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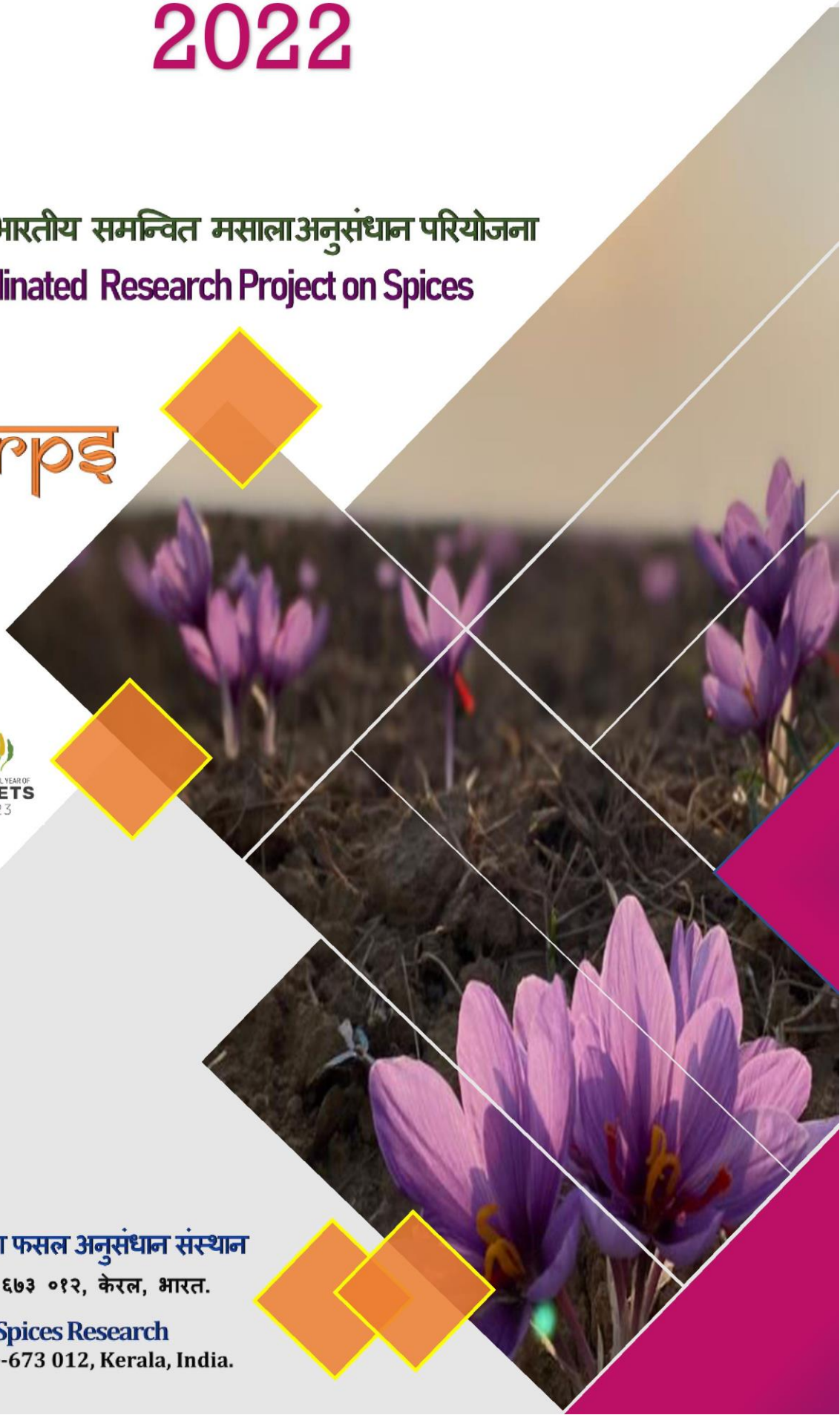
ANNUAL REPORT
2022

भा.कृ.अनु.प -अखिल भारतीय समन्वित मसालाअनुसंधान परियोजना
ICAR-All India Coordinated Research Project on Spices

icar aicrps



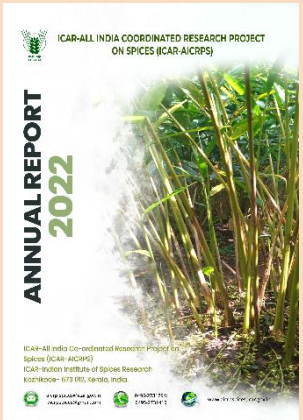
भा.कृ.अनु.प -भारतीय मसाला फसल अनुसंधान संस्थान
मरिकुन्नु पी. ओ, कोझिकोड - ६७३ ०१२, केरल, भारत.

ICAR- Indian Institute of Spices Research
Marikunnu P.O., Kozhikode-673 012, Kerala, India.

VARIETY IDENTIFIED FOR RELEASE DURING 33rd AICRPS ANNUAL GROUP MEETING

IISR Manushree (IC 349537)

About welcome page:



IISR-Manushree belongs to malabar type and was selected from germplasm collection (IC 349537) at ICAR-IISR Regional station, Appangala. The variety is moisture stress tolerant, with a stable yielding capacity of 550 kg dry capsules ha^{-1} under irrigated condition and 360 kg dry capsules ha^{-1} under moisture stress condition. Variety contains 8.74% essential oil (irrigated condition) and 8.84% essential oil (moisture stress condition), with 50% of the capsules having > 8 mm size. Essential oil components such α-terpinyl acetate and 1,8-cineole did not show significant variation between control and moisture stress conditions. The variety has been recommended for small cardamom growing tracts of Karnataka and Kerala.

ICAR-ALL INDIA COORDINATED RESEARCH PROJECT ON SPICES (ICAR-AICRPS)

ANNUAL REPORT 2022

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About cover page

"The Red Gold"- Saffron.

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कार्यकारी सारांश

मसालों पर आईसीएआर-एआईसीआरपी भारत में सबसे बड़ी मसाला अनुसंधान प्रणाली है, जो वर्तमान में 19 नियमित, 11 सहकारी, 8 स्वैच्छिक और 2 परियोजना मोड़ के केंद्रों के नेटवर्क के साथ 17 अधिदेश फसलों पर ध्यान केंद्रित कर रही है। मसालों पर एआईसीआरपी ने अपनी स्थापना की शुरूआत से वांछित कृषि संबंधी लक्षणों के साथ उच्च उपजवाली किस्मों, उत्पादन और उत्पादकता बढ़ाने के लिए प्रौद्योगिकियों और कीटों और रोगजनकों से निपटने के लिए प्रबंधन रणनीतियों को विकसित करके तथा फसल के नुकसान को काफी हद तक कम करने में महत्वपूर्ण योगदान दिया है।

शाब्दिक तौर पर देखें तो मसाले 'फसलों का मिश्रित थैला' है जिसमें पौधों के अलग अलग स्वभाव/कद और जीवन काल होता है, मांसल प्रकंद और शाकीय वार्षिक से लेकर चिरस्थायी वुडी आरोहक तथा पेडों तक, आकृति विज्ञान में भिन्न, उपयोगी भागों/उपयोगों और घटकों/सक्रिय घटकों में भारत के कृषि निर्यात में सामूहिक रूप से पर्याप्त योगदान होता है। उनमें से, एआईसीआरपीएस काली मिर्च, बड़ी इलायची, छोटी इलायची, अदरक, हल्दी, आम अदरक, दालचीनी, जायफल, लौंग, धनिया, जीरा, सौंफ, मेथी, अजवाइन, निगेल्ला, केसर और कालाजीरा पर अनुसंधान गतिविधियों का समन्वय करता है। मिर्च जैसी नई फसलों को इसके दायरे में लाने का प्रयास ज़ारी है, जो मसाला फसलों में सबसे बड़ी निर्यात अर्जक है। वर्ष 2022 के लिए एआईसीआरपीएस की वार्षिक बजट 965.71 लाख (परिषद का अंश भी शामिल है) रुपए थे।

नई पहल

धनिया और मेथी में अर्बुस्कुलार माइकोरैज़ल कवक (एएमएफ) और वृद्धि नियामकों का उपयोग करके सतत मसाला उत्पादन, अदरक में समन्वित किस्म परीक्षण और जीरा के ब्लाइट, मेथी के पाउडरी मिल्ड्यू और निगेल्ला के जड़ गलन के खिलाफ प्रबंधन परीक्षण के लिए नई अनुसंधान परियोजनाएं शुरू की गई हैं।

मसालों की पांच प्रजातियों जैसे, अदरक की प्रजाति आईआईएसआर वज्रा, हल्दी प्रजाति डॉ. वाइएसआरएचयु लाम स्वर्णा, अजवाइन प्रजाति डॉ. वाइएसआरएचयु लाम वर्षा और मेथी की दो प्रजातियां आरएमटी 354 और गुजरात मेथी-3 को बागवानी फसलों के फसल मानक, प्रजातियों की अधिसूचना और विमोचन के केंद्रीय उप समिति, नई दिल्ली की 29वीं बैठक के दौरान गज़ट अधिसूचना मिली।

एआईसीआरपीएस की तैंतीसवीं वार्षिक समूह बैठक में ज़ारी करने के लिए अनुशंसित प्रजातियाँ

भाकृअनुप-भारतीय मसाला फसल अनुसंधान संस्थान क्षेत्रीय स्टेशन, अप्पंगला, कोडगु, कर्नाटक से आईआईएसआर मनुश्री (अप्पंगला-3) नामक छोटी इलायची की बेहतर नमी तनाव सहिष्णु प्रजाति को 13-15 अक्तूबर 2022 को एएनडीयुएटी & टी, कुमारगंज, अयोध्या (उत्तर प्रदेश) में संपन्न एआईसीआरपीएस की तैंतीसवीं वार्षिक समूह बैठक में विमोचित करने के लिए संस्तुत की गई।

तनाव सहने वाली किस्म

आईआईएसआर मनुश्री मलबार प्रकार का है और आईसीएआर-आईआईएसआर क्षेत्रीय स्टेशन, अप्पंगला के जर्मप्लाज़म संग्रह (आईसी 349537) से चयन किया गया है। यह प्रजाति नमी तनाव सहिष्णु है और उसको सिंचित स्थिति के तहत 550 कि. ग्रा. शुष्क कैप्स्यूल /हेक्टर और नमी तनाव की स्थिति के तहत 360 कि. ग्रा. शुष्क कैप्स्यूल/हेक्टेयर की स्थिर उपज क्षमता होती है। इस प्रजाति में 8.74% एसन्शयल तेल (सिंचित स्थिति) और 8.84% एसन्शयल तेल (नमी तनाव की स्थिति में) होता है, जिसमें 50% कैप्स्यूल > 8 मि.मी. आकार के होते हैं। एसन्शयल तेल संघटक जैसे α-टेरपिनैल एसिटेट और 1-8 सिनियोल ने नियंत्रण और नमी तनाव की स्थिति में कोई महत्वपूर्ण अंतर नहीं दिखाया। कर्नाटक और केरल के छोटी इलायची उगाने वाले इलाकों के लिए इस प्रजाति की सिफारिश की गई है। (**चित्र 1**)

एआईसीआरपीएस की तैंतीसवीं वार्षिक समूह बैठक के दौरान अनुशंसित तकनीकें

आईसीएआर-एआईसीआरपीएस ने समूह बैठक को दौरान दो फसल उत्पादन और फसल सुरक्षा प्रौद्योगिकियों की सिफारिश की, जिसका सारांश नीचे दिया गया है।

चित्र 1: स्नाप शॉट ऑफ आईआईएसआर मनुश्री

एसकेएनएयु, जोबनर द्वारा जीरे में सूक्ष्म पोषक तत्व प्रबंधन

जीरे में, 3.96 उच्च लाभ लागत अनुपात के साथ उच्च उपज (685 कि. ग्रा./हेक्टर) प्राप्त करने के लिए ज़िंक, लोहा, मैंगनीस और बोरोन की आधी अनुशंसित खुराक को मिट्टी पर आवेदन के साथ पर्ण छिड़काव का प्रयोग करने की सिफारिश की जाती है।

एसकेएनएयु, जोबनर और आईसीएआर-एनआरसीएसएस, अजमेर द्वारा मेथी में ड्रिप सिंचाई अंतराल का मानकीकरण और सूक्ष्म पोषक फर्टिगेशन विधि

मेथी में उच्च उपज (जोबनर और अजमेर में क्रमश: 1802 और 2516 कि. ग्रा./हेक्टर) और उच्च आर्थिक लाभ (जोबनर और अजमेर में क्रमश: 2.22 और 2.34 का लाभ लागत अनुपात) के लिए सभी सूक्ष्म पोषक तत्वों के फर्टिगेशन के साथ चार दिनों के अंतराल में ड्रिप सिंचाई की सिफारिश की जाती है। जोबनर और अजमेर में चार दिनों के अंतराल पर ड्रिप सिंचाई से क्रमश: 7.93 और 8.98 कि. ग्रा. /हेक्टेयर –मि. मी. की जल उपयोग दक्षता प्राप्त की गई।

एसडीएयु, जगुदान द्वारा जीरे में एकीकृत कीट एवं रोग प्रबंधन

क्रेज़ोक्सिम मिथाइल 44.3 एस सी @ 0.044% के तीन छिड़काव (पहली छिड़काव रोग की शुरुआत पर और बाद में पहली छिड़काव के 15 दिनों के बाद छिड़काव करना) और थियामिथोक्सिाम 25 डब्ल्यु जी @ 0.0084% के दो छिड़काव (पहला छिड़काव एफिड़ का प्रकोप शुरू होने पर और दूसरा छिड़काव पहली छिड़काव के 10 दिनों के बाद) उच्च उपज, शुद्ध लाभ और कम झुलसा और एफिड़ घटना के साथ वृद्धिशील लाभ लागत अनुपात प्राप्त करने के लिए प्रभावी पाए गए।

अनुसंधान उपलब्धियां

काली मिर्च

एआईसीआरपीएस के अम्बलवयल, पन्नियूर, सिरसी, चिंतापल्ली, दापोली, पुंडिबारी, येरकॉड केंद्र काली मिर्च के आनुवंशिक संसाधन प्रबंधन पर काम करने के लिए अधिदेशित है। वर्तमान में काली मिर्च के कुल 690 अक्सेशनों (628 कल्टिवेटड प्रकार, 59 वन्य और संबंधित प्रकार और 3 विदेशी प्रकार) को एआईसीआरपीएस के विभिन्न केंद्रों में संरक्षित की जा रही है।

पीआरएस, पन्नियूर केंद्र में 2021-2022 काल में मूल्यांकन किए गए जर्मप्लाज़म अक्सेशनों में से पीआरएस 124 जीन प्रकार और पन्नियूर 5 (पीआरएस 116) उच्च उत्पादक थे। 4.50 कि. ग्रा. हरी बरी उपज और 982 स्पाइक्स/बेल के साथ पीआरएस 124 पहले स्थान पर रहा और इसके बाद 4.35 कि. ग्रा. हरी बरी उपज और 982 स्पाइक्स/बेल के साथ पन्नियूर 5 आता है। वर्ष 2022 के दौरान एआईसीआरपीएस केंद्र सिरसी में बनाए गए आरएमएच, सल्कानी नामक एक नये अक्सेशन को जर्मप्लाज़म अक्सेशनों में जोड़ा गया। काली मिर्च के किसानो की प्रजाति पर सीवीटी में 3 आशाजनक किसान प्रजातियों को राष्ट्रीय चैक पन्नियूर 1 के साथ 5 स्थानों में रूपात्मक, उपज और उपज के गुणों के लिए मूल्यांकन किया गया। विभिन्न उपज मापदंडों के लिए विभिन्न केंद्रों पर मूल्यांकन की गई काली मिर्च के किसानों की प्रजातियों के पूल्ड विश्लेषण में पन्नियूर-1 को स्पाइक की लंबाई, ताज़ा और प्रत्येक पौधे से प्राप्त सूखी बरियों तथा सूखी उपज की प्राप्ति से बेहत्तर जीनोटाइप के रूप में पता चला। लेकिन चैक पन्नियूर-1 की 43.84 की अपेक्षा कुम्बक्कल ने प्रति स्पाइक की बरियों की संख्या 50.09 के साथ श्रेष्टतम दिखाई। सतत उत्पादकता और खाद्य सुरक्षा सुनिश्चित करने के लिए काली मिर्च आधारित मिश्रित फसल प्रणाली परीक्षण में, अंतरफसलों में से याम की अधिकतम उपज 10.71 कि. ग्रा. अंकित की तत्पश्चात पन्नियूर में 4 मी. X 2 मी. के अंतराल पर एलिफन्ट फूट याम (8.0 कि. ग्रा.) आता है। अधिकतम बी:सी अनुपात काली मिर्च में एलिफन्ट फूट याम (1.81) के साथ काली मिर्च के अंतर फसल में देखा गया, तत्पश्चात सिरसी में कोलोकैसिया (1.49) के साथ काली मिर्च के अंतर फसल में देखा गया। दापोली में एलिफन्ट फूट याम ने उच्चतम उपज (11.43 कि. ग्रा/प्लॉट) अंकित की तत्पश्चात टपियोका (10.22 कि. ग्रा./प्लॉट। पन्नियूर के किसी भी परीक्षण प्लॉट के काली मिर्च बेलों के राइज़ोस्फियर मृदा में कवक रोगजनक जैसे फाइटोफ्थोरा या सूत्रकृमियों का प्रकोप नहीं देखा गया। हालांकि, ज़ड़ मीलीबग के साथ कवक रोगजनक फ्युसेरियम के आक्रमण से बेलों पर पीलापन दिखाई पड़ा। खाद्य सुरक्षा आश्वासन और मसालों में कीटनाशक अवशेषों को कम करने के अनुरूप, स्ट्रोबिल्यूरिन कवकनाशी और एक्टिनोमाइसीट्स का मूल्यांकन काली मिर्च में फूट रॉट के प्रबंधन और धीमीगति से गिरावट की शुरूआत की गई और सिरसी में प्रथम वर्ष (2020-21 में शुरूआत) के परिणाम के दौरान पता चला कि उपचार टी-3 एरगोन 44.3% (डब्ल्यु/बड्ल्यु) [क्रेसोक्सिम मीथाइल 500 ग्रा. /लि.] 7 मि. लि. /लि. का पत्तों पर प्रयोग और एरगोन 7 मि. लि. /लि.] + कार्बोसल्फान 1 मि. लि. / लि. @ 2-3 लि./बेल का मृदा प्रयोग करने से पत्तों पर आक्रमण सबसे कम (13.70), पतझड़ (14.58), पीलापन (23.75) और सूत्रकृमि संक्रमण (23.75) अंकित की गई।

छोटी इलायची

कुल 323 इलायची अक्सेशनों को वर्तमान में जीन बैंक में संरक्षित है, जिसमें 188 अक्सेशनें पाम्पाडुम्पारा में और 132 मुडिगेरे में हैं। पाम्पाडुम्पारा केंद्र में दो विशिष्ट संग्रह जैसे मिरकिल इलायची और एरुमतुरुतियिलेलम को इडुक्कि के अडिमाली, वंडिपेरियार क्षेत्र से जोड़ा गया। वर्ष 2021-22 के दौरान, नमी तनाव सहिष्णु इलायची जीन प्रकार, आईआईएसआर मनुश्री के विमोचन के साथ छोटी इलायची के सूखा सहनशीलता की सीवीटी समाप्त हुई। इलायची के किसानों की प्रजातियों पर सीवीटी के तहत मूल्यांकन करने पर छोटी इलायची की आठ किसान प्रजातियों के बीच महत्वपूर्ण अंतर थे। सकलेशपुर, मुडिगेरे, मैलाडुम्पारा और पांपाडुम्पारा में किसानों की प्रजातियों जैसे अर्जुन, वंडर इलायची, पनिकुलंगरा, तिरुताली, एलराजन, पच्चकाई, पाप्पलू, ज़ंल्लानी ग्रीन गोल्ड और पीएनएस गोपिनाथ को उनके वनस्पति और उपज गुणों के लिए मूल्यांकन किया गया। मैलाडुम्पारा में थ्रिप्स सहिष्णु इलायची प्रकारों के बहु-स्थानीय मूल्यांकन ने संकेत दिया कि छह जीन प्रकारों (आईसी 349362, आईसी 349364, आईसी 349370, आईसी 349606, ज़ंल्लानी ग्रीन गोल्ड और आईसीआरआई 8) में से जीन प्रकार आईसी 349606 में सबसे कम थ्रिप्स क्षति (1.4%) अंकित की गयी जबकि सक्लेशपुर में, ज़ंल्लानी ग्रीन गोल्ड में थ्रिप्स की संख्या अधिक थी और इसके बाद आईसी 349364 है। छोटी इलायची के पर्ण ब्लाइट सहनशील प्रकारों की छान-बीन करने के लिए किये गये एमएलटी में ज़ंल्लानी ग्रीन गोल्ड ने अप्पंगला और मैलाडुम्पारा में सबसे कम संक्रमण अंकित किया। छोटी इलायची की वृद्धि और उपज पर सूक्ष्म पोषक तत्वों के प्रभाव का मूल्यांकन करने के लिए पांच केंद्रों में तीन प्रजातियों पर संयुक्त रूप से किये गये परीक्षण ने निष्कर्ष निकाला कि सूक्ष्म पोषक तत्वों के छिड़काव ने छोटी इलायची में वृद्धि और उपज मापदंडों में

सुधार किया। इलायची के पर्ण ब्लाइट के प्रति रासायनिक उपचार (कार्बेंडाज़िम) की तुलना में जैवनियंत्रण कारकों (एकल या संयोजन में) के प्रभाव का मूल्यांकन करने पर सूचित किया कि T_2 (हेक्साकोनाज़ोल @ 2 मि.लि./लि) उपचार ने 21.66% पीडीआई के साथ निम्नतम रोग आपतन अंकित किया, तत्पश्चात T_1 (कार्बेंडाज़िम + मैंकोज़ेब @ 2 ग्रा. / लि.) और T_3 (मैंकोज़ेब @ 2 ग्रा. / लि.) है।

बड़ी इलायची

गांगटोक, सिक्किम के दो एआईसीआरपीएस केंद्रों में बड़ी इलायची के 64 जर्मप्लाज़म अक्सेशनों का रखरखाव किया जा रहा है। गैज़िंग जिले उत्तरी क्षेत्र के किसानों के खेत से दो विशिष्ट जर्मप्लाज़म अक्सेशनों का संग्रह किया गया। इन अक्सेशनों को बेहत्तर वृद्धि प्रदर्शन, इनसेक्ट कीट और रोगों (चिरके और फुरकी) के प्रति सहनशीलता के साथ आशाजनक पाया गया और उन्हें एआईसीआरपीएस के तहत आईसीआरआई के पांगथांग अनुसंधान फार्म में रोपण किया गया।

बडी इलायची की उपजता पर मल्चिंग के प्रभाव का मूल्यांकन करने के लिए किए गए प्रयोग ने संकेत दिया कि T1 (लीफ मौल्ड) के तहत पत्तियों की संख्या /सबसे लंबे टिलर और उत्पादक टिलर/क्लंप की संख्या काफी अधिक थी, जो T2 (ताज़ा लीफ टिल्लर) के बराबर थी। अपरिपक्व टिलर/क्लंप की अधिकतम संख्या और टिल्लर /क्लंप की कुल संख्या T1 के तहत अंकित की गयी जो अन्य उपचारों की तुलना में काफी अधिक थी। अन्य उपचारों की तुलना में T1 (यद्यपि T2 के बराबर थी) के तहत काफी अधिक सूखी कैप्स्यूल उपज प्राप्त हुई थी।

अदरक

विभिन्न कृषि जलवायु क्षेत्रों में स्थित धोली, कुमारगंज, पुंडिबारी, बारापानी, पोट्टांगी, राइगढ़ और सोलन केंद्रों में अदरक जर्मप्लाज़म के संग्रह, लक्षण वर्णन, मूल्यांकन और संरक्षण गतिविधियां की जा रही है। इन एआईसीआरपीएस केंद्रों द्वारा संयुक्त रूप से कुल 514 अक्सेशनों का संरक्षण किया जा रहा है। अदरक में रोग सहिष्णुता परीक्षण पर सीवीटी में, 8 स्थानों में रूपात्मक, उपज और उपज के गुणों के लिए 10 आशाजनक जीनोटाइप्स का मूल्यांकन किया गया। वेरियन्स के विश्लेषण से 10 जीनोटाइप्सों में प्रकंद उपज और उपज के गुणों में महत्वपूर्ण अंतर देखा गया। औसत ताज़ा प्रकंद उपज में 11.1 से 14.2 टन/हेक्टर का अंतर है और उच्चतम उपज वीआईई 4-1 (14.2 टन/हेक्टर) में देखा गया तत्पश्चात आर 1.25/4 (14.1 टन/हेक्टर) जो संख्यात्मक दृष्टि से राष्ट्रीय चैक, आईआईएसआर वरदा (13.7 टन/हेक्टर) से अधिक थी। राष्ट्रीय चैक, आईआईएसआर वरदा (पीडीआई =18.4) की तुलना में छह परीक्षण जीनोटाइप्स जैसे, आर 1.25/4, जी1.00/4, एचपी 05/15, एचपी 0.5/2 ने कम औसत मृदु गलन स्कोर अंकित किया, जिनमें से एचपी 05/15 (औसत पीडीआई = 14.6%) और आर 1.25/4 (औसत पीडीआई = 15.0%) को सहनशील जीनोटाइप्स (पीडीआई 6.0 से 15.0 के बीच) के रूप में चुना गया। जीनोटाइप जी 1.00/4, वी1ई4-1, वी1ई4-5, एचपी 0.5/2, आईआईएसआर वरदा (चैक), वी 0.5/2 और इंदिरा अदरक को मध्यम सहिष्णु जीनोटाइप्स (औसत पीडीआई स्कोर 16.0 से 25.0% के साथ) के तहत समूह बद्ध किया गया था।

सब्जी उद्देश्य के लिए अदरक के जीनोटाइप्स के मूल्यांकन पर सीवीटी परीक्षण 2018-19 में 7 एआईसीआरपीएस केंद्रों में आठ बोल्ड अदरक कल्टिवर के साथ शुरू किया गया था। खारिफ के दौरान वर्ष 2021-22 में ताज़ा प्रकंद उपज में 12.3 से 15.2 टन/हेक्टर तक अंतर थे। जॉन के अदरक में उच्चतम उपज (15.2 टन/हेक्टर) देखा गया तत्पश्चात पीजी-121 (14.2 टन/हेक्टर) है। स्थान वार औसत ताज़ा प्रकंद उपज में 10.5 टन/हेक्टर (सिक्किम) से 14.2 टन/हेक्टर (पोट्टांगी) तक का अंतर है। अदरक की विभिन्न अंतर-फसल प्रणालियों में, पोट्टांगी के परिणामों ने संकेत दिया कि अदरक में अंतर फसल के रूप में अधिकतम (रुपए 480/बेड) धनिया में था तत्पश्चात जावित्री (रुपए 200/-) में। मिज़ोरम में, अदरक के साथ सभी अंतर फसल संयोजनों को प्रभावी देखा गया और अदरक-मेथी अंतर फसल को छोड़कर बाकी सब में उच्च उत्पादकता प्रणाली प्राप्त हुई।

हल्दी

एआईसीआरपीएस के विभिन्न केंद्रों में हल्दी के 1820 अक्सेशनों और उसके वन्य संबंधितों का रखरखाव किया जा रहा है। आम अदरक पर सीवीटी करने पर, 8 स्थानों में रूपात्मक, उपज और उपज के गुणों के लिए 10 आशाजनक जीनोटाइप का मूल्यांकन किया गया। वैरियन्स के विश्लेषण से प्रकंद उपज और उपज के गुणों की दृष्टि से 10 प्रविष्टियों में महत्वपूर्ण अंतर देखा गया।

परीक्षण स्थल के अनुसार औसत ताज़ा प्रकंद उपज में 22.2 टन/हेक्टर (अम्बा) से 31.1 टन/हेक्टर (अक्से. 347) तक का अंतर अंकित किया। सभी नौ परीक्षण प्रविष्टियों ने संख्यात्मक रूप से चैक, अंबा से अधिक उपज श्रेष्ठता दिखाई । अक्से. 347 ने औसत ताज़ा प्रकंद उपज (31.1 टन/हेक्टर) में पहले स्थान पर रही, इसके बाद सीएएम-3 (28.6 टन/हेक्टर) और एनवीएमजी 2 (28.2 टन/हेक्टर) है। उच्च उपज और उच्च कुरकुमिन हल्दी (2019-20 में शुरु किये) पर सीवीटी करने पर 11 आशाजनक जीनोटाइप का 9 स्थानों में रूपात्मक, उपज और गुणवत्ता लक्षणों के लिए मूल्यांकन किया गया। परीक्षण स्थानों में औसत ताज़ा प्रकंद उपज में 17.6 टन/हेक्टर (आरआरएन 1) से 26.7 टन/हेक्टर (एनवीएसटी 56) का अंतर अंकित किया गया। आठ परीक्षण प्रविष्टियों में से, दो प्रविष्टियों ने संख्यात्मक रूप से सर्वश्रेष्ठ प्रदर्शन करने वाले जांच, आईआईएसआर प्रगति से अधिक श्रेष्ठता दिखाई। प्रविष्टि एनवीएसटी 56 ने औसत ताज़ा प्रकंद उपज (26.7 टन/हेक्टर) में पहले स्थान पर रही, तत्पश्चात आईटी 26 (26.3 टन/हेक्टर) रही, जबकि सर्वश्रेष्ठ चैक प्रविष्टि, आईआईएसआर प्रगति ने औसत ताज़ा प्रकंद उपज 26.2 टन/हेक्टर) अंकित की। विशिष्ट बाज़ार के लिए हल्के पीले रंग की हल्दी पर सीवीटी किया, जिसका उद्देश्य हल्के पीले रंग की हल्दी उत्पादन के लिए उपयुक्त हल्दी जीनोटाइप की पहचान करना है। परीक्षण के दूसरे वर्ष, 11 परीक्षण प्रविष्टियों में से, दो प्रविष्टियों, अक्से. 849 (33.7टन/हेक्टर) और पीटीएस 50 (28.5 टन/हेक्टर) ने सर्वश्रेष्ठ प्रदर्शन करने वाली चेक प्रविष्टि, आईआईएसआर प्रतिभा को पीछे छोड़ दिया।

ट्राइकोप्राइम (मेटालक्सिल-मैंकोज़ेब और इमिडाक्लोप्रिड, टेबुकोनाज़ोल इमिडाक्लोप्रिड का संयोजन) को अंकुरण वृद्धि, ओज और भंडारण सडांध दमन के लिए अनुशंसित पीओपी के साथ प्राइमिंग प्रकंदों की प्रभावकारिता का मूल्यांकन करने के लिए एक पौध संरक्षण प्रयोग शुरू किया गया था। औसत साफ उपज (14 स्थानों) में T4 में 25.84 से T_1 में 28.82 टन/हेक्टर का अंतर है। खरीफ 2021-22 काल में ट्राइकोप्राइम (T_1) के साथ राइज़ोम का उपचार 14 केंद्रों में से 9 केंद्रों में सबसे श्रेष्ठ उपचार बन गयी, जबकि इमिडाक्लोप्रिड (T_3) 14 केंद्रों में से 3 केंद्रों में सबसे श्रेष्ठ उपचार बन गयी। हल्दी में प्ररोह बेधक के लिए प्रभावी कीटनाशक के अनुसूचित छिड़काव को मानकीकृत करने के लिए पौध संरक्षण के अन्य उपचार में औसत साफ उपज में 25.27 टन/हेक्टर से 19.5 टन/हेक्टर (नियंत्रण-जल छिड़काव) का अंतर देख लिया। आठ केंद्रों में से 2 केंद्रों में क्लोरान्ट्रानिलिप्रोल @ 0.5 मि.लि/लि. (टी2) का छिड़काव सबसे श्रेष्ठ उपचार बन गयी। हल्दी में प्रकंद गलन और सूत्रकृमियों का प्रबंधन करने के लिए ट्राइकोडरमा अस्परेल्लुम & पोचोणिया क्लामिडोस्पोरिया के प्रभाव को समझने के लिए अन्य परीक्षण में, टी. अस्परेल्लुम टाल्क संयोजन में औसत साफ प्रकंद उपज में 27.2 टन/हेक्टर से 33.17 टन/हेक्टर का अंतर नियंत्रण में देखा गया जो 5 स्थानों में से 3 में सबसे श्रेष्ठ उपचार के स्थान पर रही है।

वृक्ष मसाले

पेचिपराई में संरक्षित और मूल्यांकित अक्सेशनों में से एम एफ-4 में फलों की अधिकतम संख्या (685.40) अंकित की गई और एकल फल वज़न भी एम एफ-4 में सबसे अधिक (53.55 ग्रा.) थी, और प्रति पेड़ जावित्री की उपज 288.89 ग्रा./पेड़ अंकित किया। जबकि स्थानीय चैक ने 499 फल/पेड़ अंकित किया, एकल फल वज़न (50.3ग्रा.) और जावित्री उपज 163.22ग्रा./पेड़ है। दापोली में मूल्यांकित 16 जायफल अक्सेशनों (1996-97 में लगाए गए) में से, औसत फल वज़न 2021-22 में 42.1 और 76.9 ग्रा. के बीच अंकित किया। अक्सेशन डीबीएसकेकेवी 9772 ने अधिकतम फल (710) अंकित किया, उच्चतम औसत फल वज़न (76.9 ग्रा.) उच्च शुष्क फल उपज (6.3 कि. ग्रा.) के साथ और शुष्क जावित्री उपज (1.7 कि. ग्रा.) है। समग्र प्रदर्शन से डीबीएसकेकेवी एमएफ 9772 के जीनोटाइप को इसके फल उपज मापदंडों पर विचार करते हुए आशाजनक पाया गया।

दापोली में 1996-97 के दौरान लगाए गए लौंग के जर्मप्लासम में चार आशाजनक जीनोटाइप का चयन किया गया। पौधों की ऊंचाई में 6.42 से 7.85 मी. व्यास में 56.12 से 65.22 से. मी. तथा फैलाव में 2.87 से 3.92 मी. तक का अंतर है। वर्ष 2021-22 में कोई पुष्पन नहीं देखा गया। इन विकास मापदंडों का ध्यान में रखते हुए जीनोटाइप डीबीएसकेकेवीएसए-1 को अन्य जीनोटाइप से बेहतर पाया गया। पीचिपराई में 24 अक्सेशनों में से, स्थानीय चेक (11.06 मी.) की तुलना में, एसए-1 में वृक्षों की उच्चतम ऊंचाई 13.44 मी. अंकित की, इसके बाद एसए-3 (12.59 मी.) है। अक्सेशन एस ए-3 अन्य अक्सेशनों से काफी बेहतर था और उच्चतम तने का व्यास (52.19 से. मी.), पत्ती की लंबाई (12.89 से. मी.), पत्ती की चौड़ाई (7.71 से. मी.) और शाखाओं की संख्या (20.00) अंकित की गई। 24 अक्सेशनों में से एसए 3 को सर्वश्रेष्ठ प्रदर्शनकर्ता के रूप में पहचान किया था सूखी कली की उपज 1.73 कि. ग्रा./वृक्ष थी जबकि स्थानीय जांच में 0.53 कि. ग्रा./वृक्ष अंकित किया गया था।

धनिया

एआईसीआरपीएस के विभिन्न केंद्रों में कुल 2494 धनिया जर्मप्लासम अक्सेशनों का रखरखाव किया जा रहा है। जोबनर में बनाए गए जर्मप्लासम से बेतरतीब ढ़ंग से अठारह जीनोटाइप का चयन किया गया था जो सूखा सहन की छान बीन करने के लिए सिंचित और सूखा प्रेरित स्थितियों के तहत बोया था। जाच किये जीनोटाइप में से UD-808, RCr-436, UD-630, DD-629, RCr-684, UD-607 और RCr-475 में अधिकतम सूखा सहन करने वाले लक्षण पाए गए। धनिया पर CVT में (2020-21 में शुरू किये) 14 स्थानों में रूपात्मक, उपज और उपज के गुणों के लिए 13 आशाजनक जीनोटाइप का मूल्यांकन किया गया। वैरियन्ट का विश्लेषण करने पर बीज की उपज और उपज के गुणों की दृष्टि से 13 जीनोटाइप में महत्वपूर्ण अंतर देखा गया। औसत बीज उपज में 11.6 से 15.4 क्विंटल/हेक्टर का अंतर था। पांच जीनोटाइप जैसे COR-198 (15.4 क्विंटल/हेक्टर), COR-200 (14.96 क्विंटल/हेक्टर), COR-197 (14.8 क्विंटल/हेक्टर), COR-199 (14.66 क्विंटल/हेक्टर), और COR-201 (14.8 क्विंटल/हेक्टर) ने सर्वश्रेष्ठ चेक COR-205 (14.06 क्विंटल/हेक्टर) की तुलना में स्ख्यात्मक रूप से उच्च बीज उपज अंकित की। COR-194 सबसे जल्दी अर्थात् 58 दिनों में खिलता है जबकि COR-196 देर से (66.8 दिन) खिलता है, जैसे कि 50% फूल आने के दिनों से संकेत मिलता है। पौधे की ऊंचाई में 73.9 से 103 से. मी. अंतर है, प्रति पौधे की प्राथमिक शाखाओं में 5.2 से 6.5 तक अंतर है, द्वितीयक शाखाओं में 10.1 से 14.7, प्रति पौधा 36.1 से 45.8 तक अमबल्स, प्रति अमबल्स में 5.3 से 6.0 तक अमबलट्स होते हैं। COR-194 (14.6g) में टेस्ट वैट अधिक था जबकि निम्नतम टेस्ट वैट COR-206 (10.0g) में अंकित किया। जोबनर में, बाष्पशील तेल सामग्री के लिए धनिया सीवीटी जीनोटाइप का भी विश्लेषण किया गया जो 0.41% से 0.65% तक था। COR-200 में बाष्पशील तेल की अधिकतम मात्रा 0.65% देखा गया, इसके बाद 0.64% COR-199 में 0.58% COR-194 और COR-203 में है, जबकि न्यूनतम 0.41% COR-195, COR-202 & COR-205 में अंकित किया। COR-198 बाष्पशील तेल उपज (8.84 लि./हेक्टर) में पहले स्थान पर आता है, उसके बाद COR-197 (8.32 लि./हेक्टर), COR-194 (7.42 लि./हेक्टर) और COR-199 (7.07 लि./हेक्टर), जबकि सबसे कम बाष्पशील तेल उपज 3.41 लि./हेक्टर COR-202 में अंकित किया गया था। पांच स्थानों पर धनिया के 22 जीनोटाइप की स्टम गाल रोग के प्रति जांच की गई, उनमें से कोई भी स्टम गाल रोग के प्रति प्रतिरोधी /रोगमुक्त नहीं पाया गया, हालांकि COR-174, COR-175, COR-178, COR-179 और COR-188 को मध्यम प्रतिरोधी पाया गया।

जीरा

एआईसीआरपीएस के विभिन्न केंद्रों में जीरा के कुल 1700 जर्मप्लासम अक्सेशनों का रखरखाव किया जा रहा है। दो वातावरण, जैसे सिंचित और सूखा प्रेरित प्लॉट में बोये गये विभिन्न केंद्रों में बनाये गये जर्मप्लासम से बेतरतीब ढ़ंग से चुने गये अठारह जीनोटाइप की छान बीन की गयी, जो सूखे की स्थिति के तहत अच्छी प्रतिक्रिया दिखायी। सूखा सहिष्णुता सूचकांक के आधार पर, UC-258, RZ-345, UC-298, RZ-345, UC-228 और RZ-209 में नमी तनाव पर्यावरण के खिलाफ अधिकतम सहनशीलता थी। सौंफ पर सीवीटी में (2022-22 के दौरान शुरू) 5 स्थानों में रूपात्मक, उपज और उपज के गुणों के लिए 13 आशाजनक जीनोटाइप् का मूल्यांकन किया गया था। विश्लेषण से बीज की उपज और उपज के गुणों के लिए 13 प्रविष्टियों के बीच महत्वपूर्ण अंतर का पता चला। परीक्षण प्रविष्टियों की औसत बीज उपज में 1.92 से 5.92 क्विंटल /हेक्टर का अंतर था। दो प्रविष्टियां जैसे, CUM-47 (5.92 क्विंटल /हेक्टर) और CUM-45 (5.92 क्विंटल /हेक्टर) ने लगभग 17% सर्वोत्तम चेक CUM-55 (5.05 क्विंटल /हेक्टर) की तुलना में बेहतर बीज उपज अंकित की। वैरियन्स के विश्लेषण से मूल्यांकित 13 प्रविष्टियों के बीच बीज उपज और उपज के गुणों के लिए प्रविष्टियों के बीच महत्वपूर्ण अंतर देख लिया। परीक्षण प्रविष्टियों में से CUM-44 पहले पुष्पन (48 दिन) जीनोटाइप था जबकि CUM-52 का पुष्पन बहुत देर से (66.9 दिन) हुआ। इसके अलावा, परिपक्वता के दिनों में 106.0 से 124.7 से. मी. पौधे की ऊंचाई 32.4 से 40.5 से. मी., प्रति पौधे की शाखाओं की संख्या में 5.7 से 6.8, प्रति पौधे के अमबल्स में 40.4 से 72.6, प्रति अमबल्स के अमबलट्स में 4.4 से 5.4 अंतर है। प्रविष्टि CUM-47 और 48 (5.2g) के लिए टेस्ट वैट अधिक था, जबकि न्यूनतम प्रविष्टि CUM-53 (4.6g) में देखा गया। जगुदान, जोबनर और आनंद में सीवीटी के तहत बारह प्रविष्टियों की बाष्पशील तेल सामग्री के विश्लेषण से बाष्पशील तेल (%) की प्रविष्टियों के बीच महत्वपूर्ण अंतर का पता चला। बाष्पशील तेल की अधिकतम मात्रा 5.39% CUM-50 में देखा गया, इसके बाद CUM-54 में 5.21%. जबकि CUM-52 में न्यूनतम 4.25% अंकित किया। जोबनर से प्राप्त आंकडों से संकेत मिलता है कि CUM-45 बाष्पशील तेल उपज (31.77 लि. /हेक्टर) की दृष्टि से पहले स्थान पर है। वर्ष 2021-22 के दौरान जगुदान में पाउडरी मिल्ड्यू रोग के प्रति प्रतिरोधकता के लिए कुल 32 (30+2) प्रविष्टियों की जांच की गयी। इसमें न्यूनतम रोग तीव्रता JCM 104 (7.50%) में देख लिया, जबकि

अधिकतम रोग तीव्रता प्रविष्टि JC 21-04 (28.25%) में अंकित किया। पाउडरी मिल्ड्यू आपतन का अंतर 7.50 से 28.25% है। जगुदान में ब्लाइट रोग के प्रति जांच किये 27 प्रविष्टियों में से न्यूनतम रोग तीव्रता JC-18-01 (20.3 %) में देख लिया, जबकि अधिकतम रोग तीव्रता प्रविष्टि CUM-43 (42.3 %) में अंकित किया। जगुदान में मुरझान रोग के प्रति मुरझान रोग बाधित प्लॉट में दो सौ ग्यारह (208+3) प्रविष्टियों की जांच की गई। मुरझान की कुल तीव्रता अधिक थी। न्यूनतम रोग तीव्रता GC 3 (40.25%) में देख लिया, उसके बाद GC 5 (42.50%) है, जबकि अधिकतम रोग तीव्रता (100%) 179 प्रविष्टियों में अंकित किया। मुरझान रोग की तीव्रता में 40.25 से 100% अंतर है। इसके अलावा, जोबनर में, जीरे की 82 जर्मप्लासम प्रविष्टियों को झुलसा और मुरझान रोग के प्रति जांच की गई। तेरह प्रविष्टियों ने झुलसा रोग के प्रति मध्यम प्रतिरोध प्रतिक्रिया दिखा दी और ग्यारह प्रविष्टियों ने मुरझान रोग के प्रति न्यूनतम आपतन दिखाया और बाकी प्रविष्टियों ने मुरझान और झुलसा रोग के प्रति संवेदनशील और अति संवेदनशील प्रतिक्रिया दिखा दी। वर्ष 2019-20 के दौरान जीरे में सूक्ष्म पोषक प्रबंधन शुरू किये परीक्षण निम्न लिखित सिफारिशों के साथ समाप्त हुआ:- जीरे की अधिक उपज प्राप्त करने के लिए ज़िंक, आयरन, मैंगनीज़ और बोरोन की आधी अनुशंसित खुराक का मिट्टी में प्रयोग के साथ पत्तियों पर छिड़काव करने की सिफारिश की गई।

सौंफ

एआईसीआरपीएस के विभिन्न केंद्रों में सौंफ की कुल 862 जर्मप्लासम अक्सेशनों का रखरखाव किया जा रहा है। सौंफ पर सीवीटी (2021-22 में शुरू किये) में 14 स्थानों में रूपात्मक, उपज और उपज गुणों के लिए 13 आशाजनक जीनोटाइप का मूल्यांकन किया गया था। वैरियन्स के विश्लेषण से बीज उपज और उपज के गुणों के लिए 13 जीनोटाइप के बीच महत्वपूर्ण अंतर देखा गया। औसत बीज उपज में 11.84 क्विंटल/हेक्टर से 16.90 क्विंटल /हेक्टर का अंतर था। चार जीनोटाइप जैसे, FNL-133 (16.9 क्विंटल /हेक्टर), FNL-132 (16.47 क्विंटल /हेक्टर), FNL-137 (15.97 क्विंटल /हेक्टर), और FNL-136 (15.73 क्विंटल /हेक्टर) ने सर्वोत्तम चेक FNL-139 (15.66 क्विंटल /हेक्टर) की तुलना में संख्यात्मक रूप से उच्च उपज अंकित की गई। पौधे की ऊंचाई 132.9 से 155.4 से. मी. थी, प्रति पौधे की प्राथमिक शाखाओं में 7.1 से 8.2 तक, माध्यमिक शाखाओं में 16.8 से 27.5 तक, प्रति पौधे की अमबल्स में 29.7 से 40.7 तक, प्रति अमबल्स के अमबलट्स में 24.8 से 28.3 तक अंतर थे। FNL-141 (6.11g) में टेस्ट वज़न अधिक थी जबकि निम्नतम FNL-132 (7.89g) में अंकित किया। बाष्पशील तेल का अंतर FNL-140 के 1.93% से FNL-135 और FNL-142 के 2.43% तक था। बाष्पशील तेल की अधिकतम मात्रा FNL-135 और उसी प्रकार FNL-142 में देखा गया उसके बाद FNL-139 (2.27%), FNL-130 (2.23%), FNL-133 (2.20%) में थे। बाष्पशील तेल उपज (46.19 लि./हेक्टर) की दृष्टि से FNL-132 पहले स्थान पर है उसके बाद FNL-133 (41.75 लि./हेक्टर), FNL-139 (41.27 लि./हेक्टर) है। जबकि 11.86 लि/हेक्टर का निम्नतम बाष्पशील तेल उपज FNL-141 में और 11.93 लि/हेक्टर FNL-142 में है। जोबनर में सौंफ की वृद्धि, उपज और गुणवत्ता पर आयरन और ज़िंक के पर्णीय अनुप्रयोग की प्रतिक्रिया के मूल्यांकन पर किये गये परीक्षण ने संकेत दिया कि 6% ज़िंक सल्फेट का पत्तों पर छिड़काव ने पौधे की अधिक ऊंचाई (92.04 से. मी.), प्रति पौधे अमबल्स (24.26), प्रति अमबल्स पर अमबलट्स (20.26), प्रति अमबल्स में बीज (350.98), टेस्ट वैट (5.50ग्रा.) एसन्श्यल तेल (1.80%), बीज उपज (22.73 क्विंटल/हेक्टर) जैविक उपज (59.20 क्विंटल/हेक्टर), नेट रिटर्न (रु.122267/हेक्टर) और बी:सी अनुपात (3.53) थे, जबकि 0.4% आयरन सल्फेट के पर्ण छिड़काव की प्रतिक्रिया के परिणामस्वरूप पौधे की ऊंचाई (89.30 से. मी.), (22.99). प्रति अमबल्स पर अमबलट्स (19.03), प्रति अमबल्स में बीज (327.82), टेस्ट वैट (5.20ग्रा.), एसन्श्यल तेल (1.73%), बीज उपज (21.42 क्विंटल/हेक्टर), भूसे की उपज (56.86 क्विंटल/हेक्टर), शुद्ध लाभ (रु. 113010/हेक्टर) और बी:सी अनुपात (3.47) थे।

मेथी

एआईसीआरपीएस के विभिन्न केंद्रों में मेथी की कुल 1467 जर्मप्लासम अक्सेशनों का रखरखाव किया जा रहा है। सूखा सहिष्णुता सूचकांकों के आधार पर RMt-354, RMt-305, UM-329, UM-216 और RMt-361 को सूखे की स्थिति के लिए वांछनीय जीनोटाइप पाए गए। सीवीटी के दौरान चेक सहित 17 जीनोटाइप का मूल्यांकन किया गया, सभी 15 जीनोटाइप ने चेक की बीज उपज को पार कर लिया। FGK-154 (17.25 क्विंटल/हेक्टर) अधिक उपज देनेवाला था, जिसके बाद FGK-147 (16.51 क्विंटल/हेक्टर) था, जिसमें सर्वोत्तम चेक FGK-156 तुलना में लगभग 14 र 10% उपज लाभ था। स्थान के अनुसार औसत में कल्याणी के 8.35 क्विंटल/हेक्टर से लेकर हिसार के 20.75 क्विंटल/हेक्टर तक था। मेथी किस्मों जैसे, एलएस-1, लाम मेथी-2 और लाम सोनाली के कीमो प्रोफाइलिंग ने संकेत दिया कि लाम मेथी-2 में अधिक

ओलियोरसिन (4.3%) है उसके बाद लाम सोनाली और एल एस-1 है। वर्ष 2019-20 में ड्रिप सिंचाई अंतराल के मानकीकरण और सूक्ष्म पोषक फर्टिगेशन विधि पर प्रयोग निम्न लिखित अनुशंसा के साथ संपन्न हुआ:- मेथी में सूक्ष्मपोषक तत्व (Zn, Fe, Mn, B, Mo) के फर्टिगेशन के साथ चार दिन के अंतराल पर ड्रिप सिंचाई करना उच्च उपज और आर्थिक लाभ के लिए अनुशंसित की जाती है।

अजवाइन

एआईसीआरपीएस के विभिन्न केंद्रों द्वारा अजवाइन की कुल 332 अक्सेशनों का रखरखाव किया जा रहा है। अजवाइन -2019 पर समन्वित प्रजाति परीक्षण 11 प्रविष्टियों के साथ 2021-22 में राबी के संदर्भ में तीसरे साल 7 स्थानों जैसे अजमेर, जोबनर, जगुदान, राइगढ़, हिसार, कुमारगंज और गुंटूर में सफलतापूर्वक आयोजित किया गया था। वैरियन्स के विश्लेषण से मूल्यांकित 11 प्रविष्टियों में बीज उपज ओर उपज के गुणों के लिए महत्वपूर्ण अंतर का पता चला। परीक्षण प्रविष्टियों की औसत बीज उपज 8.9 क्विंटल/हेक्टर से 10.7 क्विंटल/हेक्टर तक थी। चार प्रविष्टियों जैसे, AJN-07 (10.7 क्विंटल/हेक्टर), AJN-06 (10.43 क्विंटल/हेक्टर), AJN-01 (10.43 क्विंटल/हेक्टर), और AJN-02 (10.3 क्विंटल/हेक्टर) ने सर्वोत्तम चेक की तुलना में संख्यात्मक रूप से उच्च बीज उपज AJN-11 (10.27 क्विंटल/हेक्टर) अंकित की गई। प्रविष्टि AJN-05 सबसे जल्दी 88 दिनों में खिलती है जबकि, AJN-11 लगभग 104.9 दिनों के बाद खिलती है। प्रविष्टि AJN-06 (2.7g) में टेस्ट वैट अधिक थी, जबकि AJN-10 (1.9g) में सबसे कम थी। एसन्श्यल तेल सामग्री के मामले में AJN-01 (5.9%) को सर्वोत्तम पाया गया, जबकि AJN-06 में एसन्श्यल तेल सामग्री सबसे कम 4.7% थी।

निगेल्ला

एआईसीआरपीएस के विभिन्न केंद्रों द्वारा निगेल्ला की कुल 109 अक्सेशनों का रखरखाव किया जा रहा है। सीएआरएस, राइगढ़, छत्तीसगढ़ में अनुरक्षित कुल सात अक्सेशनों में से निगेल्ला 1 को छत्तीसगढ़ राज्य बीज उप-समिति, रायपुर, छत्तीसगढ़ के माध्यम से विमोचित करने के लिए चिन्हित किया गया। सीवीटी में तीसरे वर्ष के परीक्षण के दौरान, बीज उपज के मामले में जीनोटाइप NGL-07 को सबसे अच्छा प्रदर्शन करने वाला पाया गया, परीक्षण स्थानों पर औसतन 8.29 क्विंटल/हेक्टर की उपज, चेक, पन्त कृष्णा (NGL-09). से 2.21 प्रतिशत अधिक उपज दिखाया। यह हिसार (12.5 क्विंटल/हेक्टर) और कुमारगंज (8.68 क्विंटल/हेक्टर) में शीर्ष उपज देने वाला था।

केसर

जम्मु और कश्मीर के विभिन्न केसर उगाने वाले क्षेत्रों से सत्रह जर्मप्लासम अक्सेशनों को एकत्र की गई, जिससे कुल अक्सेशनें 232 हो गई। इन सभी जर्मप्लासम अक्सेशनों को विभिन्न रूपात्मक, गुणवत्ता, उपज और उपज के गुणों के लिए मूल्यांकन किया जा रहा है। ग्यारह चयनित अक्सेशनों के साथ किये गये आईईटी परीक्षण में, जीनोटाइप SRS-Saf-178 और SRS-Saf-199 नियंत्रण सहित अन्य अक्सेशनों की तुलना में काफी अधिक उपज और फूलों की संख्या/मी2 के साथ आशाजनक पाए गए।

काला जीरा

जम्मु और कश्मीर के गुरेज घाटी के ऊंचाई वाले स्थानों से 15 जर्मप्लासम अक्सेशनें एकत्र की गई, जिससे कुल 98 अक्सेशनें हो गईं। इन सभी जर्मप्लासम अक्सेशनों को विभिन्न रूपात्मक, गुणवत्ता, उपज और उपज के गुणों के लिए मूल्यांकन किया जा रहा है। आठ चयनित अक्सेशनों के साथ किये गये आईईटी परीक्षण में, जीनोटाइप SRS-KZ-177 और SRS-KZ-167 को आशाजनक पाया गया और चेक किस्म सहित अन्य अक्सेशनों की तुलना में काफी अधिक उपज (4.27 कि. ग्रा/हेक्टर) दिखाई गई। चेक की SRS-KZ-177 की उपज वृद्धि का प्रतिशत 29.2% था।

गुणवत्तायुक्त रोपण सामग्रियों का उत्पादन एवं वितरण

एआईसीआरपीएस केंद्र ने काली मिर्च का 4.10 लाख जड़ लगाए कतरन, इलायची के 10336 सकेर्स, 45 टन हल्दी, 16 टन अदरक, 2256 जायफल के कलम और 1500 दालचीनी कलम का उत्पादन करके वितरण किया

गया। बीज मसालों में 306 क्विंटल धनिया, 70 क्विंटल सौंफ, 65 क्विंटल मेथी, 10 क्विंटल अजवाइन और 12 क्विंटल निगेल्ला का उत्पादन और वितरण किया गया।

प्रौद्योगिकी का हस्तांतरण

कृषि समुदाय को वैज्ञानिक कृषि पद्धतियों और टिकाऊ मसाला उत्पादन के बारे में अवगत कराने के लिए एआईसीआरपीएस केंद्रों के वैज्ञानिक नवीनतम तकनीकों को लोकप्रिय बनाने में सक्रिय रूप से शामिल है। वर्ष के दौरान प्रदर्शित की गई कुछ प्रौद्योगिकियां निम्नानुसार है।

अधिक उपज देने वाली किस्में-किसानों के लिए वरदान

- नई विमोचित उच्च उपज वाली हल्दी किस्म YSRHU-लाम स्वर्णा (गुंटूर) का प्रदर्शन।
- तलाकांति, सुलियमारी, कोटिया, पोट्टांगी और कोरापुट, आंध्रप्रदेश (पोटांगी) में सुस्थिर कुरकुमिन वाली किस्म आईआईएसआर प्रगति का प्रदर्शन।
- अधिक उपज देने वाली मेथी किस्म RMt-354 (जोबनर) और RMt-1 (जबलपुर) का प्रदर्शन।
- उच्च उपज देने वाली सौंफ किस्म RF-290 (जोबनर) का प्रदर्शन।
- उच्च उपज देने वाली जीरा किस्म GC-4 (मंडूर) का प्रदर्शन।
- उच्च उपज देने वाली पत्तेदार धनिया कल्चर CS 38 (कोयंबत्तूर) और Cimpoo S- 33 (जबलपुर) का प्रदर्शन।
- उच्च उपज देने वाली काली मिर्च की पन्नियूर किस्में जैसे, पन्नियूर-8, पन्नियूर-9 और पन्नियूर-10 (पन्नियूर) का प्रदर्शन।
- किसानों के खेत में काली मिर्च की पांच अधिक उपज देने वाली आईआईएसआर किस्में जैसे, आईआईएसआर शक्ति, आईआईएसआर गिरिमुंडा, पौर्णमी, पंचमी, श्रीकरा (पोटांगी) को अपनाना।
- लमतापुट क्षेत्र, आंध्र प्रदेश (पोटांगी) में अप्पंगला-1 को अपनाना।
- हल्दी सीवी RCT 1 (आईसीएआर-मिजोरम) का फ्रंट लाइन प्रदर्शन।
- अदरक सीवी Bold Nadia (आईसीएआर-मिजोरम) का फ्रंट लाइन प्रदर्शन

रोपण सामग्री का तेजी से गुणन – न्यूनतम व्यय के लिए

- अदरक और हल्दी (कामरपल्ली) के गुणवत्ता पूर्ण बीज उत्पादन के लिए प्रो ट्रै कृषि तकनीकी।
- किसानों और टीएनएयु (एचआरएस पीचिपराई) के छात्रों के लिए काली मिर्च के द्रुत गुणन विधि तथा कोलम विधि का प्रदर्शन।
- फर्टिगेशन के साथ 3 से 4 पपंक्तियों वाली उठी हुई क्यारी पर दो कलियों वाली हल्दी बीज सामग्री का प्रदर्शन (कामरपल्ली)।

मृदा स्वास्थ्य के लिए सूक्ष्म पोषक तत्व और बायोकैप्स्यूल

- एआईसीआरपीएस केंद्रों द्वारा मसाला उगाने वाले सभी क्षेत्रों में विशेष तौर पर अदरक, हल्दी और काली मिर्च के लिए पायलट पैमाने पर बायोकैप्स्यूल और सूक्ष्म पोषण पैकेज के लाभकारी प्रभावों का वितरण और प्रदर्शन।
- सिक्किम (आसीआरआई गांगटोक) के किसानों के अदरक और हल्दी खेत के लिए आईआईएसआर, कोषिक्कोड, केरल से सूक्ष्म पोषक तत्वों आईआईएसआर पावर मिक्स टी, आईआईएसआर पवर मिक्स जी और बायो कैप्स्यूल्स जैसे ट्राइकोडरमा स्पीसीस, पीजीपीआर और बासिलस अमिलोलिक्विफेसिन्स का प्रदर्शन।
- हल्दी के (कोयंबततूर, गुंटूर, कामरपल्ली) पर्ण रोगों के प्रबंधन के लिए ट्राइकोडरमा और पीजीपीआर (GRB-35) के बायोकैप्स्यूल्स का उपयोग।
- नागालैंड में वृद्धि और उपज के लिए बड़ी इलायची में सूक्ष्म पोषक तत्वों का फ्रंट लाइन प्रदर्शन।

संरक्षण प्रौद्योगिकियां- पौधों के स्वास्थ्य के लिए

- ट्राइको प्राइम पाउडर से बीज उपचार के प्रभाव पर प्रौद्योगिकी प्रदर्शन।
- अदरक (पुंडिबारी) के फाइलोस्टिक्टा पर्ण चित्ती का प्रबंधन।

- ❖ इलायची में फिश मील ट्रैप (आईसीआरआई-सकलेशपुर) के साथ प्ररेह मक्खी का प्रबंधन।
- ❖ येरकाड में काली मिर्च के म्लानी के प्रति जैव नियंत्रण कारकों का प्रदर्शन, पासीघाट में बायोकैप्स्यूल (पीजीपीआर, बसिलिक और ट्राइकोडरमा) का वितरण।
- ❖ नागालैंड में अदरक बीज प्रकंद के सुरक्षित भंडारण के लिए अदरक बीज प्रकंद का प्राइमिंग।

प्रसंस्करण मशीनरियां-दक्षता में - वृद्धि लाने के लिए

- ❖ गार्सीनिया (पीचिपराई) से मूल्य वर्धित उत्पादों की तैयारी का प्रदर्शन।
- ❖ हल्दी बॉयलर, पॉलिशर (आईआईएसआर, कोषिक्कोड) का प्रदर्शन।

उपरोक्त खेत स्तरीय प्रदर्शनों के अलावा, वैज्ञानिकों ने आभासी प्रशिक्षण आयोजित करके और आभासी प्रशिक्षणों और सेमिनारों में संसाधन व्यक्तियों के रूप में भाग लेकर और विभिन्न मीडिया (समाचार पत्र, रेडिया वार्ता और टीवी कार्यक्रम) के माध्यम से भी प्रौद्योगिकियों को लोकप्रिय बनाया।

एनईएच/टीएसपी/एससीएसपी गतिविधियां

उत्तर पूर्व क्षेत्रों में बीज मसाला खेती को बढ़ावा देना

उत्तर पूर्व क्षेत्रों में बीज मसाला खेती को बढ़ावा देने और सुविधा प्रदान करने के लिए, आईसीएआर-एआईसीआरपीएस ने मेघालय, मिज़ोरम, नागालैंड, सिक्किम, असम और अरुणाचल प्रदेश में स्थित उत्तर पूर्व केंद्रों द्वारा बीज मसाला फसल जैसे अजवाइन, धनिया, जीरा, सौंफ और मेथी के बीज सामग्रियों का वितरण किया।

उत्तर पूर्व के आकांक्षी जिले में विकासात्मक गतिविधियां

मिज़ोरम के एआईसीआरपीएस केंद्र ने मिज़ोरम के आकांक्षी जिलों जैसे, लुंगलेई लॉन्गतलाई और कोलासिब के टीएसपी गांव में आजीविका सुधार और आय के लिए मसाला खेती पर तीन दिवसीय प्रशिक्षण कार्यक्रम आयोजित किया और कृषि उपकरण/ इनपुट और बीज सामग्री को नागालैंड के दिमापुर और पेरेन जिलों के अंतर्गत सोकुनोमा गांव और पुंगलवा गांव में वितरण किया। नागालैंड के पेरेन जिला और वोखा जिले के तहत रेनथन, अरुणाचल प्रदेश के सिल्लुक गांव और शि योमी जिला में जैविक मसाला उत्पादन पर प्रशिक्षण आयोजित किया।

आदिवासी गांवों में विकासात्मक गतिविधियां

मेघालय, नागालैंड, कुमारगंज, येरकॉड, कोयंबत्तूर, जबलपुर और चिंतापल्ली के एआईसीआरपीएस केंद्र ने मसालों की वैज्ञानिक खेती और उसके संसाधन पहलुओं पर आदिवासी गांव में रोपण सामग्रियों, अन्य आदानों और मशीनरी के वितरण के साथ विभिन्न प्रशिक्षण कार्यक्रम आयोजित किया। परित्यक्ता और अनुपयोगी क्षेत्रों में सफल मसाला खेती करने के लिए किसानों को प्रेरित किया गया।

अनुसूचित जाति समुदायों के लिए विकासात्मक गतिविधियां

गांगटोक, मंडोर, सिरसी, कोयंबत्तूर, कामरपल्ली, हिसार, पुंडिबारी जैसे विभिन्न एआईसीआरपीएस केंद्रों में विभिन्न प्रशिक्षण कार्यक्रम आयोजित किया गया, जिससे अनुसूचित जाति के किसानों को लाभ हुआ और किसानों को कृषि आदान वितरित किए गए।

सफलता की कहानियां

मसाला आधारित एकीकृत कृषि प्रणाली : मिज़ोरम में किसानों की आय बढ़ाने के लिए एक सतत दृष्टिकोण

एआईसीआरपीएस केंद्र, एनईएच क्षेत्र के लिए आईसीएआर रिसर्च कॉम्प्लक्स, मिज़ोरम के द्वारा मिज़ोरम में किसानों की उत्पादकता और आय बढ़ाने में मदद करने के लिए मसाला आधारित एकीकृत कृषि प्रणाली शुरू की है। इस प्रणाली में अन्य फसलों जैसे मक्का, स्वीट कॉर्न, चावल, फलियां और रोपण फसलों के साथ प्रमुख मसाले जैसे अदरक और हल्दी की खेती शामिल है। दो किसानों, श्रीमती लालसांगपुई और श्रीमती लालबियाकज़ुअली ने सफलतापूर्वक इस प्रणाली को लागू की है और अपनी आय और लागत बचत में वृद्धि का अनुभव किया है। श्रीमती लालसंगपुई हल्दी को चूर्ण में संसाधित करती है और उत्पादों को "संगपुई ऐंग" नाम से बेचती है। मसाला आधारित एकीकृत कृषि प्रणाली को लागू करने से पहले, दोनों किसान पारंपरिक प्रथाओं में लगे हुए थे, जिसके परिणामस्वरूप उपज और उत्पादकता कम हो गई थी। इन दोनों किसानों की सफलता मिट्टी के स्वास्थ्य और पर्यावरण को बनाए रखते हुए मिज़ोरम में किसानों की आय बढ़ाने के लिए मसाला आधारित एकीकृत कृषि प्रणाली की क्षमता दिखाता है। इस पहल से सीखे गए सबक समान जलवायु परिस्थितियों और कृषि पद्धतियों

वाले अन्य क्षेत्रों में लागू किए जा सकते हैं जो, सतत कृषि को बढ़ावा देने और किसानों के जीवन में सुधार लाने के लिए सहायक होते हैं।

अदरक की खेती में क्रांतिकारी बदलाव: एक वैज्ञानिक भंडारण पद्धति ने हिमाचल प्रदेश और ओडीशा के कोरापुट जिले में आजीविका को बदल दिया है।

अदरक के बीज के लिए वैज्ञानिक भंडारण पद्धति के विकास का हिमाचल प्रदेश में किसानों की आजीविक पर महत्वपूर्ण प्रभाव पड़ा है। अगले मौसम के लिए स्वस्थ बीज के भंडारण विधि की कमी के कारण उच्च रोग की घटना और खराब प्रकंद की उपज हुई, जिसके परिणामस्वरूप इसकी खेती के क्षेत्र में कमी आई। डॉ. वाई. एस. परमार औद्यानिकी एवं वानिकी विश्वविद्यालय, नौणी, सोलन ने एक वैज्ञानिक भंडारण पद्धति विसकित करने में सक्रिय भूमिका निभाई, जिसने किसानों को अदरक की खेती बढ़ाने और उनकी आय में सुधार करने में सक्षम बनाया है। उत्पादकों द्वारा इस पद्धति को व्यापक रूप से स्वीकार किया गया है और अपनाया गया है, जिससे गैर-पारंपरिक क्षेत्रों में भी अदरक के क्षेत्र और उत्पादन में बडी वृद्धि हुई है। इसी तरह, ओडीशा के कोरापुट जिले में, एआईसीआरपीएस, पोटांगी ने नई उच्च उपज वाली किस्मों और प्रथाओं के जैविक पैकेज के साथ अदरक उगाने की आधुनिक तकनीकों के साथ हस्तक्षेप किया, जिससे लाभप्रदत्ता में वृद्धि हुई। सफलता की ये कहानियां किसानों की आय बढ़ाने और स्थायी कृषि को बढ़ावा देने में वैज्ञानिक तरीकों और आधुनिक तकनीकों के महत्व को प्रदर्शित करती है।

कम पैदावार से उच्च लाभ तक : कोरापुट, ओडीशा में काली मिर्च खेती की सफलता की कहानी

एआईसीआरपीएस द्वारा विकसित आधुनिक तकनीकों को अपनाने से ओडीशा के कोरापुट जिले में काली मिर्च की सफल खेती हूई है, जिसके परिणाम में किसानों को उच्च उपज और लाभ हुआ है। एआईसीआरपीएस, पोटांगी के व्यवधानव और फसलोत्तर तकनीकों और पौधों की सुरक्षा उपायों पर किसानों को प्रदान किए गए प्रशिक्षण के माध्यम से, किसान नई तकनीकों और प्रथाओं को अपनाने में सक्षम थे। उच्च उपज देने वाली किस्मों का उपयोग, कृषि की जैविक पद्धतियां, महत्वपूर्ण इनपुट जैसे, बीजपौधे, जैव-कीटनाशक *ट्राइकोडरमा विरिडे* और *प्स्यूडोमोनस फ्लोरोसेंस* नीम केक में मिला दें और जैव- उर्वरकों जैसे एनपीके कन्सोर्टियम का प्रयोग करने के परिणामस्वरूप वैज्ञानिक प्रथाओं और प्रबंधन के साथ बंपर पैदावार हुई। एक प्रशिक्षु किसान श्री दामा चालान को सबसे अधिक शुद्ध लाभ प्रति हेक्टर रु. 370000/ और बी:सी अनुपात 4.08:1 प्राप्त हुआ। सफलता की यह कहानी इस क्षेत्र में कृषि में और विकास और नवाचार की संभावनाओं को उजागर करती है।

हल्दी की खेती और प्रसंस्करण प्रौद्योगिकियों की वैज्ञानिक पद्धतियों को अपनाने से लाभ प्राप्त करना

एआईसीआरपीएस के केंद्र उच्च उपज वाली हल्दी की किस्मों और लागत –बचत, आय को बढ़ावा देने वाली तकनीकों को अपनाकर अपनी आजीविका को बदलने में पूरे भारत मे किसानों की मदद करने में महत्वपूर्ण भूमिका निभाता है। श्री साधु राम चौरासिया, उत्तर प्रदेश के किसान ने एआईसीआरपीएस एएनडीयुएटी के विशेषज्ञों के मार्गदर्शन से हल्दी खेती अपनाकर अपनी आजीवनी में बदलाव किया। NDH-1 और NDH-2 कल्टिवरों का प्रयोग करके और संस्तुत कृषि पद्धतियों को अपनाकर उन्होंने केवल एक एकड़ से रु. 85,000/- का शुद्ध लाभ अर्जित किया। उनकी सफलता की कहानी अन्य किसानों को अधिकतम लाभ के लिए हल्दी की खेती को अपनाने के लिए प्रोत्साहित किया है। उन्होंने अपने क्षेत्र में एक प्रसंस्करण संयंत्र की आवश्यकता पर बल दिया और अपनी आय बढ़ाने के लिए हल्दी के पत्तों से तेल निकालने की एक विधि की इच्छा जताई।

आंध्र प्रदेश में "रोमा" और "आईआईएसआर प्रगति" जैसी उच्च उपज वाली हल्दी की किस्मों की शुरूआत ने आदिवासी किसानों की आजीविका को बदल दिया है। मसाला केंद्र, केवीके, बीसीटी-केवीके और गैर सरकारी संगठनों पर एआईसीआरपीएस केंद्र के बीच सहयोग के परिणामस्वरूप किसानों के लिए लाभ में वृद्धि हुई है। किसान नई कृषि प्रणाली और प्रसंस्करण तकनीकों को अपना रहे हैं, जिसके परिणामस्वरूप उच्च गुणवत्ता वाले उत्पादपैदा होता है और बाज़ार में बेहत्तर कीमत प्राप्त करते हैं। हल्दी बॉय़लर, पॉलिशर और टारपॉलिन के वितरण से किसानों को अपनी हल्दी को अधिक कुशलता से संसाधित करने में मदद मिली है।

उच्च उपज वाली हल्दी की खेती और उन्नत कृषि प्रणाली ने तेलंगाना के किसान श्री. मैगिडी चिन्नरेड्डी की आजीविका को बदल दिया है। ड्रिप सिंचाई केसाथ उठी हुई क्यारी की खेती का उपयोग करते हुए, उन्होंने हल्दी की सात विभिन्न किस्मों जैसे आईआईएसआर प्रगति, राजेंद्र सोनिया, अक्सेशन-79, बीएसआर-2, राजापुरी, पितांबर और

वैगोन की खेती करने में सक्षम है, जिसके परिणामस्वरूप उच्च गुणवत्ता वाले उत्पाद प्राप्त होते हैं, जिसे बाज़ार में बेहतर कीमत भी प्राप्त होती है। उनकी सफलता का श्रेय एआईसीआरपीएस केंद्रों और किसानों के बीच सहयोग, आधुनिक तकनीक अपनाने के माध्यम से मसाला उत्पादकता में सुधार भी होता है।

सतत मसाला उत्पादन के लिए जैवनियंत्रण कारक

वर्ष 2012 से एसएचएम द्वारा वित्तपोषित जैवनियंत्रण प्रयोगशाला इलायची अनुसंधान केंद्र, पांपाडुमपारा में बडी मात्रा में जैवनियंत्रण कारक जैसे, *प्स्यूडोमोनस फ्लूरसेन्स, ट्राइकोडेरमा विरिडे, मेटरहिजियम अनिसोप्लिया, लीकानिसेलियम लीकानी, पेसिलोमाइसस लिलासिनस, ब्युवेरिया बासियाना* और एएमएफ का उत्पादन कर रही है। इन कारकों को इलायची और काली मिर्च किसानों को कीट और रोग नियंत्रण के लिए वितरण किया गया। वर्ष 2021-22 में 22,590 कि. ग्रा. का वितरण किया गया। किसानों की प्रतिक्रिया सकारात्मक रही है और अधिक किसानों ने इन जैवनियंत्रण कारकों का उपयोग करने और उनकी प्रभावशीलता की रिपोर्ट करने की और आकर्षित हुए है। इसी तरह, येरकाड केंद्र भी कोसानों को जैव उर्वरक और वृद्धि को बढ़ावा देने वाले सूक्ष्म जीवों का वितरण कर रहा है, जो उन्हें लगातार लागू करते हैं, वे शुष्क मौसम की अवधि के दौरान पौधों की बेहत्तर वृद्धि और प्रदर्सन की रिपोर्ट करते हैं। जैवनियंत्रण प्रौद्योगिकियों की लोकप्रियता सतत कृषि पद्धतियों की शक्ति और पर्यावरणीय रासायनिक संदूषण को कम करने और मसालों के बढ़ते क्षेत्रों के क्षरण को कम करने की क्षमता प्रदर्शित करती है। आगे का लक्ष्य जैवनियंत्रण कारकों के उपयोग के माध्यम से अधिक से अधिक किसानों को पर्यावरण के अनुकूल कीट /रोग प्रबंधन के बारे में जागरूक करना है।

सहयोग और नेटवर्किंग

एआईसीआरपीएस केंद्र निम्न लिखित के सहयोग से काम करता है।

- आईसीएआर-आईआईएसआर, कोषिक्कोड और आईसीएआर-एनआरसीएसएस, अजमेर (प्रौद्योगिकियों के लिए)।
- स्पाइसस बोर्ड - आदिवासी क्षेत्रों में प्रौद्योगिकियों को लोकप्रिय बनाने के लिए
- एमआईडीएच (बागवानी के लिए कीकृत विकास मिशन) - गुणवत्ता रोपण सामग्रियों का उत्पादन और वितरण करने के लिए।
- गैर सरकारी संगठन - जनजातीय क्षेत्रों में उच्च उत्पादन प्रौद्योगिकियों को लोकप्रिय करने तथा मूल्य श्रृंखला विकास के लिए।
- राज्य कृषि और बागवानी विभाग – उत्पादन, उत्पादकता और किसानों की आय में वृद्धि करने के लिए।

निगरानी

परियोजना समन्वयक और पीसी यूनिट के वैज्ञानिकों ने व्यक्तिगत यात्राओं और ऑनलाइन समीक्षा बैठकों द्वारा एआईसीआरपीएस के विभिन्न केंद्रों और प्रायोगिक प्लॉट के कामकाज की निगरानी की। ई-मेल और फॉन कॉल के ज़रिए भी लगातार निगरानी की गई। केंद्रों से प्राप्त मासिक प्रगति रिपोर्ट एवं बजट उपयोग प्रमाणपत्रों की समीक्षा कर सुधार हेतु उचित मार्गदर्शन दिया गया। डॉ. के. एस. कृष्णमूर्ति और डॉ. शारोन अरविंद की एक मसाला निगरानी टीम ने 15.3.2022 को अंबलवयल केंद्र और 19.3.2022 को त्रिश्शूर केंद्र का दौरा किया। उन्होंने केंद्र के साथ –साथ अन्य सुविधाओं का भी निरीक्ण किया और कार्रवाई बिंदुओं का सुझाव दिया। आईसीएआर-आईआईसआर के वैज्ञानिकों ने दापोली केंद्र का भी दौरा किया और केंद्र की गतिविधियों की समीक्षा की। डॉ. सी. के. तंकमणी और डॉ. शारोन अरविंद ने बारापानी केंद्र का दौरा किया और सुधार के लिए सुझाव दिए। डॉ. के. एस. कृष्णमूर्ति और ड़. सी. के. तंकमणी ने 13.10. 2022 को कुमारगंज केंद्र के खेत और अन्य सुविधाओं का निरीक्षण किया और केंद्र की प्रगति की समीक्षा की। इनके अलावा, नियमित अंतराल पर सभी एआईसीआरपीएस केंद्रों की गतिविधियों की समीक्षा के लिए ऑनलाइन बैठकें आयोजित की गईं।

केंद्र द्वारा भेजी गई मासिक रिपोर्ट, त्रैमासिक, अर्धवार्षिक रिपोर्ट और वार्षिक रिपोर्ट के माध्यम से भी केंद्रों की गतिविधियों की निगरानी की जाती थी। इसके अलावा, भाकृअनुप-अखिल भारतीय समन्वित मसाला अनुसंधान परियोजना की XXXIIIवीं वार्षिक समूह बैठक 13-16 अक्तूबर 2022 के दौरान एएडीयुएटी, कुमारगंज, अयोध्या, उत्तर प्रदेश में आयोजित की गई थी, जिसमें एआईसीआरपीएस के सभी केंद्रों द्वारा संचालित परियोजनाओं की प्रगति की समीक्षा और उनकी सुधार के लिए बहुमूल्य सुझाव दिए गए थे।

EXECUTIVE SUMMARY

The ICAR-AICRP on Spices is India's largest spices research system, focusing on 17 mandate crops at present, with a network of 19 regular, 11 co-opting, 8 voluntary, and two project mode centers. The AICRP on Spices has contributed substantially, ever since its inception, in developing high-yielding varieties with desirable agronomic traits, technologies for increasing production and productivity, and management strategies for combating pests and pathogens, substantially reducing crop losses.

Spices are literally a 'mixed bag of crops' with varying plant habits/stature and life span, from fleshy rhizomatous and herbaceous annuals to perennial woody climbers and trees, varying in morphology, useful parts/uses and constituents/active ingredients, collectively contributing substantially to the agricultural export basket of India. Among them, the AICRPS coordinates the research activities on black pepper, large cardamom, small cardamom, ginger, turmeric, mango ginger, cinnamon, nutmeg, clove, coriander, cumin, fennel, fenugreek, ajwain, nigella, saffron and kalazeera. Efforts are on to bring new crops like chillies, the single largest export earner among the spice crops, in to its ambit. The annual budget of the AICRP on Spices for the year 2022 was Rs. 965.71 lakhs (ICAR share).

New initiatives

New research projects have been initiated for sustainable spice production utilizing arbuscular mycorrhizal fungi (AMF) and growth regulators in coriander and fenugreek, coordinated varietal trials in ginger, and management trials against cumin blight, powdery mildew of fenugreek and root rot of nigella.

Five varieties of spices viz., ginger variety, IISR-Vajra, turmeric variety, Dr. YSRHU Lam Swarna, ajwain variety Dr. YSRHU Lam Varsha and two fenugreek varieties, RMt 354 and Gujarat Methi-3 got gazette notification during 29th meeting of Central Sub-Committee on Crop Standards, Notification and Release of Varieties for horticultural crops, New Delhi.

Varieties recommended for release in XXXIII Annual Group Meeting of AICRPS

An improved moisture stress tolerant small cardamom variety named IISR-Manushree (Appangala-3) from ICAR-Indian Institute of Spices Research, Regional Station, Appangala, Kodagu, Karnataka was recommended for release in XXXIII Annual Group Meeting of AICRP on Spices held at ANDUA&T, Kumarganj, Ayodhya (UP) during 13-15th October 2022.

Stress tolerant variety

IISR-Manushree belonged to malabar type and was selected from germplasm collection **(IC 349537)** at ICAR-IISR Regional station, Appangala (Fig. 2). The variety is moisture stress tolerant, with a stable yielding capacity of 550 kg dry capsules ha^{-1} under irrigated condition and 360 kg dry capsules ha^{-1} under moisture stress condition. This variety contains 8.74% essential oil (irrigated condition) and 8.84% essential oil (moisture stress condition), with 50% of the capsules having > 8 mm size. Essential oil components such α-terpinyl acetate and 1,8-cineole did not show significant variation between control and moisture stress conditions. The variety has been recommended for small cardamom-growing tracts of Karnataka and Kerala.

Technologies recommended during XXXIII Annual Group Meeting of AICRPS

ICAR-AICRP on Spices recommended two crop production and one crop protection technologies during the group meeting as summarized below.

Fig 2: IISR-Manushree, new high-yielding, moisture stress tolerant small cardamom variety identified during 33rd AGM

Micronutrient management in cumin by SKNAU, Jobner.
Application of half recommended dose of zinc, iron, manganese and boron as soil application along with their foliar spray is recommended for obtaining a higher yield (685 kg ha^{-1}) with a high benefit-cost ratio of 3.96 in cumin.

Standardization of drip irrigation interval and method of micronutrient fertigation in fenugreek by **SKNAU, Jobner and ICAR-NRCSS, Ajmer**.
Drip irrigation at four-day intervals along with fertigation of all micronutrients is recommended for higher yield (1802 and 2516 kg ha^{-1} at Jobner and Ajmer respectively) and higher economic returns (benefit-cost ratio of 2.22 and 2.34 at Jobner and Ajmer respectively) in fenugreek. The water use efficiency of 7.93 and 8.98 kg ha^{-1} mm^{-1} were obtained at 4 days interval drip irrigation at Jobner and Ajmer respectively.

Integrated pest & disease management in cumin by SDAU, Jagudan
Three foliar sprays of kresoxym methyl 44.3 SC @ 0.044% (First spray at initiation of disease and subsequent sprays at an interval of 15 days after first spray) and two foliar sprays of thiamethoxam 25WG @ 0.0084% (First spray at the initiation of aphid infestation and the second spray after 10 days of first spray) were found effective for obtaining a higher yield, net returns and incremental benefit-cost ratio with less blight and aphid incidence.

Research Achievements

Black pepper

The AICRPS centres at Ambalavayal, Panniyur, Sirsi, Chintapalle, Dapoli, Pundibari and Yercaud are mandated to work on genetic resources management of black pepper. At present, a total of 690 accessions (628 cultivated types, 59 wild & related types and 3 exotic types) of black pepper are being maintained at different AICRPS centres.

At PRS, Panniyur centre, among the germplasm accessions evaluated during the season 2021-2022, the genotypes PRS 124 and Panniyur 5 (PRS 116) were the top yielders. PRS 124 ranked first with 4.50 kg green berry yield and 982 spikes per vine followed by Panniyur 5 with 4.35 kg green berry yield and 978 spikes per vine. A new accession namely, RMH Salkani was added to the vast collection of germplasm maintained at AICRPS centre, Sirsi during 2022. In the CVT on farmer's varieties of black pepper, 3 promising farmers' varieties were evaluated for morphological, yield and yield-attributing traits in 5 locations along with the national check, Panniyur-1. 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. But for number of berries per spike Kumbakkal showed superiority with 50.09 over 43.84 in the check, Panniyur-1. In black pepper-based mixed cropping system trial for ensuring sustainable productivity and food security, among the intercrops, greater yam recorded a maximum yield of 10.71 kg, followed by elephant foot yam (8.0 kg) from an interspace of 4 m x 2 m spacing between black pepper at Panniyur. The highest B:C ratio was observed in black pepper intercropped with elephant foot yam (1.81), followed by black pepper intercropped with colocasia (1.49) at Sirsi. The elephant foot yam recorded a better yield (11.43 kg $plot^{-1}$) followed by tapioca (10.22 kg $plot^{-1}$) at Dapoli. The fungal pathogen, *Phytophthora* and nematodes were not observed in the rhizosphere soil of any of the vines in the experimental plot at Panniyur. However, yellowing of vines was noticed due to root mealy bug attack along with the fungal pathogen, *Fusarium*. In line with food safety assurance and minimization of pesticide residue in spices, evaluation of strobilurin fungicides and actinomycetes for the management of foot rot and slow decline in black pepper was initiated and the first year results (initiated during 2020-21) at Sirsi revealed that treatment T_3-foliar application of Ergon 44.3 % (W/W) [kresoxym methyl 500 g L^{-1}] 7 ml L^{-1} and soil application of Ergon 7 ml L^{-1} + carbosulfan 1 ml L^{-1} @ 2-3 L^{-1} vine recorded least foliar infection (13.70), defoliation (14.58), yellowing (23.75) and nematode infection (23.75).

Small cardamom

A total of 323 cardamom accessions are presently conserved in the gene bank, with 188 accessions at Pampadumpara and 132 at Mudigere. At Pampadumpara centre, two unique collections *viz.* Miracle elaichi and Erumathuruthiyil elam from Adimali, Vandiperiyar areas of Idukki district respectively were added. During 2021-22, CVT of drought tolerance in small cardamom was concluded with the release of moisture stress tolerant cardamom genotype, IISR Manushree. There were significant differences among the eight farmer's varieties of small cardamom under evaluation under CVT on farmers' varieties of cardamom. The farmers varieties namely, *Arjun,* Wonder Cardamom, *Panikulangara, Thiruthali, Elarajan, Pachakai, Pappalu, Njallani Green Gold* and PNS *Gopinath* were evaluated for their vegetative and yield characters at Sakleshpur, Mudigere, Myladumpara and Pampadumpara. Multi-location evaluation of thrips-tolerant cardamom lines at Myladumpara indicated that among the six genotypes (IC 349362, IC 349364, IC 349370, IC 349606, Njallani Green Gold and ICRI 8), the lowest thrips damage (1.4%) was recorded in the genotype IC 349606 whereas at Sakleshpur, thrips population was high in Njallani Green Gold followed by IC 349364. In MLT

to screen leaf blight tolerant lines of small cardamom, Njallaani Green Gold recorded the least infection at Appangala and Myladumpara. The experiment conducted at five centres on three varieties to evaluate the effect of micronutrients on growth and yield of small cardamom jointly concluded that the micronutrient spray improved the growth and yield parameters in small cardamom. The evaluation of the efficacy of biocontrol agents (single as well as in combination) in comparison with chemical treatment (carbendazim) against leaf blight of cardamom indicated that the treatment T_2 (hexaconazole @ 2 ml L^{-1}) recorded the lowest disease incidence, with a PDI of 21.66 %, followed by T_1 (carbendazim + mancozeb @ 2 g L^{-1}) and T_3 (mancozeb @ 2 g L^{-1}).

Large cardamom

In large cardamom, 64 germplasm accessions are being maintained at the two AICRPS centres at Gangtok, Sikkim. Two unique germplasm accessions were collected from farmer's field from Uttarey area of Gayzing district. These accessions were found promising with better growth performance, and tolerance to insect pests and disease (Chirke & Foorkey) and were planted in Pangthang Research Farm of ICRI under AICRPS.

The experiment to evaluate the effect of mulching on yield of large cardamom indicated that a significantly higher number of leaves per tallest tiller and number of productive tillers per clumps were noticed under T_1 (leaf mould) which was at par with T_2 (fresh leaf litter). The maximum number of immature tillers per clump and the total number of tillers/clumps were also recorded under T_1 which was significantly higher than the other treatments. Significantly higher dry capsule yield was obtained under T_1 (though at par with T_2), as compared to other treatments.

Ginger

Collection, characterization, evaluation and conservation activities of ginger germplasm are being carried out at Dholi, Kumarganj, Pundibari, Barapani, Pottangi, Raigarh and Solan centres located in the diverse agro-climatic zones. A total of 514 accessions are being conserved by these AICRPS centres jointly. In the CVT on disease tolerance trial in ginger, 10 promising genotypes were evaluated for morphological, yield and yield-attributing traits in 8 locations. The analysis of variance revealed significant differences among the 10 genotypes for rhizome yield and yield attributing characters. The mean fresh rhizome yield ranged from 11.1 to 14.2 t ha^{-1} and the highest yield was observed in V1E4-1 (14.2 t ha^{-1}) followed by R 1.25/4 (14.1 t ha^{-1}) numerically surpassing the national check, IISR Varada (13.7 t ha^{-1}). Compared to the national check, IISR-Varada (PDI=18.4), six test genotypes viz., R 1.25/4, G 1.00/4, HP 05/15, HP 0.5/2 recorded lower average soft rot scores among which HP 05/15 (mean PDI=14.6%) and R 1.25/4 (mean PDI=15.0%) were shortlisted as tolerant genotypes (PDI between 6.0 to 15.0). The genotypes G 1.00/4, V1E4-1, V1E4-5, HP 0.5/2, IISR Varada (Check), V 0.5/2 and Indira ginger were grouped under moderately tolerant genotypes (with mean PDI score between 16.0 to 25.0%).

The CVT trial on the evaluation of genotypes of ginger for the vegetable purpose was initiated with eight bold ginger cultivars in 2018-19 at 7 AICRPS centres. During Kharif, 2021-22, the mean fresh rhizome yield ranged from 12.3 to 15.2 t ha^{-1}. The highest yield was observed in John's Ginger (15.2 t ha^{-1}) followed by PG-121 (14.2 t ha^{-1}). Location-wise mean fresh rhizome yield ranged from 10.5 t ha^{-1} (Sikkim) to 14.2 t ha^{-1} (Pottangi). In different intercropping systems of ginger, results at Pottangi indicated that the returns from coriander as intercrop in ginger was the highest (Rs 480/bed) followed by maize (Rs. 200/-). At Mizoram, all the

intercropping combinations with ginger were found effective and resulted in higher system productivity except ginger-fenugreek intercropping.

Turmeric

A total of 1820 accessions of turmeric and its wild relatives are being maintained by different AICRPS centres. In the CVT on mango ginger, 10 promising genotypes were evaluated for morphological, yield and yield attributing traits in 8 locations. The analysis of variance revealed significant differences among the 10 entries for rhizome yield and yield attributing characters. The mean fresh rhizome yield recorded across test location ranged from 22.2 t ha^{-1} (Amba) to 31.1 t ha^{-1} (ACC-347). All the nine test entries numerically showed their yield superiority over check, Amba. The entry, ACC-347 ranked first in mean fresh rhizome yield (31.1 t ha^{-1}) followed by CAM-3 (28.6 t ha^{-1}) and NVMG 2 (28.2 t ha^{-1}). In the CVT on high yield and high curcumin turmeric (initiated during 2019-20), 11 promising genotypes were evaluated for morphological, yield and quality attributing traits in 9 locations. The mean fresh rhizome yield recorded across test locations ranged from 17.6 t ha^{-1} (RRN 1) to 26.7 t ha^{-1} (NVST 56). Out of eight test entries, two entries numerically showed their yield superiority over best-performing check, IISR Pragati. The entry, NVST 56 ranked first in mean fresh rhizome yield (26.7 t ha^{-1}) followed by IT 26 (26.3 t ha^{-1}), whereas the best-performing check, IISR Pragati recorded a mean fresh rhizome yield of 26.2 t ha^{-1}. CVT on light yellow coloured turmeric for specialty market, aimed in identifying the turmeric genotypes suitable for light yellow coloured turmeric production. During the second year of testing, out of 11 test entries, two entries, Acc 849 (33.7 t ha^{-1}) and PTS 50 (28.5 t ha^{-1}) surpassed the best-performing check, IISR Prathibha.

A plant protection experiment was initiated to evaluate the efficacy of priming rhizomes with trichoprime, a combination of metalaxyl-mancozeb and imidacloprid, tebuconazole with imidacloprid along with recommended POP for enhanced germination, vigour and storage rot suppression. The mean fresh yield (14 locations) ranged from 25.84 t ha^{-1} in T_4 to 28.82 t ha^{-1} in T_1. Rhizomes primed with trichoprime (T_1) was the best treatment in 9 out of 14 centers while treatment using tebuconazole with imidacloprid (T_3) was found to be the best in 3 out of 14 centers during the kharif-2021-22 season. In another plant protection experiment to standardize the spraying schedule of effective insecticides for shoot borer in turmeric, the mean fresh yield ranged from 25.27 t ha^{-1} to 19.5 t ha^{-1} (control-water spray). Spraying Chlorantraniliprole @ 0.5 ml L^{-1} (T_2) was the best treatment in 2 out of 8 centres. In another experiment, to understand the efficacy of *Trichoderma asperellum* & *Pochonia chlamydosporia* for the management of rhizome rot and nematodes in turmeric, the mean fresh rhizome yield ranged from 27.02 t ha^{-1} in control to 33.17 t ha^{-1} in *T. asperellum* talc formulation which was ranked as the best treatment in 3 out of 5 locations.

Tree spices

Among the accessions conserved and evaluated at Pechiparai, MF-4 recorded the maximum number (685.40) of fruits and the single fruit weight was also highest in MF-4. (53.55 g), and mace yield recorded per tree was 288.89 g $tree^{-1}$. While local check recorded 499 fruits per tree, single fruit weight (50.3 g) and mace yield (163.22 g $tree^{-1}$). Among the sixteen nutmeg accessions (planted during the year 1996–97) evaluated at Dapoli. the average fruit weight recorded in 2021-22 ranged between 42.1 and 76.9 g. The accession, DBSKKV 9772 recorded the maximum number of nuts (710), the highest average nut weight (76.9 g) with the highest dry nut yield (6.3 kg) and dry mace yield (1.7 kg). From overall performance, the genotype DBSKKVMF 9772 was found promising considering its fruit yield parameters.

Among the germplasm of clove planted at Dapoli during 1996-97, four promising genotypes were selected. The plant height varied from 6.42 to 7.85 m, girth ranged from 56.12 to 65.22 cm and spread varied from 2.87 to 3.92 m. No flowering was observed during the year 2021-22. Considering these growth parameters, genotype DBSKKVSA-1 was found superior to other genotypes. Among the 24 accessions at Pechiparai, SA-1 recorded the highest tree height of 13.44 m, followed by SA-3 (12.59 m) when compared with local check (11.06 m). The accession SA-3 was significantly superior to other accessions and recorded the highest stem girth (52.19 cm), leaf length (12.89 cm), leaf breadth (7.71 cm) and number of branches (20.00). Among the 24 accessions, SA3 had been identified as the best performer as the dry bud yield was 1.73 kg per tree while the local check recorded 0.53 kg per tree.

Coriander

A total of 2494 coriander germplasm accessions are being maintained by different AICRPS centres. Eighteen genotypes randomly selected from the germplasm maintained at Jobner were sown under irrigated and drought induced conditions to screen genotypes for drought tolerance. Among the genotypes screened, UD-808, RCr-436, UD-630, DD-629, RCr-684, UD-607 and RCr-475 had maximum drought tolerance characteristics. In CVT on coriander (initiated during 2021-22), 13 promising genotypes were evaluated for morphological, yield and yield-attributing traits in 14 locations. The analysis of variance revealed significant differences among the 13 genotypes for seed yield and yield-attributing characters. Mean seed yield ranged from 11.6 to 15.4 q ha^{-1}. Five genotypes viz. COR-198 (15.4 q ha^{-1}), COR-200 (14.96 q ha^{-1}), COR-197 (14.8 q ha^{-1}), COR-199 (14.66 q ha^{-1}), and COR-201 (14.8 q ha^{-1}) recorded numerically higher seed yield over best check COR-205 (14.06 q ha^{-1}). The COR-194 flowered most early at 58 days whereas COR-196 flowered late (66.8 days) as indicated by days to 50% flowering. Plant height ranged from 73.9 to 103 cm, primary branches per plant ranged from 5.2 to 6.5, secondary branches from 10.1 to 14.7, umbels per plant from 36.1 to 45.8, umbellets per umbel from 5.3 to 6.0. Test weight was higher in COR-194 (14.6 g) whereas the lowest test weight was recorded in COR-206 (10.0 g). At Jobner, Coriander CVT genotypes were also analyzed for volatile oil content which ranged from 0.41% to 0.65%. The maximum volatile oil of 0.65% was observed in COR-200 followed by 0.64% in COR-199, 0.58% in COR-194 and COR-203, while a minimum of 0.41% was recorded in COR-195, COR-202 & COR-205. COR-198 ranked first in terms of volatile oil yield (8.84 l ha^{-1}) followed by COR-197 (8.32 l ha^{-1}), COR-194 (7.42 l ha^{-1}) and COR-199 (7.07 l ha^{-1}), while the lowest volatile oil yield of 3.41 l ha^{-1} was recorded in COR-202. Among the 22 coriander genotypes screened against stem gall disease at five locations, none of them were found immune/disease-free against stem gall, though COR-174, COR-175, COR-178, COR-179 and COR-188 were found to be moderately resistant.

Cumin

A total of 1700 cumin germplasm accessions are being maintained by different AICRPS centres. Among the eighteen genotypes randomly selected from the germplasm maintained at different centres were sown in two environments, namely, irrigated and drought-induced plot to screen entries that respond well under drought conditions. Based on drought tolerance indices, UC-258, RZ-345, UC-298, RZ-345, UC-228 and RZ-209 had maximum tolerance against moisture stress environment. In the CVT on fennel (initiated during 2021-22) 13 promising genotypes were evaluated for morphological, yield and yield-attributing traits in 5 locations. The analysis of variance revealed significant differences among the 13 entries for seed yield and yield attributing characters. The mean seed yield of test entries ranged from 1.92 to 5.92 q ha^{-1}.

Two entries viz. CUM-47 (5.92 q ha^{-1}) and CUM-45 (5.92 q ha^{-1}) recorded around 17% better seed yield over best check CUM-55 (5.05 q ha^{-1}). The analysis of variance revealed significant differences among the entries for seed yield and yield-attributing characters among the 13 entries evaluated. Among test entries, CUM-44 was earlier flowering genotype (48 days) whereas as CUM-52 flowered very late (66.9 days). Also, for days to maturity ranged from 106.0 to 124.7 cm, plant height from 32.4 to 40.5 cm, number of branches per plant ranged from 5.7 to 6.8, umbels per plant from 40.4 to 72.6, umbellets per umbel ranged from 4.4 to 5.4. Test weight was higher for entry, CUM-47 and 48 (5.2 g) whereas lowest was found in entry, CUM-53 (4.6 g). Analysis of volatile oil content of the twelve entries under CVT at Jagudan, Jobner and Sanand revealed significant differences among the entries for volatile oil (%). The maximum volatile oil of 5.39 % was observed in CUM-50, followed by 5.21 % in CUM-54. While minimum of 4.25% was recorded in CUM-52. The data obtained from Jobner indicated, entry CUM-45 ranked first in terms of volatile oil yield (31.77 L ha^{-1}). A total of thirty-two (30+2) entries of cumin were screened for the resistance against powdery mildew disease at Jagudan during 2021-22. The minimum disease intensity was noticed in JCM 104 (7.50%), while the maximum disease intensity was recorded in the entry JC 21-04 (28.25%). The powdery mildew incidence ranged from 7.50 to 28.25 %. Among the 27 entries screened for resistance against blight disease at Jagudan, the minimum disease intensity was noticed in JC-18-01 (20.3 %), while the maximum disease intensity was recorded in the entry, CUM-43 (42.3 %). Two hundred eleven (208+3) entries of cumin were screened for resistance against wilt disease under wilt sick plot conditions at Jagudan. Overall wilt incidence was very high. The minimum disease intensity was noticed in GC 3 (40.25%) followed by GC 5 (42.50%), while the maximum disease intensity (100%) was recorded 179 entries. The wilt disease incidence was ranged from 40.25 to 100.00%. Also, at Jobner, eighty-two germplasm entries of cumin were screened against blight and wilt diseases. Thirteen entries found moderately resistance reaction against blight disease and eleven entries found minimum incidence of wilt disease and rest of the entries showed susceptible and highly susceptible reaction against the wilt and blight diseases. The experiment on micronutrient management in cumin initiated during 2019-20 was concluded with following recommendations: - Application of half recommended dose of zinc, iron, manganese and boron as soil application along with their foliar spray is recommended for obtaining higher yield and returns in cumin crop.

Fennel

A total of 862 fennel germplasm accessions are being maintained by different AICRPS centres. In the CVT on fennel (initiated during 2021-22) 13 promising genotypes were evaluated for morphological, yield and yield attributing traits in 14 locations. The analysis of variance revealed significant differences among the 13 genotypes for seed yield and yield attributing characters. Average seed yield ranged from 11.84 q ha^{-1} to 16.90 q ha^{-1}. Four genotypes viz. FNL-133 (16.9 q ha^{-1}), FNL-132 (16.47 q ha^{-1}), FNL-137 (15.97 q ha^{-1}), and FNL-136 (15.73 q ha^{-1}) recorded numerically higher seed yield over best check FNL-139 (15.66 q ha^{-1}). Plant height ranged from 132.9 to 155.4 cm, primary branches per plant ranged from 7.1 to 8.2, secondary branches from 16.8 to 27.5, umbels per plant from 29.7 to 40.7, umbellets per umbel ranged from 24.8 to 28.3. Test weight was higher in FNL-141 (6.11 g) whereas lowest was recorded in FNL-132 (7.89 g). The volatile oil content ranged from 1.93% in FNL-140 to 2.43% in FNL-135 and FNL-142. The maximum volatile oil of 2.43% was observed in FNL-135 as well as FNL-142 followed by FNL-139 (2.27%), FNL-130 (2.23%), FNL-133 (2.20%). FNL-132 ranked first in terms of volatile oil yield (46.19 l ha^{-1}) followed by FNL-133 (41.75 l ha^{-1}), FNL-139 (41.27 l ha^{-1}). While lowest volatile oil yield of 11.86 l ha^{-1} was recorded in FNL-141 and 11.93 l ha^{-1} in FNL-142. Experiment on evaluation of response of foliar application of iron and zinc on growth, yield and quality of fennel at Jobner, indicated the foliar spray of 0.6%

zinc sulphate recorded significantly higher plant height (92.04 cm), umbels per plant (24.26), umbellets per umbel (20.26), seeds per umbel (350.98), test weight (5.50 g), essential oil (1.80%), seed yield (22.73 q ha^{-1}), biological yield (59.20 q ha^{-1}), net returns (Rs 122267 per ha) and B:C ratio (3.53) whereas the response of the foliar spray of 0.4% iron sulphate resulted in significantly higher plant height (89.30 cm), (22.99), umbellets/umbel (19.03), seeds/umbel (327.82), test weight (5.20 g), essential oil (1.73%), seed yield (21.42 q ha^{-1}), straw yield (56.86 q ha^{-1}), net returns (Rs 113010/ha) and B:C ratio (3.47).

Fenugreek

A total of 1467 fenugreek germplasm accessions are being maintained by different AICRPS centres. Based on drought tolerance indices, RMt-354, RMt-305, UM-329, UM-216 and RMt-361 were found to be the desirable genotypes for drought conditions. During the CVT, among the 17 genotypes including checks evaluated, all 15 genotypes surpassed the seed yield of checks. FGK-154 (17.25 q ha^{-1}) was the top yielder, followed by FGK-147 (16.51 q ha^{-1}) with around 14 and 10 % yield gain over best check, FGK-156. The location average ranged from 8.35 q ha^{-1} in Kalyani to 20.75 q ha^{-1} in Hisar. Chemo-profiling of fenugreek varieties *viz.*, LS-1, Lam Methi-2 and Lam Sonali indicated that Lam Methi-2 contains higher oleoresin (4.3%) followed by Lam Sonali and LS-1. The experiment on standardizing drip irrigation interval and method of micronutrient fertigation initiated in 2019-20 was concluded with the following recommendation: - Drip irrigation at four-day intervals along with fertigation of micronutrients (Zn, Fe, Mn, B, Mo) in fenugreek is recommended for higher yield and economic returns.

Ajwain

A total of 332 accessions belonging to Ajwain is being maintained by various AICRPS centres. Coordinated Varietal Trial on Ajwain-2019 was conducted successfully with 11 entries for the third year during Rabi, 2021-22 at 7 locations viz. Ajmer, Jobner, Jagudan, Raigarh, Hisar, Kumarganj and Guntur. The analysis of variance revealed significant differences among the entries for seed yield and yield-attributing characters among the 11 entries evaluated. The mean seed yield of test entries ranged from 8.9 q ha^{-1} to 10.7 q ha^{-1}. Four entries viz. AJN-07 (10.7 q ha^{-1}), AJN-06 (10.43 q ha^{-1}), AJN-01 (10.43 q ha^{-1}), and AJN-02 (10.3 q ha^{-1}) recorded numerically higher seed yield over best check AJN-11 (10.27 q ha^{-1}). The entry AJN-05 flowered most early at 88 days whereas AJN-11 flowered almost late at 104.9 days. Test weight was higher for entry, AJN-06 (2.7 g), whereas the lowest was found in entry, AJN-10 (1.9 g). In the case of essential oil content, AJN-01 (5.9%) was found to be best, whereas AJN-06 had the lowest essential oil content of 4.7%.

Nigella

A total of 109 accessions belongs to nigella is being maintained by various AICRPS centres. Out of total seven accessions of nigella maintained at CARS, Raigarh, Chhattisgarh Nigella 1 got identified for release through Chhattisgarh State Seed Sub-committee, Raipur, Chhattisgarh. During the third-year testing in CVT, the genotype NGL-07 was found to be the best performer in terms of seed yield, yielding an average of 8.29 q ha^{-1}, across test locations, showing 2.21 per cent higher yield over the check, Pant Krishna (NGL-09). It was the top yielder at Hisar (12.5 q ha^{-1}) and Kumarganj (8.68 q ha^{-1}).

Saffron

Seventeen germplasm accessions were collected from different saffron growing areas of J&K, making the total accessions to 232. All these germplasm accessions are under evaluation for various morphological, quality, yield and yield-attributing traits. In an IET trial conducted with 11 selected accessions, genotypes SRS-Saf-178 and SRS-Saf-199 were found to be promising

with significantly higher yield and number of flowers m^{-2} over other accessions including control.

Kalazeera

Fifteen germplasm accessions were collected from high altitudes of Gurez Valley of J & K making up a total of 98 accessions. All these germplasm accessions are under evaluation for various morphological, quality, yield and yield-attributing traits. In an IET trial conducted with 8 selected accessions, genotypes SRS-KZ-177 and SRS-KZ-167 were found to be promising and showed significantly higher yield (427.3 kg ha^{-1}) over other accessions including check variety. The percent yield increase of SRS-KZ-177 over check was 29.2%.

Production and distribution of quality planting material

The AICRPS centres have multiplied and distributed 4.10 lakhs rooted cuttings of black pepper, 10336 suckers of cardamom, 45 tons of turmeric, 16 tons of ginger, 2256 grafts of nutmeg and 1500 grafts of cinnamon. In seed spices, 306 q of coriander, 70 q of cumin, 30 q of fennel, 65 q of fenugreek, 10 q of ajwain and l2 q of nigella were produced and distributed.

Transfer of technology

Scientists from AICRPS centres are actively involved in the popularization of the latest technologies to make aware the farming community about scientific cultivation practices and sustainable spice production. Some of the technologies demonstrated during the year are as follows

High-yielding varieties- a boon to farmers

- Demonstration of newly released, high-yielding turmeric variety YSRHU-Lam Swarna (Guntur)
- Demonstration of stable curcumin variety IISR Pragati at Talakanti, Suliamari, Kotia, Pottangi and Koraput, Andra Pradesh (Pottangi)
- Demonstration of high yielding fenugreek variety RMt-354 (Jobner) and RMt-1 (Jabalpur)
- Demonstration of high-yielding fennel variety RF-290 (Jobner)
- Demonstration of high-yielding cumin variety GC-4 (Mandor)
- Demonstration of high-yielding leafy coriander culture CS 38 (Coimbatore) and Cimpoo S- 33 (Jabalpur)
- Demonstration of high-yielding Panniyur black pepper varieties viz., Panniyur-8, Panniyur-9 & Panniyur-10 (Panniyur)
- Adoption of five high-yielding IISR varieties of black pepper in farmers' field *viz.*, IISR-Shakthi, IISR-Girimunda, Pournami, Panchami, Sreekara. (Pottangi)
- Adoption of Appangala-1 in Lamataput region, Andra Pradesh (Pottangi)
- Front-line demonstration of turmeric cv. RCT 1 (ICAR-Mizoram)
- Front-line demonstration of ginger cv. Bold Nadia (ICAR-Mizoram)

Rapid multiplication of planting materials- for minimal expenditure

- Protray cultivation technique for quality seed production of ginger & turmeric (Kammarpally)
- Rapid propagation method of black pepper and column method was demonstrated for farmers and students of TNAU (Pechiparai)
- Performance demonstration of the two-budded turmeric seed material on a raised bed with 3 to 4 rows with fertigation. (Kammarpally)

Micronutrients & biocapsules for soil health

- Distribution and demonstration on beneficial effects of biocapsules and micronutrient packages specific to ginger, turmeric and black pepper were taken up on a pilot scale in all the spice growing tracts through AICRPS centres
- Demonstration of micronutrients IISR Power Mix T and IISR Power mix G and bio-capsules namely *Trichoderma* sp, PGPR and *Bacillus amyloliquefaciens* from IISR Kozhikode, Kerala in farmers field for ginger and turmeric in Sikkim (ICRI Gangtok)
- Use of biocapsules of *Trichoderma* and PGPR (GRB-35) for the management of foliar diseases in turmeric. (Coimbatore, Guntur, Kammarpally).
- Front line demonstration of micro-nutrient in large cardamom for growth & yield (Nagaland).

Protection technologies- for plant health

- Technology demonstration on the effect of seed treatment with Trichoprime powder.
- Management of management of Phyllosticta leaf spot of ginger (Pundibari)
- Management of shoot fly in cardamom with fish meal traps (ICRI-Sakleshpur)
- Demonstration of bio control agents against pepper wilt (Yercard), distribution of biocapsules (PGPR, *Bacilich* and *Trichoderma*) at Pasighat.
- Priming of ginger seed rhizomes for safe storage of ginger seed rhizomes (Nagaland)

Processing machineries- for increase in efficiency

- Demonstration of value-added products preparation from *Garcinia* (Pechiparai)
- Demonstration of turmeric boilers, polishers (IISR, Kozhikode)

Apart from the above field level demonstrations, the scientists popularised technologies by conducting virtual trainings and attending as resource persons in virtual trainings and seminars and also through various media (newspaper, radio talks and TV programmes).

NEH/TSP/SCSP activities

Promotion of seed spice cultivation in NER

In order to promote and facilitate seed spice cultivation in NER, ICAR-AICRPS distributed seed materials of seed spice crops like ajwain, coriander, cumin, fennel and fenugreek through its NE centres located at Meghalaya, Mizorm, Nagaland, Sikkim, Assam and Arunachal Pradesh.

Developmental activities in Aspirational district of North East

AICRPS centre at Mizoram conducted three days training programme in aspirational districts of Mizoram *viz.*, Lunglei and Lawngtlai and TSP village of Kolasib district, training on spices cultivation for livelihood improvement and income and distribution of farm tools/ inputs and seed materials at Socunoma village and Punglwa village under Dimapur & Peren districts, Nagaland. Training on organic spices production was conducted at Peren district and Renthan under Wokha district of Nagaland, Silluk Village and Shi Yomi district, Arunachal Pradesh

Developmental activities in the tribal villages

AICRPS centre at Megalaya, Nagaland, Kumarganj, Yercaud, Coimbatore, Jabalpur and Chintapalli conducted various training on Scientific cultivation practices of spices and their processing aspects at tribal villages along with the distribution of planting materials, other inputs and machinery. Farmers were motivated to take up successful spice cultivation in abandoned and unutilised areas.

Developmental activities for SC communities

Various training programmes were conducted by AICRPS centres at Gangtok, Mandor, Sirsi, Coimbatore, Kammarpally, Hisar, Pundibari, etc. benefitting SC farmers and agricultural inputs were distributed to the farmers.

Success stories

Spice-based integrated farming system: A sustainable approach for enhancing farmers' income in Mizoram

The AICRPS centre, ICAR Research Complex for NEH Region, Mizoram has introduced a spice-based integrated farming system to help farmers in Mizoram to increase their productivity and income. The system incorporates major spices like ginger and turmeric cultivation with other crops like maize, sweet corn, rice, legumes, and plantation crops. Two farmers, Mrs. Lalsangpuii and Mrs. Lalbiakzuali, have successfully implemented this system and experienced an increase in their income and cost savings. Mrs. Lalsangpuii processes turmeric into powder and sells the products under the name "Sangpuii Aieng." Before implementing the spice-based integrated farming system, both farmers were engaged in traditional practices resulting in lower yield and productivity. The success of these two farmers highlights the potential of the spice-based integrated farming system to enhance farmers' income in Mizoram while maintaining soil health and sustaining the environment. The lessons learned from this initiative can be applied to other regions with similar climatic conditions and farming practices, promoting sustainable agriculture and improving the lives of farmers.

Revolutionizing ginger farming: A scientific storage method transforms livelihoods in Himachal Pradesh and Koraput district of Odisha

The development of a scientific storage method for ginger seed has had a significant impact on the livelihoods of farmers in Himachal Pradesh. The lack of a storage method for healthy seed for the next season led to high disease occurrence and poor rhizome yield, resulting in a decrease in the area under its cultivation. Dr YS Parmar University of Horticulture & Forestry Nauni, Solan played an active role in devising a scientific storage method, which has enabled farmers to increase ginger cultivation and improve their income. The method has been widely accepted and adopted by growers, leading to a dramatic increase in area and production of ginger even in non-conventional growing areas. Similarly, in Koraput district of Odisha, the AICRP on Spices, Pottangi intervened with modern techniques of growing ginger with new high-yielding varieties and organic packages of practices, which led to increased profitability. These success stories highlight the importance of scientific methods and modern techniques in enhancing farmers' income and promoting sustainable agriculture.

From low yields to high profits: The success story of black pepper farming in Koraput, Odisha

The adoption of modern technologies developed by AICRP on spices has led to successful black pepper cultivation in the Koraput district of Odisha, resulting in high yields and profits for farmers. Through the intervention of AICRP on Spices, Pottangi, and training provided to farmers on post-harvest techniques and plant protection measures, farmers were able to adopt new technologies and practices. The use of high-yielding varieties, organic packages of practices, and critical inputs such as seedlings and bio-pesticides *Trichoderma viride* and *Pseudomanas flouroscens* with neem cake and biofertilizers like NPK consortia resulted in bumper yields with scientific practices and management. The highest net return was obtained by one of the trainee farmers, Mr. Dama Challan, with a net return of Rs. 370000/- per hectare

and a B:C ratio of 4.08:1. This success story highlights the potential for further growth and innovation in agriculture in the region.

Reaping benefits from the adoption of scientific methodologies of turmeric cultivation and processing technologies

The AICRP on Spices centres play a crucial role in helping farmers all over India in transforming their livelihoods through the adoption of high-yielding turmeric cultivars and cost-saving, income-promoting technologies.

Mr. Sadhu Ram Chaurasia, a farmer from Uttar Pradesh, transformed his livelihood by adopting turmeric cultivation with the guidance of experts from AICRP-Spices and ANDUAT. Using NDH-1 and NDH-2 cultivars and recommended cultural practices, he earned a net profit of Rs 85,000/- in just one acre. His success story has encouraged other farmers to adopt turmeric cultivation for maximum profits. He stressed the need for a processing plant in the area and desires a method of extracting turmeric leaf oil to increase his income.

The introduction of high-yielding turmeric cultivars such as "Roma" and "IISR-Pragati", in Andhra Pradesh has transformed the livelihoods of tribal farmers. Collaboration between AICRP on Spices centre, KVK, BCT-KVK, and NGOs has resulted in increased profits for farmers. Farmers are adopting new cultivation methods and processing techniques, resulting in higher-quality products that fetch better prices in the market. The distribution of turmeric boilers, polishers, and tarpaulins has allowed farmers to process their turmeric more efficiently.

High-yielding turmeric cultivars and innovative cultivation methods have transformed the livelihood of Telangana farmer Sri. Maggidi Chinnareddy. Using raised bed farming with drip irrigation, he has been able to cultivate seven different varieties of turmeric viz., IISR Pragati, Rajendra Sonia, ACC-79, BSR-2, Rajapuri, Pitamber, and Waigon resulting in higher-quality products that fetch a better price in the market. His success is attributed to the collaboration between AICRPS centres and farmers, improving spice productivity through modern technology adoption.

Biocontrol agents for sustainable spice production

Since 2012, the bio-control laboratory funded by SHM has been producing biocontrol agents such as *Pseudomonas flourescens, Trichoderma viride, Metarhizium anisopliae, Lecanicilium lecanii, Paecilomyces lilacinus, Beauveria bassiana,* and AMF on a large scale at the Cardamom Research Station, Pampadumpara. These agents have been distributed to cardamom and black pepper farmers for pest and disease management, with 22,590 kg distributed in 2021-22 alone. The feedback from farmers has been positive, with more farmers attracted towards using these biocontrol agents and reporting their effectiveness. Similarly, Yercaud centre has also been distributing biofertilizers and growth-promoting microorganisms to farmers, with those who continuously apply them reporting better plant growth and performance during dry weather periods. The popularity towards the biocontrol technologies highlights the power of sustainable agriculture practices and the potential to reduce environmental chemical contamination and degradation of the spices growing areas. Further goal is to make more farmers aware of eco-friendly pest/disease management through the use of biocontrol agents.

Collaboration and networking

AICRP on Spices centres work in collaboration with

- ICAR- IISR, Kozhikode and ICAR-NRCSS, Ajmer (for technologies)
- Spices Board for popularization of technologies in tribal areas

- MIDH (Mission for Integrated Development for Horticulture) for producing and supplying quality planting material
- NGOs for popularizing high production technologies in tribal areas and value chain development
- State Department of Agriculture and Horticulture for increasing production, productivity and income of farmers

Monitoring

The Project coordinator and the scientists from PC unit monitored the working of various AICRPS centres and experimental plots by personal visits and online review meetings. Frequent monitoring was done through e-mail and phone calls also. Monthly progress reports and budget utilization certificates sent from the centres were reviewed critically and proper guidance was given for improvement. A spice monitoring team involving Dr. K.S. Krishnamurthy and Dr. Sharon Aravind visited Ambalavayal centre on 15.03.2022 and Thrissur Centre on 19.03.2022. They visited the field as well as other facilities and some action points were suggested. Scientists of ICAR-IISR also visited Dapoli centre and reviewed the activities of the centre. Dr. C.K Thankamani and Dr. Sharon Aravind visited the Barapani centre and suggestions were made for improvement. Dr K.S. Krishnamurthy and Dr C.K. Thankamani visited the field and other facilities of Kumarganj centre on 13.10.2022 and reviewed the progress of the centre. Apart from these, online meetings were conducted to review the activities of all the AICRPS centres at regular intervals.

The activities of the centres were also monitored through monthly reports, quarterly, half-yearly and annual report sent by the centres. Also, the XXXIII Annual Group Meeting of ICAR-All India Coordinated Research Project on Spices was conducted at ANDUAT, Kumarganj, Ayodhya, U.P. during 13-15 October 2022 to critically review the progress of projects handled by all the AICRPS centres and valuable suggestions were made for their improvement.

Profile of AICRP on Spices

ICAR- 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-fledged 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 17 mandate crops *viz.*, black pepper, small cardamom, large cardamom, ginger, turmeric, nutmeg, cinnamon, clove, coriander, cumin, fennel fenugreek, ajwain, nigella saffron, kalazeera and mango ginger. Presently the network has 38 centres including 11 co-opting centres and 8 voluntary centres representing 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. In addition to this, there are two centres functioning under project mode funding.

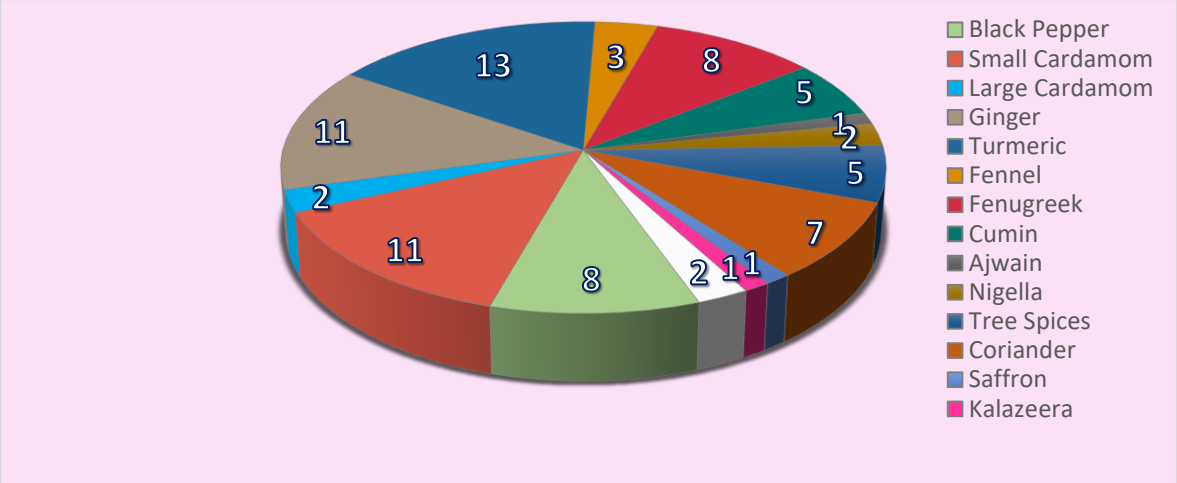


Fig 3: Number of ongoing research programs-Crop wise

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 diseases through mechanisation for production of clean spices and spice products.
- Facilitate faster adoption of proven technologies/varieties developed through technology dissemination, Field Level Demonstrations (FLDs) 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.

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

Sl. No.	State	University/ Institution	Centre	Year	Crops handled
Regular centres					
1	Andhra Pradesh	Dr YSRHU	Chintapalle	1981	Black pepper, Ginger, Turmeric
2	Andhra Pradesh	Dr YSRHU	Guntur	1975	Coriander, Fennel, Fenugreek, Ajwain
3	Bihar	RAU	Dholi	1993	Turmeric, Coriander, Fenugreek
4	Chhattisgarh	IGKV	Raigarh	1996	Coriander, Turmeric, Ginger, Ajwain, Nigella
5	Gujarat	SKDAU	Jagudan	1975	Cumin, Coriander, Fennel, Fenugreek, Ajwain
6	Haryana	CCSHAU	Hisar	1993	Coriander, Fennel, Fenugreek, Ajwain, Nigella
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	Odisha	OUAT	Pottangi	1975	Turmeric, Ginger
14	Rajasthan	SKNAU	Jobner	1975	Cumin, Coriander, Fennel, Fenugreek, Ajwain
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, Ajwain, Nigella
19	West Bengal	UBKV	Pundibari	1996	Black pepper, Turmeric, Ginger
Co-opting centres					
1	Assam	AAU	Kahikuchi	2014	Black pepper, Turmeric
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	Gangtok	2008	Large cardamom, Ginger, Turmeric
10	Tamil Nadu	TNAU	Pechiparai	2008	Black pepper, Cinnamon, Clove, Nutmeg
11	Arunachal Pradesh	CAU	Pasighat	2008	Large cardamom, Ginger, Turmeric
Voluntary centres					
1	Gujarat	NAU	Navasari	2008	Black pepper, Turmeric, Coriander
2	Gujarat	AAU	Sanand	2014	Cumin
3	Jharkhand	BIRSA AU	Kanke	2008	Ginger, Turmeric
4	Madhya Pradesh	JNKVV	Jabalpur	2008	Coriander, Fennel, Fenugreek
5	Rajasthan	AUK	Kota	2008	Coriander, Cumin, Fennel, Fenugreek, Nigella
6	Rajasthan	AUJ	Mandor	2014	Cumin
7	Uttarakhand	GBPUA&T	Pantnagar	2008	Turmeric, Coriander, Fennel, Fenugreek, Nigella
8	West Bengal	BCKV	Kalyani	2008	Ginger, Turmeric, Nigella

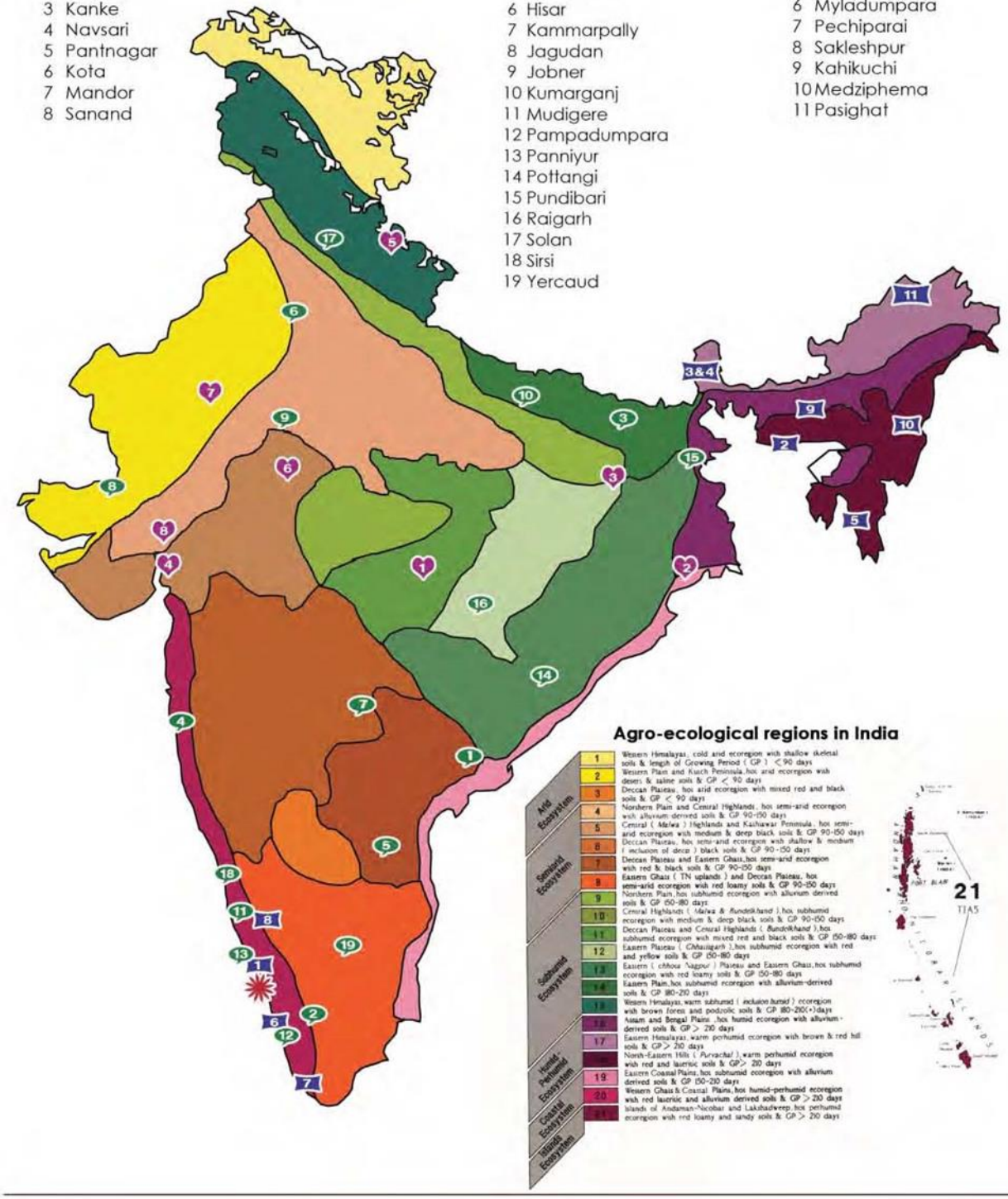
CENTRES OF AICRP ON SPICES

HEADQUARTERS
IISR, Calicut

VOLUNTARY CENTRES
1 Jabalpur
2 Kalyani
3 Kanke
4 Navsari
5 Pantnagar
6 Kota
7 Mandor
8 Sanand

REGULAR CENTRES
1 Chintapalle
2 Coimbatore
3 Dholi
4 Dapoli
5 Guntur
6 Hisar
7 Kammarpally
8 Jagudan
9 Jobner
10 Kumarganj
11 Mudigere
12 Pampadumpara
13 Panniyur
14 Pottangi
15 Pundibari
16 Raigarh
17 Solan
18 Sirsi
19 Yercaud

CO-OPTING CENTRES
1 Ambalavayal
2 Barapani
3 ICAR Gangtok
4 ICRI Gangtok
5 Kolasib
6 Myladumpara
7 Pechiparai
8 Sakleshpur
9 Kahikuchi
10 Medziphema
11 Pasighat



Technical Programme (2022)

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/3	Coordinated Varietal Trial (CVT)	
PEP/CI/3.5	CVT 2015 on Farmers varieties of black pepper – Series VII	Chintapalle, Sirsi, Panniyur, Dapoli, Yercaud.
PEP/CI/3.6	CVT 2015 on Black pepper Series VIII	Chintapalle, Sirsi, Panniyur, Dapoli, Yercaud, Kahikuchi.
PEP/CI/3.7	CVT 2018 on Black pepper Series IX	Ambalavayal, Chintapalle, Sirsi, Panniyur, Kozhikode, Dapoli, Yercaud.
PEP/CM/4	Nutrient Management Trial	
PEP/CM/4.7	Black pepper based mixed cropping system for sustainable productivity and food security	Ambalavayal, Sirsi, Panniyur, Dapoli
PEP/CP/5	Pest and Disease Management Trial	
PEP/CP/5.8	Evaluation of strobilurin fungicides and actinomycetes for the management of foot rot and slow decline in black pepper	Panniyur, Dapoli, Sirsi, Yercaud, Appangala
PEP/CP/5.10	Observational trial on the efficacy of *Trichoderma asperellum* and *Pochonia* for the management of Phytophthora foot rot and nematodes in black pepper	Sirsi, Appangala, Panniyur
PEP/CP/7.1	Screening of insecticides for Pollu beetle, *Lanka ramakrishnai* in black pepper	Panniyur, Ambalavayal, Appangala Pampadumpara,
Small cardamom		
CAR/CI/1	Genetic Resources	
CAR/CI/1.1	Germplasm collection, characterization, evaluation and conservation	Mudigere, Pampadumpara
CAR/CI/3	Coordinated Varietal Trial	
CAR/CI/3.7	CVT of drought tolerance in cardamom – Series VII	Appangala, Mudigere, Sakaleshpur, Myladumpara Pampadumpara
CAR/CI/3.8	CVT 2015 on Farmers varieties of cardamom-Series VIII	Appangala, Mudigere, Sakleshpur, Myladumpara, Pampadumpara,
CAR/CI/3.9	CVT 2018 on hybrids of cardamom-Series IX	Appangala, Mudigere, Sakleshpur, Myladumpara, Pampadumpara
CAR/CI/4	Varietal Evaluation Trial (VET)	
CAR/CI/4.4	Multilocation evaluation of thrips tolerant cardamom lines	Appangala, Mudigere, Sakleshpur, Myladumpara, Pampadumpara,
CAR/CI/4.5	MLT of leaf blight tolerant lines of small cardamom 2018	Appangala, Mudigere, Myladumpara, Sakleshpur, Pampadumpara,
CAR/CM/5	Nutrient Management Trial	
CAR/CM/5.5	Effect of micronutrients on growth and yield of small cardamom	Appangala, Sakleshpur, Mudigere, Pampadumpara, Myladumpara,

CAR/CM/5.6	Site specific recommendation for varying yield target of cardamom	Mudigere, Sakleshpur, Myladumpara, Pampadumpara,
CAR/CP/6	Pest and Disease Management Trial	
CAR/CP/6.11	Evaluation of fungicides against rhizome rot in small cardamom	Appangala, Mudigere, Pampadumpara, Myladumpara
CAR/CP/6.12	Evaluation of fungicides against leaf blight in small cardamom	Appangala, Mudigere, Pampadumpara, Myladumpara
CAR/CP/6.13	Observational trial on the efficacy of *Trichoderma asperellum* and *Pochonia chlamydosporia* for the management of rhizome rot and nematode in small cardamom	Pampadumpara, Myladumpara
Large cardamom		
LCA/CI/1	Genetic Resources	
LCA/CI/1.1	Germplasm collection and evaluation of large cardamom	ICAR Regional Station, Gangtok, ICRI Regional Research Station, Gangtok
LCA/CM/5	Nutrient Management Trial	
LCA/CM/5.1	Effect of mulching on yield of large cardamom	ICAR Gangtok, ICRI Gangtok
Ginger		
GIN/CI/1	Genetic Resources	
GIN/CI/1.1	Germplasm collection, characterization, evaluation and conservation	Barapani, Dholi, Kammarpally, Kumarganj, Pundibari, Pottangi, Raigarh, Solan
GIN/CI/2	Coordinated Varietal Trial (CVT)	
GIN/CI/2.5	CVT on disease tolerance in ginger	Barapani, Chintapalle, Kozhikode, Pundibari, Pottangi, Nagaland, Gangtok, Raigarh
GIN/CI/4	Quality Evaluation Trial	
GIN/CI/4.3	Evaluation of genotypes of ginger for vegetable purpose (observational trial)	Kozhikode, Mizoram, Gangtok, Chintapalle, Pottangi, Pundibari, Nagaland
GIN/CM/4	Nutrient Management Trial	
GIN/CM/4.1	Evaluation of different ginger based intercropping systems for higher yield and income	Pottangi, Chintapalle, ICAR Gangtok, Solan, Dholi, Pundibari, Kanke, Nagaland, Kalyani, Mizoram
GIN/CP/6	Disease Management Trial	
GIN/CP/6.15	Priming of rhizomes for enhanced germination, vigour and storage rot suppression in ginger	Chintapalle, Dholi, Barapani, Kammarpally, Pundibari, Raigarh, Solan, Kalyani, Kanke Ambalavayal, Pasighat, Nagaland, Pottangi
GIN/CP/7.1	Spray schedule optimization of effective insecticides for shoot borer (*Conogethes punctiferalis*) in ginger	Pottangi, Kahikuchi, Sirsi, Solan, Mudigere, Pundibari, Mizoram, Nagaland, Pasighat, Barapani, Ambalavayal, Kanke
GIN/CP/7.2	Observational trial on the efficacy of *Trichoderma asperellum* & *Pochonia chlamydosporia* for the management of rhizome rot and nematodes in ginger	Kozhikode, Chintapalli, Pottangi, Barapani
Turmeric		
TUR/CI/1	Genetic Resources	
TUR/CI/1.1	Germplasm collection, characterization, evaluation and conservation	Barapani, Coimbatore, Dholi, Guntur, Kammarpally, Kumarganj, Solan, Pasighat, Pottangi, Pundibari, Raigarh

TUR/CI/2	Coordinated Varietal Trial	
TUR/CI/2.7	CVT on mango ginger	Ambalavayal, Pottangi, Kozhikode, Dholi, Barapani, Pundibari, Raigarh, Navsari
TUR/CI/2.8	CVT on high yield and high curcumin	Kozhikode, Coimbatore, Guntur, Kammarpally, Pottangi, Kanke, Pasighat, Raigarh, Navsari
TUR/CI/2.9	CVT on light yellow colour turmeric for specialty market	Kozhikode, Coimbatore, Guntur, Kammarpally, Pottangi, Kanke, Pasighat
TUR/CI/3	Varietal Evaluation Trial	
TUR/CI/3.9	Initial Evaluation Trial 2018	Guntur
TUR/CP/7	Disease Management Trial	
TUR/CP/7.8	Priming of rhizomes for enhanced germination, vigour and storage rot suppression in turmeric	Chintapalle, Coimbatore, Dholi, Kammarpally, Pundibari, Raigarh, Solan, Pasighat, Ambalavayal, Mizoram, Kahikuchi, Kanke, Pottangi
TUR/CP/7.9	Spray schedule optimization of effective insecticides for shoot borer (*Conogethes punctiferalis*) in turmeric	Pottangi, Kahikuchi, Sirsi, Mudigere, Pundibari, Mizoram, Pasighat, Barapani, Pantnagar, Kammarpally, Guntur, Solan, Ambalavayal, Kanke
TUR/CP/7.10	Observational trial on the efficacy of *Trichoderma asperellum* & *Pochonia chlamydosporia* for the management of rhizome rot and nematodes in turmeric	Kozhikode, Coimbatore, Guntur, Barapani
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, Kozhikode, Thrissur, Pechiparai
TSP/CI/2	Coordinated Varietal Trial	
TSP/CI/2.2	CVT 2001 – Nutmeg	Dapoli, Pechiparai
TSP/CI/2.4	Coordinated Varietal Trial on farmer's varieties of nutmeg	Dapoli, Pechiparai, Thrissur
Project Mode	Evaluation of nutmeg genotypes	KAU Thrissur
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, Raigarh
COR/CI/1.3	Identification of drought/alkalinity tolerant source in coriander	Jobner
COR/CI/2	Coordinated Varietal Trial	
COR/CI/2.8	Coordinated Varietal Trial in coriander 2021- Series XI	Ajmer, Coimbatore, Dholi, Guntur, Hisar, Jabalpur, Jagudan, Jobner, Kumarganj, Navsari, Pantnagar, Kota, Raigarh, Kalyani, Sanand
COR/CI/4	Quality Evaluation Trial	
COR/CI/4.1	Quality evaluation in coriander	Jobner
COR/CP/6	Disease Management Trial	
COR/CP/6.7	Integrated pest and disease management in coriander	Ajmer, Coimbatore, Dholi, Hisar, Jabalpur, Raigarh, Jobner, Jagudan, Kumarganj, Pantnagar, Kota

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/1.3	Identification of drought tolerance	Jobner
CUM/CI/2	Coordinated Varietal Trial	
CUM/CI/2.5	Coordinated Varietal Trial in cumin – 2021	Ajmer, Jagudan, Jobner, Mandor, Sanand
CUM/CI/4	Quality Evaluation Trial	
CUM/CI/4.1	Quality evaluation in cumin	Jobner
CUM/CM/5	Nutrient Management Trial	
CUM/CM/5.5	Micronutrient management in cumin	Jobner, Jagudan, Mandor, Ajmer
CUM/CP/6	Disease Management Trial	
CUM/CP/6.8	Integrated pest and disease management in cumin	Ajmer, Jobner, Jagudan, Mandor
Fennel		
FNL/CI/1	Genetic Resources	
FNL/CI/1.1	Germplasm collection, characterization, evaluation, conservation and screening against diseases	Dholi, Hisar, Jagudan, Jobner, Kumarganj, Navsari
FNL/CI/2	Coordinated Varietal Trial	
FNL/CI/2.8	Coordinated Varietal Trial in fennel 2021 – Series XI	Ajmer, Dholi, Hisar, Jabalpur, Jagudan, Jobner, Kumarganj, Pantnagar, Navsari
FNL/CI/4	Quality Evaluation Trial	
FNL/CI/4.1	Quality Evaluation in fennel	Jobner
FNL/CM/5	Nutrient Management Trial	
FNL/CM/5.1	Response of foliar application of iron and zinc on growth, yield and quality of fennel	Jagudan, Jobner, Hisar, Dholi, Kumarganj, Mandor
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, Raigarh
FGK/CI/1.3	Identification of drought tolerance source in fenugreek	Jobner
FGK/CI/2	Coordinated Varietal Trial	
FGK/CI/2.5	Coordinated Varietal Trial in fenugreek 2021 – Series XI	Ajmer, Dholi, Hisar, Jabalpur, Jagudan, Jobner, Kumarganj, Navsari, Pantnagar, Kota, Raigarh, Kalyani
FGK/CI/3	Varietal Evaluation Trial	
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/CM/5	Nutrient Management Trial	
FGK/CM/5.9	Standardization of drip irrigation interval and method of micronutrient fertigation in fenugreek	Ajmer, Coimbatore, Jagudan, Jobner, Kumarganj, Pantnagar, Raigarh, Kota
Ajwain		
AJN/CI/2	Coordinated Varietal Trial	
AJN/CI/2.1	Coordinated Varietal Trial- 2019	Ajmer, Guntur, Hisar, Jobner, Jagudan, Kumarganj, Raigarh
Nigella		
NGL/CI/2	Coordinated Varietal Trial	
NGL/CI/2.1	Coordinated Varietal Trial-2019	Ajmer, Hisar, Kota, Kalyani, Kumarganj, Raigarh, Pantnagar

Saffron		
Project mode	Conservation, evaluation and utilization of exotic and indigenous saffron germplasm lines	Pampore
Kalazeera		
Project mode	Exploration, collection and conservation of kalazeera from high altitudes of northern Himalayas	Pampore
Seed spices		
SS/CM/4	Nutrient Management Trial	
SS/CM/4.1	Intercropping of seed spices with vegetables for higher yield and income	Jobner, Dholi, Kumarganj, Raigarh, Jagudan, Jabalpur
SS/CP/7.1	Survey and monitoring of diseases and insect pests of seed spices for development of prediction models	Ajmer, Jobner, Jagudan, Guntur, Kumarganj, Raigarh, Dholi, Kalyani, Sanand, Coimbatore, Kammarpally

01 BLACK PEPPER

Genetic Resources

PEP/CI/1.1 Germplasm collection, characterization, evaluation and conservation (Centres: Ambalavayal, Chintapalle, Dapoli, Panniyur, Pundibari, Sirsi, Yercaud)

A total of 690 black pepper germplasm accessions are being maintained by different AICRPS centres nationwide. The details of germplasm collections of black pepper maintained at various AICRPS centres are presented in Table 1.

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

Centre	Indigenous		Exotic	Total
	Cultivated	Wild & related species		
Ambalavayal	30	-	-	**30**
Chintapalle	26	-	-	**26**
Dapoli	62	-	-	**62**
Panniyur	335	56	3	**394**
Pundibari	22	-	-	**22**
Sirsi	75	-	-	**75**
Yercaud	25	3	-	**28**
Pampadumpara	53	-	-	**53**
Total	**628**	**59**	**3**	**690**

Currently, 394 accessions (335 cultivated types, 56 wild & related types and 3 exotic types) of black pepper are being maintained at PRS, Panniyur. Ten new accessions were collected during 2021-22 from farmers' fields at Wayanad and Iritty and planted in the nursery for multiplication. During the year 2021-2022, the genotypes PRS 124 and Panniyur 5 (PRS 116) were the top yielders. PRS 124 ranked first with 4.50 kg green berry yield and 982 spikes/vine followed by Panniyur 5 with 4.35 kg green berry yield and 978 spikes vine^{-1}. Spike length was maximum in PRS 119 (16 cm). The number of developed berries/ spikes was more in PRS 137 (78). The 100-berry weight was high for PRS 126 (13 g). The dry recovery % was more for PRS 124 (36.40%). A new accession (RMH Salkani) was added to the vast collection of germplasm maintained at AICRPS centre at Sirsi during 2022. Fifty-three promising germplasm accessions are maintained in polyhouse after culling out duplicates and these are also planted in the main field for evaluation along with national checks. Among the 16 different genotypes evaluated at Dapoli, maximum height of vine (5.70 m) was observed in DBSKKVPN-3 (IC-0611290) whereas minimum height (1.60 m) was noted in DBSKKVPN-13. The maximum yield per vine was observed in genotype DBSKKVPN-19 (648.12 g vine^{-1}) whereas minimum was recorded in DBSKKVPN-13 (25 g vine^{-1}). A total of 30 accessions are maintained in the germplasm block at Ambalavayal which are mostly released varieties. At Pundibari, 22 black pepper accessions including released varieties and genotypes collected from Sub-Himalayan Terai region adjoining Bhutan boarder (including Totopara) are being maintained. Among 28 germplasm accessions maintained at Chintapalle centre, Panniyur-1 recorded the highest number of spikes per vine (623.27), fresh berry yield per vine (3.92 kg), dry yield (1.23 kg), fresh yield per ha (3.94 t ha^{-1}) whereas the highest no. of berries per spike

was recorded in Neelamundi (82) and highest dry recovery was recorded in Perambramundi (31.83 %). At Yercaud, 8 new germplasm accessions of black pepper were collected with high-yielding trait from the different locations of Yercaud and Kolli hills and are planted. During the 2022-23, 28 accessions were evaluated for the yield characters viz., spike length, number of berries per spike. The spike length ranged from 7.50 cm to 12.03 cm. The highest spike length was observed in PN 74 (12.03 cm) and the lowest spike length was observed in PN 58 (7.50 cm). Accession PN 47 recorded maximum mean number of berries per spike (65.32) followed by PN 60 (63.57) and PN 33 (62.37). The minimum number of berries per spike was observed in the entry PN 55 (33.63).

Crop Improvement

PEP/CI/3 Coordinated Varietal Trial (CVT)

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 2021-22, 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. But for number of berries per spike Kumpakkal showed superiority with 50.09 over 43.84 in check, Panniyur. (Table. 2)

Table 2. Pooled data of yield parameters recorded across testing locations for CVT 2015 on Farmers' varieties during 2021-22

Entries	Spike length (cm)	Number of berries per spike	Fresh berry yield per vine (kg)	Dry berry yield per vine (kg)	Dry recovery (%)
Zion mundi	9.11	40.72	0.53	0.17	32.05
Kumpukkal	9.62	50.09	0.61	0.21	31.96
Pepper Thekkan	8.19	41.87	0.37	0.11	30.98
Panniyur 1 (Check)	10.4	43.84	0.67	0.22	32.05
Mean	**9.33**	**44.13**	**0.55**	**0.18**	**31.76**

There was significant difference among the treatments with respect to the yield-related characters such as the average number of berries per spike, spike length, fresh berry yield, dry berry yield and dry recovery at Panniyur centre. Among the entries, Panniyur-1 recorded highest spike length of 12.80 cm which was on par with Karimunda (12.43 cm) and Zion mundi (12.13 cm). Panniyur-1 (39.43) recorded maximum average number of berries per spike which was statistically on par with Zion mundi (38.03) and Kumpukkal (35.20). Kumpukkal recorded highest fresh berry yield of 1.35 kg vine^{-1} which was on par with Karimunda (1.27 kg vine^{-1}), Panniyur-1 (1.26 kg vine^{-1}) and Zion mundi (1.18 kg vine^{-1}). Maximum dry berry yield was observed in Kumpukkal (0.51 kg vine^{-1}) followed by Karimunda (0.42 kg vine^{-1}) and Panniyur-1 (0.41 kg vine^{-1}). Lowest dry berry yield was recorded in Pepper Thekkan (0.21 kg/vine). The dry recovery per cent was the highest in Kumpukkal (37.80 %) followed by Panniyur-1 (32.73 %) and Karimunda (32.33 %) (Table. 3).

Table 3. CVT 2015 on Farmers' varieties – Yield parameters at PRS, Panniyur during 2021-22

Entries	Average spike length (cm)	No of berries / spike	Green berry yield (kg)	Dry berry yield (kg)	Dry recovery %
Zion mundi (T_1)	12.13^{a}	38.03^{a}	1.18^{a}	0.35^{b}	29.90^{c}
Pepper Thekkan (T_2)	9.77^{b}	25.33^{c}	0.67^{b}	0.21^{c}	30.67^{c}
Kumpukkal (T_3)	10.27^{b}	35.20^{ab}	1.35^{a}	0.51^{a}	37.80^{a}
Panniyur-1 (T_4)	12.80^{a}	39.43^{a}	1.26^{a}	0.41^{b}	32.733^{b}
Karimunda (T_5)	12.43^{a}	28.87^{bc}	1.27^{a}	0.42^{b}	32.33^{b}
CD (0.05)	1.49	7.54	0.234	0.08	1.04
CV %	6.89	12.07	10.91	10.79	1.69

At Sirsi, among the four different varieties, the national check variety (Panniyur-1) recorded the highest mean height (3.70 m) and spike length (10.70 cm,) and lowest height (1.71 m) by Zion mundi and lowest spike length (4.87 cm) was recorded in Pepper Thekkan. Concerning number of berries per spike and number of spikes, in Kumpukkal recorded maximum (46 & 34 cm respectively) followed by Panniyur-1 compared to other varieties. Among all four varieties Panniyur-1 recorded highest green berry yield per vine (0.805 kg), followed Kumpukkal (0.505 kg) and lowest yield (0.200 kg) was recorded in Thekkan. (Table. 4)

Table 4. CVT 2015 on Farmers' varieties – Yield parameters at PRS, Sirsi during 2021-22

Entries	Average spike length (cm)	No of berries / spike	Green berry yield (kg)	Dry berry yield (kg)	Dry recovery %
Zion mundi (T_1)	5.92	22	0.480	0.173	36.2
Pepper Thekkan (T_2)	4.87	18	0.200	0.073	35.7
Kumpukkal (T_3)	9.45	46	0.505	0.190	34.7
Panniyur-1 (T_4)	10.70	34	0.805	0.280	34.9
CD (0.05)	1.49	7.54	0.234	0.08	NS
CV %	11.35	11.65	11.90	23.65	10.71

At Chintapalle, Kumpukkal recorded the maximum plant height (4.26 m), a greater number of branches (18.61) and no. of berries per spike (95.47). Panniyur-1 recorded the highest berry yield per vine (0.79 kg fresh and 0.24 kg dry berry) and dry recovery percentage (30.84%). At Yercaud, the highest vine length was recorded in Zion mundi (3.23 m) followed by Kumpukkal (3.11 m). The maximum number of branches per vine was recorded in Thekkan (10.95). The highest number of spikes per meter square (31.98) was recorded in Kumpukkal followed by Panniyur 1 (29.04). The number of berries per spike was highest in the variety Panniyur 1 (57.10) followed by Zion mundi (55.88). At Dapoli, the genotype Pepper Thekkan recorded the maximum plant height (1.46 m), whereas the genotype Zion mundi recorded minimum plant height (0.67 m), and a greater number of berries per spike (72.90) whereas a greater number of spikes per vine (15.62). Zion mundi recorded the highest spike length (10.12 cm) while maximum fresh weight (85.73 g) and dry weight (25.00 g) were observed in Pepper Thekkan.

PEP/CI/3.6 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 2021-22, there was no significant difference among the treatments with respect to the yield-related characters at Panniyur. Highest average spike length was recorded in PRS 161 (19.93 cm) followed by Karimunda (15.53 cm) which was on par with SV 17 (15.23 cm). At Yercaud, the highest vine length was recorded in IISR Thevam (3.07 m) followed by Vijay (3.00 m). The maximum number of branches per vine was recorded in PRS 161 (9.66). The highest number of spikes per meter square (18.77) was recorded in IISR Thevam followed by Panniyur 1 (18.45). The number of berries per spike was highest in the variety Vijay (82.63) followed by PRS 160 (81.70). (Table. 5). At Kahikuchi, Panniyur-1 recorded the highest fresh & dry berry weight per vine (2.97 & 1.01 kg) followed by Arka Coorg Excel (2.75 & 0.85 kg). At Sirsi, Panniyur-1 recorded the highest vine length (3.20 m) followed by SV-11 (2.75 m) and lowest vine length was observed in PRS-161 (1.66 m). Crop is in vegetative stage at Chintapalle. The trial at Dapoli has been completely lost due to the "Nisarga" cyclone during June, 2020 and has been replanted. The growth of all genotypes is satisfactory. Panniyur-1 recorded highest plant height (3.55 m), maximum number of spikes (129.12), maximum number of berries per spike (85.50) and maximum dry berry yield (165.82 g $vine^{-1}$) while maximum dry recovery was recorded in Vijay (30.19 %).

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 %
PRS 161 (T_1)	19.93^{a}	70.10	1.41	0.52	37.13
PRS160 (T_2)	13.40^{b}	27.33	1.39	0.46	33.55
SV17 (T_3)	15.23^{bc}	40.20	1.37	0.45	32.31
SV11 (T_4)	13.08^{cd}	46.53	1.36	0.48	35.20
Panniyur-1 (T_5)	13.13^{d}	47.00	1.37	0.47	35.01
Panniyur 5 (T_6)	13.97^{d}	50.36	1.39	0.50	35.23
Karimunda (T_7)	15.53^{d}	41.60	1.56	0.55	35.02
Arka Coorg Excel (T_8)	13.63^{d}	25.80	1.56	0.50	32.01
Vijay (T_9)	10.67^{e}	51.67	1.34	0.45	33.28
CD (0.05)	1.409	NS	NS	NS	NS
CV %	5.699	39.46	8.87	8.19	2.23

PEP/CI/3.7 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.

Among 11 entries, national check Panniyur-1 recorded the highest number of spikes (18.0) followed by IISR-Thevam (14.0) and least in HP 117 x Thommankodi (IISR). HP-780 (IISR) recorded the highest vine length (3.35 m) followed by OPKM (IISR) and Panniyur-1 (3.25 m) and lowest in Ponmani (IISR) (2.05 m). Analysis of variance for different yield parameters at Dapoli centre suggested a significant difference among test entries for characters studied except for plant height. Among the genotypes, only OPKM and HP-1411 were better, with 28.7% and 10.9% fresh weight gain over the check Panniyur-1. The variety OPKM recorded the maximum height of 1.82 m and spike length of 12.05 cm. The maximum number of spikes per plant (14.23) was recorded in HP-780. OPKM registered the highest yield (42.60 g vine^{-1}) while the maximum dry recovery was recorded in HP-780 (31.17 %). (Table. 6)

Table 6. CVT 2018 – Yield parameters recorded at Dapoli

Entries	Average height (m)	Number of spikes/ vines	Spike length (cm)	Number of berries/ spike	Fresh weight (g/vine)	Dry weight (g/vine)	Dry recovery (%)
Kumpukkal	1.10	12.35	10.56	61.50	83.61	25.20	30.14
HP 780	1.24	14.23	11.02	66.63	97.59	30.42	31.17
Ponmani	1.05	10.23	9.78	58.57	67.56	20.12	29.78
SV-7	1.30	10.2	9.84	89.56	98.52	30.00	30.45
HP-1411	1.62	11.1	10.25	98.90	131.53	38.00	28.89
OPKM	1.82	13.41	12.05	88.69	152.58	42.60	27.92
PRS- 137	1.26	10.56	11.82	54.48	72.91	20.48	28.09
Kurimalai (KM)	1.18	9.78	10.02	61.79	68.33	20.32	29.74
New HP (IISR)	1.28	8.05	8.98	85.39	84.92	24.16	28.45
Thevam	0.52	9.78	8.65	54.46	65.80	18.72	28.45
Panniyur–1 (Check)	1.72	11.35	10.24	95.49	118.52	35.84	30.24
Mean	1.28	11.03	10.29	74.13	94.71	27.81	23.39
S. Em ±	0.12	1.23	1.10	3.42	3.36	1.10	1.42
CD (p=0.05)	NS	2.82	3.20	10.82	10.12	3.22	3.02
CV	3.21	16.26	10.20	23.47	29.27	11.95	3.53

Among the entries evaluated at Yercaud, the highest vine length of 3.34 m was recorded in HP 1411. IISR Thevam recorded the highest number of branches per vine (7.30). Whereas SV 7 recorded the highest spike length of 12.30 cm and the highest no. of berries per spike was recorded in Kurimalai (68.00). At AICRPS centres viz., Ambalavayal, Chintapalle, Panniyur, 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
(Ambalavayal, Sirsi, Panniyur, Dapoli)

The black pepper-based mixed cropping system trial for ensuring sustainable productivity and food security was initiated in 2014 at four centres (Ambalavayal, Sirsi, Panniyur and Dapoli) with colocasia, arrowroot, greater yam, elephant foot yam and tapioca as intercrops.

Among the intercrops, greater yam recorded maximum yield of 10.71 kg, followed by elephant foot yam (8.00 kg) from an inter space of 4 m x 2 m between black pepper vines at Panniyur. The green berry yield, Spike yield and number of laterals in black pepper remained unaffected by intercropping. The mixed cropping system did not deplete the soil nutrient status as the soil data clearly indicated that the available nutrient content was high. Pest and disease incidence in black pepper was unaffected due to intercrops. From the results, it can be concluded that intercrops have not affected the yield of the black pepper and the mixed cropping system is beneficial. Among the treatments, highest BC ratio was obtained in the mixed cropping system, T_5- greater yam+ black pepper (3.98), followed by T_3- elephant foot yam + black pepper (3.83) realizing more revenue from those systems.

In the cropping system trial with black pepper (Panniyur-1), colocasia, elephant foot yam, sweet potato (red and white types) and mango ginger under arecanut at Sirsi, elephant foot yam performed better (6.20 kg plant^{-1}) among the intercrops. The highest B:C ratio was observed in black pepper intercropped with elephant foot yam (1.81), followed by black pepper intercropped with colocasia (1.49).

As per the observations recorded at Ambalavayal, there was no significant variation in the black pepper yield among the treatments. Among the intercrops evaluated, highest yield was observed in greater yam (0.925 kg plant^{-1}), which was on par with colocasia (0.82 kg plant $^{-1}$). At Dapoli, among the intercrops, elephant foot yam recorded the highest yield (11.43 kg plot^{-1}) followed by tapioca (10.22 kg plot^{-1}) and greater yam (7.21 kg plot^{-1}). Maximum plant height (3.04 m) was recorded in T_1, in black pepper as compared to monocrop (T_6) (2.20 m), whereas the maximum yield of black pepper was recorded in treatment T_3 (0.533 kg plot^{-1}).

Crop Protection

PEP/CP/5.8 Evaluation of strobilurin fungicides and actinomycetes for the management of foot rot and slow decline in black pepper
(Panniyur, Dapoli, Sirsi, Yercaud, Appangala)

Among the six treatments, T_4 (foliar application of metalaxyl-mancozeb @ 1.25 g L^{-1} and soil application of metalaxyl-mancozeb @ 1.25 g L^{-1} + carbosulfan 1 ml L^{-1}) and T_5 (POP-foliar application of potassium phosphonate 3 ml L^{-1} and soil application of carbosulfan 1 ml L^{-1} @ 2-3 litres vine^{-1}) were found to be superior in reducing the yellowing of vines in black pepper with 2.5% PDI. The number of berries/spikes (97.68 and 97.18, respectively), average spike length (18.5 cm and 18.3 cm, respectively), 100 berry weight (15.69 g, 16.38 g), dry recovery (33.43% and 32.93%) and dry berry yield (1.6 kg vine^{-1} each) were significantly higher in T_4 compared to other treatments at Panniyur. The results at Sirsi revealed that the treatment T_3 *i.e.*, foliar application of ergon 44.3% (W/W) [kresoxim methyl 500 g L^{-1}] and soil application of ergon 7 ml L^{-1} + carbosulfan 1ml L^{-1} @ 2-3 L vine^{-1} recorded least foliar infection (12.97%) and defoliation (12.50%) followed by T_4, *i.e.*, foliar application of metalaxyl+mancozeb @ 1.25 g L^{-1} and soil application of metalaxyl+mancozeb @ 1.25 g L^{-1} + carbosulfan 1 ml L^{-1} (14.16% and 18.74%

respectively) as compared to control (34.31% and 47.90% respectively). Among all the treatments highest green berry yield was recorded in T_3 (29.22 q ha^{-1}), followed by T_4 (26.95 q ha^{-1}). The least green berry yield was recorded in control (17.40 q ha^{-1}) (Table. 7). At Yercaud, the treatment T_2 recorded the maximum number of branches per vine (48.15), fruit set percent (67.05), and spike length (11.61 cm). Whereas the highest average number of berries per spike (82.43) was recorded in the T_4. However, at Appangala, among the treatments, T_2 (foliar spray with Bordeaux mixture (1%) and soil application of *Trichoderma harzianum* (MTCC 5179) and *Pochonia chlamydosporia* (MTCC 5412) @ 50 g $vine^{-1}$) was found to be superior over the other treatments in terms of PDI followed by T_3 (foliar application of ergon 44.3% (W/W) [kresoxim methyl 500 g l^{-1}] and soil application of ergon 7 ml L^{-1} + carbosulfan 1 ml L^{-1} @ 2-3 L $vine^{-1}$).

Table 7. Evaluation of strobilurin fungicides and actinomycetes for the management of foot rot and slow decline in black pepper at Sirsi

Treatments	PDI (%)			Nematode (%)	Green berry yield (q ha^{-1})
	Foliar infection (0-3)	Defoliation (0-3)	Yellowing (0-3)	Yellowing (1-5)	
T_1: Foliar spray with Bordeaux mixture (1%) and soil application of combination of Actinobacteria (Act 1+5+9) (@ 50 g $vine^{-1}$	17.17 (24.48)	24.99 (29.99)	16.66 (24.09)	23.75 (29.17)	24.59
T_2: Foliar spray with Bordeaux mixturé (1%) and soil application of *Trichoderma harzianum* (MTCC 5179) and *Pochonia chlamydosporia* (MTCC 5412) @ 50 g $vine^{-1}$	16.97 (24.32)	22.91 (28.60)	14.58 (22.45)	26.25 (30.82)	26.89
T_3: Foliar application of ergon 44.3% (W/W) [kresoxim methyl 500 g L^{-1}] 7 ml L^{-1} and soil application of ergon 7 ml L^{-1} + carbosulfan 1 ml L^{-1} @ 2-3 L $vine^{-1}$	12.97 (21.11)	12.50 (20.70)	12.50 (20.70)	22.50 (28.32)	29.22
T_4: Foliar application of metalaxyl-mancozeb @ 1.25 g L^{-1} and soil application of metalaxyl-mancozeb @ 1.25 g L^{-1}+ carbosulfan 1 ml L^{-1}	14.16 (22.11)	18.74 (25.65)	14.58 (22.45)	27.50 (31.63)	26.95
T_5: Foliar spray with Bordeaux mixture (1%) and soil application of copper oxychloride @ 2.5 g L^{-1}	19.34 (26.09)	33.32 (35.26)	14.58 (22.45)	33.75 (35.52)	26.00
T_6: Control	34.31 (35.86)	47.90 (43.80)	39.57 (38.98)	45.00 (42.13)	17.40
S. Em. ±	1.25	2.18	2.01	2.43	1.99
CD at 5 %	3.77	6.58	6.06	7.31	6.01

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. (Sirsi, Appangala, Panniyur)

Treatments were imposed at Sirsi and Appangala (at ICAR-IIHR, CHES, Chettali) in the variety, Panchami. At Appangala, there were no significant difference among the treatments and control as the natural incidence of disease was low during the year. Observations recorded at Panniyur centre showed lower *Phytophthora* foot rot disease incidence in T_4 *ie.*, metalaxyl-mancozeb (drenching @ (0.125%) and T_6 *i.e.*, recommended nematicide (drenching carbosulfan 25 EC @ 1 g L^{-1}) with 7.5 PDI. At Sirsi, treatment T_3 *ie.*, drenching of metalaxyl+mancozeb @ 1.25 g L^{-1} recorded least foliar infection (19.22%) and it was on par

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

with T_1 (20.67%) and T_2 (22.16%). The highest foliar infection was recorded in the control (34.87%). Among all the treatments, the highest green berry yield was recorded in T_1 (27.63 q ha^{-1}), followed by T_4 (24.89 q ha^{-1}) and the least yield was recorded in control (18.31 q ha^{-1}).

PEP/CP/7.1: Screening of insecticides for pollu beetle, *Lanka ramakrishnai* in black pepper
(Panniyur, Ambalavayal, Pampadumpara, Appangala)

Experimental plants were selected, treatments were imposed during August 2021, and observations were recorded at Panniyur and Appangala. At Panniyur, among different treatments, the percentage of damage was least for Chlorantraniliprole @ 0.3 ml L^{-1} (T_1) and Chlorantraniliprole @ 0.5 ml L^{-1} (T_2), which were on par with 11.5 percent damage. All the treatments were on par for controlling the pest incidence at Ambalavayal and Pampadumpara. The treatments were imposed at Appangala during 2021, and the average infestation ranged from 3.06 to 5.77 percent among the treatments except for untreated checks. The average number of berries per spike ranged between 26.1 to 84, and the average number of berries infested per spike was in between 1.33 to 3.57. The treatments viz., Chlorantraniliprole @ 0.5 ml & Flubendiamide @ 0.5 ml were on par and recorded the lowest percent infestation (3.06 to 3.44%) compared to other treatments.

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

02 SMALL CARDAMOM

Genetic Resources

CAR/CI/1.1 Germplasm collection, characterization, evaluation and conservation (Mudigere, Pampadumpara)

A total of 323 cardamom accessions are presently conserved at AICRPS centres viz., Pampadumpara and Mudigere jointly (Table 8).

Table 8. Small cardamom germplasm collections maintained at various AICRPS centres

AICRPS Centre	Cultivated	Wild and related species	Total
Mudigere	132	Nil	132
Pampadumapra	188	3	191
Total	**310**	**3**	**323**

At Pampadumpara centre, two unique accessions of small cardamom have been collected during 2021-22 namely, *Miracle elaichi* and *Erumathuruthiyil* elam from Adimali and Vandiperiyar areas of Idukki district respectively.

Fig 6:* A. *Erumathurutiyil elam **B. *Miracle elaichi***

At Pampadumpara centre obtained IC numbers for 29 accessions during the year. Also, out of 188 cultivated accessions, 15 accessions were characterised for yield parameters in which PPK-2 (CRSP 23) was found promising for 100 capsule weight, capsule volume and also for capsule length. The fresh and dry weight of capsules were higher in BEP 2 (Table. 9).

Among the germplasm accessions evaluated at Mudigere, M-2 recorded maximum plant height (365.32 cm) and SKP-170 recorded maximum tillers per clump (70.56), SKP-170 was found to be the best for panicles per clump and yield per plant (30.18) and (450.50 g plant^{-1}) respectively.

Table 9. Performance of germplasm accessions evaluated at CRS, Pampadumpara

Accession number	Pedigree	100 capsule weight (g)	100 capsule volume (ml)	Capsule length (cm)	Capsule width (cm)	No. of seeds/ capsule	Fresh weight (g)	Dry weight (g)	Dry recovery (%)
CRSP 22	PPK 1	136	120	1.7	1.46	21	398	67	16.7
CRSP 3	PV3	100	100	1.5	1.45	18	310	63	20.3
CRSP 2	PV2	100	100	1.5	1.15	16	349	62	17.8
CRSP 23	PPK 2	139	150	2	1.15	19	448	67	15.0
CRSP	PS28	115	120	2	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 135	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	SAM1	81	70	1.5	1.31	16	191	36	18.8
CRSP 24	BEP 1	110	120	2	1.15	16	293	50	17.1
CRSP 25	BEP 2	109	110	1.5	1.27	20	455	79	17.4
CRSP 4	PV 4	89	100	1.5	1.11	21	152	26	17.1
CRSP 132	BABU 3	85	100	1.9	1.15	13	150	30	20.0

Crop Improvement

CAR/CI/3.7 CVT of drought tolerance in cardamom – Series VII
(Centres: Appangala, Mudigere, Sakaleshpur, Myladumpara Pampadumpara)

The coordinated varietal trial of drought tolerance in cardamom aims to identify moisture stress tolerant cardamom genotypes. The trial laid out in split plot design with two main treatments (control and moistures stress), each with seven genotypes (IC 349537, IC 584058, GG×NKE-12, IC 584078, CL 668, HS 1, IC 584090) with one check (Appangala 1) as sub treatments with three replications. The trial was initiated during 2017 at 5 AICRPS centres. Moisture stress was imposed during summer (February to April) in stress block by withholding irrigation, whereas control block was irrigated by sprinkler (25 mm) once in 12-15 days interval. The characters like plant height, number of tillers/clump (yielding and non-yielding), number of green leaves per tillers, total number of panicles per plants, length of panicle (cm) and capsule yield (kg ha^{-1}) were recorded.

During the final year of evaluation during 2021-22, at Appangala, plant height, number of yielding tillers per clump, number of panicles per clump, panicle length and number of capsules per panicle recorded significant variation between the treatments (control vs moisture stress), among genotypes and their interaction. It was observed that all the growth parameters of cardamom were reduced under stress (Table. 10).

Photosynthetic rate (µ moles m^{-2} s^{-1}) ranged from 8.883 to 3.123 under control and 8.8 to 3.153 under stress. Stomatal conductance (m moles m^{-2} s^{-1}) ranged from 0.15 to 0.060 in control and

in stress it ranged from 0.170 to 0.090. Chlorophyll fluorescence ranged from 0.803 to 0.76 in control and from 0.793 to 0.763 under stress.

Table 10. Effect of moisture stress on yield & other growth parameters of small cardamom entries recorded at Appangala, in CVT of drought tolerance, 2021-22.

Entries	Plant height (cm)			No. of yielding tillers			No. of panicles/ plant			Length of panicle (cm)			No. of capsules/ panicle		
	T_1	T_2	Mean	T_1	T_2	Mean	T_1	T_2	Mean	T_1	T_2	Mean	T_1	T_2	Mean
IC 349537	283	240	261.5	15	14	14.5	24	22	22.7	65	47	56.1	108	89	98.4
IC 584058	289	265	277.4	16	14	14.9	26	21	23.7	60	53	56.5	144	98	120.8
GG × NKE-12	263	266	264.7	14	14	14.1	22	23	22.4	56	45	50.6	119	93	106.0
IC 584078	272	249	260.7	10	15	12.5	16	24	19.8	42	42	41.9	81	71	76.0
CL 668	261	251	256.0	14	14	13.9	24	20	21.7	35	35	34.9	92	78	84.9
HS-1	281	270	275.6	16	14	15.1	24	22	22.7	52	35	43.1	113	71	92.0
APG-1	285	257	271.0	17	16	16.5	28	23	25.3	38	48	43.4	240	108	173.9
IC 584090	280	254	266.8	16	11	13.1	25	16	20.5	45	39	42.1	93	55	74.1
Mean	**277**	**257**		**15**	**14**		**24**	**21**		**49**	**43**		**124**	**83**	
	V	T	V x T	V	T	V x T	V	T	V x T	V	T	V x T	V	T	V x T
CD (0.05)	19.1	9.6	27.0	2.5	1.3	3.6	4.7	2.3	6.6	9.9	5.0	14.0	36	18	51.9
CV (%)	6.08			14.91			17.79			18.24			30.15		

Entries	Yield (kg/ha)		Essential oil (%)		Oleoresin (%)		8 mm capsule %	
	Control	Stress	Control	Stress	Control	Stress	Control	Stress
IC 349537	124.31	118.75	8.74	8.84	4.18	3.73	35.04	34.11
IC 584058	313.54	254.52	9.08	9.51	3.92	4.18	70.28	67.05
GG × NKE-12	175.83	138.96	8.55	8.99	4.28	4.14	62.79	59.03
IC 584078	150.35	121.18	8.59	8.36	4.34	4.18	53.05	64.48
CL 668	131.25	95.51	8.69	8.67	3.93	4.31	54.97	52.73
HS-1	161.04	114.58	9.65	8.85	4.15	4.22	64.05	67.62
APG-1	130.97	115.63	9.21	8.88	4.34	4.31	29.17	32.32
IC 584090	94.10	74.44	8.95	9.13	4.21	3.82	41.43	60.37
Mean	**160.17**	**129.19**	**8.93**	**8.90**	**4.17**	**4.11**	**51.35**	**54.71**
CD (@ 5 %)								
Irrigation (I)	22.430		NS		NS		NS	
Variety (V)	44.860		0.457		NS		NS	
I × V	NS		NS		NS		NS	

Accession IC 584058 recorded the highest yield both in control (313.54 kg ha^{-1}) and stress condition (254.52 kg ha^{-1}), followed by HS-1 (161.04 kg ha^{-1}) in control and GGxNKE 12 (138.96 kg ha^{-1}) under stress. Essential oil content ranged from 9.65 to 8.59% with a mean of 8.93% in control and under stress, it ranged from 9.51 to 8.36% with a mean of 8.9%. Oleoresin

content ranged from 4.34 to 3.92% in control and from 4.31 to 3.92% under moisture stress. Percent bold capsule (8 mm) ranged from 70.28 (IC 584058) to 29.17% in control and from 67.05 (IC 584058) to 32.32% under stress.

At Pampadumpara, IC 349537 recorded the highest fresh weight (317.66 g) followed by Appangala 1 (275.33 g), and they were statistically on par under moisture stress. The yield performance by different genotypes under control and drought stress induced plot evaluated at different AICRPS centre is shown in Table 11.

Table 11. Yield performance by different entries under control and drought stress induced plot evaluated at different AICRPS centre (2021-22)

Entries	Appangala			Mudigere			Sakleshpur			Myladumpara		
	T_1	T_2	Mean	T_1	T_2	Mean	T_1	T_2	Mean	T_1	T_2	Mean
IC 349537	124.3	118.8	121.5	105.0	94.3	99.7	1065.0	681.3	873.1	678.1	527.2	602.7
IC 584058	313.5	254.5	284.0	327.5	184.2	255.9	949.3	471.6	710.5	567.2	454.6	510.9
GGXNKE-12	175.8	139.0	157.4	380.8	164.3	272.5	943.3	531.3	737.3	549.9	517.3	533.6
IC 584078	150.4	121.2	135.8	407.5	250.0	328.7	855.6	685.3	770.5	510.8	340.7	425.8
CL 668	131.3	95.5	113.4	385.0	170.8	277.9	893.3	491.6	692.5	468.9	323.6	396.3
HS-1	161.0	114.6	137.8	441.2	329.2	385.2	796.6	498.3	647.5	517.1	358.3	437.7
APG-1 (Check)	131.0	115.6	123.3	134.0	83.2	108.6	701.6	562.3	632.0	453.6	408.2	430.9
IC 584090	94.1	74.4	84.3	89.1	66.7	77.9	633.6	378.3	506.0	536.8	315.7	426.2
Mean	160.2	129.2	-	283.7	167.8	-	854.8	537.5	-	535.3	405.7	-
Comparing the mean of	CD (5%)			CD (5%)			CD (5%)			CD (5%)		
Irrigation (I)	22.4			23.73			20.0			15.9		
Variety (V)	44.8			47.46			40.0			31.9		
I × V	(NS)			67.13			56.5			45.2		

CAR/CI/3.8 CVT 2015 on farmers' varieties of cardamom

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

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.

At Appangala, the highest dry yield per plant was recorded in the variety *Thiruthali* (0.318 kg plant^{-1}) followed by *Panikulangara* (0.247 kg plant^{-1}). Same varieties also recorded higher yield contributing traits *viz.*, number of bearing tillers, number of panicles and panicle length. Disease incidence recorded indicated that the rhizome rot score ranged from 18.89 to 30.00% with *Pachaikkai* recording maximum incidence. The leaf blight incidence ranged from 16.67 to 22.22 % with maximum incidence in varieties Njallani Green Gold and *Elarajan*.

Fig 7: Capsules from CVT farmer's varieties of small cardamom at Appangala

Biometric observations recorded at Sakleshpur showed that the number of tillers was significantly higher in *Thiruthali* (66) followed by *Pappalu* and ICRI 8 (61.3). Plant height was significantly higher in *Pappalu* (262.7cm), followed by *Thiruthali* (261.3 cm). Number of panicles were significantly higher in *Thiruthali* (32), Wonder Cardamom (31.3), followed by Arjun (28). Length of panicle was significantly higher in *Thiruthali* (77 cm), followed by ICRI 8 (66.3 cm). No of racemes/ panicle was higher in *Thiruthali* (33) followed by Wonder Cardamom (26.0). *Thiruthali* produced significantly higher yield (956 kg ha^{-1}).

At Myladumpara, number of tillers was significantly higher in *Panikulangara I* (82.00) followed by *Arjun* (77.33). Plant height was significantly higher in *Panikulangara I* (318.00) followed by *Elarajan* (316.67). Number of leaves of the tallest tiller was the highest in *Panikulangara 1* (15.00) followed by *Elarajan* and *Patchakai* (14.00). Numbers of vegetative buds were highest in *Pappalu* and Wonder Cardamom (5.67). Significantly more panicles were found in *Thiruthali* (39.67) followed by *Elarajan* (37.33). Number of racemes per panicle was more in *Pachaikkai* (27.67) and numbers of capsules per racemes were more in *Panikulangara 1* (9.00). *Thiruthali* performed better concerning yield (1365.28 kg ha^{-1}) followed by the clone Wonder Cardamom (1312.73 kg ha^{-1}).

At Mudigere, plant height was maximum in *Pappalu* (212.96 cm) which was on par with *Thiruthali* (209.96 cm). Among the genotypes, *Panikulangara* recorded a greater number of tillers (25.9), followed by *Thiruthali* (23.2) and *Pappalu* (21.2). At Mudigere, plant height was maximum in *Pappalu* (263.50 cm) followed by *Arjun* (249.00 cm). *Panikulangara* recorded more no. of tillers (25.9) followed by *Pappalu* (44.63) and *Thiruthalli* (44.60). *Pappalu* also recorded higher number of panicles (61.88), a greater number of capsules per panicle (73.70) and highest panicle length (61.88).

CAR/CI/3.9 Coordinated varietal trial (CVT) on hybrids of small cardamom (Appangala, Mudigere, Sakleshpur, Myladumpara, Pampadumpara)

The Coordinated varietal trial (CVT) on hybrids of small cardamom aims to evaluate the performance of F_1 hybrids of small cardamom in different tracts. The trial laid out in RBD with nine F_1 hybrids of small cardamom *viz*., (GG x NKE 19) x Bold (Appangala), GG x Bold x

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 as well as dry yield per plant were recorded in the hybrid PH 13 (6.30 kg plant^{-1} and 1.18 kg plant^{-1} respectively) which was on par with PH-14 and Bold × IC 547219 where the dry yield per plant was 0.94 and 0.82 kg plant^{-1}, respectively. PH-13 which recorded highest yield had the highest percentage of I grade – 8 mm and above (65.81 %) capsules which was followed by PH-14 (62.85 %) and Bold × IC 547219 (52.98 %). The incidence of rhizome rot ranged from 17.77 to 23.33 % and maximum PDI was recorded in hybrid (GG×NKE 19) × Bold. The leaf blight incidence ranged from 12.22 to 22.22 % and maximum PDI was recorded in SHC 1 and SHC 2. Data on growth characters such as tillers per clump, tiller height (cm), number of leaves and number of vegetative buds were recorded at Myladumpara and MHC-1 performed well in all the parameters recorded. Plants started to bear capsules, still, uniformity in flowering is not observed at Pampadumpara.

At Sakleshpur, number of tillers was significantly higher in SHC 1 followed by (GG × NKE 19) × Bold (21). Significantly higher tiller height was recorded in MHC-2 (204 cm) and Bold × IC 547219 (199.3 cm). Significantly higher number of panicles was observed in SHC 2 (14) and Bold × IC 547219 (14.7).

CAR/CI/4.4 Multi-location evaluation of thrips tolerant cardamom lines
(Centres: Appangala, Mudigere, Pampadumpara, Myladumpara, Sakleshpur)

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. The lowest thrips damage (1.4%) was recorded in the genotype IC 349606. Observations on thrips population recorded at Myladumpara revealed that IC 349606 had the lower thrips population than other accessions. Among the vegetative characters studied at Pampadumpara, PV2 recorded the highest leaf length and leaf width, which were statically superior to all the other genotypes. However, Green Gold showed maximum plant height (163.33 cm). Maximum number of tillers per clump was produced by IC 349364 which was statistically superior to all the other genotypes. Thrips population was highest in Njallani followed by IC 349364.

CAR/CI/4.5 MLT of leaf blight tolerant lines of small cardamom 2018
(Centres: Appangala, Mudigere, Pampadumpara, Myladumpara, Sakleshpur)

In order to screen out the leaf blight tolerant small cardamom genotypes, multilocational 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 2021-22, 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

CAR/CM/5.5 Effect of micronutrients on growth and yield of small cardamom (Centres: Appangala, Mudigere, Pampadumpara, Myladumpara, Sakleshpur)

Experiment was laid out at Appangala with two main treatments (T_1- recommended package of practice (control), T_2- recommended package of practices + IISR cardamom micronutrient spray (four sprays of micronutrients during March, April, May and June at 5 g L^{-1}) with three sub treatments (varieties): V_1-Appangala 1, V_2-IISR Avinash and V_3-Green Gold in three replications in 2019.

During the third season, micronutrients spray recorded better growth and yield parameters and more number of 8 mm bold capsules compared to control in all the genotypes. Yield ranged from 398.96 to 478.47 kg ha^{-1} in control and from 486.46 to 621.53 kg ha^{-1} under micronutrient application. Appangala-1 recorded 10.2%, IISR Avinash 30% and Njallani Green Gold 25 % yield increase over control. Appangala-1 recorded 4.83%, IISR Avinash 24.1% and Njallani Green Gold 7.1% increase in 8 mm capsule (bold) compared to control. Essential oil ranged from 6.84 to 9.1% and oleoresin ranged from 3.28 to 5.28% among the genotypes and there was not much variation between treatments.

At Pampadumpara, the experiment comprised of three treatments (T_1- Recommended dose of fertilizer (RDF) + IISR cardamom mix spray (March, April, May, June @ 5 g L^{-1}), T_2- T_1 + humic acid spray @ 0.2 % + drenching of humic acid, T_3- RDF (control) which was superimposed on three varieties of cardamom namely, KAU PV-3, KAU PV 5 and Green Gold (GG). Maximum plant height was recorded in PV3 (305.56 cm) and the maximum plant height was registered by T_2 (284.07 cm). Maximum leaf length was observed in KAU PV 3 (68.00 cm) and the maximum leaf length was registered under T_1 (65.82 cm). Leaf width was maximum in PV5 (11.88 cm) under T_1 (11.44 cm). Maximum no. of tillers (38.85) and panicles (57.59) were recorder under T_2. PV 3 recorded maximum number of panicles (71.00). PV3 (79.14 cm) also recorded maximum panicle length. The maximum fresh weight (1061.21 g plant^{-1}) and dry weight (190.882 g/plant) were recorded in PV3 and maximum fresh weight (1019.74 g plant^{-1}) and dry weight (175.00g plant^{-1}) were registered by T_2.

At Sakleshpur, better growth attributes were observed in ICRI 8 & APG-1. Better growth and yield attributes were recorded in the treatment where IISR cardamom power mix was applied. Significantly higher dry capsule yield was observed in cardamom cultivar APG-1(596.4 kg ha^{-1}) and in treatment receiving IISR power mix (587.5 kg ha^{-1}). Significant response was observed due to interaction effect of micronutrient and cardamom cultivars. Significantly higher dry capsule yield was observed in APG-1 with IISR power mix (623.2 kg ha^{-1}) application as compared to ICRI-3 & ICRI -8 varieties.

The experiment has been laid out at Myladumpara with ICRI-5, *Thiruthali* and MCC 260 where the ICRI 5 recorded maximum yield in T_1 (527.59) which was further increased with foliar application of IISR cardamom micronutrient mix (532.24 kg ha^{-1}). It also recorded higher number of bearing tillers per clump, number of panicles per clump and number of racemes per

panicle. whereas at Mudigere, among the varieties, M-3 recorded significantly higher number of tillers per plant and plant height when compared to M-1 and M-2. RDF + IISR cardamom micronutrient spray and drenching of humic acid (0.2%) recorded significantly higher number of tillers per plant compared to other treatments. The summary of the experiment conducted at different locations during *kharif*, 2021-22 can be comprehended through Table 12.

Table 12. Yield performance by different entries under POP and micronutrient treated plot evaluated at different AICRPS centre (2021-22)

Varieties	Appangala		Sakleshpur		Myladumpara		Mudigere		Pampadumpara	
	T_1	T_2	T_1	T_2	T_1	T_2	T_1	T_2	T_1	T_2
V_1	429.9	486.5	477.6	521.2	265.0	266.1	218.3	223.0	275.8	349.3
V_2	478.5	621.5	565.1	618.2	527.6	532.2	205.3	211.0	190.8	272.3
V_3	399.0	498.6	569.6	623.2	58.6	61.9	308.5	313.7	312.6	446.6
Mean	435.8	535.5	537.4	587.5	283.7	286.7	244.1	249.2	259.7	356.1
CD @5% (Fertilizer)	--		27.6		--		5.08		17.19	
CD@5% (Variety)	--		23.2		--		7.08		15.66	
VXT	--		38.1		--		10.01		27.14	

Note: At Appangala V_1: Appangala-1; V_2: IISR Avinash; V_3: Green gold;
Sakaleshpur V_1: ICRI-3; V_2: ICRI-8; V_3: Appangala-1;
Myladumpara V_1: *Thiruthali*; V_2: ICRI-5; V_3: MCC-260;
Mudigere V_1: Mudigere-1; V_2: Mudigere-2; V_3: Mudigere-3;
Pampadumpara V_1: PV-3; V_2: PV-5; V_3: Green Gold;
T_1: Recommended package of practice (control); T_2- T_1 + IISR cardamom micronutrient spray.

Fig 8: Field view of the micronutrient plot at Pampadumpara

CAR/CM/5.6: Site-specific recommendation for varying yield target of cardamom. (Mudigere, Myladumpara, Pampadumpara and Sakleshpura)

The experiment has been initiated at Myladumpara, Pampadumpara and Sakleshpur. Preliminary soil analysis of the selected plot has been done for its physio-chemical characteristics and the treatments have been imposed.

Crop Protection

CAR/CP/6.11 Evaluation of fungicides against rhizome rot in small cardamom (Appangala, Mudigere, Pampadumpara and Myladumpara)

The experiment on the evaluation of fungicides against rhizome rot in small cardamom was initiated in 2020 with five treatments (T_1: Spray and drench Tebuconazole @ 1 ml L^{-1}; T_2: Spray and drench Fenamidone + Mancozeb @ 2 g L^{-1}; T_3: Spray and drench Metalaxyl-Mancozeb @ 1.25 g L^{-1}; T_4: Spray and drench copper oxychloride @ 2 g L^{-1}; and T_5: Recommended package of practices) with four replications each designed in RBD. During the second season of the trial (2021), all treatments, including the recommended package of practices (control), had a significant impact on reducing the percentage disease incidence (PDI) compared to the control except for the Appangala location. Among the treatments, T_2 (spray and drenching with Fenamidone+Mancozeb @ 2 g L^{-1}) showed the highest reduction in PDI at all four locations. The higher degree of disease incidence was recorded in T_5 (recommended POP) in all the centres. The percent disease incidence score for rhizome rot incidence recorded at different locations during *kharif*, 2021-22 can be comprehended through Table 13.

Table 13: Evaluation of fungicides against rhizome rot in small cardamom (2021-22)

Treatment	Appangala		Mudigere		Pampadumpara		Myladumpara	
	PDI	Reduction (%) over control	PDI	Reduction (%) over control	PDI	Reduction (%) over control	PDI	Reduction (%) over control
T_1: Tebuconazole @ 1 ml L^{-1}	21.66	17.49	1.25	78.56	29.17	0.00	3.88	72.73
T_2: Fenamidone+Mancozeb @ 2 g L^{-1}	17.91	31.77	0.42	92.80	20.83	28.57	3.72	73.88
T_3: Metalaxyl+Mancozeb @ 1.25 g L^{-1}	21.25	19.05	0.83	85.76	29.17	0.00	4.56	67.96
T_4: COC @ 2 g L^{-1}	26.39	0.53	2.92	49.91	20.83	28.57	6.95	51.16
T_5: Recommended POP	26.25	--	5.83	--	29.17	--	14.23	--
CD (p=0.05)	5.958	--	6.32	--	NS	--	1.86	--
CV %	19.01	--	2.04	--	23.56	--	19.7	--

At Appangala, the result of the trial showed that treatments T_1, T_2, and T_3 recorded the lowest disease incidence during 2022, with PDI 21.66%, 17.91%, and 21.25%, respectively. The highest disease incidence was recorded in T_4 (26.39%). Among the different fungicides evaluated at Mudigere against rhizome rot of cardamom, fungicide Fenamidone + Mancozeb @ 2 g L^{-1} showed the lowest rhizome rot severity (0.42 PDI), which was statistically on par

with Metalaxyl + Mancozeb @ 1.25 g L^{-1} (0.83 PDI) and Tebuconazole @ 1 ml/L (1.25 PDI). The untreated control showed maximum disease severity (10.00 PDI). At Myladumpara, the highest reduction in rhizome rot incidence was observed in T_2 (73.88%) followed by T_1 (72.73%) and T_3 (67.96%), which were on par with each other. Among the five treatments evaluated at Pampadumpara, T_2 (spray and drench with Fenamidone + Mancozeb @ 2 g L^{-1}) and T_4 (spray and drench with Copper oxychloride @ 2 g L^{-1}) recorded a lesser percent disease incidence. But there is no significant difference between them for rhizome rot incidence. However, they showed a significant difference for borer incidence, in which T_2 followed by T_4 showed the least incidence.

CAR/CP/6.12 Evaluation of fungicides against leaf blight in small cardamom (Appangala, Mudigere, Pampadumpara, Myladumpara)

The experiment on the evaluation of fungicides against leaf blight in small cardamom was initiated in 2020 with five treatments (T_1: Spray Tebuconazole @ 1 ml/lit or Carbendazim @ 2g/L; T_2: Spray Hexaconazole @ 2ml/L; T_3: Spray Azoxystrobin @ 0.5g/L; T_4: Spray Carbendazim @ 2g L^{-1} or Tebuconazole @ 1ml L^{-1}; and T_5: Recommended package of practices) with four replications each designed in RBD.

During the year 2021, all treatments, including the recommended package of practices (control), had a significant impact on reducing the percentage disease incidence (PDI) compared to the control. Among the treatments, T_4 (spray Carbendazim @ 2g L^{-1} or Tebuconazole @ 1ml L^{-1}) showed the highest reduction in PDI at three out of four locations (Mudigere, Pampadumpara, and Myladumpara), followed by T_2 (spray Hexaconazole @ 2ml L^{-1}), whereas the reduction in PDI was higher for T_2 at Appangala followed by T_4 (spray Tebuconazole @ 1ml L^{-1}). The highest disease incidence was recorded in T_5 (recommended POP) in all the centres except in Pampadumpara.

Table 14: Evaluation of fungicides against leaf blight in small cardamom (2021-22)

Treatments	Appangala		Mudigere		Pampadumpara		Myladumpara	
	PDI	Reduction (%) over control	PDI	Reduction (%) over control	PDI	Reduction (%) over control	PDI	Reduction (%) over control
T_1 : Carbendazim+Mancozeb @ 2 g L^{-1}	24.17	25.63	5.83	70.22	75.70	4.44	7.04	70.15
T_2 : Hexaconazole @ 2 g L^{-1}	19.16	41.05	5.42	72.32	68.85	13.08	6.80	71.17
T_3 : Mancozeb @ 2 g L^{-1}	24.58	24.37	9.17	53.17	82.17	(+) 3.73	7.96	66.26
T_4* :	23.79	26.80	4.58	76.61	70.14	11.45	6.44	72.69
T_5 : Recommended package of practices (Control)	32.5	--	19.58	--	79.22	--	23.59	--
CD (P=0.05)	4.34		2.26		6.97		2.27	
CV (%)	17.05		0.74		8.08		14.67	

* At Appangala, T_4 was Tebuconazole @ 1 ml L^{-1} where in other centres, it was Carbendazim @2g L^{-1}

At Appangala, the treatment T_2 recorded the lowest disease incidence, with PDI 19.16%, followed by T_1, T_3, and T_4. At ZAHRS, Mudigere among the treatments, fungicide Tebuconazole @ 1 ml L^{-1} showed the lowest leaf blight severity (4.58 PDI), which was

statistically on par with Hexaconazole @ 2 ml L^{-1} (5.42 PDI) and Carbendazim + Mancozeb @ 2g L^{-1} (5.83 PDI). The untreated control showed maximum disease severity (19.58 PDI). At Pampadumpara, T_2 (spray Hexaconazole @ 2ml L^{-1}) and T_4 (spray Carbendazim @ 2g L^{-1}) reported lesser percent disease incidence for leaf blight with a PDI score of 68.85 and 70.14%, respectively. At Myladumpara, the highest reduction in leaf blight incidence was observed in T_4 (72.69%) followed by T_2 (71.17%), T_1 (70.15%), and T_3 (66.26%), which were on par with each other (Table 14).

CAR/CP/6.13: Observational trial on the efficacy of *Trichoderma asperellum* and *Pochonia chlamydosporia* for the management of rhizome rot and nematodes in small cardamom (Appangala, Pampadumpara, Myladumpara)

The trial was laid out in a randomized block design (RBD) at three locations, with six treatments (T_1: Control; T_2: *T. asperellum* talc formulation mass multiplied in cowdung:neem cake mixture 9:1, mix *T. asperellum* talc formulation @ 1-2 Kg per 100 Kg mixture. Apply 2-5 Kg *T. asperellum* mass multiplied mixture/plant; T_3: *T. asperellum* biocapsule formulation, 1 biocapsule in100 L water, apply 2-3 litre solution per plant; T_4: Metalaxyl+Mancozeb, drench the fungicidal solution 0.125%; T_5: *Pochonia chlamydosporia* liquid formulation, drench @ 1ml L^{-1}; T_6: Recommended nematicide, drench the nematicide solution) with four replications each.

Table 15: Gist of the observational trial for the management of rhizome rot and nematodes in small cardamom (2021-22)

Treatment	Myladumpara						Appangala		Pampadumpara	
	Rhizome rot (PDI)	Reduction (%) over control	Fusarium infections (PDI)	Reduction (%) over control	Nematode infestations (PDI)	Reduction (%) over control	Rhizome rot (PDI)	Reduction (%) over control	Rhizome rot (PDI)	Reduction (%) over control
T_1 Control	9.68	-	4.54	-	1.90	-	46.66	0.00	16.67	0.00
T_2 *T. asperellum* talc formulation	3.48	64.08	2.00	55.92	0.93	51.32	33.33	55.95	8.33	50.00
T_3 *T. asperellum* biocapsule formulation	2.79	71.19	2.08	54.24	0.80	57.89	36.66	54.19	14.58	12.50
T_4 Metalaxyl-Mancozeb (0.125%)	2.56	73.51	3.35	26.17	1.56	17.76	35.33	26.21	14.58	12.50
T_5 *Pochonia chlamydosporia* liquid formulation	4.94	48.97	2.55	43.80	0.73	61.51	36.66	43.83	12.50	25.00
T_6 Recommended nematicide	3.98	58.91	2.30	49.31	0.94	50.66	46.55	49.34	12.50	25.00
CD (p=0.05)	1.15	-	1.50	-	0.63	-	1.52		NS	
CV%	23.40		12.40		19.60		11.49		21.57	

During the year 2021, the results showed that all treatments, including the recommended package of practices, had a significant impact on reducing the percentage disease incidence (PDI) compared to the control. At Myladumpara, the highest reduction in rhizome rot incidence

was observed in T_4 (73.51%) followed by T_3 (71.19%), which were statistically similar. The highest reduction in *Fusarium* infections was observed in T_2 (55.92%) followed by T_3 (54.24%), T_6 (49.31%), and T_5 (43.80), which were also statistically similar. The highest reduction in nematode infestations (leaf rosetting) was observed in T_5 (61.512%) followed by T_3 (57.89%), T_2 (51.32%), and T_6 (50.66%), which were statistically similar.

At Appangala, the minimum disease incidence was recorded in T_2 (*T. asperellum* talc formulation mass multiplied in cowdung:neem cake mixture (9:1) followed by T_3 (*T. asperellum* biocapsule. Among the five treatments evaluated at Pampadumpara, the treatment T_2 (*Trichoderma asperellum* talc formulation) showed the lowest rhizome rot disease incidence followed by the treatment T_5 (*Pochonia chlamydosporia* liquid formulation) and T_6 (Recommended nematicide), but there was no significant difference among them. The percent disease incidence score for rhizome rot, Fusarium and nematode infections recorded at different locations during *kharif*, 2021-22 can be comprehended through Table 15.

Fig 9: Cardamom Field day held at IISR (RS), Appangala

03 LARGE CARDAMOM

Genetic Resources

LCA/CI/1.1 Germplasm collection and evaluation of large cardamom
(Centres: ICAR, Regional Station, Gangtok; ICRI, Regional Station, Gangtok)

A total of 64 large cardamom accessions (57 at ICRI and 7 at ICAR, RS) have been maintained in the germplasm repository.

A collaborated survey was conducted by both the centres in Sikkim and collected two germplasm accessions, one each from Lamaten Rongli area of Pakyong district and another from Uttarey area of Gayzing district. The collected accessions were maintained in ICRI, Pangthang farm and passport data of collected accessions is given below (Table 16). The accessions were found promising having high yielding ability with disease escape character.

Table 16. Passport data collected from accessions from collaborated survey

Accession	Cultivar name	Collection site & date	Characteristics	No. of leaves	Height of plant (cm)	Length of leaf (cm)	Breath of leaf (cm)
SCC-217	Regulang	Lamaten, Rongli 10/08/22	Elongated peduncle of spike, hardy pseudostem with disease tolerance	06	54	48	48
SCC-218	Uttarey Varlang	Uttarey West Sikkim 01/03/22	Disease tolerance	05	170	48	12

Characterization and evaluation of previously collected germplasm accessions at ICRI, Regional Station, Gangtok was initiated based on growth parameters and disease escape traits. Among these, accessions SCC 216 (IC No. 590071) and SCC 217 (IC No. 590072) performed better in terms of growth performance and low insect pest and disease incidence, especially Chirke and Foorkey diseases. (Table 17).

Table 17: Evaluation of large cardamom accessions on the basis of growth parameters

Sl. No.	Accession	Cultivar	Plant height (cm)	No. of tillers /clump	No. of leaves	Leaf area (cm^2)
1	SCC 242	Ramsey	139.0	25.0	11.0	52.6
2	SCC 243	Seremna	85.7	34.0	12.3	51.1
3	SCC 246	Ramsey	128.2	29.6	12.0	56.6
4	SCC 251	Varlangey	153.4	42.0	10.6	56.7
5	SCC 299	Varlangey	143.2	27.6	10.0	60.4
6	SCC 300	Ramsey	133.6	26.3	10.6	54.8
7	SCC-216	Ramla	161.7	59.0	14.3	68.3
8	SCC-217	Ramla	166.7	63.0	14.3	67.1
9	SCC-227	Ramsey	146.1	35.6	13.0	59.6

10	SCC-228	Varlangey	152.6	35.6	8.3	59.6
11	SCC-229	Ramsey	154.1	25.0	11.0	60.4
12	SCC-250	Varlangey	147.6	39.3	13.6	64.3
13	SCC-256	Seremna	86.0	40.3	11.3	54.6
14	SCC-258	Ramsey	143.3	23.6	10.3	54.1
15	SCC-260	Varlangey	158.3	30.0	12.0	59.6
16	SCC-262	Ramsey	140.3	29.6	12.0	56.0
17	SCC-266	Seremna	95.1	35.0	9.3	52.2
18	SCC-307	Varlangey	155.0	27.0	11.6	60.1
19	SCC-317	Regulang	160.3	35.6	10.3	67.0
20	SCC-318	Uttarey Varlang	173.3	29.0	8.3	55.3

Crop Management

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

(Centres: ICAR, Regional Station, Gangtok; ICRI, Regional Station, Gangtok)

An experiment on evaluating the effect of different mulching treatments on the yield of large cardamom was initiated during the year 2021 at farmer's field. The experiment comprising of six treatments (T_1: Leaf mould; T_2: Fresh leaf litter; T_3: Paddy straw; T_4: Paddy husk; T_5: Black polyethylene sheets; T_6: Control) and was laid out in randomised block design (RBD) with four replications.

Fig 10. Imposition of treatments at farmers field in Kabi, North Sikkim

Field experiments conducted during the pre-kharif season at a farmer's field in Dzongu, North Sikkim by ICAR, Regional station, Gangtok showed that among the different mulching treatments, maximum plant height was recorded under T_1, which was statistically on par with T_2 and T_3 but significantly higher than T_4. Significantly higher numbers of leaves/tallest tiller and productive tillers/clump were observed under T_1 compared to other treatments but remained on par with T_2. Maximum immature tillers/clump and total number of tillers/clumps were recorded under T_1, which was significantly higher than other treatments. T_1 also recorded significantly higher dry capsule yield compared to other treatments except for T_2, which was on par. Maximum gross returns, net returns, B:C ratio and profitability were observed under T_1 followed by T_2 (Table 18).

Table 18. Effect of mulching on yield of large cardamom at farmers field in Dzongu, Sikkim, 2021-22

Treatment	PH (cm)	No. leaves/ main tiller	No. of productive tillers/ clump	No. of tillers/ clump	Dry capsule yield (Kg/ha)	Cost of cultivation (x 10^3 Rs/ha)	Net returns (x 10^3 Rs/ha)	B: C ratio	Profitability (Rs/ha/day)
T_1: Leaf mould	147.4	9.93	19.0	40.0	419	99.7	151.7	2.52	562
T_2: Fresh leaf litter	143.1	9.41	18.0	37.0	407	98.7	145.5	2.47	539
T_3: Paddy straw	140.3	9.22	15.0	33.0	363	92.5	125.3	2.35	464
T_4: Paddy husk	138.7	8.89	14.0	31.0	311	94.3	92.3	1.98	342
T_5: Black polyethylene sheets	137.1	8.72	14.0	30.0	287	103.9	68.3	1.66	253
T_6: Control	132.7	7.10	11.0	25.0	220	90.2	49.8	1.61	184
S Em ±	3.20	0.23	0.42	0.94	4.03	-	2.09	0.06	8.12
LSD (*p=0.05*)	8.98	0.67	1.12	2.87	12.7	-	6.31	0.18	24.4

A similar experiment was conducted at a farmer's field at Rongpa, Kabi Mangan district by the ICRI Regional station, Gangtok. Initial morphological data viz., plant height, number of leaves/tillers, number of tillers/clumps, number of productive tillers, leaf length, leaf breadth & incidence of disease/pest were recorded as per the technical programme. Soil samples were collected from the experimental plot for analysis of nutrient status and soil pH. The highest increase in calcium and manganese content in soil was noticed in T_1 (41.78% and 196.23%), followed by T_5 (86.36%) and T_2 (55.56%). It was observed that dried capsules of T_1 contained the highest amount of oil (4.25%) and oleoresin (3.1%) compared to other treatments.

04 GINGER

Genetic Resources

GIN/CI/1.1 Germplasm collection, characterization, evaluation and conservation (Centres: Barapani, Dholi, Kumarganj, Pundibari, Pottangi, Raigarh, Solan)

Collection, characterization, evaluation and conservation activities of ginger germplasm is being carried out at Dholi, Kumarganj, Pundibari, Kammarpally, Barapani, Pottangi, Raigarh, and Solan centres, located in the diverse agro-climatic zones. A total of 514 accession being conserved and maintained by these AICRPS centres jointly (Table 19).

Table 19. Ginger germplasm collections maintained at various AICRPS centres

Centre	Indigenous		Exotic	Total
	Cultivated	Wild & related species		
Barapani	54	1	-	55
Dholi	48	-	-	48
Kumarganj	63	-	-	63
Pundibari	33	-	-	33
Pottangi	200	3	3	206
Nagaland	12	-	-	12
Solan	40	-	-	40
Raigarh	57	-	-	57
Total	**507**	**4**	**3**	**514**

During the year, Barapani centre evaluated thirty-five accessions of ginger maintained there. The plant height of the accessions ranged from 41.23 cm to 59.17 cm, and the highest plant height was recorded in IC-584339 (59.17 cm) followed by IC-584336 (59.10 cm). Leaf length ranged from 18.17 cm to 22.40 cm and the highest length was observed in IC-584336 (22.40 cm) followed by IC-584329 (21.83 cm). Leaf breadth ranged from 1.97 cm to 2.83 cm. The highest leaf breadth was recorded in IC-584363 (2.83 cm). The number of tillers per plant ranged from 2.0-3.0 and the maximum number of tillers was recorded in IC-584341 (3.00). Highest yield was recorded in the accession IC-584334 (8.80 t ha^{-1}). The highest oleoresin content was recorded in IC-584343 (6.45%). Among 48 ginger accessions evaluated at Dholi, accession RG-9 registered highest yield of (18.22 t ha^{-1}) followed by RG-44 (17.37 t ha^{-1}) and RG-43 (15.16 t ha^{-1}) as compared to check variety, Nadia (11.98 t ha^{-1}). Of the 63 germplasm accessions evaluated at Kumarganj, NDG-6 (154 g $plant^{-1}$), followed by NDG-23 (145 g $plant^{-1}$) and NDG-23 (145 g $plant^{-1}$) were found to be promising.

Among the 33 germplasm accessions evaluated at Pundibari, the highest rhizome yield was recorded in GCP 25 followed by GCP 12, GCP 27 and GCP 20 (12.12, 11.16, 10.68, and 9.77 t $ha^{-1,}$ respectively). The lowest rhizome rot and wilt disease incidence was recorded in GCP 25 (10.00) followed by GCP 20 (12.00%), GCP 12 (12.00%), and GCP 27 (15.00%). Out of 198 ginger germplasm accessions evaluated at Pottangi, 42 accessions yielded more than 5 kg fresh rhizomes per $3m^2$ plot with a mean yield of 4.5 kg/$3m^2$ during 2021-22. The range of plot yield being 0.70 kg/$3m^2$ (PGS-119) to 9.2 kg/$3m^2$ (S-62). At Raigarh, the genotypes *viz.*, Indira

Ginger-1 (26.5 t ha^{-1}), IG-4 (24.1 t ha^{-1}) and IG-3 (23.5 t ha^{-1}) recorded higher yield over the two national checks, Suprabha (18.9 t ha^{-1}) and Suruchi (6.6 t ha^{-1}). At Solan, out of the forty ginger genotypes, SG19-11 recorded the highest fresh rhizome yield of 240.28 g plant^{-1} with 4.90% oleoresin content.

Crop Improvement

GIN/CI/2.5 Coordinated Varietal Trial (CVT) on disease tolerance trial in ginger (Barapani, Chintapalle, Kozhikode, Nagaland, Pottangi, Pundibari, Gangtok, 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 *kharif,* 2021-22 the mean fresh rhizome yield ranged from 11.1 to 14.2 t ha^{-1}. Among the ginger test entries, the highest yield observed in V1E4-1 (14.2 t ha^{-1}) followed by R 1.25/4 (14.1 t ha^{-1}) numerically surpassing the national check, IISR Varada (13.7 t ha^{-1}). Location-wise, mean fresh rhizome yield ranged from 5.6 t ha^{-1} (Barapani) to 21.3 t ha^{-1} (Raigarh) with an average yield of 12.8 t ha^{-1} (Table 20; Fig. 11)

Table 20. Fresh Rhizome yield (in t ha^{-1}) recorded in CVT on disease tolerance trial in ginger *Kharif* - 2021 at different locations

Entries	BPI	CPE	KOZ	NGD	POT	PUN	RAI	SKM	Mean	Rank
R 1.25/4	5.9	12.1	24.1	18.5	12.0	8.9	20.4	11.3	**14.1**	2
G 1.00/4	3.8	17.8	15.0	13.1	12.9	9.0	24.4	8.3	**13.0**	5
HP 05/15	9.4	14.4	14.2	8.4	13.3	7.5	17.4	12.1	**12.1**	8
HP 0.5/2	7.7	17.2	13.2	9.5	11.5	9.9	12.4	7.1	**11.1**	10
V 0.5/2	6.9	11.2	12.2	14.2	15.1	9.8	13.4	6.4	**11.2**	9
V1E4-1	5.2	16.2	23.6	17.3	12.9	9.0	20.5	9.3	**14.2**	1
V1E4-5	3.5	15.0	8.3	14.1	15.1	7.2	26.2	9.4	**12.4**	6
V2E5-2	3.1	17.3	14.4	12.5	13.8	8.3	22.6	5.2	**12.2**	7
Indira ginger	5.1	12.2	18.8	14.1	11.1	8.0	30.2	6.6	**13.3**	4
IISR Varada (Check)	--	17.6	16.2	--	12.0	9.0	--	--	**13.7**	3
Other local (Check)*	--	--	--	19.8	--	--	25.3	11.1	**18.7**	
Mean	**5.6**	**15.1**	**16.0**	**14.1**	**13.0**	**8.6**	**21.3**	**8.7**	**12.8**	
SEm ±	1.0	1.0	0.4	1.0	1.0	1.0	0.9	1.0		
CD (0.05)	3.0	2.9	1.1	3.0	3.1	3.0	2.6	3.0		
CV %	18.6	11.2	4.1	18.6	4.6	18.6	7.5	18.6		

Where, **BPI:** Barapani; **CPE:** Chintapalle; **KOZ:** Kozhikode; **NGD:** Nagaland; **POT:** Pottangi; **PUN:** Pundibari; **RAI:** Raigarh; **SKM:** Sikkim.
*Yield from local check was not considered for ranking the genotypes.

Compared to the national check IISR Varada (PDI=18.4), six test genotypes, viz., R 1.25/4, G 1.00/4, HP 05/15, HP 0.5/2 had lower average soft rot scores, among which HP 05/15 (mean PDI=14.6%) and R 1.25/4 (mean PDI=15.0%) were categorized as tolerant genotypes (PDI score in between 6.0 to 15.0). The genotypes viz. G 1.00/4, V1E4-1, V1E4-5, HP 0.5/2, IISR

Table 21. Soft rot incidence (PDI) recorded in CVT on disease tolerance trial in ginger *Kharif* - 2021 at different locations

Entries	BPI	CPE	KOZ	NGD	POT	PUN	RAI	SKM	Mean	Rank
R 1.25/4	30.0	12.7	6.7	23.9	7.6	15.7	8.0	15.6	**15.0**	2
G 1.00/4	26.0	9.1	3.3	18.0	8.3	16.1	16.0	27.1	**15.5**	3
HP 05/15	20.0	19.7	2.5	25.6	2.5	19.7	13.0	13.7	**14.6**	1
HP 0.5/2	17.0	10.8	0.0	22.1	8.7	13.8	30.0	29.2	**16.4**	6
V 0.5/2	19.0	9.7	27.5	24.7	7.5	13.7	35.0	34.9	**21.5**	8
V1E4-1	24.0	9.1	7.5	32.2	7.5	19.1	7.5	22.9	**16.2**	4
V1E4-5	22.0	8.6	17.5	28.5	8.3	18.6	8.0	18.6	**16.3**	5
V2E5-2	21.0	12.7	16.7	26.3	9.7	18.7	47.0	56.1	**26.0**	10
Indira ginger	24.0	19.0	19.2	37.2	12.3	19.0	12.0	33.2	**22.0**	9
IISR Varada (Check)	NS	12.2	30.0	NS	15.3	16.2	NS	NS	**18.4**	7
Other local (Check)*	--	--	--	36.5	--	--	36.0	15.6	**29.4**	--
Mean	**22.6**	**12.4**	**13.1**	**27.5**	**8.8**	**17.1**	**21.3**	**26.7**	**19.2**	
SEm ±						1.3		1.0		
CD (0.05)						4.0		2.8		
CV %						13.5		13.5		

Where, **BPI:** Barapani; **CPE:** Chintapalle; **KOZ:** Kozhikode; **NGD:** Nagaland; **POT:** Pottangi; **PUN:** Pundibari; **RAI:** Raigarh; **SKM:** Sikkim.
*Soft rot disease score from local check was not considered for ranking the entries.

Table 22. Bacterial wilt incidence (PDI) recorded in CVT on disease tolerance trial in ginger *Kharif* - 2021 at different locations

Entries	BPI	CPE	KOZ	NGD	POT	PUN	RAI	SKM	Mean	Rank
R 1.25/4	0.0	0.0	0.0	4.3	0.0	0.0	0.0	0.0	**2.2**	2
G 1.00/4	0.0	0.0	0.0	6.5	0.0	0.0	0.0	0.0	**3.3**	3
HP 05/15	0.0	0.0	0.0	6.8	0.0	0.0	0.0	0.0	**3.4**	4
HP 0.5/2	0.0	0.0	0.0	10.6	0.0	0.0	0.0	0.0	**5.3**	7
V 0.5/2	0.0	0.0	0.0	8.5	0.0	0.0	0.0	0.0	**4.3**	5
V1E4-1	0.0	0.0	0.0	10.3	0.0	0.0	0.0	0.0	**5.2**	6
V1E4-5	0.0	0.0	0.0	22.2	0.0	0.0	0.0	0.0	**11.1**	10
V2E5-2	0.0	0.0	0.0	17.5	0.0	0.0	0.0	0.0	**8.8**	8
Indira ginger	0.0	0.0	0.0	19.6	1.7	0.0	0.0	0.0	**10.7**	9
IISR Varada (Check)	--	0.0	0.0	--	1.3	0.0	--	--	**1.3**	1
Other local (Check)*	--	--	--	24.7	--	--	0.0	0.0	**24.7**	
Mean	**0.0**	**0.0**	**0.0**	**13.1**	**0.3**	**0.0**	**0.0**	**0.0**	**6.7**	
SEm ±						1.3		1.0		
CD (0.05)						4.0		2.8		
CV %						13.5		13.5		

*Bacterial wilt score from Nagaland and Pottangi centre was considered for the calculation of mean disease score and the local check was not considered for ranking the entries.

Varada (check), V 0.5/2 and Indira ginger fell under the moderately tolerant category (with mean PDI score between 16.0 to 25.0%) (Table 21).

Bacterial wilt was observed only at Nagaland and Pottangi centres. The mean PDI score ranged from 1.3% in IISR-Varada to 11.1% in V1E4-5. Among the genotypes, R 1.25/4, G 1.00/4, HP 05/15 and V 0.5/2 had a lower PDI of less than 5% (Table 22).

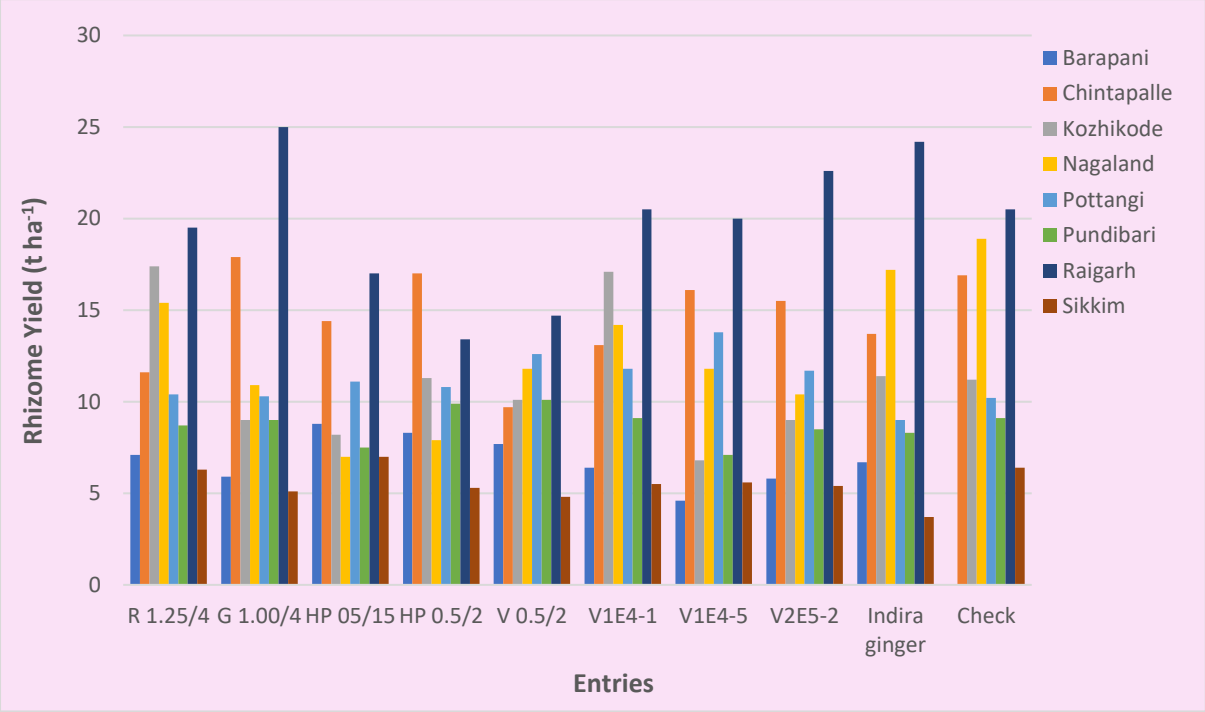


Fig 11: Pooled data showing the comparative performance of CVT entries of ginger at different AICRPS centres

Table 23. Fresh Rhizome yield (in t ha^{-1}) recorded during the evaluation of ginger genotypes for vegetable purpose in *Kharif* - 2021 at different locations

Entries	CPE	KOZ	MZM	NGD	POT	PUN	SKM	Mean	Rank
Bold Nadia	13.5	11.0	19.4	15.9	8.4	13.6	8.1	**12.8**	4
PGS-95	13.0	11.0	15.5	11.1	15.2	10.3	10.0	**12.3**	7
PGS-102	13.1	8.5	16.8	13.3	15.6	12.0	8.6	**12.6**	6
PGS-121	13.8	16.0	12.9	14.2	19.2	11.4	12.2	**14.2**	2
Bhaise	15.9	9.8	14.1	13.6	11.0	12.1	12.4	**12.7**	5
Gorubathan	15.4	12.0	14.5	12.2	13.2	12.2	12.9	**13.2**	3
John's ginger	12.0	18.0	24.6	12.9	16.5	12.6	9.5	**15.2**	1
Mean	**13.8**	**12.3**	**16.8**	**13.3**	**14.2**	**12.1**	**10.5**	**13.3**	
SEm ±	0.5	0.3	0.4	1.3	0.4	0.4	0.3		
CD(0.05)	1.5	0.9	1.1	3.9	1.1	1.1	0.9		
CV %	5.9	6.4	8.2	8.4	5.4	5.9	6.4		

Where, **CPE:** Chintapalle; **KOZ:** Kozhikode; **MZM:** Mizoram; **NGD:** Nagaland; **POT:** Pottangi; **PUN:** Pundibari; **SKM:** Sikkim.

GIN/CI/4.3 Evaluation of genotypes of ginger for vegetable purpose
(Kozhikode, Mizoram, Nagaland, Gangtok, Pundibari, Pottangi, Chintapalle)

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., Gorubathan, Bold Nadia, Bhaise, John's ginger, PGS 121, PGS 95 and PGS 102 with three replications. The trial was initiated during *kharif*, 2018-19.

During *kharif*, 2021-22, the mean fresh rhizome yield ranged from 12.3 to 15.2 t ha^{-1}. The highest yield observed in John's ginger (15.2 t ha^{-1}) followed by PG-121 (14.2 t ha^{-1}), numerically surpassing mean yield of 13.3 t ha^{-1}. Location-wise, mean fresh rhizome yield ranged from 10.5 t ha^{-1} (Sikkim) to 16.8 t ha^{-1} (Mizoram) (Table 23).

After the completion of three years, pooled analysis on rhizome yield revealed significant variation for fresh rhizome yield and other characters among the genotypes evaluated in the trial. The highest yield was recorded in PGS-121 (13.7 t ha^{-1}) followed by John's ginger (13.5 t ha^{-1}). Location-wise mean fresh rhizome yield ranged from 10.3 t ha^{-1} (Sikkim) to 14.7 t ha^{-1} (Nagaland). Both PGS-121 and John's ginger were found suitable for vegetable use (Fig. 12).

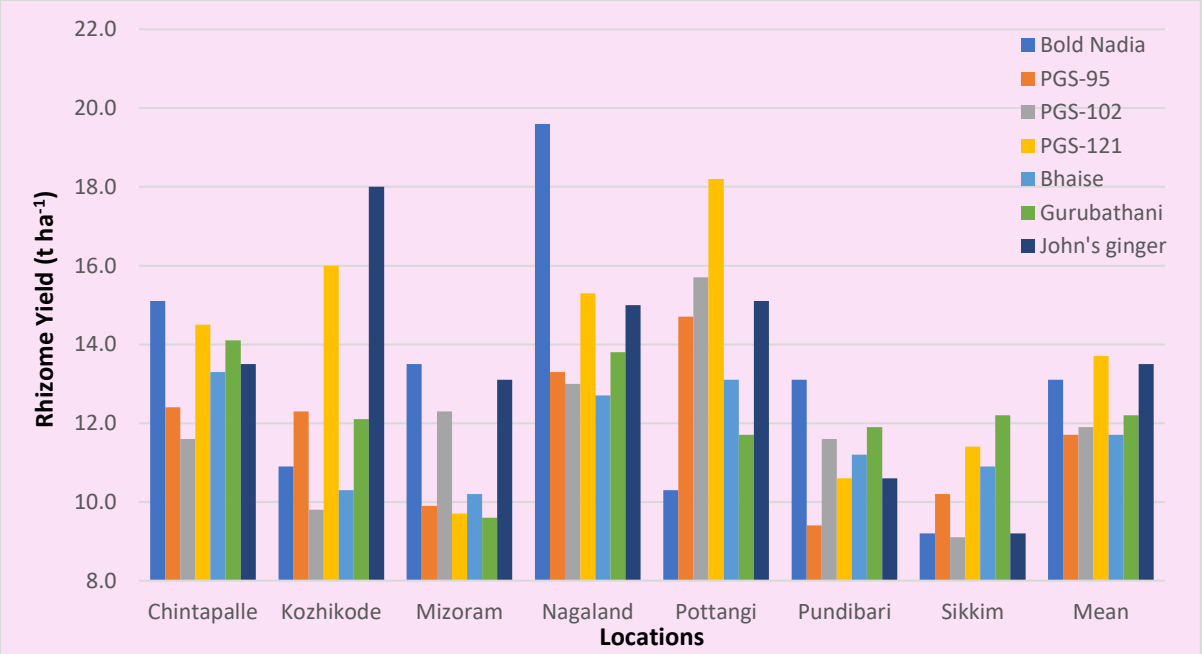


Fig 12. Pooled data showing the comparative performance ginger genotypes evaluated for vegetable purpose at different AICRPS centres

Crop Management

GIN/CM/4.1: Evaluation of different ginger based intercropping systems for higher yield and income
(Pottangi, Chintapalle, ICAR Gangtok, Solan, Dholi, Pundibari, Nagaland, Kalyani, Mizoram)

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 2021-22 (*kharif/rabi*) with eight treatments: T_1- sole ginger; T_2- ginger + papaya + leafy coriander (grow papaya with a spacing of 180 x 180 cm. Between two lines of papaya ginger will be sown in a spacing of 30 x 25 cm and leafy coriander will be broadcasted in the border

area. After harvesting of leafy coriander, the mulching will be imposed.); T_3- ginger + banana (grow banana with a spacing of 200 x 200 cm. Between two lines of banana ginger will be sown in a spacing of 30 x 25 cm. Banana may be grown once in two years); T_4- ginger + coriander + leafy vegetables (grow ginger and coriander in 2:2 ratio. After harvesting of coriander, grow leafy vegetables in place of coriander); T_5- ginger + maize (2:1 or 2:2) (grow sweet corn in *kharif, rabi* and *summer*- 3 times); T_6- ginger + french bean (2:2) (grow french bean in *kharif, rabi* and *summer*- 3 times); T_7- ginger + arhar (3:1) (Grow arhar in *kharif*); T_8- ginger + taro (2:2) (Grow taro in *kharif*).

Results from Pottangi centre revealed that, highest fresh rhizome yield including ginger equivalent yield obtained from intercrops (60.1 t ha^{-1}) was in the treatment T_2 (papaya and leafy coriander intercropped with ginger) followed by T_4 (leafy coriander & leafy vegetables intercropped with ginger) with 42.4 t ha^{-1}. However, the B:C ratio was highest (6.05:1) in T_4 followed by T_6 (French bean intercropped with ginger) with 4.88:1. Return from coriander as intercrop in ginger was the highest (Rs 480/- per bed) followed by maize (Rs. 200/-). Among different cropping systems at Chintapalle, plant height (69.30 cm) was highest in Ginger + maize (2:2) intercropping system, whereas number of tillers (11.47) was highest in Ginger + French bean (2:2). The highest fresh rhizome yield per plant (231.07 g) and yield per hectare (16.62 t) was recorded in ginger grown as sole crop followed by Ginger + arhar (3:1) intercropping system (11.75 t). The highest benefit cost ratio (2.73:1) was recorded in Ginger + coriander + leafy vegetables followed by Ginger + elephant foot yam (2.59:1). At Kalyani, the initial trend of the experiment suggested greater economic return from Ginger + elephant foot yam (2:2) followed by Ginger + coriander+ leafy vegetables & Ginger + French bean. The results showed that significantly higher ginger equivalent yield (13.0 t ha^{-1}) and system productivity (18 t ha^{-1}) were noticed under Ginger + coriander + leafy vegetables (grow ginger and coriander in 2:2 ratio, after harvesting of coriander, grow leafy vegetables in place of coriander) at Gangtok.

Crop Protection

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

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

This experiment was initiated to evaluate the efficacy of priming rhizomes with agrochemicals, with four treatments, T_1: Rhizome treatment with Trichoprime; T_2: Rhizome treatment with metalaxyl-mancozeb @ 1.25 g L^{-1} + imidacloprid 0.5 ml L^{-1} for 30 minutes; T_3: Rhizome treatment with tebuconazole @ 1 ml L^{-1} + imidacloprid 0.5 ml L^{-1} for 30 minutes; T_4: Recommended package of practices (POP) was initiated during 2020-21.

During *kharif*, 2021-22 at Dholi, all the treatments were found to have significant effect on different parameters viz., sprouting (%), plant population at 50 DAS (%), plant height, number of tillers per clump, fresh rhizome yield, and rhizome rot incidence at 60 & 90 DAP (%). Storage rot was observed in none of the treatments. Maximum sprouting (86.25%), plant population (72.50%), plant height (36.96 cm), numbers of tillers per clump (8.05), fresh rhizome yield (7.97 t ha^{-1}) and lowest rhizome rot incidence (18.86%) were recorded in treatment T_4 where recommended state package of practices was adopted. Among the four treatment combinations evaluated at Barapani, the maximum plant height (36.0 cm) was recorded in T_1 (Trichoprime), followed by T_3 (Rhizome treatment with tebuconazole @ 1 ml L^{-1} + imidaclorpid @ 0.5 ml ml L^{-1} for 30 minutes) (33.00 cm). The maximum sprouting percentage (98%), no. of tillers per plant (2.67) and yield (8.11 t ha^{-1}) were also observed in T_1 (Trichoprime) compared to other treatments.

Table 24. Priming of rhizomes for enhanced germination, vigor and storage rot suppression in ginger at Dholi

Treatment	Sprouting (%)	Plant population at 50 DAP (%)	Plant height (cm)	No. of tillers/ clump	Fresh weight of clump (g)	Rhizome rot incidence at 60 DAP (PDI)	Rhizome rot incidence at 90 DAP (PDI)
T_1	67.50	55.00	35.26	6.95	93.83	5.60	20.59
T_2	65.63	52.50	29.68	4.15	87.40	7.13	22.19
T_3	61.88	47.50	27.50	3.88	89.42	8.17	27.75
T_4	86.25	72.50	36.96	8.05	91.35	3.48	18.86
T_5	44.38	33.75	27.57	4.35	104.70	16.75	46.09
SEm (±)	5.65	3.15	1.59	0.48	3.05	2.61	4.94
CD (*p*-0.05)	17.61	9.83	4.94	1.50	9.51	8.12	15.40
CV (%)	17.36	12.07	10.11	17.55	6.54	63.40	36.49

At Kalyani, concerning sprouting percentage, plant population, maximum plant height, dry yield per hectare, dry recovery percentage and oleoresin (%), the highest values were recorded when rhizomes were treated with Trichoprime (T_1), whereas maximum clump fresh weight and fresh yield (t ha^{-1}) were recorded in rhizome treatment with metalaxyl-mancozeb @1.25 g L^{-1} + imidacloprid 0.5 ml L^{-1} for 30 minutes (T_2) with the lowest rhizome rot %.

Priming significantly enhanced the sprouting percentage as compared to the local practice (hot water treatment before sowing rhizomes) from 80 % & to 87.33% at Nagaland. Fresh rhizome yield per clump and yield per ha were the highest (146.23 g & 17.52 t ha^{-1} respectively) with Trichoprime (T_1) treated rhizomes. Minimum percentage of storage rot (8.69 %) was recorded in rhizome treatment with Trichome (T_1) and highest storage rot was observed in treatment T_4 (32.75%). PDI for rhizome rot and borer infestation (%) were lowest in T_1 PDI (12.34 & 25.33) and highest in T_4 with 22.46 & 29.34 respectively.

At Pasighat, the maximum weight per clump (98.50 g) was recorded in T_1 which was at par with T_2 (88.9 g) and the lowest weight of clump as recorded in T4 (66.80 g). The highest yield was recorded in T_1 (11.69 t ha^{-1}) which was at par with T_2 (11.06 t ha^{-1}) and lowest yield was recorded in T_4 (8.02 t ha^{-1}). The minimum incidence of the rhizome rot disease at 90 DAP was recorded in T_1 (8.33 %) followed by T_2 (12.50 %) compared to the maximum incidence in T_4 (19.91 %). The maximum shoot borer attack was recorded in T_2 (15.80 %) and minimum in T_3 (10.80%).

At Pundibari, the highest sprouting percentage (87.50), plant stand at 50 DAS (35.00) and tiller number (3.67) were recorded T_1. However, the lowest *Phyllosticta* leaf spot (PDI 17.59) was recorded in T_3 followed by T_1 (PDI 17.72). Lowest storage rot recorded in T_1 (10.61%). Highest yield was recorded in rhizome treated with Trichoprime (13.41 t ha^{-1}), whereas highest dry recovery was recorded in T_2 (21.20%).

Fig 13. Field view of trichoprime trials at different centres (A: Kammmarapally B: Nagaland C: Barapani D: Pottangi)

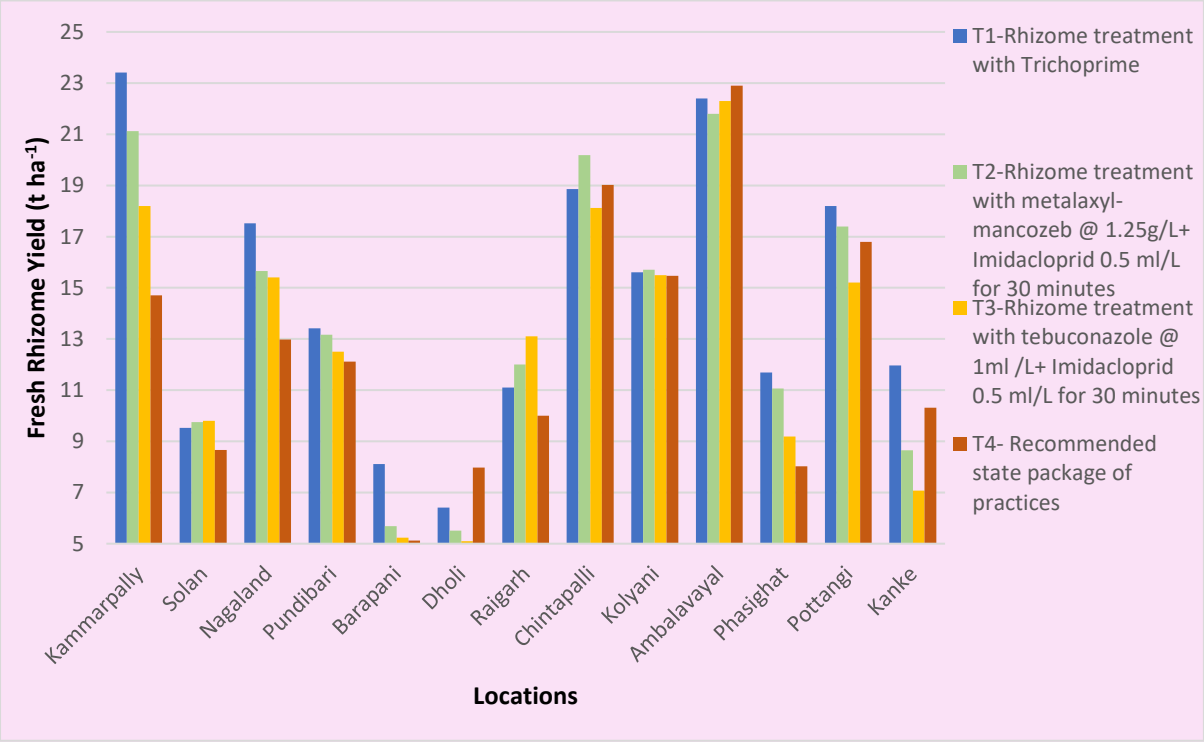


Fig 14. Influence of various rhizome priming treatments on yield of ginger at different AICRPS centres

Ginger rhizome treated with Trichoprime (T_1) had significant effect on yield (11.96 t ha^{-1}), followed by T_2 (10.31 t ha^{-1}) at Kanke. Lowest disease incidence was observed in T1 (20.17%) followed by T_4 (20.33% at 90 DAP). At Kammarpally, among the treatments, T_1 (Trichoprime) recorded maximum yield (35.55 t ha^{-1}), followed by T_2 (metalaxyl-mancozeb + imidacloprid (28.72 t ha^{-1}) compared to control. At Solan, rhizome treatment with tebuconazole (T_3) resulted in highest rhizome germination (92.25%), number of tillers per plant (5.75), plant height (69.00 cm) and yield (9.80 t ha^{-1}) and minimum rhizome rot incidence (15.25%), followed by rhizome treatment with metalaxyl-mancozeb (T_2). At Raigarh also, rhizome germination of 95 per cent, minimum disease incidence of 17.34% and maximum yield (13.10 t ha^{-1}) were observed in the treatment T_3 (rhizome treatment with tebuconazole). However, at Chintapalle, among the different treatments, the highest plant height (62.75 cm) and no. of tillers (10.83) were recorded in T_2 (application of *T. asperellum* talc formulation). The highest fresh rhizome yield per plant (397.24 g) and yield per hectare (22.99 t) were recorded in T_4 (*Pochonia chlamydosporia* liquid formulation). At Ambalavayal, there was no significant difference in yield among the treatments. Storage rot incidence and initial rhizome rot incidence were observed to be slightly higher under treatment with Trichoprime in comparison with chemical treatments. The influence of various plant protection chemicals on fresh rhizome yield of ginger at different AICRPS centres is depicted in Fig. 15.

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

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

At Pottangi spaying of chlorantraniliprole and spinosad @ 0.5 ml L^{-1} (alternatively) was found to be the best treatment, followed by spraying with chlorantraniliprole @ 0.5 ml L^{-1}. At Nagaland, out of 8 treatment combinations, sprouting percentage and plant population were found to be highest (68.74 % and 16.50 respectively) in T_7 (chlorantraniliprole -spinosad @ 0.5 ml L^{-1}). Yield per plot and yield per ha were highest in T_4 (flubendiamide @ 0.5 ml L^{-1}) with 8.30 kg and 4.15 tonnes, respectively. During the final count, it was observed that T_7-chlorantraniliprole + spinosad @ 0.5 ml L^{-1} and T_6-spinosad @ 0.5 ml L^{-1} had least infestation whereas T8 (control) recorded the highest infestation percentage (36%). Results at Mizoram also indicated that applying chlorantraniliprole + spinosad @ 0.5 ml l^{-1} (alternatively) at fortnightly intervals was very effective resulting in good growth, better yield attributes and ultimately higher fresh rhizome yield (17.8 t ha^{-1}) as compared to other insecticide treatments.

At Pundibari, the highest sprouting percentage (91.67%) was observed in control (water spray). No infested shoot was found before the spray and after spray. At Ambalavayal, all the chemical treatments were found to be effective in controlling the shoot borer incidence in ginger, which were on par and there was no significant difference in yield among the treatments.

The experiment was initiated during 2022 at Sirsi, Mudigere, Pasighat, Barapani, and Kanke the treatments were imposed as per the technical programme. The influence of various treatments on fresh rhizome yield of ginger recorded during observational trial conducted at different AICRPS centres is depicted in Fig. 16.

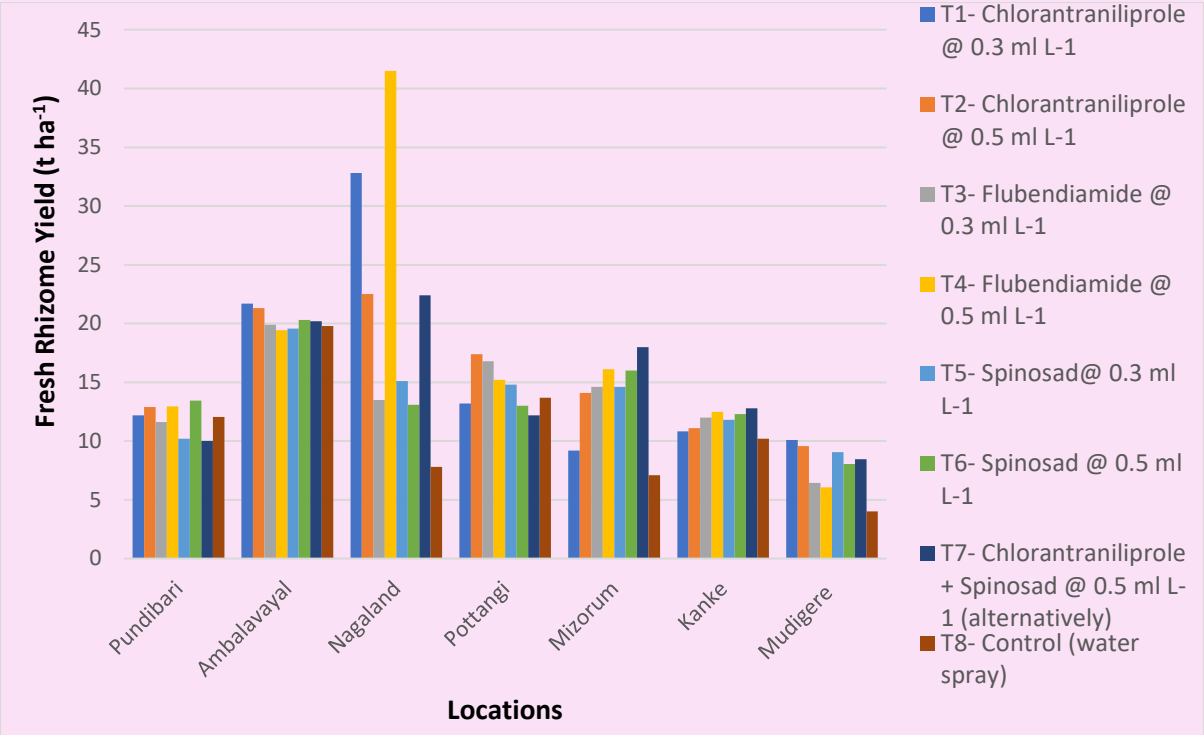


Fig 15. Influence of various plant protection chemicals on yield of ginger at different AICRPS centres

Fig 16. Influence of various treatments on yield of ginger recorded during observational trial conducted at different AICRPS centres

GIN/CP/7.2: Observational trial on the efficacy of *Trichoderma asperellum* & *Pochonia chlamydosporia* for the management of rhizome rot and nematodes in ginger

(Pottangi, Chintapalle, Kozhikode, Barapani)

Observations at Pottangi indicated that rhizome treatment with (T_2) *T. asperellum* talc formulation, produced a higher yield (18.2 t ha^{-1}) followed by T_5- spinosad @ 0.3 ml L^{-1} (17.4 t ha^{-1}) compared to control. At Chintapalle, among the treatments, T_2 (application of *T. asperellum talc* formulation) recorded the highest plant height (62.75 cm) and no. of tillers (10.83). However, fresh rhizome yield per plant (397.24 g) and yield per hectare (22.99 t) were highest in T_4 (*Pochonia chlamydosporia* liquid formulation). Treatments were imposed as per the schedule and population of fungal pathogens and nematodes were enumerated before and after imposing different treatments at Kozhikode. Total nematode population was significantly reduced in treatments drenched with *Pochonia* liquid formulation and no rhizome rot incidence was observed in ginger. Soil samples analyzed after imposing remedies recorded reduction in the viable colony units of *Phytophthora*, *Pythium* and *Fusarium* in treatments with the biocontrol agents, *Trichoderma asperellum* and *Pochonia chlamydosporia*. At Barapani, rhizome yield was the highest in T_2 (18.0 t ha^{-1}), whereas the rhizome rot was the lowest in T_1.

05 TURMERIC

Genetic Resources

TUR/CI/1.1 Germplasm collection, characterization, evaluation and conservation (Centres: Barapani, Coimbatore, Dholi, Guntur, Kammarpally, Kumarganj, Solan, Pasighat, Pottangi, Pundibari, Raigarh)

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 1820 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

Centre	Indigenous		Exotic	Total
	Cultivated	Wild & related species		
Coimbatore	269	9	2	280
Dholi	67	-	-	67
Kammarpally	312	-	-	312
Kumarganj	180	-	-	180
Pottangi	178	23	-	201
Pundibari	177	35	-	212
Raigarh	102	12	-	114
Guntur	250	-	-	250
Pantnagar	52	-	-	52
Pasighat	75	2	-	77
Solan	40	-	-	40
Barapani	35			35
Total	**1737**	**81**	**2**	**1820**

Pundibari centre in the Terai region, being a part of the centre of diversity for turmeric, plays an important role in collection, maintenance and evaluation of germplasm of *Curcuma* sp. in view of the large extent of variability found in adjoining foot hills of Himalayan range and the abundance of shoti or Indian arrow root (*Curcuma angustifolia*) and wild turmeric (*C. aromatica*) in the fallow uplands and forest areas. Germplasm accessions of 177 cultivated types and 35 related sp. are maintained at Pundibari centre, including three new accessions (TCP 280, TCP 281 and TCP 282) collected from Terai region. Phenotyping of the germplasm accessions could classify the accessions as high yielding (>35 t ha^{-1}, 32 accessions) and resistance to foliar diseases viz., leaf blotch (PDI <10, 61 accessions) and leaf spot (PDI <10, 64 accessions) which is given in Table 26.

Table 26. List of promising accessions having higher yield, and disease resistance

Trait	Selection criteria	Promising genotypes
Yield	Above 35 t/ha	TCP 4, TCP 8, TCP 12, TCP 29, TCP 45, TCP 48, TCP 52, TCP 53, TCP 58, TCP 66, TCP 70, TCP 73, TCP 74, TCP 87, TCP 90, TCP 93, TCP 111, TCP 120, TCP 123, TCP 140, TCP 153, TCP 154, TCP 169, TCP 171, TCP 190, TCP 193, TCP 217, TCP 220, TCP 223, TCP 229, TCP 231, TCP 242
Leaf blotch resistance	PDI below 10	TCP 4, TCP 5, TCP 7, TCP 13, TCP 16, TCP 24, TCP 29, TCP 33, TCP 40, TCP 41, TCP 42, TCP 45, TCP 48, TCP 51, TCP 55, TCP 56, TCP 57, TCP 58, TCP 66, TCP 67, TCP 70, TCP 71, TCP 73, TCP 74, TCP 78, TCP 87, TCP 88, TCP 90, TCP 92, TCP 93, TCP 109, TCP 111, TCP 112, TCP 115, TCP 130, TCP 136, TCP 137, TCP 140, TCP 146, TCP 160, TCP 165, TCP 170, TCP 173, TCP 190, TCP 191, TCP 200, TCP 201, TCP 206, TCP 207, TCP 209, TCP 214, TCP 217, TCP 221, TCP 223, TCP 224, TCP 225, TCP 244, TCP 247, TCP 249, TCP 250, TCP 276.
Leaf spot resistance	PDI below 10	TCP 3, TCP 6, TCP 7, TCP 11, TCP 12, TCP 14, TCP 18, TCP 23, TCP 36, TCP 42, TCP 43, TCP 44, TCP 46, TCP 47, TCP 48, TCP 50, TCP 52, TCP 54, TCP 58, TCP 62, TCP 70, TCP 74, TCP 79, TCP 81, TCP 84, TCP 87, TCP 93, TCP 100, TCP 101, TCP 111, TCP 114, TCP 115, TCP 116, TCP 120, TCP 124, TCP 136, TCP 137, TCP 139, TCP 153, TCP 154, TCP 159, TCP 169, TCP 170, TCP 172, TCP 173, TCP 179, TCP 190, TCP 191, TCP 198, TCP 200, TCP 209, TCP 214, TCP 221, TCP 224, TCP 225, TCP 230, TCP 231, TCP 234, TCP 236, TCP 237, TCP 239, TCP 241, TCP 244, TCP 250

A total 107 germplasm accessions (92 *Curcuma longa*, 7 *Curcuma amada*, 3 black turmeric and 5 released varieties) of turmeric are maintained at CARS, Raigarh. Among the genotypes evaluated, highest rhizome yield was recorded by IT 3 (17.2 t ha^{-1}) followed by IT 69 (16.8 ton/ha) and IT 6 (16.2 t ha^{-1}). IC number was obtained for 55 accessions from NBPGR New Delhi. Among 168 turmeric (*Curcuma longa*) accessions evaluated during 2022 at HARS, Pottangi, 13 accessions recorded more than 10 kg/$3m^2$ fresh rhizome yield. PTS-3 (18.8 kg/ $3m^2$), PTS-47 (17.9 kg/$3m^2$), Kuchipudi (16.3 kg/$3m^2$) were the most promising genotypes among them. Out of 23 medicinal turmeric (*Curcuma aromatica*) germplasm accessions evaluated, 12 accessions recorded more than 5.0 kg /$3m^2$ fresh rhizome yield and genotypes Kalarminar (8.0 kg/$3m^2$), Kasturi Tanak (7.6 kg/$3m^2$) and Etham Kalam (7.0 kg /$3m^2$) were the most promising genotypes. Among 67 accessions evaluated at Dholi, RH-432 recorded highest yield of (43.18 t ha^{-1}) followed by RH-448 (42.34 t ha^{-1}) and RH-435 (41.23 t ha^{-1}) as compared to check variety, Rajendra Sonali (37.54 t ha^{-1}). At Coimbatore, a total of 200 genotypes were evaluated for fresh rhizome yield per plant, dry rhizome yield per plant, dry recovery per cent and total curcuminoid content. CL 180 recorded the highest fresh rhizome yield per plant (667.63 g) followed by CL 171 (658.15 g), CL 161 (620.08 g) CL 99 (548.59 g) and CL 229 (532.25 g). Dry recovery varied significantly among the accessions and the mean dry recovery was 24 %. The highest dry recovery was recorded in CL 9 (29.18 %)

which was followed by CL 5 (27.10 %), CL 209 (27.01 %), CL 258 (26.83 %) and CL 154 (26.57 %). The total curcuminoid content (ASTA method) among the genotypes also varied significantly. The highest total curcuminoid content was registered in CL 272 (5.87 %). This was followed by CL 253 (5.73 %), CL 257 (5.17 %), CL 242 (5.11 %) and CL 258 (5.09 %). At Solan, out of 40 genotypes evaluated, ST19-27 recorded the highest fresh rhizome yield of 411.98 g plant^{-1} with 3.39 % curcumin content. In germplasm evaluation trial at the Kammarpally, all the DUS characters were recorded for the 280 turmeric germplasm accessions maintained at station. Among the them, acc 194 recorded maximum yield of 44.99 t ha^{-1} followed by TCP 191 (44.84 t ha^{-1}). Evaluation of 180 germplasm accessions maintained at Kumarganj revealed maximum yield in NDH-74 (280 g plant^{-1}) and NDH-86 (270 g plant^{-1}) among the early maturing types; NDH-114 (265 g plant^{-1}) and NDH-135 (262 g plant^{-1}) among medium, and NDH-8 (270 g plant^{-1}), NDH-11 (265 g plant^{-1}) and NDH-2 (260 g plant^{-1}) among the late maturing types. Among the 47 genotypes evaluated at Guntur, fifteen genotypes recorded significantly higher rhizome yield compared to the best check Mydukur (494.4 g plant^{-1}). The top five genotypes were LTS-47 (916.7 g plant^{-1}), LTS-46 (675.1 g plant^{-1}), CL-5 (662.6 g plant^{-1}), RH-5 (662.1 g plant^{-1}) and LTS-45 (649.3 plant^{-1}). Also, under clonal block, 23 clones were evaluated, among which clones CS-2021-4 (657.3 g plant^{-1}), CS-2021-2 (648.9 g plant^{-1}), CS-2021-8 (634.9 g plant^{-1}) and CS-2021-18 (630.5 g plant^{-1}) were found superior. Among the 35 accessions evaluated at Barapani centre, highest yield was recorded in IC-586764 (34.10 t ha^{-1}), while the highest curcumin content was recorded in IC-586771 (6.17 %) and highest oleoresin content was recorded in IC-584343 (6.45 %). Among the 58 diverse genotypes collected from the entire NE region and evaluated at Pasighat, promising genotypes were CHFT-8, CHFT-36 (28.27 t ha^{-1}) followed by CHFT-4 (27.66 t ha^{-1}).

Crop Improvement

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

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

Table 27. Fresh rhizome yield (t ha^{-1}) recorded in CVT on mango ginger during Kharif, 2021-22

Entries	ABL	BPI	DHI	KOZ	NAV	POT	PUN	RAI
ACC-265	2.3	11.2	32.0	45.0	30.7	27.3	32.5	12.6
ACC-347	3.0	10.9	22.2	53.8	31.3	26.4	27.2	25.5
CAM-2	NG	NG	26.9	53.4	28.2	28.9	26.8	8.1
CAM-3	NG	NG	33.8	48.8	29.5	34.5	27.5	23.2
IMG 1	5.3	8.2	31.3	47.5	28.6	14.5	28.8	29.4
NVMG 2	2.7	NG	36.5	45.4	38.6	26.1	30.8	10.7
NVMG 9	5.0	NG	19.1	17.1	18.6	14.7	26.3	10.2
NVMG 10	3.0	NG	27.8	48.3	34.9	18.0	29.5	9.0
RH 408	NG	NG	32.3	36.3	24.1	33.8	28.8	11.2
AMBA (Check)	2.7	9.1	31.6	41.3	19.7	14.3	28.9	12.4
Loc. Mean	**3.4**	**9.9**	**29.4**	**26.2**	**28.4**	**23.8**	**28.7**	**15.2**
CD (*p=0.05*)	0.839	0.598	7.199	11.054	4.633	4.285	3.122	2.400
CV (%)	13.749	10.516	14.294	14.749	9.508	10.474	6.340	9.182

Where, **ABL:** Ambalavayal; **BPI:** Barapani; **DHI:** Dholi; **KOZ:** Kozhikode; **NAV:** Navsari; **POT:** Pottangi; **PUN:** Pundibhari; **RAI:** Raigarh, **NG:** Not germinated.

The trial consisting of nine test entries (two from ICAR-IISR, two from OUAT, three from NAU, one each from Dholi and IGKV) along with check, Amba are being evaluated since 2019-2020.

In the third year of evaluation, the mean fresh rhizome yield recorded across test locations ranged from 22.2 t ha^{-1} (Amba) to 31.1 t ha^{-1} (ACC-347). All the nine test entries numerically showed their yield superiority over check, Amba. The entry, ACC-347 ranked first in mean fresh rhizome yield (31.1 t ha^{-1}) followed by CAM-3 (28.6 t ha^{-1}) and NVMG 2 (28.2 t ha^{-1}).

TUR/CI/2.8 Coordinated Varietal Trial on high yield and high curcumin turmeric

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

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 2021 *kharif* season, the mean fresh rhizome yield recorded across test locations ranged from 17.6 t ha^{-1} (RRN 1) to 26.7 t ha^{-1} (NVST 56). Out of eight test entries, two entries numerically showed their yield superiority over best performing check, IISR Pragati. The entry, NVST 56 ranked first in mean fresh rhizome yield (26.7 t ha^{-1}) followed by IT 26 (26.3 t ha^{-1}), whereas the best performing check, IISR Pragati recorded a mean fresh rhizome yield of 26.2 t ha^{-1}.

Table 28. Fresh rhizome yield(t ha^{-1}) recorded in CVT on high yield and high curcumin turmeric during Kharif, 2021-22

Entries	ABL	BPI	DHI	KOZ	NAV	POT	PUN	RAI	Mean	Rank
RRN 1	26.0	35.0	3.9	9.3	10.3	23.6	18.2	21.8	**10.4**	17.6
CL 258	13.5	46.6	27.3	14.7	11.4	27.0	9.9	33.5	**6.0**	21.1
CL 272	23.5	40.8	39.1	13.1	13.0	26.7	7.0	33.8	**9.1**	22.9
PTS 47	29.2	31.1	25.7	38.9	17.5	28.4	15.2	29.8	**13.6**	25.6
PTS 6	27.9	58.6	25.9	28.7	16.0	27.2	7.1	22.2	**14.8**	25.4
IT 26	24.5	35.4	34.8	37.0	12.1	28.3	20.6	35.4	**8.3**	26.3
NVST 56	13.3	63.6	36.8	10.8	16.2	25.6	10.7	48.5	**14.4**	26.7
NVST 84	13.6	29.1	13.8	14.5	15.5	22.5	7.0	46.5	**6.5**	18.8
IISR Pratibha (Check)	32.5	26.1	39.4	18.4	15.0	25.6	13.0	31.9	**14.0**	24.0
IISR Pragati (Check)	37.7	40.0	38.4	11.5	16.2	25.0	14.5	33.5	**19.3**	26.2
CIM Pitamber (Check)	34.0	48.4	33.3	23.2	11.7	21.8	11.6	NG	**17.7**	25.2
CD (*p=0.05*)	1.2	6.2	2.2	13.0	1.7	4.4	3.6	5.8	3.0	
CV (%)	2.79	8.74	10.3	37.94	7.6	9.17	13.06	10.1	14.4	

Where, **KOZ:** Kozhikode; **CBE:** Coimbatore; **GTR:** Guntur; **KPL:** Kammarpally; **POT:** Pottangi; **KKE:** Kanke; **RAI:** Raigarh; **NAV:** Navsari; **PGT:** Pasighat; **NG:** Not germinated

The mean dry rhizome yield among the genotypes ranged from 4.0 t ha^{-1} to 8.5 t ha^{-1} The entry PTS 6 came on top with highest mean dry rhizome yield (8.5 t ha^{-1}) followed by IT 26 (7.9 t ha^{-1}). However, the dry recovery % was highest in IT 26 (23.6%) followed by CL 258 (22.8%) and PTS 47 (22.2%). Still the total curcuminoid present was highest in check IISR Prathibha (3.7%) (Table 29).

Table 29. Dry rhizome yield, dry recovery and curcumin content recorded in CVT on high yield and high curcumin turmeric during Kharif, 2021-22

Entries	KOZ			CBE			KPL			Mean			Rank	Rank
	DRY	DR (%)	TC (%)	DRY	DR (%)	TC (%)	DRY	DR (%)	TC (%)	DRY	DR (%)	TC (%)	DR (%)	TC (%)
RRN 1	5.5	21.2	3.4	6.9	19.7	1.9	2.0	22.0	3.2	4.8	21.0	2.9	7	7
CL 258	2.9	21.7	4.8	12.0	25.6	3.1	3.1	21.0	2.6	6.0	22.8	3.5	**2**	3
CL 272	4.4	18.7	5.3	9.4	23.0	2.6	3.1	24.0	2.7	5.6	21.9	3.5	**4**	2
PTS 47	4.0	13.7	4.4	7.2	23.0	2.1	11.7	30.0	0.7	7.6	22.2	2.4	**3**	9
PTS 6	4.5	16.0	2.1	13.9	23.8	3.3	7.2	25.0	3.1	8.5	21.6	2.8	6	8
IT 26	4.0	16.4	2.8	7.9	22.4	2.1	11.8	32.0	2.1	7.9	23.6	2.3	**1**	10
NVST 56	2.0	14.9	2.0	19.4	26.5	1.6	2.0	18.0	2.5	7.8	19.8	2.0	9	11
NVST 94	2.3	16.7	5.0	7.3	25.0	1.8	2.5	17.0	1.8	4.0	19.6	2.9	10	6
IISR Prathiba (Check)	6.9	21.3	5.2	6.0	23.1	3.1	3.9	21.0	2.9	5.6	21.8	3.7	5	1
IISR Pragati (Check)	6.4	16.9	4.8	8.8	22.0	2.0	2.1	18.0	2.8	5.8	19.0	3.2	11	4
CIM Pitamber (Check)	7.2	21.2	3.4	9.5	19.6	2.6	4.6	20.0	3.3	7.1	20.3	3.1	8	5
CD (*p=0.05*)	0.3	0.6	0.2	2.7	1.0	0.2	0.3	1.1	0.1					
CV(%)	3.3	2.1	2.9	16.2	2.6	5.0	4.0	2.7	2.3					

Where, **KOZ:** Kozhikode; **CBE:** Coimbatore; **GTR:** Guntur; **KPL:** Kammarpally; **POT:** Pottangi; **KKE:** Kanke; **RAI:** Raigarh; **NAV:** Navsari; **PGT:** Pasighat; **DRY:** Dry rhizome yield (t ha^{-1}); **DR (%)**: Dry recovery (%); **TC (%)**: Total curcuminoids (%); **NG:** Not germinated.

TUR/CI/2.9: Co-ordinated Varietal Trial on light yellow colour turmeric for specialty market

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

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 *kharif*, 2021, mean fresh rhizome yield recorded across test locations ranged from 21.9 t ha^{-1} (Mydukur) to 33.7 t ha^{-1} (Acc 849). All the genotypes recorded significantly higher yield than the check Mydukur (21.9 t ha^{-1}). Among the genotypes Acc 849 and PTS 50 surpassed the best performing check, IISR Prathiba (28.3 t ha^{-1}) achieved an average fresh rhizome yield of 33.7 and 28.5 t ha^{-1} respectively.

Table 30. Fresh rhizome yield (t ha^{-1}) recorded in CVT on light yellow colour turmeric for specialty market during Kharif, 2021-22

Entries	KOZ	CBE	GTR	KPL	POT	KKE	PGT	Mean	Rank
RRN 2	20.0	41.7	40.6	29.6	8.1	25.5	13.8	**25.6**	7
RRN 3	19.8	43.5	40.3	37.9	9.6	25.0	16.6	**27.5**	4
RRN 4	25.2	62.6	40.2	9.2	9.3	23.4	15.6	**26.5**	5
Acc 849	39.6	39.6	37.6	57.8	14.0	25.6	21.4	**33.7**	1
Acc 1545	36.5	36.4	23.2	23.7	12.7	23.9	11.1	**23.9**	8
CL 223	12.3	35.0	33.3	29.5	11.8	22.5	13.0	**22.5**	10
CL 21	22.3	47.2	43.6	25.4	10.7	22.0	10.1	**25.9**	6
PTS 50	21.0	58.1	10.9	64.0	12.2	24.0	9.6	**28.5**	2
KPS 11	13.3	42.4	33.9	20.8	10.0	25.3	14.5	**22.9**	9
IISR Prathiba (Check)	25.0	58.9	44.2	17.9	12.0	24.4	15.7	**28.3**	3
Mydukur (Check)	13.2	31.1	41.0	12.6	12.8	20.7	21.9	**21.9**	11
CD (*p=0.05*)	0.7	8.1	2.5	13.0	2.3	2.9	1.6		
CV(%)	1.8	10.5	8.8	37.9	8.6	7.2	6.1		

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

Table 31. Dry rhizome yield, dry recovery and curcumin content recorded in CVT on light yellow colour turmeric for specialty market during Kharif, 2021-22

Entries	KOZ			CBE			KPL			Mean			Rank	Rank
	DRY	DR (%)	TC (%)	DRY	DR (%)	TC (%)	DRY	DR (%)	TC (%)	DRY	DR (%)	TC (%)	DR (%)	TC (%)
RRN 2	4.4	22.1	2.2	9.6	23.0	2.0	7.7	23.0	1.6	7.2	23.7	2.0	4	10
RRN 3	4.6	23.4	2.5	10.4	23.8	2.9	10.2	23.8	2.1	8.4	24.7	2.5	3	7
RRN 4	4.4	17.4	2.6	17.4	22.4	2.1	2.2	22.4	1.7	8.0	21.3	2.1	9	9
Acc 849	8.6	21.6	1.6	10.5	26.5	3.0	16.2	26.5	0.9	11.8	25.4	1.8	1	11
Acc 1545	7.7	21.1	4.6	8.4	23.1	2.6	4.5	23.1	3.1	6.9	21.1	3.4	10	3
CL 223	2.5	20.5	4.0	7.7	22.0	2.6	6.5	22.0	2.8	5.6	21.5	3.1	8	4
CL 21	4.9	21.8	5.4	9.3	19.6	2.1	6.9	19.6	2.9	7.0	22.8	3.5	5	2
PTS 50	5.1	24.2	1.7	15.4	22.5	2.9	17.9	22.5	2.0	12.8	24.9	2.2	2	8
KPS 11	2.5	18.7	2.8	8.3	19.7	3.0	3.8	19.7	2.1	4.9	18.8	2.6	11	6
IISR Prathiba (Check)	5.4	21.5	5.8	17.6	25.6	2.3	3.6	25.6	2.6	8.9	22.4	3.6	6	1
Mydukur (Check)	2.7	20.7	3.1	7.2	23.0	3.0	2.9	23.0	2.2	4.3	22.2	2.8	7	5
CD (*p=0.05*)	0.2	0.8	0.2	3.7	0.8	0.1	0.3	0.8	0.1					
CV (%)	2.4	2.2	3.0	19.3	1.9	2.6	2.3	1.9	2.9					

Where, **KOZ:** Kozhikode; **CBE:** Coimbatore; **KPL:** Kammarpally; **DRY:** Dry rhizome yield (t ha^{-1}); **DR (%):** Dry recovery (%); **TC (%):** Total curcuminoids (%).

The mean dry rhizome yield among the genotypes ranged from 4.3 t ha^{-1} to 12.8 t ha^{-1}. PTS 50 recorded the highest mean dry rhizome yield (12.8 t ha^{-1}) followed by Acc 849 (11.8 t ha^{-1}). However, the dry recovery % was highest in Acc 849 (25.4%) followed by PTS 50 (24.9%) and RRN 3 (24.7%). Total curcuminoid content was highest in check IISR Prathibha (3.6%).

TUR/CI/3.9: Initial Evaluation Trial (IET) 2021
(Guntur)

Ten entries, along with one check were evaluated in RBD. Among the entries evaluated, LTS-19-4 (44.0 t ha^{-1}) and LTS-19-3 (43.6 t ha^{-1}) recorded significantly higher fresh yield per ha than the check Mydukur (39.2 t ha^{-1}).

Crop Protection

TUR/CP/7.8 Priming of rhizomes for enhanced germination, vigour and storage rot suppression in turmeric
(Chintapalle, Coimbatore, Dholi, Kammarpally, Pundibari, Raigarh, Solan, Pasighat, Ambalavayal, Mizoram, Kahikuchi, Kanke, Pottangi, Kumarganj)

This experiment was initiated to evaluate the efficacy of priming rhizomes with Trichoprime, combination of metalaxyl-mancozeb and imidacloprid, tebuconazole with imidacloprid along with recommended POP for enhanced germination, vigour and storage rot suppression in turmeric and the growth parameters.

During 2021-22, at Chintapalle there was no significant difference among the treatments for different vegetative and yield characters. Among the treatments, T_2 (metalaxyl-mancozeb @ 1.25 g L^{-1} + imidacloprid 0.5 ml L^{-1} for 30 minutes) recorded the highest fresh rhizome yield per plant (320.77 g), fresh rhizome yield per ha (30.27 t) and dry rhizome yield per ha (7.55 t). No storage rot and rhizome rot disease incidence were observed in any of the treatments. At Coimbatore different priming treatments completely suppressed the storage rot. Among the treatments, the maximum yield was recorded in T_1, Trichoprime primed rhizome (45.43 t ha^{-1}). Turmeric rhizome treated with trichoprime also improved the quality characters viz., curcumin content (3.84%) and oleoresin (5.6%). All the treatments were found to have significant effect on different parameters viz., sprouting (%), plant population at 50 DAS (%), plant height, number of tillers per clump, fresh rhizome yield per ha, and rhizome rot incidence at 60 & 90 DAP (%). No storage rot was observed in any of the treatments. Among the treatments, T_4 (State university recommended POP) recorded maximum yield (36.87 t ha^{-1}) followed by T_3 with tebuconazole + imidacloprid combination (33.96 t ha^{-1}). Rhizome treatment with Trichoprime (*T. harzianum*) was found to be the best (17.2 t ha^{-1}), followed by rhizome treatment with metalaxyl mancozeb @1.25 g L^{-1} + imidacloprid @ 0.5 ml L^{-1} for 30 minutes at Pottangi. The highest fresh rhizome yield (32.36 t ha^{-1}) was recorded in T_1 with 24% dry recovery and 3.25 % curcumin content. The storage rot was not observed. Rhizome rot was lowest in T_1 (17.66 %) at 90 days after planting at Kumarganj. Results at Mizoram also indicated that turmeric rhizomes primed with Trichoprime recorded significantly higher sprouting percentage (95.1%), plant population (24.9 plants m^{-2}), number of tillers per plant (2.8) and plant height (125.9 cm). The maximum yield was recorded in T_1 (30.2 t ha^{-1}) followed by T_2 (27.7 t ha^{-1}). Storage rhizome rot was not observed.

The data recorded at Pasighat indicated that different priming treatments did not significantly influence the plant population and the plant height of turmeric. However, the tallest plant was observed in the treatment T_4 (188.00 cm) and lowest in T_2 (186.33 cm). Maximum number of tillers per plants was recorded in the treatment T_2 (2.20) which was at par with T_3 (1.73) and

T_4 (1.733) which was significantly higher than T_1 (1.65). The data on rhizome yield per hectare varied significantly, the maximum yield (29.0 t ha^{-1}) was recorded in the treatment T_1 followed by T_3 and T_4 (21.7 and 21.5 t ha^{-1}respectively) and minimum in T_2 (19.2 t ha^{-1}). The highest incidence of leaf blotch observed in T_1 (12.08 %) and minimum in T_2 (2.91 %) and maximum leaf spot is observed in T_2 (75.00 %) and minimum in T_3 (43.33%). The minimum incidence of shoot borer was observed in T_1 (6.67%) and maximum in T_4 (20.00%). At Pundibari, highest plant height (83.67 cm) was noticed in T_1 and T_3. Highest number tillers (4.00) per plant was noticed in T_1. No rhizome rot and wilt incidence were recorded. Lowest leaf spot (PDI 2.59) and leaf blotch (PDI 1.85) incidence was recorded in T_3. Lowest storage rot (11.98) was recorded in T_2 followed by T_1 (12.86%). Highest yield (24.1 t ha^{-1}) was recorded in T_1 followed by T_3. Highest dry recovery (25.04%) was recorded in T_2. No rhizome rot and wilt incidence were recorded in any of the treatments.

At Kahikuchi, lowest storage rot (1.87%) and rhizome rot (3.53% at 90DAP) was observed in T_3 with the maximum yield (21.87 t ha^{-1}). Priming turmeric rhizomes with Trichoprime had significant effect on yield at Kanke. Maximum yield (34.92 t ha^{-1}) was observed under the treatment (T_1), followed by rhizomes treated with metalaxyl-mancozeb (31.42 t ha^{-1}), metalaxyl- mancozeb + imidacloprid (T_2) (31.42 t ha^{-1}) which was at par with tebuconazole + imidacloprid (T_3) (28.12 t ha^{-1}). No incidence of rhizome rot was found under any of the treatments. At Ambalavayal, there was no significant difference in yield and other plant growth parameters while using various rhizome treatment in turmeric. Also, storage rot incidence and other rhizome rot incidence were observed to be slightly higher under the treatment with T_1 on comparison to T_4, indicating rhizome priming agents doesn't provide necessary plant protection when compared to state package of practices followed.

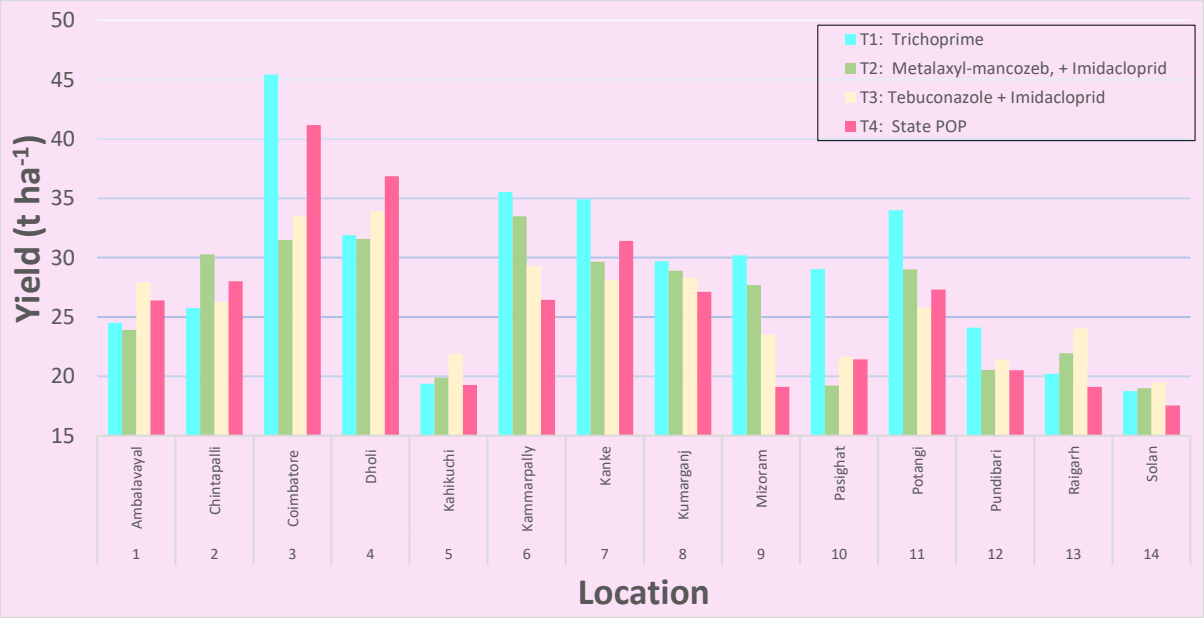


Fig 17: Effect of rhizome treatments on yield of turmeric at various locations

At Solan, rhizome treatment with tebuconazole + imidacloprid (T_3) resulted in highest rhizome germination (89.75%), number of tillers per plant (5.5), plant height (125.50 cm) and yield (19.50 t ha^{-1}). Storage and rhizome rot were not observed. At Raigarh, maximum yield (24.05 t ha^{-1}) was obtained again in T_3 (tebuconazole + imidachloprid with minimum disease intensity of *Colletotrichum* leaf spot (14.39 %). No storage & rhizome rot was observed.

In conclusion, the pooled data from 14 centres revealed that the mean fresh yield ranged from 25.84 t ha^{-1} in T4 to 28.82 t ha^{-1} in T_1. T_1 was the best treatment in 9 out 14 centres while T_3 was the second-best treatment, (in 3 out 14 centres) (Fig 17).

TUR/CP/7.9: Title: Spray schedule optimization of effective insecticides for shoot borer (*Conogethes punctiferalis*) in turmeric
(Pottangi, Sirsi, Mudigere, Pundibari, Mizoram, Nagaland, Pasighat, Barapani, Ambalavayal, Kanke)

At Pottangi, spaying of chlorantraniliprole and spinosad @ 0.5 ml L^{-1} (alternatively) was found to be the best treatment, followed by spaying with chlorantraniliprole @ 0.5 ml L^{-1}. All the chemical treatments were found to be effective in controlling the shoot borer incidence in turmeric in comparison to control at Ambalavayal. The maximum yield was recorded in T_4 (30.1 t ha^{-1}). Among the treatments, chlorantraniliprole (0.5 ml L^{-1} and 0.3 ml L^{-1}) was found effective at Mudigere centre in reducing the shoot borer incidence followed by Spinosad @ 0.5 ml L^{-1}. The highest damage was noticed in control. At Kanke, shoot borer infestation was negligible in treated plot and highest yield was observed in T_7 treatment (29.50 t ha^{-1}). Similar observation was recorded by Guntur, in which the treatment T_7 significantly reduced the incidence of shoot borer and also recorded higher yields (44.6 t ha^{-1}) compared to other treatments. Whereas, T_2 was found to be the best at Kammarapally and it reduced incidence of shoot borer after 2nd spray by 1.45% realizing a maximum yield of 37 t ha^{-1}. At Mizoram also, application of chlorantraniliprole + spinosad @ 0.5 ml L^{-1} (alternatively) at fortnightly intervals was found very effective resulting in good growth, higher yield attributes and ultimately higher yield (26.0 t ha^{-1}) as compared to other insecticide treatments.

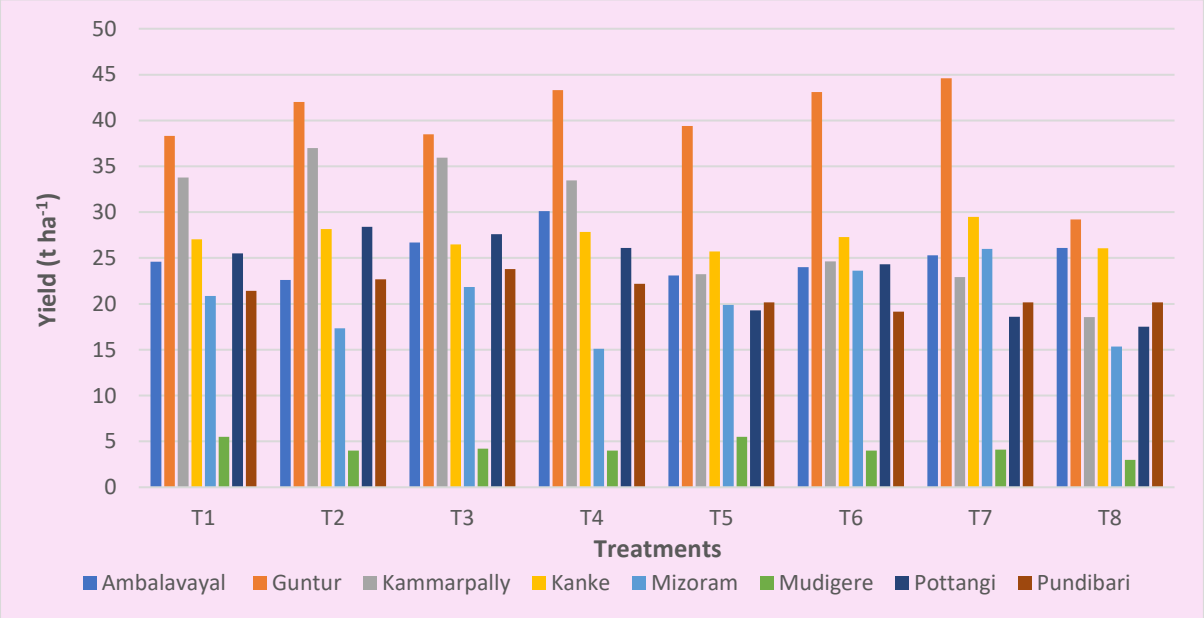


Fig 18. Fresh rhizome yields as influenced by insecticide spray

At Pundibari, no infested shoot was found before the spray. An average of 1.75 shoots were found to be infested by shoot borer in T_5 (spinosad @ 0.3 ml L^{-1}) and T_8 (control-water spray) and an average of 0.5 shoots were found to be infested by shoot borer in T_6 (Spinosad @ 0.5 ml l^{-1}). Highest plant height (105.72 cm) was recorded in T_4 (flubendiamide @ 0.5 ml l^{-1}). Highest leaf length (61.70 cm) and leaf breath (12.34 cm) were observed in f T5 (Spinosad @ 0.3 ml l^{-1}) and T_1 (chlorantraniliprole @ 0.3 ml l^{-1}) respectively. The highest fresh yield (23.8 t ha^{-1}) was recorded in T_3 (flubendiamide @ 0.3 ml l^{-1}) followed by T_2 (chlorantraniliprole @ 0.5 ml l^{-1}) (22.7 t ha^{-1}).

In conclusion, pooled data from 8 centres revealed that the mean fresh yield ranged from 25.27 t ha^{-1} in T_2 which is at par with 25.26 t ha^{-1} in T_4 to 19.5 t ha^{-1} in T_8. T_2 was the best treatment in 2 out 8 centres (Fig 18).

TUR/CP/7.10: Observational trial on the efficacy of *Trichoderma asperellum* & *Pochonia chlamydosporia* for the management of rhizome rot and nematodes in turmeric
(Kozhikode, Coimbatore, Guntur, Barapani)

Rhizome rot disease incidence was recorded at Kozhikode during August and September and the minimum disease incidence was recorded in T_2 (*T. asperellum* talc formulation) with 24.4 t ha^{-1} of fresh rhizome yield, followed by T_3 (T_3- *T. asperellum* biocapsule formulation with 23.2 t ha^{-1}. At Coimbatore, soil application of *T. asperellum* (T_2) enhanced the plant population (38.36) at 50 DAP, plant height (105.63 cm), number of tillers per clump (5.94), fresh weight of clump (755.56 g), fresh rhizome yield (55.4 t ha^{-1}) followed by the drenching with metalaxyl-mancozeb solution @ 0.125% (T_3), with a fresh rhizome yield of 46.73 t ha^{-1}. Rhizome rot was not noticed in any of the treated plots except in control which recorded 10.5% rhizome rot incidence. At Guntur, all the treatments were at par. At Barapani, the highest plant height (104.9 cm) was recorded in T_2 (*T. asperellum* talc formulation treatment at the time of planting, 30 DAP and 60 DAP). No. of leaves (20.67 cm) was highest in T_5 (Recommended nematicide; drench the nematicidal solution); Leaf length (46.97 cm) and breadth (12.13 cm) was highest in T_2. Yield was highest (25 t ha^{-1}) in T_4 (*P. chlamydosporia* liquid formulation drench @1ml L^{-1}). Pooled analysis revealed that the mean fresh rhizome yield ranged from 27.02 t ha^{-1} to 33.2 t ha^{-1}. Overall, the treatment T_2 (T. *asperellum* talc formulation) was the best treatment (in 3 out of 5 centres) followed by T_4 (Fig.19).

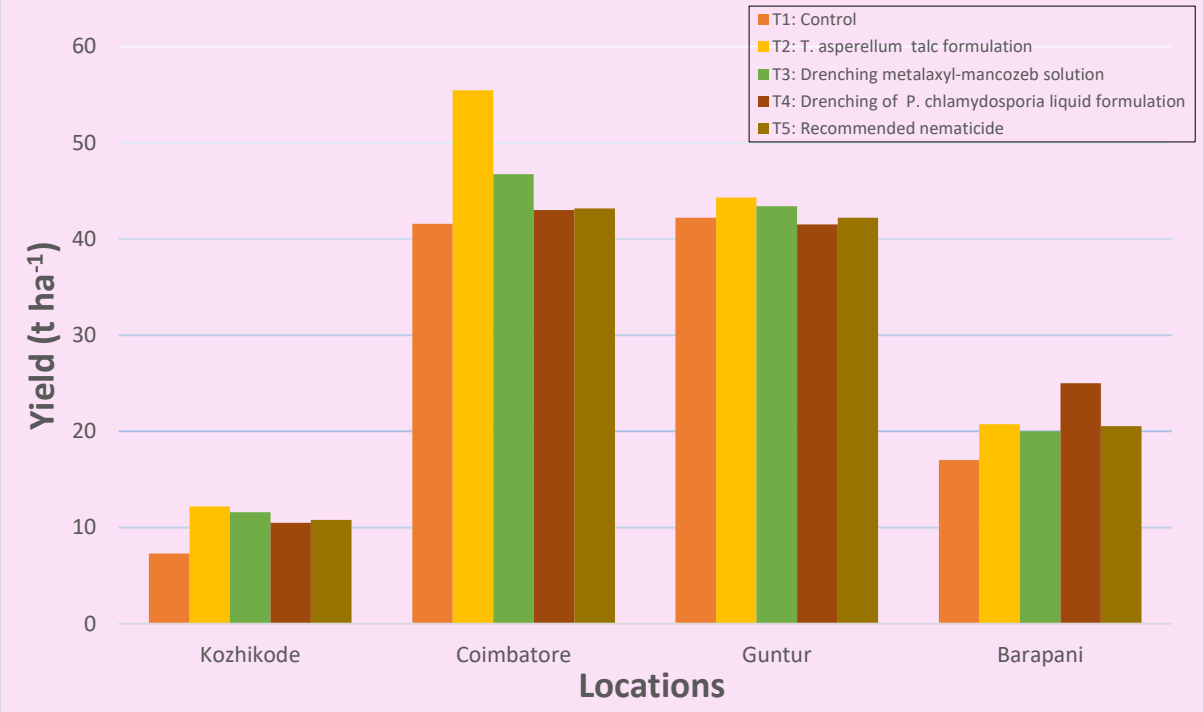


Fig 19. Observational trial on the efficacy of *Trichoderma asperellum* & *Pochonia chlamydosporia* for the management of rhizome rot and nematodes on yield of turmeric at various locations.

06 TREE SPICES

Genetic Resources

TSP/CI/1.1 Germplasm collection, characterization, evaluation and conservation of clove, nutmeg and cinnamon
(Centres: Dapoli, Pechiparai)

Nutmeg

Among the sixteen nutmeg accessions (planted in 1996–97) evaluated at Dapoli. it was found that the average fruit weight recorded in 2021-22 ranged between 42.1 and 76.9g. The accession DBSKKV 9772 recorded the maximum number of nuts (710), and the highest average nut weight (76.9 g) with the highest dry nut yield (6343.14 g) and dry mace yield (1670.3 g). From overall performance, the genotype DBSKKVMF 9772 was found to be a promising genotype considering its fruit yield parameters (Fig. 20). Among the accessions conserved and evaluated at Pechiparai, MF-4 recorded the maximum number of fruits (685.40 tree^{-1}) and the single fruit weight was also highest in MF-4. (53.55 g), and mace yield was 288.89 g tree^{-1}. While local check recorded 499 fruits tree^{-1}, 50.3 g single fruit weight, and 163.22 g tree^{-1} mace yield (Table. 32).

Fig. 20. Photograph showing the field view of DBSKKV 9772 along with its fruit, mace and nuts.

Table 32. Growth and yield performance of nutmeg accessions evaluated at Pechiparai

Accessions	Plant height (m)	Stem girth (cm)	Leaf length (cm)	Leaf breath (cm)	No. of fruits	Single fruit weight (g)	Mace yield (g tree^{-1})
MF-1	12.46	65.00	15.69	7.22	334.66	43.00	197.20
MF-2	10.09	48.06	16.27	6.54	360.81	40.56	188.25
MF-3	8.06	43.21	16.30	6.22	434.00	49.40	179.80
MF-4	8.59	26.00	20.33	9.22	685.40	53.55	288.89
MF-5	9.67	54.22	13.30	5.63	360.01	50.10	151.52
MF-6	9.78	52.55	14.72	7.59	340.12	49.22	217.22
MF-7	10.00	43.80	15.74	7.20	400.15	44.90	239.42
MF-8	9.59	44.00	13.29	6.22	385.00	42.50	250.15
MF-9	5.34	45.15	14.69	6.20	440.15	42.32	163.22
MF-10	10.09	47.99	13.36	6.21	365.50	38.12	150.21
MF-11	8.17	40.09	13.68	6.54	466.00	40.22	159.57
MF-12	8.28	47.03	15.69	7.58	520.90	36.82	192.15
MF-13	8.30	40.48	17.34	8.32	521.00	37.10	200.20
MF-14	9.09	36.91	15.39	6.59	579.77	39.20	220.12
MF-15	9.06	37.91	15.72	4.58	583.00	37.50	223.15
MF-16	9.08	37.09	13.29	7.21	503.00	51.20	240.38
MF-17	8.90	32.88	12.39	6.52	612.00	42.45	219.72
MF-18	8.91	38.81	12.70	5.54	573.00	42.97	263.75
MF-19	7.79	37.77	14.28	7.19	557.18.	48.21	280.92
MF-20	8.09	38.93	13.68	6.35	515.67	48.27	199.72
MF-21	8.58	24.00	14.80	6.24	586.06	45.98	182.23
MF-22	7.18	22.79	14.62	6.63	255.99	46.26	197.50
MF-23	6.17	18.88	19.84	6.58	600.00	51.22	179.92
MF-24	6.08	15.08	17.29	6.55	500.06	49.20	153.51
Local check	9.05	33.88	17.74	6.21	499.00	50.3	163.22
SEd	0.28	1.99	0.20	0.18	10.64	0.70	5.49
CD (P=0.01)	0.70	0.67	0.64	0.56	0.61	0.55	0.54
CV	3.58	0.78	1,86	3.67	0.05	0.56	0.12

Clove

Among the germplasm of clove planted at Dapoli during 1996-97, four promising genotypes were selected. The plant height varied from 6.42 to 7.85 m, girth ranged from 56.12 to 65.22 cm and spread varied from 2.87 to 3.92 m. No flowering was observed during the year 2021-22. From all these growth parameters, genotype DBSKKVSA-1 was found superior over other genotypes. Among the 24 accessions at Pechiparai, SA-1 recorded the highest tree height of 13.44 m, followed by SA-3 (12.59 m) when compared with local check (11.06 m). The

accession SA-3 was significantly superior to other accessions and recorded highest stem girth (52.19 cm), highest leaf length (12.89 cm), leaf breadth (7.71 cm) and number of branches (20.00). Among the 24 accessions, SA3 has been identified as the best performer (dry bud yield is 1.73 kg tree $^{-1}$) as against 0.53 kg tree^{-1} in the local check.

Cinnamon

Among twelve accessions evaluated at Pechiparai, CV-5 recorded maximum tree height (5.9 m), the maximum number of shoots from rejuvenation growth after 300 days (42), and stem girth (17.32 cm) compared to the local check (5.08 m, 25.50 and 16.66 cm, respectively). Table 33 will provide a snapshot of the performance of the cinnamon accession got evaluated at the Pechiparai centre.

Table 33. Performance of cinnamon accessions evaluated at Pechiparai

Accessions	Tree Height (m)	No of shoots	Stem girth (cm)
CV-1	4.88	29.50	15.77
CV-2	4.78	33.70	12.86
CV-3	5.22	29.86	11.58
CV-4	5.13	37.67	13.92
CV-5	5.90	42.00	17.32
CV-6	5.00	33.30	12.97
CV-7	5.22	25.50	13.96
CV-8	5.06	30.16	10.40
CV-9	5.36	30.72	11.60
CV-10	5.88	29.78	11.97
CV-11	5.42	37.60	13.40
CV-12 (check)	5.08	25.50	16.66
SEd	0.02	0.01	0.10
CD (P=0.01)	0.35	0.27	0.75

Table 34. Tree spices germplasm collections maintained at various AICRPS centres

Crop/Centre	Collection	Crop/Centre	Collection
Clove		**Cinnamon**	
Dapoli	02	Dapoli	11
Pechiparai	24	Pechiparai	12
Yercaud	01	Yercaud	02
Total	**27**	**Total**	**25**
Nutmeg		**Cassia**	
Dapoli	72	Dapoli	06
Pechiparai	24	Pechiparai	04
Total	**96**	**Total**	**10**

Table 34 provides information on the germplasm collections of tree spices conserved at various AICRPS centres.

TSP/CI/1.2 Collection of unique germplasm in tree spices
(Centres: Dapoli, Kozhikode, Thrissur, Pechiparai)

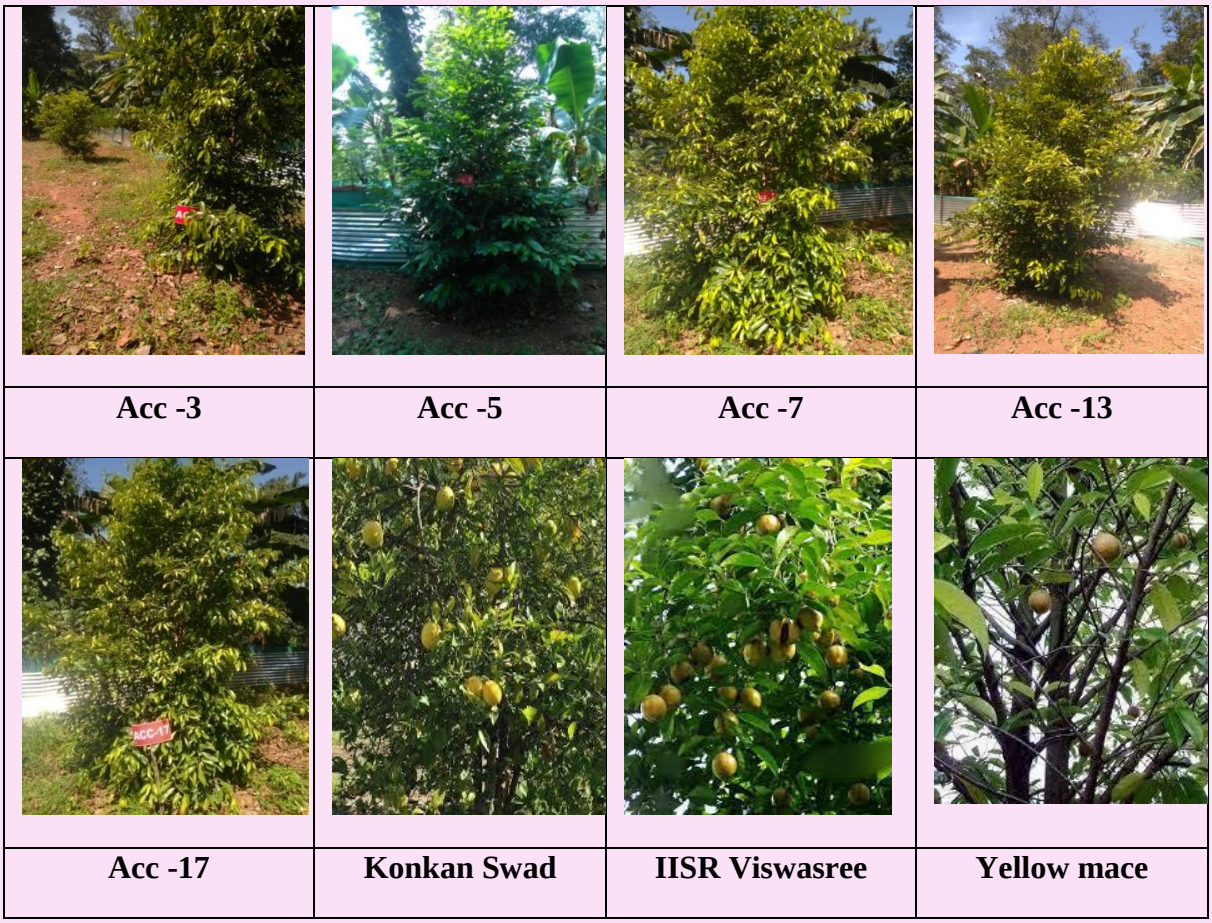


Fig. 21. Unique collection of nutmeg genotypes

Table 35. Growth and yield parameters of unique nutmeg planted at Pechiparai

Entries	Plant height (m)	No of branches	No. of fruits	Single fruit weight (g)	Mace yield (g tree^{-1})
Konkan Swad	5.27	20.22	25.99	35.94	7.56
Yellow nutmeg	5.46	21.25	20.25	31.93	6.59
IISR Viswashree	7.13	23.89	31.50	40.50	14.20
Konkan Suganda	4.74	20.08	26.55	27.99	7.92
Konkan Shreemanthi	5.09	21.81	22.90	26.91	7.87
Acc-3	5.06	16.55	26.89	35.10	9.92
Acc-5	4.92	14.06	27.00	38.91	6.50
Acc-7	4.79	20.00	22.91	35.23	7.20
Acc-13	5.99	.18.14	25.89	38.00	8.10
Acc-17	3.93	12.19	24.50	34.07	11.20
SEd	0.03	0.05	0.03	0.04	0.12
CD (0.01)	0.43	0.53	0.45	0.51	0.81
CV	3.34	1.19	0.74	0.63	3.85

The different unique genotypes have been planted in germplasm block of nutmeg at Dapoli (Fig. 21). The growth of plants is satisfactory. The plant height varied from 1.42 to 4.14 m, number of branches from 15.3 to 58.4 and spread of tree from 1.09 to 2.80 m. The maximum plant height (4.14 m), average no. of branches (58.4) and maximum plant spread (2.8 m) and maximum number of nuts per plant (88) were recorded in genotype- Yellow mace respectively. Among the unique types planted at Pechiparai, the maximum plant height was recorded in IISR Viswashree (7.13 m), maximum branches (23.89). Whereas acc.17 recorded lowest plant height (3.93 m) and branches (12.19).

Crop Improvement

TSP/CI/2.2 Coordinated Varietal Trial-2001 in nutmeg
(Centres: Dapoli, Pechiparai)

Growth observations recorded at Dapoli indicated significant differences among the genotypes for all the parameters (Fig. 22). The plant height ranged from 1.96 to 3.64 m, girth from 33.84 to 49.38 cm, number of branches from 18.24 to 28.38 and spread from 1.52 to 3.64 m, the number of nuts per tree was 17.34 to 147.30 and dry mace from 12.86-118.30 g tree^{-1}. The genotype, A9/150 was found to be significantly superior over the rest of the genotypes for all the parameters with maximum value for average girth (49.38 cm), number of branches (28.38), plant spread (3.64 m) as well as yield (147.30 nuts tree^{-1}).

Fig. 22. Nutmeg accessions being evaluated in coordinated varietal trial-2001 in nutmeg

At Pechiparai also, A9/150 recorded the highest plant height (8.77 m), stem girth (35.66 cm), maximum number of branches (20.69) and number of fruits (239.0) and mace yield tree^{-1} (169.59 g) compared to the local check (6.77 m, 25.22 cm, 19.55, 183.92 and 142.64 g, respectively).

Table 36. Growth parameters and yield performance of entries in CVT 2001-nutmeg trial during 2021-22.

Accessions	Average height (m)			Average girth (cm)			Average number of branches		
	DAP	PECH	Mean	DAP	PECH	Mean	DAP	PECH	Mean
A – 9/4	2.27	7.98	5.13	39.67	33.54	36.6	18.24	17.83	18.03
A – 9/20	3.64	7.94	5.79	45.38	29.03	37.2	22.55	18.94	20.74
A – 9/25	2.94	7.96	5.45	35.12	28.97	32.04	21.76	15.97	18.86
A – 9/71	2.85	7.88	5.36	48.34	30.96	39.65	23.2	15.94	19.57
A – 9/150	2.87	8.77	5.82	49.38	35.66	45.52	28.38	20.69	24.53
Male	2.67	7.86	5.26	33.84	30.07	31.95	19.49	20.17	19.83
Local check	1.96	6.77	4.36	31.5	25.22	28.36	19.71	19.55	19.63
K. Sugandha	3.42	-	-	39.1	-	-	24.51	-	-
Range	1.96-3.64	6.77-8.77		33.84-49.38	25.22-35.66		18.24-28.38	15.94-20.69	
S.Em ±	0.08	0.02		1.77	0.04		1.88	0.04	
CD (*p=0.01*)	0.23	0.4		5.38	0.5		5.69	0.51	
CV	5.48	1.97		6.7	0.65		13.5	1.11	

Accessions	Average spread (m)	Number of fruits tree^{-1}			Mace yield (g tree^{-1})		
	DAP	DAP	PECH	Mean	DAP	PECH	Mean
A – 9/4	1.85	63.67	193.04	128.35	52.24	162.79	107.51
A – 9/20	3.27	101.00	200.03	150.51	78.14	168.20	123.17
A – 9/25	2.31	97.00	205.74	151.37	70.36	161.53	115.94
A – 9/71	2.11	112.23	217.05	164.64	88.52	163.07	125.79
A – 9/150	3.64	147.30	239.00	193.15	118.3	169.59	143.94
Male	2.86	17.37	215.83	116.60	12.86	161.99	87.42
Local check	2.65	63.63	183.82	123.72	47.10	142.64	94.87
K. Sugandha	1.52	97.63	-	-	72.62	-	-
Range	1.52-3.64	17.37-147.30	183.82-239		12.86-118.30	142.64-169.59	
S.Em ±	0.06	2.99	0.02		1.32	0.06	
CD (*p=0.01*)	0.18	9.06	0.36		3.92	0.64	
CV	3.67	6.02	0.07		2.01	0.16	

Where, **DAP**: Dapoli and **PECH**; Pechiparai

TSP/CI/2.4 Coordinated Varietal Trial (CVT) on farmer's varieties of nutmeg (Dapoli, Pechiparai, 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 8 m x 8 m and and a few accessions have started flowering and fruiting at Thrissur. Morphological observations at Dapoli indicated significant differences for the growth parameters. The significantly highest

Fig. 23. Farmer's varieties of nutmeg maintained at KAU, Thrissur

plant height was observed in genotype Kochukudy (3.92 m). The maximum number of branches was observed in Punnathanam Jathy (44.12), whereas Kochukudy recorded the maximum plant spread (3.02 m). The highest yield (42 nuts per tree) was registered in Acc.1. Among the farmers' varieties, the "Improved nutmeg" variety recorded maximum plant height (4.00 m) with maximum branches (21.09 nos.). Minimum plant height of 2.48 cm. was recorded by Acc.23, whereas minimum branches (8.97 nos.) was recorded in Acc.20 at Pechiparai.

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. All the genotypes except Acc. 28 have flowered profusely and started bearing fruits. Among the accessions, Acc. 23 recorded maximum no. of branches, maximum spread, maximum flowers and fruits (Table 37).

Table 37. Growth and yield parameters of nutmeg genotypes

Accession	Plant height (cm)	No. of branches	Plant spread (cm)		No. of flowers	No. of fruits
			EW	NS		
Acc.1	335	41	250	233	90	30
Acc.5	388	50	281	294	46	34
Acc.12	253	32	192	201	26	08
Acc.13	313	33	222	213	36	11
Acc.14	355	45	298	281	95	45
Acc.17	310	32	201	211	37	24
Acc.20	307	43	166	153	29	3
Acc.21	388	54	260	224	34	7
Acc.23	392	60	400	406	142	118
Acc.28	243	27	200	193	9	-
Local check	192	24	214	196	3	02

07 CORIANDER

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 aims at collecting, conserving and evaluating the available coriander germplasm towards identifying promising accessions with high yielding potential/resistance to powdery mildew disease. A total of 2494 coriander accessions are presently conserved at various AICRPS centres jointly (Table 38).

Table 38. Coriander germplasm collections at various AICRPS Centres

Centre	Indigenous	Exotic	Total
Coimbatore	278	-	**278**
Dholi	74	-	**74**
Guntur	350	-	**350**
Hisar	168	-	**322**
Jagudan	132	19	**151**
Jobner	756	102	**852**
Kumarganj	200	-	**200**
Pantnagar	132	-	**132**
Raigarh	35	-	**35**
Kota	100		**100**
Total	**2225**	**121**	**2494**

One hundred sixty-eight accessions of coriander were evaluated in two row plots of 3 m length each using Hisar Sugandh, Hisar Bhumit and Hisar Anand as checks during 2021-2022. The mean seed yield ranged from 36.4 g plant^{-1} (DH-287) to 96.8 g plant^{-1} (DH-253). The most promising genotypes for seed yield were DH-220, DH-253, DH-298, DH-304, DH-310, DH-362, DH-366, DH-376, DH-382 and DH-387. At Jagudan, 152 accessions were evaluated with G.Co 1, G.Co 2 and G.Co 3 as check for yield performance. The seed yield ranged from 100 to 330 g plant^{-1}. A total of 200 germplasm accessions of coriander were evaluated at Kumarganj, the highest yield was recorded in NDCor-22 (29.00 g plant^{-1}) followed by NDCor-11 (28.20 g plant^{-1}), NDCor-12 (27.55 g plant^{-1}) and NDCor-32 (27.25 g plant^{-1}). Among the 278 genotypes of coriander maintained in the germplasm, 48 genotypes were evaluated along with one check (CO (CR) 4 for growth and yield characters during 2021-2022 at Coimbatore. Among the germplasm accessions CS 95 & CS 99 (8.80 g plant^{-1}), CS 162 (8.78 g plant^{-1}), CS 124 (8.68 g plant^{-1}), CS 131 (8.55 g plant^{-1}) and CS 132 (8.18 g plant^{-1}) recorded significantly higher seed yield compared to the best check CO(CR) 4 (7.05 g plant^{-1}). Among the promising accessions identified at Dholi, RD-414 recorded the highest yield (19.6 q ha^{-1}) followed by RD-417 (19.36 q ha^{-1}). Out of 75 germplasm accessions screened against stem gall only two accessions (RD-23 & RD-405) were found moderately resistant.

Among the 35 accessions evaluated at in augmented block design at Guntur, LCC-336 (5.34 g plant^{-1}), LCC-343 (5.29 g plant^{-1}), LCC-344 (5.19 g plant^{-1}), LCC-319 (5.14 g plant^{-1}) and LCC-316 (4.84 g plant^{-1}) were found significantly superior in yield over the best check Suguna (3.62 g plant^{-1}). Also, among the 21 accessions evaluated for herb/green leaf purpose along with 3 checks, LCC-365 was found promising for longest basal leaf (13.6 cm), a greater number of leaves at 50 DAS (16.2) and for highest herb weight (5.6 g). But longest duration for initiation of flowering was observed in LCC-351 and LCC-361(70-75 days). At Jobner, 224 germplasm accessions were evaluated along with five check varieties viz., RCr-20, RCr-41, RCr-435, RCr-436, & RCr-728 in augmented design having five blocks. Promising accessions identified based on seed yield per five plants are UD-1 (71.0 g), UD-50 (72.0 g), UD-67 (53.5 g), UD-70 (70.5 g), UD-93 (52.0 g), UD-120 (68.5g), UD-218 (52.5 g), UD-248 (74.5 g), UD-268 (51.0 g), UD-309 (64.5 g), UD-416 (81.5 g), UD-423 (68.0 g), UD-744 (65.0 g), UD-805 (50.5 g), UD-808 (71.0 g), UD-818 (51.5 g), UD-824 (61.5 g), UD-854 (53.0 g), UD-838 (57.5 g), UD-845 (63.5 g), UD-829 (57.5 g), UD-775 (61.3 g), UD-436-124 (53.5 g), UD-808-SPS-1 (58.0 g) and Peempoda (71.0 g). Among the 32 germplasm accessions conserved and evaluated at Raigarh, higher seed yield was recorded in RCC 12-7 (15 q ha^{-1}), ICS 15 (14 q ha^{-1}), ICS 29 (13.2 q ha^{-1}) over best performing national check CG Shri Chandrahasini Dhaniya-2 (13 q ha^{-1}) and Hisar Anand (11.2 q ha^{-1}) as well as local check CGD 1 (8.5 q ha^{-1}). Out of 132 germplasm accessions evaluated at Pantnagar, Pant Cor-21, Pant Cor-34, Pant Cor-56, and Pant Cor-65 were found to be promising for higher seed yield.

Screening of coriander germplasm against powdery mildew

Among the 276 coriander germplasm accessions maintained at Coimbatore, 48 were screened for the incidence of powdery mildew. The powdery mildew incidence was noticed in all the accessions with the PDI ranging from 38.50 to 98.50. The accession CS 56 recorded the lowest incidence of 38.50 PDI with a seed yield of 6.6 g plant^{-1} followed by CS 62 (39.50 PDI) with a seed yield of 7.98 g plant^{-1}. The highest intensity of powdery mildew was recorded in CS 174 (98.5 PDI) with the seed yield of 5.70 g plant^{-1}.

COR/CI/1.3 Identification of drought tolerant genotypes in coriander (Centre: 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-808, RCr-436 and UD-630 showed yield superiority under both conditions, whereas genotypes UD-808, RCr-436, UD-630, RCr-475, UD-608, RCr-684 and UD-629 under normal irrigated condition and UD-808, RCr-436, UD-630, UD-629, RCr-684, UD-607 and RCr-475 under moisture stress condition have shown yield superiority under stress conditions. Drought-tolerant (TOL) values indicated that genotypes UD-686, UD-542, UD-605, UD-599, UD-616, UD-119 and UD-607 had least deviation from zero and indicating that the performance is stable over both the environments. Based on stress susceptibility index (SSI) genotypes UD-686, UD-605, UD-542, UD-599, UD-616, UD-607 and RCr-436 were found to be the desirable genotypes for t moisture stress condition. Stress tolerance index (STI) revealed that genotypes UD-808, RCr-436, UD-630, DD-629, RCr-684, UD-607 and RCr-475 had maximum tolerance to moisture stress.

Crop Improvement

COR/CI/2.8 Coordinated Varietal Trial

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

Coordinated Varietal Trial in Coriander-2021-Series XI, was conducted with 13 genotypes for the first year during *rabi*, 2021-22 at 14 locations viz. Ajmer, Coimbatore, Dholi, Guntur, Hisar, Jabalpur, Jagudan, Jobner, Kumarganj, Kota, Navsari, Pantnagar and Raigarh. There were significant differences among the 13 genotypes at various AICRPS centres for seed yield and yield attributing characters. Mean performance of the 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 39.

Table 39. Growth and yield performance of coriander CVT genotypes (*rabi*, 2021-22)

Entries	Days to 50 % flowering	Days to maturity	Plant height (cm)	Primary branches / plant	Secondary branches / plant	No. of umbels/plant	No. of umbellates /umbel	No. of seeds / umbellate	Test weight (g)	Seed yield (q ha^{-1})	Volatile oil (%)	Volatile oil Yield (l ha^{-1})
COR-193	61.5	109.2	98.0	5.3	12.0	38.2	5.9	42.9	13.1	13.48	0.4	3.8
COR-194	58.0	109.3	80.5	5.4	10.1	37.0	5.7	48.2	14.6	11.65	0.6	7.4
COR-195	59.5	110.1	84.2	5.5	10.5	38.8	5.8	48.4	13.8	13.21	0.4	4.4
COR-196	66.8	114.5	94.1	6.2	11.4	40.6	5.8	49.0	11.8	13.72	0.5	6.4
COR-197	62.0	112.0	92.2	6.3	12.8	40.2	5.8	43.7	13.1	14.81	0.5	8.3
COR-198	58.6	108.2	85.4	6.5	13.0	45.8	5.7	51.6	12.5	15.44	0.6	8.8
COR-199	66.5	113.9	101.6	6.5	13.4	43.8	6.0	51.7	10.5	14.66	0.6	7.1
COR-200	66.6	116.5	103.0	5.9	12.2	37.6	5.9	46.8	11.2	14.96	0.7	4.9
COR-201	59.0	109.3	87.3	5.7	13.0	36.1	5.4	50.3	13.0	14.08	0.5	5.8
COR-202	65.4	99.7	73.9	5.7	14.7	40.5	5.3	16.6	12.1	9.77	0.4	3.4
COR-203	58.7	106.2	84.9	5.2	10.9	39.9	5.6	51.3	12.8	13.37	0.6	5.8
COR-205 (Check)	62.1	107.9	89.2	5.7	10.2	39.8	6.0	49.8	12.9	14.06	0.4	4.1
COR-206 (Check)	65.3	108.6	87.4	5.6	11.6	36.4	5.6	54.2	10.0	13.17	0.5	6.4

Location-wise performance for seed yield is presented in Table 40. Mean seed yield ranged from 11.6 to 15.4 q ha^{-1}. Five entries viz. COR-198 (15.4 q ha^{-1}), COR-200 (14.96 q ha^{-1}), COR-197 (14.8 q ha^{-1}), COR-199 (14.66 q ha^{-1}), and COR-201 (14.8 q ha^{-1}) recorded numerically higher seed yield over best check COR-205 (14.06 q ha^{-1}). The analysis of variance revealed significant differences among the entries for seed yield and yield-attributing characters among the 13 entries evaluated. The entry COR-194 flowered most early at 58 days whereas COR-196 flowered almost late of 66.8 days as indicated by days to 50% flowering. Plant height ranged from 73.9 to 103 cm, primary branches per plant ranged from 5.2 to 6.5, secondary branches from 10.1 to 14.7, umbels per plant from 36.1 to 45.8, and umbellets per umbel ranged from 5.3 to 6.0. Test weight was maximum in COR-194 (14.6 g) and was lowest in COR-206 (10.0 g).

Table 40. Yield performance (q ha^{-1}) of coriander CVT entries across locations (*rabi*, 2021-22)

Entries	AJM	COI	DHI	GTR	HSR	JBR	JAG	JOB	KYI	KOT	KGJ	NAV	PNR	RAI	SAD	Mean	Rank
COR-193	20.4	8.1	19.9	6.0	19.6	14.8	7.6	8.6	10.0	4.9	12.0	22.1	16.7	9.8	21.9	**13.5**	8
COR-194	13.0	8.5	17.7	11.6	11.7	12.4	7.4	12.8	10.8	5.1	11.0	20.2	6.6	8.0	18.1	**11.7**	13
COR-195	22.4	8.8	12.3	4.3	18.2	16.5	8.3	10.6	7.1	12.5	12.7	21.1	8.4	8.3	26.7	**13.2**	10
COR-196	21.9	5.2	13.8	5.5	20.9	14.6	8.0	13.5	7.3	5.9	15.6	19.9	19.6	14.3	19.7	**13.7**	7
COR-197	23.4	6.3	15.1	6.1	16.1	12.0	11.6	16.0	9.7	12.3	12.1	22.1	16.6	16.3	26.7	**14.8**	3
COR-198	19.0	9.6	20.6	10.4	16.9	16.8	14.0	16.1	10.3	12.6	11.1	18.4	11.0	17.5	27.4	**15.4**	1
COR-199	25.2	8.3	18.8	4.9	19.2	17.4	7.0	11.1	6.9	9.8	12.9	22.7	24.7	11.4	19.8	**14.7**	4
COR-200	22.6	9.7	18.1	6.9	18.7	12.3	8.5	7.5	12.1	11.0	14.0	18.9	22.7	19.4	22.0	**15.0**	2
COR-201	23.0	7.6	16.9	11.7	13.7	13.0	12.6	11.2	8.4	10.3	12.5	21.8	11.7	13.3	23.5	**14.1**	5
COR-202	22.5	6.7	NG	NG	NG	NG	NG	8.3	9.2	0.0	NG	13.0	10.7	14.3	3.1	**9.8**	14
COR-203	23.6	9.0	16.4	6.8	18.9	13.7	11.0	10.0	9.3	9.8	11.2	18.9	7.6	16.4	18.1	**13.4**	9
COR-205 (check)	22.4	0.7	17.0	4.2	16.1	13.8	9.6	10.0	8.4	13.8	12.1	20.8	23.0	15.4	23.8	**14.1**	6
COR-206 (check)	21.7	4.9	16.6	9.0	17.1	13.5	7.4	12.0	10.9	5.9	13.1	17.4	19.6	10.3	18.4	**13.2**	11
Mean	**21.6**	**7.2**	**16.9**	**7.3**	**17.3**	**14.2**	**9.4**	**11.4**	**9.2**	**8.8**	**12.5**	**19.8**	**15.3**	**13.4**	**20.7**	**13.2**	
SE±	1.3	0.1	0.5	0.4	0.2	0.3	0.7	0.4	0.7	0.6	0.6	1.1	0.6	0.9	1.0	0.6	
CD (0.05)	4.5	0.4	1.5	1.3	0.7	0.6	2.0	1.3	1.8	1.9	1.6	3.1	1.9	2.3	3.0	1.7	
CV (%)	12.0	3.0	8.0	10.0	3.0	14.0	12.0	7.0	14.0	12.0	8.0	9.0	7.0	12.0	9.0	9.0	

Where, **AJM:** Ajmer; **COI:** Coimbatore; **DHI:** Dholi; **GTR:** Guntur; **HSR:** Hisar; **JBR:** Jabalpur; **JAG:** Jagudan; **JOB:** Jobner; **KYI:** Kalyani; **KOT:** Kota; **KGJ:** Kumarganj; **NAV:** Navsari; **PNR:** Pantnagar; **RAI:** Raigarh; and **SAD;** Sanand.
*__NG__: Not germinated.

Reaction to wilt was recorded at Jabalpur by using a standard rating scale. COR-199 showed highly resistant reaction and COR-197 and COR-198 showed resistance (R) reaction. COR-206 was found susceptible (S) and COR-193 showed high susceptibility. None of the genotypes was immune/disease-free against stem gall, though COR-196 was found to be resistant. At Jobner, COR-195, COR-197, COR-198, COR-203 and COR-205 showed moderately resistant and the remaining eight genotypes showed susceptible reaction against the powdery mildew disease.

COR/CI/4.1 Quality evaluation in coriander

(Centres: Jobner)

At Jobner, coriander CVT genotypes were also analyzed for volatile oil content using the Clevenger apparatus. The analysis of variance revealed significant differences among the genotypes for volatile oil which ranged from 0.41 to 0.65%. The maximum volatile oil of 0.65% was observed in COR-200 followed by 0.64% in COR-199, 0.58% in COR-194 and COR-203, while a minimum of 0.41% was recorded in COR-195, COR-202 & COR-205. COR-198 ranked first in terms of volatile oil yield (8.84 L ha^{-1}) followed by COR-197 (8.32 L ha^{-1}), COR-194 (7.42 L ha^{-1}), and COR-199 (7.07 L ha^{-1}), While lowest volatile oil yield of 3.41 L ha^{-1} was recorded in COR-202.

Crop Protection

COR/CP/7.1: Screening of coriander varieties against stem gall disease (Dholi, Kumarganj, Kota, Hisar, Jabalpur)

Among the 22 coriander genotypes screened against stem gall disease at five locations, none of them were found immune/disease-free against stem gall, though COR-174, COR-175, COR-178, COR-179 and COR-188 were found to be moderately resistant (PDI<25%) with PDI scores ranged between 11.52 to 16.06%. The resistant checks Acr-1 and Acr-2 showed less than 5% disease incidence, while the susceptible check had a high incidence of stem gall disease. Among test entries, COR-184 was found to have susceptible reaction with mean PDI score of 50.24% (Table 41).

Table 41. Stem gall incidence (PDI) of coriander genotypes across locations

Entries	Dholi	Jabalpur	Kota	Kumarganj	Hisar	Mean PDI	Disease reaction
COR-174	2.46	20.93	33	11.63	1.77	**13.95**	MR
COR-175	2.81	28.61	24	12.43	2.51	**14.07**	MR
COR-176	39.68	63.31	33	20.88	37.09	**38.79**	MS
COR-177	35.12	37.63	23	9.50	27.14	**26.48**	MS
COR-178	2.49	22.53	22	9.32	1.25	**11.52**	MR
COR-179	6.90	22.72	19	12.08	1.39	**12.42**	MR
COR-180	48.50	24.18	43	48.48	46.08	**42.05**	MS
COR-181	35.94	65.95	58	23.77	40.90	**44.91**	MS
COR-182	39.75	55.75	28	18.43	45.18	**37.42**	MS
COR-183	36.04	44.44	55	22.12	33.70	**38.26**	MS
COR-184	47.95	49.22	67	47.12	39.92	**50.24**	S
COR-185	53.41	8.68	62	50.50	41.54	**43.23**	MS
COR-186	44.82	39.51	36	15.20	49.49	**37.00**	MS
COR-187	47.85	24.87	33	19.47	46.27	**34.29**	MS
COR-188	8.32	33.06	31	11.40	1.52	**16.06**	MR
COR-189	26.85	30.08	52	24.25	47.72	**36.18**	MS
COR-190	48.43	24.97	43	12.58	41.62	**34.12**	MS
COR-191	11.82	34.61	43	10.60	5.59	**21.12**	MS
COR-192	33.82	37.70	37	20.55	44.88	**34.79**	MS
Acr-1 (Res. check)	2.75	0.00	4	5.67	1.92	**2.87**	R
Acr-2 (Res. check)	1.85	0.00	0.00	5.35	1.14	**1.67**	R
Sus. check	66.67	63.33	65	54.63	53.33	**60.59**	S
Sem (±)	0.77	0.24	1.50	1.39	1.01	0.57	
CD (p=0.05)	2.22	0.69	4.29	4.01	2.87	1.59	
CV (%)	5.4	7.2	7.7	12.3	6.1	24.3	

08 CUMIN

Genetic Resources

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

(Jagudan, Jobner, Mandor, Sanand)

A total of 1700 cumin germplasm accessions are being maintained by different AICRPS centers. The details of the germplasm collection maintained are given in Table 42.

Table 42. Coriander germplasm collections at various AICRPS Centres

Centre	Indigenous	Exotic	Total
Jagudan	327	7	**334**
Jobner	370	6	**376**
Sanand	27	-	**27**
Mandor	963	-	**963**
Total	**1687**	**13**	**1700**

During the *rabi* season 2021-22, 172 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)	23.8-38.6	JC-95-22, JC-95-13, JC-95-35, JC-96-2, JC-96-47, JC-99-5 (dwarf in nature)
No. of branches/plant	2.6-4.8	JC-94-61, JC-95-30, JC-95-72, JC-96-24 (with more branches)
No. of umbels/plant	4.6-26.2	JC-99-16, JC-99-19, JC-99-23 (with higher umbels)
No. of umbellate/ umbel	4.2-6.0	JC-95-32, JC-95-75, JC-96-1, JC-96-6, JC-99-22 (more umbellates)
No. of seeds/ umbellate	4.6-6.6	JC-95-29, JC-95-114, JC-95-123, JC-96-7, JC-99-24 (more seeds)

At Jobner, seventy-seven germplasm accessions were evaluated and promising accessions viz., UC-216 (92.0 g), UC-316 (88.0 g), UC-277 (69.0 g), UC-347 (47.0 g), UC-298 (46.5 g), UC-328 (42.0 g), UC-287 (41.5 g), UC-290 (38.5 g), UC-348 (36 g) and UC-282 (35.9 g) for seed yield were identified. Similarly, a total of 963 germplasm accessions were evaluated at Mandor centre along with checks GC 4 and MCU-9 in augmented design in which 111 accessions showed significant improvement in seed yield over best check GC-4 (20 g/plot). While at Sanand, among the 27 new germplasm accessions collected and maintained eleven accessions recorded significantly superior yield than check varieties GC 5 and GC 4. Among them, genotypes Piplon 2 (873.00 g plot^{-1}), Uncharda (608.00 g plot^{-1}), Merta-1 (608.00 g plot^{-1}) and Indawar (569.50 g plot^{-1}) were the top yielders and had very less infection of blight disease.

Screening of cumin entries for resistance against powdery mildew disease

A total of thirty-two (30+2) entries of cumin were screened for resistance against powdery mildew disease at Jagudan during 2021-22. The minimum disease intensity was noticed in JCM

104 (7.50%), while the maximum disease intensity was recorded in the entry JC 21-04 (28.25%). The powdery mildew incidence ranged from 7.50 to 28.25 percent.

Screening of cumin entries for resistance against blight disease

Among the 27 genotypes screened for resistance against blight disease at Jagudan, the minimum disease intensity was noticed in JC-18-01 (20.3 %), while the maximum disease intensity was recorded in CUM-43 (42.3 %).

Screening of cumin entries for resistance against wilt disease under wilt sick plot

Two hundred eleven (208+3) genotypes of cumin were screened for resistance against wilt disease under wilt sick plot at Jagudan. Overall wilt incidence was very high. The minimum disease intensity was noticed in GC 3 (40.25%) followed by GC 5 (42.50%), while the maximum disease intensity (100%) was recorded in 179 genotypes. At Jobner, eighty-two germplasm accessions were screened against blight and wilt diseases. Thirteen genotypes showed moderately resistant reactions and eleven genotypes showed minimum incidence of wilt disease and the rest of the genotypes showed susceptible and highly susceptible reactions against the wilt and blight diseases.

Table 44. Performance of cumin genotypes under normal irrigation (E_1) and staggered irrigation (E_2) conditions during *rabi*, 2021-22, at Jobner centre.

Entries	Seed yield(g) in E_1		Seed yield (g) in E_2		TOL	Rank	SSI	Rank	STI	Rank
	Mean	Rank	Mean	Rank						
UC-217	8.78	10	7.57	8	1.21	8	0.73	7	0.81	9
UC-220	5.96	14	5.38	16	0.58	4	0.52	5	0.39	16
UC-228	11.20	6	8.55	4	2.65	14	1.26	11	1.17	5
UC-231	9.05	8	8.40	5	0.65	5	0.38	4	0.93	7
UC-232	7.97	13	5.54	15	2.43	13	1.62	16	0.54	13
UC-258	11.73	4	11.19	1	0.54	3	0.24	3	1.60	1
UC-263	5.84	16	7.01	12	-1.17	1	-1.07	1	0.50	14
UC-268	5.51	18	4.12	18	1.39	9	1.34	14	0.28	18
UC-296	8.46	11	7.51	9	0.95	6	0.60	6	0.78	11
UC-298	12.95	3	9.81	2	3.14	15	1.29	12	1.55	3
UC-310	8.23	12	6.17	14	2.06	12	1.33	13	0.62	12
UC-331	5.65	17	6.27	13	-0.62	2	-0.58	2	0.43	15
UC-343	5.87	15	4.90	17	0.97	7	0.88	10	0.35	17
UC-348	8.88	9	7.48	10	1.40	10	0.84	8	0.81	10
RZ-19	9.20	7	7.69	7	1.51	11	0.87	9	0.86	8
EZ-209	11.30	5	7.18	11	4.12	17	1.94	17	0.99	6
RZ-223	13.27	1	9.72	3	3.55	16	1.42	15	1.57	2
RZ-345	13.07	2	7.80	6	5.27	18	2.14	18	1.24	4
Mean	9.05		7.35							
CV (%)	7.48		6.69							
CD at 5%	1.12		0.82							

Where, **E_1**- Normal irrigation; **E_2**- Staggered irrigation; **Seed yield**- seed yield per five plants (g); **TOL**- stress tolerance: **SSI**- stress susceptibility index; **STI**- Stress tolerance index

CUM/CI/1.3: Identification of drought tolerance in cumin (Jobner)

In this experiment on identifying moisture stress/drought tolerant lines in cumin, 18 genotypes randomly selected from the germplasm repository at Jobner were sown in two environments, namely, irrigated (E_1-normal irrigation) and moisture stress (E_2-staggered irrigations i.e. half of that provided in normal irrigation). The mean performance of genotypes indicated that the genotypes viz., RZ-223, UC-298, UC-258, and UC-231 were superior under both environments, while RZ-223, RZ-345, UC-298, UC-258, RZ-209, UC-231 and RZ-19 were superior under normal while UC-258, UC-298, RZ-223, UC-228 and UC-231 were superior under moisture stress condition compared to the other genotypes. Based on the stress susceptibility index (SSI) genotypes UC-263, UC-331, UC-258, UC-231, UC-220, UC-296 and UC-217 were found to be the desirable genotypes for moisture stress conditions. Stress tolerance index (STI) revealed that genotypes UC-258, RZ-345, UC-298, RZ-345, UC-228 and RZ-209 had maximum tolerance to moisture stress (Table 44).

Crop Improvement

CUM/CI/2.4: Coordinated varietal trial (CVT) in cumin (Ajmer, Jagudan, Jobner, Mandor and Sanand)

Coordinated Varietal Trial on Cumin-2021-Series XI, was conducted successfully with 13 genotypes for the first year during Rabi, 2021-22 at 5 locations viz. Ajmer, Jagudan, Jobner, Mandor and Sanand. There were significant differences among the 13 genotypes tested 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, number of branches per plant, umbels per plant, umbellates per umbel, seeds per umbellate, biological yield, test weight and volatile oil content, disease incidence level are given in Table 45.

Table 45. Growth and yield performance of CVT cumin genotypes - series XI rabi, 2021-22

Entries	Days to 50% flowering	Days to maturity	Plant height (cm)	Number of branches per plant	Number of umbels per plant	Umbellates/ umbel	Number of seeds per umbel	Test weight (g)	Biological yield (q ha^{-1})	Seed yield (q ha^{-1})	Volatile oil (%)	Wilt (PDI %)	Blight (PDI %)	PM (PDI %)
CUM-44	48.1	106.0	32.7	5.7	41.5	4.4	13.7	4.9	6.56	2.91	4.95	62.3	55.9	18.9
CUM-45	62.9	120.3	32.4	6.5	61.4	5.4	14.2	5.1	16.01	5.92	4.91	56.8	40.2	14.0
CUM-46	62.5	117.7	40.5	6.2	60.2	5.2	15.0	5.0	15.06	4.77	4.85	58.5	29.1	20.5
CUM-47	64.0	124.0	38.5	6.8	62.1	5.4	14.3	5.2	18.14	5.92	4.64	57.4	30.3	12.8
CUM-48	62.3	121.7	34.2	6.5	47.3	5.4	13.9	5.2	12.36	4.54	4.54	22.5	36.2	19.9
CUM-49	64.7	122.3	39.5	5.8	46.1	4.7	14.3	4.7	9.11	3.92	4.29	59.2	58.1	16.1
CUM-50	61.3	118.0	36.4	5.9	40.4	5.3	14.3	5.1	15.32	4.16	5.39	14.2	41.1	18.8
CUM-51	66.5	123.3	40.4	6.5	70.6	5.3	15.4	4.8	10.44	1.93	4.26	60.1	34.3	16.0
CUM-52	66.9	124.7	40.4	5.8	65.8	5.0	16.7	4.8	11.89	2.37	4.25	39.2	47.0	17.0
CUM-53	62.3	121.7	38.8	5.7	51.8	5.1	14.2	4.6	10.82	2.61	4.26	26.3	38.8	16.8
CUM-54	66.3	120.3	35.0	6.1	72.6	5.0	14.0	4.7	13.66	3.43	5.21	21.0	34.2	18.3
CUM-55 (Check)	63.4	122.7	34.6	6.4	55.7	5.4	14.6	5.0	15.21	5.05	4.77	10.1	33.3	19.1
Mean	62.6	120.2	37.0	6.2	56.3	5.1	14.6	4.9	12.9	3.93	4.69	40.6	39.9	17.3

Location-wise performance for seed yield is presented in Table 46. The mean seed yield of test entries ranged from 1.92 q ha^{-1} to 5.92 q ha^{-1}. Two entries viz. CUM-47 (5.92 q ha^{-1}) and CUM-45 (5.92 q ha^{-1}) recorded around 17% better seed yield over best check CUM-55 (5.05 q ha^{-1}). The analysis of variance revealed significant differences among the genotypes for seed yield and yield-attributing characters. Among test genotypes, CUM-44 was an early flowering genotype (48 days) whereas as CUM-52 flowered very late (66.9 days). Days taken to maturity ranged from 106.0 to 124.7, plant height from 32.4 to 40.5 cm, number of branches per plant from 5.7 to 6.8, umbels per plant from 40.4 to 72.6, umbellates per umbel ranged from 4.4 to 5.4. was higher for entry, CUM-47 and CUM-48 (5.2g) recorded maximum test weight whereas CUM-53 (4.6g) recorded the lowest.

Table 46. Seed yield (q ha^{-1}) of CVT cumin genotypes across locations, rabi 2021-22

Entries	AJM	JAG	JOB	MDR	SAD	Mean	Rank
CUM-44	NG	2.55	1.67	2.63	4.79	**2.91**	10
CUM-45	1.63	5.28	6.35	7.33	8.99	**5.92**	**2**
CUM-46	1.23	6.41	3.60	6.94	5.66	**4.77**	4
CUM-47	0.99	6.30	6.08	8.29	7.94	**5.92**	**1**
CUM-48	2.78	5.95	2.68	6.67	2.85	**4.19**	5
CUM-49	NG	6.13	1.53	5.58	2.45	**3.92**	8
CUM-50	0.79	4.65	5.77	6.13	3.48	**4.16**	6
CUM-51	NG	1.78	1.55	2.08	2.29	**1.92**	13
CUM-52	NG	2.01	1.92	3.58	1.96	**2.37**	12
CUM-53	1.18	2.59	1.64	3.46	4.19	**2.61**	11
CUM-54	0.94	5.49	2.44	4.14	4.15	**3.43**	9
CUM-55 (check)	1.61	5.51	5.14	5.25	7.75	**5.05**	3
Mean	**1.39**	**4.55**	**3.36**	**5.17**	**4.71**	**3.93**	
C .D. at 5%	62.3	101	53.12	125	202.63		
C.V %	26.53	13.08	6.99	12.2	25.42		

Where, **AJM:** Ajmer; **JAG:** Jagudan; **JOB:** Jobner; **MDR:** Mandor; **SAD:** Sanand;
*NG: Not germinated.

Analysis of the volatile oil content of the twelve genotypes under CVT at Jagudan, Jobner, and Sanand revealed significant differences among the genotypes. The maximum volatile oil of 5.39 % was observed in CUM-50, followed by 5.21 % in CUM-54. While a minimum of 4.25% was recorded in CUM-52. CUM-45 ranked first in terms of volatile oil yield (31.77 L ha^{-1}).

The minimum incidence of wilt in CUM-55 (10.1%) was followed by CUM-50 (14.2%) and the maximum incidence in CUM-44 (62.3%). For blight incidence, none of the entries showed resistance (PDI<10%) whereas three entries i.e. CUM-48 and CUM-44 showed highly susceptible reaction (PDI ≥ 50.1) against the blight disease.

Crop Management

CUM/CM/ 5.5: Micronutrient management in cumin (Jobner, Mandor, Ajmer)

The experiment on micronutrient management in cumin was started in 2019-20 with four combinations of micronutrients (Zn alone, Zn + Fe, Zn + Fe + Mn and Zn + Fe + Mn + B) and three application methods (soil application, foliar application and soil + foliar application). Standard recommended POP was followed along with light irrigations and RDF (30-20-0). The overall results from the trials at all the centres indicated that the application of micronutrients resulted in a significant increase in all the growth and yield parameters (the plant height, branches per plant, umbels per plant, umbellets per umbel, seeds per umbel, test weight, and seed yield) and lesser incidence of blight and powdery mildew in cumin, as compared to control. Among the method of application, the soil and foliar application of micronutrients resulted in higher gain over other methods of application. The data recorded at all the centres along with pooled data analysis is given in Table 47.

Table 47. Pooled data on the effect of micronutrient management on seed yield and economics of cumin at Jobner, Ajmer & Mandor conducted during rabi, 2019-22.

Treatment	Jobner			Mandor			Ajmer			Mean		
	Seed yield (kg ha^{-1})	Net returns (Rs ha^{-1})	B:C ratio	Seed yield (kg ha^{-1})	Net returns (Rs ha^{-1})	B:C ratio	Seed yield (kg ha^{-1})	Net returns (Rs ha^{-1})	B:C ratio	Seed yield (kg ha^{-1})	Net returns (Rs ha^{-1})	B:C ratio
Micronutrient												
Control	507.0	77483	3.67	335	18266	1.51	312.4	1457	0.36	385	32402	1.85
Zn	587.2	91074	3.82	398	28435	1.78	541.4	39743	1.09	509	53084	2.23
Zn + Fe	649.8	102430	4.02	425	31143	1.81	613.5	50812	1.28	563	61462	2.37
Zn + Fe + Mn	701.6	109023	3.89	428	29782	1.72	712.8	66045	1.53	614	68283	2.38
Zn + Fe + Mn + B	735.5	111945	3.70	495	37852	1.88	884.3	93529	1.99	705	81109	2.52
SEm±	10.4	1563	0.06	5.3			16.9	2685	0.05			
CD (P= 0.05)	29.4	4453	0.18	14.8			48.3	7690	0.15			
Method of application												
Soil application	582.4	85274	3.33	401	25834	1.65	566.4	41560	1.07	517	50889	2.02
Foliar application	641.7	102560	4.17	409	29245	1.77	607.1	50676	1.29	553	60827	2.41
Soil + foliar application	684.6	107340	3.96	439	32207	1.80	665.2	58716	1.39	596	66088	2.38
SEm±	8	1208	0.05	6.8			13.1	2173	0.04			
CD (P= 0.05)	22.8	3615	0.14	19.2			37.4	6224	0.12			

The results obtained during *rabi* 2021-22 from the trial at Mandor showed that the application of all micronutrients *viz.*, zinc, iron and manganese with or without boron recorded significantly higher plant height, umbels per plant, umbellets per umbel, test weight, seed yield (7.35 kg ha^{-1}), net return and B:C ratio over other treatments. The application of 50% micronutrient in soil application along with foliar spray significantly increased the plant height, umbels per plant, umbellets per umbel, test weight and seed yield of cumin as compared to sole soil application and foliar spray. Foliar spray of micronutrients was at par with application of 50% micronutrient in soil application along with foliar spray for branches per plant, net return and B:C ratio. During the study, minimum percent disease index of *Alternaria* blight and

powdery mildew were recorded with zinc, iron, manganese and boron in soil and foliar application.

The application of all micronutrients (zinc, iron, manganese and boron) at Jobner also resulted in significantly increased the plant height, branches per plant, umbels per plant, umbellets per umbel, seeds per umbel, test weight, seed yield, net returns, B:C ratio and incidence of blight and powdery mildew in cumin as compared to control. The application of all micronutrients viz., zinc, iron, manganese and boron recorded significantly higher plant height (33.84 cm), branches per plant (7.92), seeds per umbel (27.57), test weight (4.60 g), net returns (Rs 111945 ha^{-1}) and volatile oil (2.85%) over application of iron and zinc, zinc alone but remained at par with application of iron, zinc and manganese. Similarly, application of all micronutrients viz., zinc, iron, manganese and boron recorded significantly highest umbels per plant (20.30), umbellets per umbel (5.70), seed yield (735.5 kg ha^{-1}) and minimum incidence of blight (11.9 %) and powdery mildew (14.80%). The application of 50% micronutrients in soil application along with foliar spray significantly increased the plant height (32.20 cm), branches per plant (7.31), umbels per plant (18.79), umbellets per umbel (5.28), seeds per umbel (26.14), test weight (4.38 g), seed yield (684.6 kg ha^{-1}), net returns (Rs 107340 ha^{-1}), B:C ratio (3.96), volatile oil (2.81%) and minimum incidence of blight (23.0%) and powdery mildew (22.2%).

Similarly, in the trial at Ajmer, the application of all micronutrients (zinc, iron, manganese and boron) resulted in significantly higher plant height (31.0 cm), primary branches per plant (8.87), umbels per plant (39.82), umbellets per umbel (6.08), seeds per umbel (36.87), test weight (5.63 g), seed yield (884 kg ha^{-1}), net returns (Rs. 93529 ha^{-1}), B:C ratio (1.99) and minimum incidence of blight (8.94%) and powdery mildew (3.94%). The soil application of 50% micronutrients along with foliar spray resulted in maximum plant height (28.9 cm), umbellets per umbel (5.99), seeds per umbel (34.13), test weight (5.25 g), seed yield (6.65 q ha^{-1}), net returns (Rs. 58716 ha^{-1}), B:C ratio (1.39) and slightly higher incidence of blight (20.34%) and powdery mildew (9.89%).

Overall recommendation

Application of half recommended dose of zinc, iron, manganese and boron as soil application along with their foliar spray is recommended for obtaining higher yield and returns in cumin crop.

09 FENNEL

Genetic Resources

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

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

A total of 862 fennel germplasm accessions are being maintained by different AICRPS centres. The details of the germplasm collection maintained are given in Table 48. Apart from these, NRCSS, Ajmer also maintains a vast collection of fennel germplasm. About 100 accessions of fennel were evaluated at NRCSS, Ajmer in two-row plots of 3.0-meter length each using AF-2, AF-3, RF-101 & RF -205 as checks during 2021-2022. The most promising lines were AF-255, AF-62, AF-149, AF-116, AF-137, AF-81, AF-297, AF-144, AF-28, AF-54 and AF-50.

Table 48. Fennel germplasm collections maintained at various AICRPS centres

Centre	Indigenous	Exotic	Total
Dholi	43	-	**43**
Hisar	180	-	**180**
Jagudan	160	2	**162**
Jobner	289	20	**309**
Kumarganj	168	-	**168**
Total	**840**	**22**	**862**

Among the forty-three germplasm accessions evaluated at Dholi for yield and quality, only four accessions (RF-31, RF-74, RF-55 and RF-66) yielded more than the check variety, Rajendra Saurabh. The highest yield was recorded in RF-31 (17.19 q ha^{-1}) followed by RF -74 (17.03 q ha^{-1}) against check variety, Rajendra Saurabh (16.37 q ha^{-1}). Among 138 accessions of fennel accessions evaluated at Hisar, the seed yield ranged from 35.4 g $plant^{-1}$ (HF-120) to 98.4 g $plant^{-1}$ (HF-184). The most promising lines were HF-103, HF-122, HF-184, HF-194, HF-210, HF-219, HF-225, HF-230, HF-235 and HF-249. At Jagudan**,** the seeds per umbellate ranged from 22 to 76.4 among the 81 entries evaluated. Promising genotypes identified were JF-311, JF-427-1-1, JF-535-1 and JF-519. One hundred and twenty-nine inbred lines were raised by bagging individual umbel with muslin cloth and on maturity seeds were harvested separately to raise the lines for the next season at Jobner. A total of 168 germplasm accessions of fennel were evaluated at Kumarganj centre. The highest yield was recorded in NDF-46 (53.6 g $plant^{-1}$) followed by NDF-52 (52.7 g $plant^{-1}$) and NDF-47 (50.5 g $plant^{-1}$).

Crop Improvement

FNL/CI/2.7 Coordinated Varietal Trial (CVT) in Fennel

(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, 2021-22 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.

Table 49. Growth and yield performance of fennel entries in CVT (*rabi*, 2021-22)

Entries	Plant height (cm)	Primary branches/ plant	Secondary branches/ plant	Umbel/ plant	Umbellet/ Umbel	Seeds/ umbel	Seed yield (q ha^{-1})	Test weight (g)
FNL-130	152.0	7.1	17.5	33.4	27.7	133.8	13.96	7.39
FNL-131	154.4	7.4	20.4	29.7	28.3	108.4	13.39	6.83
FNL-132	144.3	7.6	17.6	35.3	26.3	175.5	16.82	7.89
FNL-133	145.8	8.0	23.3	34.9	27.1	156.0	16.90	7.34
FNL-134	142.2	7.7	23.3	40.7	26.3	162.9	15.54	7.24
FNL-135	146.9	7.6	23.8	37.0	27.4	133.9	14.82	7.44
FNL-136	154.1	7.3	22.1	36.2	25.8	153.9	15.73	7.37
FNL-137	155.4	7.4	21.4	37.6	26.8	131.6	15.94	7.47
FNL-138	148.6	7.5	16.8	33.4	25.0	149.2	12.99	6.71
FNL-139 (Check)	142.5	8.2	27.5	39.7	26.8	151.4	15.66	7.64
FNL-140 (Check)	132.9	7.4	17.3	34.4	24.8	140.0	12.12	6.73
FNL-141	142.3	7.8	26.2	32.0	25.6	109.7	13.09	6.11
FNL-142	144.8	8.2	24.6	32.1	25.9	136.2	11.84	6.24
Mean	**146.6**	**7.6**	**21.7**	**35.1**	**26.5**	**141.7**	**14.47**	**7.11**

Fig 24. Photograph of CVT in Fennel undertaken at A. Jobner, B: Hisar, C: Kumarganj D: Navsari centres

Location-wise performance for seed yield is presented in Table 50. Mean seed yield ranged from 11.84 to 16.90 q ha^{-1}. Four entries viz. FNL-133 (16.9 q ha^{-1}), FNL-132 (16.47 q ha^{-1}), FNL-137 (15.97 q ha^{-1}), and FNL-136 (15.73 q ha^{-1}) recorded numerically higher seed yield over best check FNL-139 (15.66 q ha^{-1}). The analysis of variance revealed significant differences among the genotypes for seed yield and yield-attributing characters. Plant height ranged from 132.9 to 155.4 cm, primary branches per plant ranged from 7.1 to 8.2, secondary branches from 16.8 to 27.5, umbels per plant from 29.7 to 40.7, umbellets per umbel ranged from 24.8 to 28.3. Test weight was highest in FNL-141 (6.11 g) and lowest FNL-132 (7.89 g).

Table 50. Yield performance (q ha^{-1}) of coriander CVT entries across locations (*rabi*, 2021-22)

Entries	AJM	DHI	HSR	JBR	JAG	JOB	KGJ	NAV	PNR	Mean	Rank
FNL-130	19.69	15.04	21.87	12.51	11.72	9.52	10.34	9.52	15.45	**13.96**	8
FNL-131	14.10	15.76	21.62	13.17	11.41	8.74	9.26	9.16	17.28	**13.39**	9
FNL-132	14.07	14.87	16.24	10.74	19.61	21.28	13.12	25.74	15.68	**16.47**	**2**
FNL- 133	15.71	17.76	19.62	10.96	15.28	18.97	12.47	23.02	18.29	**16.90**	**1**
FNL-134	16.42	14.57	18.48	14.74	13.21	17.71	13.73	12.28	18.76	**15.54**	6
FNL-135	15.80	16.84	14.57	14.37	11.87	15.80	10.52	13.75	19.82	**14.82**	7
FNL-136	16.80	17.10	17.76	12.86	14.80	15.93	9.35	20.16	16.77	**15.73**	**4**
FNL-137	18.95	16.82	18.80	12.72	14.10	14.27	11.73	21.04	15.06	**15.94**	**3**
FNL-138	13.07	16.08	16.30	13.38	9.46	9.82	12.10	12.50	14.19	**12.99**	11
FNL-139 (Check)	14.32	15.95	15.87	9.74	14.31	18.18	11.36	24.00	17.24	**15.66**	5
FNL-140 (Check)	13.02	15.55	14.75	8.33	12.52	8.18	10.65	10.95	15.16	**12.12**	12
FNL-141	9.10	17.44	17.44	9.31	9.73	5.92	10.25	20.00	18.63	**13.09**	10
FNL-142	8.89	16.30	14.05	9.07	9.43	4.91	9.41	16.73	17.74	**11.84**	13
Mean	**14.61**	**16.16**	**17.49**	**11.68**	**12.88**	**13.02**	**11.10**	**16.83**	**16.93**	**14.50**	
CD (0.05)	3.49	1.61	0.8	2.76	2.73	1.57	2.18	3.13	2.44		
CV (%)	14.09	10.5	3.0	14.02	21.16	7.18	12.06	11.03	8.62		

Where, **AJM:** Ajmer; **DHI:** Dholi; **HSR:** Hisar; **JBR:** Jabalpur; **JAG:** Jagudan; **JOB:** Jobner; **KGJ:** Kumarganj; **NAV:** Navsari and **PNR:** Pantnagar.

FNL/CI/4.1 Quality evaluation in fennel
(Centres: Jobner)

The volatile oil content among the 14 genotypes under the CVT ranged from 1.93% in FNL-140 to 2.43% in FNL-135 and FNL-142. The maximum volatile oil of 2.43% was observed in FNL-135 as well as FNL-142 followed by FNL-139 (2.27%), FNL-130 (2.23%), FNL-133 (2.20%). FNL-132 ranked first in terms of volatile oil yield (46.19 l ha^{-1}) followed by FNL-133 (41.75 L ha^{-1}), FNL-139 (41.27 L ha^{-1}). While lowest volatile oil yield of 11.86 L ha^{-1} was recorded in FNL-141 and 11.93 L ha^{-1} in FNL-142.

Crop Management

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

(Jagudan, Jobner, Dholi, Kumarganj, Mandor)

The second-year pooled results indicated that zinc and iron sulphate significantly increased the plant height, umbels/plant, umbellets /umbel, test weight, seed, and biological yields, gross and net returns and B:C ratio of fennel except in Jagudan. The pooled data of the effect of foliar application of zinc and iron sulphate on fennel seed yield during rabi, 2021-22 along with net returns and B:C ratio across testing locations is presented in Table 51.

Table 51. Pooled data on the effect of micronutrient management on seed yield and economics of fennel at different testing locations conducted during rabi, 2019-22.

Treatment	Jobner			Mandor			Dholi			Jagudan		
	Seed yield (q ha^{-1})	Net returns* (Rs ha^{-1})	B:C ratio	Seed yield (q ha^{-1})	Net returns* (Rs ha^{-1})	B:C ratio	Seed yield (q ha^{-1})	Net returns* (Rs ha^{-1})	B:C ratio	Seed yield (q ha^{-1})	Net returns* (Rs ha^{-1})	B:C ratio
Zinc sulphate												
Control	17.3	85.5	2.92	11.8	52.4	2.9	14.5	51.0	1.02	8.8	64.4	1.56
Foliar spray (0.2%)	19.7	100.2	3.12	13.3	63.2	3.2	16.5	60.2	1.09	10.5	84.9	2.04
Foliar spray (0.4%)	21.4	112.5	3.36	14.4	71.6	3.5	16.6	60.8	1.10	11.1	91.7	2.19
Foliar spray (0.6%)	22.7	122.3	3.53	14.9	75.8	3.6	16.8	62.0	1.11	10.0	78.5	1.86
SEm (+)	0.30	2.25	0.05	0.26	2.01	0.1	0.32	-	-	0.85	-	-
CD (P= 0.05)	0.85	6.37	0.13	0.73	5.70	0.2	0.97	-	-	NS	-	-
Iron sulphate												
Control	17.9	89.7	3.01	12.0	53.5	2.9	14.5	51.0	1.02	8.8	64.4	1.56
Foliar spray (0.2%)	19.9	101.7	3.15	13.2	62.8	3.2	15.8	55.6	1.01	11.1	91.5	2.15
Foliar spray (0.4%)	21.4	113.0	3.37	14.3	71.1	3.4	16.6	61.0	1.10	10.6	83.6	1.96
Foliar spray (0.6%)	21.9	116.1	3.41	14.9	75.6	3.6	17.4	66.3	1.19	9.9	74.3	1.65
SEm (+)	0.30	2.25	0.05	0.26	2.01	0.1	0.32	-	-	0.85	-	-
CD (P= 0.05)	0.85	6.37	0.13	0.73	5.70	0.2	0.97	-	-	NS	-	-

* Net returns are indicated as Rs. in x1000 ha^{-1}

During rabi, 2021-22 at Jobner, the foliar spray of 0.6% zinc sulphate recorded significantly higher plant height (92.04 cm), umbels/plant (24.26), umbellets/umbel (20.26), seeds/umbel (350.98), test weight (5.50 g), essential oil (1.80%), seed yield (22.73 q ha^{-1}), biological yield (59.20 q ha^{-1}), net returns (Rs 122267/ha) and B:C ratio (3.53). The foliar spray of 0.4% iron sulphate recorded significantly higher plant height (89.30 cm), umbellets/umbel (19.03), seeds/umbel (327.82), test weight (5.20 g), essential oil (1.73%), seed yield (21.42 q ha^{-1}), straw yield (56.86 q ha^{-1}), net returns (Rs 113010 ha^{-1}) and B:C ratio (3.47). Similarly, at Mandor, the foliar spray of 0.6% zinc sulphate recorded significantly higher plant height (149 cm), umbels/plant (35.6), umbellets /umbel (32.9), test weight (3.29 g), seed yield (14.91 q ha^{-}

^{1}), biological yield (62.33 q ha^{-1}), net returns (Rs 75834 ha^{-1}) and B:C ratio (3.6) over control. The foliar spray of 0.4% iron sulphate (which was on par with foliar spray of 0.6% iron sulphate) recorded significantly higher plant height (149 cm), umbels/plant (35.5), umbellets /umbel (32.6), test weight (3.30 g), seed yield (14.28 q ha^{-1}), biological yield (62.37 q ha^{-1}), net returns (Rs 71060 ha^{-1}) and B:C ratio (3.4) over the foliar spray of 0.2% iron sulphate and control. Among the 16 treatments, three treatments recorded significantly higher yield at Dholi as compared to control, highest yield (19.71 q ha^{-1}) was recorded in treatment (T_{14}) – foliar spray with $FeSO_4$ (0.6%) + $ZnSO_4$ (0.4%) followed by 18.83 q ha^{-1} in T_{15} - $FeSO_4$ (0.6%) + $ZnSO_4$ (0.6%) as compared to check variety, Rajendra Saurabh (15.68 q ha^{-1}). At Kumarganj also, the highest yield was recorded in treatment T_{12} (foliar spray of $FeSO_4$ (0.4%) + $ZnSO_4$ (0.6%)) (16.04 q ha^{-1}) followed by T_{13} (foliar spray of $FeSO_4$ (0.6%) + $ZnSO_4$ (0.2%)) (15.28 q ha^{-1}) and T_{14} (foliar spray of $FeSO_4$ (0.6%) + $ZnSO_4$ (0.4%)) (14.10 q ha^{-1}) while the lowest yield (10.76 q ha^{-1}) was recorded in control. However, at Jagudan centre, foliar application of zinc (0.4%) and iron (0.2%) was on par with control for seed yield though higher seed yield (11.12 q ha^{-1} and 11.15 q ha^{-1} respectively) was recorded compared to control, higher B:C ratio of 2.04 and 2.15 was achieved with the same treatments.

Fig 25. Photograph of Crop Management trial for evaluating the response of foliar application of iron and zinc on growth, yield and quality of fennel undertaken at Jobner centre

10 FENUGREEK

Genetic Resources

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

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

A total of 1479 fenugreek germplasm accessions are being maintained by different AICRPS centres. The details of the germplasm collection maintained are given in Table 52.

Table 52. Germplasm collection of fenugreek in various AICRPS centres

Centre	Indigenous	Exotic	Total	Evaluated 2021-22
Dholi	170	-	170	50
Guntur	124	-	124	124
Hisar	406	-	406	120
Jagudan	76	-	76	76
Jobner	473	12	485	345
Kumarganj	204	-	204	204
Raigarh	14	-	14	14
Total	**1467**	**12**	**1479**	**933**

A total of 204 fenugreek germplasm accessions are being maintained and evaluated at Kumarganj, the highest yield was found in NDM-49 (6.5 g plant^{-1}) followed by NDM-45 (6.1 g plant^{-1}), NDM-37 (6.0 g plant^{-1}), NDM-92 (5.9 g plant^{-1}) and NDM-54 and NDM-140 both (5.8 g plant^{-1}). Three hundred forty-five) germplasm accessions were evaluated at Jobner, promising accessions identified based on the seed yield per five plants are UM-131 (100.8 g), UM-61 (93.8 g), UM-285 (88.8 g), UM-135 (88.5 g), UM-110 (88.5 g), UM-374 (87.5 g), UM-133 (84.5 g), UM-246 (83.3 g), UM-377 (82.0 g), UM-136 (78.5 g), UM-379 (78.0 g), UM-151 (76.8 g), UM-344 (76.0 g), UM-129 (75.5 g), UM-137 (74.5 g), UM-118 (72.8 g), UM-354 (72.8 g), UM-376 (72.8 g), UM-305 (71.8 g), UM-106 (70.5 g), UM-361 (70.3 g), UM-281 (69.8 g), UM-10 (69.5 g), UM-145 (69.5 g), UM-267 (68.5 g), UM-141 (68.3 g), UM-142 (67.5 g), UM-146 (67.5 g) and UM-355 (67.3 g).

Among the 124 genotypes evaluated at Guntur, twenty-one recorded significantly higher yield than the best check Lam Sonali (4.96 g plant^{-1}). The top five performing entries are LFC-122 (6.57 g plant^{-1}), LFC-41 (6.38 g plant^{-1}), LFC-32 (6.23 g plant^{-1}), LFC-82 (6.22 g plant^{-1}) and LFC-38 (6.21 g plant^{-1}). Among the accessions evaluated, the accession LFC-7 recorded highest fresh yield at 7, 14 and 21 DAS followed by LFC-2. One hundred twenty accessions of fenugreek were evaluated at Hisar along with Hisar Sonali, Hisar Suvarna and Hisar Mukta as checks and among them, the most promising accessions for seed yield were HM-343Y, HM-421, HM-429, HM-436, HM-440 and HM-464. At Jagudan, 76 germplasm accessions were evaluated along with two checks viz., GM-1 and GM-2 and promising genotypes were grouped for specific traits. A total of 14 accessions (11 germplasm + 3 released varieties) of fenugreek maintained during rabi 2021-22 at CARS, Raigarh were evaluated in which IFGS 11 (14.2 q ha^{-1}) had maximum seed yield followed by IFGS 9 (13 q ha^{-1}) over checks RMT 305 (10.3 q

ha^{-1}) and Gujarat 2 (9.3 q ha^{-1}). Among 50 fenugreek accessions evaluated at Dholi, RM-188 (92.72 g per five plants; 17.07 q ha^{-1}) and RM-112 (91.60 g per five plants; 16.92 q ha^{-1}) recorded higher yield than best check variety, Hisar Sonali (91.60 g per five plants; 16.85 q ha^{-1}).

FGK/CI/1.3 Identification of drought tolerant source in fenugreek
(Centre: Jobner)

Eighteen genotypes randomly selected from the germplasm were sown in two environments, namely, irrigated (normal irrigation) and drought (staggered irrigation i.e. half of that provided in normal irrigation). The genotypes, RMt-354, UM-216, RMt-305, UM-162 and UM-373 were the better yielders under normal conditions, while UM-329, RMt-354, RMt-305, UM-300 and RMt-361 were better under stress compared to other genotypes. Based on stress indices, RMt-354, RMt-305, UM-329, UM-216 and RMt-361 were found to be the desirable entries for drought conditions.

Fig 26. Field view of fenugreek crop improvement trials undertaken at A: Jabalpur B: Guntur C: Raigarh D: Pantnagar centres

Crop Improvement

FGK/CI/2.5 Coordinated Varietal Trial in fenugreek Series-XI, 2021
(Centres: Ajmer, Dholi, Hisar, Jabalpur, Jagudan, Jobner, Kumarganj, Navsari, Pantnagar, Kota, Raigarh, Kalyani)

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*, 2021-22 at 12 locations and there were significant differences among genotypes at various AICRPS centres for seed yield and yield attributing characters.

Table 53. Yield performance (q ha^{-1}) of fenugreek CVT genotypes across locations

Entries	AJM	DHI	HSR	JBR	JAG	JOB	KLN	KOT	KGJ	NAV	PNR	RAI	Mean	Rank
FGK-139	11.0	20.4	21.5	19.8	9.4	19.1	7.7	10.8	17.9	13.1	19.0	6.1	**14.65**	14
FGK-142	12.4	17.1	21.8	19.2	15.5	18.6	8.8	10.6	20.4	16.2	21.4	8.1	**15.82**	4
FGK-143	12.1	20.1	22.1	21.1	10.2	20.7	7.4	12.2	20.2	15.5	19.2	6.3	**15.58**	9
FGK-144	14.3	17.9	23.2	18.3	10.5	17.8	7.3	14.3	19.0	14.8	21.2	7.6	**15.51**	10
FGK-145	10.4	15.1	20.0	18.8	17.7	18.6	7.8	12.8	19.2	16.7	21.2	6.9	**15.43**	6
FGK-146	10.6	16.9	18.3	13.0	11.1	20.3	10.3	10.6	17.0	17.3	16.9	7.2	**14.11**	15
FGK-147	13.5	19.6	24.5	19.4	10.5	21.3	7.9	10.1	23.8	16.8	24.1	6.6	**16.51**	**2**
FGK-148	10.8	16.5	19.8	17.2	18.3	20.6	9.1	10.5	20.9	16.5	19.3	6.8	**15.52**	5
FGK-149	12.0	21.2	21.1	17.2	10.3	19.8	8.1	13.3	22.0	16.2	24.2	7.7	**16.08**	3
FGK-150	12.7	17.1	20.3	19.7	15.1	19.3	8.2	14.2	18.9	14.6	19.1	10.4	**15.79**	8
FGK-151	14.9	17.1	22.4	18.1	12.5	21.4	7.8	11.8	17.3	15.6	23.9	8.0	**15.90**	7
FGK-152	11.9	14.4	19.3	16.0	12.3	19.0	9.7	14.3	16.4	15.4	21.1	9.1	**14.91**	11
FGK-153	8.8	16.0	16.0	13.6	7.9	15.0	7.4	12.9	15.2	11.6	13.7	12.9	**12.57**	16
FGK-154	12.9	16.1	21.0	25.3	16.2	19.7	8.6	11.8	19.1	16.0	24.1	16.2	**17.25**	**1**
FGK-155 (check)	12.4	16.3	20.8	19.3	10.5	19.3	9.8	12.2	16.0	16.2	16.2	6.5	**14.63**	12
FGK-156 (check)	10.6	16.0	20.0	19.4	11.0	21.8	7.9	11.5	15.8	12.2	19.7	11.3	**14.76**	13
Mean	**12.0**	**17.3**	**20.8**	**18.5**	**12.4**	**19.5**	**8.4**	**12.1**	**18.7**	**15.3**	**20.3**	**8.6**	15.31	-
CD (p=0.05)	2.9	1.5	2.1	5.6	2.5	2.2	0.5	2.5	3.2	2.2	2.9	2.9	-	-
CV (%)	14.6	5.2	6.1	13.6	12.1	7.2	-	12.6	10.1	8.8	8.8	19	-	-

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

All 15 test genotypes surpassed the seed yield of checks. FGK-154 (17.25 q ha^{-1}) recorded the highest yield followed by FGK-147 (16.51 q ha^{-1}) with 14 and 10 % yield gain respectively over the best check, FGK-156. The location average ranged from 8.35 q ha^{-1} in Kalyani to 20.75 q ha^{-1} in Hisar.

Screening of germplasm entries against powdery mildew disease

In *rabi* 2021-22, CVT fenugreek genotypes were screened against powdery mildew and downy mildew disease under at Jobner. Among them, five genotypes viz., FGK-143, FGK-147, FGK-148, FGK-151 and FGK-156 showed moderately resistant and the rest showed susceptible and highly susceptible reactions against the powdery mildew. Five genotypes viz., FGK-144, FGK-148, FGK-149, FGK-151 and FGK-156 showed moderately resistant and the rest showed susceptible and highly susceptible reactions against the downy mildew.

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

(Centres: Ajmer, Coimbatore, Guntur, Dholi, Hisar, Jobner, Kumarganj)

At Guntur, three released varieties viz., LS-1, Lam Methi-2 and Lam Sonali were analysed for oleoresin content, crude fibre, carbohydrate content, fixed oil and protein content. Among them, Lam Mehti-2 recorded 4.3% oleoresin followed by Lam Sonali and LS-1. Chemo-profiling (by HPLC) of fenugreek varieties viz., CO 1 and CO 2 at Coimbatore revealed that diosgenin content in CO1 and CO2 was 0.71 and 0.79 %, whereas the trigonelline content was 0.52 and 0.50 %) respectively.

Crop Management

FGK/CM/5.9. Standardization of drip irrigation interval and method of micronutrient fertigation in fenugreek

(Centres: Ajmer, Coimbatore, Jobner, Pantnagar)

The experiment on standardizing drip irrigation interval and method of micronutrient fertigation in fenugreek was started in 2019-20. The treatments consist of four drip irrigation intervals (2, 4, 6 and 8 days) and four micronutrient application methods (control, soil application, foliar application and fertigation). During the third and final year of testing (2021-22), results revealed that drip irrigation at an interval of 4 days recorded better growth, yield attributes, seed yield and net returns at all the locations which were at par with drip irrigation at 2 days intervals. The 4 days interval of drip irrigation produced seed yield of 18.02, 25.16 and 16.56 q ha^{-1} at Jobner, Ajmer and Pantnagar respectively with net returns of Rs 68829, Rs 131819 and Rs 62145 ha^{-1} respectively in Fenugreek. The water use efficiency of 7.93, 8.98 and 9.67 kg ha^{-1} mm was obtained at 4 days interval drip irrigation at Jobner, Ajmer and Pantnagar respectively. Application of micronutrients through fertigation being at par with foliar application recorded better growth, yield attributes and seed yield (17.19, 26.90 and 16.76 q ha^{-1}, with net returns of Rs 61063, Rs 142186 and Rs 61225 ha^{-1} and B:C ratio of 2.04, 2.42 and 2.08). Also, the water use efficiency was 7.70, 9.53 and 9.25 kg ha^{-1} mm at Jobner, Ajmer and Pantnagar, respectively.

Overall recommendation

Drip irrigation at four-day intervals along with fertigation of micronutrients (Zn, Fe, Mn, B, Mo) in fenugreek is recommended for higher yield and economic returns from fenugreek crop.

Table 54. Crop yield obtained and estimated economics of micronutrient fertigation experiment in fenugreek conducted during *rabi*, 2021-22 at different centres.

Treatment	Jobner			Ajmer			Pantnagar			Jobner		Ajmer	
	Seed yield (q ha^{-1})	WUE (kg ha^{-1} mm)	B:C ratio	Seed yield (q ha^{-1})	WUE (kg ha^{-1} mm)	B:C ratio	Seed yield (q ha^{-1})	WUE (kg ha^{-1} mm)	B:C ratio	Downey mildew (%)	Powdery mildew (%)	Downey mildew (%)	Powdery mildew (%)
Drip irrigation interval													
2 days	16.79	7.30	2.08	25.69	9.21	2.41	14.26	8.96	2.05	33.00	30.94	18.75	23.08
4 days	18.02	7.93	2.22	25.16	8.98	2.34	16.56	9.67	2.18	22.92	18.45	17.66	18.83
6 days	15.25	6.88	1.90	24.33	8.73	2.24	15.42	8.10	1.88	26.53	23.97	15.63	12.21
8 days	14.85	7.08	1.85	23.06	8.33	2.04	15.17	8.40	1.80	30.57	27.92	14.22	8.28
SEm±	0.20	0.09	0.03	0.34	0.13	0.05	0.36	0.18	0.05	0.41	0.23	1.07	0.97
CD (*p= 0.05*)	0.59	0.27	0.08	1.21	0.44	0.17	0.64	0.75	0.07	1.21	0.7	N/A	3.15
Method of application													
Control	14.08	6.36	2.00	21.69	7.87	2.33	13.37	7.25	2.01	42.58	41.8	22.97	21.69
Soil application	16.38	7.32	1.94	23.56	8.49	1.95	14.66	8.62	1.92	26.75	28.40	13.28	12.52
Foliar application	17.26	7.81	2.06	26.09	9.37	2.34	15.47	9.05	2.02	23.4	12.48	13.91	15.20
Fertigation	17.19	7.70	2.04	26.90	9.53	2.42	16.76	9.25	2.08	20.28	18.60	16.09	12.98
SEm±	0.17	0.08	0.02	0.65	0.23	0.07	0.35	0.55	0.03	0.26	0.18	0.81	0.75
CD (*p= 0.05*)	0.49	0.22	0.06	1.90	0.66	0.22	0.56	1.45	0.07	0.73	0.5	2.33	2.15

SS/CM/4.1: Intercropping of seed spices with vegetables for higher yield and income

(Jobner, Dholi, Kumarganj, Raigarh, Jagudan, Jabalpur)

Among the different intercropping systems, the higher fennel equivalent yield of 20.34 q ha^{-1} was recorded under fennel + carrot intercropping which was at par with fennel + cabbage (19.71 q ha^{-1}). But, higher net return (Rs. 114704 ha^{-1}) and B:C ratio (2.67) were obtained with fennel + cabbage intercropping. At Jobner, the results showed that intercropping of vegetables significantly influenced growth, yield attributes and yield of fennel and coriander. The sole fennel and coriander recorded higher growth; yield attributes and yields as compared to intercropping with vegetables. The results indicated that intercropping of vegetables also significantly influenced fennel equivalent yield and economics. Significantly higher fennel equivalent yield (32.7 q ha^{-1}) and net returns (Rs 195533 ha^{-1}) were recorded with fennel + garlic intercropping, closely followed by sole garlic (fennel equivalent yield of 31.7 q ha^{-1} and net returns of Rs 179488 ha^{-1}). The highest net return of Rs. 357760 ha^{-1} with a B:C ratio of 3.57 was obtained in coriander + cabbage intercropping followed by fennel + cabbage intercropping (net return Rs. 316940, B:C ratio - 3.19) and in cabbage sole crop (net return Rs. 280100, B:C ratio 3.07). The least net return (Rs.36340) with least B:C ratio (1.18) was recorded in garlic sole crop at Kumarganj. Among all the treatments, net returns of 3.26 lakhs ha^{-1} and B:C ratio of 2.68 was recorded in coriander + garlic at Raigarh. At Dholi, the yield of coriander was highest in those intercropped with garlic (14.61 q ha^{-1}) whereas the yield in coriander cv. Rajendra Dhania-1 alone as sole crop was 18.58 q ha^{-1}. The yield of fennel intercropped with garlic was found to be maximum (10.16 q ha^{-1}) as compared to other vegetable crops, whereas the yield of fennel variety, Rajendra Saurabh as the sole crop was 16.81 q ha^{-1}. Among the vegetables (garlic, carrot & cabbage), the maximum yield of carrot (47.84 q ha^{-1}) and cabbage (188.59 q ha^{-1}) was obtained in intercropping with fennel while the maximum yield of garlic (44.73 q ha^{-1}) was recorded in intercropping with coriander. The highest fennel equivalent yield of 42.26 q ha^{-1} was recorded in intercropping of coriander with garlic consequently resulting in the highest B:C ratio of 2.18. The details regarding the yield obtained, net returns received and BC ratio for each intercropping treatment at different AICRPS centres are given by Table 55.

Coriander + cabbage | Coriander + carrot

Fig 27. View of intercropping of vegetables with seed spices at Jabalpur

Table 55. Effect of intercropping of vegetables with seed spices on yield at AICRPS centres

Treatment	DHI			JBR			JAG			JOB			KGJ			RAI		
	Yield *	net returns *	BC Ratio *	Yield *	net returns *	BC Ratio *	Yield *	net returns *	BC Ratio *	Yield *	net returns *	BC Ratio *	Yield *	net returns *	BC Ratio *	Yield *	net returns *	BC Ratio *
Fennel + Garlic	30.7	1.69	1.9	32.5	1.92	2.4	12.4	0.63	1.7	32.7	1.96	4.9	57.8	0.97	1.4	40.2	2.50	1.7
Fennel + Carrot	23.4	0.96	1.3	18.0	1.75	2.8	20.3	0.89	1.2	19.8	1.06	3.5	35.2	0.71	1.5	79.9	1.57	1.6
Fennel + Cabbage	36.1	1.45	1.4	14.0	1.12	2.1	19.7	1.15	2.7	25.5	1.45	4.2	79.8	3.34	3.3	127.3	1.05	1.2
Coriander + Garlic	42.3	2.19	2.3	32.2	4.17	2.9	10.2	0.47	1.4	27.9	1.52	3.6	67.4	1.74	1.8	46.2	3.26	2.7
Coriander + Carrot	28.1	1.18	1.8	13.4	1.06	2.1	14.5	0.44	0.6	18.4	0.97	3.4	44.6	1.36	2.0	81.7	1.64	1.7
Coriander + Cabbage	41.4	1.82	1.9	12.3	0.81	1.8	15.4	0.82	2.0	24.9	1.35	3.6	81.3	3.58	3.8	126.8	1.02	1.2
Fennel sole	16.8	0.67	1.1	17.3	2.02	4.5	8.9	0.33	0.9	19.1	1.01	3.4	14.4	0.36	1.7	11.2	0.40	0.6
Coriander sole	21.2	0.89	1.7	11.3	1.11	2.9	9.1	0.39	1.1	14.1	0.72	3.1	23.4	0.60	1.8	12.3	0.55	0.8
Garlic sole	39.3	1.86	1.5	41.8	4.65	4.9	6.6	0.18	0.5	31.7	1.79	4.1	50.3	0.47	1.2	50.6	3.65	2.4
Carrot sole	34.0	1.44	1.7	14.7	1.55	3.4	24.8	0.88	0.8	15.5	0.68	2.4	43.2	1.29	2.0	92	2.10	1.8
Cabbage sole	55.0	2.06	1.4	16.0	1.55	2.8	9.0	0.24	0.5	26.8	1.51	4.0	69.2	2.80	3.1	205.7	1.05	1.1
SEm±	3.5	N/A	N/A	1.2	0.14	0.17	1.8	N/A	N/A	0.69	0.05	0.1	1.7	0.10	0.1	2.78	0.00	0.1
CD (*p= 0.05*)	10.5	N/A	N/A	3.5	0.4	0.51	5.2	N/A	N/A	1.96	0.15	0.3	5.0	0.30	0.2	N/A	N/A	N/A

* **Yield:** in q ha^{-1}; **net returns:** in lakhs INR; **BC Ratio:** Benefit-Cost Ratio.

Crop Protection

SS/CP/7.1: Survey and monitoring of diseases and insect pests of seed spices for the development of prediction models.

(Jobner, Jagudan, Guntur, Kumarganj, Raigarh, Dholi, Kalyani, Sanand, Coimbatore)

As part of this project, it is envisaged to conduct surveys in farmer's fields of cumin, coriander, fenugreek, fennel, ajwain and nigella for the prevalence of various diseases and insect pests during the cropping season. Also, the local popular/ susceptible variety of cumin, coriander, fenugreek and fennel crops were planted in experimental plots. Plots (5m x 5m) were maintained under natural conditions without any plant protection measures for any of the pests/ disease on seed spice crop. Observations for diseases and pests along with meteorological factors were recorded during crop germination to maturity at weekly intervals. Standard package of practices was followed in these plots except plant protection measures.

Field survey of diseases and insect pests of seed spices

The Dholi centre conducted the field survey for analyzing the incidence of diseases and insect pests of seed spices (coriander and fenugreek) in the Samastipur district of the state of Bihar. The Coriander crop was found to be affected by stem gall disease caused by *Protomyces macrosporus*. Disease incidence was found to be in the range of 18.42 to 44.17%, with a mean disease incidence of 31.02%. The crop was also found to infested by aphid population per plant ranging from 18.60 to 28.40 with mean aphid population of 22.88 per plant. While no disease was observed in fenugreek. But the fenugreek crop was also found to be infested by aphid in the surveyed area. The number of aphids ranged from 18.20 to 26.80 per plant with mean aphid population of 22.0 per plant. Nigella was not found to be cultivated by the farmers in the district.

Surveys were conducted by Jobner centre in the seed spices growing areas of Jaipur, Ajmer, Nagaur, Jodhpur and Jaisalmer in Rajasthan. The details of the field survey are summarised in Table 56.

Table 56. Incidence of pests and diseases on farmer fields (2021-22)

Crop	Disease/ Pest	Mean Incidence	Survey area
Cumin	Blight (PDI)	31.30	Jaipur (Locations: 06), Ajmer (Locations: 04), Nagaur (Locations: 08), Jodhpur (Locations: 07), and Jaisalmer (Locations:06)
	Wilt (%)	23.60	
	Powdery Mildew (PDI)	2.80	
	Aphids/Umbel	38.26	
Coriander	Powdery Mildew (PDI)	15.32	
	Aphids/Umbel	32.50	
Fenugreek	Downy mildew (PDI)	8.30	
	Powdery mildew (PDI)	18.50	
	Aphids/plant	13.40	
Fennel	Ramularia blight (PDI)	4.50	
	Aphids/Plant	39.45	

During the survey in the state of Chhattisgarh, maximum disease intensity of powdery mildew 25.23 percent found in powdery mildew of coriander in Taldevari village of Baramkela, 17.98% *Alternaria* leaf blight of coriander in Bhaghanpur Village and 7.8 percent of root rot of fenugreek found in Bhaganpur village of Baramkela block. A survey was conducted by Kalyani centre in two districts of West Bengal (North and South Dinajpur) where nigella was cultivated moderately in the state to identify different diseases and pests occurring in those areas and to assess the severity of different diseases and pests. Nine well-distributed locations within those districts were selected for the survey. In each location, the survey was done at 3 different places. No pest was found in any of the places. However, wilt disease caused by *Fusarium oxysporum f. sp. cumini* was evident in all the fields surveyed. The disease incidence varied from 43.7 to 68.8% in different places of both the districts with a mean incidence of 56.99% and 63.36% in North Dinajpur and South Dinajpur districts of West Bengal, respectively.

An intensive diseases and insect pests survey was conducted at Ravanapuram, Ganapathipalayam and A. Nagoor villages of Tirupur district by Coimbatore centre. In the observation plot, only powdery mildew (mean: 42.53 PDI) was recorded at the flowering to maturity stage of the crops. (Fig. 28). In case of field survey in Gujarat conducted by Jagudan centre, the incidence of blight and powdery mildew in cumin was moderate to high at different surveyed locations. The aphid and thrips infestation were very low in cumin. In fennel, the very low infestation of *Ramularia* blight and aphid was recorded. In Ajwain, no incidence of any pests and diseases was noticed. The Off-farm survey on insect pests and disease on seed spices conducted by Kumarganj centre for the year 2021-22 in various locations across Uttar Pradesh revealed that coriander crops are grown at Ayodhya, Ambedkar Nagar, and Sultanpur are affected by stem gall disease and aphids. The percentage of stem gall disease incidence in affected areas ranges from 22.66% to 43.80% in Ayodhya, 24.20% to 34.30% in Ambedkar Nagar, and 25.00% to 35.10% in Sultanpur. However, fenugreek crops in all locations were found to be free from any disease. Similarly, the aphid attack on coriander at Ayodhya ranged from 15.1% to 33.0% (highest in Gosainganj), in Ambedkar Nagar, it was 13.7 to 29.4%

(highest in Khaspur), and in Sultanpur it was 5.5 to 30.2% (highest in Bahurawan). For fenugreek, the range of aphid attacks at Ayodhya was 13.3% to 31.2% (highest in Mashodha).

Fig. 28. Field view of trials plots for the survey and monitoring of diseases and insect pests of seed spices for the development of disease prediction models

Monitoring diseases and insect pests of seed spices in the Institute farms

At Dholi, the coriander crop (Rajendra Swati) was grown in a plot (5 m x 5 m) under natural conditions without any plant protection measures and was found to be affected by stem gall disease caused by *Protomyces macrosporus*. The average disease incidence was found to be 34.67% and an average population of aphid/5 twigs was observed to be 13.2. The average population of aphids/5 twigs was found to be 14.7 in fenugreek (var. Rajendra Kanti), while no incidence of powdery mildew/ downy mildew disease was observed. In fennel, no disease (Ramularia blight, Powdery mildew) or insect pest (aphid, seed wasps) were observed. Similarly, in Ajwain also, no disease (root rot) and insect pest (aphids, lugus bug) were observed. In Nigella also, no disease (root rot) or insect pest (termite, capsule borer) was observed.

On monitoring the disease and insect pest status of seed spices in the university farm at Jagudan, it was revealed that the incidence of blight was moderate to high (59.50%) in cumin. The powdery mildew (25.00%) was recorded with lower intensity in cumin. The aphid index was recorded was recorded higher as 75.4 whereas, the thrips population was observed as 3.0 per plant. In fennel, *Ramularia* blight was recorded maximum with 38.50PDI. The aphid index was slightly higher (75.6 per plant). The incidence of seed wasps was not observed during the experimentation period. In coriander, the intensity of powdery mildew (28.75%) was moderate. The aphid index was 55.4 per plant, whereas no seed wasp infestation was noticed. In fenugreek, the powdery mildew intensity was high (42.50%). The aphid index was 45.5, whereas leaf hopper was 2.9 per plant. In Ajwain, the incidence of pests and diseases *viz*., root rot, aphids, lygus bugs *etc*. was not recorded.

At Coimbatore, the experiment was laid out at the College Orchard, HC & RI, Coimbatore with the coriander variety, CO (CR) 4 and fenugreek variety CO-2. Diseases and pests incidence along with meteorological factors were recorded under natural conditions from crop germination to maturity at weekly intervals. In coriander, powdery mildew severity (45.00 PDI) was recorded at the flowering to maturity stage of the crop.

At Raigarh, the powdery mildew severity was 29.5 PDI and 22.3 PDI recorded at the flowering to maturity stage of the coriander and fenugreek. Whereas the aphid incidence measured by aphids' count/plant was 280 and 300 respectively in coriander and fennel.

11 AJWAIN

Genetic Resources

Germplasm collection, characterization, evaluation and conservation
(Centres: Ajmer, Guntur, Hisar, Jagudan, Jobner, Kumarganj, Raigarh)

A total of 332 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

Centre	No. of accessions	Unique collections registered	IC number obtained
Ajmer	127	50	50
Kumarganj	44	5	5
Raigarh	4	1	1
Guntur	101	-	35
Hisar	56	-	-
Total	**332**	**55**	**90**

Crop Improvement

AJN/CI/2.2 Coordinated Varietal Trial
(Centres: Ajmer, Guntur, Hisar, Jobner, Jagudan, Kumarganj, Raigarh)

Coordinated Varietal Trial on ajwain-2019, was conducted successfully with 11 entries for the third year during rabi 2021-22 at 7 locations viz. Ajmer, Jobner, Jagudan, Raigarh, Hisar, Kumarganj and Guntur.

Table 58. Growth and yield parameters of CVT on ajwain-2019 *rabi*, 2021-22

Entries	Seed yield (kg/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-01	10.43	103.0	112.6	9.2	58.2	174.2	21.3	17.6	2.2	5.9
AJN-02	10.31	97.6	111.8	9.3	53.4	169.7	21.8	16.4	2.4	5.1
AJN-03	9.13	98.1	110.5	10.4	54.6	180.0	20.9	16.6	2.5	5.6
AJN-04	9.27	98.2	110.8	11.1	54.1	179.6	23.9	17.2	2.2	5.4
AJN-05	9.23	88.0	110.0	9.3	49.3	166.2	19.6	15.7	2.0	5.3
AJN-06	10.43	101.1	109.5	9.7	54.7	148.8	22.0	16.6	2.7	4.7
AJN-07	10.71	102.5	110.4	10.9	54.4	159.2	23.8	17.9	2.1	5.1
AJN-08	10.21	101.7	108.2	9.3	72.0	181.0	23.1	16.8	2.5	4.9
AJN-09	9.57	98.7	106.3	9.2	54.7	158.2	22.7	16.8	2.1	5.2
AJN-10 (Check)	8.92	104.9	113.2	10.4	48.2	156.1	25.6	17.5	1.9	5.3
AJN-11 (Check)	10.27	104.1	113.8	9.8	59.5	168.5	23.0	17.0	2.0	5.8

Fig. 29. Plate showing the photographs of 11 entries contributed in CVT, Ajwain-2019

Location-wise performance for seed yield is presented in Table 58 and 59. Mean seed yield ranged from 8.9 - 10.7 q ha^{-1}. Four genotypes viz. AJN-07 (10.7 q ha^{-1}), AJN-06 (10.43 q ha^{-1}), AJN-01 (10.43 q ha^{-1}), and AJN-02 (10.3 q ha^{-1}) recorded numerically higher seed yield over best check AJN-11 (10.27 q ha^{-1}). The analysis of variance revealed significant differences in seed yield and yield attributing characters among the genotypes. AJN-05 flowered most early at 88 days whereas AJN-11 was the last to flower with 104.9 days. Plant height ranged from 106.3 to 113.8 cm, primary branches per plant ranged from 9.2 to 11.1, secondary branches from 48.2 to 72.0, umbels per plant from 148.8 to 181.0 and the umbellets per umbel ranged from 19.6 to 25.6. Test weight was maximum in AJN-06 (2.7 g) whereas it was lowest in AJN-10 (1.9 g). AJN-01 (5.9%) recorded the highest essential oil content and was least in AJN-06 (4.7%).

Table 59. Yield performance (q ha^{-1}) of Ajwain CVT entries across locations

Entries	AJM	HSR	KGJ	JAG	JOB	RAI	GTR	Mean	Rank
AJN-01	17.8	10.1	10.8	16.9	6.9	3.1	7.5	**10.4**	14
AJN-02	16.3	11.7	11.8	16.9	6.9	5.9	2.6	**10.3**	4
AJN-03	13.0	12.6	8.7	13.9	4.8	7.1	3.9	**9.1**	9
AJN-04	13.5	12.7	8.3	12.8	5.1	9.1	3.5	**9.3**	10
AJN-05	17.0	9.3	7.2	11.7	5.2	9.2	5.2	**9.2**	6
AJN-06	19.9	8.1	11.2	15.5	7.2	5.3	5.9	**10.4**	15
AJN-07	20.5	11.6	12.4	13.1	7.3	5.1	4.9	**10.7**	**2**
AJN-08	18.7	12.3	9.1	12.8	6.8	5.7	6.0	**10.2**	5
AJN-09	20.3	8.8	10.0	14.4	6.1	4.6	2.7	**9.6**	3
AJN-10 (Check)	16.5	9.5	9.6	13.3	5.7	3.5	4.4	**8.9**	8
AJN-11 (Check)	21.6	11.9	9.3	14.1	4.6	4.7	5.7	**10.3**	7
Mean	**17.7**	**10.8**	**9.9**	**14.1**	**6.1**	**5.8**	**4.8**	**9.9**	-
CD (*p=0.05*)	2.9	1.5	2.1	5.6	2.5	2.2	0.5	2.5	-
CV (%)	14.6	5.2	6.1	13.6	12.1	7.2	-	12.6	-

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

12 NIGELLA

Genetic Resources

Germplasm collection, characterization, evaluation and conservation
(Centres: Dholi, Guntur, Hisar, Jagudan, Jobner, Kumarganj, Raigarh)

A total of 109 accessions of nigella is being maintained by various AICRPS centres (Table 60). During 2021-22, Kumarganj centre evaluated 37 accessions for yield and yield contributing traits. NDBC-20 recorded maximum yield (9.2 g plant^{-1}) followed by NDBC-7 (8.9 g plant^{-1}) and NDBC-19 & NDBC- 31 (8.7 g plant^{-1}). Similarly, out of seven accessions of nigella maintained at CARS, Raigarh, Chhattisgarh Nigella 1 is identified for release through Chhattisgarh State Seed Sub-committee, Raipur, Chhattisgarh. IC number obtained from NBPGR, New Delhi, and DNA fingerprinting completed from IISR, Kozhikode. The preparation of the notification proposal is in progress.

Table 60. Germplasm collection of nigella maintained in various AICRPS centres

Centre	No. of accessions	Unique collections registered	IC number obtained
Ajmer	38	10	10
Kumarganj	37	Nil	5
Raigarh	7	1	1
Pantnagar	19	Nil	Nil
Hisar	8	Nil	Nil
Total	109	11	16

Crop Improvement

NGL/CI/2.2 Coordinated Varietal Trial on nigella-Series II (2021-22)
(Centres: Ajmer, Hisar, Kota, Kumarganj, Raigarh, Pantnagar)

The CVT of nigella was started during the *rabi* season of 2019-2020 for evaluating promising nigella accessions across the coordinating centres in the country for yield and its components. The experiment was laid out in RBD design with a total of nine genotypes including two checks, with three replications. During its third year of evaluation, NGL-07 was found to be the best-performing genotype in terms of seed yield, yielding an average of 8.29 q ha^{-1}, across test locations, showing a 2.21 percent higher yield over the check, Pant Krishna (NGL-09). The genotype NGL-07 ranked first for its performance for yield at Hisar (12.5 q ha^{-1}) and Kumarganj (8.68 q ha^{-1}), The mean performance of the genotypes at various locations during 2021-22 is given in Table 61.

Significant differences were observed for all the parameters at Ajmer. Plant height ranged from 67.3 to 75.7 cm, the number of siliqua/ plants from 54.0 to 64.7 and the number of seeds/ siliquae from 63 to 68. Maximum seed yield (16.56 q ha^{-1}) was recorded in NGL-03, followed by NGL-05 (15.12 q ha^{-1}). Significant differences were observed for all the parameters at Hisar, with plant height ranging from 72.8 to 83.5 cm, siliqua per plant from 102.2 to 138.8 and seeds per silique from 84.0 to 101.3. Maximum seed yield (12.50 q ha^{-1}) was recorded in NGL-07 followed by NGL-01 (10.90 q ha^{-1}) and NGL-03 (10.80 q ha^{-1}), respectively. Maximum yield was recorded in NGL-07 (8.33 q ha^{-1}), followed by NGL-01 (7.29 q ha^{-1}) and NGL-06 (7. 08 q ha^{-1}) at Kumarganj. While at Raigarh, the local check, CG Karayat 1 recorded maximum seed

yield (4.6 q ha^{-1}), followed by NGL-09 (4.5 q ha^{-1}) and NGL-08 (4.2 q ha^{-1}). The variety, CG Karayat-1, has been identified for Chhattisgarh state through CG State Seed Certification Agency during 2021, and the IC number (IC643949) has been obtained.

Table 61. Yield performance (q ha^{-1}) of nigella entries in CVT across locations

Entries	AJM	HSR	KGJ	PNR	RAI	KOT	Mean	Rank
NGL-01	13.41	10.90	7.92	7.17	2.43	4.73	7.76	5
NGL-02	12.82	9.23	8.06	7.67	3.88	5.28	7.82	4
NGL-03	16.56	10.80	6.25	7.03	3.64	3.73	8.00	3
NGL-04	14.52	8.34	7.08	8.03	2.78	5.64	7.73	6
NGL-05	15.20	8.13	6.67	5.47	2.03	4.76	7.04	9
NGL-06	14.63	7.91	7.50	7.70	3.51	4.86	7.68	7
NGL-07	14.29	12.50	8.68	7.13	2.40	4.75	8.29	1
AN-20 (Check)	12.72	8.76	7.64	5.45	4.28	5.54	7.40	8
Pant Krishna (Check)	13.82	9.82	7.22	7.03	4.56	6.21	8.11	2
Mean	14.22	9.60	7.45	6.97	3.28	5.06	7.76	
CD (5%)	1.93	1.57	1.24	6.50	1.03	1.00		
CV (%)	7.83	9.3	9.54	5.59	18.2	11.94		

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

Fig 30. Pictures depicting blooming and foliage of nigella entries in CVT conducted at Ajmer.

13 SAFFRON

Genetic Resources

Conservation, evaluation and utilization of exotic and indigenous saffron germplasm accessions (Centre: Pampore)

Seventeen germplasm accessions were collected from different saffron growing areas of J&K, making the total accessions to 232. All these germplasm accessions are under evaluation for various morphological, quality, yield and yield-attributing traits. The range of variability is presented in germplasm maintained is given in Table 62.

Table 62. Evaluation of saffron germplasm for morphological traits

Sl. No	Traits	Trait expression range
1.	Foliage colour	Light green (27), Green (161), Dark green (27)
2.	Leaf tip shape	Pointed (190) Round (25)
3.	Location of hairs on leaf	Absent
4.	Presence of white or pale stripe	Present
5.	No. of leaves in main sprout	5–10
6.	Leaf lamina thickness (mm)	0.11 - 0.37
7.	Number of days from sowing to 50% sprouting	101 – 105 (1st week of July sowing)
8.	Number of days from sowing to 50% flowering	105 – 117 (1st week of July sowing)
9.	Presence of leaves at flowering	Yes (25)
10.	Number of flowers per corm	1 – 2
11.	Tepal shape	Elliptic (9), Linear (16), Oblanceolate (38), Obovate (152)
12.	Tepal apex shape	Acuminate (16), Acute (33), Obtuse (159), Rounded (7)
13.	Outer tepals length (cm)	2.8-4.8
14.	Outer tepals width (cm)	1.0-2.7
15.	Inner tepals length (cm)	2.2 - 4.4
16.	Inner tepals width (cm)	1.0 - 1.9
17.	Style branching	Non-visible branching
18.	Stigma colour	Light red (41), Red (108), Dark Red (66)
19.	Style length (cm)	0.91 – 4.0
20.	Pistil length (cm)	3.43 – 7.26
21.	Fresh weight of pistil (mg)	17.40 – 45.38
22.	Dry weight of pistil (mg)	3.90 – 9.13
23.	Stigma length (cm)	2.23 – 5.13

Initial Evaluation Trial (IET)

Eleven elite accessions, including check (Shalimar Saffron-1) are planted under Initial Evaluation Trial-I (IET-I) with three replications (Fig. 31). The accessions showed significant variation among them with regard to yield and yield-attributing traits. Amongst these accessions, SRS-Saf-178 and SRS-Saf-199 were found to be promising with significantly higher yield and number of flowers m^{-2} over other accessions including control (Table 63).

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

Accession name	Pistil length (cm)	Fresh weight of pistil (mg)	Dry weight of pistil (mg)	Stigma length (cm)	Flowers m^{-2}	Yield (kg ha^{-1})
SRS-Saf-124	5.92	24.56	5.04	3.1	110.3	7.35
SRS-Saf-128	5.33	21.41	5.20	3.52	122.0	8.13
SRS-Saf-157	5.56	34.78	7.16	4.00	113.0	7.53
SRS-Saf-178	5.42	40.34	8.32	4.23	132.8	8.85
SRS-Saf-183	5.01	33.92	6.25	3.85	117.7	7.85
SRS-Saf-194	5.25	36.44	6.94	3.00	120.4	8.03
SRS-Saf-195	6.17	34.13	6.51	4.64	115.2	7.68
SRS-Saf-199	6.18	39.95	8.42	4.53	130.5	8.70
SRS-Saf-251	5.26	39.21	7.33	3.92	121.5	8.10
SRS-Saf-253	5.21	32.06	6.97	3.26	128.3	8.55
SS-1	5.27	35.63	7.12	3.92	115.7	7.71
CD (*p=0.05*)	0.628	3.841	0.768	0.427	3.214	0.173

Fig 31. Pictures depicting blooming and foliage of saffron germplasm at Pampore

14 KALAZEERA

Genetic Resources

KAZ/CI/1.1 Exploration, collection and conservation of Kalazeera from high altitudes of northern Himalayas (Pampore)

Fifteen germplasm accessions were collected from high altitudes of Gurez Valley of J & K making up a total of 98 accessions. The mean performance and range of the germplasm accessions for morphological, yield and yield attributes are presented in Table 64 which revealed significant variability among the accessions.

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

Sl. No.	Traits	Trait expression range
A.	Morphological traits	
1.	Leaf colour	Light green (11), Green (42), Dark green (5), Blackish green (3), Pink (6), Dark pink (3)
2.	Leaf shape	Pedate (29), Pinnatipartite (13), Elliptic (5), Multifid (4), Linear (7), Lobed (5), Ovate (3), Acicular (1), Lorate (3)
3.	Flower colour	White (61), Light pink (3), Dark pink (5), Yellowish green (1)
4.	Plant growth habit	Spreading (64), Non-spreading (6)
5.	Early seed colour	Pink (5), Light pink (4), Greenish pink (8), Dark green(53)
6.	Seed colour at harvesting	Blackish (51), Greyish black (13), Pale green (7)
7.	Seed Size	Small (47), Medium (12), Bold (11)
B.	Yield attributes	
1.	Plant height (cm)	22.86 – 96.52
2.	No. of primary branches/plant	1 - 6
3.	No. of secondarybranches/ plant	1 - 16
4.	No. of tertiary branches/plants	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.	No. of umbels/ plant	1 – 40
9.	Number of seeds/ umbels	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

Initial Evaluation Trial (IET)

Seven elite accessions along with a check (Shalimar Kalazeera-1) were evaluated under Initial Evaluation Trial-1 (IVT-1) for growth, yield and yield-related traits. Among the elite accessions SRS-KZ-177 and SRS-KZ-167 were found to be promising and showed significantly higher yield (427.3) over other accessions including check variety. The percent yield increase of SRS-KZ-177 over check was 29.17% (Table 65).

Table 65. Yield and yield attributes of Saffron accessions evaluated under IET-I

Accession name	Plantheight (cm)	Branches plant^{-1}	Umbels plant^{-1}	Days to maturity	Seed yield (kg ha^{-1})	Essential oil content (%)
SRS-KZ-149	45.7	28	30	214	378.8	8.8
SRS-KZ-158	73.7	35	28	211	373.8	9.2
SRS-KZ-167	86.3	33	35	207	416.3	9.2
SRS-KZ-170	91.4	29	33	209	394.8	9.3
SRS-KZ-172	58.4	31	23	221	340.5	9.1
SRS-KZ-177	83.4	36	39	219	427.3	9.2
SRS-KZ-192	68.7	27	20	209	312.3	9.1
SK-1	89.8	20	28	217	330.8	9.3
CD (*p=0.05*)	7.440	1.835	3.042	NS	27.768	0.237

Fig 32. Pictures depicting blooming and foliage of Kalazeera germplasm at Pampore

15 MONITORING

The Project Coordinator and the scientists from the PC unit monitored the working of various AICRPS centres and experimental plots through personal visits and online review meetings. Frequent monitoring was done through e-mail and phone calls also. Monthly progress reports and budget utilization certificates sent from the centres were reviewed critically and proper guidance was given for improvement. A spice monitoring team involving Dr. K.S. Krishnamurthy and Dr. Sharon Aravind visited Ambalavayal centre on 15.03.2022 and Thrissur Centre on 19.03.2022. They visited the field as well as other facilities and some action points were suggested. Scientists of ICAR-IISR also visited Dapoli centre and reviewed the activities of the centre. Dr. C.K Thankamani and Dr. Sharon Aravind visited Barapani centre and suggestions were made for improvement. Dr K.S. Krishnamurthy and Dr C.K. Thankamani visited the field and other facilities of Kumarganj centre on 13.10.2022 and reviewed the progress of the centre. Apart from these, online meetings were conducted to review the activities of all the AICRPS centres at regular intervals.

The activities of the centres were also monitored through monthly reports, quarterly, half-yearly and annual report sent by the centres. Also, the XXXIII Annual Group Meeting of ICAR-All India Coordinated Research Project on Spices was conducted at ANDUAT, Kumarganj, Ayodhya, U.P. during 13-16 October, 2022 to critically review the progress of projects handled by all the AICRPS centres and valuable suggestions was made for their improvement.

Fig 33. Dr. C.K. Thankamani, Director (acting), IISR & PC, AICRPS and Dr. K. S. Krishnamurthy, ICAR-IISR-Kozhikode, Kerala Monitored AICRP-Spices Trials at ANDUAT, Kumarganj

16 ANNUAL GROUP MEETING

The XXXIII Annual Group Meeting (AGM) of ICAR-All India Coordinated Research Project on Spices (AICRPS) was conducted offline the first time after the COVID-19 pandemic during 13-15 October, 2022 at Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya, Uttar Pradesh. Dr. N.K. Krishna Kumar, Former DDG (HS), ICAR, New Delhi, inaugurated the group meeting. In his inaugural address, he highlighted strengthening the market potential and also creating market intelligence for spice trade in India. Dr. C. K. Thankamani, Director & Project Co-ordinator (Spices), ICAR-IISR, Kozhikode, welcomed the gathering and presented the achievements of AICRP on Spices during 2021-22 with emphasis on various ongoing research activities, new initiatives, and flagship programs pertaining to NE regions, SCSP and TSP. Dr. Bijendra Singh, Vice-Chancellor, ANDUAT, Kumarganj presided over the function and in his presidential address, he emphasised upon the importance of growing spices as intercrops for uplifting the farmers income. Dr. V. A. Parthasarathy, Former Director & PC (Spices), ICAR-IISR, Kozhikode was the guest of honour during the occasion.

During the inaugural session the "Best AICRPS Centre Award 2021-22" was presented to the AICRPS centre at Sardarkrushinagar Dantiwada Agricultural University, Jagudan. Dr. J. Rema, Former Director & PC (Spices), ICAR-IISR, Kozhikode, Dr. Homey Cheriyan, Director DASD, Kozhikode, Dr. Sanjay Pathak, Dean, College of Horticulture, ANDUAT, Kumarganj, Dr. S.N. Saxena, Acting Director, ICAR-NRCSS, Ajmer, Rajasthan, Dr. A. B. Remashree, Director (Research), Spices Board, Kochi offered felicitations. Dr. K. S. Krishnamurthy, Principal Scientist, ICAR- IISR, Kozhikode proposed the vote of thanks.

The workshop was organized in six Technical Sessions viz., Genetic Resources and Crop Improvement, Crop Management, Crop Protection, Variety Release, Technology Transfer and Plenary Session. During the workshop, one small cardamom variety, namely IISR Manushree (Appangala-3) has been recommended for release by ICAR-AICRPS. The variety, IISR Manushree was developed by ICAR-IISR Regional station, Appangala, Kodagu, Karnataka. This variety is moisture stress tolerant, with a stable yielding capacity of 550 kg dry capsules/ha under irrigated conditions and 360 kg dry capsules/ha under moisture stress conditions, with 50% bold (7-8 mm sized) capsules.

Three technologies were also recommended for adoption in XXXIII AGM of AICRPS. viz.,

1. Application of half the recommended doses of zinc, iron, manganese, and boron as soil treatment along with their foliar spray could boost cumin productivity to 684.6 kg/ha with a high benefit-cost ratio of 3.96.

2. Standardization of drip irrigation interval and method of micronutrient fertigation in fenugreek

3. Management of aphids and blight in cumin using three foliar sprays of kresoxym methyl 44.3 SC @ 0.044% (first spray at initiation of disease and subsequent sprays at an interval of 15 days after first spray) and two foliar sprays of thiamethoxam 25WG @ 0.0084% (first spray at the initiation of aphid infestation and the second spray after 10 days of first spray).

The Plenary Session of the XXXIII AGM of AICRPS held on 15 October 2022, was jointly chaired by Dr. N.K. Krishna Kumar, Former DDG (Hort.) ICAR, New Delhi, Dr. V. A.

Parthasarathy, Former PC & Director, ICAR-IISR, Kozhikode and Dr. Vikramaditya Pandey, Asst. Director General (HS I), ICAR, New Delhi. Ten extension booklets/pamphlets on spices production technologies in English and regional languages from different AICRPS centres were released during the occasion. Dr. C.K. Thankamani thanked the chairmen for their exemplary suggestions which would help in shaping future programmes and the XXXIII AICRPS Group Meeting came to an end with a formal vote of thanks by Dr. Pradip Kumar, ANDUAT, Kumarganj.

Fig 34. Glimpses of Annual Group Meeting of AICRPS held at Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya, Uttar Pradesh

17 NEH/TSP/SCSP ACTIVITIES

Promotion of seed spice cultivation in NER

In order to promote and facilitate seed spice cultivation in NER, ICAR-AICRPS distributed seed materials of seed spice crops like ajwain, coriander, cumin, fennel and fenugreek through its NE centres located at Meghalaya, Mizorm, Nagaland, Sikkim, Assam and Arunachal Pradesh.

Developmental activities in the Aspirational district of North East

AICRPS centre at Mizoram conducted three days training programme in aspirational districts of Mizoram *viz.*, Lunglei and Lawngtlai and TSP village of Kolasib district, training on spices cultivation for livelihood improvement and income and distribution of farm tools/ inputs and seed materials at Socunoma village and Punglwa village under Dimapur & Peren districts, Nagaland. Training on organic spices production was conducted at Peren district and Renthan under Wokha district of Nagaland, Silluk Village and Shi Yomi district, Arunachal Pradesh

Developmental activities in the tribal villages

AICRPS centre at Megalaya, Nagaland, Kumarganj, Yercaud, Coimbatore, Jabalpur and Chintapalli conducted various training on Scientific cultivation practices of spices and their processing aspects at tribal villages along with the distribution of planting materials, other inputs and machinery. Farmers were motivated to take up successful spice cultivation in abandoned and unutilised areas.

Developmental activities for SC communities

Various training programs were conducted by AICRPS centres at Gangtok, Mandor, Sirsi, Coimbatore, Kammarpally, Hisar, Pundibari, etc. benefitting SC farmers and agricultural inputs were distributed to the farmers.

18 POPULARIZATION OF TECHNOLOGIES

Scientists from AICRPS centres are actively involved in popularization of the latest technologies to make aware the farming community about scientific cultivation practices and sustainable spice production. Some of the technologies demonstrated during the year as follows

High yielding varieties- boon to farmers

- Demonstration of newly released, high yielding turmeric variety YSRHU-Lam Swarna (Guntur)
- Demonstration of stable curcumin variety IISR Pragati at Talakanti, Suliamari, Kotia, Pottangi and Koraput, Andra Pradesh (Pottangi)
- Demonstration of high yielding fenugreek variety RMt-354 (Jobner) and RMt-1 (Jabalpur)
- Demonstration of high yielding fennel variety RF-290 (Jobner)
- Demonstration of high yielding cumin variety GC-4 (Mandor)
- Demonstration of high yielding leafy coriander culture CS 38 (Coimbatore) and Cimpoo S- 33 (Jabalpur)
- Demonstration of high yielding Panniyur black pepper varieties viz., Panniyur-8, Panniyur-9 & Panniyur-10 (Panniyur)
- Adoption of five high yielding IISR varieties of black pepper in farmers' field *viz.*, IISR-Shakthi, IISR-Girimunda, Pournami, Panchami, Sreekara. (Pottangi)
- Adoption of Appangala-1 in Lamataput region, Andra Pradesh (Pottangi)
- Front line demonstration of turmeric cv. RCT 1 (ICAR-Mizoram)
- Front line demonstration of ginger cv. Bold Nadia (ICAR-Mizoram)

Rapid multiplication of planting materials- for minimal expenditure

- Protray cultivation technique for quality seed production of ginger & turmeric (Kammarpally)
- Rapid propagation method of black pepper and column method was demonstrated for farmers and students of TNAU (HRS Pechiparai)
- Performance demonstration of the two budded turmeric seed material on raised bed with 3 to 4 rows with fertigation. (Kammarpally)

Micronutrients & biocapsules for soil health

- Distribution and demonstration on beneficial effects of biocapsules and micronutrient packages specific to ginger, turmeric and black pepper were taken up on a pilot scale in all the spice growing tracts through AICRPS centres
- Demonstration of micronutrients IISR Power Mix T and IISR Power mix G and bio-capsules namely *Trichoderma* sp, PGPR and *Bacillus amyloliquefaciens* from IISR Kozhikode, Kerala in farmers field for ginger and turmeric in Sikkim (ICRI Gangtok)
- Use of biocapsules of *Trichoderma* and PGPR (GRB-35) for the management of foliar diseases in turmeric. (Coimbatore, Guntur, Kammarpally).
- Front line demonstration of micro-nutrient in large cardamom for growth & yield (Nagaland).

Protection technologies- for plant health

- Technology demonstration on the effect of seed treatment with Trichoprime powder.

- ❖ Management of management of Phyllosticta leaf spot of ginger (Pundibari)
- ❖ Management of shoot fly in cardamom with fish meal traps (ICRI-Sakleshpur)
- ❖ Demonstration of bio control agents against pepper wilt (Yercard), distribution of biocapsules (PGPR, *Bacilich* and *Trichoderma*) at Pasighat.
- ❖ Priming of ginger seed rhizomes for safe storage of ginger seed rhizomes (Nagaland)

Processing machineries- for increase in efficiency

- ❖ Demonstration of value-added products preparation from *Garcinia* (Pechiparai)
- ❖ Demonstration of turmeric boilers, polishers (IISR, Kozhikode)

Apart from the above field level demonstrations, the scientists popularised technologies by conducting virtual trainings and attending as resource persons in virtual trainings and seminars and also through various media (newspaper, radio talks and TV programmes).

19 SUCCESS STORIES

Spice-based integrated farming system: A sustainable approach to enhancing farmers' income in Mizoram

In Mizoram, farmers have been practicing shifting cultivation for a long time, but this method has resulted in low productivity and income due to the cultivation of traditional local cultivars of paddy, maize, pulses etc., under rainfed conditions. To address this issue, the ICAR Research Complex for NEH Region, Mizoram Centre, Kolasib has introduced a spice-based integrated farming system that incorporates major spices like ginger and turmeric cultivation with other crops like maize, sweet corn, rice, legumes, and plantation crops. The system also includes the establishment of Jalkund for providing supplement irrigation to the crop in *rabi* season. Mizoram's climate and fertile soil make it an ideal location for this type of farming, which offers year-round income and employment generation while maintaining soil health and sustaining the environment. Two farmers, Mrs. Lalsangpuii and Mrs. Lalbiakzuali, have successfully implemented this system with the technical support of ICAR Research Complex for NEH Region, Mizoram, Kolasib. Mrs. Lalsangpuii cultivates ginger cv. Bold Nadia and Turmeric cv. IISR Pragati and RCT 1 with scientific integration of other crops like sweet corn, upland rice, *Acacia pennata*, and established Jalkund and vermiculture unit on her farm. She now processes turmeric into powder and sells the products under the name "Sangpuii Aieng." (Fig. 35). Mrs. Lalbiakzuali has also cultivated RCT 1 successfully and supplies turmeric powder for selling in and around her locality (Fig. 36). Before implementing the spice-based integrated farming system, both farmers were engaged in traditional practices resulting in lower yield and productivity. However, after receiving technical support from ICAR Kolasib, Mrs. Lalsangpuii's gross annual income increased from Rs. 2,58,560 to Rs. 3,68,243, while Mrs. Lalbiakzuali's annual income increased from Rs. 93,400 to Rs. 1,94,190. Additionally, both farmers have experienced cost savings due to the interventions. The success of these two farmers highlights the potential of the spice-based integrated farming system to enhance farmers' income in Mizoram while maintaining soil health and sustaining the environment.

Overall, the introduction of the spice-based integrated farming system in Mizoram has proven to be a successful approach to enhancing farmers' income while promoting sustainable agriculture. The system offers year-round income and employment generation while maintaining soil health and sustaining the environment. The success of Mrs. Lalsangpuii and Mrs. Lalbiakzuali highlights the potential of this approach to improve the livelihoods of farmers in the region. Additionally, the processing of turmeric into powder opens up new marketing opportunities for farmers, providing them with additional income streams. The lessons learned from this initiative can be applied to other regions with similar climatic conditions and farming practices, promoting sustainable agriculture and improving the lives of farmers.

Fig. 35. Mrs. Lalsangpuii from Venglai, Thingdawl village, Kolasib district

Fig 36. Mrs. Lalbiakzuali from Venglai, Thingdawl village, Kolasib district

Revolutionizing ginger farming: A scientific storage method transforms livelihoods in Himachal Pradesh and Koraput district of Odisha

In Himachal Pradesh, the cultivation of ginger is a significant source of livelihood for farmers in Sirmour and Solan districts. However, the area under its cultivation was decreasing due to the lack of a scientific storage method for healthy seed for the next season, leading to high disease occurrence and poor rhizome yield. Traditional methods such as storing ginger seed in soil or corners of rooms resulted in a large quantity of seed rhizomes rotting during storage. Seed borne infection to the tune of 87 per cent has been reported. This led to farmers shifting to short-duration cash crops like vegetables. To address this issue, Dr YS Parmar University of Horticulture & Forestry, Nauni, Solan played an active role in devising a scientific storage method which is as follows:

- Dig a pit of 1x1 m^3 size in moisture free area and lay stones on the sides.
- Put a layer of sand of 10-15 cm thickness in the pit.
- Treat the healthy rhizomes in a mixture of 250 g mancozeb per 100 litres of water for one hour and then dry the rhizomes in shade for 48 hours to remove excess of moisture.
- The treated rhizomes kept in pits leaving 10-15 cm area free from top for free aeration and then covered with cow dung paste.
- The temperature in the pit will be is 12-13^{o}C with a relative humidity of 65%.
- The rhizomes are taken out of the pit, dried in shade and selected before planting by culling out rotten pieces in April and May-June respectively in mid and low hills.
- The diseased rhizomes are buried in soil.
- Rhizomes with watery spots are dipped in streptocycline solution (20g/100 L water) for 30 minutes and then shade dried. Treated rhizomes are again kept in pits till planting time.

This scientific storage method has not only strengthened the hopes of ginger growers but also fulfilled the requirements of needy growers within and outside the state. The demonstrations at farmer's field revealed more than 90% recovery of the seed rhizomes. With the adoption of this storage method of ginger, a dramatic increase in area and production of ginger in the state has been observed even in the non-conventional ginger growing areas of the state like Kangra, Mandi, Hamirpur, Una, Chamba and Bilaspur districts. The growers are using this method for their own use and supplying healthy ginger seed, leading to increased cultivation of ginger and improved income for farmers.

Overall, the development of a scientific storage method for ginger seed has had a significant impact on the livelihoods of farmers in Himachal Pradesh. By addressing the issue of high disease occurrence and poor rhizome yield, this technology has enabled farmers to increase their cultivation of ginger and improve their income. The method has been widely accepted and adopted by growers, leading to a dramatic increase in area and production of ginger even in non-conventional growing areas. The university has played an important role in promoting this technology through demonstrations, training programs, and distribution of chemicals and treatment bins. As a result, the morale of ginger growers has improved, and they are now able to store healthy seed for the next season, ensuring the sustainability of their livelihoods.

Similar to Himachal Pradesh, there are success stories of farmers in ginger cultivation in Koraput district of Odisha. Ginger is the one district one product of Koraput, Odisha, but due to cultivation of degenerated local varieties and traditional practices, it was not as profitable as expected. The AICRP on Spices, Pottangi intervened with modern techniques of growing ginger with new high yielding varieties and organic packages of practices. The farmers were

supplied critical inputs such as HYV ginger *cv., Suprabha* and bio-pesticide *Trichoderma viride* and *Pseudomonas flouroscence* with neem cake and biofertilizers like NPK consortia to FLD farmers. Then farmers were guided during all the cultural practices. The farmers were trained regarding flat bed techniques of 1m width, 6 inches height and length as desired by farmers according to their plot sizes, mulching (15 t during planting), spacing (30 cm x 25 cm), 10 litres of NPK consortia, 10 kg *Trichoderma viride* and 10 kg *Pseudomonas flouroscence*, 2t Neem cake, inter cultural operations at 45 DAP and 90 DAP, plant protection measures as and when needed. Farmers were also trained on post-harvest techniques. The results were encouraging, with farmers now able to harvest 150 quintals of ginger per hectare, resulting in a net profit of Rs. 550,000 to Rs. 650,000 per hectare (Fig. 37).

Fig. 37. Successful farmers in ginger cultivation in Koraput district of Odisha

In conclusion, the intervention by AICRP on Spices, Pottangi has transformed ginger farming in Koraput district of Odisha, making these crops more profitable and improving the livelihoods of farmers. By introducing modern techniques and high yielding varieties, and providing critical inputs and training, farmers are now able to achieve higher yields and profits. This success story is a testament to the importance of research and development in agriculture and highlights the potential for further growth and innovation in the sector.

From low yields to high profits: The success story of black pepper farming in Koraput, Odisha

The adoption of modern technologies developed by AICRP on spices has led to successful black pepper cultivation in the Koraput district of Odisha, resulting in high yields and profits for farmers. Through the intervention of AICRP on Spices, Pottangi, and training provided to

farmers on post-harvest techniques and plant protection measures, farmers were able to adopt new technologies and practices. The use of high-yielding varieties, organic packages of practices, and critical inputs such as seedlings and bio-pesticides *Trichoderma viride* and *Pseudomanas flouroscens* with neem cake and biofertilizers like NPK consortia resulted in bumper yields with scientific practices and management. The highest net return was obtained by one of the trainee farmers, Mr. Dama Challan, with a net return of Rs. 370000/- per hactare and a B:C ratio of 4.08:1. This success story highlights the potential for further growth and innovation in agriculture in the region.

Reaping benefits from adoption of scientific methodologies of turmeric cultivation and processing technologies

The AICRP on Spices centres play a crucial role in helping farmers all over India in transforming their livelihoods through the adoption of high-yielding turmeric cultivars and cost-saving, income promoting technologies.

Mr. Sadhu Ram Chaurasia, a farmer from Uttar Pradesh, transformed his livelihood by adopting turmeric cultivation with the guidance of experts from AICRP-Spices and ANDUAT. Using NDH-1 and NDH-2 cultivars and recommended cultural practices, he earned a net profit of Rs 85,000/- in just one acre. His success story has encouraged other farmers to adopt turmeric cultivation for maximum profits. He stressed the need for a processing plant in the area and desires a method of extracting turmeric leaf oil to increase his income.

The introduction of high-yielding turmeric cultivars such as "Roma" and "IISR-Pragati," in Andhra Pradesh has transformed the livelihoods of tribal farmers. Collaboration between AICRP on Spices centre, KVK, BCT-KVK, and NGOs has resulted in increased profits for farmers. Farmers are adopting new cultivation methods and processing techniques, resulting in higher-quality products that fetch better prices in the market. The distribution of turmeric boilers, polishers, and tarpaulins has allowed farmers to process their turmeric more efficiently.

High-yielding turmeric cultivars and innovative cultivation methods have transformed the livelihood of Telangana farmer Sri. Maggidi Chinnareddy. Using raised bed farming with drip irrigation, he has been able to cultivate seven different varieties of turmeric viz., IISR Pragati, Rajendra Sonia, ACC-79, BSR-2, Rajapuri, Pitamber, and Waigon resulting in higher-quality products that fetch better price in the market. His success is attributed to collaboration between AICRPS centres and farmers, improving spice productivity through modern technology adoption.

Biocontrol agents for sustainable spice production

Since 2012, the bio-control laboratory funded by SHM has been producing biocontrol agents such as *Pseudomonas flourescens, Trichoderma viride, Metarhizium anisopliae, Lecanicilium lecanii, Paecilomyces lilacinus, Beauveria bassiana,* and AMF on a large scale at the Cardamom Research Station, Pampadumpara. These agents have been distributed to cardamom and black pepper farmers for pest and disease management, with 22,590 kg distributed in 2021-22 alone. The feedback from farmers has been positive, with more farmers attracted towards using these biocontrol agents and reporting their effectiveness. Similarly, Yercard centre has also been distributing biofertilizers and growth-promoting microorganisms to farmers, with those who continuously apply them reporting better plant growth and performance during dry weather periods. The popularity towards the biocontrol technologies highlights the power of sustainable agriculture practices and the potential to reduce environmental chemical contamination and degradation of the spices growing areas. Further goal is to make more farmers aware of eco-friendly pest/disease management through the use of biocontrol agents.

20 KRISHI MELAS & FARMERS TRAINING

Krishi Melas / Exhibition Organised

- GB Pant University of Agriculture and Technology, Pantnagar organized two Krishi mela cum exhibitions, each during *kharif* (22-24 March, 2022) and *rabi* (14-17 October,2022) seasons during which around 2000 farmers all over India especially from states like Uttarakhand, Uttar Pradesh, Himachal Pradesh, Rajasthan, Punjab and Haryana participated.
- Saffron day was celebrated on 29 October 2022 at saffron fields of Advanced Research Station for Saffron & Seed Spices, Pampore to promote saffron cultivation in Pampore area of south Kashmir's Pulwama district.
- Sher e Kashmir University of Agricultural Sciences and Technology, organized four-day Krishi mela from 07-10 March, 2022 in which there was an active participation of Advanced Research Station for Saffron & Seed Spices, Pampore in farmers scientists interaction and technology transfer.
- Horticultural College & Research Institute, Periyakulam in association with AICRP on spices Pechiparai centre organized Spice Expo-2022 during 13-14 July 2022. A total 35 stalls were occupied by Spice Entrepreneurs & Exporters, Spice FPOs, Farm Implement Companies, Farm Input Companies & Government Institutions for display of their products & services. Expo attracted more than 500 farmers, entrepreneurs, scientists & students.
- ANDUAT, Kumarganj actively participated and exhibited stall of Spices, fruits and vegetables in the State Fruits, Vegetables and Flowers Exhibition during 4-6 March 2022 at Raj Bhawan Campus, Lucknow.
- CCS Haryana Agricultural University, Hisar organised two Kisan melas each during kharif (15-16 March 2022) and rabi (08-09 September 2022) and around 2000 farmers benefited from each mela conducted.
- Dr. V. Sivakumar was involved in display of improved spices varieties and modern agrotechniques on behalf of AICRPS (Chintepalle) during "Udyana Sandarshana" organised by Dr. YSRHU at Venkataramannagudem during 24.02.2022.
- AICRP (Spices) Sirsi centre actively participated in "Totagarike Mela 2022" organised by UHS, Bagalkot during 29-31 December 2022 in showcasing improved spices varieties and modern agro-techniques related to spices production and processing.
- AICRP (Spices) Sirsi centre actively participated in UAS, Dharwad Krishi mela, which was held during 17–20 September 2022. Scientists displayed improved spice varieties and cutting-edge agro-techniques connected to the growing and processing of spices.
- AICRP (Spices) Jobner actively participated in three days "Agri Expo-2022" organized by Directorate of Extension Education SKN Agriculture University, Jobner State level Farmer's fair during 28-30 March, 2022 at Sri Karan Narendra Agriculture University, Jobner.
- AICRP (Spices) Coimbatore was involved in display and field demonstration of varieties and technologies of spices during the event "AGRI INTEX 2022" (exhibition), organized by CODISSIA in association with TNAU, Coimbatore during 15-18 July 2022 at CODISSIA Trade Fair Complex, Coimbatore. More than 1000 farmers benefited during the event.
- AICRP (Spices) Jobner was involved in organizing the three days event "Agri Expo – 2022" conducted during 28-30 March, 2022. More than 1000 farmers benefited during the event.

Trainings organised by various AICRPS centres

Sl. No.	Date	Details of training	Centre involved	No. of participants
1	06.01.2022	Turmeric production technology	AICRP (Spices), Dr. YSRHU, Guntur	75
2	06.01.2022	Spice clinic (ginger, seed spices & turmeric) at Chalamthang Pacheykhani	ICRI, Gangtok	36
3	18.01.2022	Farmer training on "Pest and disease management in cardamom and black pepper" organised by Agriculture Department as a part of ATMA.	CRS, KAU, Pampadumpara	30
4	22.01.2022	Training programme on Organic farming of turmeric and exhibition of turmeric varieties at Koratikal village, Mamada mandal, Nirmal district	TRS, SKLTSHU, Kammarpally	100
5	27.01.2022	District level seminar on high -tech cultivation of turmeric organised by NHM – state Department of Horticulture at Koluthupalayam, Kodumudi, Erode	AICRP (Spices), TNAU, Coimbatore	50
6	29.01.2022	Class on "Quality Improvement training programme for turmeric growers" with the support of Spices Board, Field Office, Koraput at SHG training hall, Toyaput Village, Laxmipur Tehsil, Koraput	HARS, OUAT, Pottangi	40
7	03.02.2022	Spice clinic at Shipgyer, North Sikkim	ICRI, Gangtok	32
8	04.02.2022	Farmers training on "Operation and maintenance of automation unit in drip irrigation system"	AICRP (Spices), Jobner	26
9	08.02.2022	Spice clinic & demonstration of multipurpose electric dryer at Pangthang farm	ICRI, Gangtok	33
10	16.02.2022 to 18.02.2022.	Three days training on "Livelihood improvement through training cum input distribution for aspirational villages of Mizoram" at ICAR Kolasib	ICAR, Kolasib	55
11	21.02.2022	Scientific cultivation practices of black pepper	PRS, KAU, Panniyur	40
12	21.02.2022	RAFTAAR Agri Business Incubator, KAU sponsored training on "Post-harvest handling of spices for processing ".	CRS, KAU, Pampadumpara	9
13	21.02.2022	Farmer training on "Integrated pest and disease management in cardamom" organised by state Agriculture Department as a part of capacity building programme.	CRS, KAU, Pampadumpara	25
14	24.02.2022	Udyana Sandarshana organized by organised by Dr.YSRHU, displayed spices crops and participated in farmers scientists interaction	AICRP (Spices), Dr. YSRHU Chintapalle	50
15	28.02.2022	Distribution of multipurpose electric dryer (SCSP) at Hee Gaon, West Sikkim	ICRI, Gangtok	05

Sl. No.	Date	Details of training	Centre involved	No. of participants
16	March,2022	Demonstration on pro-tray method of seedling production in turmeric at Agarwaigani, Dapoli district, Ratnagiri	AICRP (Spices), Dr. BSKKV, Dapoli	50
17	07.03.2022	Training programme e on Organic farming of turmeric and exhibition of turmeric varieties at Kammarpet village, Medipally mandal, Jagtial district	TRS, SKLTSHU, Kammarpally	100
18	09.03.2022	Class on "Management of scale insects in cardamom" for the Krishi bhavan staff organised by CRS, Pampadumpara and state Agriculture Department	CRS, KAU, Pampadumpara	16
19	11.03.2022	Awareness training on turmeric cultivation and expanding turmeric area in Modakurichi, Vadukapatti village, Erode	AICRP (Spices), TNAU, Coimbatore	50
20	11.03.2022	Production technology of spice crops	AICRP (Spices), CCS HAU, Hisar	75.
21	01.03.2022 to 11.03.2022	NADP training programme on new multitier cropping system	AICRP (Spices), TNAU, Yercaud	40
22	14.03.2022	Class on "Management of pest and diseases in nutmeg, cardamom & black pepper" at Vathikudy Krishi bhavan, Idukki Block, Idukki	CRS, KAU, Pampadumpara	40
23	15.03.2022	Programme on Revival of cardamom from increasingly degraded ecosystem	CRS, KAU, Pampadumpara	52
24	15.03.2022 to 16.03.2022	Farmers training programme on spices under SCSP programme	BCKVV, Kalyani	100
25	20.03.2022	Launching of Farmers Assist App for black pepper and spices	PRS, KAU, Panniyur	75
26	14.03.2022 & 21.03.2022	Production technology of spice crops at Collage of Horticulture, Dapoli	AICRP (Spices), Dr. BSKKV, Dapoli	50
27	21.03.2022	Creating awareness on turmeric cultivation and expanding turmeric area for upliftment of SC community group at Gobichettipalayam, Erode	AICRP (Spices), TNAU, Coimbatore	50 SC farmers
28	21.03.2022 to 23.03.2022.	Three days Farmers' workshop on "Improved production techniques and value addition of major spices of Mizoram"	ICAR, Kolasib	40
29	26.03.2022	Farmers Training on "Organic ginger cultivation" at Machhakund, Lamataput	HARS, OUAT, Pottangi	75
30	28.03.2022	Trainer's training programme on "Pepper cultivation" at Tusuba, Lamataput, Koraput	HARS, OUAT, Pottangi	75
31	31.03.2022	Student awareness class on "Major pests and their management in cardamom" organised by Kerala Agricultural University as a part of study tour	CRS, KAU, Pampadumpara	100

Sl. No.	Date	Details of training	Centre involved	No. of participants
32	10.4.2022	Farmers training on "Organic coriander cultivation" at Tillesara, Jirajarang, Tarva, Subarnapur	HARS, OUAT, Pottangi	50
33	20.04.2022	Pre-zonal Research Extension Advisory Council meeting of Northern Telangana Zone with HRS, Adilabad	TRS, SKLTSHU, Kammarpally	
34	20.04.2022	Class on "Organic ginger cultivation" at Aborda	HARS, OUAT, Pottangi	75
35	23.04.2022	Integrated disease management in black pepper	AICRP (Spices), HREC, Sirsi	30
36	26.04.2022	Farmers scientist interface organised by Agriculture Development and Farmers' Welfare department and Krishi Vijnan Kendra, Shanthanpara	CRS, KAU, Pampadumpara	350
37	30.04.2022	Management of diseases in coconut and black pepper	AICRP (Spices), HREC, Sirsi	100
38	30.04.2022	Nutrient management in coconut and black pepper	AICRP (Spices), HREC, Sirsi	100
39	06.05.2022	NABARD sponsored training on "Cardamom, climate change and sustainability"	CRS, KAU, Pampadumpara	35
40	06.05.2022	NABARD sponsored training on "Good agricultural practices in spices on the contest of climate change"	CRS, KAU, Pampadumpara	35
41	07.05.2022	Training on "Masala phasalon ki unnat tacniqi" Badkhera, Kundam block, Jabalpur district	JNKVV, Jabalpur	35
42	17.05.2022	Farmers training on "Organic turmeric cultivation" at Kajurpanga, Pliheri, Daringibadi, Kandhamala	HARS, OUAT, Pottangi	40
43	22.05.2022	Lecture on "Biodiversity, climate change, pesticide use and sustainability" at Horti Research Centre LLP, Kochera P.O, Chettukuzhy, Idukki	CRS, KAU, Pampadumpara	800
44	22.05.2022	WSHG training on "Ginger value addition" at Lamataput, Koraput	HARS, OUAT, Pottangi	36
45	23.05.2022	Class on "Organic ginger cultivation" at Jeera	HARS, OUAT, Pottangi	75
46	April-June, 2022	Establishment of common turmeric centre for processing of raw turmeric into powder at Nursery, College of Horticulture, Dapoli.	AICRP (Spices), Dr. BSKKV, Dapoli	No:4; Processed 35 ton of turmeric
47	02.06.2022	Farmers training on "Organic ginger cultivation including soil health management" at Talagaluru, Pottangi, Koraput	HARS, OUAT, Pottangi	50

Sl. No.	Date	Details of training	Centre involved	No. of participants
48	03.06.2022	Farmers training on "Organic ginger cultivation including soil health management" at Padua, Nandapur	HARS, OUAT, Pottangi	40
49	05.06.2022	Farmers training on "Organic ginger cultivation including soil health management" at Parjakhudibi, Lamataput, Koraput	HARS, OUAT, Pottangi	48
50	06.06.2022	Class on "Botanical aspects of cardamom" to farmers organized by state Agriculture Department as a part of ATMA within the district training at CRS, Pampadumpara	CRS, KAU, Pampadumpara	25
51	08.06.2022	Farmers training on "Organic ginger cultivation including soil health management" at Malikhudi, Semiliguda, Koraput	HARS, OUAT, Pottangi	46
52	09.06.2022	Training on "Integrated pest and disease management in crops at Chakkupallam" organized by state Agriculture Department as part of capacity building programme	CRS, KAU, Pampadumpara	25
53	10.06.2022	Organic cultivation of high curcumin varieties of turmeric & exhibition	TRS, SKLTSHU, Kammarpally	100
54	10.06.2022	Farmers fraining on "Doubling of farmers income through spices cultivation" at Gunthaput, Semiliguda, Koraput	HARS, OUAT, Pottangi	60
55	12.06.2022	WSHG training on "Commercial cultivation of vegetables including ginger" at Koraput	HARS, OUAT, Pottangi	38
56	13.06.2022	Class on "Organic cultivation practices in cocoa and black pepper at Upputhura" organized by state Agriculture Department as part of PKVY training programme	CRS, KAU, Pampadumpara	35
57	14.06.2022	Class on "Cultivation aspects of black pepper and cardamom" organised by Arakkulam Krishi bhavan and ATMA	CRS, KAU, Pampadumpara	30
58	15/06/2022	Class on "Cultivation aspects of cocoa and black pepper" organised by Agricultural Knowledge Centre (AKC) scheme at Idukki block	CRS, KAU, Pampadumpara	150
59	15.06.2022	Farmer scientist Interface on "Pest management in black pepper and cocoa" conducted by state Agriculture Department, Idukki block and CRS Pampadumpara	CRS, KAU, Pampadumpara	150
60	16.06.2022	Spice clinic on ginger, turmeric & large cardamom at Gnon Sangdong, North Sikkim	ICRI, Gangtok	24
61	20.06.2022	Farmers training on "Organic ginger cultivation including soil health management" at Doraguda, Lamataput, Koraput	HARS, OUAT, Pottangi	25
62	23.06.2022	Farmers taining on "Organic ginger cultivation including soil health management" at FIAC, Pottangi, Koraput	HARS, OUAT, Pottangi	45
63	25.06.2022	Demonstration on planting of pro-tray seedlings at Agarwaingani,. Dapoli dist. Ratnagiri	AICRP (Spices), Dr. BSKKV, Dapoli	50

Sl. No.	Date	Details of training	Centre involved	No. of participants
64	28.06.2022	Training on "Organic management of black pepper" organized by state Agriculture Department as part of PKVY training programme	CRS, KAU, Pampadumpara	30
65	28.06.2022	Spice clinic on ginger & turmeric at Pacheykhani East Sikkim	ICRI, Gangtok	20
66	29.06.2022	Improved disease management strategies in spice cultivation	AICRP (Spices), HREC, Sirsi	50
67	29.06.2022	Training on "Integrated pest and disease management in cardamom and black pepper "as part of FFS training program by state Agriculture Department	CRS, KAU, Pampadumpara	35
68	10.07.2022	Farmers Training on "Organic ginger cultivation including soil health management" at Deopottangi, Pottangi, Koraput	HARS, OUAT, Pottangi	70
69	20.07.2022	Central Training Institute (CTI) Mannuthy, KAU organised training on "Crop management technologies in cardamom"	CRS, KAU, Pampadumpara	140
70	25.07.2022	Farmers training on "Cardamom cultivation" at Podei, Padua, Nandapur	HARS, OUAT, Pottangi	75
71	03.08.2022	Spice Clinic & field visit at Pacheykhani East Sikkim	ICRI, Gangtok	14
72	12.08.2022	Class on "Value chain approaches in ginger" at Kunduli	HARS, OUAT, Pottangi	30
73	13.08.2022	Class on "Value chain approaches in ginger" at Subai	HARS, OUAT, Pottangi	30
74	17.08.2022	Training programme on "Cardamom -Crop production and management"	CRS, KAU, Pampadumpara	25
75	17.08.2022	Class on "Production technology in nutmeg" at Krishi bhavan, Mankulam	CRS, KAU, Pampadumpara	25
76	17.08.2022	Monsoon care – Cardamom cultivation (Farmers day seminar)	CRS, KAU, Pampadumpara	60
77	31.08.2022 to 02.09.2022.	Three days of training on "Advance production techniques of ginger and turmeric cultivation in Mizoram"	ICAR, Kolasib	29
78	10.09.2022	Farmers training on "Organic Spices cultivation" at RRTTS, Semiliguda	HARS, OUAT, Pottangi	75
79	23.09.2022	Awarness programme on "Integrated nutrient management and IPDM in black pepper" to pepper samithy at Erattayar organized by state Agriculture Department and MSSRF - Village level agroclinic	CRS, KAU, Pampadumpara	40
80	24.09.2022	Farmers training on "Organic ginger and turmeric cultivation" at Thuria, Pottangi, Koraput	HARS, OUAT, Pottangi	56

Sl. No.	Date	Details of training	Centre involved	No. of participants
81	30.09.2022	SCSP training programme on upliftment of SC farmers of Shevroys hills through mixed farming at Maramangalam village	AICRP (Spices), TNAU, Yercaud	30
82	14.10.2022	Class on "Integrated pest and disease management in black pepper and cardamom" organized by MSSRF - Village level agroclinic	CRS, KAU, Pampadumpara	25
83	18.10.2022	Establishment of demonstration plot of sole planting of black pepper on farmers field of Shri. Rajaram Shigawan at Wakawali	AICRP (Spices), Dr. BSKKV, Dapoli	50
84	19.10.2022	Capacity Building programme on "Pest and disease management in cardamom" organized by state Agriculture Department -	CRS, KAU, Pampadumpara	25
85	20.10.2022	Management of leaf spot of arecanut and wilt disease in black pepper	AICRP (Spices), HREC, Sirsi	60
86	20.10.2022	Class on "Cultivation aspects of nutmeg" organised by Kanjikuzhi Krishi bhavan, Idukki block, Idukki district	CRS, KAU, Pampadumpara	50
87	21.10.2022	IDM in arecanut based black pepper cultivation	AICRP (Spices), HREC, Sirsi	25
88	21.10.2022	Class on "Cultivation aspects of nutmeg" organised by Vathikudy Krishi bhavan, Idukki block, Idukki district	CRS, KAU, Pampadumpara	80
89	21.10.2022	FS training programme on "Pest and disease management in black pepper" at Mankulam organized by state Agriculture Department	CRS, KAU, Pampadumpara	30
90	22.10.2022	Class on "Cultivation aspects of black pepper" organised as part of ATMA capacity building, Kanjikuzhi Krishi bhavan	CRS, KAU, Pampadumpara	60
91	26.10.2022	Class on "Spice cultivation" as part of Krishipadashala, Udumbanchola Krishi bhavan	CRS, KAU, Pampadumpara	35
92	31.10.2022	Class on "Improved Black pepper cultivation" at Ballel, Jalahanjar	HARS, OUAT, Pottangi	75
93	02.11.2022	Dealers training on "Use of safer pesticides" organised by KVK, Malkangiri	HARS, OUAT, Pottangi	40 dealers
94	10.11.2022	Entrepreneurship Development Programme for spice farmers of Idukki district	CRS, KAU, Pampadumpara	120
95	12.11.2022	Farmers Training on "Cardamom cultivation" at Jeera, Padua, Nandapur	HARS, OUAT, Pottangi	75
96	14.11.2022	Capacity building programme on "Pest and disease management in cardamom and black pepper" at Kanjiyar organized by state Agriculture Department	CRS, KAU, Pampadumpara	30
97	18.11.2022	FS training programme on "Pest and disease management in black pepper" at Vandanmedu organized by state Agriculture Department	CRS, KAU, Pampadumpara	30

Sl. No.	Date	Details of training	Centre involved	No. of participants
98	22.11.2022	Class on "Recent techniques in spice production" organized by Department of Agriculture & Farmers Welfare, Devikulam block, Idukki	CRS, KAU, Pampadumpara	25
99	23.11.2022	SCSP training programme on upliftment of SC farmers of Shevroys hills through mixed farming at Arangam village	AICRP (Spices), TNAU, Yercaud	30
100	25.11.2022	FS training programme on "Pest and disease Management in cardamom and black pepper in Vellathooval organized by state Agriculture Department	CRS, KAU, Pampadumpara	30
101	30.11.2022	FS training programme on "Pest and disease management in cardamom and black pepper" in Chakkupallam organized by state Agriculture Department	CRS, KAU, Pampadumpara	30
102	05.12.2022	Farmers training on "Cardamom cultivation" at Aborda, Padua, Nandapur	HARS, OUAT, Pottangi	75
103	05.12.2022 & 07.12.2022	Pre Krishidarshan-training on Recent trends in INM and IPM practices in spice cultivation and use of biocontrol agents (black pepper and nutmeg) organized by ATMA, Kottayam	CRS, KAU, Pampadumpara	45
104	10.12.2022	Farmers training program on "Organic cultivation of turmeric & field visit	TRS, SKLTSHU, Kammarpally	100
105	14.12.2022	SCSP training programme on upliftment of SC farmers of Shevroys hills through mixed farming at Manjakuttai village	AICRP (Spices), TNAU, Yercaud	30
106	15.12.2022	Practical sessions on primary processing of cardamom	CRS, KAU, Pampadumpara	12
107	15.12.2022	Farmers training on "Organic ginger and turmeric cultivation" at Ballel, Lamataput, Koraput	HARS, OUAT, Pottangi	75
108	12.12.2022 to 17.12.2022	Training on Good Agricultural Practices and Entrepreneurship Development Programme for cardamom farmers	CRS, KAU, Pampadumpara	70
109	21.12.2022	Class on "Nutmeg farming" as part of ATMA field school, Kamakshi Krishibhavan, Idukki block	CRS, KAU, Pampadumpara	50
110	22.12.2022	Conducted farmer training programme on "Organic cultivation of turmeric & field visit	TRS, SKLTSHU, Kammarpally	50
111	28.12.2022	Master training programme on "Quality spices production" with support of Spices Board, Field Office, Koraput at RRTTS, Semiliguda, Koraput	HARS, OUAT, Pottangi	28
112	29.12.2022 to 30.12.2022	Farmers training programme on Advances in turmeric cultivation, post-harvest, mechanization and value addition	TRS, SKLTSHU, Kammarpally	100

Sl. No.	Date	Details of training	Centre involved	No. of participants
113	29.12.2022	Quality improvement training programme for turmeric growers with the support of Spices Board, Field Office, Koraput, at Rajiv Bhawan, Pottangi	HARS, OUAT, Pottangi	50

Spice Expo-2022 conducted at TNAU, Horticultural College & Research Institute, Periyakulam

Field day on **" Agriculture innovations for sustainable livelihood" held at Mudigere**

Demonstration on AICRPS technologies during **AGRI INTEX 2022 programme** held at TNAU, Coimbatore

Farmers training programme conducted at AICPRS, Hisar

21 PUBLICATIONS

RESEARCH PAPERS

AICRPS HEAD QUARTERS

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22 AWARDS & RECOGNITIONS

Best AICRP on Spices Centre Award (2021-22)

AICRP on Spices centre at **Sardarkrushinagar Dantiwada Agricultural University,** Jagudan secured best AICRPS centre award during XXXIII Annual group meeting of AICRPS held at ANDUAT, Kumarganj during 13-15 October 2022.

Recognition

Dr. K. Giridhar, Principal Scientist (Horticulture), ICAR-AICRP on Spices -Guntur centre was awarded **Distinguished Scientist Award** during 5th Global Meet on Science and Technology held in virual mode at Subharthi University on 08 December, 2022.

Dr. S.K. Tehlan, Principal Scientist, ICAR-AICRP on Spices-Hisar centre has been admitted as **Fellow (2022) of the Society for Horticultural Research and Development** for his significant contribution in vegetable science.

Dr. R. K. Patel, ICAR-AICRP on Spices, Navsari centre got GAAS Award for in developing coriander variety '*GCO-3*' as co-worker.

Dr. B. Tanuja Priya, Senior Scientist (Horticulture), ICAR-AICRP on Spices-Guntur centre, was awarded **"Merit certificate for publishing research article in high rated NAAS journal"** held in virtual mode, awarded by Dr.YSRHU, Venkataramannagudem on 25 May, 2022.

Dr. G.L. Kumawat, ICAR-AICRP on Spices, Jobner centre won **"Best Poster Presentation"** for paper presentation on "Management of blight, powdery mildew and aphid infestation in cumin (*Cuminum cyminum* L.)" authored by G.L. Kumawat, A.C. Shivran, D.K. Gothwal, Jitendra Singh, S.S. Punia and G.K. Mittal in IPSCONF-2022 held at SKNAU, Jobner, Jaipur, Rajasthan.

Dr. G. K. Mittal, ICAR-AICRP on Spices, Jobner centre won **"Best Poster presentation Award"** for paper presentation on "Metabolomic studies during storage in coriander (*Coriandrum sativum* L.) genotypes" authored by Dr. G. K. Mittal, R. Inaniya, G. L. Kumawat, A. C. Shivran, Bhuri Singh and S. N. Saxena in the National Conference cum 9th Rajasthan Science Congress on "Harnessing frontier science and technologies for food, nutrition, health and environmental security", held at SKN Agriculture University, Jobner, Rajasthan during December 15-17, 2022.

ICAR-AICRP on Spices, Guntur centre won **"Best oral presentation Award"** for paper presentation authored by Deepthi, S., Tanuja Priya, B., V. Sudha Vani, K. Giridhar, K. Sireesha and T. Gayathri in the" National Seminar on "Empowerment of Rural Youth with Novel Agricultural technologies (ERYNAT-2022)" on 28-29 January, 2022 held at ANGRAU, Bapatla.

Farmers awarded for their success in spices cultivation

- **Shri. Yohannan P. D.,** Kottarakkara, Kollam district backed by PRS Panniyur centre has successfully demonstrated cultivation of Panniyur black pepper varieties in vertical column method with drip irrigation system in roof top and bagged award at Rural Innovators' Meet 2021 of the Kollam-Trivandrum region organized by KSCSTE.

- **Shri. Maggidi Chinnareddy** from Maggidi Village, Armoor mandal, Nizamabad district backed by TRS, Kammarpally was felicitated by District Collector, Nizamabad for his success in turmeric cultivation. He cultivated high curcumin and high yielding varieties like Duggirala Red, Rajendra Sonia, Rajendra Sonali, IISR Pragati etc. and making an agreement to sell his turmeric produce to Smart Agro Food Park, Nandipet, Nizamabad district.

- **Shri. Biman Pujari**, Bandaguda, Semiliguda, Koraput backed by AICRPS, Pottangi centre was awarded as **best ginger cultivator** from Krushi Bhavan Odisha, Bhubaneswar.

- **Shri. Ms Lalsangpuii** backed by ICAR-Mizoram has been honoured as an **'Innovative Farmer'** by the State of Mizoram and this recognition was conferred during North East Krishi Kumbha, Regional Agri Fair 4-6 January 2023 at ICAR, Umiam, Meghalaya

- **Smt. Bindu Joseph**, a progressive women farmer from Kozhikode, Kerala backed by ICAR-IISR, Kozhikode has been awarded **ICAR-Pandit Deendayal Upadhyay Antyodaya Krishi Puraskar-2021** during ICAR-foundation day 2022.

23 STAFF POSITION

PROJECT COORDINATORS OFFICE

1.	Project Co-ordinator	:	Dr. J Rema (Upto 31.05.2022)
		:	Dr. C. K. Thankamani (from 01.06.2022 to 07.12.2022)
		:	Dr. R. Dinesh (from 08.12.2022)
2.	Principal Scientist (Plant Physiology)	:	Dr. K.S. Krishnamurthy
3.	Scientist (SPMAP)	:	Dr. Sharon Aravind (upto 31.03.2022)
	Scientist (Plant Physiology)	:	Dr. M. Alagupalamuthirsolai (from 01.04.2022 to 01.12.2022)
	Scientist (Plant Genetics)	:	Mr. Mukesh Sankar. S (From 20.12.2022)
4.	Chief Technical Officer	:	Mr. John George
5.	Personal Assistant	:	Vacant
6.	Skilled Supporting Staff	:	Vacant

COORDINATING CENTRES

1. Cardamom Research Station, KAU, Pampadumpara

1.	Jr. Horticulturist	:	Dr. Nimisha Mathews
2.	Laboratory Assistant	:	Mr. R. Anilkumar

2. Pepper Research Station, KAU, Panniyur

1.	Horticulturist	:	Dr. Resmi Paul
2.	Jr. Pathologist	:	Dr. C. K. Yamini Varma
3.	Jr. Agronomist	:	Dr. Sudha B
4.	Technical Assistant	:	Vacant
5.	Lab Assistant	:	Mr. K. Rajeev

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

1.	Horticulturist	:	Dr. M. Shivaprasad
2.	Technical Assistant	:	Vacant

4. Horticultural Research Station (UHS), Sirsi

1.	Horticulturist	:	Mr. Sudheesh Kulkarni
2.	Jr. Pathologist	:	Dr. Abdul Kareem
3.	Technical Assistant	:	Mr. Laxman A. Padanad

5. Horticultural Research Station (TNAU), Yercaud

1.	Jr. Horticulturist	:	Dr. V.A. Sathiyamurthy (from 14.11.2022)
2.	Lab Assistant	:	Mrs. K. Leela

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

1.	Jr. Horticulturist	:	Dr. B. Senthamizh Selvi (upto 17.10.2022)
		:	Dr. M. Mohanalakshmi (from 18.10.2022)
2.	Jr. Pathologist	:	Dr. S. Sundravadana (upto May.2022)
		:	Dr. S. Maruthasalam
3.	Technical Assistant	:	Th. R. Swaminathan

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
2.	Technical Assistant	:	Vacant (Contract Basis)

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

1.	Horticulturist	:	Dr. K. Giridhar
2.	Jr. 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. Budhi Singh

11. High Altitute 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. D. K. Gothwal (from 09.11.2022)
		:	Dr. Sumer Singh Puniya (Upto 08.11.2022)
2.	Jr. Pathologist	:	Sh. G. L. Kumawat (Upto 12.12.2022-On Study Leave)
3.	Jr. Agronomist	:	Dr. A. C. Shivran
4.	Assistant Biochemist	:	Dr. G.K. Mittal (Part-time)
5.	Assistant Breeder	:	Dr. S.S. Rajput (Part-time)
		:	Dr. Ram Kunwar (Part-time)
6.	Jr. Technical Assistant	:	Sh. S. R. Kumawat (upto 30.04.2022)

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. T. P. Malik

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

1.	Jr. Horticulturist	:	
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. C. N. Ram (Upto 01.9.2022)
3.	Technical Assistant	:	Sh. R. K. Gupta

17. Department of Horticulture (UBKV), Pundibari

1.	Horticulturist	:	Dr. Suchand Dutta (upto 22.05.2022)
2.	Horticulturist	:	Dr. Ram Krishna Sarkar (from 23.05.2022)
3.	Pathologist	:	Dr. Anamika Debnath
4.	Technical Assistant	:	Sh. Murari Krishna Roy

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

1.	Horticulturist	:	Dr. P. C. Mali
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	:	Vacant

24 TRAININGS & CAPACITY BUILDING

Training undergone by staff of AICRPS

Sl. No	Name of the staff	Details of programme	Duration	Venue	Organisers
1	M.H. Khan	Awareness, motivation and technology transfer in temperate spice crops	--	Division of Vegetable Sciences, SKUAST-K	Division of Vegetable Sciences SKUAST-K
2	Nimisha Mathews	Data analysis and hands on training on statistical methods	18.02.2022 to 20.02.2022	Department of Agricultural Statistics, College of Agriculture, Vellayani, KAU	College of Agriculture, Vellayani, KAU
3	K. Giridhar, B. Tanuja Priya, Meenu Gupta, Reena Nair, Yamini Varma C.K, Airina C.K, Sudheesh Kulkarni, V. Sivakumar, Nimisha Mathews, Anamika Debnath, Mallik, Tehlan	Data digitalization and visualization	22.02.2022 to 24.02.2022	Online	ICAR-IISR, Kozhikode
4	G.L. Kumawat	ICAR sponsored 21 days Winter school on “Disease scenario in climate change conditions- Challenges, experience, innovation and future prospects”	02.03.2022 to 22.03.2022	SKNCOA, Jobner	SKNCOA, Jobner
5	Meenu Gupta	National symposium on “Crop protection through bio-rational approaches- current trends and future perspective”	10.03.2022	Online	IPS, New Delhi & HAU Hisar
6	Tehlan and Mallik (Co-ordinator)	Training programmes on “Production technology of spice crops”	11.03.2022	CCS HAU, Hisar	CCS HAU, Hisar

Sl. No	Name of the staff	Details of programme	Duration	Venue	Organisers
7	Nimisha Mathews	Advanced technologies in vegetable science	11.03.2022	Department of Vegetable Science, College of Agriculture, Vellanikara, KAU	College of Agriculture, Vellanikara, KAU
8	V. Sivakumar	Faculty Development Programme on Teaching competency enhancement through innovative methods	15-03-2022 to 19-03-2022	ICAR-NAARM, Hyderabad	ICAR-NAARM, Hyderabad
9	Airina C. K.	International seminar on "Sustainable urban agricultural systems and community resilient cities" production and propagation method for urban areas"	22.03.2022	Hybrid mode	Training Service Scheme, Vellayani and Department of Agricultural Extension, COA, Vellayani
10	A.C. Shivran, G.L. Kumawat (as organisers)	8th International conference on Plant pathology: Retrospect and prospects organized by Indian Phytopathological Society, IARI, New Delhi	23.03.2022 to 26.03.2022	SKNCOA, Jobner	SKNCOA, Jobner
11	Meenu Gupta	Brainstorming Session on "Necessity for judicious use of pesticides in mushroom and other minor crops	24.03.2022	Online	ICAR DMR, Solan (HP).
12	S.S. Punia, A.C. Shivran, G.L. Kumawat, S.S. Rajput, Ram Kunwar, G.K. Mittal	Agri Expo – 2022	28.03.2022 to 30.03.2022	SKNAU, Jobner	SKNAU, Jobner
13	Meenu Gupta	National symposium on "Novel strategies in plant stress diagnosis and management"	06.05.2022 to 07.05.2022	Department of Plant Pathology, UHF, Nauni	HPS, Nauni and Department of Plant Pathology, UHF, Nauni

Sl. No	Name of the staff	Details of programme	Duration	Venue	Organisers
14	Anamika Debnath & Ram Krishna Sarkar	National seminar on Horticulture for sustainable development, nutritional and livelihood security	26.05.2022 to 27.05.2022	Uttar Banga Krishi Viswavidyalaya , Pundibari, Cooch Behar	National Agricultural Higher Education Project,Uttar Banga Krishi Viswavidyalaya
15	Sudheesh Kulkarni	Tri-monthly workshop – 1, 2 & 3 (Horticulture crops)	23.06.2022, 06.09.2022 & 23.12.2022	AICRP (Spices), HREC, Sirsi	AICRP (Spices), HREC, Sirsi
16	Preeti Verma	IPR awareness program under National Intellectual Property Awareness mission	15.08.2022	Online	Intellectual property, India & Government of India
17	P.C. Mali	XXXI AGM of AICRP on Palms	16.09.2022 to 18.09.2022	CPCRI, Kasaragod	AICRP on Palms
18	Nimisha Mathews	Plant health management in protected cultivation	26.09.2022 to 30.09.2022	NIPHM, Hyderabad	NIPHM Hyderabad
19	C.S. Maiti	Attended National Spice conference	06.10.2022 to 07.10.2022	Mumbai, India	World Spice Organisation (WSO),
20	Anamika Debnath, Ram Krishna Sarkar & C.S. Maiti	6th International Symposium on Minor fruits, medicinal and aromatic crops	24.11.2022 to 26.11.2022	Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar	Society of Minor Fruits, Medicinal & Aromatic Plants (SMF & AP)
21	S.S. Punia, A.C. Shivran, G.L. Kumawat, S.S. Rajput, Ram Kunwar, G.K. Mittal	National conference cum 9th Rajasthan Science Congress	15.12.2022 to 17.12.2022	SKNAU, Jobner	SKNAU, Jobner
22	Chandra Deo and Arwankie Shadap	State level seminar on 'Technological advancements in cultivation, post-harvest handling & marketing of spices'	21.12.2022 & 22.12.2022	College of Horticulture & Forestry, Pasighat.	College of Horticulture & Forestry, Pasighat.

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-22	19.0	2	22.0	11.1	-	-	91.0	34.9	22.1
Feb-22	4.4	1	22.6	11.9	-	-	90.8	35.9	22.8
Mar-22	53.9	5	24.6	14.3	18.2	4	92.9	37.4	24.7
Apr-22	236.4	12	24.8	14.5	120.0	10	93.5	36.1	26.2
May-22	274.3	15	23.2	13.0	342.0	16	93.5	33.2	25.5
June-22	145.7	14	22.9	12.7	389.9	24	93.4	32.1	25.4
July-22	649.0	25	21.2	11.2	1150.1	26	93.0	29.9	25.1
Aug-22	678.2	23	21.3	11.3	668.5	25	94.4	31.0	25.0
Sep-22	298.9	13	22.2	12.2	261.8	16	92.9	31.7	25.2
Oct-22	418.3	14	22.3	12.5	85.7	10	94.0	33.1	24.6
Nov-22	155.6	12	22.0	12.1	121.0	16	93.4	33.5	24.1
Dec-22	96.0	11	20.8	11.1	15.0	2	91.7	33.7	23.1

MUDIGERE						SIRSI				
Month	Rain fall (mm)	RH (%)		Temperature (°C)		Rain fall (mm)	RH (%)		Temperature (°C)	
		I	II	Max.	Min.		I	II	Max.	Min.
Jan-22	-	71.6	80.5	20.29	31.06	0.0	80	74	33.0	14.0
Feb-22	-	61.3	82.2	18.1	29.21	0.0	79	72	36.0	18.0
Mar-22	3.5	60.8	80.3	19.48	37.19	20.0	76	71	38.0	18.8
Apr-22	78.8	60.6	80.5	17.09	27.63	56.8	84	82	36.3	22.6
May-22	158.8	60.5	81.9	18.58	27.37	292.4	90	89	33.0	22.0
June-22	284.5	99.4	100.0	19.6	21.73	249.6	90	83	31.5	21.4
July-22	940.2	42.9	64.3	19.62	22.45	1313.4	91	88	28.3	20.5
Aug-22	1083.0	39.1	61.8	19.32	25	825.2	91	88	28.3	20.4
Sep-22	242.0	57.4	63.2	21.3	26.1	301.0	89	86	29.5	19.9
Oct-22	293.2	45.0	84.5	18.4	24.8	82.6	89	84	29.7	18.7
Nov-22	-	-	-	-	-	0.0	86	79	30.4	16.4
Dec-22	-	-	-	-	-	0.0	83	73	29.4	17.7

GUNTUR							SOLAN			
Month	Rain fall (mm)	No. of rainy days	RH (%)		Temperature (°C)		Rain fall (mm)	RH (%)	Temperature (°C)	
			I	II	Max.	Min.			Max.	Min.
Jan-22	36.6	3	96.5	77.9	28.8	17.8	168.3	68.0	15.7	2.5
Feb-22	0.0	0	96.3	66.5	30.4	18.3	38.5	57.0	20.2	4.1
Mar-22	0.0	0	95.4	66.1	31.4	19.1	171.8	62.0	21.2	7.2
Apr-22	0.0	0	97.4	53.8	36.1	25.4	47.7	51.0	27.6	10.7
May-22	17.6	3	88.1	56.2	36.8	27.1	54.9	42.0	30.7	16.1
June-22	33.2	4	87.4	49.7	36.7	27.4	190	62.0	29.7	18.9
July-22	177.7	14	97.5	67.6	30.8	24.7	340.2	81.0	26.7	20.2
Aug-22	246.8	12	98.2	65.8	31.3	25.2	216.6	79.0	27.6	20
Sep-22	127.6	6	92.0	0.0	27.9	23.6	224.3	76.0	26.5	16.9
Oct-22	286.6	14	99.0	74.8	29.1	23	26	53.0	25.1	9.1
Nov-22	46.2	2	100.0	74.1	29.2	19.1	24.8	59.0	21.7	6.5
Dec-22	46.2	3	100.0	74.1	29.2	19.1	21.6	58.0	18.1	1.6

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-22	17.0	2	27.4	13.5	11.2	3	19.4	9.3	92.4	59.9
Feb-22	0.0	0	30.7	14.1	3.0	1	23.1	10.4	89.1	44.0
Mar-22	10.0	1	36.3	19.7	0.0	0	31.8	15.1	85.2	44.7
Apr-22	26.2	2	37.7	23.4	0.0	0	35.6	18.5	68.8	38.2
May-22	92.4	5	37.0	24.2	40.4	3	31.0	23.5	70.3	51.6
June-22	127.5	10	34.2	24.4	152.6	9	34.0	27.0	89.8	65.6
July-22	302.4	20	28.1	22.9	152.6	9	34.8	27.0	89.8	65.6
Aug-22	401.6	16	29.4	22.8	127.4	10	32.9	26.8	90.3	75.8
Sep-22	426.2	14	30.0	22.7	203.4	10	33.0	26.5	91.5	70.5
Oct-22	272.4	15	30.4	22.3	212.0	5	31.8	20.9	89.9	61.2
Nov-22	0.0	0	29.8	14.9	0.0	0	27.0	13.0	89.5	61.3
Dec-22	0.0	0	30.4	15.2	0.0	0	29.5	8.5	91.8	63.0

DAPOLI						PUNDIBARI				
Month	Rain fall (mm)	Temperature (°C)		RH (%)		Rain fall (mm)	Temperature (°C)		RH (%)	
		Max.	Min.	I	II		Max.	Min.	I	II
Jan-22	0.4	29.5	12.9	94.1	56.0	4.0	24	11	90	55
Feb-22	0.0	31.4	12.4	90.2	49.5	47.0	24	11	82	51
Mar-22	0.0	34.6	17.8	88.2	50.7	28.0	32	18	71	45
Apr-22	0.0	34.1	20.8	88.0	63.2	565.0	29	21	89	75
May-22	0.3	32.9	23.0	86.7	67.3	623.0	31	22	83	71
June-22	21.6	31.0	23.1	91.2	75.2	1266.0	30	23	94	86
July-22	39.2	28.2	23.1	95.2	89.4	426.3	34	24	86	73
Aug-22	35.3	28.2	22.5	95.0	90.6	450.0	33	23	88	76
Sep-22	14.7	29.1	22.3	92.9	85.0	242.0	32	22	89	77
Oct-22	4.5	30.7	19.9	92.2	77.7	218.6	31	18	82	69
Nov-22	0.0	32.5	15.5	89.9	54.3	0.0	30	11	71	51
Dec-22	0.0	32.8	16.2	93.0	52.3	0.0	28	9	79	49

AMBALAVAYAL						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-22	0.0	27.5	15.0	93	59	2.2	--	31.0	23.7	80.0
Feb-22	0.1	29.2	17.2	93	48	12	1	33.0	24.5	75.0
Mar-22	121.4	30.2	18.7	94	54	26.8	3	32.0	23.1	79.0
Apr-22	160.7	29.5	20.0	91	65	247.4	12	30.1	23.8	82.0
May-22	343.0	26.8	19.5	93	78	389.9	17	29.0	23.5	83.0
June-22	204.7	26.4	19.6	94	79	251.3	11	30.2	23.6	78.0
July-22	810.8	24.0	19.3	95	87	127.3	8	30.5	23.8	80.0
Aug-22	594.1	25.4	19.4	94	81	143.1	12	30.6	24.3	81.5
Sep-22	137.3	26.1	18.3	90	75	364.3	20	30.2	24.0	84.0
Oct-22	200.6	26.7	17.9	94	70	166.7	7	29.0	23.8	85.0
Nov-22	61.0	25.8	17.1	93	75	90.3	6	29.5	23.5	87.0
Dec-22	40.8	25.9	15.5	94.0	69	72.1	4	33.0	24.0	80.0

MYLADUMPARA						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-22	19.0	2	25.5	13.0	90.2	22	3	12	2
Feb-22	4.4	1	26.8	13.0	89.6	86	11	12	1
Mar-22	53.9	5	28.8	13.5	86.1	144	7	19	6
Apr-22	236.4	12	28.2	14.6	90.0	837	26	21	12
May-22	274.3	15	25.9	14.6	93.7	721	21	21	14
June-22	145.7	14	26.5	14.2	92.9	1172	30	20	15
July-22	649.0	25	22.7	13.8	95.5	428	23	22	16
Aug-22	678.2	23	23.6	13.8	95.4	781	26	22	16
Sep-22	298.9	13	26.0	13.8	93.0	699	27	20	15
Oct-22	418.3	14	26.1	13.7	92.1	485	10	20	10
Nov-22	155.6	12	25.4	13.1	92.3	12	1	16	7
Dec-22	96.0	11	24.0	12.4	92.1	7	1	13	6

BARAPANI						NAGALAND				
Month	Rain fall (mm)	Temperature (°C)		RH (%)		Rain fall (mm)	Temperature (°C)		RH (%)	
		Max.	Min.	I	II		Max.	Min.	I	II
Jan-22	44.0	19.4	8.2	70.8	58.6	34.6	22.7	10.1	96	56
Feb-22	29.2	19	7.1	65.5	52.3	56.3	23.2	9.6	95	48
Mar-22	10.8	27.5	13.9	58.7	38	2.3	32.2	15.5	90	40
Apr-22	109.6	26.5	17.1	73.5	66.4	175.7	30.9	19.9	90	68
May-22	499.2	25.2	17.6	84.9	86.1	224.7	30.5	21.9	92	71
June-22	446.1	26.4	19.7	90.9	89.1	160.8	32	23.9	95	72
July-22	278.2	28.9	20.8	88.1	86.6	375.8	33.3	24.6	92	69
Aug-22	253.6	28.9	20.8	87.6	86.1	261.8	33	24.1	94	70
Sep-22	241.1	27.7	19.5	88.3	88.6	161.2	33	23.8	91	69
Oct-22	313.6	26.1	16.2	84.6	N/A	94.8	30.5	21.3	94	69
Nov-22	30.4	25	11.4	72.6	N/A	0	28.4	14.8	96	58
Dec-22	5.0	22.1	8.4	77.8	N/A	14.6	23	10.2	83	46

KOTA							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-22	13.0	2	19.8	7.5	75.4	63.4	2	1	26.6	9.4
Feb-22	0.0	0	24.7	10.7	73.1	53.3	0	0	30.7	10.9
Mar-22	0.0	0	37.1	20.0	39.1	22.8	0	0	36.4	16
Apr-22	0.0	0	41.7	25.8	32.2	13.6	0	0	31.6	15.8
May-22	7.5	2	44.0	29.7	40.3	19.6	0	0	30	18.5
June-22	120.9	7	40.7	28.9	46.8	43.2	8	2	31.1	20
July-22	451.0	17	34.3	25.8	82.5	73.6	357	15	26.5	21.1
Aug-22	480.6	24	32.8	24.8	82.7	84.4	85	8	20.7	16.5
Sep-22	100.1	7	33.7	24.6	91.3	88.4	111	6	30.3	21.8
Oct-22	28.0	4	33.9	20.2	92.0	92.0	13	2	24.6	14.3
Nov-22	0.0	0	31.7	14.0	71.8	79.0	0	0	27.4	11.8
Dec-22	0.0	0	26.3	10.1	41.3	62.3	0	0	23.9	8.8

CHINTAPALLE							PAMPORE		
Month	Rain fall (mm)	No. of rainy days	Temperature (°C)		RH (%)		Rain fall (mm)	Temperature (°C)	
			Max.	Min.	I	II		Max.	Min.
Jan-22	3.1	1	26.0	10.8	99.1	66.3	3.3	6.5	0.3
Feb-22	0.0	0	28.3	12.0	97.5	64.5	3.6	10.3	0.4
Mar-22	2.7	1	32.3	15.1	95.2	63.5	42.4	18.5	3.3
Apr-22	82.9	5	34.3	19.3	95.3	64.4	160.3	21.4	6.8
May-22	208.6	8	32.7	21.4	93.6	69.9	50.8	24.6	9.0
June-22	77.8	5	31.2	21.8	92.8	74.0	50.8	24.7	9.2
July-22	164.3	20	27.5	21.0	96.0	85.4	134.2	28.8	17.2
Aug-22	235.7	13	28.2	21.2	94.9	80.6	120.6	30.7	16.6
Sep-22	219.9	11	28.6	20.9	96.9	77.9	22.8	28.0	11.9
Oct-22	118.4	12	28.0	18.4	96.7	74.5	10.5	21.7	2.9
Nov-22	19.8	1	27.3	14.7	98.3	62.1	138.2	12.1	0.1
Dec-22	43.3	4	27.6	13.9	98.5	62.0	5.6	9.4	-4.6

SAKALESHAPUR			YERCAUD		RAIGARH				
Month	Rain fall (mm)	Rainy days	Rain fall (mm)	Rainy days	Rain fall (mm)	Temperature (°C)		RH (%)	
						Max.	Min.	I	II
Jan-22	-	-	6.5	3	50.8	25.2	13.0	85.2	55.1
Feb-22	-	-	124.3	9	4.6	29.4	14.1	84.1	50.1
Mar-22	45	3	146	8	1.6	36.9	20.4	73.2	35.5
Apr-22	36	1	108.4	10	4.2	40.7	28.4	66.1	35.3
May-22	339	12	162.9	12	14.6	40.7	31.8	62.9	34.5
June-22	355	16	149.8	12	181.2	37.0	29.1	70.7	51.3
July-22	1526	27	164.4	9	444.2	31.6	26.8	85.0	74.6
Aug-22	1228	24	120.6	12	584.8	31.3	26.8	84.7	72.2
Sep-22	287	16	164.4	9	251.8	31.4	25.9	85.9	74.1
Oct-22	151	8	120.6	12	57.6	31.5	23.1	86.9	64.3
Nov-22	16	2	67.4	10	0.0	30.1	16.1	82.4	46.0
Dec-22	60	3	185.4	11	0.0	28.8	12.1	81.4	43.4

26 AICRP BUDGET

AICRPS CENTRE-WISE BUDGET

Centres	Salary		RC		TSP	SCSP	NEH		Capital		Total		Grand Total
	ICAR	State	ICAR	State	100%	100%	ICAR	State	ICAR	State	ICAR	State	
Regular Centres													
Pampadumpara (KAU)	20.14	6.71	7.73	2.58	2.00	-	-	-	-	-	29.87	9.29	39.16
Panniyur (KAU)	38.00	12.67	3.50	1.17	-	-	-	-	-	-	41.50	13.84	55.34
Mudigere (UAHS)	28.00	9.33	2.90	0.97	-	-	-	-	-	-	30.90	10.30	41.20
Sirsi (UHS)	40.00	13.33	3.70	1.23	-	1.50	-	-	-	-	45.20	14.56	59.76
Yercaud (TNAU)	24.00	8.00	1.05	0.38	-	-	-	-	-	-	25.05	8.38	33.43
Coimbatore (TNAU)	33.81	11.27	2.70	0.90	-	-	-	-	-	-	36.51	12.17	48.68
Chintapalle (Dr. YSRHU)-TSP	15.00	5.00	1.40	0.47	2.50	-	-	-	-	-	18.90	5.47	24.37
Kammarpally (SKLTSHU)	36.81	12.27	1.50	0.5	-	7.50	-	-	-	-	45.81	12.77	58.58
Guntur (Dr. YSRHU)	47.00	15.67	2.45	0.82	-	-	-	-	-	-	49.45	16.49	65.94
Solan (YSPUHF)	18.00	6.00	0.70	0.23	-	-	-	-	-	-	18.70	6.23	24.93
Pottangi (OUAT)-TSP	21.00	7.00	8.60	2.87	1.50	2.95	-	-	-	-	34.05	9.87	43.92
Jobner (SKNAU)	75.00	25.00	2.80	0.93	-	-	-	-	-	-	77.80	25.93	103.73
Jagudan (SDAU)	27.00	9.00	-	-	-	-	-	-	-	-	27.00	9.00	36.00
Hisar (HAU)	61.00	20.33	1.85	0.67	-	-	-	-	-	-	63.85	21.00	84.85
Dholi (RAU)	-	-	4.00	-	-	-	-	-	-	-	4.00	-	4.00
Kumarganj (NDUAT)	38.00	12.67	2.70	0.90	-	-	-	-	-	-	40.70	13.57	54.27
Pundibari (UBKVV)	-	-	-	-	-	5.00	-	-	-	-	5.00	-	5.00
Dapoli (BSKKV)	19.00	6.33	1.50	0.50	-	-	-	-	-	-	20.50	6.83	27.33
Raigarh (IGKV)	29.00	9.67	3.80	1.27	-	3.50	-	-	0.17	-	36.47	10.94	47.41
Total	**570.76**	**190.25**	**52.88**	**16.39**	**6.00**	**20.45**	**-**	**-**	**0.17**	**-**	**651.26**	**206.64**	**857.9**
Co-opting Centres													
Ambalavayal (KAU)	-	-	0.40	0.13	-	-	-	-	-	-	0.40	0.13	0.53
Pechiparai (TNAU)	-	-	1.35	0.45	-	-	-	-	-	-	1.35	0.45	1.80
Gangtok (ICRI)-NEH	-	-	-	-	-	-	5.15	1.72	0.75	0.25	5.90	1.97	7.87
Sakleshpur (ICRI)	-	-	2.40	0.80	-	-	-	-	-	-	2.40	0.80	3.20
Myladumpara (ICRI)	-	-	2.70	0.90	-	-	-	-	-	-	2.70	0.90	3.60
ICAR RC NEHR, Barapani-NEH	-	-	-	-	-	-	8.90	-	3.00	-	11.90	-	
ICAR RC NEHR, Mizoram-NEH	-	-	-	-	-	1.25	10.15	-	1.70	-	13.10	-	
ICAR RC NEHR, Gangtok-NEH	-	-	-	-	-	-	2.40		-	-	2.40	-	
Nagaland (AU)	-	-	-	-	2.00	-	15.62	-	-	-	15.62	-	
Kahikuchi (AAU)	-	-	-	-	-	-	7.00	2.33	-	-	7.00	2.33	9.33
Pasighat (CAU)-NEH	-	-	-	-	-	-	9.15	-	1.50	0.50	10.65	0.50	11.15
Total	**-**	**-**	**6.85**	**2.28**	**2.00**	**1.25**	**58.37**	**4.05**	**6.95**	**0.75**	**73.42**	**7.08**	**80.5**
Voluntary Centres													
Pantnagar (GBPUAT)	-	-	0.30	0.10	-	-	-	-	-	-	0.30	0.10	0.40
Kanke (BIRSAAU)-TSP	-	-	0.30	0.10	-	-	-	-	-	-	0.30	0.10	0.40
Kalyani (BCKVV)	-	-	2.21	0.74	-	-	-	-	-	-	2.21	0.74	2.95
Kota (AUK)	-	-	2.40	0.80	-	-	-	-	0.84	-	3.24	0.80	4.04
Navsari (NAU)	-	-	1.90	0.63	-	-	-	-	-	-	1.90	0.63	2.53
Jabalpur (JNKV)	-	-	0.35	0.12	-	-	-	-	-	-	0.35	0.12	0.47
Mandor (AUJ)	-	-	3.32	1.11	-	1.00	-	-	-	-	4.32	1.11	5.43
Sanand (AAU)	-	-	1.92	0.64	-	-	-	-	-	-	1.92	0.64	2.56
Total	**-**	**-**	**12.7**	**4.24**	**-**	**1.00**	**-**	**-**	**0.84**	**-**	**14.54**	**4.24**	**18.78**
Project Mode centres													
KAU, Thrissur	-	-	0.30	0.10	-	-	-	-	-	-	0.30	0.10	0.4
SRS Pampore	-	-	0.30	0.10	-	-	-	-	-	-	0.30	0.10	0.40
Total	**-**	**-**	**2.21**	**0.74**	**-**	**-**	**-**	**-**	**-**	**-**	**2.21**	**0.74**	**2.95**
Miscellaneous													
XXXIII Annual Group Meeting	-	-	4.12	-	-	-	-	-	-	-	4.12	-	4.12
Others	-	-	0.11	-	-	-	-	-	-	-	0.11	-	0.11
Total	**570.76**	**190.25**	**81.16**	**22.91**	**8.00**	**22.7**	**58.37**	**4.05**	**7.96**	**0.75**	**747.95**	**217.76**	**965.71**

* amount given here is Rs. in lakhs.

27 AICRPS CENTRES

AICRPS CENTRES

HEAD QUARTERS
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ICAR-All India Coordinated Research Project on Spices
ICAR-Indian Institute of Spices Research, Kozhikode-673 012, Kerala
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COORDINATING CENTRES

Sl. No.	Centre and Contact address	Telephone	Fax/E. mail
	Regular Centres		
Andhra Pradesh			
1	**Horticultural Research Station** (Dr. Y.S. R Horticultural University), **CHINTAPALLE**-531 111, Visakhapatnam, Andhra Pradesh	07382024496(M)	07382024496(M) siva200619@gmail.com hrs-ctpli@drysrhu.edu.in
2	**Horticultural Research Station** (Dr. Y.S. R Horticultural University), **GUNTUR** – 522 034, Andhra Pradesh	9490083422(M)	9490083422(M) gkalidasu@yahoo.com tpriyahort@gmail.com
Bihar			
3	**Department of Horticulture** Dr. Rajendra Prasad Central Agricultural University) **DHOLI**-843 121, Bihar	0621-2293227(O) 09973218436 (M)	0621-2293227 pi.spices@rpcau.ac.in ashim_sigatoka@yahoo.com
Chhattisgarh			
4	**Regional Agricultural Research Station** (Indira Gandhi Krishi Vishwavidyalaya), **RAIGARH** – 496 001, Chhattisgarh	07762-222402/215235(O) 09425536852 (M)	07762- 222402 /215235 singh_ajit8@rediffmail.com shrikant.sawargaonkar@gmail.com
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5	**Centre for Research on Seed Spices** (Sardarkrushinagar Dantiwada Agricultural University), **JAGUDAN** – 382 710 Dist. Mehsana, Gujarat	02762-285337 (O) 09426412289 (M)	02762-285337 rsspices@sdau.edu.in nrp_dax@sdau.edu.in
Haryana			
6	**Department of Vegetable Crops** (Chaudhary Charan Singh Haryana Agricultural University) **HISAR** – 125 004, Haryana	01662-289207 (O) 09416961854(M)	01662-234952/284306 aicrpspices@hau.ernet.in tpmalik@yahoo.com, sktehlan07@gmail.com

Himachal Pradesh			
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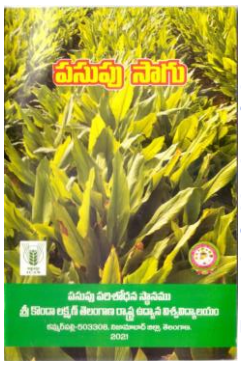
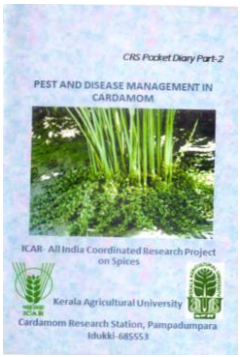
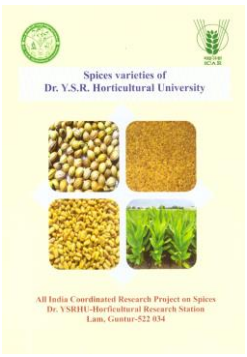


Turmeric Cultivation of cloves (Telugu).



Pest & Disease Management in Cardamom.

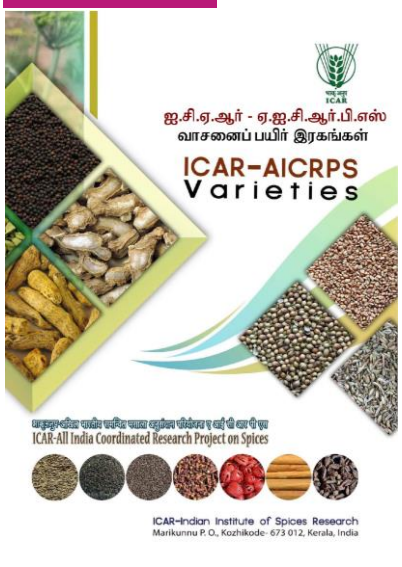


Spices varieties of Dr. Y.S.R Horticultural University

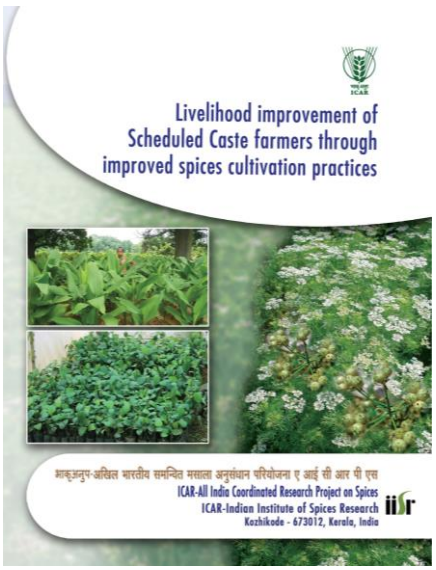
Current techniques in successful coriander cultivation in Rajasthan (Hindi)

Scientific cultivation practices of spices crop (Hindi)

Significant achievement of AICRPS, Kumarganj

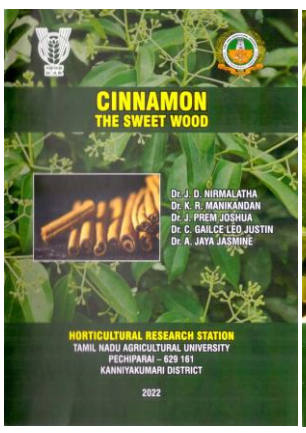


ICAR-AICRPS Varieties (Tamil)



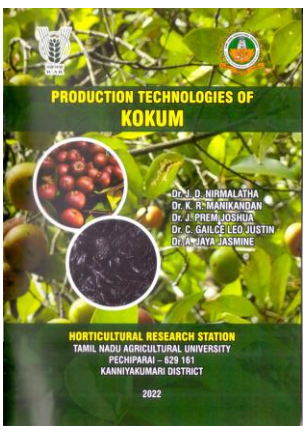
Livelihood improvement of SC farmers through improved spices cultivation practices

Advanced production technologies in large cardamom

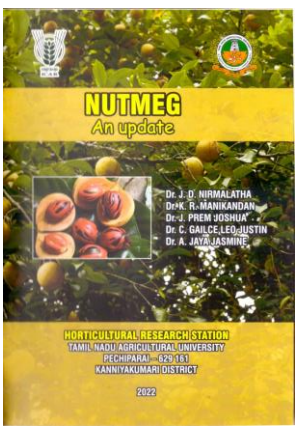


Cinnamon-The Sweet wood

Cultivation of cloves (Tamil).



Production technologies of Kokum



Nutmeg an update

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