29 (14.1 kg/3m²), Kuchipudi (13.1 kg/3m²), VK-5 (12.8 kg/3m²) *etc.* The projected yield ranged from 2.7 t ha⁻¹ (No.18) -31.3 t ha⁻¹ (CLS-29) with the mean of 14.5 t ha⁻¹ whereas clump weight ranged from 50 g (PTS-5) to 400g (PTS-15). In *Curcuma aromatica* the range in fresh rhizome yield varied from 1.0 kg/3 m² to 6.7 kg/3 m². Among 23 accessions in *Curcuma aromatic*, 15 entries gave more than 5 kg/3m² fresh rhizome yields.

At Raigarh, germplasm entry IT 36 (10.1 kg) recorded higher rhizome yield /plot followed by IT 37 (7.85 kg) and IT 38 over five national checks Suranjana, IT 2, Prabha, Narendra Haldi and BSR 2. Among the 38 new germplasm collected and evaluated for yield and yield attributing traits at experimental farm of CARS, Raigarh the entries IT 60, IT 61, IT 62 recorded higher rhizome yield/plot over national checks IT 2, Narendra Haldi and BSR-2.

Table 11: Turmeric germplasm collections at various AICRPS centres

Centre	Indigenous			Exotic	Total
	Cultivated		Wild and related sp.		
	Existing	Addition 2015-16	Existing	Existing	
Coimbatore	266	-	7	2	275
Dholi	90	2	2	-	94
Kammarpally	182	-	-	-	182
Kumarganj	155	-	-	-	155
Pantnagar	36	-	-	-	36
Pasighat	63	-	2	-	65
Pottangi	155	-	24	-	179
Pundibari	186	-	26	-	212
Raigarh	42	13	-	-	55
Guntur	2	173	-	-	175
Total	1177	188	61	2	1428

Crop Improvement

TUR/CI/2 Coordinated Varietal Trial

TUR/CI/2.5 CVT on Turmeric 2013

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

At Chintapalle, among the 13 genotypes evaluated during the year 2015-16 for Morphological characters, maximum plant height was recorded in PTS-12 (166.13 cm) followed by PTS-55 (164.33 cm). Maximum leaf area was recorded in PTS-8 (640.5 sq.cm). All the entries showed eight months duration. In terms of yield parameters, maximum rhizome yield per plant was observed in

NDH-98 (490.07 g plant⁻¹) followed by NDH-79 (474.20 g plant⁻¹). Maximum fresh rhizome yields were recorded from NDH-79 (50.91 t ha⁻¹) and highest dry recovery was recorded in NDH-98 (23.4 %) and PTS -8 (23.2 %) over the other entries with life saving irrigations under rain fed cultivation in prolonged drought (climate change conditions).

Among the genotypes tested at Coimbatore, the genotype NDH 79 recorded the lowest number of tillers per plant (2.40) and the genotype PTS 12 recorded the highest number of tillers per plant (3.80). Fresh rhizome yield was found to be high (455.60 g plant⁻¹) in the genotype PTS 12. The fresh rhizome yield per plot (9 m²) was significantly different in various genotypes which ranged from 27.22 kg in NDH 98 to 41.00 kg in PTS 12. Four genotypes registered significantly higher values than the grand mean of 31.57 kg plot⁻¹. The projected rhizome yield per hectare differed significantly among the ten



Fig. 12: CVT-2013 Turmeric at Coimbatore

genotypes tested, which ranged from 30.24 t ha⁻¹ (NDH 98) to 45.56 t ha⁻¹ (PTS 12) with a mean of 35.08 t ha⁻¹. The mean per cent incidence of leaf blotch disease varied between 12.02 PDI (PTS 12) and 27.75 PDI (BSR 2). The genotype PTS 5 recorded the lowest leaf spot incidence of 5.5 PDI followed by the genotype Acc. 48 and PTS 12 (7.39 PDI). Among the different genotypes the dry recovery ranged from 14.70 per cent in the genotype PTS 12 to 24.30 per cent in the genotype TCP 64.

At Kammarpally, genotypes NDH-8 recorded highest fresh rhizome yield (28.04 t ha⁻¹) followed by NDH-98 (25.57 t ha⁻¹) in comparison to National check - IISR Prathibha (18.16 t ha⁻¹) and Local check- Duggirala Red (21.73 t ha⁻¹).

The third year 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 morphological and yield characteristics. Among the accessions studied, maximum yield was recorded in NDH 98 followed by Acc. 48.

At Kumarganj, maximum rhizome yield was obtained in NDH-98 (30.88 t ha⁻¹) followed by TCP-64 (28.33 t ha⁻¹) and NDH-8 (28.17 t ha⁻¹). In case of foliar diseases, minimum leaf blotch incidence has been observed in TCP-64 and NDH-98 (25.87 %) followed by NDH-79 (28.07 %), Acc. 48 (31.03 %), and Acc. 74 (31.53 %), whereas in case of leaf spot, minimum severity was found in PTS-55 (1.9 %) followed by PTS-12 (2.26 %), NDH-98 (3.03 %) and TCP-64 (3.9 %).

At Pundibari, PTS-8 recorded highest yield of 17.40 kg plot⁻¹ (35.08 t ha⁻¹) followed by TCP-64 – 16.94 kg plot⁻¹ (34.13 t ha⁻¹). Lowest yield was obtained in TCP-2 (17.67 t ha⁻¹). Highest dry recovery (%) was recorded in TCP- 64 (34.33) and lowest was in NDH98 (24.67). Days to maturity was more in PTS-55 (237.33 days) and was less in TCP-64 (219.3 days). The lowest leaf blotch disease severity PDI (19.51) was found in PTS-12 which is followed by TCP-2 (PDI 23.21). The lowest leaf spot disease severity was found in NDH8 (PDI 4.23) followed by PTS 12 (PDI 4.76) and NDH 79 (PDI 5.66).

It was revealed from the analyzed pooled data (2013-14 to 2015-16) of 12 entries tested at Pottangi that the entry NDH-98 (24.2 t ha⁻¹) was the top yielder with the yield advantages of 56.5 % than the national check variety Prathibha (15.5 t ha⁻¹) followed by PTS-55 (23.8 t ha⁻¹), Roma (19.5 t ha⁻¹), NDH-8 (18.1 t ha⁻¹) and PTS-8 (16.4 t ha⁻¹). The range of projected yield was from 7.0 t ha⁻¹ to 24.2 t ha⁻¹ among the tested entries having the mean of 17.0 t ha⁻¹. The heaviest clump was observed in NDH-98 (351.3 g).

At Raigarh, NDH 98 recorded higher rhizome yield (41.8 t ha⁻¹) followed by entry NDH 79 (22.6 t ha⁻¹) and SLP 389-1 (19.6 t ha⁻¹) over

national checks IT 2 (20.7 t ha⁻¹), Narendra Haldi (14.5 t ha⁻¹) and Prathibha (10.1 t ha⁻¹).

At Pasighat, ten turmeric genotypes namely Acc. 48, Acc. 79, SLP 389/1, NDH 8, NDH 79, NDH 98, TCP 64, PTS 12, PTS 8, PTS 55 were evaluated in Randomized Block Design with three replications along with National Check, Prathibha and Local Check, Megha Turmeric-1 during 2015-16. Data revealed that NDH-98 gave maximum rhizome yield (22.64 t ha⁻¹), which was significantly superior over National Check Prathibha (9.32 t ha⁻¹) and local check Megha Turmeric-1 (11.54 t ha⁻¹). Lowest rhizome yield was recorded in genotype TCP-64 (6.55 t ha⁻¹).

NDH-98 recorded significantly higher green rhizome yield (33.46 t ha⁻¹) over the local check (GNT-1) and national check (Prathibha) at Navsari. This entry was also found promising for rhizome weight (466.0 g), mother rhizome per plant (4.13), rhizome length (21.60 cm) and rhizome breadth (22.13 cm).

TUR/CI/3 Varietal Evaluation Trial

TUR/CI/3.6 Initial Evaluation Trial 2013

(Centre: Eastern plateau and hills region – Pottangi)

It was revealed from the analyzed pooled data that the entry CLS-38 (29.2 t ha⁻¹) was the top yielder with the yield advantage of 42.6 % than the local check variety Roma (21.2 t ha⁻¹) followed by PTS-12 (22.5 t ha⁻¹) and PTS-18 (21.2 t ha⁻¹). The heaviest clump was observed in PTS-57 (399.9 g).

TUR/CI/3.7 Initial Evaluation Trial 2015

(Centres: Middle Gangetic Plain Region - Kumarganj)

At Kumarganj, 10 entries were evaluated under IET, highest yield was observed in

NDH-136 (30.99 t ha⁻¹) followed by NDH-16 (30.88 t ha⁻¹) and NDH-129 (30.66 t ha⁻¹). Whereas minimum disease severity of leaf spot, was recorded in NDH-45 (8.46 %) followed by NDH-16 (10.69 %) and NDH-116 (15.60 %).

Crop Management

TUR/CM/5 Nutrient Management Trial.

TUR/CM/5.9 Source sink relationship in turmeric

(Centres: Southern plateau and hills region – Coimbatore, Kammarpally; West coast plains and ghat region – IISR; East coast plains and hill region – Guntur; Middle Gangetic Plain Region – Dholi; Eastern Himalayan Region - Barapani)

During 2015-16, an experiment was conducted to study the rhizome bulking pattern of the five varieties *i.e.* BSR 2, Rajendra Sonia, Duggirala Red, Mydukur and Prathiba at Coimbatore. Fresh weight of whole rhizome increased considerably from September to February. Among the varieties evaluated, BSR 2 registered vigorous growth and the highest fresh rhizome weight (450 g plant⁻¹) followed by Rajendra Sonia (320 g plant⁻¹) which were significantly different from each other at 240 DAS.

At Kammarpally, at 60 DAS, Duggirala Red recorded highest fresh rhizome yield (10.47 g plant⁻¹) followed by IISR Prathibha (9.73 g plant⁻¹). At 90 DAS, Mydukur recorded highest fresh rhizome yield (16.27 g plant⁻¹) followed by Duggirala Red (13.2 g plant⁻¹). At 120 DAP, Duggirala Red, Rajendra Sonia recorded highest fresh rhizome yield (96.0 g plant⁻¹) followed by Rajendra Sonia (87.6 g plant⁻¹). At harvest BSR-2 recorded higher



Fig. 13: Plant growth in different varieties at 120 DAS in source-sink relationship trial at Guntur

fresh rhizome weight ($133.0 \text{ g plant}^{-1}$) followed by Duggirala Red ($84.50 \text{ g plant}^{-1}$) which are significantly different from each other at harvest.

At 60 days after planting (DAP), leaf showed maximum partitioning percentage followed by stem while at 120 DAP, rhizomes showed the highest partitioning percentage. Similar trend was noticed in almost all the centres. Among the varieties partitioning to rhizomes was maximum in Rajendra Sonia followed by IISR Prathibha in general at 120 DAP in all the centres. With respect to quality, all the varieties had similar oil and oleoresin levels at Coimbatore while IISR Prathibha & R. Sonia had maximum at Guntur. Oil and oleoresin contents were similar in both Guntur and Coimbatore but less compared to IISR & Dholi. Rajendra Sonia, Prathibha and BSR 2 had the similar oil and oleoresin contents at both IISR and Dholi. IISR Prathibha had the highest oil and oleoresin at Barapani while all the other varieties had similar oil levels but oleoresin content varied among the varieties. In general, IISR Prathibha showed higher oil and oleoresin content among varieties under different agro climatic conditions. Yield wise also, this variety performed well in all the locations. Hence among these varieties, IISR Prathibha seems to be a stable variety both in terms of yield and quality.

At Guntur five varieties were sown in the first week of July and evaluated for rhizome bulking with periodical sampling. Fresh weight of whole rhizome increased considerably from December to February. Among the five varieties evaluated, Prathibha was found to be vigorous in growth and recorded highest fresh rhizome weight ($312.56 \text{ g plant}^{-1}$) and significantly superior to all other varieties evaluated.

At Barapani, Mydkur variety recorded highest fresh rhizome weight ($542.76 \text{ g plant}^{-1}$) followed by Rajendra Sonia ($454.24 \text{ g plant}^{-1}$).

TUR/CM/5.10 Organic production of turmeric

(Centres: Eastern Himalayan Region – Mizoram; Eastern Himalayan Region – Barapani)

At Mizoram, maximum yield was recorded for T_2 (100 % organic manure equivalent to 75 % N requirement of turmeric), with a yield of 35.24 t ha^{-1} , followed by T_1 (100 % organic manure equivalent to 100 % N requirement of turmeric) with a yield of 34.05 t ha^{-1} , T_5 (75 % N requirement of turmeric + micronutrients) with a yield of 33.54 t ha^{-1} . Dry recovery was highest in T_4 (100 % organic manure + Vermiwash 10 %) with dry recovery of 17.51 %

followed by T₁ (100% organic manure equivalent to 100% N requirement of turmeric) with dry recovery of 17.25%, and T₃ (100% organic manure + micronutrients) with dry recovery of 16.65%.

TUR/CM/5.11 Screening of post-emergent herbicides for selectivity in turmeric

(Centre: East coast plains and hill region – Guntur)

At Guntur, the selectivity of ten post-emergence herbicides viz. Pyrithiobac sodium 10 % (Hitweed), Byspyribac 10 % (Nominee Gold), Imazethapyr 10 % (Pursuit), Ethoxysulfuron 15 % (Sunrice), Pyrazosulfuron 10 % (Saathi), Atrazine 50 % (Atrataf), Metribuzin 70 % (Cencor) and Chlorimuron ethyl 25% (Classic), for turmeric was studied. The survival percentage of the

crop ranged from 33.8 % (Pyrithiobac sodium) to 95.8 % (control). More than 50 % survival was reported in Byspyribac (60 %), Metribuzin (64.9 %) and Chlorimuron ethyl (74.3 %). The highest fresh rhizome yield was recorded in Chlorimuron ethyl (176.0 g plant⁻¹) in herbicide treatments. The visual score for selectivity for turmeric observed at 3 weeks after spraying was 3 (None: Injury more pronounced but not persistent) for Pyrithiobacsodium, Byspyribac, Imazethapyr, Ethoxy sulfuran and Pyrazosulfuran. The score for Atrazine was 7 (Severe: Severe injury and stand loss), Metribuzine was 8 (Severe: Crop almost destroyed, few plants survived) and for Clorimuron ethyl was 4 (Moderate: Moderate injury to crop Recovery possible) (Table 12). The study paved the way for directed use of specific post-emergence herbicides in turmeric.

Table 12: Survival (%) and yield of turmeric as influenced by different post-emergent herbicides

Herbicide	Dosage (a.i. g/ha)	Survival (%)	Yield (kg plot ⁻¹)	Rhizome fresh (g plant ⁻¹)
T ₁ -Pyrithiobacsodium10% (Hitweed)	63	33.8	7.7	114.1
T ₂ -Bispyribac 10% (Nominee Gold)	25	59.7	17.3	144.9
T ₃ - Imazethapyr 10% (Pursuit)	50	36.2	9.1	126.0
T ₄ - Ethoxy sulfuran 15% (Sunrice)	20	40.0	11.7	145.9
T ₅ - Pyrazosulfuran 10% (Saathi)	20	40.0	11.3	141.2
T ₆ -Atrazine 50 % (Atrataf)	1000	46.5	14.5	155.6
T ₇ - Metribuzine 70% (Cencor)	200	64.9	22.0	169.6
T ₈ -Clorimuron ethyl 25% (Classic)	12	74.3	26.1	176.0
T ₉ - Control	Water spray	95.8	45.7	238.4

TUR/CM/5.12 Mechanical planting in turmeric (Observational trial)

(Centre: Southern plateau and hills region – Coimbatore)

In the observational trial on method of planting in turmeric at Coimbatore, the sprouting percentage of the treatments differed significantly. Manual planting registered 83.44 per cent sprouting and the lowest sprouting (67.63 %) was noticed in mechanical planting. Manual planting showed earliest sprouting (16.27 days) and maximum plant height (78.63 cm) whereas mechanical planting recorded late sprouting (20.12 days) and reduced plant height (75.59 cm). The highest weight of fresh rhizome (565 g plant⁻¹) and highest plot (9 m²) yield (66.19 kg) was recorded in manual planting whereas the mechanical planting recorded the least per plant yield (510 g plant⁻¹) yield per plot (58.64 kg).

TUR/CM/5.13 Comparative performance of turmeric entries under polyhouse and field conditions

(Centre: Eastern plateau and hills region - Raigarh)

From this study, it was observed that two checks BSR 2 and Narendra Haldi-1

performed well in polyhouse as well as in field conditions as compared to checks Suranjana and Chhattisgarh Haldi 1 (IT 2). The testing of turmeric entries under polyhouse conditions found that entries IT 41, IT 38 and IT 36 respectively recorded higher rhizome yield over checks Suranjana and IT 2. Similarly testing of turmeric entries under field conditions recorded higher rhizome yield in four entries IT 41, IT 23, IT 38 and IT 36 respectively over suranjana and IT 2 (Fig. 14).

Crop Protection

TUR/CP/7 Disease Management Trial

TUR/CP/7.1 Survey and identification of disease causing organisms in turmeric and screening of turmeric germplasm against diseases (Disease Surveillance)

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

Survey was conducted in different places of Erode and Coimbatore districts. The leaf blotch intensity was maximum in Erode district compared to Coimbatore district. In Erode district, the maximum leaf spot intensity of 17.9 PDI was noticed at

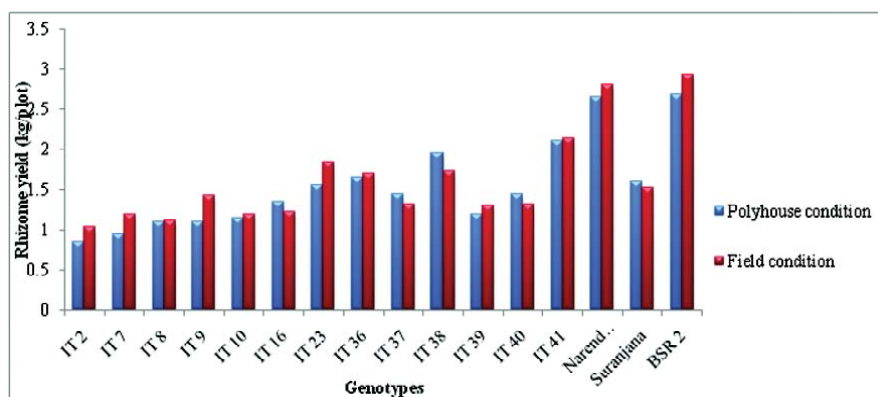


Fig. 14 : Rhizome yield (kg plot⁻¹) of turmeric entries under polyhouse and field conditions at Raigarh

Sathyamangalam followed Kasipalayam (12.9 PDI) and Gobi (12.1 PDI). The leaf blotch intensity was maximum at Sathyamangalam (38.2 PDI), followed by Gobi (36.6 PDI) and Avalpoondurai (32.3 PDI). In Coimbatore district, maximum intensity of leaf blotch was noticed in Thondamuthur (24.7 PDI) followed by Annur (22.8 PDI). The leaf spot intensity was maximum in Karamadai (28.2 PDI) followed by Annur (15.3 PDI).

A survey was conducted by Pundibari centre in 2 blocks of Coochbehar (Coochbehar I and II) and some places of Tufanganj I of Coochbehar district to identify the diseases occurring in the area and to assess the severity of different diseases of turmeric in this area. Nine well distributed locations within those places were selected for the survey. In each location the survey was done at 3 different places. Three major diseases of turmeric were found to be prevalent in this area, namely, Leaf Blotch (*Taphrina* sp.), *Colletotrichum* Leaf spot (*Colletotrichum* sp.) and *Helminthosporium* leaf spot (*Helminthosporium* sp.). Most of the area is covered with local varieties which are highly susceptible to leaf blotch disease and some of the areas are highly susceptible to leaf spot disease too. In the survey it was found that leaf blotch disease severity was highest in Coochbehar I block (average PDI 37.92) followed by Coochbehar II block (average PDI 34.85) and Tufanganj I (average PDI 32.50). Regarding leaf spot of turmeric it was found that disease severity was also highest in Coochbehar I (average PDI 29.45) which was followed by Tufanganj I (average PDI 24.06) and Coochbehar II block (average PDI 22.98).

Survey conducted by Dholi centre revealed that turmeric crop cultivated by farmers were found to be affected by leaf spot caused by *Colletotrichum capsici* and *Taphrina maculans* in Darbhanga district of Bihar. *Colletotrichum* leaf

spot incidence of turmeric was found in the range of 0 to 15 % with mean disease incidence of 10 %. *Taphrina* leaf spot incidence of turmeric ranged from 5 to 55% with mean disease incidence of 26 %.

At Raigarh during the survey in the village Khokhra of Tamnar Developmental block 52.45 per cent of disease intensity of *Colletotrichum* leaf spot and *Taphrina* leaf blotch was observed and 44.36 percent disease intensity at Village Bhupdeopur at Kharsiya developmental block.

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

(Centres: Eastern plateau and hills region – Raigarh; Southern plateau and hills region – Coimbatore)

From the pooled data of last three years at Raigarh, minimum disease intensity of *Colletotrichum* leaf spot (13.64 %) and maximum yield 14.08 t ha⁻¹ was recorded when rhizomes treated with Carbendazim + Mancozeb (1:1) (0.1%) + Foliar spray of Carbendazim + Mancozeb (0.1%) on 45 and 90 days followed by Azystobin spray (0.1 %) after 45, 75 and 105 DAS (disease intensity 15.73 per cent and yield 14.08 t ha⁻¹). Both the treatments are statistically *at par*. In case of *Taphrina* leaf blotch in turmeric crop minimum disease intensity 13.12 percent and maximum yield 14.08 t ha⁻¹ was found when rhizome treated with Carbendazim + Mancozeb (1:1) (0.1%) + Foliar spray of Carbendazim + Mancozeb (0.1%) on 45 and 90 days followed by Azystobin spray (0.1%) after 45, 75 and 105 DAS after Planting (disease intensity 15.48% and yield 13.14 t ha⁻¹). Both of the treatments were statistically *at par*.

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

(Centres: Southern plateau and hills region – Coimbatore, Kammarpally; Middle Gangetic Plain Region - Dholi, Kumarganj, Pundibari; Eastern plateau and hills region – Raigarh; East coast plains and hill region – Guntur; Western Himalayan Region - Solan)

All the disease tolerant lines of turmeric recorded 82.0 to 97.0 per cent sprouting at Coimbatore. Among different lines, TCP 161 registered the highest sprouting (96.66 %). The disease tolerant lines recorded the least leaf spot incidence between 6.17 and 12.94 PDI where as the susceptible check BSR-2 registered the highest incidence of 22.20 PDI. The accession number *viz.*, TCP 129 recorded the least leaf spot intensity of 6.17 followed by CL 34, RH 407 and NDH 40 (7.09 PDI). The leaf blotch incidence in disease tolerant lines ranged from 4.63 to 18.81 PDI, while the maximum incidence was noticed in the susceptible check BSR-2 (32.99 PDI). The accessions CL 34 and RH 407 recorded the least leaf blotch intensity of 4.63 PDI followed by TCP 129 (4.93 DI) with maximum yield of 30.69, 30.47 and 29.97 t ha⁻¹ respectively.

At Dholi, among 16+1 (Susceptible check var. Morangia) germplasm of turmeric screened against leaf spot & leaf blotch disease, RH-406

gave highest yield (26.81 t ha⁻¹) with no leaf spot incidence & leaf blotch incidence (PDI 20.00) followed by Rajendra Sonali giving yield of 23.89 t ha⁻¹ with no leaf spot incidence and leaf blotch incidence (PDI 33.33). Check var. Morangia recorded yield of 11.92 t ha⁻¹ with PDI = 41.67 (Susceptible) and PDI= 51.66 (Highly susceptible) to leaf spot and leaf blotch disease respectively. Highest germination (81.67 %), less height (109 cm), maximum number of tillers/ plant (4.0), maximum number of leaves/ tiller (8.0) and minimum days to maturity (203) were recorded in case of germplasm NDH-40, NDH-74, RH-410, NDH-10 and RH-7 respectively.

At Kumarganj, minimum leaf blotch severity was recorded in TCP-161 (31.30 %) followed by NDH-74 (31.70 %) and NDH-40 (34.03 %). The leaf spot severity was lowest in CL-34 (27.40 %) followed by TCP-129 (28.10 %) and TCP-161 (31.80 %). Maximum fresh weight of rhizome was recorded in NDH-74 (40.66 t ha⁻¹) in comparison to RH 406 (37.11 t ha⁻¹), NDH-40 (36.10 t ha⁻¹) and TCP-14 (35.55 t ha⁻¹).

At Pundibari, TCP 129 recorded lowest leaf blotch (PDI 12.78) and leaf spot (PDI 7.26) disease severity among the 11 germplasm tested including the local check. TCP 14 produced the second lowest leaf blotch disease severity (PDI 13.47) and CL 52



Fig. 15: Field view of evaluation of turmeric lines against foliar diseases at a. Dholi and b. Coimbatore



Fig. 16: Leaf spot and leaf blotch tolerant line TCP-129 at Pundibari

produced second lowest leaf spot disease severity (PDI 8.76). The highest leaf blotch disease severity (PDI 37.39) was recorded by RH 406 closely followed by RH 407 (PDI 37.16) whereas the highest leaf spot disease severity (PDI 36.38) was recorded by RH 410. TCP 129 produced 46.48 % and 70.03 % less leaf blotch and leaf spot disease over local check respectively. Overall 4 germplasm produced lower leaf blotch disease severity and 7 germplasm produced lower leaf spot disease severity than local check (TCP 2). The highest yield of 14.34 kg plot⁻¹ (28.91 t ha⁻¹) was obtained by TCP 129 which is followed by TCP 14 with 11.59 kg plot⁻¹ (23.37 t ha⁻¹) and CL 34 with a yield of 9.30 kg plot⁻¹ (18.75 t ha⁻¹).

TUR/CP/7.5 Eco-friendly management of foliar disease of turmeric

(Centre: Middle Gangetic Plain Region - Kumarganj)

Minimum leaf blotch incidence was observed in foliar spray of Argimone oil @ 1.0% (25.07 %) followed by Mahuwa oil (28.7 %) and Jatropha oil (32.6%). Argimone oil treatment was *at par* with Propiconazole. Leaf spot

incidence was highest in control (74.2 %) and lowest in Propiconazole (17.3 %). Highest fresh yield of rhizome was recorded in the spray with Jatropha oil (18.0 t ha⁻¹) followed by Argimone oil (17.81 t ha⁻¹) and neem oil (17.20 t ha⁻¹) spray.

TUR/CP/7.6 Field screening of different varieties of turmeric against leaf spot and rhizome rot

(Centre: Western plateau and hills region – Dapoli)

Out of 30 varieties screened against leaf spot (*Colletotrichum capsici*), variety Krishna was found resistant (R) and 23 varieties recorded as moderately resistant (MR). Whereas, six varieties *viz.*, Roma (31.83 %), BSR-2 (30.83 %), Kanti (27.50 %), Alleppy Supreme (27.83 %), Arunachal Local (25.67 %) and Jalpalguri Local (26.67 %) were found to be susceptible to leaf spot.

Two varieties *viz.*, Krishna and Alleppy Supreme were resistant (R) to rhizome rot with PDI (4.67 % and 4.33 % respectively). Remaining 28 were found moderately resistant (MR).

VI. Tree Spices

Genetic Resources

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

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

Tree spices *viz.*, clove, nutmeg, cinnamon and cassia germplasm maintained at various AICRPS centres (Table 13)

a. Nutmeg

Among the germplasm maintained at Dapoli, average number of fruits for four years ranged from 73-226. The genotype DBSKKVMF 28 (226), DBSKKVMF 24 (172), DBSKKVMF 19 (163) recorded higher average number of fruits per tree. The genotype DBSKKVMF 24 recorded maximum dry nut yield (1464.0 g) and dry mace yield (320.25 g) in year 2015 – 16. Average dry nut yield (1376.0 g) and dry mace yield (288.0g) was recorded in genotype DBSKKVMF 28 from 2006 to 2015. The genotype DBSKKVMF 29 is found promising considering its fruit weight, nut weight and mace weight.



Fig. 17: Variability in fruits of nutmeg accessions maintained at Pechiparai

At Pechiparai, MF- 4 recorded maximum number of fruits (1150 fruits /tree) and single fruit weight (108.0 g) and the mace yield (440.50 g tree⁻¹). Local check recorded 128.0 fruits /tree and single fruit weight (69.25 g tree⁻¹) and the mace yield (125.50 g tree⁻¹).

b. Clove

Among the germplasm of clove at Dapoli, four promising genotypes were selected. The plant height varied from 4.73 to 7.4 m., girth ranged from 32.30 to 37.5 cm and spread varied from 3.70 m to 5.30 m. However the yield of fresh clove is 105 g plant⁻¹ recorded in selection DBSKKVSA - 3.

Among the 24 accessions, maintained at Pechiparai, SA-1 recorded the highest tree height of 9.53 m, followed by SA-2 (9.20 m) compared with local check (7.30 m). The accession SA-13 was significantly superior to other accessions and recorded highest stem girth (41.50 cm) compared with local check (30.00 cm). The accession SA-3 recorded the highest leaf length (16.50 cm), leaf breadth (6.20 cm) and dry bud yield (5.50 kg tree⁻¹). The local check recorded dry bud yield of 3.00 kg tree⁻¹.



Fig. 18: Promising clove accession SA 3 at Pechiparai

Table 13: Tree spices germplasm collection at AICRPS centres

Crop/Centre	Indigenous		Total
	Cultivated		
	Existing	Addition (2015 -16)	
<i>Clove</i>			
Dapoli	2	-	02
Pechiparai	27	-	27
Yercaud	01	-	01
Total	30		30
<i>Nutmeg</i>			
Dapoli	94	-	94
Pechiparai	28	-	28
Total	122		122
<i>Cinnamon</i>			
Dapoli	11	-	11
Pechiparai	14	-	14
Yercaud	02	-	02
Total	27		27
<i>Cassia</i>			
Dapoli	6	-	6
Pechiparai	4	-	4
Total	10		10

c. Cinnamon

At Pechiparai, CV-5 recorded maximum plant height (6.69 m), stem girth (29.10 cm), leaf yield (8.90 kg plant⁻¹) and dry bark yield (625.00 g plant⁻¹) and local check recorded plant height (5.40 m), stem girth (21.80 cm), leaf yield (7.40 kg plant⁻¹) and dry bark yield (282.50 g plant⁻¹).

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

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

Unique accessions of nutmeg were identified from Pathanamthitta, Kottayam, Ernakulam, Thrissur, Malappuram, Palakkad and Kozhikode of Kerala by Thrissur centre. Uniqueness with respect to tree shape, branching pattern, leaf size, sex form, fruit ,mace and kernel characters, yield , reaction to biotic and abiotic stress were looked into. Observations were recorded from the trees. Flower and fruit characters and yield were recorded in the peak season. Quality of pericarp, mace and kernel were assessed and oil, oleoresin and butter content estimated. GC-MS profiling of the essential oil was carried out in some of the accessions. Fourteen new accessions have been identified from Kerala during this year.



Fig. 19: Yellow maced nutmeg accession Acc. 16

Crop Improvement

TSP/CI/2 Coordinated Varietal Trial

TSP/CI/2.2 CVT 2001-Nutmeg

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

No significant variation was observed for all parameters except number of branches at Dapoli. The plant height ranged from 1.70 to 2.67 m, the girth from 16.67 to 24.65 cm and the tree spread varied from 1.00 – 2.20 m. Some of the grafts are started bearing.

At Pechiparai A9/150 has recorded the highest plant height (5.10 m), stem girth (26.50cm), number of branches (24.50) and number of fruits/tree (64.0) compared with local check which has a plant height of 3.25 m stem girth of 21.15cm, number of branches (8.80) and number of fruits (48 fruits / tree)

TSP/CI/2.3 CVT-2001-Cassia

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

At Dapoli, no significant difference was observed in plant height, girth and number of branches. The genotype KKVCTSH₂ recorded higher girth (48.21 cm) followed by KKVCTSH₁ (43.63 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. The accession D₅ recorded highest leaf area 98.64 cm².

At Pechiparai centre, The accession D3 recorded the maximum plant height (7.70 m), stem girth (45.00 cm), leaf yield (420.50 g tree⁻¹) and bark yield (258.50 g tree⁻¹) whereas the local check recorded the plant height (4.35 m), stem girth (26.10 m), leaf yield (310.10 g tree⁻¹) and bark yield (225.00 g tree⁻¹).

Table 14: Performance of nutmeg accessions at Pechiparai

Accessions	Plant height (m)	Stem girth (cm)	No. of branches	No. of fruits per tree
A9/4	4.50	24.50	8.58	25.0
A9/20	2.80	23.40	17.50	38.0
A9/25	3.95	22.10	16.50	32.0
A9/71	3.70	24.00	16.75	42.0
A9/150	5.10	26.50	24.50	64.0
M.L.	3.90	15.50	10.50	31.0
Local check	3.25	21.15	8.80	48.0
SEd	0.39	0.91	4.10	4.95
CD(p=0.05)	0.68	1.52	6.95	9.25

VII. Coriander

Genetic Resources

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

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

Coriander germplasm collected and conserved at different AICRPS centres (Table 15)



Fig. 20: Maintaining purity of coriander germplasm at Jobner

Out of the 276 germplasm accessions maintained at Coimbatore, 42 genotypes were selected based on genetic divergence, yield and quality characters and evaluated during 2015-16. Plant height at harvest varied significantly from 43.50 cm to 70.20 cm with a mean value of 57.83 cm. The genotype CS

144 recorded the highest plant height of 70.20 cm, which was *on par* with the genotype CS 210 (69.90 cm). The genotype CS 230 registered the lowest plant height (30.10 cm). The number of umbels per plant varied from 10.70 to 22.30 with an overall mean of 16.98. The lowest seed yield of 1.97 g per plant was recorded in CS 144. The seed yield per plot (1 m²) ranged from 49.25 to 120.00 g. Out of 42 collections evaluated, 18 genotypes recorded the maximum yield than the mean yield (72.08 g plot⁻¹). The estimated seed yield per hectare varied from 3.94 q to 9.60 q with a mean of 5.76 q. The genotype CS 134 recorded the highest seed yield of 9.60 q ha⁻¹ followed by the genotypes CS 244 (8.60 q) and CS 57 (8.00 q) respectively.

Out of one hundred fifty six accessions maintained at Dholi, seventeen accessions namely-RD-399, RD-423, RD-401, RD-425, RD-404, RD-434, DH-13, RD-415, RD-395, RD-426, LCC-133, DH-206, UD-308, GC-43, UD-284, UD-50 and Jco-115 recorded higher yield ranging from 60.99 to 43.53 g per five plants as compared to best check variety Pant Haritima (39.90 g per five plant). Among seventeen promising accessions, RD-399 gave the highest yield 60.99 g per five plant followed by RD-423 (60.32 g per five plants).

One hundred eighty six accessions of coriander were evaluated at Kumarganj. The highest yield was recorded in NDCor-11 (32.10 g plant⁻¹) followed by NDCor-32 (29.60 g plant⁻¹), NDCor-64 (28.70 g plant⁻¹), NDCor-22 (27.70 g plant⁻¹) and NDCor-4 (26.40 g plant⁻¹). The stem gall severity was observed minimum in NDCor-97 (5.0 %) and NDCor-98 (5.23 %) followed by NDCor-112 (15.25 %) and NDCor -109 (25.0 %).

Thirty five germplasm lines were evaluated in Augmented Block Design with six checks at Guntur. Among the entries evaluated, LCC-328 (1.31 g plant⁻¹), LCC-322 (1.06 g plant⁻¹), LCC-325 (1.06 g plant⁻¹), LCC-345 (1.04 g plant⁻¹), LCC-330 (1.03 g plant⁻¹), LCC-339 (0.99 g plant⁻¹), LCC-319 (0.98 g plant⁻¹), LCC-320 (0.98 g plant⁻¹) and LCC-341(0.94 g plant⁻¹) were identified as superior in yield over the best check Suguna (3.95 g plant⁻¹). The overall yield was low due to the severe drought prevailed since September.

At Hisar, 6 new collections of coriander were collected in this year and added to the germplasm. A total of 299 germplasm lines are maintained at the centre.

At Jagudan, 79 entries were evaluated with GCori-2 as checks for yield performance. The seed yield ranged from 3.12 to 17.96 g plant⁻¹. Among the tested genotypes 15 genotypes gave higher seed yield per plant than check GCori-2.

At Jobner, two hundred thirty seven (237) germplasm accessions were evaluated along with eight checks namely RCr-20, RCr-41, RCr-435, RCr-436, RCr-475, RCr-480, RCr-728 and local check. Out of 237 accessions, 29 accessions were better than best check variety RCr-435 (34.5 g) on the basis of seed yield per 5 plants. Promising accessions identified were UD-30 (62 g), UD-39 (57.6 g), UD-854 (57.5 g), UD-774 (51 g), UD-290 (50 g), UD-301 (50 g), UD-303 (49 g), UD-436-117 (48 g), UD-92 (111 g) and UD-123 (45.5 g).

Among 17 accessions tested at Raigarh, six entries recorded higher seed yield /plot over Rajendra swati (193.3), ICS 1 (183.3), Hisar Anand (166.7) and Gujarat 2 (130). ICS 5-2 (653.3 Kg), ICS 4 (491.7) and RCC 12-5 (446.7) ranked first, second and third respectively over national checks.

Screening of coriander germplasm against powdery mildew

Among the 276 coriander germplasm, 42 entries were screened for the incidence of

Table 15: Coriander germplasm collections at various AICRPS centres

Centres	Indigenous			Total
	Cultivated		Wild and related species	
	Existing	Addition 2015 -2016	Existing	
Coimbatore	275	-	-	275
Dholi	149	7	-	156
Guntur	350	-	-	350
Hisar	293	6	-	299
Jagudan	95	-	21 (Exotic)	116
Jobner	230	-	-	230
Kumarganj	170	-	-	170
Pantnagar	85	-	-	85
Total	1647	13	21	1681

powdery mildew at Coimbatore. The powdery mildew incidence was noticed in all the accessions with the PDI ranged from 44.30 PDI to 86.60 PDI. The accessions *viz.*, CS 134 recorded the lowest incidence of 44.30 PDI with the highest yield of 9.60 q ha⁻¹ followed by CS 57 (54.30 PDI), CS 170 and CS 244 (56.20 PDI) with a yield of 8.00 q, 8.60 q and 7.00 q ha⁻¹ respectively. The highest intensity of powdery mildew was recorded in CS 14, 91, 114, 185 and 221 (86.60 PDI) with the yield range of 4.00 to 6.00 q ha⁻¹.

Out of forty entries of coriander screened under natural condition, at Jagudan, none of the entry was found free from the powdery mildew incidence. The minimum disease intensity was noticed in JCr 390 (17.9 %). The maximum disease intensity was recorded in the entry JCr-2013-6 (75.5 %). The per cent disease intensity ranged between 17.9 and 75.5 per cent.

COR/CI/1.3 Identification of drought/alkalinity tolerant source in coriander

(Centres: Central plateau and hills region – Jobner)

The genotypes; UD 554, UD 627, UD 705, UD 461 and RCr 475 in normal conditions while UD 23, UD 705, UD 573, UD 747, RCr 20 and RCr 475 were top yielders in stress conditions. Based on stress indices RCr 20 was found to be the desirable entry for drought conditions, followed by UD 717, UD 747, UD 580 and UD 23.

COR/CI/1.4 Multilocation evaluation of germplasm in coriander - 2015

(Centres: Central plateau and hills region – Ajmer, Jobner; Southern plateau and hills region – Coimbatore; East coast plains and hill region – Guntur; Trans Gangetic Plain



Fig. 21: Field view of multilocation evaluation of coriander at Coimbatore

Region – Hisar; Middle Gangetic Plain Region – Kumarganj, Dholi; Gujarat plains and hills region – Jagudan; Western dry region – Kota; Eastern plateau and hills region - Raigarh)

Among the 30 genotype evaluated a wide range of variability was found for all the characters studied. Out of 30 accessions, 08 accessions were better than best check variety RCr-436 (20.5 g). Some of the promising accessions identified on the basis of yield per 5 plants were LCC-250 (29 g), LCC- 231 (25 g), LCC-234 (25 g), LCC-233 (24 g), LCC-241 (22 g), LCC-226, LCC-229 and LCC-247 (21 g).

A trial on multi-location evaluation of coriander genotypes was laid out at Coimbatore with 48 genotypes from six centres and four checks. The mean performance of the genotypes for plant height ranged from 30.10 cm to 73.23 cm. The highest number of umbels per plant was recorded in RCr 20 (31.00) which was on par with LCC 233 (30.67) and the lowest was recorded in the genotype AD 1 (11.00). The highest number of seeds per plant was recorded in the genotype LCC 229 (37.33) and the lowest was recorded in the genotype CS 273 (20.00). The seed yield varied from 3.50 to 9.00 q ha⁻¹ and the

maximum seed yield was recorded in the genotype LCC 168 (9.00 q ha⁻¹) which was on par with RCC-12-11 (8.93 q ha⁻¹) and better than the check variety Hisar Anand (7.73 q ha⁻¹).

At Guntur centre, forty germplasm lines from six centers were evaluated in Augmented Block Design with seven checks. Among the entries evaluated, RD-365 (1.24 g plant⁻¹), NDC-111 (1.16 g plant⁻¹), NDC-118 (1.10 g plant⁻¹), DH-283 (1.00 g plant⁻¹), DH-279 (1.00 g plant⁻¹) and RD-417 (1.00 g plant⁻¹) were found significantly superior in yield over the best check Suguna (0.84 g plant⁻¹).

Under multi location evaluation 58 entries were evaluated and promising entries were NDCar-94 (12.80 q ha⁻¹) followed by NDCar-90 (12.0 q ha⁻¹) and LCC-241 (12.35 q ha⁻¹) at Kumarganj.

Crop Improvement

COR/CI/2 Coordinated Varietal Trial

COR/CI/2.5 Coordinated Varietal Trial on coriander 2015 - IX series

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

Coordinated varietal trial of coriander was laid with 26 test entries and two check at Ajmer. The check RCr-728 gave 10.49 q ha⁻¹ seed yield. The test entry COR 110 gave the

highest seed yield followed by COR 111 and COR 109.

At Jabalpur, early flowering was noted in COR 101 (42.66 days). Maximum plant height was recorded in COR 112 (164.74 cm) and minimum (81.66 cm) in COR 99. Maximum number of branches (10.76) and yield (25.30 q ha⁻¹) was obtained with COR 118.

The trial was started in the year 2015-16 and is in the 1st year of progress at Jobner. The analysis of variance revealed significant differences among the entries for all the traits except umbellets/umbel. The seed yield ranged from 5.80 to 17.36 q ha⁻¹. Of the thirty entries evaluated, RCr-436 recorded maximum seed yield of 17.36 q ha⁻¹ followed by COR-110 (15.82 q ha⁻¹), COR-96 (15.53 q ha⁻¹), COR-95 (15.26 q ha⁻¹), COR-109 (14.61 q ha⁻¹) and COR-105 (14.21 q ha⁻¹), while lowest seed yield of 5.80 q ha⁻¹ was recorded in COR-102.

At Coimbatore the plant height of the genotypes ranged from 32.62 cm to 57.48 cm. The highest number of umbels per plant was recorded by the genotype COR 99 (22.89) followed by COR 120 (22.78) which were *on par* with check varieties CO (CR) 4 (23.44) and RCr 728 (22.89). The seed yield per hectare differed significantly among the 26 genotypes tested, which ranged from 3.40 q ha⁻¹ (COR 96) to 6.40 q ha⁻¹ (COR 106) with a mean of 4.21 q ha⁻¹. The genotype COR 106 has recorded significantly higher yield when compared with Co (CR) 4 (3.95 q ha⁻¹) - the local check and RCr-728 (3.50 q ha⁻¹) - the national check.

At Dholi, COR-114, COR-109, COR-98, and COR-112 recorded significantly more number of primary branches per plant (9.33, 8.93, 8.40 & 8.33 respectively) as compared to best check variety Rajendra Swati (7.27). However, COR-

118 recorded significantly higher number of umbels per plant (75.97) as compared to best check variety Rajendra Swati (65.53). While, COR-116, COR-108 and COR-112 recorded significantly more number of grains per umbellet (9.00, 8.27 & 7.60 respectively) as compared to best check variety Rajendra Swati (6.07). None of the entries were significantly superior as compared to best check variety Rajendra Swati. However, among the twenty seven entries, COR-116 gave the highest yield per plot (1.29 kg 6m²).

At Kumarganj total 29 entries were evaluated under CVT coriander. The promising entries were COR-119 (17.08 q ha⁻¹) followed by COR-98 (16.66 q ha⁻¹), COR-110 (16.04 q ha⁻¹), COR-11 (15.76 q ha⁻¹) and COR-114 (15.62 q ha⁻¹). The lowest stem gall severity was found in COR-97 (5.0 %) followed Rcr-729 (13.0 %), COR-112 (15.25 %), COR-109 (25.0 %) and COR-96 (20.5 %).

During *Rabi* season, twenty one genotypes of Coriander from different coordinating centers were tested with Rcr-728 and Suguna as checks at Guntur centre. Among the entries evaluated, COR-108 (11.91 q ha⁻¹), COR-107 (13.42 q ha⁻¹), COR-104 (11.42 q ha⁻¹), COR-106 (9.95 q ha⁻¹), COR-120 (9.73 q ha⁻¹) and COR-98 (9.63 q ha⁻¹) recorded significantly higher yields than all other entries including best check AD-1 (8.25 q ha⁻¹).

At Hisar, a significant difference was observed for all the parameters. Plant height ranged from 78.0 to 98.3, number of branches 5.2 to 7.3, umbels per plant 29.5 to 48.5 and seeds per umbel 22.8 to 41.5. Maximum seed yield (21.49 q ha⁻¹) was recorded in COR-114 followed by COR-115 (20.68 q ha⁻¹) and COR-116 (19.76 q ha⁻¹).

The yield differences among the entries were found significant at Jagudan. The entries

COR-95 (14.14 q ha⁻¹), COR-96 (13.89 q ha⁻¹) and COR-98 (13.87 q ha⁻¹) yielded significantly higher than best check GCr-2 (11.69 q ha⁻¹), which were 20.96, 18.82 and 18.65 per cent higher over best check GCr-2. These entries gave 81.97, 78.75 and 78.51 per cent higher yield over National check RCr-728, respectively.

Based on seed yield, COR-99 (15.09 q ha⁻¹), COR-100 (14.50 q ha⁻¹), COR-95 (14.35 q ha⁻¹) and COR-105 (13.95 q ha⁻¹) observed as promising genotypes at Navsari. COR-99 and COR-100 also recorded significantly early flowering compared to all national checks. These entries found promising for yield contributing traits like umbels per plant and umbellate per plant compared check varieties.

At Pantnagar, significant differences were observed for all the parameters. Maximum seed yield was recorded in Cor-118 (32.91 q ha⁻¹).

At Kota, maximum seed yield was recorded for COR 118 (16.88 q ha⁻¹) followed by COR 120 (16.35 q ha⁻¹). The national check (RCr – 728) recorded seed yield of 7.92 q ha⁻¹.

At Raigarh, it was observed that out of 26 entries evaluated COR 118 (10.77 q ha⁻¹) recorded higher grain yield followed by COR 115 (7.39 q ha⁻¹) and COR 110 (7.26 q ha⁻¹) over national checks Hisar Anand (7.24 q ha⁻¹) and ICS 1 (6.69 q ha⁻¹) while COR 121 and COR 114 recorded higher seed yield over check ICS 1.

COR/CI/3 Varietal Evaluation Trial

COR/CI/3.6 Initial Evaluation Trial in coriander

(Centres: Trans Gangetic Plain Region – Hisar, Central plateau and hills region - Jobner)

At Hisar the initial evaluation trial (IET) in coriander was conducted with ten accessions along with Hisar Anand as check during 2014-2015 and 2015-2016 in plots measuring 3.0 x 2.0 m. The results indicated that DH-208 and DH-312 gave significantly better yield over Hisar Anand (check) showing 22.6 and 19.4 % increase in yield, from two years mean respectively.

The trial was started in the year 2014-15 and is in 2nd year of progress at Jobner. In *Rabi* 2015-16, ten (10) entries were evaluated. The analysis of variance revealed significant differences among the entries for all the traits. The seed yield ranged from 5.92 to 13.33 q ha⁻¹. Of the ten entries evaluated, UD-808 recorded maximum seed yield of 13.33 q ha⁻¹ followed by UD-815 (12.29 q ha⁻¹), UD-814 (11.48 q ha⁻¹), UD-848 and RCr-435 (11.01 q ha⁻¹), while lowest seed yield of 5.92 q ha⁻¹ was recorded in UD-826.

Table 16: Performance of coriander germplasm under IET at Hisar and Jobner

Entries	Seeds yield (q ha ⁻¹) at Hisar	Entries	Seeds yield (q ha ⁻¹) at Jobner
DH-208	20.09	UD-808	13.33
DH-213	19.78	UD-814	11.48
DH-236	18.35	UD-815	12.29
DH-240	17.76	UD-826	5.92
DH-279	18.06	UD-835	8.26
DH-298	18.58	UD-848	11.01
DH-302	19.12	UD-851	10.46
DH-312	19.75	RCr-435	11.01
DH-315	19.06	RCr-436	10.50
Hisar Anand	16.57	RCr-728	10.18

COR/CI/3.8 Initial Evaluation Trial - 2015

(Centres: East coast plains and hill region – Guntur; Gujarat plains and hills region – Jagudan; Middle Gangetic Plain Region – Kumarganj; Middle Gangetic Plain Region – Dholi; Eastern plateau and hills region – Raigarh)

During 2015-16, ten promising coriander accessions from germplasm entries were tested at Guntur with APHU Dhania-1 and Suguna as checks. Among the ten entries tested, LCS-12-6 recorded highest yield of (8.95 q ha⁻¹) followed by LCS-12-9 (8.62 q ha⁻¹) and LCS-12-7 (8.37 q ha⁻¹) which were significantly superior to the best check Suguna (7.32 q ha⁻¹).

The entries tested under the trial were found significant differences for yield at Jagudan. The entries JCr-2013-16 (20.06 q ha⁻¹), JCr-2013-15 (18.93 q ha⁻¹) and JCr-2013-23 (18.25 q ha⁻¹) gave numerically higher seed yield over the check GCr-2 (17.55 q ha⁻¹), which was 14.30, 7.86 and 3.99 per cent higher than GCr-2, respectively.

At Kumarganj, 11 entries were selected for IET coriander. The highest yield was recorded in NDCor-110 (16.25 q ha⁻¹) followed by NDCor-102 (15.07 q ha⁻¹), NDCor-94 (14.65 q ha⁻¹) and NDCor-120 (13.02 q ha⁻¹). NDCor-97 and NDCor-98 were found stem gall resistant with 10 per cent disease severity.

At Dholi, Hisar Anand gave higher yield per plot (0.44 kg/3m²) as compared to check variety Rajendra Swati (0.40 kg/3m²). Among eight promising entries and two check varieties, RD-417 and RD-416 found significantly superior in yield as compared to best check variety Hisar Anand. However, between two best entries (RD-17 & RD-16), RD-417 recorded higher yield per plot (0.65 kg/3m²) followed by RD-416 (0.55 kg/3m²).

Crop Management

COR/CM/5 Nutrient management trial

COR/CM/5.6 Effect of different level of fertilizers with bio-fertilizer on coriander

(Centre: Middle Gangetic Plain Region - Dholi)

Among nine treatment and control, T₃- 100% N,P,K + Azospirillum, T₉- 100% N,P,K + PSB and T₆- 100% N,P,K + Azotobactor were produced significantly more number of primary branches per plant (8.10, 7.73 and 7.33, respectively), number of secondary branches per plant (40.80, 33.42 and 33.40, respectively), number of umbels per plant (71.33, 57.87 and 50.27, respectively), number of grains per umbel (52.80, 38.40 and 37.93, respectively) and yield per plot (1.31, 1.25 and 1.14kg 6m⁻², respectively) as compared to control T₁₀: 100% N,P,K *i.e.*, number of primary and secondary branches per plant (7.13 and 20.60), number of umbels per plant (34.93), number of grains per umbel (32.33) and yield per plot (0.90kg 6m⁻²). Among the treatments, T₃- 100% N,P,K + Azospirillum was produced the highest number of primary branches per

plant (8.10), number of secondary branches per plant (40.80), number of umbels per plant (71.33), number of grains per umbel (52.80) and yield per plot (1.31 kg 6m⁻²) or yield per hectare (21.83 q) followed by T₉- 50% N,P,K + PSB regarding primary branches per plant (7.73), number of umbels per plant (57.87), number of grains per umbel (38.40) and yield per plot (1.25kg 6m⁻²) or yield per hectare (20.88 q).

COR/CM/5.7 Standardization of drip irrigation and fertigation in coriander

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

Drip fertigation significantly increased the plant height, umbels/ plant, umbellets /umbel, seeds per umbel, test weight, seed yield and water use efficiency of coriander as compared to surface irrigation with conventional fertilization at Jobner. The drip fertigation at 0.8 IW/CPE ratio recorded significantly higher plant height (106.47 cm), umbels/plant (28.65), umbellets/umbel (5.74), seeds/umbel (48.71), test weight (13.36 g), seed yield (21.37 q ha⁻¹)

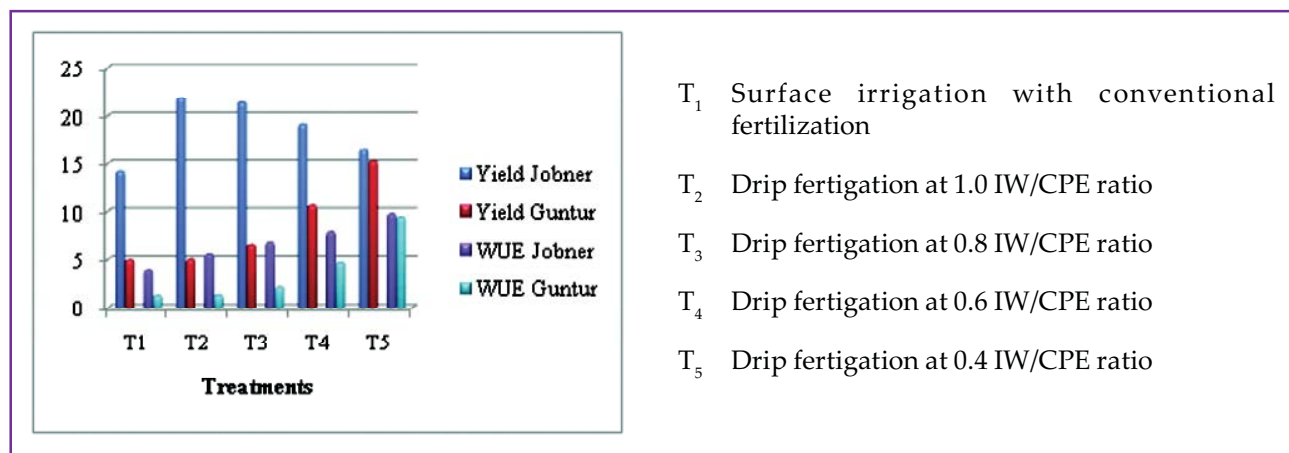


Fig. 22: Yield (t ha⁻¹) and Water Use Efficiency (WUE) (kg ha mm⁻¹) influenced by different drip fertigation levels

and water use efficiency (6.71 kg/ha mm⁻¹). However it remained *at par* to drip fertigation at 1.0 IW/CPE ratio.

Five treatments of drip irrigation were given in coriander at Kumarganj. The highest yield was observed in drip fertigation at 1.6 IW/CPE ratio (20.03 g plant⁻¹) followed by drip fertigation at 1.4 IW/CPE ratio (18.23 g plant⁻¹), drip fertigation at 1.0 IW/CPE (cumulative per evaporation) ratio (16.03 g plant⁻¹) and drip fertigation at 0.8 IW/CPE ratio (13.93 g plant⁻¹).

At Guntur, five irrigation treatments were evaluated. The total potential evapo transpiration was 379 mm during the crop period. Irrigation treatments were fixed month wise for 1, 0.8, 0.6, 0.4 IW/CPE and surface irrigation as check. Highest yield was recorded in T₄-0.4 IW/CPE (15.25 q ha⁻¹) and was significantly superior over all other treatments and control. The Water Use Efficiency was also maximum (9.39 kg ha mm⁻¹) in this treatment. The lower yields recorded at other IW/CPE levels were due to partial anoxic conditions that had prevailed in the plots which caused mortality of plants.

Crop Protection

COR/CP/6 Disease Management Trial

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

(Centre: Middle Gangetic Plain Region - Dholi)

Out of 156 germplasm, 8 accessions *viz.*, RD-395, RD-434, RD-407, RD-412, RD-417, DH-205, UD-687 and Pant Haritima were found Highly Resistant against stem gall disease under natural condition. Susceptible check

(Rajendra Swati) also showed Highly Resistant reaction against stem gall disease under natural condition. Coriander field surveyed under Darbhanga districts of state were found to be infested with stem gall disease caused by *Protomyces macrosporus*.

COR/CP/6.4 Management of coriander powdery mildew using new generation fungicides

(Centres: Southern plateau and hills region - Coimbatore; Central plateau and hills region - Jobner; Gujarat plains and hills region - Jagudan, Middle Gangetic Plain Region - Kumarganj; Eastern plateau and hills region - Raigarh)

A field trial was laid out during 2015-16 at Coimbatore to test the efficacy of different new generation fungicides for the management of coriander powdery mildew. Among the six fungicides tested, propiconazole effectively controlled the powdery mildew incidence. The disease incidence in propiconazole sprayed plants was (4.26 PDI) followed by tebuconazole (7.60 PDI), while in control the incidence was 83.20 PDI. The plant height was 51.3 cm in propiconazole sprayed plants. This treatment recorded the highest seed yield of 8.85 q ha⁻¹ as compared to control (7.21 q ha⁻¹).

An experiment on efficacy of new generation fungicides against powdery mildew of coriander was conducted at Jobner. Out of seven treatments, minimum (13.33 %) disease intensity and maximum seed yield of 15.31 q ha⁻¹ was recorded with foliar spray of Hexaconazole 5% SC @ 0.1%. It was statistically at par with foliar spray of Propiconazole 25% EC @ 0.1% where 16.67 per cent disease intensity and 15.048 q ha⁻¹ seed yield was observed. Maximum (68.33 %) seed yield was observed.

disease intensity and minimum seed yield (10.13 q ha⁻¹) was recorded under the untreated control.

There was significant difference in per cent disease intensity at Jagudan. The minimum disease intensity was observed in T₅ i.e. spraying of Hexaconazole 0.1% and was at par with T₆ i.e. Spraying of Propiconazole 0.1%, T₄ i.e. spraying of wettable sulphur 0.2% and T₁ i.e. Spraying of Tebuconazole 0.1%. Effect of different treatments on coriander yield was found significant. Spraying of various fungicides was at par and recorded significantly higher yield than control. However highest yield was recorded in T₅ i.e. spraying of Hexaconazole 0.1% followed by T₆ i.e. Spraying of Propiconazole 0.1% and T₄ i.e. spraying of wettable sulphur 0.2%.

Six fungicides were evaluated against powdery mildew of coriander at Kumarganj. The minimum per cent severity was observed in foliar spray of Azoxystrobin 0.1 % (40.8 %) followed by foliar spray of Tebuconazole 0.1% (41.5 %), foliar spray of Propineb 0.2% (42.5 %) and foliar spray of Propiconazole 0.1% (43.8 %). Whereas the highest yield was recorded in foliar spray of Tebuconazole 0.1 % (5.73 q ha⁻¹) and minimum in control (3.82 q ha⁻¹).

Minimum disease intensity 4.5 per cent and maximum yield was found in the treatment foliar spray of wettable sulphur 0.2% at Raigarh.

COR/CP/6.5 Eco-friendly management of stem gall of coriander

(Centres: Middle Gangetic Plain Region – Kumarganj)

The nine treatment were tested for the management of stem gall of coriander during 2015-16. The most effective treatment was Soil solarization by polythene covering (60 days) + Plastic mulching (From sowing to harvest) + Seed treatment and three foliar spray at 45, 60 and 90 days with 1.0 % neem oil (21.3 PDS) followed by Seed treatment with propiconazole @0.2% (22.5 PDS) and Soil solarization by polythene sheet (60 days) + Plastic mulching (From sowing to harvest) 22.8 PDS). In case of yield, maximum yield was recorded in Soil solarization by polythene sheet (60 days) + Seed treatment and three foliar spray at 45, 60 and 90 days with 1.0% neem oil (11.7 q ha⁻¹) followed by Soil solarization by polythene sheet (60 days) + Plastic mulching (From sowing to harvest) (10.06 q ha⁻¹), Soil solarization by polythene sheet (60 days) + Plastic mulching (From sowing to harvest) + Seed treatment and three foliar spray at 45,60 and 90 days with 1.0% neem oil (9.02 q ha⁻¹) and Seed treatment with propiconazole @ 0.2% (8.68 q ha⁻¹).

COR/CP/6.6 Integrated management of stem gall disease of coriander

(Centre: Middle Gangetic Plain Region - Dholi)

Lowest disease (PDI=13.89) and highest yield (19.70 q ha⁻¹) was recorded in treatment where soil application with *Trichoderma* sp. @ 10 kg ha⁻¹ followed by foliar spray with Azoxystrobin + Tebuconazole @ 0.1% at 45, 60 & 75 DAS and in treatment where soil application with *Trichoderma* sp. @ 10 kg ha⁻¹ along with seed treatment with carboxin + thiram @ 0.40%.

VIII. Cumin

Genetic Resources

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

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

Germplasm of cumin conserved at Jagudan, Jobner, Sanand and Mandor (Table 17)

During this year 214 entries of cumin germplasm were sown for seed multiplication and conservation at Jagudan. The seeds of each entry were collected for conservation.

In this trial 646 germplasm lines obtained from NRCSS, Ajmer and available at Mandor were sown for evaluation and maintenance. Due to very poor germination and plant stand the trial was vitiated. Although seed for many lines were saved for next year sowing.

Screening for resistance against *Alternaria* blight disease

Total eighteen (15+3) entries of cumin were screened for the resistance against blight disease at Jagudan. The minimum disease intensity was noticed in GC-3 (5.7 %) followed by GC-4 (10.1 %), while the maximum disease

intensity was recorded in the entry CUM-30 (59.9 %). The blight disease incidence ranged from 5.7 to 59.9 per cent.

Screening for resistance against powdery mildew disease

At Jagudan, eighteen (15+3) entries of cumin were screened for the resistance against powdery mildew disease. The minimum disease intensity was noticed in JC-2010-1 (3.5 %), while the maximum disease intensity was recorded in the entry CUM-26 (10.2 %). The powdery mildew incidence ranged from 3.5 to 10.2 per cent.

Screening for resistance against wilt disease

Total forty eight (45+3) entries of cumin were screened for the resistance against wilt disease at Jagudan under wilt sick plot conditions. Overall wilt incidence was very high. The minimum disease intensity was noticed in GC-4 (41.75 %) and it was followed by GC-3 (48.5 %). The wilt disease incidence ranged from 41.75 to 100.00 per cent.

CUM/CI/1.3 Identification of drought tolerance

(Centre: Central plateau and hills region - Jobner)

An experiment was conducted during *Rabi* 2015-16 to identify drought tolerance in cumin. 30 genotypes were randomly selected from the germplasm being maintained at Jobner. The genotypes; UC 238, UC 242, UC 243, UC 292, UC 256 and UC 339 in normal conditions while UC 292, UC 242, UC 243, UC 260, UC 255 and UC 256 in stress conditions were top yielders. Based on stress indices UC

Table 17: Cumin germplasm collections at various AICRPS centres

Centre	Indigenous	Exotic	Total
Jagudan	207	7	214
Jobner	70	6	76
Sanand	50	-	50
Total	327	13	340

260 was found to be the desirable entry for drought conditions, followed by UC 250, UC 336, UC 292, UC 253 and UC 234.

Three years data of cumin indicated that the genotypes UC 238, UC 339, UC 293, RZ 223 and RZ 209 in normal while UC 250, UC 245, UC 292, UC 247 and UC 257 in stress conditions were top yielders. Based on stress indices UC 250 was found to be the desirable entry for drought conditions, followed by UC 247, UC 257 and UC 240.

Crop Improvement

CUM/CI/2 Coordinated Varietal Trial

CUM/CI/2.4 Coordinated Varietal Trial – 2013

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

This trial is started in the year 2013-14 and is in the 3rd year of progress.

At Ajmer total six entries along with two check varieties RZ-209 and GC-4 were tested in the *rabi* season 2015-16. The trial was laid down in RBD with three replication with plot size 2.4 x 4 mt sq, sowing was done on 17th Nov, 2015, germination of the entries was good, but in the vegetative and plant stand reduced significantly by the incidence of wilt + root rot. During the later stage blight incidence damaged the crop severely. The data on yield could not be recorded. Hence the trial may be treated as failed at the centre.

The trial was considered as vitiated at Jagudan as the seeds of the entries CUM-30 and CUM-31 were not germinated and the

entries CUM-28 and CUM-29 had poor seed germination.

The trial was failed during this year at Jobner as most of the entries were highly susceptible to wilt and blight and observed very poor yield. The trial is to be continued.

CUM/CI/3 Varietal Evaluation Trial

CUM/CI/3.4 IET on Cumin 2012

(Centre: Central plateau and hills region – Jobner)

The trial was started at Jobner, in the year 2013-14 and is in the 3rd year of progress. During *rabi* season of this year, ten (10) entries were evaluated. The analysis of variance revealed significant differences among the entries for all the traits except branches/plant. The seed yield ranged from 0.96 to 2.83 q ha⁻¹. Of the ten entries evaluated, JC-95-136 recorded maximum seed yield of 2.83 q ha⁻¹ followed by local check (2.64 q ha⁻¹), UC-265 (2.33 q ha⁻¹), JC-95-7 (2.25 q ha⁻¹) and UC-260 (2.21 q ha⁻¹), while lowest seed yield of 0.96 q ha⁻¹ was recorded in RZ-19.

CUM/CI/3.5 Initial Evaluation Trial 2013

(Centres: Gujarat plains and hills region – Jagudan)

At Jagudan, ten genotypes of cumin were evaluated with national check GC-4. The yield differences were found significant among entries. But none of the entry found significantly superior over check. However, the entries JC-95-119 (6.62 q ha⁻¹), JC-2000-28 (6.30 q ha⁻¹) and JC-2010-1 (6.20 q ha⁻¹) gave higher yield than the check GC-4 (5.99 q ha⁻¹), which were 10.52, 5.18 and 3.51 per cent higher than GC-4, respectively.

Project Mode Scheme

Performance evaluation of Cumin genotypes for Tamil Nadu conditions

(Centre: Periyakulam)

The evaluation of cumin genotypes at Ramanathapuram had revealed that early germination (10 days) was registered by the genotype GC3, and it also recorded earliness *i.e.* days to first flowering as 102 days after sowing followed by RZ-209 as 105 days. The highest grain yield per plant was recorded by GC3 and RZ-209 as 1.52g, with estimated grain yield of 1.52 q ha⁻¹.

Similarly under Sivagangai conditions the highest grain yield per plant was registered by the genotype GC3 (0.76 g) and RZ-209 (0.76 g) followed by RZ-341 (0.75 g).

Under Periyakulam conditions the highest grain yield per plant was recorded by the genotype RZ-209 (1.49 g) followed by RZ-345 (1.48 g) and GC3 (1.48 g).

Crop Management

CUM/CM/5 Nutrient Management Trial

CUM/CM/5.2 Organic nutrient and disease management in cumin

(Centre: Central plateau and hills region - Jobner)

The experiment has been failed due to severe attack of blight and wilt disease.

CUM/CM/5.3 Response of sulphur and bio regulators on yield and quality of cumin

(Centre: Central plateau and hills region - Mandor)

The experiment was conducted at Agriculture Research Station, Mandor (Agriculture University, Jodhpur) to find out the effect of sulphur and bio-regulators on seed yield and quality of cumin during three consecutive seasons of 2013-14, 2014-15 and 2015-16. Pooled data revealed that application of sulphur @ 45 kg ha⁻¹ significantly increased the seed yield over control, 15 & 30 kg S/ha by 23.95 %, 16.34 % and 5.02 %, respectively and foliar application of bio-regulators at vegetative and flowering stage recorded significantly higher seed yield of cumin over the control (water sprays). Whereas among the bio-regulators foliar application of TGA @ 100 ppm at vegetative and flowering stage recorded significantly higher seed yield of cumin by 11.44 % over the control (water sprays). The highest net return and benefit: cost ratio (Rs. 93,250 and 3.32) was observed in application of sulphur @ 45 kg/ha. Similarly application of TGA @ 100 ppm at vegetative and flowering stage recorded maximum net return of Rs. 86,120/ha with B: C ratio of 3.12.

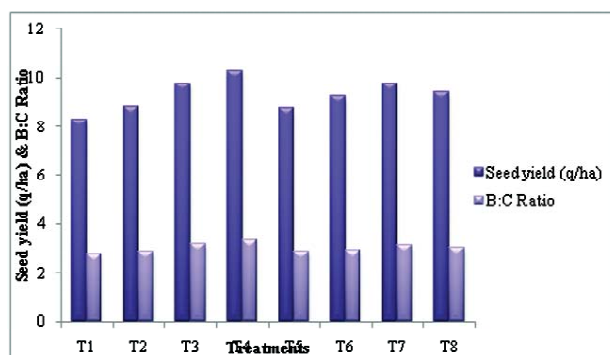


Fig. 23: Pooled data on seed yield (q ha⁻¹) and B: C ratio as influenced by sulphur and bio regulators

Note: Treatments

T₁ - Control (No Sulphur application)

T₂ - S-15 kg/ha

T₃ - S-30 kg/ha

T₄ - S-45 kg/ha

T₅ - Water spray at vegetative & flowering stage

T₆ - Foliar spray of Ascorbic acid (100 ppm) at vegetative & flowering stage

T₇ - Foliar spray TGA (100 ppm) at vegetative & flowering stage

T₈ - Foliar spray Salicylic acid (100ppm) at vegetative & flowering stage

Crop Protection

CUM/CP/6 Disease Management Trial

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

(Centre: Gujarat plains and hills region - Jagudan)

The crop sown by line sowing either 30 cm or 45 cm revealed its superiority over broadcasting method with respect to increase in overall yield and reduced intensity of blight disease. The powdery mildew intensity was reported low during the season and it was ranged from 15.58 to 18.92 per cent. The difference was non-significant among different treatments. The application of potash at the rate of 10 kg or 20 kg reduced the intensity of blight and powdery mildew and increased the yield. The interaction effect of spacing and potash levels found to be non-significant.

CUM/CP/6.6 Bio-efficacy of newer molecules of insecticides against cumin aphid

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

The trial undertaken at Jagudan revealed that the aphid infestation on umbels differs significantly among different treatments. Thiamethoxam 25WG @ 25g a.i/ha followed by thiacloprid 21.7 SC @ 25g a.i/ha had registered the least (3.34%) umbels aphid infestation at 7days after second spray. The plots sprayed with thiamethoxam 25WG @ 25g a.i/ha followed by clothianidin 50WDG @ 20g a.i/ha had registered 6.66 per cent aphid infestation at 7days after second spray but it was statistically at par with the treatment of acetamiprid 20SP @ 20g a.i/ha followed by thiacloprid 21.7SC @ 25g a.i./ha (7.69%). Non-protected plots of cumin had exhibited the highest (37.63%) per cent umbels aphid infestation at 7days after second spray.

Mean population of coccinellids varied significantly among different treatments. However, mean population of predatory coccinellids varied from 1.82 (acetamiprid 20SP @ 20g a.i/ha followed by clothianidin 50WDG @ 20g a.i./ ha) to 3.06 per plant (untreated control; carbosulfan 25 EC @ 250g a.i. /ha followed by *verticillium lecanii* 1.15 WP @ 40 g/10lit.

At Jobner experiment has been failed due to severe attack of blight and wilt disease.

CUM/CP/6.7 Management of powdery mildew in cumin through new chemicals

(Centre: Central plateau and hills region – Jobner)

The experiment has been failed due to severe attack of blight and wilt disease.

IX. Fennel

Genetic Resources

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

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

Table 18 shows the germplasm collection and maintained at various AICRPS centres

Out of sixty accessions evaluated at Dholi, fifteen accessions namely- RF-66 (IC-0598507), RF-27 (0598490), RF-38 (IC-0598501), RF-71, RF-69 (IC-0598496), RF-74, RF-13 (IC-0598510), RF-21 (IC-0598511), RF-29 (IC-0598506), RF-28 (IC-059493), RF-18 (IC-0598500), RF-61 (IC-0598514), RF-62 (IC-0598504), RF-10 (IC0598512) and RF-15 gave the highest yield ranging from 72.19 to 54.62 g per plant as compared to the best check variety GF-2 (50.10 g). Among the fifteen promising

accessions, RF-66 produced the highest yield 72.19 g per plant followed by RF-27 (69.72 g).

At Kumarganj, 156 germplasm of fennel were evaluated and recorded maximum yield in NDF-46 (58.52 g plant⁻¹) followed by NDF-51 (52.62 g plant⁻¹), NDF-5 (51.75 g plant⁻¹) and NDF-49.62 g plant⁻¹). Incidence of powdery mildew was recorded at the time of maturity. Hence yield is not affected by the disease.

At Hisar, the seed yield of the germplasm ranged from 32.8 g plant⁻¹ (HF-220) to 95.5 g plant⁻¹ (HF-150). The most promising lines were HF-113, HF-148, HF-150, HF-157, HF-167, HF-172, HF-175, HF-220, HF-221 and HF-231.

During the *Rabi* season, the 159 indigenous and 2 exotic entries of fennel were evaluated for different yield attributes with GF-12 as check at Jagudan. Among them nine entries were dwarf types, having less than 125 cm plant height. Eight entries had good branches *i.e.* more than 8 branches per plant. Thirteen entries recorded

Table 18: Germplasm collection of fennel in various AICRPS centres

Centre	Indigenous		Exotic	Total
	Cultivated			
	Existing	Addition (2015-16)	Existing	
Dholi	60	0	-	60
Guntur	2	-	-	2
Hisar	160	4	-	164
Jagudan	161	-	2	163
Jobner	137	-	-	137
Kumarganj	140	-	-	140
Pantnagar	21	-	-	21
Total	681	4	2	687

more than 27 umbellates per umbel. Ten entries observed early maturity (< 143 days). Fifteen entries isolated as high yielder recorded more than 30 g/ plant grain yield.

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

During *Kharif* season, total thirty eight (36 +2) entries of fennel were screened under natural conditions at Jagudan. None of the entry was found free from the *Ramularia* blight. The minimum intensity of *Ramularia* blight was noticed in Selection-49 (15.0 %) and it was followed by Selection-62 (15.2 %), Selection-35 (15.3 %), Selection-20 (15.4 %) and Selection-3 (15.5%). The per cent disease intensity was ranged between 15.0 and 35.4 per cent. Among the forty six (42+4) entries of fennel screened during *Rabi* season at Jagudan, none of the entry was found free from the *Ramularia* blight intensity. The minimum intensity of *Ramularia* blight was noticed in JF-671-4 (10.9 %) and it was followed by JF-2013-11 (11.2 %), JF-2013-28 (12.0 %), FNL-83 (12.1 %), FNL-86 (12.2%), FNL-80 (12.3 %) and JF-2012-6 (12.4 %). The per cent disease intensity ranged between 8.9 and 25.0 per cent.

Crop Improvement

FNL/CI/2 Coordinated Varietal Trial

FNL/CI/2.6 Coordinated Varietal Trial on Fennel 2015 Series – Series IX

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

Fifteen entries were evaluated at Ajmer during the *Rabi* season. The entry FNL 81 recorded

maximum seed yield of 30.48 q ha⁻¹ followed by check RF-205 (29.45q ha⁻¹).

Among the fifteen genotypes of fennel tested at Jabalpur, FNL 78 gave early flowering (93.66 days) with minimum number of umbel/ plant (14.89). Maximum plant height was noted in FNL 86 (163.08 cm) and it was minimum with FNL 77 (127.97cm). In terms of yield the check variety RF 205 recorded maximum yield (16.42 q ha⁻¹).

The analysis of variance revealed significant differences among the entries for all the traits at Jobner. The seed yield ranged from 29.29 to 5.74 q ha⁻¹. Of the seventeen entries evaluated, the entry RF-143 recorded maximum seed yield of 29.29 q ha⁻¹ followed by RF-101 (27.27 q ha⁻¹), RF-281 (26.51 q ha⁻¹), RF-205 (26.37 q ha⁻¹), FNL-82 (26.07 q ha⁻¹) and FNL-80 (25.46 q ha⁻¹), while lowest seed yield of 5.74 q ha⁻¹ was recorded in FNL-88.

Among thirteen entries and three check varieties tested at Dholi, FNL-88 and FNL-87 recorded significantly higher number of umbels per plant (93.83 & 92.17 respectively), number of umbellets per umbel (69.17 & 68.00 respectively) and number of grains per umbellet (47.33 & 47.16 respectively) as compared to best check variety Rajendra Saurabh. However, yield of RF-88 and RF-87 were not significant as compared to best check variety Rajendra Saurabh.

Out of 16 genotypes of fennel tested at Kumarganj under CVT, the highest yield was



Fig. 24: CVT fennel at Jobner

observed in FNL-86 (15.62 q ha⁻¹) as compared to FNL-84 (14.16 q ha⁻¹), FNL-78 (13.54 q ha⁻¹) and FNL-89 (13.33 q ha⁻¹).

At Hisar, significant differences were observed for all the parameters. Plant height ranged from 109.7 to 152.7, number of branches 7.2 to 9.9, umbels per plant 28.2 to 39.8, umbellate per umbel 23.2 to 30.6 and seeds per umbel 372.9 to 620.1 Maximum seed yield recorded was 20.91 q ha⁻¹ in FNL-84 followed by FNL-83 (20.33 q ha⁻¹) and FNL-88 (19.22 q ha⁻¹).

The yield differences among the entries were found significant at Jagudan. The entry FNL-77 (15.42 q ha⁻¹) produced significantly higher seed yield over two national check, RF 205 (13.62 q ha⁻¹) and RF 201 (12.64 q ha⁻¹) as well as local check GF 12 (13.38 q ha⁻¹) which were 13.31, 21.99 and 15.24 per cent higher, respectively.

The significant differences were observed for all the characters except umbellate per umbel at Pantnagar. Highest yield (25.87 q ha⁻¹) was recorded in FNL-87.

FNL/CI/3 Varietal Evaluation Trial

FNL/CI/3.4 Initial Evaluation Trial 2014

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

The trial is in the 2nd year of progress at Jobner. The analysis of variance revealed significant differences among the entries for all the traits. The seed yield ranged from 19.62 to 28.51 q ha⁻¹. Of the ten entries evaluated, UF-286 recorded maximum seed yield of 28.51 q ha⁻¹ followed by UF-287 (25.55 q ha⁻¹), RF-125 (25.00 q ha⁻¹) and UF-284 (24.96 q ha⁻¹) while lowest seed yield of 19.62 q ha⁻¹ was recorded in UF-285.

At Hisar, the initial evaluation trial (IET) in fennel was conducted with ten accessions along with HF-

33 as check. Maximum seed yield was recorded in HF-179 (21.17 q ha⁻¹) followed by HF-146 (19.70 q ha⁻¹) showing an increase of 29.9 and 20.9 % (over check), from two years mean respectively.

FNL/CI/3.5 Initial Evaluation Trial 2015

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

Ten entries were evaluated including check GF-12. The yield differences among the entries were found significant. An entry JF-2013-21 gave significantly higher yield (14.36 q ha⁻¹) followed by JF-2013-19 (13.86 q ha⁻¹) which were 15.05 and 11.04 per cent higher than check variety GF-12.

Ten genotypes of fennel including check were tested in IET. Maximum yield was recorded in

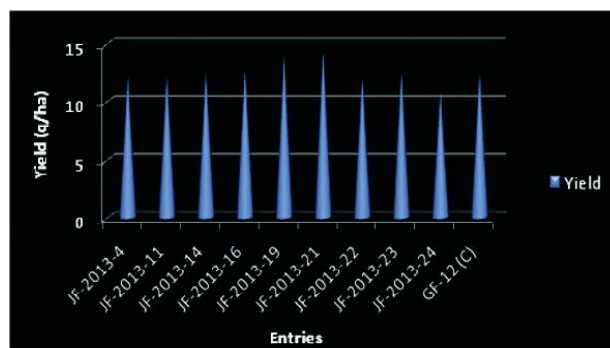


Fig. 25: Yield (q ha⁻¹) of fennel entries in IET at Jagudan

NDF-84 (15.20 q ha⁻¹) and minimum in NDF-74 (13.05 q ha⁻¹) in comparison to NDF-6 (ch) 12.43 q ha⁻¹.

Nine entries and two checks were tested. Between two checks, GF-11 was found superior as compared to other check variety Rajendra Saurabh regarding all the character except number of grain per umbellet. Among nine entries and two check variety, none of the entries were found significant superior regarding all the characters. But RF-55 gave more number of

primary branches per plant (11.00), number of umbels per plant (48.13), yield per plot (0.80 kg 5.4m²) and yield per hectare (14.81 q ha⁻¹) as compared to other entries and check varieties.

Crop Management

FNL/CM/5 Nutrient Management Trial

FNL/CM/5.4: Effect of ferrous and zinc enriched FYM on yield and quality of fennel

(Centres: Gujarat plains and hills region - Jagudan)

The seed yield of fennel was influenced significantly due to different micronutrient treatments at Jagudan. Among the different treatments, application of 3.0 kg Fe + 1.5 kg Zn/ha enriched with FYM @ 200 kg/ha along with recommended dose of fertilizer (T₈) produced significantly higher seed yield over rest of the treatments, but remained *at par* with treatments T₇: RDF (90 kg N + 30 kg P₂O₅/ha) + 200 kg FYM enriched with 1.5 kg Zn/ha and T₆: RDF + 200 kg FYM enriched with 3.0 kg Fe/ha. The lower seed yield of fennel was recorded with the treatment with recommended dose of fertilizer *i.e.* 90 + 30 kg NP/ha (T₁). The treatment T₈: RDF + 200 kg FYM enriched with 3.0 kg Fe/ha + 1.5 kg Zn/ha recorded higher plant height, number of umbels/plant, number of umbellates/umbel and number of seeds/umbellates during investigation period. The effect of different treatments on volatile oil content and test weight were found non-significant.

FNL/CM/5.5 Standardization of drip fertigation in fennel

(Centres: Central plateau and hills region - Jobner)

The experiment was conducted during Rabi 2015-16. The soil was loamy sand, low in organic carbon (0.23 %), available N (143.5 kg ha⁻¹), available P (8.8 kg ha⁻¹) and medium in available K (169.6 kg ha⁻¹) with alkaline (pH 8.1) in reaction having 1.48 Mg/m³ bulk density, 2.57 Mg/m³ particle density, 13.45 % field capacity and 4.13 % permanent wilting point at the beginning of the experiment. The ten treatments consisted of surface irrigation with conventional fertilization, drip irrigation with 50, 75 and 100% conventional fertilization and drip fertigation with 50, 75 and 100% recommended dose of nitrogen and recommended dose of fertilizers were evaluated. The results showed that drip irrigation as well as drip fertigation significantly increased the plant height, umbels/plant, umbellets/umbel, seeds per umbel, test weight, seed yield and water use efficiency of fennel as compared to surface irrigation with conventional fertilization. The drip fertigation with 75% RDF recorded significantly higher plant height (121.16 cm), umbels/plant (30.64), umbellets/umbel (25.08), seeds/umbel (411.1), test weight (6.07g), seed yield (25.80 q ha⁻¹) and water use efficiency (5.86 kg/ha-mm). However it remained *at par* to drip fertigation with 100% RDF and drip fertigation with 100% RDN.

X. Fenugreek

Genetic Resources

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

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

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



Fig. 26: Variability in germplasm of fenugreek at Jobner

One hundred seventy five accessions of fenugreek were maintained and evaluated at Dholi. Among the evaluated accessions, eighteen accessions namely- RM-206, RM-200, RM-201 (IC-590114), RM-191 (IC-590098), RM-199 (IC-590096), HM-144, RM-208, RM-198 (IC-590126), RM-205, J. Fenu-148, RM-189 (IC-590125), RM-203 (IC-590099), RM-196 (IC-590105), J. Fenu-270, J. Fenu- 102, RM-112, HM-10 and Sel. 37 gave the highest yield per

plot ranging from 1.30 to 1.06 kg 5.4m² as compared to best check variety Hisar Sonali (1.03 kg per 5.4m² plot). Among eighteen promising accessions, RM-206 was the topmost yielder with 1.3 kg per 5.4m² plot.

One hundred and ninety accessions of fenugreek were maintained and evaluated at Kumarganj. The highest yield was found in NDM-15 (4.6 g plant⁻¹) followed by NDM-17 (4.5 g plant⁻¹), NDM-45 (4.5 g plant⁻¹), NDM-76 (4.5 g plant⁻¹) and NDM-16 (4.3 g plant⁻¹). Data on incidence of *Cercospora* leaf spot was also recorded and found minimum disease intensity in NDM-7 (15.0 %) Followed by NDM-2 (17.5 %), NDM-6 (17.5 %), NDM-27 (18.2 %) and NDM-29 (18.9 %) in comparison to Hisar Sonali (42.5 %) and PGB-2 (40.0 %).

At Guntur 124 germplasm lines along with ten checks were evaluated in Augmented Block Design. Among the entries evaluated, only four entries i.e. LFC-51 (1.77 g plant⁻¹), LFC-74 (1.37 g plant⁻¹), LFC-66 (1.34 g plant⁻¹) and LFC-67 (1.33 g plant⁻¹) were significantly superior to the best check APHU Methi-1 (1.10 g plant⁻¹).

One hundred and ten germplasm accessions were evaluated at Jobner, along with nine checks namely RMt-1, RMt-305, RMt-365, RMt-361, RMt-354, RMt-303, RMt-351, RMt-143 and Local Check. Wide range of variability was found for all the characters studied. Out of 110 accessions, 18 accessions were better than best check variety RMt-361 (35 g.). Some of the promising accessions identified on the basis of grain yield per 5 plants were LFC-85 (58 g.), LFC-86 (53 g.), LFC-5, LFC-17, LFC-84, LFC-123 (41 g.), LFC-113 (39 g.), LFC-21 and LFC-32 (38 g.).

Table 19: Germplasm collection of fenugreek in various AICRPS centres

Centre	Indigenous		Total
	Existing	Addition (2015-16)	
Dholi	175	7	182
Guntur	124	-	124
Hisar	373	8	381
Jagudan	75	-	75
Jobner	348	-	348
Kumarganj	190	-	190
Pantnagar	65	-	65
Total	1350	15	1365

Screening of germplasm

Powdery mildew disease (Caused by: *Erysiphe polygoni* and *Leveillula taurica*)

Total ten (9+1) entries of fenugreek were screened under natural condition. None of the entry was found free from the powdery mildew incidence. The minimum incidence was noticed in JFg -80 (5.0 %), while the maximum per cent disease intensity was recorded in entry GM-2 (16.2 %). The per cent disease intensity was ranged between 5.0 and 16.2 per cent.

One hundred and twenty one entries of fenugreek were screened under this trial against powdery mildew disease. Thirty two entries viz., LFC-6, LFC-7, LFC-8, LFC-9, LFC-11, LFC-12, LFC-17, LFC-19, LFC-20, LFC-23, LFC-37, LFC-38, LFC-39, LFC-40, LFC-41, LFC-49, LFC-50, LFC-55, LFC-56, LFC-74, LFC-88, LFC-89, LFC-90, LFC-92, LFC-93, LFC-98, LFC-108, LFC-110, LFC-111, LFC-113, Hisar Sonali I and Hisar Sonali II were observed as moderately resistant against powdery mildew disease.

Crop Improvement

FGK/CI/2 Coordinated Varietal Trial

FGK/CI/2.4 Coordinated Varietal Trial 2015 Series IX

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

At Ajmer, highest yield was recorded in FGK 85 i.e. 21.33 q ha⁻¹ followed by FGK-86 i.e. 21.17 q ha⁻¹. The check variety RMt-361 gave 18.68 q ha⁻¹ seed yield.

At Jabalpur, early flowering was observed in RMt 361(40.0) days and it was maximum in FGK 92 (45.33 days). The plant height was maximum in FGK 80 (83.37) with minimum seed yield (16.70 q ha⁻¹). Maximum yield was recorded by RMt 361 (25.30 q ha⁻¹).

The analysis of variance revealed significant differences among the entries for all the traits except days to flowering at Jobner. The seed yield ranged from 3.19 to 22.91 q ha⁻¹. Of the eighteen entries evaluated, FGK-88 recorded maximum seed yield of 22.91 q ha⁻¹ followed by RMt-361 check (21.94 q ha⁻¹), FGK-79, FGK-86 (21.75 q ha⁻¹), FGK-83 (21.43 q ha⁻¹) and FGK-82 (20.74 q ha⁻¹), while lowest yield of 3.19 q ha⁻¹ was recorded in FGK-92. The entries FGK-79 and FGK-83 were observed as moderately resistant against powdery mildew disease.

At Coimbatore, the plant height varied from 36.10 cm (RMt 361) to 42.69 cm (FGK 82). The genotype FGK 93 (27.00) recorded maximum number of pods per plant and the genotype FGK 92 (17.11) recorded lowest number of pods per plant. Seed yield per plot (1 m²) varied from 33.99 g to 42.99 g with a mean of 37.85 g. The highest seed yield of 4.29 q ha⁻¹ was recorded by FGK 86 whereas the local check CO 2 and national check RMt-361 has recorded a seed yield of 3.39 q ha⁻¹ and 3.83 q ha⁻¹ respectively.

Among fifteen entries and two check varieties tested at Dholi, FGK-93, Hisar Sonali, FGK-84 and FGK-82 produced significantly higher number of pods per plant (133.76, 107.80, 93.33 and 90.27, respectively) as compared to best check variety Rajendra Kanti (73.80). FGK-80, FGK-82, FGK-83, FGK-84, FGK-88, FGK-89, Hisar Sonali, FGK-91 and FGK-145 recorded late maturity as compared to early maturing check variety Rajendra Kanti. Regarding yield, none of entries were found significantly superior as compared to best check variety Rajendra Kanti. However, FGK-93 and Hisar Sonali produced higher number of pods per plant (133.76 & 107.80), and yield per plot (1.83 & 1.83kg 6m²) or yield per hectare (30.55 & 30.50 q) as compared to other promising entries and check varieties.

At Kumarganj, maximum yield was recorded in FGK-82 (13.5 q ha⁻¹) followed by FGK-79 (12.49 q ha⁻¹), FGK-81 (12.14 q ha⁻¹), FGK-84 (12.01 q ha⁻¹) and FGK-80 (11.80 q ha⁻¹). During the year, only *Cercospora* leaf spot incidence was observed and minimum disease intensity was recorded in FGK-92 (3.8 %) followed by FGK- 93 (5.0 %), FGK-81 (7.5 %), FGK-84 (9.5 %) and FGK-86 (10.5 %) in comparison to RMt-361 (24.5 %).

At Guntur, fifteen genotypes from different coordinating centers were evaluated along

with two checks in RBD replicated thrice. Among the seventeen entries evaluated, none of the entries were found significantly better than the best check AM-1. However, the entries FGK-86 (4.33 q ha⁻¹) and FGK-85 (4.22 q ha⁻¹) recorded significantly higher yield over national check RMt-361 (3.47 q ha⁻¹).

Significant differences were obtained for all the parameters at Hisar. Plant height ranged from 57.8 to 104.5 cm, pods per plant 36.5 to 94.5, length of pods 7.0 to 8.5 and seeds per pod 14.4 to 16.4. Maximum seed yield (22.63 q ha⁻¹) was recorded in Hisar Sonali followed by FGK-89 (22.55 q ha⁻¹) and FGK-83 (20.49 q ha⁻¹).

At Jagudan, significant yield differences were observed among the entries but none of the entries found significantly superior over best check GM-2. However, the entries FGK-91 and FGK-79 gave higher yield (17.59 q ha⁻¹ and 16.16 q ha⁻¹) over best check GM-2, which were 9.34 and 0.44 per cent higher respectively. These two entries recorded significantly higher yield of 32.47 and 21.69 per cent over national check RMt-361.

Out of 16 entries evaluated during *Rabi* season at Navsari, FGK-83 (14.19 q ha⁻¹), FGK-86 (13.82 q ha⁻¹), FGK-81 (13.64 q ha⁻¹), FGK-87 (13.45 q ha⁻¹), FGK-89 (13.33 q ha⁻¹) and FGK-91 (12.96 q ha⁻¹) recorded significantly higher seed yield over HM-57. The highest yielding entries were also found promising for other related yield contributing characters like number of pods per plant, pod length and number of seeds per pod.

At Pantnagar maximum seed yield (22.31 q ha⁻¹) was recorded in FGK-88.

At Raigarh, none of entries performed better over local check and RMt 361 (329 g plot⁻¹) while two entries FGK 91(325.3 g plot⁻¹) and FGK 87 (325 g plot⁻¹) were at par with national checks.

At Kota the seed yield ranged from 2.00 – 12.88 q ha⁻¹. During the first year of evaluation, FGK 91 and Hisar Sonali were found to be the best performing entries in terms of seed yield, yielding 12.88 q ha⁻¹ followed by Hisar Sonali (12.67 q ha⁻¹) and showing 6.13 per cent higher yield over the check RMt 361. The entry FGK – 92 did not show any germination in all the three replications. The mean days to flowering ranged from 51 days (FGK 89) to 63 days (FGK 93); days to maturity from 112 days (FGK 91) to 116 days (FGK 83); plant height from 70.28 cm (FGK 93) to 85.79 cm (FGK - 83); pods per plant from 37.53 (FGK - 89) to 59.60 (FGK 86); pod length from 7.68 cm (FGK 84) to 9.33 cm (FGK 91); seeds per pod from 8.87 (FGK 80) to 14.40 (FGK 81) and test weight from 10.99 g (FGK -71) to 13.29 (FGK-77).

FGK/CI/3 Varietal Evaluation Trial

FGK/CI/3.6 Initial Evaluation Trial on fenugreek

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

Among eight entries and two check varieties, tested at Dholi, RM-204 entry was found significantly superior in number of pods per plant and yield per hectare (20.00 q) as compared to best check variety Rajendra Kanti (13.33 q).

The initial evaluation trial (IET) in fenugreek was conducted at Hisar with eight accessions along with Hisar Sonali and Hisar Suvarna as check during 2014- 2015 and 2015-2016. The results indicated that maximum mean seed yield was recorded in HM-273 (25.91 q ha⁻¹) followed by HM-355 (25.79 q ha⁻¹) showing an increase of 15.2 and 14.7 % over Hisar Sonali (check), respectively.

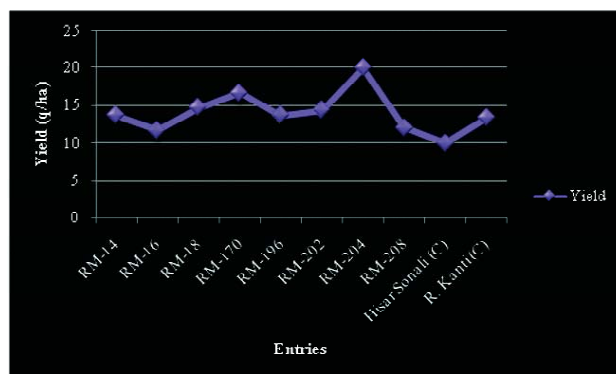


Fig. 27: Yield of fenugreek entries in IET at Dholi

FGK/CI/3.7 Chemo-profiling for identification of industrial types among the released varieties of fenugreek

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

In the trial on chemo-profiling of fenugreek varieties, two varieties viz., CO 1 and CO 2 were evaluated at Coimbatore. The seed shapes of both varieties are angular in shape. The seed colour of the variety CO 1 is light brownish yellow in colour and CO 2 is dark brownish yellow in colour. The variety CO 2 recorded highest thousand seed weight (12.38 g) when compared to CO 1 (11.61 g). The seed samples have been sent for quality analysis.

At Guntur, LFC-103 variety was produced and sent for analysis to AICRPS centre, Jobner.

FGK/CI/3.8 Initial Evaluation Trial 2015

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

Under IET of fenugreek at Kumarganj a total of 11 entries were tested. Maximum yield was recorded in NDM-120 (14.37 q ha⁻¹) followed NDM-80 (13.88 q ha⁻¹), NDM-83 (12.15 q ha⁻¹), NDM-112 (11.80 q ha⁻¹) and NDM-84 (10.97 q ha⁻¹). In case of leaf spot, minimum disease intensity was observed in NDM-112 (10.5 %) followed by NDM-111 (15.0 %), NDM-80 (20.6 %), NDM-83 (20.5 %) in comparison to Hisar Sonali (40.5 %).

At Jagudan, the yield differences were found significant among entries during the year. The entries JFg-2013-2 and JFg-2013-8 gave higher yield (13.38 and 13.15 q ha⁻¹ respectively) than GM-2, which was 8.96 and 7.08 per cent higher over GM-2, respectively.

In *Rabi* 2015-16, ten entries were evaluated at Jobner. The analysis of variance revealed significant differences among the entries for all the traits including seed yield. The seed yield ranged from 7.73 to 19.30 q ha⁻¹. Of the ten entries evaluated, entry UM-411 recorded maximum seed yield of 19.30 q ha⁻¹ followed by UM-410 (13.33 q ha⁻¹), RMt-361 (12.77 q ha⁻¹) and RMt-1 (12.22 q ha⁻¹), while lowest yield of 7.73 q ha⁻¹ was recorded in UM-415. Ten (IET) entries of fenugreek were screened against powdery mildew disease. Entries UM-398 and UM-415 were observed moderately resistant against powdery mildew disease.

XI. Monitoring

Monitoring and reviewing the progress of work in the centres was done by Project Coordinator and Scientists of PC unit visiting the centres and also through e-mail and phone. Monthly progress report and budget utilization certificates sent from the centres were reviewed critically and suggestions were given to carry out the research activities in the

centre. A seed spices monitoring committee was formed during the workshop for reviewing the progress of work in the seed spices centres and this team consisting of Dr. Gopal Lal from NRCSS, Ajmer and Dr. Dharendra Singh from SKNAU, Jobner visited the seed spices centres and reviewed the progress made.

Visit to the centres during the period from 1st April 2015 to 31st March 2016

Sl. No.	Date	Centre visited
1.	10-06-2015 to 11-06-2015	AICRPS center, Jagudan
2.	16-06-2015 to 18-06-2015	AICRPS center, Chintapalle
3.	06-07-2015	AICRPS Center, Ambalavayal, KAU
4.	23 to 30-07-2015	AICRPS Center, Dholi, Bihar
5.	11 to 12-08-2015	AICRPS Center at Coimbatore
6.	18-08-2015	AICRPS Center Panniyur, KVK Kannur
7.	24-08-2015	AICRPS Project mode center Trichur
8.	06-09-2015	AICRPS Center at YS Parmer Hort. University, Solan
9.	15 to 20-09-2015	AICRPS Center at Spices Board and ICAR RC for NEHR at Gangatok
10.	28-10-2015	Kerala Agricultural University, Trichur
11.	04-11-2015	AICRP Spices Center , TNAU, Coimbatore
12.	28.11.2015	AICRP Spices Center , TNAU, Coimbatore
13.	15 to 19-12-2015	TNAU, Coimbatore
14.	05-01-2016	KAU, Ambalavayal
15.	30-01 to 01-02-2016	AICRPS Jobner center
16.	01 to 05-02-2016	Visit to AICRPS voluntary center Ajmer
17.	09-02-2016	COH, Bengaluru (Project Mode centre)
18.	21-02-2016 to 29-02-2016	Seed Spices Monitoring team - Pantnagar, Jagudan, Kumarganj, Guntur, Dholi
19.	23 to 24-02-2016	AICRPS center at Sirsi
20.	09-03-2016	AICRPS Panniyur center and farmer fields
21.	29-03-2016	KAU Trichur



Project coordinator and Seed Spices monitoring team visit to centres

XII. Annual Group Meeting

The 26th annual group meeting of ICAR-All India Coordinated Research Project on Spices was conducted during 5-7th October 2015 under the guidance of Dr V.A. Parthasarathy Former Director, ICAR-IISR and National Coordinator, Bioversity international and Dr. M. Anandaraj, Director, ICAR-IISR in the presence of Dr. Balraj Singh, Director, National Research Center for Seed Spices, Ajmer, Dr. Homey Cheriyan, Director, Directorate of Arecanut and Spices Development, Kozhikode and Dr. Jitendra Kumar, Director, Directorate of Medicinal Plants Research, Anand at ICAR- Indian Institute of Spices Research, Kozhikode, Kerala.

Luminaries like Dr. P. N. Jagadev, Director of Research, OUAT, Bhubaneswar, Dr. Satyanarayana Reddy, Director of Research, SKLTSU, Hyderabad; Dr. James George, Project Coordinator, AICRP on Tuber Crops, Dr. H. P. Maheswarappa, Project Coordinator, AICRP on Palms, Dr. Devasahayam, Head, Division of Crop Protection, Dr. T. John Zachariah, Head, Division of Crop Production, Dr. B. Sasikumar, Head, Division of Crop Improvement and Biotechnology, Dr. S. J. Ankegowda, Head, IISR Research Station Appangala from Indian Institute of Spices Research; Dr. Gopal Lal, Principal Scientist, NRC for Seed Spices were present to help and guide us through the proceedings.

In the inaugural session the Project Coordinator presented the action taken report (ATR) on the recommendations of previous meeting and that was approved by the workshop. There were 5 technical sessions under Genetic Resources & Crop Improvement, Crop Management, Crop

Protection, Varietal Release and Transfer of Technology where presentations were done by various workers on the progress made. The projects were discussed thoroughly, suggestions were given and also new projects were approved in the workshop.



Inauguration of the workshop by the chief guest Dr. V. A. Parthasarathy

A brain storming session on small cardamom – way forward was also conducted simultaneously under the chairmanship of Dr. M. Anandaraj and Dr. M. N. Venugopal. Experts like Dr. Varadarasan, Former Entomologist from ICRI, Dr. V. Krishnakumar, Crop management expert from CPCRI (formerly from ICRI), Dr. Goplal Krishnan, Dy. Director (Development), Spices Board were the experts in addition to all research workers on cardamom from IISR, KAU, UHS Shimoga, Spices Board, ICRI, AICRPS. An action plan was presented by Dr. S. J. Ankegowda, Head ICAR-IISR Regional Station, Appangala and was discussed.

An industry – scientist interface on spices was also conducted under the chairmanship of Dr. M. Anandaraj and Mr. Philip Kuruivilla Chairman, WSO. Dr. Prabir Benerjee, Chief Operating Officer Amalgamated Plantations

Pvt. Limited (A TATA enterprise), Kolkata, presented their initiatives on spices in the NE states. He said spices production in NE should be the focal point if India has to regain the top spot in black pepper/ spices production. The AICRP and IISR promised to extend help in TOT of varieties and technologies developed by them in the NE. Two most important decisions are finalization of common GAPS for cumin, black pepper and cardamom in the next 2 months and aggressive campaigning with the help of Industry, Spices Board and DASD under NHM with technical knowledge from AICRPS, IISR and NRCSS.



Scientist-Industry Interface meeting

In addition to general recommendations, some important decisions taken are

1. The unique germplasm collections presented in this workshop – for eg. ‘Madagascar clove’, high value black ginger, extra long spike black pepper, leaf blight resistant large cardamom, leaf disease tolerant turmeric, thrips resistant cardamom, many specialty farmers varieties in nutmeg - will be registered with – NBPGR/ PPV&FRA as early as possible.
2. In view of spices gaining importance the centers were asked to take up programmes in more spices crops for example Sikkim will take up programmes in ginger, Kammarpally (Telangana), Pasighat (Arunachal) and Medziphema (Nagaland), Pottangi (Odisha) on black pepper, coriander and fenugreek *etc.* as per the growing importance of these crops in these regions.
3. As we have many varieties with yield potential, in all future CVTs for resistance to biotic and abiotic stress and quality will be given highest priority.
4. The state of art facilities and expertise available at IISR and NRCSS and if needed at NBPGR will be utilized for confirmation of quality parameters, chemo profiling, DNA finger printing, correct identification of pathogens *etc.* to avoid confusion.
5. All nurseries of AICRP centers have to be accredited for production of nucleus (Breeders seed) planting materials. The help of DASD who are the authorized agency to accredit the nurseries, will be taken
6. The AICRPS centers will collect and provide information on the regions where the best clean and quality spices are grown in their jurisdiction for the industry.
7. Since *in vitro* screening methods were yet to be standardized for confirming resistance to biotic and abiotic stresses in seed spices – the screening has to be done in identified hot spot regions for each crop and the disease/pest/ drought before they are recommended for the specific trait. Wherever required the help from NRCSS should be taken.

Some important New Projects initiated from this year are

Coordinated Varietal Trial on Farmers varieties of Black Pepper, Small Cardamom; Chemo-profiling for identification of industrial types among the released varieties of fenugreek; Standardization of drip irrigation and fertigation in coriander, cumin, fennel; Integrated Management of stem gall disease of coriander.

In addition 2 other projects were recommended by the workshop, to be taken in a project mode for next 3 years with contingency of Rs. 1 lakh/ year based on availability of funds. They are

1. Evaluation of seed spices genotypes in Bengaluru conditions at Department of Plantation Spices Crops, College of Horticulture (UHSB), Bengaluru.
2. Studies on the performance of the Nutmeg (*Myristica fragrans* Houtt) ecotypes in coconut based cropping system in Tamil Nadu, TNAU, Coimbatore
3. In view of the cost of nutmeg scion materials and grafts the project mode funding of KAU, Trichur enhanced to 2 lakh/ year

This year the Coimbatore Center, TNAU was adjusted the best AICRPS center for their contribution, new initiatives, prompt reporting, utilization of funds, transfer of technology and submission of AUCs

Technologies developed

Seven location specific technologies for various states were recommended

1. Standardization of water requirement for turmeric through drip irrigation for



Scientists of AICRPS, Coimbatore centre receiving "Best AICRPS Centre" Award from the Chief Guest

Andhra Pradesh, Telangana, Uttar Pradesh and North Bengal - drip once in two days at 80% pan evaporation with 4 l/h resulted in increase in yield by 10-15 % in turmeric.

2. **Micro irrigation in fennel** at 0.8 IW/CPE ratio with paired row planting is recommended for higher water use efficiency (6.96 kg/ha-mm), water saving (18.9%) and yield increase (107.4%) over surface irrigation at 1.0 IW/CPE ratio in Rajasthan.
3. **Micro irrigation in fenugreek** at 0.6 IW/CPE ratio with paired row planting is recommended for higher water use efficiency (6.74 kg/ha-mm), water saving (35.3%) and yield increase (49.3%) over surface irrigation at 1.0 IW/CPE ratio in Rajasthan.
4. **Management of *Phytophthora* Foot Rot of Black Pepper in New Plantation in Kerala** - Soil application of *Trichoderma harzianum* (MTCC 5179) @ 50 g/vine and drenching and spraying with Potassium phosphonate @ 0.3% during May – June and August – September

5. **Effectiveness of New Molecules of Fungi toxicants against *Phytophthora* Foot Rot of Black Pepper in existing plantation in Karnataka and Andhra Pradesh** - by spraying and drenching with Fenamidone (10%) + Mancozeb (50 %) @ 0.1 % + Soil application of *T. harzianum* @ 50 g/vine + neem cake @ 1 kg/vine or alternatively by applying Potassium phosphonate (0.3%) + *T. harzianum* @ 50g + 1 kg Neem cake/ vine based on cost of chemicals.
6. **Management of seed wasp of fennel** in Gujarat and Rajasthan, two foliar sprays of acetamiprid 0.004% (2g/10lit. water; 20g a.i. /ha) or thiamethoxam 0.0084% (3.36 g/ 10 lit. water; 42g a.i. /ha) were advocated. First foliar spray should be made at appearance of seed wasp damage and subsequent spray should be applied at 10 days after first spray. The PHI of both the insecticides is 66 days and pesticide residues detected were far below MRLs.
7. **Management of pseudostem rot in small cardamom in Kerala**- Chemical control by drenching of Carbendazim @ 2g/l (5 l/ plant) at monthly intervals from Feb-May or biological control by combined application of *Trichoderma harzianum* (50 g with 1 kg neem cake) + *Pseudomonas fluorescens* (2% spray).

Publications released

18 publications in local languages and English on package of practices of spices and technologies/varieties developed by the centres were released during the workshop.

Release of varieties

Five high yielding varieties of spices were recommended for release. One coriander variety- **LCC 219 (Susthira)** with high yield, suitable to rainfed and irrigated conditions with high essential oil content was recommended for release in Andhra Pradesh, Telangana and Tamil Nadu. Two fennel varieties **Ajmer Fennel-2 (AF-2)** with high essential oil content and moderate resistance to *Ramularia* blight is recommended for release at national level and **RF-157** with high yield potential and better seed quality is recommended for release in Rajasthan, Gujarat and Haryana. Two fenugreek varieties, **RMt-354** with high yield potential and moderate resistance to powdery mildew and downy mildew and **Narendra Methi 2 (NDM 69)** recommended for release.

The workshop came to an end on 7th October 2016. During the plenary session Dr. B. K. Pandey, Principal Scientist from ICAR Headquarters complemented the work done in the AICRPS. He also suggested submitting a copy of all the publications released to the SMD.



Plenary session

XIII. Popularization of Technology

Scientists of AICRPS centres are involved in technology demonstration by conducting FLD's to make the technologies developed by the centre visible to the farmers. Following are the technologies demonstrated in the year 2015-16:

- ❖ Demonstration of ginger portray propagation for tribal farmers and resource persons at Wynad (AICRP Head Quarter)
- ❖ FLD on high yielding turmeric variety Co-2 (Coimbatore)
- ❖ Demonstration of technique of removing bark of cinnamon, Pro tray propagation



FLD on high yielding turmeric variety Co-2



FLD on organic ginger cultivation

technique for ginger and turmeric, Processing of black pepper, Processing of turmeric, Soft wood grafting technique in nutmeg and kokum, Bush pepper production technology (Dapoli)

- ❖ FLD on management of leaf spot disease through fungicide application (Dholi)
- ❖ FLD on high yielding high oil content coriander variety Suguna (LCC-236) (Guntur)
- ❖ FLD on disease management technologies and high yielding varieties of cumin & coriander and fennel (Jagudan)
- ❖ FLD on HYV and advance technologies in fenugreek, cumin and fennel (Jobner)
- ❖ Pro tray propagation technique for turmeric (Kammarappally)
- ❖ Adoption of drip irrigation in cardamom (Mudigere)
- ❖ Root grub management in cardamom (Pampadumpara)
- ❖ Yield potential of Panniyur varieties under proper IPDM and High yielding capacity of Panniyur varieties under abiotic stress (Panniyur)
- ❖ FLD on organic cultivation of ginger (Pottangi)
- ❖ Biofumigation using cabbage for the control of soft rot and bacterial wilt diseases in ginger (Pundibari)
- ❖ Bush pepper cultivation (Sirsi)
- ❖ FLD on promising ginger genotype IC-593889 (SG-26-04) along with check cv Himgiri (Solan)

XIV. Success Stories

Success story of local germplasm conservation and cultivation of Black pepper in Uttara Kannada dist. (Karnataka)

Preamble

As far as the spices are concerned, breeders targets quality apart from productivity as the market value of the produce is highly dependent on quality. Black pepper is a crop blessed with great genetic diversity and India is rich in diverse varieties and cultivars of the black gold. Once the home gardens of the black pepper growing tracts were dominated with such local cultivars and these genotypes were named after their geographical area or peculiar morphological features. After the introduction and popularization of high yielding varieties, many of the local cultivars were disappeared from the farmer's field and its presence is restricted to the germplasm repositories of few research institutions. Even though they are not comparable with the released varieties in the yield potential, their quality, resistance to biotic and abiotic stresses and capacity to with stand adverse climatic conditions are remarkable. Hence preservation of the valuable genetic resources in farmer's field is a matter of great importance. Apart from conservation point of view, maintenance of genetic variability gives protection to the plantation from pest and disease threat also.

Local germplasm conservation and cultivation of Black pepper

Mr. Shridhar Bhat from Sirsi, Karnataka is a progressive farmer who has succeeded in conservation of unique black pepper

genotypes with his inborn interest and research support.

He has conserved more than twenty local genotypes of black pepper in an area of five acres. All these genotypes are well adopted in this area and are systematically studied by the scientists. Selections made by him are varying in their leaf structure, yield, berry quality and resistance to pests and diseases. From his collections, two promising genotypes (Swaranavalli Surya and Swaranavalli Shalmala) have been selected and studies are being taken up. About 22 genotypes have been identified and are being studied for their growth and yield potentials. These genotypes are collected and added to the black pepper germplasm of Sirsi centre.

He has been cultivating black pepper from last three decades and presently he is having 1600 vines. Apart from his unique collections, he is maintaining different local cultivars and varieties like Thirapu kare, Kari mallisara, Bilimallisara and Panniyur-1. Mr. Bhat believes that the low yielding nature of local cultivars can be rectified with improved agro-techniques, and they are resistant to major pests and diseases. The scientists of AICRPS centre at Sirsi are constantly encouraging him with necessary technical advice and helping him for quality analysis of the unique genotypes. His name has been recommended for the Plant Genome savior award.



(a) Mr. Shridhar Bhat along with the Scientist of AICRPS, Sirsi
(b-e) promising black pepper genotypes from his farm

Impact of technology / variety in spices production and productivity in Odisha

Since 1995, young enterprising youths of Pottangi came forward for cultivation of ginger and turmeric with improved package of practices. They were supplied with high yielding varieties of ginger and turmeric and provided with all improved technology by the scientists

of AICRPS, HARS, Pottangi. After they became successful in getting a very high return, many unemployed youth and progressive farmers were attracted towards the cultivation of ginger and turmeric.

List of some successful ginger and turmeric growers of Koraput during 2015-16

Name and address	Variety grown	Area (ha)	Yield of fresh rhizome obtained (Quintal)	Total cost of production (Rs.)	Gross return (Rs.)	Net return (Rs.)
Dumuri Pujari, Bandaguda, Khidi, Semiliguda	Ginger-Suprabha Turmeric-Roma	8.0 1.0	580.0 100.0	12,00,000/- 1,00,000/-	17,40,000/- 2,00,000/-	5,40,000/- 1,00,000/-
Rajendra PangiVill: Hantapur, Gunthaput Block: SemiligudaDist: Koraput	Suprabha	6.0	360.0	9,00,000/-	10,80,000/-	1,80,000/-
Danei Hantal, Similiput, Khurji, Nandapur	Suprabha	4.0	280.0	6,00,000/-	8,40,000/-	2,40,000/-
Kamalu Alasa, Semili, Khurji, Nandapur, Koraput	Suprabha	3.0	180.0	4,50,000/-	5,40,000/-	90,000/-

Selling Price of Ginger (TL Seed) = Rs. 3000/- per Qtl. Turmeric (TL seed) = Rs.2000/- per Qtl.

XV. UNIQUE GERmplasm COLLECTION (2015-16)

Karivilanchi-A unique accession with oval berries



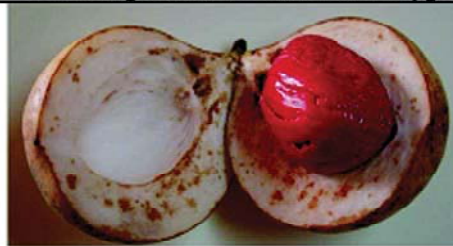
"A machuvadai"- a high yielding farmers variety



Pattani pepper- a unique accession with vigorous growth and extra bold berries



Unique nutmeg accessions – Pear shaped fruit, Whole mace type, Yellow mace type



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Pundibari

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Weeds in ginger and turmeric (In English)

Packages and practices of turmeric (In English)

Packages and practices of ginger (In English)

Jobner

1. Book "Seed Spices Varieties Developed at Jobner"
2. Book "Paradigm in Seed Spices Research"
3. Folder "Dhaniya" (Hindi)
4. Folder "Methi" (Hindi)
5. Folder "Sonf" (Hindi)
6. Folder "Jeera" (Hindi)

XVII. Awards and Recognitions

Fellow of Societies

Dr. A. C. Shivran and **Dr. Dharendra Singh** AICRP on Spices, Jobner - Fellow of Indian Society of Seed Spices, NRCSS, Ajmer

Dr. Dharendra Singh AICRP on Spices, Jobner - Fellow of Indian Society for Spices, Indian Institute of Spices Research, Kozhikode

Best AICRPS Centre Award

AICRP on Spices centre at Department of Spices and Plantation Crops, TNAU, Coimbatore.

Oral / Poster Presentation Awards

Surya Kumari, S., Giridhar, K. and Naram Naidu, L. 2016. Scope and Relevance of Nanotechnology in spice, aromatic and drug industry. In: National Seminar on "New dimensional approaches for enhancement of seed spices productivity and profitability under era of climate change". ICAR-National Research Centre on Seed Spices, Ajmer, 2nd to 3rd February 2016. **(Best Oral Presentation Award)**

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Mishra A. K. and Singh S. P. "Management of stem gall disease of coriander". In: National seminar on "New dimensional approaches for seed spices production and profitability under era of climate change". NRC on Seed Spices, Ajmer 2nd to 3rd February 2016 **(Best Poster Presentation Award)**.

XVIII. STAFF POSITION

PROJECT COORDINATOR'S OFFICE

- | | | |
|-----------------------------|---|--|
| 1. Project Coordinator | : | Dr. K. Nirmal Babu |
| 2. Scientist (SPMAP) | : | Ms. H. J. Akshitha |
| 3. Scientist (SPMAP) | : | Mr. Muhammed Nissar V. A
(From 30.12.2015 to till date) |
| 4. Technical Officer | : | Dr. Utpala Parthasarathy
(Till 29.02. 2016 and then vacant) |
| 5. Personal Assistant | : | Ms. C. N. Divya (From 21.04.2015 to
12.08.2015 and then vacant) |
| 6. Skilled Supporting Staff | : | Sh. K. Chandran Nair (Till 30.06. 2015 and
then vacant) |

COORDINATING CENTRES

1. Cardamom Research Station, KAU, Pampadumpara

- | | | |
|---|---|--|
| 1. Assistant Professor (Ag. Entomology) | : | Dr. K. B. Deepthy
(Transferred on 30/11/2015) |
| 2. Associate Professor (Agron/Hort.) | : | Vacant |
| 3. Assistant Professor (Pl. Breeding) | : | Vacant |
| 4. Farm Manager Gr. I | : | Mr. C.T. Jacob |
| 5. Laboratory Assistant Gr. II | : | Mr. Anil Kumar |
| 6. Peon | : | Mr. Shinoj Antony |

2. Pepper Research Station, KAU, Panniyur

- | | | |
|--|---|--------------------------|
| 1. Asst. Professor/ Jr. Breeder (Pl. Breeding) | : | Dr. P. M. Ajith |
| 2. Asst Professor (Plant Pathology) | : | Dr. C. R. Rini |
| 3. Asst. Professor (Agron / Hort) | : | Vacant |
| 4. Asst. Professor (Pl. Pathology) | : | Vacant |
| 5. Farm Superintendent | : | Sh. K. J. Joseph |
| 6. Farm Manager Gr I | : | Mr. P. P. Muralidharan |
| 7. Farm Manager Gr II | : | Mr. P. Krishnan |
| 8. Lab Asst. Gr.III | : | Sh. K. Rajeev |
| 9. Peon Gr II | : | Sh. Mohanan Valayangatan |

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

- | | | |
|--|---|--------------------|
| 1. Associate Professor (Agronomy) | : | Dr. K. M. Devaraju |
| 2. Associate Professor (Plant Breeding) | : | Mr. M. G. Sunil |
| 3. Associate Professor (Plant Pathology) | : | Dr. H. Manjunatha |

- | | | |
|-------------------------------------|---|-------------------|
| 4. Associate Professor (Entomology) | : | Ms. R. Rashmi |
| 5. Technical Assistant | : | Mr. Mahadevappa |
| 6. Technical Assistant | : | Ms. H. R. Manjula |
| 7. Messenger | : | Ms. Savithri |

4. Horticultural Research Station (UHS), Sirsi

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

5. Horticultural Research Station (TNAU), Yercaud

- | | | |
|------------------------|---|---------------------|
| 1. Agronomist (Hort.) | : | Dr. K. Nageswari |
| 2. Jr. Breeder (Hort.) | : | Dr. M. Palani Kumar |
| 3. Lab Assistant | : | Mrs. P. Pappa |

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

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

7. Turmeric Research Station (SKLTSHU), Kammarpally

- | | | |
|------------------------|---|---------------------------------------|
| 1. Jr. Pathologist | : | Dr. B. Mahender (From 17.07.2015) |
| 2. Jr. Horticulturist | : | Dr. M. Hanuman Naik (Till 17.07.2015) |
| 3. Technical Assistant | : | Mr. K. Venkanna |

8. Horticultural Research Station (Dr. YSR Horticultural University), Chintapalle

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

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

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

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

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

11. High Altitude Research Station (OUAT), Pottangi

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

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

- | | | |
|-------------------------------|---|---------------------------------------|
| 1. Sr. Breeder | : | Dr. Dharendra Singh |
| 2. Breeder | : | Dr. D. K. Gothwal |
| 3. Senior Pathologist | : | Dr. K. S. Shekhawat (Up to Sep. 2015) |
| 4. Asst. Biochemist | : | Dr. Girish Kumar Mittal |
| 5. Agronomist | : | Dr. A. C. Shivran |
| 6. Senior Technical Assistant | : | Dr. S. S. Rajput |
| 7. Junior Technical Assistant | : | Sh. S. R. Kumawat |

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

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

14. Department of Vegetable Crops, CCS HAU, Hisar

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

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

- | | | |
|------------------------|---|------------------|
| 1. Horticulturist | : | Dr. S. P. Singh |
| 2. Jr. Pathologist | : | Dr. A. K. Mishra |
| 3. Technical Assistant | : | Mr. A. N. Mishra |

16. Department of Vegetable Science (NDUAT), Kumarganj

- | | | |
|--------------------|---|------------------|
| 1. Horticulturist | : | Dr. V. P. Pandey |
| 2. Jr. Breeder | : | Vacant |
| 3. Jr. Pathologist | : | Dr. R. S. Mishra |
| 4. Tech. Asst. | : | Sh. R. K. Gupta |
| 5. Tech. Asst. | : | Sh. Vinod Singh |

17. Department of Horticulture (UBKV), Pundibari

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

5. Technical Assistant : Sh. Samsul Haque

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

- | | | |
|------------------------|---|---|
| 1. Horticulturist | : | Dr. Gargi, D. Shrike (Till 15.03.2016)
Dr. R. G. Khandekar (From 15.03.2016) |
| 2. Jr. Pathologist | : | Prof. Uttam, K. Sawant (Till 02.06.2015)
Dr. Rajesh Rangrao Rathod (From 03.06.2015) |
| 3. Jr. Breeder | : | Prof. U. B. Pethe |
| 4. Technical Assistant | : | Sh. D. D. Bhandari |
| 5. Technical Assistant | : | Sh. G. D. Bandre |

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

- | | | |
|------------------------|---|------------------------------------|
| 1. Horticulturist | : | Dr. Sarita Sahu (From 29.10.2015) |
| 2. Jr. Breeder | : | Dr. Shrikant Laxmikant Swargaonkar |
| 3. Jr. Pathologist | : | Dr. Ajit Kumar Singh |
| 4. Technical Assistant | : | Mr. D. S. Kshatriya |
| 5. Technical Assistant | : | Vacant |

XIX. TRAINING AND CAPACITY BUILDING

Trainings attended by the Staff of AICRPS

Sl. No.	Name and designation	Details of training	Venue	Duration
1.	Dr. K. Nirmal Babu, Project Coordinator (AICRPS)	Management Development Programme on Leadership Development (a pre-RMP programme)	NAARM, Hyderabad	12 days (30.11.2015 to 11.12.2015)
2.	Dr. K. Giridhar, Scientist (H), HRS, Guntur	Advanced Breeding Strategies for Biotic and Abiotic Stress Tolerance in Vegetable Crops Orientation programme on RTI Act.	ICAR- Indian Institute of Horticultural Research, Bengaluru College of Horticulture. Dr. YSRHU, Venkataramanagudem.	21 days (08.10.2015 to 28.10.2015) 21.08.2015
3.	Dr. S. Surya Kumari, PS (H) & Dr. K. Giridhar, Scientist (H) HRS, Guntur	The Biological diversity act, Rules & Access and Benefit Sharing (ABC) Mechanism	At Vijayawada conducted by ABSBB	04.03.2016
4.	D.G.Patel, Asst. Res. Scientist (Pl.Breeding), CRSS, Jagudan	“Recent Advances in Improvement of Vegetable Crops”	Department of Vegetable Science, (DrYSPUHF), Solan	21 days (17.02.2016 to 08.03.2016)
5.	Dr. R. N. Sharma, Sr. Technical Assistant, SKNCOA, Jobner	“Organic Farming and Sustainable Agriculture”	Jobner	7days (15.12.15 to 21.12.15)

Trainings organized for various categories of employees

Sl. No	Date	Particulars	Place	Details of participants
1.	11-12-2015	Production technology of turmeric	HRS, Lam	Field staff of Spices Board
2.	7 days (15.12.15 to 21.12.15)	Organic Farming and Sustainable Agriculture	Jobner	Assistant Professors and other officers of the university

Name of the centres	(Rs. in lakhs)															
	Pay and Allowances		TA		RC		Tech-A		Total RC		Work		Total		Grand Total	
	Total	ICAR	Total	ICAR	Total	ICAR	Total	ICAR	Total	ICAR	Total	ICAR	State share	ICAR share	Total	Grand Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)				
Pampadumpara (KAU)	28.64	21.48	1.00	0.75	3.00	2.25	2.35	0.10	2.35	24.58	8.16	32.74				
Panniyur (KAU)	35.37	26.53	1.00	0.75	3.00	2.25	2.35	0.10	2.35	29.63	9.84	39.47				
Mudigere (UAHS)	36.34	27.26	1.00	0.75	3.00	2.25	2.35	0.10	2.35	30.36	10.08	40.44				
Sirsi (UHS)	26.03	19.52	1.00	0.75	3.00	2.40	2.50	0.10	2.50	22.77	7.36	30.13				
Yercaud (TNAU)	36.05	27.04	1.00	0.75	3.00	2.25	2.35	0.10	2.35	30.14	10.01	40.15				
Coimbatore (TNAU)	17.49	13.12	1.00	0.75	3.00	2.25	2.35	0.10	2.35	16.22	5.37	21.59				
Chintapalle (Dr YSRHU)	2.17	1.63	0.50	0.375	7.035	6.66	6.76	0.10	6.76	13.33	10.00	23.135				
Kamarpally (SKLTSHU)	3.10	2.325	0.50	0.375	1.50	1.125	1.225	0.10	1.225	3.925	1.275	5.2				
Guntur (Dr YSRHU)	30.63	22.97	1.00	0.75	3.00	2.25	2.45	0.20	2.45	26.17	8.66	34.83				
Solan (YSPUHF)	31.32	23.49	1.50	1.125	4.50	3.375	3.475	0.10	3.475	28.09	9.33	37.42				
Pottangi (OUAT)	0.73	0.545	0.50	0.375	7.045	6.67	6.77	0.10	6.77	3.81	2.86	12.185				
Jobner (SKNAU)	77.96	58.47	2.50	1.875	7.50	5.625	5.725	0.10	5.725	66.07	21.99	88.06				
Jagudan (SDAU)	23.95	17.95	1.00	0.75	3.00	2.25	2.35	0.10	2.35	21.06	6.99	28.05				
Hisar (HAU)	34.83	26.12	1.00	0.75	3.00	2.25	2.35	0.10	2.35	29.22	9.71	38.93				
Dholi (RAU)	28.31	21.23	1.00	0.75	3.00	2.25	2.35	0.10	2.35	24.33	8.08	32.41				
Kumarganj (NDUAT)	36.525	27.39375	1.00	0.75	3.00	2.25	2.35	0.10	2.35	30.49375	10.13	40.625				
Pundibari (UBKV)*	-	-	-	-	0.80	0.60	0.70	0.10	0.70	0.70	0.20	0.90				
Dapoli (BSKKV)	26.45	19.04	1.50	1.125	4.50	3.375	3.475	0.10	3.475	24.44	8.11	32.55				
Raigarh (IGKV)	11.32	8.49	1.00	0.75	7.42	6.67	6.77	0.10	6.77	16.01	3.83	19.84				
AICRPS Workshop	1.47625															
Reserve contingency (Seed spices monitoring team)	1.00		1.00		1.00		1.00		1.00		1.00		1.00		1.00	
Total	487.215	364.6038	19.00	14.25	73.30	61.48	63.48	2.00	63.48	17.14	12.86	456.00	145.135	601.13		

Name of the centres	Pay and Allowances		TA		RC		Tech-A	Total RC	Work Total	ICAR	Total		Grand Total
	Total	ICAR	Total	ICAR	Total	ICAR					State share	ICAR share	
Co-operating Centres													
Ambalavayal(KAU)	-	-	-	-	-	-	-	-	-	-	-	-	-
Peechiparai (TNAU)	-	-	0.67	0.50	5.33	4.00	-	4.00	-	-	4.50	1.50	6.00
Gangtok (ICRI)	-	-	0.50	0.50	3.26	3.26	-	3.26	-	-	3.76	-	3.76
Sakleshpur (ICRI)	-	-	0.50	0.50	3.26	3.26	-	3.26	-	-	3.76	-	3.76
Myladumpara (ICRI)	-	-	0.50	0.50	3.26	3.26	-	3.26	-	-	3.76	-	3.76
ICAR RC NEHR, Barapani	-	-	0.50	0.50	1.84	1.84	-	1.84	-	-	2.34	-	2.34
ICAR RC NEHR, Mizoram	-	-	0.50	0.50	3.27	3.27	-	3.27	-	-	3.77	-	3.77
ICAR RC NEHR, Gangtok	-	-	-	-	-	-	-	-	-	-	-	-	-
Nagaland (NAU)	-	-	0.67	0.50	5.33	4.00	-	4.00	-	-	4.50	1.50	6.00
Kahikuchi (AAU)	-	-	0.67	0.50	5.33	4.00	-	4.00	-	-	4.50	1.50	6.00
Voluntary centres													
Pantnagar (GBPUAT)	-	-	0.66	0.50	2.66	1.02	-	1.02	-	-	1.52	0.50	2.02
Pasighat (CAU)	-	-	-	-	-	-	-	-	-	-	-	-	-
Kanke (BIRSAAU)	-	-	0.66	0.50	0.31	0.23	-	0.23	-	-	0.73	0.24	0.97
Kalyani (BCKVV)	-	-	0.66	0.50	2.00	1.50	-	1.50	-	-	2.00	0.66	2.66
Kota (AUK)	-	-	0.66	0.50	2.66	2.00	-	2.00	-	-	2.50	0.83	3.30
Navasari (NAU)	-	-	0.66	0.50	1.11	0.83	-	0.83	-	-	1.33	0.44	1.77
Jabalpur (JNKV)	-	-	0.66	0.50	0.62	0.46	-	0.46	-	-	0.96	0.32	1.28
Mandor (AUJ)	-	-	0.66	0.50	1.25	0.94	-	0.94	-	-	1.44	0.47	1.91
Sanand (AAU)	-	-	0.66	0.50	1.51	1.13	-	1.13	-	-	1.63	0.54	2.17
Project mode funding													
Trichur (KAU)	-	-	-	-	2.66	2.00	-	2.00	-	-	2.00	0.66	2.66
Periyakulam (TNAU)	-	-	-	-	1.33	1.00	-	1.00	-	-	1.00	0.33	1.33
COH, Bengaluru (UHS)	-	-	-	-	1.33	1.00	-	1.00	-	-	1.00	0.33	1.33
HC&RL, Coimbatore (TNAU)	-	-	-	-	1.33	1.00	-	1.00	-	-	1.00	0.33	1.33
Total	-	-	9.79	8.00	49.65	40.00	-	40.00	-	-	48.00	10.15	58.12
Grand Total	487.215	364.60	28.79	22.25	122.95	101.48	2.00	103.48	17.14	12.86	504.00	155.29	659.25

XXI. Weather Data

Panniyur

Pampadumpara

Month / Year	Rain fall (mm)	No. of Rainy Days	Temperature (°C)		RH (%)	Rainfall (mm)	Temperature (°C)		RH (%)	
			Max.	Min.			Max.	Min.	I	II
April'15	13.42	7	36.42	26.57	93.86	11.10	24.82	22.33	95.20	94.33
May	15.82	13	33.80	26.24	92.96	4.64	23.52	20.51	94.61	94.71
June	28.81	26	30.36	25.51	92.66	7.72	22.35	18.50	95.53	96.50
July	31.93	26	29.86	25.08	93.96	9.43	21.70	17.62	96.00	95.63
Aug.	22.41	22	31.5	24.97	93.87	5.73	21.98	18.06	96.06	95.06
Sept.	24.26	17	32.96	25.06	93.86	8.77	22.60	18.73	94.87	95.50
Oct.	28.06	17	33.28	25.34	93.61	3.90	22.69	18.74	95.42	95.48
Nov.	11.28	14	33.75	24.56	94.66	9.26	21.93	18.00	94.57	95.60
Dec.	11.25	4	36.02	23.94	94.67	2.00	20.82	17.23	95.26	95.74
Jan.'16	0	0	37.35	23.03	95.38					
Feb	0	0	37.78	24.26	94.68					
March	0	0	38.93	26.43	93.52					

Coimbatore

Yercaud

Month / Year	Rain fall (mm)	No. of Rainy Days	Temperature (°C)		RH (%)		Rain fall mm	No. of Rainy Days	Temperature (°C)		RH (%)
			Max.	Min.	I	II			Max.	Min.	
April'15	62.7	6	34.3	24.0	83	47	101.0	10	27.3	19.4	74.5
May	195.7	9	32.7	23.5	91	61	164.6	11	21.1	20.8	83.6
June	46.9	6	32.3	23.7	82	55	97.8	9	21.5	20.0	83.1
July	5.1	1	32.2	22.9	85	50	104.0	10	20.7	19.2	79.7
Aug.	28.1	2	32.3	23.2	86	51	154.4	14	22.2	19.5	79.8
Sept.	66.2	4	33.0	23.8	83	47	284.8	13	23.1	21.2	80.9
Oct.	65.2	3	31.6	23.3	87	52	215.9	9	21.5	19.1	80.6
Nov.	191.2	12	38.6	22.0	93	71	415.7	15	20.2	17.7	88.2
Dec.	24.1	2	29.0	21.5	90	62	47.2	11	18.2	16.5	86.0
Jan.' 16	0.2	-	30.0	19.5	86	46	0	0	18.9	18.2	85.5
Feb.	0.0	-	33.4	21.5	81	37	0	0	40.0	38.5	79.5
March	0.0	-	35.7	24.0	82	38	0	0	20.0	19.4	83.3

Mudigere

Sirsi

Month / Year	Rain fall (mm)	No. of Rainy Days	Temperature (°C)		RH (%)	Rain fall (mm)	No. of Rainy Days	Temperature (°C)		RH (%)
			Max.	Min.				Max.	Min.	
April'15	262.8	11	31.5	18.3	86.6	41.9	2	36	22	70.0
May	152.4	13	31.5	18.5	86.6	56.2	6	37	23	74.0
June	827.2	17	27.7	17.7	85.2	498.6	18	31	22	84.0
July	222.9	23	23.	19.4	78.5	676.6	18	31	22	89.0
Aug.	196.2	23	24.1	19.4	86.1	506.2	16	30	21	72.5
Sept.	164.1	17	24.9	28.0	84.9	235.6	14	31	22	69.0
Oct.	79.5	18	28.4	18.3	84.1	111.2	3	31	21	69.0
Nov.	56.7	12	25.7	19.3	83.7	38	1	30	20	59.0
Dec.	1.0	1	27.5	18.5	84.2	6.9	00	31	18	54.0
Jan.'16	-	-	-	-	-	0.3	00	30	17	-
Feb	-	-	-	-	-	2.2	00	34	20	-
Mar	-	-	-	-	-	0.0	00	37	23	-

Guntur

Pasighat

Month / Year	Rain fall (mm)	No. of Rainy Days	Temperature (°C)		RH (%)		Rainfall (mm)	Temperature (°C)		RH (%)
			Max.	Min.	I	II		Max.	Min.	
April'15	33.4	3.0	36.7	27.1	93.0	46.0	296	26.2	-	81.3
May	21.1	1.0	40.8	28.1	70.4	39.5	267	29.6	-	79.9
June	163.8	10.0	35.1	25.9	81.2	56.4	1036.9	29.4	-	87.2
July	116.6	8.0	37.9	26.1	74.6	47.1	613.7	34.0	-	77.8
Aug.	253.1	15.0	36.1	24.1	90.0	62.6	1262.2	29.4	-	86.8
Sept.	241.7	13.0	33.4	25.3	92.2	68.5	330.5	27.1	-	83.9
Oct.	22.5	4.0	36.0	24.6	93.1	59.5	0.0	26.7	-	69.4
Nov.	73.0	4.0	32.3	21.0	95.3	65.2	46.1	25.3	-	73.0
Dec.	0.1	0.0	32.1	17.7	97.9	67.7	46.3	24.9	-	76.5
Jan.' 16	0.0	0.0	31.2	16.9	98.5	53.9				
Feb.	0.0	0.0	33.8	19.3	97.1	46.0				
March	0.0	0.0	36.7	22.7	89.6	53.2				

Dapoli

Pottangi

Month / Year	Rain fall (mm)	Temperature (°C)		RH (%)		Rain fall (mm)	No. of Rainy Days	Temperature (°C)		RH (%)	
		Max.	Min.	I	II			Max.	Min.	I	II
April' 15	0.03	33.07	21.42	86.7	58.3	94.8	5	42.8	30.5	76.0	58.0
May	0.01	33.96	23.97	85.6	59.1	49.0	5	43.4	31.5	73.0	57.0
June	38.05	30.29	23.81	89.6	76.9	280.0	14	41.0	29.5	70.0	60.0
July	11.08	29.45	24.67	88.9	79.5	40.0	7	39.5	26.5	66.0	61.0
Aug.	14.75	28.72	23.71	94.2	83.1	295.0	12	35.5	24.5	78.0	70.0
Sept.	7.31	29.78	22.75	92.6	78.1	638.0	17	32.5	20.0	89.0	69.0
Oct.	3.47	33.35	22.68	93.7	68.4	102.0	4	30.5	18.5	74.0	68.0
Nov.	0.00	33.64	19.71	91.8	51.6	15.0	3	25.5	16.5	70.0	65.0
Dec.	0.00	33.63	19.61	92.0	51.2	Nil	-	24.5	9.0	70.0	60.0
Jan. ' 16	32.15	32.15	32.15	32.1	32.1	7.0	1	26.0	10.5	74.0	59.0
Feb.	31.10	31.10	31.10	31.1	31.1	Nil	-	29.0	17.5	70.0	57.0
March	33.31	33.31	33.31	33.3	33.3	7.2	2	32.8	23.5	65.0	53.0

Jagudan

Navsari

Month / Year	Rain fall (mm)	No. of Rainy Days	Temperature (°C)		RH (%)	Rain fall (mm)	No. of Rainy Days	Temperature (°C)		RH (%)	
			Max.	Min.				Max.	Min.	I	II
April'15	2.8	0	42.4	21.5	70.45						
May	10.4	1	42.8	24.9	78.56	0.0	0.0	35.0	26.4	83.0	58.0
June	91.2	3	39.8	25.6	74.7	379.5	12.0	32.0	25.7	86.7	74.5
July	616.8	7	37.8	23.6	73.54	321.0	12.0	30.7	26.2	87.0	78.0
Aug.	92.9	4	34.6	24.6	55.45	65.0	5.0	30.6	25.3	90.0	74.0
Sept.	59	2	36.4	24.4	76.13	440.0	11.0	31.0	23.4	92.0	69.0
Oct.	0	0	38.4	18.7	83.54	3.0	1.0	35.5	23.1	86.0	45.0
Nov.	0	0	34.2	16.5	85.65	0.0	0.0	34.1	20.3	78.0	41.0
Dec.	0	0	30.9	9.1	85.68	0.0	0.0	31.3	13.1	72.0	29.0
Jan.'16	0	0	31.5	9.4	86.96	0.0	0.0	23.8	15.1	81.0	31.0
Feb.	0	0	35.4	11.4	87	0.0	0.0	30.43	14.73	81.40	34.53
March	0	0	38.0	18.9	83.2						

Solan

Hisar

Month / Year	Rainfall (mm)	Temperature (°C)		RH (%)	Rainfall (mm)	Temperature (°C)		RH (%)	
		Max.	Min.			Max.	Min.	I	II
April'15	71.8	25.4	11.9	58	91.1	34.0	19.0	53.8	53.8
May	16.1	31.3	15.7	45	0.0	40.4	23.0	42.3	42.3
June	93.6	30.5	17.3	58	161.0	38.2	25.0	61	61
July	258.3	27.9	19.3	80	156.1	34.5	26.0	74.7	74.7
Aug.	102.2	28.4	19.4	74	54.8	34.7	26.1	75.15	75.15
Sept.	19.0	26.9	17.2	72	19.8	35.8	22.6	60.25	60.25
Oct.	34.6	25.6	11.3	59	7.0	34.3	18.5	56.1	56.1
Nov.	0.0	23.5	06.4	50	2.9	27.8	12.3	66.7	66.7
Dec.	0.0	19.7	03.2	54	0.0	22.4	6.0	71	71
Jan.' 16	49.4	16.6	02.6	64	-	-	-	-	-
Feb.	80.4	21.5	05.8	68	-	-	-	-	-
March	15.3	23.6	08.1	63	-	-	-	-	-

Dholi

Kanke

Month / Year	Rain fall (mm)	Temperature (°C)		RH (%)		Rain fall (mm)	No. of Rainy Days	Temperature (°C)		RH (%)	
		Max.	Min.	I	II			Max.	Min.	I	II
April '15	33.2	33.15	19.9	82.27	42.8	22.2	1	26.5	2.2	82.5	71.1
May	43.8	35.6	23.6	82	47	8.1	1	33.3	4.0	83.2	66.9
June	55.4	36.7	25.6	84.5	51.4	4.1	1	36.4	10.3	82.6	63.1
July	149.60	33.81	25.0	114.3	70.4	69.7	5	39.5	17.4	82.5	68.5
Aug.	456.80	33.63	24.4	91.00	68.5	63.9	3	42.4	19.6	82.4	54.5
Sept.	155.8	33.7	23.9	89	64	146.0	10	41.3	16.2	80.0	54.5
Oct.	4.2	32.07	20.2	89	50	170.7	12	36.4	16.4	83.2	61.7
Nov.	0.0	29.3	14.6	89	50	290.6	9	35.2	17.5	83.0	62.5
Dec.	0.0	23.3	8.6	86	53	31.0	3	36.3	18.3	82.7	62.6
Jan.'16	0.0	22.0	8.0	89	57	115.1	5	32.5	11.5	82.7	63.8
Feb.	2.8	26.7	17.3	87	52	0.0	0	30.3	8.5	83.5	65.7
March	3.8	32.6	17.0	82	40	3.2	1	29.6	3.1	83.2	67.6

Pundibari

Kalyani

Month / Year	Rain fall (mm)	Temperature (°C)		RH (%)		Rainfall (mm)	Temperature (°C)		RH (%)	
		Max.	Min.	I	II		Max.	Min.	I	II
April'15	132.40	29.83	19.73	78.62	69.27	3.94	36.18	24.21	87.37	49.03
May	377.80	31.77	22.29	84.58	76.65	200.57	36.72	26.62	90.39	55.26
June	622.00	31.20	23.90	91.40	82.87	182.4	35.33	27.64	90.97	68.27
July	296.90	33.42	25.12	84.49	74.97	251.1	32.18	26.54	95.42	81.10
Aug.	25.72	31.77	25.15	88.89	81.10	362.7	32.32	26.44	96.42	79.55
Sept.	9.99	32.88	24.92	78.53	71.63	231.0	32.43	26.02	96.63	76.30
Oct.	0.00	32.59	22.33	72.62	67.74	331.7	33.38	22.52	92.71	59.55
Nov.	0.00	29.28	22.66	81.67	74.87	0.0	29.39	17.33	93.00	55.40
Dec.	0.00	25.11	18.16	83.26	79.32	0.0	25.25	11.74	95.26	59.10
Jan.'16	0.00	23.54	9.70	88.97	81.23	0.0	23.61	10.13	95.35	61.45
Feb.	0.00	27.49	12.83	81.41	68.97	16.8	27.05	13.76	95.40	52.92
March	0.03	30.69	17.17	70.16	59.52	0.76	32.73	18.48	91.83	48.54

Mizoram

Barapani

Month / Year	Rain fall (mm)	No. of Rainy Days	Temperature (°C)		RH (%)		Rain fall (mm)	Temperature (°C)		RH (%)	
			Max.	Min.	I	II		Max.	Min.	I	II
April'15	522.60	15	29.33	18.25	74	41	41.08	26.76	14.38	77.48	56.72
May	443.80	18	31.65	21.38	90	56	47.60	27.88	16.58	83.73	65.30
June	431.60	24	31.44	22.15	88	58	54.00	27.95	19.2	84.25	70.08
July	509.80	22	30.83	22.93	94	59	60.47	28.64	19.16	84.66	71.62
Aug.	453.60	22	30.48	22.40	94	58	57.95	27.53	19.13	89.38	79.33
Sept.	301.60	15	30.92	23.63	88	50	52.22	27.7	18.05	87.65	79.1
Oct.	162.20	8	30.38	20.54	88	51	54.45	27.36	14.88	86.5	72.74
Nov.	014.60	2	28.20	18.45	81	48	55.82	24.45	9.58	86.18	59.08
Dec.	010.60	1	23.14	13.99	80	48	56.18	20.94	5.56	84.66	54.4
Jan.'16	2.4	0	21.2	12.2	88	55	55.32	19.9	5.1	86.38	55.45
Feb.	77.2	5	24.9	16.3	79	51	41.08	26.76	14.38	77.48	56.72

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Publications released during 26th AICRPS workshop



1. Paradigm in Seed Spices Research
2. Seed Spices Varieties - Developed at Jobner
3. AICRPS - TNAU Profile
4. Unique Germplasm in Nutmeg
5. Bush Pepper Cultivation (Kannada)
6. Cardamom cultivation (Odiya)
7. Cinnamon Cultivation (Odiya)
8. Weeds in Turmeric and Ginger
9. Package of Practices of Turmeric
10. Package of Practices of Ginger
11. Biofumigation and its use (Hindi)
12. Disease Management in Black Pepper (Malayalam)
13. Vegetative propagation in Black Pepper (Malayalam)
14. Insect-Pest Management in Black Pepper (Malayalam)
15. Insect-Pest Management in Ginger (Malayalam)
16. Disease Management in Ginger (Malayalam)
17. Black Pepper – Planting and Protection During Monsoon (English)
18. Practices to be adopted and quality standards for export of Turmeric (Telugu)



Evaluation of fennel at bengaluru



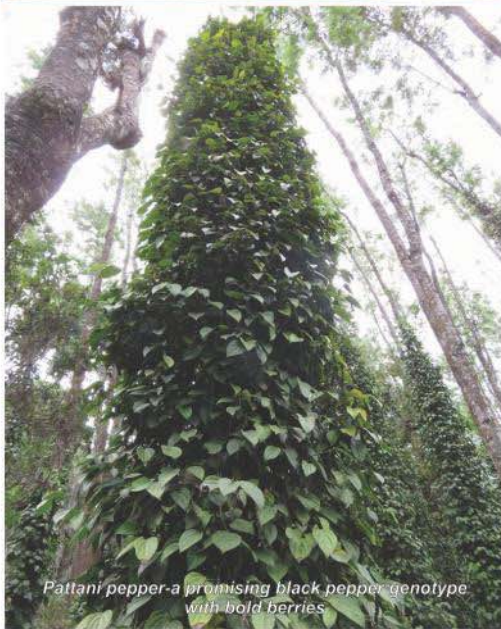
Growing coriander under polythene tunnel



Maintaining genetic purity of coriander



Mother clove



Pattani pepper-a promising black pepper genotype with bold berries



Quality planting material production in farmers field at pottangi



variability in fenugreek germplasm at Jobner



हर कदम, हर डगर
किसानों का हमसफर
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Agri search with a human touch

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