

वार्षिक प्रतिवेदन ANNUAL REPORT 2023



भा.कृ.अनु.प - अखिल भारतीय समन्वित मसाला अनुसंधान परियोजना
ICAR-ALL INDIA COORDINATED RESEARCH
PROJECT ON SPICES

icar वाटरपड



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ANNUAL REPORT 2023

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About cover page

"Reaping profit from ginger : aids AICRPS technologies"

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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, बड़ी इलायची, छोटी इलायची, अदरक, हल्दी, दालचीनी, जायफल, लोंग, 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 पुष्प 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, कोषिकोड 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, एरोरुट, 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 ड्रिफिंग 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 कैप्स्यूल 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 कैप्स्यूल (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 कोम्प्लेक्स, 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 सिंचित 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 संबंध 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 संबंध पर दक्षिण, उत्तर तथा उत्तर पूर्व राज्यों के 6 विभिन्न केन्द्रों में निम्न प्रजातियों जैसे आई आई एस आर प्रतिभा, राजेन्द्र सोनिया, दुगिराला लाल, मिदुरुर 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 कोयम्बतूर 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 (14.45 टन/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, त्रिशूर 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 एसके के वी एम एफ 24 (172) तथा डी बी एसके के वी एम एफ 19 (163) जीन प्रकार में अंकित की गयी। जीन प्रकार डी बी एसके 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 एसके के वी एम एफ में अंकित की गयी। जीन प्रकार डी बी एसके 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 लॉग 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 (8.90 कि. 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/ हेक्टेयर) 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 ज़िंक 1.5 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 अ 200 कि. ग्राम एफ वाई एम 1.5 कि.ग्राम ज़िंक 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 ग्राफ्टिंग, 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, करनाटक 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 संबंधित सभी तकनीकी जानकारीयों 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 40 centres (19 regular, 10 co-opting and 9 voluntary centres) supplemented by two more in project mode funding, spreading over various agro climatic zones in 25 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 2023/24 was Rs. 793.7 lakhs.

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/submitting 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 'Aanachuvadan' 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 2023 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 30th October 2023 to 1st November at UHS, Bagalkot university campus Bengaluru.

Profile of AICRP on Spices

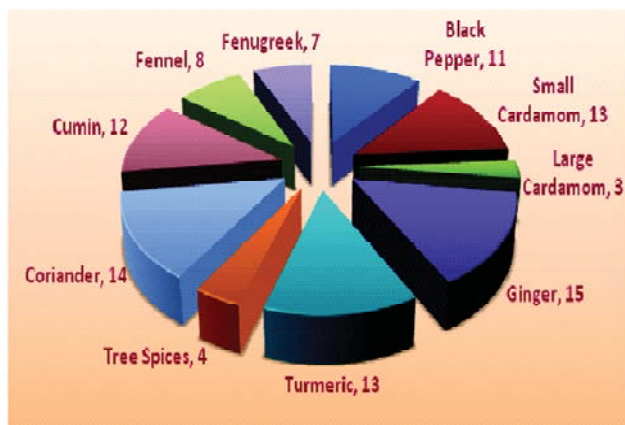
All India Coordinated Research Project on Spices (ICAR-AICRPS) is the largest spices research network in the country through which a nationwide collaborative and interdisciplinary research is being carried out, linking ICAR system with the State Agricultural Universities and central institutions. AICRPS 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

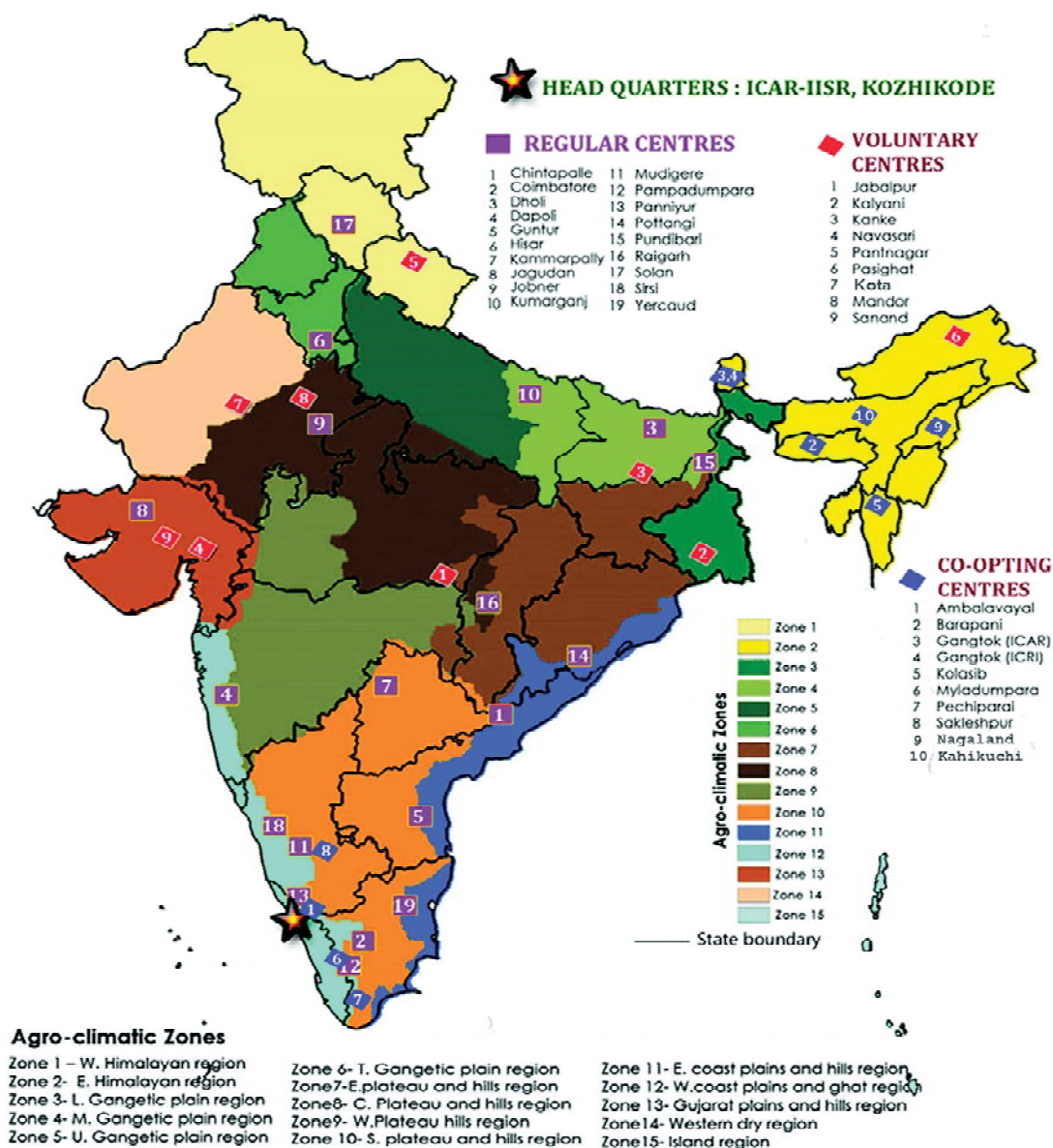


AICRPS centres, year of start and crops handled by the centre

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 (2022-23)

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

Genetic Resources

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

(Centres: Ambalavayal, Dapoli, Panniyur, Pundibari, Sirsi, Yercaud)

Across the nation, a total of 706 black pepper germplasm accessions are preserved at various AICRPS centres. Table 1 provides a comprehensive overview of the black pepper germplasm collections maintained at these centres.

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

Centre	Indigenous		Exotic	New Collections	Total
	Cultivated	Wild & related species			
Ambalavayal	20	-	-	-	20
Dapoli	60	-	-	11	71
Panniyur	333	57	3	10	403
Pundibari	16	6	-	-	22
Sirsi	53	-	-	-	53
Yercaud	137	-	-	-	137
Total	619	63	3	21	706

PRS, Panniyur centre currently manages 333 cultivated types, 57 wild and related types, and 3 exotic types of black pepper. In the 2022-23 period, ten new accessions were gathered from farmers' fields in Wayanad and Iritty and are now being propagated in the nursery.

During 2022-2023, the accessions *PRS 62* and *PRS 157* among germplasm characterized were the top yielders. *PRS 62* achieved the highest green berry yield (4.47 kg green berry yield) with 793 spikes per vine, while *PRS 157* followed with 4.23 kg green berry yield with 811 spikes per vine. Spike length was maximum for *PRS 168* (19.74 cm) followed by *PRS 62* (19.12 cm). *PRS 62* also recorded the highest number of developed berries per spike (42.17), and the highest 100-berry weight (13.50 g) and dry recovery percentage (36.50%) followed by *PRS 158* (100-berry weight of 12.07 & dry recovery % of 35.74 %).

At Dapoli centre, around 60 accessions from the Konkan region are maintained in the germplasm block, at College of Horticulture, Dapoli. After cyclone damage, 11 accessions were reacquired for replanting. Out of 29 accessions evaluated during 2022-23, revealed plant height ranging from 1.78 to 6.98 m. *DBSKKVPN-4* registered maximum vine height of 6.78 m, while the minimum was 1.98 m in *DBSKKVPN-15*. The highest yield per vine, 0.824 kg vine⁻¹, was recorded in *DBSKKVPN-19*, and the lowest was 0.088 kg vine⁻¹ in *DBSKKVPN-17*.

Table 2: Plant Growth Performance of Black Pepper Accessions evaluated at Dapoli during 2022-23

Sr. No.	Name of Accessions	Height (m)	No. of Spikes/Vine	Yield (kg/Plant)	Sr. No.	Name of Accessions	Height (m)	No. of Spikes/Vine	Yield (kg/Plant)
1	DBSKKVPN 1	3.12	224	0.665	17	DBSKKVPN 17	2.5	48	0.088
2	DBSKKVPN 2 (IC – 0611289)	5.48	252	0.712	18	DBSKKVPN 18	3.40	68	0.140
3	DBSKKVPN 3 (IC – 0611290)	6.60	241	0.688	19	DBSKKVPN 19	4.22	304	0.824
4	DBSKKVPN 4 (IC – 0611291)	6.78	188	0.575	20	DBSKKVPN 20	4.32	218	0.415
5	DBSKKVPN 5 (IC – 0611294)	3.72	82	0.210	21	DBSKKVPN 21	2.78	57	0.118
6	DBSKKVPN 6 (IC – 0611292)	-	-	-	22	DBSKKVPN 22	3.56	83	0.188
7	DBSKKVPN 7 (IC – 0611296)	2.12	64	0.121	23	DBSKKVPN 23	2.44	50	0.921
8	DBSKKVPN 8 (IC – 0611295)	3.32	91	0.224	24	DBSKKVPN 24	3.28	85	0.200
9	DBSKKVPN 9	3.10	60	0.118	25	DBSKKVPN 25	3.84	76	0.159
10	DBSKKVPN 10	2.98	74	0.168	26	DBSKKVPN 26	6.42	172	0.563
11	DBSKKVPN 11 (IC – 0611298)	3.10	226	0.428	27	DBSKKVPN 27	4.62	235	0.678
12	DBSKKVPN 12	2.88	116	0.265	28	DBSKKVPN 28	6.30	113	0.300
13	DBSKKVPN 13	2.12	52	0.102	29	DBSKKVPN 29	5.28	244	0.702
14	DBSKKVPN 14	2.22	70	0.145		Mean	3.73	128.96	0.326
15	DBSKKVPN 15	1.98	55	0.110		SD	1.63	84.57	0.250
16	DBSKKVPN 16	2.08	63	0.128		CV%	43.65	0.250	7.67

Sirsi centre maintains 53 accessions of black pepper, out of which 11 got IC numbers. During the current year, at Sirsi centre among the 34 different germplasms of black pepper under field evaluation, significant difference was observed for the traits viz., plant height, number of leaves, leaf length, leaf width, leaf thickness and petiole length. V-2 has recorded the highest mean height (132.40 cm) followed by V-1 (122.97 cm) and lowest height (18.10 cm) by the *Kallabbe*. Whereas, with respect to leaf length, SV-17 recorded maximum (11.67 cm) followed by SV-3 (11.43cm) compared to other germplasms and lowest leaf length (5.33 cm) was recorded in *Yellapur*.



Fig: Germplasm Conservation and Evaluation block at Sirsi Centre

At Yercaud centre, during the year 2022-23, berry set was observed in 28 accessions out of 137 collections made. The spike length of different accessions ranged from 9.90 cm to 14.75 cm. The highest spike length was observed in *PN 11* (14.75 cm) and the lowest spike length was observed in *PN 77* (9.90 cm). The same accession *PN 11* recorded maximum mean number of berries per spike (102.18) followed by *PN 54* (99.42) and *PN 84* (97.70). The maximum green berry yield was recorded in *PN 1* (10.64 kg vine⁻¹). The maximum dry berry yield was recorded in *PN 33* (3.84 kg vine⁻¹) followed by *PN 1* (3.71 kg vine⁻¹).

The germplasm collection maintained at Pundibari is focused on black pepper, a significant spice crop. The collection includes a total of 22 accessions, all of which are indigenous collections. These accessions represent a variety of types, including 2 landraces, 3 farmers' varieties, and 11 released varieties. Additionally, 6 related species are also conserved.

The trial in Ambalavayal started in 2010 and is continuing. A total of 20 accessions are maintained in the germplasm. The accessions maintained are *Girimunda*, *Thevam*, *Sreekara*, *Subhakara*, *Vijay*, *Sakthi*, *Panchami*, *Pournami*, *Palode 2*, *Malabar Excel*, *Panniyur 1*, *Panniyur 2*, *Panniyur 3*, *Panniyur 4*, *Panniyur 5*, *Panniyur 6*, *Panniyur 7*, *Panniyur 8*, *Thekkan*, *Cul 5308*, (Total number-20).

This comprehensive germplasm collection across various centre's highlights the extensive efforts dedicated to preserving and enhancing black pepper varieties, ensuring their continued availability and improvement for future generations.

Crop Improvement

PEP/CI/3.5: Coordinated varietal trials (CVT) on farmer's varieties of black pepper

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

The trial which was initiated during 2015 is in progress concurrently at five centres (Chintapalle, Sirsi, Panniyur, Dapoli and Yercaud). The trial consists of three popular farmers' varieties viz., *Zion mundi*, *Pepper Thekkan*, *Kumpukkal* along with check variety, *Panniyur-1*. The experiment was laid in RBD with four replications having 6 plants per plot.

During 2022-23, pooled analysis of farmers varieties of black pepper evaluated at different centres for various yield parameters revealed *Panniyur-1* as the superior genotype for spike length, Fresh and dry berries per plant and dry recovery. However, for the number of berries per spike *Kumpakkal* showed superiority with 34.01 over 31.33 in check, *Panniyur-1*. (Table. 2)

Table 2. Pooled data of yield parameters recorded across testing locations for CVT 2015 on Farmers' varieties during 2022-23

Entries	Spikelength (cm)	Number of berries per spike	Fresh berry yield per vine (kg)	Dry berry yield per vine (kg)	Dry recovery (%)
<i>Zion mundi</i>	9.3	61.9	1.11	0.32	29.17
<i>Kumpukkal</i>	9.8	70.6	1.21	0.41	34.01
<i>Pepper Thekkan</i>	8.6	63.5	0.95	0.30	31.77
<i>Panniyur-1 (Check)</i>	12.5	67.3	1.59	0.50	31.33
Mean	10.1	65.9	1.22	0.39	31.58

During 2022-23, there was significant difference among the treatments with respect to the yield-related characters such as the spike length, average number of berries per spike, fresh berry yield, dry berry yield and dry recovery. *Panniyur-1* recorded highest spike length of 16.00 cm followed by *Karimunda* (12.17 cm), *Zion Mundi* (11.42 cm), *Pepper Thekkan* (10.30 cm) and *Kumpukkal* (9.97 cm) which were on par with each other. *Panniyur-1* (69.67) recorded maximum average number of berries per spike which was statistically on par with *Pepper Thekkan* (64.93) followed by *Karimunda* (54.42). *Panniyur-1* recorded highest fresh berry yield of 1.61 kg vine⁻¹, which was on par with *Karimunda* (1.49 kg vine⁻¹), and *Kumpukkal* (1.31 kg vine⁻¹). Maximum dry berry yield was observed in *Panniyur-1* (0.54 kg/vine) which was on par with *Karimunda* (0.49 kg/vine) and *Kumpukkal* (0.49 kg vine⁻¹). The dry recovery per cent was the highest for *Kumpukkal* (37.05 %) followed by *Panniyur 1* (33.43 %) and *Karimunda* (32.76 %), which were on par with each other. (Table. 3).

Table 3. CVT 2015 on Farmers' varieties – Yield parameters at PRS, Panniyur during 2022-23

Entries	Average spike length (cm)	No of berries / spike	Green berry yield (kg)	Dry berry yield (kg)	Dry recovery %
<i>Zion mundi</i> (T ₁)	11.42 ^b	38.72 ^c	0.80 ^b	0.24 ^b	30.35 ^c
<i>Pepper Thekkan</i> (T ₂)	10.30 ^b	64.93 ^a	0.89 ^b	0.27 ^b	30.85 ^c
<i>Kumpukkal</i> (T ₃)	9.97 ^b	34.55 ^c	1.31 ^a	0.49 ^a	37.05 ^a

<i>Panniyur-1</i> (T ₄)	16.00 ^a	69.67 ^a	1.61 ^a	0.54 ^a	33.43 ^b
<i>Karimunda</i> (T ₅)	12.17 ^b	54.42 ^b	1.49 ^a	0.49 ^a	32.76 ^b
CD (0.05)	2.79	6.72	0.33	0.12	1.00
CV %	12.36	6.80	14.38	15.25	1.61

At Sirsi, among the four different varieties, the national check variety (*Panniyur-1*) recorded the highest mean vine height (4.68 m) and spike length (11.60 cm,) and lowest height (2.26 m) by *Zion mundi* and lowest spike length (5.24 cm) was recorded in *Pepper Thekkan*. Concerning number of spikes, in *Kumpukkal* recorded maximum (58) but the no. of berries per spike was maximum for *Zion mundi* (81) compared to other varieties. Among all four varieties, *Panniyur-1* recorded highest green berry yield per vine (1.61 kg), followed *Kumpukkal* (1.01 kg) which is on par with *Zion mundi* (0.96 kg) and lowest yield (0.85 kg) was recorded in *Thekkan*. Still *Pepper Thekkan* recorded the among pepper entries with high dry recovery of 38.70%. (Table. 4)

Table 4. CVT 2015 on Farmers' varieties – Yield parameters at HRS, Sirsi during 2022-23

Entries	Av. Vine Height (m)	No. of spikes	Average spike length (cm)	No. of berries/spike	Green berry yield (kg)	Dry berry yield (kg)	Dry recovery %
<i>Zion mundi</i> (T ₁)	2.26 ^d	38 ^c	6.10 ^b	81 ^b	0.96 ^{bc}	0.285	29.47 ^b
<i>Pepper Thekkan</i> (T ₂)	3.17 ^c	26 ^d	5.24 ^c	94 ^a	0.85 ^c	0.313	38.70 ^a
<i>Kumpukkal</i> (T ₃)	3.43 ^b	58 ^a	7.26 ^b	64 ^c	1.01 ^b	0.394	36.64 ^a
<i>Panniyur-1</i> (T ₄)	4.68 ^a	44 ^b	11.60 ^a	58 ^d	1.61 ^a	0.549	33.89 ^{ab}
CD (0.05)	0.48	7.16	1.16	10.8	0.168	NS	5.02
CV %	10.82	11.36	11.15	10.56	10.99	38.25	10.50

At Chintapalle, Kumbakkal recorded the maximum plant height (4.98 m), more number of branches (21.41), no. of berries per spike (100.76). *Panniyur-1* recorded the highest berry yield per vine (0.94 kg fresh and 0.29 kg dry berry) and dry recovery percentage (30.64%). At Yercaud, the highest vine length was recorded in *Zion Mundi* (3.46 m) followed by *Thekkan* and *Panniyur 1* (3.20 m). The maximum number of branches per vine was recorded in *Panniyur-1* (11.8). The highest number of spikes per meter square (29.81) was recorded in *Kumbakkal* followed by *Panniyur-1* (29.70). The number of berries per spike was highest in the variety *Panniyur-1* (59.27) followed by *Zion Mundi* (54.46). The same variety recorded the highest spike length (10.84). The highest green berry yield was recorded in *Panniyur-1* (1.459 kg vine⁻¹). At Dapoli, the black pepper trial, replanted in June, 2021 after cyclone damage and again in September, 2022, shows satisfactory growth, but still in the vegetative stage. The tallest was *Pepper Thekkan* (1.20 m), and the shortest was *Kumpukkal* (0.95 m).

PEP/CI/3.5: Coordinated varietal trials (CVT) 2015 on Black pepper Series VIII

(Centres: Chintapalle, Sirsi, Panniyur, Dapoli, Yercaud, Kahikuchi)

The trial, which was initiated in 2015 is in progress concurrently at six centres viz., Chintapalle, Sirsi, Panniyur, Dapoli, Yercaud and Kahikuchi. The trial consists of six

test entries viz., *Vijay*, *Arka Coorg Excel*, *PRS 160*, *PRS 161*, *SV 11*, and *SV 17* evaluated along with two national checks, *IISR Thevam* and *Panniyur-1*. The experiment was laid in RBD with three replication each having 6 plants per plot.

During 2022-23 evaluation at Panniyur centre, there noticed significant difference among the treatments with respect to the yield-related characters such as the spike length, average number of berries per spike, fresh berry yield, dry berry yield and dry recovery. *PRS 161* recorded highest spike length of 21.67 cm which was on par with *PRS 160* (20.78 cm) followed by *Vijay* (18.05 cm) and *Panniyur-5* (17.16 cm). *PRS 161* (68.02) recorded maximum average number of berries per spike followed by *Panniyur-5* (33.11). *PRS 161* recorded highest fresh berry yield of 1.92 kg vine⁻¹ which was on par with *SV 11* (1.57 kg vine⁻¹). All other genotypes were on par with each other in fresh berry yield. Maximum dry berry yield was observed in *PRS 161* (0.70 kg vine⁻¹) followed by *SV 11* (0.55 kg vine⁻¹) which was on par with *Karimunda* (0.53 kg vine⁻¹), *SV 17* (0.48 kg vine⁻¹), *Panniyur-1* (0.47 kg vine⁻¹), *Panniyur-5* (0.47 kg vine⁻¹) and *PRS 162* (0.42 kg vine⁻¹). The dry recovery per cent was the highest for *PRS 161* (36.65 %) followed by *Panniyur-1* (35.32 %), *Karimunda* (35.11 %), *SV 11* (34.99 %) and *Panniyur 5* (34.93 %) which were on par with each other (table 5). At Yercaud, the highest vine height was recorded in *Panniyur-1* (3.12 m) followed by *Vijay* (3.10 m). The maximum number of branches per vine was recorded in *PRS 161* (9.82). The highest number of spikes per meter square (18.86) was recorded in *IISR Thevam* followed by *Panniyur-1* (18.69). The number of berries per spike was highest in the varieties *SV 17* and *Panniyur-1* (81.00). With respect to vine length, *Panniyur-1* recorded highest vine length (3.75 m) followed by *SV-11* (3.67 m) and lowest vine length was observed in *Arka Coorg Excel* (2.52 m). Similarly, *Panniyur-1* recorded highest number of spikes per vine (36) followed by *SV-11* (21) and *IISR Thevam* (19). Lowest number of spikes per vine was recorded in *PRS-161* (6) at Sirsi centre. At Kahikuchi, earliness of flowering was recorded in *Panniyur-1* (Check) followed by *Arka Coorg Excel* and *Vijay* with a fresh berry yield 2.85 kg, 2.60 kg and 2.30 kg per vine per year, respectively. Similarly dry berry yield was recorded highest in *Panniyur-1* (1.048 kg vine⁻¹) followed by *Arka Coorg Excel* (0.785 kg vine⁻¹) and *Vijay* (0.762 kg vine⁻¹).



Fig: CVT Trial plot at Kahikuchi and sirsi with arecanut as standards

Table 5. CVT 2015 on Black pepper Series VIII – Yield parameters at PRS, Panniyur

Entries	Average spike length (cm)	No of berries / spike	Green berry yield (kg)	Dry berry yield (kg)	Dry recovery %
<i>PRS 161</i> (T ₁)	21.67 ^a	68.02 ^a	1.92 ^a	0.70 ^a	36.65 ^a
<i>PRS160</i> (T ₂)	20.78 ^a	26.50 ^c	1.26 ^b	0.42 ^{bcd}	33.16 ^c
<i>SV17</i> (T ₃)	14.89 ^d	27.00 ^{bc}	1.45 ^b	0.48 ^{bcd}	32.80 ^c
<i>SV11</i> (T ₄)	14.50 ^d	27.39 ^{bc}	1.57 ^{ab}	0.55 ^b	34.99 ^b
<i>Panniyur-1</i> (T ₅)	16.00 ^{cd}	26.33 ^c	1.34 ^b	0.47 ^{bcd}	35.32 ^b
<i>Panniyur 5</i> (T ₆)	17.17 ^{bc}	33.11 ^b	1.34 ^b	0.47 ^{bcd}	34.93 ^b
<i>Karimunda</i> (T ₇)	12.17 ^e	24.33 ^c	1.49 ^b	0.53 ^{bc}	35.11 ^b
<i>Arka Coorg Excel</i> (T ₈)	9.71 ^f	15.36 ^d	1.19 ^b	0.39 ^d	32.74 ^c
<i>Vijay</i> (T ₉)	18.05 ^b	28.32 ^{bc}	1.20 ^b	0.40 ^{cd}	33.20 ^c
<i>IISR Thevam</i> (T ₁₀)	8.95 ^f	11.33 ^d	1.23 ^b	0.41 ^{cd}	33.05 ^c
CD (0.05)	2.02	6.52	0.39	0.14	0.77
CV %	7.65	13.20	16.33	16.79	1.32

PEP/CI/3.7: Coordinated varietal trials (CVT) 2018 on Black pepper Series IX

(Centres: Ambalavayal, Chintapalle, Sirsi, Panniyur, Kozhikode, Dapoli, Yercaud)

The trial which was initiated during 2018 is in progress concurrently at seven centres viz., Ambalavayal, Chintapalle, Sirsi, Panniyur, Kozhikode, Dapoli and Yercaud. The trial consists of ten test entries viz., *HP 780*, *HP 1411*, *OPKM*, *HP 117 X Thommankodi*, *IISR Thevam*, *Kumpukkal*, *Ponmani*, *PRS 137*, *SV 7*, *Kurimalai* along with *Panniyur-1* (check). The experiment was laid in RBD with three replications, each with six plants per replication.

Table : 6 Yield and yield-contributing traits recorded in entries in CVT 2018 trial

Entries	Spike length (cm)	No. of berries/spike	Green berry yield/vine (kg)	Dry berry yield/vine (kg)	Dry recovery (%)
HP 780	11.3	66.2	0.619	0.232	36.105
HP- 1411	10.4	79.1	0.739	0.243	36.350
OPKM	11.1	57.6	0.522	0.171	34.467
New HP	9.8	71.3	0.665	0.198	31.115
IISR-Thevam	10.3	60.5	0.585	0.124	25.200
Kumpukkal	10.8	66.0	0.649	0.209	35.695
Ponmani	10.3	58.9	0.425	0.177	38.930
PRS- 137	10.4	60.8	0.535	0.156	31.375
SV -7	10.9	73.6	0.428	0.139	34.560
Kurimalai	11.8	54.6	0.585	0.198	35.643
Panniyur-1	10.4	52.0	0.416	0.177	36.427
Mean	11.0	80.3	0.217	0.084	38.220

Note: The data represents the mean values recorded from Dapoli, Yercaud, and Panniyur centres. Other locations are in the vegetative stage.

Based on the mean values across different traits recorded from Dapoli, Yercaud and Panniyur centre during 2022-23, among the entries, *HP-1411* exhibited the highest number of berries per spike (79.1), while *Kurimalai* recorded the longest spike length (11.8 cm). In terms of green berry yield per vine, *HP-1411* (0.739 kg) performed the best, followed by *HP-2127* (0.665 kg) and *Kumbakal* (0.649 kg). For dry berry yield per vine, *HP-1411* (0.243 kg) and *HP 780* (0.232 kg) showed superior performance. Ponmani recorded the highest dry recovery percentage (38.93%), indicating a better conversion of green berries to dry yield. At AICRPS centres viz., Ambalavayal, Chintapalle, Sirsi, and Kozhikode, crop is still at vegetative stage.

Crop Management

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

(Centres: Ambalavayal, Dapoli, Sirsi, Panniyur)

The black pepper-based mixed cropping system trial for ensuring sustainable productivity and food security was initiated in 2014 at four centres with six intercrop treatments viz., colocasia (T₁), arrowroot (T₂), elephant foot yam (T₃), Cassava (T₄) and greater yam (T₅), as intercrops and sole crop of black pepper as control (T₆).

During 2022-23, the experiment was concluded. The dry berry yield of black pepper based on individual centre data as well as pooled analysis, indicated varying performance across different treatments. In the pooled data analysis, the highest dry berry yield was observed with the T₅, yielding an average of 0.991 kg vine⁻¹, followed by T₄ at 0.867 kg vine⁻¹. Other treatments, such as T₁ and T₃, yielded 0.868 kg vine⁻¹ and 0.837 kg vine⁻¹, respectively. However, the analysis also revealed that the differences in dry berry yield among the treatments were not statistically significant at certain centres and in pooled analysis, indicating that while some combinations showed promise, the overall impact on black pepper yield was variable and did not consistently favour any specific intercrop across all locations.

Among the intercrops, the highest yield was achieved with the treatment of elephant foot yam + pepper (T₃), which produced an average of 6.121 kg per 8 m² interspace. This was followed by T₄, yielding 5.416 kg, T₂, with a yield of 3.255 kg. In contrast, the treatment of T₅ yielded 4.903 kg, while T₁ yielded 2.723 kg. Notably, the results indicated that the intercrops, particularly elephant foot yam and cassava, significantly contributed to the overall productivity of the pepper garden under pooled analysis, displaying the potential of these mixed cropping systems to enhance yield and optimize land use. However, the analysis also highlighted that the yield differences were not statistically significant at certain centres, suggesting that while some combinations were productive, the effectiveness of intercrops can vary based on location and environmental factors.

Hence the conclusion of the experiments was drawn based on the benefit-cost ratio in which the centre-wise benefit-cost (B:C) ratio obtained from the mixed farming

systems involving black pepper and various intercrops were assessed and following recommendation made:

Ambalavayal: Here, the treatment of cassava + black pepper yielded the highest B:C ratio of 1.34, while the elephant foot yam + black pepper treatment had a ratio of 2.40, suggesting that these combinations were more profitable compared to others.

Dapoli: The treatment of elephant foot yam + black pepper again showed a strong performance with a B:C ratio of 3.08, while other treatments like arrowroot + black pepper and colocasia + black pepper had ratios of 2.06 and 2.04, respectively.

Panniyur: The highest B:C ratio was observed with the treatment of elephant foot yam + black pepper (3.57), indicating a strong profitability from this combination. Other treatments also showed favorable ratios, such as greater yam + black pepper (3.45) and arrowroot + black pepper (2.61).

Sirsi: The treatment of elephant foot yam + black pepper led to the highest B:C ratio of 3.77, indicating significant profitability. Other treatments, such as cassava + black pepper and greater yam + black pepper, also showed competitive ratios of 3.07 and 2.86, respectively.

Overall, the mixed cropping systems, particularly those involving elephant foot yam, consistently demonstrated higher B:C ratios across the centers, highlighting their potential to enhance profitability in black pepper cultivation while maintaining sustainable agricultural practices.

Crop Protection & Food Safety

PEP/CP/5.8: Evaluation of strobilurin fungicides and actinomycetes for the management of foot rot and slow decline in black pepper

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

The study was conducted across five centers, initiated in the 2020-21 period, and concluded in 2023 after three years of testing. The trial was conducted in a plot consisting of 80 black pepper vines of the same age, planted at a spacing of 3m × 3m. The trial was laid out in a RBD with four replications and five treatments. Each replication included one set of all five treatments, with each treatment consisting of four vines per replication. The treatments applied in the study were as follows: T₁: Foliar spray with Bordeaux mixture (1%) combined with a soil application of Actinobacteria (Act 1+5+9) at a rate of 50 g vine⁻¹; T₂: Foliar spray with Bordeaux mixture (1%) along with soil application of *Trichoderma harzianum* (MTCC 5179) and *Pochonia chlamydosporia* (MTCC 5412) at 50 g vine⁻¹; T₃: Foliar application of Ergon 44.3% (W/W) [Kresoxim methyl 500 G/L] and soil application of Ergon at 7 ml L⁻¹, supplemented with Carbosulfan at 1 ml L⁻¹, applied at 2-3 L vine⁻¹; T₄: Foliar application of Metalaxyl-Mancozeb at 1.25 g L⁻¹, with a corresponding soil application of Metalaxyl-Mancozeb at 1.25 g L⁻¹ plus Carbosulfan at 1 ml L⁻¹; T₅: Following the recommended State Package of Practices, including a foliar spray with Potassium Phosphonate at 3 ml L⁻¹ and soil application of Carbosulfan at 1 ml L⁻¹, applied at 2-3 L vine⁻¹.

The pooled data analysis for the various parameters related to trial reveals the following inferences based on superiority and statistical significance:

Dry Yield: The highest dry yield of 1.17 kg per vine was observed in T₂ followed by T₁ averaging 1.04 kg vine⁻¹, which was statistically non-significant, compared to other treatments. **Yellowing %:** T₁ showed the least yellowing symptoms at 10.5% closely following 11.11%, indicating effective disease management. **Spike length & berry set:** The treatment T₄ resulted in the longest average spike length at 12.96 cm and highest fruit set percentage at 66.89% in T₁ closely followed by T₂ (65.31%). **Average no of berries per spike:** it was highest in T₁ (61.42) followed by T₂ (60.01). **Bulk density:** similarly trend with the bulk density was highest in the treatment with T₁ (556.33 g L⁻¹), essential oil (2.27%) all highest in which T₁. However, the treatments are found non-significant association with all the traits. Hence the recommendation was made considering the BC ratio.

BC Ratio (BCR): The economic analysis of crop protection measures for black pepper, based on the BCR, reveals valuable insights into the financial viability of different treatments. The treatments exhibited varying BC ratios, indicating their economic effectiveness:

T₁ (*Actinobacteria* + Bordeaux mixture): The BCR was 1:1.7 in Panniyur and 1:1.14 in Dapoli, suggesting a favourable return on investment, particularly in Panniyur.

T₂ (*Trichoderma harzianum* + *Pochonia chlamydosporia*): This treatment showed a BCR of 1:1.2 in Panniyur and 1:1.22 in Dapoli, indicating a moderate economic return.

T₃ (Ergon + Carbosulfan): The BCR was lower at 1:1.0 in Panniyur and 0.70 in Dapoli, suggesting that this treatment may not be economically justified.

T₄ (Metalaxyl-mancozeb + Carbosulfan): This treatment had a BCR, 1:1.9 in Panniyur and 1:1.13 in Dapoli, indicating it is the most economically beneficial option, particularly in Panniyur.

T₅ (Recommended state package): The BCR was 1:1.7 in Panniyur and 1:1.20 in Dapoli, showing a strong economic return, similar to T₁.

In summary, treatments T₁, T₄, and T₅ demonstrated the highest BCR, indicating they are the most economically viable options for crop protection in black pepper cultivation.

PEP/CP/5.10: Observational trial on the efficacy of *Trichoderma asperellum* & *Pochonia chlamydosporia* for the management of *Phytophthora* foot rot and nematodes in black pepper.

(Centres: Appangala, Panniyur, Sirsi)

The observational trial was Initiated in 2021, aiming to evaluate the effectiveness of different biological and chemical treatments against foot rot of black pepper and nematode. Trial is being conducted in a plot of a total of 24 black pepper vines of popular improved varieties suited to each location following RBD pattern with six treatments replicated four times. The treatments included a control (T₁), *T. asperellum* talc formulation (T₂), *T. asperellum* biocapsule formulation (T₃), Metalaxyl-

Mancozeb fungicidal drench (T₄), *P. chlamydosporia* liquid formulation (T₅), and a recommended nematicide (T₆). Application was carried out twice a year, during May-June and September-October.

In the Panniyur experiment, the lowest incidence of *Phytophthora* foot rot disease was observed in treatments T₄ and T₆, both showing a PDI (Percent Disease Index) of 7.5%. Treatments T₂, T₃, and T₅, which involved various formulations of *Trichoderma asperellum* and *Pochonia chlamydosporia*, showed a PDI of 12.5%, performing significantly better than the control (T₁) which had a PDI of 18.5%. Regarding vegetative growth parameters, no significant differences were observed among the treatments in terms of plant height and the number of leaves. However, the dry berry yield was highest for T₄ and T₆, yielding 1.74 kg vine⁻¹, significantly outperforming other treatments.

In the Sirsi center, the second-year results (2022-23) of the experiment initiated in 2021-22 indicated that T₄ recorded the least foliar infection at 18.93%, which was statistically on par with T₂ (19.57%). The highest foliar infection was observed in the control (33.52%). In terms of yield, T₂ (26.72 q ha⁻¹) recorded the highest green berry yield, which was statistically on par with T₄ (24.66 q/ha) and T₃ (23.56 q ha⁻¹). The control treatment (T₁) had the least green berry yield at 16.67 q ha⁻¹.

An observational trial was conducted with the *IISR Panchami* variety at Appangala (at ICAR-IIHR, CHES, Chettali). The second-year results showed no significant differences between the treatment and control groups, primarily due to the low natural incidence of the disease during the year.

Treatments	PDI			Dry berry yield (kg vine ⁻¹)			BC RATIO
	Panniyur*	Appangala	Sirsi	Panniyur	Appangala	Sirsi	
T ₁	18.5 (25.62)	12.5	8.33	1.61	1.218	0.64	1: 1.7
T ₂	12.5 (20.18)	9.38	12.50	1.34	1.328	0.57	1: 1.2
T ₃	12.5 (20.18)	6.25	8.33	1.30	2.804	0.59	1: 1.0
T ₄	7.5 (15.68)	12.5	18.74	1.74	0.936	0.55	1: 1.9
T ₅	18.5 (25.31)	6.25	18.74	1.65	1.7	0.51	1: 1.7
T ₆	7.5 (15.69)	6.25	22.91	1.74	1.16	0.40	1:1.9
C.D.	7.17	NS	3.65	0.27	NS	0.09	
C.V. (%)	23.26	27.74	8.81	11.24	32.88	8.81	

*Figures in parentheses are arc sine transformed values

Fig 4: Observational trial on the management of *Phytophthora* foot rot and nematodes in black pepper at Panniyur and Sirsi



PEP/CP/7.1: Screening of insecticides for pollu beetle, *Lanka ramakrishnai* in black pepper

(Centres: Appangala, Panniyur)

The screening trial for insecticides was initiated during *kharif*, 2021 to evaluate the eight treatments, including insecticides at different concentrations and a control (water spray), replicated four times. The treatments comprised Chlorantraniliprole at 0.3 ml L^{-1} (T₁) and 0.5 ml L^{-1} (T₂), Flubendiamide at 0.3 ml L^{-1} (T₃) and 0.5 ml L^{-1} (T₄), Spinetoram at 0.3 ml L^{-1} (T₅) and 0.5 ml L^{-1} (T₆), Quinalphos at 2 ml L^{-1} (T₇), and a control treatment (T₈). The trial was conducted on popular improved varieties of black pepper suited to each location. The first spray was applied in August, followed by subsequent sprays at monthly intervals, with a total of four applications. The study aimed to identify the most effective insecticide for pollu beetle management while ensuring economic feasibility and safety in black pepper cultivation.

The yield performance as well as disease incidence indicated by PDI varied significantly across locations. At Panniyur, regarding the percentage of damage all treatments T₂ (Chlorantraniliprole @ 0.5 ml) showed the lowest percent damage (0.44). T₁ and T₄ were on par with 0.53 and 1.23. Remaining treatments were on par except the absolute control with 13% damage. Dry berry yield was on par for T₁ and T₂ with $0.87 \text{ kg vine}^{-1}$. Remaining treatments were on par except the absolute control with $0.53 \text{ kg vine}^{-1}$.

At Appangala, Treatment T₆ showed the highest disease incidence, producing 3.94% PDI, which is on par with T₂ (4.78), T₄ (4.16) and T₅ (4.36), significantly outperformed the other treatments.

Benefit-Cost (BC) ratio at Panniyur indicated that T₁ provided the most economic benefit, with the highest BC ratio of 2.098. Treatment T₂ also showed a favourable BC ratio of 2.042, while T₆ and T₇ followed closely with BC ratios of 1.86 and 1.92, respectively. The lowest BC ratio was recorded in T₈, with a value of 1.66, indicating lower economic returns compared to other treatments.

Treatments	Appangala	Panniyur	Sirsi	Dry berry yield (kg vine ⁻¹) at Panniyur	B:C ratio at Panniyur
T ₁ : Chlorantraniliprole @ 0.3 ml L ⁻¹	6.87 ^{bc}	0.533 (0.118) ^{bc}	23.60	0.875 ^a	2.098
T ₂ : Chlorantraniliprole @ 0.5 ml L ⁻¹	4.78 ^d	0.441 (0.066) ^c	19.16	0.875 ^a	2.042
T ₃ : Flubendiamide @ 0.3 ml L ⁻¹	5.23 ^{cd}	1.993 (0.141) ^b	25.46	0.784 ^b	1.85
T ₄ : Flubendiamide @ 0.5 ml L ⁻¹	4.16 ^d	1.298 (0.114) ^{bc}	23.29	0.784 ^b	1.80
T ₅ : Spinetoram @ 0.3 ml L ⁻¹	4.36 ^d	2.267 (0.151) ^b	26.73	0.742 ^b	1.80
T ₆ : Spinetoram @ 0.5 ml L ⁻¹	3.94 ^d	2.440 (0.157) ^b	25.68	0.784 ^b	1.86
T ₇ : Quinalphos @ 2 ml L ⁻¹	8.47 ^b	2.240 (0.150) ^b	17.40	0.784 ^b	1.92
T ₈ : Control (Water Spray)	13.23 ^a	13.894 (0.382) ^a	40.77	0.53 ^c	1.66
CD	2.24	1.67	8.05	0.059	
CV	10.69	4.09	18.20	4.383	



Fig 5: Experimental plot undertaken at PRS, Panniyur, Kerala for screening of insecticides for pollu beetle, Lanka ramakrishnai in black pepper.

Genetic Resources

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

(Centres: Pampadumpara, & Mudigere)

A total of 324 small cardamom germplasm accessions are currently being maintained by AICRPS centres *viz.*, Pampadumpara and Mudigere. The details of the germplasm collection maintained are given in Table 57.

Table 57. Cardamom germplasm collections maintained at various AICRPS centres

AICRPS Centre	Cultivated	Wild and Related Species	Total
Mudigere	132	Nil	132
Pampadumpara	188	4	192
Total	320	4	324

The germplasm collection of small cardamom at CRS, Pampadumpara, is both extensive and diverse, comprising a total of 188 cultivated germplasm accessions.



Fig Photograph of unique accession of cardamom, *Aryananda* (CRSP 186)

Additionally, the centre maintains four wild relatives of small cardamom. Notably, 102 accessions have already obtained IC Numbers from the NBPGR. During 2022-23, planting materials from seven new accessions were deposited and accepted at the NAG Centre in Appangala. Two unique accessions, *Miracle Elaichi* and *Erumathuruthiyil Elam*, were collected last year from the Adimali and Vandiperiyar areas. During the current season, another new accession of the Malabar type, namely *Aryananda*, was collected from the Kochera area of Idukki

district. This accession is characterized by a robust plant stature and branched panicles. These newly added accessions have been included in the field gene bank.

Under germplasm evaluation, the data suggest that *CRSP 23*, *CRSP 25*, and *CRSP 48* are among the top-performing. *CRSP 23* (PPK 2) stands out for its heavy sized capsules (139g for 100 capsule), long capsule size (2 cm) but has a lower dry recovery (15%). *CRSP 25* (BEP 2) and *CRSP 48* (PS28) are promising accessions with high fresh weights (455 g and 309 g, respectively) and dry weights (79 g and 64 g, respectively), coupled with good dry recovery (17.4% and 20.7%, respectively), making them strong candidates for cultivation with high yield potential.

Table 58: Summary of germplasm evaluation of cardamom accessions at CRS, Pampadumpara (2022-23)

Accession Number	Pedigree	100 cap. wt. (g)	100 cap volume (ml)	Capsule Length (cm)	Capsule width (cm)	No. of seeds/cap wt. (gm)	Fresh Wt. (gm)	Dry wt. (gm)	Dry recovery
CRSP 22	PPK 1	136	120	1.7	1.46	21	398	66.5	16.7
CRSP 9	PV3	100	100	1.5	1.45	18	310	63	20.3
CRSP 8	PV2	100	100	1.5	1.15	16	349	62	17.8
CRSP 23	PPK 2	139	150	2.0	1.15	19	448	67	15.0
CRSP 48	PS28	115	120	2.0	1.40	20	309	64	20.7
CRSP 58	SAM 7	116	130	1.5	1.34	21	277	49	17.7
CRSP 29	PS 4	95	90	1.5	1.27	16	175	33	18.9
CRSP 30	PS 5	104	100	1.4	1.34	19	225	45	20.0
CRSP 113	Clonal Selection	115	130	1.9	1.34	16	266	46	17.3
CRSP 89	HY 18	89	80	1.4	1.27	19	129	21	16.3
CRSP 52	SAM 1	81	70	1.5	1.31	16	191	36	18.8
CRSP 24	BEP 1	110	120	2.0	1.15	16	293	50	17.1
CRSP 25	BEP 2	109	110	1.5	1.27	20	455	79	17.4
CRSP 10	PV 4	89	100	1.5	1.11	21	152	26	17.1
CRSP 115	BABU 3	85	100	1.9	1.15	13	150	30	20.0

The germplasm collection of small cardamom at ZAHRS, Mudigere, is equally robust, with a total of 132 germplasm entries. During 2022-23, a set of 101 accessions were evaluated in augmented design, showcasing significant variations in agronomic traits. Among these, the accession, *M-2* recorded the maximum plant height at 360.21 cm. *SKP-170* emerged as a superior accession with the highest number of tillers per clump (75.43) and demonstrated excellent performance in terms of panicles per clump and yield per plant, with values of 35.46 and 470.50 g plant⁻¹, respectively.

Crop Improvement

CAR/CI/3.8: Coordinated varietal trials (CVT) on Farmers varieties of Cardamom - Series VIII

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

The coordinated varietal trial on farmers' varieties of cardamom aims to evaluate the performance of different farmers varieties of small cardamom in different tracts. The trial was laid out in RBD with eight farmer's varieties viz., *Arjun*, *Wonder Cardamom*, *Panikulangara*, *Thiruthali*, *Elarajan*, *Patchakai*, *Pappalu* and *PNS Gopinath*, supplied by the National Innovation Foundation (NIF), along with *Njallani Green Gold* (national check) and a local check variety in three replications (Fig. 7). The trial was initiated during 2017 at 5 AICRPS centres. Observations on morphological and yield parameters (plant height, number of tillers, number of bearing tillers; number of panicles and panicle length) were recorded.

Table 59: Data of CVT on farmers varieties of cardamom recorded 2022-23 for dry yield of capsules per hactere

Entries	AGL	PAM	MDG	SKP	MYL	Mean	Rank	%IOC
V ₁ -Thiruthali	274	311	265	932	1365	629	1	5.3
V ₂ -Wonder cardamom	122	352	245	784	1313	563	3	-5.7
V ₃ -Njallani Green Gold (Check)	150	190	265	768	1615	598	2	0
V ₄ -Panikulangara	302	152	270	552	1223	500	6	-16.4
V ₅ -Elarajan	150	206	225	711	1108	480	7	-19.7
V ₆ -Pappalu	159	371	256	841	1003	526	5	-12
V ₇ -Arjun	148	385	243	818	1156	550	4	-7.9
V ₈ -Patchaikkai	116	270	185	599	1210	476	9	-20.3
V ₉ -PNS Gopinath	127	--	232	--	1079	479	8	-19.8
V ₁₀ -Local Check	196	303	253	783	1486	604		
CV (%)	65	37.1	7.04	15	18.5			
CD @ 5%	113	43.7	29	202	398			

Where, AGL: Appanagala; PAM: Pampadumpara; MDG: Mudigere; SKP: Sakleshpura; MYL: Myladumpara, %IOC: Percentage increment over check.

Across location, *Thiruthali* (V₁) recorded the highest dry capsule yield per hectare (mean: 629 kg ha⁻¹), ranking 1st with a 5.3% increase over the national check (*Njallani Green Gold*). *Njallani Green Gold* achieved a mean yield of 598 kg ha⁻¹, ranking 2nd. *Wonder Cardamom* (V₂) and *Arjun* (V₇) followed closely with mean yields of 563 kg ha⁻¹ and 550 kg ha⁻¹, ranking 3rd and 4th, respectively.

CAR/CI/3.9: Coordinated varietal trial (CVT) on hybrids of cardamom-Series IX

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

The CVT on hybrids of small cardamom aims to evaluate the performance of F₁ hybrids of small cardamom in different tracts. The trial laid out in RBD with nine F₁ hybrids of small cardamom viz., (GG x NKE 19) x Bold (Appangala), GG x Bold Appangala 1 (Appangala), Bold x IC 547219 (Appangala), MHC-1 (Myladumpara), MHC-2 (Myladumpara), SHC-1 (Sakleshpur), SHC-2 (Sakleshpur), PH-13 (Pampadumpara), PH-14 (Pampadumpara) and two standard checks (Njallani Green Gold and Mudigere-1) in three replications. The trial initiated during 2020 at five AICRPS centres. Observations on morphological and yield parameters (plant height, number of tillers, number of bearing tillers; number of panicles and panicle length) were recorded.

At Appangala, among the hybrids, highest fresh (1.71 kg plant⁻¹) and dry weight per plant (0.32 kg plant⁻¹) was recorded in the hybrid Bold x IC 547219 followed by PH 13 (1.43 kg fresh capsules plant⁻¹ and 0.27 kg dry plant⁻¹) and PH 14 (1.42 kg capsules fresh plant⁻¹ and 0.29 kg dry capsules plant⁻¹). Among the 10 Hybrids evaluated at Mudigere, (GG x Bold) x Appangala-1 was observed highest plant height (278.33 cm) followed by (GG x NKE 19) x Bold (264.67 cm). More number of suckers observed in (GG x NKE 19) x Bold. At Sakleshpur, Number of tillers is significantly more in SHC 2 (30.0) followed by (GG x Bold) x Appangala-1 (28.3).

Height of tillers is significantly high in PH 13 (211.7 cm). Significantly a greater number of panicles were observed in Bold × IC 547219 (17.3) and SHC 1 (16.7) and SHC-1 produced significantly more yield (493.4 kg ha⁻¹) followed by PH-14 (403.3 kg ha⁻¹).

At Pampadumpara, uniformity in flowering and yield were not observed. The yield contributing characters like plant height, leaf length, leaf width and number of tillers were found significantly different between the treatments. Number of tillers was found more in (GG × NKE 19) × Bold followed by PH 13, MHC 2 and (GG × bold) × Appangala 1. At Myladumpara, MHC-1 recorded highest yield of 89.23 kg ha⁻¹, along with the tallest tillers (201.71 cm), the highest number of leaves per tiller (14.55), the maximum number of vegetative buds (5.93), and the highest number of panicles per clump (14.81). These traits strongly contributed to its superior performance. Similarly, MHC-2 showed a high yield of 82.30 kg ha⁻¹, with traits such as tall tillers (192.86 cm) and a high number of leaves per tiller (13.34), as well as good performance in the number of vegetative buds (4.53) and panicles per clump (13.72). Overall, MHC-1 and MHC-2 outperformed the other treatments in terms of yield and associated traits, demonstrating their potential superiority under the tested conditions.

CAR/CI/4.4: Multi-location evaluation of thrips tolerant cardamom lines

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

The experiment on multi locational evaluation of thrips tolerant lines in cardamom was initiated during 2017 to screen the promising small cardamom line against cardamom thrips. Trial was undertaken at Sakleshpur, Appangala, Mudigere, Myladumpara and Pampadumpara, with 6 genotypes (IC 349362, IC 349364, IC 349370, IC 349606, Njallani Green Gold and ICRI 8) in 3 replications. Observations on thrips population and thrips damaged capsule (%) were recorded at monthly intervals along with other growth parameters.

At Appangala, the genotype IC 349362 recorded maximum plant height (230.7 cm), highest average number of panicles (17.8) and length of panicle (142.6 cm). The average thrips damage on capsules ranged from 1.4 to 12.8 per cent in all the four genotypes. Observations on thrips population recorded at Myladumpara revealed that among the accessions, IC 349370 has low thrips population (0.35 No. of thrips per leaf sheath) than other accessions. Whereas Njallani Green Gold recorded 2.80 No. of thrips / leaf sheath which was highest among the tested entries. Among the vegetative characters studied at Pampadumpara, plant height, leaf length and leaf width found significantly different among the treatments. The harvest is yet to be achieved. PV2 (60.333 cm) recorded the highest leaf length and leaf width (11cm). Green Gold showed maximum plant height (161.667 cm). The evaluation of thrips-tolerant cardamom accessions at Sakleshpura revealed significant variations in thrips population and their impact on capsule damage, influenced by both the genotype and plant age as represented by harvest intervals. The thrips population varied across genotypes, with Njallani Green Gold (control) recording the highest mean population (2.30), while ICRI 8 exhibited the lowest (1.04). Genotypes IC 349606 (1.34) and IC

349370 (1.08) also had lower thrips populations compared to other lines, indicating potential resistance traits. Among the genotypes, ICRI 8 consistently exhibited the lowest thrips damage across all harvests, with a mean of 32.0%, followed closely by IC 349370 with a mean damage of 33.3%. In contrast, Njallani Green Gold had the highest damage (52.6%), demonstrating its susceptibility. Reduction in damaged capsules over the control was highest for ICRI 8 (40.5%), followed by IC 349370 (36.6%) and IC 349362 (34.5%). These genotypes demonstrated higher tolerance to thrips compared to others.

CAR/CI/4.5: MLT of leaf blight tolerant lines of small cardamom 2018

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

In order to screen out the leaf blight tolerant small cardamom genotypes, multilocal trial of leaf blight tolerant lines of small cardamom initiated during 2018-19. The trial was laid in RBD design with three replications of 6 test entries viz., IC-349650, IC-547222, IC-547223, IC-547156, IC-349649 and IC-349648 along with a susceptible check (IISR Vijetha) and two resistant checks (Appangala 1 & Njallani Green Gold).

During 2022-23, at Myladumpara growth parameters and PDI of leaf blight were recorded and the disease incidence ranged from 5.56 (Njallani Green Gold) to 8.33% (IISR Vijetha). Similarly, at Appangala, it ranged from 11.11 to 21.11%. Maximum disease incidence was recorded in IISR Vijetha and the least incidence was recorded in Njallani Green Gold. The fresh yield ranged from 9.64 to 390 g plant⁻¹. At Pampadumpara, IC 547156 had the highest leaf width and was statistically different from all other accessions. However, highest plant height was recorded in IC 547222 (150.11cm).

Crop Management

GIN/CM/5.5 Effect of micronutrients on growth and yield of small cardamom

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

The experiment was initiated in 2021-22 to evaluate the effectiveness of micronutrient management on small cardamom cultivars. The experiment was laid out in a factorial randomized block design with five replications with two levels of treatments viz., T₁: Recommended package of practice as the control, and T₂: Recommended package of practices + IISR cardamom micronutrient spray (four sprays of micronutrients during March, April, May and June at 5 g L⁻¹) with sub treatments three cultivars.

Experiment was laid out at Appangala with three sub treatments (varieties): V₁-Appangala 1, V₂-IISR Avinash and V₃-Green Gold in three replications in 2022. T₂ improved overall growth parameters, with V₂ (IISR Avinash) achieving the highest yield under the micronutrient treatment (46.53 kg ha⁻¹), followed by V₁ (Appangala 1). While varietal differences were significant for traits such as plant height, yielding tillers, total tillers, panicle number, nodes per panicle, and capsule number, the effect of micronutrient treatment and their interaction with varieties was not statistically

significant for most traits except panicle length. Similarly, Mudigere centre also indicated significant differences all the traits including dry yield of cardamom (kg ha^{-1}) among cultivars, treatments and their interaction. Treatment T_2 (micronutrient application) consistently improved dry weight across all cultivars, with a mean of $249.22 \text{ kg ha}^{-1}$ compared to $244.05 \text{ kg ha}^{-1}$ under T_1 (control). Among the cultivars, V_3 (Mudigere-3) showed the highest mean dry yield ($311.08 \text{ kg ha}^{-1}$), followed by V_1 (Mudigere-1) with $220.66 \text{ kg ha}^{-1}$, and V_2 (Mudigere-2) with the lowest mean dry weight ($208.16 \text{ kg ha}^{-1}$). The interaction effect between cultivars and treatments was significant with most favoured combination being V_3 under T_2 with mean yield of $311.08 \text{ kg ha}^{-1}$ of dry cardamom. At Sakleshpura, the micronutrient treatment (T_2) consistently outperformed the control (T_1) across all cultivars, particularly in fresh capsule yield and dry capsule yield. Among cultivars, V_3 (APG-1) recorded the highest mean dry capsule yield (122.0 kg ha^{-1}) and fresh capsule yield ($207.50 \text{ g clump}^{-1}$), followed V_2 (ICRI-8) with a mean dry capsule yield of 106.1 kg ha^{-1} , while V_1 (ICRI-3) recorded the lowest values for all traits. However, the differences due to variety-micronutrient application interaction found not statistically significant for dry capsule yield (LSD for micronutrient = 19.2 kg ha^{-1}). Significant differences were observed among cultivars for all traits, with LSD values of 24.1 kg ha^{-1} for dry capsule yield, confirming the superiority of V_3 under the experimental conditions. Interaction effects between cultivars and micronutrient treatments were also significant. These findings underscore the potential of APG-1 (V_3) for higher productivity, particularly under improved nutrient management.

At Pampadumpara, there found significant differences in all traits for treatments, variety as well as their interactions including the dry weight. Among treatments, T_2 (micronutrient application) significantly improved dry weight across all varieties, with a mean of $192.33 \text{ g plant}^{-1}$, compared to $111.11 \text{ g plant}^{-1}$ under the control (T_1). Across the varieties, PV3 recorded highest mean dry weight ($175.17 \text{ g plant}^{-1}$), followed by PV5 ($154.25 \text{ g plant}^{-1}$), with GG showing the lowest mean dry weight ($125.75 \text{ g plant}^{-1}$). The interaction effect (variety $\times$ treatment) was also significant, with the highest dry weight observed in PV3 under T_2 ($221.00 \text{ g plant}^{-1}$). These results emphasize the role of both variety selection and micronutrient management in enhancing biomass production in cardamom. Results from the Myladumpara centre also highlight the influence of micronutrient application on the yield of cardamom across different varieties. Among the varieties, V_3 : MCC 260 exhibited the highest mean yield ($105.88 \text{ kg ha}^{-1}$), followed by V_1 : Thiruthali (85.19 kg ha^{-1}), with V_2 : ICRI 5 showing the lowest yield (74.89 kg ha^{-1}). Treatment-wise T_2 (micronutrient application) consistently outperformed T_1 (control), with an overall mean yield of $100.23 \text{ kg ha}^{-1}$ compared to 76.66 kg ha^{-1} under control. However, the effect of treatments was not statistically significant. There was strong significant variety-treatment interaction effect, with V_3 under T_2 given the highest potential yield of $130.19 \text{ kg ha}^{-1}$. These findings underscore the potential benefits of micronutrient application in micronutrient responsive varieties like V_3 .

GIN/CM/5.5: Site specific recommendations for varying yield levels of cardamom

(Centres: Mudigere, Myladumpara, Sakleshpur, Pampadumpara)

The experiment focuses on developing site-specific recommendations for achieving varying yield targets of cardamom. Initiated in 2020-21, layout in RBD design with five replications and four treatments: T₁ represents the existing Package of Practices (POP), while T₂, T₃, and T₄ target yield levels of 6 q ha⁻¹, 8 q ha⁻¹, and 10 q ha⁻¹, respectively is to optimize yield by tailoring recommendations to different production targets.

The trial conducted at Pampadumpara revealed significant variation in plant height among the treatments, with T₅ (253.89 cm) and T₄ (244.49 cm) recording the highest values. T₄ also exhibited the greatest fresh weight (1.008 kg plant⁻¹) and dry weight (0.202 kg plant⁻¹), followed by T₃ (0.730 kg plant⁻¹ fresh weight and 0.146 kg plant⁻¹ dry weight). Although other parameters did not show significant differences, T₄ demonstrated a numerical advantage in contributing to yields. At Myladumpara during 2022-23, the highest yield was obtained in the POP treatment T₁ (108.55 kg ha⁻¹), closely followed by T₃ (108.02 kg ha⁻¹), with the yield differences being statistically non-significant. The maximum number of tillers was recorded in T₂, the highest number of panicles in T₄, and T₁ recorded the most racemes per panicle and capsules per raceme.

At Mudigere centre, under the experiment on site-specific recommendations for varying yield targets of small cardamom, plant height differed significantly among treatments, while the number of suckers, panicles, tillers, and bearing tillers per plant did not. Numerically, T₂ showed the highest yield (152.3 kg ha⁻¹). At Sakleshpur, no significant differences were observed in plant height, number of panicles per clump, or capsule yield across treatments. However, T₄, targeting a yield of 10 q ha⁻¹, recorded a significantly higher number of tillers. Despite the lack of statistical significance in yield variations, T₄ produced the highest capsule yield (158.4 kg ha⁻¹).

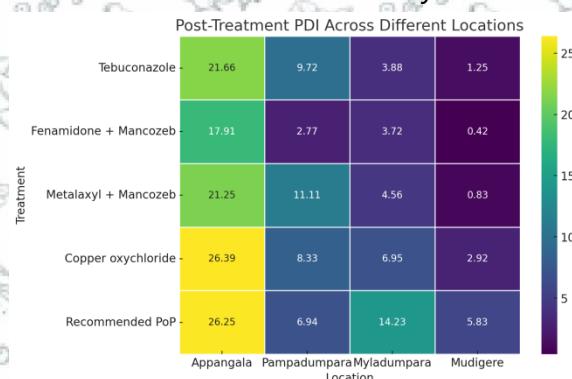
Crop Protection & Food Safety

CAR/CP/6.11: Evaluation of fungicides against rhizome rot in small cardamom

(Centres: Appangala, Mudigere, Myladumpara, Pampadumpara)

The trial aims to devise new fungicides or combination for the management of rhizome rot in small cardamom which was initiated in 2020, following RBD pattern with five treatments and four replications. The experiment was conducted on existing plants of the Njallani Green Gold / Appangala-1 varieties, planted at spacings of 3 × 3 m at four different location of CHR. Each experimental plot consisted of 12 plants, and the treatments included the T₁: spray and drench application of Tebuconazole @1 ml L⁻¹; T₂: Fenamidone + Mancozeb @ 2 g L⁻¹; T₃: Metalaxyl + Mancozeb @1.25 g L⁻¹; T₄: Copper oxychloride @2 g L⁻¹ and the T₅: recommended PoP as a standard check.

At Appangala, the pre-treatment disease severity was comparable across treatments, ranging from 7.5 to 9.58. Post-treatment, all fungicide treatments except T₄ significantly reduced disease severity compared to the control (T₅). Application of T₂ resulted in the highest reduction (31.44%), followed by T₃ (18.57%) and T₁ (16.78%). Copper oxychloride, however, showed an increase in disease severity post-treatment (1.30%). In Pampadumpara, T₂ was the most effective treatment, reducing disease severity by 59.99% over the control, whereas T₁ and T₃ showed a negative reduction, indicating an increase in disease severity (40.01% and 60.01%, respectively). T₄ also exhibited a negative effect, with a 20% increase in disease severity post-treatment. At Myladumpara, all treatments led to substantial reductions in disease severity, with T₂ achieving the highest reduction (73.8%), followed closely by Tebuconazole T₁ (72.77%) and T₃ (67.9%). Copper oxychloride T₄ was the least effective, showing only a 51.1% reduction. The results from Mudigere further confirmed the superior performance of T₂, which recorded the lowest rhizome rot severity (PDI=0.42), statistically on par T₃ (PDI=0.83) and T₁ (PDI=1.25). The untreated control exhibited the highest disease severity (PDI=10.0), reinforcing the effectiveness of fungicidal treatments in managing rhizome rot.

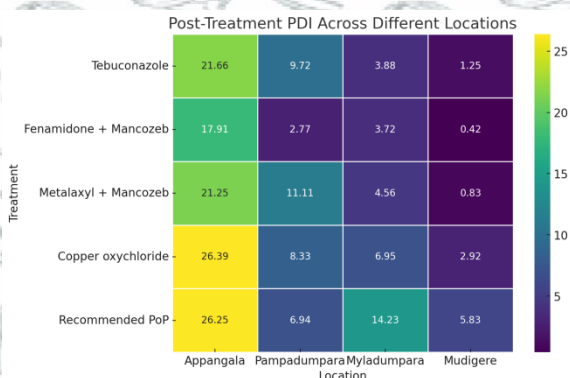


Overall, the study demonstrated that Fenamidone + Mancozeb (T₂) consistently outperformed other treatments across different locations, making it the most promising fungicide for rhizome rot management in small cardamom.

CAR/CP/6.12: Evaluation of fungicides against leaf blight in small cardamom

(Centres: Appangala, Mudigere, Myladumpara, Pampadumpara)

The trial was initiated in 2020 to assess the efficacy of different fungicides in managing leaf blight. Conducted in RBD with four replications, the trial involved existing plants of Njallani green gold or Appangala-1 varieties, spaced at 3 × 3 m at four locations. Each plot consisted of 12 plants. The treatments included foliar sprays of T₁: Carbendazim + Mancozeb @ 2 g L⁻¹, T₂: Hexaconazole @ 2 g L⁻¹, T₃: Mancozeb @ 2 g L⁻¹, T₄: Tebuconazole @ 1 ml L⁻¹, and the T₅: recommended PoP.



Post-treatment disease incidence varied across locations, with notable reductions in severity observed for specific treatments. At Appangala, Hexaconazole (T₂) exhibited the highest reduction in disease severity (40%) with a post-treatment PDI=19.16, while T₅ recorded the highest disease severity (PDI=32.50). Pampadumpara results indicated significant reduction, with

application of T₂ showing a 49.46% decrease over the control. Similarly, at Myladumpara, T₄ exhibited the highest reduction in disease severity (72.7%), followed by T₂ (71.1%), while the recommended package of practices showed the least effectiveness. Mudigere results also followed a similar trend, with T₄ showing the highest reduction in disease severity (64.5%), while T₁ and T₂ showed a reduction of 54.8% and 58%, respectively. T₅ (Control) had the highest disease severity with PDI=12.92.

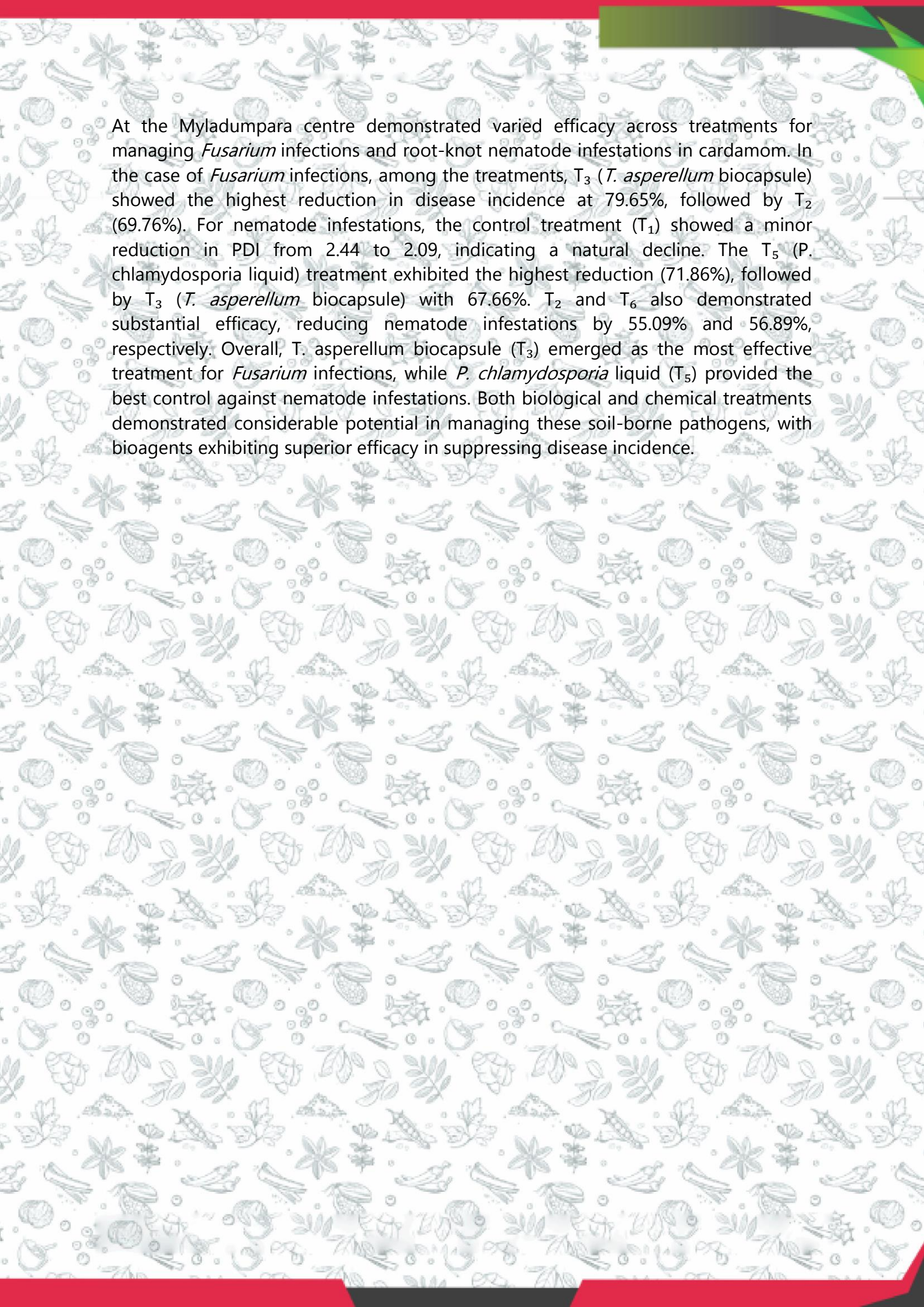
Overall, Tebuconazole (T₄) and Hexaconazole (T₂) were among the most effective treatments across locations, significantly reducing disease severity and proving to be promising options for managing leaf blight in small cardamom.

GIN/CP/7.1: Observational trial on the efficacy of *Trichoderma asperellum* and *Pochonia chlamydosporia* for the management of rhizome rot and nematode in small cardamom

(Centres: Appangala, Myladumpara, Pampadumpara)

The experiment was initiated in the year 2021–22 to evaluate the efficacy of *Trichoderma asperellum* and *Pochonia chlamydosporia* for managing rhizome rot and nematodes in small cardamom across three locations. The experiment plot followed individual plot size of 3m in RBD with six treatments and four replications. The treatments included T₁ : control; T₂: *T. asperellum* applied in talc formulation mass-multiplied with cow dung-neem cake mixture; T₃: *T. asperellum* biocapsule formulation, T₄: fungicidal drench with Metalaxyl-Mancozeb, T₅: liquid formulation of *P. chlamydosporia*, and T₆: recommended nematicide. Each treatment was applied twice during May-June and September-October. The experimental plot size was 3m, and the treatments were assessed for their potential in controlling rhizome rot and nematode infestation.

With regards to rhizome rot, at Appangala, the highest reduction in disease incidence compared to the control was observed with T₂ (*T. asperellum* talc formulation), with 15.94% reduction, followed closely by T₃ (13.33%) and T₅ (13.04%). The chemical fungicide T₄ showed moderate efficacy with a 4.36% reduction, while the nematicide (T₆) reduced disease incidence by 7.25%. At Myladumpara, all treatments significantly reduced rhizome rot compared to the control (T₆). T₃ showed the highest reduction (78.23%), followed closely by T₄ (77.6%) and T₂ (70.06%). The nematicide (T₆) also performed well, reducing disease by 68.45%, whereas T₅ was less effective, achieving a 59.79% reduction. At Pampadumpara, T₂ showed the greatest reduction in rhizome rot disease incidence at 60.00%, followed by T₄ (39.99%), and T₆ (30.00%). T₃ exhibited a 24.99% reduction, while T₅ had the least impact, reducing disease by only 15.00%. Overall, biological treatments, especially *T. asperellum* formulations, showed promising results in rhizome rot disease management, with T₂ (*T. asperellum* talc) and T₃ (*T. asperellum* biocapsule) consistently performing well.



At the Myladumpara centre demonstrated varied efficacy across treatments for managing *Fusarium* infections and root-knot nematode infestations in cardamom. In the case of *Fusarium* infections, among the treatments, T₃ (*T. asperellum* biocapsule) showed the highest reduction in disease incidence at 79.65%, followed by T₂ (69.76%). For nematode infestations, the control treatment (T₁) showed a minor reduction in PDI from 2.44 to 2.09, indicating a natural decline. The T₅ (*P. chlamydosporia* liquid) treatment exhibited the highest reduction (71.86%), followed by T₃ (*T. asperellum* biocapsule) with 67.66%. T₂ and T₆ also demonstrated substantial efficacy, reducing nematode infestations by 55.09% and 56.89%, respectively. Overall, *T. asperellum* biocapsule (T₃) emerged as the most effective treatment for *Fusarium* infections, while *P. chlamydosporia* liquid (T₅) provided the best control against nematode infestations. Both biological and chemical treatments demonstrated considerable potential in managing these soil-borne pathogens, with bioagents exhibiting superior efficacy in suppressing disease incidence.

03

LARGE CARDAMOM

Genetic Resources

LCA/CI/1.1: Germplasm collection, characterization, evaluation and conservation of Large Cardamom

(Centres: ICAR Regional Station-Gangtok and ICRI Regional Station-Gangtok)

ICRI RS, Gangtok initiated the programme in 2009-2010, has made significant progress in conserving and characterizing this valuable spice crop. Since its inception, a total of 57 germplasm accessions have been collected from Sikkim, Darjeeling, Kalimpong, Arunachal Pradesh, Nagaland, and other major large cardamom growing regions in India. These accessions are meticulously preserved in gene banks at our research farms in Pangthang (1952 m above msl) and Kabi (1567 m above msl).

Building upon this foundation, intensive surveys were conducted in Sikkim and Arunachal Pradesh during 2022-23. These surveys yielded two new germplasm accessions: one from Dzongu, Mangan district in Sikkim (SCC 320), and another from Rahung, West Kameng district in Arunachal Pradesh (SCC 319) from the farmer's field. Passport data for these new accessions has been meticulously documented (Table 1). Moreover, characterization and evaluation of previously collected germplasm accessions from 2020 to 2023 is in progress and the results of this evaluation are presented in Table 2 of the report

Table 1: Passport data for newly collected accessions (2022-23)

Entry	Local Name	Geographical Reference	Trait Specific	Photograph
SCC-319	Ramsey	Village: Rahung, West Kameng, Arunachal Pradesh Lat: 27°18'56"N, Long: 92°22'21"E Altitude: 1690 m above MSL Collected on: 4/4/2023	High Yields (1120 kg ha ⁻¹)	
SCC-320	Seremna	Village: Dzongu, Mangan, Sikkim Lat: 27°31'37.88"N, Long: 88°30'57.4"E Altitude: 1300 m above MSL Collected on: 14/9/2022	Dwarf nature & High Yields (1050 kg ha ⁻¹)	
SCC-318	Uttarey Varlang	Village: Simphok, Uttarey, West Sikkim Lat: 27°61'5"N, Long: 88°45'4"E Altitude: 1870 m above MSL Collected on: 01/03/2023	High yielding & Disease Tolerant (Chirke)	

Table 2. Evaluation of collected accessions- 2020 to 2023 conducted by ICRI, Gangtok

Accession	Collection year	Plant height (cm)	No. of tillers/clump	No. of productive tillers/clump	No. of leaves/tiller	Leaf length (cm)	Leaf breadth (cm)
<i>SCC-314</i>	2020	96.9	15.2	4.4	8.4	35.7	7.4
<i>SCC-315</i>	2020	99.1	13.6	4.6	8.4	46.6	7.2
<i>SCC-316</i>	2020	118.3	12.2	5.0	10.0	46.0	8.5
<i>SCC-317</i>	2021	108.6	10.2	-	9.2	48.8	8.0
<i>SCC-318</i>	2021	169.3	9.4	-	9.2	48.3	7.8
<i>SCC-319</i>	2023	163.8	8.6	-	9.0	39.5	9.0
<i>SCC-320</i>	2023	57.5	7.4	-	7.2	38.4	8.1
CD 5%		2.85	1.8	1.5	1.42	5.9	0.8
SEm		0.97	0.6	0.4	0.484	2.03	0.2

ICAR Regional Station Gangtok has been actively involved in the collection and conservation of large cardamom germplasm. In collaboration with the Indian Cardamom Research Institute and the Spices Board in Tadong, Gangtok, the station has successfully collected unique accessions *ie.* *SCC-318* which found to be high-yielding with chirke disease tolerance.

Crop Improvement

LCA/CI/2.1: Coordinated Varietal Trial (CVT) on Large Cardamom

(Centres: ICAR Regional Station-Gangtok, ICRI Regional Station-Gangtok and ICAR, KVK, Anjaw, Arunachal Pradesh)

The Coordinated Varietal Trial (CVT) on large cardamom, initiated in the *kharif* season of 2023-24, aimed to evaluate promising large cardamom accessions aims to identify and promote large cardamom cultivars that can significantly improve the income of farmers in Sikkim, the North East, and the Darjeeling Hills. The trials are being conducted across three centers: ICRI RRS, Spices Board, Tadong, Gangtok, Sikkim; ICAR Research Complex for NEH Region, Sikkim Centre, Gangtok; and CAU, COH, Pasighat (ICAR KVK Anjaw), Arunachal Pradesh.. The trial, was laid out in a Randomized Block Design (RBD) with ten genotypes, including national as well as local check varieties. Now the trial is under the establishment stage.



Crop Management

LAC/CM/5.1: Effect of mulching on yield of large cardamom

(Centres: ICRI, Gangtok & ICAR, Gantok)

The aim of experiment, initiated during *kharif*, 2021 to evaluate the impact of different mulching materials on the yield of large cardamom. The trial is being conducted at the farmer's field in North Sikkim, focusing on the variety *Varlangey*. The experiment was laid out using RBD with four replications, and the plot size was set at 4.5 x 4.5 m with a spacing of 1.5 x 1.5 m. Six mulching treatments were evaluated, including leaf mould (T₁), fresh leaves litters (T₂), paddy straw (T₃), paddy husk (T₄), black polyethylene sheets (T₅), and a control (T₆) with no mulching.

The field experiment was conducted during *pre-kharif* season at farmer's field, Dzongu, North Sikkim to evaluate the effect of mulching on yield of large cardamom. The experiment comprised of six mulching treatments was laid out in randomized block design (RBD) with four replications. Among the different mulching treatments, maximum plant height was recorded under T₁ which was statistically at par with T₂, T₃ and significantly higher than other treatments, respectively. Significantly higher number of leaves/tallest tiller and number of productive tillers per clump was noticed under T₁ as compared to other treatments but remained at par with T₂. Maximum number of immature tillers per clump and total number of tillers/clump were recorded under T₁ which was significantly higher than other treatments, respectively. The significantly maximum dry capsule yield was noticed under T₁ as compared to other treatments. The significant maximum gross return was noticed under T₁ followed by T₄. Significant highest net return was recorded under T₁. While, highest B: C ratio was recorded under T₁ followed by T₂ and T₃.

Treatment	PH (cm)	NL/tallest tiller	NimT/C	NPT/C	T/C	DCY	GR	CC	NR	BCR
T1	143.2	9.89	20.1	19.1	39.2	398	498	100.9	397	3.93
T2	140.4	9.23	18.3	18.6	36.9	382	478	99.9	378	3.78
T3	138.3	9.00	17.0	15.3	32.3	353	441	92.7	349	3.76
T4	136.2	8.85	16.1	14.2	30.3	307	384	95.5	288	3.02
T5	135.6	8.74	15.3	13.1	28.4	279	349	104.1	245	2.35
T6	129.4	7.10	14.0	11.0	25	239	299	90.2	209	2.31
SEm±	3.21	0.20	0.41	0.39	0.87	4.13	5.33	-	4.09	0.09
LSD (P=0.05)	9.10	0.62	1.27	1.17	2.61	12.2	14.8	-	11.3	0.27

Genetic Resources

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

(Centres: Barapani, Dholi, Kammarpally, Kumarganj, Pundibari, Pottangi, Raigarh, Solan)

This long-term project focuses on collecting, conserving, and evaluating ginger germplasm to identify promising accessions with high-yield potential. Currently, a total of 490 ginger accessions are conserved across various AICRPS centres with details presented (Table 38).

Table 25. Ginger germplasm collections maintained at various AICRPS centres

Centers	No. of Germplasm conserved			No. of Germplasm evaluated during 2022-23
	Existing	Addition (2022-23)	Total	
Barapani	32	0	32	32
Dholi	50	2	52	50
Kammarpally	10	0	10	10
Kumarganj	66	0	66	66
Pundibari	38	2	40	36
Pottangi	203	0	203	198
Raigarh	43	4	47	35
Solan	40	0	40	40
Total	482	8	490	457

Under germplasm evaluation, during the kharif season 2022-23, out of 32 ginger accession conserved at the Barapani centre, Highest yield was recorded from the accession IC-584363 (12.67 t). Highest oleoresin content was recorded in IC-584346 (6.27%). The other top yielders, based on fresh rhizome yield per hectare basis were IC-584341 (11.95 t), IC-584361 (10.47 t), IC-584334 (10.23 t), and IC-584348 (9.85 t). For oleoresin content, the other highest entries were IC-584325 (6.04%), IC-584347(5.62%), and IC-584343 (5.43%). At the Dholi Centre, germplasm evaluation augmented design was used for 50 collections, with 2 new collections. Among 50 ginger accessions evaluated, only nine accessions gave higher yield over check variety, Nadia (16.43 t ha⁻¹) and promising accessions in which RG-43 registered highest yield of (21. 19 t ha⁻¹) followed by RG-60 (20.16 t ha⁻¹) and RG-10 (20.11 t ha⁻¹). Of the 66 germplasm lines maintained at Kumarganj, all were evaluated and found promising accessions namely NDG-6 (156 g plant⁻¹), followed by NDG-28 (148 g plant⁻¹) and NDG-47 (145 g plant⁻¹). They showed significantly outperformed all three check varieties, substantially exceeding the mean yields of Varda (Ch.) at 106.33 g plant⁻¹, Mahima (Ch.) at 72.33 g plant⁻¹, and Local (Ch.) at 86.33 g plant⁻¹. Among the 198 germplasm lines evaluated at Pottangi, 22 entries yielded more than 5 Kg fresh

rhizomes per 3 m² plot with the mean yield of 3.5 Kg/3m² during 2022-23. The range measured in varied from genotypes PGS-119 (0.5 Kg/3m²) to S-62 (7.2 Kg/3m²). When measured per hectare basis, the yield ranged from 1.1 t to 15.9 t, with a mean yield of 7.8 t ha⁻¹. Among the promising high-yield varieties, S-62 (15.9 t ha⁻¹), closely followed by Zo-9 and PGS-150, both yielding 15.5 t ha⁻¹.

Thirty-eight ginger germplasm lines (36 accessions along with two released varieties as checks) were evaluated during the 2022-2023 season at the Pundibari Centre. The lowest incidence of rhizome rot and wilt disease was recorded in germplasm lines GCP 5 and GCP 14 (both 14.29%), followed by GCP 9 (14.44%), GCP 30 (15.33%), and GCP 4 (15.33%). GCP 9 exhibited the highest rhizome yield (12.02 t ha⁻¹), followed by GCP 13 (11.45 t ha⁻¹) and GCP 37 (11.29 t ha⁻¹). Several other lines, specifically GCP 22, GCP 31, GCP 56, GCP 14, GCP 15, GCP 5, GCP 4, and GCP 3, also yielded more than 10 t ha⁻¹. Two new ginger genotypes were collected from Suripara and Malda during the 2022-2023 period at the Pundibari Centre.

At AICRP on Spices, CARS, Raigarh total 43 (41 germplasms and two checks Suprabha, and Suruchi) germplasms of Ginger maintained. Out of 41 during 2022-23 total 35 accessions of ginger evaluated for rhizome yield and yield attributing traits. For rhizome yield Indira Ginger-1 (28.5 t ha⁻¹), recorded maximum rhizome yield followed by IG-4 (26.1 t ha⁻¹), and IG-3 (22.4 t ha⁻¹) over two national checks Suprabha (15.6 t ha⁻¹) and Suruchi (14.2 t ha⁻¹). Total 4 new germplasm of Ginger collected during 2023 and planted at research farm of AICRP on Spices, CARS, Raigarh during *Kharif*, 2023 which will be screened for rhizome rot and other disease reactions. Under evaluation of breeding lines at solan, Ginger genotype SG19-11 gave the highest fresh rhizome yield of 216.28 g plant⁻¹ with 3.72% oleoresin content, out of forty genotypes.

Here is the summary table based the evaluation of ginger germplasm across various AICRPS centres:

Centres	No. of Accessions Evaluated	Mean Yield (t/ha)	Range of Yield (t/ha)	Promising Accessions Based on Yield
Barapani	32	7.3	3.7 - 12.7	IC-584363 (12.7), IC-584341 (12.0)
Dholi	50	14.5	12.0 - 15.7	RG-43 (15.7), RG-60 (14.9)
Kumarganj	66	11.2	9.1 - 13.9	NDG-6 (13.9), NDG-28(13.1), NDH-23(13.0)
Pottangi	198	7.8	1.1 - 15.9	S-62 (15.9), Zo-9 (15.5), PGS-150 (7.0)
Pundibari	40	8.6	5.7 - 12.1	GCP-30(12.1), GCP-9(12.0), GCP-13(11.5)
Raigarh	47	18.5	9.1 - 28.4	IG-1 (28.4), IG-4 (26.1), IG-3 (22.4)
Solan	40	11.9	5.6-19.1	SG19-11(19.1), SG19-14(16.4), SG19-29(16.2)



Crop Improvement

GIN/CI/2.5: Coordinated Varietal Trial (CVT) on disease tolerance trial in Ginger 2019 – Series X

(Centres: Barapani, Chintapalli, Gangtok, Kozhikode, Nagaland, Pottangi, Pundibari, Raigarh)

The coordinated varietal trial on disease tolerance trial in ginger aims to find out the high yielding ginger genotypes performing well under disease pressure. The trial laid out at 8 AICRPS centres in RBD with nine test genotypes (R 1.25/4, G 1.00/4, HP 05/15, HP 0.5/2, V 0.5/2, V1E4 1, V1E4 5, V2E5 2 and Indira Ginger) with one national check (IISR Varada) or local check.

During the kharif 2022-23, the mean fresh rhizome yield across test entries ranged from 11.9 to 16.5 t ha⁻¹. Among the ginger test entries, the highest yield was recorded in 'Indira Ginger' (16.5 t ha⁻¹), followed by 'IISR Varada' (16.0 t ha⁻¹) and 'R 1.25/4' (14.6 t ha⁻¹). These entries numerically surpassed several other genotypes, with 'Indira Ginger' only exceeding the national check, IISR Varada. The average yield across all test entries was 14.0 t ha⁻¹.

Entries	BPI	CPE	GTK	KOZ	NGD	POT	PUN	RAI	Mean	Rank	%IOC
R 1.25/4	5.87	11.14	13.03	41.10	10.34	13.40	7.96	14.17	14.6	3	-8.71
G 1.00/4	3.82	11.50	11.10	30.60	8.31	13.77	7.90	14.80	12.7	8	-20.57
HP 05/15	9.38	12.57	15.64	23.55	8.56	14.23	7.55	11.20	12.8	7	-19.88
HP 0.5/2	7.73	9.87	9.88	34.35	6.92	12.37	10.10	18.20	13.7	6	-14.63
V 0.5/2	6.92	11.28	10.96	23.25	17.03	15.53	8.15	19.20	14.0	5	-12.37
V1E4 1	5.17	10.23	12.40	41.85	10.93	15.57	7.77	11.90	14.5	4	-9.65
V1E4 5	3.53	10.35	12.97	19.65	7.31	15.97	7.50	24.30	12.7	9	-20.76
V2 E5 2	3.07	12.34	11.60	28.80	8.72	14.60	7.28	8.80	11.9	10	-25.72
Indira Ginger	5.13	9.81	13.29	40.50	14.27	13.47	7.54	28.20	16.5	1	3.15
IISR Varada (Check)	6.53	15.87	14.84	32.40	18.12	11.97	8.15	20.30	16.0	2	0.00
Loc MEAN	5.71	11.50	12.57	31.61	11.05	14.09	7.99	17.1	14.0		
F (Prob)	0.000	0.007	0.000	0.000	0.000	0.000	0.004	0.000	0.000		
CD (p=5%)	0.29	2.73	0.58	3.44	1.36	1.45	1.15	0.14	0.5106		
CV (%)	2.96	13.84	2.70	6.34	7.20	6.01	8.37	0.47	0.1837		
SE (m)	0.10	0.92	0.20	1.16	0.46	0.49	0.39	0.05	10.8		

Where, **BPI**: Barapani; **CPE**: Chintapalle; **GTK**: Gangtok; **KOZ**: Kozhikode; **NGD**: Nagaland; **POT**: Pottangi; **PUN**: Pundibari; **RAI**: Raigarh;.

In case of soft rot incidence in ginger the mean incidence across five centres recorded ad 21.5% PDI. Compared to the national check IISR Varada (PDI = 25.9), nine test genotypes, exhibited lower incidence of soft rot. Among these, HP 05/15 (PDI = 15.2), HP 0.5/2 (PDI = 18.0), G 1.00/4 (18.7), and V 0.5/2 (19.6) showed the highest reduction in incidence and can be categorized as resistant genotypes. Genotypes V1E4-5 (PDI=19.6), and V2 E5 2 (20.9), IISR Indira Ginger (PDI=24.7), R 1.25/4 (PDI=25.0), Varada (control), with PDI=25.9 and V1E4 1 (PDI=27.7) recorded relatively higher soft rot incidences, indicating moderate resistant.

Entries	BPI	CPE	GTK	KOZ	NGD	POT	PUN	RAI	Mean	Rank	%IOC
R 1.25/4	30.00	20.00	7.8	52.37	23.80	16.35	25.0	8	3.32	30.00	20.00
G 1.00/4	26.67	21.67	8.9	19.69	19.13	16.27	18.7	3	27.74	26.67	21.67
HP 05/15	20.00	15.83	3.3	21.29	11.00	19.54	15.2	1	41.46	20.00	15.83
HP 0.5/2	17.00	20.67	7.8	27.50	23.07	11.92	18.0	2	30.57	17.00	20.67
V 0.5/2	19.00	18.33	33.3	18.43	13.00	15.03	19.5	4	24.65	19.00	18.33
V1E4 1	24.00	20.00	36.7	55.44	10.93	18.89	27.7	10	-6.74	24.00	20.00
V1E4 5	22.00	17.50	8.9	35.61	14.67	18.70	19.6	5	24.49	22.00	17.50
V2 E5 2	21.00	21.67	24.4	26.63	10.93	20.55	20.9	6	19.45	21.00	21.67
Indira Ginger	24.00	23.33	25.6	35.35	19.47	20.23	24.7	7	4.82	24.00	23.33
IISR Varada (Check)	19.00	20.00	32.2	46.27	19.80	18.14	25.9	9	0.00	19.00	20.00
Loc MEAN	22.3	19.9	18.89	33.9	16.6	17.6	21.5			22.3	19.9
F (Prob)	0.000	0.001	0.000	0.000	0.000	0.017				0.000	0.001
CD (p=5%)	1.98	2.67	3.44	0.16	2.18	4.45				1.98	2.67
CV (%)	5.17	7.82	6.34	0.27	7.68	14.78				5.17	7.82

SE (m)	0.66	0.90	1.16	0.05	0.74	1.50				0.66	0.90
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Where, **BPI**: Barapani; **CPE**: Chintapalle; **GTK**: Gangtok; **KOZ**: Kozhikode; **NGD**: Nagaland; **POT**: Pottangi; **PUN**: Pundibari; **RAI**: Raigarh;.

Based on the bacterial wilt incidence recorded at the three centers—Gangtok, Nagaland, and Pottangi—during Kharif 2022-23, the mean PDI values of 29.6% at Gangtok, 12.8% at Nagaland, and 1.2% at Pottangi with overall incidence of 14.5%. The disease incidence varied significantly among genotypes, as indicated by the highly significant F values ($P < 0.001$). But none of the entries were resistant (PDI score 0 to 10%). Among the tested genotypes, HP 05/15 recorded the lowest mean PDI (7.9%), followed by R 1.25/4 (8.8%) indicating moderately resistant to bacterial wilt (PDI score 6 to 10%). On the other hand, all other including IISR Varada serving as the control exhibited mildly susceptibility (PDI score 11 to 25%).

Entries	GTK	NGD	POT	Mean	Rank	%IOC
R 1.25/4	24.13	2.26	0.00	8.8	2	48.46
G 1.00/4	27.99	9.45	0.00	12.5	3	26.88
HP 05/15	18.18	5.51	0.00	7.9	1	53.73
HP 0.5/2	30.08	8.62	1.07	13.3	5	22.33
V 0.5/2	34.94	3.66	1.00	13.2	4	22.66
V1E4 1	37.67	7.45	0.00	15.0	7	11.88
V1E4 5	22.44	21.31	0.00	14.6	6	14.56
V2 E5 2	57.95	12.74	0.00	23.6	10	-38.07
Indira Ginger	22.35	31.26	4.60	19.4	9	-13.68
IISR Varada (Check)	20.24	25.37	5.60	17.1	8	0.00
Loc MEAN	29.6	12.8	1.2	14.5		
F (Prob)	0.000	0.000	0.000			
CD (p=5%)	1.07	0.31	0.37			
CV (%)	2.12	1.43	17.69			
SE (m)	0.36	0.11	0.13			

Where, **GTK**: Gangtok; **NGD**: Nagaland; **POT**: Pottangi; **PUN**: Pundibari; **RAI**: Raigarh;.

GIN/CI/4.3: Evaluation of genotypes of ginger for vegetable purpose

(Centres: Chintapalle, Gangtok, Kozhikode, Mizoram, Nagaland, Pottangi, Pundibari)

The trial on evaluation of genotypes of ginger for vegetable purpose aims to identify the bold ginger genotypes suitable for vegetable purposes. The trial laid out at 7 AICRPS centres in RBD with seven test genotypes, viz., Gorubathani, Bold Nadia, Bhaise, Johns ginger, PGS 121, PGS 95 and PGS 102 with three replications. The trial was initiated during kharif, 2018-19.

During kharif, 2022-23, the mean fresh rhizome yield ranged from 10.1 to 12.0 t ha⁻¹. The highest yield observed in PGS-121 (12.0 t ha⁻¹) followed by Johns ginger (11.3 t ha⁻¹), numerically surpassing mean yield of 10.8 t ha⁻¹. Location-wise, mean fresh

rhizome yield ranged from 7.24 t ha⁻¹ (Nagaland) to 13.92 t ha⁻¹ (Chinthapalle) (Table 28).

Table 28. Fresh rhizome yield (t ha⁻¹) recorded in evaluation of genotypes of ginger for vegetable purpose during Kharif, 2022-23

Entries	CPE	MZM	NGD	POT	PUN	SKM	KOZ	Mean	Rank	%IOC
Bold Nadia	13.5	8.73	10.2	8.4	12.3	7.77	6	10.2	6	-1.9
PGS-95	14.36	6.44	8.7	15.2	9.3	9.63	--	10.6	4	1.9
PGS-102	13.54	9.09	4.7	15.6	9.2	8.27	3	10.1	7	-2.9
PGS-121	14.15	8.02	7.3	19.2	11.6	11.8	3.5	12.0	1	15.4
Bhaise	12.59	9.67	5.3	11	12	12	10.6	10.4	5	0
Gurubathani	13.67	9.88	5.8	13.2	11.8	12.5	1.5	11.1	3	6.7
John's ginger	15.63	6.95	8.7	16.5	10.8	9.17	7	11.3	2	8.7
Mean	13.92	8.4	7.24	14.2	11.0	10.16	5.27	10.8		
SEm ±	0.52	0.46	0.136	0.35	0.47	0.27				
CD(0.05)	1.61	1.34	0.42	1.05	1.4	0.84				
CV %	6.44	13.49	15.6	5.4	8.7	8.8				

Where CPE : Chinthapalle, MZM : Mizoram, NGD: Nagaland, POT : Pottangi, PUN : Pundibari, SKM: Sikkim, and KOZ: Kozhikode.

Crop Management

GIN/CM/4.1 Evaluation of different ginger based intercropping systems for higher yield and income

(Centres: Chintapalli, Pottangi, Pundibari, ICAR-Gangtok, Solan, Dholi, Nagaland, Mizoram, Kalyani)

The aim of the experiment was to assess the different ginger based intercropping systems for higher yield and income under organic management condition. This experiment was initiated during 2022-23 (*kharif/rabi*) with eight treatments: T₁- sole ginger; T₂- Ginger + Fenugreek (Grow ginger and fenugreek in 2:2 ratio. Grow fenugreek in *Kharif* and *Rabi*); T₃- Ginger + Coriander + leafy vegetables (Grow ginger and coriander in 2:2 ratio. After harvesting of coriander, grow leafy vegetables in place of coriander), T₄- Ginger + Maize (2:1 or 2:2) (Grow sweet corn in *Kharif*, *Rabi* and *Summer*- 3 times); T₅- Ginger + French Bean (2:2) (Grow French bean in *Kharif*, *Rabi* and *Summer*- 3 times); T₆- Ginger + Arhar (3:1) (Grow arhar in *Kharif*) and T₇- Ginger + Elephant foot yam (2:2) (Grow Elephant foot yam in *Kharif*).

In different intercropping systems of ginger, results proved intercrops in ginger makes farming to be a more productive and profitable approach than cultivating sole ginger. Among the tested systems, Ginger + Elephant Foot Yam (T₇) stood out, delivering the highest total ginger yield (22.00 t ha⁻¹) alongside a BCR of 2.80, making it the most effective system in terms of overall productivity. Ginger + Coriander + Leafy Vegetables (T₃) also performed remarkably well, achieving a total ginger yield of 20.25 t ha⁻¹ and the highest economic efficiency with a BCR of 2.85. Pottangi centre recorded the highest ginger yield across treatments, with Sole Ginger

producing 33.78 t ha⁻¹, highlighting its suitability for ginger cultivation. Nagaland exhibited exceptional economic efficiency, with BCR values exceeding 4.0 for treatments such as Ginger + Maize and Ginger + Coriander + Leafy Vegetables, making these combinations particularly viable for maximizing returns. Meanwhile, Kalyani and Mizoram also demonstrated strong intercropping potential, with Ginger + Coriander + Leafy Vegetables (T₃) emerging as a consistently high performer, reinforcing its adaptability across different agro-climatic conditions.

Treatments	Chintapalle			Dholi			Gangtok			Kalyani			Mizoram		
	Yld	GEY	BCR	Yld	GEY	BCR	Yld	GEY	BCR	Yld	GEY	BCR	Yld	GEY	BCR
Sole Ginger	15.24	0.00	3.51	12.25	0.00	1.23	9.33	0.00	1.74	14.53	0	2.03	10.5	0.00	1.37
Ginger + Fenugreek (2:2)	8.60	2.89	2.03	5.66	6.03	1.00	5.32	5.55	2.01	13.98	1.09	1.96	10.6	11.68	2.47
Ginger + Coriander + Leafy Veg.	6.94	5.86	2.10	5.49	5.93	0.96	5.11	13.2	2.67	15.16	2.03	3.09	10.8	14.32	3.82
Ginger + Maize (2:2)	5.56	8.37	2.21	5.81	6.19	1.06	5.01	7.68	2.06	12.85	1.39	2.12	9.95	14.61	3.68
Ginger + French Bean (2:2)	7.50	5.51	2.18	5.31	5.57	0.88	4.94	7.03	1.90	16.29	2.24	4.09	8.97	10.45	2.38
Ginger + Arhar (3:1)	11.31	2.24	2.60	8.86	9.25	1.21	5.45	5.33	1.87	13.34	1.18	2.26	7.61	8.93	2
Ginger + Elephant Foot Yam or Taro (2:2)	7.33	17.23	3.66	6.52	12.45	1.93	4.98	4.67	1.79	16.10	2.11	3.98	8.37	11.92	3.01

Treatments	Nagaland			Pottangi			Pundibari			Solan			Total	
	Yld	GEY	BCR	Yld	GEY	BCR	Yld	GEY	BCR	Yld	GEY	BCR	TY	BCR
Sole Ginger	12.81	0.00	1.71	33.78	0.00	4.5	13.07	0.00	2.30	18.80	0.00	0.90	15.59	2.14
Ginger + Fenugreek (2:2)	7.92	1.1	1.59	NA	NA	NA	9.92	1.45	1.78	18.03	3.67	0.50	12.61	1.67
Ginger + Coriander + Leafy Veg.	9.02	2.13	2.27	38	9.79	7.6	9.54	5.03	2.47	17.97	5.93	0.65	20.25	2.85
Ginger + Maize (2:2)	8.43	1.77	4.04	30.7	6.23	5.3	9.29	2.97	2.02	18.63	2.18	1.81	19.70	2.70
Ginger + French Bean (2:2)	10.32	1.47	2.07	32.2	8.01	6.3	8.58	6.33	2.85	18.00	7.15	0.74	18.43	2.60
Ginger + Arhar (3:1)	8.71	1.2	2.02	37.4	6.23	6.1	9.76	3.48	2.41	16.30	1.75	0.94	17.59	2.38
Ginger + Elephant Foot Yam or Taro (2:2)	7.78	2.4	1.91	25.4	2.90	5	6.37	34.7	3.06	17.53	9.20	0.87	22.00	2.80

TUR/CM/5.1 Evaluation of Plant Growth Promoting *Rhizobacteria*, *Bacillus safensis* for phosphorus (P) solubilization potential in ginger

(Centres: Ambalavayal, Chintapalli, Kalyani, Kammarpally, Kumarganj, Pasighat, Pottangi, Pundibari, Raigarh)

The trial was initiated in 2022-23 across 9 AICRPS centres, to assess the efficacy of *Bacillus safensis* in enhancing phosphorus solubilization and its impact on ginger

growth, yield, and nutrient uptake under different phosphorus application regimes. The trial was conducted in a RBD with seven treatments and four replications, using popular improved varieties of ginger specific to each centre. The treatments included T₁ (100% recommended phosphorus fertilizer), T₂ (75% phosphorus fertilizer), T₃ (75% phosphorus fertilizer + *Bacillus safensis*), T₄ (50% phosphorus fertilizer), T₅ (50% phosphorus fertilizer + *Bacillus safensis*), T₆ (*Bacillus safensis* alone), and T₇ (control without phosphorus). *Bacillus safensis* was applied as a soil drench at planting, 30 DAP, and 60 DAP. Growth parameters were recorded at 90 and 120 DAP, and soil nutrient analysis was carried out at 120 DAP to estimate available phosphorus and other macro- and micronutrients. Nutrient uptake was analyzed at harvest, followed by yield and quality assessments to determine the economic feasibility of using *Bacillus safensis* in phosphorus management.

During the first year of the study, treatment T₃ recorded the highest average fresh yield of 16.3 t ha⁻¹, emerging as the most effective treatment across multiple locations. Notably, T₃ ranked first in the majority of tested locations, with peak performances observed in Ambalavayal (33.62 t ha⁻¹), Chinthapalle (12.98 t ha⁻¹), Kalayani (17.92 t ha⁻¹), and Pasighat (12.14 t ha⁻¹). This highlights its superior yield performances. The second-best treatment was T₁, which achieved a mean yield of 14.56 t ha⁻¹ and ranked second overall. T₅ closely followed with a mean yield of 14.52 t ha⁻¹, demonstrating competitive efficacy. Conversely, the lowest performance was observed in the control treatment without phosphorus (T₇), which recorded the lowest mean value of 11.69 t ha⁻¹, reaffirming the crucial role of phosphorus in maximizing yield realization.

Overall, the results suggest that T₃, incorporating phosphorus application, stands out as the most effective strategy for improving ginger productivity.

Fresh rhizome yield

Treatment	ABL	CPE	KAL	KPL	KUM	PGT	POT	PUN	RAI	Mean	RANK
T ₁	30.87	10.98	15.20	7.99	9.83	10.82	16.1	15.09	14.12	14.56	2
T ₂	26	10.32	14.57	8.71	8.83	8.80	14.5	14.48	12.00	13.13	4
T ₃	33.62	12.98	17.92	9.32	13.16	12.14	17.5	17.85	12.23	16.3	1
T ₄	25.75	11.03	13.87	5.27	8.25	8.08	13.9	13.77	11.60	12.39	6
T ₅	28.5	13.28	16.68	7.22	11.58	9.57	16.7	16.59	10.60	14.52	3
T ₆	27.12	11.90	13.28	6.87	7.75	7.55	15.5	13.18	9.38	12.5	5
T ₇ (Control, No P)	28	10.56	12.15	5.89	7.26	7.14	13.8	12.04	8.34	11.69	7
C.D.(5%)	NS	2.07	0.430	0.556	4.832	1.25	1.1	0.39	0.578		
SE(m)+ ₋	1.94	0.67	0.138	1.66	14.47	0.420	0.4	1.14	-		
C.V.(5%)	13.60	9.95	-	19.30	10.14	9.17	0.5	4.64	-		

GIN/CM/5.2 Evaluation of Plant Growth Promoting *Rhizobacteria*, *Bacillus safensis* for zinc (Zn) solubilization potential in ginger

(Centres: Chintapalli, Kalyani, Kammarpally, Kumarganj, Pasighat, Pottangi, Raigarh)

The trial was initiated during 2022-23 and conducted seven different AICRPS centres, aimed to assess the efficacy of *Bacillus safensis* in enhancing zinc solubilization and its subsequent impact on plant growth, nutrient uptake, and yield parameters in turmeric. The trial was laid in RBD with five treatments and five replications. Popular improved variety of ginger was planted for each respective centre. The treatments included T₁: 100% recommended zinc fertilizer, T₂: 50% zinc fertilizer and *Bacillus safensis*, T₃: 50% zinc fertilizer alone, T₄: *Bacillus safensis* alone), and T₅: Control without Zn application. The crop was planted in beds measuring 3 × 1 m with a spacing of 15 × 30 cm, totaling 25 experimental units. The bacterial application was performed as soil drench at the time of planting, 30 days after planting (DAP), and 60 DAP, while fertilizers were applied as per the recommended dosage. Observations were recorded for growth parameters at 90 and 120 DAP, soil nutrient analysis (available Zn and other macro and micronutrients at 120 DAP), nutrient uptake in leaves and rhizomes at harvest, yield and quality analysis.

Treatment	CPE	KAL	KPL	KUM	PGL	POT	RAI	Mean	RANK
T ₁	10.07	16.53	9.22	10.13	11.58	14.4	12.50	12.06	2
T ₂	12.29	17.82	10.24	11.2	12.51	15.2	10.64	12.84	1
T ₃	11.79	15.14	8.62	8.7	10.10	13.5	9.4	11.04	3
T ₄	9.61	14.50	8.07	8.13	9.11	14.1	9.03	10.36	4
T ₅ (Control, No Zn)	9.43	12.11	7.09	7.66	7.47	12.9	8.2	9.27	5
C.D.(5%)	1.73	-	0.432	3.73	0.430	1.0	0.838		
SE(m)+ _	0.57	-	1.721	11.301	1.29	0.3	-		
C.V.(5%)	12.03	-	18.456	9.11	9.46	5.7	-		

During the evaluation of zinc solubilization, treatment T₂ demonstrated the highest mean yield of 12.84 t ha⁻¹, ranking first among all treatments. This indicates its superior ability to enhance zinc solubilization across multiple locations. Notably, T₂ exhibited the best performance in Chintapalle (12.29 t ha⁻¹), Kalyani (17.82 t ha⁻¹), Kammarpally (10.24 t ha⁻¹), and Pasighat (12.51 t ha⁻¹), reinforcing its effectiveness in improving zinc availability. Following closely, T₁ achieved a mean yield of 12.06 t ha⁻¹, ranking second overall, demonstrating moderate effectiveness in solubilizing zinc. The control treatment without zinc application (T₅) recorded the lowest mean value of 9.27 t ha⁻¹, confirming the essential role of zinc in improving solubilization efficiency.

Overall, the findings highlight that combining *Bacillus safensis* with 50% of the recommended Zn fertilizer (T₂) not only improved Zn utilization but also significantly

enhanced fresh and dry rhizome yields, making it a promising and cost-effective approach for sustainable ginger production.

Crop Protection & Food Safety

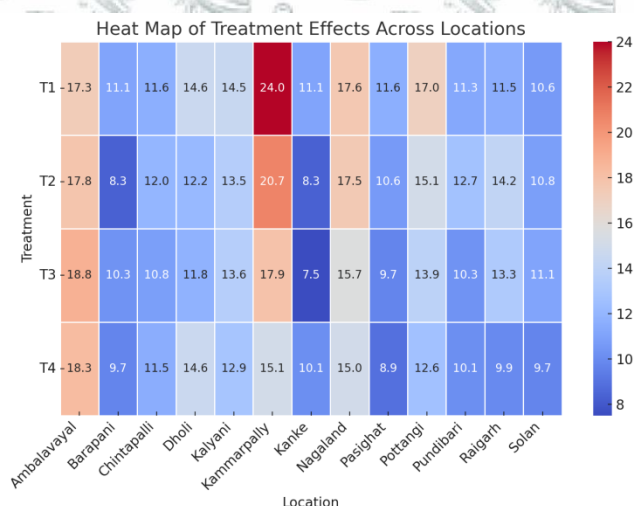
GIN/CP/6.15 Priming of rhizomes for enhanced germination, vigour and storage rot suppression in ginger

(Centres: Ambalavayal, Barapani, Chintapalli, Dholi, Kalyani, Kammarpally, Kanke, Nagaland, Pasighat, Pottangi, Pundibari, Raigarh, Solan)

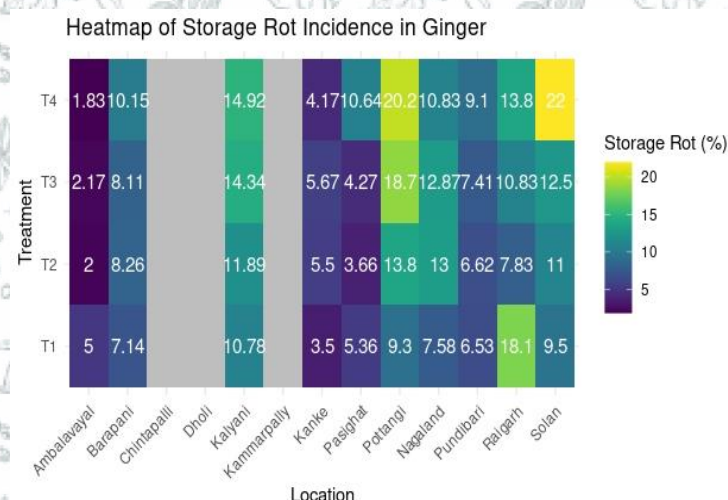
This experiment was conducted to assess the efficacy of rhizome priming with Trichoprime, a combination of metalaxyl-mancozeb and imidacloprid, and tebuconazole with imidacloprid, along with the recommended package of practices (POP), for improving germination, vigour, and storage rot suppression in ginger, as well as evaluating growth parameters. Now in its third year (2022–2023), the trial followed a Randomized Block Design (RBD) with four treatments, six replications, and a plot size of $3.0 \times 1.0 \text{ m}^2$, accommodating 40 plants per bed. The treatments included T₁: Trichoprime-based rhizome priming; T₂: Rhizome treatment with metalaxyl-mancozeb (1.25 g L^{-1}) + imidacloprid (0.5 ml L^{-1}) for 30 minutes; T₃: Rhizomes were treated with tebuconazole (1 ml L^{-1}) + imidacloprid (0.5 ml L^{-1}) for 30 minutes; and T₄: Recommended state package of practices.

Multi-location experiment conducted during *kharif*, 2022–23 showed considerable variation on ginger fresh rhizome yield across locations (Fig. . and Storage rot incidence (Fig.)

The analysis of fresh rhizome yield across different locations reveals that T₁ is the most effective, showing the best yield in eight out of thirteen locations, including barapani, Dholi, Kalyani, Kammarpally, Kanke Nagaland, Pasighat, and Pottangi. T₂ demonstrate limited superiority, emerging as the top performer in only two locations excelling in Pundibari and Raigarh and T₃ in Solan. Meanwhile, T₃ and T₄ does not stand out as the best in any location, indicating its relatively lower effectiveness compared to the others, which suggest a consideration of any rhizome treatment other than recommended POP is required in overall case.



The analysis of storage rot and rhizome rot incidence across different ginger-growing location reveals distinct treatment responses. In a few locations, no storage rot or rhizome rot was observed, indicating favourable growing conditions. Notably,



in Chinthapalle and Kalyani. But most cases diseases incidence was significant where storage rot incidence was recorded.

Treatment T₄: Recommended POP consistently exhibits the highest percentage of storage rot across most locations, with particularly high values in Solan (22.0%), Pottangi (20.2%), and Kalyani (14.92%). T₃ also shows

relatively high storage rot incidence in locations such as Pottangi (18.7%) and Kalyani (14.3%), suggesting its limited effectiveness in suppressing rot. In contrast, T₁ and T₂ generally result in lower storage rot percentages, with T₂ performing better in Ambalavayal (2.0%) and T₁ showing lower incidence in seven locations viz., Barapani (7.14%), Kalyani (14.3%), Kanke (3.5%), Pottangi (9.3%), Nagaland (7.58%), Pundibari (6.53%) and Solan (9.5%). Overall, mean performance suggested T₄ (11.76%) appears to be the least effective in controlling storage rot, while T₁ (8.27%) and T₂ (8.36%) demonstrate relatively better performance in reducing incidence, making them more promising options for disease suppression.

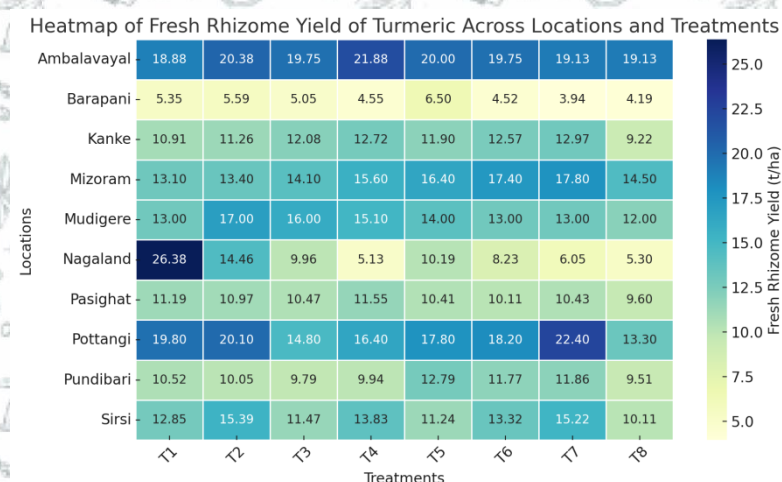
GIN/CP/7.1 Spray schedule optimization of effective insecticides for shoot borer (*Conogethes punctiferalis*) in ginger

(Centres: Ambalavayal, Barapani, Kanke, Mizoram, Mudigere, Nagaland, Pasighat, Pottangi, Pundibari, Sirsi)

The experiment was initiated in the year 2021–22 to evaluate the efficacy of different insecticide treatments in managing shoot infestation in ginger across eleven locations. The experiment followed a RBD with eight treatments and four replications. The treatments included T₁ & T₂: Chlorantraniliprole at two different concentrations (0.3 ml L⁻¹ and 0.5 ml L⁻¹), T₃ & T₄: Flubendiamide at 0.3 ml L⁻¹ and 0.5 ml L⁻¹, T₅ & T₆: Spinosad at 0.3 ml L⁻¹ and 0.5 ml L⁻¹, and T₇: an alternating treatment of Chlorantraniliprole and Spinosad at 0.5 ml L⁻¹, and T₈: with a control treatment receiving only water spray. A popular improved ginger variety specific to each centres was used for the study and treatments was applied as per technical programme.

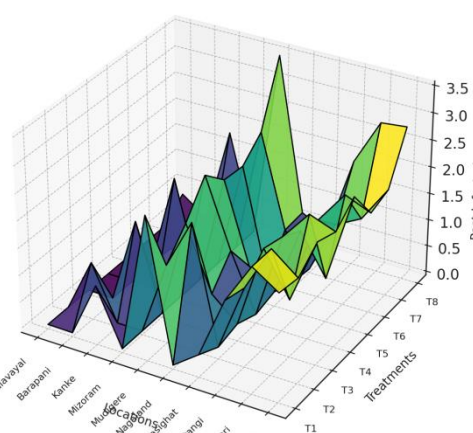
The mean fresh rhizome yield varied significantly across locations, with the highest recorded in Ambalavayal (19.86 t ha⁻¹), Pottangi (17.85 t ha⁻¹), and Mizoram (15.29 t ha⁻¹), while the lowest was observed in Barapani (4.96 t ha⁻¹). T₇: an alternating

treatment of Chlorantraniliprole and Spinosad at 0.5 ml L⁻¹, was found superior at most locations (five times), followed by T₂ (four times), indicating its potential effectiveness in improving fresh rhizome yield. Other treatments showed varied responses, with T₄ being superior three times, while T₁, T₃, T₅, and T₆ had limited superior performance at different locations. Notably, T₈ (Control without any chemicals) did not emerge as the best treatment at any location indicating the synergistic effect of these chemical on yield levels.



synergistic effect of these chemical on yield levels. The trials results on shoot borer infestation data collected as no. of shoots per clump infested indicated that before treatment, the infestation levels were relatively low across most locations, with some variation. Post-treatment, significant differences were observed among the treatments, with T₈ (control) showing the highest infestation levels after treatment in multiple locations, including Ambalavayal (0.338), Mudigere (3.5), Pottangi (1.9), and Sirsi (2.8), suggesting need to devised a measure of control. Based on the mean values of shoot borer-infested shoots per clump of ginger before and after treatment application, the most effective treatment for managing the insect population is T₇, followed closely by T₆. T₇ recorded the lowest post-treatment infestation mean of 0.72 no. of shoots per clump, indicating the highest level of insect suppression, followed by T₆ with a post-treatment mean of 0.73 no. of shoots per clump. These treatments showed a substantial reduction in infestation compared to pre-treatment levels. In contrast, T₈ had the highest post-treatment infestation mean of 1.41 no. of shoots per clump, suggesting that it was the least effective in controlling the insect population. Therefore, T₇ can be considered the best treatment for effective shoot borer management in ginger.

3D Surface Plot of Post-Infestation Data



TUR/CP/7.2 Observational trial on the efficacy of *Trichoderma asperellum* and *Pochonia chlamydosporia* for the management of rhizome rot and nematode in ginger

(Centres: Barapani, Chinthapalle, Kozhikode, Pottangi)

During 2022-23, the trial was conducted across four locations: Barapani, Chinthapalle, Kozhikode, and Pottangi, to evaluate the efficacy of *Trichoderma asperellum* and

Pochonia chlamydosporia in managing rhizome rot and nematodes in ginger. The results indicated variations in sprouting percentage, fresh rhizome yield, rhizome rot incidence, and nematode suppression across treatments.

In terms of sprouting percentage, the highest was observed in T₂ (90.45%), followed by T₃ (89.75%) and T₄ (86.15%). The control treatment (T₁) exhibited a sprouting percentage of 79.9%, which was the lowest. Statistical analysis indicated that the treatment effects were significant, with T₂ showing the most prominent effect on sprouting percentage. Fresh rhizome yield (FRY) varied across treatments, with the highest recorded in T₂ (16.515 t ha⁻¹), followed by T₃ (15.8875 t ha⁻¹) and T₄ (14.8 t ha⁻¹). The control treatment (T₁) yielded 11.91 t ha⁻¹, which was lower compared to the other treatments. These results suggest that treatments with *Trichoderma asperellum* and *Pochonia chlamydosporia* contributed to significantly higher yields.

The incidence of rhizome rot disease was lowest in T₃ (10.85%), followed by T₂ (12.8%) and T₄ (22.8%). The control treatment (T₁) showed the highest disease incidence at 31.1%. Statistical analysis indicated that T₂ and T₃ were the most effective in managing rhizome rot disease, with T₂ showing a marked improvement over the control. For nematode soil population, the highest reduction was observed in T₅ (36.7%), where the nematode count decreased from 42.3 to 5.6, indicating a substantial reduction. T₄ also exhibited a significant reduction of 31.6%, followed by T₂ (20.9%). The control treatment (T₁) showed an increase in the nematode count, with a delta count of 127.6%, indicating the least effectiveness in nematode suppression.

In conclusion, T₂, involving the application of *Trichoderma asperellum* talc formulation, was the most effective treatment for improving sprouting and fresh rhizome yield, as well as reducing rhizome rot disease incidence. T₅, with nematicide application, was highly effective in reducing nematode counts, with T₄ also showing comparative results in nematode suppression.

Genetic Resources

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

(Centres: Barapani, Coimbatore, Dholi, Guntur, Kammarpally, Kumarganj, Pasighat, Pottangi, Pundibari, Raigarh, Solan)

The rich genetic diversity plays a great role in varietal improvement of any crop and turmeric, being a vegetatively propagated crop, the importance of variability is further accentuated for its possible exploitation in clonal selection.

A total of 1778 accessions of turmeric including its wild relatives are being maintained by different AICRPS centres. The details of germplasm collection maintained are given in Table 25.

Table 25. Turmeric germplasm collections maintained at various AICRPS centres

Centers	No. of Germplasm conserved			No. of Germplasm evaluated during 2022-23
	Existing	Addition (2022-23)	Total	
Barapani	29	0	29	29
Coimbatore	269+8*	0	277	200
Dholi	66+4*	7	70	70
Guntur	252+4*	0	256	72
Kammarpally	312	0	312	302
Kumarganj	186+2*	0	188	186
Pasighat	75	0	75	75
Pottangi	178+23*	0	201	198
Pundibari	179+35*	0	214	179
Raigarh	114	0	114	102
Solan	40	2	42	40
Total	1776	9	1778	1453

*Representing the figures of eild and wild relatives of *Curcuma longa*

Under germplasm evaluation of turmeric, during the *kharif* season 2022-23, across multiple AICRP centres demonstrated significant diversity in yield and other agronomic traits. At Barapani, 29 accessions were evaluated, with IC-586779 exhibiting the tallest plant height (121.63 cm) and highest leaf dimensions, while IC-586767 recorded the highest fresh rhizome yield (608.33 g plant⁻¹) and IC-586767 had the highest estimated yield per hectare (13.33 t ha⁻¹). At Coimbatore, 200 genotypes were assessed, with CL 180 showing the highest fresh rhizome yield per clump (634.3 g), and CL 272 exhibiting the highest total curcuminoid content (5.84%). Dholi evaluated 70 accessions, with RH-432 achieving the highest yield (48.47 t ha⁻¹). In Guntur, among 72 accessions, LTS-18 had the highest fresh clump weight (474.9 g clump⁻¹). At Kammarapally, 302 lines were evaluated, with Acc No. 194 recording the

highest yield (44.99 t ha⁻¹). Kumarganj assessed 186 accessions, with NDH-74 yielding the highest among early maturing types (285 g plant⁻¹), NDH-14 among medium maturing types (268 g plant⁻¹), and NDH-11 among late maturing types (272 g plant⁻¹). Pasighat evaluated 75 accessions, with CHFT-36 showing the highest estimated rhizome yield (28.27 t ha⁻¹). At Pottangi, 168 accessions were evaluated, with PTS-3 recording the highest fresh rhizome yield per plot (21.0 Kg 3m⁻²) and estimated yield (46.62 t ha⁻¹). Pundibari screened 179 accessions, with 32 exceeding 35 t ha⁻¹ in rhizome yield, while several exhibited resistance to leaf blotch and leaf spot diseases. Raigarh maintained 114 accessions, with IT 3 recording the highest rhizome yield (17.2 t ha⁻¹). Solan evaluated 40 genotypes, with ST19-27 achieving the highest fresh rhizome yield (391.08 g plant⁻¹) with 3.58% curcumin content. The extensive characterization and conservation efforts highlight the genetic diversity in turmeric and provide valuable insights for future breeding and crop improvement initiatives.

Here is the summary table based the evaluation of ginger germplasm across various AICRPS centres:

Center	No. of Accessions Evaluated	Mean Yield (t/ha)	Range of Yield (t/ha)	Promising Accessions Based on Yield
Barapani	29	10.14	6.6 - 13.3	IC-586767 (13.3), IC-586777 (13.2),
Coimbatore	200	--	--	CL 180 (634.3 g/clump), CL 171 (620.26 g/clump), CL 161 (600.10 g/clump), CL 99 (560.03 g/clump), CL 229 (510.30 g/clump)
Dholi	70	41.23	37.54 - 48.47	RH-432 (48.47 t/ha), RH-50 (47.34 t/ha), RH-414 (46.11 t/ha)
Guntur	72	208.6	10.8- 474.9	LTS-18 (474.9 g/clump), LTS-2 (408.3 g/clump), CL-6 (405.7 g/clump)
Kammarapally	302	27.6	13.58- 47.19	CCA-304 (48.74 t/ha), JTS-13 (46.99 t/ha), CLI-316 (40.49 t/ha), JTS-38 (40.49 t/ha), JTS-315 (40.49 t/ha)
Kumarganj	186	168	168-328	NDH-98 (328 g/plant), NDH-74 (285 g/plant), NDH-88 (275 g/plant)
Pasighat	75	15.3	5.3-28.27	CHFT-36 (28.27 t/ha), CHFT-8 (28.05 t/ha), CHFT-56 (27.66 t/ha)
Pottangi	168	14.0	4.44 - 46.62	PTS-3 (46.62 t/ha), PTS-47 (19.9 Kg 3m ²), Kuchipudi (19.4 Kg 3m ²)
Pundibari	179	--	25 - 35+	No Information supplied
Raigarh	102	15.98	3.9-37.2	IT 1 (37.2 t/ha), IT 28 (31.2 t/ha), IT 3 (30.2 t/ha)
Solan	40	152.98 g/plant	152.98- 393.1	ST19-27 (391.08 g/plant), ST19-22 (372.71 g/plant), ST19-15 (362.28 g/plant)



Crop Improvement

TUR/CI/2.7: Coordinated Varietal Trial (CVT) on mango ginger

(Centres: Ambalavayal, Barapani, Dholi, Kozhikode, Navsari, Pottangi, Pundibari, Raigarh)

CVT on Mango Ginger was conducted to assess the performance of different mango ginger accessions under specific agro-climatic conditions. The aim was to identify high-yielding and agronomically superior genotypes suitable for cultivation. The trial followed a RBD Design RBD with three replications and was conducted over three years (2020-23). A total of ten genotypes, including the check variety Amba, were evaluated. The trial was laid out with a net plot size of $3.0 \times 1.8 \text{ m}^2$, maintaining a

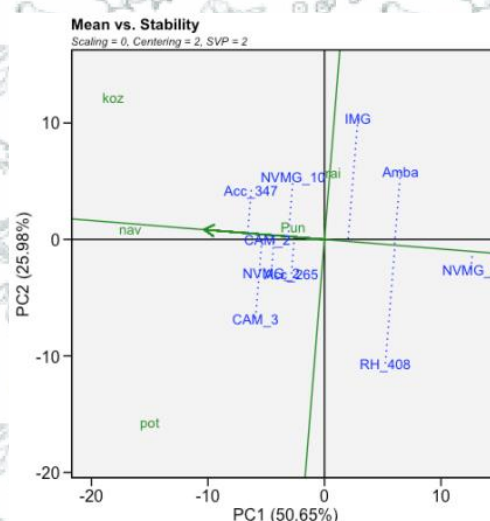
spacing of 45 cm between rows and 30 cm within rows. A summary of the findings after three years of evaluation is presented in Table XX and Table XX.

The fresh rhizome yield of mango ginger entries varied across different testing locations over three years of trial (2020-23), with the average yield ranging from 21.6 to 29.0 t ha⁻¹. Among the evaluated genotypes, *Acc 347* recorded the highest mean yield (29.0 t ha⁻¹), followed by RH 408 (27.9 t ha⁻¹) and NVMG 10 (27.7 t ha⁻¹), whereas the check variety, Amba, yielded 21.6 t ha⁻¹, making it the lowest-performing genotype in the trial. The % yield increase over check (IOC) was highest for *Acc 347* (34.7%), followed by RH 408 (29.6%) and NVMG 10 (28.6%), suggesting their superior yield potential over the check and potential for release. Location-wise, the highest mean yield was observed at Kozhikode location (35.3 t ha⁻¹) and Pottangi (34.9 t ha⁻¹), while the lowest was recorded at Barapani (15.4 t ha⁻¹).

Entry	ABL	BPI	DHI	KOZ	NAV	POT	PUN	RAI	Mean	Rank	%IOC
Acc 265	26.0	17.0	27.8	35.6	30.6	26.1	31.7	16.6	26.4	7	22.5
Acc 347	36.4	16.1	24.5	45.8	28.8	26.9	27.9	25.9	29.0	1	34.7
CAM 2	NG	NG	24.7	34.1	28.9	27.3	27.4	19.2	26.9	5	24.9
CAM 3	NG	NG	27.0	20.7	29.0	34.9	28.4	21.9	27.0	4	25.1
Indira Mango Ginger	26.7	14.7	31.5	37.9	24.7	13.8	29.0	30.1	26.0	8	20.8
NVMG 2	19.8	NG	33.4	24.4	38.1	24.8	29.8	15.9	26.6	6	23.4
NVMG 9	39.0	NG	20.6	38.4	18.7	13.8	25.5	18.9	25.0	9	15.9
NVMG 10	25.5	NG	26.3	41.8	34.8	17.1	31.8	16.9	27.7	3	28.6
RH 408	NG	NG	30.9	38.6	19.6	29.2	28.1	21.3	27.9	2	29.6
Amba (Check)	15.3	13.7	27.9	35.3	18.2	13.7	28.6	19.9	21.6	10	0.0
Location MEAN	27.0	15.4	27.5	35.3	27.1	22.7	28.8	20.6	25.5		

Where, ABL : Ambalavayal , BPI : Barapani , DHI : Dholi , KOZ : Kozhikode , NAV : Navsari , POT : Pottangi , PUN : Pundibari , RAI : Raigarh %IOC: percentage increment over check

Mean vs. Stability analysis in the GGE biplot visually represents the performance and stability of different mango ginger genotypes across multiple environments. *Acc 347*, NVMG10, and RH-408 to have higher mean yields whereas Amba (check) and NVMG_9 have lower yields compared to others. Most stable genotypes are CAM-2, CAM-3, *Acc 265*. But comparing both mean and stability together, *Acc 347* emerges as the most promising genotype, as it combines high yield with moderate stability. NVMG 10 and RH-408, while high-yielding, exhibit greater variability, making them less stable across environments. On the other hand, CAM-2, CAM-3, and *Acc 265* demonstrate greater stability but with slightly lower yields. Therefore, *Acc 347* can be considered a balanced choice for both high yield and moderate stability.



TUR/CI/2.8: Coordinated Varietal Trial (CVT) on high yield and high curcumin

(Centres: Coimbatore, Guntur, Kammarpally, Kanke, Kozhikode, Navsari, Pasighat, Pottangi, Raigarh)

Coordinated varietal trial on high yield and high curcumin was initiated at 9 AICRPS centres with the aim to identify high yielding turmeric genotypes with high curcumin.

The trial consists of eight test entries along with three national checks was evaluated in RBD with three replications.

During the 2022-23 and second year of testing, the average fresh rhizome yield recorded across test locations ranged from 19.3 (RRN 1) to 28.7 t ha⁻¹ (NVST 56). Among the test entries, NVST 56 exhibited the highest mean fresh rhizome yield (28.7 t ha⁻¹), followed by Check, IISR Pragati (28.2 t ha⁻¹). Notably, NVST 56 also demonstrated superior performance at multiple locations, with the highest yield recorded at Coimbatore (72.4 t ha⁻¹) and Navsari (48.5 t ha⁻¹). The overall location mean fresh rhizome yield was 24.3 t ha⁻¹.

Table 28. Fresh rhizome yield (t ha⁻¹) recorded in CVT on high yield and high curcumin turmeric during Kharif, 2022-23

Entries	CBE	GTR	KPL	KKE	KOZ	NAV	PGT	POT	RAI	Mean	Rank
RRN1	34.9	17.4	16.8	21.9	18.8	21.8	10.3	14.0	22.2	19.3	11
CL 258	45.5	18.8	12.8	26.0	15.3	33.5	6.2	13.1	18.7	22.9	10
CL 272	40.6	26.8	9.2	24.9	26.6	33.8	7.3	13.5	17.6	25.1	4
PTS 47	31.7	18.0	18.2	27.7	13.2	29.8	8.5	14.4	19.1	24.5	4
PTS 6	54.4	19.6	15.4	26.4	18.8	22.2	9.8	15.2	14.6	25.4	3
IT 26	33.9	17.7	12.6	27.1	24.5	35.4	8.3	11.9	24.1	24.2	4
NVST 56	72.4	32.6	17.4	25.1	8.1	48.5	8.8	13.5	15.8	28.7	1
NVST 84	29.4	26.5	11.7	21.6	9.8	46.5	6.5	11.3	14.9	22.1	5
IISR Pratibha (Check)	27.0	25.5	12.1	24.8	27.8	31.9	10.5	12.1	17.2	23.3	4
IISR Pragati (Check)	43.9	25.4	12.2	24.0	29.8	33.5	13.4	NP	18.8	28.2	1
CIM.Pitamber (Check)	48.0	13.8	6.6	19.5	23.8	NP	11.7	12.1	NP	23.7	2
Loc MEAN	42.0	22.0	13.2	24.5	19.7	33.7	9.2	13.1	18.3	24.3	
F (Prob)	0.000	0.000	0.000	0.128	0.000	0.001	0.000	0.011	0.000		
CD (p=5%)	3.3	3.8	2.7	5.6	6.0	5.8	2.4	1.9	2.0		
CV (%)	4.6	10.3	12.2	13.4	18.0	10.8	15.06	8.6	6.4		
SE (m)	1.1	1.3	0.9	1.9	2.0	2.0	0.8	0.7	0.7		

Where CBE : Coimbatore, GTR : Guntur, KPL: Kammarpally, KKE: Kanke, KOZ: Kozhikode, NAV: Navsari, PGT :Pasighat, POT : Pottangi, and RAI: Raigarh.

Table 28. Ancillary data recorded in CVT on high yield and high curcumin turmeric during Kharif, 2022-23

Entries	FRY	DRY	Cur%	PH	T/C	FCW	RR	LS	SB
RRN1	19.3	4.47	3.978	87.0	3.0	332.7	2.27	5.14	1.20
CL 258	22.9	5.88	3.489	99.9	3.6	298.3	1.34	8.43	1.04

CL 272	25.1	4.69	4.214	102.0	3.2	333.6	2.00	10.00	0.67
PTS 47	24.5	5.08	3.137	110.5	3.3	340.9	2.00	8.03	1.17
PTS 6	25.4	6.38	3.650	106.7	3.5	359.0	1.20	3.24	0.60
IT 26	24.2	4.07	3.339	100.5	3.4	334.5	2.84	8.95	1.10
NVST 56	28.7	8.45	2.600	105.0	3.2	470.9	3.20	7.00	1.00
NVST 84	22.1	3.94	2.611	101.2	3.1	331.7	3.05	8.39	1.20
IISR Pratibha (Check)	23.3	3.59	4.458	104.0	3.3	370.1	2.07	8.90	1.27
IISR Pragati (Check)	28.2	5.85	3.856	101.5	3.3	438.3	1.00	7.60	1.00
CIM Pitamber (Check)	23.7	4.39	3.888	88.1	3.3	313.8	3.14	5.24	2.15
Loc MEAN	24.3	5.07	3.587	101.8	3.3	357.8	2.35	7.50	1.15

Where **FRY** : fresh rhizome yield (t/ha), **DRY** : dry rhizome yield (t/ha), **Cur%** : curcumin content (%), **PH**: plant height (cm), **T/C**: number of tillers per clump, **FCW** : fresh clump weight per plant (g), **RR** : rhizome rot incidence (PDI), **LS**: leaf spot incidence (PDI), and **SB** : shoot borer incidence (%).

During the 2022-23 season, the curcumin content across the test entries ranged from 2.600% (NVST 56) to 4.458% (IISR Pratibha), with a mean of 3.587%. The highest dry yield was recorded in NVST 56 (8.45 t ha⁻¹), followed by PTS 6 (6.38 t ha⁻¹) and CL 258 (5.88 t ha⁻¹), while the overall mean dry rhizome yield was 5.07 t ha⁻¹. Among the checks, IISR Pragati recorded a dry yield of 5.85 t ha⁻¹ with a curcumin content of 3.856%. Regarding other traits, plant height varied from 87.0 cm (RRN 1) to 110.5 cm (PTS 47), while the number of tillers per clump ranged from 3.0 (RRN 1) to 3.6 (CL 258). Fresh clump weight per plant was highest in NVST 56 (470.9 g) and lowest in CL 258 (298.3 g). Disease and pest incidence showed variability, with rhizome rot incidence ranging from 1.00 PDI (IISR Pragati) to 3.20 PDI (NVST 56), leaf spot incidence between 3.24 PDI (PTS 6) and 10.00 PDI (CL 272), and shoot borer incidence from 0.60% (PTS 6) to 2.15% (CIM Pitamber).

TUR/CI/2.9: Coordinated Varietal Trial (CVT) on light yellow colour turmeric for speciality market

(Centres: Coimbatore, Guntur, Kammarpally, Kanke, Kozhikode, Pasighat, Pottangi)

Coordinated varietal trial on light yellow coloured turmeric for specialty market, aimed in identifying the turmeric genotypes suitable for light yellow coloured turmeric production. The trial consists of nine test entries (five from ICAR-IISR, two from TNAU, one each from Pottangi and Kammarpally) along with national check, IISR Prathiba and Mydukur are being evaluated since 2020-21.

During the 2022-23 and second year of testing, the mean fresh rhizome yield across test locations ranged from 18.4 t ha⁻¹ (KPS 611, Mydukur) to 26.2 t ha⁻¹ (Acc 849), with a location mean of 22.2 t ha⁻¹. Among the test entries, Acc 849 ranked first in mean fresh rhizome yield (26.2 t ha⁻¹), followed by CL 223 (23.9 t ha⁻¹) and CL 21 (23.6 t ha⁻¹). The best-performing check, IISR Pratibha, recorded a mean fresh rhizome yield of 23.5 t/ha.

Table 28. Fresh rhizome yield ($t\ ha^{-1}$) recorded in CVT on light yellow colour turmeric for speciality market during Kharif, 2022-23

Entries	CBE	GTR	KPL	KKE	KOZ	PGT	POT	Mean	Rank
RRN 3	40.6	23.7	17.3	24.2	17.3	9.0	12.4	20.7	10
RRN 4	38.1	21.7	23.5	24.6	23.5	9.1	11.6	21.7	9
RRN 2	41.2	26.3	19.9	24.6	19.9	9.2	12.7	22.0	8
Acc 849	36.1	22.2	36.2	24.8	36.2	13.5	14.7	26.2	1
Acc 1545	31.1	22.5	31.2	23.1	31.2	8.3	11.0	22.6	6
CL 223	37.4	35.2	26.2	21.0	26.2	9.6	11.5	23.9	2
CL 21	33.3	37.3	25.8	21.6	25.8	9.2	11.9	23.6	3
PTS 50	41.1	23.3	27.0	23.8	27.0	7.7	13.5	23.3	5
KPS 611	32.8	23.8	13.7	23.8	13.7	10.3	11.0	18.4	12
IISR Pratibha (Check)	39.4	27.1	24.8	24.1	24.8	11.0	13.5	23.5	4
Mydukur (Check)	32.5	32.7	9.5	19.4	9.5	14.2	11.3	18.4	11
Loc MEAN	36.7	26.9	23.2	23.2	23.2	10.1	12.3	22.2	
F (Prob)	0.000	0.000	0.000	0.522	0.000	0.000	0.000		
CD (p=5%)	4.4	3.8	5.4	5.4	5.4	1.7	1.4		
CV (%)	7.1	8.3	13.8	13.6	13.8	9.7	6.8		
SE (m)	1.5	1.3	1.8	1.8	1.8	0.6	0.5		

Where CBE : Coimbatore, GTR : Guntur, KPL: Kammarpally, KKE: Kanke, KOZ: Kozhikode, PGT :Pasighat, POT : Pottangi.

The highest dry yield was recorded in PTS 50 ($5.7\ t\ ha^{-1}$), followed by Acc 849 ($5.3\ t\ ha^{-1}$), while Mydukur had the lowest ($3.2\ t\ ha^{-1}$). Curcumin content (%) varied from 2.5% (PTS 50, KPS 611) to 3.9% (IISR Pratibha), with an overall mean of 3.0%. Regarding variability measures, plant height (PH) ranged from 75.2 cm (RRN 4) to 94.4 cm (Acc 849), while the number of tillers per clump (T/C) varied between 2.4 (RRN 3) and 2.8 (RRN 2, CL 21). Fresh clump weight (FCW) showed considerable variation, ranging from 226.9 g (RRN 3) to 305.8 g (Acc 849), with a mean of 268.2 g.

Table 28. Ancillary data recorded in CVT on high yield and high curcumin turmeric during Kharif, 2022-23

Entries	FRY	DRY	Cur%	PH	T/C	FWC
RRN 3	20.7	4.2	3.1	76.8	2.4	226.9
RRN 4	21.7	4.2	3.7	75.2	2.5	241.7
RRN 2	22.0	4.5	3.5	81.4	2.8	258.2
Acc 849	26.2	5.3	2.6	94.4	2.6	305.8
Acc 1545	22.6	4.3	2.9	86.8	2.6	264.5
CL 223	23.9	4.7	3.2	87.0	2.7	278.9
CL 21	23.6	4.6	2.7	86.1	2.8	302.9
PTS 50	23.3	5.7	2.5	79.1	2.6	272.1
KPS 611	18.4	3.4	2.5	86.8	2.5	253.7
IISR Pratibha (Check)	23.5	4.5	3.9	88.4	2.5	298.9

Mydukur (Check)	18.4	3.2	2.8	83.6	2.6	247.1
Loc MEAN	22.2	4.4	3.0	84.1	2.6	268.2

Where **FRY** : fresh rhizome yield (t/ha), **DRY** : dry rhizome yield (t/ha), **Cur%** : curcumin content (%), **PH**: plant height (cm), **T/C**: number of tillers per clump, **FCW** : fresh clump weight per plant (g)

TUR/CI/2.11: Coordinated Varietal Trial (CVT) on black turmeric *Curcuma caesia*

(Centres: Barapani, Coimbatore, Kozhikode, Kumarganj, Mizoram, Navsari, Pottangi, Pundibari)

A new CVT on Black Turmeric (*Curcuma caesia*) was initiated in 2022-23 to evaluate the performance of eight different black turmeric entries across diverse agro-climatic conditions. The trial is being conducted at eight centres for duration of three years to assess the yield potential, quality parameters, and adaptability of selected genotypes.

During the season 2022-23, all participating centres received and multiplied the entries to ensure sufficient planting material for the upcoming trials. The botanical identity of each genotype was confirmed as *Curcuma caesia*, and only validated entries were included for further evaluation. The replicated trial is now set to begin in the 2023-24 planting season at all centres.

Crop Management

TUR/CM/5.1 Evaluation of Plant Growth Promoting *Rhizobacteria*, *Bacillus safensis* for phosphorus (P) solubilization potential in turmeric

(Centres: Chintapalle, Coimbatore, Kahikuchi, Kalyani, Kammarpally, Kozhikode, Pasighat, Pottangi, Pundibari, Raigarh, Solan)

The trial was initiated in 2022-23 across 11 AICRPS centres, to assess the efficacy of *Bacillus safensis* in enhancing phosphorus solubilization and its impact on turmeric growth, yield, and nutrient uptake under different phosphorus application regimes. The trial was conducted in a RBD with seven treatments and four replications, using popular improved varieties of turmeric specific to each centre. The treatments included T₁ (100% recommended phosphorus fertilizer), T₂ (75% phosphorus fertilizer), T₃ (75% phosphorus fertilizer + *Bacillus safensis*), T₄ (50% phosphorus fertilizer), T₅ (50% phosphorus fertilizer + *Bacillus safensis*), T₆ (*Bacillus safensis* alone), and T₇ (control without phosphorus). *Bacillus safensis* was applied as a soil drench at planting, 30 DAP, and 60 DAP. Growth parameters were recorded at 90 and 120 DAP, and soil nutrient analysis was carried out at 120 DAP to estimate available phosphorus and other macro- and micronutrients. Nutrient uptake was analyzed at harvest, followed by yield and quality assessments to determine the economic feasibility of using *Bacillus safensis* in phosphorus management.

During the first year, among the treatments, based on the mean fresh yield performance results, the treatment T₃ (75% P + *Bacillus safensis*) recorded the highest mean yield of 25.56 t ha⁻¹ of turmeric fresh yield, making it the most effective

treatment for enhancing productivity. This was followed by T₅ (50% P + *Bacillus safensis*), which achieved a mean yield of 22.69 t ha⁻¹. T₃ further ranked first in 8 out of 10 locations tested whereas T₅ did not rank first in any location but closely followed T₅ to be the second best one. The lowest yield was observed in the control treatment without phosphorus (T₇), with a mean yield of 18.35 t ha⁻¹, confirming the essential role of phosphorus in yield improvement. Overall, the results suggest that the combined application of *Bacillus safensis* with either 50% or 75% of the recommended phosphorus fertilizer (T₅ and T₃, respectively) significantly enhanced fresh and dry rhizome yield, highlighting its potential as a sustainable phosphorus management strategy in turmeric cultivation.

Fresh rhizome yield

Treatment	CPE	CBE	KAHI	KAL	KPL	PGT	POT	PUN	RAI	SOL	Mean	RANK
T ₁	23.49	21.02	21.23	25.49	21.99	16.23	13.8	23.74	20.13	26.69	21.38	3
T ₂	24.74	22.25	20.51	22.95	18.24	13.76	14.5	21.81	21.75	25.12	20.56	4
T ₃	26.91	24.95	27.49	30.17	30.93	18.22	17.5	-	23.27	30.63	25.56	1
T ₄	24.69	22.45	20.7	20.86	13.61	12.48	14.9	28.97	19.86	23.24	20.18	5
T ₅	25.84	23.32	26.83	26.75	24.31	14.48	16.7	-	20.06	25.96	22.69	2
T ₆	25.22	22.8	20.56	21.03	20.68	11.88	14.6	18.59	18.46	26.77	20.06	6
T ₇ (Control, No P)	23.56	21.65	19.1	18.78	10.87	11.66	14.2	25.17	18.03	20.44	18.35	7
C.D.(5%)	1.98	0.85	0.91	0.94	0.504	0.44	1.1	2.11	0.72	1.49		
SE(m)+ ₋	0.64	0.28	-	0.3	0.168	0.14	0.4	0.71	-	0.48		
C.V.(5%)	4.43	2.52	-	2.22	4.19	7.01	0.5	5.66	-	3.34		

It was consistently noticed the T₃ lead to the highest dry rhizome yield, with a mean yield of 5.04 t ha⁻¹, outperforming all other treatments. However with case of dry recovery percentage, T₃ also showed a consistently good performance with a mean of 19.32%, while T₁ (100% recommended P fertilizer) recorded the highest dry recovery at 25.78%.

Treatment	Dry recovery (%)					Dry rhizome yield (t)				
	CPE	CBE	KAHI	POT	Mean	CPE	CBE	KAHI	POT	Mean
T ₁	27.4	26.7	21.23	25.8	25.78	6.91	6.57	4.45	3.6	5.92
T ₂	27.2	26.9	20.75	25.1	18.7	6.72	6.12	4.13	3.6	4.24
T ₃	27.3	27.3	22.65	27.2	19.32	7.35	6.77	6.04	4.8	5.04
T ₄	26.3	26.2	20.35	24.7	18.21	6.18	5.65	4.14	3.7	4.06
T ₅	27.2	27	21.65	26.5	18.96	7.04	5.52	5.63	4.4	4.54
T ₆	27.1	26.6	21.47	24.6	25.65	6.39	5.17	4.32	3.6	5.27
T ₇ (Control, No P)	27	25.1	21.32	24.5	25.14	6.69	5.27	4.07	3.5	4.22
C.D.(5%)	NS	1.23	0.35	0.4		NS	0.53	0.37	0.4	

SE(m)+_	0.43	0.41	-	0.1		0.24	0.17	-	0.1	
C.V.(5%)	2.74	0.39	-	1.2		6.07	6.06	-	5.2	

The findings indicate that integrating *Bacillus safensis* with reduced phosphorus levels significantly enhances yield potential, making it a viable alternative for optimizing phosphorus use efficiency in crop production.

TUR/CM/5.2 Evaluation of Plant Growth Promoting *Rhizobacteria*, *Bacillus safensis* for zinc (Zn) solubilization potential in turmeric

(Centres: Chintapalle, Coimbatore, Dholi, Kahikuchi, Kalyani, Kammarpally, Kanke, Kozhikode, Kumarganj, Pasighat, Pottangi, Pundibari, Raigarh)

The trial was initiated during 2022-23 and conducted thirteen different AICRPS centres, aimed to assess the efficacy of *Bacillus safensis* in enhancing zinc solubilization and its subsequent impact on plant growth, nutrient uptake, and yield parameters in turmeric. The trial was laid in RBD with five treatments and five replications. Popular improved variety of turmeric was planted for each respective centre. The treatments included T₁: 100% recommended zinc fertilizer, T₂: 50% zinc fertilizer and *Bacillus safensis*, T₃: 50% zinc fertilizer alone, T₄: *Bacillus safensis* alone), and T₅: Control without Zn application. The crop was planted in beds measuring 3 × 1 m with a spacing of 15 × 30 cm, totaling 25 experimental units. The bacterial application was performed as soil drench at the time of planting, 30 days after planting (DAP), and 60 DAP, while fertilizers were applied as per the recommended dosage. Observations were recorded for growth parameters at 90 and 120 DAP, soil nutrient analysis (available Zn and other macro and micronutrients at 120 DAP), nutrient uptake in leaves and rhizomes at harvest, yield and quality analysis.

Treatment	CPE	CBE	DHL	KAHI	KAL	KPL	KUM	PGL	POT	PUN	RAI	Mean	RANK
T ₁	22.9	21.7	53.13	21.3	28.79	27.3	30.1	15.5	19	27.1	24.2	26.46	2
T ₂	25.2	22.5	50	23.5	30.08	30.8	33.1	16.3	19	28.7	20.3	27.22	1
T ₃	22.4	21.3	47.53	19.5	25.42	24.6	29.5	13.1	18	23.8	20.5	24.18	4
T ₄	24.1	20.7	48.83	22.4	27.32	22	28.5	12.4	21	25.4	19.8	24.74	3
T ₅ (Control, No Zn)	21.2	19.5	45.3	20.4	22.89	18.4	27.1	9.19	18	21.7	19.5	22.11	5
C.D.(5%)	1.42	0.37	3.89	1.57	1.25	2.12	0.39	0.71	1.1	0.54	0.55		
SE(m)+_	0.47	0.17	1.25	-	0.37	-	1.32	0.23	0.3	1.6	-		
C.V.(5%)	4.52	1.3	-	-	2.43	11.7	2.32	13.4	4.3	3.74	-		

Treatment	Dry recovery (%)					Dry rhizome yield (t)				
	CPE	CBE	KAHI	POT	Mean	CPE	CBE	KAHI	POT	Mean
T ₁	27.30	26.28	22.85	27.20	26.05	6.23	6.12	4.37	5.20	5.63

T ₂	27.60	26.60	21.43	27.20	18.90	6.96	6.48	5.85	5.20	4.82
T ₃	26.38	25.22	20.65	25.80	18.06	5.90	5.50	4.10	4.80	3.87
T ₄	26.74	26.18	21.32	28.30	25.43	6.44	6.26	4.71	5.90	5.67
T ₅ (Control, No P)	26.58	26.30	21.17	25.80	25.23	5.63	5.54	4.27	4.70	5.08
C.D.(5%)	NS	N/A	1.13	0.60		0.51	0.28	0.41	0.30	
SE(m)+_	0.51	0.35	0.43	0.20		0.17	0.009	-	0.10	
C.V.(5%)	4.26	3.03	-	2.20		6.03	3.52	-	7.10	

The results revealed that the application of T₂ (50% Zn fertilizer + *Bacillus safensis*) led to the highest overall mean yield (27.22 t ha⁻¹) across locations, ranking first among all treatments. This was closely followed by T₁ (100% Zn fertilizer), which recorded a mean yield of 26.46 t ha⁻¹, demonstrating that *Bacillus safensis* effectively enhanced Zn availability even at a reduced fertilizer dose. The treatments T₄ (*Bacillus safensis* alone) and T₃ (50% Zn alone) recorded intermediate yields of 24.74 and 24.18 t ha⁻¹, respectively, while the control treatment T₅ (no Zn application) had the lowest yield at 22.11 t ha⁻¹, confirming the critical role of Zn in turmeric productivity.

In terms of dry rhizome yield, T₂ again showed superior performance with a mean yield of 4.82 t ha⁻¹, followed by T₁ (5.63 t ha⁻¹) and T₄ (5.67 t ha⁻¹), indicating that microbial inoculation contributed to improved nutrient uptake and biomass accumulation. Dry recovery percentage remained comparable across treatments, with T₂ and T₁ showing the highest values of 27.60% and 26.05%, respectively. The lowest dry rhizome yield was recorded in T₃ (3.87 t ha⁻¹) and the control T₅ (5.08 t ha⁻¹), reinforcing the importance of zinc supplementation.

Overall, the findings highlight that combining *Bacillus safensis* with 50% of the recommended Zn fertilizer (T₂) not only improved Zn utilization but also significantly enhanced fresh and dry rhizome yields, making it a promising and cost-effective approach for sustainable turmeric production.

Crop Protection & Food Safety

TUR/CP/7.8 Priming of rhizomes for enhanced germination, vigour and storage rot suppression in turmeric

(Centres: Ambalavayal, Chintapalli, Coimbatore, Dholi, Kammarpally, Kahikuchi, Kanke, Kumarganj, Mizoram, Pasighat, Pottangi, Pundibari, Raigarh, Solan)

This experiment was conducted to assess the efficacy of rhizome priming with Trichoprime, a combination of metalaxyl-mancozeb and imidacloprid, and tebuconazole with imidacloprid, along with the recommended package of practices (POP), for improving germination, vigour, and storage rot suppression in turmeric, as well as evaluating growth parameters. Now in its third year (2022–2023), the trial followed a Randomized Block Design (RBD) with four treatments, six replications, and a plot size of 3.0 × 1.0 m², accommodating 40 plants per bed. The treatments

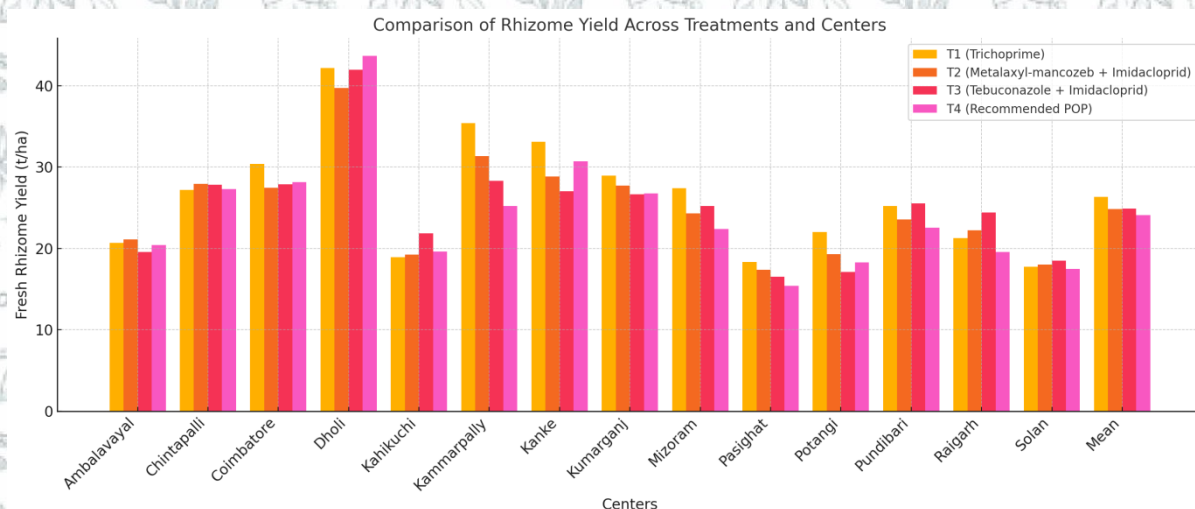
included T₁: Trichoprime-based rhizome priming; T₂: Rhizome treatment with metalaxyl-mancozeb (1.25 g L⁻¹) + imidacloprid (0.5 ml L⁻¹) for 30 minutes; T₃: Rhizomes were treated with tebuconazole (1 ml L⁻¹) + imidacloprid (0.5 ml L⁻¹) for 30 minutes; and T₄: Recommended state package of practices.

During 2022-23, at Ambalavayal, there were no significant differences among the priming treatments in controlling storage rot and rhizome rot in turmeric. Similarly, at Chintapalli, no significant differences were observed among the treatments for vegetative and yield parameters, and no incidence of storage rot, scale insects, or rhizome rot was recorded across the four treatments. In contrast, at Coimbatore, the experiment conducted on turmeric variety CO-2 showed that T₁ achieved complete suppression of storage rot and recorded the highest fresh rhizome yield of 30.40 t ha⁻¹. Additionally, Trichoprime significantly reduced the severity of foliar diseases, with leaf spot and leaf blotch PDI values of 5.89 and 7.46, respectively, compared to the untreated control (PDI: 23.25). At Dholi, all treatments had a non-significant effect on sprouting percentage, plant population at 50 DAS, plant height, and the number of tillers per clump. However, T₄ recorded the highest fresh rhizome yield of 37.72 t ha⁻¹, with no storage rot or rhizome rot incidence at any observation period (30, 60, or 90 DAS). In Kammarpally, T₁ recorded the maximum yield of 35.37 t ha⁻¹, followed by T₂ (33.50 t ha⁻¹), while storage rot was also observed in T₁. The highest dry recovery was recorded in T₁ (24%), followed by T₂ and T₃ (23%), whereas curcumin content was highest in T₂ (3.56%), followed by T₃ (2.73%). At Kahikuchi, T₃ performed best, recording the highest sprouting percentage (96.48%) and the lowest incidence of rhizome rot at 90 DAP (3.42%). This treatment also resulted in the lowest storage rot in stored rhizomes up to the fourth week of storage, the highest fresh rhizome yield (21.87 t ha⁻¹), dry rhizome yield (4.32 t ha⁻¹), and curcumin content (5.77%). At Kanke, turmeric rhizomes treated with T₁ recorded the highest yield (33.13 t ha⁻¹), followed by T₄ (30.68 t ha⁻¹), while T₂ and T₃ yielded 28.83 t ha⁻¹ and 27.03 t ha⁻¹, respectively. Storage rot incidence was lowest in T₁ (4.33%) and highest in T₃ (7.50%).

At Kumarganj, the highest fresh rhizome yield (28.94 t ha⁻¹) was recorded in T₁, followed by T₂ (27.72 t ha⁻¹) and T₄ (26.78 t ha⁻¹), while the lowest yield was observed in T₃ (26.67 t ha⁻¹). In Mizoram, turmeric rhizomes primed with T₁ showed significantly higher fresh clump weight (206 g), the highest number of rhizomes per clump (33), and the highest yield (27.4 t ha⁻¹), while the lowest values were observed in T₄ (recommended state package without priming). At Pasighat, T₁ exhibited the best performance, recording the highest sprouting percentage (92.78%), plant height (116.08 cm), number of tillers per clump (3.30), yield per clump (187.39 g), and yield per hectare (18.31 t ha⁻¹). In contrast, T₄ recorded the highest rhizome rot incidence (10.64%), while T₂ (metalaxyl-mancozeb + imidacloprid) also performed well in terms of yield and plant characteristics. At Pottangi, T₁ was the best-performing treatment, followed by T₂.

At Pundibari, T₁ demonstrated the best results with 100% sprouting, the highest plant population (37), tallest plants (99.06 cm), and the most tillers (2.35), with no incidence of rhizome rot, wilt, or leaf blotch. T₃ recorded the lowest leaf spot incidence (PDI 4.07) and the lowest stem borer infestation while achieving the highest yield (25.54 t ha⁻¹), followed closely by T₁ (25.20 t ha⁻¹). Additionally, T₁ had the highest dry recovery rate (23%), and no scale infestation was recorded during storage. At Raigarh, T₃ showed superiority in terms of maximum germination percentage (96.67%) and the highest yield (24.42 t ha⁻¹). At Solan, rhizome treatment with T₃ resulted in the highest germination (90.00%), the maximum number of tillers per plant (5.00), the tallest plants (120.50 cm), and the highest yield (185.00 q ha⁻¹), with the lowest rhizome rot incidence (14.00%). This was followed by T₂ (metalaxyl-mancozeb + imidacloprid), which ranked second in enhancing horticultural parameters.

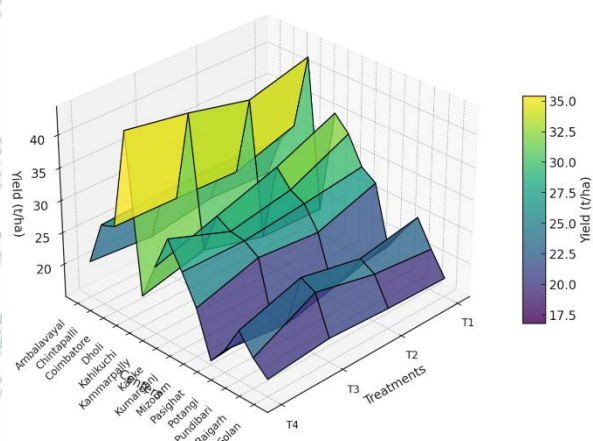
Overall, T₁ (Rhizome treatment with Trichoprime) **seven times** consistently demonstrated superior performance across multiple locations. It showed higher fresh rhizome yield in several centres, including Coimbatore (30.40 t ha⁻¹), Kammarpally (35.37 t ha⁻¹), Kanke (33.13 t ha⁻¹), Kumarganj (28.94 t ha⁻¹), Mizoram (27.4 t ha⁻¹), and Pasighat (18.31 t ha⁻¹). Additionally, it recorded the highest plant vigour, lowest rhizome rot incidence, and better dry recovery rates in most locations.



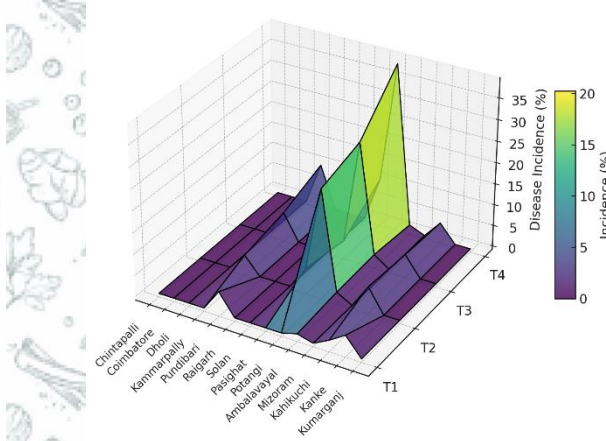
The analysis of storage rot and rhizome rot incidence across different turmeric-growing location reveals distinct treatment responses. In multiple locations, no storage rot or rhizome rot was observed across all treatments, indicating favourable growing conditions. Notably, in Kammarpally, Pasighat, and Potangi, significant rhizome rot incidence was recorded, with T₄ (Recommended Package of Practices) consistently showing the highest percentage of rhizome rot (ranging from 9.92% to 41.7%), suggesting its lesser efficacy in suppressing the disease. There T₁ (Trichoprime) emerged as the most effective in minimizing storage rot and rhizome rot incidence, ranking best in four locations. At Kanke and Pundibari, T₁ resulted in some storage rot but no rhizome rot incidence, while in Potangi and Kahikuchi, T₃

(Tebuconazole + Imidacloprid) recorded notable disease suppression. However, T₂ (Metalaxyl-Mancozeb + Imidacloprid) performed well in two locations, and T₃ showed limited effectiveness, ranking best in only one centre. Overall, the findings suggest that T₁ (Trichopryme) offers the most consistent protection against storage and rhizome rot, followed by T₂ and T₃, while T₄ had the least effectiveness in disease suppression.

3D Surface Plot of Fresh Rhizome Yield Across Centers and Treatments



3D Surface Map of Disease Incidence

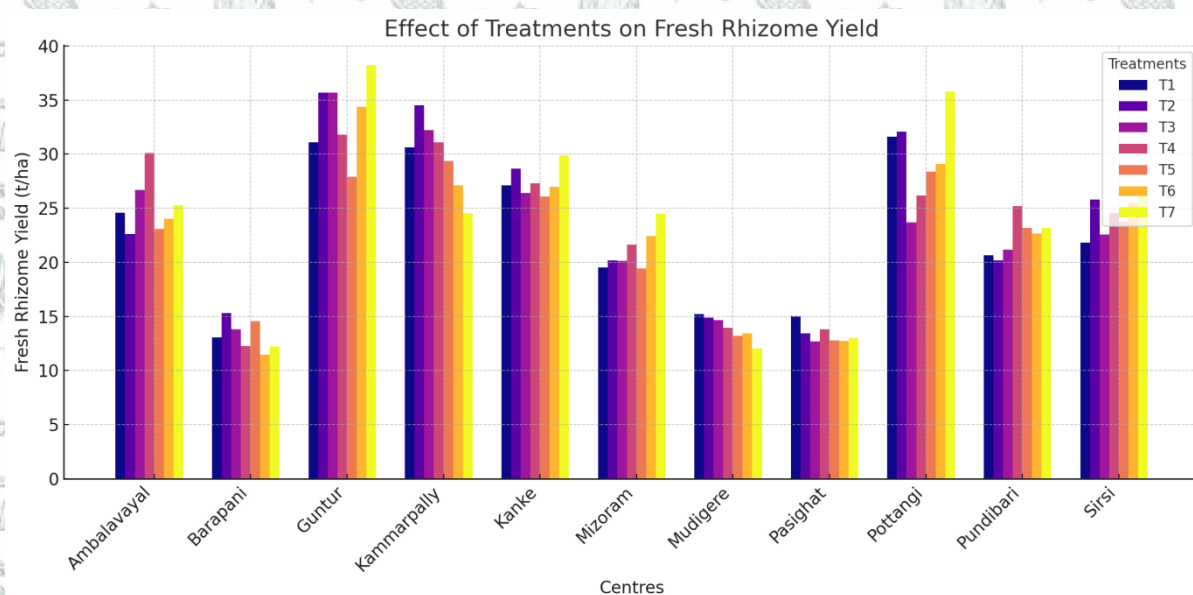


TUR/CP/7.9 Spray schedule optimization of effective insecticides for shoot borer (*Conogethes punctiferalis*) in turmeric

(Centres: Ambalavayal, Barapani, Guntur, Kammarpally, Kanke, Mizoram, Mudigere, Pasighat, Pottangi, Pundibari, Sirsi)

The experiment was initiated in the year 2021–22 to evaluate the efficacy of different insecticide treatments in managing shoot infestation in turmeric across eleven locations. The experiment followed a RBD with eight treatments and four replications. The treatments included T₁ & T₂: Chlorantraniliprole at two different concentrations (0.3 ml L⁻¹ and 0.5 ml L⁻¹), T₃ & T₄: Flubendiamide at 0.3 ml L⁻¹ and 0.5 ml L⁻¹, T₅ & T₆: Spinosad at 0.3 ml L⁻¹ and 0.5 ml L⁻¹, and T₇: an alternating treatment of Chlorantraniliprole and Spinosad at 0.5 ml L⁻¹, and T₈: with a control treatment receiving only water spray. A popular improved turmeric variety specific to each centres was used for the study and treatments was applied as per technical programme.

During 2022-23 season, based on the mean fresh rhizome yield data across different locations, the highest yield was observed at Guntur (33.54 t ha⁻¹), followed by Kammarpally (29.94 t ha⁻¹) and Pottangi (29.56 t ha⁻¹). Among the treatments, the combination of T₇ (Chlorantraniliprole + Spinosad) exhibited the highest frequency of superiority, being the best-performing treatment in four locations. T₂ was found superior at three locations, while T₄ and T₁ were effective in two locations each. T₃, T₅, and T₆ did not emerge as the best-performing treatments in any location.

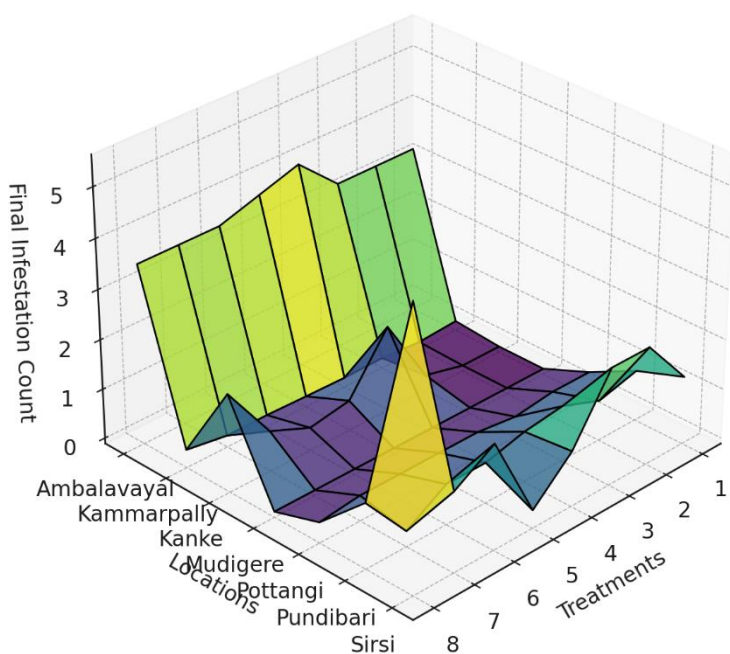


These results indicate that the combination treatment (T₇) had a consistent advantage across multiple locations, followed by T₂, suggesting its potential for maximizing rhizome yield under different agro-climatic conditions.

The results of this study provide insights into the comparative effectiveness of these insecticides in reducing infestation and enhancing yield, which are discussed in detail below.

how to narrate the result and also do interpretation in running sentence and not in bulleted point about the table with Percentage of Shoot borer damage in the optimization of effective insecticides for shoot borer in turmeric -2022-23

3D Surface Map of Shoot Borer Infestation (Final Count)



TUR/CP/7.10 Observational trial on the efficacy of *Trichoderma asperellum* and *Pochonia chlamydosporia* for the management of rhizome rot and nematode in turmeric

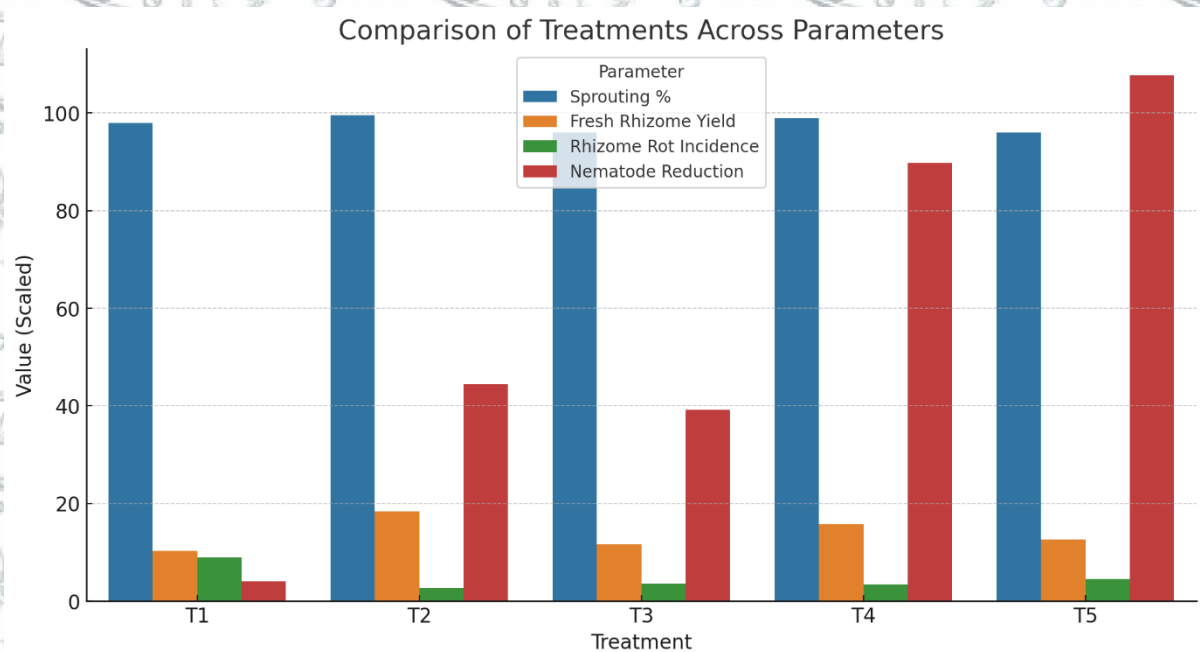
(Centres: Barapani, Coimbatore, Guntur, Kozhikode)

During 2022-23, the trial was conducted across four locations: Kozhikode, Coimbatore, Guntur, and Barapani, to evaluate the efficacy of *Trichoderma asperellum* and *Pochonia chlamydosporia* in managing rhizome rot and nematodes in turmeric. The results indicated variations in sprouting percentage, fresh rhizome yield, rhizome rot incidence, and nematode suppression across treatments.

In terms of sprouting percentage, the highest was observed in T₂ at Kozhikode (99.6%), followed by T₄ (99%) and T₁ (98%). At Coimbatore, T₂ also recorded the highest sprouting (95.5%), followed by T₃ (94.1%) and T₅ (94.16%). Statistical analysis indicated that treatment effects were non-significant in Kozhikode but significant in Coimbatore, with a critical difference (CD) of 2.73.

Fresh rhizome yield (FRY) varied across locations, with the highest recorded in T₂ at Kozhikode (18.35 t ha⁻¹), followed by T₄ (15.78 t ha⁻¹) and T₅ (12.62 t ha⁻¹). In Coimbatore, T₂ (32.5 t ha⁻¹) and T₃ (29.4 t ha⁻¹) exhibited the highest yields. Guntur recorded comparable yields across treatments, with T₂ (27.57 t ha⁻¹) showing a slight edge, while Barapani recorded the highest yield in T₂ (12.48 t ha⁻¹). The incidence of rhizome rot disease was lowest in T₂ (PDI: 2.67%) at Kozhikode, followed by T₃ (PDI: 3.57%) and T₄ (PDI: 3.4%). Coimbatore did not observe any disease incidence for certain treatments. The disease suppression effect was most prominent in T₂,

suggesting its higher efficacy in rhizome rot management. For nematode soil population at Kozhikode, the highest reduction in nematode count was observed in T₅, where the count decreased from 138.5 to 30.75, indicating a reduction of 107.75%. T₄ also exhibited a significant reduction of 89.75%, followed by T₂ (44.5%) and T₃ (39.25%). T₁ showed the least reduction (4.0%), indicating lower efficacy in nematode suppression. In conclusion, T₂, which involved the application of *Trichoderma asperellum* and *Pochonia chlamydosporia*, was the most effective treatment for improving sprouting, increasing fresh rhizome yield, and reducing rhizome rot incidence. On the other hand, T₅ and T₄ were highly effective in reducing nematode counts post-treatment, with T₅ showing the maximum reduction.



Genetic Resources

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

(Centres: Dapoli, Pechiparai)

A total of 254 accessions of various tree spices are being maintained across different AICRPS centres. These collections include 184 accessions of nutmeg, 29 accessions of cinnamon and cassia, and 27 accessions of clove, all of which fall under the mandate crops of the AICRPS centers. Detailed information about the germplasm collections is provided in Table 57.

Table 25. Various tree spice germplasms collections maintained at various AICRPS centres

Tree Spices Crop	Dapoli	Pechiparai	KAU, Thrissur	Total
Nutmeg*	72	57	55	184
Cinnamon*	11	12	--	23
Cassia*	06	--	--	6
Clove*	02	25	--	27
All spice	01	--	--	1
Kokum	02	--	--	2
Curry Leaf	02	--	--	2
Malabar Tamarind	--	9	--	9
Total	96	103	55	254

*Representing the AICRP on Spices mandate crops

Nutmeg

Among the different germplasm collections of nutmeg planted during the year 1996 – 97 at Dapoli, sixteen promising genotypes have been identified for evaluation. From the experiment, it was observed that the highest nuts per tree (1642) were recorded by accession, *DBSKKVMF 9772*. Also this genotype recorded maximum fresh nut weight (11.82 g), whereas a minimum fresh nut weight (7.44 g) was found in genotype *DBSKKVMF 30*. The genotype *DBSKKV 9772* recorded maximum dry nut yield per tree (14.55 kg) and dry mace yield (3.64 kg). The minimum dry nut yield per tree (0.240 kg) and dry mace per tree (0.053 kg) was found in *DBSKKVMF 27*. From overall performance the genotype *DBSKKVMF 9772* was found promising genotype considering its fruit yield parameters.

Performance of nutmeg accession at Dapoli centre

Sr. No.	Selection/ Genotype	Yield (No. of fruits)	Nut wt. (g)		Mace wt. (g)		Yield (g)	
			Fresh	Dry	Fresh	Dry	Dry nut	Dry mace
1	DBSKKVMF 16	446	8.2	5.34	3.36	1.48	2.38	0.660
2	DBSKKVMF 17	612	10.4	6.98	4.24	2.24	4.27	1.371
3	DBSKKVMF 18	478	10.8	7.40	4.52	2.60	3.54	1.243
4	DBSKKVMF 19	1236	10.22	7.2	2.18	1.2	8.90	1.483
5	DBSKKVMF 20	52	9.12	6.12	2.66	1.42	0.32	0.740
6	DBSKKVMF 21	608	8.8	5.72	2.56	1.66	3.48	1.009
7	DBSKKVMF 22	725	8.46	5.62	2.36	1.24	4.07	0.899
8	DBSKKVMF 23	625	9.62	6.1	3.24	2.3	3.81	1.438
9	DBSKKVMF 24	452	10.2	6.44	2.9	1.3	2.91	0.588
10	DBSKKVMF 25	726	8.4	5.24	3.18	2.42	3.80	1.757
11	DBSKKVMF 26	740	8.52	5.68	2.98	1.36	4.20	1.006
12	DBSKKVMF 27	44	8.64	5.56	2.58	1.20	0.24	0.530
13	DBSKKVMF 28	336	8.24	5.44	2.2	0.84	1.83	0.282
14	DBSKKVMF 29	882	11.6	7.30	3.18	1.38	6.44	1.217
15	DBSKKVMF 30	652	7.44	4.24	2.42	0.88	2.76	0.574
16	DBSKKVMF 9772	1642	11.82	8.86	3.88	2.22	14.55	3.645
Range		44-1642	7.44-11.8	4.24-8.86	2.18-4.52	0.84-2.6	0.24-14.54	0.282-3.65
Mean		641.00	9.41	6.20	3.03	1.61	4.22	1.08
CD @ 5 %		394.72	1.29	1.11	0.7	0.56	3.45	0.85
CV (%)		61.58	13.72	17.90	23.12	34.81	81.76	78.62

At Pechiparai centre, *MF-1* recorded maximum tree height (12.74m) and stem girth (67 cm) at pechiparai centre. The maximum leaf length (20.80cm) and leaf breadth (8.22 cm) was registered in *MF-4*. Among the 24 accessions, *MF-4* recorded maximum number of fruits 710.24 fruits tree⁻¹ and the single fruit weight was also highest in *MF-4*. (58.62 g), and mace yield recorded per tree was 1.420 Kg tree⁻¹. Local check recorded 520.40 fruits tree⁻¹, single fruit weight (42.16 g) and mace yield (0.910 g tree⁻¹).

Performance of nutmeg accession at Pechipari centre

Accession	Plant height (m)	Stem girth (cm)	Leaf length (cm)	Leaf breadth (cm)	No. of fruits	Single fruit weight (g)	Mace yield (kg tree ⁻¹)
MF-1	12.74	67.00	16.62	7.26	320.60	43.60	0.561
MF-2	10.40	49.86	17.12	6.58	310.52	41.20	0.466
MF-3	8.36	45.12	17.26	6.40	450.12	50.40	0.788
MF-4	8.80	29.20	20.80	8.22	710.24	58.62	1.420
MF-5	9.96	57.14	13.68	5.68	380.12	50.26	0.665
MF-6	10.26	55.22	14.84	7.62	400.26	50.42	0.700
MF-7	10.40	46.14	16.12	7.30	390.00	51.18	0.682
MF-8	9.84	47.26	13.60	6.24	442.16	44.56	0.773
MF-9	5.80	47.62	15.18	6.26	360.14	44.32	0.630
MF-10	10.40	49.64	13.42	6.24	365.82	30.14	0.640
MF-11	8.47	45.26	13.72	6.58	420.14	40.20	0.787
MF-12	8.50	50.58	15.60	7.62	540.14	36.74	0.945
MF-13	8.62	45.12	17.80	8.18	530.22	37.60	0.927
MF-14	9.42	40.18	15.60	6.60	580.72	40.20	1.016
MF-15	9.48	40.22	15.80	4.59	586.40	36.54	1.026
MF-16	9.52	41.26	13.40	7.23	520.12	52.20	0.910
MF-17	9.20	36.14	12.50	6.54	600.10	40.45	1.050
MF-18	9.26	42.18	12.90	5.58	570.10	40.98	0.978
MF-19	7.96	39.76	14.32	7.23	540.42	49.27	0.946
MF-20	8.42	41.26	13.82	6.38	520.60	46.90	0.911
MF-21	8.86	26.82	14.90	6.28	590.10	44.26	1.032
MF-22	7.40	24.56	14.72	6.69	260.12	50.20	0.465
MF-23	6.42	20.52	20.50	6.59	610.14	48.14	1.068
MF-24	6.40	17.94	17.32	6.62	500.68	50.60	0.876
Local check	9.46	36.82	17.94	6.27	520.40	42.16	0.910
SEm	0.234	4.908	0.831	0.134	590.120	5.514	35.56
CD ($P = 0.01$)	1.060	4.851	1.996	0.801	53.197	5.142	97.770
CV (%)	5.392	5.311	5.851	5.477	5.052	5.236	5.270

Clove

Four promising genotypes were selected among the different germplasms of clove planted at Dapoli during the year 1996-97. The plant height varied from 4.52 m to

5.26 m, girth ranged from 68.26 to 88.30 cm and spread varied from 4.25 to 5.12 m. No flowering was observed during the year 2022-23.

From the growth parameters, genotype *DBSKKUSA-1* was found superior over other genotypes. The germplasm characterization of 24 clove accessions done at Pechiparai revealed significant variations all character including dry bud yield per tree. Among the accessions, *SA-3* exhibited the highest dry bud yield of 1.92 kg tree⁻¹, along with a notable tree height of 12.86 m and a stem girth of 52.26 cm, making it a standout performer in terms of yield potential. *SA-13* also demonstrated a high dry bud yield of 1.75 g tree⁻¹, with the largest leaf length (16.12 cm), indicating its potential for high productivity. Another noteworthy accession was *SA-18*, which, despite its shorter height of 8.36 meters, produced a significant dry bud yield of 1.33 kg tree⁻¹.

Performance of clove accessions at Pechipari centre

Accessions	Tree height (m)	Stem girth (cm)	Leaf length (cm)	Leaf breadth (cm)	No of branches (Nos.)	Dry bud yield (kg tree ⁻¹)
SA- 1	13.72	41.16	12.89	6.35	34.14	0.700
SA -2	11.80	51.18	11.86	7.39	15.12	0.760
SA -3	12.86	52.26	12.91	7.74	21.00	1.920
SA -4	9.82	41.10	11.52	6.67	17.20	0.800
SA -5	10.38	40.44	10.90	6.41	14.80	0.750
SA -6	11.70	51.08	11.49	6.72	18.14	0.720
SA -7	10.20	46.62	9.79	7.35	16.92	1.100
SA -8	10.32	47.32	8.77	6.46	15.25	0.900
SA -9	11.34	45.70	7.72	4.91	13.72	0.650
SA -10	10.38	48.72	8.41	6.31	18.24	0.700
SA -11	10.42	34.98	6.35	6.72	17.26	0.720
SA -12	9.40	44.64	9.88	6.69	17.28	0.950
SA -13	10.40	51.35	16.12	6.33	18.28	1.750
SA -14	9.36	42.63	8.42	4.59	13.92	0.760
SA- 15	8.52	35.38	9.80	4.77	15.10	1.300
SA-16	10.20	36.39	8.39	4.58	16.26	0.920
SA -17	9.10	32.32	11.92	5.72	13.92	0.720
SA -18	8.36	31.26	10.91	3.75	11.74	1.330
SA -19	7.14	30.92	9.50	3.59	12.92	1.100
SA -20	7.40	25.28	11.52	4.72	15.12	1.000
SA -21	7.32	26.19	7.41	5.72	16.32	0.900
SA -22	6.26	15.92	10.30	5.66	12.96	0.920
SA -23	5.30	18.24	11.89	3.67	12.52	0.780
SA -24	6.40	13.26	11.92	4.67	11.94	0.700

Local check	11.42	42.10	11.62	4.70	12.12	0.600
SEd	0.218	4.324	0.278	0.093	0.615	0.002
CD (P = 0.01)	1.022	4.553	1.154	0.667	1.717	0.098
CV (%)	4.870	5.493	5.024	5.354	4.873	4.791

Cinnamon

The characterization of 12 cinnamon accessions done at Pechiparai revealed notable variations in all plant characters including dry quills yield per plant. The tallest tree was recorded in accession CV-5 at 6.40 m, closely followed by CV-10 (6.24 m) and CV-9 (5.88 m). Accession CV-5 also exhibited the maximum stem girth at 18.20 cm and the highest number of shoots (43.24), resulting in the highest dry quills yield of 706 g plant⁻¹, making it a promising candidate.

Accessions	Tree height (m)	Stem girth (cm)	No of shoots	Dry quills yield (g plant ⁻¹)
CV-1	5.86	16.2	32.5	320
CV-2	4.4	13.12	35.6	340
CV-3	5.7	14.2	34.52	246
CV-4	5.2	18.14	38.28	542
CV-5	6.4	18.2	43.24	706
CV-6	5.8	14.5	35.6	582
CV-7	5.44	11.22	27.62	296
CV-8	5.36	12.4	32.8	408
CV-9	5.88	12.48	34.12	490
CV-10	6.24	12.6	32.46	482
CV-11	5.82	14.66	39.42	422
CV-12 (Local check)	5.6	12.12	26.8	312
SEd	5.4	10.24	22.44	320
CD(P=0.01)	0.61	0.425	2.553	606.431
CV (%)	0.565	1.489	3.649	56.239

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

(Centres: Dapoli, Pechiparai)

Accession No.	Average height (m)			Av. no. of Branches			Number of nuts/tree			Mace yield/tree (g)		
	DAP	PECH	Mea n	DAP	PECH	Mea n	DAP	PECH	Mea n	DAP	PECH	Mea n
Vishwasree	3.16	7.16	5.16	28	24	26	52	32.1	42.03	16.96	14.43	15.70
Yellow mace type	5.35	5.47	5.41	65	22	43.5	112	20.5	66.25	15.56	6.63	11.10
Red 12-month type	3.64	--	3.64	36.18	--	36.18	2.60	--	2.60	22.00	--	22.00
Seedless	3.80	--	3.80	44.20	--	44.20	2.84	--	2.84	--	--	--
Nova	4.44	--	4.44	48.6	--	48.6	3.12	--	3.12	14.00	--	14.00

KAU Pullan	3.16	2.90	3.03	32.24	14.29	23.27	66.00	--	66	18.42	--	18.42
Farmers Variety (Acc-3)	2.44	5.10	3.77	38.00	17.00	27.5	--	27.1	27.1	--	9.99	9.99
Farmers Variety (Acc-5)	1.88	4.94	3.41	28.00	14.12	21.06	2.64	27.1	14.88	--	6.70	6.70
KAU Kochukudi	2.26	4.96	3.61	30	15	22.5	12	29	20.5	18.24	51.1	34.67
Farmers Variety (Acc-7)	2.04	4.86	3.45	34.1	21	27.55	--	23.2	23.22	--	7.63	7.63
KAU Mundathanum	1.6	6.32	3.96	24	19	21.5	--	24	24	--	46.23	46.23
Farmers Variety (Acc-13)	1.88	6	3.94	28	18.18	23.09	2.64	26	14.33	--	8.65	--
Farmers Variety (Acc-17)	1.68	3.96	2.82	34	13	23.5	--	25	25	--	11.14	11.14
Local type	3.62	4.24	3.93	38	14	26	--	20	20	--	--	--
Konkan Swad	--	5.29	5.29		20.23	20.23	--	26.3	26.34	--	7.62	7.62
Konkan Suganda	--	4.76	4.76		20.16	20.16	--	26.9	26.88	--	7.79	7.79
Konkan Shremathi	--	5.18	5.18		21.84	21.84	--	23.3	23.3	--	7.9	7.9
SEm±	0.1	0.79	--	2.29	1.21	--	--	2.32	--	--	1.85	--
CD @ 5 %	0.3	2.3	--	6.54	2.56	--	--	3.54	--	--	5.45	--
CV (%)	8.05	5.33	--	14.54	5.66	--	--	5.52	--	--	4.87	--

A total of 20 and 10 unique nutmeg accessions have been maintained and evaluated in the germplasm blocks at Dapoli and Pechiparai, respectively. The overall growth of the plants is satisfactory. Among the evaluated accessions, Yellow Mace type exhibited superior performance with the highest average plant height (5.35 m) and the maximum number of branches (65). In contrast, *Vishwasree* and *KAU Pullan* demonstrated consistent growth, with an average plant height of 3.16 m and approximately 32 branches per tree. The Seedless and Nova varieties showed greater plant heights of 3.80 m and 4.44 m, respectively, with a higher branch count of 44.20 and 48.60. In terms of nut production, the Yellow Mace type was the most prolific, yielding an average of 112 nuts per tree, followed by *KAU Pullan* with 66 nuts tree⁻¹. Farmers Variety (*Acc-3*) and Farmers Variety (*Acc-7*) recorded moderate nut yields ranging between 30 and 40 nuts tree⁻¹. However, varieties such as *Seedless*, *Nova*, and Farmers Variety (*Acc-5*) did not produce any nuts. Regarding mace yield, the highest yield was observed in *KAU Pullan* (18.42 g tree⁻¹), followed by *Vishwasree* (15.70 g) and Yellow Mace type (11.10 g). Red 12-month type also recorded a mace yield of 11.10 g per tree. Conversely, Farmers Variety (*Acc-5*) and *KAU Mundathanum* exhibited relatively lower mace yields, approximately 6-7 g tree⁻¹. These findings highlight the superior performance of Yellow Mace type and *KAU Pullan* in terms of both nut and mace yield, making them promising candidates for further cultivation and improvement efforts.

Crop Improvement

TSP/CI/2.4: Coordinated Varietal Trial on farmers varieties of nutmeg (2016)

(Centres: *Dapoli, Pechiparai, KAU Thrissur*)

The trial has been laid out in 2016 with four farmer's varieties (*Kochukudy, Punnathanam Jathy, Kadukkamakkan Jathy* and *Cheripuram*) provided by NIF/farmer), along with one local check and a national check at Dapoli, Pechiparai and Thrissur (Fig. 23). Budded plants of the varieties were planted in existing coconut plantation at a spacing of 8m x 8m. Morphological observations indicated significant differences for the growth parameters. Based on provided data, *Kochukudy* exhibits the highest average plant height (4.18 m), followed closely by *Punnathanam Jathy* (3.91 m). When considering the average number of branches, *Punnathanam Jathy* and *Kochukudy* perform the best, with an average of 44 branches, though *Kochukudy* displays slightly more consistency with 54 branches. Regarding plant spread, both *Kochukudy* and *Punnathanam Jathy* show wide spreads, averaging 3.12 m and 3.18m, respectively. In terms of yield, *Punnathanam Jathy* leads with the highest nut yield at 143 nos. tree⁻¹, followed by *Kochukudy* with 53 nos. tree⁻¹. *Kadukkamakkan Jathy* yields the fewest nuts, with only 3 nos. tree⁻¹. In conclusion, *Punnathanam Jathy* stands out as the superior genotype in terms of plant height, number of branches, and yield, making it the most productive. *Kochukudy* also shows good performance but with a lower nut yield.

Genotypes	Plant height (m)				Av. no. of Branches				Plant spread (m)		Yield (Nut/tree)		
	DAP	PECH	KAU	Mean	DAP	PECH	KAU	Mean	DAP	KAU	DAP	KAU	Mean
Punnathanam Jathy	4.22	3.6	3.92	3.91	56	20	56	44	3.1	3.175	26	143	85
Kochukudy	5.16	3.24	4.13	4.18	52	21	54	42	3.28	3.12	36	53	45
Kadukkamakkan Jathy	3.42	3.72	2.68	3.27	38	19	29	29	3.16	2.535	18	3	11
Cheripuram	3.28	4.2	3.16	3.55	34	22	43	3	3.22	3.24	34	6	20
Local Check	2.9	2.42	3.83	3.05	24	14	45	28	3.14	2.835	16	33	25
CD @ 5 %	0.54	0.5	0.52	-	9.31	2.65		-	0.14	0.16	4.43	10.39	-
CV (%)	3.71	5.34	10.9	-	32.11	5.05		-	2.7	3.84	34.81	19.65	-

TSP/CI/5.1: Evaluation of nutmeg genotypes (Thrissur)

The trial was laid out with the budded plants of all the genotypes. The plants are five-year-old and are showing good growth. *Acc. 5* shows the highest performance in terms of plant height, branch number, plant spread, number of flowers, number of fruits, and nut weight, making it one of the most productive genotypes. Overall, *Acc. 5* emerged as the superior genotypes based on their growth and yield parameters, while *Acc. 12* and *Acc. 28* are the least productive.

Genetic Resources

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

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

This long-term project focuses on collecting, conserving, and evaluating coriander germplasm to identify promising accessions with high-yield potential and resistance to powdery mildew disease. Currently, a total of 2,317 coriander accessions, including 2,196 indigenous and 121 exotic accessions, are conserved across various AICRPS centers with details presented (Table 38).

Unique accessions CS 38 as leafy coriander type CS 46 with high seed yield

Table 25. Coriander germplasm collections maintained at various AICRPS centres

Centers	No. of Germplasm conserved			No. of Germplasm evaluated during 2022-23
	Indigenous	Exotic	Total	
Coimbatore	278	-	278	48
Dholi	75	-	75	75
Guntur	315	-	315	35
Hisar	168	-	168	168
Jagudan	132	19	151	151
Jobner	756	102	858	134
Kumarganj	200	-	200	200
Pantnagar	140	-	140	140
Raigarh	32	-	32	32
Kota	100	-	100	100
Total	2196	121	2317	1083

During the *rabi* season-2022-23, out of 278 coriander accessions conserved at the Coimbatore centre, 48 genotypes were evaluated along with a check viz., (CO (CR) 4 for growth and yield characters under field conditions. Among the germplasm lines evaluated, 8 genotypes recorded significantly higher seed yield compared to the best check CO(CR) 4 (7.05 g plant⁻¹). The best seven accessions in terms of seed yield per plant are CS 95 & CS 99 (8.80g), CS 162 (8.78 g), CS 124 (8.68 g), CS 131 (8.55 g) and CS 132 (8.18 g) were shortlisted. At Dholi, 75 coriander accessions, along with two checks—Pant Haritma and Rajendra Dhanias-1—were evaluated to identify high-yielding lines. Three accessions, namely RD-446, RD-482, RH-389, RH-420, and RD-442, exceeded the yields of Rajendra Dhanias-1 (16.73 g plant⁻¹) and Pant Haritma (15.70 g plant⁻¹). The ten best-performing accessions yielded between 13.36 g and 18.18 g plant⁻¹, with RD-446 topping the list at 18.18 g plant⁻¹, followed by RD-482 at

17.92 g plant⁻¹. Guntur centre evaluated 35 germplasm lines and identified LCC-319, LCC-343, LCC-336, LCC-344, and LCC-316 as superior in yield. Additionally, 16 local leafy accessions were collected, and 37 entries were evaluated, with LCC-351 emerging as the most promising, recording the highest fresh herb yield. At Hisar, 168 coriander accessions were evaluated in two-row plots (3m each), using Hisar Sugandh, Hisar Bhoomit, and Hisar Anand as checks during 2022–23. Seed yield varied from 39.4 g plant⁻¹ (DH-270) to 94.5 g per plant (DH-229). Prominent high-yielding lines included DH-222, DH-229, DH-233, DH-277, DH-293-1, DH-298, DH-354, DH-375, DH-368, and DH-381. In Jagudan, 151 entries were assessed alongside checks G. Cor 1, G. Cor 2, and G. Cor 3. GP 85 stood out as the highest-yielding genotype, achieving 820 g plot⁻¹. At Kota, 100 accessions were evaluated with six check varieties (RCr-435, RCr-436, RCr-446, RCr-480, RCr-684, and RCr-728), showing wide variability. Seed yield ranged from 8.0 g per five plants (UD-138) to 64.0 g (UD-279 and UD-788). Of 134 accessions, 26 outperformed the best check, RCr-480 (47.20 g). The top 10 high-yielding accessions included UD-279 and UD-788 (64.0 g), UD-335 (63.0 g), and others yielding between 55.0 g and 59.0 g. At Kumarganj, 200 germplasm lines were evaluated, with NDCor-22 achieving the highest yield (28.75 g per plant), followed by NDCor-11 (27.80 g), NDCor-12 (27.10 g), and NDCor-32 (26.90 g). Finally, at CARS Raigarh, 32 germplasm accessions were maintained, and their performance was assessed. ICS-1 achieved the highest seed yield (13.3 q ha⁻¹), surpassing the national check, Rajendra Swati (11.3 q ha⁻¹), and CG Shri Chandrahasini Dhaniya-2 (11.0 q ha⁻¹). Other promising entries included ICS-22 (12.7 q ha⁻¹) and ICS-8 (12.2 q ha⁻¹).

Screening of coriander germplasm against powdery mildew

Among the 48 genotypes screened for the incidence of powdery mildew at Coimbatore, the PDI ranged from 38.50 to 98.50 PDI. The accessions *viz.*, CS 62 recorded lowest incidence of 38.50 PDI with a seed yield of 7.40 g plant⁻¹ followed by CS 56 (39.50 PDI) with a seed yield of 6.50 g/plant. The highest intensity of powdery mildew was recorded in CS 174 (98.5 PDI) with the seed yield of 5.53 g plant⁻¹.

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

(Centres: Jobner)

Eighteen genotypes randomly selected from the germplasm were sown in two environments, irrigated (normal irrigation) and drought (staggered irrigation with half of that provided in normal irrigation). The genotypes *viz.*, UD-686, UD-607, UD-542, UD-629, RCr-684, UD-808 and UD-599 under normal irrigated conditions while UD-625, UD-607, UD-599, UD-119, UD-542 and RCr-684 under moisture stress condition were top yielders. Thus, the average performance of genotypes *viz.*: UD-607, UD-542, UD-599 and RCr-684 was better in both environments. TOL values indicated that genotypes UD-119, RCr-475, UD-625, UD-626, UD-599, UD-627 and UD-616 had the least deviation from zero and thus, performance is stable over both environments. Based on the stress susceptibility index (SSI) genotypes UD-119, UD-625, RCr-475, UD-599, UD-626, UD-607 and UD-627 were found to be the desirable

genotypes for drought (moisture stress) conditions. Stress tolerance index (STI) revealed that genotypes UD-607, UD-686, UD-599, UD-625, UD-642, RCr-684 and UD-119 had maximum tolerance against moisture stress environment.

Crop Improvement

COR/CI/2.8: Coordinated Varietal Trial in Coriander-2021-Series XI (2021-23)

(Centres: Ajmer, Coimbatore, Dholi, Guntur, Hisar, Jabalpur, Jagudan, Jobner, Kumarganj, Kota, Navsari, Pantnagar, Raigarh)

Coordinated Varietal Trial (CVT) on coriander, initiated in the *rabi* season, 2021-22, aimed to evaluate promising coriander accessions across thirteen centres. The trial, laid out in a Randomized Block Design (RBD) with 13 genotypes, including two check varieties, was successfully completed second year of testing in 2022-23.

Location-wise performance for seed yield presented in the table. Mean seed yield ranged from 1,280 to 1,558 kg ha⁻¹. Analysis of variance revealed significant differences among the entries for seed yield, indicating substantial variability among treatments. The entry UD 565 recorded the highest seed yield at 1,513 kg ha⁻¹, while the entry SCr-24 recorded the lowest yield at 1,299 kg ha⁻¹. Seven entries, namely UD 565 (1,513 kg ha⁻¹), LCS-19-1 (1,425 kg ha⁻¹), SCr-24 (1,299 kg ha⁻¹), DH 316 (1,375 kg ha⁻¹), JCr 16-02 (1,397 kg ha⁻¹), PD 7 (1,419 kg ha⁻¹), and RC 728 (1,431 kg ha⁻¹), recorded numerically higher seed yield compared to the best check Hisar Anand (1,280 kg ha⁻¹).

Entries	AJM	CBE	DHL	HSR	JBR	JAG	JOB	KOT	KUM	KAL	NAV	PNR	RAI	SAD	Grand Mean	Rank
NCOR-102	921	804	1928	1415	1357	784	989	1167	1536	985	1504	1526	1400	2310	1331	8
LCS-19-1	712	847	2014	1165	1300	900	1307	1317	1496	1071	1982	764	2301	2771	1425	3
SCr-24	953	879	1541	1551	1548	1056	1135	1355	1484	705	1320	858	1209	2598	1299	10
DH 316	1048	517	1596	1733	1413	787	1478	1062	1738	722	1142	1743	2320	1958	1375	7
JCr 16-02	1507	631	1666	1470	1132	1111	1329	1500	1504	964	1679	1553	1334	2181	1397	6
UD 565	1033	961	2033	1193	1725	920	1978	1581	1321	1025	1010	1546	2301	2555	1513	1
PD 7	1677	560	1752	1518	1767	620	1156	1206	1889	681	1932	2299	1166	1639	1419	4
NDCor 22	1323	977	1722	1566	1226	404	838	935	1687	1203	1253	2151	1242	1734	1304	9
CS 46	1003	763	1773	1227	1475	833	1215	1343	1508	832	1838	1230	572	2483	1293	11
ICS 15	1354	673	1361	1862	1461	824	911	1420	1671	920	2263	1149	1336	2476	1406	5
ACr 7	1387	904	1823	1481	1365	821	1108	1044	1377	926	1468	863	920	2253	1267	13
Hisar Anand (Check)	1025	483	1661	1694	1242	620	1090	1036	1393	791	1280	2225	1298	2086	1280	12
RCr 728 (Check)	1694	796	2139	2084	1393	875	1355	1074	1806	831	1153	1817	1078	1940	1431	2
Loc MEAN	1203	753	1770	1535	1416	812	1222	1234	1570	897	1525	1517	1421	2230	1365	
F (Prob)	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
	0	0	0	0	6	0	0	1	0	0	0	0	0	0		
CD (p=5%)	255.36	216.19	183.22	32.517	323.85	202.78	205.4	267.97	173.38	37.268	226.97	199.18	357.4	310.96		
CV (%)	12.5	17.0	6.14	1.25	13.5	14.8	9.97	12.8	6.55	2.46	8.83	7.79	15.3	8.27		

	97	27	29	67	74	21	24	87	36	62	27		95	65		
SE (m)	87.4	74.0	62.7	11.1	110.	69.4	70.3	91.8	59.4	12.7	77.7	68.2	122.	106.		
	87	67	72	4	95	75	71	09	01	68	63	42	45	54		

Entries	SY	DF	DM	PH	PB	SB	UP	U _B P	S/U	TSW	EO
NCOR-102	1331	65	111	96.8	6.2	17.8	36.0	5.9	20.8	12.5	0.237
LCS-19-1	1425	58	114	85.9	5.9	17.6	37.1	5.5	20.6	13.2	0.337
SCr-24	1299	64	115	83.5	5.8	17.5	35.5	5.6	21.5	13.1	0.286
DH 316	1375	67	116	93.6	6.4	18.4	37.2	5.7	20.9	11.1	0.261
JCr 16-02	1397	61	114	93.2	6.3	19.1	39.6	5.4	21.0	12.7	0.299
UD 565	1513	61	112	92.8	7.1	20.7	44.4	5.9	22.5	13.2	0.376
PD 7	1419	65	117	98.4	6.8	19.7	42.0	5.8	20.7	10.9	0.326
NDCor 22	1304	66	117	101.7	6.3	19.5	42.6	5.7	20.7	11.6	0.379
CS 46	1293	62	114	90.4	5.9	18.5	37.7	5.4	17.4	13.1	0.332
ICS 15	1406	63	114	93.1	6.5	17.8	38.8	5.8	23.1	11.9	0.256
ACr 7	1267	67	112	95.2	6.3	17.9	39.2	5.7	19.7	12.0	0.322
Hisar Anand (Check)	1280	63	112	93.7	5.3	16.7	37.5	5.8	20.4	12.5	0.286
RCr 728 (Check)	1431	68	116	97.9	6.3	18.2	42.3	5.7	21.4	10.8	0.333
Loc MEAN	1365	64	114	93.6	6.3	19.4	37.2	5.7	23.2	12.2	0.310

Crop Management

COR/CM/5.1: Growth and yield of Coriander as influenced by AMF (Arbuscular Mycorrhizal Fungi)

(Centres: Ajmer, Coimbatore, Dholi, Guntur, Jabalpur, Kota)

The experiment was initiated in the year 2022-23 with the aim of evaluating the influence of arbuscular mycorrhizal fungi (AMF) on the growth and yield of coriander. A total of ten different treatments were laid out in a Factorial RBD (FRBD) with three replications. The plot size for each experimental unit was 4.0 x 2.4 m².

Effect of treatments on yield and BC ratio across locations

Treatment	Ajmer		Guntur		Mean	
	Seed yield (kg/ha)	B:C Ratio	Seed yield (kg/ha)	B:C Ratio	Seed yield (kg/ha)	B:C Ratio
100% RDP + seed treatment	973.7	1.11	1115.7	-	1044.7	-
100% RDP + soil treatment	692.0	0.27	1239.7	-	965.85	-
100% RDP + seed & soil treatment	1120.7	0.83	1251.7	-	1186.2	-
75% RDP + seed treatment	813.7	0.78	1049.0	-	931.35	-
75% RDP + soil treatment	639.7	0.18	1277.0	-	958.35	-
75% RDP + seed & soil treatment	1010.7	0.66	1232.7	-	1121.7	-
50% RDP + seed treatment	809.0	0.79	992.7	-	900.85	-

50% RDP + soil treatment	572.3	0.06	1081.0	-	826.65	-
50% RDP + seed & soil treatment	831.0	0.37	1086.7	-	958.85	-
Control	461.0	0.22	787.7	-	624.35	-
SEm±	55.5	0.12				
CD (P=0.05)	166.1	0.35	190.1			
CV (%)	12.1	38.1	10.0			

The results revealed that the treatment with 100% RDP (recommended dose of phosphorus) combined with both seed and soil treatment produced the highest seed yield across both Ajmer and Guntur, with mean values of 1120.7 kg ha⁻¹ and 1251.7 kg ha⁻¹, respectively, resulting in an overall mean yield of 1186.2 kg ha⁻¹. The B:C ratio for this treatment in Ajmer was 0.83, indicating a moderate return on investment.

COR/CM/6.1: Effect of modern growth regulators on yield and quality of coriander

(Centres: Guntur, Jabalpur, Jobner, Kota)

The experiment was initiated in year 2022-23 with an aim to evaluate the influence of modern growth regulators on both the yield and the quality of coriander. A total of nine different treatments laid out in RBD, with three replications; with plot size for each experimental unit is 4.0 x 2.4 m².

Effect of treatments on yield and BC ratio across locations

Treatment	Guntur		Jabalpur		Jobner		Kota		Mean	
	Yield (q ha ⁻¹)	BC Ratio	Yield (q ha ⁻¹)	BC Ratio	Yield (q ha ⁻¹)	BC Ratio	Yield (q ha ⁻¹)	BC Ratio	Yield (q ha ⁻¹)	BC Ratio
SA @ 50 ppm	12.27	2.20	14.25	2.21	13.81	3.59	14.34	2.80	13.67	2.70
SA @ 100 ppm	9.69	1.73	14.75	2.32	14.02	3.63	15.51	3.09	13.49	2.69
JA @ 50 ppm	11.35	1.49	16.85	2.79	13.55	1.95	13.85	2.68	13.90	2.23
JA @ 100 ppm	11.73	1.21	15.19	2.42	13.66	1.36	14.68	2.89	13.82	1.97
BA @ 10 ppm	11.76	2.02	15.85	2.56	13.19	3.33	14.30	2.75	13.78	2.67
BA @ 20 ppm	10.88	1.78	17.99	3.04	13.31	3.27	11.63	2.00	13.45	2.52
Brassinosteroid @ 0.5 ppm	11.35	1.63	16.03	2.61	15.00	3.13	13.24	2.06	13.91	2.36
Brassinosteroid @ 1.0 ppm	10.96	1.32	16.89	2.80	15.37	2.68	10.33	1.11	13.39	1.98
Water spray	9.77	1.76	11.96	1.69	11.14	2.90	13.09	2.49	11.49	2.21
SEm±	0.36	-	0.36	-	0.67	0.13	0.79	0.21	-	-
CD (P=0.05)	1.36	-	1.10	-	2.01	0.40	2.37	0.62	-	-

The experimental results reveal that the treatments involving different growth regulators significantly influenced both yield and benefit-cost (BC) ratio across the four locations (Guntur, Jabalpur, Jobner, and Kota). Among the treatments, Brassinosteroid at 0.5 ppm achieved the highest mean yield (13.91 q ha⁻¹) but with a moderate BC ratio of 2.36, suggesting its potential for high productivity with

reasonable cost efficiency. Salicylic Acid (SA) at both 50 ppm and 100 ppm displayed balanced performance, with mean yields of 13.67 q ha⁻¹ and 13.49 q ha⁻¹, respectively, coupled with the highest BC ratios (2.70 and 2.69), making them the most economically viable options.

Crop Protection & Food Safety

COR/CP/7.1: Screening of coriander varieties against stem gall disease in coriander

(Centres: Dholi, Kumarganj, Kota, Hisar, Jabalpur)

The experiment is being conducted at five centers: Dholi, Kumarganj, Kota, Hisar, and Jabalpur. It was initiated in *rabi*, 2020-21 and concluded after three years trial. The experiment involves a total of 19 test entries, along with two resistant checks (ACr-1 and ACr-2) and a susceptible check (Rajendra Swati). Each entry is replicated three times. The rows are 3m long, with a spacing of 30 cm between rows and 10 cm between plants within a row.

Analysis of stem gall disease incidence revealed the susceptible check with an average of 55.46%, confirming its susceptibility. Entries Cor. 174 and Cor. 178 demonstrated moderate resistance with mean disease incidences of 19.51% and 19.23%, respectively. However, the majority of entries exhibited moderate to high disease levels, ranging from 22% to 44%. These findings suggest that while some entries showed moderate resistance, none achieved the high resistance levels observed in the resistant checks, indicating a need for further research to develop coriander varieties with enhanced resistance to stem gall disease.

Entries	Percentage stem gall disease incidence						Disease Reaction	Yield (Kg/ha)
	DHL	JBR	KOT	KUM	HSR	Mean		
Cor. 174	12.49	22.18	37	15.98	9.92	19.51	MR	1562
Cor. 175	18.32	27.02	41	13.60	12.46	22.48	MS	1450
Cor. 176	35.94	55.18	47	31.67	30.70	40.10	MS	1062
Cor. 177	35.68	32.11	44	24.93	26.85	32.71	MS	1378
Cor. 178	12.46	21.63	37	14.93	10.14	19.23	MR	1608
Cor. 179	18.32	32.11	37	14.40	11.39	22.64	MS	1436
Cor. 180	39.75	29.18	41	30.67	30.90	34.30	MS	1389
Cor. 181	36.04	53.48	44	56.40	30.08	44.00	MS	1036
Cor. 182	47.95	51.12	44	39.53	34.88	43.50	MS	931
Cor. 183	53.41	39.14	41	36.23	37.09	41.37	MS	1273
Cor. 184	44.82	42.05	41	54.03	31.54	42.69	MS	993
Cor. 185	36.04	21.63	37	46.40	31.09	34.43	MS	1042
Cor. 186	47.95	40.89	37	42.70	30.90	39.89	MS	986
Cor. 187	47.85	26.38	51	42.90	26.08	38.84	MS	917
Cor. 188	11.32	44.67	47	20.50	9.49	26.60	MS	1158
Cor. 189	33.82	26.57	37	32.20	26.08	31.13	MS	1173

Cor. 190	47.85	27.22	44	41.50	15.18	35.15	MS	1019
Cor. 191	11.82	34.23	51	7.43	10.90	23.08	MS	1289
Cor. 192	35.68	42.48	47	32.63	26.18	36.79	MS	1014
Acr-1 (Res. Ch.)	2.49	0.00	3.46	1.97	2.46	2.08	R	1232
Acr-2 (Res. Ch.)	1.26	0.00	2.46	1.73	1.92	1.47	R	1209
Sus. Ch.	57.85	53.41	60	58.10	47.95	55.46	S	914
SEm (±)	0.83	0.63	2.54	1.64	2.07	1.46	-	64.38
CD (p=0.05)	2.22	1.68	7.40	4.36	6.14	4.36	-	191.23
CV (%)	7.61	7.40	8.29	8.50	8.36	14.30	-	6.40

Genetic Resources

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

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

A total of 402 ajwain germplasm accessions are being maintained by different AICRPS centres. The details of the germplasm collection maintained are given in **Table 57.**

Table 57. Germplasm collection of Ajwain maintained in various AICRPS centres

Centres	Total accessions available	IC number obtained
Ajmer	150	50
Kumarganj	44	5
Raigarh	4	1
Guntur	105	105
Hisar	56	-
Jagudan	96	-
Jobner	45	-
Total	402	91

At Jagudan, 96 germplasms were assessed alongside check varieties GA 1 and GA 2. GP no. 83 emerged as the highest-yielding genotype with a seed yield of 450 g plot⁻¹. Additionally, promising genotypes were identified for various traits such as plant height, number of branches per plant, and yield, with significant variability observed across the evaluated accessions. At Guntur, 75 accessions from a collection of 105 were evaluated, with LAS-21-2 demonstrating the highest yield (1574.9 kg ha⁻¹), significantly outperforming the superior check, Lam Varsha. LAS-21-9 also stood out for its highest essential oil content of 5.5% v/w. Meanwhile, 48 Ajwain accessions at Hisar were evaluated alongside checks, with seed yields ranging from 11.2 to 35.0 g plant⁻¹. The most promising lines for seed yield included HAJ-4, HAJ-12, and HAJ-21. A total of 44 germplasm of ajwain were evaluated at Kumarganj and recorded maximum yield in NDAJ -21 (9.7 g plant⁻¹) followed by NDAJ-34 (9.0 g plant⁻¹) and NDAJ-30 (8.9 g plant⁻¹). At Jobner, forty-five (45) germplasm accessions of ajwain were evaluated along with three check varieties viz., AA-1, AA-2 and AA-73 in augmented design. Data on seed yield and other morphological traits were recorded on a random sample of five plants and averaged. A wide range of variability was recorded for all the characters studied. Based on seed yield per five plants, out of 45 accessions evaluated, only 6 accessions were found superior than best check variety AA-73 (38.0 g). Promising accessions identified based on seed yield per five plants are JAJ-21 (70.0 g), JAJ-20 (69.0 g), JAJ-18 (59.0 g), JAJ-01 (54.0 g), JAJ-35 (39.0 g) and JAJ-16 (38.0 g).

Crop Improvement

AJN/CI/2.2: Coordinated Varietal Trial (CVT) on Ajwain-Series II (2019-23)

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

Coordinated varietal trial on ajwain, initiated in the rabi season of 2019-20, aimed to evaluate promising ajwain accessions across seven centers. The trial, laid out in a Randomized Block Design (RBD) with eleven genotypes, including two check varieties, was successfully concluded in 2022-23 after three years of evaluation.

The variety JA-17-06 emerges as the top performer with the highest average seed yield of 1035 kg ha⁻¹. Following closely are JA-18-05 with an average yield of 1010 kg ha⁻¹ and NDAJ-21 with a yield of 1004 kg ha⁻¹. JA-17-06 consistently ranks among the top three in 9 out of 21 trials, demonstrating its robust performance. Similarly, JA-18-05 also secures a top-three positions in 9 trials, while NDAJ-21 leads with a top-three ranking in 10 out of 21 trials. In terms of yield improvement, JA-17-06 shows a mean increase of 4.5% over AA-2, the best check, and a notable 12.9% increase over AA-1, the second-best check. This indicates the superior yield potential of JA-17-06 relative to both benchmark varieties. JA-18-05 is a medium-maturity variety with a growth period of approximately 164 days. It is characterized by its compact seeds arranged in umbellate clusters and a higher number of umbels per plant. The seeds are notably bold, with a test weight of 1.15 grams. In terms of essential oil content, the variety has a volatile oil content averaging 5.50%, and it is distinguished by a high thymol content of 48.17%, enhancing its overall richness in essential oil components. Overall, JA-17-06 was the most promising genotype, demonstrating the highest yield and the most substantial yield increment over the check varieties. This variety, JA-17-06, was identified as Gujarat Ajwain-3 (GA-3) has been recommended for national release by the XXXIV Workshop/Group Meeting of the All India Coordinated Research Project on Spices, held from October 30 to November 1, 2023, at the College of Horticulture, Bengaluru,



Ajwain Variety, Gujarat Ajwain-3 (JA-17-06)

Karnataka



Table 1. Summary of Seed Yield per Hectare (Kg ha⁻¹) data of CVTs on Ajwain-2019 Series

Particulars	Year of testing	No. of trials	Check (AA-1)	Check (AA-2)	JA-18-05	JA-17-06	AA-3	AA-27	AA-96	HAJ-24	HAJ-29	NDAJ-21	NDA3-30
Mean Seed Yield (Kg/ha)	2020	7	847	1086	918	937	900.2	832.3	819.1	823.4	1003	996.9	962.1
	2021	7	893	1028	1044	1032	913.9	927.1	919.0	1043	1071	1021	957.0
	2022	7	1010	897	1068	1136	1127	1087	980.5	912.5	1000	1072.3	1092.2
Weighted Mean		21	917	1004	1010	1035	981	949	906	927	1025	1030	1004
Percentage increase or decrease over the Best check (ie.AA-2)	2020	7	--	--	-15.4	-13.7	-17.1	-23.4	-24.6	-24.2	-7.6	-8.2	-11.4
	2021	7	--	--	1.5	0.4	-11.1	-9.8	-10.6	1.6	4.2	-0.6	-6.9
	2022	7	--	--	19.1	26.7	25.8	21.3	9.4	1.8	11.6	19.6	21.8
Weighted mean		21	--	--	1.7	4.5	-0.8	-4.0	-8.6	-6.9	2.7	3.6	1.2
Percentage increase or decrease over the Second best check (ie.AA-1)	2020	7	--	--	8.5	10.7	6.3	-1.7	-3.2	-2.7	18.6	17.8	13.7
	2021	7	--	--	16.9	15.6	2.4	3.8	2.9	16.9	20	14.4	7.2
	2022	7	--	--	5.7	12.4	11.6	7.6	-3	-9.7	-1	6.1	8.1
Weighted mean		21	--	--	10.4	12.9	6.8	3.2	-1.1	1.5	12.5	12.8	9.7
Frequency in the top three group (pooled for three years)		21			3/21	9/21	9/21	4/21	1/21	6/21	10/21	10/21	5/21

Mean seed yield performance (kg ha⁻¹) of ajwain entries evaluated in CVT trials across location (Pooled for three years)

Entries	AJM	GTR	HSR	JAG	JOB	KGJ	RAI	Grand Mean	Rank
JA-18-05	1542	837	1073	1227	903	901	587	1010	4
JA-17-06	1277	779	1159	1261	1009	1039	720	1035	1
AA-3	1343	620	1175	1152	877	829	869	981	7
AA-27	1272	663	1239	1012	808	799	850	949	8
AA-96	1296	710	992	1095	736	706	808	906	11
HAJ-24	1338	650	971	1301	741	854	630	927	9
HAJ-29	1576	741	1156	1183	946	949	625	1025	3
NDAJ-21	1439	934	1196	1172	941	965	564	1030	2
NDA3-30	1535	808	1083	1196	835	891	677	1004	5
AA-1 (Check)	1496	635	921	1153	797	794	620	917	10
AA-2 (Check)	1833	653	1180	1127	815	822	594	1003	6
Loc. Mean	1450	730	1104	1171	855	868	686	981	

Where, AJM: Ajmer, GTR: Guntur, HSR: Hisar, JAG: Jagudan, JOB: Jobner, KGJ: Kumarganj, RAI: Raigarh

AJN/CI/2.1: Coordinated Varietal Trial (CVT) on Ajwain-Series III (2022-25)

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

Another series of Coordinated Varietal Trial (CVT) on Ajwain, initiated in the *rabi* season of 2022-23, aimed to evaluate another set of promising ajwain accessions across seven centres. The trial, laid out in Randomized Block Design (RBD) with ten

genotypes, including a check variety, Ajmer Ajwain-2, was successfully conducted in the first year of testing during 2022-23.

Table 1: Evaluation of Ajwain entries in Coordinated Varietal Trial for seed yield (kg ha⁻¹; 2022-23)

Entries *	AJM	GTR	HSR	JAG	JOB	KGJ	RAI	Mean	Rank
AJN-20	1641	1366	1278	795	863	1285	1238	1210	1
AJN-21	752	1077	1308	1198	664	965	989	993	7
AJN-22	1737	1062	1216	1063	1070	1007	1219	1196	2
AJN-23	281	1192	1097	758	1014	1229	1392	995	6
AJN-24	298	1103	865	688	688	1104	1415	880	9
AJN-25	370	1146	1002	1131	586	1035	1513	969	8
AJN-26	609	1018	1030	929	797	1181	1466	1004	5
AJN-27	587	1366	1083	1029	611	944	1598	1031	4
AJN-28	1234	1057	1228	1052	1088	653	1359	1096	3
AJN-29	744	1147	771	409	568	1125	1206	853	10

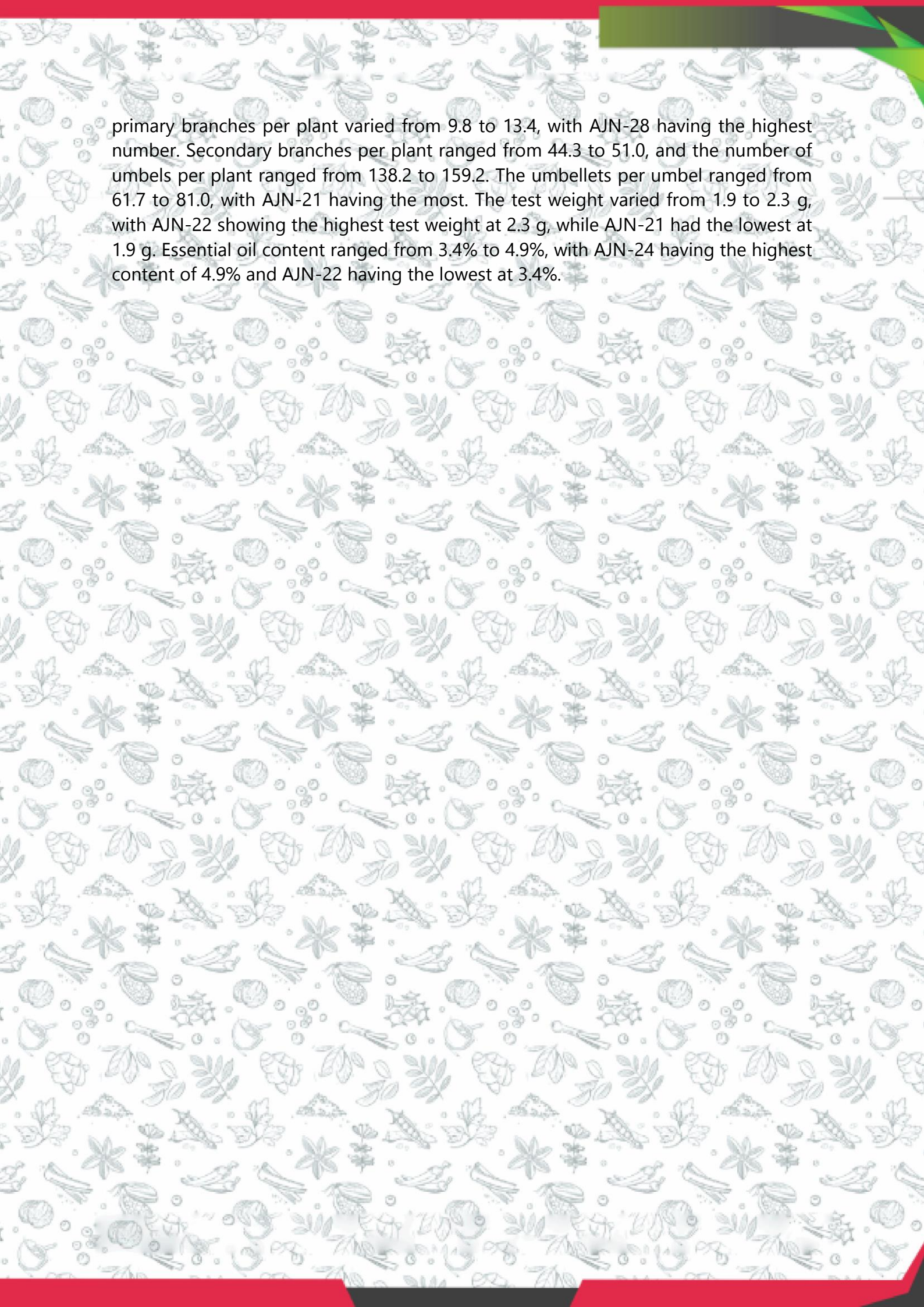
Where, AJM: Ajmer, HSR: Hisar, GTR: Guntur, JAG: Jagudan, JOB: Jobner, KGJ: Kumarganj, RAI: Raigarh

*The entries names are given in code names and its identity were maintained at PC cell, AICRPS and revealed at the end of the trial.

Table 58. Growth and yield parameters of CVT on ajwain-2022 rabi, 2022-23

Entries	Seed yield (q/ha)	Days to 50% flowering	Plant height (cm)	Primary branches/plant	Secondary branches/plant	Umbels per plant	Umbellets per umbel	Seeds per umbellate	Test weight (g)	Essential oil (%)
AJN-20	12.1	89.9	110.0	10.7	50.8	159.2	69.4	134.0	2.0	4.0
AJN-21	9.9	94.0	108.0	10.6	50.0	154.9	81.0	158.1	1.9	4.1
AJN-22	12.0	91.9	109.7	11.6	46.4	150.9	63.8	130.3	2.3	3.4
AJN-23	10.0	91.3	113.2	11.3	47.6	146.7	64.5	130.1	2.1	3.6
AJN-24	8.8	93.6	113.0	10.1	44.3	138.2	64.7	125.7	2.2	4.9
AJN-25	9.7	92.7	117.3	10.4	47.2	142.2	61.7	135.2	1.9	4.8
AJN-26	10.0	93.7	114.2	10.5	48.9	140.8	76.7	152.8	2.0	4.1
AJN-27	10.3	94.2	114.6	10.8	50.4	143.1	68.7	149.3	2.0	3.8
AJN-28	11.0	91.2	117.1	13.4	51.0	151.0	64.8	136.5	1.9	4.5
AJN-29	8.5	95.3	110.3	9.8	50.3	140.2	63.6	136.5	2.0	4.4

The mean seed yield across the entries ranged from 8.5 to 12.1 q ha⁻¹. The highest seed yield was recorded by AJN-20 (12.1 q ha⁻¹), followed closely by AJN-22 (12.0 q ha⁻¹), and AJN-28 (11.0 q ha⁻¹). In comparison, the lowest seed yield was observed in AJN-24 (8.8 q ha⁻¹). The analysis of variance indicated significant differences in seed yield and associated yield attributes among the genotypes. AJN-20 exhibited the highest seed yield despite having a medium test weight of 2.0 g. Regarding plant characteristics, days to 50% flowering varied from 89.2 to 95.3 days. AJN-28 flowered earliest at 91.2 days, while AJN-29 took the longest at 95.3 days. Plant height ranged from 108.0 to 117.3 cm, with AJN-25 being the tallest at 117.3 cm. The number of



primary branches per plant varied from 9.8 to 13.4, with AJN-28 having the highest number. Secondary branches per plant ranged from 44.3 to 51.0, and the number of umbels per plant ranged from 138.2 to 159.2. The umbellets per umbel ranged from 61.7 to 81.0, with AJN-21 having the most. The test weight varied from 1.9 to 2.3 g, with AJN-22 showing the highest test weight at 2.3 g, while AJN-21 had the lowest at 1.9 g. Essential oil content ranged from 3.4% to 4.9%, with AJN-24 having the highest content of 4.9% and AJN-22 having the lowest at 3.4%.

Genetic Resources

FNL/CI/1.1: Germplasm collection, characterization, evaluation and conservation of fennel.

(Centres: Jagudan, Jobner, Mandor, Sanand)

A total of 1695 cumin germplasm accessions are being maintained by different AICRPS centers. The details of the germplasm collection maintained are given in Table 42.

Table 25. Cumin germplasm collections maintained at various AICRPS centres

Centers	No. of Germplasm conserved			No. of Germplasm evaluated during 2022-23
	Indigenous	Exotic	Total	
Jagudan	327	7	334	104
Jobner	370	6	376	77
Sanand	22	-	22	22
Mandor	480	-	963	63
Total	1199	13	1695	266

During the *rabi* season 2022-23, 104 germplasm accessions were evaluated at Jagudan and identified promising genotypes for yield attributing characters (Table 43).

Table 43. List of promising genotypes identified at Jagudan centre

Character	Range	Promising genotypes
Plant height (cm)	21.0-32.6	GP no. 125,126,152,177,182,202 (dwarf in nature)
No. of branches/plant	2.6-5.0	GP no. 132,147,148,168,177,180 (with more branches)
No. of umbels/plant	8.4-21.6	GP no.152,164,168,180,182 (with higher umbels)
No. of umbellate/umbel	4.2-8.6	GP no. 156,159,163,178,182 GP no. 156,159,163,178,182 (more umbellates)
No. of seeds/ umbellate	4.0-7.0	GP no.189,196,199,200,204 (more seeds)

At Jobner, seventy-seven germplasm accessions were evaluated, and several promising ones were identified based on per plant seed yield. These included UC-276 (17.8 g plant⁻¹), UC-316 (17.6 g plant⁻¹), UC-277 (11.6 g plant⁻¹), UC-328 (10.4 g plant⁻¹), UC-298 (9.3 g plant⁻¹), UC-329 (9.0 g plant⁻¹), UC-348 (8.4 g plant⁻¹), UC-287 (8.3 g plant⁻¹), UC-282 (8.2 g plant⁻¹), UC-295 (7.8 g plant⁻¹), UC-290 (7.7 g plant⁻¹), and UC-306 (7.7 g plant⁻¹).

Similarly, a total of 63 germplasm accessions were evaluated long with three checks at Mandor centre in augmented design. Upon evaluation seed yield per plant ranges 0.57 g to 5.75 g, with promising entries GP-65, GP-9, GP-37, GP-7, GP-55, GP-64, GP-36, GP-60, GP-44 and GP-34.

While at Sanand, among the 22 germplasm accessions maintained were evaluated. All germplasm affected at early stage by cumin root rot and at later stage, cumin blight disease severely.

Screening of cumin entries for resistance against powdery mildew disease

A total of thirty-seven entries of cumin were screened for the resistance against powdery mildew disease at Jagudan during 2022-23. The minimum disease intensity (6.67%) was observed in CUM 51 and CUM 52, while the maximum disease intensity was recorded in the entry JC 21-07 (18.33%). The powdery mildew intensity was very low and ranged from 6.67 to 18.33 per cent.

Screening of cumin entries for resistance against blight disease

At Jagudan, a total of thirty-seven entries of cumin were evaluated for the resistance against blight disease during 2022-23. The minimum disease intensity (20.00%) was recorded in entries viz., GC 4, JCM 119 and JCM 120, while the maximum disease intensity was recorded in the entry CUM 51 (91.15%). The blight disease intensity was very high and ranged from 20.00 to 91.15 per cent.

Crop Improvement

CUM/CI/2.8: Coordinated Varietal Trial in Cumin-2021-Series XI (2021-23)

(Centres: Ajmer, Jagudan, Jobner, Mandore, Sanand)

Coordinated Varietal Trial (CVT) on cumin, initiated in the *rabi* season of 2021-22, aimed to evaluate promising cumin accessions across five centres. The trial, laid out in Randomized Block Design (RBD) with 12 genotypes, including a national check variety, GC-4 was successfully completed second year of testing in 2022-23.

Location-wise seed yield performance for the evaluated cumin for second year of testing is presented in the **table**. There was considerable variation observed among the different entries for seed yield. The mean seed yield varied 470 kg ha⁻¹ (MCU 105) to 95 kg ha⁻¹ (UC 257) across locations. The entries MCU 105 (470 kg ha⁻¹), CZC 135(393 kg ha⁻¹) and MCU 73 (359 kg ha⁻¹) recorded numerically higher seed yield and surpass the yield level to national check, GC-4 (335 kg ha⁻¹).

Entries	AJM	JAG	JOB	MDR	SAD	Mean	Rank
CZC-94	147	109	192	101	287	147	10
CZC-135	174	74	572	432	541	393	2
MCU 73	114	111	334	628	439	359	3
MCU 105	151	97	553	707	355	470	1
JC 18-10	78	150	302	220	549	200	7
JC 18-09	97	188	166	165	321	143	11
UC 350	38	132	634	113	352	262	5
UC 257	71	148	197	16	163	95	12
UC 250	49	157	424	14	315	162	9

SPS/166/2-3	68	169	178	258	1188	168	8
BC 13	105	116	339	328	625	257	6
GC 4	65	166	519	421	792	335	4
Loc MEAN	96	135	674	284	494	351	
F (Prob)	0.000	0.849	0.000	0.000	0.043		
CD (p=5%)	18.166	133.957	109.151	49.969	533.095		
CV (%)	11.126	58.660	17.547	10.404	63.742		
SE (m)	6.194	45.674	37.216	17.037	181.764		

Where AJM: Ajmer, JAG: Jagudan; JOB: Jobner, MDR: Mandore, SAD: Sanand.

The Jag and Sanand produced high Cv of CV>30% were omitted from calculating the grand mean.

Table 2. Mean performance of ancillary characters in the CVT-cumin trial across seven AICRP locations during *rabi*, 2022-23

Entries	DFF	DM	PH	NB	NUp	NUu	NSP	TSW	wilt	Blight	Volatile Oil
CUM-44	59	106	29.63	5.0	29.0	4.4	10.5	3.61	50.8	57.4	4.07
CUM-45	65	117	30.92	5.9	28.8	5.3	13.1	3.97	26.0	46.0	4.03
CUM-46	64	115	37.29	6.5	33.4	5.4	14.0	4.32	30.3	43.9	4.14
CUM-47	66	118	35.84	6.9	31.1	5.6	13.4	4.71	27.8	40.1	4.24
CUM-48	65	119	34.47	6.5	33.9	5.7	13.0	4.34	39.2	63.1	4.28
CUM-49	67	119	35.03	5.0	28.9	5.0	12.9	3.88	35.8	58.3	3.89
CUM-50	65	118	35.15	5.9	33.4	5.4	13.0	4.38	39.0	48.6	4.32
CUM-51	64	116	34.48	4.9	30.7	5.2	11.9	4.20	55.8	71.6	3.76
CUM-52	65	119	35.13	4.9	26.6	5.2	13.0	4.01	53.8	72.6	3.87
CUM-53	66	121	33.44	6.1	33.0	5.1	12.4	4.53	42.3	57.0	4.36
CUM-54	66	122	33.21	5.9	30.7	5.4	12.7	4.24	40.7	53.7	4.25
CUM-55	65	120	31.77	6.5	35.6	5.8	11.6	4.39	23.5	51.4	4.05

* DFF: Days to 50% Flowering; DM: Days to Maturity; PH: Plant Height (cm); NB: Number of Branches per Plant; NUp: Number of Umbels per Plant; NUu: Number of Umbellates per Umbel; NSP: Number of Seeds per Plant; TSW: Test Weight (g).

* Wilt incidence: Mean Percent Disease Index (PDI) from Jobner and Mandor.

* Blight incidence: Mean PDI from Jagudan, Jobner, and Mandor.

* Volatile oil percentage: Mean PDI from Ajmer, Jagudan, and Jobner.

Table 2 presents the mean performance of various cumin entries for several ancillary characters across seven AICRP locations during *rabi*, 2022-23. The data reveals a range of variability among the entries for the measured traits. Days to 50% flowering (DFF) varied from 59 days for CUM-44 to 67 days for CUM-49. Days to maturity (DM) ranged from 106 days for CUM-44 to 122 days for CUM-54. Plant height (PH) showed variation as well, with CUM-46 exhibiting the tallest growth at 37.29 cm and CUM-44 the shortest at 29.63 cm. The number of branches per plant (NB) ranged from 4.9 for CUM-51 and CUM-52 to 6.9 for CUM-47. Number of umbels per plant (NUp) varied from 26.6 for CUM-52 to 35.6 for CUM-55. The number of umbellates per umbel (NUu) ranged from 4.4 for CUM-44 to 5.8 for CUM-55. Number of seeds per plant (NSP) was lowest for CUM-55 at 11.6 and highest for CUM-46 at 14.0. Test weight (TSW) ranged from 3.61 g for CUM-44 to 4.71 g for CUM-47. Wilt incidence, expressed as mean PDI from Jobner and Mandor, was lowest for CUM-45 at 26.0 and highest for CUM-52 at 72.6. Blight incidence, recorded as mean PDI from Jagudan,

Jobner, and Mandor, was lowest for CUM-46 at 43.9 and highest for CUM-51 at 71.6. Finally, volatile oil percentage, recorded as mean PDI from Ajmer, Jagudan, and Jobner, ranged from 3.76 for CUM-51 to 4.36 for CUM-53. These results highlight the diverse performance of the cumin entries across different locations and provide valuable information for selection and breeding programs.

Crop Protection

CUM/CP/7.1 Eco-friendly management of cumin blight

(Centres: Jobner, Jagudan and Mandore)

A cumin crop protection trial to manage the cumin blight disease through eco friendly chemicals was initiated in 2022-23, is being conducted across three centers: Jobner, Jagudan, and Mandore. The experiment, laid out in a Randomized Block Design with three replications, examines eleven treatments including negative control. Each plot measures 3.0 x 3.0 m² and employs a crop geometry of 30 x 05 cm. The results presented here pertain to the first year of the experiment, 2022-23.

The lowest blight incidence expressed in Percent Disease Index (PDI) across all locations (Jobner, Jagudan, and Mandore) was recorded in T₁₀ (consisted of three foliar sprays of Kresoxim-methyl 44.3 SC at 0.044% (10 ml 10 L⁻¹ water) in which the first spray was applied 35 days after germination, followed by two subsequent sprays at 10-day intervals) with mean PDI score of 12.69% followed by T₉, (involving seed treatment and four foliar sprays of *B. subtilis* 1.15 WP (1x10⁸ cfu g⁻¹) at 40 g 10 L⁻¹ water combined with *P. fluorescens* 1.15 WP (1x10⁸ cfu g⁻¹) at 50 g 10 L⁻¹ water) with mean PDI score of 20.81%. The specific PDI values for each treatment and location are detailed in the accompanying table. The Highest seed yield recorded in T₁₀ (6.93 q ha⁻¹) followed by T₉ (6.07 q ha⁻¹) in the entire centre like Jobner, Jagudan & Mandore recorded.

Treat. No.	Treatment details	Jobner	Jagudan	Mandore	Pooled
T1	<i>P. fluorescens</i>	35.08 (36.24)*	35.17 (36.37)	21.33 (27.5)	30.53 (33.53)
T2	<i>P. fluorescens</i> + <i>T. harzianum</i>	46.42 (42.94)	42.42 (40.64)	16.67 (24.09)	35.17 (36.37)
T3	<i>P. fluorescens</i> + <i>T. viride</i>	34.67 (36.03)	35.08 (36.32)	18.33 (25.35)	29.36 (32.80)
T4	<i>T. harzianum</i>	44.92 (42.07)	43.92 (41.51)	22.33 (28.2)	37.06 (37.47)
T5	<i>T. viride</i>	37.58 (37.78)	43.42 (41.22)	23.67 (29.11)	34.89 (36.18)
T6	<i>B. subtilis</i>	29.42 (32.77)	35.83 (36.77)	17.00 (24.34)	27.42 (31.55)
T7	<i>B. subtilis</i> + <i>T. harzianum</i>	32.08 (34.49)	33.58 (35.42)	21.00 (27.27)	28.89 (32.49)
T8	<i>B. Subtilis</i> + <i>T. viride</i>	43.17 (41.07)	40.17 (39.33)	22.33 (28.18)	35.22 (36.40)

T9	<i>B. subtilis</i> + <i>P. fluorescens</i>	23.83 (29.17)	25.25 (30.17)	13.33 (21.33)	20.81 (27.10)
T10	Standard chemical check (Kresoxim-methyl 44.3 SC @ 0.044)	12.92 (21.05)	15.50 (23.18)	9.67 (18.11)	12.69 (20.84)
T11	Control (water spray)	61.17 (51.49)	52.50 (46.43)	39.00 (38.63)	50.89 (45.51)
S.Em.±		1.87	2.33	1.01	1.17
CD (p=0.05)		5.51	6.90	2.97	3.46
CV (%)		8.78	10.91	8.53	6.03

*Figures in parenthesis are angular transformed values.

Genetic Resources

FNL/CI/1.1: Germplasm collection, characterization, evaluation and conservation of fennel.

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

A total of 845 fennel germplasm accessions are being maintained by different AICRPS centres. The details of the germplasm collection maintained are given in Table 48.

Table 25. Fennel germplasm collections maintained at various AICRPS centres

Centers	No. of Germplasm conserved			No. of Germplasm evaluated during 2022-23
	Indigenous	Exotic	Total	
Dholi	44	-	44	44
Hisar	180	-	180	138
Jagudan	160	2	162	150
Jobner	271	20	291	82
Kumarganj	168	-	168	344
Total	823	22	845	819

During the 2022-23 *rabi* season, fennel germplasm was actively collected, characterized, evaluated, conserved, and screened for disease resistance across various AICRPS centres. At Dholi, 44 accessions, along with the checks Rajendra Saurabh and GF-11, were assessed for yield potential. RF-27 (105.24 g plant⁻¹) and RF-55 (100.65 g plant⁻¹) surpassed the yield of Rajendra Saurabh (98.48 g plant⁻¹). At Hisar, 138 accessions were evaluated, yielding between 37.2 g plant⁻¹ and 99.8 g plant⁻¹. The top 5% of entries, based on seed yield, included HF-154 (99.8 g plant⁻¹), HF-150 (99.7 g plant⁻¹), HF-167 (98.8 g plant⁻¹), HF-148 (98.4 g plant⁻¹), HF-172 (98.4 g plant⁻¹), HF-231 (97.7 g plant⁻¹), HF-163 (97.6 g plant⁻¹), and HF-195 (97.6 g plant⁻¹). At Jagudan, 78 genotypes were compared to check varieties GF 11 and GF 12. GP no. 14 achieved the highest yield at 85.1 g plant⁻¹. In addition to GP no. 14, high-yielding genotypes included GP numbers 6, 17, 31, 37, and 76. At Jobner, 278 accessions were screened, out of which 82 outperformed the check variety RF-101, which recorded a yield of 16.2 g plant⁻¹. Promising high-yielding accessions included UF-185 (37.0 g plant⁻¹), UF-79 (32.1 g plant⁻¹), UF-64 (32.0 g plant⁻¹), UF-65 (30.0 g plant⁻¹), UF-8 (30.0 g plant⁻¹), UF-27 (30.0 g plant⁻¹), UF-31 (29.4 g plant⁻¹), UF-308 (28.9 g plant⁻¹), UF-187 (26.2 g plant⁻¹), UF-58 (25.0 g plant⁻¹), UF-90 (24.8 g plant⁻¹), and UF-304 (24.8 g plant⁻¹). At Kumarganj, of the 100 accessions evaluated, NDF-46 (55.1 g plant⁻¹), NDF-48 (52.0 g plant⁻¹), and NDF-59 (51.8 g plant⁻¹) exhibited the best yields.

Table 25. Top yielding fennel accessions identified during germplasm evaluation at various AICRPS centres

AICRPS Centres	No. of Germplasm Evaluated	Yield Range (g plant ⁻¹)	Top Entries (Yield in g plant ⁻¹)
Dholi	44	81.72 - 105.24	RF-27 (105.24), RF-55 (100.65)
Hisar	138	37.2 - 99.8	HF-154 (99.8), HF-148 (98.4), HF-150 (99.7), HF-163 (97.6), HF-167 (98.8),
Jagudan	78	10.1 - 85.1	GP no. 14 (85.1), GP no. 6, GP no. 17, GP no. 31, GP no. 37, GP no. 76
Jobner	278	24.8 - 37	UF-185 (37), UF-79 (32.1), UF-64 (32), UF-65 (30), UF-8 (30)
Kumarganj	100	31.7 - 55.1	NDF-46 (55.1), NDF-48 (52.0), NDF-59 (51.6), NDF-52 (51.9), NDF-24 (50.1)

Crop Improvement

FNL/CI/2.8: Coordinated Varietal Trial in Fennel-2021-Series XI (2021-23)

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

Coordinated Varietal Trial in Fennel-2021-Series XI, was conducted successfully with 13 genotypes for the first year during rabi, 2022-23 at 14 locations viz, Ajmer, Dholi, Hisar, Jabalpur, Jagudan, Jobner, Kumarganj, Navsari and Pantnagar. There were significant differences among the 13 genotypes at various AICRPS centres for seed yield and yield attributing characters. Mean performance of genotypes across locations along with checks for seed yield, days to 50% flowering, days to maturity, plant height, primary branches per plant, secondary branches per plant, umbels per plant, umbellets per umbel, seeds per umbellate, test weight and essential oil content are given in Table 49.

Entries	AJM	DHL	HSR	JBR	JAG	JOB	KUM	NAV	PNR	Mean	Rank
HF 256	2585	1768	2169	977	1091	975	1722	2184	1288	1640	8
HF 192	2766	1581	2087	1415	1058	1542	1278	1335	1354	1602	12
JF 18-13	2015	1559	1649	1201	1500	1361	1528	2325	1448	1621	10
JF 18-03	1875	1756	1811	1091	1897	1678	1701	2421	1474	1745	5
UF 231	2024	1494	2033	1193	1483	2205	1875	2118	1504	1770	2
UF 230	2109	1681	1814	1317	1582	1843	1569	2120	1687	1747	4
AF 87	1803	1764	1681	1325	1460	1781	1653	1998	1140	1623	9
AF 17	1968	1684	1952	1251	1401	1544	1660	2545	1258	1696	6
RF 67	2385	1615	1762	1101	1195	1200	1632	1210	1206	1478	13
RF-101 (Check)	2321	1567	1413	1093	1457	1661	1500	1957	1479	1605	11
RF-205 (Check)	2223	1525	1817	885	1630	1970	1583	2253	1321	1690	7
NDF 59	2615	1699	1863	1119	1907	1499	1660	2442	1479	1809	1
NDF 46	2150	1647	1847	1210	1883	1388	1514	2929	1352	1769	3

Loc MEAN	2218	1642	1838	1168	1503	1588	1606	2141	1384	1676	
F (Prob)	0.000	0.008	0.000	0.008	0.001	0.000	0.018	0.000	0.002		
CD (p=5%)	302.78	152.34	49.11	238.59	392.24	348.31	249.82	484.34	213.30		
CV (%)	8.099	5.507	1.586	12.126	15.483	13.014	9.232	13.422	9.146		
SE (m)	103.73	52.192	16.83	81.744	134.39	119.34	85.592	165.94	73.078		

Location-wise performance for seed yield per ha is presented in the table. Mean seed yield ranged from 1478 to 1,809 kg ha⁻¹. The analysis of variance revealed significant differences among the entries for seed yield, indicating substantial variability among treatments. The entry NDF 59 recorded the highest seed yield at 1,809 kg ha⁻¹, while the entry RF 67 recorded the lowest yield at 1,478 kg ha⁻¹. six entries, namely NDF 59 (1809 kg ha⁻¹), UF 231 (1770 kg ha⁻¹), NDF 46 (1769 kg ha⁻¹), UF 230 (1747 kg ha⁻¹), JF 18-03 (1745 kg ha⁻¹), and AF 17 (1696 kg ha⁻¹), recorded numerically higher seed yield compared to the best check RF-205 (1690 kg ha⁻¹).

Entries	DFF	DM	PH	PB	SB	U/p	U/u	S/u	TSW	EO
HF 256	108.1	205.9	159.8	7.6	18.9	41.7	31.0	227.8	6.05	2.200
HF 192	109.5	203.1	150.8	8.1	17.8	40.3	30.0	191.1	5.97	3.104
JF 18-13	103.1	194.6	139.6	7.3	19.0	39.9	28.3	199.5	6.64	2.869
JF 18-03	106.5	196.4	143.4	8.4	19.3	48.8	27.2	171.7	6.19	2.730
UF 231	106.2	195.4	150.2	8.5	18.7	50.8	32.0	234.2	6.54	2.785
UF 230	106.7	204.9	149.3	8.4	20.5	43.4	29.6	212.6	7.29	2.514
AF 87	106.5	197.2	156.0	8.7	21.9	47.0	33.0	192.8	6.27	2.547
AF 17	107.5	200.8	161.2	8.1	21.8	41.8	32.5	185.5	6.64	2.588
RF 67	109.4	197.1	158.6	8.4	19.5	42.6	30.4	189.4	6.33	2.643
RF-101 (Check)	103.5	193.4	146.1	8.5	21.0	41.6	27.0	165.8	6.00	2.756
RF-205 (Check)	106.8	195.0	147.9	9.0	26.4	45.3	26.3	193.9	6.00	2.652
NDF 59	105.7	197.4	142.1	8.3	17.8	42.1	29.9	177.1	6.58	2.501
NDF 46	106.1	194.1	146.6	8.3	20.4	40.3	31.8	210.7	6.43	3.006
Loc MEAN	106.6	198.1	150.1	8.3	20.2	43.5	29.9	196.3	6.39	2.685

Crop Management

FNL/CM/5.1: Response of foliar application of iron and zinc on growth, yield, and quality of fennel

(Centres: Dholi, Jagudan, Jobner, Kumarganj, Mandor)

The experiment was initiated in the year 2020-21 with the aim to evaluate the effects of foliar application of iron and zinc on the growth, yield, and quality of fennel. The trial was successfully conducted for three years (2020-21, 2021-22, and 2022-23), were laid out in a Factorial RBD (FRBD) with three replications. Each plot measured 3 x 4.5 m², with crop geometry of 50 x 20 cm, encompassing a total of 16 treatment

combinations. The foliar sprays were administered at critical growth stages—60, 75, and 90 days after sowing.

The results indicate a clear trend where the foliar application of both zinc and iron significantly increases both seed yield and net returns compared to control treatments. The maximum average seed yield of 1678 kg ha⁻¹ was observed with the treatment of Foliar (0.6%) of Zinc Sulphate, and 1641 kg ha⁻¹ under the foliar spray of 0.6% Iron sulphate, confirming the positive impact of micronutrients on fennel productivity. All foliar treatments (0.2%, 0.4%, and 0.6%) consistently outperformed the control treatment across all locations, with Foliar (0.4%) and (0.6%) yielding the best results. In case of Zinc sulphate application, highest average net returns were achieved with Foliar (0.6%) treatment, at Rs. 103142 per hectare, whereas the net return (95112 per hectare) was highest during 0.4% foliar application of FeSO₄. This demonstrates the profitability associated with the recommended nutrient application. Foliar treatments led to substantially higher financial returns compared to control treatments. But under economic Considerations 0.4% level could provide a good balance between not being too low (which might not optimize yield) and not being excessively high (which could lead to increased input costs without proportionate benefits). Hence For foliar application in fennel cultivation, farmers should use iron sulphate and zinc sulphate each at a concentration of 0.4%. It is advisable to perform the foliar sprays at 60, 75, and 90 days after sowing. The technology is recommended is recommended for higher yield and net returns for Rajasthan, Gujarat, Uttar Pradesh and Bihar.

Treatment	Dholi		Jagudan		Jobner		Kumarganj		Mandore		Average	
	Seed Yield	Net Returns	Seed Yield	Net Returns	Seed Yield	Net Returns	Seed Yield	Net Returns	Seed Yield	Net Returns	Seed Yield	Net Returns
Control	1506	46631	1300	112280	1678	81510	1177	47,463	1433	93394	1419	76256
Foliar (0.2%)	1607	58323	1351	115580	1918	96605	1279	49,546	1601	107812	1551	85573
Foliar (0.4%)	1642	63699	1390	121340	2093	109263	1431	50,583	1757	121055	1663	93188
Foliar (0.6%)	1558	64135	1373	118700	2227	118842	1498	91,092	1735	122942	1678	103142
SEm+	25	1,806	33		24	1769	6	19,787	34	2589		
CD (P=0.05)	78	5,628	NS		66	4971	18	NS	99	7353		
Control	1506	46631	1321	115430	1744	86268	1347	48,592	1480	95028	1480	78390
Foliar (0.2%)	1554	58478	1398	122640	1940	98210	1344	89,600	1572	106633	1562	95112
Foliar (0.4%)	1563	60524	1336	113260	2091	109186	1343	50,121	1729	120005	1612	90619
Foliar (0.6%)	1611	63602	1359	116630	2141	112556	1350	50,371	1744	123536	1641	93339

SEm+	25	1,806	30		24	1769	6	19,787	34	2589		
CD (P=0.05)	78	5,627	NS		66	4971	NS	NS	99	7353		
CV%			15						7	8.1		

When preparing the solution, ensure that the micronutrient solutions are neutralized with lime before application for better effectiveness.

Genetic Resources

NGL/CI/1.1: Germplasm collection, characterization, evaluation and conservation

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

A total of 111 nigella germplasm accessions are being maintained by different AICRPS centres. The details of the germplasm collections maintained are given in **Table 57**.

Table 57. Details of nigella germplasm collection maintained in various AICRPS centres

Locations	Total accessions available	IC number obtained
Ajmer	40	20
Kumarganj	37	5
Raigarh	7	1
Pantnagar	19	03
Hisar	8	Nil
Total	111	26

Among the 37 germplasm lines evaluated at Kumarganj centre, the highest yields were recorded in *NDBC-20* (9.5 g plant⁻¹), followed by *NDBC-7* (9.3 g plant⁻¹), and *NDBC-31* (9.0 g plant⁻¹). At Raigarh, seven nigella germplasm accessions were maintained during the *Rabi* season of 2022-23. Notably, *CG Nigella 1* became the first Nigella variety notified for release in Chhattisgarh, as approved in the CVRC meeting for horticultural crops on May 4, 2023. Additionally, *Pant Krishna*, a variety from Pantnagar, was identified during CVT evaluation for its high Thymoquinone content, a desirable biochemical component in Nigella. Pantnagar also obtained IC numbers for three unique Nigella germplasm lines (*PK-1*, *PK-7*, *PK-8*).

Crop Improvement

NGL/CI/2.2: Coordinated Varietal Trial (CVT) on Ajwain-Series II (2019-23)

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

Coordinated varietal trial on Nigella, initiated in the rabi season of 2019-20, aimed to evaluate promising Nigella accessions across six centers: Ajmer, Hisar, Kota, Kumarganj, Raigarh, and Pantnagar. The trial, laid out in a Randomized Block Design (RBD) with nine genotypes, including two check varieties, was successfully concluded in 2022-23 after three years of evaluation.

The top performer was HKL-12, which secured the first position with an average seed yield of 878 kg/ha, showing a significant yield increase of 5.4% over the check variety AN-20 and 10.4% over Pant Krishna. The check varieties, AN-20 and Pant Krishna, recorded average yields of 830 kg/ha and 805 kg/ha, respectively. HKL-12 is a

medium maturing (145-150 days) and high-yielding Nigella variety, demonstrating its superiority in both yield and quality. The seeds of HKL-12 contain 24.84% total oil, which is on par with the check varieties AN-20 and Pant Krishna. Additionally, HKL-12 exhibits moderate tolerance to root rot, with a PDI of 20.51 under field conditions. Overall, HKL-12 was the most promising genotype, demonstrating the highest yield and the most substantial yield increment over the check varieties. This variety, HKL-12, has been recommended for national release by the XXXIV Workshop/Group Meeting of the All India Coordinated Research Project on Spices, held from October 30 to November 1, 2023, at the College of Horticulture, Bengaluru, Karnataka.



Nigella Variety, Hisar Kalonji 12(HKJ-12)

Table 1. Summary of Seed Yield per Hectare (Kg ha⁻¹) data of CVTs on Nigella-2019 Series

Particulars	Year of testing	No. of trials/ locations	Check (AN-20)	Check (Pant Krishna)	AN-19	AN-4	AN-9	NDBC -11	NDBC -7	PK-3	HKL-12
Mean Seed Yield (Kg/ha)	2020	6	824	803	791	800	734	816	752	715	818
	2021	6	736	807	773	779	798	765	701	765	826
	2022	6	944	778	927	906	874	846	915	997	989
Weighted Mean		18	835	796	830	828	802	809	790	826	878
Percentage increase or decrease over the Best check (ie.AN-20)	2020	6	--	--	-4.1	-2.9	-10.9	-1	-8.7	-13.2	-0.8
	2021	6	--	--	5	5.8	8.4	3.9	-4.8	4	12.2
	2022	6	--	--	-1.8	-4	-7.4	-10.3	-3.1	5.6	4.8
Weighted mean		18	--	--	-0.3	-0.4	-3.3	-2.5	-5.5	-1.2	5.4
Percentage increase or	2020	6	--	--	-1.5	-0.3	-8.6	1.6	-6.3	-10.9	1.8
	2021	6	--	--	-4.2	-3.5	-1.1	-5.2	-13.1	-5.1	2.4

decrease over the Second best check (ie.Pant Krishna)	2022	6	--	--	19.2	16.5	12.4	8.8	17.6	28.1	27.1
Weighted mean		18	--	--	4.5	4.2	0.9	1.7	-0.6	4.0	10.4
Frequency in the top three group (pooled for three years)		18			8/18	6/18	5/18	5/18	6/18	7/18	8/18

Mean seed yield performance (kg ha⁻¹) of nigella entries evaluated in CVT trials across location (Pooled for three years)

Entries	AJM	HSR	KOT	KGJ	RAI	PNR	Mean	Rank
AN-19	1195	1058	526	768	712	722	830	3
AN-4	1200	1083	571	687	685	744	828	4
AN-9	1408	927	504	634	679	660	802	7
NDBC-11	1332	1002	444	634	638	805	809	6
NDBC-7	1404	1013	457	653	608	602	789	9
PK-3	1238	932	556	715	810	704	826	5
HKL-12	1246	1230	657	813	623	697	878	1
AN-20 (Check)	1151	1129	556	688	832	653	835	2
Pant Krishna (Check)	1201	1056	548	639	654	679	796	8
Loc MEAN	1264	1048	535	692	693	696	821	

Where, **AJM**: Ajmer; **HSR**: Hisar; **KOT**: Kota; **KGJ**: Kumarganj; **PNR**: Pantnagar; **RAI**: Raigarh.

Crop Protection & Food Safety

NGL/CP/7.1: Management of root rot of nigella

(Centres: Dholi, Kumarganj and Raigarh)

The trial under the crop protection discipline, initiated in *Rabi*, 2022-23 across three centres, aims to evaluate the efficacy of various soil treatments and drenching schedules over a three-year period (2022-23 to 2024-25) for controlling root rot in *Nigella*. During the initial season (2022-23), among the seven treatments tested, the lowest disease incidence (6.82% to 8.33%) and highest yield (6.8 to 10.67 q ha⁻¹) were observed in treatment T₆ (Soil drenching with Azoxystrobin [20.5%] + Difenconazole [12.5%] SC @ 0.2%), followed by T₅ (Soil drenching with Boscalid [25.2%] + Pyraclostrobin [12.8%] WG @ 0.2%) with a disease incidence of 7.16% to 9.32% and yield of 6.6 to 9.67 q/ha, and T₁ (Soil application with Talc-based *Trichoderma viridae* @ 2.5 kg, multiplied in a minimum of 250 kg FYM ha⁻¹) with a disease incidence of 7.12% to 10.93% and yield of 6.30 to 9.22 q ha⁻¹. In contrast, the control treatment recorded the highest disease incidence (15.28% to 23.85%) and the lowest yield (4.4 to 7.33 q ha⁻¹). A table with the detailed disease scores and corresponding yields is appended for reference.

Table: Disease incidence (PDI) and corresponding yield of nigella under various soil treatments for management of root rot presented across three centres (Rabi 2022-23)

Treatment	Dholi		Kumarganj		Raigarh	
	Disease incidence	Yield q ha ⁻¹	Disease incidence	Yield q ha ⁻¹	Disease incidence	Yield q ha ⁻¹
T₁ - Soil application with Talc based <i>Trichoderma viridae</i>	8.39	9.22	7.12	8.33	10.93	6.3
T₂ - Soil application with mustard oil cake	10.4	8.22	9.32	7.67	16.6	5.59
T₃ - Soil application with neem cake	9.53	8.67	8.4	7.89	15.19	5.33
T₄ - Soil application with castor oil cake	12.4	8.11	10.86	7	18.32	4.7
T₅ - Soil drenching with Boscalid (25.2%) + Pyraclostrobin (12.8%) WG @0.2%	7.4	9.67	7.16	8.44	9.32	6.6
T₆ - Soil drenching with Azoxystrobin (20%) + Difenoconazole (12.5%) SC @0.2%	7.72	10.7	6.82	9.11	8.33	6.8
T₇ - Control	18.16	7.33	15.28	5.89	23.85	4.4
SEm(±)	1.04	0.46	1.18	0.34	1.15	0.22
CD at 5%	3.19	1.46	2.22	1.51	1.43	0.43
C.V.	16.8	9.21	13.27	10.8	9.21	4.36

Genetic Resources

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

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

This ongoing project is focused for the collection, conservation, and evaluation of fenugreek germplasm, aiming to identify superior accessions with high yield potential and resistance to powdery mildew. At present, a total of 1,326 fenugreek accessions—comprising 1,314 indigenous and 12 exotic types—are being maintained across multiple AICRPS centres, as detailed in Table 38.

Table 25. Coriander germplasm collections maintained at various AICRPS centres

Centers	No. of Germplasm conserved			No. of Germplasm evaluated during 2022-23
	Indigenous	Exotic	Total	
Dholi	278	-	170	60
Guntur	75	-	124	124
Hisar	315	-	406	150
Jagudan	168	-	82	82
Jobner	132	12	385	344
Kumargunj	756	-	148	148
Raigarh	200	-	11	11
Total	1314	12	1326	819

During 2022-23, at the Dholi center, sixty fenugreek accessions and two checks (Rajendra Kanti and Hisar Sonali) were evaluated. Five accessions (RM-185, RM-220, RM-197, RM-212, and RM-170) outperformed the best check, Rajendra Kanti. RM-185 achieved the highest yield ($18.11 \text{ g plant}^{-1}$), followed by RM-220 ($17.92 \text{ g plant}^{-1}$), exceeding Rajendra Kanti ($15.82 \text{ g plant}^{-1}$) and Hisar Sonali ($14.64 \text{ g plant}^{-1}$). The top ten accessions yielded between 16.38 and $18.11 \text{ g plant}^{-1}$. At the Guntur centre, among 124 entries, ten yielded significantly more than the best check, Lam Methi-2 ($4.54 \text{ g plant}^{-1}$). The top five performers were LFC-41 ($6.39 \text{ g plant}^{-1}$), LFC-32 ($6.19 \text{ g plant}^{-1}$), LFC-38 ($6.17 \text{ g plant}^{-1}$), LFC-14 ($6.01 \text{ g plant}^{-1}$), and LFC-51 ($6.00 \text{ g plant}^{-1}$). For herb yield at 14 DAS, LFC-123 ($200 \text{ mg plant}^{-1}$), LFC-121 ($170 \text{ mg plant}^{-1}$), LFC-102 ($169 \text{ mg plant}^{-1}$), LFC-122 ($166 \text{ mg plant}^{-1}$), and LFC-110 ($159 \text{ mg plant}^{-1}$) were the highest yielding. At Hisar, 150 fenugreek accessions were evaluated with Hisar Sonali, Hisar Suvarna, and Hisar Mukta as checks during 2022-23. Seed yields ranged from $10.1 \text{ g plant}^{-1}$ (HM-600) to $33.6 \text{ g plant}^{-1}$ (HM-509). Promising lines for seed yield included HM-509, HM-510, HM-519, HM-521, HM-525, HM-548, HM-595, HM-603, HM-606, HM-609, and HM-641. At Jagudan, 85 germplasms were evaluated. GP numbers 12 and 25 exhibited the highest seed yield, at 700 g plot^{-1} . At Jobner, 345

fenugreek germplasm accessions were evaluated with seven checks. Thirty-two accessions surpassed the best check, RMT-354 (13.6 g plant⁻¹). The top ten accessions, based on seed yield per plant, were UM-131 (20.16 g), UM-61 (18.04 g), UM-135 (17.70 g), UM-374 (17.60 g), UM-106 (17.20 g), UM-285 (17.20 g), UM-133 (16.90 g), UM-246 (16.80 g), UM-377 (16.60 g), and UM-379 (16.11 g). At Kumarganj, 148 fenugreek germplasm accessions were maintained and evaluated. NDM-49 (6.7 g plant⁻¹) had the highest yield, followed by NDM-37 (6.2 g plant⁻¹) and NDM-45 (6.0 g plant⁻¹). At Raigarh, 14 fenugreek genotypes were maintained. IFGS 7 (1870 kg ha⁻¹) had the highest seed yield, followed by IFGS 11 (1670 kg ha⁻¹), exceeding the checks RMT 305 (1330 kg ha⁻¹) and Gujarat 2 (1220 kg ha⁻¹).

Table 25. Top yielding germplasm identified during germplasm evaluation at various AICRPS centres

Centre	No. Evaluated	Yield range (g plant ⁻¹)	Best Check (Yield, g plant ⁻¹)	High yielding genotypes	
				No.	Promising Genotypes
Dholi	60 + 2 (c)	7.2– 18.1	R Kranti (15.8 g plant ⁻¹)	10	RM-185, RM-220, RM-197, RM-212, RM-170
Guntur	124 + 5 (c)	2.2– 6.4	Lam Methi-2 (4.54 g plant ⁻¹)	12	LFC-41, LFC-32, LFC-38, LFC-14, LFC-51
Hisar	150 + 3 (c)	10.1 – 33.6	H Sonali (25.4 g plant ⁻¹)	56	HM-509, HM-510, HM-519, HM-521, HM-525
Jagudan	82 + 3 (c)	2.1-6.2	GM-1 (5.6 g plant ⁻¹)	5	JFg-239, JFg-179, JFg-196, JFg-263, JFg-245
Jobner	344 + 5 (c)	2.8-20.2	Rmt-354 (13.6 g plant ⁻¹)	32	UM-100, UM-255, UM-372, UM-44, UM-352
Kumargunj	204 + 2 (c)	4.1–7.6	H. Sonali (5.3 g plant ⁻¹)	3	NDM-49, NDM-26, NDM-37
Raigarh	11 + 3 (c)	8–20	Rmt-305 (13 g plant ⁻¹)	2	IFGS-7, IFGS-11

Screening of Germplasm Entries Against Powdery Mildew and Downy Mildew Disease

In *rabi* 2022-23, CVT fenugreek genotypes were screened against powdery mildew and downy mildew diseases at multiple locations, including Ajmer, Jagudan, Jobner, and Kota for powdery mildew, and Ajmer and Jobner for downy mildew. Among them, five genotypes—FGK-140, FGK-145, FGK-149, FGK-150, and FGK-155—showed a moderately resistant (MR) reaction to powdery mildew at multiple locations, while the rest exhibited susceptible (S) to highly susceptible (HS) reactions.

For downy mildew, five genotypes—FGK-148, FGK-149, FGK-150, FGK-153, and FGK-155—exhibited a moderately resistant (MR) reaction at one or both locations, whereas the remaining genotypes showed susceptible (S) to highly susceptible (HS)

reactions. This screening against diseases identified promising fenugreek genotypes for resistance breeding programs against these major fungal diseases.

Entries	Reaction To Powdery Mildew										Reaction To Downy Mildew					
	AJM		JAG		JOB		KOT		Mean		AJM		JOB		Mean	
	PDI	DR	PDI	DR	PDI	DR	PDI	DR	PDI	R	PDI	DR	PDI	DR	PDI	DR
FGK-139	46	S	40	MR	70	HS	51	S	51.8	10	23	MR	51	S	37.3	9
FGK-140	38	MR	35	MR	58	S	60	S	48.0	9	35	MR	44	S	39.5	13
FGK-142	65	HS	46	S	80	HS	54	S	61.2	14	20	R	56	S	37.7	10
FGK-143	70	HS	40	MR	58	S	51	S	54.9	12	22	MR	46	S	33.9	6
FGK-144	64	HS	50	S	83	HS	12	MR	52.3	11	21	MR	45	S	33.0	5
FGK-145	38	MR	40	MR	53	S	57	S	46.8	7	34	MR	42	S	38.3	12
FGK-146	68	HS	65	S	85	HS	54	S	68.0	17	20	R	56	S	38.2	11
FGK-147	68	HS	50	S	58	S	78	HS	63.4	15	27	MR	42	S	34.8	7
FGK-148	68	HS	25	MR	42	S	51	S	46.5	6	25	MR	33	MR	29.0	3
FGK-149	55	S	30	MR	59	S	15	MR	40.0	4	24	MR	39	MR	31.7	4
FGK-150	61	HS	20	MR	68	HS	18	MR	41.8	5	31	MR	43	S	37.1	8
FGK-151	42	S	45	S	77	HS	90	HS	63.5	16	20	R	33	MR	26.8	2
FGK-152	51	S	45	S	53	S	87	HS	59.1	13	26	MR	60	S	42.9	17
FGK-153	49	S	15	R	50	S	12	MR	31.5	1	26	MR	59	S	42.2	16
FGK-154	45	S	22	MR	55	S	18	MR	35.1	2	30	MR	53	S	41.4	15
FGK-155	40	MR	20	R	34	MR	54	S	37.0	3	23	MR	56	S	39.9	14
FGK-156	55	S	20	MR	59	S	57	S	47.8	8	21	MR	32	MR	26.6	1
PDI	37.5-70		15.16-65.25		34.17-85		12-90				19.6-35.4		31.87-59.47			
Range																

Where, **AJM**: Ajmer; **JAG**: Jagudan; **JOB**: Jobner; **KOT**: Kota;
PM: Powdery mildew; **DM**: Downy mildew; **PDI**: Percentage disease incidence; **R**: Rank.

FGK/CI/1.3: Identification of drought tolerant source in fenugreek

(Centres: Jobner)

Eighteen (18) accessions of fenugreek were randomly selected from the germplasm were sown in two environments namely irrigated (normal irrigation) and drought (staggered irrigations i.e., half of that given in normal irrigation). Based on mean seed yield, accessions viz., UM-216, UM-163, RMt-361, RMt-354 and RMt-305 under normal irrigated condition while UM-216, UM-199, UM-300, UM-373 and UM-134 under moisture stress condition, were top yielders. TOL values indicated that genotypes UM-249, UM-329, UM-368, UM-199 and UM-300 had least deviation from zero and thus performance was found stable over both the environments. Based on stress susceptibility index (SSI) genotypes UM -249, UM-199, UM-300, UM-329, UM-368 and UM-134 were found to be the desirable genotypes for drought (moisture stress) condition. Stress tolerance index (STI) revealed that genotypes UM-216, UM-199, UM-300, RMt-354, RMt-361, UM-373, and UM-134 had maximum tolerance against moisture stress environment.

Crop Improvement

FGK/CI/2.4: Coordinated variety trial of fenugreek - 2021 (Series XI)

(Centres: Ajmer, Coimbatore, Dholi, Guntur, Hisar, Jabalpur, Jagudan, Jobner, Kumarganj, Kota, Navsari, Pantnagar, Raigarh)

The CVT of fenugreek was started in 2021-22 with the objective of evaluating promising fenugreek entries across the coordinating centres in the country for yield and other attributes. The trial was conducted with 17 genotypes during rabi, 2022-23 at 12 locations and there were significant differences among genotypes at various AICRPS centres for seed yield and yield attributing characters.

Location-wise performance for seed yield is presented in the [table](#). Analysis of variance revealed highly significant differences among the entries at all locations for seed yield, suggesting the presence of substantial genetic variability. The mean seed yield of fenugreek across 12 locations ranged from 1407 (PM 4) to 1857 kg ha⁻¹ (UM 259). Four genotypes—UM 259 (1857 kg ha⁻¹), IFGS6 (1758 kg ha⁻¹), HM 560 (1741 kg ha⁻¹), and JFg-17-04 (1738 kg ha⁻¹)—outperformed RMt 361. The overall mean seed yield across all genotypes and locations was 1649 kg ha⁻¹. Among all the entries, UM 259 was the highest-yielding entry during second year of testing, showing significant superiority over the best check.

Entries	AJM	DHL	HSR	JBR	JAG	JOB	KOT	KGJ	KNL	NAV	PNR	RAI	Mean	Rank
AFg 9	1569	2113	1768	2246	1602	1586	1330	2254	761	1126	1489	1767	1634	10
AFg 10	2069	1738	1886	1501	1817	1696	1666	NG	820	1216	1496	1421	1575	14
NDM 119	2020	2089	2096	1796	1528	1377	1858	2028	872	1201	1810	1794	1706	7
HM 242	1447	1585	2376	2330	1692	1256	1718	1944	738	1213	1517	1870	1640	9
HM 560	2033	1648	2470	2226	1806	1444	1660	2052	725	1178	1747	1902	1741	3
JFg-17-04	2056	1687	2223	2519	1718	1885	1405	1897	773	1187	1753	1752	1738	4
JFg-17-06	1391	1913	1718	1267	1299	1379	1503	1825	1041	1321	1621	1731	1501	15
UM 259	2171	1717	2113	2444	1621	2218	1928	2329	783	1337	1945	1677	1857	1
UM 233	1608	2029	1592	1811	1646	2020	1668	1968	903	1083	1649	1506	1624	12
NFG 201	1618	1724	2174	2311	1834	1804	1589	2036	808	1076	1756	1792	1710	6
NFG 202	1531	1690	2330	2500	1819	1097	1305	1984	819	1192	1510	1763	1628	11
PM 4	1272	2137	1963	1546	974	1341	752	1937	782	1029	1724	1431	1407	17
KFG 12	1158	1591	2127	2049	1716	1422	1685	2107	962	1081	1434	1635	1581	13
KFG 17	1814	1728	1712	1968	1732	937	1481	1778	729	913	1168	1924	1490	16
IFGS6	1995	1589	2164	2769	1780	1595	1634	1988	860	1193	1978	1555	1758	2
Hisar Sonali (Check)	1670	1672	2184	2134	1528	1847	1866	1869	979	1131	1207	2029	1676	8
RMt 361 (Check)	1659	2173	2024	2214	1625	1564	1971	2214	791	935	1624	1943	1728	5
Loc MEAN	1711	1813	2054	2096	1632	1557	1589	2013	832	1142	1613	1735	1649	
F (Prob)	0.001	0.000	0.000	0.000	0.001	0.000	0.000	0.024	0.000	0.004	0.000	0.000		
CD (p=5%)	451.2	155.9	176.2	441.4	324.0	177.6	324.1	288.2	38.70	191.7	224.0	101.9		
CV (%)	16.05	5.172	5.158	12.66	11.94	6.859	12.26	8.648	2.796	10.09	8.351	3.520		
SE (m)	156.6	54.14	61.18	153.2	112.5	61.66	112.5	99.80	13.44	66.55	77.79	35.26		

Where, **AJM**: Ajmer; **DHL**: Dholi; **HSR**: Hisar; **JBR**: Jabalpur; **JAG**: Jagudan; **JOB**: Jobner; **KNL**: Kalyani; **KOT**: Kota; **KGJ**: Kumarganj; **NAV**: Navsari; **PNR**: Pantnagar; and **RAI**: Raigarh.

FGK/CI/2.7: Chemo-profiling for identification of industrial types among the released varieties of fenugreek

(Centre: Guntur, Kumargunj, Coimbatore, Dholi, Jobner)

The trial is being carried out at multiple centres, aims to identify industrially significant fenugreek varieties based on their biochemical composition, which can serve as potential sources for pharmaceutical, nutraceutical, and flavouring industries.

During 2022-23, seed samples from Kumargunj and Guntur have been analyzed, with diosgenin and 4-hydroxyisoleucine (4-HAL) quantification completed for CO-1, CO-2, Rajendra Kranti, RM-28, and RM-204. At Jobner, the essential oil (EO) content and saponin levels of 10 released varieties were assessed, with EO content ranging between 2.7-4.0 %w/v and saponin content varying from 4.7-6.4%. Further analysis of diosgenin, 4-hydroxyisoleucine, trigonelline, and volatile oil profiles is yet to be completed. At Guntur, biochemical profiling of three varieties was performed, including the analysis of fixed oil, ash content, and crude fiber. Previously, oleoresin, crude fiber, carbohydrate (CHO), fat, and protein content were evaluated for LS-1, Lam Methi-2, and Lam Sonali. In 2022-23, crude fat, ash content, and crude fiber were analyzed, with LS-1 showing the highest crude fat content (6.61%) and Lam Sonali exhibiting the highest crude fiber content (7.50%). At Coimbatore, diosgenin and trigonelline content in CO-1 and CO-2 were analyzed using HPTLC, with diosgenin levels of 0.71% (CO-1) and 0.79% (CO-2), and trigonelline content of 0.52% (CO-1) and 0.50% (CO-2). Further analysis of these varieties is ongoing. Additionally, seed samples of CO-1 and CO-2 were submitted to NRCSS, Ajmer, for advanced chemoprofiling.

Crop Management

FGK/CM/5.9: Standardization of drip irrigation interval and method of micro nutrient application in fenugreek

(Centres: Ajmer, Coimbatore, Jobner, and Pantnagar)

The experiment focuses on the optimization of irrigation water management along with fertigation practices for fenugreek, aiming to enhance seed yield and economic returns through the standardization of drip irrigation intervals and micro-nutrient application methods. Initiated in 2019-20 and spanning three years, conducted across four AICRPS centers (Ajmer, Coimbatore, Jobner, and Pantnagar), the study employs a split-plot design. Main plot treatments consist of four drip irrigation intervals (2, 4, 6, and 8 days) combined with four micronutrient application methods (control/no application, soil application, foliar application, and fertigation) as subplot treatments, resulting in 16 treatment combinations. Each treatment is replicated thrice in plots measuring 3.0 x 3.6 m², with a plant spacing of 30 x 10 cm.

Treatment	Ajmer			Coimbatore			Jobner			Pantnagar			Average	
	SY	WUE	BCR	SY	WUE	BCR	SY	WUE	BCR	SY	WUE	BCR	SY	WUE
Drip Irrigation Interval														
2 days	2,569	9.21	2.41	860	NG	1679	7.3	2.08	1426	8.96	2.05	1,634	8.49	2.18
4 days	2,516	8.98	2.34	948	NG	1802	7.93	2.22	1656	9.67	2.18	1,731	8.86	2.25
6 days	2,433	8.73	2.24	828	NG	1525	6.88	1.9	1542	8.1	1.88	1,582	7.9	2.01
8 days	2,306	8.33	2.04	644	NG	1485	7.08	1.85	1517	8.4	1.8	1,488	7.94	1.9
SEm±	34	0.13	0.05	9		20	0.09	0.03	36	0.18	0.05			
CD (P=0.05)	121	0.44	0.17	22		59	0.27	0.08	64	0.75	0.07			
Method of Micro Nutrient Application														
Control	2,169	7.87	2.33	792	NG	1408	6.36	2	1337	7.25	2.01	1,427	7.16	2.11
Soil Application	2,356	8.49	1.95	804	NG	1638	7.32	1.94	1466	8.62	1.92	1,566	8.14	1.94
Foliar Application	2,609	9.37	2.34	821	NG	1726	7.81	2.06	1547	9.05	2.02	1,676	8.74	2.14
Fertigation	2,690	9.53	2.42	865	NG	1719	7.7	2.04	1676	9.25	2.08	1,738	8.83	2.18
SEm±	65	0.23	0.07	8		17	0.08	0.02	35	0.55	0.03			
CD (P=0.05)	190	0.66	0.22	16		49	0.22	0.06	56	1.45	0.07			

Seed yield Kg/ha, WUE (kg ha⁻¹ mm), BCR: BC ratio

Across all four locations, drip irrigation at 4-day intervals optimized fenugreek growth, yield components, seed yield, and net returns. This 4-day interval proved most effective, yielding the highest average seed yield (1,731 kg ha⁻¹), superior economic returns (benefit-cost ratio [BCR] of 2.25), and optimal water use efficiency (WUE) of 8.86 kg ha⁻¹ mm⁻¹. Specifically, the 4-day interval produced seed yields of 1802, 2516, 1656, and 948 kg ha⁻¹ at Jobner, Ajmer, Pantnagar, and Coimbatore, respectively, with corresponding net returns of Rs 68,829/-, Rs 131,819/-, and Rs 62,145/- per hectare. WUEs at these locations were 7.93, 8.98, and 9.67 kg ha⁻¹ mm⁻¹, respectively. While the 2-day interval also produced good yields, it exhibited diminishing returns in terms of BCR and WUE compared to the 4-day interval.

Fertigation, closely followed by foliar application, proved the most effective micronutrient application method. Fertigation resulted in an average seed yield of 1,738 kg/ha, a WUE of 8.83 kg ha⁻¹ mm⁻¹, and a BCR of 2.18. Foliar application yielded 1,676 kg/ha, demonstrating its potential but falling slightly short of fertigation's advantages. At Jobner, Ajmer, and Pantnagar, fertigation (and statistically similar foliar application) resulted in seed yields of 1719, 2690, and 1676 kg/ha, respectively; net returns of Rs 61,063/-, Rs 142,186/-, and Rs 61,225/- per hectare, respectively; BCRs of 2.04, 2.42, and 2.08, respectively; and WUEs of 7.70, 9.53, and 9.25 kg ha⁻¹ mm⁻¹, respectively.

Therefore, for maximizing fenugreek yield, WUE, and economic returns in regions like Tamil Nadu and Uttarakhand, it is recommended to follow drip irrigation at 4-day intervals combined with micronutrient application *via* fertigation. The suggested nutrient application comprises a balanced NPK ratio of 20:30:30 kg ha⁻¹ and essential micronutrients (ZnSO₄ at 15 kg ha⁻¹, FeSO₄ at 25 kg ha⁻¹, MnO at 14 kg ha⁻¹, and B at 10 kg ha⁻¹) applied in two splits during the flowering and pod-filling stages.

FGK/CM/5.1: growth and yield of fenugreek as influenced by arbuscular mycorrhiza fungi

(Centres: Jodhpur and Kota)

The trial was initiated during *rabi*, 2022-23 to determine the effect of phosphorus levels and different modes of mycorrhizal application for enhancing fenugreek productivity. The trial was laid out in Factorial Randomized Block Design (FRBD) in which each treatment is replicated three times. The main factor is different phosphorus levels included Control, 100% Recommended Dose of Phosphorus (RDP), 75% RDP, and 50% RDP while the mycorrhizal application methods forms the second factor including Seed Treatment (@100 g kg⁻¹ seed), Soil Application (5 kg acre⁻¹ at 20 DAS), and a combination of Seed Treatment + Soil Application along with an untreated control. The experimental plot size was 3.0 × 2.4 m,

Among the phosphorus treatments, the application of 100% RDP resulted in the highest seed yield (17.23 q ha⁻¹ at Mandore and 10.74 q ha⁻¹ at Kota) and benefit-cost ratio (BCR of 2.7 and 1.99, respectively). This was followed by 75% RDP, while 50% RDP recorded the lowest yield and economic returns at both locations. Regarding the mode of application, the combined application of seed treatment and soil application of mycorrhiza (S₃) exhibited superior performance, with the highest mean seed yield (13.34 q ha⁻¹) and BCR (2.22), followed by soil application alone (S₂), while seed treatment alone (S₁) recorded the lowest yield and economic return. The absolute control treatment resulted in the lowest yield and BCR across both locations. The interaction between phosphorus levels and mode of application did not show a significant effect on yield parameters. However, the general trend suggests that higher phosphorus application combined with integrated mycorrhizal application can enhance the productivity and profitability of fenugreek cultivation.

Treatment	Mandore		Kota		Mean	
	SY (q ha ⁻¹)	BCR	SY (q ha ⁻¹)	BCR	SY (q ha ⁻¹)	BCR
Phosphorus Level (P)						
P ₁ (100% RDP)	17.23	2.7	10.74	1.99	13.99	2.35
P ₂ (75% RDP)	16.87	2.7	9.32	1.68	13.1	2.19
P ₃ (50% RDP)	14.71	2.4	7.14	1.14	10.93	1.77
SEm±	0.26	-	0.22	-	0.24	-
CD (p=0.05)	0.73	-	0.66	-	0.7	-

Mode of Application (S)						
S ₁ (Seed treatment @100g/kg)	15.93	2.6	7.86	1.43	11.9	2.02
S ₂ (Soil application @5 kg/acre-20 DAS)	16.03	2.6	9.03	1.55	12.53	2.08
S ₃ (Seed treatment + Soil application)	16.37	2.6	10.31	1.84	13.34	2.22
SEm±	0.23	-	0.22	0.07	0.23	0.07
CD (p=0.05)	0.65	-	0.66	0.19	0.66	0.19
Absolute control	12.925	2.1	7.22	1.6	7.22	7.2625
Interaction effect (PxS)						
S.Em.±			0.13	0.04	0.13	0.04
CD (p=0.05)	0.51	-	0.38	NS	0.445	NS

FGK/CM/6.1: Effect of modern growth regulators on yield and quality of fenugreek

(Centres: Ajmer, Jobner, Kota)

The experiment was initiated in year 2022-23 with an aim to evaluate the influence of modern growth regulators on both the yield and the quality of fenugreek. A total of nine different treatments laid out in RBD, with three replications; with plot size for each experimental unit is 4.0 x 2.4 m².

Effect of Treatments on Yield and BC Ratio Across Locations

Treatment	Ajmer		Jobner		Kota		Average	
	SY (q/ha)	BCR	SY (q/ha)	BCR	SY (q/ha)	BCR	SY (q/ha)	BCR
Salicylic acid @ 50 ppm	5.48	-0.19	15.72	3.7	11.37	2.4	10.86	1.95
Salicylic acid @ 100 ppm	7.23	-0.40	16.02	3.7	13.38	3	12.21	2.09
Jasmonic acid @ 50 ppm	5.22	-0.45	14.77	1.9	12.63	2.8	10.87	1.42
Jasmonic acid @ 100 ppm	7.54	-0.18	14.88	1.4	13.38	3	11.93	1.38
Benzyl adenine @ 10 ppm	7.07	-0.01	14.81	3.4	11.11	2.3	11.00	1.87
Benzyl adenine @ 20 ppm	7.99	0.33	15.17	3.3	12.88	2.7	12.01	2.12
Brassinosteroid @ 0.5 ppm	6.81	0.46	16.4	3.1	11.05	1.8	11.42	1.76
Brassinosteroid @ 1.0 ppm	6.87	0.31	16.79	2.6	12.37	1.7	12.01	1.53
Water spray	4.16	0.32	12.23	2.9	10.61	2.2	9.00	1.80
CD (P=0.05)	1.75	0.30	2.32	0.4	1.734	0.5		
Sem	0.58	0.10	0.77	0.1	0.5783	0.2		

The first-year evaluation of different plant growth regulators on seed yield (SY) and benefit-cost ratio (BCR) in fenugreek was conducted across Ajmer, Jobner, and Kota. The results indicated that Benzyl adenine @ 20 ppm recorded the highest average seed yield (12.01 q ha⁻¹) across locations, followed by Salicylic acid @ 100 ppm (12.21

q ha⁻¹) and Brassinosteroid @ 1.0 ppm (12.01 q ha⁻¹). The lowest seed yield was observed in the control *i.e.*, water spray treatment (9.00 q ha⁻¹), demonstrating the positive impact of growth regulators on crop productivity.

In terms of benefit-cost ratio (BCR), Salicylic acid @ 100 ppm (2.09) and Benzyl adenine @ 20 ppm (2.12) exhibited the highest economic returns, suggesting their potential as effective treatments for improving fenugreek yield. However, at Ajmer, most treatments showed a negative BCR, indicating that the cost of application might not be justified under specific conditions. At Jobner and Kota, all treatments resulted in a positive BCR, with the highest values observed for Salicylic acid @ 50 ppm (3.7) and Salicylic acid @ 100 ppm (3.7) at Jobner. The findings suggest that Benzyl adenine and Salicylic acid treatments at appropriate concentrations significantly enhance seed yield and profitability, but further trials are needed to confirm these results across multiple seasons and agro-climatic conditions.

Crop Protection & Food Safety

FGK/CP/7.1: Bio-efficacy of fungicides against powdery mildew of fenugreek

(Centres: Coimbatore, Hisar, Jabalpur, Jagudan, Jobner, Kota)

The trial was initiated during *rabi*, 2022-23, conducted to evaluate the bio-efficacy of different fungicides in managing powdery mildew in fenugreek. The trial was planted in RBD design consisted of seven treatments with three replications, with each plot measuring 3 × 2.5 m and a spacing of 30 × 10 cm. The treatments included two foliar sprays applied at 15-day intervals, testing the efficacy of different fungicides: T₁: Azoxystrobin 23% EC (0.1%), T₂: Tebuconazole 25.9% EC (0.1%), T₃: Hexaconazole 5% SC (0.1%), T₄: Propiconazole 25% EC (0.1%), T₅: Myclobutanil 10% WP (0.05%), along with T₆: standard POP practice as per concern SAUs and T₇: an untreated control.

The findings from first year of study indicated that all fungicidal treatments significantly reduced disease incidence compared to the untreated control. Among the treatments, T₄ (Propiconazole 25% EC at 0.1%) recorded the lowest mean disease incidence (PDI=17.35%) across locations, followed by T₂ with PDI=17.19% and T₃ with PDI=16.62%. The highest disease incidence was observed in the untreated control (T₇), with a mean PDI of 44.74%, confirming the severity of the disease in the absence of control measures. In terms of yield performance, T₂ recorded the highest yield of 14.3 q ha⁻¹, closely followed by T₃ with 14.4 q ha⁻¹ and T₆ (SAU-recommended practice) with 14.5 q ha⁻¹. The lowest yield (9.98 q ha⁻¹) was obtained in the control (T₇), highlighting the detrimental impact of powdery mildew on crop productivity.

Treatment	Powdery mildew (PDI)*						Mean incidence	Mean yield (q/ha)
	Coimbatore	Jabalpur	Jagudan	Jobner	Kota	Raigarh		
T ₁	17.86	36.67	22.67	35.5	10	19.07	23.63	12.5
T ₂	16.43	23.33	21.58	22.83	8.33	10.63	17.19	14.3

T3	14.27	36.67	12.5	9.92	9.67	16.66	16.62	14.4
T4	7.85	34.67	18.42	17	9	17.18	17.35	13.8
T5	20.19	28	32.47	24.5	10.67	14.58	21.74	13.1
T6 (POP)	10.18	25.33	17.17	16.08	14.67	8.66	15.35	14.5
T7 (control)	30.46	58.67	55.67	58.08	42.33	23.22	44.74	9.98
SEm	1.13	0.29	1.45	1.07	-	-	-	-
CD (5%)	1.97	0.997	4.5	3	3.14	1.338	2.5	2.17
CV (%)	8.75	9.57	8.38					

T₆ (SAU-POP practice): For Coimbatore, 0.1% carbendazim; Jabalpur: Wettable sulphur (0.2%); Jagudan: Wettable sulphur (0.25%), Jobner: Wettable sulphur (0.2%); Kota: Wettable sulphur (0.2%); Raigarh : 0.1% carbendazim & 0.2% wettable Sulphur.

Genetic Resources

NGL/CI/1.1: Germplasm collection, characterization, evaluation and conservation

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

A total of 111 nigella germplasm accessions are being maintained by different AICRPS centres. The details of the germplasm collections maintained are given in **Table 57.**

Table 57. Details of nigella germplasm collection maintained in various AICRPS centres

Locations	Total accessions available	IC number obtained
Ajmer	40	20
Kumarganj	37	5
Raigarh	7	1
Pantnagar	19	03
Hisar	8	Nil
Total	111	26

Among the 37 germplasm lines evaluated at Kumarganj centre, the highest yields were recorded in *NDBC-20* (9.5 g plant⁻¹), followed by *NDBC-7* (9.3 g plant⁻¹), and *NDBC-31* (9.0 g plant⁻¹). At Raigarh, seven nigella germplasm accessions were maintained during the *Rabi* season of 2022-23. Notably, *CG Nigella 1* became the first Nigella variety notified for release in Chhattisgarh, as approved in the CVRC meeting for horticultural crops on May 4, 2023. Additionally, *Pant Krishna*, a variety from Pantnagar, was identified during CVT evaluation for its high Thymoquinone content, a desirable biochemical component in Nigella. Pantnagar also obtained IC numbers for three unique Nigella germplasm lines (*PK-1*, *PK-7*, *PK-8*).

Crop Improvement

NGL/CI/2.2: Coordinated Varietal Trial (CVT) on Ajwain-Series II (2019-23)

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

Coordinated varietal trial on Nigella, initiated in the rabi season of 2019-20, aimed to evaluate promising Nigella accessions across six centers: Ajmer, Hisar, Kota, Kumarganj, Raigarh, and Pantnagar. The trial, laid out in a Randomized Block Design (RBD) with nine genotypes, including two check varieties, was successfully concluded in 2022-23 after three years of evaluation.

The top performer was HKL-12, which secured the first position with an average seed yield of 878 kg/ha, showing a significant yield increase of 5.4% over the check variety AN-20 and 10.4% over Pant Krishna. The check varieties, AN-20 and Pant Krishna, recorded average yields of 830 kg/ha and 805 kg/ha, respectively. HKL-12 is a

medium maturing (145-150 days) and high-yielding Nigella variety, demonstrating its superiority in both yield and quality. The seeds of HKL-12 contain 24.84% total oil, which is on par with the check varieties AN-20 and Pant Krishna. Additionally, HKL-12 exhibits moderate tolerance to root rot, with a PDI of 20.51 under field conditions. Overall, HKL-12 was the most promising genotype, demonstrating the highest yield and the most substantial yield increment over the check varieties. This variety, HKL-12, has been recommended for national release by the XXXIV Workshop/Group Meeting of the All India Coordinated Research Project on Spices, held from October 30 to November 1, 2023, at the College of Horticulture, Bengaluru, Karnataka.



Nigella Variety, Hisar Kalonji 12(HKJ-12)

Table 1. Summary of Seed Yield per Hectare (Kg ha⁻¹) data of CVTs on Nigella-2019 Series

Particulars	Year of testing	No. of trials/ locations	Check (AN-20)	Check (Pant Krishna)	AN-19	AN-4	AN-9	NDBC -11	NDBC -7	PK-3	HKL-12
Mean Seed Yield (Kg/ha)	2020	6	824	803	791	800	734	816	752	715	818
	2021	6	736	807	773	779	798	765	701	765	826
	2022	6	944	778	927	906	874	846	915	997	989
Weighted Mean		18	835	796	830	828	802	809	790	826	878
Percentage increase or decrease over the Best check (ie.AN-20)	2020	6	--	--	-4.1	-2.9	-10.9	-1	-8.7	-13.2	-0.8
	2021	6	--	--	5	5.8	8.4	3.9	-4.8	4	12.2
	2022	6	--	--	-1.8	-4	-7.4	-10.3	-3.1	5.6	4.8
Weighted mean		18	--	--	-0.3	-0.4	-3.3	-2.5	-5.5	-1.2	5.4
Percentage increase or	2020	6	--	--	-1.5	-0.3	-8.6	1.6	-6.3	-10.9	1.8
	2021	6	--	--	-4.2	-3.5	-1.1	-5.2	-13.1	-5.1	2.4

decrease over the Second best check (ie.Pant Krishna)	2022	6	--	--	19.2	16.5	12.4	8.8	17.6	28.1	27.1
Weighted mean		18	--	--	4.5	4.2	0.9	1.7	-0.6	4.0	10.4
Frequency in the top three group (pooled for three years)		18			8/18	6/18	5/18	5/18	6/18	7/18	8/18

Mean seed yield performance (kg ha⁻¹) of nigella entries evaluated in CVT trials across location (Pooled for three years)

Entries	AJM	HSR	KOT	KGJ	RAI	PNR	Mean	Rank
AN-19	1195	1058	526	768	712	722	830	3
AN-4	1200	1083	571	687	685	744	828	4
AN-9	1408	927	504	634	679	660	802	7
NDBC-11	1332	1002	444	634	638	805	809	6
NDBC-7	1404	1013	457	653	608	602	789	9
PK-3	1238	932	556	715	810	704	826	5
HKL-12	1246	1230	657	813	623	697	878	1
AN-20 (Check)	1151	1129	556	688	832	653	835	2
Pant Krishna (Check)	1201	1056	548	639	654	679	796	8
Loc MEAN	1264	1048	535	692	693	696	821	

Where, **AJM**: Ajmer; **HSR**: Hisar; **KOT**: Kota; **KGJ**: Kumarganj; **PNR**: Pantnagar; **RAI**: Raigarh.

Crop Protection & Food Safety

NGL/CP/7.1: Management of root rot of nigella

(Centres: Dholi, Kumarganj and Raigarh)

The trial under the crop protection discipline, initiated in *Rabi*, 2022-23 across three centres, aims to evaluate the efficacy of various soil treatments and drenching schedules over a three-year period (2022-23 to 2024-25) for controlling root rot in *Nigella*. During the initial season (2022-23), among the seven treatments tested, the lowest disease incidence (6.82% to 8.33%) and highest yield (6.8 to 10.67 q ha⁻¹) were observed in treatment T₆ (Soil drenching with Azoxystrobin [20.5%] + Difconazole [12.5%] SC @ 0.2%), followed by T₅ (Soil drenching with Boscalid [25.2%] + Pyraclostrobin [12.8%] WG @ 0.2%) with a disease incidence of 7.16% to 9.32% and yield of 6.6 to 9.67 q/ha, and T₁ (Soil application with Talc-based *Trichoderma viridae* @ 2.5 kg, multiplied in a minimum of 250 kg FYM ha⁻¹) with a disease incidence of 7.12% to 10.93% and yield of 6.30 to 9.22 q ha⁻¹. In contrast, the control treatment recorded the highest disease incidence (15.28% to 23.85%) and the lowest yield (4.4 to 7.33 q ha⁻¹). A table with the detailed disease scores and corresponding yields is appended for reference.

Table: Disease incidence (PDI) and corresponding yield of nigella under various soil treatments for management of root rot presented across three centres (Rabi 2022-23)

Treatment	Dholi		Kumarganj		Raigarh	
	Disease incidence	Yield q ha ⁻¹	Disease incidence	Yield q ha ⁻¹	Disease incidence	Yield q ha ⁻¹
T₁ - Soil application with Talc based <i>Trichoderma viridae</i>	8.39	9.22	7.12	8.33	10.93	6.3
T₂ - Soil application with mustard oil cake	10.4	8.22	9.32	7.67	16.6	5.59
T₃ - Soil application with neem cake	9.53	8.67	8.4	7.89	15.19	5.33
T₄ - Soil application with castor oil cake	12.4	8.11	10.86	7	18.32	4.7
T₅ - Soil drenching with Boscalid (25.2%) + Pyraclostrobin (12.8%) WG @0.2%	7.4	9.67	7.16	8.44	9.32	6.6
T₆ - Soil drenching with Azoxystrobin (20%) + Difenoconazole (12.5%) SC @0.2%	7.72	10.7	6.82	9.11	8.33	6.8
T₇ - Control	18.16	7.33	15.28	5.89	23.85	4.4
SEm(±)	1.04	0.46	1.18	0.34	1.15	0.22
CD at 5%	3.19	1.46	2.22	1.51	1.43	0.43
C.V.	16.8	9.21	13.27	10.8	9.21	4.36

Genetic Resources and Crop Improvement

Project Mode: Conservation, evaluation and utilization of exotic and indigenous saffron germplasm lines (Centre: Pampore)

During 2022-23, the Pampore Centre collected six new saffron germplasm lines, bringing the total to 238 lines; however, after culling out redundant germplasm lines, only 208 clones were retained for germplasm evaluation. The conserved germplasm lines demonstrated significant performance in terms of growth, quality, yield, and yield-attributing traits. The range of variability is presented in germplasm maintained is given in **Table 62**.

Table 62. Morphological and yield characteristics of Saffron germplasm maintained at Pampore

S. No	Traits	Trait expression range
1.	Foliage colour	Light Green, Green, Dark green
2.	No. of leaves in main sprout	5–10
3.	Days to 50% flowering [d]	105 – 117 (1 st week of July sowing)
4.	Number of flowers per corm	1 – 2
5.	Tepal shape	Oblanceolate, Obovate
6.	Outer tepals length [cm]	2.8-4.8
7.	Outer tepals width [cm]	1.0-2.7
8.	Style length (cm)	0.91 – 4.0
9.	Pistil length (cm)	3.43 – 7.26
10.	Fresh Weight of pistil (mg)	17.40 – 45.38
11.	Dry weight of pistil(mg)	3.90 – 9.13
12.	Stigma length (cm)	2.23 – 5.13
13.	Plant height (cm)	10.2 – 26.5
14.	Number of leaf sprouts	2-7

Advanced Varietal trials of Saffron (AVT)

Among the, eleven elite lines, including the check variety evaluated under the Advanced Varietal Trial-I (1st year, HDP), exhibited considerable variation in yield and yield attributes. Notably, the line *SRS-Saf-178*, on par with *SRS-Saf-199*, showed a significantly higher yield of 5.93 kg ha⁻¹ and produced 89.0 flowers m⁻². *SRS-Saf-178* exhibited distinct morphological advantages, including the highest pistil length (6.28 cm) among the evaluated accessions. Despite of having the shortest stigma length (3.10 cm), it also recorded the maximum fresh (35.92 mg) and dry (7.18 mg) pistil weight, highlighting its superior floral biomass which directly contributed to its superior saffron yield potential. (Table 4).

Table 63. Yield and yield attributes of Saffron accessions evaluated under AVT-I

S.No	Accession Name	Pistil length (cm)	Fresh Weight of pistil (mg)	Dry weight of pistil (mg)	Stigma length (cm)	Flowers/ m ²	Saffron yield/ha
1.	SRS-Saf-124	6.05	32.61	6.52	3.21	72	4.80
2.	SRS-Saf-128	5.41	27.33	5.47	3.65	74	4.93
3.	SRS-Saf-157	5.82	32.14	6.43	4.25	76	5.07
4.	SRS-Saf-178	6.28	35.92	7.18	3.10	89	5.93
5.	SRS-Saf-183	5.11	29.77	5.95	3.96	74	4.93
6.	SRS-Saf-194	5.33	31.14	6.23	4.33	78	5.20
7.	SRS-Saf-195	6.12	33.57	6.71	4.67	73	4.87
8.	SRS-Saf-199	6.21	34.13	6.83	4.78	85	5.67
9.	SRS-Saf-251	5.42	28.21	5.64	4.02	79	5.27
10.	SRS-Saf-253	5.17	27.06	5.41	3.35	82	5.47
11.	SS-1	5.91	35.63	7.13	4.05	77	5.13
CD (p=0.05)		0.667	3.732	0.647	0.405	3.984	0.416



Fig 31. Pictures depicting Saffron Germplasm Block and Trials taken at Pampore

Genetic Resources and Crop Improvement

Project Mode: Exploration, collection and conservation of Kalazeera from high altitudes of Northern Himalayas (Centre: Pampore)

During 2022-23, four germplasm lines were collected from the high altitudes of the Gurez Valley in J&K, bringing the total to 102 accessions. The range and mean performance of these germplasm lines for morphological characteristics, yield, and yield attributes, as presented in Table 3, revealed significant variability among the accessions.

Table 64. Morphological and yield characteristics of Kalazeera germplasm maintained at Pampore

S. No	Yield attributes	Expression range
1.	Plant height (cm)	22.86 – 96.52
2.	Number of primary branches plant ⁻¹	1 - 6
3.	Number of secondary branches plant ⁻¹	1 - 16
4.	Number of tertiary branches plant ⁻¹	1 - 18
5.	Days from tuber sprouting to full bloom (days)	68 - 72
6.	Umbel Shape	Flat (9), Compound (11), Irregular (9), Round (41)
7.	Umbel diameter (cm)	1.6 - 11.3
8.	Number of umbels plant ⁻¹ (No.)	1 – 40
9.	Number of seeds umbel ⁻¹ (No.)	2.0 - 26.0
10.	Seed Length (mm)	2.1 - 6.5
11.	Seed breadth (mm)	0.5 - 1.4
12.	Seed shape	Crescent (41), Slender (29)
13.	Days to maturity (days)	170 - 180
14.	1000-seed weight (g)	0.90 - 2.88
15.	Biological yield (g/m ²)	27.36 - 229.45
16.	Harvest index (%)	0.23 - 0.44
17.	Seed yield (g/plant)	0.35 - 13.10

Advanced Varietal trials of Kalazeera (AVT)

Seven elite lines, along with the check variety *Shalimar Kalazeera-1*, were evaluated under Advanced Varietal Trial-1 (AVT-1) for growth, yield, and yield-related traits. Among these elite lines, *SRS-KZ-177*, on par with *SRS-KZ-167*, demonstrated a significantly higher yield of 442.7 kg ha⁻¹ compared to other accessions, including the check variety. The percent yield increase of *SRS-KZ-177* over the check was observed to be 28.09% (Table 4).

Table 63. Yield and yield attributes of Kalazeera accessions evaluated under AVT-I

S.No	Accession name	Plant height (cm)	Branches per plant	Days to maturity (days)	Seed Yield / ha (kgs)	Essential oil content (%)
1.	SRS-KZ-149	72.1	27	208	393.3	8.6
2.	SRS-KZ-158	77.4	29	205	388.5	9.1
3.	SRS-KZ-167	81.6	36	202	428.6	9.2
4.	SRS-KZ-170	94.9	32	203	409.2	9.4
5.	SRS-KZ-172	62.1	34	218	355.4	9.3
6.	SRS-KZ-177	72.5	38	216	442.7	9.3
7.	SRS-KZ-192	68.7	28	212	327.5	9.0
8.	SK-1	87.8	26	214	345.6	9.2
CD (p=0.05)		7.440	6.878	1.835	NS	13.661



Fig 31. Pictures depicting Kalazeera Germplasm Block and Trials taken at Pampore

16 ANNUAL GROUP MEET

The XXXIV Annual Group Meeting (AGM) of ICAR-All India Coordinated Research Project on Spices (AICRPS) was conducted during 30 October-01 November, 2023 at the College of Horticulture, University of Horticulture campus, Bengaluru, Karnataka. About 150 participants including 99 participants from AICRP on spices network were attended the gathering.

Dr. D. Prasath, Project Coordinator, ICAR-AICRP (Spices), formally welcomed the gathering of eminent scientists from various AICRPS centers across the country. The AICRPS Group meeting was inaugurated by Dr. S V Suresha, Honourable Vice Chancellor of the University of Agricultural Sciences (UAS) Bengaluru, Karnataka. Dr. Sudhakar Pandey, ADG (FVS & MP), ICAR presided over the function and in his presidential address, outlined critical insights and imperatives for the spice industry. Notably, he underscored the pivotal role of horticultural crops, constituting 33% of the total GDP, and emphasized the need for identifying successful crop varieties to achieve the ambitious goal of doubling farmers' income. Dr. N. K. Krishna Kumar, Dr. S. B. Dandin, Dr. V.A. Parthasarathy, Dr. R. Dinesh were the Guest of Honour during the occasion. Dr. Nirmal Babu, Former Director of ICAR-IISR, Kozhikode; Dr. SJ Eapen, Former Director of ICAR-IISR; Dr. Augustine Jerard, Project Coordinator (AICRPS Palms); and Dr. EVD Sastri, Head of Jaipur University, along with HODs of ICAR-IISR, scientists from NRC on Seed Spices, and other delegates, graced the occasion.



Best AICRPS centre award was conferred to SKN, College of Agriculture, Jobner, Rajasthan. Shri. Ramakanth Ramachandra Hegde, a progressive farmer was honoured for his endeavor in conserving indigenous land races and his contribution in developing farmer variety 'Sigandini'. A database on spice varieties -"Spice Var" was launched which gives detailed information on the significant characters of the spice

varieties. Fifteen extension booklets/pamphlets on spices production technologies in English and regional languages from different AICRPS centres were released during the occasion. During this inaugural session, various AICRPS centres showcasing the genetic diversity and varietal wealth of spices was exhibited. The inaugural session was concluded with a vote of thanks by Dr. H.P. Maheshwarappa DoR, UHS Bagalkot.

The workshop was organized in seven Technical Sessions viz., AICRP Progress Report presentation by project co-ordinator, Genetic Resources and Crop Improvement, Crop Management, Crop Protection, Variety Release, Technology Transfer and Plenary Session.

During the XXXIV AGM of Spices, four new spice varieties were identified for release:

- Gujarat Ajwain-3 (high yielding Ajwain cultivar with an average seed yield of 1035 kg/ha, greater number of umbels per plant and seeds per umbel with bold seed size)
- Hisar Kalonji-12 (medium maturing, 145-150 days and high yielding nigella variety, seeds contains 24.84% total oil, showing moderately tolerant to root rot)
- IISR Amrit (high yielding mango ginger variety having high yield potential (average yield 31 t/ha, potential yield 45.75 t/ha, bold and plumpy rhizomes, light yellow core having desirable flavour with myrcene (55.54 %) & β pinene (14.53%),
- Kamakhya 1 (a black pepper variety with 2.14 kg dry yield, compact spike with higher quality under Assam condition, essential oil content (3.43%), piperine (5.1%), and oleoresin (9.36%).

Additionally, eight new spice technologies were unveiled, covering integrated pest and disease management for coriander, integrated management of cumin aphids, black pepper-based mixed cropping systems, biological control of soil-borne pathogens in black pepper, and intercropping of seed spices with vegetables.

1. A black pepper-based mixed cropping system, integrating elephant foot yam, exhibits exceptional productivity and profitability, with a remarkable benefit-to-cost ratio of 3.21. Ideal for Karnataka, Kerala, and Maharashtra.
2. Biological control of soil-borne pathogens in black pepper involves strategic applications of *Trichoderma harzianum* and *Pochonia chlamydosporia*, reducing the reliance on chemical pesticides in Karnataka, Kerala, and Maharashtra.
3. Pioneering the management of pseudostem rot in cardamom, employing *Trichoderma harzianum* and *Pseudomonas fluorescens* applications, promises effective control for cardamom cultivation in Karnataka, subject to strain deposition.

4. For seed spices, intercropping strategies, such as coriander with garlic, fennel with garlic, and fennel with carrot, showcase substantial productivity gains and profitability, recommended for Bihar, Uttar Pradesh, Chhattisgarh, Madhya Pradesh, Rajasthan, and Gujarat.
5. Integrated pest and disease management in coriander introduces innovative foliar sprays and treatments, ensuring stem gall and aphid control across various regions, including Bihar, Uttar Pradesh, Chhattisgarh, Rajasthan, Gujarat, Madhya Pradesh, and Uttarakhand.
6. Fennel benefits from a foliar application of iron and zinc, enhancing growth, yield, and quality. Recommended for Rajasthan, Gujarat, Uttar Pradesh, and Bihar.
7. Fenugreek sees improved yield and water use efficiency through a recommended fertigation schedule, boosting economic returns and benefit-to-cost ratio. Ideal for Tamil Nadu and Uttarakhand.
8. Integrated aphid management in cumin, featuring thiamethoxam sprays, proves effective against aphid infestation in Gujarat and Rajasthan.

These technologies collectively represent a transformative stride toward ecological safety, sustainability, and enhanced profitability for farmers across diverse agricultural landscapes.

The group meeting witnessed the presentation of seven new research programs on crop improvement, production, and protection by AICRP on spices, setting the stage for future research in the spice sector.

In the Plenary session of the XXXIV AGM of AICRPS held on 01 November 2023, Dr. Vikramaditya Pandey, Principal Scientist, ICAR, New Delhi, Dr. Prakash Patil, Project Coordinator, AICRP (Fruits) and Dr. R. Dinesh, Director, ICAR- IISR were the chairpersons. They reviewed the new projects to be initiated in AICRP in forthcoming years. They emphasized the importance of integrated farming approaches and sought networking with spice-allied sectors.

17 FLAGSHIP PROGRAMMES

All India Coordinated Research Project (AICRP) on Spices has been instrumental in implementing the flagship initiative by the Government of India like Tribal-Sub plan Program (TSP), Scheduled Caste Sub Plan (SCSP) program, and North Eastern Hill (NEH) program. This report provides a quantifiable overview of the achievements of the different program at various AICRP on Spices centres, highlighting key outcomes, beneficiary engagement, and the overall impact on communities. The interventions primarily focused on enhancing spice cultivation, value addition, and ensuring the distribution of quality planting materials to improve the livelihoods of concern farmers.

TSP Programme

1. Chintapalle Centre, Andhra Pradesh

TSP program implemented by the Chintapalle Centre, targeted the sustainable livelihood enhancement of tribal farmers through improved spice cultivation practices in Andhra Pradesh. The program was carried out in Chowdupalli (V), Kitumula (V), Pedabarada (V), Chintapalle Mandal, Alluri Seetharamaraju District, Andhra Pradesh. With a budget of Rs. 2,00,000, the entire amount was efficiently utilized to support 95 tribal beneficiaries through various interventions. Key activities included four training sessions conducted on March 2, March 7, March 18, and March 22, 2024, focusing on Good Agricultural Practices (GAP), organic farming techniques, pest and disease management, and post-harvest handling of spices. These training programs aimed to improve the knowledge and attitude of stakeholders, particularly regarding black pepper and turmeric cultivation and processing. Demonstration plots showcased improved techniques such as drying black pepper and turmeric on tarpaulins to maintain quality and using hand polishers for turmeric. A significant portion of the budget was allocated to providing high-quality planting materials, including black pepper rooted cuttings, cinnamon seedlings, and ginger seed rhizomes, ensuring access to improved varieties. Additionally, agricultural equipment such as battery sprayers and tarpaulins was distributed to enhance farm efficiency and post-harvest processing. The program brought notable improvements in spice crop productivity, farmers' awareness of modern cultivation techniques, and the adoption of sustainable organic farming.

2. Yercaud Centre, Tamil Nadu

TSP program in Yercaud was designed to enhance the sustainable livelihoods of tribal farmers through mixed farming approaches. The initiative focused on imparting scientific knowledge and skills to tribal farmers through training on spice and fruit cultivation, while also promoting entrepreneurship through value addition units. The

program targeted the Yercaud Block, Salem, Tamil Nadu, with key crops including coffee, black pepper, and subtropical fruits. An allocated budget of Rs. 1,00,000 was fully utilized for training, demonstrations, and input distribution activities. Three training sessions were conducted, benefiting 90 farmers and equipping them with integrated pest and disease management (IPDM) and integrated nutrient management (INM) techniques. Planting materials, including 400 rooted cuttings of black pepper, 50 cinnamon seedlings, and 25 air-layered fig plants, were distributed, benefiting five farmers each. Essential agricultural inputs such as power sprayers (for 5 beneficiaries), vermicompost (250 kg for five beneficiaries), and Trichoderma (50 kg for 10 beneficiaries) were provided to enhance crop productivity and soil health. The intervention significantly improved farmers' income and productivity, as demonstrated by one farmer who, after adopting improved technologies and timely plant protection measures, saw a 20% increase in production and a 46% rise in income (from Rs. 1,71,000 to Rs. 2,50,000). The program also created awareness of sustainable mixed farming, encouraging additional income opportunities from crops like banana, fig, and cinnamon. These efforts have contributed to long-term improvements in tribal farmers' livelihoods and agricultural sustainability in the region.

3. Kahikuchi Centre, Assam

Under the TSP program for the 2023-24, the Kahikuchi centre was allocated Rs. 2,00,000 for implementing activities aimed at tribal community development. Two major initiatives were conducted utilizing the allotted funds. A two-day residential training program on 'Production Technology and Post-Harvest Management of Black Pepper, Ginger, and Turmeric' was organized, benefiting 30 trainees, including 26 women and 4 men, all belonging to ST communities of Loharghat under Rabha Hasong Council in Kamrup Rural District, Assam. This training enhanced their knowledge and skills in scientific crop production and post-harvest techniques. Another key activity focused on the distribution of planting materials and agricultural inputs in four clusters among tribal communities in Rani, Goreswar, Sonapur, and SC communities in Hajo under Kamrup District. The program provided 16 battery-operated spray machines, 2,400 black pepper seedlings, and 1,200 arecanut seedlings, benefiting approximately 160 farm families. These interventions helped farmers adopt improved farming practices, enhancing productivity and sustainability. The distribution of spray machines ensured the timely and efficient application of plant protection chemicals, reducing crop losses and improving yields. Furthermore, the introduction of high-quality planting materials is expected to enhance farm productivity and income. Overall, the TSP interventions at Kahikuchi have contributed to strengthening sustainable agricultural livelihoods and fostering economic development in the tribal communities of Assam.

4. CARS, Raigarh, Chhattisgarh

TSP program at AICRP on Spices, CARS, Raigarh, for the year 2023-24, aimed at introducing seed spices to tribal and scheduled caste farmers in Chhattisgarh while

improving their socioeconomic status. The program focused on turmeric, ginger, coriander, fenugreek, ajwain, and nigella cultivation. The target areas included Padigaon in Tamnar Block. With a total budget of Rs. 2 lakhs (Rs. 1 lakh under TSP and Rs. 1 lakh under SCSP), the funds were fully utilized for training and input distribution. Four training programs were conducted, benefiting 87 farmers. These sessions covered the demonstration of portray techniques in turmeric and ginger, field visits to tribal and scheduled caste farmers, and training on quality seed production of coriander at AICRP on Spices, CARS, Raigarh. The practical knowledge imparted enabled farmers to adopt improved spice cultivation techniques. A key intervention involved the distribution of 40 sprayers to 40 beneficiaries, ensuring better plant protection practices. The training programs significantly improved the knowledge and attitude of stakeholders regarding spice cultivation, raising awareness about the importance of these crops. Farmers particularly appreciated the portray technique in turmeric and ginger, as it reduced input seed costs and enhanced production efficiency. The initiative successfully promoted sustainable spice farming, contributing to increased farm productivity and better livelihood opportunities for tribal and scheduled caste farmers in Chhattisgarh.

5. Pottangi Centre, Odisha

TSP program at AICRP on Spices, Pottangi, Odisha, was implemented to enhance the livelihoods of the ST community through spice cultivation and value addition. The initiative targeted Konnagaon and Lamataput in Koraput, Odisha, focusing on key spice crops such as ginger, turmeric, black pepper, cardamom, cinnamon, and allspice. With an allocated budget of Rs. 2 lakh, the funds were fully utilized for training programs, input distribution, and demonstration activities. A training program was conducted for 75 tribal beneficiaries, equipping them with scientific knowledge on spice cultivation and post-harvest management. Additionally, a spice unit development program was established in Konnagaon and Lamataput to encourage sustainable farming practices. As part of input distribution, 750 black pepper rooted cuttings, 1,225 small cardamom seedlings, 2,500 cinnamon seedlings, 675 allspice seedlings, and 1,425 vanilla seedlings were provided to 75 farmers, ensuring access to high-quality planting materials. A demonstration on organic spice cultivation was conducted at Konnagaon on 29.02.24, along with another demonstration on spice unit development at Technology Village, Lamataput. The program resulted in increased awareness of modern spice cultivation techniques, improved farm productivity, and better economic stability for beneficiaries. Through these efforts, tribal farmers gained access to improved agricultural inputs and knowledge, fostering long-term sustainable spice cultivation in the region.

6. Pechiparai Centre, Tamil Nadu

TSP program at Pechiparai Centre, aimed to improve black pepper yield and quality while fostering tribal entrepreneurship in Pechiparai, Kanyakumari District, Tamil Nadu. With a total budget of Rs. 1,00,000, which was fully utilized, the program focused on scientific interventions for pepper cultivation. Two training sessions were

conducted, benefiting 50 farmers in each session, covering scientific pepper cultivation methods, value addition, and cost-effective production techniques. Demonstrations on rapid clonal multiplication in pepper, air-layering in cinnamon, and Bordeaux mixture preparation and application were held in Thanikundu on 29.02.2024 and Kadabanmoodu on 16.03.2024. As part of input distribution, 500 rooted cuttings of black pepper and 500 cinnamon seedlings were provided, each benefiting 50 farmers. Additionally, three quintals of fertilizers were distributed to 50 beneficiaries, enhancing soil nutrition and plant growth. The program also included two technology demonstrations to showcase improved farming practices. These interventions led to an increase in farmers' knowledge, adoption of scientific cultivation techniques, and reduced production costs, ultimately improving net profit through high-quality produce. The initiative strengthened sustainable pepper farming and value chain development, empowering tribal farmers with better agricultural practices and economic stability in the region.

7. Nagaland Centre

TSP program at the Nagaland Centre aimed to develop location-specific technologies for crop improvement, production, and processing while establishing market linkages in Bade village, Dimapur, and Biesumpuikam village, Peren, Nagaland. With a budget of Rs. 2,00,000, fully utilized, the program focused on training, technology transfer, and input distribution to tribal farmers. Five training sessions were conducted, benefiting 150 farmers, covering advanced production technology, processing of turmeric, and high-yielding spice cultivation. Demonstrations on micronutrient application in ginger, organic inputs for turmeric, and seed rhizome production of turmeric cv. Pragati and Lakadong were conducted in April 2023. As part of input distribution, 3,500 kg of ginger seed rhizomes were provided to 30 farmers, along with agricultural inputs such as pesticides, fungicides, fertilizers, traps, neem cake, neem oil, vermicompost, and micronutrients. Three demonstrations were conducted for 150 beneficiaries to showcase improved farming techniques. The intervention improved farmers' knowledge of ginger and turmeric cultivation, plant protection measures, and market linkages. The adoption of AICRPS-developed disease management technology for rhizome rot and bacterial wilt in ginger helped reduce crop losses. The program led to increased area under cultivation, enhanced productivity compared to traditional practices, and improved livelihood status among tribal farmers.

SCSP Programmes

1. Pampadumpara Centre, Kerala

SCSP program at the AICRPS, Pampadumpara, for 2023-24 aimed to enhance the economic returns of Scheduled Caste small cardamom growers through optimized resource utilization. Targeting Pampadumpara and Balagram in Idukki, Kerala, the project had a total budget of Rs. 9,00,000, benefiting 250 farmers. Eight training programs were conducted, covering good agricultural practices, innovative

interventions, pest and disease management, and soil health improvement. Impact assessments indicated a significant increase in knowledge levels, with post-training mean scores rising from 7.90 to 11.80. Demonstrations on disease management, shade regulation, and nutrient applications were conducted, benefiting 160 farmers. Essential inputs distributed included 152 agricultural implements, 250 kg of IISR cardamom special micronutrients, 300 kg of *Pseudomonas fluorescens*, 200 kg of *Metarhizium anisopliae*, 300 kg of VAM, 5200 kg of Trichoderma-enriched cow dung neem cake mixture, 2000 kg of vermicompost, 250 kg of bonemeal, 150 kg of lime powder, and 800 liters of Jeevamrutham. The initiative significantly improved farmers' technical knowledge, pest and disease management strategies, and soil health practices, contributing to higher productivity and sustainable cardamom cultivation.

2. Pottangi Centre, Koraput, Odisha

SCSP program at Pottangi, Koraput, Odisha, aimed to enhance the capacity building of the SC community through spice cultivation and value addition, along with the distribution of quality planting materials in the Technology Village. The program focused on crops like ginger, turmeric, black pepper, cardamom, cinnamon, and allspice, targeting the villages of Janmura and Singhari in Sonapur, Odisha. With a total budget of Rs. 2 lakh, the program achieved full utilization of funds towards training and input distribution. One training program was conducted for 75 SCSP beneficiaries, providing them with scientific knowledge on spice cultivation. Two spice unit development programs were also implemented in Janmura and Singhari, Sonapur, to promote the adoption of improved cultivation practices. Input distribution included 750 black pepper rooted cuttings, 1,225 small cardamom seedlings, 2,500 cinnamon seedlings, 675 allspice seedlings, and 1,425 vanilla seedlings, benefiting 75 farmers. A demonstration on organic spice cultivation was conducted in Janmura and Singhari, Sonapur, on February 19, 2024, emphasizing eco-friendly agricultural practices. Additionally, a program on the development of spice units in the Technology Village was held on the same day, promoting the long-term adoption of spice-based livelihoods.

3. Mandor Centre, Rajasthan

SCSP program at Agricultural Research Station, Mandor, for 2023-24 focused on enhancing farmers' awareness of seed spice cultivation in Western Rajasthan, specifically in Teja Nagar, Osian (Jodhpur), and Aakeli A, Merta City (Nagaur). With a budget of Rs. 4,26,490, the utilized amount was Rs. 3,60,697, and Rs. 65,793 was refunded. Two training sessions on the scientific cultivation of cumin were conducted, benefiting 110 farmers. Two Front Line Demonstrations (FLDs) were held at both locations on multiple dates. The program included the distribution of 150 kg of cumin seeds, benefiting 120 farmers. Agricultural inputs such as pesticides (16.5 kg), fungicides, and iron seed storage bins (2q capacity) were provided to 30 beneficiaries each. A total of 30 technology demonstrations were conducted, each benefiting 30 farmers. These interventions improved farmers' technical knowledge, storage capabilities, and access to high-quality planting materials.

4. Pundibari Centre, UBKV, Cooch Behar, West Bengal

SCSP program at Pundibari Centre, Uttar Banga Krishi Viswavidyalaya, Cooch Behar, West Bengal, for 2023-24 aimed to enhance spice cultivation among Scheduled Caste farmers in the Cooch Behar and Alipurduar districts. The initiative promoted the adoption of black pepper and turmeric cultivation, integrating them into existing homestead arecanut gardens. A total of 2,000 rooted black pepper cuttings and 1,000 kg of turmeric seed rhizomes, along with farm implements, fertilizers, and plant protection chemicals, were distributed to 40 beneficiaries. A Farmers' Training cum Input Distribution Programme on "Spices Cultivation and Processing" was conducted at Telipara, Kumargram, Alipurduar District (2nd March 2024) and Topsikhata, Alipurduar District (3rd March 2024). The training focused on scientific production technologies, input distribution, and processing techniques for black pepper and turmeric. With a budget of Rs. 2,00,000, the utilized amount was Rs. 1,75,042.

NEH Programmes

1. AICRPS, Nagaland Centre

NEH program at Nagaland Centre for 2023-24 focused on developing location-specific technologies for crop improvement, protection, processing, and marketing linkages, with a strong emphasis on knowledge transfer to promote sustainable practices among spice growers. The program targeted ginger and turmeric cultivation in Socunoma Village (Chumoukedima district), Bade village (Dimapur district), Medziphema, and Punglwa villages in Nagaland. With a budget of ₹9,10,000 and an expenditure of ₹9,07,646, the program achieved a high utilization rate. Four training programs were conducted, benefiting 110 farmers, focusing on advanced production technologies, processing, and organic cultivation of ginger and turmeric. The program distributed 6,100 kg of ginger seed rhizomes among 61 farmers and 6,000 kg of turmeric seed rhizomes to 80 farmers. Essential farm implements, 0.6 quintals of micronutrients, and 110 liters of neem oil were supplied to 110 farmers, along with 260 implements to enhance farming efficiency. Three demonstrations were conducted for 30 beneficiaries, showcasing micronutrient application for ginger, organic nutritional sources for turmeric, and seed rhizome production of turmeric varieties Pragati and Lakadong. These interventions significantly improved awareness of scientific crop production, encouraged organic cultivation practices, and enhanced productivity through better input management, ultimately improving production efficiency, access to quality planting material, and the adoption of sustainable agricultural practices, leading to improved livelihoods.

2. AICRPS Pasighat Centre, Arunachal Pradesh

The NEH program at the Co-opted Center, Pasighat, Arunachal Pradesh, for 2023-24 focused on enhancing farmer awareness and capacity building through training on scientific spice cultivation, frontline demonstrations of high-yielding varieties, and distribution of essential inputs in remote villages. The program also emphasized the collection, evaluation, characterization, and conservation of turmeric genetic

resources. Targeting ginger and turmeric cultivation in the aspirational districts of East Siang, the initiative benefited 30 farmers by providing them with the basic infrastructure for turmeric seed rhizome production. The total budget for the program was ₹5,93,482.28. Through targeted interventions, farmers gained exposure to improved production techniques, better seed materials, and resource-efficient farming practices. The program significantly contributed to increasing awareness of scientific cultivation, promoting high-yielding spice varieties, and strengthening the conservation of turmeric germplasm in the region.

3. ICRI-RRS, Gangtok, Sikkim

NEH program at Spices Board, ICRI-RRS, Gangtok, for 2023-24 focused on enhancing large cardamom production by utilizing genetic resources and improving crop management practices. Implemented across Sikkim, the program aimed to benefit farmers through training, demonstrations, and scientific interventions. With a total budget of ₹7,70,000, fully utilized, the program conducted three training sessions, benefiting 41 farmers, covering critical aspects of large cardamom cultivation. The first training, held on May 27, 2023, in Dzongu, Mangan district, Sikkim, included a spice clinic and demonstration on planting large cardamom suckers in the main field. The second and third training programs, organized on January 18 and 19, 2024, in Suruk and Today villages of Kalimpong district, West Bengal, focused on disease management, best cultivation practices, and productivity enhancement strategies. These interventions provided farmers with hands-on exposure to improved cultivation techniques, disease prevention measures, and efficient planting methods, leading to better crop establishment and yield improvements. The program significantly contributed to strengthening the knowledge base of farmers, promoting the adoption of improved planting materials, and fostering sustainable large cardamom cultivation practices in the region.

4. AICRPS, Mizoram Centre

NEH program at the Mizoram Centre for 2023-24 focused on the collection, identification, characterization, and conservation of genetic resources of ginger and turmeric, along with technology transfer through training, awareness programs, and frontline demonstrations. Implemented in villages across Kolasib district, including Thingdawl, Bukvannei, Saiphai, Meidum, and Kolasib, the initiative aimed to enhance farmers' knowledge and productivity. With a budget of ₹72,520, the program benefited 38 farmers through a training session held at ICAR Research Complex for NEH Region, Mizoram Centre, Kolasib, from March 18-20, 2024, on the scientific production technology of turmeric and ginger. As part of the intervention, 200 kg of seed rhizomes were distributed to 10 farmers, while 30 farm implements were provided to 30 farmers, aiding in improved crop management. The training significantly enhanced farmers' knowledge, skills, and adoption of scientific cultivation techniques. The introduction of Megha turmeric led to a threefold increase in turmeric production, encouraging more farmers to adopt its cultivation. Furthermore, the success of this initiative motivated farmers to explore value addition

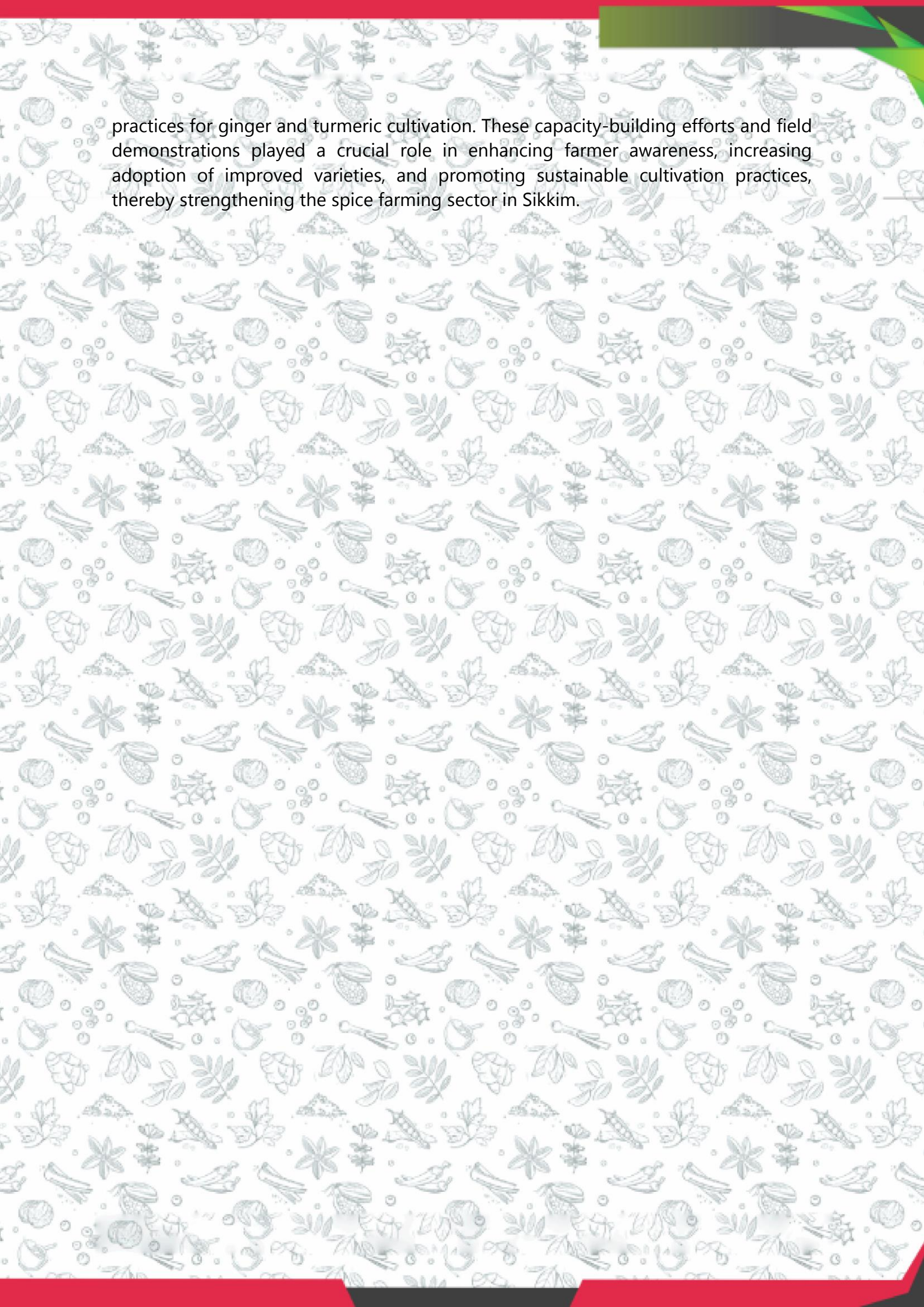
by processing turmeric into powder, thereby opening new marketing opportunities and nearly doubling their income compared to selling raw rhizomes. These interventions not only improved productivity but also contributed to the economic upliftment of farmers by promoting sustainable practices and market-driven approaches in ginger and turmeric cultivation.

5. AICRPS, Barapani, Meghalaya

NEH program at AICRPS, Barapani, Meghalaya, for 2023-24 focused on the collection, evaluation, characterization, and conservation of genetic resources of turmeric, ginger, mango ginger, and newly included black turmeric. The program also emphasized the identification of ideal crop management and protection measures for ginger and turmeric, along with technology transfer through training, awareness programs, and frontline demonstrations. Targeting Ribhoi and Jaintia Hills districts of Meghalaya, the initiative had a total budget of ₹8,90,000, with an expenditure of ₹8,18,574. Two training programs were conducted, benefiting 92 farmers, with sessions on improved production techniques of spices and tuber crops at Shiliangmyntang, Jaintia Hills, on September 15, 2023, and advances in nursery and crop production of spices and horticultural crops at Umiam from March 18-23, 2024. A total of 1,800 kg each of turmeric and ginger seed rhizomes were distributed to 61 farmers, along with 50 farm implements and 2,000 kg of fertilizers provided to 50 farmers. Two demonstrations were conducted, benefiting 71 farmers, focusing on the rapid multiplication technique for organic production in Mukhap, Jaintia Hills, on March 26, 2024, and good agricultural practices for Megha Turmeric-1 and Nadia ginger in Sarikushi, Marngar, Ri-Bhoi district, in November 2023. The adoption of rapid multiplication techniques led to a 25% reduction in seed rate, reducing cultivation costs, while scientific cultivation practices improved livelihoods by increasing productivity and income for tribal farmers engaged in turmeric and ginger farming.

6. ICAR Research Complex for NEH Region, Sikkim Centre, Tadong, Gangtok

The NEH program at ICAR Research Complex for NEH Region, Sikkim Centre, Tadong, Gangtok, for 2023-24 aimed to enhance the livelihoods of spice farmers through sustainable and profitable farming practices while improving spice crop productivity and quality via capacity building and technology transfer. The program conducted eight demonstrations, benefiting 95 farmers, and developed two demonstration blocks, positively impacting 30 farmers. The adoption of the ginger cultivar Nadia resulted in a 34% increase in yield and a 57% rise in profitability compared to the local variety, Bhaise, showcasing its potential for higher productivity and economic gains. Similarly, the turmeric cultivar RCT 1-1 demonstrated a 39.3% yield improvement and a 52% increase in profitability over the local cultivar, establishing it as a superior alternative for turmeric cultivation. These improvements highlight the adaptability, resilience, and economic viability of the introduced cultivars, ensuring better incomes for farmers. Two training sessions were conducted in February 2024 at Dzongu, North Sikkim, on good agronomic management



practices for ginger and turmeric cultivation. These capacity-building efforts and field demonstrations played a crucial role in enhancing farmer awareness, increasing adoption of improved varieties, and promoting sustainable cultivation practices, thereby strengthening the spice farming sector in Sikkim.

Scientists affiliated with the AICRPS, who have been assiduously engaged in the evolution and popularization of a cornucopia of cutting-edge technologies, all in the service of augmenting spice production and bestowing benefits upon our agrarian community; these dedicated efforts are furthermore committed to the dissemination of awareness regarding AICRPS-validated technologies, as well as their judicious regional fine-tuning to ensure optimal suitability across diverse agro-ecologies and in response to the specific desiderata of the farmers.. Key technology demonstrations across different AICRPS centers are categorized below:

High Yielding Varieties - Boon to Farmers

- ❖ Demonstration and distribution of turmeric variety YSRHU-Lam Swarna and LTS-2 in comparison to local varieties (Guntur).
- ❖ Turmeric Varietal demonstration at KVKs Ambedkar nagar, Jaunpur, MES, Horticulture, Maaudha, Sultan Pur, and SHDA Gorakhpur, Ramkola Block, Kushi nagar (Kumarganj).
- ❖ Demonstration of Panniyur series black pepper varieties demonstrated. Under high altitude areas (Panniyur-8) was demonstrated (Panniyur).
- ❖ Newly developed Panniyur 10 variety distributed for mass multiplication (Panniyur).
- ❖ FLD Demonstration on seed production practices for newly released Turmeric genotype (GNT-3) and mango ginger genotype (GNMG-1 and GNMG-2) (Navsari).
- ❖ Demonstration of High yielding varieties of spices (Hisar).
- ❖ Seed production of coriander (Variety- Pant Haritima), Fenugreek (Variety- Pant Ragini, Fennel (Variety- Pant Madurika), Nigella (Variety- Pant Krishna, Turmeric (Variety- Pant Peetabh) (Pantnagar).

Rapid Multiplication of Planting Materials for Minimum Expenditure

- ❖ Serpentine method for rapid multiplication of black pepper cutting was demonstrated (Dapoli).
- ❖ Demonstrated the two budded seed material on raised bed method with 3 to 4 rows with fertigation (Kammarpally).
- ❖ Pro tray techniques of nursery raising in ginger and turmeric (Barapani).
- ❖ A demonstration plot of Rapid propagation method of pepper and column method was established (Pechiparai).

Micronutrient and Biocapsules for Soil Health and Resource Budgeting

- ❖ Nutrient management in different spices crops (Dapoli).
- ❖ Distributed bio-capsules supplied by IISR to turmeric growing farmers (Guntur).
- ❖ Technology demonstrated on Organic package & micronutrients booster dosages in turmeric and ginger (Kammarpally).
- ❖ Micronutrients booster spray to turmeric and ginger at 60 and 60 DAP (Kammarpally).
- ❖ Successfully demonstrated the use of IISR-special, micronutrient mixture for black pepper (Panniyur).
- ❖ Technology for soil health management, soil and water conservation through mulching practices were disseminated (ICRI Gangtok).

Plant Protection Technologies and Food Safety Interventions

- ❖ Demonstration of bio control agents for pepper wilt (Yercaud).
- ❖ Management of rhizome rot of ginger using talc formulation of Trichoderma (Solan).
- ❖ Improved cultivation practices of large cardamom with reference to crop & soil health management; plant protection aspects, water conservation & irrigation etc. were highlighted & demonstrated (ICRI Gangtok).
- ❖ Fish Meal Traps was found effective against shoot fly in cardamom and popularized (Sakleshpur).

Processing Machineries for Increased Efficiencies

- ❖ Value added products in Garcinia was demonstrated (Pechiparai)

19

SUCCESS STORY

Transforming Spices Cultivation in Ratnagiri through AICRPS led technologies

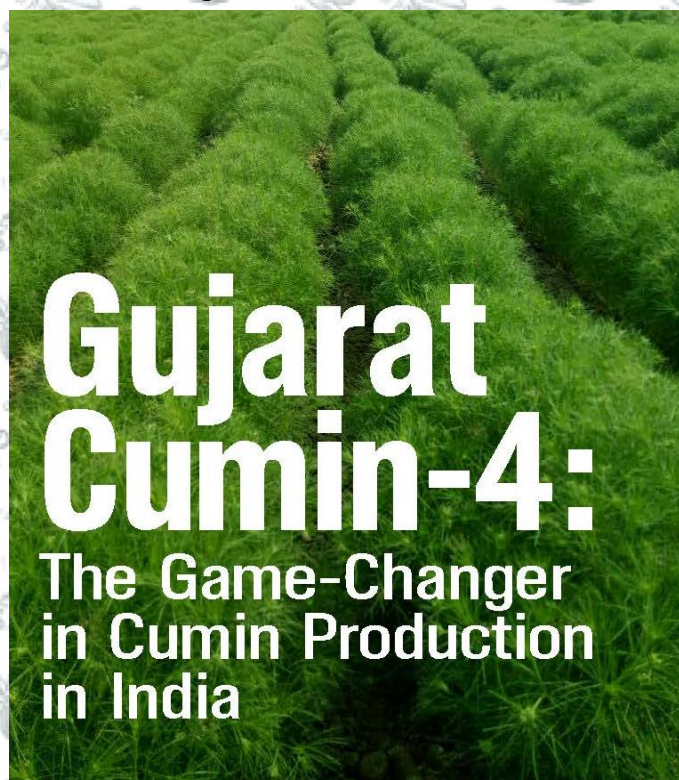
Ratnagiri's progressive farmers are redefining spice cultivation with cutting-edge technologies supported by AICRPS Dapoli. Mr. Gopal Bhagvat from Wakawali, Dapoli, revolutionized turmeric farming by adopting plastic mulch technology. On just 10 gunthas, he achieved an impressive 10 tons/acre yield of Salem turmeric. By integrating AICRPS-recommended biofertilizers, raised-bed planting, and pest management, he enhanced soil health, controlled weeds, and ensured efficient moisture conservation. His commitment to turmeric processing and cooperative farming is paving the way for sustainable agriculture in the region. In Kotluk, Ratnagiri, Mr. Anil Laxman Gorivale leveraged the AICRPS-developed pro-tray seedling method for turmeric cultivation on 2 acres. This innovative approach, combined with scientific fertilizer application, biofertilizers, and modern spraying techniques, resulted in a remarkable 10 tons/acre yield. With one acre under organic farming, his model highlights the commercial viability of precision agriculture in turmeric cultivation, setting a new standard for high productivity and sustainability. Mr. Milind Vishnu Bapat from Asond, Dapoli, embraced advanced fertigation technology for bush pepper cultivation on 5 gunthas. Under a polyhouse with Panniyur-1 variety, he optimized water and nutrient delivery, ensuring robust plant growth. Backed by AICRPS, he employed biofertilizers, power sprayers, and efficient pest control, maximizing yield while conserving resources. His meticulous post-harvest management and advocacy for cooperative farming make him a trailblazer in sustainable pepper production. These success stories showcase how AICRPS-led interventions are driving a spice revolution in Ratnagiri, blending innovation with sustainability to empower farmers and boost productivity.





Gujarat Cumin-4: The Game-Changer in Cumin Production in India

Mega variety, Gujarat Cumin-4 (GC-4) has revolutionized cumin cultivation in India, particularly benefiting farmers in Gujarat and Rajasthan. Variety is a collaborative effort led by the Seed Spices Research Station (SSRS), Jagudan under S. D. Agricultural University (SDAU), Gujarat and the ICAR-All India Coordinated Research Project on Spices (AICRPS). Since its national release in 2006, GC-4 has quickly gained acceptance among farmers, occupying approximately 90% of cumin-growing area in Gujarat and 60% in Rajasthan by 2023. Its resistance to wilt disease and higher yield potential have made it a preferred choice over traditional varieties. The production trend has witnessed a remarkable shift; from an estimated 158,400 tonnes in 2005-06, cumin production soared to around 495,900 tonnes in the crop year 2022-23, largely attributed to the continuous adoption of GC-4. This increase in output has not only assured food security but has also bolstered India's position as a leading exporter of cumin, with exports rising significantly. The export volume of cumin increased eightfold since GC-4 became prevalent, contributing approximately ₹25,480.5 crores to export earnings from varieties of cumin, essential oils, and oleoresins by 2022-23. Farmers' livelihoods have improved tremendously due to GC-4. For instance, Mr. Devrajbhai Amthabhai Patel from Banaskantha, Gujarat, transformed his income from ₹3 lakhs to about ₹20 lakhs through the adoption of GC-4 and seed production initiatives. Similarly, Shri Kalu Ram from Rajasthan



doubled his income to ₹1.15-1.45 lakhs per hectare by switching from local varieties to GC-4. These success stories exemplify how Gujarat Cumin-4 has not only enhanced cumin production and export potential but also significantly uplifted the economic status and livelihoods of farmers across the cumin-producing regions of India.

(For more details about this success story, please visit: <http://14.139.189.27/AICRPS/OP/GC4.pdf>)

Empowering Farmers, Transforming Lives: Usha Rabha's Rise with AICRP on Spices

In Hanapara village, Assam, Usha Rabha and her family struggled with limited income from traditional farming. Supporting her three daughters and son was difficult, with little hope for financial stability. However, her life transformed in 2014 when she was introduced to black pepper cultivation through the AICRPS, Kahikuchi with support from Diya Foundation. AICRP on Spices center at Kahikuchi played a crucial role in this transformation by providing Usha with technical training, quality planting materials, and continuous guidance on best agricultural practices. With their support, she successfully planted 350 black pepper plants, leading to an annual yield of 1.5 to 2 quintals of dry pepper, earning ₹75,000. Recognizing further opportunities, she started a pepper nursery, generating an additional ₹50,000–₹60,000 annually. This financial stability changed her life—she built a pucca house for her family and bought a scooter for her daughters, ensuring their safe commute to college. Usha's achievements didn't stop at personal success. Her expertise in black pepper cultivation earned her the position of Director of Rangsang Agro Producer Company Limited, where she now mentors farmers, helping them improve their livelihoods. Looking ahead, Usha plans to expand her nursery and cultivation while mentoring more women in her village, proving that agriculture, when supported by strong research and extension programs, can drive lasting community transformation.



Fig.19: Mrs. Usha Rabha in her farm field

The Project Coordinator (PC) and the scientists from the PC unit have actively monitored the trials conducted under the All India Coordinated Research Project on Spices (AICRPS). Monitoring activities included personal visits to experimental sites, virtual meetings, and regular communication through emails and phone calls. Monthly progress reports, budget utilization certificates, and other documents submitted by the centres were critically reviewed, and necessary guidance was provided to ensure improvements in trial execution and reporting.

Monitoring Activities:

- **In-Person Visits:** The PC and the team frequently visited various AICRPS centres to evaluate the implementation of trials on-site. These visits allowed for direct interaction with local scientists, ensuring timely resolution of challenges.
- **Virtual Reviews:** Online meetings were conducted regularly to assess progress, discussion made on ongoing issues, and provided technical advice. This facilitated continuous oversight even for remote centres.
- **Periodic Reports:** Centres submitted monthly, quarterly, half-yearly, and annual reports, which were carefully analyzed for compliance with the project objectives. Feedback was given for enhancing research outputs.
- **Annual Group Meeting:** The XXXIV Annual Group Meeting of AICRPS was held from October 30 to November 1, 2023, at the College of Horticulture, University of Horticulture (Campus), Bengaluru, Karnataka. This group meeting provided an opportunity to critically review the progress of all AICRPS centres, exchange research findings, and implement valuable suggestions for improvement.

Schedule of AICRP monitoring

During the 2023-24 following monitoring schedule is proposed

Period	Monitoring Team	Place of visit (AICRPS Centres)
08.06.2023	Dr.D.Prasath	Mandor, Rajasthan
14.07.2023 to 15.07.2023	Mr. Mukesh Sankar S	Monitoring of Cardamom, and Ginger trials undertaken by Appangala centre
15.07.2023 – 18.07.2023	Dr.D.Prasath	To attend ICAR Foundation Day and ICAR technology showcasing, New Delhi presented AICRP activities
20.07.2023	Dr.D.Prasath	Myladumpara, Kerala

Period	Monitoring Team	Place of visit (AICRPS Centres)
21.07.2023	Dr. D. Prasath	Pampadumpara, Kerala
09.08.2023	Dr. D. Prasath Mr. Mukesh Sankar. S	Panniyur, Kerala
13.09.2023	Dr. D. Prasath	Kahikuchi, Assam
14.09.2023	Dr. D. Prasath	Barapani, Meghalaya
09.10.2023	Dr. D. Prasath Dr. Shivakumar M.S. Mr. Mukesh Sankar	Monitoring & discussion with Centres involved in Black pepper, Cardamom, and Large cardamom trials (Virtual Mode)
10.10.2023	Dr. D. Prasath Mr. Mukesh Sankar. S. Dr. C.K. Thankamani Dr. Kandiannan Dr. Aarthi R	Monitoring & discussion with Centres involved in Ginger and Turmeric trials (Virtual Mode)
16.10.2023	Dr. D. Prasath Dr. M. Nisar Mr. Mukesh Sankar	Monitoring & discussion with Centres involved in Tree spices, Saffron, and Kalazerra trials (Virtual Mode)
19.10.2023 - 20.10.2023	Dr. D. Prasath Dr. M. Nisar Mr. Mukesh Sankar	Monitoring & discussion with Centres involved in Seed spices trials (Virtual Mode)
25.10.2023	Dr. D. Prasath Dr. K.S. Krishnamurthy Mr. Mukesh Sankar	Initial evaluation of Variety Identification Proposals, Transfer of Technology Proposals, and New Research Project proposals (Virtual Mode)
30.10.2023- 01.11.2023	AICRP on Spices Group meet	Annual review of AICRP trials undertaken by various centres, UHS Bengaluru
15.11.2023	Dr. D. Prasath Dr. Giridhar Kalidasu Dr. Tanuja Priya Mr. Mukesh Sankar	Monitoring and discussion with Centres involved in Crop Management trials of Seed Spices (Virtual Mode)
16.11.2023	Dr. D. Prasath Dr. Praveena R Dr. V. Srinivasan Mr. Mukesh Sankar	Monitoring & discussion with Centres involved in <i>Bacillus safensis</i> trial and Priming Experiment trials in Ginger and turmeric (Virtual Mode)
20.11.2023	Dr. D. Prasath	Visited to monitor the AICRP trials at TRS, Kammarpally
04.12.2023	Dr. D. Prasath	Visited to monitor the AICRP trials TNAU, Coimbatore
19.12.2023	Dr. D. Prasath Dr. V. Srinivasan Mr. Mukesh Sankar	Discussion on Crop Management Trials in Small Cardamom (Virtual Mode)
17.01.2024 - 19.01.2024	Dr. D. Prasath Mr. Mukesh Sankar. S	Monitoring of AICRP on Spices trials in Black pepper, Cardamom, and tree spices at ICAR-IISR, Kozhikode, and ICAR-IISR (RS), Appangala.

Period	Monitoring Team	Place of visit (AICRPS Centres)
25.02.2024 – 02.03.2024	Dr. D. Prasath	Attended III Phase QRT review at AICRPS, Jobner, Rajasthan on 28 th February, 2024
11.03.2024 – 13.03.2024	Dr. D. Prasath Mr. Mukesh Sankar. S	Organised III Phase QRT review at AICRPS, Guntur, Andhra Pradesh on 12 th March, 2024 to monitor R & E undertaken by Ginger and turmeric group.
11.03.2024 – 13.03.2024	Dr. D. Prasath	Monitoring meeting at Medziphema to monitor the AICRPS Activities undertaken for NEH development.

Seed spice monitoring

The seed spice monitoring team, constituted by Dr. Vinay Bhardwaj, Director, ICAR-NRC on Seed Spices (Chairman), Dr. D. Prasath, Project Coordinator, AICRP on Spices, and other esteemed members, undertook visits to various AICRP centers to monitor the ongoing research activities. On 19th February 2024, the team visited the Voluntary Centre for AICRP on Spices at ARS, Mandor, Rajasthan. During this visit, they assessed the progress of research under the AICRPS, particularly in the areas of crop improvement, crop production, and crop protection. On 28th February 2024, Dr. Bhardwaj and Dr. S. S. Meena, Principal Scientist at NRCSS, along with other QRT members, visited the research facility at SKN College of Agriculture, Jobner, Rajasthan, where CVT and IET experiments were conducted on cumin, coriander, fennel, fenugreek, and ajwain. The research was found to be progressing well in these areas. Additionally, on 20th February 2024, the monitoring team visited the Seed Spices Research Station at Anand Agricultural University, Sanand, and the Seed Spices Research Station at SDAU, Jagudan, where similar experiments were underway. These visits provided valuable insights into the current state of research in crop improvement, production, and protection under the AICRPS program, further strengthening the foundation of seed spice research in India.



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RESEARCH PAPERS

AICRPS Head quarters

Alagupalamuthirsolai, M., Suresh, R., Thankamani, C. K., Srinivasan, V., Sivaranjani, R., Krishnamurthy, K. S., Sarathambal, C., Gobu, R., Asangi, H., Akshitha, H. J., & Peeran, M. F. (2023). Application methodology and physiological insights of melatonin hormone for water stress alleviation in black pepper (*Piper nigrum* L.). *International Journal of Environment and Climate Change*, 13(8), 219–228.

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Mukesh Sankar. S., Bharathan, R., and D. Prasath (2023). Proceedings of XXXIV Annual Group Meeting, ICAR- All India Coordinated Research Project on Spices, 30 October - 01 November 2023, College of Horticulture, University of



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22 AWARDS & RECOGNITION

Best AICRP on Spices centre award (2022-23)

AICRP on Spices Centre at Sri Karan Narendra Agriculture University, Jobner, Rajasthan, secured the "Best AICRP Award-2023" during the XXXIVth Annual Group Meeting of ICAR-AICRP on Spices, held at the College of Horticulture, UHS, Bangalore, from October 30 to November 1, 2023. The award recognized the centre's contributions to developing high-yielding, disease-resistant, region-specific varieties of cumin, coriander, fennel, and fenugreek, as well as its advancements in sustainable agro-techniques.

Individual Achievements:

Scientists from Dr. Reena Nair belongs to Jabalpur Centre and Dr. Bashir belongs to Pampore centers received the "Excellence in Research Award- 2023" by the Agricultural Technology Development Society (ATDS), Gaziabad, UP during 6th International Conference on Strategies and Challenges in Agricultural and Life science for Food Security and sustainable Environment (SCALFE – 2023) during 28 – 30 April at Himachal Pradesh University, Summer Hill, Shimla, H.P.

Awards for Presentations and Publications:

- Dapoli Centre received the *Best Poster Presentation Award* for research papers on *Black Pepper-Based Mixed Cropping Systems and Management of Foot Rot and Slow Decline in Black Pepper*.
- Dapoli Centre, the center was also awarded the *Best Poster Presentation Award* for the paper titled "*Evaluation of Strobilurin Fungicide and Actinomycetes for the Management of Foot Rot and Slow Decline in Black Pepper*" during the *3rd International Conference on ICSTESP-2023*, held on *October 13-14, 2023, at Kozhikode, Kerala*.
- Ch. Pallavi Sri Padma, Tanuja Priya, B. Sailaja, V. Giridhar, K. Sudha Vani, and M. Sowmya (AICRPS-Guntur) received the "Best Oral Presentation" award for their paper titled "*Turmeric: A Spice Crop is Also a Root Vegetable*" at the *National Conference on Ethnic Vegetables*, organized by Dr. YSRHU-College of Horticulture, Anantharajupeta, held in hybrid mode on May 11-12, 2023.
- Dr. G.L. Kumawat and Dr. G.K. Mittal from the *Jobner Centre* received *Best Poster Presentation* awards at various conferences for their research on *Cumin and Coriander*.
- Pundibari center received "Outstanding paper presentation Award" at 5th regional Science and technology congress 2022-23
- The research paper on "*Identification, Characterization, and Evaluation of Antagonistic Potential of Different Fluorescent Pseudomonads*" received the

Outstanding Paper Presentation Award at the 5th Regional Science and Technology Congress 2022-23, organized by Cooch Behar Panchanan Barma University and the Department of Science and Technology and Biotechnology, Government of West Bengal, held on January 17-18, 2023, at Cooch Behar Panchanan Barma University.

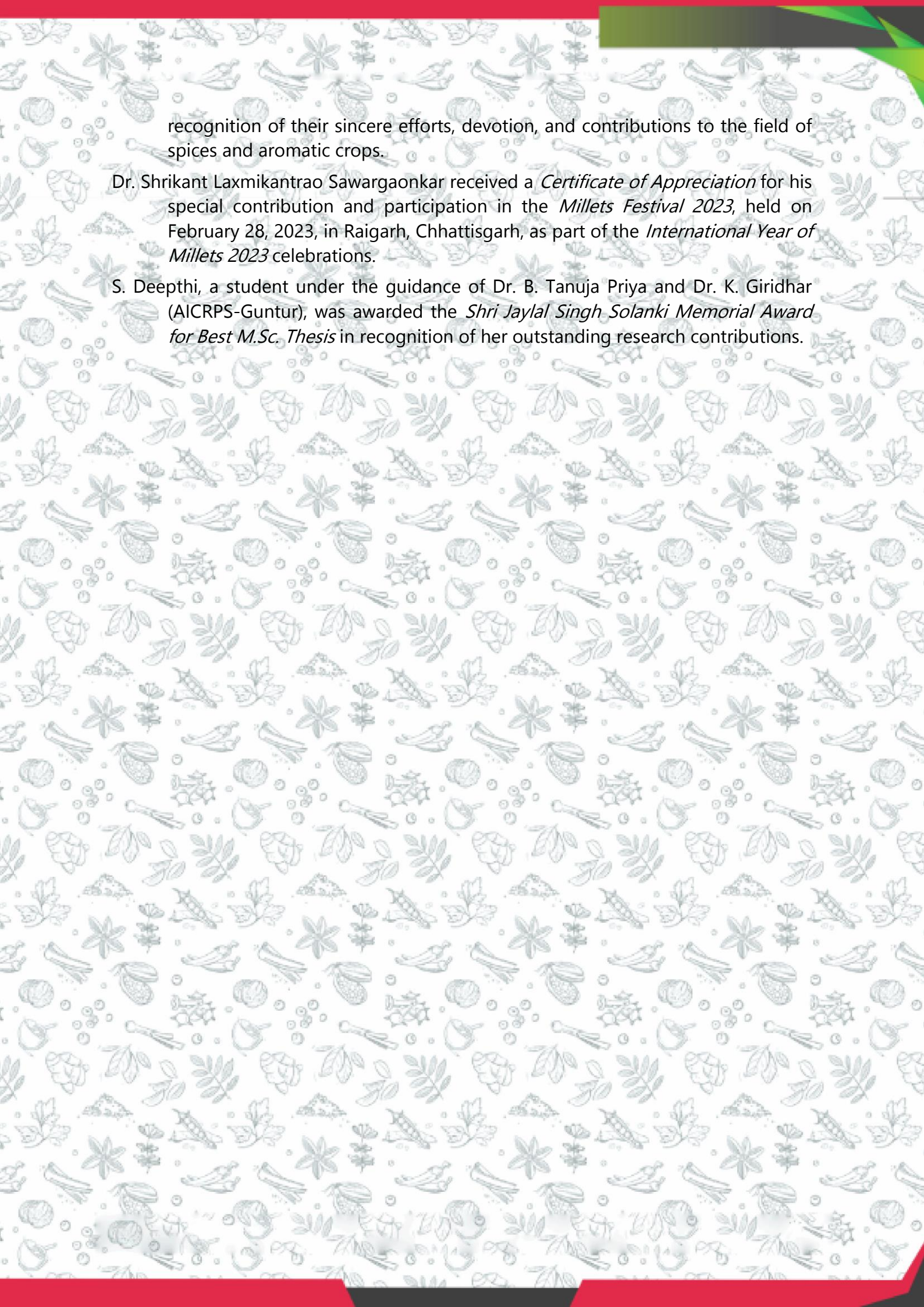
- Panniyur center received "Best poster presentation award" at the International Seminar on "Exotic and underutilised horticultural crops International Seminar on Exotic and Underutilized Horticultural Crops: Priorities & Emerging Trends October 17-19, 2023, Bengaluru, India
- Best poster presentation award paper entitled Black pepper based mixed cropping system for sustainable productivity and food security during 3rd International conference on ICSTESP-2023 held on 13-14 October, 2023 at Kozhikode, Kerala.
- Best poster presentation award for the poster entitled "Exploiting the wealth of underexploited flora of Wayanad district of Kerala for ornamental and landscape uses" authored by Mini Sankar, Sreelatha U, Anupama T .V. and Resmi Paul in the International Seminar on "Exotic and underutilised horticultural crops : Priorities and emerging trends" held during 17 – 19 October 2023 at ICAR – Indian Institute of Horticultural Research, Bengaluru.
- The paper titled "*Biological Control of Slow Decline and Production of Ecosafe Black Pepper*", authored by Mohammed Faisal Peeran, Ankegowda S.J., Biju C.N., Balaji Rajkumar M., Akshihta H.J., Shivakumar M.S., and Honnappa Asangi, received the *First Prize in Oral Presentation* at the *National Conference on Spices, Aromatic and Medicinal Plants for Economic Prosperity and Ecological Sustainability (SAMPEPES-2023)*, held at ICAR–Central Island Agricultural Research Institute, Port Blair, Andaman and Nicobar Islands, in 2022.
- The poster titled "*Exploiting the Wealth of Underexploited Flora of Wayanad District of Kerala for Ornamental and Landscape Uses*", authored by Mini Sankar, Sreelatha U, Anupama T.V., and Resmi Paul, received the *Best Poster Presentation Award* at the *International Seminar on Exotic and Underutilized Horticultural Crops: Priorities and Emerging Trends*, held from October 17–19, 2023, at ICAR–Indian Institute of Horticultural Research, Bengaluru.

Best Stall Recognition:

AICRP on Spices centre (Pottangi) exhibition stall secured the *Third Prize* in the *Regional Mechanisation Krushi Mela* for the *Best Spices Exhibition Stall*, held on December 30, 2023, at Jeypore Stadium Complex, Jeypore, Koraput.

Recognition

Dr. Shrikant Laxmikantrao Sawargaonkar and Dr. Ajit Kumar Singh, Raigarh, were honored with the *Vice Chancellor Appreciation Certificate* by Dr. Girish Chandel, Vice-Chancellor, IGKV, Raipur (C.G.), on March 14, 2023, in



recognition of their sincere efforts, devotion, and contributions to the field of spices and aromatic crops.

Dr. Shrikant Laxmikantrao Sawargaonkar received a *Certificate of Appreciation* for his special contribution and participation in the *Millets Festival 2023*, held on February 28, 2023, in Raigarh, Chhattisgarh, as part of the *International Year of Millets 2023* celebrations.

S. Deepthi, a student under the guidance of Dr. B. Tanuja Priya and Dr. K. Giridhar (AICRPS-Guntur), was awarded the *Shri Jaylal Singh Solanki Memorial Award for Best M.Sc. Thesis* in recognition of her outstanding research contributions.

PROJECT COORDINATORS OFFICE			
1.	Project Co-ordinator	:	Dr. D. Prasath
2.	Scientist (Plant Genetics)	:	Mr. Mukesh Sankar. S
3.	Chief Technical Officer	:	Mr. R. Bharathan
4.	Personal Assistant	:	Vacant
5.	Skilled Supporting Staff	:	Vacant
COORDINATING CENTRES			
1.	Cardamom Research Station, KAU, Pampadumpara		
1.	Jr. Horticulturist	:	Dr. Nimisha Mathews
2.	Laboratory Assistant	:	Mr. Anil Kumar
2.	Pepper Research Station, KAU, Panniyur		
1.	Horticulturist	:	Dr. Resmi Paul
		:	Dr. Sudha (03-07-2024 to till date)
2.	Jr. Pathologist	:	Dr. Sanju Balan (01-01-2024 to 31-12-2024)
3.	Lab Assistant	:	Mr. Mohanan P.V.
3.	Horticultural Research Station (UAHS), ZAHRS, Mudigere		
1.	Horticulturist	:	Dr. Sivaprasath
2.	Technical Assistant	:	Vacant
4.	Horticultural Research Station (UHS), Sirsi		
1.	Horticulturist	:	Mr. Sudheesh Kulkarni
2.	Jr. Pathologist	:	Dr. Kirankumar K.C.
3.	Technical Assistant	:	Mr. Laxman A. Padanad
5.	Horticultural Research Station (TNAU), Yercaud		
1.	Jr. Horticulturist	:	Dr. G. Malathi
2.	Lab Assistant	:	Mrs. K. Leela
6.	Department of Spices & Plantation Crops (TNAU), Coimbatore		
1.	Jr. Horticulturist	:	Dr. M. Mohanalakshmi
2.	Jr. Pathologist	:	Dr. S. Sundravadana
3.	Technical Assistant	:	Th. D. Gopalakrishnan
7.	Turmeric Research Station (SKLTSHU), Kammarpally		
1.	Jr. Pathologist	:	Dr. B. Mahender
2.	Jr. Horticulturist	:	Dr. P. Srinivas
3.	Technical Assistant	:	Mr. K. Vijaya Kumar
8.	Horticultural Research Station (Dr. YSR Horticultural University), Chintapalle		
1.	Horticulturist	:	Dr. V. Sivakumar (till 27-09-2024)
		:	Mrs. Chetti Bindhu (from 28-09-2024 till date)
2.	Technical Assistant	:	Vacant (Contract Basis)
9.	Horticultural Research Station (Dr. YSR Horticultural University), Guntur		
1.	Horticulturist	:	Dr. Ramireddy Nagalakshmi
2.	Breeder	:	Dr. Tanuja Priya
3.	Technical Assistant	:	Vacant
10.	Department of Vegetable Crops (Dr. YSPUHF), Solan		
1.	Jr. Pathologist	:	Dr. Meenu Gupta
2.	Technical Assistant	:	Mr. Surat Singh Negi
11.	High Altitude Research Station (OUAT), Pottangi		

	1.	Jr. Breeder	:	Dr. Parshuram Sial
	2.	Technical Assistant	:	Vacant
12.	Department of Genetics and Plant Breeding (SKNAU), Jobner			
	1.	Sr. Breeder	:	Dr. Shailesh Marker
	2.	Jr. Pathologist	:	Sh. G. L. Kumawat
	3.	Jr. Agronomist	:	Dr. A. C. Shivran
	4.	Jr. Technical Assistant	:	Sh. S. R. Kumawat
13.	Centre for Research on Seed Spices (SDAU), Jagudan			
	1.	Pathologist	:	Dr. N. R. Patel
	2.	Jr. Breeder	:	Dr. Surabhi S. Chauhan
	3.	Technical Assistant	:	Mrs. Rekha Chaudhari
14.	Department of Vegetable Crops, (CCS HAU), Hisar			
	1.	Pathologist	:	Dr. Suresh K. Tehlan
	2.	Horticulturist	:	Dr. Makhan Lal
15.	Department of Horticulture, Tirhut College of Agriculture (RAU), Dholi			
	1.	Jr. Horticulturist	:	Dr. C. Mukhim
	2.	Jr. Pathologist	:	Dr. A. K. Mishra
	3.	Technical Assistant	:	Sh. A. N. Mishra
16.	Department of Vegetable Science (NDUAT), Kumarganj			
	1.	Jr. Pathologist	:	Dr. Pradip Kumar
	2.	Horticulturist	:	Dr. D.K Upadhyay
	3.	Technical Assistant	:	Sh. R. K. Gupta
17.	Department of Horticulture (UBKV), Pundibari			
	1.	Horticulturist	:	Dr. Ram Krishna Sarkar
	2.	Pathologist	:	Dr. Anamika Debnath
	4.	Technical Assistant	:	Sh. Murari Krishna Roy
18.	Department of Horticulture (Dr. BSKKV), Dapoli			
	1.	Horticulturist	:	Dr. R. C.Gaibhiye
	2.	Jr. Breeder	:	Dr. A.V. Bhuwad
	3.	Technical Assistant	:	Shri. R. G. Nachare
19.	College of Agriculture and Research Station (IGKV), Raigarh			
	1.	Jr. Pathologist	:	Dr. Ajith Kumar Singh
	2.	Jr. Breeder	:	Dr. Shrikant Laxmikant Sawargaonkar
	3.	Technical Assistant	:	Mr. Mahendra Kumar Sahu (Joined on 01-09-2023)

21 Training & Capacity Building

Training and HRD Activities under gone by AICRPS Staffs

Sl. No.	Name of Staff	Details of Programme Attended	Duration	Venue	Organizers
1	Dr. A. C. Shivran	International Training	01.11.2023 - 15.11.2023	Tampere University, Tampere, Finland	World Bank sponsored ICAR-NAHEP-IDP, SKNAU, Jobner, Rajasthan, India
2	Dr. D. K. Gothwal	Visited Konkuk University, Seoul	10.08.2023 - 23.08.2023	Konkuk University, Seoul, South Korea	World Bank sponsored ICAR-NAHEP-IDP, SKNAU, Jobner, Rajasthan, India
3	P. Srinivas	Natural farming: Present Status and Future Prospects	21.08.2023 -	UAS, Dharwad	UAS, Dharwad
4	Dr. Resmi Paul	Faculty Development Programme on “Future Foods: Cutting-edge Technologies in Food Processing”	27.11.2023 - 02.12.2023	Thrissur, Kerala	College of Horticulture, Vellanikkara, Kerala Agricultural University
5	Punbibari Centre	“Emerging Problem & Recent Advances in Applied Sciences: Basic To Molecular Approaches”	26.02.2023 -	Meerut, UP	Astha Foundation
6	Dr. M. Senthilkumar, Dr. V. A. Sathiyamurthy	39 th CSM Horticulture	13.06.2023	-	Directorate of Research
7	Dr. M. Senthilkumar, Dr. V. A. Sathiyamurthy	NHB Training cum Awareness Programme on NHB Schemes	22.06.2023	-	Dean (Hort.)
8	Dr. M. Senthilkumar, Dr. V. A. Sathiyamurthy	FPO Linkage Programme	24.06.2023	-	Director, CARDS
9	Dr. M. Senthilkumar	KAVYADP Programme	21.07.2023	-	Dept. of Agriculture, Yercaud
10	Dr. M.	KAVYADP	02.08.2023, -	-	ATMA, Dept. of

	Senthilkumar	Programme and Joint Field Inspection by Scientist and Extension Worker	08.08.2023		Agriculture, Ayothiappattinam
11	Dr. M. Senthilkumar	KAVYADP Programme and Joint Field Inspection by Scientist and Extension Worker	02.08.2023	-	ATMA, Dept. of Agriculture, Yercaud
12	Dr. M. Senthilkumar	Block Level Farmers Advisory Council and Block Level Technology Team Meeting	14.08.2023	-	ATMA, Dept. of Agriculture, Ayothiappattinam
13	Dr. M. Senthilkumar	Block Level Farmers Advisory Council and Block Level Technology Team Meeting	23.08.2023	-	ATMA, Dept. of Agriculture, Yercaud
14	Dr. M. Senthilkumar	RPAC Meeting at TNAU, Coimbatore	24.08.2023	-	Director, CPPS, TNAU, Coimbatore
15	Dr. M. Kiruba	Evaluation and Action Planning Workshop on Sustainable Development Goals	22.09.2023	-	NGO-SEEDS
16	Dr. K. Sara Parwin Banu	Farmers' Grievances Day Meeting	22.09.2023	-	Department of Agriculture, Salem
17	Dr. P. Balasubramanian	AICRP – Spices XXXIV Annual Group Meet	30.10.2023	UHS, Bangalore	-
18	Dr. M. Senthilkumar	9th Naadalaviya Velan Ariviyal Tamil Research Conference	01.11.2023 16.12.2023	Offline	Velan Ariviyal Tamil Iyakkam, New Delhi
19	Nafeesa. M	Integrated Soil Nutrient and Rhizosphere Management	13.02.2023 15.02.2023	NIPHM	NIPHM
20	Nafeesa. M	Pesticide Application Technique and Safety Measures	03.07.2023 07.07.2023	NIPHM	NIPHM
21	Dr. Reena Nair	MOOC Course on Digital Teaching Techniques	01.10.2023 31.10.2023	NAARM Hyderabad	NAARM Hyderabad
22	Dr. Reena Nair	Advanced Statistical Techniques for Efficient Agricultural Experimentation	24.07.2023 31.07.2023	Department of Basic Sciences, Dr. YS Parmar University of	Department of Basic Sciences, Dr. YS Parmar University of Horticulture and

				Horticulture and Forestry, Nauni, Solan (HP)	Forestry, Nauni, Solan (HP)
23	Dr. Reena Nair	AgMOOCs - Eight-week Online Course on Integrated Pest Management (IPM)	11.07.2023 - 15.09.2023	NAARM Hyderabad	NAARM Hyderabad
24	Dr. Reena Nair	AgMOOCs - Six-week Online Course on Agricultural Statistics in Practice	11.07.2023 - 31.08.2023	NAARM Hyderabad	NAARM Hyderabad
25	Dr. Reena Nair	10-day Training Programme on “Entrepreneurship Development Among the Students on Innovative Technologies in Horticulture Production”	13.03.2023 - 22.03.2023	Department of Horticulture, College of Agriculture, JNKVV	NAHEP, CoAE, JNKVV, Jabalpur, MP
26	Dr. Meenu Gupta	Advanced Statistical Techniques for Efficient Agricultural Experimentation	24.07.2023 - 31.07.2023	Department of - Basic Sciences, Dr. YS Parmar University of Horticulture and Forestry, Nauni, Solan (HP)	

25 METEOROLOGICAL DATA

PAMPADUMPARA					PANNIYUR					
Month	Rain fall (mm)	No. of rainy days	Temperature (°C)		Rain fall (mm)	No. of rainy days	RH (%)	Temperature (°C)		
			Max.	Min.				Max.	Min.	
Jan-23	10.6	2	20.03	10.35	5	1	92.06	35.03	21.87	
Feb-23	14.4	2	21.01	11.32	-	-	92.11	37.26	22.99	
Mar-23	52	5	23.4	13.54	-	-	89.41	38.96	23.09	
Apr-23	47.4	8	24.96	15.2	9	1	93.23	39.41	25.78	
May-23	70.6	8	24.79	15.16	53.9	10	94.51	38.94	25.69	
June-23	70.8	12	23.1	13.51	378.5	20	96.77	34.07	25.49	
July-23	318.6	22	21.17	11.75	1149.1	31	98.74	30.66	25.25	
Aug-23	14	6	23.41	18.98	153.5	14	98.93	32.92	25.05	
Sep-23	164.8	21	22.8	20.4	461.6	22	98.53	31.72	25.24	
Oct-23	348.4	21	23.03	20.95	225.6	12	98.77	33.29	25.39	
Nov-23	308.4	20	22.56	21.05	152.3	9	98.83	33.81	25.23	
Dec-23	254	9	21.32	20.11	98	2	97.87	34.52	24.44	
MUDIGERE					PUNDIBARI					
Month	Rain fall (mm)	RH (%)		Temperature (°C)		Rain fall (mm)	RH (%)		Temperature (°C)	
		I	II	Max.	Min.		I	II	Max.	Min.
Jan-23	0.02	96.39	48.16	29.27	12.49	4.0	90.0	55.0	24.0	11.0
Feb-23	0	82.71	32.54	31.09	13.85	47.0	82.0	51.0	24.0	11.0
Mar-23	0	82.71	39.61	31.51	13.85	28.0	71.0	45.0	32.0	18.0
Apr-23	0.33	95.93	62.70	33.11	18.30	565.0	89.0	75.0	29.0	21.0
May-23	2.45	98	81.71	30.9	19.93	623.0	83.0	71.0	31.0	22.0
June-23	3.37	97.73	92.30	27.23	20.10	1266.0	94.0	86.0	30.0	23.0
July-23	17.84	99.45	96.77	24.08	19.92	426.3	86.0	73.0	34.0	24.0
Aug-23	1.97	99	89.84	26.76	19.02	450.0	88.0	76.0	33.0	23.0
Sep-23	8.35	99.57	93.43	25.54	19.59	242.0	89.0	77.0	32.0	22.0
Oct-23	3.10	98.19	82.90	28.94	18.94	218.6	82.0	69.0	31.0	18.0
Nov-23	1.62	93.27	76.73	29.10	18.96	0.0	71.0	51.0	30.0	11.0
Dec-23	1.02	96.23	68.77	28.67	17.19	0.0	84.0	52.0	27.0	8.0
GUNTUR						AMBALAVAYAL				
Month	Rain fall (mm)	No. of rainy days	RH (%)		Temperature (°C)		Rain fall (mm)	RH (%)	Temperature (°C)	
			I	II	Max.	Min.			Max.	Min.
Jan-23	0.00	0.00	70.27	0.00	30.70	17.82	5	82	14.1	27.4
Feb-23	0.00	0.00	99.93	58.79	34.20	19.21	0	82	15.9	30
Mar-23	22.00	2.00	99.33	59.70	34.25	22.08	110.5	72	18.1	30.8
Apr-23	24.50	2.00	98.07	43.47	38.03	25.77	108.3	76	19.3	30.5
May-23	81.90	7.00	97.57	52.90	38.48	28.12	179.4	78	19.9	29.4
June-23	102.40	10.00	89.40	38.13	40.43	28.92	146.6	84	19.5	27.4
July-23	265.80	14.00	98.53	75.23	32.33	26.30	610.7	91	19.3	24.3
Aug-23	96.20	5.00	98.19	56.26	34.71	26.63	64.2	83	18.6	26.7
Sep-23	232.60	8.00	98.53	64.03	33.37	25.70	197.3	89	19	25.9
Oct-23	17.40	1.00	97.68	59.77	34.10	24.56	141.6	84	18.6	27.1
Nov-23	30.60	3.00	98.73	73.03	31.50	23.00	149.1	84	18.5	27.3
Dec-23	185.60	2.00	99.23	70.45	29.55	19.84	30.6	85	17.5	26.9

POTTANGI					KUMARGANJ					
Month	Rain fall (mm)	No. of rainy days	Temperature (°C)		Rain fall (mm)	No. of rainy days	Temperature (°C)		RH (%)	
			Max.	Min.			Max.	Min.	I	II
Jan-23	0	0	30.6	13.5	4.4	2	18.2	7.1	90.6	66.3
Feb-23	0	0	32.2	13.9	00	00	27.1	9.7	90.4	65.4
Mar-23	127.7	5	33.0	19.1	16.4	2	30.6	14.9	89.9	59.4
Apr-23	148.1	8	35.4	22.1	44.6	2	36.2	19.2	89.4	49.2
May-23	101.3	7	36.7	22.9	68.2	6	36.5	22.2	87.9	45.7
June-23	176.6	11	36.2	25.0	81.6	6	37.6	25.2	87.9	48.3
July-23	193	17	28.3	23.5	188.2	11	33.8	26.6	93.7	67.6
Aug-23	110	10	29.9	23.0	242.8	11	33.2	25.9	93.9	69.3
Sep-23	387	16	29.7	23.1	222.0	10	33.7	24.9	91.9	65.2
Oct-23	2.0	1	32.5	19.9	11	2	32.0	18.7	88.2	57.4
Nov-23	6.0	1	31.3	18.3	2.4	1	30.1	14.0	87.1	55.5
Dec-23	171.0	3	27.8	13.3	2.0	1	23.5	9.5	88.0	55.0
DAPOLI						KAMMARPALI				
Month	Rain fall (mm)	Temperature (°C)		RH (%)		Rain fall (mm)	Temperature (°C)		RH (%)	
		Max.	Min.	I	II		Max.	Min.	I	II
Jan-23	0.00	30.38	12.76	93.45	52.19	0	0	0	0	0
Feb-23	0.00	34.69	13.16	86.64	40.43	0	0	0	0	0
Mar-23	2.80	33.16	16.75	85.58	48.84	24.8	34.0	19.9	88.1	43.5
Apr-23	0.60	32.35	19.80	84.57	56.63	26.4	37.3	22.4	82.4	45.1
May-23	36.20	32.98	22.22	82.13	63.68	102.4	39.4	24.1	73.9	39.0
June-23	580.80	32.20	24.03	85.83	70.57	67.9	38.8	26.4	72.9	45.3
July-23	2060.20	27.90	23.21	95.52	91.77	742.1	31.6	923.6	87.6	68.2
Aug-23	465.00	28.79	23.28	92.77	85.23	92.0	32.3	24.2	87.0	63.6
Sep-23	771.60	29.31	22.71	93.40	83.97	290.4	31.2	23.5	93.3	70.1
Oct-23	126.20	32.44	21.00	92.32	68.00	20.0	33.2	20.1	92.5	50.3
Nov-23	1.40	33.49	18.70	90.63	51.73	1.0	31.8	18.5	90.7	52.5
Dec-23	0.00	32.76	14.94	91.77	48.48	2.5	29.7	14.9	90.1	43.8
HISAR						PECHIPARAI				
Month	Rain fall (mm)	Temperature (°C)		RH (%)		Rain fall (mm)	No. of rainy days	Temperature (°C)		RH (%)
		Max.	Min.	I	II			Max.	Min.	
Jan-23	4.7	17.0	5.7	97	74	11.0	1	33.0	24.0	80.0
Feb-23	0	25.9	8.9	95	57	5.60	-	34.0	24.5	75.0
Mar-23	12.8	28.9	13.9	89	57	115.7	7	33.0	24.0	79.0
Apr-23	6.7	34.7	19.0	70	35	131.5	14	33.0	24.0	82.0
May-23	59.7	36.9	21.4	65	33	173.9	7	33.0	24.0	83.0
June-23	18.8	36.9	25.8	72	47	103.5	6	32.0	23.8	78.0
July-23	107.3	35.0	27.1	87	68	122.3	9	33.5	23.8	80.0
Aug-23	16.6	35.9	26.7	82	55	4.0	-	33.5	24.5	81.5
Sep-23	14.2	35.8	25.0	87	54	354.8	24	31.0	23.5	84.0
Oct-23	19.2	33.4	17.7	86	39	620.1	20	30.0	23.5	85.0
Nov-23	0	27.2	12.8	92	48	424.5	17	30.0	24.0	87.0
Dec-23	5.5	22.5	7.1	96	53	237.5	5	31.0	24.0	80.0

SIRSI						ICRI GANGTOK				
Month	Rain fall (mm)	No. of rainy days	Temperature (°C)		RH (%)	Rain fall (mm)	No. of rainy days	Temperature (°C)		
			Max.	Min.				Max.	Min.	
Jan-23	0.0	0	31.0	16.0	74	6.0	01.0	14.0	4.0	
Feb-23	0.0	0	34.0	16.0	79	89.0	11.0	13.0	6.0	
Mar-23	4.0	1	35.0	18.0	78	324.0	16.0	16.0	7.0	
Apr-23	0	0	37.0	22.0	84	453.0	19.0	21.0	8.0	
May-23	69.4	5	37.0	22.0	84	400.0	22.0	24.0	12.0	
June-23	144.8	9	33.0	23.0	87	887.0	22.0	25.0	15.0	
July-23	1170.6	28	28.0	22.0	95	733.0	28.0	21.0	16.0	
Aug-23	93.4	9	30.0	22.0	92	689.0	30.0	20.0	16.0	
Sep-23	170.0	15	30	22	95	327.0	19.0	20.0	15.0	
Oct-23	77.6	5	33	21	91	268.0	13.0	20.0	9.0	
Nov-23	14.8	1	31	21	88	3.0	1.0	17.0	8.0	
Dec-23	0.0	0	30	17	85	11.0	2.0	13.0	4.0	
MIZORAM						KAIKUCHI				
Month	Rain fall (mm)	Temperature (°C)		RH (%)		Rain fall (mm)	Temperature (°C)		RH (%)	
		Max.	Min.	I	II		Max.	Min.	I	II
Jan-23	0	22.9	12.9	83	63	10.3	20.35	9.2	70.0	67.0
Feb-23	0	25.5	15.2	82	55	6.7	24.7	10.3	69.3	64.0
Mar-23	72.5	28	17.7	74	57	16.2	29.5	13.2	70.9	63.0
Apr-23	206.1	30.4	19.9	65	56	153.3	31.3	18.5	78.0	70.1
May-23	111.4	29.7	20.9	78	67	197.8	33.7	22.3	80.7	73.5
June-23	326.5	29.6	22.5	89	78	287.3	34.2	23.7	83.1	77.5
July-23	343.6	29.8	23	90	81	290.7	34.7	26.9	88.4	80.2
Aug-23	357.9	28.5	23	92	84	193.5	36.3	28.7	89.3	81.4
Sep-23	385	29.9	22.8	92	81	133.7	35.9	28.9	88.5	82.3
Oct-23	112.1	28.3	20.8	95	83	69.3	35.3	26.9	83.5	80.3
Nov-23	110.8	26.3	17.6	92	74	25.0	32.7	20.8	80.7	74.6
Dec-23	72.6	23.2	15.3	87	72	9.7	24.2	11.3	78.9	72.1
COIMBATORE							SANAND			
Month	Rain fall (mm)	No. of rainy days	Temperature (°C)		RH (%)		Rain fall (mm)	No. of rainy days	Temperature (°C)	
			Max.	Min.	I	II			Max.	Min.
Jan-23	6.16	6	29.45	19.0	81.85	39.8	0	0	41.3	20.5
Feb-23	6.45	5	32.20	19.0	80.0	27.5	0	0	41.7	26.0
Mar-23	35.43	21	34.0	22.1	80.0	33.4	8	2	30.5	26.2
Apr-23	67.07	21	35.7	24.0	80.4	37.5	357	15	32.0	25.8
May-23	100.52	28	31.98	22.71	87.94	55.0	85	8	32.1	25.5
June-23	95.8	29	31.89	20.23	85.25	49.13	111	6	33.2	24.2
July-23	139.38	22	29.20	21.19	86.06	47.90	13	2	34.5	20.1
Aug-23	60.48	12	31.34	21.48	84.69	61.13	0	0	32.6	14.5
Sep-23	163.08	24	29.01	21.12	87.06	54.43	0	0	29.6	11.8
Oct-23	176.83	22	29.39	20.82	86.31	57.61	0	0	26.6	9.2
Nov-23	395.9	24	29.05	20.65	87.06	51.07	0	0	32.1	10.8
Dec-23	135.65	15	27.35	19.37	86.59	47.50	0	0	34.7	17.5

CHINTAPALLE							MYLADUMPARA		
Month	Rain fall (mm)	No. of rainy days	Temperature (°C)		RH (%)		Rain fall (mm)	Temperature (°C)	
			Max.	Min.	I	II		Max.	Min.
Jan-23	0.0	0.0	27.8	10.3	8.1	58.2	14.6	25.09	10.87
Feb-23	0.0	0.0	31.1	12.4	97.0	50.0	11.6	26.26	11.60
Mar-23	116.9	8.0	30.7	14.5	95.4	55.9	32.2	28.08	13.22
Apr-23	69.0	7.0	32.6	18.4	94.8	60.1	20.7	29.74	14.18
May-23	172.5	9.0	33.4	20.4	93.6	60.1	28.3	28.26	14.80
June-23	92.8	8.0	33.9	22.2	88.8	63.0	32.9	26.61	13.93
July-23	190.6	14.0	28.3	22.2	94.5	82.2	430.6	23.92	13.75
Aug-23	135.7	10.0	28.9	21.7	3.5	73.5	70.3	27.59	13.43
Sep-23	352.3	9.0	28.6	21.3	95.5	78.1	187.0	24.95	13.46
Oct-23	57.2	4.0	29.2	18.4	96.6	65.0	375.0	26.22	13.19
Nov-23	48.5	4.0	27.9	20.3	96.6	71.2	469.8	25.31	13.11
Dec-23	171.8	3.0	26.2	14.0	97.7	65.5	464.45	24.28	12.64
SAKALESHAPUR			YERCAUD		Solan				
Month	Rain fall (mm)	Rainy days	Rain fall (mm)	Rainy days	Rain fall (mm)	Temperature (°C)		RH (%)	
						Max.	Min.	I	II
Jan-23	-	-	-	-	39.20	18.75	2.85	61.24	
Feb-23	-	-	4.4	1	7.20	22.78	5.56	52.48	
Mar-23	20	1	68.4	5	130.6	23.58	8.04	63.77	
Apr-23	24	1	32.6	5	114.3	26.62	10.51	51.14	
May-23	187	9	128.8	10	15.4	27.9	13.2	65.0	
June-23	94	12	84.4	6	190.0	29.7	18.9	62.0	
July-23	1165	31	57.0	8	340.2	26.7	20.2	81.0	
Aug-23	166	10	145.0	9	216.6	27.6	20.0	79.0	
Sep-23	384	22	158.6	13	224.3	26.5	16.9	76.0	
Oct-23	387	7	56.6	6	26.0	25.1	9.1	53.0	
Nov-23	155	6	88.0	9	24.8	21.7	6.5	59.0	
Dec-23	86	2	30.4	6	21.6	18.1	1.6	58.0	

Centre	Salary	RC	TA (ONEH)	TA (NEH)	NEH	TSP RC	SCSP	ONEH Capita	Total released
Chintapalli (Dr YSRHU)	12.78	3.82	0.30			2.00			18.90
Coimbatore (TNAU)	55.00	8.00	0.35					2.62	65.97
Dapoli (KKV)	44.00	2.02							46.02
Dholi (RAU)		4.12	0.40					2.86	7.38
Guntur (Dr YSRHU)	45.00	1.97	0.50						47.47
Hisar (HAU)	49.00	5.42							54.42
Jagudan (SDAU)	32.03	3.35	0.19						35.57
Jobner (SKNAU)	36.44	6.43	0.91						43.77
Kammarpally	32.52	2.75	0.07						35.34
Kumarganj (ANDUAT)	30.50	2.95							33.45
Mudigere (UAHS)	25.00	0.50	0.05						25.55
Pampadumpara (KAU)	13.07	4.61	0.28				9.00	3.16	30.12
Panniyur (KAU)	30.51	5.50	0.40						36.41
Pottangi (OUAT)	27.00	2.81	0.30			2.00	2.00		34.11
Pundibari (UBKW)		2.50					2.00		4.50
Raigarh (IGKW)	5.00	5.98				1.00	1.00		12.98
Sirsi (UHS)	35.00	7.95	0.10						43.05
Solan (YSPUHF)	22.00	2.53							24.53
Yercaud (TNAU)	27.21	2.00	0.17			1.00			30.38
Ambalavayal (KAU)		1.95	0.15						2.10
Gangtok (ICRI)-NEH				0.60	7.10				7.70
Barapani-NEH					8.90				8.90
Gangtok-NEH					6.70				6.70
Mizoram-NEH				0.70	4.30				5.00
Jabalpur (JNKV)		2.50							2.50
Kahikuchi (AAU) NEH				0.60	8.80	1.00			10.40
Kalyani (BCKV)		2.08	0.20						2.28
Kanke (BIRSAU) -TSP		0.50	0.10						0.60
Kota		2.75	0.20						2.95
Mandor		2.15	0.30				4.00		6.45
Myladumpara (ICRI)		2.99	0.30						3.29
Nagaland (AU) NEH				0.80	9.10	2.00			11.90
Navasari (NAU)		2.38	0.26						2.64
Pantnagar (GBPUAT)		1.44	0.10						1.54
Pasighat (CAU)-NEH				0.60	5.10				5.70
Pechiparai (TNAU)		1.33	0.16			1.00			2.49
Sakleshpur (ICRI)		3.00	0.20						3.20
Sanand		2.30	0.20						2.50
SRS PAMPORE		2.48	0.40						2.88
Thrissur-KAU		2.35	0.20						2.55
RC AICRPS, Kozhikode		5.43						1.36	6.80
Refund to council	33.65	29.09							62.73
Total	555.7	139.91	6.79	3.3	50	10	18	10	793.7

* amount given here is Rs. in lakhs

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