वार्षिक प्रतिवेदन
Annual Report
2021

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

भाकृअनुप-भारतीय मसाला फसल अनुसंधान संस्थान
ICAR-Indian Institute of Spices Research
Kozhikode - 673012, Kerala, India

Varieties recommended for release during XXXII Annual Group Meeting of AICRPS

RF 289

Chhattisgarh Raigarh Dhaniya 3

Gujarat Methi 3

HM 273

Lam Ajwain 3

Chhattisgarh Raigarh Haldi 3

ICAR-ALL INDIA COORDINATED RESEARCH PROJECT ON SPICES

ANNUAL REPORT 2021

ICAR-All India Coordinated Research Project on Spices (ICAR-AICRPS)
Indian Institute of Spices Research
Kozhikode – 673 012, Kerala, India

Published by

Project Coordinator (Spices),
ICAR-All India Coordinated Research Project on Spices
Kozhikode – 673 012, Kerala, India
Phone: 0495 2731954, Fax : 0495 2731954
email: aicrp.spices@icar.gov.in, aicrpspices@gmail.com
Website : www.aicrpspices.icar.gov.in

Compiled and Edited by

Sharon Aravind
John George
K. S. Krishnamurthy
E. Radha
J. Rema

Hindi Translation

N. Prasannakumari

Cover Design

A. Sudhakaran

Correct Citation

Sharon Aravind, John George, Krishnamurthy K. S., Radha E. and J. Rema (Eds.) Annual Report 2021. ICAR-All India Coordinated Research Project on Spices, ICAR-IISR, Kozhikode, Kerala, India 158p.

February 2021

CONTENTS

कार्यकारी सारांश

भाकृअनुप-अखिल भारतीय समन्वित मसाला अनुसंधान परियोजना (आईसीएआर-एआईसीआरपीएस) भारत में सबसे बडी मसाला अनुसंधान प्रणाली है, जो वर्तमान में 17 अधिदेश फसलों पर केन्द्रित है, जिसमें 19 नियमित, 11 सह-चयनित, 8 स्वैच्छिक और 2 परियोजना मोड के केन्द्रों का नेटवर्क है। आईसीएआर-एआईसीआरपीएस ने अपनी स्थापना के बाद, वांछनीय कृषि अनुकूल क्षेत्रों से उच्च उपज देने वाली प्रजातियों, उत्पादन और उत्पादकता बढ़ाने के लिए प्रौद्योगिकियों और कीटों और रोगजनकों को निपटने के लिए प्रबंधन रणनीतियों को विकसित करके फसल के नुकसान को काफी हद तक कम करने में महत्वपूर्ण योगदान दिया है।

मसाले वस्तुतः पौधों के अलग अलग भागों/कद और जीवन काल के साथ 'फसलों का मिश्रित रूप' है, जो मांसल प्रकंद और जड़ी-बूटी वार्षिक से लेकर चिरस्थायी पेड़ पर बढ़ने वाले और पेड़ है और आकार में भिन्न होते हैं, उपयोगी भागों / उपयोगों और घटकों/ सक्रिय घटकों का सम्मिलित देन भारत के कृषि निर्यात बासकेट के लिए महत्वपूर्ण देन होता है। एआईसीआरपीएस इनमें से, काली मिर्च, बड़ी इलायची छोटी इलायची अदरक, हल्दी, आम अदरक, दालचीनी, जायफल, लौंग, धनिया, जीरा, सौंफ, मेथी, अजवाइन, कलौंजी, केसर और कालाजीरा आदि पर अनुसंधान गतिविधियों का समन्वय करता है। मिर्च जैसी नई फसलों को अपने दायरे में लाने का प्रयास किया जा रहा है, जो मसाला फसलों में सबसे बड़ा निर्यात अर्जक है। वर्ष 2021 के लिए एआईसीआरपीएस का वार्षिक बजट रु. 663.19 लाख (आईसीएआर शेयर) थे।

नई पहल

अदरक और हल्दी में जिंक और फॉसफोरेस घुलनशीलता क्षमता के लिए पादप वृद्धि को बढ़ाने वाले राइज़ोबैक्टीरिया, *बैसिलस सफेन्सिस* का उपयोग करते हुए स्थायी मसाला उत्पादन हेतु तथा धनिया, सौंफ, मेथी, एरोमटिक हल्दी और काली मिर्च में समन्वित प्रजातीय परीक्षण करते हुए नई शोध परियोजनाएं शुरू की गई है।

एमआरएल तय करने और कीटनाशकों और कवकनाशकों के लिए लेबल का दावा प्राप्त करने के लिए, काली मिर्च, छोटी इलायची, बडी इलायची, अदरक, हल्दी, जीरा, सौंफ और मेथी जैसे मसाला फसलों के सभी पौध संरक्षण परीक्षणों के लिए अवशेष विश्लेषण किया गया।

मेघा हल्दी तथा आईआईएसआर प्रगति के शुद्ध बीजों की उपलब्धता को सुविधाजनक बनाने के लिए उत्तर पूर्व क्षेत्रों में स्थित सभी केन्द्रों में कुरकुमिन समृद्ध हल्दी किस्म मेघा हल्दी और कुरकुमिन स्थिर हल्दी प्रजाति आईआईएसआर प्रगति के शुद्ध ब्लॉक की एक प्रदर्शन सह-बीज उत्पादन इकाई स्थापित की गई थी।

उत्तर पूर्व राज्यों जैसे मेघालय, मिज़ोरम, सिक्किम, नागालैंड तथा अरुणाचल प्रदेश में बीज मसाला फसलों जैसे धनिया, सौंफ, मेथी तथा अजवाइन को उगाने लगा।

कंप्यूटर / लापटॉप, प्रिंटर ओर अन्य वस्तुओं की खरीद के लिए वित्तीय सहायता प्रदान करके एआईसीआरपीएस केन्द्रों को डिजिटल वनक्टिविटी की सुविधा प्रदान की।

अदरक प्रजाति आईआईएसआर वज्रा, हल्दी प्रजाति डॉ. वाई एसआरएचयु लाम स्वर्णा, अजवाईन प्रजाति डॉ. वाईएसआरएचयु लाम वर्षा तथा मेथी किस्म गुजरात मेथी 3 को बागवानी फसल प्रजातियों की अधिसूचना एवं विमोचन, फसल मानकों पर केंद्रीय उप-समिति, नई दिल्ली द्वारा अधिसूचित करने के लिए प्रस्तुत किया।

एआईसीआरपीएस की XXXII वीं वार्षिक समूह बैठक में विमोचित करने के लिए अनुशंसित प्रजातियां

आईसीएआर-आईआईएसआर, कोषिक्कोड में आयोजित एआईसीआरपीएस की XXXIIवीं वार्षिक समूह बैठक में छह नई लक्षण विशिष्ट प्रजातियां, मेथी में दो, धनिया, सौंफ, हल्दी और अजवाईन में एक एक को विमोचित करने के लिए अनुशंसित किया गया।

औद्योगिक रूप से समृद्ध किस्में

छत्तीसगढ़ राईगढ़ धनिया 3 एआईसीआरपीएस केन्द्र, इंदिरा गांधी कृषि विश्वविद्याल. राईगढ़ द्वारा विकसित धनिया के नये किस्म है। यह प्रजाति पत्ती और बीज दोनों के लिए उपयुक्त है और उच्च उपजवाली (15 क्विंटल / हेक्टर) प्रजाति भी है। इसमें सुखद गंध, मध्यम आकार के बीज और गहरे हरे पत्ते होते हैं। अनाज में उच्च बाष्पशील तेल सामग्री (0.47%) है और पाउडरी मिल्ड्यू और एफिड्स के लिए मध्यम प्रतिरोध प्रदर्शित करता है। यह बिहार, छत्तीसगढ़, मध्य प्रदेश, राजस्थान, उत्तर प्रदेश, हरियाणा, गुजरात, उत्तराखंड, तमिलनाडु और आन्ध्र प्रदेश में उगाने के लिए उपयुक्त है।

आरएफ 289 (करन सौंफ I) एआईसीआरपीएस केन्द्र श्री करन नरेन्द्र कृषि विश्व विद्यालय, जोबनर द्वारा विकसित सौंफ की नई प्रजाति है। यह उच्च उत्पादन वाली (25.24 क्विंटल / हेक्टेयर) और उच्च गुणवत्ता (2.18% एसन्श्यल तेल) वाली प्रजाति है और *रामुलारिया* ब्लाइट के प्रति मध्यम रूप से सहनशील प्रजाति है। राजस्थान, मध्य प्रदेश तथा गुजरात में यह अच्छी तरह पनपता है।

लाम अजवाइन 3 एआईसीआरपीएस केन्द्र डॉ. वाईएसआरएचयु गुंटूर द्वारा विकसित अजवाइन की नई प्रजाति है। यह उच्च उत्पादन क्षमता वाली (8.13 क्विंटल / हेक्टेयर) प्रजाति है। इसके बीज मोटे एवं आकर्षक भूरे रंग के हैं तथा बाष्पशील तेल सामग्री भी अधिक (7.8%) है जो एसनश्यल तेल उत्पादक उद्योगों के लिए उपयुक्त है। यह राजस्थान, गुजरात एवं आन्ध्र प्रदेश में उगाने के लिए उपयुक्त है।

तनाव सहिष्णु किस्म

छत्तीसगढ़ राईगढ़ हल्दी 3 एआईसीआरपीएस केन्द्र इंदिरा गांधी कृषि विश्व विद्यालय, राइगढ़ द्वारा विकसित हल्दी की नई प्रजाति है जिसकी उपजता 27 टन /हेक्टर ताज़ा उपज है। यह प्रजाति जल्दी पकने वाली (187 दिन) है और इसमें गहरे पीले रंग के भीतरी कोर के साथ मोटे प्राइमरी प्रकंद है। इसमें 25.8% शुष्क उपज, 3.78% कुरकुमिन, 4.8% एसन्श्यल तेल और 10.64% ओलियोरसिन है। यह प्रजाति *कोलेटोट्राइकम* पर्ण चित्ती और *टफ्रीना* पर्ण ब्लॉच के लिए मध्यम प्रतिरोध प्रदर्शित करती है। यह छत्तीसगढ़, आन्ध्र प्रदेश, पश्चिं बंगाल, ओडीशा, उत्तर प्रदेश, गुजरात और तमिलनाडु में उगाने के लिए उपयुक्त है।

एचएम 273 एआईसीआरपीएस केन्द्र चौधरी चरण सिंह हरियाणा कृषि विश्व विद्यालय, हिसार द्वारा विकसित मेथी की नई प्रजाति है। यह प्रजाति उच्च उपज (20-25 क्विंटल/हेक्टर) देने वाली है और डाउनी मिल्ड्यू और पाउडरी मिल्ड्यू रोग के प्रति प्रतिरोध दिखाती है। यह हरियाणा, राजस्थान, छत्तीसगढ़, उत्तराखंड, तमिलनाडु और गुजरात में अच्छा प्रदर्शन करता है।

गुजरात मेथी 3 एआईसीआरपीएस केन्द्र सरदार कृषिनगर दंडिवाडा कृषि विश्व विद्यालय, जगुदान द्वारा विकसित मेथी की नई प्रजाति है। यह प्रजाति प्रत्येक पौधे में अधिक फलियां देने वाली उच्च उपज (23.50 क्विंटल/हेक्टर) देने वाली है और पाउडरी मिल्ड्यू रोग के प्रति प्रतिरोध दिखाती है। यह राजस्थान, आन्ध्र प्रदेश, उत्तर प्रदेश, बिहार, छत्तीसगढ़, उत्तराखंड, तमिलनाडु और गुजरात में अच्छा प्रदर्शन करता है।

एआईसीआरपेस की XXXII वीं वार्षिक समूह बैठक के दौरान अनुशंसित प्रौद्योगिकियां

टीएनएयु, कोयंबतोर द्वारा हल्दी के पर्ण रोग जैसे, पर्ण चित्ती (*कोलेटोट्राइकम कैप्सीसी*) और पर्ण ब्लॉच (*टफ्रीना माकुलन्स*) का प्रबन्धन

हल्दी के पर्ण चिती और पर्ण ब्लॉच को कम करने के लिए प्रोपिकोनाज़ोल (0.1%) के साथ प्रकन्द उपचार और प्रोपिकोनाज़ोल (0.1%) के पर्ण छिडकाव को अनुशंसित किया जाता है। इस उपचार के फलस्वरूप तमिलनाडु में 3.69 के उच्च लाभ लागत अनुपात के साथ उत्पादन में वृद्धि (37.78 टन / हेक्टर) हुई।

टीएनएयु, कोयंबतोर द्वारा नयी पीढ़ी के कवकनाशी का उपयोग करके धनिया के पाउडरी मिल्ड्यू (*एरिसिफे पोलिगोनी*) का प्रबन्धन

धनिया में पाउडरी मिल्ड्यू रोग को कम करने के लिए रोग की शुरूआत में प्रोपिकोनाज़ोल (0.1%) का पर्ण छिड़काव और पहले छिड़काव के बाद 15 दिनों के बाद दूसरी छिड़काव करने की सिफारिश की जाती है। इस उपचार के फलस्वरूप तमिलनाडु में 4.22 के उच्च लाभ लागत अनुपात के साथ बीज उपज में वृद्धि (8.75 क्विंटल / हेक्टर) हुई।

आरपीसीएयु, धोली द्वारा धनिया में स्टम गाल रोग का प्रबन्धन

बिहार के धनिया उगानेवाले क्षेत्रों में धनिया के स्टम गाल रोग को कम करने के लिए तथा बीज उत्पादन बढ़ाने एवं किसानों को 2.91 लाभ लागत अनुपात के साथ शुद्ध लाभ मिलने के लिए अज़ोक्सिस्ट्रोबिन (11% एस सी) + टेबुकोनाज़ोल (18.3% एस सी) के मिश्रण के साथ बुआई के 45, 60 और 75 दिनों के बाद 219.75 ग्रा. a.i./हेक्टर की दर से पर्ण छिड़काव की सिफारिश की जाती है।

अनुसंधान उपलब्धियां

काली मिर्च

अम्बलवयल, पन्नियूर, सिरसी, चिंतापल्ली, दापोली, पुंडिबारी तथा येरकाड के एआईसीआरपीएस केन्द्रों को काली मिर्च के आनुवंशिक संसाधन प्रबन्धन पर काम करना अनिवार्य है। वर्तमान में, पीआरएस, पन्नियूर में काली मिर्च के कुल 403 अक्सेशनों (343 कल्टिवेटड प्रकार, 57 वन्य एवं संबंधित प्रकार तथा 3 विदेशी प्रकार) का रखरखाव किया जा रहा है और एआईसीआरपीएस केन्द्र सिरसी में कर्नाटक के उत्तर कन्नडा जिला के सिद्दापुर तालुक से एक जीनोटाइप को एकत्र किया गया, सिरसी केन्द्र में बनाए गए जर्मप्लाज़म अक्सेशनों को 266 तक बढ़ा दिया, जिसमें 45 प्रजाति और सात संबंधित स्पीसीस (*पी. कोलुब्रिनम, पी. अरबोरियम, पी. छाबा, पी. लोंगम, पी. अटेन्युआटम, पी. हिमेनोफिलम और पी. हुक्केरी*) और वियतनाम से संचित एक विदेशी संग्रह भी शामिल है।

वर्ष 2021 के दौरान, पन्नियूर में जीनोटाइप के बीच उपज से संबंधित लक्षणों जैसे, प्रति स्पाइक में बरियों की औसत संख्या, ताज़े बरियों की संख्या तथा सूखी बरी की उपज के संबंध में कोई महत्वपूर्ण अंतर नहीं था। पन्नियूर 5 और करिमुंडा ने 2.0 कि. ग्राम / बेल की उपज अंकित की।

टिकाऊ उत्पादकता और खाद्य सुरक्षा सुनिश्चित करने के लिए काली मिर्च आधारित मिश्रित फसल प्रणाली परीक्षण में, अंतर फसलों के बीच, ग्रेटर याम ने 6.08 कि. ग्राम की अधिकतम उपज अंकित की, इसके बाद पन्नियूर में काली मिर्च के बीच में 4 मी. x 2 मी. अंतराल में जिमींकंद (5.32 कि. ग्राम) ने दर्ज किया। उच्चतम बी:सी अनुपात काली मिर्च के बीच ज़िमींकंद को अंतर फसल के रूप में खेती करने पर प्राप्त हुआ, जिसके बाद सिरसी में काली मिर्च के साथ कोलोकैसिया (1.49) की खेती करने पर प्राप्त हुआ। दापोली में ज़िमींकंद ने बेहतर उपज (11.70 कि. ग्राम / प्लॉट) अंकित की, उसके बाद ग्रेटर याम (9.42 कि. ग्राम / प्लॉट) और टपियोका (8.75 कि. ग्राम / प्लॉट) ने दर्ज किया।

पन्नियूर के प्रायोगिक प्रक्षेत्र के किसी भी बेलों की राइज़ोस्फियर मिट्टी में *फाइटोफ्थोरा* और सूत्रकृमि जैसे कवक रोगजनक को नहीं देखा गया। हालांकि, कवक रोगजनक, *फुसेरियम* के साथ रूट मीली बग के आक्रमण के कारण बेलों में पीलापन दिखाई पड़ा। खाद्य सुरक्षा आश्वासन और मसालों में कीटनाशक अवशेषों को कम करने के क्रम में, काली मिर्च में खुर गलन तथा मन्द पतन रोग के प्रबंधन के लिए स्ट्रोबिल्यूरिन कवकनाशी

और एक्टिनोमाइसेट्स का मूल्यांकन शुरू किया और सिरसी में पहले वर्ष के परिणाम (2020-2021 के दौरान शुरू) से पता चलता है कि एर्गोन का टी 3 पर्ण अनुप्रयोग 44.3% (डबाल्यु/डब्ल्यु) [क्रेसोक्सिम मीथाइल 500 जी /एल] 7 मि. लि./ लि. और मिट्टी में एर्गोन 7 मि. लि./ लि. + कार्बोसल्फान 1 मि. लि. / लि. @ 2-3 लिटर / बेल में कम से कम पर्ण संक्रमण (13.70) पतझड़ (14.58), पीलापन (23.75) और सूत्रकृमि संक्रमण (23.75) अंकित किया गया।

छोटी इलायची

वर्तमान में, जीन बैंक में कुल 330 इलायची अक्सेशनों को संरक्षित किया गया है, जिसमें पाम्पाडुमपारा के 198 और मुडिगरे के 132 अक्सेशनें शामिल है। सकलेशपुर, मुडिगरे, मैलाडुमपारा और पाम्पाडुमपारा में मूल्यांकन के तहत छोटी इलायची की आठ किसानों की प्रजातियों (अर्जुन, वंडर इलायची, पनिकुलंगरा, तिरुताली, एलराजन, पचकाय, पप्पलु, न्जल्लानी और पीएनएस गोपिनाथ) के बीच उनके वानस्पतिक और उपज गुणों के संबंध में महत्वपूर्ण अंतर थे। मैलाडुमपारा में इलायची की थ्रिप्स के सहनशील प्रकारों के प्राथमिक निरीक्षण से संकेत मिलता है कि छह जीनोटाइप (आईसी 349362, आईसी 349364, आईसी 349370, आईसी 349606, न्जल्लानी ग्रीन गोल्ड तथा आईसीआरआई 8) में से आई सी 349606 में सबसे कम थ्रिप्स आबादी अंकित की।

इलायची के लीफ ब्लाइट के प्रति रासायनिक उपचार (कार्बेंडाज़िम) की तुलना में जैवनियंत्रण कारक (एकल तथा संयोजन में) की प्रभावकारिता का मूल्यांकन सूचित करता है कि उपचार टी 2 (हेक्साकोनाज़ोल 2 मि. लि. / लि. की दर) ने पीडीआई 21.66% के साथ सबसे कम रोग आपतन अंकित की, तत्पश्चात् है टी1 (कार्बेंडाज़िम + मैंकोज़ेब 2 ग्रा. / लि. की दर) और टी 3 (मैंकोज़ेब 2 ग्रा. / लि. की दर)।

बडी इलायची

गांगटोक, सिक्किम के दो एआईसीआरपीएस केंद्र में बडी इलायची के 61 जर्मप्लाज़म अक्सेशनों का रखरखाव किया जा रहा है। पूर्व सिक्किम के लामाटन क्षेत्र में सर्वेक्षण किया गया था और किसान के खेत से विशिष्ट जर्मप्लाज़म (06 इकाइयां) को एकत्र किया गया था, जिसमें हार्डी टिल्लेर्स, लंबी डंठल वाली स्पाइक्स, चिर्के, फुर्की और ब्लाइट रोगों के लिए कम संवेदनशील और दलदली क्षेत्रों में बेहत्तर प्रदर्शन करने वाले है और जो एआईसीआरपीएस के तहत आईसीआरआई, पंगथांग रिसर्च फार्म में बेहतर प्रदर्शन करने वाले हैं।

बड़ी इलायची की उपज पर मल्चिंग के प्रभाव का मूल्यांकन करने के लिए किए गए प्रयोग ने संकेत दिया कि टी 1 (लीफ मोल्ड) के तहत पत्तों / सबसे ऊंचे टिल्लर और उत्पादक टिलर/क्लंप की संख्या में काफी अधिक संख्या देखी गई, लेकिन टी 2 (ताज़ा लीफ टिल्लर) के बराबर थे। अपरिपक्व टिलर / क्लंप की अधिकतम संख्या और टिलर / क्लंप की कुल संख्या भी टी 1 के तहत दर्ज की गई जो अन्य उपचारों की तुलना में काफी अधिक थी। अन्य उपचारों की अपेक्षा महत्वपूर्ण रूप से उच्च शुष्क कैप्स्यूल उपज टी 1 (हालांकि टी 2 के बराबर) के तहत प्राप्त की गई थी।

अदरक

विभिन्न कृषि जलवायु क्षेत्रों में स्थित धोली, कुमारगंज , पुंडिबारी, कामारपल्ली, बारापानी, पोटांगी, राइगढ़ और सोलन केन्द्रों में अदरक जर्मप्लाज़म का संग्रह, लक्षण वर्णन, मूल्यांकन और संरक्षण गतिविधियां की जा रही है। धोली में अनुरक्षित 67 अक्सेशनों में से, ग्यारह अक्सेशनों ने चेक किस्म, नदिया (5.43 टन/हेक्टर), की तुलना में आर जी 38 की उच्चतम उपज 10.44 टन/हेक्टर) के साथ अधिक उपज दर्ज की, तत्पश्चात् आर जी 4 (10.24 टन/हेक्टर) और आर जी 34 (9.38 टन/हेक्टर) है। कुमारगंज में एकत्रित एवं मूल्यांकित 63 जर्मप्लाज़म प्रकारों में से, एन्डीजी-55 (432 ग्रा./पौधा) और उसके बाद एन्डीजी-6 (145 ग्रा./पौधा) और एन्डीजी-23 (142 ग्रा./पौधा) को आशाजनक पाया गया।

अदरक की विभिन्न अंतर फसल प्रणालियों में, पोट्टांगी के परिणाम दर्शाते हैं कि अदरक में अंतर फसल के रूप में धनिये की खेती से सबसे अधिक (480 रुपए /बेड) और उसके बाद मक्का (200 रुपए /बेड) का लाभ हुआ। मिज़ोरम में, अदरक के साथ सभी अंतर फसल संयोजन प्रभावी पाए गए और इसके परिणामस्वरूप अदरक-मेथी अंतर फसल को छोड़कर उच्च उत्पादकता प्राप्त हुई।

हल्दी

सीएआरएस, राइगढ़ में हल्दी की कुल 107 जर्मप्लाज़म प्रकारों (92 *कुरकुमा लोंगा*, 7 *कुरकुमा अमदा*, 3 काली हल्दी और 5 विमोचित प्रजातियां) का अनुरक्षण किया जाता है। मूल्यांकन किए गए जीनोटाइप में से, 15 प्रकारों ने प्रति पौधा क्लंप वज़न 500 ग्राम से अधिक दर्ज किया, जिसमें, आईटी 59 (950 ग्राम) में प्रति पौधा उच्चतम क्लंप वज़न दर्ज किया गया। एचएआरएस, पोटांगी में मूल्यांकित 168 *कुरकुमा लोंगा* अक्सेशनों में से, 75 अक्सेशनों ने 5 कि. ग्रा. 3 मी.^{2} से अधिक दर्ज किया गया और 10 जीनोटाइप में 10 कि. ग्रा. 3मी.^{2} से अधिक ताज़ा प्रकंद उपज दर्ज की गई। *कुरकुमा एरोमटिका* में, 23 अक्सेशनों में से 12 में 5 कि. ग्रा. 3मी.^{2} से अधिक ताज़ा प्रकंद उपज दर्ज की गई। धोली में जांच किये 65 अक्सेशनों में से चेक प्रजाति राजेन्द्र सोनाली (46.77 टन / हेक्टर) की तुलना में आर एच-432 ने उच्चतम उपज (52.44 टन / हेक्टर) और उसके बाद आर एच -3 (50.43 टन / हेक्टर) और आर एच 448 (49.23 टन / हेक्टर) दर्ज की गई।

हल्दी में अंकुरण वृद्धि, क्षमता और भंडारण सडांध दमन के लिए अनुशंसित पीओपी के साथ ट्राइकोप्राइम, मेटालक्सिल- मैंकोज़ेब और इमिडाक्लोप्रिड का संयोजन, इमिडाक्लोप्रिड के साथ टेबुकोनाज़ोल के संयोजन के साथ प्राइमिंग राइज़ोम की प्रभावकारिता का मूल्यांकन करने के लिए एक नया प्रयोग शुरू किया गया है। कोयंबतोर में विभिन्न प्राइमिंग उपचारों ने भंडारण सडांध को पूरी तरह से दबा दिया। ट्राइकोप्राइम से उपचारित हल्दी के राइज़ोम ने रोपण के 50 दिनों के बाद पौधे की आबादी (59.6), पौधे की ऊंचाई (105.6), प्रति क्लंप टिलर की संख्या (5.9), क्लंप का ताज़ा वज़न (0.684 ग्राम), ताज़ा प्रकंद उपज (37.74 टन / हेक्टर) बढाया। ट्राइकोप्राइम के साथ प्राइमिंग करने से गुणवत्ता के लक्षणों, जैसे कुरकुमिन सामग्री (3.84%) और ओलियोरसिन (5.6%) में भी सुधार हुआ। इस प्रकार ट्राइकोप्राइम के साथ प्रकंद उपचार ने अनुपचारित नियंत्रण की तुलना में पर्ण रोग की गंभीरता को काफी कम कर दिया, जिसमें 48.95 पीडीआई की टफ्रीना लीफ ब्लॉच की गंभीरता दर्ज की गई। इसके अलावा, एल सी- एम एस -एम एस द्वारा निर्धारित कवकनाशी और कीटनाशक अवशेषों की उपस्थिति से पता चला कि हल्दी के प्रकंदों में कवकनाशी और इमिडाक्लोप्रिड अवशेष पता लगाने योग्य सीमा (बीडीएल) से कम थे।

वृक्ष मसाले

पीचिपराई में संरक्षित और मूल्यांकित 28 जायफल अक्सेशनों में से, एमएफ-1 ने पेड़ की अधिकतम ऊंचाई (12.17 मीटर) और तने की परिधि (64.98 से. मी.) और एम एफ 4 ने पत्तों की अधिकतम लंबाई (25.66 से. मी.), पत्तों की ब्रीथ (9.2 से. मी.), फलों की संख्या (682.5), एकल फल भार (53. 55 ग्रा.) और जावित्री उपज (288.86 ग्राम / वृक्ष) अंकित की गई। दापोली में जायफल जर्मप्लाज़म संग्रह (वर्ष 1996-97 में लगाए गए) के बीच सोलह आशाजनक जीनोटाइप की पहचान की गई थी। जीनोटाइप डीबीएसकेकेवी 19 ने अधिकतम सूखे नट की उपज (3146.0 ग्रा.) और सूखे जावित्री की उपज (786.5 ग्रा.) दर्ज की। समग्र प्रदर्शन से डीबीएसकेकेवीएमएफ 19 जीनोटाइप को इसके फल उपज मापदंडों को देखते हुए आशाजनक पाया गया।

वर्ष 1996-97 में दापोली में लगाए गए लौंग के जर्मप्लाज़म में से, चार आशाजनक जीनोटाइप का चयन किया गया था। पौधे की ऊंचाई 6.15 से 7.40 मीटर, परिधि 44-52 से. मी. और 2.85 मीटर से 3.65 मीटर तक फैली हुई है। वर्ष 2020 में कोई फूल नहीं देखा गया था। पीचिपराई के 24 अक्सेशनों में से एस ए-1 ने 12.98 मीटर की उच्चतम पेड़ की ऊंचाई दर्ज की, उसके बाद एस ए-3 (12.55 मीटर) को स्थानीय चैक (11.02 मीटर) की तुलना में दर्ज की गई। अक्सेशन एस ए -13 अन्य अक्सेशनों की अपेक्षा उच्चतम थे और स्थानीय चैक

(41.90 से.मी.) की तुलना में उच्चतम तना परिधि (52.19 से. मी.) दर्ज की। अक्सेशन एस ए-3 ने उच्चतम पत्ती की लंबाई (12.87 से. मी.), पत्ती की चौड़ाई (7.70 से. मी.), शाखाओं की संख्या (19.92) और सूखी कली उपज (1.70 कि. ग्रा. / पेड़) दर्ज की।

धनिया

हिसार में 3.0 मीटर लंबाई के दो पंक्ति भूखंडों में धनिया के एक सौ चालीस अक्सेशनों का मूल्यांकन किया गया था, जिसमें हिसार सुगंध, हिसार भूमित और चैक के रूप में हिसार आनंद थे। औसत बीज उपज 36.4 ग्राम /पौधा (डीएच-287) से लेकर 92.8 ग्राम/पौधा (डीएच-305) तक थी। डीएच-219, डीएच- 226, डीएच-233, डीएच-238-1, डीएच- 242, डीएच-293-1, डीएच- 294-1, डीएच- 305, डीएच- 314, डीएच- 344 और डीएच-355 आदि बीज उपज के लिए सबसे आशाजनक अक्सेशन थे। जगुदान में, उपज प्रदर्शन के लिए 19 प्रविष्टियों का मूल्यांकन जी. के साथ सीओ.-3 चैक के रूप में किया गया था। बीज की उपज 170 से 510 ग्रा. / पौधा के बीच होती है। कुमारगंज में, मूल्यांकन की गई 200 जर्मप्लाज़म लाइनों में, सबसे अधिक उपज एनडीसीओआर-11 (29.10 ग्राम/पौधा) में दर्ज की गई, तत्पश्चात्, एनडीसीओआर-22 (28.40 ग्राम/पौधा), एनडीसीओआर-12 (27.30 ग्राम/पौधा) और एनडीसीओआर-32 (26.80 ग्राम/पौधा) है।

राइगढ़ में 2020-21 में रबी के दौरान धनिया प्रविष्टियों की सीवीटी मूल्यांकन से पता चला कि उच्चतम बीज उपज (क्विन्टल/ हेक्टर) सीओआर 476 (19.4 क्विन्टल/ हेक्टर) में दर्ज की गई थी। तत्पश्चात्, सीओआर 183 (16.4 क्विन्टल/ हेक्टर) और सीओआर 186 (14.6 क्विन्टल/ हेक्टर) और चेक में छत्तीसगढ श्री चंद्रहासिनी धनिया-2 (11.0 क्विन्टल/ हेक्टर), हिसार आनंद (10 क्विन्टल/ हेक्टर), राजेन्द्र स्वाती और छत्तीसगढ़ धनिया-1 (9.9 क्विन्टल/ हेक्टर) है। नवसारी में संख्यात्मक रूप से उच्च बीज उपज सीओआर -178 (19.41 क्विन्टल/ हेक्टर) में अंकित की तत्पश्चात्, सीओआर -189 (18.00 क्विन्टल/ हेक्टर) और सीओआर -179 (17.18 क्विन्टल/ हेक्टर) में दर्ज की गई, जबकि, कुमारगंज में, उच्चतम उपज सीओआर -177 (15.76 क्विन्टल/ हेक्टर) में दर्ज की गई थी, तत्पश्चात् सीओआर -178 (13.96 क्विन्टल/ हेक्टर) और सीओआर -191 (13.40 क्विन्टल/ हेक्टर) का स्थान आता है। जबलपुर में जीनोटाइप सीओआर-183 (19.41 क्विन्टल/हेक्टर) में उच्चतम उपज दर्ज की गई, जो सीओआर -186 (17.84 क्विन्टल/ हेक्टर) के बराबर थी।

T_2 (प्रोपिकोनाज़ोल 25 ई सी 0.05 % की दर में पर्ण छिड़काव (10 मि. लि. /10 लि. (पहली और दूसरी छिड़काव) + एसिटामिप्रिड 20 एस पी (0.004%) के दो पर्ण छिड़काव) में कम प्रतिशत रोग तीव्रता के साथ जगुदान में नियंत्रण की तुलना में रोग आपतन को नियंत्रित करने में सभी उपचार काफी बेहत्तर पाए गए जो T_1 के बराबर थे। एफिड इन्डक्स T_2 में सबसे कम एफिड इन्फेक्शन (0.40 अफिड इंडेक्स) के साथ अलग अलग उपचारों में काफी भिन्न था, इसके बाद T_9 (0.60 एफिड इंडेक्स) और T_8 (0.65 एफिड इंडेक्स) थे। विभिन्न उपचारों के बीच कोसिनेल्लिड्स की औसत आबादी 1.54 (टी5) से 2.73 (T_{10}) प्रति पौधे तक भिन्न होती है। उपचार T_{10}, T_2, T_9 और टी 3 में दूसरे छिड़काव के 7 दिनों के बाद प्रति पौधे क्रमशः 2.73, 2.32, 2.26 और 2.19 परभक्षी कोसिनेल्लिड्स दर्ज किए गए। T_2 उपचार के उन्नत उपज के साथ सभी उपचारों को नियंत्रण से काफी बेहत्तर पाए गए।

जीरा

जगुदान में मूल्यांकन की गई 79 जर्मप्लाज़म लाइनों में (चेक के रूप में जी सी-4 के साथ), जे सी 2000-28, जेसी 2000-65, जेसी 2002-4 और जेसी 2002-19 अधिक उत्पादन देने वालों के साथ बीज उपज में 40-380 ग्राम/पौधा के अंतर रहे। मंडोर में मूल्यांकन किये गये 980 जर्मप्लाज़म लाइनों में से 65 ने सर्वोत्तम चेक, जी सी 4 की तुलना में काफी बेहत्तर बीज उपज दर्ज की गई, जबकि सानंद में, मध्यप्रदेश और राजस्थान के विभिन्न किसानों के खेत से संचित 22 नये जर्मप्लाज़म लाइनों में से चेक जी सी 2 (2.99 ग्राम / पौधा) और जी सी 4 (3.39 ग्राम / पौधा) की तुलना में किसी ने भी काफी उन्नत उपज अंकित नही की। फिर भी

जीनोटाइप "*इंदावर*" उपज (3.63 ग्राम / पौधा) में संख्यात्मक रूप से उन्नत थी जो दोनों चेकों की तुलना में जल्दी फूलने वाली (48.33 दिन) और परिपक्व(102.00 दिन) होने वाली थी।

वैरियन्स के विश्लेषण से पता चला कि जोबनर में बीज उपज और उपज के गुणों की प्रविष्टियों के बीच महत्वपूर्ण अंतर थे। बीज उपज का अंतर 2.93 क्विन्टल / हेक्टर (आर ज़ेड-345) से 6.97 क्विन्टल / हेक्टर (जीसी-4) के बीच थे। मूल्यांकन की गई दस प्रविष्टियों में से, जी सी-4 ने अधिकतम बीज उपज 6.97 किन्टल / हेक्टर दर्ज की, तत्पश्चात् सीयुएम-40 (6.22 क्विन्टल / हेक्टर), सीयुएम-42 (5.93 क्विन्टल / हेक्टर), आर ज़ेड-223 (5.15 क्विन्टल / हेक्टर) और सीयुएम 41 (5.12 क्विन्टल / हेक्टर) है। मूल्यांकन की गई दस प्रविष्टियों में से, सीयुएम-41 ने 8.82 क्विन्टल / हेक्टर की अधिकतम बीज उपज अंकित की तत्पश्चात् आर ज़ेड-223 (8.76 क्विन्टल / हेक्टर), सीयुएम -39 (8.74 क्विन्टल / हेक्टर), जी सी -4 (8.74 क्विन्टल / हेक्टर) और सीयुएम-40 (8.56 क्विन्टल / हेक्टर) है, जबकि सबसे न्यूनतम बीज उपज 5.84 क्विन्टल / हेक्टर सीयुएम-42 में दर्ज की। वर्ष 2017-18 से 2020-21 के दौरान, जीरे की सी वी टी में मूल्यांकन की गई प्रविष्टियों के औसत प्रदर्शन से पता चला कि जीनोटाइप जी सी -4 की उपज 5.49 क्विन्टल / हेक्टर है, तत्पश्चात् सीयुएम-40 (5.29 क्विन्टल / हेक्टर) और सीयुएम-41 (5.16 क्विन्टल / हेक्टर) है। सीयुएम-41 (4.22 क्विन्टल / हेक्टर) को जगुदान में राष्ट्रीय चेक प्रजाति जी सी -4 से 8.2% अधिक संख्यात्मक रूप से बेहत्तर पाया गया।

सभी केंद्रों पर सूक्ष्म पोषक तत्वों के परीक्षणों के समग्र परिणामों से संकेत मिलता है कि सूक्ष्म पोषक तत्वों के अनुप्रयोग के परिणामस्वरूप सभी वृद्धि और उपज मापदंडों (पौधे की ऊंचाई, शाखाएं/पौधे, अम्बल्स/पौधे, अम्बल्लट्स/अम्बल, बीज प्रति अम्बल, परीक्षण वज़न और बीज उपज) में उल्लेखनीय वृद्धि हुई है और नियंत्रण की अपेक्षा जीरे में ब्लाइट और पाउडरी मिल्ड्यू का आपतन कम होता है।

वर्ष 2019 में जोबनेर, अजमेर, मंडोर और जगुदान केंद्रों में जीरे के एकीकृत कीट और रोग प्रबंधन पर एक परीक्षण शुरू किया गया था। जोबनर में जीरे की पाउडरी मिल्ड्यू और ब्लाइट रोग की गंभीरता के प्रतिशत पर निरीक्षण करने से संकेत मिलता है कि नियंत्रण (टी $_{16}$) की तुलना में, तीन पर्ण छिड़काव क्रेसोक्सिम मीथाइल 44.3 एस सी @ 0.044 % (10 मि. लि / 10 लि. पानी) + थियामीथोक्सम का 25 डब्ल्यु जी (0.0084%) (टी 4) (8.36%, 68.13% और 5.56%, 82.35%) में सबसे कम रोग आपतन और अधिकतम रोग नियंत्रण सूचित करता है, उसके बाद क्रेसोक्सिममीथाइल 44.3 एस सी @ 0.044% (10 मि. लि / 10 लि. पानी) का तीन पर्ण छिड़काव + थियामीथोक्सम 25 डब्ल्यु जी (0.0084%) की पहली पर्ण छिड़काव और *लीकानिसिल्लियम लीकानी* 1.15 डब्ल्यु पी ($1x10^9$cfu/gm) (40 ग्रा./ 10 लि.) (टी $_{10}$) (9.02%, 65.61% और 7.21%, 77.11%) की दूसरी पर्ण छिड़काव से सबसे कम रोग आपतन और अधिकतम रोग नियंत्रण पाया गया। नियंत्रण (टी$_{16}$) (3.10 क्विन्टल/ हेक्टर) की तुलना में, अधिकतम बीज उपज टी$_4$ उपचार (7.64 क्विन्टल/ हेक्टर) में अंकित किया गया।

सौंफ

सौंफ पर सीवीटी (2018-19 के दौरान शुरू की गई) में 14 आशाजनक जीनोटाइप का मूल्यांकन रूपात्मक, उपज और उपज विशेष लक्षणों के लिए किया गया था। वैरियन्स के विश्लेषण से जोबनर में बीज उपज और उपज विशेष लक्षणों के लिए 14 प्रविष्टियों में महत्वपूर्ण अंतर का पता चला। बीज उपज में 9.43 (एफएनएल-123) से 18.92 क्विन्टल/हेक्टर (एफएनएल-126) का अंतर देख लिया। नवसारी के समन्वित प्रजाति परीक्षण के तहत मूल्यांकन किये 14 प्रविष्टियों में से, जीनोटाइप एफएनएल-123 (25.40 क्विन्टल/हेक्टर) और एफएनएल-118 (24.94 क्विन्टल/हेक्टर) ने दोनों राष्ट्रीय जांचों पर काफी अधिक बीज उपज अंकित की।

जोबनर में, 0.6% ज़िंक सल्फेट के पर्ण छिड़काव से पौधे की अधिक ऊंचाई (94.91 से. मी.), अम्बल्स/पौधे (24.74), अम्बल्लट्स/अम्बल (20.85), बीज / अम्बल (363.3), परीक्षण वज़न (5.48 ग्रा.), एसनश्यल तेल

(1.71%), बीज उपज (23.74 क्विन्टल/हेक्टर), पुआल उपज (60.85 क्विन्टल/हेक्टर), शुद्ध लाभ (रु. 129849 / हेक्टर) और बीःसी अनुपात (3.69) काफी अधिक अंकित किया।

मेथी

जबलपुर में, 17 आशाजनक प्रविष्टियों और चेक में से, एफजीके-135 को जल्दी फूलना (46.0 दिन) और एफजीके-125 को लंबा (115.53 से. मी.) बढ़ते हुए देखा गया। एफजीके-123 में प्रति पौधा अधिक संख्या में फली (51.22) और साथ ही साथ उच्च फली लंबाई (13.94 से. मी.) थी। एफजीके-128 में अधिकतम बीज उपज 25.46 क्विन्टल/हेक्टर अंकित किया, जो एफजीके-134 (23.05 क्विन्टल/हेक्टर) और एफजीके-124 (22.58 क्विन्टल/हेक्टर) के बराबर थी। कोटा में, बीज उपज में 7.15 से 19.03 क्विन्टल/हेक्टर (एफजीके 125) का अंतर है। पुष्पित होने का औसत दिन 67 दिनों (एफजीके 124) से 73 दिनों (एफजीके 137) तक है और परीक्षण वज़न 9.6 ग्रा. (एफजीके-132) से 16.28 ग्रा. (एफजीके-124) तक है।

टीएनएयु, कोयंबतोर (सीओ1 और सीओ 2) से ज़ारी मेथी की दो प्रजातियों की मेटाबोलाइट प्रोफाइलिंग कोयंबतोर में जीसी - एमएस का उपयोग करके की गई थी। मेथी प्रजाति सीओ 1 में पहचान किये 40 यौगिकों में से उच्चतम शिखर क्षेत्र एज़िरिडिन 1,2,3-ट्राइमीथाइल-1, ट्रान्स (16.47%) में देखा गया, तत्पश्चात् है हेप्टाकोसयिन (4.34%), साइक्लोहेक्साइन, 1,1'- (1,2-डीमीथाइल-1,2- एथनिडियल) बिस-(2.85%) और सुक्रोस (2.61%)।

अजवाइन

वैरियन्स के विश्लेषण से जोबनर में मूल्यांकन की गई 11 प्रविष्टियों में से, बीज उपज और उपज गुणों के लिए प्रविष्टियों के बीच महत्वपूर्ण अंतर का पता चला। बीज उपज में 10.80 (एजेएन-5) से 16.09 क्विन्टल/हेक्टर (एजेएन-2) का अंतर है जिसमें एजेएन-7 (14.96 क्विन्टल/हेक्टर), एजेएन-10 (14.62 क्विन्टल/हेक्टर), एजेएन-11 (14.50 क्विन्टल/हेक्टर) और एजेएन-1(14.28 क्विन्टल/हेक्टर) के साथ बेहतर उपज दे रहे हैं। हिसार में सभी मापदंडों के लिए महत्वपूर्ण अंतर देखा गया। पौधे की ऊंचाई 118.5 से 130.3 से. मी./ पौधा, प्रति पौधा अम्बल्स 184.4 से 245.8 और बीज प्रति अम्बल 335.4 से 397.7 तक होती है। अधिकतम बीज उपज एजेएन -4 (12.99 क्विन्टल/हेक्टर) में दर्ज की गई, उसके बाद क्रमशः एजेएन -3 (12.61 क्विन्टल/हेक्टर) और एजेएन -11 (12.03 क्विन्टल/हेक्टर) है जबकि गुंटूर में, एजेएन -02 (8.87 क्विन्टल/हेक्टर), एजेएन -08 (8.78 क्विन्टल/हेक्टर) और एजेएन-10 (8.76 क्विन्टल/हेक्टर) ने सर्वोत्तम चेक लाम अजवाइन -2 (7.84 क्विन्टल/हेक्टर) की तुलना में काफी अधिक उपज दर्ज की।

निगेला

हिसार में, सभी मापदंडों के लिए महत्वपूर्ण अंतर देखा गया, जिसमें पौधे की ऊंचाई 59.8 से 67.9 से. मी., फली प्रति पौधे 59.8 से 67.9 और बीज प्रति फली 82.8 से 101.1 तक थी। अधिकतम बीज उपज (13.1 क्विन्टल / हेक्टर) एनजीएल-08 में दर्ज की गई, उसके बाद एनजीएल-02 (13.3 क्विन्टल / हेक्टर) और एनजीएल 05 (12.38 क्विन्टल / हेक्टर) में दर्ज किया गया। अधिकतम उपज एनजीएल-07 (8.33 क्विन्टल / हेक्टर) में दर्ज की गई, उसके बाद एनजीएल-01 (7.29 क्विन्टल / हेक्टर) और एनजीएल 06 (7.08 क्विन्टल / हेक्टर) कुमारगंज में दर्ज की गई, जबकि रायगढ़ में, स्थानीय चेक सीजी करायत 1 ने अधिकतम बीज उपज (9.1 क्विन्टल / हेक्टर) दर्ज की, इसके बाद एनजीएल 08 (8.5 क्विन्टल / हेक्टर), एनजीएल -5 (7.5 क्विन्टल / हेक्टर) और एनजीएल 01 (8क्विन्टल / हेक्टर) रहा।

केसर

जम्मु और कश्मीर के केसर उगाने वाले विभिन्न क्षेत्रों से पन्द्रह जर्मप्लासम अक्सेशनों को एकत्र किया गया जिससे कुल अक्सेशन 215 हो गए। इन सभी जर्मप्लाज़म अक्सेशनों का मूल्यांकन विभिन्न रूपात्मक, गुणवत्ता, उपज और उपज के लक्षणों के लिए किया जा रहा है। इन अक्सेशनों में से, 10 अक्सेशनों जैसे SRF-Saf-124,

SRF-Saf-128, SRF-Saf-157, SRF-Saf-178, SRF-Saf-195, SRF-Saf-251, SRF-Saf-253, SRF-Saf-183, SRF-Saf-194 और SRF-Saf-199 को वृद्धि, उपज और गुणवत्ता के लक्षणों के संबंध में श्रेष्ठ वर्ग के रूप में पहचाना गया है।

काला जीरा

जम्मु और कश्मीर के गुरेज़ घाटी के ऊंचाई वाले क्षेत्र से तेरह जर्मप्लाज़म अक्सेशनों को एकत्र किया गया था, जिससे कुल 83 अक्सेशनें हो गए। उनमें से SRS-KZ-192, SRS-KZ-158, SRS-KZ-172, SRS-KZ-77, SRS-KZ-170, SRS-KZ-149 और SRS-KZ-167 ने अन्य अक्सेशनों की तुलना में वृद्धि, उपज और उपज लक्षणों के संबंध में बेहत्तर प्रदर्शन दिखाया।

गुणवत्ता रोपण सामग्रियों का उत्पादन एवं वितरण

एआईसीआरपीएस केन्द्रों ने 1.25 लाख जड़ लगाए काली मिर्च कतरनें, 10000 इलायची सकेर्स, 22.44 टन हल्दी, 6.5 टन अदरक, जायफल के 5000 ग्राफ्ट और दालचीनी के 2000 ग्राफ्ट का उत्पादन करके वितरित किया है। बीज मसालों में, 200 क्विंटल धनिया, 50 क्विंटल जीरा, 42 क्विंटल सौंफ, 105 क्विंटल मेथी, 10 क्विंटल अजवाइन और 12 क्विंटल निगेल्ला का उत्पादन और वितरण किया गया।

प्रौद्योगिकी का हस्तांतरण

एआईसीआरपीएस केन्द्रों के वैज्ञानिकों ने वैज्ञानिक खेती प्रथाओं तथा स्थायी मसाला उत्पादन के बारे में कृषक समुदाय को अवगत कराने के लिए नवीनतम तकनीकों को लोकप्रिय बनाने में सक्रिय रूप से शामिल किया है। वर्ष के दौरान प्रदर्शित कुछ प्रौद्योगिकियां निम्न प्रकार हैः-

अधिक उपज देने वाली प्रजातियां- किसानों के लिए वरदान

- ❖ कुरकुमिन से भरपूर हल्दी प्रजाति मेघा हल्दी 1 (सभी उत्तर पूर्व केन्द्र) का प्रदर्शन
- ❖ स्थायी कुरकुमिन प्रजाति आईआईएसआर प्रगति (कोयंबतोर) का प्रदर्शन
- ❖ अधिक उपज देने वाली मेथी प्रजाति एचएम 257 (हिसार) का प्रदर्शन
- ❖ अधिक उपज देने वाली धनिया प्रजाति (हिसार) का प्रदर्शन

रोपण सामग्री का तेज़ी से गुणन- न्यूनतम खर्च के लिए

- ❖ कृषि विज्ञान केन्द्र, कोंडेमपुडी, विशाखपत्तनम (चिंतापल्ली) के सहयोग से पडेरू, दुब्रिगुडा और अरकु में हल्दी के प्रो-ट्रै प्रौद्योगिकी की लोकप्रियता।
- ❖ अदरक और हल्दी (कामरपल्ली, पोट्टांगी, नागालैंड) के गुणवत्ता बीज उत्पादन के लिए प्रो-ट्रै खेती तकनीक।
- ❖ अदरक और हल्दी के लिए प्रो-ट्रै प्रवर्धन प्रविधि, जायफल और कोकुम में सोफ्ट वुड ग्राफ्टिंग प्रविधि, बुश पेप्पर उत्पादन तकनीकी (दापोली)।
- ❖ 2.0 एकड़ (कोयंबतोर) में हल्दी प्रत्यारोपण का प्रदर्शन।

मृदा स्वास्थ्य के लिए सूक्ष्म पोषक तत्व और बायोकैप्स्यूल

- ❖ एआईसीआरपीएस केन्द्रों के माध्यम से मसाला उगाने वाले सभी इलाकों में अदरक, हल्दी और काली मिर्च के लिए विशिष्ट बायोकैप्स्यूल और सूक्ष्म पोषक पैकेजों के लाभकारी प्रभावों पर प्रदर्शन एवं वितरण किया गया।

संरक्षण तकनीकियां - पौधों के स्वास्थ्य के लिए

- ❖ धनिया (धोली) के स्टम गाल रोग का प्रबन्धन।

प्रसंस्करण मशीनरी- बढ़ी हुई दक्षता के लिए

- बड़ी इलायची और अदरक को सुखाने के लिए बहुउद्देश्यीय इलेक्ट्रिक ड्रायर का प्रदर्शन (आईसीआरआई सिक्किम)।
- हल्दी बॉयलर और पॉलिशर का प्रदर्शन।

उपरोक्त खेत स्तरीय प्रदर्शनों के अलावा, वैज्ञानिकों ने आभासी प्रशिक्षण आयोजित करके और आभासी प्रशिक्षण और संगोष्ठियों में विशिष्ट व्यक्तियों के रूप में और विभिन्न मीडिया (समाचार पत्र, रेडियो वार्ता और टी वी कार्यक्रम) के माध्यम से प्रौद्योगिकियों को लोकप्रिय बनाया।

एनईएच / टीएसपी / एससीएसपी गतिविधियां

उत्तर पूर्व क्षेत्र में बीज मसाला खेती का बढ़ावा

उत्तर पूर्व क्षेत्र में बीज मसाले की खेती को बढ़ावा देने और सुविधा देने के लिए, आईसीएआर-एआईसीआरपीएस ने मेघालय, मिज़ोरम, नागालैंड, सिक्किम, असम और अरुणाचल प्रदेश में स्थित अपने उत्तर पूर्व केंद्रों के माध्यम से धनिया, सौंफ, मेथी, अजवाइन और निगैल्ला जैसी बीज मसाला फसलों की बीज सामग्री वितरित की।

उत्तर पूर्व के आकांक्षी जिले में विकासात्मक गतिविधियां

मिज़ोरम के एआईसीआरपीएस केन्द्र ने मिज़ोरम के आकांक्षी जिलों जैसे लुंगलेई और लवंगतलाई और कोलासिब जिले के टीएसपी गांव में तीन दिवसीय प्रशिक्षण कार्यक्रम आयोजित किया। एसएएसआरडी, नागालैंड ने नागालैंड के रेंथन, वोखा और बेसुम्पुइकम गांवों में मसालों के उत्पादन की संभावनाओं पर प्रशिक्षण आयोजित किया।

आदिवासी गांवों में विकासात्मक गतिविधियां

पोट्टांगी और चिंतापल्ली के एआईसीआरपीएस केन्द्र ने काली मिर्च की रोपण सामग्रियों, अदरक और हल्दी के बीज प्रकंदों के वितरण के साथ साथ कोरापुट और विशाखपत्तनम के आदिवासी गांवों में मसालों की वैज्ञानिक खेती प्रणालियों और उनके प्रसंस्करण पहलुओं पर तीन दिवसीय प्रशिक्षण कार्यक्रम आयोजित किया।

अनुसूचित जाति समुदायों के लिए विकासात्मक गतिविधियां

अम्बलवयल, हिसार, मंडोर, पुंडिबारी, मिज़ोरम आदि के एआईसीआरपीएस केन्द्र द्वारा विभिन्न प्रशिक्षण कार्यक्रम और आदानों का वितरण आयोजित किया गया, जिससे अनुसूचित जाति के किसानों को लाभ हुआ।

सफलता की कहानियां

राज्य और राष्ट्रीय स्तर की अर्थव्यवस्था में जीरा प्रजाति जी सी 4 का प्रभाव मूल्यांकन

जीरा की पहली विल्ट सहिष्णु प्रजाति, जी सी 4 को 2006 के दौरान राष्ट्रीय स्तर पर ज़ारी किया गया था और यह आग की तरह फैल गई और गुजरात और राजस्थान में जीरा के तहत क्रमशः लगभग 90 और 60 प्रतिशत क्षेत्र को कवर किया। बीज मसाला अनुसंधान केन्द्र, जगुदान ने गुजरात और अन्य राज्यों में विभिन्न उत्पादन स्थितियों के तहत खेती के लिए 2006 में राष्ट्रीय स्तर पर गुजरात जीरा 4 (जीसी 4) ज़ारी किया है। जीसी 4 प्रजाति के ज़ारी होने के बाद जीरे के उत्पादन क्षेत्र, उत्पादन और उत्पादकता में उल्लेखनीय वृद्धि हुई है। गुजरात में जीरे का क्षेत्रफल, उत्पादन और उत्पादकता वर्ष 2001-02 की तुलना में 2020-21 में क्रमशः 331%, 700% और 216% हो गई है। देश के जीरा उत्पादन क्षेत्र एवं उत्पादन में गुजरात का हिस्सा 2001-02 के दौरान 27 से 30 प्रतिशत था जो 2020-21 के दौरान बढ़कर 51 और 50 प्रतिशत हो गया। इस प्रकार, बीज मसाला अनुसंधान में किए गए निवेश को उत्पादकता और उत्पादन की वृद्धि के माध्यम से अर्जित किया गया है। इस जीरा प्रजाति के अलावा, एसडीएयु, जगुदान ने जीरे में फसल उत्पादन और फसल संरक्षण पर कई तकनीकों का विकास किया है जिसके फलस्वरूप उत्पादन लागत में कमी, प्राकृतिक संसाधनों का संरक्षण और उत्पादकता में वृद्धि हुई है।

सहयोग और नेटवर्किंग

एआईसीआरपीएस निम्न के सहयोग से काम करता है-

- आईसीएआर-आईआईएसआर, कोषिक्कोड और आईसीएआर-एनआरसीएसएस, अजमेर (प्रौद्योगिकियों के लिए)।
- आदिवासी क्षेत्रों में प्रौद्योगिकियों को लोकप्रिय बनाने के लिए मसाला बोर्ड।
- गुणवत्ता रोपण सामग्रियों का उत्पादन एवं वितरण के लिए एमआईडीएच (बागवानी के लिए एकीकृत विकास मिशन)।
- जनजातीय क्षेत्रों में उच्च उत्पादन प्रौद्योगिकियों को लोकप्रिय बनाने और मूल्य श्रृंखला विकास के लिए सरकारी संगठन।
- किसानों के उत्पादन, उत्पादकता और आय बढ़ाने के लिए राज्य कृषि और बागवानी विभाग।

निगरानी

परियोजना समन्वयक और पी सी यूनिट के वैज्ञानिकों ने व्यक्तिगत दौरे द्वारा विभिन्न एआईसीआरपीएस केन्द्रों और प्रायोगिक खेतों की कामकाज की निगरानी की। इस वर्ष के दौरान, तीन केन्द्रों का दौरा किया गया जिनमें नियमित, सह-चयनित, स्वैच्छिक और परियोजना मोड के केन्द्र शामिल थे। ई-मेल और दूरभाष के माध्यम से लगातार निगरानी की जाती थी। केन्द्रों से भेजे गये मासिक प्रगति रिपोर्ट एवं बजट उपयोगिता प्रमाण-पत्रों की समीक्षा की गई तथा सुधार हेतु उचित मार्गदर्शन दिया गया। बीज मसाला निगरानी दल जिसमें डॉ. गोपाल लाल (निदेशक, भाकृअनुप-राष्ट्रीय बीज मसाला अनुसंधान केन्द्र, अजमेर), डॉ. ए. यु. अमीन (एसडीएयु, जगुदान), डॉ. वाई. के. शर्मा (भाकृअनुप-राष्ट्रीय बीज मसाला अनुसंधान केन्द्र, अजमेर), डॉ. एस. के. तेहलान (सीसीएसएचएयु, हिसार), डॉ. एस. एस. मीणा (भाकृअनुप-राष्ट्रीय बीज मसाला अनुसंधान केन्द्र, अजमेर) और डॉ. गिरिधर कालिदास (डॉ. वाईएसआरएचयु, गुंटूर) ने परीक्षणों की प्रगति की निगरानी के लिए बीज मसाला केन्द्रों का दौरा किया।

एआईसीआरपीएस केन्द्रों की तिमाही उपलब्धियों की समीक्षा के लिए आईसीएआर-आईआईएसआर, कोषिक्कोड में एआईसीआरपीएस केन्द्रों (ऑनलाइन) की समीक्षा बैठक आयोजित की गई।

- दिनांक 28 मई 2021 को एआईसीआरपीएस के छोटी इलायची केन्द्र।
- दिनांक 24 जून 2021 को एआईसीआरपीएस के अदरक और हल्दी केन्द्र।
- दिनांक 12 जुलाई 2021 को एआईसीआरपीएस के काली मिर्च और वृक्ष मसाला केन्द्र।
- दिनांक 17 जनवरी 2022 को एआईसीआरपीएस के बीज मसाला केन्द्र।

केन्द्रों की गतिविधियों पर केन्द्र द्वारा भेजी गई मासिक रिपोर्ट, तिमाही रिपोर्ट और अर्धवार्षिक रिपोर्ट के माध्यम से भी निगरानी की जाती थी। साथ ही, 22-24 सितंबर 2021 के दौरान भाकृअनुप-भारतीय मसाला फसल अनुसंधान संस्थान, कोषिक्कोड में भाकृअनुप-अखिल भारतीय समन्वित मसाला अनुसंधान परियोजना की XXXII वीं वार्षिक समूह बैठक वस्तुतः सभी एआईसीआरपीएस केन्द्रों द्वारा संचालित परियोजनाओं की प्रगति की समीक्षा करने और उनके सुधार के लिए बहुमूल्य सुझावों देने के लिए आभासी रूप में आयोजित की गई थी।

EXECUTIVE SUMMARY

The ICAR-AICRP on Spices is the largest spices research system in India, focusing on 17 mandate crops at present, with a network of 19 regular, 11 co-opting, 8 voluntary and 2 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 the 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. Annual budget of the AICRP on Spices for the year 2021 was Rs. 663.19 lakhs (ICAR share).

New initiatives

New research projects have been initiated for sustainable spice production utilizing Plant Growth Promoting Rhizobacteria, *Bacillus safensis* for zinc and phosphorus solubilization potential in ginger and turmeric, coordinated varietal trials in coriander, fennel, fenugreek, aromatic turmeric and black turmeric.

For fixing MRLs and obtaining label claim for pesticides and fungicides, residue analysis was conducted for all the plant protection trials of spice crops viz., black pepper, small cardamom, large cardamom, ginger, turmeric, coriander, cumin, fennel and fenugreek.

A demonstration-cum-seed production unit of pure block of curcumin rich turmeric variety Megha Turmeric and curcumin stable turmeric variety IISR Pragati was established in all the centres located in the NE region to facilitate the availability of pure seeds of Megha Turmeric and IISR Pragati.

Introduction of seed spice crops like coriander, fennel fenugreek and ajwain to NE states like Meghalaya, Mizoram, Sikkim, Nagaland and Arunachal Pradesh

Facilitated digital connectivity to AICRPS centres by providing financial support to procure computer/ laptop, printer and other accessories

Presentation of ginger variety IISR Vajra, turmeric variety, Dr. YSRHU Lam Swarna, ajwain variety Dr. YSRHU Lam Varsha and fenugreek variety, Gujarat Methi 3 for notification by Central Sub- Committee on Crop Standards, Notification and Release of varieties for horticultural crops, New Delhi

Varieties recommended for release in XXXII Annual Group Meeting of AICRPS

Six new trait-specific varieties, two in fenugreek, one each in coriander, fennel, turmeric and ajwain were recommended for release in XXXII Annual Group Meeting of AICRP on Spices held at ICAR-IISR, Kozhikode.

Industrially rich varieties

Chhattisgarh Raigarh Dhaniya 3 is the new coriander variety developed by AICRPS centre at Indira Gandhi Krishi Viswavidyalaya, Raigarh. This variety is suitable for both leaf as well as seed purpose and is high yielding (15 q ha^{-1}). It has pleasant smell, medium sized seeds and with dark green leaves. The grains are having high volatile oil content (0.47%) and exhibits moderate resistance to powdery mildew and aphids. It is suitable for growing in Bihar, Chhattisgarh, Madhya Pradesh, Rajasthan, Uttar Pradesh, Haryana, Gujarat, Uttarakhand, Tamil Nadu and Andhra Pradesh.

RF 289 (Karan Sonf 1) is the new fennel variety developed by AICRPS centre at Sri Karan Narendra Agriculture University, Jobner. This is a high yielding (25.24 q ha^{-1}) and high quality (2.18% essential oil) variety and moderately tolerant to *Ramularia* blight. It performs well in Rajasthan, Madhya Pradesh and Gujarat.

Lam Ajwain 3 is the new ajwain variety developed by AICRPS centre at Dr. YSRHU, Guntur. This variety is high yielding (8.13 q ha^{-1}). It has bold seeds with attractive brown colour and rich in volatile oil content (7.8%) suitable for essential oil producing industries. It is suitable for growing in Rajasthan, Gujarat and Andhra Pradesh.

Stress tolerant variety

Chhattisgarh Raigarh Haldi 3 is the new turmeric variety developed by AICRPS centre at Indira Gandhi Krishi Viswavidyalaya, Raigarh with a fresh rhizome yield of 27 t ha^{-1}. This variety is early maturing (187 days) and has bold primary rhizomes with dark yellow colour inner core. It has 25.8% dry recovery, 3.78%, curcumin, 4.8% essential oil and 10.64% oleoresin. The variety exhibits moderate resistance to *Colletotrichum* leaf spot and *Taphrina* leaf blotch. It is suitable for growing in Chhattisgarh, Andhra Pradesh, West Bengal, Odisha, Uttar Pradesh, Gujarat and Tamil Nadu.

HM 273 is the new fenugreek variety developed by AICRPS centre at Chaudhary Charan Singh Haryana Agricultural University, Hisar, This variety is high yielding (20-25 q ha^{-1}) and shows resistance against downy mildew and powdery mildew diseases. It performs well in Haryana, Rajasthan, Chhattisgarh, Uttarakhand, Tamil Nadu and Gujarat.

Gujarat Methi 3 is the new fenugreek variety developed by AICRPS centre at Sardarkrushinagar Dantiwada Agricultural University, Jagudan. This variety is high yielding (23.50 q ha^{-1}) with more number of pods per plant and shows resistance against powdery mildew disease. It performs well in Rajasthan, Andhra Pradesh, Uttar Pradesh, Bihar, Chhattisgarh, Uttarakhand, Tamil Nadu and Gujarat.

Technologies recommended during XXXII *Annual Group Meeting of AICRPS*

Management of turmeric foliar diseases like leaf spot (*Colletotrichum capsici*) and leaf blotch (*Taphrina maculans*) by TNAU, Coimbatore

Rhizome treatment with propiconazole (0.1%) and foliar spray of propiconazole (0.1) is recommended to minimize the leaf spot and leaf blotch diseases in turmeric. This treatment produced increased yield (37.78 t ha^{-1}) with a high benefit cost ratio of 3.69 in Tamil Nadu.

Management of coriander powdery mildew (*Erysiphe polygoni*) using new generation fungicides by TNAU, Coimbatore

Foliar spray of propiconazole (0.1 %) at the initiation of the disease and second spray at 15 days after first spray is recommended to minimize the powdery mildew disease in coriander. The treatment produced increased seed yield (8.75 q ha^{-1}) with a high benefit cost ratio of 4.22 in Tamil Nadu.

Management of stem gall disease in coriander by RPCAU, Dholi
Foliar spray @ 219.75 g a.i. ha^{-1} at 45, 60 & 75 DAS with ready mixture formulation of Azoxystrobin (11% SC) + tebuconazole (18.3% SC) is recommended to minimize the stem gall disease in coriander, increase the seed yield and also farmers net profit with a benefit cost ratio of 2.91 in coriander growing areas of Bihar.

Leaf spot (*Colletotrichum capsici*)

Leaf blotch *(Taphrina maculans)*

Fig 1: Symptoms of foliar diseases in turmeric

Fig 2: Symptoms of stem gall disease in coriander

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 403 accessions (343 cultivated types, 57 wild & related types and 3 exotic types) of black pepper are being maintained at PRS, Panniyur and AICRPS centre at Sirsi collected a genotype from Siddapur taluk of Uttara Kannada Ddistrict of Karnataka, enhancing the germplasm accessions maintained at Sirsi centre to 266, which includes 45 varieties, seven related species (*P. colubrinum*, *P. arborium*, *P. chaba*, *P. longum*, *P. attenuatum*, *P. hymenophyllum* and *P. hookeri*) and one exotic collection from Vietnam.

During 2021, there was no significant difference among the genotypes at Panniyur with respect to yield related characters like average number of berries per spike, fresh berry yield and dry berry yield. Panniyur 5 and Karimunda recorded a fresh berry yield of 2.0 kg $vine^{-1}$.

In the black pepper based mixed cropping system trial for ensuring sustainable productivity and food security, among the intercrops, greater yam recorded maximum yield of 6.08 kg, followed by elephant foot yam (5.32 kg) from an inter space 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 better yield (11.70 kg plot^{-1}) followed by greater yam (9.42 kg plot^{-1}) and tapioca (8.75 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 fungicide 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 reveal that treatment T3-foliar application of Ergon 44.3 % (W/W) [kresoxim methyl 500 G/L] 7 ml l^{-1} and soil application of Ergon 7 ml l^{-1} + carbosulfan 1 ml l^{-1} @ 2-3 l/vine recorded least foliar infection (13.70), defoliation (14.58), yellowing (23.75) and nematode infection (23.75).

Small cardamom

A total of 330 cardamom accessions are presently conserved in the gene bank, with 198 accessions at Pampadumpara and 132 at Mudigere. There were significant differences among the eight farmer's varieties of small cardamom under evaluation (*Arjun*, Wonder Cardamom, *Panikulangara, Thiruthali, Elarajan, Patchakai, Pappalu, Njallani* and PNS *Gopinath*) with respect to their vegetative and yield characters at Sakleshpur, Mudigere, Myladumpara and Pampadumpara. Preliminary observations of thrips tolerant lines in cardamom at Myladumpara indicated that among the six genotypes (IC 349362, IC 349364, IC 349370, IC 349606, Njallani Green Gold and ICRI 8), IC 349606 recorded lowest thrips population.

The evaluation of efficacy of biocontrol agents (single as well as in combination) in comparison with chemical treatment (carbendazim) against leaf blight of cardamom indicate that the treatment T2 (hexaconazole @ 2 ml l^{-1}) recorded lowest disease incidence, with PDI 21.66 %, followed by T1 (carbendazim + mancozeb @ 2 g l^{-1}) and T3 (mancozeb @ 2 g l^{-1}).

Large cardamom

In large cardamom, 61 germplasm accessions are being maintained at the two AICRPS centres at Gangtok, Sikkim. Survey was conducted at Lamaten area of East Sikkim and collected unique germplasm (06 units) from farmer's field having hardy tillers, spikes with elongated stalk, less susceptible to *Chirke*, *Foorkey* and blight diseases and performing better in swampy areas and planted under AICRPS at ICRI, Pangthang Research Farm.

The experiment to evaluate the effect of mulching on yield of large cardamom indicated that significantly higher number of leaves/tallest tiller and number of productive tillers/clump were noticed under T1 (leaf mould) but at par with T2 (fresh leaf litter). Maximum number of immature tillers/clump and total number of tillers/clump were also recorded under T1 which was significantly higher than other treatments. Significantly higher dry capsule yield was obtained under T1 (though at par with T2), as compared to other treatments.

Ginger

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. Among the 67 accessions maintained at Dholi, eleven accessions recorded higher yield compared to the check variety, Nadia (5.43 t ha^{-1}), with RG-38 giving the highest yield 10.44 t ha^{-1}, followed by RG-4 (10.24 t ha^{-1}) and RG-34 (9.38 t ha^{-1}). Of the 63 germplasm lines collected evaluated at Kumarganj, NDG-55 (432 g/plant), followed by NDG-6 (145 g/plant) and NDG 23 (142 g/plant) were found to be promising.

In different intercropping systems of ginger, results at Pottangi indicate that the returns from coriander as inter crop in ginger was the highest (Rs 480/bed) followed by maize (Rs. 200/-). At Mizoram, all the intercropping combinations with ginger was found effective and resulted in higher system productivity except ginger-fenugreek intercropping.

Turmeric

A total 107 germplasm lines (92 *Curcuma longa*, 7 *Curcuma amada*, 3 black turmeric and 5 released varieties) of turmeric are maintained at CARS, Raigarh. Among the genotypes evaluated, 15 of them recorded more than 500 g clump weight per plant with the highest clump weight per plant recorded in IT 59 (950 g). Out of the 168 *Curcuma longa* accessions evaluated at HARS, Pottangi, 75 accessions recorded more than 5 kg $3m^{-2}$ and 10 genotypes recorded more than 10 kg $3m^{-2}$ fresh rhizome yield. In *Curcuma aromatica*, 12 among the 23 accessions recorded more than 5 kg $3m^{-2}$ fresh rhizome yield. Among the 65 accessions screened at Dholi, RH-432 recorded the highest yield of (52.44 t ha^{-1}), followed by RH-3 (50.43 t ha^{-1}) and RH-448 (49.23 t ha^{-1}) as compared to check variety Rajendra Sonali (46.77 t ha^{-1}).

A new experiment has been 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. At Coimbatore different priming treatments completely suppressed the storage rot. Turmeric rhizomes treated with trichoprime, enhanced the plant population (59.6) at 50 DAP, plant height (105.6), number of tillers per clump (5.9), fresh weight of clump (0.684 g), fresh rhizome yield (37.74 t ha^{-1}). Priming with trichoprime also improved the quality characters *viz*., curcumin content (3.84%) and oleoresin (5.6 %). Thus rhizome treatment with trichoprime significantly mitigated the foliar disease severity as compared to the untreated control which recorded *Taphrina* leaf blotch severity of 48.95 PDI. Further, the presence of fungicidal and insecticidal residues determined by LC-MS-MS revealed that the fungicide and imidacloprid residues were below detectable limit (BDL) in the turmeric rhizomes.

Tree spices

Among the 28 nutmeg accessions conserved and evaluated at Pechiparai, MF- 1 recorded maximum tree height (12.17 m) and stem girth (64.98 cm) and MF 4 recorded maximum leaf length (25.66 cm), leaf breath (9.2 cm), number of fruits (682.5), single fruit weight (53.55 g) and mace yield (288.86 g $tree^{-1}$). Sixteen promising genotypes among the germplasm collections of nutmeg (planted during the year 1996–97) were identified at Dapoli. The genotype DBSKKV 19 recorded maximum dry nut yield (3146.0g) and dry mace yield (786.5 g). From overall performance the genotype DBSKKVMF 19 was found to be 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 6.15 to 7.40 m., girth ranged from 44 -52 cm and spread varied from 2.85 m to 3.65 m. No flowering was observed during the year 2020. Among the 24 accessions at Pechiparai, SA-1 recorded the highest tree height of 12.98 m, followed by SA-3 (12.55 m) when compared with local check (11.01 m). The accession SA-13 was significantly superior to other accessions and recorded highest stem girth (52.19 cm) compared with local check (41.90cm). The accession SA-3 recorded the highest leaf length (12.87 cm), leaf breadth (7.70 cm), number of branches (19.92) and dry bud yield (1.70 kg/tree/year).

Coriander

One hundred and forty accessions of coriander were evaluated at Hisar in two row plots of 3.0 meter length each with Hisar Sugandh, Hisar Bhoomit and Hisar Anand as checks. The mean seed yield ranged from 36.4 g plant^{-1} (DH-287) to 92.8 g plant^{-1} (DH-305). The most promising accessions for seed yield were DH-219, DH-226, DH-233, DH-238-1, DH-242, DH-293-1, DH-294-1, DH-305, DH-314, DH-344 and DH-355. At Jagudan, 19 entries were evaluated with G.Co.-3 as check for yield performance. The seed yield ranged from 170 to 510 g plant^{-1}. Among the 200 germplasm lines evaluated at Kumarganj, the highest yield was recorded in NDCor-11 (29.10 g plant^{-1}), followed by NDCor-22 (28.40 g plant^{-1}), NDCor-12 (27.30 g plant^{-1}) and NDCor-32 (26.80 g plant^{-1}).

Evaluation of CVT coriander entries during Rabi 2020-21 at Raigarh revealed that the highest seed yield (q ha^{-1}) was recorded in COR 176 (19.4 q ha^{-1}) followed by COR 183 (16.4 q ha^{-1}) and COR 186 (14.6 q ha^{-1}) over the checks Chhattisgarh Shri Chandrahasini Dhaniya-2 (11.0 q ha^{-1}), Hisar Anand (10 q ha^{-1}), Rajendra Swati and Chhattisgarh Dhaniya-1 (9.9 q ha^{-1}). COR-178 recorded numerically higher seed yield (19.41 q ha^{-1}) at Navsari, followed by COR-189 (18.00 q ha^{-1}) and COR-179 (17.18 q ha^{-1}) while at Kumarganj, highest yield was recorded in COR-177 (15.76 q ha^{-1}), followed by COR-178 (13.96 q ha^{-1}) and COR-191 (13.40 q ha^{-1}). The highest yield was recorded in the genotype COR-183 (19.41 q ha^{-1}) at Jabalpur, which was at par with COR-186 (17.84 q ha^{-1}).

All the treatments were found significantly superior in controlling the disease incidence as compared to control at Jagudan with lower percent disease intensity in T_2 (foliar spray of propiconazole 25 EC @ 0.05% (10 ml 10 L^{-1} (first & second spray) + two foliar sprays of acetamiprid 20 SP (0.004%) which was at par with T_1. .Aphid index differed significantly among different treatments with the lowest aphid infestation (0.40 aphid index) in T_2, followed by T_9 (0.60 aphid index) and T_8 (0.65 aphid index). Mean population of coccinellids differed significantly among the different treatments, varying from 1.54 (T_5) to 2.73 (T_{10}) per plant. The treatments T_{10}, T_2, T_9 and T_3 recorded 2.73, 2.32, 2.26 and 2.19 predatory coccinellids per plant, respectively at 7days after second spray. All the treatments were found significantly superior over control with significantly higher yield in treatment T_2

Cumin

Among the 79 germplasm lines evaluated at Jagudan (with GC-4 as check), the seed yield ranged from 40-380 g plant^{-1}, with JC-2000-28, JC-2000-65, JC-2002-4 and JC-2002-19 being the top yielders. Out of the 980 germplasm lines evaluated at Mandor, 65 showed significant gain in seed yield over the best check, GC-4, while at Sanand, among the 22 new germplasm lines collected from different farmer's fields of Madhya Pradesh and Rajasthan, none of them recorded significantly superior yield compared to the checks, GC 2 (2.99 g plant^{-1}) and GC 4 (3.39 g plant^{-1}). However, the genotype "*Indawar*" was numerically higher in yield (3.63 g plant^{-1}) and significantly early in flowering (48.33 days) and maturity (102.00 days) than both the checks.

The analysis of variance revealed significant differences among the entries for seed yield and yield attributing characters at Jobner. The seed yield ranged from 2.93 q ha^{-1} (RZ-345) to 6.97 q ha^{-1} (GC-4). Of the ten entries evaluated, GC-4 recorded maximum seed yield of 6.97 q ha^{-1}, followed by CUM-40 (6.22 q ha^{-1}), CUM-42 (5.93 q ha^{-1}), RZ-223 (5.15 q ha^{-1}), and CUM-41 (5.12 q ha^{-1}). Of the ten entries evaluated, CUM-41 recorded maximum seed yield of 8.82 q ha^{-1}, followed by RZ-223 (8.76 q ha^{-1}), CUM-39 (8.74 q ha^{-1}), GC-4 (8.74 q ha^{-1}), and CUM-40 (8.56 q ha^{-1}), while lowest seed yield of 5.84 q ha^{-1} was recorded in CUM-42. Mean performance of the entries evaluated in CVT of cumin over 2017-18 to 2020-21

revealed that the genotypes GC-4 yielding 5.49 q ha^{-1}, followed by CUM-40 (5.29 q ha^{-1}) and CUM-41 (5.16 q ha^{-1}). CUM-41 (4.22 q ha^{-1}) was found to be numerically superior over national check variety GC-4 by 8.2 % at Jagudan.

The overall results from the micronutrient trials at all the centres indicate that application of micronutrients resulted in significant increase in all the growth and yield parameters (the plant height, branches/plant, umbels/plant, umbellets /umbel, seeds per umbel, test weight, and seed yield) and lesser incidence of blight and powdery mildew in cumin, as compared to control.

An experiment on integrated pest and disease management of cumin was initiated at Jobner, Ajmer, Mandor and Jagudan centres during 2019. Observations on percent disease severity of powdery mildew and blight of cumin at Jobner indicate that lowest incidence and maximum disease control were found in three foliar sprays of kresoxym methyl 44.3 SC @ 0.044% (10 ml 10 L^{-1} water) + two foliar sprays of thiamethoxam 25WG (0.0084%) (T_4) (8.36%, 68.13% and 5.56%, 82.35%), followed by three foliar sprays of kresoxym methyl 44.3 SC @ 0.044% (10 ml 10 L^{-1} water) + first foliar spray of thiamethoxam 25WG (0.0084%) and second foliar spray of *Lecanicillium lecanii* 1.15WP ($1x10^9$ cfu/gm) (40g 10 L^{-1}) (T_{10}) (9.02%, 65.61% and 7.21%, 77.11%), as compared to control (T_{16}). The maximum seed yield was also recorded in the T_4 treatment (7.64 q ha^{-1}), as compared to control (T_{16}) (3.10 q ha^{-1}).

Fennel

In the CVT on fennel (initiated during 2018-19) 14 promising genotypes were evaluated for morphological, yield and yield attributing traits. The analysis of variance revealed significant differences among the 14 entries for seed yield and yield attributing characters at Jobner. The seed yield ranged from 9.43 (FNL-123) to 18.92 q ha^{-1} (FNL-126). Among the 14 entries evaluated under coordinated varietal trial at Navsari, the genotypes FNL-123 (25.40 q ha^{-1}) and FNL-118 (24.94 q ha^{-1}) recorded significantly higher seed yield over both the national checks.

At Jobner, the foliar spray of 0.6% zinc sulphate recorded significantly higher plant height (94.91 cm), umbels/plant (24.74), umbellets/umbel (20.85), seeds/umbel (363.3), test weight (5.48 g), essential oil (1.71%), seed yield (23.74 q ha^{-1}), straw yield (60.85 q ha^{-1}), net returns (Rs. 129849 ha^{-1}) and B:C ratio (3.69).

Fenugreek

Among the 17 promising entries and checks under evaluation at Jabalpur, FGK-135 was observed to be flowering early (46.0 days) and FGK-125 growing taller (115.53 cm). FGK-123 had more number of pods per plant (51.22) as well as higher pod length (13.94 cm). The maximum seed yield of 25.46 q ha^{-1} was recorded in FGK-128, which was at par with FGK-134 (23.05 q ha^{-1}) and FGK-124 (22.58 q ha^{-1}). At Kota, the seed yield ranged from 7.15 to 19.03 q ha^{-1} (FGK 125). The mean days to flowering ranged from 67 days (FGK 124) to 73 days (FGK 137) and test weight from 9.6 g (FGK-132) to 16.28 g (FGK 124).

Metabolite profiling of two fenugreek varieties released from TNAU, Coimbatore (CO 1 and CO 2) was done using GC-MS at Coimbatore. Among the 40 compounds identified in fenugreek var. CO 1, the highest peak area was observed in aziridine 1,2,3-trimethyl-, trans (16.47%) followed by heptacosane (4.34%), cyclohexane, 1,1'-(1,2-dimethyl-1,2-ethanediyl) bis-,(2.85%) and sucrose (2.61%).

Ajwain

The analysis of variance revealed significant differences among the entries for seed yield and yield attributing characters among the 11 entries evaluated at Jobner. The seed yield ranged

from 10.80 (AJN-5) to 16.09 q ha^{-1} (AJN-2), with AJN-7 (14.96 q ha^{-1}), AJN-10 (14.62 q ha^{-1}), AJN -11 (14.50 q ha^{-1}) and AJN -1 (14.28 q ha^{-1}) also giving better yield. Significant differences were observed for all the parameters at Hisar. Plant height ranged from 118.5 to 130.3 cm, umbels per plant from 184.4 to 245.8 and seeds per umbel from 335.4 to 397.7. Maximum seed yield was recorded in AJN-4 (12.99 q ha^{-1}), followed by AJN-3 (12.61 q ha^{-1}) and AJN-11 (12.03 q ha^{-1}), respectively while at Guntur, AJN-02 (8.87 q ha^{-1}), AJN-08 (8.78 q ha^{-1}) and AJN-10 (8.76 q ha^{-1}) recorded significantly higher yield over the best check, Lam Ajwain-2 (7.84 q ha^{-1}).

Nigella

Significant differences were observed for all the parameters at Hisar, with plant height ranging from 59.8 to 67.9 cm, pods per plant from 59.8 to 67.9 and seeds per pod from 82.8 to 101.1. Maximum seed yield (13.1 q ha^{-1}) was recorded in NGL-08 followed by NGL-02 (13.03 q ha^{-1}) and NGL-05 (12.38 q ha^{-1}). 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 1recorded maximum seed yield (9.1 q ha^{-1}), followed by NGL-08 (8.5 q ha^{-1}), NGL-05 (7.5 q ha^{-1}) and NGL-01 (8 q ha^{-1}).

Saffron

Fifteen germplasm accessions were collected from different saffron growing areas of J&K, making the total accessions to 215. All these germplasm accessions are under evaluation for various morphological, quality, yield and yield attributing traits. Amongst these accessions, 10 accessions *viz.*, SRS-Saf-124, SRS-Saf-128, SRS-Saf-157, SRS-Saf-178, SRS-Saf-195, SRS-Saf-251, SRS-Saf-253, SRS-Saf-183, SRS-Saf-194 and SRS-Saf-199 have been identified as elite with regard to growth, yield and quality traits.

Kalazeera

Thirteen germplasm accessions were collected from high altitudes of Gurez Valley of J & K making up the total to 83 accessions. Amongst them, SRS-KZ-192, SRS-KZ-158, SRS-KZ-172, SRS-KZ-77, SRS-KZ-170, SRS-KZ-149 and SRS-KZ-167 exhibited superior performance with regard to growth, yield and yield related traits as compared to other accessions.

Production and distribution of quality planting material

The AICRPS centres have multiplied and distributed 1.25 lakhs rooted cuttings of black pepper, 10000 suckers of cardamom, 22.44 tons of turmeric, 6.5 tons of ginger, 5000 grafts of nutmeg and 2000 grafts of cinnamon. In seed spices, 200 q of coriander, 50 q of cumin, 42 q of fennel, 105 q of fenugreek, 10 q of ajwain and l2 q of nigella were produced and distributed.

Transfer of technology

Scientists from AICRPS centres have 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 curcumin rich turmeric variety Megha Turmeric 1 (all NE centres)
- Demonstration of stable curcumin variety IISR Pragati (Coimbatore)
- Demonstration of high yielding fenugreek variety HM 257 (Hisar)
- Demonstration of high yielding coriander varieties (Hisar)

Rapid multiplication of planting materials- for minimal expenditure

- Protray technology popularization in turmeric in Paderu, Dumbriguda and Araku in collaboration with KVK, Kondempudi, Visakhapatnam (Chintapalle)
- Protray cultivation technique for quality seed production of ginger & turmeric (Kammarpally, Pottangi, Nagaland)
- Demonstration of protray propagation technique for ginger and turmeric, soft wood grafting technique in nutmeg and kokum, bush pepper production technology (Dapoli)
- Performance of turmeric transplants in 2.0 acres (Coimbatore)

Micro nutrients & 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

Protection technologies- for plant health

- Management of stem gall disease of coriander (Dholi)

Processing Machineries- for increased efficiency

- Demonstration of multipurpose electric dryers for drying large cardamom and ginger (ICRI Sikkim)
- Demonstration of turmeric boiler and polisher

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 coriander, fennel, fenugreek, ajwain and nigella 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. SASRD, Nagaland conducted training on Prospects of spices production at Renthan, Wokha and Beisumpuikam villages of Nagaland.

Developmental activities in the tribal villages

AICRPS centre at Pottangi and Chintapalli conducted three days training programme on Scientific cultivation practices of spices and their processing aspects at tribal villages of Koraput and Visakhapatnam respectively along with the distribution of planting materials of black pepper, seed rhizomes of ginger and turmeric.

Developmental activities for SC communities

Various training programmes and distribution of inputs were conducted by AICRPS centre at Ambalavayal, Hisar, Mandor, Pundibari, Mizoram etc. benefitting SC farmers

Success stories

Impact assessment of cumin variety GC 4 in State and National level economy

The first wilt tolerant cumin variety, GC 4 was released at National level during 2006 and it spread like a fire and covered about 90 and 60 per cent area under cumin in Gujarat and

Rajasthan, respectively. The Seed Spices Research Station, Jagudan has released Gujarat Cumin 4 (GC 4) in 2006 at National level for cultivation under different production conditions in Gujarat and other states. There is a significant increase in the area, production and productivity of cumin after the release of GC 4 variety. The area, production and productivity of cumin in Gujarat have increased to 331 %, 700 % and 216 %, respectively by the year 2020-21 as compared with 2001-02. The share of Gujarat in cumin area and production of the country was 27 and 30 per cent during 2001-02 which increased to 51 and 50 per cent during 2020-21. Thus, the investment made in seed spice research has been repaid through increased productivity and production. In addition to this cumin variety, SDAU, Jagudan has developed numerous technologies on crop production and crop protection in cumin resulting in reduction in production cost, conservation of natural resources and increase in productivity.

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 report and budget utilization certificates sent from the centres were reviewed critically and proper guidance was given for improvement.

A seed spices monitoring team involving Dr. Gopal Lal (Director, ICAR-NRCSS, Ajmer), Dr. A.U. Amin (SDAU, Jagudan), Dr. Y.K. Sharma (ICAR-NRCSS, Ajmer), Dr. S. K. Tehlan (CCSHAU, Hisar), Dr. S. S. Meena (ICAR-NRCSS, Ajmer) and Dr. Giridhar Kalidasu (Dr. YSRHU, Guntur) visited the seed spices centres for reviewing the progress of the experiments.

Review meeting of AICRPS centres (online) was conducted at ICAR-IISR, Kozhikode to review the quarterly achievements of AICRPS centres

- small cardamom centres of AICRPS on 28 May 2021
- ginger & turmeric centres of AICRPS on 24 June 2021
- black pepper & tree spices centres of AICRPS on 12 July 2021
- seed spice centres of AICRPS on 17 January 2022

The activities of the centres were also monitored through monthly reports, quarterly, half yearly and annual report sent by the centres. Also, the XXXII Annual Group Meeting of ICAR-All India Coordinated Research Project on Spices was conducted virtually at ICAR-IISR, Kozhikode during 22-24 September 2021 to critically review the progress of projects handled by all the AICRPS centres and valuable suggestions 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 focusing the major agro climatic regions of the country. These centres are mostly located in State Agricultural Universities and some centres in ICAR Institutes and also Spices Board. In addition to this, there are two centres functioning under project mode funding.

Mandates of the AICRPS are:

- Evolving high yielding, high quality varieties suitable for various agro-ecological situations and that are tolerant/ resistant to biotic and abiotic stresses to mitigate climate change
- Development of location specific green agro technologies for improved production with water and nutrient management, organic farming, ecologically sound control measures against pests and through mechanisation for production of quality clean spices and spice products.
- Facilitate faster adoption of proven technologies/varieties developed through technology dissemination, Field Level Demonstrations (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.

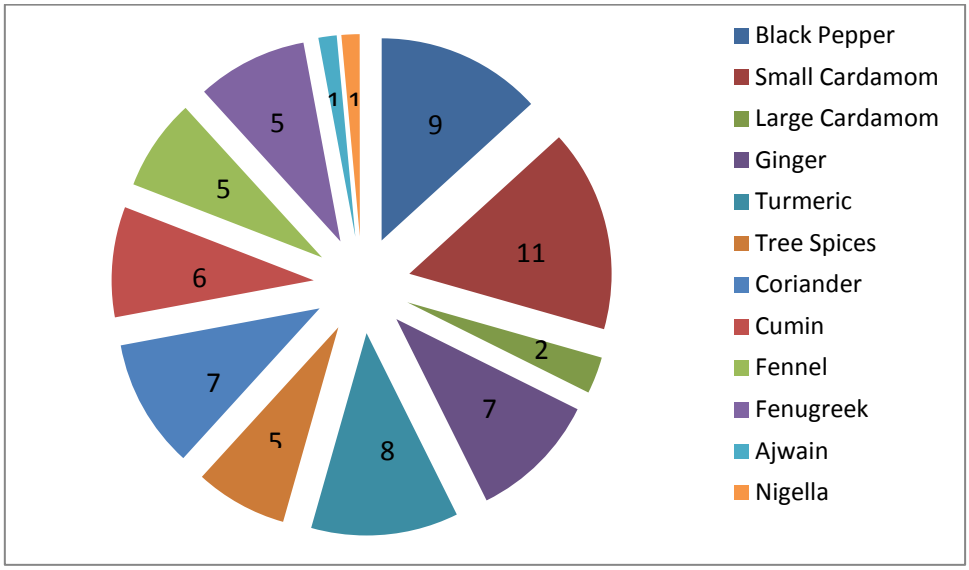


Fig 3: Number of ongoing research programs-Crop wise

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

Sl. No.	State	University/ Institution	Centre	Year of start	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
3	Bihar	RAU	Dholi	1993	Turmeric, Coriander, Fenugreek
4	Chhattisgarh	IGKV	Raigarh	1996	Coriander, Turmeric, Ginger
5	Gujarat	SKDAU	Jagudan	1975	Cumin, Coriander, Fennel, Fenugreek
6	Haryana	CCSHAU	Hisar	1993	Coriander, Fennel, Fenugreek
7	Himachal Pradesh	YSPUHF	Solan	1971	Ginger, Turmeric
8	Karnataka	UAHS	Mudigere	1971	Cardamom, Black pepper
9	Karnataka	UHS	Sirsi	1981	Black pepper, Turmeric, Ginger
10	Kerala	KAU	Panniyur	1971	Black pepper
11	Kerala	KAU	Pampadumpara	1971	Black pepper, Cardamom
12	Maharashtra	BSKKV	Dapoli	1995	Black pepper, Nutmeg, Clove, Cinnamon
13	Odisha	OUAT	Pottangi	1975	Turmeric, Ginger
14	Rajasthan	SKNAU	Jobner	1975	Cumin, Coriander, Fennel, Fenugreek
15	Telangana	SKLTSHU	Kamarpally	1986	Turmeric
16	Tamil Nadu	TNAU	Coimbatore	1975	Coriander, Fenugreek, Turmeric
17	Tamil Nadu	TNAU	Yercaud	1981	Clove, Nutmeg, Cinnamon, Black pepper

18	Uttar Pradesh	NDUAT	Kumarganj	1995	Turmeric, Ginger, Fennel, Coriander, Fenugreek
19	West Bengal	UBKV	Pundibari	1996	Black pepper, Turmeric, Ginger
	Co-opting centres				
1	Assam	AAU	Kahikuchi	2014	Black pepper, Turmeric, Nutmeg
2	Karnataka	ICRI	Sakaleshapura	2008	Cardamom
3	Kerala	KAU	Ambalavayal	2008	Black pepper, Ginger, Turmeric,
4	Kerala	ICRI	Myladumpara	2008	Cardamom
5	Meghalaya	ICAR RC NEHR	Barapani	2008	Ginger, Turmeric
6	Mizoram	ICAR RC NEHR	Mizoram	2008	Ginger, Turmeric
7	Nagaland	SASRD	Medziphema	2014	Black pepper, Ginger, Turmeric
8	Sikkim	ICRI	Gangtok	2008	Large Cardamom
9	Sikkim	ICAR RC NEHR	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
6	Rajasthan	AUJ	Mandor	2014	Cumin
7	Uttarakhand	GBPUA&T	Pantnagar	2008	Turmeric, Coriander, Fennel, Fenugreek
8	West Bengal	BCKV	Kalyani	2008	Ginger, Turmeric

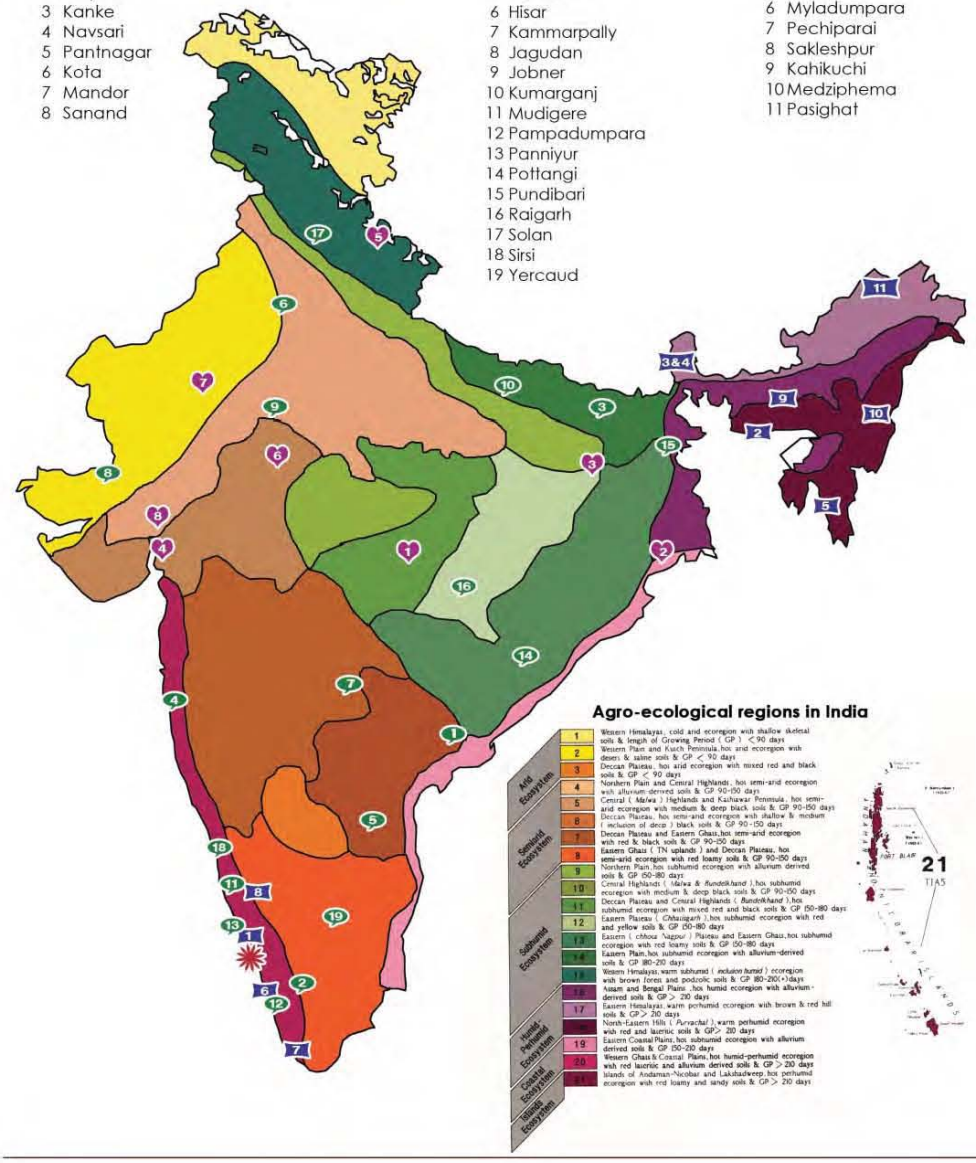
CENTRES OF AICRP ON SPICES

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 (2021)

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/3.3	CVT 2006 Series VI	Chintapalle, Dapoli, Panniyur, Pampadumpara, Sirsi, Yercaud, Pechiparai
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	**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, Pampadumpara, Appangala
	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, Pampadumpara, Sakleshpur, Myladumpara,
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, Pampadumpara, Myladumpara, Sakleshpur

CAR/CI/4.5	MLT of leaf blight tolerant lines of small cardamom 2018	Appangala, Mudigere, Pampadumpara, Myladumpara, Sakleshpur
CAR/CM/5	**Nutrient Management Trial**	
CAR/CM/5.5	Effect of micronutrients on growth and yield of small cardamom	Appangala, Mudigere, Pampadumpara, Myladumpara, Sakleshpur
CAR/CM/5.6	Site specific recommendation for varying yield target of cardamom	Mudigere, Myladumpara, Pampadumpara, Sakleshpur
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, Pasighat
	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	Pottangi, Kahikuchi, Sirsi, Solan,

	insecticides for shoot borer (*Conogethes punctiferalis*) in ginger	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 color 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 nematode 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	Coimbatore, Dholi, Guntur, Hisar, Jagudan, Jobner, Kumarganj,

	diseases	Raigarh
COR/CI/1.3	Identification of drought/alkalinity tolerant source in coriander	Jobner
COR/CI/2	**Coordinated Varietal Trial**	
COR/CI/2.7	Coordinated Varietal Trial on coriander 2018-Series X	Ajmer, Coimbatore, Dholi, Guntur, Hisar, Jabalpur, Kota, Jagudan, Jobner, Kumarganj, Navsari, Pantnagar, Raigarh
COR/CI/2.8	Coordinated Varietal Trial on coriander 2021-Series XI	Ajmer, Coimbatore, Dholi, Guntur, Hisar, Jabalpur, Jagudan, Jobner, Kumarganj, Navsari, Pantnagar, Kota, Raigarh, Kalyani, Sanand
COR/CI/2.9	Screening of coriander varieties against stem gall disease	Dholi, Kumarganj, Kota, Hisar, Jabalpur
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 on 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/2.7	Coordinated Varietal Trial on Fennel 2018 – Series X	Ajmer, Dholi, Hisar, Jabalpur, Jagudan, Jobner, Kumarganj, Pantnagar, Navsari
FNL/CI/2.8	Coordinated Varietal Trial on 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/2.4	Coordinated Varietal Trial of fenugreek 2018 – Series X	Ajmer, Coimbatore, Dholi, Guntur, Hisar, Jagudan, Jabalpur, Jobner, Kumarganj, Pantnagar, Navsari, Raigarh, Kota
FGK/CI/2.5	Coordinated Varietal Trial on 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

I BLACK PEPPER

Genetic Resources

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

At present, a total of 403 accessions (343 cultivated types, 57 wild & related types and 3 exotic types) of black pepper are being maintained at PRS, Panniyur. During 2021, the genotypes PRS 124 and PRS 157 were the top yielders. PRS 124 ranked first with 4.80 kg green berry yield and 1032 spikes/vine, followed by PRS 157 with 4.78 kg green berry yield and 1000 spikes/vine. Spike length was maximum in PRS 119 (17 cm). The number of developed berries/spike was more in PRS 137 (75). PRS 126 recorded the maximum 100 berry weight (14 g) while the highest dry recovery % was recorded in PRS 64 (38.40%).

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	60	-	-	60
Panniyur	343	57	3	403
Pundibari	22	-	-	22
Sirsi	258	7	1	266
Yercaud	34	3	-	37
Pampadumpara	52	-	-	52
Total	825	67	4	896

AICRPS centre at Sirsi collected a genotype from Siddapur taluk of Uttara Kannada District of Karnataka, enhancing the germplasm accessions maintained at Sirsi centre to 266, which includes 45 varieties, seven related species (P. colubrinum, P. arborium, P. chaba, P. longum, P. attenuatum, P. hymenophyllum and P. hookeri) and one exotic collection from Vietnam.
Under the trial initiated during 1987 at Chintapalle, 26 germplasm accessions are being maintained. Among them, Panniyur-1 recorded the highest number of spikes per vine (690), fresh berry yield per vine (4.58 kg), dry yield (1.43 kg), fresh yield per ha (4.56 t), whereas the highest number of berries per spike was recorded in Neelamundi (85.0) and highest dry recovery was recorded in Perambramundi (31.76%). At Yercaud, berry set was observed in 28 accessions. The accession PN 11 recorded the highest green and dry berry yield per vine (3.57 kg and 1.09 kg), followed by PN 55 (3.38 kg and 1. 0 kg).

A total of 30 accessions are maintained in the germplasm block at Ambalavayal. The accessions include IISR Girimunda, IISR Thevam, Sreekara, Subhakara, Vijay, Sakthi, Panchami, Pournami, Palode 2, IISR Malabar Excel, Panniyur 1, Panniyur 2, Panniyur 3, Panniyur 4, Panniyur 5, Panniyur 6, Panniyur 7, Panniyur 8, Thekkan and Cul 5308. 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.

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 during 2015 is in progress concurrently at five centres (Chintapalle, Sirsi, Panniyur, Dapoli and Yercaud). During 2020-21, there was no significant difference among the genotypes at Panniyur with respect to yield related characters like average number of berries per spike, fresh berry yield and dry berry yield. Panniyur 5 and Karimunda recorded a fresh berry yield of 2.0 kg vine^{-1}. The highest spike length was recorded in Panniyur 5 (15.4 cm) which was on par with Panniyur 1 (14.0 cm). The dry recovery % was the highest in Panniyur 1(35.2) which was on par with Panniyur 5 (35.1) and Zion mundi (34.5), followed by Kumbukkal (32.5) and Karimunda (32).

At Sirsi, the national check variety (Panniyur 1) recorded the highest mean height (3.0 m) while Zion mundi recorded the lowest (1.50 m). Kumbukkal recorded maximum number of leaves, number of spikes, and spike length (191, 34 & 9.3 cm, respectively) and for number of branches, no differences were observed among the four accessions. At Chintapalle, the genotype Kumbukkal recorded the maximum plant height (3.73 m), more number of branches (17.46) and number of berries per spike (92.69). However, Panniyur-1 recorded the highest berry yield per vine and dry recovery percentage (30.62%).

The yield attributing characters *viz.*, number of spikes per meter square, number of berries per spike, green and dry berry yield showed significant difference among the entries/varieties tested at Yercaud. The highest number of spikes per meter square (31.85) and the number of berries per spike (35.34) were recorded in Kumbukkal. However, the green berry and dry berry yield were higher in the variety Panniyur-1 (0.47 kg and 0.15 kg, respectively), followed by Kumbukkal (0.46 kg and 0.13 kg, respectively). At Dapoli, the genotype Thekken, recorded the maximum plant height (1.52 m), whereas the genotype Zion mundi recorded minimum plant height (0.67 m).

PEP/CI/3.6 CVT 2015 on Black pepper Series VIII (Centres: Chintapalle, Sirsi, Panniyur, Dapoli, Yercaud, Kahikuchi)

Panniyur 5 recorded a fresh berry yield of 1.59 kg vine^{-1}, followed by Karimunda with 1.56 kg vine^{-1} at Panniyur. However, the yield related characters like number of berries per spike, fresh berry yield and dry berry yield showed no significant differences among the treatments at Panniyur. The highest average spike length was recorded for PRS 161 (19.6 cm), followed by Panniyur 5 (15.4 cm), while the dry recovery was the higher in PRS 161 (37.2%), followed by Panniyur 1 (35.2%), Panniyur-5 (35.1%) and SV11 (35.0).

At Kahikuchi, the varieties, Vijay and Arka Coorg Excel, recorded a fresh berry yield of 2.50 kg and 2.75 kg per plant, respectively. Among the different accessions studied at Sirsi, all plants have established well but none of the accessions have flowered. With respect to plant height, three accession, SV 11, Arka Coorg Excel, SV 17 and Panniyur 1, recorded same height (2.0 m) while PRS-161 recorded the lowest height (1.45 m). Highest number of leaves was recorded in Pannyur 1 (51), followed by SV 17 (43).

Crop is at vegetative stage at Chintapalle and the vines are in fruiting stage at Yercaud. The trial at Dapoli has been completely lost due to the "Nisarga" cyclone during June, 2020 and the experiment will be replanted in ensuing rainy season.

Table 2. CVT 2015 – Yield parameters at PRS, Panniyur

Sl No	Treatment	Average spike length (cm)	No of berries / spike	Green berry yield (kg)	Dry berry yield (kg)	Dry recovery %
1	PRS 161 (T1)	19.6 ^{a}	70.1	1.40	0.52	37.2^{a}
2	PRS160 (T2)	13.3^{cd}	27.4	1.39	0.47	33.5^{cd}
3	SV17 (T3)	15.0^{bc}	40.1	1.37	0.44	32.3^{de}
4	SV11 (T4)	13.1^{de}	46.7	1.37	0.48	35.0^{b}
5	Panniyur 1 (T5)	14.0^{bcd}	50.3	1.44	0.51	35.2^{b}
6	Panniyur 5 (T6)	15.4 ^{b}	41.3	1.59	0.56	35.1^{b}
7	Karimunda (T7)	13.7^{bcd}	25.7	1.56	0.50	32.0^{e}
8	Arka Coorg Excel (T8)	10.6^{f}	51.3	1.33	0.44	33.4^{d}
9	Vijay (T9)	11.5^{ef}	57.7	1.40	0.49	34.8^{bc}
	CD (0.05)	1.817	NS	NS	NS	1.304
	CV %	7.491	39.416	7.972	8.720	2.198

PEP/CI/3.7 CVT 2018 on Black pepper Series IX
(Centres: Ambalavayal, Chintapalle, Sirsi, Panniyur, Kozhikode, Dapoli, Yercaud)
Ten genotypes *viz.*, HP 780, HP 1411, OPKM, HP 117 X Thommankodi, IISR Thevam, Kumbukkal, Ponmani, PRS 137, SV 7, Kurimalai along with Panniyur 1 (check) are being evaluated under this trial. Preliminary observations at Sirsi showed that HP-780 has recorded highest vine length (4.0 m) and number of leaves (201), followed by the national check, Panniyur 1 (3.0 m and 175, respectively). Non significant differences were observed for plant height and number of branches per plant among all the varieties under study at Dapoli. The maximum height of 2.04 m was recorded in Kurimalai, whereas maximum number of branches was recorded in OPKM (4.24).

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 6.08 kg, followed by elephant foot yam (5.32 kg) from an inter space of 4 m x 2 m spacing between black pepper at Panniyur. No significant differences were observed among the treatments with respect to the green berry yield, height of the vine, number of laterals/ 50 cm^2 and number of spikes/ 50 cm^2 of black pepper. The treatment T4- black pepper+ tapioca +pineapple, recorded maximum height of the vine (4.37 m), while maximum number of laterals/ 50 cm^2 was found in T1- black pepper+ colocasia +pineapple (3.77). T6 (black pepper alone) recorded maximum number of spikes/ 50 cm^2 (10.54) and maximum yield per vine was recorded by T5 black pepper + greater yam+ pineapple (1.92 kg). The mixed cropping system has not depleted soil nutrient status as the soil data clearly indicated that the available nutrient content was high. There was no incidence of pest and diseases in intercrops, but mild

incidence of pollu beetle was observed in black pepper. 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 for the mixed cropping system, T5- greater yam+ black pepper (3.21), followed by T3- elephant foot yam + black pepper (2.92) and T2- arrowroot + black pepper (2.49).

In the cropping system trial at Sirsi, with black pepper (Panniyur 1) and colocasia, elephant foot yam, sweet potato (red and white types) and mango ginger under arecanut, elephant foot yam performed better (2.43 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 elephant foot yam (7.7 kg plot^{-1}), which was on par with tapioca (6.4 kg plot^{-1}). At Dapoli, among the intercrops, elephant foot yam recorded better yield (11.70 kg plot^{-1}) followed by greater yam (9.42 kg plot^{-1}) and tapioca (8.75 kg plot^{-1}). Maximum plant height (1.63 m) was recorded in $T_{1,}$ in black pepper as compared to monocrop ($T_{6)}$ (1.42 m), whereas the maximum yield of black pepper was recorded in treatment T_3 (0.489 kg plot^{-1}).

Crop Protection

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

(Panniyur, Dapoli, Sirsi, Yercaud, Appangala)

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*. Among the six treatments, T4 (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 T5 (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. This was followed by T1 (foliar spray with Bordeaux mixture (1%) and soil application of combination of Actinobacteria (Act 1+5+9) (@ 50 g vine^{-1}) and T3 (foliar application of Ergon 44.3% (W/W) [kresoxim methyl 500 G/l] and soil application of Ergon 7 ml l^{-1} + carbosulfan 1ml l^{-1} @ 2-3 l vine^{-1}) with 8.75% PDI. Number of berries/spike, (103 and 101, respectively), average spike length (18.5 cm and 18.3 cm, respectively) 100 berry weight (16.5 g, 15.69 g), dry recovery (33.25 % and 32.25 %) dry berry yield (1.62 kg vine^{-1} and 1.58 kg vine^{-1}) were significantly higher in T4 and compared to other treatments. However, the number of branches/vine among the treatment was at par.

The first year results (initiated during 2020-21) at Sirsi reveal that treatment T3-foliar application of Ergon 44.3 % (W/W) [kresoxim methyl 500 G/L] 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%), followed by T4-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} which recorded 14.88% foliar infection, 22.91% defoliation, 12.50% yellowing and 31.25% nematode infection as compared to control. Among the treatments, highest green berry yield was recorded in T3 (30.38 q ha^{-1}), followed by T2 (27.91 q ha^{-1}) as compared to control (14.83 q ha^{-1}). At Yercaud, the treatment T5 recorded the maximum number of branches per vine

(12.73), % fruit set (73.60), average number of berries/spike (37.60), dry berry yield (0.149 kg vine^{-1}) and 100 berry weight (3.51 g). However, at Appangala, there were no significant difference among the treatments with respect to disease incidence and also yield.

Table 3. Evaluation of strobilurin fungicides and actinomycetes for the management of foot rot and slow decline in black pepper at Sirsi

Tr. No.	Treatment details	Percent Disease Intensity (%)			Nematode (%)	Green berry yield (q/ha)
		Foliar infection (0-3)	**Defoliation (0-3)**	**Yellowing (0-3)**	**Yellowing (1-5)**	
1	Foliar spray with Bordeaux mixture (1%) and soil application of combination of Actinobacteria (Act 1+5+9) (@ 50 g /vine	15.69 (23.33)	29.16 (32.68)	14.58 (22.45)	35.00 (36.27)	24.25
2	Foliar spray with Bordeaux mixturé (1%) and soil application *of Trichoderma harzianum* (MTCC 5179) and *Pochonia chlamydosporia* (MTCC 5412) @ 50 g/vine	16.06 (23.62)	27.07 (31.35)	10.41 (18.83)	35.00 (36.27)	27.91
3	Foliar application of Ergon 44.3% (W/W) [Kresoxim methyl 500 G/L] 7 ml l^{-1} and soil application of Ergon 7 ml l^{-1} + carbosulfan 1 ml l^{-1} @ 2-3 l /vine	13.70 (21.72)	14.58 (22.45)	10.41 (18.83)	23.75 (29.17)	30.38
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}	14.88 (22.69)	22.91 (28.60)	12.50 (20.70)	31.25 (33.99)	26.24
5	Foliar spray with Bordeaux mixture (1%) and soil application of copper oxychloride @ 2.5 g l^{-1}	21.87 (27.87)	35.40 (36.51)	10.41 (18.83)	26.25 (30.82)	25.31
6	Control	32.40 (34.69)	43.73 (41.40)	24.99 (29.99)	38.75 (38.50)	14.83
S.Em. ±		1.48	4.21	3.23	2.36	2.50
CD at 5 %		4.46	12.68	9.72	7.10	7.53

BP/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. Observations are being recorded at Panniyur centre upon imposition of treatments.

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 are being recorded at Panniyur and Appangala. All the treatments were on par

for controlling the pest incidence at Ambalavayal. Survey was conducted in Kamakshi, Nedumkandam, Pampadumpara and Upputhara areas of Idukki district and pollu beetle incidence was noticed in a farmer's field in Upputhara. Hence trial will be initiated during July- August month of 2022.

Fig 4: Field view of screening for insecticides for pollu beetle trial at Panniyur

II SMALL CARDAMOM

Genetic Resources

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

A total of 198 cardamom accessions are presently conserved in the gene bank of Pampadumpara and 132 accessions at Mudigere (Table 4). Among the germplasm accessions evaluated at Mudigere, M2 recorded maximum plant height (320.21 cm) and 12-7-D-11 recorded maximum tillers per clump (65.40). SKP-170 was found to be the best performing in terms of bearing tillers per clump (34.91), panicles per clump (25.54) and yield per plant (400.65 g).

Table 4. Cardamom germplasm collections of AICRPS Centres

AICRPS Centre	Cultivated	Wild and related sp.	Total
Mudigere	132	Nil	132
Pampadumapra	197	1	198
Total	329	1	330

Crop Improvement

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

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

Six genotypes of cardamom (IC 349537, IC 584058, GG×NKE-12, IC 584078, CL 668, HS 1, IC 584090) with one check (Appangala 1) were evaluated for drought tolerance at Appangala. Mositure stress was imposed during summer (February to April) in stress block by withholding irrigation. The 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/tiller, total number of panicles/plant, length of panicle (cm) and capsule yield (kg ha^{-1}) recorded significant variations between control and stress treatments at Appangala. Dry capsule yield (kg ha^{-1}) ranged from 83.68 (IC 584090) to 313.54 (GGXNKE-12) in control and under stress, it ranged from 35.76 (IC 584090) to 151.04 (GGXNKE-12). Accession IC 584058 recorded 70.28 per cent 8 mm bold capsules, followed by HS 1 which recorded 64.05% in control. Under stress conditions, the accession HS 1 recorded 67.62 per cent 8 mm bold capsules, followed by IC 584058 (67.05%) . Essential oil content did not vary significantly between treatments and genotypes. It ranged from 8.35 % (IC 584090) to 9.50 (IC 584078) in control with a mean of 8.83% in control and under stress, it ranged from 8.69 (IC 349537) to 9.12 (IC 584090) with a mean of 9.01 %.

Observations recorded at Myladumpara and Sakleshpura also clearly indicated that morphological and yield contributing characters like number of panicles, length of panicles, number of racemes/ panicle and number of capsules/ raceme were significantly more in T_1 (without moisture stress) than T2 (moisture stress). At Myladumpara, IC 349537 showed better yield (554.87 kg ha^{-1}), followed by IC 584058 (499.47 kg ha^{-1}) in the control plot, whereas under moisture stress treatment it could realize a better yield (334.88 kg ha^{-1}), followed by IC 584096 (312.43 kg ha^{-1}). At Sakleshpura, the number of tillers, tiller height, number of panicles, length of panicle, number of raceme/ panicle and number of capsules /

raceme were significantly more in the control treatment (I_1), as compared to the moisture stress treatment (I_2). V_1 (IC 349537) produced significantly higher yield (826.8 kg ha^{-1}).

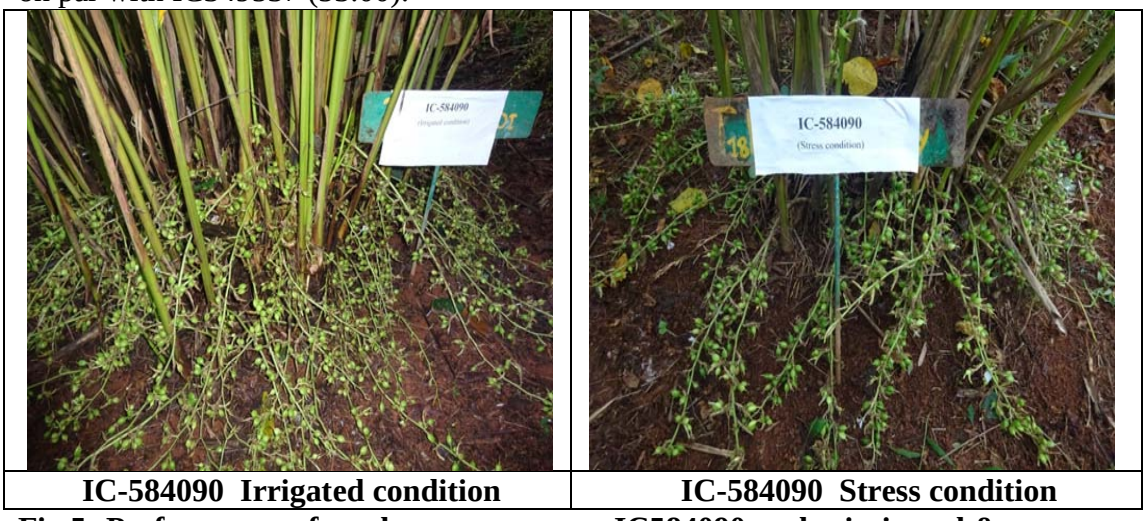
Table 5. Yield attributes of small cardamom at Sakleshpura

Variety	Length of panicles / clump			No of racemes / panicle			No of capsule / raceme			Yield kg /ha		
	I_1	I_2	Mean	I_1	I_2	Mean	I_1	I_2	Mean	I_1	I_2	Mean
IC 349537	72.7	65.3	69.0	20.3	15.0	17.7	5.3	5.4	5.4	1011.6	642.0	826.8
IC 584096	71.0	55.0	63.0	18.0	17.0	17.5	5.0	5.1	5.1	829.0	554.0	691.5
IC 584058	53.0	50.3	51.7	18.0	13.3	15.7	5.0	4.8	4.9	752.0	421.6	586.8
IC 584078	54.0	46.0	50.0	18.6	14.0	16.3	5.3	5.0	5.2	800.6	528.0	664.3
CL 668	52.7	45.0	48.8	18.0	15.6	16.8	5.0	4.0	4.5	829.0	367.0	598.0
HS 1	51.0	43.3	47.2	17.3	12.3	14.8	5.0	4.7	4.9	538.3	351.0	444.7
APG-1	52.0	45.3	48.7	18.0	15.6	16.8	5.0	4.7	4.9	925.0	411.6	668.3
IC 584090	66.3	40.6	53.5	20.2	13.8	17.0	5.3	4.0	4.7	845.3	286.0	565.7
Mean	59.1	48.9	54.0	18.6	14.6	16.6	5.1	4.7	4.9	816.4	445.2	630.8
Comparing the mean of	SE(m) ±	CD(5%)		SE(m) ±	CD(5%)		SE(m) ±	CD(5%)		SE(m) ±	CD(5%)	
Irrigation (I)	0.65	1.89		0.29	0.86		0.11	0.32		6.3	18.2	
Variety (V)	1.3	3.79		0.59	1.73		0.23	-		12.5	36.3	
I × V	1.85	5.37		2.44	0.84		0.31	-		17.7	51.4	

I_1 without moisture stress I_2 moisture stress

At Mudigere, among the eight genotypes, maximum plant height was observed in IC-584078 (313.03cm) under sufficient moisture conditions, while it was only 281.13 cm under moisture stress. The number of suckers/plant was more in IC-584090 (48.60) under moisture stress condition, while IC-584090 (62.60) and Appangala-1 (63.0) produced more number of suckers/plant under normal condition. Maximum yield was obtained in IC-584090 (5.27 kg $plant^{-1}$) followed by IC-584078 (4.01 kg $plant^{-1}$), while it was 7.61 kg $plant^{-1}$ in IC-584090 and 6.54 kg $plant^{-1}$ in IC-584078, under normal (irrigated) conditions.

Biometric observations recorded at Pampadumara indicated that maximum plant height (241.67cm) was recorded in GG x NKE 12 (241.67 cm) and maximum leaf length (66.33 cm) in IC 584058. Maximum number of tillers was recorded in Appangala 1 (54.33) which was on par with IC349537 (53.00).



IC-584090 Irrigated condition | **IC-584090 Stress condition**

Fig 5: Performance of cardamom genotype IC584090 under irrigated & stress condition at Mudigere

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

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

This trial with eight farmer's varieties of small cardamom *viz.*, *Arjun*, Wonder Cardamom, *Panikulangara*, *Thiruthali*, *Elarajan*, *Patchakai*, *Pappalu*, *Njallani* and PNS *Gopinath*, supplied by the National Innovation Foundation (NIF), along with Njallani Green Gold (national check) and a local check variety were planted during June 2017.

Observations on morphological and yield parameters (plant height, number of tillers, number of bearing tillers; number of panicles and panicle length) were recorded from CVT on farmer's varieties of cardamom trial. At Appangala, the highest dry yield per plant was recorded in the variety *Panikulangara* (340.67 g plant^{-1}), followed by *Thiruthali* (334.78 g plant^{-1}). Same varieties also recorded higher values for yield contributing traits *viz.*, number of bearing tillers, number of panicles and panicle length.

Fig 6: Capsules from CVT farmer's varieties of small cardamom at Appangala

Biometric observations recorded at Sakleshpura showed that while the number of tillers were significantly more in Arjun (60.6), followed by *Thiruthali* (59.3) and Wonder Cardamom (58.6), plant height was significantly more in *Thiruthali* (272.6 cm), followed by *Pappalu* (260.0 cm). Numbers of panicles were significantly more in *Thiruthali* (31.0) and Wonder Cardamom (31.0), followed by Arjun (29.5) whereas length of panicle was significantly higher in *Thiruthali* (85.6). No of racemes/panicles were higher in *Thiruthali* (34), followed by Wonder Cardamom (26.0). Number of capsule/raceme was also significantly higher in *Thiruthali* (8.43), followed by Njallani (8.3). *Thiruthali* produced significantly more yield (1041 kg ha^{-1}).

At Myladumpara, number of tillers (70.0), plant height (309.43) and number of leaves (14.67) were significantly more in *Panikulangara* 1. Significantly more panicles were found in Wonder Cardamom (40.00), followed by *Panikulangara* 1 (37.00). Number of racemes per panicle was more in Wonder Cardamom (30.67) and number of capsules per raceme was more in *Panikulangara* 1 (9.00). Wonder Cardamom performed better with regard to yield (1317.34 kg ha^{-1}), followed by *Thiruthali* (1133.02 kg ha^{-1}). At Pampadumpara, all the characters showed significant difference among the varieties. The highest fresh weight and dry weight were recorded in *Patchakai* (1.655 kg plant^{-1}, 0.364 kg plant^{-1}), followed by PV2. However, *Elarajan* showed highest value for 100 capsule weight (114 g) and 100 capsule volume (125 ml), which is significantly different from other varieties, indicating bigger size of capsules in this variety. *Thiruthalli* recorded maximum number of panicles (58.61), which is statistically on par with *Elarajan* (55.33) and *Green Gold* (55.88) and longest panicle

(91.72 cm), which is statistically on par with *Pappalu* (82.33 cm). However, maximum number of racemes per panicle was recorded in *Pappalu* (29.56).

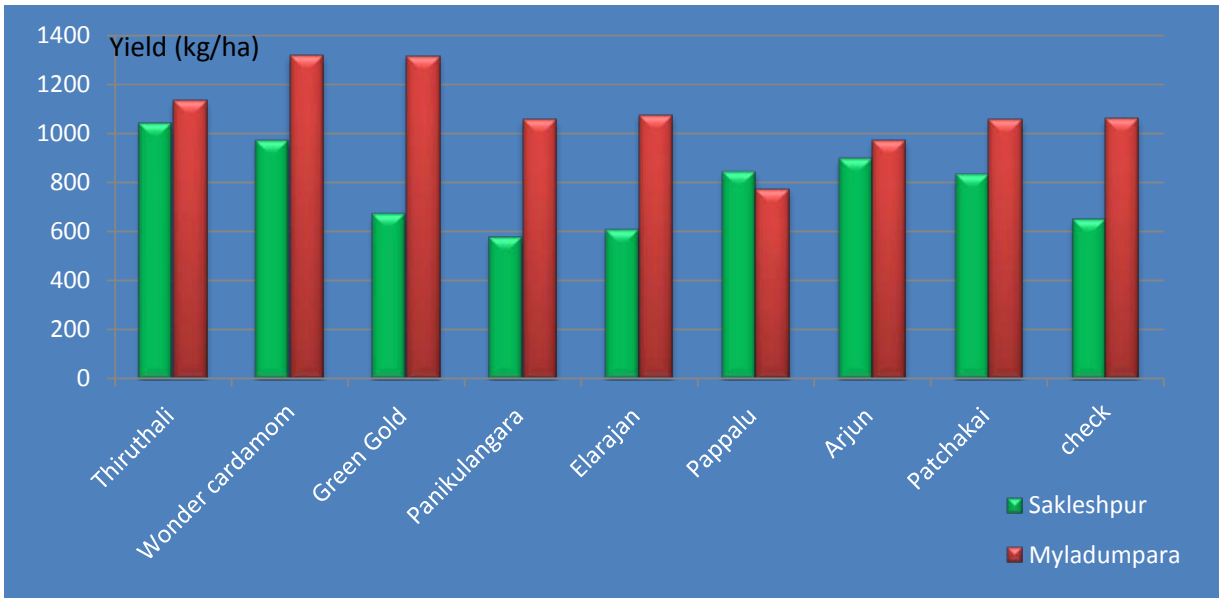


Fig 7: Variation in fresh yield of farmer's varieties of small cardamom at Sakleshpur & Myladumpara

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 more number of tillers (25.9), followed by *Thiruthali* (23.2) and Pappalu (21.2).

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

Experiment is being taken up at Appangala, Mudigere, Sakleshpur, Myladumpara and Pampadumpara with nine hybrids, namely, (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 RCBD design.

At Appangala, highest dry yield of capsules per plant was recorded in hybrid PH-13 (841.67 g plant^{-1}), followed by hybrid Bold × IC 547219 (361.33 g plant^{-1}). Data on growth characters such as tillers/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 are in vegetative stage at Pampadumpara. Njallani Green Gold showed maximum plant height (134 cm) which was on par with SHC1 (120.67 cm) and SHC2 (130.33 cm).

At Sakleshpur, the number of tillers is significantly more in SHC 1, followed by (GG × NKE 19) × Bold (17.3). Height of tillers was significantly high in MHC-2 (212.67 cm) and Bold × IC 547219 (205 cm). Significantly more number of vegetative buds was observed in SHC 2 (6.10) and SHC 1 (5.17). Experiment was initiated during the month of June 2021 at ZAHRS, Mudigere.

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

The experiment on evaluation of thrips tolerant lines in cardamom was initiated at Sakleshpur, Appangala, Mudigere, Myladumpara and Pampadumpara, with 6 genotypes (IC

349362, IC 349364, IC 349370, IC 349606, Njallani Green Gold and ICRI 8).Observations on thrips population were recorded at monthly intervals on different cardamom accessions at Myladumpara and preliminary results indicate that among the accessions, IC 349606 has low thrips population. Initial observations on nymph/thrips population at Sakleshpur indicate that thrips population was high in (T_6) Njallani and the least in (T_4) IC 349370.

Experiment was initiated during the month of June 2021 at ZAHRS, Mudigere. In Appangala and Pampadumpara, crop is in the vegetative stage. Morphological observations revealed that the genotypes showed significant difference for these characters. IC 349364 produced more number of tillers (22.667), which is statistically on par with IC 349362 (19.0). Green Gold exhibited highest plant height (163.33 cm) which was significantly different from all other genotypes followed by PV2 (139 cm), released variety from Pampadumpara. The average number of tillers of all the genotypes range of 10.83 to 15.79 at Appangala. The genotype IC 349362 (T3) recorded with maximum plant height (189.4 cm), highest average number of panicles (5.44), length of panicle (22.89cm) and no of capsules (30.81).The average number of panicles of all other genotypes were between 0.37 to 2.81.

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

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

The cardamom accessions (IC547156, IC547222, IC349650, IC349648, IC349649 and APG1- check (which were found to be resistant/moderately resistant on screening for four consecutive years) along with Njallani Green Gold have been planted in the trial at ICAR-IISR Regional Station, Appangala. The trial was initiated in the experimental farm of Pampadumpara, ICRI, Myladumpara and at ZAHRS, Mudigere during the current year.

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 (T1- Recommended package of practice (control), T2- Recommended package of practices + IISR cardamom micronutrient spray (four sprays of micronutrients during March, April, May and June at 5 g l^{-1}) with three sub treatments (varieties *viz.*,Appangala 1, IISR Avinash and Green Gold) in 2019. Initial results indicated that plant height, number of yielding tillers, total number of tillers and panicle length did not differ between the treatments. Total number of panicles per clump, number of capsules per panicle and capsule yield were found to be significant betwen the treatments. Spraying micronutrients in addition to general package of practices increased yield by 5.5% and 2.75% in 8 mm bold capsules.

At Pampadumpara, the experiment comprised of three treatments (T1- Recommended dose of fertilizer (RDF) + IISR cardamom mix spray (March, April, May, June @ 5 g l^{-1}), T2- T1 + Humic acid spray @ 0.2 % + Drenching of humic acid, T3- RDF (Control) which was superimposed on three varieties of cardamom namely, KAU PV-3, KAU PV and Green Gold (GG). Maximum plant height was recorded for GG (276.96 cm) and the maximum plant height was registered by T2 (314.44 cm). Maximum number of tillers (60.33) and panicles (60.22) were recorded under T2. GG recorded maximum number of panicles (58.89).

At Sakleshpur, significantly higher plant height and number of tillers per clump was recorded in cultivar ICRI 8 as compared to ICRI 3, whereas treatment receiving recommended dose of fertilizer, FYM along with three rounds of foliar spray of IISR cardamom powermix had significantly higher plant height and number of tillers per lump. The experiment has been laid out at Myladumpara during the year by planting ICRI-5, Thiruthali and MCC 260 wheras at Mudigere, among the varieties, M-3 recorded significantly more tillers per plant and plant

height when compared to M-1 and M-2. Among the nutritional requirements, RDF + IISR cardamom micronutrient spray and drenching of humic acid (0.2%) recorded significantly more tillers per plant compared to other treatments.

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 characterics 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 trial was initiated during 2020 with five treatments: T1- spray and drench tebuconazole @ 1 ml l^{-1}; T2- spray and drench fenamidone + mancozeb @ 2g l^{-1} ; T3-spray and drench metalaxyl- mancozeb @ 1.25 g l^{-1}; T4- spray and drench copper oxy chloride @ 2g l^{-1} and T5 - recommended package of practices (control).

Two rounds of application of fungicides were completed at Appangala and preliminary observations recorded on rhizome rot indicate that the treatment T1 and T3 had the lowest disease incidence during August 2021, with a PDI of 34.17% and 33.33% respectively. The highest disease incidence was recorded in T4 (50.83%). There was no significant difference in yield reduction among treatments. At Pampadumpara, the experiment was re laid out in the varietal plot of PV 5 with four replications.

At Myladumpara, pre treatment observations on growth, yield and disease incidence were recorded, the first round of treatments was imposed in July 2021, subsequently the second and third round of treatments were also imposed at monthly intervals and the observations were recorded. However, the treatment T2 could not be imposed during 2021 since the fungicide fenamidone+mancozeb was not available in the market.

At Mudigere, among the treatments, fungicide fenamidone + mancozeb 60% WG @ 0.2% (1.67 PDI) showed lowest rhizome rot severity and was statistically on par with metalaxyl + mancozeb 68% WP @ 0.125% (2.50 PDI) and tebuconazole @ 0.1% (3.33 PDI). The untreated control showed maximum disease severity (22.50 PDI). Significantly higher capsule yield (dry) was recorded in fenamidone + mancozeb 60% WG @ 0.2% (352.39 kg ha^{-1}) which was on par with metalaxyl + mancozeb 68% WP @ 0.125% (335.23 kg ha^{-1}).

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

The trial was initiated during 2020 with five treatments: T1-spray carbendazim + mancozeb@ 2 g l^{-1}; T2 -spray hexaconazole @ 2 ml l^{-1}; T3 -spray mancozeb @ 2 g l^{-1}; T4 – spray tebuconazole @ 1 ml l^{-1}; T5 -recommended package of practices (control). Two rounds of application of fungicides were completed at Appangala and preliminary observations recorded on leaf blight during August and October, 2021 indicate that the treatment T2 recorded lowest disease incidence, with a PDI of 21.66 %, followed by T1 and T3. The highest disease incidence was recorded in T4 (33.33%). There was no significant difference in yield reduction among the treatments.

At Pampadumpara, pre-treatment observations and the first spray application of fungicides has been completed. Least disease incidence was observed in the treatment T1- carbendazim + mancozeb @ 2g l^{-1} after 1st spray. At Myladumpara, pre treatment observations on growth, yield and disease incidence were recorded during 2021, the first round of treatments was imposed in October 2021 and subsequently the second and third round of treatments were also imposed at monthly intervals.

At Mudigere, among the treatments, tebuconazole 250 EC @ 0.1% (10.00 PDI) showed lowest leaf blight severity and was statistically on par with hexaconazole 5% SC @ 0.2% (11.67 PDI) and carbendazim + mancozeb 75% WP @ 0.2% (12.50 PDI). The untreated control showed maximum disease severity (42.50 PDI). Significantly higher capsule yield (dry) was noticed in tebuconazole 250 EC @ 0.1% (306.62 kg ha^{-1}) which was statistically on par with hexaconazole 5% SC @ 0.2% (293.76 kg ha^{-1}).

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 (Pampadumpara, Myladumpara)

The trial has been initiated at Pampadumpara and Myladumpara centres with six treatments (T1-Control; T2- *T. asperellum* talc formulation mass multiplied in cowdung: neem cake mixture 9:1, mix *T. asperellum* talc formulation @ 1-2 kg/100 kg mixture. Apply 2-5 kg *T. asperellum* mass multiplied mixture/plant; T3 -*T. asperellum* biocapsule formulation, 1 biocapsule /100 l water, Apply 2-3 l solution/plant; T4 -Metalaxyl + mancozeb, drench the fungicidal solution 0.125%; T5 *Pochonia chlamydosporia* liquid formulation, drench @ 1ml l^{-1}; T6 Recommended nematicide, (drench the nematicide solution) with 4 replications each.

Pre-treatment observations on growth, yield and disease incidence were recorded and the first round of treatments was imposed in July 2021. Subsequently the second round of treatment was also imposed after one month and the observations recorded. The data on disease incidence and yield are being compiled. The samples were also taken for the analysis of fungicide residue at Pampadumpara and Myladumpara.

Fig 9: Field day on "Integrated farming system practices for Spices held at Mudigere

III L ARGE CARDAMOM

Genetic Resources

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

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

Survey was conducted at Lamaten area of East Sikkim and collected an unique germplasm from a farmer's field which has hardy tillers, spikes with elongated stalk, less susceptible to *Chirke*, *Foorkey* and blight diseases and performing better in swampy areas and planted under AICRPS at ICRI, Pangthang Research Farm. Details of germplasm accessions maintained at AICRPS centres are given in Table 6.

Table 6. Large cardamom collections maintained at AICRPS centres

AICRPS Centre	No. of collections
ICAR- RC NEH, RS,Gangtok	7
ICRI RRS, Gangtok	55
Total	62

Three unique accessions (SCC-214 to SCC-216) from ICRI, Gangtok have been submitted to NBPGR, New Delhi for allotment of IC number.

Crop Management

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

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

This experiment on evaluating the effect of mulching on yield of large cardamom was started during year 2021 at farmers' fields, with six mulching treatments: T1- leaf mould; T2–fresh leaf litter; T3–paddy straw; T4–paddy husk; T5–black polyethylene sheets and T6–control. Treatments were imposed at a farmer's field at Rongpachulung, Kabi North Sikkim by the ICRI Regional Station, Gangtok. Initial morphological data *viz.*, plant height, number of leaves / tiller, number of tillers / clump, 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 and sent for analysis of nutrient status and soil pH.

Fig 10: Impositon of treatments at farmers field in Kabi North Sikkim

ICAR Gangtok centre has initiated the experiment during pre-kharif season of 2021 at a farmer's field in Dzongu, North Sikkim. Preliminary obdervations indicate that among the different mulching treatments, maximum plant height was recorded under T1 which was statistically at par with T2, T3, T4 and significantly higher than other treatments. Significantly higher number of leaves/tallest tiller and number of productive tillers/clump were noticed under T1 but at par with T2. Maximum number of immature tillers/clump and total number of tillers/clump were also recorded under T1 which was significantly higher than other treatments. Significantly higher dry capsule yield was obtained under T1 (though at par with T2), as compared to other treatments.

Table 7: Effect of mulching on yield of large cardamom at a farmer's field in Dzongu, Sikkim

Treatment	Plant height (cm)	Number of leaves/ tallest tiller	Number of immature tillers/ clump	Number of productive tillers/clump	Total number of tillers/ clump	Dry capsule yield (kg ha^{-1})
T1: Leaf mould	147.4	9.93	21.0	19.0	40.0	967
T2: Fresh leaf litter	143.1	9.41	19.0	18.0	37.0	934
T3: Paddy straw	140.3	9.22	18.0	15.0	33.0	834
T4: Paddy husk	138.7	8.89	17.0	14.0	31.0	812
T5: Black polyethylene sheets	137.1	8.72	16.0	14.0	30.0	803
T6: Control	132.7	7.10	14.0	11.0	25.0	723
SEm±	3.20	0.23	0.46	0.42	0.94	42.7
LSD (P=0.05)	8.98	0.67	1.35	1.12	2.87	130.1

IV 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.

Among the 68 accessions maintained at Dholi, RG-43 recorded highest yield of (19.11 t ha^{-1}), followed by RG-44 (18.57 t ha^{-1}) and RG-9 (16.56 t ha^{-1}), as compared to the check variety, Nadia (13.06 t ha^{-1}). Of the 63 germplasm accessions evaluated at Kumarganj, NDG-55 (438 g $plant^{-1}$), followed by NDG-6 (152 g $plant^{-1}$) and NDG-23 (147 g $plant^{-1}$) were found to be promising.

Table 8. Ginger germplasm collections in AICRPS centres

Centre	Cultivated	Wild & related spp	Exotic	Total
Dholi	68		-	68
Kumarganj	63	-	-	63
Pundibari	33	-	-	38
Pottangi	202	3	3	208
Nagaland	25			25
Solan	40	-	-	40
Barapani	54	1		54
Pundibari	33			33
Total	518	4	3	525

Among the 33 germplasm accessions evaluated at Pundibari, highest rhizome yield was recorded in GCP 25, followed by GCP 23, GCP 52 and GCP 57 (13.01 t ha^{-1}, 12.50 t ha^{-1}, 12.00 t ha^{-1} and 12.00 t ha^{-1} respectively). Lowest rhizome rot and wilt disease incidence were recorded in GCP 57 (10.00), followed by GCP 25 (10.00) and GCP-23 (12.00%).

Out of 198 ginger germplasm accessions evaluated at Pottangi, 33 accessions yielded more than 5 kg fresh rhizomes 3m^{-2}. At Raigarh, the genotypes *viz.*, Indira Ginger -1 (25.6 t ha^{-1}), IG-4 (22.5 t ha^{-1}) and IG-3 (21.4 t ha^{-1}) recorded high yield over the two national checks, Suprabha (20.6 t ha^{-1}) and Suruchi (20.7 t ha^{-1}). During the year, Barapani centre made eight new trait-specific collections (for yield and quality traits) from Umtung Village, Ri-Bhoi district. Among the accessions, wider variability was observed for all the agro-morphological traits. Highest yield was recorded in IC-584354 (20.76 t ha^{-1}). At Solan, out of the forty ginger genotypes, SG19-11 recorded the highest fresh rhizome yield of 240.28 g/plant with 3.90% oleoresin content.

Crop Improvement

GIN/CI/2.5 Coordinated Varietal Trial (CVT) on disease tolerance trial in ginger (Barapani, Chintapalle, Kozhikode, Pundibari, Pottangi, Nagaland, Gangtok, Raigarh)

This experiment is under progress with nine genotypes from IISR *viz.*, M1, M2, M3, M4, M5 and three genotypes from Pottangi viz.$V_2E_5$2, $V_1E_4$1, V_1E_4 5 along with national/ local checks. At Barapani, M4 recorded the highest plant height (69.87cm) followed by M5 (65.90cm). M5 also recorded the highest no. of tillers/plant (3.33), whereas M2 recorded the highest yield/plant (225g) and fresh rhizome (7.49 t ha^{-1}). M4 recorded the highest oleoresin content (4.22%).

Initial results of Coordinated Varietal Trial (CVT) of ginger for yield and disease reaction at Raigarh revealed that HP 05/ 15 (IISR), recorded maximum rhizome yield (25.2 t ha^{-1}), followed by Indira Ginger -1 (22.6 t ha^{-1}), and V1E4 5 (Pottangi) (20.5 t ha^{-1}) in comparison with the national checks (IISRVarada) (18.1 t ha^{-1}), Suruchi (16 t ha^{-1}) and Suprabha (15.7 t ha^{-1}). At Pottangi, Indira Local showed maximum (23.9%) bacterial wilt symptoms. The entry V_1 E_4-5 (13.2 t ha^{-1}) was having the highest fresh rhizome yield, followed by IISR M_5 (V 0.5/2) (11.3 t ha^{-1}).

At Chintapalle, among the 10 genotypes, Indira Local recorded the highest plant height (67.80 cm) followed by M1 (63.24 cm) and number of tillers were highest in V_1E_4 1 (10.47). M2 recorded the highest fresh weight of the rhizome per plant (239.17) and fresh rhizome yield/ha (17.96 t ha^{-1}). It was observed that sprouting per cent of seed rhizomes significantly varied from 46% to 86% at the Himalayan foot hill agro-climatic conditions of Nagaland. Highest plant population per plot (19.33) was recorded in M2 and M5; however, highest number of tillers was produced by V1E4-5 (3.67) and lowest was 1.80 with M3. Rhizome weight per clump produced significant variation among the accessions with 145 g harvested from the plots of M5 followed by Nadia (138.34 g) and V2E5-2 (115 g). Highest yield/ha was recorded in Nadia (17.99 t), followed by M5 (16.72 t) and Raigarh Local (13.34), though non-significant.

At Pundibari, the highest rhizome yield was obtained in case of M5 (10.50 t ha^{-1}) which was closely followed by M4 (9.75 t ha^{-1}), IISR Varada (9.20 t ha^{-1}) and V1E4-1 (9.15 t ha^{-1}). Lowest rhizome rot and wilt incidence was recorded in IISR-M4 (10.38%) followed by and M5 (10.55%). Highest plant height was recorded in Raigarh ginger (53.40 cm) followed by IISR Varada (52.00 cm). Highest dry recovery was recorded in IISR-M5 (21.21%) followed by V1E4-1(19.99%). At Kozhikode, the maximum yield was recorded in R 1.25/4 and V1E4 1, which were on par (Fig.7).

Significantly higher sprouting (98.9%) was recorded in HP 05/15 as compared to other cultivars but remained at par with R 1.25/4, V 0.5/2, V1E4-1 and Bhaise in Gangtok. Significantly higher number of tillers per clump (4.25) was observed in HP 05/15 as compared to other cultivars except V 0.5/2 and Bhaise. The lowest incidence of disease (13.7%) was recorded in HP 05/15 which was statistically at par with R 1.25/4 and Bhaise but significantly lower than other cultivars, respectively. Maximum fresh rhizome yield (12.1 t ha^{-1}) was recorded in HP 05/15 which was statistically at par with R 1.25/4 and Bhaise but significantly higher than remaining cultivars, respectively. As compared to other cultivars, significantly higher dry rhizome yield (3.18 t ha^{-1}) was registered in HP 05/15 but remained at par with Bhaise. Ginger cultivar HP 05/15 followed by R 1.25/4 and Bhaise performed better under organic management condition in Sikkim Himalayas.

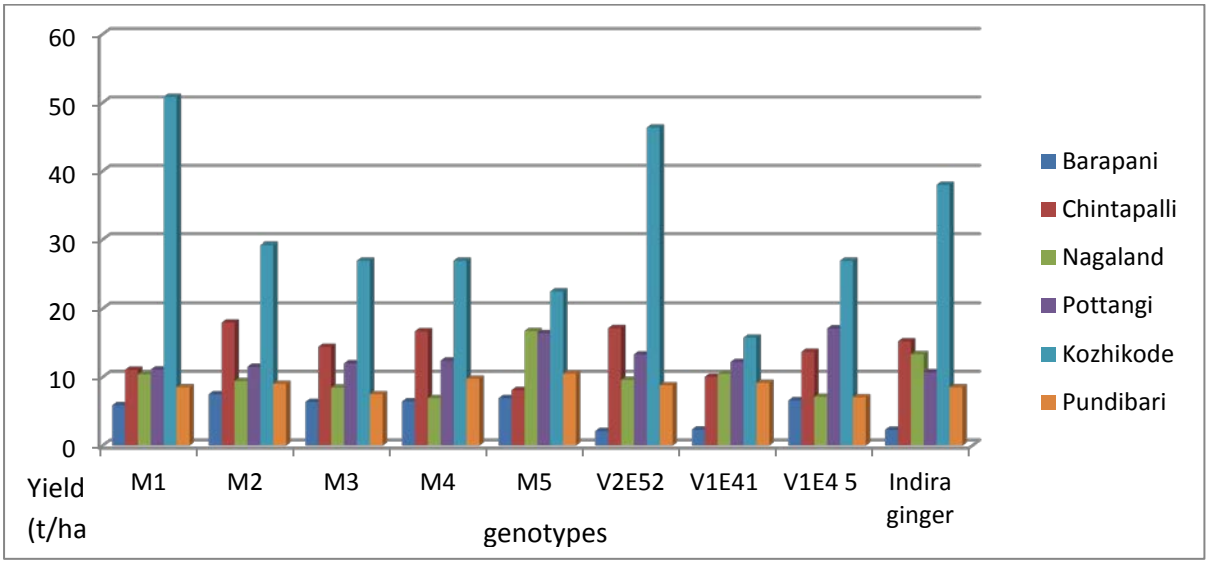


Fig 11: Comparative performance of CVT entries of ginger at different AICRPS centres

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

Seven entries (three from OUAT, one each from ICAR-IISR, Gangtok, Nagaland and Pundibari) were evaluated during 2019-2020 and 2020-2021. At Mizoram, significantly higher number of tillers per plant was recorded in Bold Nadia (5.3 no.) at par with Bhaise, whereas least was observed in Gorubathan. Plant height was significantly higher in PGS 121 (60.3 cm) at par with Bhiase and lowest in PGS 95. Number of leaves per plant at maturity was higher in Bhaise (62) and lowest in Gorubathan (30). Significantly higher fresh weight of clump was recorded in Bold Nadia (334.0 g) followed by PGS 121 and least in PGS 95. Similarly, Bold Nadia recorded significantly higher yield (10.26 t ha^{-1}), followed by PGS 102 and PGS 121 whereas lowest yield was observed in PGS 95.

Bold Nadia had the highest sprouting per cent of rhizomes (94.44%), followed by PGS 95 (87.77%) at Nagaland. Plant height and number of tillers produced were significantly lower in John's Ginger (67.2 cm and 1.90). Highest rhizome weight per clump was recorded in Bold Nadia with 165.56 g and minimum of 68.90 g per clump in PGS 95. The cultivar Nadia recorded highest yield/ha (17.26 t) under foothill condition of Nagaland, followed by Bhaise with a projected yield of 16.20 t ha^{-1}. Bold Nadia and PGS 95 also recorded maximum dry recovery (17%) followed by John's ginger (16.86%). However, fibre, oleoresin and essential oil content recorded significant variations among the cultivars.

At Pottangi, the highest cumulative mean yield (2018-19 to 2020-21) of 17.2 t ha^{-1} was recorded in Bold Nadia, followed by PGS 121 (16.7 t ha^{-1}) and John's ginger 16.4 t ha^{-1}). A similar trend was recorded across the locations (from 2019-2021) with 14.1 t ha^{-1} in Bold Nadia, followed by John's ginger (12.8 t ha^{-1}). At Chintapalle, significant differences were observed among the genotypes for all characters except sprouting percentage. The highest plant height was recorded in PGS 102 (38 cm) followed by Bhaise (37 cm). The highest fresh yield per plant (432.59 g) and per hectare (20.20 t) was recorded in John's ginger. At Pundibari, the highest yield (13.09 t ha^{-1}) was recorded in Bold Nadia, followed by Bhaise (11.94 t ha^{-1}) and Gorubathan (11.65 t ha^{-1}).

At ICAR Sikkim Centre, growth, yield and yield attributes showed significant variations under organic management conditions. Maximum number of tillers per clump and maximum

number of leaves per plant were recorded in PGS-121, significantly higher than other cultivars. Significantly higher plant height was noticed in Gorubathan. Compared to other cultivars, highest fresh rhizome yield was obtained in Gorubathan (statistically at par with PGS-121 and Bhaise).

Table 9. Mean performance of bold ginger entries across the locations from 2019-2021

Genotype	Fresh rhizome yield (t ha^{-1})						
	Sikkim	Nagaland	Chintapalle	Mizoram	Pundibari	Pottangi	Mean
Bold Nadia	7.2	21.6	15.8	10.3	12.7	17.2	14.1
PGS-102	7.6	14.3	14.8	11.5	10.6	15.3	12.3
PGS-121	8.4	13.6	10.9	8.8	9.7	16.7	11.4
PGS-95	9.0	11.8	12.1	9.2	8.4	15.6	11.0
Bhaise	7.3	5.4	12	8.2	10.1	16.3	9.9
Gorubathan	9.5	15.4	13.4	10.3	11.4	14.7	12.5
John's ginger	7.0	17.3	14.2	13.1	8.8	16.4	12.8
SE(m)	0.4	0.4	0.6	0.4	0.35	0.35	0.4
CD(0.05)	1.1	1.1	1.74	1.1	1.05	1.05	1.2
CV %	5.4	5.4	6.4	8.4	5.4	5.4	6.1

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)

This experiment was initated during 2021-22 (Kharif/Rabi) with eight treatments : T1- sole ginger ; T2- ginger + papaya + leafy coriander (grow papaya with a spacing of 180 x 180 cm. Between two lines of payaya 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.); T3- 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); T4- ginger + coriander + leafy vegetables (Grow ginger and coriander in 2:2 ratio. After harvesting of coriander, grow leafy vegetables in place of coriander); T5- ginger + maize (2:1 or 2:2) (Grow sweet corn in kharif, rabi and summer- 3 times); T6- ginger + french bean (2:2) (Grow french bean in kharif, rabi and summer- 3 times); T7- ginger + arhar (3:1) (Grow arhar in kharif); T8- ginger + taro (2:2) (Grow taro in kharif).

Initial results from Pottangi indicate that the returns from coriander as inter crop in ginger was the highest (Rs 480/bed) followed by Maize (Rs. 200/-). At Mizoram, all the intercropping combinations with ginger was found effective and resulted in higher system productivity except ginger-fenugreek intercropping. At Nagaland, there were only non-significant effects among the treatment combinations with respect to growth parameters and the crop is not yet harvested. At Dholi, the trial failed due to water-logging owing to unprecedented rainfall of 1883.60 mm during 2021.

The results showed that significantly higher ginger equivalent yield (28 t ha^{-1}) and system productivity (39 t ha^{-1}) were noticed under ginger + maize (2:1 or 2:2) (Grow sweet corn in kharif, rabi and summer- 3 times) followed by Ginger + taro (2:2) as compared to other sole and intercropping system at Gangtok.

This experiment was executed during khari*f* 2021 as per the approved technical programme at Chintapalli and Kalyani. All cultural and management practices are implemented to maintain healthy crop.

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)

A new trial 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 @ 1ml L^{-1}+ imidacloprid 0.5 ml L^{-1} for 30 minutes; T_4: Recommended package of practices (POP) was initiated during 2020-21.

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 (74.38%), plant population (73.13%), plant height (37.86 cm), numbers of tillers per clump (8.30), fresh rhizome yield (7.00 t ha^{-1}) and lowest rhizome rot incidence (16.33%) was 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 (67.60 cm) was recorded in T_1 (Trichoprime), followed by T4 (Recommended package of practices) (66.37). Highest yield per plant (270 g $plant^{-1}$) was recorded in T_1, followed by T_3 (266 g). Yield (8.44 t ha^{-1}) and oleoresin content (3.16%) were also found to be higher in T1 (Trichoprime) compared to other treatments.

Table 10. Priming of rhizomes for enhanced germination, vigour 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	61.88	56.88	36.01	7.45	83.08	3.58	25.15
T_2	58.75	55.00	25.55	4.40	90.90	3.47	26.17
T_3	48.13	45.00	26.00	4.25	86.58	2.93	37.48
T_4	74.38	73.13	37.86	8.30	78.17	1.99	16.33
T_5	41.88	36.25	28.57	4.85	86.45	3.46	44.80
SEm (±)	4.67	4.55	1.89	0.51	4.784	0.60	4.98
CD (*p*-0.05)	14.54	14.16	5.88	1.59	NS	NS	15.50
CV (%)	16.37	17.07	12.26	17.44	11.25	38.79	33.18

At Kalyani, highest sprouting percentage was recorded when rhizomes were treated with Trichoprime (T1), followed by the treatment T2 (rhizomes treated with metalaxyl-mancozeb @ 1.25 g L^{-1} + imidacloprid 0.5 ml L^{-1} for 30 minutes). Highest plant population and plant height were observed in Trichoprime (T1) followed by T2 (metalaxyl-mancozeb). However, maximum number of tillers and higher clump weight were noticed in T2. Lowest rhizome rot

and wilt were recorded in T1, whereas lowest *Phyllosticta* leaf spot was recorded in T3 (rhizome treatment with tebuconazole @ 1 ml L^{-1} + imidacloprid 0.5 ml L^{-1} for 30 minutes).

Priming significantly enhanced the sprouting percentage as compared to the local practice (hot water treatment before sowing rhizomes) from 82.67 to 96.33 % at Nagaland. There were no significant variations observed on plant population and tiller production among the treatments. Minimum percentage of storage rot (3.33%) was recorded under T1 and low borer infestation with PDI of 15.66. However, T3 and T2 recorded highest PDI value of 39.45 and 35.58, respectively for soft rot disease.

At Pasighat, none of the treatments could significantly influence the plant population and spouting (%) of ginger. The maximum plant height and number of tillers per plant were recorded in the treatment T1 (Trichoprime) which did not vary significantly with T2 (metalaxyl-mancozeb) and T3 (tebuconazole) but differed with T4 (recommended PoP). Significantly higher yield (11.88 t ha^{-1}) was realized under T1 (Trichoprime), followed by T2 (10.78 t ha^{-1}). The minimum incidence of rhizome rot was found in T1 (Trichoprime) which was at par with T2 (Metalaxyl-Mancozeb). The maximum shoot borer attack was recorded with T4 (recommended PoP), at par with T2 (metalaxyl-mancozeb).

At Pundibari, the highest sprouting percentage, plant stand at 50 DAS and plant height were recorded under T1 and T2, whereas the highest number of tillers was noticed in treatment T2 (4.5). Lowest storage rot (10.85%), lowest rhizome rot and wilt (13.44%) were recorded in the treatment T1, whereas lowest *Phyllosticta* leaf spot (PDI 15.64) was recorded in the treatment T3, followed by treatment T1 (Trichoprime) (PDI 17.08). Highest yield (13.40 t ha^{-1}) and dry recovery (24.50%) was recorded in T1, whereas highest clump weight was recorded in T2 (237.58g).

Fig 12: Field view of trichoprime trial at Pottangi

Ginger rhizome treated with Trichoprime (T1) had significant effect on yield (11.66 t ha^{-1}), followed by T4 (10.12 t ha^{-1}) at Kanke. Lowest disease incidence was observed in T4 (18.33%) followed by T1 (21.18% at 90 DAP). At Kammarpally, among the treatments, T1 (Trichoprime) recorded maximum yield (25.4 t ha^{-1}), followed by T2 (metalaxyl-mancozeb + imidacloprid (19.9 t ha^{-1}). At Solan, rhizome treatment with tebuconazole (T3) 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 (T2). At Raigarh also, rhizome germination of 95 percent, minimum disease incidence of 17.34% and maximum yield (13.10 t ha^{-1}) were observed in the treatment T3 (rhizome treatment with tebuconazole).

However, at Chintapalle there was no significant difference among the treatments for different vegetative and yield characters. Among the treatments, T4 (recommended state POP) recorded the highest fresh rhizome yield $plant^{-1}$ (306.30 g) and fresh rhizome yield ha^{-1} (20.68 t). At Ambalavayal also, there was no significant difference in yield among the treatments.

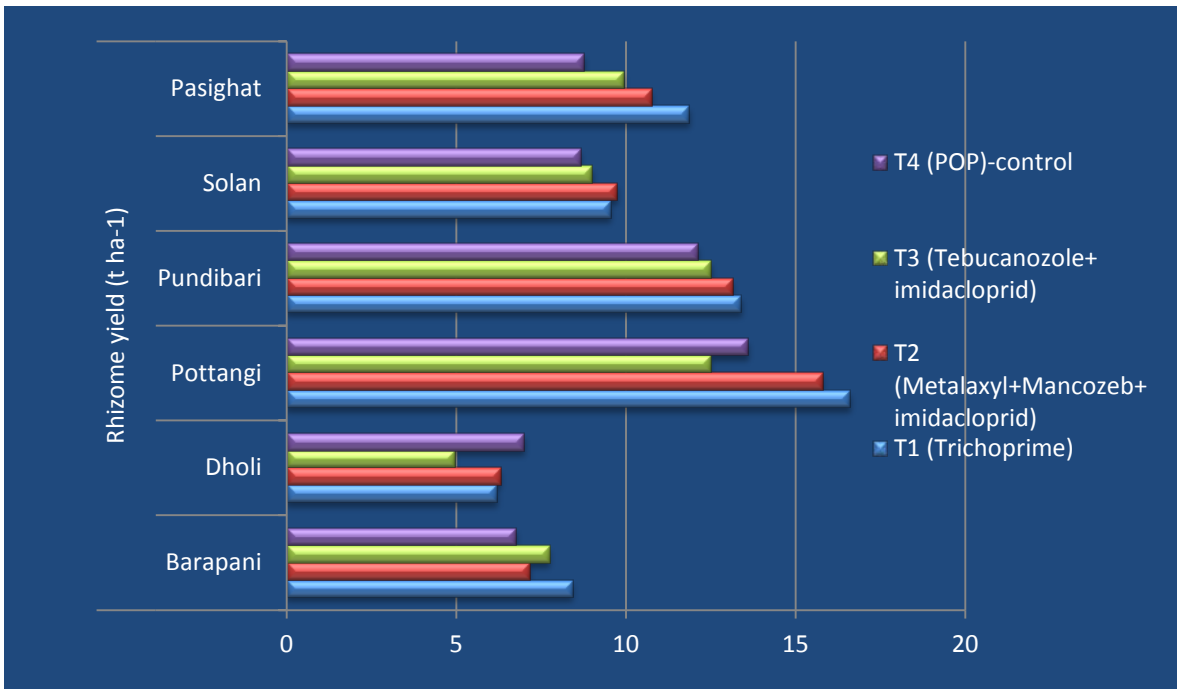


Fig 13: Influence of various rhizome treatments on yield of ginger at different AICRPS centres

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

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

Preliminary observations at Pottangi indicate that 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, the crop is not yet harvested and the observations on growth parameters indicate non-significant differences among the treatments. Results at Mizoram also indicate that application of 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 (18.0 t ha^{-1}) as compared to other insecticide treatments. At Pundibari, it was found that highest sprouting percentage (91.67%) was observed in control (water spray). No infested shoot was found before the spray and after spray.

The experiment was implemented during 2021 at Sirsi, Mudigere, Pasighat, Barapani, Kanke and Ambalavayal and the treatments were imposed as per the experiment details given. But at Sirsi, because of heavy rainfall the crop stand was poor. Therefore the experiment was vitiated. It will be taken up in the ensuing season.

Table 11. Performance of different insecticide sprays in ginger at Mizoram

Treatment	Plant height at harvest	No. of leaves per plant at harvest	No. of tillers per plant	Fresh weight of clump (g)	Yield (t ha^{-1})
T_1- Chlorantraniliprole @ 0.3 ml L^{-1}	50.4	36.8	5.7	125.0	9.2
T_2- Chlorantraniliprole @ 0.5 ml L^{-1}	59.2	48.9	6.2	157.6	14.1
T_3- Flubendiamide @ 0.3 ml L^{-1}	60.4	56.4	9.2	236.0	14.6
T_4- Flubendiamide @ 0.5 ml L^{-1}	61.2	50.3	6.8	167.0	16.1
T_5- Spinosad @ 0.3 ml L^{-1}	37.7	49.9	6.1	126.8	14.6
T_6- Spinosad @ 0.5 ml L^{-1}	64.3	42.9	5.3	158.3	16.0
T_7- Chlorantraniliprole + Spinosad@ 0.5 ml L^{-1} (alternatively)	64.7	51.1	9.7	245.0	18.0
T_8-Control (water spray)	46.8	26.1	3.0	106.7	7.1
LSD (P=0.05)	17.0	8.6	2.3	40.5	3.6

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)

Preliminary observations at Pottangi indicate that rhizome treatment with *T. asperellum* talc formulation (mass multiplied in cowdung: neem cake mixture, 9:1) was found to be the best. The experiment was executed during kharif 2021 as per the approved technical programme at Chintapalle and Barapani.

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 treatments recorded reduction in the viable colony units of *Phytophthora*, *Pythium* and *Fusarium* in treatments with the biocontrol agents, *Trichoderma asperellum* and *Pochonia chlamydosporia*.

V 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.

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 turmeric accessions (TCP 280, TCP 281 and TCP 282) collected from Terai region. Profiling of the germplasm accessions shows a good number of genotypes to be high yielding and many of them are resistant or moderately resistant to the foliar diseases, leaf blotch and leaf spot.

Table 12. Turmeric germplasm collections maintained at various AICRPS centres

Centre	Cultivated	Wild & related species	Exotic	Total
Coimbatore	269	9	2	280
Dholi	65	-	-	65
Kammarpally	287	-	-	287
Kumarganj	180	-	-	180
Pottangi	178	23	-	201
Pundibari	177	35	-	212
Raigarh	97	10	-	107
Guntur	252	-	-	252
Pantnagar	52	-	-	52
Pasighat	56	2	-	58
Solan	41	-	-	41
Barapani	32			32
Total	1688	77	2	1767

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, 15 of them recorded more than 500 g clump weight per plant with the highest clump weight per plant recorded in IT 59 (950 g). Towards genetic enhancement of PGR of turmeric, single plant selection from bulk population of all the germplasm accessions were selected during 2020, which is representative of the respective germplasm, for maintenance of true to type plant and individual plant progenies of selected SPS of accessions were planted during kharif 2021. A total of 96 germplasm accessions of turmeric were processed for dry

recovery which ranged from 10 % (IT 25) to 31% (IT 7). Proposals for variety notification of CG Haldi-1 and CG Haldi-2 were re-submitted to CVRC, New Delhi during February 2021.

Out of the 168 *Curcuma longa* accessions evaluated at HARS, Pottangi, 75 accessions recorded more than 5 kg $3m^{-2}$ and 10 genotypes recorded more than 10 kg $3m^{-2}$ fresh rhizome yield. In *Curcuma aromatica*, 12 among the 23 accessions recorded more than 5 kg $3m^{-2}$ fresh rhizome yield. Among the 65 accessions screened at Dholi, RH-432 recorded the highest yield of (52.44 t ha^{-1}), followed by RH-3 (50.43 t ha^{-1}) and RH-448 (49.23 t ha^{-1}) as compared to check variety Rajendra Sonali (46.77 t ha^{-1}). Among the 65 germplasm accessions of turmeric including one susceptible check (Morangia) screened against foliar diseases, 12 germplasm accessions were found to be resistant and 49 of them moderately resistant against leaf blotch disease caused by *Taphrina maculans*, whereas all the other germplasm (including Morangia) accessions were found to be highly resistant against leaf spot disease caused by *Colletotrichum capsici*. Twelve germplasm accessions (RH-12, RH-7, RH-80, RH-5/80, RH-401, RH-402, RH-13/90, RH-416, RH-424, RH-425, RH-430 and RH-446) were found resistant against leaf blotch disease caused by *Taphrina* and highly resistant against *Colletotrichum* leaf spot.

At Coimbatore, characterization was done for a new set of genotypes selected based on high rhizome yield, curcumin, dry recovery and short duration types. Among the high curcumin genotypes evaluated, CL 258 with curcumin content of 5.79 % recorded the highest fresh rhizome yield of 439.00 g $plant^{-1}$, followed by CL 123 (431.00 g $plant^{-1}$) with 5.00 % curcumin. 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. At Kammarpally, 287 accessions were maintained and evaluated for their growth and yield attributes. Among them, SLP-389/1 (50.24 t ha^{-1}) and CLI-326 (40.49 t ha^{-1}) performed well when compared to local check (Duggirala Red) (18.74 t ha^{-1}) and IISR Prathibha (National check) (17.99 t ha^{-1}). These accessions were also screened against major foliar diseases and DUS characters were recorded for all the accessions.

Evaluation of 180 germplasm accessions maintained at Kumarganj revealed maximum yield in NDH-74 (277 g $plant^{-1}$) and NDH-86 (266 g $plant^{-1}$) among the early maturing types; NDH-98 (320 g $plant^{-1}$) and NDH-135 (263 g $plant^{-1}$) under medium, and NDH-8 (266 g $plant^{-1}$), NDH-2 (264 g $plant^{-1}$) and NDH-7 (260 g $plant^{-1}$) among the late maturing types. Among the 47 genotypes evaluated at Guntur, fifteen entries recorded significantly higher clump weight compared to the best check Duggirala Red (454.4 g). The top five entries were LTS-45 (762.3 g), LTS-46 (674.5 g), CLI-196 (657.6 g), LTS-42 (613.5 g) and LTS-44 (590.1 g).

Among the 32 accessions evaluated at Barapani centre, the highest plant height (101.40 cm), leaf length (65.0 cm) and breadth (17.57 cm), and the number of leaves (30.33) were recorded in IC-586780. However, highest yield was recorded in IC-586756 (37.11 t ha^{-1}), while the highest curcumin content was recorded in IC-586771 (6.07%). Among the 58 diverse genotypes collected from the entire NE region and evaluated at Pasighat, the maximum fresh rhizome yield (388.65 g $plant^{-1}$ and 39.83 t ha^{-1}) was recorded in CHFT-8.

Table 13. Promising germplasm accessions (2020-21) at Guntur

S. No.	Entry	Clump weight (g)	S. No.	Entry	Clump weight (g)
1	LTS-45	762.3	11	BSR-2 (C)	387.3
2	LTS-46	674.5	12	Duggirala Red (C)	454.4
3	CLI-196	657.6	13	Mydukur (C)	430.6
4	LTS-42	613.5	14	Prathibha (C)	391.5
5	LTS-44	590.1	15	Salem (C)	431.2
6	RH-410	566	16	Tekuripet (C)	419.9
7	LTS-47	561.1	Mean		427.3
8	TC-14	550.8	LSD (p=0.05)		26.5
9	CLI-96	543.2	CV (%)		12.1
10	CLI-339	535.2			

Crop Improvement

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

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

Nine 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 second year of evaluation (pooled data), Acc. 347 recorded the maximum yield (52.29 t ha^{-1}), followed by NVMG 2 (44.38 t ha^{-1}) at IISR, Kozhikode. At Dholi, none of the ten entries recorded significantly higher yield than check variety Amba, though NVMG-2 recorded higher yield (36.54 t ha^{-1}) compared to the other entries. The trial was initiated at Ambalavayal.

At Navsari, six genotypes (NVMG-2, NVMG-10, ACC-265, CMA-2, CMA-3 and ACC-347) were found significantly superior in mean performance for fresh rhizome yield over the national check Amba (13.29 t ha^{-1}) while at Pottangi, CAM-3 (24.2 t ha^{-1}) was the top yielder, followed by CAM-2 (22.6 t ha^{-1}). At Barapani, the highest sprouting % was recorded in Acc. 265 (90.33), while the highest plant height was recorded in Acc.347 (105.7cm). Higher number of tillers/clump was found in Acc.347 (3.52), followed by Indira Mango Ginger-1 (3.44). The fresh weight of clump and fresh rhizome yield were higher in Acc.265 (69.44g). Highest fibre content was recorded in local ginger (2.66%), while the highest oleoresin content was found in Indira Mango Ginger-1 (5.28%).

There were significant variations among the genotypes with repect to different growth and yield characters at Pundibari. The tallest plant was observed in Indira Mango Ginger (128.60 cm) which was statistically on par with Amba (124.20 cm) and ACC-347 (122.80 cm). Tiller number per plant varied from 3.13 to 4.47 and number of leaves ranged from 9.40 to 11.60. On the basis of fresh rhizome yield, the highest yield was recorded in NVMG-10 (35.80 t ha^{-1}), followed by ACC-265 (31.07 t ha^{-1}). At Raigarh, Indira Mango Ginger-1 recorded the highest rhizome yield (31.0 t ha^{-1}), followed by RH 408 (29.7 t ha^{-1}) and ACC 347 (27.5 t ha^{-1}) over control Amba (20 t ha^{-1}).

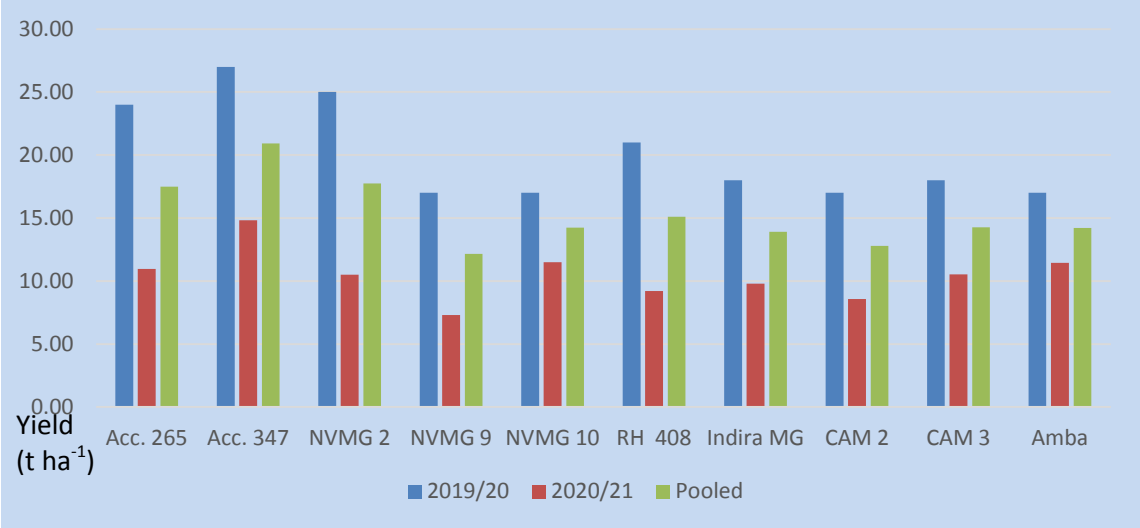


Fig 14: Yield performance of mango ginger genotypes (Pooled data) at Kozhikode

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

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

In this coordinated varietal trial, eight genotypes along with three national checks and one local check are being evaluated for identifying high yielding turmeric genotypes with high curcumin. At Coimbatore, observations on plant growth characters at 120 DAP revealed that the genotype IT 26 registered the maximum plant height of 62.40 cm with a pseudostem girth of 9.06 cm and an average of 2.0 tillers per plant. Among the seven entries CL272 recorded the highest clump yield per plant (334.00 g) which was however lesser than the local check CO 2 (359.67 g). Among the other entries, NVST 56 recorded the clump yield of 259.67 g followed by CL 258 (255.00 g) and RRN 1 (208.67 g).

At Pasighat, maximum sprouting (%) and plant population were observed in the cultivar CL258 and CL272. The maximum number of tillers per plant was observed in the cultivar CL258 which did not vary with NVST 56 and IISR Pragati. Higher yield was observed in the check CIM Pitamber (35.88 t ha^{-1}) followed by NVST 56 (33.66 t ha^{-1}). The minimum incidence of leaf blotch was found in CIM Pitamber and lesser incidence of leaf spot in RRN1, CL 258, IISR Prathiba and CIM Pitamber. Similiarly the minimum incidence of stem borer was observed in RRN1 and IT 26.

At Pottangi, the entry PTS-47 (18.0 t ha^{-1}) was the top yielder with the yield advantage of 20 % than the national check variety IISR Pratibha (15.0 t ha^{-1}), followed by NVST-56 (17.6 t ha^{-1}) and PTS-6 (17.6 t ha^{-1}). At Kanke, highest yield of 28.20 t ha^{-1} was recorded in IT26 (Raigarh), followed by IISR Pragati (25.23 t ha^{-1}). While at Kammarpally, CL272 recorded maximum yield (24.79 t ha^{-1}) followed by PTS 6 (20.26 t ha^{-1}). At Guntur, NVST-84 was found to be on par with the best check Mydukur (38.5 t ha^{-1}). At Navsari, NVST-56 (47.20 t ha^{-1}) and NVST-84 (45.81 t ha^{-1}) were found to be significantly superior over both the national checks IISR Pragati (39.17 t ha^{-1}) and IISR Pratibha (32.41 t ha^{-1}).

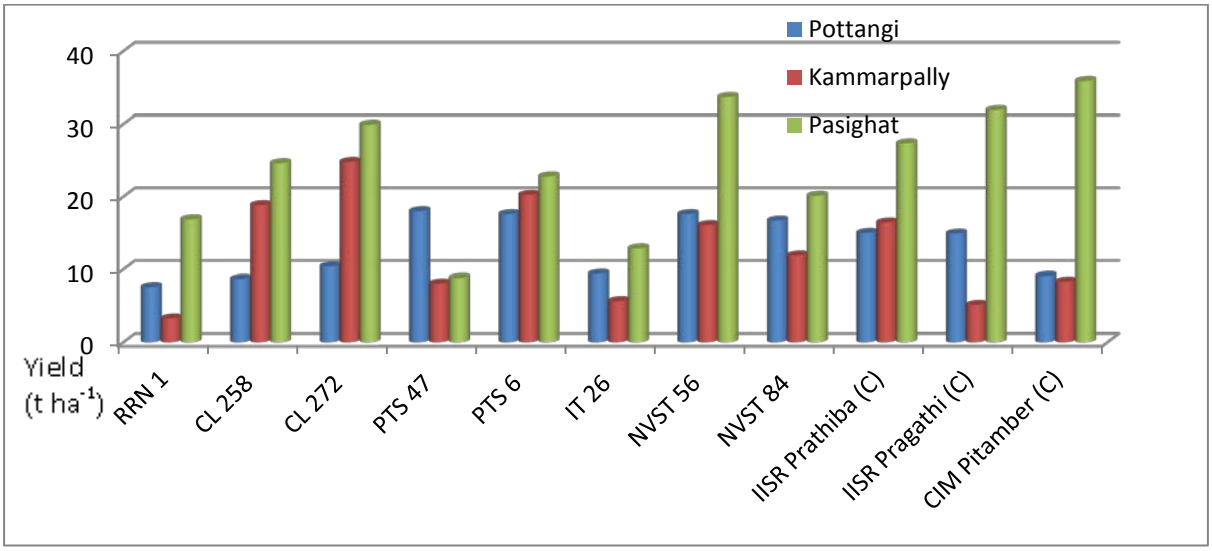


Fig 15: Variation in the yield of turmeric genotypes at various locations

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

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

In the coordinated varietal trial on suitability of light yellow coloured turmeric for specialty market, ten genotypes (Mydukur from Guntur, PTS-50 from Pottangi, RRN2, RRN3, RRN4, Acc 1545 and Acc 849 from ICAR-IISR, CL-223 and CL-21 from Coimbatore and KPS -611 from Kammarpally) along with two national checks and one local check are being evaluated at various centres.

Preliminary observations at Coimbatore centre revealed that the genotype KPS 11 recorded the highest clump yield per plant (242.67 g) followed by PTS 50 (209.00), ACC 1545 (199.67 g) and CL 21 (195.33 g) though much lesser than the local check, CO 2 (359.67 g). The data from Pasighat revealed that the maximum sprouting (%) and plant population were recorded in IISR Pratibha and Mydukur. The maximum plant height was found in CL 21. Maximum number of tillers per plant was recorded in RRN3 and Acc 849 which was at par with KPS 611 and IISR Pratibha. The highest yield was observed in the genotype RRN 3 (30.09 t ha^{-1}), followed by ACC 849 and KPS 611. The minimum leaf blotch incidence was found in CL 223 and was on par with CL 21, KPS 611 and Mydukur. There was no incidence of leaf spot in any of the genotypes. Significantly lower incidence of stem borer was recorded in KPS 611 and the maximum in Acc 1545. At Pottangi, the entry Acc-849 (12.0 t ha^{-1}) was the top yielder with the yield advantage of 7.6 % over the national check variety, IISR Pratibha (11.2 t ha^{-1}), followed by PTS-50 (11.6 t ha^{-1}), while at Kammarpally KPS 611 recorded maximum yield (24.53 t ha^{-1}), followed by CL 223 (18.39 t ha^{-1}). At Kanke, RRN 2, ACC 849, KPS 611 performed better with fresh rhizome yield of 28.45 t ha^{-1}, 25.29 t ha^{-1}, 24.59 t ha^{-1}, respectively. However at Guntur, none of the entries were found significantly superior to the best check Mydukur (38.2 t ha^{-1}).

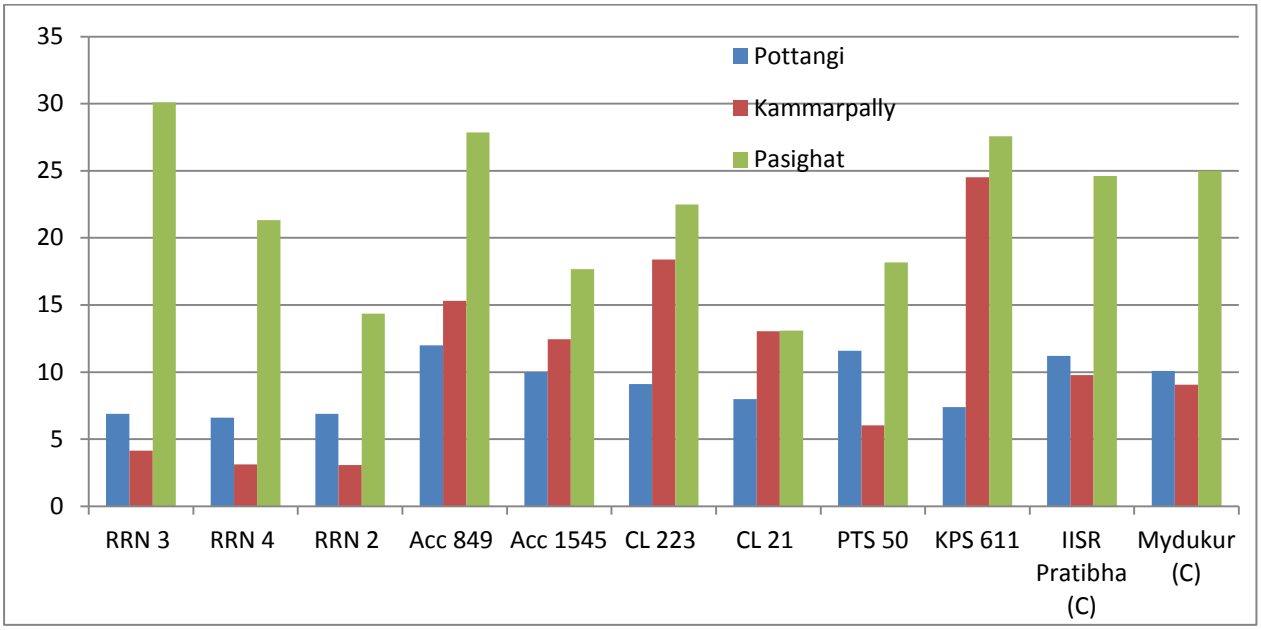


Fig 16: Variation in the yield of turmeric genotypes at various locations

TUR/CI/3 Varietal Evaluation Trial
TUR/CI/3.9 Initial Evaluation Trial (IET) 2018
(Guntur)

During the year 2020-21, ten genotypes along with one check were evaluated in RBD. All the genotypes recorded significantly higher yield than the check Mydukur (38.9 t ha^{-1}). The first three promising genotypes were LTS-19-4 (53.3 t ha^{-1}), LTS-19-1 (52.8 t ha^{-1}) and LTS-19-3 (50.0 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 were recorded during 2019-20.

At Coimbatore different priming treatments completely suppressed the storage rot. Turmeric rhizomes treated with trichoprime enhanced the plant population (59.6) at 50 DAP, plant height (105.6 cm), number of tillers per clump (5.9), fresh weight of clump (0.684 g), fresh rhizome yield (37.74 t ha^{-1}). Priming with trichoprime also improved the quality characters *viz*., curcumin content (3.84%) and oleoresin (5.6 %). Thus rhizome treatment with trichoprime significantly mitigated the foliar disease severity as compared to the untreated control which recorded *Taphrina* leaf blotch severity of 48.95 PDI. Further, the presence of fungicidal and insecticidal residues determined by LC-MS-MS revealed that the fungicide and imidacloprid residues were below detectable limit (BDL) in the turmeric rhizomes.

Table 14. Assessment of priming of rhizomes on quality parameters in turmeric (2020-2021) at Coimbatore

Treatment	Curcumin (%)	Oleoresin (%)
T_1: Rhizome treatment with Trichoprime	3.84	5.6
T_2: Rhizome treatment with metalaxyl-mancozeb @ 1.25g/L+ Imidacloprid @ 0.5 ml/L	2.84	5.1
T_3: Rhizome treatment with tebuconazole @ 1ml /L+ Imidacloprid @ 0.5 ml/L	3.70	5.4
T_4: Recommended state package of practices (Rhizome treated with carbendazim @ 1g/L and phosalone @ 2 ml/L)	3.31	5.3
SE.d	0.154	0.163
CD (p=0.05)	0.356	0.376

Rhizome treatment with Trichoprime (*T. harzianum*) was found to be best (17.2 t ha^{-1}), followed by rhizome treatment with metalaxyl mancozeb @1.25g L^{-1} +imidacloprid @ 0.5ml L^{-1} for 30 minutes at Pottangi.The highest fresh rhizome yield (31.45 t ha^{-1}) was recorded in T1, followed by T2 (31.11 t ha^{-1}), T4 (30.28 t ha^{-1}) and T3 (29.44 t ha^{-1}) at Kumarganj. Also, at Kammarpally, T1 (Trichoprime) recorded maximum yield (32.36 t ha^{-1}), followed by T2 (metalaxyl-mancozeb + imidacloprid) (28.72 t ha^{-1}). Results at Mizoram also indicate 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) whereas, least were from recommended state package of practices (without priming). Similarly, significantly higher fresh weight of clump (500.4 g), no of rhizomes per clump (12.5 no) and yield (30.2 t ha^{-1}) were recorded in T1 that was statistically at par with T2.

All the treatments were on par except for yield, sprouting (%), plant population at 50 DAS (%), plant height (cm) and number of tillers per clump at Dholi. Neither storage rot nor rhizome rot incidence was recorded at 30, 60 & 90 DAS. There were no significant difference among the treatments for different vegetative and yield characters at Chintapalle. Among the treatments, T4 (Recommended State POP) recorded the highest fresh rhizome yield $plant^{-1}$ (351.44 g), fresh rhizome yield ha^{-1} (28.26 t) and dry rhizome yield ha^{-1} (6.87 t). The data recorded at Pasighat indicate that different priming treatments could not significantly influence the plant population and the sprouting percentage of turmeric. Maximum number of tillers/plant was recorded in the treatment T1 which was on par with T3, but superior to the other two treatments (T2 and T4). The maximum yield (29.67 t ha^{-1}) was recorded in the treatment T1 (Trichoprime treatment) followed by T2 and T3 (28.78 and 28.44 t ha^{-1} respectively). The highest incidence of leaf blotch, leaf spot and shoot borer was observed in T4 and it was on par with T3. The minimum incidence of stem borer was observed in T1 (Trichoprime) and the incidence of shoot borer was at par among the treatments.

At Pundibari, highest plant height (93 cm) and highest number of tillers per plant (4) were noticed under T1, followed by T2 (89.67 cm and 3.67, respectively). No rhizome rot and wilt incidence were recorded in any of the treatments. Lowest incidence of leaf spot (PDI 6.61) and leaf blotch (PDI 9.52) were recorded in T3 while lowest storage rot was recorded in T1 (11.32%). Highest clump weight (396.17g), highest yield (26.33 t ha^{-1}) and highest dry

recovery (24.97%) were recorded in T3. At Kahikuchi, sprouting was found highest (97.76%) in T3, followed by T4 (97.22%). Rhizome rot incidence was very less and a maximum of 5.36% was recorded in T1 followed by T2 (4.87%) and the minimum was recorded in T3 (3.53%). Similarly, storage rot after four weeks of storage was found lowest (1.87%) in T3 treatment.

Priming turmeric rhizomes with Trichoprime had significant effect on yield at Kanke. Maximum yield (36.39 t ha^{-1}) was observed under the treatment (T1), followed by rhizomes treated with metalaxyl-mancozeb (32.77 t ha^{-1}), metalaxyl- mancozeb + imidacloprid (T2) (29.83 t ha^{-1}) which was at par with tebuconazole + imidacloprid (T2) (27.56t ha^{-1}). No incidence of rhizome rot was found under any of the treatments. At Solan, rhizome treatment with tebuconazole + imidacloprid (T3) 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%). This was followed by rhizome treatment with metalaxyl-mancozeb + imidacloprid. At Raigarh, maximum yield (24.05 t ha^{-1}) was obtained in T3 (tebuconazole + imidachloprid with minimum disease intensity of *Colletotrichum* leaf spot (14.39 %).

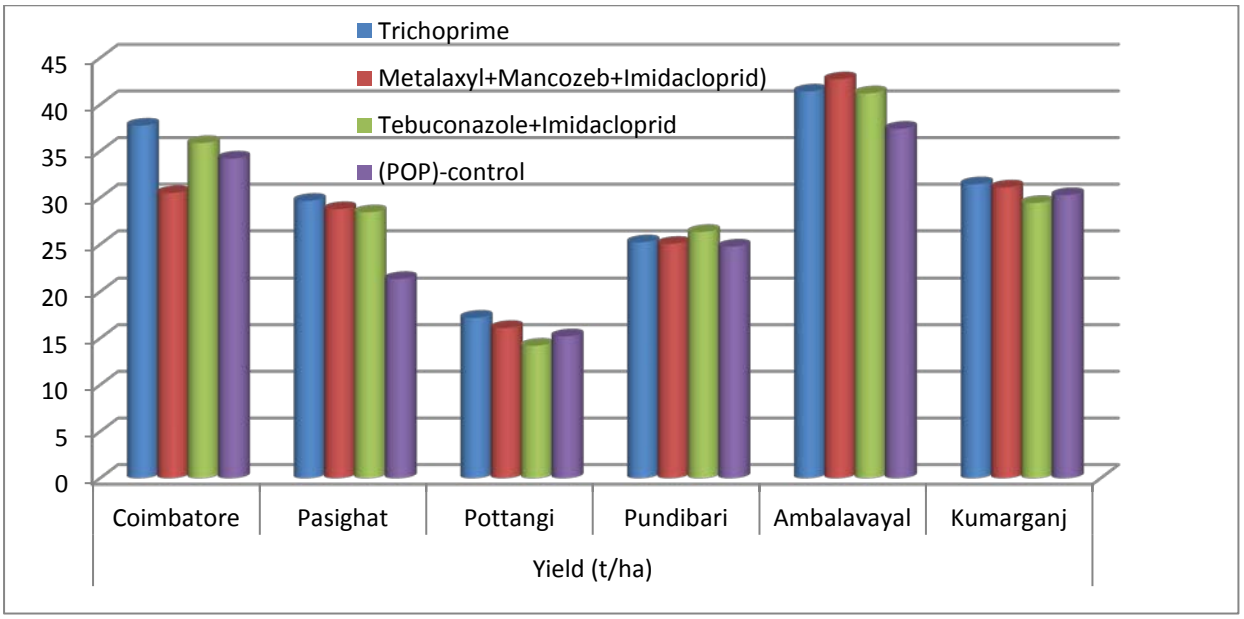


Fig 17: Effect of rhizome treatments on yield of turmeric at various locations

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)

The experiment was initiated during the month of June 2021 by Mudigere centre at AHRS, Kademadkal. 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}. 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.

The experiment has been implemented at Sirsi, Pasighat, Barapani, Ambalavayal, Kanke, Nagaland and the treatments were imposed as per the treatments. 100% sprouting was

obtained for all the treatments 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 case of treatment 5 (Spinosad@ 0.3 ml L^{-1}) and treatment 8 (control- water spray) and an average of 0.5 shoot was found to be infested by shoot borer in case of T6 (spinosad @ 0.5 ml L^{-1}). Highest plant height was recorded in T4 (flubendiamide @ 0.5 ml L^{-1}).

Table 15. Effect of different insecticides on shoor borer infestation on turmeric at Pundibari

Treatment	Sprouting (%)	No of shoots/ clump (Pre-treatment count)	No of infested shoots/ clump (Pre-treatment count)	Plant height (cm)	Leaf length (cm)	Leaf width (cm)	No of infested shoots/ clump
T1	100	1.83	0.0	105.62	58.47	12.34	0.0
T2	100	1.67	0.0	104.20	58.62	11.54	0.0
T3	100	1.50	0.0	100.25	60.42	11.33	0.0
T4	100	1.63	0.0	**105.72**	60.54	11.88	0.0
T5	100	1.92	0.0	102.84	**61.70**	**11.77**	1.75
T6	100	1.29	0.0	91.06	53.69	10.33	0.5
T7	100	1.75	0.0	101.00	53.56	11.66	0.0
T8	100	1.58	0.0	91.02	52.49	10.40	1.75

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)

In the first year of observational trial on the efficacy of *Trichoderma asperellum* and *Pochonia chlamydosporia* for the management of rhizome rot and nematodes in turmeric at Coimbatore, Guntur and Barapani, the treatments were imposed at the time of planting, 30 days after planting (DAP), 60 days after planting (DAP). 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 treatments recorded reduction in the viable colony units of *Phytophthora*, *Pythium* and *Fusarium* in treatments with the biocontrol agents, *Trichoderma asperellum* and *Pochonia chlamydosporia*.

VI 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 accessions conserved and evaluated at Pechiparai, MF- 1 recorded maximum tree height (12.17 m) and stem girth (64.98 cm) while MF 4 recorded maximum leaf length (25.66 cm), leaf breath (9.2 cm), number of fruits (682.5), single fruit weight (53.55 g) and mace yield (288.86 g tree-^{1}). Sixteen promising genotypes among the germplasm collections of nutmeg (planted during the year 1996–97) were identified at Dapoli. The genotype DBSKKV 19 recorded maximum dry nut yield (3146.0 g) and dry mace yield (786.5 g). From overall performance the genotype DBSKKVMF 19 was found to be promising considering its fruit yield parameters.

Table 16. Performance of nutmeg accessions at Pechiparai

Sl. No.	Accession	Plant height (m)	Stem Girth (cm)	Leaf length (cm)	Leaf breath (cm)	No. of fruits	Single fruit weight (g)	Mace yield/ tree (g)
1.	MF-1	12.17	64.98	15.68	7.21	334.61	42.46	196.96
2.	MF-2	10.06	48.00	16.26	6.54	356.81	39.42	186.86
3.	MF-3	8.05	43.10	16.30	6.22	432.89	47.48	175.75
4.	MF-4	8.55	25.66	20.32	9.20	682.50	53.55	288.86
5.	MF-5	9.49	54.19	13.30	5.63	355.00	49.49	149.48
6.	MF-6	9.77	52.49	14.70	7.57	396.48	47.98	213.11
7.	MF-7	9.99	43.77	15.71	7.20	400.03	42.94	237.36
8.	MF-8	9.55	43.98	13.27	6.22	384.50	42.44	248.46
9.	MF-9	5.25	45.10	14.69	6.20	439.05	41.93	159.58
10.	MF-10	10.06	47.95	13.30	6.20	365.00	37.38	147.46
11.	MF-11	8.10	40.00	13.68	6.54	465.00	39.39	154.53
12.	MF-12	8.25	47.00	15.59	7.56	520.77	35.86	188.87
13.	MF-13	8.27	40.45	17.33	8.22	520.22	36.88	197.96
14.	MF-14	9.00	36.89	15.29	6.57	579.56	38.90	217.16
15.	MF-15	9.01	37.88	15.72	4.53	582.50	37.39	219.17
16.	MF-16	9.02	37.01	13.29	7.21	502.90	49.50	236.35
17.	MF-17	8.88	32.84	12.29	6.52	600.00	42.43	218.16
18.	MF-18	8.89	38.78	12.70	5.54	572.90	41.94	250.48
19.	MF-19	7.77	37.75	14.27	7.19	556.38	47.49	276.75
20.	MF-20	8.00	38.89	13.68	6.25	515.50	47.99	197.96
21.	MF-21	8.51	23.90	14.30	6.24	585.50	43.96	174.73
22.	MF-22	7.15	22.77	14.62	6.62	255.66	45.97	196.96
23.	MF-23	6.15	18.85	19.34	6.56	555.90	50.00	177.76
24.	MF-24	6.05	15.00	17.29	6.55	495.00	47.98	149.48
25.	check	9.00	33.80	17.74	6.21	495.66	48.99	160.59
	SEd	0.16	0.83	0.28	0.13	7.19	0.79	3.35
	CD	0.46	1.63	0.54	0.25	14.44	1.52	6.75

Clove

Among the germplasm of clove planted at Dapoli during 1996-97, four promising genotypes were selected. The plant height varied from 6.15 to 7.40 m, girth ranged from 44 -52 cm and spread varied from 2.85 m to 3.65 m. No flowering was observed during the year 2020. Among the 24 accessionsat Pechiparai, SA-1 recorded the highest tree height of 12.98 m, followed by SA-3 (12.55 m) when compared with local check (11.01 m). The accession SA-13 was significantly superior to other accessions and recorded highest stem girth (52.19 cm) compared with local check (41.90 cm). The accession SA-3 recorded the highest leaf length (12.87 cm), leaf breadth (7.70 cm), number of branches (19.92) and dry bud yield (1.70 kg/tree/year).

Fig 18: View ofpromising genotypes of clove & cinnamon at Pechiparai

Cinnamon

Among twelve accessions evaluated at Pechiparai, CV-5 recorded maximum tree height (5.75 m), number of shoots (41.99) and stem girth (17.17 cm) compared to the local check (5.01 m, 25.0 and 16.64 cm, respectively).

Table 17. Performance of cinnamon accessions at Pechiparai

Sl.No.	Accession	Tree Height (m)	No of shoots (from rejuvenation growth after 300 days)	Stem girth (cm)
1.	CV-1	4.86	29.45	15.77
2.	CV-2	4.77	33.67	12.82
3.	CV-3	5.20	29.84	11.52
4.	CV-4	5.10	37.66	13.88
5.	CV-5	5.75	41.99	17.17
6.	CV-6	4.95	33.29	12.90
7.	CV-7	5.20	25.00	13.89
8.	CV- 8	5.00	29.90	10.00
9.	CV- 9	5.29	29.20	10.88
10.	CV- 10	5.89	29.77	11.66
11.	CV- 11	5.40	37.56	13.89
12.	CV -12 (check)	5.01	25.00	16.64
	SEd	0.13	0.86	0.37
	CD (P=0.01)	0.24	1.74	0.74

The details of germplasm of tree spices being conserved at the AICRPS Centres are presented in Table 18.

Table 18. Tree spices germplasm collections at 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	99	Dapoli	06
Pechiparai	24	Pechiparai	4
Total	123	Total	10

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

(Centres: Dapoli, Kozhikode, Thrissur, Pechiparai)

The different unique genotypes have been planted in germplasm block of nutmeg at Dapoli. The growth of plants is satisfactory. The maximum height, number of branches and plant spread were more in genotype, Yellow mace (3.66, 49.8 and 2.59 m respectively), whereas the maximum plant spread was more in Nova (1.85 m). Among the unique types planted at Pechiparai, the maximum plant height (7.10 m), numbers of branches (23.85.), number of fruits (30.94), single fruit weight (39.99) and mace yield tree^{-1} (13.97g) were more in IISR Viswashree.

ACC -3 | **ACC -5** | **ACC -7** | **ACC -13**

ACC -17	Konkan Swad	IISR Viswasree	Yellow mace

Fig 19: Unique genotypes of nutmeg

Crop Improvement

TSP/CI/2.2 Coordinated Varietal Trial in Nutmeg

(Centres: Dapoli, Pechiparai)

Growth observations recorded at Dapoli indicate significant differences among the genotypes for all the parameters. The plant height ranged from 1.63 to 3.28 m, girth from 27.83 to 44.83 cm, number of branches from 12.83 to 25.83 and spread from 1.22 to 3.80 m. The genotype A9/150 was found to be significantly superior over rest of the genotypes for all the parameters (except plant height), especially with regard tothe number of fruits per plant (228.67). At Pechiparai also, A9/150 recorded the highest plant height (8.75 m), stem girth (35.0 cm), maximum number of branches (20.56) and number of fruits (235.0) and mace yield/tree (169.50 g) compared to the local check (6.70 m, 24.66 cm, 18.8, 182.9 and 142.6 g, respectively).

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 Jathi* and *Cheripuram*) provided by NIF/farmer), along with one local check and a national check at Dapoli, Pechiparai and Thrissur. 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 indicate significant differences for the growth parameters except average spread. The genotype, *Kochukudy* recorded highest plant height (3.05 m), followed by *Punnathanam Jathy* (2.68 m). The genotype, *Punnathanam Jathy* produced maximum branches (39.17), followed by *Kochukudy*, while maximum spread was recorded by *Kochukudy* (2.37 m). The improved nutmeg variety recorded the maximum plant height (3.46 m) and number of branches (19.25) at Pechiparai.

Kochukudy

Punnathanam Jathy

Kadukkamakkan Jathi

Cheripuram

Fig 20: Farmer's varieties of nutmeg at Dapoli

TSP/CI/5.1 Evaluation of nutmeg genotypes

(Thrissur)

Budded plants of all the genotypes were made and trial laid out. The plants are four year old and are showing good growth. All the genotypes except Acc. 12, Acc. 28 and IISR Viswashree have flowered profusely and started bearing fruits.

Acc. 12	Acc. 13	Acc. 14

Fig 21: Fruiting in nutmeg genotypes at Thrissur

VII 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.

Table 19. Coriander germplasm collections at various AICRPS Centres

Centre	Indigenous	Exotic	Total
Coimbatore	276	-	276
Dholi	74	-	74
Guntur	350	-	350
Hisar	322	-	322
Jagudan	132	19	151
Jobner	756	102	858
Kumarganj	200	-	200
Pantnagar	85	-	85
Raigarh	32	-	32
Kota	100		100
Total	2327	121	2448

One hundred and forty accessions of coriander were evaluated at Hisar in two row plots of 3.0 meter length each with Hisar Sugandh, Hisar Bhoomit and Hisar Anand as checks. The mean seed yield ranged from 36.4 g plant^{-1} (DH-287) to 92.8 g plant^{-1} (DH-305). The most promising lines for seed yield were DH-219, DH-226, DH-233, DH-238-1, DH-242, DH-293-1, DH-294-1, DH-305, DH-314, DH-344 and DH-355. At Jagudan, 19 entries were evaluated with G.Co.-3 as check for yield performance. The seed yield ranged from 170 to 510 g plant^{-1}. Among the 200 germplasm lines evaluated at Kumarganj, the highest yield was recorded in NDCor-11 (29.10 g plant^{-1}), followed by NDCor-22 (28.40 g plant^{-1}), NDCor-12 (27.30 g plant^{-1}) and NDCor-32 (26.80 g plant^{-1}).

Among the 276 genotypes evaluated at Coimbatore, CS 274 (5.00 g plant^{-1}), CS 185 (4.83 g plant^{-1}), CS 190 (4.50 g plant^{-1}) and CS 211 (5.43 g plant^{-1}) were found to be significantly superior in yield over the best check CO (CR) 4 (4.16 g plant^{-1}). Among the promising accessions identified at Dholi, RD-424 recorded the highest yield (97.14 g per five plant, per plot yield of 1.63 kg 7.2 m^{-2} & per hectare yield of 19.95 q ha^{-1}), followed by RD-412 (94.29 g, 1.58 kg & 19.36 q respectively). Among the 35 entries evaluated at Guntur, LCC-349 (5.42 g plant^{-1}), LCC-343 (5.40 g plant^{-1}), LCC-332 (5.32 g plant^{-1}), LCC-336 (5.32 g plant^{-1}) and LCC-320 (5.22 g plant^{-1}) were found significantly superior in yield over the best check Suguna (3.06 g plant^{-1}).

Three hundred fifty one (351) germplasm accessions were evaluated along with nine check varieties at Jobner. Promising accessions identified on the basis of seed yield per 5 plants were UD-619 (106.5 g), UD-487 (86.3 g), UD-97 (66.3 g), UD-703 (63.5 g), UD-291 (61.3

g), UD-620 (60.5 g). Among the 32 germplasm lines conserved and evaluated at Raigarh, higher seed yield was recorded in CGSCD-2 (14.2 q ha^{-1}), ICS 29 (13.8 q ha^{-1}), ICS 10 (13.5 q ha^{-1}) over Hisar Anand (10.5 q ha^{-1}) and CGD 1 (10 q ha^{-1}).

Fig 22: Field view of coriander germplasm at Jobner

Screening of coriander germplasm against powdery mildew

Among the 276 coriander germplasm entries, 42 entries were screened at Coimbatore for the incidence of powdery mildew. The powdery mildew incidence was noticed in all the accessions with the PDI ranging from 36.20 to 85.50. The accessions *viz.,* CS 46 recorded lowest incidence of 36.20 PDI with a yield of 43.50 g $plot^{-1}$ ($1m^2$), followed by CS 242 (48.6 PDI) with an yield of 41.50 g $plot^{-1}$. The highest intensity of powdery mildew was recorded in CS 210 (85.50 PDI) with the yield of 32.50g $plot^{-1}$.

Among the 349 genotypes of coriander screened at Jobner, seventy one entries showed moderately resistant and remaining entries showed susceptible (130) and highly susceptible (157) reaction against the disease. Among the twenty (CVT) entries tested, three entries (COR-186, COR-190 and COR-192) showed moderately resistant and thirteen entries *viz.,* COR-174, COR-176 to COR-181, COR-183, COR-187 to COR-189, COR-191 and RCr-728 entries showed susceptible and rest of the entries showed highly susceptible reaction against the disease.

Among the twenty nine (28+1) entries screened under natural condition at seed Spices Research Station, Jagudan, the minimum disease intensity was noticed in JCr–16-02 and COR-174 (5.7%). The maximum disease intensity was recorded in the entry COR 187 (35.4 %).

COR/CI/1.3 Identification of drought tolerant lines in coriander
(Centres: Jobner)

Thirty genotypes randomly selected from the germplasm were sown in two environments, irrigated (normal irrigation) and drought (staggered irrigation with half of that given in normal irrigation). The genotypes viz., UD 39 and UD-431 showed yield superiority under both conditions, whereas genotypes UD 40, UD 246, UD 220, UD- 209 and RCr 435 under normal conditions and UD-30, UD-35, UD- 39 and RCr 475 have shown yield superiority under stress conditions. Mean yield data of three-years indicated that the genotype RCr-475, UD-40, UD-246, RCr-436, RCr-20 and UD-39 under normal condition while UD-77, UD-39,

UD-431, UD-123, UD-35 and UD-246 performed better under stress conditions. Based on stress susceptibility index (SSI) UD-86, UD-87, UD-30, UD-431, UD-123 and UD-77 were found to be the desirable genotypes for moisture limited conditions.

Crop Improvement

COR/CI/2.7 Coordinated Varietal Trial

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

There were significant differences among the 20 entries at various AICRPS centres for seed yield and yield attributing characters. At Jobner, the seed yield during 2020-21 ranged from 2.08 q ha^{-1} (COR-184) to 25.20 q ha^{-1} (COR-189) with COR-190 (22.75 q ha^{-1}), COR-177 (22.13 q ha^{-1}), COR-187 (21.13 q ha^{-1}), COR-186 (19.76 q ha^{-1}), COR-191 (19.63 q ha^{-1}) and COR-1181 (19.53 q ha^{-1}) producing higher yields. Mean performance over 2018-19, 2019-20 and 2020-21 revealed superior performance of COR-189 yielding 24.33 q ha^{-1}, followed by COR-190 (23.62 q ha^{-1}) and COR-177 (22.98 q ha^{-1}). Among the entries evaluated at Coimbatore, COR 190 (8.06 q ha^{-1}), COR 180 (7.82 q ha^{-1}), COR 187 (7.33 q ha^{-1}), COR 185 (6.29 q ha^{-1}) and COR 174 (7.82 q ha^{-1}) recorded significantly higher yield when compared to the local check CO (CR) 4 (5.27 q ha^{-1}). At Guntur, COR-184 (13.51 q ha^{-1}), COR-185 (13.26 q ha^{-1}) and COR-186 (13.01 q ha^{-1}) were significantly superior to the check Susthira (10.85 q ha^{-1}).

At Jagudan, none of the entries were found to be significantly superior over the local check G.Co 3, though entries like COR 189 (18.56 q ha^{-1}) and COR 190 (17.01 q ha^{-1}) were numerically higher than check G.Co 3 with 12.3% and 2.9%, respectively, while at Dholi the pooled results indicated that none of them showed significantly higher yield over check variety Rajendra Dhania-1, though COR-176 recorded highest yield (1.47 kg 6 m^{-2} & 21.67 q ha^{-1}), followed by COR-183 (1.35 kg 6m^{-2} & 19.87 q ha^{-1}), COR-178 (1.31 kg 6 m^{-2} & 18.79. q ha^{-1}) and COR-186 (1.24 kg 6 m^{-2} & 18.09 q ha^{-1}). Among the genotypes evaluated at Hisar, maximum seed yield (19.95 q ha^{-1}) was recorded in COR-175, followed by COR-177 (19.75 q ha^{-1}) and COR-176 (19.62 q ha^{-1}). Analysis of pooled data showed that maximum mean seed yield (20.88 q ha^{-1}) was recorded in DH-208 (COR-174), followed by COR-175 (19.63 q ha^{-1}) and COR-176 (19.63 q ha^{-1}) showing an increase of 32.2 and 24.3 % over Hisar Anand (Check), respectively. At Kota, COR–189 was found to be the best performing entry in terms of seed yield, yielding 18.11 q ha^{-1}, followed by COR–176 (17.70 q ha^{-1}) and COR-177 (16.83 q ha^{-1}).

Evaluation of CVT coriander entries during Rabi 2020-21 at Raigarh revealed that the highest seed yield (q ha^{-1}) was recorded by entry COR 176 (19.4 q ha^{-1}) followed by COR 183 (16.4 q ha^{-1}) and COR 186 (14.6 q ha^{-1}) over the checks Chhattisgarh Shri Chandrahasini Dhaniya-2 (11.0 q ha^{-1}), Hisar Anand (10 q ha^{-1}), Rajendra Swati and Chhattisgarh Dhaniya-1 (9.9 q ha^{-1}). COR-178 recorded numerically higher seed yield (19.41 q ha^{-1}) at Navsari, followed by COR-189 (18.00 q ha^{-1}) and COR-179 (17.18 q ha^{-1}) while at Kumarganj, highest yield was recorded in Cor-177 (15.76 q ha^{-1}), followed by Cor-178 (13.96 q ha^{-1}) and Cor-191 (13.40 q ha^{-1}). The highest yield was recorded in the genotype COR-183 (19.41 q ha^{-1}) at Jabalpur, which was at par with COR-186 (17.84 q ha^{-1}).

Table 20. Yield & ancillary characters of CVT entries at Jagudan

Sr No.	Entry	50% Fl	Matu.	Pl ht (cm)	Br/ Pl	Umb/ Pl	Umbt / Umb	Seeds / Umblt	Test wt. (gm)	Vol. Oil (%)	Yield/ Net Plot (g)	Yield kg ha^{-1}	%IOC G.Co-3
1	COR 174	61	124	64.6	3.2	18.0	5.2	6.2	14.2	0.20	947	877	-46.9
2	COR 175	62	126	62.9	3.7	24.1	6.1	5.9	13.8	0.19	1025	949	-42.6
3	COR 176	63	126	71.5	3.4	22.5	5.6	6.7	13.8	0.30	1502	1390	-15.9
4	COR 177	66	126	73.8	4.0	26.1	5.7	7.5	16.2	0.31	1307	1210	-26.8
5	COR 178	68	125	84.4	3.7	21.3	6.6	6.6	15.4	0.29	1273	1179	-28.7
6	COR 179	65	127	80.3	3.6	23.8	6.0	6.5	14.2	0.30	1300	1204	-27.2
7	COR 180	46	116	80.5	3.7	22.9	6.0	7.8	15.1	0.40	1470	1361	-17.7
8	COR 181	47	116	70.3	3.5	27.5	5.5	7.2	14.6	0.39	1670	1546	-6.5
9	COR 182	49	109	39.2	5.0	17.8	6.5	10.1	13.7	0.28	688	637	-61.4
10	COR 183	64	126	65.6	4.0	24.6	5.3	6.6	14.9	0.27	878	813	-50.8
13	COR 186	68	125	64.2	3.9	27.9	6.5	6.9	15.2	0.19	1367	1265	-23.4
14	COR 187	65	126	75.2	3.5	19.5	6.0	6.8	15.5	0.29	1571	1455	-12.0
15	COR 188	63	126	78.6	4.1	20.2	4.9	5.4	13.2	0.28	1222	1131	-31.6
16	COR 189	68	125	90.3	3.7	27.5	6.2	7.3	15.8	0.40	2005	1856	**12.3**
17	COR 190	63	127	91.8	3.5	24.1	6.5	7.9	14.4	0.51	1837	1701	**2.9**
18	COR 191	68	126	77.9	3.9	21.2	4.6	7.0	14.1	0.20	907	840	-49.2
19	COR 192	69	127	69.5	3.9	27.8	6.4	6.3	15.1	0.50	1388	1285	-22.2
20	G Cor 3©	65	127	73.4	3.5	20.7	5.8	8.0	15.8	0.31	1785	1653	
											S.Em. ±	84.00	
											C.D. at 5%	241.00	
											C.V. %	13.02	

Out of 19 entries, evaluated under CVT coriander at Ajmer, the three years yield pooled data (2018-19 to 2020-21) showed that the highest yield (14.12 q ha^{-1}) was obtained from the entry COR-188 (Ch) followed by COR-177 (13.09 q ha^{-1}), COR-178 (12.91 q ha^{-1}) and COR-191 (12.87 q ha^{-1}) respectively.

* For COR 184 and COR 185, the average was calculated based on two years data only

Fig 23: Field view of CVT coriander at Kumarganj & Jabalpur

COR/CI/2.9: Screening of coriander varieties against stem gall disease (Dholi, Kumarganj, Kota, Hisar, Jabalpur)

Among the 21 coriander entries screened against stem gall disease at Kumarganj, none of them were found immune/disease-free against stem gall, though COR-174, COR-175, COR-177, COR-178, COR-179, COR-188, COR-191 and ACr-1 were found to be moderately resistant. At Jabalpur, it was observed that among the genotypes under CVT, COR-176, COR-179, COR-181, COR-182, COR-185 and COR-188 were highly susceptible against stem gall. Out of the 21 CVT entries evaluated at Dholi, including one resistant (ACr-2) and susceptible check (Rajendra Swati) each, none of the CVT entries except COR - 179 were found resistant against stem gall disease. The resistant check (ACr-2) showed resistant and the susceptible check (Rajendra Swati) showed highly susceptible reaction against stem gall disease. During 2020-21, there was no infestation of stem gall disease in any of the CVT entries including the susceptible check at Hisar.

COR/CI/4.1 Quality evaluation in coriander

(Centres: Jobner)

Estimation of volatile oil content of the 20 entries of coriander under CVT at Jobner revealed significant differences among them. The volatile oil content ranged from 0.40% (COR-185) to 0.66% in COR-192. The entry COR-189 ranked first in terms of volatile oil yield (12.85 l ha^{-1}), followed by COR-191 (12.71 l ha^{-1}), COR-181 (12.11 l ha^{-1}) and COR-176 (12.05 l ha^{-1}), while lowest volatile oil yield of 0.90 l ha^{-1} was recorded in COR-184. The mean performance (three-years) also indicate that the highest mean volatile oil content of 0.66% was in COR-192, followed by COR-190 (0.64%), COR-181 & COR-175 (0.63% each) and COR-191 (0.62%). However, the highest mean volatile oil yield of 14.79 l ha^{-1} was found in COR-190, followed by COR-192 (13.01 l ha^{-1}), COR-189 (12.90 l ha^{-1}) and COR-177 (12.46 l ha^{-1}).

Crop Protection

COR/CP/6.7 Integrated pest and disease management in coriander

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

In the trial on integrated pest and disease management in coriander at Coimbatore, seed germination ranged between 85.98 to 89.57 %. Among the twelve treatments, T7 (two foliar sprays of acetamiprid, followed by a spray of propiconazole and carbendazim each) significantly reduced the powdery mildew intensity (1.07 PDI), which was on par with T5 (two foliar sprays of *Lecanicillium lecanii* followed by a spray of propiconazole and carbendazim) (2.07 PDI) and T12 (two foliar sprays of *Lecanicillium lecanii* followed by a spray of carbendazim and propiconazole) (2.54 PDI) and T6 (two foliar sprays of acetamiprid followed by carbendazim and propiconazole) (3.32 PDI), as against the PDI of 38.42 in control. Further, the presence of fungicide residue determined by LC-MS-MS revealed that propiconazole and other fungicides residues were below detectable limit (BDL) in the coriander seeds.

In the experiment on integrated pest and disease management of coriander at Jobner, lowest incidence of powdery mildew (5.36%), highest (78.24%) disease reduction and maximum (17.77 q ha^{-1}) seed yield were found in foliar spray of propiconazole 25 EC @ 0.05% (10 ml 10 L^{-1}) (first & second spray)+ two foliar sprays of acetamiprid 20 SP (0.004%) (T_2), which was statistically at par with foliar spray of propiconazole 25 EC @ 0.05% (10 ml 10 L^{-1}) (first & second spray)+ two foliar sprays of *Lecanicillium lecanii* 1.15WP ($1x10^9$cfu/gm) (40 g/10 L) (T_1) (6.13%, 75.11%, respectively). Lowest incidence (5.32%) and highest (75.64%) disease reduction in case of blight of coriander were recorded in package developed by SAU

(seed treatment with carbendazim @ 2 g kg seed^{-1} + FS carbendazim @ 2 g^{-1} L+ 2 FS dimethoate 30% EC @1.0 ml L^{-1} + FS mancozeb @ 2 g L^{-1}.) (T_9), which was at par with foliar spray of carbendazim 50 WP @ 0.1% (20 g 10 L^{-1} water) (first and second spray)+ two foliar sprays of acetamiprid 20 SP (0.004%) (T_4) (5.90 % & 72.99 %). Treatment T2 (foliar spray of propiconazole 25 EC @ 0.05% (10 ml 10 L^{-1} (first & second spray) + two foliar sprays of acetamiprid 20 SP (0.004%) showed significantly lowest aphid index (2.98, 1.18, 2.04 and 0.32) at 3 and 7 days both sprays and found significantly superior over rest of the treatments and unprotected plot (T_{12}) (4.14, 4.76 and 4.28, 4.83). Mean population of predatory *coccinellids* differed significantly among the treatments from 0.64 (spray of propiconazole 25 EC @ 0.05% (10 ml 10 L^{-1}.) (first and second spray) + two foliar sprays of acetamiprid 20 SP (0.004%) (T_2)] to 2.52 per plant in non protected plots (untreated control (T_{10})).

Powdery mildew was not noticed in coriander during the season at Ajmer. Maximum reduction in aphid index was observed in T2 (two sprays of propiconazole + two foliar sprays of acetamiprid), T4 (two spray of carbendazim+ two foliar sprays of acetamiprid), T7 (two foliar sprays of acetamiprid + spray of propiconazole) (first spray) + spray of carbendazim) and T8 (two foliar sprays of acetamiprid + spray of carbendazim (first spray) + spray of propiconazole) at 7 days after 2nd spray. However, maximum seed yield and test weight were observed in treatment T8, followed by T7.

All the treatments were found significantly superior in controlling the disease incidence as compared to control at Jagudan with lower percent disease intensity in T_2 which was at par with T_1. .Aphid index differed significantly among different treatments with the lowest aphid infestation (0.40 aphid index) in T_2, followed by T_9 (0.60 aphid index) and T_8 (0.65 aphid index). Mean population of coccinellids differed significantly among the different treatments, varying from 1.54 (T_5) to 2.73 (T_{10}) per plant. The treatments T_{10}, T_2, T_9 and T_3 recorded 2.73, 2.32, 2.26 and 2.19 predatory coccinellids per plant, respectively at 7 days after second spray. All the treatments were found significantly superior over control with significantly higher yield in treatment T_2. At Raigarh, the minimum disease intensity (6.47 %) of powdery mildew and minimum aphid population (5.77) were found in treatment package developed by the respective SAU. While at Jabalpur, lowest aphid infestation was in treatment T8 and lowest PDI was reported in T6, followed by T10.

At Dholi, all the treatments were found to be significantly reducing the stem gall disease incidence and average aphid population over control. However, lowest stem gall disease incidence (25.34%) and average population of aphid per 5 twigs (8.19) were recorded in treatment, T_9- seed treatment and foliar spray with hexaconazole @ 0.1% at 45, 60 & 75 DAS + spraying dimethoate (30% EC) @ 0.1% at appearance of aphid followed by 2 spray at 10 days interval (Package developed by Dholi centre) and T_8- two foliar sprays of acetamiprid 20SP (0.004%) + spray of carbendazim 50 WP @ 0.1% (20 g 10 L^{-1} water) (first spray) + spray of propiconazole 25 EC @ 0.05% (10 ml 10 L^{-1}) (second spray). However, the treatment T_8 recorded significantly highest yield of 14.18 q ha^{-1} while the highest ICBR of 1:5.53 was recorded in treatment, T_5. At Kumarganj, minimum disease intensity of stem gall (11.40%) and seed gall (11.49 %) were recorded in T6, followed by T9 (stem gall 12.13% and seed gall 12.98 %), while minimum powdery mildew disease severity (11.84 %) was recorded in T-9, followed by T-2 (11.84 %) and T-10 (12.66%). The highest seed yield (16.57 q ha^{-1}) was obtained in T9 followed by T 6 (16.00 q ha^{-1}) and T-5 (15.50 q ha^{-1}) treatments.

Table 21. Effect of various treatments against aphid and stem gall disease of coriander (Pooled Result: 2018-19; 2019-20 & 2020-21) at Dholi.

Treatments	Stem gall disease incidence (PDI *)	Average population of aphid /5 twigs	Yield (q/ha)	ICBR
T_1	38.22	12.16	13.49	1:3.57
T_2	38.51	10.78	13.25	1:3.51
T_3	45.52	14.62	9.91	1:0.50
T_4	41.20	11.10	11.36	1:1.12
T_5	39.80	15.09	13.86	1:5.53
T_6	37.59	13.26	14.17	1:4.52
T_7	42.40	12.21	12.30	1:3.46
T_8	39.94	8.19	14.18	1:3.85
T_9	25.34	9.76	12.62	1:3.20
T_{10}	61.02	27.40	9.25	-
SEm (±)	1.78	1.05	0.99	-
CD (p=0.05)	5.32	3.16	2.95	-
CV (5%)	7.52	13.56	13.20	-

*** PDI = Per cent disease incidence.**

Table 22. Integrated pest and disease management in coriander at Kumarganj.

Sl.No.	Treatment	Stem gall (PDI)	Disease reduction over check	Seed gall (PDI)	Disease reduction over check	Powdery mildew (PDI)	Disease reduction over check	Seed yield q/ha
1	T 1	19.85 (26.44)	58.86	19.74 (26.35)	58.69	13.82 (21.78)	64.12	14.32
2	T 2	18.81 (25.68)	61.01	18.82 (25.69)	60.62	11.84 (20.81)	69.26	15.17
3	T3	25.29 (30.18)	47.58	27.93 (31.89)	41.56	18.88 (20.96)	50.99	14.15
4	T4	23.05 (28.66)	52.23	26.80 (31.16)	43.92	19.76 (26.57)	48.70	14.19
5	T5	13.93 (21.90)	71.13	12.95 (21.06)	72.90	16.15 (26.37)	58.07	15.50
6	T6	11.40 (19.70)	76.37	11.49 (19.80)	75.96	18.84 (24.27)	51.09	16.00
7	T7	12.49 (20.67)	74.11	30.69 (33.61)	35.78	24.27 (24.80)	36.99	14.49
8	T8	21.68 (27.73)	55.07	23.62 (29.06)	50.57	22.28 (25.57)	42.16	13.88
9	T9	12.13 (20.37)	74.86	12.98 (21.11)	72.84	11.22 (29.48)	70.87	16.57
10	T10	13.99 (21.96)	71.00	13.05 (21.17)	72.69	12.66 (29.05)	67.13	15.23
11	T11	14.52 (22.38)	69.90	14.15 (22.06)	70.39	15.54 (25.19)	59.66	14.16
12	T12	48.25 (43.98)	-	47.79 (43.72)	-	38.52 (19.18)	-	8.40
	S.E.m	0.627		0.625		1.052		0.537
	C.D.	1.851		1.845		3.105		1.585
	C.V.	4.208		3.976		7.436		6.487

- Figures in parentheses are transformed values

Fig 24: Field view of IPDM in coriander plot at Jobner

VIII CUMIN

Genetic Resources

CUM/CI/1.1: Germplasm collection, characterization, evaluation, conservation and screening against diseases (Jagudan, Jobner, Mandor, Sanand)

Among the 79 germplasm lines evaluated at Jagudan (with GC-4 as check), the seed yield ranged from 40-380 g plant^{-1}, with JC-2000-28, JC-2000-65, JC-2002-4 and JC-2002-19 being the top yielders. Out of the 980 germplasm lines evaluated at Mandor, 65 entries showed significant gain in seed yield over the best check, GC-4, while at Sanand, among the 22 new germplasms of cumin collected from different farmer's fields of Madhya Pradesh and Rajasthan, none of them recorded significantly superior yield compared to the checks, GC 2 (2.99 g plant^{-1}) and GC 4 (3.39 g plant^{-1}). However, the genotype "*Indawar*" was numerically higher in yield (3.63 g plant^{-1}) and significantly early in flowering (48.33 days) and maturity (102.00 days) than both the checks.

Table 23. Germplasm collection of cumin in various AICRPS centres

Centre	Indigenous	Exotic	Total
Jagudan	327	7	334
Jobner	370	6	376
Sanand	27	-	27
Mandor	980		980
Total	1704	13	1717

Screening of cumin entries for resistance against powdery mildew disease

Among the twenty (18+2) entries of cumin screened for resistance against powdery mildew disease at Jagudan, the minimum disease intensity was noticed in JC 18-05 and JC-4 (7.5 %), while the maximum disease intensity was recorded in JC-18-02 (15.7 %).

Screening of cumin entries for resistance against wilt and blast diseases

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 %).

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

One hundred and five cumin entries were screened for resistance against wilt disease under wilt sick plot conditions. Overall wilt incidence was high. The minimum disease intensity was noticed in GC-5-1(w) (10.2%) followed by JC-18-11(b) (15.1%) while the maximum disease intensity was recorded up to 100.0 %.

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

In this experiment for 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 (normal irrigation) and moisture stress (staggered irrigations i.e. half of that given in normal irrigation). Mean performance of genotypes indicated that the genotypes viz., UC-258, RZ-223, UC-268, UC-263 and UC-296 were superior under both the environments, while RZ-19 under normal and RZ-209 under stress environment. Based on stress susceptibility index (SSI), UC-268 was found to be the most desirable entry for drought conditions, followed by RZ -223, UC-348, UC-258, RZ-19 and UC-217.

Crop Improvement

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

The analysis of variance revealed significant differences among the entries for seed yield and yield attributing characters at Jobner. The seed yield ranged from 2.93 q ha^{-1} (RZ-345) to 6.97 q ha^{-1} (GC-4). Of the ten entries evaluated, GC-4 recorded maximum seed yield of 6.97 q ha^{-1}, followed by CUM-40 (6.22 q ha^{-1}), CUM-42 (5.93 q ha^{-1}), RZ-223 (5.15 q ha^{-1}), and CUM-41 (5.12 q ha^{-1}). Of the ten entries evaluated, CUM-41 recorded maximum seed yield of 8.82 q ha^{-1}, followed by RZ-223 (8.76 q ha^{-1}), CUM-39 (8.74 q ha^{-1}), GC-4 (8.74 q ha^{-1}), and CUM-40 (8.56 q ha^{-1}), while lowest seed yield of 584.38 q ha^{-1} was recorded in CUM-42. Mean performance of the entries evaluated in CVT of cumin over 2017-18 to 2020-21 revealed that the genotypes GC-4 yielding 5.49 q ha^{-1}, followed by CUM-40 (5.29 q ha^{-1}) and CUM-41 (5.16 q ha^{-1}) perform better over the years. CUM-41 (4.22 q ha^{-1}) was found to be numerically superior over national check variety GC-4 by 8.2 % at Jagudan.

Table 24. Seed yield and other ancillary characters under the CVT at Jobner

SN	Entries	Days to flower	Plant height (cm)	Branches per plant	Umbels per plant	Umbellets per umbel	Seeds per umbel	Biological yield per plant (g)	Seed yield (kg/ha)	Test weight (g)
1.	CUM-38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.	CUM-39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.	CUM-40	76.33	48.20	7.73	37.80	5.07	28.73	1875.00	622.57	4.63
4.	CUM-41	74.33	50.47	7.10	45.13	5.07	32.67	1770.83	512.50	4.65
5.	CUM-42	74.67	43.67	8.20	38.47	5.67	33.40	1493.06	593.06	4.26
6.	CUM-43	78.33	47.47	8.07	44.33	5.47	31.40	1388.89	423.27	3.94
7.	GC-4 NC	80.00	41.00	8.87	40.80	5.67	36.00	1562.50	697.22	3.74
8.	RZ-19	75.33	49.20	7.53	28.33	5.27	35.87	1388.89	472.92	3.85
9.	RZ-223	72.67	49.20	7.53	30.80	5.53	36.67	1736.11	515.28	3.75
10.	RZ-345	77.00	45.73	7.87	29.80	5.27	36.47	902.78	293.40	4.01
	Mean	**60.87**	**37.49**	**6.29**	**29.55**	**4.30**	**27.12**	**1211.81**	**516.28**	**3.28**
	CD at 5%	**3.64**	**4.70**	**1.49**	**8.12**	**0.41**	**5.07**	**587.74**	**163.37**	**0.02**
	CV (%)	**2.73**	**5.73**	**10.80**	**12.56**	**4.40**	**8.55**	**16.62**	**13.55**	**0.23**

At Ajmer, maximum plant height (37 cm) was recorded in entry CUM-41, followed by CUM-42 (34.2). Maximum number of primary branches was recorded on CUM-41 and CUM-42 (5.5), while maximum number of secondary branches (17.3) and umbels per plant (26.7) were recorded in CUM-42. Maximum number of umbellate per plant (109.7) was recorded in CUM-40, followed by CUM-42 (105.7). Maximum no. of seeds/umbel (34.5) was recorded in CUM-43.

CUM/CI/4.1: Quality evaluation in cumin (Jobner)

Analysis of volatile oil content of the ten entries under CVT at Jobner revealed significant differences among the entries for volatile oil (%).The maximum volatile oil of 4.90 % was observed in GC-4, followed by 4.36 % in RZ-19, 4.27% in RZ-345, while minimum of 3.83% was recorded in CUM-43. The entry GC-4 ranked first in terms of volatile oil yield (34.16 l ha^{-1}), followed by CUM-40 (24.16 l ha^{-1}). The mean performance over the last four years indicated that the highest mean volatile oil content of 4.18 % was found in GC-4

followed by RZ-345 (4.05 %), CUM-43 (4.00 %), CUM-42 (3.99 %) and CUM-41 (3.89 %). The highest mean volatile oil yield of 22.93 l ha^{-1} was found in GC-4 followed by CUM-41 (20.07 l ha^{-1}), CUM-40 (19.85 l ha^{-1}) and RZ-223 (18.86 l ha^{-1}).

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 were followed along with light irrigations and RDF (30-20-0). The overall results from the trials at all the centres indicate that application of micronutrients resulted in significant increase in all the growth and yield parameters (the plant height, branches/plant, umbels/plant, umbellets /umbel, seeds per umbel, test weight, and seed yield) and lesser incidence of blight and powdery mildew in cumin, as compared to control.

The results 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, branches/plant, umbels/plant, umbellets/umbel, seeds/umbel, test weight and seed yield (6.34-6.45 q ha^{-1}), net return and B: C ratio over rest of the treatments as well as control. The application of 50% micronutrient in soil application along with foliar spray yielded significant increase in the plant height, umbels/ plant, umbellets /umbel, test weight and seed yield (5.99 q ha^{-1}) of cumin as compared to sole soil application and foliar spray, although, foliar spray of micronutrients was at par with application of 50% micronutrient in soil application along with foliar spray for branches/plant, net return and B:C ratio.

The application of all micronutrients (zinc, iron, manganese and boron) at Jobner also resulted in significantly higher plant height (32.65 cm), branches/ plant (7.49), umbels/plant (18.04), umbellets/umbel (5.59), seeds/umbel (26.97), test weight (4.52 g), seed yield (6.78 q ha^{-1}), net returns (Rs 72,815 ha^{-1}), B:C ratio (2.76) and lesser incidence of blight (12.55%) and powdery mildew (12.67%). The application of 50% micronutrient in soil application along with foliar spray significantly increased the plant height (31.21 cm), branches/ plant (7.04), umbels/plant (16.72), umbellets per umbel (5.19), seeds/umbel (25.52), test weight (4.31 g), seed yield (629.11 q ha^{-1}), net returns (Rs 70520 ha^{-1}), B:C ratio (2.94) and minimum incidence of blight (24.89%) and powdery mildew (25.27%) on cumin

Similarly, in the trial at Ajmer, the application of all micronutrients (zinc, iron, manganese and boron) resulted in significantly higher plant height (30.7 cm), primary branches/ plant (9.73), secondary branches/ plant (19.55), umbels/plant (45.42), umbellets/umbel (6.27), seeds/umbel (33.82), test weight (4.62 g), seed yield (7.34 q ha^{-1}), net returns (Rs.67,945 ha^{-1}), B:C ratio (1.2) 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 (29.2 cm), umbellets/umbel (5.93), seeds/umbellet (5.93), seeds/umbel (34.1), test weight (4.4 g), seed yield (4.95 q ha^{-1}), net returns (Rs. 29,822 ha^{-1}), B:C ratio (0.53) and slightly higher incidence of blight (20.34%) and powdery mildew (9.89%).

Table 25. Effect of micronutrient management on yield and economics of cumin at Jobner, Ajmer & Mandor

Treatment	Seed yield (kg/ha)			Net returns (Rs/ha)			B:C ratio		
	Jobner	Ajmer	Mandor	Jobner	Ajmer	Mandor	Jobner	Ajmer	Mandor
Control	465.42	209.1	442	50122	-16,094	28690	2.73	-0.31	1.81
Zn	540.57	349.6	508	59643	7,127	36514	2.85	0.14	1.98
Zn + Fe	600.11	407.2	567	67980	15,737	43424	3.00	0.29	2.12
Zn + Fe + Mn	646.27	483.2	634	71551	26,997	49583	2.90	0.49	2.18
Zn + Fe + Mn + B	678.41	733.9	645	72815	67,945	46429	2.76	1.20	2.00
SEm±	14.22	13.2	16.7	1817	2,156	2417	0.07	0.04	0.06
CD (P= 0.05)	40.70	37.8	48.3	5202	6,175	7001	0.19	0.12	0.17
Soil application	538.52	381.9	518	54518	10,204	34060	2.50	0.17	1.84
Foliar application	590.84	432.7	560	68229	21,002	43180	3.10	0.39	2.13
Soil + foliar application	629.11	495.3	599	70520	29,822	45544	2.94	0.53	2.09
SEm±	11.01	10.2	12.9	1410	1,646	1872	0.05	0.03	0.05
CD (P= 0.05)	31.53	29.3	37.4	4032	4,715	5423	0.15	0.09	0.13

Crop Protection

CUM/CP/6.8: Integrated pest and disease management in cumin (Ajmer, Jobner, Jagudan, Mandor)

An experiment on integrated pest and disease management of cumin was initiated at Jobner, Ajmer, Mandor and Jagudan centres during 2019. Observations on percent disease severity of powdery mildew and blight of cumin at Jobner indicate that lowest incidence and maximum disease control were found in three foliar sprays of Kresoxym methyl 44.3 SC @ 0.044% (10 ml 10 L^{-1} water) + two foliar sprays of thiamethoxam 25WG (0.0084%) (T_4) (8.36%, 68.13% and 5.56%, 82.35%), followed by three foliar sprays of Kresoxym methyl 44.3 SC @ 0.044% (10 ml 10 L^{-1} water) + first foliar spray of thiamethoxam 25WG (0.0084%) and second foliar spray of *Lecanicillium lecanii* 1.15WP ($1x10^9$ cfu/gm) (40g 10 L^{-1}) (T_{10}) (9.02%, 65.61% and 7.21%, 77.11%), as compared to control (T_{16}). The maximum seed yield was also recorded in the T_4 treatment (7.64 q ha^{-1}), as compared to control (T_{16}) (3.10 q ha^{-1}).

Treatment combination of three foliar sprays of Kresoxym methyl +two foliar sprays of thiamethoxam (T_4) also showed significantly lowest aphid index (2.96, 1.08, 2.02 and 0.25) at 3 and 7 days after both sprays and found significantly superior over rest of the treatments. Mean population of *coccinellids* differed significantly among the different treatments. However, mean population of predatory *coccinellids* varied from 0.65 under T_{13} (package developed by University) to 2.74 per plant in unprotected plots. Pooled analysis of three years data revealed that application of fungicides, insecticides and bio-pesticides significantly decreased incidence of powdery mildew, blight and infestation of aphid in cumin as compared to control. T_4 recorded significantly minimum incidence of powdery mildew (10.59 %), blight (14.81 %) and lowest aphid index (3.05, 1.20 and 2.12, 0.46) at 3 and 7 days after both sprays and maximum seed yield (6.96 q ha^{-1}) along with highest B:C ratio.

At Mandor, lowest incidence and maximum disease control were found in three sprays of hexaconazole 5 EC @ 0.005% (10 ml 10 L^{-1} water) + two foliar sprays of thiamethoxam 25WG (0.0084%) (T_1) (6.1, 81.1 and 3.0, 63.8) which was at par with package developed by the SAU (three foliar sprays of pyraclostrobin 133G L^{-1} + epoxiconaxole 50 G L^{-1} SE@ 750 ml ha^{-1}) (T_{15}) (6.0%, 81.3% and 2.6 %, 68.8 %) and three foliar sprays of Kresoxim methyl 44.3 SC @ 0.044% (10 ml 10 L^{-1} water) + two foliar sprays of thiamethoxam 25 WG (0.0084%) (T_4) (6.4%, 80.1% and 2.3%, 72%) as compared by control (T_{16}). The maximum seed yield was recorded in T15 (867 q ha^{-1}) which was at par with T1 and T4 (811 q ha^{-1}) as compared to control (T_{16}) (431 q ha^{-1}). Among the treatments, minimum incidence of wilt disease (2.3%) was recorded with T_4, followed by package developed by the SAU (T_{15}). At Ajmer, all the treatments could reduce the blight PDI significantly, as compared to untreated control and among the treatments, T4 and T8 were most effective Maximum reduction in aphid index was observed in T1 and T4 at 7 days after 2nd spray.

Table 26. Effect of various treatments on management of disease in cumin (2020-21) at Mandor

S No.	Treatment	*Alternaria* blight (PDI)	Disease reduction over control	Powdery mildew (PDI)	Disease reduction over control	Wilt (%)	Disease reduction over control	Seed yield (kg ha^{-1})
1	T_1	6.1 (14.2)	81.1	8.3 (16.7)	42.9	3 (9.9)	63.8	828
2	T_2	7.9 (16.3)	75.3	9.6 (18)	33.4	4.6 (12.4)	43.8	794
3	T_3	8.7 (17.1)	73.0	9.8 (18.3)	32.2	4.3 (12)	47.4	667
4	T_4	6.4 (14.6)	80.1	8 (16.4)	44.7	2.3 (8.7)	72.0	811
5	T_5	6.7 (15)	79.1	8.4 (16.9)	41.7	4.4 (12.1)	46.6	700
6	T_6	7.9 (16.3)	75.3	9.2 (17.6)	36.7	3.9 (11.4)	52.7	631
7	T_7	9.2 (17.6)	71.5	9.3 (17.7)	35.8	3.5 (10.8)	57.1	724
8	T_8	9.1 (17.5)	71.8	9.5 (17.9)	34.3	3 (9.8)	64.0	603
9	T_9	6.4 (14.6)	80.0	8.9 (17.4)	38.2	3.3 (10.4)	59.9	553
10	T_{10}	6.7 (15)	79.1	8 (16.4)	44.7	3 (9.8)	64.1	633
11	T_{11}	7.3 (15.6)	77.4	9 (17.4)	38.1	4.6 (12.4)	43.8	600
12	T_{12}	7.5 (15.9)	76.7	8.5 (16.9)	41.1	4.1 (11.7)	50.4	628
13	T_{13}	7.6 (16)	76.3	8.6 (17.1)	40.3	5 (12.9)	39.0	708
14	T_{14}	8.6 (17)	73.3	8.7 (17.2)	39.7	4.3 (11.9)	47.3	639
15	T_{15}	6 (14.2)	81.3	8.3 (16.7)	42.9	2.6 (9.2)	68.8	867
16	T_{16}	32.2 (34.5)	0.0	14.5 (22.3)	0.0	8.2 (16.7)	0.0	431
G. Mean		9.0		9.2		4.0		676
SEm ±		0.6		0.5		0.3		41.2
CD at 5%		1.8		1.6		0.8		118.9
CV (%)		11.8		10.2		12.1		10.6

*Figures in parenthesis are angular transformed value

At Jagudan, wilt incidence was found significantly lower in all the treatments (except T_1, T_3, T_2, and T_{11}) as compared to untreated control with the lowest incidence in T_{13} (package developed by the SAU). Blight intensity and powdery mildew were found to be significantly lower in all the treatments as compared to untreated control. Lower blight intensity was observed in T_4 and was at par with T_{13}, T_{10}, T_6, T_{12}, T_5 and T_8. Lower intensity of powdery

mildew was observed in T_1 which was at par with T_2, T_9, T_3 and T_{13}. Among the 14 treatments including the control, the treatment T4 has registered the least aphid infestation (0.86 aphid index) and the highest seed yield (6.8 q ha^{-1}), followed by T13 (1.12 aphid index and yield of 6.44 q ha^{-1}), T10 (1.26 aphid index and 5.98 q ha^{-1}) and T8 (1.60 aphid index and 5.16 q ha^{-1}), whereas, non-protected plots of cumin had exhibited the highest aphid infestation (3.72 aphid index). Mean population of predatory coccinellids remained higher in the T14) (3.0 per plant) as well as T2, T4 and T17 (2.32).

Fig 25: IDM of Cumin (2020-21) at Jobner

IX FENNEL

Genetic Resources

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

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

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 next season at Jobner. A wide range of variability was found for all the characters studied and 17 inbreds were found better than best check variety RF-101(74.17 g) on the basis of seed yield per 5 plants. Among the forty three germplasm accessions evaluated at Dholi for yield and quality, only four accessions (RF-68, RF-14, RF-34 and RF-38) yielded more than the check variety, Rajendra Saurabh. The highest yield was recorded in RF-68 (17.46 q ha^{-1}), followed by RF-14 (17.13 q ha^{-1}). The seed yield ranged from 38.4 g $plant^{-1}$ (HF-226) to 96.2 g $plant^{-1}$ (HF-108) at Hisar and the most promising lines were HF-108, HF-140, HF-143, HF-147, HF-150, HF-185 HF-186 HF-192, HF-196, HF-212, HF-214 and HF-233. Among the 168 germplasm collections of fennel evaluated at Kumarganj, maximum yield was recorded in NDF-46 (53.2 g $plant^{-1}$), followed by NDF-52 (52.5 g $plant^{-1}$) and NDF -47 (50.6 g $plant^{-1}$). At Jagudan**,** the seed yield ranged from 100 to 1350 g $plot^{-1}$ and among the 80 entries, twenty two genotypes recorded higher seed yield than the check, GF-12.

Table 27. Germplasm collection of fennel in various AICRPS centres

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

Crop Improvement

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

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

In the CVT on fennel (initiated during 2018-19), 14 promising genotypes were evaluated for morphological, yield and yield attributing traits. The analysis of variance revealed significant differences among the 14 entries for seed yield and yield attributing characters at Jobner. The seed yield ranged from 9.43 (FNL-123) to 18.92 q ha^{-1} (FNL-126). Mean performance of the entries over 2018-19 to 2020-21 also indicate superior performance of FNL-126 yielding 20.35 q ha^{-1}, followed by FNL-118 (19.34 q ha^{-1}), FNL-127 (18.69 q ha^{-1}) and FNL-122 (17.58 q ha^{-1}. At Jabalpur, the highest seed yield was recorded in FNL-129 (15.23 q ha^{-1}), followed by FNL-128 (14.13 q ha^{-1}) and FNL-121 (13.53 q ha^{-1}).

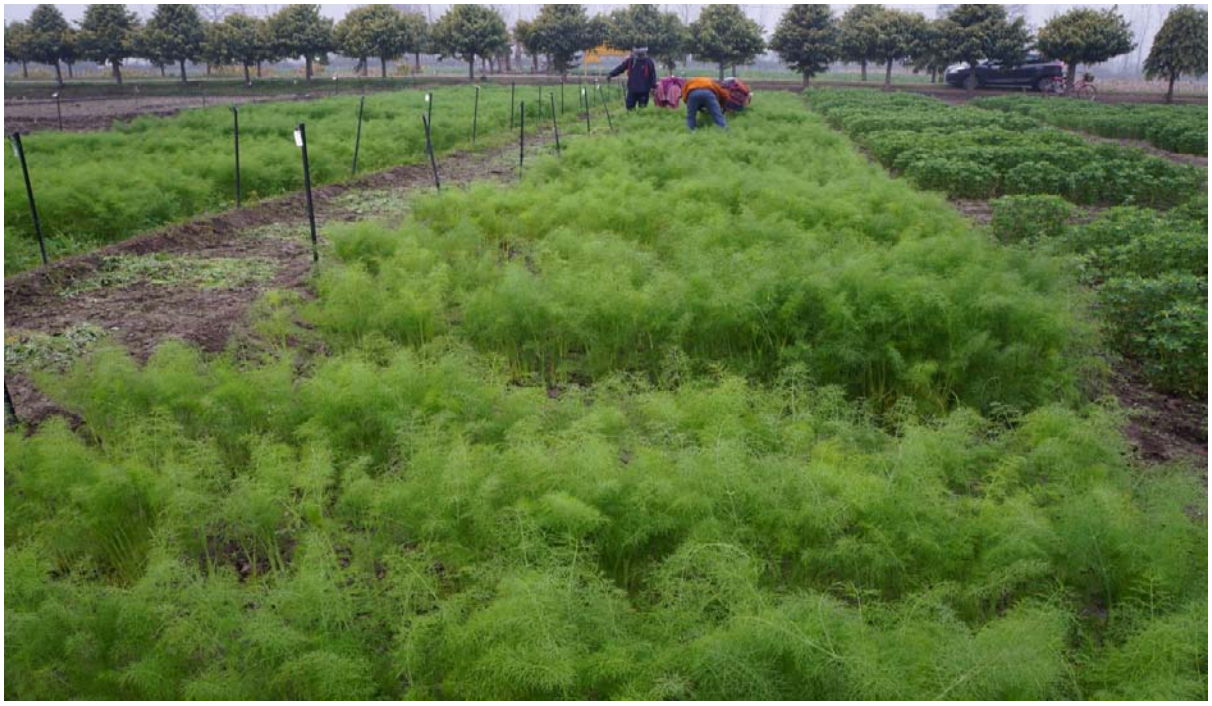


Fig 26: Field view of CVT fennel at Jobner, Hisar and Pantnagar

Among the 14 entries evaluated under coordinated varietal trial at Navsari, the genotypes FNL-123 (25.40 q ha^{-1}) and FNL-118 (24.94 q ha^{-1}) recorded significantly higher seed yield over both the national checks. FNL-123 was also found significantly superior in umbels per plant (35.80), umbellets per umbel (35.40) and seeds per umbellate (32.73) over both the national checks i.e. FNL-128 (28.33, 29.60 and 25.60) and FNL-129 (22.47, 28.80 and 24.53). Maximum mean seed yield recorded at Hisar was 20.74 q ha^{-1} in FNL-116, followed by FNL-117 (20.28 q ha^{-1}) with an increase of 19.85 and 17.25 % over RF-205 (Check), while at Dholi, three entries *viz.*, FNL-116 (17.44 q ha^{-1}), FNL-123 (16.82 q ha^{-1}) and FNL-124 (15.86 q ha^{-1}) recorded more yield per hectare as compared to check variety Rajendra Saurabh (14.87 q ha^{-1}), and were at par with each other.

At Kumarganj, FNL-125 recorded maximum yield (14.72 q ha^{-1}), followed by FNL-123 (17.34 q ha^{-1}) and FNL-121 (13.75 q ha^{-1}). The analysis of three years pooled data also showed similar trend with highest yield in FNL-125 (14.70 q ha^{-1}), followed by FNL-123 (14.12 q ha^{-1}) and FNL-121 (13.72 q ha^{-1}). FNL-126 (26.02 q ha^{-1}), FNL-129 (22.27 q ha^{-1}) and FNL-127 (20.32 q ha^{-1}) were the top three entries at Jagudan. Three years yield pooled

data of the CVT entries at Ajmer showed that the highest yield was obtained in FNL-125 (14.70 q ha^{-1}) followed by FNL-123 (14.12 q ha^{-1}) and FNL-121 (13.72 q ha^{-1}).

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

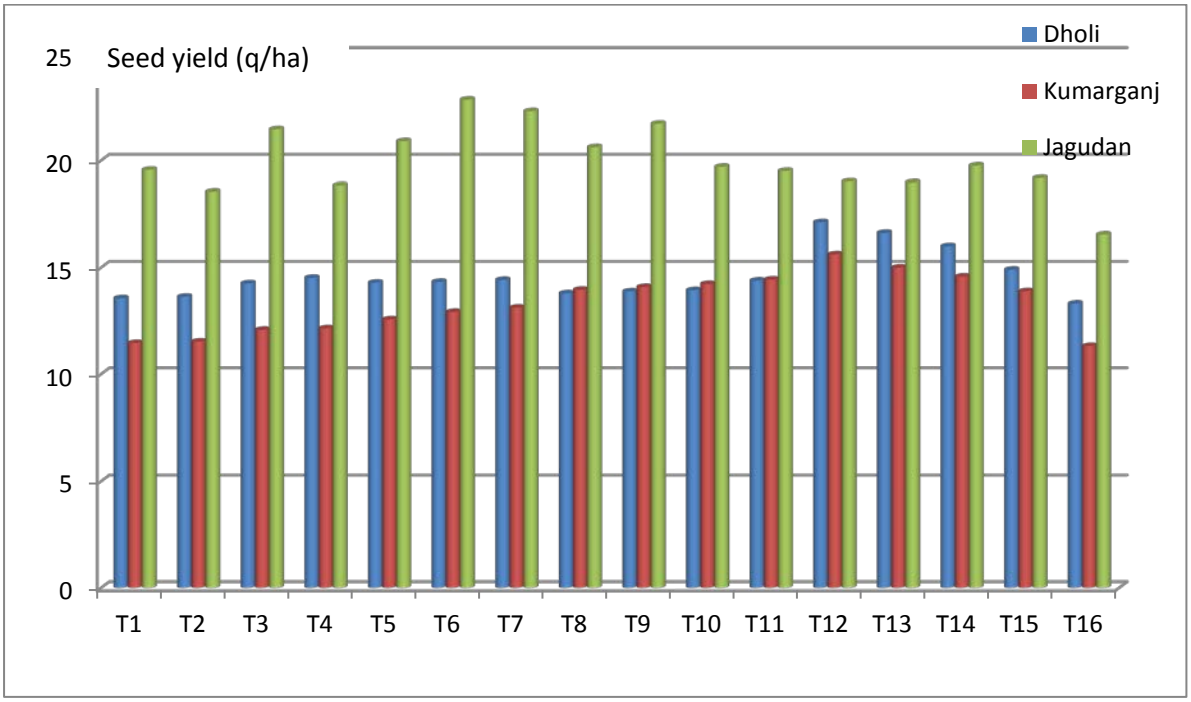
The volatile oil content among the 14 entries under the CVT ranged from 1.91% in FNL-124 to 2.43% in FNL-122. The entry FNL-122 ranked first in terms of volatile oil yield (36.50 l ha^{-1}), followed by FNL-126 (34.25 l ha^{-1}). The mean performance of three years indicate that the highest mean volatile oil content of 2.34% was found in FNL-122, followed by FNL-120 and FNL-121 (2.21%), FNL-116, FNL-118, FNL-123 (2.18%), and FNL-117 (2.12%), while the highest mean volatile oil yield of 42.80 l ha^{-1} was found in FNL-118, followed by FNL-126 (41.26 l ha^{-1}), FNL-122 (41.41 l ha^{-1}) and FNL-127 (40.59 l ha^{-1}).

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 first year results indicate 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. At Jobner, the foliar spray of 0.6% zinc sulphate recorded significantly higher plant height (94.91 cm), umbels/plant (24.74), umbellets/umbel (20.85), seeds/umbel (363.3), test weight (5.48 g), essential oil (1.71%), seed yield (23.74 q ha^{-1}), straw yield (60.85 q ha^{-1}), net returns (Rs. 129849 ha^{-1}) and B:C ratio (3.69). The foliar spray of 0.4% iron sulphate recorded significantly higher plant height (92.69 cm), umbels/plant (23.65), umbellets/umbel (19.68), seeds/umbel (341.65), test weight (5.17 g), essential oil (1.66%), seed yield (22.34 q ha^{-1}), straw yield (58.27 q ha^{-1}), net returns (Rs 1,19,910 ha^{-1}) and B:C ratio (3.51). Similarly at Mandor, the foliar spray of 0.4% zinc sulphate recorded significantly higher plant height (163.4 cm), umbels/plant (34.87), umbellets/umbel (32.57), test weight (3.37 g), seed yield (15.70 q ha^{-1}), biological yield (61.00 q ha^{-1}), net returns (Rs 82305 ha^{-1}) and B:C ratio (3.0). The foliar spray of 0.4% iron sulphate recorded significantly higher plant height (162.7 cm), umbels/plant (35.82), umbellets/umbel (32.18), test weight (3.38 g), seed yield (15.63 q ha^{-1}), biological yield (61.04 q ha^{-1}), net returns (Rs 81726 ha^{-1}) and B:C ratio (3.0) over the foliar spray of 0.2 % iron sulphate and control.

Among the 16 treatments, three of them recorded significantly higher yield at Dholi as compared to control, with the highest yield recorded in T_{12}- $FeSO_4$ (0.4%) + $ZnSO_4$ (0.6%) i.e. 0.584 kg 3.24 m^{-2} and 17.13 q ha^{-1}, followed by T_{13}- $FeSO_4$ (0.6%) + $ZnSO_4$ (0.2%) 0.567 kg 3.24 m^{-2} and 16.63 q ha^{-1} and T_{14}- $FeSO_4$ (0.6%) + $ZnSO_4$ (0.4%) 0.546 kg 3.24 m^{-2} and 16.00 q ha^{-1}as compared to control (0.454 kg 3.24 m^{-2} and 13.31 q ha^{-1}). At Kumarganj also, the highest yield was recorded in T-12 (15.62 q ha^{-1}), followed by T-13 (15.00 q ha^{-1}) and T-14 (14.58 q ha^{-1}) in comparison with the control (11.32 q ha^{-1}). However, at Jagudan, the preliminary results indicate that foliar spray of iron and zinc had no influence on the yield of fennel. The higher fennel seed yield of 22.85 q ha^{-1} was recorded under foliar spray of ZnSO4 (0.6%) (T6), followed by foliar spray of FeSO4 (0.2%) + ZnSO4 (0.2%) (T7) (22.31 q ha^{-1}).



T1: $FeSO_4$ (0.2%) T2: $FeSO_4$ (0.4%) T3: $FeSO_4$ (0.6%) T4: $ZnSO_4$ (0.2%) T5: $ZnSO_4$ (0.4%)
T6: $ZnSO_4$ (0.6%) T7: $FeSO_4$ (0.2%) + $ZnSO_4$ (0.2%) T8: $FeSO_4$ (0.2%) + $ZnSO_4$ (0.4%)
T9: $FeSO_4$ (0.2%) + $ZnSO_4$ (0.6%) T10: $FeSO_4$ (0.4%) +$ZnSO_4$ (0.2%) T11: $FeSO_4$ (0.4%) +$ZnSO_4$ (0.4%)
T12: $FeSO_4$ (0.4%) +$ZnSO_4$ (0.6%) T13: $FeSO_4$ (0.6%) +$ZnSO_4$ (0.2%) T14: $FeSO_4$ (0.6%) +$ZnSO_4$ (0.4%)
T15: $FeSO_4$ (0.6%) +$ZnSO_4$ (0.6%) T16: control

Fig 27: Response of foliar application of iron and zinc on yield of fennel at various AICRPS centres

X FENUGREEK

Genetic Resources

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

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

Among the 204 germplasm lines being maintained and evaluated at Kumarganj, the highest yield was obtained in NDM-49 (6.4 g plant^{-1}) followed by NDM-45 (5.9 g plant^{-1}), NDM-51 (5.8 g plant^{-1}) and NDM-54 (5.7 g plant^{-1}). Among the 50 accessions of fenugreek evaluated at Dholi, four lines were found to be promising with respect to yield and quality, with the highest yield was recorded in RM-170 (17.04 q ha^{-1}), followed by RM -70 (16.92 q ha^{-1}) as against check varieties, Rajendra Kanti (15.12 q ha^{-1}) and Hisar Sonali (14.64 q ha^{-1}). Among the 14 germplasm accessions maintained at CARS, Raigarh, IFGS-11 recorded maximum seed yield (15.5 q ha^{-1}), followed by IFGS 9 (12 q ha^{-1}) over checks RMT 305 (11.3 q ha^{-1}) and Gujarat 2 (10.3 q ha^{-1}).

Table 28. Germplasm collection of fenugreek in various AICRPS centres

Centre	Indigenous	Exotic	Total
Dholi	50	-	50
Guntur	124	-	124
Hisar	406	-	406
Jagudan	74	-	74
Jobner	373	12	385
Kumarganj	204	-	204
Pantnagar	139	-	139
Kota	50		50
Total	1420	12	1432

Fig 28: Fenugreek germplasm at Guntur

Among the 124 entries evaluated at Guntur, 13 entries recorded significantly higher yield than the best check LM-2 (3.70 g plant^{-1}) and the better performing entries were LFC-122 (5.19 g plant^{-1}), LFC-32 (4.99 g plant^{-1}), LFC-41 (4.99 g plant^{-1}), LFC-82 (4.97 g plant^{-1}) and LFC-115 (4.93 g plant^{-1}). One hundred twenty accessions of fenugreek were evaluated at Hisar along with Hisar Sonali, Hisar Suvarna and Hisar Mukta as checks and among them, HM 407, HM 412, HM 427, HM 429, HM 435, HM 453, HM 455, HM 486, HM 492, HM 541 and HM

543 were identified as promising lines for seed yield. At Jagudan, 76 germplasm lines were evaluated along with two checks viz., GM-1 and GM-2 and promising genotypes were grouped for specific traits.

Screening of germplasm entries against powdery mildew disease

Among the ten (IET) entries of fenugreek screened against powdery mildew disease, two entries *viz.*, UM-259 and UM-337 showed moderately resistant and seven entries *viz.*, UM-233, UM-251, UM-261, UM-333, RMt-1, RMt-305 and RMt-361 showed susceptible while UM-274 showed highly susceptible reaction against the disease.

Among the seventeen (CVT) entries screened against powdery mildew and downy mildew diseases five entries viz., FGK-127, FGK-131, FGK-134, FGK-135 and FGK-137 showed moderately resistant and rest of the entries showed susceptible and highly susceptible reaction against the powdery mildew while two entries viz., FGK-127 and FGK-136 showed moderately resistant and rest of the entries showed susceptible and highly susceptible reaction against the downy mildew.

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

(Centre: Jobner)

Thirty genotypes randomly selected from the germplasm were sown in two environments, namely, irrigated (normal irrigation) and drought (staggered irrigations i.e. half of that given in normal irrigation). The genotypes, UM-88, UM-68, UM-83, UM-79 and UM-74 were the better yielders under normal conditions, while Rmt-143, UM-81, UM-87, Rmt-305 and UM-85 were the better yielders under stress conditions. Based on stress indices, UM -80, Rmt-305, UM-92, UM-95, UM-75, UM-93 and UM-89 were found to be the desirable entries for drought conditions.

Fig 29: Field view of fenugreek at Jobner

Crop Improvement

FGK/CI/2.4 Coordinated Varietal Trial

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

The CVT of fenugreek was started in 2018-2019 with the objective of evaluating promising fenugreek entries across the coordinating centres in the country for yield and other attributes. Among the 17 genotypes evaluated, the plant height ranged from 37.58 cm (FGK 135) to 50.84 cm (FGK 126) at Coimbatore. The genotype FGK 124 (29.33) recorded the highest seed yield per plot of 1 m^2 (394.67 g $plant^{-1}$) and FGK 126 recorded the maximum seed yield of 9.87 q ha^{-1}.

Among the 17 promising entries and checks under evaluation at Jabalpur, FGK-135 was observed to be flowering early (46.0 days) and FGK-125 growing taller (115.53 cm). FGK-123 had more number of pods per plant (51.22) as well as higher pod length (13.94 cm). The maximum seed yield of 25.46 q ha^{-1} was recorded in FGK-128, which was at par with FGK-134 (23.05 q ha^{-1}) and FGK-124 (22.58 q ha^{-1}). At Kota, the seed yield ranged from 7.15 to 19.03 q ha^{-1} (FGK 125). The mean days to flowering ranged from 67 days (FGK 124) to 73 days (FGK 137) and test weight from 9.6 g (FGK-132) to 16.28 g (FGK 124).

The analysis of variance revealed significant differences among the entries for seed yield and yield attributing characters at Jobner. The seed yield ranged from 5.21 (FGK-123) to 25.89 q ha^{-1} (FGK-127) during 2020-21, while the analysis of mean yield over the years (2017-18 to 2020-21) revealed the superior performance of FGK-124 yielding 24.17 q ha^{-1}, followed by FGK-136 (23.50 q ha^{-1}) and FGK-126 (23.00 q ha^{-1}).

At Jagudan, the genotypes FGK-137 (20.32 q ha^{-1}), FGK -134 (19.91 q ha^{-1}) and FGK-128 (19.81 q ha^{-1}) recorded higher yield over the national check variety GM-2 (16.90 q ha^{-1}) by 20.3 %, 17.8% and 17.2 %, respectively, while at Navsari, FGK-137 (15.14 q ha^{-1}), FGK-133 (13.23 q ha^{-1}), FGK-135 (13.17 q ha^{-1}), FGk-136 (12.70 q ha^{-1}), FGK-130 (12.60 q ha^{-1}) and FGK-134 (12.37 q ha^{-1}) have recorded significantly higher seed yield over national check FGK-(NC) (9.79 q ha^{-1}). These promising genotypes were also found superior for yield related traits.

Table 29. Co-ordinated Varietal Trial in fenugreek (2020-2021) at Hisar

S. No.	Entries	Plant height (cm)	Branches/ plant	Pods/ plant	Pod length (cm)	Seeds/ pod	Seed yield (kg/ha)
1.	FGK-124	104.5	6.0	91.2	8.5	17.1	2251.3
2.	FGK-125	96.2	6.4	99.8	8.3	17.1	2385.9
3.	FGK-126	76.2	5.6	82.9	8.7	16.3	2182.0
4.	FGK-127	93.5	5.9	72.8	8.6	16.0	1697.9
5.	FGK-128	94.0	5.5	81.5	8.2	16.8	2043.4
6.	FGK-129	97.0	5.9	76.0	8.0	16.4	1881.0
7.	FGK-130	103.3	6.0	85.1	8.3	16.7	1980.1
8.	FGK-131	91.6	5.8	78.7	8.2	16.9	2020.0
9.	FGK-132	78.8	5.7	90.2	8.2	16.7	2118.6
10.	FGK-133	106.1	5.5	74.9	8.3	16.5	1845.5
11.	FGK-134	95.3	5.9	72.1	8.6	16.4	1851.3
12.	FGK-135	93.8	6.0	80.1	8.3	16.8	1958.0
13.	FGK-136	100.7	5.9	87.0	8.6	16.9	2237.4
14.	FGK-137	91.2	6.0	92.0	8.4	16.9	2243.3
15.	FGK-138	89.4	5.8	81.2	8.6	16.9	1980.0
16.	Rmt-361	89.2	5.4	85.9	8.3	16.4	1956.2
CD at 5%		8.6	NA	10.1	0.3	0.5	166.1
CV		5.4	5.9	7.2	2.2	2.0	4.9

Significant differences were observed among the genotypes for all the parameters (except branches per plant) in the CVT at Hisar. Plant height ranged from 78.8 to 106.1 cm, pods per plant from 72.1 to 99.8 and seeds per pod from 16.3 to 17.1. Maximum seed yield (23.86 q ha^{-1}) was recorded in FGK-125, followed by FGK-124 (22.51 q ha^{-1}) and FGK-137 (22.43 q ha^{-1}), respectively. The seed yield ranged from 8.61 (FGK-123) to 13.46 q ha^{-1} (FGK-128)

during 2020-21 at Ajmer, while the analysis of mean yield over the years (2017-18 to 2020-21) revealed the superior performance of FGK-133 yielding 17.68 q ha^{-1}, followed by FGK-128 (17.58 q ha^{-1}).

At Raigarh, the evaluation of CVT Fenugreek revealed that FGK 126 (25.3 q ha^{-1}) recorded maximum seed yield, followed by FGK 138 (22.43 q ha^{-1} over the check, Hisar Sonali (15.23 q ha^{-1}). Among seventeen entries evaluated at Dholi, FGK-132 recorded highest yield per hectare (23.85 q), followed by FGK-138 (22.58 q) and was found at par with check variety Rajendra Kanti (21.46.q). At Guntur, FGK-135 (11.86 q ha^{-1} recorded significantly higher yield over the check Lam Sonali (10.16 q ha^{-1}), while high yield was recorded in FGK-123 (16.18 q ha^{-1}), followed by FGK-128 (15.34 q ha^{-1}) and FGK-136 (15.2 q ha^{-1}) at Kumarganj. Analysis o f three years pooled data also showed same trend with the highest yield recorded in FGK-123 (16.09 q ha^{-1}), followed by FGK-128 (15.46 q ha^{-1}) and FGk-136 (15.18 q ha^{-1}).

Fig 30: Field view of IET of fenugreek at Jobner & CVT of fenugreek at Hisar

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

(Centres: Coimbatore, Guntur)

Metabolite profiling of two fenugreek varieties released from TNAU, Coimbatore (CO 1 and CO 2) was done using GC-MS. at Coimbatore. Among the 40 compounds identified in fenugreek var. CO 1, the highest peak area was observed in aziridine 1,2,3-trimethyl-, trans (16.470) followed by heptacosane (4.338), cyclohexane, 1,1'-(1,2-dimethyl-1,2-ethanediyl) bis-,(2.851) and sucrose (2.610). Similarly, in fenugreek variety, CO 2 the highest peak area was observed in aziridine 1,2,3-trimethyl-, trans- (16.303), 3-O-methyl-d-glucose (8.492), oleic Acid (5.310), melezitose (3.725), squalene (3.286), heptacosane (2.986), isodecyl methacrylate (2.691), 2-butenoic acid, 2,3-dimethyl-(2.369) and 9,12-octadecadienoic acid (Z,Z)- (2.270). Thus, the seeds of both the varieties of fenugreek (*Trigonella foenum-graecum)* consisted of aziridine, 1, 2,3-trimethyl-, trans- as the major phytochemical which may prove to be a potential antimicrobial agent. Quantification of diosgenin and trogonelline using HPTLC in the above varieties is in progress. Proximate analysis of three varieties released from Guntur (LS-1, Lam Methi-2 and Lam Sonali) for oleoresin, crude fibre, CHO, fat and protein percent was completed. During the current year, samples were submitted to IISR, Kozhikode for analysis.

Table 30. Results of the GC-MS profiling of fenugreek variety CO1 at Coimbatore

S.No	Compound name	Retention time	Area (%)
1.	Mannosamine	3.088	0.673
2.	1 -Butanol,3 - methyl-acetate	3.183	1.321
3.	Carbidopa	3.464	0.445
4.	2-propenoic acid, 3- ethoxy,ethyl ester	3.654	1.080
5	Pentane, 1,1-diethoxy	4.134	0.589
6	Aziridine, 1,2,3-trimethyl-, trans	6.605	7.117
7	Aziridine, 1,2,3-trimethyl-, trans	7.080	16.470
8	6-Hepten-3 one ,5-hydroxy-4,6-dimrthyl	7.260	0.953
9	(2,2- Dimethylcyclobutyl) methylamine	7.515	0.459
10	2-Nonenoic acid, ethyl ester	7.770	0.446
11	Dodecane	7.865	0.721
12	2-Butenoic acid, 2,3-dimethyl-	7.950	1.979
13	Cyclohexane, 1,1'-(1,2-dimethyl-1,2-ethanediyl)bis-, (R*,R*)-(ñ)-	8.00	2.851
14	2-Undecanone	9.186	0.476
`15	Nà-Acetyl-L-lysine-N-methylamide	9.376	0.547
16	Hexadecanol	10.696	0.697
17	Tetradecane	10.846	1.299
18	Sucrose	11.332	2.687
19	4,7,7-Trimethylbicyclo[2.2.1]heptan-2,3-dione, 2-O-methyloxime	13.538	0.560
20	Cetene	14.848	1.252
21	Hexadecane	15.008	0.990
22	3-O-Methyl-d-glucose	16.023	7.366
23	1-Nonadecene	19.125	1.460
24	Octadecane	19.275	0.468
25	Octadecane, 3-ethyl-5-(2-ethylbutyl)-	19.990	0.763
26	10-Nonadecanone	20.735	0.486
27	Lidocaine	20.960	0.465
28	Hexadecanoic acid, methyl ester	21.776	1.047
29	Dibutyl phthalate	22.301	1.671
30	n-Hexadecanoic acid	22.386	1.312
31	1-Docosene	23.126	1.044
32	Methyl 9-cis,11-trans-octadecadienoate	24.942	1.443
33	9,12,15-Octadecatrienoic acid, methyl ester, (Z,Z,Z)-	25.047	1.273
34	9,12-Octadecadienoic acid (Z,Z)	25.587	1.476
35	Oleic acid	25.697	1.495
36	Heptadecane, 9-hexyl	25.792	1.237
37	Behenic alcohol	26.928	0.452
38	Pyrrolidine, 1-(1-oxo-7,10-hexadecadienyl)-	28.738	0.562
39	Octadecane, 3-ethyl-5-(2-ethylbutyl)	29.284	0.547
40	Heptacosane	29.569	4.338

Table 31. Results of GC-MS profiling of fenugreek seeds variety CO2

S.No	Compound name	Retention time	Area (%)
1.	Propane, 1,1-diethoxy-2-methyl-	3.023	1.436
2.	1-Butanol, 3-methyl-, acetate	3.218	0.634
3.	2-Propenoic acid, 3-ethoxy-, ethyl ester, (E)-	3.684	0.990
4.	Butane, 1,1-diethoxy-3-methyl-	4.169	0.548
5	Aziridine, 1,2,3-trimethyl-, trans-	6.640	2.724
6	Aziridine, 1,2,3-trimethyl-, trans-	7.115	16.303
7	2,4-Dimethylhexanedioic acid	7.815	0.432
8	Dodecane	7.900	0.655
9	2-Butenoic acid, 2,3-dimethyl-	7.980	2.369
10	Isodecyl methacrylate	8.035	2.691
11	L-Lysine, N2-acetyl-	8.220	0.606
12	Spermine	9.401	1.544
13	1-Hexadecanol	10.741	0.683
14	Tetradecane	10.886	1.116
`15	Melezitose	11.407	3.725
16	7-Thiabicyclo[4.1.0]heptane	12.067	0.455
17	9-Decene-1-nitrile	13.588	0.456
18	1-Nonadecene	14.893	1.228
19	Hexadecane	15.053	0.907
20	3-O-Methyl-d-glucose	16.083	8.492
21	1-Nonadecene	19.160	1.292
22	Lidocaine	20.990	0.653
23	Benzenepropanoic acid, 3,5-bis(1,1-dimethylethyl)-4-hydroxy-, methyl ester	21.836	0.846
24	Triphenylphosphine oxide	22.136	0.433
25	Triphenylphosphine oxide	22.216	0.920
26	Dibutyl phthalate	22.331	1.545
27	n-Hexadecanoic acid	22.416	0.727
28	1 Octadecane, 3-ethyl-5-(2-ethylbutyl)-	22.751	0.446
29	1-Nonadecene	23.151	0.852
30	9,12-Octadecadienoic acid, methyl ester, (E,E)-	24.967	0.744
31	10-Octadecenoic acid, methyl ester 765 785 10.6 13481-95-3 mainlib 31 25.092 2 6-Octadecenoic acid, methyl ester, (Z)	25.092	0.569
32	9,12-Octadecadienoic acid (Z,Z)-	25.612	2.270
33	Oleic acid	25.722	5.310
34	Octadecanoic acid	26.197	0.949
35	Trichloroacetic acid, hexadecyl ester	26.948	0.431
36	2H-Pyran, 2-(2-heptadecynyloxy)tetrahydro-	28.748	0.496
37	17-Pentatriacontene	28.848	0.714
38	Octadecane, 3-ethyl-5-(2-ethylbutyl)-	29.014	0.621
39	Heptacosane	29.214	2.986
40	Squalene	29.569	3.286

Crop Management

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

(Centres: Ajmer, Coimbatore, Jobner, Pantnagar)

The new experiment for 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 micronutrients application methods (control, soil application, foliar application and fertigation). The second year results from Ajmer indicate that drip irrigation interval significantly affected growth parameters, yield attributes, yield and water use efficiency of fenugreek. Drip irrigation at an interval of 2 days produced maximum germination (83.6%), plant height (85.9 cm), number of primary branches/plant (4.72) and number of secondary branches/plant (7.4); however, number of days to maturity was more (148.1), besides higher incidence of downy mildew (30.6%) and powdery mildew (43.96%). Drip irrigation at an interval of 2 days produced maximum pods/plant (41.52), seeds/pod (18.05), pod length (13.37 cm) with test weight (16.58 g), seed yield (30.1 q ha^{-1}), straw yield (62.57 q ha^{-1}), net returns (Rs 1,41,775 ha^{-1}), B:C ratio (2.53) and water use efficiency (9.88 kg ha-mm^{-1}) over 4, 6, and 8 days interval of drip irrigation. The 8 day interval of drip irrigation though recorded minimum incidence of downy mildew and powdery mildew, but the seed yield (25.30 q ha^{-1}) levels and net returns (Rs 1,097,69 ha^{-1}) reduced significantly.

The application methods of micronutrients also significantly affected growth parameters, yield attributes, yields, economics and water use efficiency of fenugreek. The application of micronutrients through fertigation recorded maximum germination (75.9%), maximum plant height (88.0 cm), number of secondary branches (7.55), pods/plant (41.15), seeds per pod (18.58), pod length (13.55 cm), test weight (17.02 g), seed yield (3043 kg ha^{-1}), straw yield (6176 kg ha^{-1}), net returns (Rs 139913 ha^{-1}), B:C ratio (2.38) and water use efficiency (9.99 kg/ha-mm) at Ajmer. However, minimum incidence of powdery mildew was recorded in the treatment with the foliar spray. The foliar spray of micronutrients, being at par with fertigation, also recorded more number of days to 50% flowering (53.4), days to maturity (145.4), plant height (87.0 cm), number of primary branches/plant (4.68), number of secondary branches/plant (7.38), seeds/pod (17.92), test weight (16.47 g) and minimum incidence of downy mildew with the seed, straw and biological yield of 27.88, 57.24 and 85.12 q ha^{-1}.

At Jobner, though drip irrigation at an interval of 2 days produced maximum germination, days to maturity, plant height, number of primary branches/plant, number of secondary branches/plant, downy mildew and powdery mildew incidence, drip irrigation at an interval of 4 days produced maximum pods/plant (32.01), seeds/pod (17.07), pod length (11.71 cm), test weight (12.84 g), seed yield (17.34 q ha^{-1}), straw yield (33.56 q ha^{-1}), net returns (Rs 64,726 ha^{-1}), B:C ratio (2.15) and water use efficiency (7.09 kg ha-mm^{-1}). The 4 day drip irrigation interval also recorded minimum incidence of downy mildew and powdery mildew. The application methods also significantly affected growth parameters, yield attributes, yields, economics and water use efficiency of fenugreek. The foliar spray recorded maximum germination (74.08%), pods/plant (31.20), seeds/pod (16.24), pod length (11.37 cm), seed yield (16.60 q ha^{-1}), straw yield (33.12 q ha^{-1}), net returns (Rs 57976 ha^{-1}), B:C ratio (2.0) and water use efficiency (6.94 kg ha-mm^{-1}). The foliar spray recorded minimum incidence of powdery mildew. The fertigation, being at par with foliar spray of micronutrients, also recorded more number of days to 50% flowering, days to maturity, plant height, number of primary branches per plant, number of secondary branches per plant, test weight and minimum incidence of downy mildew.

At Coimbatore, drip irrigation at an interval of 2 days registered maximum germination of 85.00%, whereas drip irrigation at 4 days interval recorded the highest seed yield of 8.57 q ha^{-1}. Foliar spray of micronutrients resulted in maximum seed yield of 7.26 q ha^{-1}, whereas the interaction effect of drip irrigation at 4 days interval and foliar spray of micronutrients registered the maximum seed yield of 9.18 q ha^{-1}.

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

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

Preliminary results from Jagudan indicate that fennel equivalent yield (q ha^{-1}) was significantly influenced by different intercropping of seed spices with vegetables. Among the different intercropping systems, the higher fennel equivalent yield of 19.47 q ha^{-1} was recorded under fennel + carrot intercropping and was found at par with fennel + garlic (17.73 q ha^{-1}), coriander + carrot (16.38 q ha^{-1}), fennel sole (16.11 q ha^{-1}), coriander + cabbage (15.53 q ha^{-1}) and fennel + cabbage (14.91 q ha^{-1}). The lowest fennel equivalent yield of 8.21 q ha^{-1} was recorded with cabbage sole. While at Jobner, though the sole fennel and coriander recorded higher growth, yield attributes and yields as compared to intercropping with vegetables, the intercropping of vegetables significantly influenced fennel equivalent yield and economics. The significantly maximum fennel equivalent yield (34.96 q ha^{-1}) and net returns (Rs 1,98,205 ha^{-1}) were recorded with coriander + cabbage intercropping, closely followed by sole garlic (fennel equivalent yield (34.09 q ha^{-1}) and net returns (Rs. 1,97,700 ha^{-1}).

Table 32. Effect of intercropping of vegetables with seed spices on yield at AICRPS centres

Treatment	Fennel equivalent yield (q/ha)				Net returns (Rs/ha)			
	Raigarh	Kumarganj	Jagudan	Dholi	Raigarh	Kumarganj	Jagudan	Dholi
Fennel + Garlic	34.6	106.5	17.7	34.6	406006	283300	132947	203777
Fennel + Carrot	15.0	51.9	19.5	18.7	168000	124700	146035	89288
Fennel + Cabbage	14.9	69.5	14.9	26.3	181003	209250	111788	123672
Coriander + Garlic	43.6	74.7	12.7	37.1	425007	345760	91927	220011
Coriander + Carrot	19.1	40.0	16.4	18.7	174005	197680	122859	94033
Coriander + Cabbage	18.0	50.0	15.5	29.2	167006	278760	99648	153223
Fennel sole	10.8	14.3	16.1	15.0	65000	31650	120833	67349
Coriander sole	10.4	17.1	8.7	14.3	43001	60640	65481	71479
Garlic sole	50.6	65.3	11.6	38.0	541009	275240	87322	203144
Carrot sole	92.0	218.0	13.5	23.3	138005	207045	100988	117595
Cabbage sole	202	263.9	8.21	33.6	204009	268820	61572	145976
SEm(+)	2.21	0.22	1.57	1.08	10.8			9205
CD (P= 0.05)	6.48	0.63	4.62	3.19	31.6			27157

At Dholi, among intercropped combinations, the highest yield of coriander was in those intercropped with cabbage (20.56 q ha^{-1}) whereas the yield in coriander (cv. Rajendra Dhania-1) alone as sole crop was 24.50 q ha^{-1}. The yield of fennel intercropped with garlic

was found to be maximum as compared to other vegetable crops, whereas the yield of fennel cv. Rajendra Saurabh as sole crop was 14.98 q ha^{-1}. At Kumarganj, the highest net returns (Rs.3,45,760) with maximum B:C ratio (2.52) was obtained in coriander+ garlic intercropping, followed by fennel +garlic intercropping (net returns Rs.2,83,300, B:C ratio - 2.14) and coriander + cabbage intercropping (net returns Rs.278760, B:C ratio 3.3). At Raigarh, the highest net returns of Rs. 4,25,000 was recorded in case of coriander + garlic with a B:C ratio of 3.96, From the perspective of increasing total production and profitability per unit area without affecting the production of the sole crops, crop combination of fennel+ carrot was found to the best with a benefit cost ratio of 2.66 at Jabalpur, whereas in case of sole planting, garlic sole was found to the best with a BC ratio of 3.15.

Coriander + cabbage | **Coriander + carrot**

Fig 31: View of intercropping of vegetables with seed spices at Jabalpur

Crop Protection

SS/CP/7.1: Survey and monitoring of diseases and insect pests of seed spices for 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 farmers' 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 will be planted in experimental plots. Plots (5 m x 5 m) will be 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 will be taken from crop germination to maturity at weekly interval. Standard package of practices are 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, fenugreek and nigella) in the Muzaffarpur 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 15 to 40%, with a mean disease incidence of 27%, while no disease was observed in fenugreek. Average

population of aphids/5 twigs was found to be 24.60 in coriander, while it was 23.80 in fenugreek. 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 (Kanwarasa, Kazipura, Khandel, Norangpura, Boraj and Kot Jewar villages), Ajmer (Daulat Khera, Arjunpura Khalsa, Beawar, Bagawas villages) and Pali (Sojat, Sandiya, Chandawal) in Rajasthan. During the survey in the state of Chhattisgarh, maximum disease intensity of powdery mildew (22.12 percent) was found in coriander, 17.45 percent of *Alternaria* leaf blight in coriander and 6.3 percent of root rot in fenugreek.

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 45 to 70% in different places of both the districts with a mean incidence of 57.32% and 63.39% in North Dinajpur and South Dinajpur districts of West Bengal, respectively.

An intensive diseases and insect pests survey was conducted at Udumalai block (Mukonam, Ganapathypalayam villages) of Tirupur district by Coimbatore centre. *Alternaria* leaf blight was noticed at seedling stage and powdery mildew incidence at maturity stage. In case of field survey in Gujarat conducted by Jagudan centre, the incidence of blight and powdery mildew in cumin was moderate. The aphid and thrips infestation was very high in cumin. In fennel, moderate infestation of *Ramularia* blight and aphid was recorded. In ajwain, no incidence of any pests and diseases was noticed.

Monitoring diseases and insect pests of seed spices in the Institute farms
At Dholi, coriander crop (Rajendra Swati) was grown in plot (5 m x 5 m) under natural condition without any plant protection measures and was found to be affected by stem gall disease caused by *Protomyces macrosporus*. Average disease incidence was found to be 56.67% and average population of aphid/5 twigs was observed to be 30.4. Average population of aphids/5 twigs was found to be 22.2 in fenugreek (var. Rajendra Kanti), while no incidence of powdery mildew/ downy mildew disease was observed. Nigella (Rajendra Shyama) was found to be infected with root rot disease with a disease incidence of 16.67%, while capsule borer was not found associated with the crop during the period of study.

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 (47.00%) in cumin. The powdery mildew (15.00%) was recorded in negligible proportion. The aphid index was recorded as 1.5 whereas, thrips population was observed as 3.7 per plant. The per cent disease intensity of blight and powdery mildew diseases as well as aphid index in cumin were significantly positively correlated with relative humidity and maximum temperature while the correlation with minimum and mean temperature was non-significant. Correlation between thrips population and relative humidity and thrips population and temperature was non-significant.

In fennel, *Ramularia* blight was recorded maximum with 1.5 PDI. The aphid index was 1.75. The incidence of seed wasp was not observed during the experimentation period. The percent disease intensity of *Ramularia* blight and aphid index in fennel were significantly positively correlated with relative humidity and correlation of blight with maximum, minimum and mean temperature was non-significant, whereas they all were negatively correlated with wind

speed. In coriander, the higher intensity of powdery mildew (50.00%) was recorded. The aphid index was 1.5, whereas no seed wasp infestation was noticed. The percent disease intensity of powdery mildew in coriander was significantly positively correlated with relative humidity, whereas correlation with maximum, minimum and mean temperature was non-significant. The aphid index was significantly positively correlated with maximum temperature and relative humidity and correlation with mean and minimum temperatures were non-significant. They were negatively correlated with wind speed.

In fenugreek, the powdery mildew intensity was high (50.00%). The aphid index was 1.50, whereas leaf hopper was 2.00 per plant. The percent disease intensity of powdery mildew and aphid index in fenugreek were significantly positively correlated with relative humidity, minimum and mean temperature, whereas, its correlation with maximum temperature was non-significant and were negatively correlated with wind speed. The leaf hoppers population was significantly positively correlated with minimum and mean temperature whereas it was significantly negatively correlated with maximum temperature, relative humidity and wind speed. In ajwain, the incidence of pests and diseases *viz*., root rot, aphids, lygus bugs etc. was not recorded. At Coimbatore, the experiment plots were laid out at the College Orchard, HC & RI, Coimbatore with the coriander variety, CO (CR) 4 and fenugreek variety CO2. 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 (47.89 PDI) was recorded at flowering to maturity stage of the crop.

Table 33. Results of field survey conducted by Raigarh centre in the state of Chhattisgarh

District	**Developmental block**	**Village**	Crop	**Disease**		
				PM	Leaf spot	Root rot
Raigarh	Raigarh	Nansiya	Coriander	18.56	16.34	-
			Fenugreek	13.36	-	5.6
		Bhagora	Coriander	20.34	12.67	
			Fenugreek	14.12	-	3.9
		Tarkela	Coriander	14.32	14.24	
			Fenugreek	10.32	-	4.7
	Pussore	Telipali	Coriander	14.32	12.54	
			Fenugreek	9.65	-	4.3
		Kavariha	Coriander	19.67	9.78	
			Fenugreek	12.56	-	3.7
	Baramkela	Bundeli	Coriander	21.32	11.32	
			Fenugreek	13.24	-	5.2
		Khichari	Coriander	**22.12**	**17.45**	
			Fenugreek	9.65	-	**6.3**
	Sarangarh	Malda	Coriander	14.67	13.24	
			Fenugreek	7.36	11.89	
Bilaspur	Masturi	Darrighat	Coriander	14.32	14.32	
	Masturi	Paraghat	Coriander	19.52	14.12	
JanjgirChampa		Kamrid	Coriander	18.78	12.67	
		Kosmanda	Coriander	18.45	16.32	

Cumin

Date/ PDI	2020						2021								
	20/11	27/11	4/12	11/12	18/12	26/12	1/1	8/1	15/1	22/1	29/1	6/2	13/2	20/2	27/2
Blight (PDI)	0	0	0	0	0	0	2.00	3.75	5.50	10.25	20.25	35.75	45.50	47.0	47.0
PM (PDI)	0	0	0	0	0	0	0	0	0	0	5.5	8.75	10.0	15.0	15.0
Wilt (%)	0	2.25	3.2	5.5	5.5	5.5	7.75	8.25	8.25	10.0	10.00	15.25	15.50	15.50	17.25
Root rot (%)	2	4.5	5.25	10.0	15.25	15.50	20.00	20.25	20.25	22.0	24.25	25.00	25.50	25.50	25.50
Aphid index	0	0	0	0	0	0	0	0	0	1.0	1.0	1.5	1.5	1.5	1.5
Thrips/plant	0	0	0	0	0	0	0	0	0	0	3.2	3.5	3.5	3.5	3.7

Pearson correlation matrix

	Max. temp.	Min. temp.	Mean temp	RH	Wind
Blight	0.089^{NS}	0.399^{NS}	0.290^{NS}	0.657^{**}	-0.177^{NS}
Powdery mildew	0.215^{NS}	0.464^{NS}	0.391^{NS}	0.616^{*}	-0.160^{NS}
Aphids	0.058^{NS}	0.374^{NS}	0.260^{NS}	0.570^{*}	-0.268^{NS}
Thrips	0.048^{NS}	0.343^{NS}	0.236^{NS}	0.462^{NS}	-0.110^{NS}

Fennel

Date/ PDI	2020						2021								
	20/11	27/11	4/12	11/12	18/12	26/12	1/1	8/1	15/1	22/1	29/1	6/2	13/2	20/2	27/2
***Ramularia* blight (PDI)**	0	0	0	0	0	0	0	0	0	10.00	20.25	25.0	26.50	30.75	30.75
Aphid index	0	0	0	0	0	0	0	0	0	0	1.0	1.25	1.5	1.5	1.75
Seed wasp (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Pearson correlation matrix

	Max. temp.	Min. temp.	Mean temp	RH	Wind
Ramularia blight	0.107^{NS}	0.412^{NS}	0.307^{NS}	0.569^{*}	-0.204^{NS}
Aphids	0.115^{NS}	0.399^{NS}	0.303^{NS}	0.556^{*}	-0.132^{NS}

Coriander

Date/ PDI	2020						2021								
	20/11	27/11	4/12	11/12	18/12	26/12	1/1	8/1	15/1	22/1	29/1	6/2	13/2	20/2	27/2
PM (PDI)	0	0	0	0	0	0	0	0	0	0	0	5.25	20.75	45.75	50.0
Aphid index	0	0	0	0	0	0	0	0	0	0	1.0	1.2	1.5	1.5	1.5
Seed wasp (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Pearson correlation matrix

	Max. temp.	Min. temp.	Mean temp	RH	Wind
Powdery mildew	0.384 NS	0.558 *	0.530 *	0.703 **	-0.169 NS
Aphid index	0.089 NS	0.381 NS	0.279 NS	0.547 *	-0.125 NS

Fenugreek

Date/ PDI	2020						2021								
	20/11	27/11	4/12	11/12	18/12	26/12	1/1	8/1	15/1	22/1	29/1	6/2	13/2	20/2	27/2
PM (PDI)	0	0	0	0	0	0	0	5.25	7.5	15.75	25.25	35.50	50.0	50.0	50.0
Aphid Index	0	0	0	0	0	0	0	0	0	0	1.0	1.3	1.4	1.5	1.5
Jassid/ plant (Leaf hopper)	0	0	0	0	0	0	0	0	0`	0	2.0	2.4	2.5	2.0	2.0

Pearson Correlation Matrix

	Max. temp.	Min. temp.	Mean temp	RH	Wind
Powdery mildew	0.081 NS	0.412 NS	0.294 NS	0.672 **	-0.195 NS
Aphids	0.090 NS	0.375 NS	0.276 NS	0.529 *	-0.131 NS
Leaf hopper - Jassids	-0.580 *	0.547 *	0.984 **	-0.991 **	-0.575 *

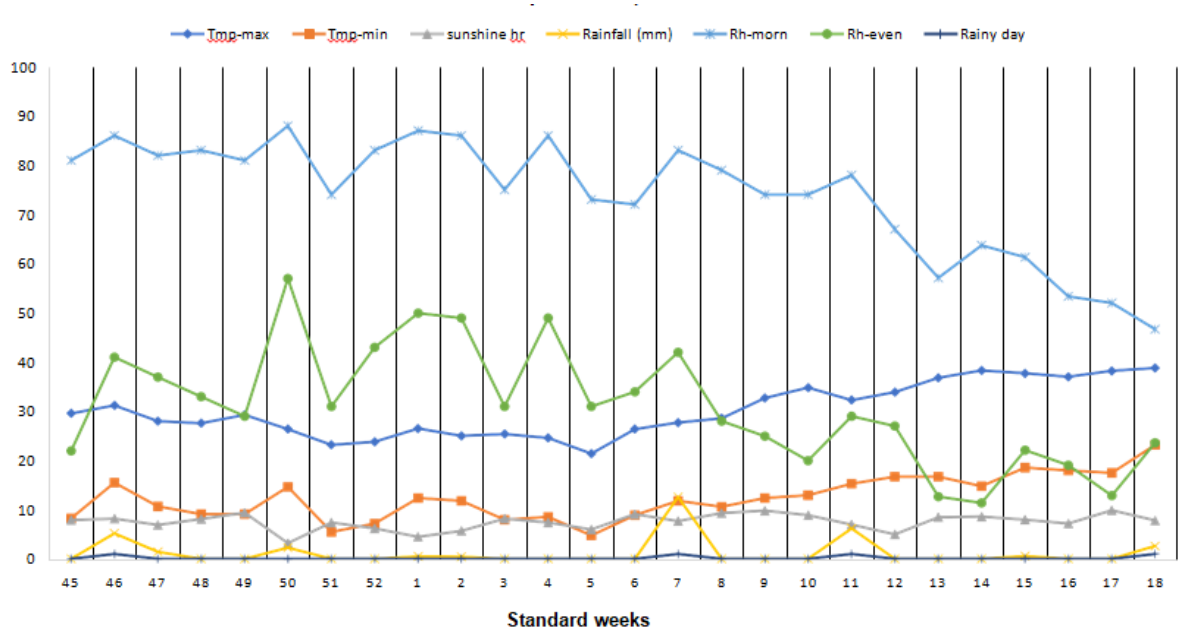


Fig 32: Weekly morphological parameters (November 2020 to April 2021) at Jabalpur

XI AJWAIN

Crop Improvement

AJN/CI/2.2 Coordinated Varietal Trial

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

The analysis of variance revealed significant differences among the entries for seed yield and yield attributing characters among the 11 entries evaluated at Jobner. The seed yield ranged from 10.80 (AJN-5) to 16.09 q ha^{-1} (AJN-2) , with AJN-7 (14.96 q ha^{-1}), AJN-10 (14.62 q ha^{-1}), AJN -11 (14.50 q ha^{-1}) and AJN -1 (14.28 q ha^{-1}) also giving better yield. Significant differences were observed for all the parameters at Hisar. Plant height ranged from 118.5 to 130.3 cm, umbels per plant 184.4 to 245.8 and seeds per umbel 335.4 to 397.7. Maximum seed yield was recorded in AJN-4 (12.99 q ha^{-1}), followed by AJN-3 (12.61 q ha^{-1}) and AJN-11(12.03 q ha^{-1}a), respectively while at Guntur, AJN-02 (8.87 q ha^{-1}), AJN-08 (8.78 q ha^{-1}) and AJN-10 (8.76 q ha^{-1}) recorded significantly higher yield over the best check, Lam Ajowan-2 (7.84 q ha^{-1}). At Jagudan, yield performances of AJN-6 (14.24 q ha^{-1}), AJN-11 (13.42 q ha^{-1}) and AJN-08 (13.39 q ha^{-1}) were numerically higher than local check variety GA-2 (13.23 q ha^{-1}) by 7.7 %, 1.4% and 1.2%, respectively.

At Kumarganj, maximum yield was recorded in ANJ-02 (9.86 q ha^{-1}), followed by ANJ-08 (9.23 q ha^{-1}) and ANJ-07 (8.75 q ha^{-1}). None of the entries recorded higher seed yield over the local check, CG Ajwain-1 (9.7 q ha^{-1}) at Raigarh, though AJN-3 (8.8 q ha^{-1}) and AJN-9 (7.9 q ha^{-1}) recorded better seed yield among the CVT entries. The variety, CG Ajwain-1, was identified for Chhattisgarh state through Chhattisgarh State Seed Certification Agency during 2020, of which notification process is in progress. Significant differences were observed for all the parameters at Ajmer. Plant height ranged from 133.20 to 122.93 cm and number of umbels/plant ranged from 286.60 to 243.53. Maximum seed yield (17.54 q ha^{-1}) was recorded in AJN-11, followed by AJN-07 (14.42 q ha^{-1}).

Fig 33: Field view of ajwain CVT at Jobner

Table 34. Ajwain CVT - Yield and ancillary characters of ajwain at Jagudan

Sr. No.	Entry	50 % Fl	Matu. days	Pl.ht (cm)	Br/ Pl	Umbel ser plant	Umbellets per umbel	seed per umbel	Test wt. (gm)	volatile oil per cent	Yield / plot	Yield (kg/ha)	% IOC GA-2
1	AJN 1	93	166	140.0	3.5	43.6	17.9	17.1	3.78	3.78	1247	1154	-12.7
2	AJN 2	94	162	142.3	2.8	35.0	16.7	16.9	3.88	3.88	1217	1127	-14.8
3	AJN 3	95	164	118.3	3.8	39.9	15.3	14.3	3.41	3.41	1033	957	-27.7
4	AJN 4	93	160	119.0	4.1	42.4	16.3	17.4	3.02	3.02	957	886	-33.0
5	AJN 5	90	158	99.3	4.7	58.1	17.1	17.6	3.61	3.61	1408	1304	-1.4
6	AJN 6	89	163	112.0	3.7	71.1	17.1	18.6	3.39	3.39	1538	1424	**7.7**
7	AJN 7	91	164	120.0	4.0	48.0	17.9	18.4	3.57	3.57	1226	1135	-14.2
8	AJN 8	93	165	109.3	2.9	54.9	16.5	19.7	4.44	4.44	1446	1339	**1.2**
9	AJN 9	95	163	115.0	2.7	26.2	18.1	18.1	3.88	3.88	1071	992	-25.0
10	AJN 10	97	163	134.7	3.1	36.7	14.9	15.5	4.08	4.08	1230	1139	-13.9
11	AJN 11	92	166	118.7	3.8	58.0	16.8	15.9	3.28	3.28	1449	1342	**1.4**
12	GA 2 (LC)	92	164	133.0	2.8	54.5	19.7	18.7	4.11	4.11	1428	1323	
											S.Em. ±	89.06	
											C.D.at5%	261	
											C.V. %	13.11	

Fig 34: Monitoring ajwain experiments at Hisar

XII NIGELLA

Crop Improvement

NGL/CI/2.2 Coordinated Varietal Trial

(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. During its third and final year of evaluation, AN-1 was found to be the best performing entry in terms of seed yield, yielding 9.90 q ha^{-1}, followed by AN-23 (9.0 q ha^{-1}) and showing 8.14 per cent higher yield over the check, AN-20. The mean days to flowering ranged from 96 days (AN-23) to 100 days (AN-20, NDBC-21, PK-2 and Pant Krishna); days to maturity from 139 days (Pant Krishna) to 151 days (AN-1); and test weight from 7.17 g (Pant Krishna) to 8.12g (HKL-7). Significant differences were observed for all the parameters at Ajmer. Plant height ranged from 91.67 to 72.27 cm, number of sillequas/ plant from 81.73 to 68.93 and number of seeds/ sillequa from 82.67 to 69.93. Maximum seed yield (11.25 q ha^{-1}) was recorded in NGL-04, followed by NGL-03 (10.82 q ha^{-1}).

Significant differences were observed for all the parameters at Hisar, with plant height ranging from 59.8 to 67.9 cm, pods per plant from 59.8 to 67.9 and seeds per pod 82.8 to 101.1. Maximum seed yield (13.1 q ha^{-1}) was recorded in NGL-08 followed by NGL-02 (13.03 q ha^{-1}) and NGL-05 (12.38 q ha^{-1}). 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 1recorded maximum seed yield (9.1 q ha^{-1}), followed by NGL-08 (8.5 q ha^{-1}), NGL-05 (7.5 q ha^{-1}) and NGL-01 (8 q ha^{-1}). The variety, CG Karayat-1, has been identified for Chhattisgarh state through CG State Seed Certification Agency during 2021, of which notification process is in progress. Seed samples have been submitted to IISR Kozhikode for DNA fingerprinting.

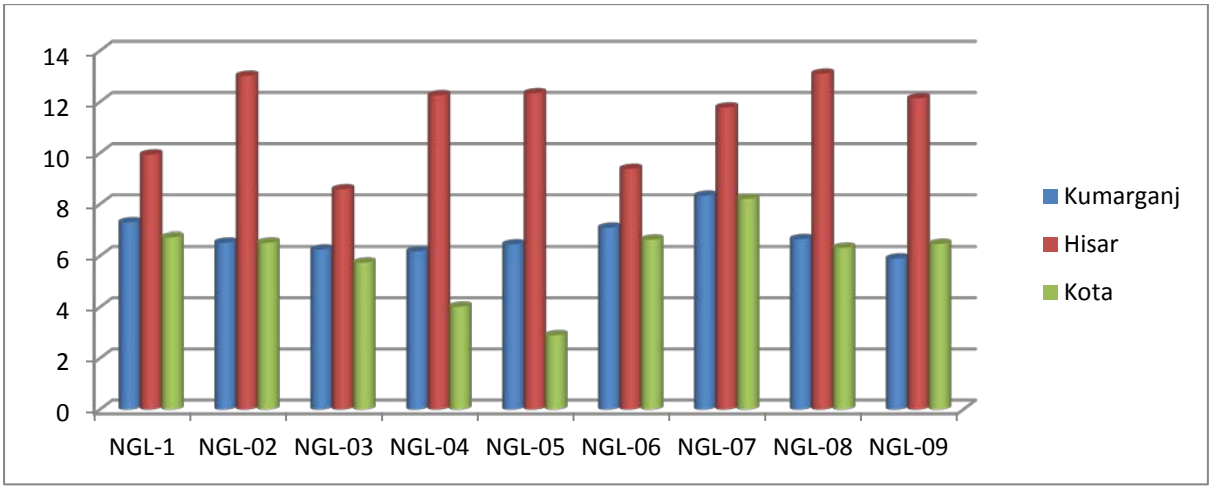


Fig 35:Variation in the yield of nigella at various AICRPS centres

XIII SAFFRON

Genetic Resources

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

Fifteen germplasm accessions were collected from different saffron growing areas of J&K, making the total accessions to 215. All these germplasm accessions are under evaluation for various morphological, quality, yield and yield attributing traits. Amongst these accessions, 10 accessions *viz.*, SRS-Saf-124, SRS-Saf-128, SRS-Saf-157, SRS-Saf-178, SRS-Saf-195, SRS-Saf-251, SRS-Saf-253, SRS-Saf-183, SRS-Saf-194 and SRS-Saf-199 have been identified as elite with regard to growth, yield and quality traits. These accessions have been planted under Initial Varietal Trial (IVT) with three replications.

Table 35. Yield characteristics of elite lines of saffron

S.No	Accession name	Pistil length (cm)	Fresh Weight of pistil (mg)	Dry weight of pistil (mg)	Stigma length (cm)	Weight of stigma (g)
1.	SRS-Saf-124	6.00	24.67	5.00	3.02	0.0520
2.	SRS-Saf-128	5.47	20.67	5.13	3.46	0.0532
3.	SRS-Saf-157	5.24	35.63	7.20	3.64	0.0555
4.	SRS-Saf-178	5.28	36.35	7.32	3.00	0.0585
5.	SRS-Saf-183	4.75	34.56	6.25	3.63	0.0523
6.	SRS-Saf-194	5.25	40.34	8.30	4.39	0.0675
7.	SRS-Saf-195	6.20	40.25	8.29	4.48	0.0512
8.	SRS-Saf-199	6.25	33.03	6.60	4.43	0.0590
9.	SRS-Saf-251	5.77	38.80	7.70	3.80	0.0540
10.	SRS-Saf-253	5.00	31.41	6.39	3.25	0.0590
11.	SD 1-13	6.15	37.85	7.67	4.12	0.0593

Fig 36: Saffron flowering & corm development

XIV KALAZEERA

Genetic Resources

KAZ/CI/1.1Exploration, collection and conservation of kalazeera from high altitudes of northern Himalayas

(Pampore)

Thirteen germplasm accessions were collected from high altitudes of Gurez valley of J & K making up the total to 83 accessions. Among them, SRS-KZ-192, SRS-KZ-158, SRS-KZ-172, SRS-KZ-77, SRS-KZ-170, SRS-KZ-149 and SRS-KZ-167 exhibited superior performance with regard to growth, yield and yield related traits as compared to other accessions. These superior accessions will be evaluated under Initial Varietal Trial (IVT) during the current cropping season.

Table 36. Morphological and yield characteristics of elite lines

S.N	Accession Name	Plant height (cm)	Primary branches/ plant	Secondary branches/ plant	Tertiary branches/ plant	Primary umbels /plant
1.	SRS-KZ-149	66.0	1	4	7	3
2.	SRS-KZ-158	73.7	1	4	6	1
3.	SRS-KZ-167	66.0	3	7	14	9
4.	SRS-KZ-170	91.4	2	7	12	6
5.	SRS-KZ-172	58.4	3	7	11	9
6.	SRS-KZ-177	45.7	6	9	13	11
7.	SRS-KZ-192	68.7	3	6	11	9
8.	SK - 1	96.78	2.4	9	14.5	7

S.N	Accession Name	Secondary umbels /plant	Tertiary umbels /plant	Umbelets/ primary umbel	Umbelets/ secondary umbel	Umbelets /tertiary umbel	Days to maturity	Yield per plant (gm)
1.	SRS-KZ-149	9	7	15	13	7	175.0	10.1
2.	SRS-KZ-158	12	7	11	11	5	172.0	10.65
3.	SRS-KZ-167	14	14	15	13	6	168.0	7.49
4.	SRS-KZ-170	12	12	18	17	7	170.0	12.09
5.	SRS-KZ-172	8	11	11	10	6	182.0	7.79
6.	SRS-KZ-177	19	18	12	9	5	179.0	9.95
7.	SRS-KZ-192	13	14	11	10	7	169.0	9.92
8.	SK - 1	16	12	14	11	6	171	10.13

XV 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 report and budget utilization certificates sent from the centres were reviewed critically and proper guidance was given for improvement.

Table 37. Visit of PC & AICRPS scientists to various AICRPS centres

S. No.	Date of visit	Centre visited
1	23.01.2021	AICRPS Centre at PRS, Panniyur
2	29.01.2021	AICRPS Centre at RARS, Ambalavayal
3	09.11.2021	AICRPS Centre at SKUAST, Kashmir

Visit to PRS, Panniyur

Visit to SKUAST, Kashmir

Fig 37: Visit of PC & AICRPS scientists to various AICRPS centres

Review meeting of AICRPS centres (online) were conducted at ICAR-IISR, Kozhikode to review the quarterly achievements of A ICRPS centres

- small cardamom centres of AICRPS on 28 May 2021
- ginger & turmeric centres of AICRPS on 24 June 2021
- black pepper & tree spices centres of AICRPS on 12 July 2021
- seed spice centres of AICRPS on 17 January 2022

A seed spices monitoring team involving Dr. Gopal Lal (Director, ICAR-NRCSS, Ajmer), Dr. A.U. Amin (SDAU, Jagudan), Dr. Y.K. Sharma (ICAR-NRCSS, Ajmer), Dr. S. K. Tehlan (CCSHAU, Hisar), Dr. S. S. Meena (ICAR-NRCSS, Ajmer) and Dr. Giridhar Kalidasu (Dr. YSRHU, Guntur) visited the seed spices centres for reviewing the progress of the experiments.

Mandor

Hisar

Jagudan

Jobner

Fig 38: Visit of seed spices monitoring team to various AICRPS centres

XVI ANNUAL GROUP MEETING

The XXXII Annual Group Meeting of ICAR-All India Coordinated Research Project on Spices (AICRPS) was conducted during 22-24 September 2021 at ICAR- Indian Institute of Spices Research, Kozhikode through virtual platform. The workshop was inaugurated by Prof. Jeet Singh Sandhu, Hon'ble Vice Chancellor, Sri Karan Narendra Agriculture University (SKNAU), Jobner on 22 September 2021. In his inaugural address, he emphasized on the necessity of holding deliberations with organizations such as APEDA, role of KVKs in popularizing technologies and mechanization as well as strengthening research endeavours on natural pollinators like honey bees. Dr. A. K. Singh, Deputy Director General (Horticultural Science), Indian Council of Agricultural Research, New Delhi presided over the function. He opined that productivity of spices can be increased with strategic interventions based on innovative technologies and streamlined policy frameworks. Dr. Vikramaditya Pandey, Assistant Director General (Horticultural Science), ICAR, New Delhi was the Guest of Honour and he insisted to identify the yield gap in spice varieties cultivated across different agro-climatic zones and to develop ecological and cropping system-based technologies to achieve doubling farmer's income. Dr. J. Rema, Project Coordinator, AICRPS welcomed the gathering and presented the achievements of AICRP on Spices with emphasis on various on-going research activities, new initiatives and flagship programmes pertaining to NE regions, SCSP and TSP.

During the inaugural session the "Best AICRPS Centre Award 2020-21" was presented to AICRPS centre at Chaudhary Charan Singh Haryana Agricultural University, Hisar. Ten booklets/pamphlets on spices production technologies in English and local languages from different AICRPS centres were released during the occasion and felicitations were offered to Dr. J. Rema, Dr. Santhosh J. Eapen, Dr. R. Ramakrishnan Nair, Dr. Miniraj and Dr. E. Radha, personnel due for superannuation from service and who rendered service to AICRPS for decades. Dr. Homey Cheriyan, Director, DASD, Kozhikode and Dr. S. N. Saxena, Director, ICAR-NRC for Seed Spices, Ajmer 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, six varieties (1 coriander, 2 fenugreek, 1 fennel, 1 turmeric and 1 ajwain) *viz.*, Chhattisgarh Raigarh Dhaniya 3 (high yielding, high quality essential oil coriander suitable for both leafy as well as seed purpose developed by IGKV, Raigarh), RF 289 (high yielding, high quality, moderately tolerant to *Ramularia* blight by SKNAU, Jobner), HM 273 (high yielding fenugreek variety resistant to downy mildew and tolerant to powdery mildew by CCSHAU, Hisar), Gujarat Methi 3 (high yielding powdery mildew tolerant fenugreek variety by SDAU, Jagudan), Lam Ajwain 3 ((high yielding & high quality ajwain variety) and Chhattisgarh Raigarh Haldi 3 (high yielding, early maturing, bold rhizome with dark yellow colour developed by IGKV, Raigarh) were recommended for release.

Three technologies were also recommended for adoption in XXXII AGM of AICRPS. *viz.*, 1. Management of turmeric foliar diseases like leaf spot (*Colletotrichum capsici*) and leaf blotch (*Taphrina maculans*) using propiconazole (0.1%) as rhizome treatment and foliar spray developed by TNAU, Coimbatore. 2. Management of coriander powdery mildew (*Erysiphe*

polygoni) using new generation fungicides like propiconazole (0.1%) by TNAU, Coimbatore. 3. Control of stem gall disease in coriander by foliar spray @ 219.75 g a.i. ha^{-1} at 45, 60 & 75 DAS with ready mixture formulation of Azoxystrobin (11%SC) + tebuconazole (18.3% SC) by RPCAU, Dholi.

In the Plenary session of the XXXII AGM of AICRPS held on 24 September 2021, Dr. N. K. Krishna Kumar, Former DDG (Horticulture), ICAR, New Delhi and Dr. K.M. Indiresh, Hon'ble Vice Chancellor, UHS, Bagalkot were the chair persons. Dr. N. K. Krishna Kumar suggested to facilitate the conduct of training program on statistical analysis of field data to the breeders/scientists involved in the AICRPS trials. He and Dr. Indiresh K. M. also suggested to initiate indexing of varieties using weighted parameters and traits of industrial importance such as boldness, luster, unique flavour etc.

Fig 39:Glimpses of Annual Group Meeting of AICRPS held on virtual mode

XVII NEH/TSP/SCSP ACTIVITIES

Promotion of seed spices cultivation in NER

In order to promote and facilitate seed spices cultivation in NER, ICAR-AICRPS distributed seed materials of seed spice crops like coriander, fennel, fenugreek, ajwain and nigella through its NE centres located at Meghalaya, Mizoram, Nagaland, Sikkim, Assam and Arunachal Pradesh. Package of practices of these crops were collected from ICAR-NRCSS, Ajmer and sent to the NE centres of AICRPS for adoption.

Developmental activities in Aspirational districts of North East

AICRPS centre at Mizoram conducted three days training programme at aspirational districts of Mizoram *viz.*, Lunglei and Lawngtlai and TSP village of Kolasib district. Planting materials, seed rhizomes and minor implements were distributed to the trainees. SASRD, Nagaland conducted training on Prospects of spices production in Renthan, Wokha and Beisumpuikam villages of Nagaland.

Developmental activities in the tribal villages

AICRPS centre at Pottangi and Chintaplle conducted three days training programme on scientific cultivation practices of spices and their processing aspects in tribal villages of Koraput and Visakhapatnam respectively along with the distribution of planting materials of black pepper and seed rhizomes of ginger and turmeric.

Developmental activities for SC communities

For the benefit of SC community, AICRPS centre at Ambalavayal conducted a one day training programme entitled, 'Newer trends in spice production' for the farmers of SC community of Pathiri Ambedkar Colony of Pulppally in the Waynad district of Kerala on 28 January 2021. Hon'ble M.P. of Wayanad, Sri. Rahul Gandhi inaugurated the distribution of input kits to farmers in the presence of Project Coordinator (i/c), Dr. K. S. Krishnamurthy and other scientists of IISR, Kozhikode. The kit contained planting materials of spices such as ginger (Rio di Jenerio), turmeric (Shobha) and bio inputs like *Pseudomonas*, *Trichoderma* and Sampoorna and a micro sprayer.

Agricultural Research Station, Mandor, AU, Jodhpur organized two farmers trainings at Narva- kheemsar (Nagaur) on 18 March 2021 and Ujaliya, Bawdi (Jodhpur) on 20 March 2021 and one agriculture input distribution programme to farmers at Khudiyala, Balesar, Jodhpur (adopted village of AU, Jodhpur) in which 176 (56+60 +60) farmers were benefitted. AICRPS centre at Hisar conducted two training programmes on "Scientific production technology of spice crops" for schedule cast farmers of Haryana during 19 and 20 March 2021 benefitting 100 farmers.

Five training programmes under SCSP scheme of AICRP on Spices were conducted at various locations in Solan, Sirmour and Bilaspur districts of Himachal Pradesh during 9, 10, 12, 13 & 19 March 2021 in which 80 scheduled tribe farmers were benefitted. Two trainings entitled "Improved production technique of turmeric cultivation and improved production techniques of ginger and black pepper cultivation" were conducted in Chaitannyarhat of Cooch Behar district, Topsikatha, Alipurduar district, Cooch Behar I and Dinhata II of Cooch Behar district. Eighty beneficiaries were included in the training programme. In addition to training, different agricultural inputs were distributed.

Seed material distribution at Mizoram

Input distribution at Mandor

Planting material distribution at Pundibari

Farmer's training programme at Hisar

Farmer's training programme at Pundibari

Awareness programme at Hisar

Fig 40: SCSP activities at AICRPS centres

XVIII POPULARIZATION OF TECHNOLOGIES

Scientists from AICRPS centres have 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 curcumin rich turmeric variety Megha Turmeric 1 (all NE centres)
- Demonstration of stable curcumin variety IISR Pragati (Coimbatore)
- Demonstration of high yielding fenugreek variety HM 257 (Hisar)
- Demonstration of high yielding coriander varieties (Hisar)

Rapid multiplication of planting materials- for minimal expenditure

- Protray technology popularization in turmeric in Paderu, Dumbriguda and Araku in collaboration with KVK, Kondempudi, Visakhapatnam (Chintapalle)
- Protray cultivation technique for quality seed production of ginger & turmeric (Kammarpally, Pottangi, Nagaland)
- Demonstration of protray propagation technique for ginger and turmeric, soft wood grafting technique in nutmeg and kokum, bush pepper production technology (Dapoli)
- Performance of turmeric transplants in 2.0 acres (Coimbatore)

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

Protection technologies- for plant health

- Management of stem gall disease of coriander (Dholi)

Processing Machineries- for increase in efficiency

- Demonstration of multipurpose electric dryers for drying large cardamom and ginger (ICRI Sikkim)
- Demonstration of turmeric boilers, polishers

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).

Fig 41: News paper clippings of activities of AICRPS centres

XIX SUCCESS STORIES

Impact assessment of cumin variety GC 4 in State and National economy

The first wilt tolerant cumin variety, GC 4 was released at National level during 2006 and it spread like a fire and covered about 90 and 60 per cent area under cumin in Gujarat and Rajasthan, respectively. The Seed Spices Research Station, Jagudan has released Gujarat cumin 4 (GC 4) in 2006 at National level for cultivation under different production conditions in Gujarat and other states. There is a significant increase in the area, production and productivity of cumin after the release of GC 4 variety. The area, production and productivity of cumin in Gujarat have increased to 331 %, 700 % and 216 %, respectively by the year 2020-21 as compared with 2001-02. The share of Gujarat in cumin area and production of the country was 27 and 30 per cent during 2001-02 which increased to 51 and 50 per cent during 2020-21. Thus the investment made in seed spice research has been repaid through increased productivity and production. In addition to this cumin variety, SDAU, Jagudan has developed numerous technologies on crop production and crop protection in cumin resulting in reduction in production cost, conservation of natural resources and increase in productivity.

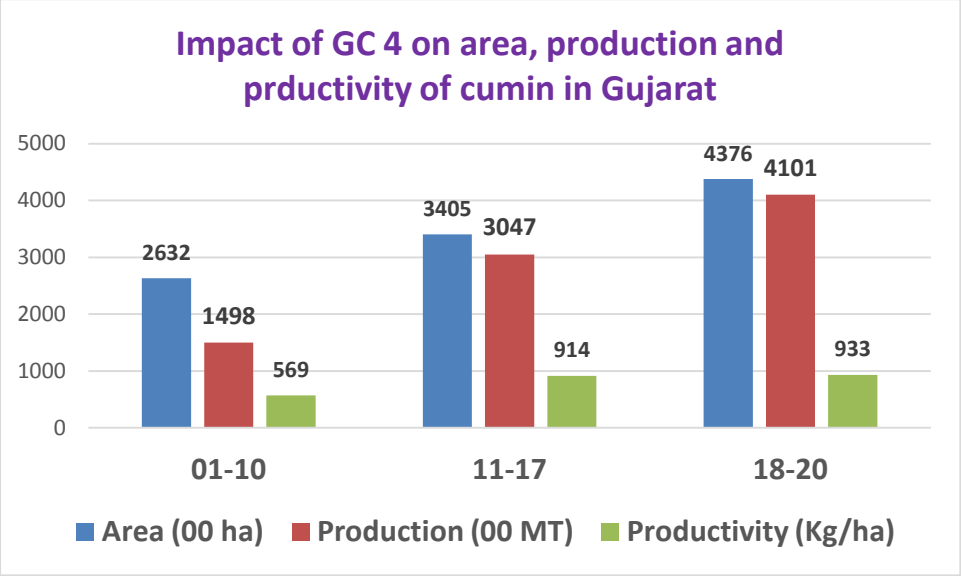


Fig 42: Impact of GC 4 on area, production and productivity of cumin in Gujarat

Fig 43: Field view of cumin variety GC 4

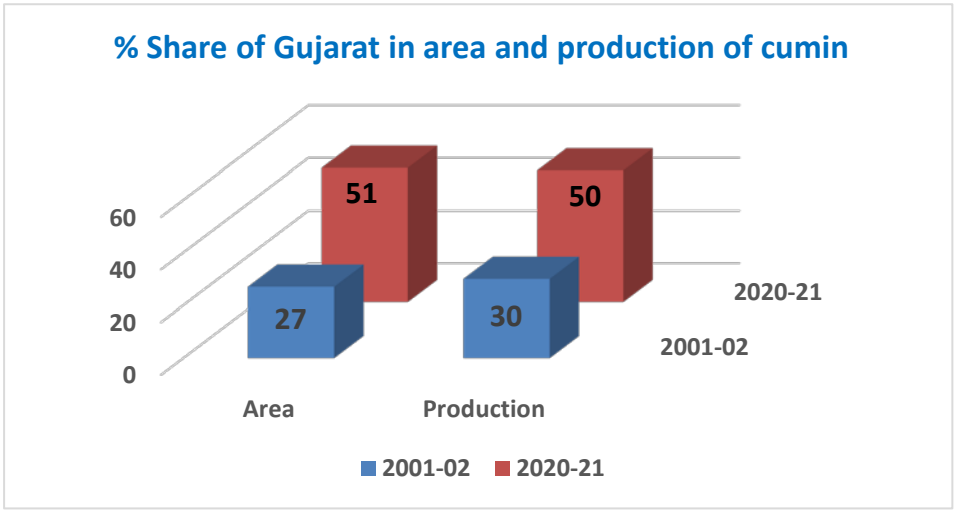


Fig 44: Increase in share towards national area and production

There is a quantum jump in the export of seed spices in general and cumin in particular as recorded during the last decade which was a result of increased production and thereby more surplus for export. The export earnings from cumin has jumped from 59.0 crores (2003-04) to 4253 crores (2020-21) thus playing a crucial role in foreign exchange earnings. On the other hand, the import of cumin reduced which saved foreign exchange.

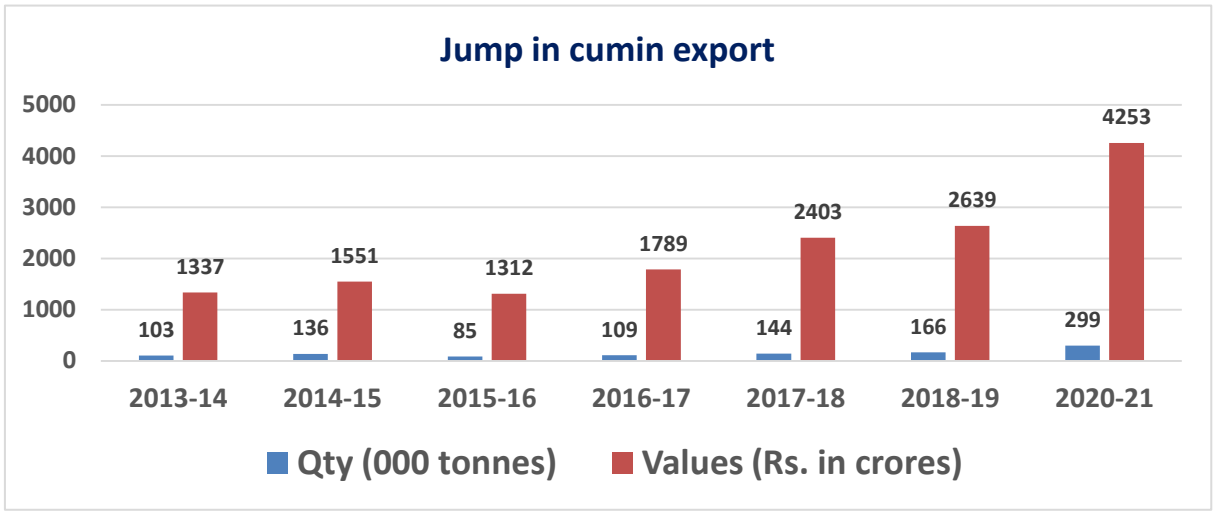


Fig 45: Export earnings of cumin in national economy

XX KRISHI MELAS & FARMER'S TRAININGS

Krishimelas/ exhibitions organised

- ICAR- AICRPS centre at Sirsi, UHSB conducted Totagarike mela from 2-4 January 2021 which benefitted 25000 farmers.
- Spices exhibits in "Kisan Mela'' held at Sport Ground Complex of RPCAU, Pusa, Samastipur, Bihar during 07 to 09 February, 2021 by Dholi centre.
- Kumarganj centre organized Exhibition of spices at Farmers' Fair at Banda Agricultural University, Banda, Uttar Pradesh during 22-23 February 2021.
- Exhibition of spices 2021 in the University stall was organized at Farmers' Fair at Deoria district, Kumarganj, Uttar Pradesh during 22-23 February 2021
- Kisan Mela was organized at Regional Agricultural Research Station, Chintapalli and demonstrated new technologies available in spice crops at Chintapalli on 26 February 2021 which was beneficial to tribal farmers of Visakhapatnam and also participated in Farmers-Scientists interaction and answered the queries raised by farmers.
- Field Day on 5 March 2021 at Spices Seed Production Plot at Kaijia, Pusa, Samastipur, Dholi, Bihar by Dholi centre.
- Guntur centre organized Kisan mela at RARS, Lam on 9 March 2021 along with Farmers-Scientists interaction and clarified the doubts in horticultural crops.
- Field day on "Integrated farming system practices for spices" organised at ZAHRS, Mudigere on 10 March 2021
- Krishi Mela (Rabi) organized at CCS Haryana Agriculture University, Hisar during 08-09 September, 2021
- Kisan Mela was organized by RARS, Chintapalli on 22 November 2021 and displayed a stall on new technologies available in different horticultural crops and explained to tribal farmers. Also conducted interactive session with farmers.
- Field day on " Importance of crop diversification on doubling of farmers income" organised at ZAHRS, Mudigere on 17 December 2021

Table 38. Training organized by various AICRPS centres

SL. No.	Date	AICRPS centre	Details of training	No. of participants
1	16.01.2021	OUAT, Pottangi	Organic ginger and turmeric cultivation	52
2	18.01.2021	KAU, Panniyur	Training session to farmers of Aralam Panchayath on "Homestead black pepper cultivation and bush pepper production"	40
3	19.01.2021	KAU, Pampadumpara	Importance and scope of floriculture' (online)	25
4	19.01.2021 to 22.01.2021	UHS, Sirsi	Quality black pepper production and export from Karnataka state (UAHS & ICAR-IISR)	30
5	19.01.2021	TNAU,	Exposure visit within state organized by	100

	to 23.01.2021	Yercaud	District Watershed Development Agency, Cuddalore	
6	20.01.2021	CAU, Dholi	Harvesting, post harvest management, storage, packaging & economic analysis of turmeric. (virtual mode)	122
7	24.01.2021	KAU, Pampadumpara	Planning and executing a kitchen garden (Online)	80
8	27.01.2021 to 31.01.2021	TNAU, Yercaud	Exposure visit within state organized by District Watershed Development Agency, Cuddalore.	100
9	28.01.2021	UHS, Sirsi	Farmers experience in organic cultivation of small cardamom	15
10	30.01.2021	OUAT, Pottangi	Training to Tumudibandha Farmers Spices cultivation"	18
11	02.02.2021	OUAT, Pottangi	Doubling of farmers income through spices cultivation	30
12	05.02.2021	SKNCOA, Jobner	Micro-irrigation for higher water productivity (in collaboration with Project on micro irrigation management, RKVY-11).	59
13	06.02.2021	SKNCOA, Jobner	Micro-irrigation technique for water saving under dry land farming.	58
14	08.02.2021	OUAT, Pottangi	Dealers training on "Use of safer pesticides"	25
15	10.02.2021	SKNCOA, Jobner	Commercial cultivation of medicinal and aromatic plants and post harvest management.	
16	11.02.2021	OUAT, Pottangi	Training to Nabarangapur farmers on spices cultivation	18
17	11.02.2021	SKNCOA, Jobner	Rain water harvesting and its effective utilization through micro irrigation.	80
18	12.02.2021	SKNCOA, Jobner	Doubling farmer's income through micro irrigation."	77
19	17.02.2021	KAU, Panniyur	NHM funded one day seminar on Good agricultural practices in black pepper"	35
20	17.02.2021 to 18.02.2021	TNAU, Coimbatore	Improved production techniques in spices at Cherumalli village, Gudalur funded by DASD, Calicut	150
21	18.02.2021	TNAU, Coimbatore	Large scale demonstration of biocontrol of ginger rhizome rots at Cherumalli village, Gudalur	50
22	18.02.2021	UHS, Sirsi	Production of quality planting materials of black pepper	30
23	18.02.2021 to 19.02.2021	KAU, Panniyur	Mass production of biocontrol agents for Agriculture Assistants	25
24	22.02.2021	IGKV, Raigarh	Production of vermicompost in Municipal Corporation & Nagar Panchayat Baramkela, Raigarh under Godhan Nyaya Yojna.	50

25	22.02.2021 to 19.03.2021	OUAT, Pottangi	Skilled development training to spices crop cultivators	25
26	23.02.2021 to 24.02.2021	AAU, Kahikuchi	Production, protection and PHT of turmeric and black pepper	25
27	24.02.2021	CCSHAU, Hisar	Production technology of spice crops	75
28	26.02.2021	NDUAT, Kumarganj	Masala avam sugandh paudh ki jaivik kheti at village-Jamuvari, Shukla Bajar, Amethi	48
29	28.02.2021	OUAT, Pottangi	Spices cultivation" to Nandahandi farmers	100
30	03.03.2021	CCSHAU, Hisar	Production technology of spice crops	75
31	04.03.2021 to 06.03.2021	ICAR Tadong	Large cardamom cultivation under changing climatic condition	20
32	10.03.2021	ZAHRS, Mudigere	Field day on "Integrated farming system practices for spices"	23
33	16.03.2021	OUAT, Pottangi	Organic turmeric cultivation	75
34	17.03.2021	NDUAT, Kumarganj	Spices cultivation	30
35	17.03.2021	OUAT, Pottangi	Organic spices cultivation	150
36	18.03.2021	OUAT, Pottangi	Cardamom cultivation	75
37	19.03.2021	OUAT, Pottangi	Cardamom cultivation	75
38	20.03.2021	OUAT, Pottangi	Cardamom cultivation	75
39	20.03.2021	AUJ, Mandor	Production of seed spices, precautions and their storage	25
40	20.03.2021	AUJ, Mandor	Disease management of seed spice crops	32
41	20.03.2021	AUJ, Mandor	Good agricultural practices in seed spices	30
42	22.03.2021	ICAR RC NEH Mizoram	Scientific way of turmeric cultivation	23
43	22.03.2021 to 24.03.2021	RPCAU, Dholi	Spices cultivation	53
44	26.03.2021	OUAT, Pottangi	Organic spices cultivation	75
45	27.03.2021	OUAT, Pottangi	Organic spices cultivation	75
46	07-06-2021	Dr. YSRHU Guntur	Turmeric for Horticulture Officers, V H As, V A As via virtual mode	40
47	18.06.2021 to 19.06.2021	RPCAU, Dholi	Land preparation, application of manures & fertilizer and planting of turmeric (virtual mode)	122

48	28.06.2021 to 01.07.2021	KAU, Panniyur	Enhancing productivity and economic security in spices" (Sugandavilakile udpaadana kshamathayum sambathika badrathayum").	96
49	05.08.2021	ICRI- Sikkim	Spice clinic programme	18
50	05.08.2021	ICRI-Sikkim	Spice clinic programme for SHGs group	10
51	11.08.2021	KAU, Pamadumpara	Plant nutrient deficiencies and management"	25
52	25.08.2021	ICRI Gangtok	Large cardamom cultivation"	75
53	30.08.2021	KAU, Panniyur	Black pepper cultivation- Challenges and remedies	50
54	17.09.2021	Kahikuchi	Nursery raising of black pepper	40
55	20.09.2021	OUAT, Pottangi	Organic ginger and turmeric cultivation	75
56	13.10.2021	RPCAU, Dholi	Diseases & pest management in turmeric	122
57	31.10.2021	OUAT, Pottangi	Improved black pepper cultivation	75
58	01.11.2021	KAU, Panniyur	Scientific cultivation and pest and disease management of black pepper and vegetables	40
59	06.11.2021	OUAT, Pottangi	Organic ginger and turmeric cultivation	75
60	12.11.2021	OUAT, Pottangi	Good agricultural practices in black pepper	36
61	15.11.2021	OUAT, Pottangi	Organic ginger and turmeric cultivation	50
62	22.11.2021 to 26.11.2021	TNAU, Yercaud	Conservation, management and utilization of horticultural genetic resources for livelihood and nutritional security	35
63	23.11.2021 to 25.11.2021	ICAR-NEHR Barapani	Improved production techniques in ginger, turmeric, tuber, vegetable and fruit crops	61
64	25.11.2021	AAU, Kahikuchi	"Post harvest management of black pepper "under Gramin Sahara at Kahua, Kulsi	42
65	27.11.2021	KAU, Pampadumpara	Mass Awareness Campaign on pesticide usage in cardamom Idukki.	25
66	27.11.2021	AAU, Kahikuchi	Post harvest management of turmeric under Gramin Sahara at Bagan Bazar	37
67	27.11.2021	KAU, Pamadumpara	Mass Awareness Campaign on pesticide usage in cardamom	28
68	01.12 2021	TNAU, Coimbatore	"Improved production technologies for quality improvement in turmeric and nutmeg" funded by Spices Board	50
69	04.12.2021	ICAR-NEHR Barapani	"Improved production techniques in ginger, turmeric, tuber, vegetable and fruit crops"	31
70	07.12.2021	ICAR-NEHR Barapani	Frontline demonstration cum field day on "Good agricultural practices of potential seed spices for livelihood improvement"	55

71	12.12.2021	SASRD, Nagaland	Prospects of spices production conducted at Renthan, Wokha and Beisumpuikam villages. (NITI Aayog identified aspirant villages)	55
72	16.12.2021	IGKV, Raigarh	Natural farming online and offline mode	290
73	17.12.2021	ZAHRS, Mudigere	Field day on " Importance of crop diversification on doubling of farmers income"	34
74	23.12.2021	BSKKV, Dapoli	Celebration of National Farmers day and distribution of farm implements to 20 farmers.	156
75	23.12.2021	KAU, Pampadumpara	Mass Awareness Campaign against pesticide misusage in cardamom at Kattappana Krishi Bhavan.	48

Fig 46: Training programme organized by Ambalavayal centre

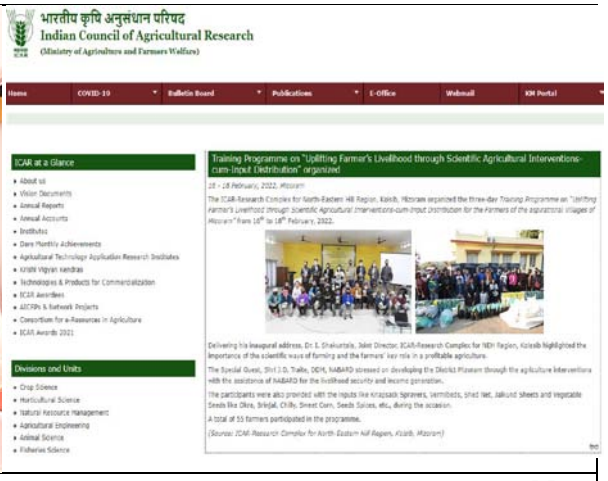


Fig 47: Training programme organized by Mizoram centre reported in ICAR website

Fig 48: Farmers training in the tribal belt of Odisha

XXI PUBLICATIONS

Research Papers

Pampadumpara

Ashokkumar K, Sampathrajan V, Murugan M, Dhanya M K, Manoharan A, Gunasekaran A, Aiswarya S, Tom W, Adhimoolam K 2021 Essential oil profile diversity in cardamom accessions from southern India, *Frontiers in Sustainable Food Syst*ems (5): 1-8. https://doi.org/10.3389/fsufs.2021.639619

Ashokkumar K, Murugan M, Dhanya M K, Pandian A and Warkentin T 2021 Phytochemistry and therapeutic potential of black pepper [*Piper nigrum* (L.)] essential oil and piperine: a review. *Clinical Phytoscience* 7:52.

Ashokkumar K, Vellaikumar S, Murugan M, Dhanya M K, Karthikeyan A, Ariharasutharsan G, Sivakumar P, Arjun P, and Aishwarya S 2021 GC/MS analysis of essential oil composition from selected seed spices. *National Academy of Science Letters*. https://doi.org/10.1007/s40009-021-01066-7 (IF: 0.79)

Ashokkumar K, Vellaikumar S, Murugan M, Dhanya M K, Karthikeyan A, Akilan M, Ariharasutharsan G, Nimisha M and Aiswarya S 2021 Assessment of phytochemical diversity in essential oil composition of eighteen *Piper nigrum* (L.) accessions from southern India. *Journal of Essential Oil Research* 33(6) 2021https://doi.org/10.1080/10412905.2021.1975578 (IF: 1.963)

Dhanya M K, Murugan M, Neenu T T, Bisnamol J, Ashok Kumar K, Surya R, Doncy S P and Nimisha M 2021 First report of *Phoma* sp. in small cardamom [*Elettaria cardamomum* (L.) Maton] from Western Ghats, India. *Indian Phytopatholo*gy 74: 1161–1165 https://doi.org/10.1007/s42360-021-00401-8

Sathyan T, Dhanya M K, Murugan M, Ashokkumar K, Aswathy T S, Narayana R and Deepthy K B 2021. Evaluation of bio-agents, synthetic insecticides and organic amendments against the root-knot nematode, *Meloidogyne* spp. In Cardamom (*Elettaria cardamomum* (L.) Maton). *Journal of Biological Control* 35(2): 242-248. https://doi.org/10.18311/jbc/2021/26772 (IF: 0.93)

Mudigere

Rashmi C, Shivaprasad M, Swamy A V, Vinay J U and Shilpa M 2021 Studies on impact of seasonal and environmental factors on incidence of shoot and capsule borer in cardamom varieties M-1 and M-2. *Journal of Entomology and Zoology Studies*, 9(1): 1631-1633.

Rashmi C, Shivaprasad M, Swamy A V, Vinay J U and Shilpa M 2021 Management of shoot and capsule borer of small cardamom through insecticides and bio-pesticides. *International Journal of Chemical Studies*, 9(1): 1998-2001.

Rashmi C, Shivaprasad M, Swamy A V, Vinay J U, Ranjitha B R and Shilpa M 2021 Studies on bio-ecology of shoot and capsule borer (*Conogethus punctiferalis* Guenee) on small cardamom at Malnad region of Karnataka. *The Pharma Innovation Journal*, 10(11): 510-514.

Shivaprasad M, Vinay J U, Swamy A V, Rashmi C and Ranjitha B R 2021 Eco-friendly management of pseudostem rot of small cardamom in hill zone of Karnataka. *The Pharma Innovation Journal*, 10 (10) : 912-915.

Coimbatore

Elakkiya S, M Suganthy, K Bhuvaneswari, V Rajasree, J Renugadevi and B Senthamizh Selvi 2021 Development of eco-friendly pest management module for the management of aphids, *Hyadaphis coriandri* (Das) infesting coriander, *Coriandrum sativum* L. *The Pharma Innovation Journal*, 10(10): 1027-1031.

Gothandan G, B Senthamizh Selvi, S Velmurugan and P Meenakshi 2021 Performance of coriander genotypes (*Coriandrum sativum* L.) for herbage yield and quality parameters under coconut during *Kharif* season. *The Pharma Innovation Journal*, 10(10): 1324-1328.

Krishnaveni B, P Irene Vethamoni, B Senthamizh Selvi and M Raveendran 2021 Studies on genetic variability, correlation and path co-efficient analysis in fenugreek (*Trigonella foenum graecum* L.). *Electronic Journal of Plant Breeding*, 12(3): 835-840.

Chintapalle

Vamshi Krishna S, Sivakumar V, Umajyothi K, Dorajeerao A V D and Umakrishna K 2021 Trait link ages among turmeric (*Curcuma longa* L.) genotypes for yield and its attributing characters. *Frontiers in Crop Improvement*, 9: 317-320.

Pottangi

Behera S, Sial P, Biswal G and Pradhan K 2021 Role of Bio Pesticides towards efficient management of rhizome rot in ginger *International journal of Current Microbiology and Applied Sciences*, *10*(01): 941-945.

Behera S, Sial P, Biswal G and Pradhan K 2020 *Ralstonia solanacearum* the causal agent of ginger bacterial wilt - A review. *International journal of Current Microbiology and Applied Sciences*, *9*(12): 2709-2715.

Jobner

Kumawat G L, Gothwal D K, Ram Kunwar, Shivran A C, Kumawat P and Meena A K 2021 Screening of powdery mildew (*Erysiphe polygoni* DC.) tolerance in coriander (*Coriandrum sativum* L.) germplasm. *The Pharma Innovation Journal*, 10 (4): 1112-1116.

Kumari V, Kumawat P, Rajput S S, Meena M K and Jakhar M L 2021 Molecular markers and their role in crop improvement. *The Pharma Innovation Journal*, 10(9): 1348-1354.

Kumari V, Kumawat P, Yeri S and Rajput S S 2021 CRISPER- Cas9: A genome editing tool in crop plants. *Agricultural Reviews, ARCC/R-2298 doi: 10.18805/ag.R-2298: 1-6.*

Hisar

Deswal S, Singh M, Kumar K and Tehlan S K 2020 Efficiency of bio fertilizers in increasing the production potentials of seed spice — A Review. *Progressive Research – An International Journal*, 15 (Special): 287-291.

Telugu R K, Tehlan S K and Mor V S, Reddy P S S and Kowsalya N 2021 Analysis of seed quality and vigour in fifty fennel genotypes (*Foeniculum vulgare* Mill.). *Annals of Phytomedicine*, 10(1): 289-297.

Vijaykumar S, Kushal Raj and Tehlan S K 2021 Screening of coriander genotypes against stem gall disease caused by *Protomyces macrospores. International journal of Current Microbiology and Applied Sciences*, 10 (03): online

Jagudan

Amin A M, N R Patel, B G Prajapati, R K Jaiman and S G Gondaliya 2021 Integrated management of Ramularia blight (*Ramularia foeniculi*) in fennel. *Journal of Applied and Natural Science*, 13(1): 191 – 196.

Kumarganj

Gautam Satish Kumar, Ram C N, Rao O P and Nath Shiva 2021 Appraisal studies on genetic variability, heritability and genetic advance in fenugreek (*Trigonella foenum-graecum* L.). *The Pharma Innovation Journal*, 10(7): 1573-1576.

Gautam Satish Kumar, Ram C N, Yadav G C and Lal Mohit 2021 Assessment of correlation coefficients analysis in fenugreek (*Trigonella foenum-graecum* L.). *The Pharma Innovation Journal*, 10(7): 1577-1581.

Pandey Rang Nath, Ram CN, Kumar Pradip and Rao OP 2021 Study on genetic variability in germplasm of coriander (*Coriandrum sativum* L.). *The Pharma Innovation Journal*, 10(8): 1476-1477.

Rajbhar Ramesh, Ram C N, Kumar Pradip, Rao O P and Nath Shiva 2021 Assessment of genetic variability, heritability and genetic advance in coriander (*Coriandrum sativum* L.). *The Pharma Innovation Journal*, 10(8): 1585-1586.

Jabalpur

Reena Nair, S K Pandey and Jyotsana J 2021 Growth and yield of fenugreek (*Trigonella foenum-graecum* L.) in response to different levels of phosphorus and biofertilizer (Rhizobium and PSB) under Kymore Plateau and Satpura hill agro-climatic zone of Madhya Pradesh. *The Pharma Innovation Journal*, 10(1): 419-422.

Reena Nair, S B Das and Jyotsana J 2021 Integrated management of aphid (*Hydaphis coriandri* (Das) and powdery mildew in coriander. *Journal of Entomology and Zoology Studies*, 9(2):1019-1022.

Sharma A, Rehan and Reena Nair 2020 Phytomicrobiomes: A tool for a better crop management and ensured sustainability. *International Journal of Current Microbiology and Applied Science*, Special Issue-11: 411-424.

Mandor

Mehriya M L, Geat N, Kumhar S R, Alrajhi A A , Alkuriji M A, Dewidar A Z and Mattar M A 2021 Efficacy of herbicides in controlling wild onion (*Asphodelus tenuifolius* L.) in cumin grown under arid climatic conditions. *Agronomy*, 11: 1597.

Mehriya M L, Sarita, Hitesh Borana and Neelam Geat 2021 Effective and profitable weed management in rainy season groundnut grown under arid zone of Rajasthan. *Indian Journal of Weed Science*, 53(3): 269–274.

Motilal Mehriya, Uma Nath Shukla, P K Upadhyay, Hitesh Borana and Rajiv Kumar Singh 2021 Leaf and seed yield of nagauri methi (*Trigonella corniculata*) as influenced by seed rates and nitrogen levels. *Indian Journal of Agricultural Sciences*, 91(7): 1093–1095.

Navsari

Priya Patel, Patel R K, Modha K G, Thokchom Joydeep singh and Manju Singh 2021 Genetic variability and molecular diversity analysis in turmeric (*Curcuma longa* L.). *Indian journal of* Agricultural *Research*, 1-7.

Kota

Preeti Verma, Solanki R K, Meghwal H P and Yamini Tak 2021 Variable expression of anthocyanin in flower and stem of coriander (*Coriandrum sativum* L.) breeding implications. *International Journal of Chemical Studies*, 9(1): 1180-1183.

Preeti Verma and Meghwal H P 2021 Effect of Sib Mating on seed yield and weight of coriander genotypes and as influenced by pollination. *Indian Journal of Entomology*, 83: 82-84.

Vishnu Choudhary, Preeti Verma, Sharma S C, Yadav D L and Narolia R S 2021 Genetic variability and character

association studies for yield and its contributing traits in coriander (*Coriandrum sativum* L.). *The Pharma Innovation Journal*, 10(11): 1830-1834.

Pampore

Ajaz A Lone, Khan M H, Alie B A, Dar Z A, Mir G H, Qureshi A M I, Dar N A and Dar S A 2021 Shalimar Kala Zeera-1: First Variety of Black Gold from Kashmir. *e-Magazine for Agricultural Articles*. 1(5): 36-38

AICRPS Headquarters, Kozhikode

Sharon Aravind, Biju C N, Ankegowda S J, Shivakumar M S, Senthil Kumar R and Peeran M F 2021 Screening small cardamom (*Elettaria cardamomum* Maton) field gene bank accessions for phenotypic characters, yield potential and disease resistance *Journal of Spices and Aromatic Crops* 29 (2): 105-112.

Short communication

Pampadumpara

Ashok kumar K, Sampathrajan V, Murugan M, Dhanya M K and Aiswarya S 2021 Compositional variation in the leaf, mace, kernel and seed essential oil of nutmeg (*Myristica fragrance* Houtt.) from the Western Ghats, India.*Nat. Prod. Res.*1-4**.**

Book

Pampadumpara

Ashok kumar K, Muthusamy Murugan and M.K Dhanya A book on small cardamom entitled "Cardamom [*Elettariacardamomum*(L.) Maton] Production, Breeding, Management, Phytochemistry and Health Benefits" edited by the scientist of the station, has been published from Nova Science Publishers, New York, 2021.

Coimbatore

Pugalendhi L, Jayasankhar Subramanian, K Rajamani, J Suresh, M Ganga, T Elaiyabharathi, L Nalina, H Usha Nandhini Devi, B Senthamizh Selvi, M Velmurugan and P Aruna 2021 Compendium of Lead and Research Papers, Abstracts of the International Conference on Horticulture- Next Generation Horticulture (Next Gen-Hort) organized by TNAU, Coimbatore during 16 -19 September, 2021. p. 291. (ISBN No. 9 789384 909383).

Book Chapters

Pampadumpara

Ashokkumar K, Murugan M, Dhanya M K, Alagupalamuthirsolai M, Sathyan T, and Silvas Jebakumar Prince 2021 In Cardamom [*Elettaria cardamomum*(L.) Maton] Plant Breeding Approches for Cardamom Improvement. Production, Breeding, Management, Phytochemistry and Health Benefits. Ashokkumar K, Murugan M and Dhanya M K (Eds). Nova Science publishers. pp 53-82.

Ashokkumar K, Dhanya M K, Murugan M, Arjun Pandian, Saradha devi Muthukrishnana and Sampathrajan Vellaikumar 2021 In Cardamom [*Elettaria cardamomum* L. Maton] Cardamom as a source of biologically active compunds: essential oil and biological activity. production, breeding, management, phytochemistry and health benefits. Ashok kumar K, Murugan M and Dhanya M K (Eds). Nova Science publishers. pp 207-226.

Deepthy K B, Sathyan T, Dhanya M K, Murugan M, Sachin G Pai and Shana O M 2021 pest complex in cardamom and their management. In Cardamom [*Elettaria cardamomum*(L.) Maton] production, breeding, management, phytochemistry and health benefits. Ashokkumar K, Murugan M and Dhanya M K (Eds). Nova Science publishers. pp 103-136.

Dhanya M K, Ayisha R , Murugan M , Ashokkumar K, Sathyan T , Deepthi K B, Aishwarya M, Nijamol V and Nimisha M 2020 Diseases of small cardamom and their management. In. Cardamom [*Elettaria cardamomum* L. Maton] production, breeding, management, phytochemistry and health benefits. Ashok kumar K, Murugan M and Dhanya M K (Eds). Nova Science publishers. pp 137-166.

Murugan M, Ashokkumar K, Dhanya M K and Subbaish S 2021 History of Land and Agriculture in the Indian Cardamom Hills. In. Cardamom [*Elettariacardamomum*(L.) Maton] production, breeding, management, phytochemistry and health benefits. Ashokkumar K, Murugan M and Dhanya M K (Eds). Nova Science publishers. pp-20.

Nimisha M, Vikram H C, Ashokkumar K, Dhanya M K, Murugan M and Anu S 2021 Cultivation, harvesting, processing and products of cardamom. In. Cardamom [*Elettariacardamomum*(L.) Maton] production, breeding, management, phytochemistry and health benefits. Ashokkumar K, Murugan M and Dhanya M K (Eds). Nova Science publishers. pp 21-52.

Sathyan T, Deepthy K B, Dhanya M K , Murugan M, and Shana O M 2021. Bio-Pesticides for the management of pests and diseases in cardamom In. Cardamom [*Elettaria cardamomum* L. Maton] production, breeding, management, phytochemistry and health benefits. Ashokkumar K, Murugan M and Dhanya M K (Eds). Nova Science publishers. pp 167-192.

Kumarganj

Kumar Pradip, Yadav Gulab Chand & Singh Ram Lakhan 2021 Major diseases of fennel (*Foeniculum vulgare* L.) and their management. In: Modern Technology of Agriculture, pp. 20-26.

Yercaud

Anand M, Kamalkumaran P R, Sathiymurthy V A and Pugalendhi L 2021 Performance and assessment of pepper accessions for growth and yield parameters. In *Book of Souvenir & Abstracts published during International Conference on Advances in Agricultural & Food Sciences to Face the Challenges to Environment and Biosecurity* (p. 143). School of Agricultural Sciences, Sharda University, Knowledge Park 3, Greater Noida, India.

Chintapalli

Dr. V. Sivakumar 2021 Turmeric cultivation (Telugu) in Udyana Panchangam, Dr. YSRHU, A.P.
Dr. V. Sivakumar 2021 Ginger cultivation (Telugu) in Udyana Panchangam, Dr. YSRHU, A.P.
Dr. V. Sivakumar 2021 Black pepper cultivation (Telugu) in Udyana Panchangam, Dr. YSRHU, A.P.
Dr. V. Sivakumar 2021 Cardamom cultivation (Telugu) in Udyana Panchangam, Dr. YSRHU, A.P.
Dr. V. Sivakumar 2021 Coffee cultivation (Telugu) in Udyana Panchangam, Dr. YSRHU, A.P.

Pampore

Qureshi A M I, A Dar Zahoor, Mehraj uddin Sofi, Aijaz A Lone, Abidi I, Syed S Mahdi, Gowhar A, Khan M H, Altaf Wani M, Aazima Hyder, Tehmeena Bano 2021 Qureshi A M I, A Dar Zahoor, Mehraj uddin Sofi, Aijaz A Lone, Abidi I, Syed S Mahdi, Gowhar A, Khan M H, Altaf Wani M, Aazima Hyder, Tehmeena Bano 2021 Functional analysis of glutamate receptor-like channels in plants. *Calcium Transport Elements in Plants*, 215-229

Khan M H, Alie B A, Qureshi A M I , Mir G H, Dar N A, Shahid Qayoom, Tauseef Ali, Dar S A, Lone A A, Dar Z A, Ahmad M, Bhat M A & Sheikh F A 2021 Saffron: A Therapeutic and Prophylactic Nutrition for Human Population. *Medicinal and Aromatic Plants: Healthcare and Industrial Applications*, 303-324.

AICRPS Headquarters, Kozhikode

Nirmal Babu K, Lijo Thomas & Sharon Aravind 2021 Realizing the export potential of spices: Challenges and Strategies. In Pandey S K, Reena Nair & Kanchan S Bhan (Eds.) Horticultural crops Emerging issues and techniques. Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh page 1-8

Technical Bulletin/Popular article

Coimbatore

Ushamalini C and B Senthamizh Selvi 2021 Pests and diseases in turmeric. Pachai Bhoomi:12-13.
Velmurugan S and B Senthamizh Selvi 2021 Turmeric varieties of Tamil Nadu. Dinamalar. p:15

Jobner

Bana R C, Shivran A C and Kumawat G L 2021 February mah ke mukhya karya. *Jobner Krishi*, 6(2), 6-7.

Gothwal D K, Shivran A C and Kumawat G L 2021 Beejey masala jeera ki unnat utpadan takaneek. *Krishi Smarika*, pp. 66-69.

Kumawat G L, Ghasolia R P, Goyal S K, Jitendra Singh and Singh M 2021 Management of insect pests and diseases of pearl millet, Just Agriculture e- Newsletter. 2 (1), 1-8.

Ola R, Shivran AC, and Kumawat G L, 2021 Weed management in kharif crops. *Jobner Krishi*, 6 (8), 3-6.

Ola R, Kumawat G L, Shivran A C, and Dudhwal B L 2021 Shushk kshetreey mukhy phasal baajara mein samay par keet evam rog prabandhan karake aay mein badhotaree. *Jobner Krishi*, 6 (9), 2-4.

Shivran A C, Gothwal D K, Singh D and Kumawat G L 2021 Beejey masala phasalon kee unnat utpaadan takaneek. AICRP on Spices, SKNAU, Jobner. pp. 1-34.

Mudigere

Shivaprasad M, Ravi C S, Swamy A V, Vinay J U, Rashmi C, Shilpa malaghan and Ranjitha B R 2021 Bordodravana thayarike mattu adara upayogagalu (Bordeaux mixture : Its importance, preparation and its application) Published by: Publication Centre, University of Agricultural and Horticultural Sciences, Shivamogga UAHS2020F014

Kumarganj

C N Ram, and Puta Yadav 2021 Bhartiya Kisan: Keetnashkon ka prayog karate samay keen baton kadhyan rakhen ya sawadhania kaise barten. Published in Krishk Aradhana, 15-21, March, 2021.

Dijendra Kumar and C N Ram 2021 Vaigyanik Vidhi se Greenhouse men tamatar ki bemausami kheti karana Madhya Bhart Krishik Bharti, January, 2021 pp 47.

Kumar Pradip 2021 Kisano Ki Aay Dugani Karane Me Sahayak Masalon Ki Kheti, In: Smarika, Pradeshik Phal, Shakbhaji Evam Pushpa Pradarshani-2021, Rajbhavan Prangan, Uttar Pradesh, Lucknow, 6-8 February 2021, pp 68-70.

Kumar Dijendra & Ram CN 2021 Matar Ki Vaigyanik Vidhi Se Jaivik Kheti Karana, Madhya Bhart Krishik Bharti, January, 2021 pp 38-39.

Pradip Kumar 2021 Methi ki Jaivik Kheti (In: Masala evam Sagandh Paudh Ki Jaivik Kheti, (S Mishra & O P Rao Eds). pp 30-33

Dholi

Choudhary C S, Mishra A K, Choudhary R K and Singh R S 2021 Khaadyan evam Dalhani Faslo ke Bijopadan par bhivin bimariyon ke lakshan evam roktham. In: Krishak Prashikshan Patrika (*Beej Utpadan, Parishikshan evam Bhandaran*). Published by Publication Division, RPCAU, Pusa, Bihar, pp 98-109.

Choudhary C S and Mishra A K 2021 Dhan ki Kheti me hone wale Rog-Wyadhi evam uska Prabandhan. In: Bihar me Kisano ke Sahbhagita se Shankar Dhan Beej Utpadan ka Sampoorn Takniki Gyan. Published by Publication Division, RPCAU, Pusa, Bihar, pp 101.

Mishra A K and Choudhary C S 2021 Masala Faslo ka Beej Utpadan Takneek. In: Krishak Prashikshan Patrika (Beej Utpadan, Parishikshan evam Bhandaran). Published by Publication Division, RPCAU, Pusa, Bihar, pp 53-64.

Leaflet/Folder/Booklet/Bulletins/Practical manual/e News letter

AICRPS Headquarters, Kozhikode

Aarthi S J, Balaji Rajkumar M, Sharon Aravind, Alagupalamuthirsolai M, Sarathambal C, Prasath D & Srinivasan V (Eds.) 2021 Extension bulletin on turmeric ICAR-IISR, Kozhikode, Kerala, India 20 p.

Sharon Aravind, Parshuram Sial, Krishnamurthy K S, Rema J, Radha E & John George (Eds.) spicing up tribal welfare 2021 ICAR-All India Coordinated Research Project on Spices, ICAR-IISR, Kozhikode, Kerala, India 24p.

Sharon Aravind, Krishnamurthy K S, Rema J, John George & Radha E (Eds.) 2021 Spicing up NER through ICAR-AICRPS. ICAR-All India Coordinated Research Project on Spices, ICAR-IISR, Kozhikode, Kerala, India 30 p.

Raigarh

Sawargaonkar S L, Singh A K, Bhagat R, Sharma R N, Rathia G R, Painkara S K, Agrawal S, Rama M Savu, Prasath D, Krishnamurthy K S, Sharon A, Rema J and Nirmal Babu K (Eds.) 2021 AICRP on Spices, CARS, Raigarh, IGKV, Chhattisgarh 40 p.

Guntur

Giridhar K, Tanuja Priya B, Sarada C, Reddy, R V S K and Janaki Ram T 2021 Impact of varieties and technologies developed by Dr. YSR Horticultural University on the production of coriander in Andhra Pradesh. Published by Dr. YSRHU, Venkataramanngudem.

Panniyur

Divya K K, Neema V P, Ajith P M , Yamini Varma C K and Airina C K 2021 "Kurumulak nursery sasthreeya paripaalana murakal"

Divya K K, Neema V P, Ajith P M , Yamini Varma C K and Airina C K 2021 "Kurumulakinte keeda niyandranam"

Yamini Varma C K, Neema V P, Ajith P M, Divya K K and Airina C K 2021 "Kurumulakinte roga niyandranam" 2021

Airina C K, Neema V P, Yamini Varma C K, Ajith P M and Divya K K "Kurumulakile uthama paripalana murakal" 2021

Airina C K, Neema V P, Yamini Varma C K, Ajith PM and Divya K K "Kurumamskaranavumulak samskaranavum moolya vaardhanavum" 2021

Airina C K, Ajith P M, Neema V P, Yamini Varma C K and Divya K K." Kurumulakile Kambivala krishi reethi" 2021

Jagudan

Patel N R 2021 Insect pests of seed spices and their management Published in Agriculture & Food e-News letter Vol 3(1) (Article ID 10022 page 69)

Patel K I, Patel N R, Patel H B, Mayank Fadadu, Surbhi Chauhan and Amin A U 2021 Jiru ni Vaignanik Kheti (Shreni No. 3:4:994)

Patel N R, Patel H B, Chauhan S S, Patel K I, Patel A M, Amin A M and Amin A U 2021 Bij Masala Rojgari Vardh Pako (Shreni No :3::4:1005)

Dholi

Choudhary C S, Mishra A K, Kumar B, Sahni S and Chand P 2021 Laboratory Manual on Fundamentals of Plant Pathology. Published by Publication Division, RPCAU, Pusa, Bihar, pp101.

Navsari

Haldar ni Vaigyanik Kheti Paddhati 2021
Aadu ni Vaigyanik Kheti Paddhati 2021
Vanaspati ni Jato ane Kheduto na Hako nu Rakshan (PPV&FR) 2021

Yercaud

Anand M, Kamalkumaran P R, Velmurugan M, Krishnakumar T and Govindasamy M 2021 Potential benefits of piperin. AgriGate. July 2021, pp 21-22.

Anand M, P R Kamalkumaran and V A Sathiyamurthy 2021 Value added products in black pepper. *Just Agriculture* 1 : 1-3 (10) (e-ISSN: 2582-8223)

Chintapalle

Sivakumar V and Srinivasulu A 2021 Panasatho viluva aadhaarita utpattulu. Annadaatha, July, 34-35p.

Srinivasulu A and Sivakumar V 2021 Allam lo dumpa kullu, aku maccha tegullu. Annadata, October, 55p.

Sivakumar V and Srinivasulu A 2021 Spices as immunity boosters. Agriculture and Food e-magazine, November 2021, 3(11): 264-266.

Sivakuamar V 2021 Scope for ginger cultivation in Andhra Pradesh. Agriculture and Food e-magazine, December 2021, 3(12): 8-9.

Jobner

Bana R C, Shivran A C and Kumawat G L 2021 February mah ke mukhya karya. *Jobner Krishi*, 6(2), 6-7.

Gothwal D K, Shivran A C and Kumawat G L 2021 Beejay masala jeera ki unnat utpadan takaneek. *Krishi Smarika*, pp. 66-69.

Ola R, Shivran A C and Kumawat G L 2021 Weed management in kharif crops. *Jobner Krishi*, 6 (8), 3-6.

Publications in Seminar/Conference/ Symposium /Abstracts

Chintapalli

Rajeev, E Jayashree, D Prasath and Sivakumar V 2021 Value chain approach for promotion of spice farming systems in Paderu tribal agency area, Visakhapatnam. International Symposium on Spices as Flavours, Fragrances & Functional Foods (SYMSAC-X), held on 9-12 February 2021 through Virtual mode.

Sivakumar V 2021 Performance of turmeric (*Curcuma longa* L.) varieties under organic and inorganic production practices under eastern ghat region of Andhra Pradesh. International Conference on New Paradigms for Agriculture, Food and Sustainability Concerns (NPAFSC-2021), held on 26-28th February 2021 through virtual mode.

Srinivasulu A and Sivakumar V 2021 Scope of Black Pepper Cultivation Under Coconut Based Cropping System. National web conference on Strategies for buffering ecosystems for sustainable services in the era of intensive agriculture and climate change, held on 25-26th March 2021 through virtual mode.

Sivakumar V, Pradeep M and Srinivasulu A 2021 Performance of ginger (*Zingiber officinale* L.) varieties under organic and inorganic production practices under Eastern Ghat Region of Andhra Pradesh. National web conference on Strategies for buffering ecosystems for sustainable services in the era of intensive agriculture and climate change, held on 25-26th March 2021 through virtual mode.

Srinivasulu A and Sivakumar V 2021 Importance of development of value chain in black pepper under high altitude and tribal area of Visakhapatnam. National web conference on Strategies for buffering ecosystems for sustainable services in the era of intensive agriculture and climate change, held on 25-26th March 2021 through virtual mode.

Sivakumar V and Srinivasulu A 2021 Importance of mutation breeding for crop improvement in turmeric. International Web Conference on Innovative and Current Advances in Agriculture & Allied Sciences *(ICAAAS-2021)* during 19-21 July 2021 through virtual mode.

Pampadumpara

Nimisha M, Dhanya M K, Murugan M, Ashokkumar K, Surya R and Anu S 2021 Performance evaluation of select high yielding genotypes of small cardamom (*Elettaria cardamomum* (L.) Maton.) In: Proceedings of the 24th Plantation Crops Symposium Coping with the pandemics an beyond: Research and Innovations in the Plantation Crops Sector 14-16 December 2021, pp. 83-84 (Abstract GGPC 57).

Coimbatore

Senthamizh Selvi B, R Suresh, S Elakkiya, M Suganthy, S Sundravadana and K Venkatesan 2021 Screening of coriander genotypes for seed yield and their relative susceptibility against aphid population in field conditions. In: Book of extended abstracts (Vol. I) of the Golden Jubilee International Conference on " Global Perspectives in Crop Protection for Food Security (GPCP 2021)" held during December 08-10, 2021.

Kumarganj

Kumar Pradip, Yadav Gulab Chand, Maurya P K and Ram C N 2021 Genetic variability, correlation coefficient and path coefficient analysis in coriander germplasm. Abstract book of International Conference on Vegetable Research and Innovations for Nutrition, Entrepreneurship and Environment (ICVEG-21) at Indian Society of Vegetable Science, IIVR, Varanasi, December 14 - 16, 2021 pp. 54.

Preeti Yadav, C N Ram and Priya Rai 2021 Utilization of vegetables waste. *Abstract book of International Conference on Vegetable Research and Innovations for Nutrition, Entrepreneurship and Environment* (ICVEG-21) at Indian Society of Vegetable Science, IIVR, Varanasi, December 14 - 16, 2021 pp. 420-421.

Hisar

Tehlan S K and Malik T P 2021 Hisar Methi-425: A high yielding variety of fenugreek. Paper presented in International Symposium on "Spices as Flavours, Fragrances & Functional Foods" (virtual event) during 09–12 Feb. 2021

Bharti V, Ahlawat D S, Sharma S K and Tehlan S K 2021 Diversity of insect pollinators and impact of mode of pollination on yield parameters of ajwain [*Trachyspermum ammi* (l.) sprague] in India. Paper presented and documented in abstract of papers in "International Conference on Agriculture, Climate Change & Life Science 2021" (virtual event) during March 5-6, 2021.

Bharti V, Ahlawat D S, Sharma S K and Tehlan S K 2021 Diversity, abundance, foraging behaviour of insect pollinators and impact of mode of pollination on coriander (*Coriandrum sativum* L.). Paper presented in International Symposium on "Spices as Flavours, Fragrances & Functional Foods" (virtual event) during 09–12 Feb. 2021.

Bharti V, Ahlawat D S, Sharma S K and Tehlan S K 2021 Diversity of insect pollinators and impact of mode of pollination on yield parameters of ajwain (T*rachyspermum ammi* (L.) Sprague) in India. Paper presented in "International Conference on Agriculture, Climate Change & Life Science-2021" (virtual event) during March 5-6, 2021.

Yercaud

Kamalkumaran P R, Anand M and Velmuruan M 2021 Evaluation of taro (*Colocasia esculenta*) entries for yield and quality. Book of abstract published in the International Horticulture Conference "Next Generation Horticulture" held at TNAU, Coimbatore from 16.09.2021 to 19.09.2021. Page 58.

Kamalkumaran P R, Anand M and Sathiyamurthy V A 2021 Improvement of success percentage of air layering in timla fig (Ficus auriculata) using growth regulators. Book of abstract published in the International Horticulture Conference "Next Generation Horticulture" held at TNAU, Coimbatore from 16.09.2021 to 19.09.2021. Page 114.

Kamalkumaran P R, Anand M and Velmuruan M 2021 Validation of organic farming technologies in taro (*Colocasia esculenta*) . Book of abstract published in the International Horticulture Conference "Next Generation Horticulture" held at TNAU, Coimbatore from 16.09.2021 to 19.09.2021. Page 138.

Anand M, Kamalkumaran P R and Sathiyamurthy V A 2021 Evaluation of cut foliage under Shevaroys condition. Book of abstract published in the International Horticulture Conference "Next Generation Horticulture" held at TNAU, Coimbatore from 16.09.2021 to 19.09.2021. Page 68.

Anand M, Kamalkumaran P R and Sathiyamurthy V A 2021 Evaluation of black pepper germplasm for yield under Shevaroys Condition. Book of abstract published in the International Horticulture Conference "Next Generation Horticulture" held at TNAU, Coimbatore from 16.09.2021 to 19.09.2021. Page 69.

Anand M, Kamalkumaran P R and Sathiyamurthy V A 2021 Assesment of black pepper varieties/accessions for high yield. Book of abstract published in the International Horticulture Conference "Next Generation Horticulture" held at TNAU, Coimbatore from 16.09.2021 to 19.09.2021. Page 69

Jobner

Gothwal D K, Singh D, Kumawat G L and Shivran A C 2021 Evaluation of coriander *Coriandrum sativum* L. genotypes under normal irrigation and moisture stress conditions. In: Book of abstracts: International symposium on spices and aromatic crops (SYMSAC X) on spices as flavours, fragrances and functional foods, Published by Indian society for spices, Kozhikode, Kerala, DASD, Kozhikode, Kerala and Spices board, Kochi, Kerala held from 09th-12th February, 2021, pp. 108.

Shivran A C, Kumawat G L, Gothwal D K, and Singh D 2021 Effect of microirrigation on yield and economics in fenugreek under various planting patterns. In: Book of abstracts: International symposium on spices and aromatic crops (SYMSAC X) on spices as flavours, fragrances and functional foods, Published by Indian society for spices, Kozhikode, Kerala, DASD, Kozhikode, Kerala and Spices board, Kochi, Kerala held from 09th-12th February, 2021, pp. 115-116.

Kumawat G L, Sharma R N, Shivran A C, Gothwal D K, and Singh D, 2021 Management of coriander powdery mildew using new generation molecules. In: Book of abstracts: International symposium on spices and aromatic crops (SYMSAC X) on spices as flavours, fragrances and functional foods, Published by Indian society for spices, Kozhikode, Kerala, DASD, Kozhikode, Kerala and Spices board, Kochi, Kerala held from

09th-12th February, 2021, pp. 154.

Shivran A C, Kumawat G L, Gothwal D K, and Singh D 2021 Organic nutrients and wilt disease management in cumin *Cuminum cyminum*. In: Book of abstracts: International symposium on spices and aromatic crops (SYMSAC X) on spices as flavours, fragrances and functional foods, Published by Indian society for spices, Kozhikode, Kerala, DASD, Kozhikode, Kerala and Spices board, Kochi, Kerala held from 09th-12th February, 2021, pp. 156-157.

Inaniya, R, Mittal G K, Kumawat G L, Shivran A C, Singh B and Saxena S N 2021 Volatile oil profiling using GC-MS during storage of coriander (*Coriandrum sativum* L.) genotypes. In: Book of abstracts: International conference on Saffron and Seed Spices-Innovative technologies for sustainable development Published by Sher-e-Kashmir university of Agricultural Sciences and Tech., Shalimar, Srinagar (J&K) held from 07th-08th November, 2021, pp. 22.

Kumawat G L, Shivran A C, Gothwal D K and Mittal G K 2021 Screening of cumin (*Cuminum cyminum* L.) genotypes against blight and wilt diseases. In: Book of abstracts: International conference on Saffron and Seed Spices-Innovative technologies for sustainable development Published by Sher-e-Kashmir university of Agricultural Sciences and Tech., Shalimar, Srinagar (J&K) held from 07th-08th November, 2021, pp. 86.

Mudigere

Shivaprasad, M, A V Swamy, J U Vinay, C Rashmi and M Shilpa 2021 Influence of different irrigation and fertilizer doses on capsule yield of small cardamom In: Book of abstracts: *International symposium on spices as flavors, fragrance and functional food (SYMSAC X-2021)* IISR, Calicut, Kerala held from 9th -12th February, 2021.

Shivaprasad, M, J U Vinay, A V Swamy, C Rashmi and M Shilpa Management of psuedostem rot disease of small cardamom through fungicides and bioagents. In: Book of abstracts: *International symposium on spices as flavors, Fragrance and functional food (SYMSAC X-2021))* IISR, Calicut, Kerala held from 9th -12th February, 2021.

Shivaprasad, M, J U Vinay, A V Swamy, C Rashmi and Ranjitha B R Efficacy of new fungicide molecule, Fluxapyroxad 167g/L +Pyraclostobin 333g/L (500 SC) against coffee leaf rust in Malnad region of Karnataka *National Webinar on Plant Diseases in Eastern and Northeastern India: Current Dynamics and Proposed Action Plan for Their Management*

Jabalpur

Sharma A**,** Reena Nair and Pandey SK 2021 Effect of different doses of nitrogen and row spacing on growth and yield of coriander (*Coriandrum sativum* L.) in e-Abstracts- SYMSAC X 2021, 09-12 February 2021, International Symposium on Spices as Flavours, Fragrances & Functional Foods, Indian Society for Spices, Kozhikode, Kerala, India. S4 P55: pp 106.

Reena Nair, Pandey S K and Sharma A 2021 Performance assessment of some fennel *Foeniculum vulgare* mill genotypes in central India in e-Abstracts- SYMSAC X 2021, 09-12 February 2021, International Symposium on Spices as Flavours, Fragrances & Functional Foods, Indian Society for Spices, Kozhikode, Kerala, India. S4 P66: pp 112.

Bhavana Yadav, Reena Nair, Saxena A K & Nazneen Husain 2021 Bioefficacy of biopesticide and fungicide on percent disease index of coriander powdery mildew (*Erysiphe polygoni*) in e-Abstracts- SYMSAC X 2021, 09-12 February 2021, International Symposium on Spices as Flavours, Fragrances & Functional Foods, Indian Society for Spices, Kozhikode, Kerala, India. S5 P58: pp 154

Nazneen Husain, Reena Nair, Sahu R K and Bhavna Yadav 2021 Studies on the effect of inorganic fertilizers and bio-inoculant (Rhizobium, PSB and KSB) on symbiotic properties and yield of fenugreek in e-Abstracts- SYMSAC X 2021, 09-12 February 2021, International Symposium on Spices as Flavours, Fragrances & Functional Foods, Indian Society for Spices, Kozhikode, Kerala, India. S5 P69: pp 158.

AICRP on Spices, Kozhikode

Sharon Aravind, Kandiannan K, Rema J and Ankegowda S J 2021 Influence of genotypes on flower production in nutmeg (*Myristica fragrans* Houtt.). In. Biju C N, Alagupalamuthirsolai M, Senthil Kumar C M, Dinesh R, Prasath D, Ramakrishnan Nair R, Santhosh J Eapen (Eds) e Abstracts- SYMSAC X 2021, International Symposium on Spices as Flavours, Fragrances and Functional foods, Indian Society for Spices, Kozhikode, Kerala, India. pp 152.

Akshitha H J, Mohammed Faisal Peeran, Sharon Aravind and Balaji Rajkumar M 2021 Evaluation of small cardamom (*Elettaria cardamomum* Maton) hybrids for yield and rhizome rot resistance. In. Biju C N, Alagupalamuthirsolai M, Senthil Kumar C M, Dinesh R, Prasath D, Ramakrishnan Nair R, Santhosh J Eapen (Eds) e Abstracts- SYMSAC X 2021, International Symposium on Spices as Flavours, Fragrances and Functional foods, Indian Society for Spices, Kozhikode, Kerala, India. pp 136.

Aravind S, Gothwal D K, Chauhan S, Meena R S, Tehlan S K, Patel R, Nair R, Mukhim C, Kumar P, Singh D, Shivakumar M S, Krishnamurthy K S and Rema J 2021 Evaluation of fennel genotypes under various agro

climatic regions of India In. Souvenir & Abstracts International Conference on Saffron and seed spices- Innovative technologies for sustainable development, SKUAST, Srinagar pp 5.

Rema J, Sharon Aravind & Krishnamurthy K S 2021 Crop improvement in seed spice: Prsent scenario & future prospects In. Souvenir & Abstracts International Conference on Saffron and seed spices- Innovative technologies for sustainable development, SKUAST, Srinagar pp 13-14.

Ashutosh Gautam, Leela N K, Rayel Chhetri, Bora S S, Deka T N, Pradip Kumar K, Krishnamurthy K S, Sharon A and Rema Shree A B 2021 Study on composition of essential oils of large cardamom (*Amomum subulatum* Roxb) and its wild relatives found in Himalayan region, Sikkim In. Dhanpal K, Pradip Kumar K, Shadanaika, Ansar Ali M A, John Jo Varghese, Saju K A, Manoj Oommen and Thiyagarajan P (Eds) Book of Abstracts, Coping with the pandemic and beyond: Research and innovations in the Plantation crops sector, Kochi, pp 13-14.

Sharon Aravind, Parshuram Sial, Krishnamurthy K S and Rema J 2021 Spices pave way for tribal welfare In. Dhanpal K., Pradip Kumar K., Shadanaika, Ansar Ali M A, John Jo Varghese, Saju K A, Manoj Oommen and Thiyagarajan P. (Eds) Book of Abstracts, Coping with the pandemic and beyond: Research and innovations in the Plantation crops sector, Kochi, pp 296-298.

Radio talk

Kahikuchi

Dr. Kusum Kumar Deka spoke on “Prospect of Horticulture in Assam”, on 19.01.2021, AIR, Guwahati

Pantnagar

Dr. Dhirendra Singh spoke on *Mashalo se kheti kar kishan kaise aya bdhayen* (Hindi) broadcasted on 2 April, 2021 by Janvani Radio, Pantnagar.

Dr. Dhirendra Singh spoke on *Dhaniya ki khet garmi me kaise kare* (Hindi) broadcasted on 6 May, 2021 by Janvani Radio, Pantnagar.

Dr. Dhirendra Singh spoke on *Meth ki kheti* (Hindi) broadcasted on 12 September, 2021 by Janvani Radio, Pantnagar.

Dr. Dhirendra Singh spoke on *Sauf ki Kheti se badheyn aya* (Hindi) broadcasted on 1 October, 2021 by Janvani Radio, Pantnagar.

TV Programme

Guntur

Dr. K Giridhar, YSRHU attended RBK Channel live on “Allam sagulo yajamanya paddatulu-Rakala empika mariyu poshaka yajamanyamu” on 06-08-2021.

Dr. Thanuja Priya YSRHU attended Vamu saagulo yajamanyam recording on 29.12.2021 for RBK channel

Dr. K. Giridhar, Senior Scientist (H) attended Pasidipantalu Live programme in DD Sapthagiri titled “Cultivation practices of grain spice crop” on 07-01-2021.

Kahikuchi

Dr. Kusum Kumar Deka attended Live Phone in programme on Employment opportunity in horticultural sector on 07.04.2021.

Jagudan

Dr. Patel N R attended phone in live programme on Seed spices cultivation through DD Girnar during 2021

Dr. Patel N R delivered TV programme on *Dhaniya ke rogon ka nidhan* (Hindi) telecasted on 14 September by Hello Kishan, Dhoordarsan

Dr. Patel N R delivered TV programme on *Methi ke kheti kaise kare* (Hindi) telecasted on 16 October by Hello Kishan, Dhoordarsan

XXII AWARDS & RECOGNITIONS

Best AICRPS Centre Award

AICRP on Spices centre, Chaudhary Charan Singh Haryana Agricultural University, Hisar

Recognition

Dr. Shivaprasad M, bagged the **Scientist of the Year 2020** for outstanding contribution in the **field of Agronomy** by Agro-Environmental Development Society (AEDS), Majhra Ghat, Rampur, Uttar Pradesh during the 5th International Conference on "Advances in agriculture, environmental and bio-sciences for sustainable development (AAEBSD-2021)"

Dr. A. K. Mishra, RPCAU, Dholi, bagged Outstanding Plant Pathologist Award in the field of Spices Research during 4th National Conference and Webinar on Doubling Farmers Income for Sustainable and Harmonious Agriculture DISHA-2021, held at Jharkhand.

Dr. Tanuja Priya, Dr. YSRHU, Guntur received the **best scientist award** from Children's Space Society of India, Guntur towards the significant contributions in research field on the eve of International woman's day, 8 March, 2021

Dr. B. Senthamizh Selvi, TNAU, Coimbatore received the award for the 'Outstanding contribution in Doubling Farmers Income scheme of TNAU (2019-21) in the identified DFI village to realize the concept "Outcome is Income" at Kinathukadavu block of Coimbatore

Dr. Girdhari Lal Kumawat, S.K.N. College of Agriculture, Jobner bagged **"Young Scientist Award"** during National Webinar "Transformation of Farmers, Agriculture & Allied Sector" on 27 July, 2021 for excellent contribution in the field of agriculture & allied sector supported by Samagra Vikas Welfare Society (SVWS)

Dr. A. K. Singh, IGKV, Raigarh received certificate of appreciation by Shri Rabindra Choubey Hon'ble Minister of Agriculture Govt. of Chhattisgarh for COVID -19 for special duty on 15 August, 2021 and certificate of appreciation by Hon'ble Vice Chancellor for sincere efforts, devotion and exceptional contribution in various programme of Indira Gandhi Krishi Viswavidyalaya, Raipur on the occasion of Republic Day 2021.

Sawargaonkar S.L, Singh A K , Rathia G R , Painkara S K, Tirkery P, Sharma R N, Sharon A and Krishnamurthy K S received **Dr. Kriti Singh Best Paper Award** – 2021 given by Confederation of Horticulture Associations of India, New Delhi for the paper entitled " Evaluation of different quality planting materials of turmeric *(Curcuma longa* L.*)* by traditional and PROT technique in International Journal of Innovative Horticulture (IJIH) Vol. 9 (2): 132-136

Girdhari Lal Kumawat, A C Shivran and D K Gothwal, SKN Agriculture University, Jobner have been conferred **Best Poster Paper Award** for the research paper entitled "Management of powdery mildew (*Erysiphe polygoni* DC.) and aphid (*Hydaphis coriandri* Das) in coriander" in Management of Biotic and Abiotic Stresses, Session (Online) presented in the 9th Indian Horticulture Congress-2021, held at Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh during 18-21 November 2021.

Dr. A. K. Mishra, RPCAU, Dholi, bagged "Best Oral Presentation Award & Distinguished Scientist Award " in 3rd International Conference on " Food Agriculture and Innovations (ICFAI-2021) organized by Green Agri. Professional Society, Dhanbad, Jharkhand at Ranchi, Jharkhand during 24th – 26th December, 2021.

Dr. B. A. Alie bagged the Best Poster Presentation entitled "Indoor Saffron Cultivation – A novel Technology for Vertical Expansion of Saffron" in International Conference on Saffron and Seed Spices held on 7-8 November 2021 organized by ARSSSS, SKUAST Kashmir

Project Mode centre at SKUAST, Kashmir received Best Oral Presentation entitled "Genetic improvement of temperate spices for yield and quality gains" in International Conference on Saffron and Seed Spices held on 7-8 November 2021 organized by ARSSSS, SKUAST Kashmir

XXIII STAFF POSITION

Project Coordinator's Office

1.	Project Coordinator	: Dr. Santhosh J Eapen (upto 13 January 2021) Dr. Rema J
2.	Principal Scientist (Plant Physiology)	: Dr. K. S. Krishnamurthy
3.	Scientist (SPMAP)	: Dr. Sharon Aravind
4.	Chief Technical Officer	: Mr. John George
5.	Chief Technical Officer	: Dr. E. Radha
6.	Personal Assistant	: Vacant
7.	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.	Jr. Breeder	: Dr. P. M. Ajith (Upto 20 February 2021) Ms. T. Daliya (Upto 31 August 2021)
2.	Jr. Pathologist	: Dr. C. K. Yamini Varma
3.	Jr. Horticulturist	: Dr. C. K. Airina
4.	Technical Assistant	: Vacant (Contract basis)
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. M. Anand (Upto 8 September 2021) Dr. P. R. Kamalkumaran
2.	Lab Assistant	: Mrs. K. Leela

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

1.	Jr. Horticulturist	: Dr. B. Senthamizh Selvi
2.	Jr. Pathologist	: Dr. S. Sundravadana
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 (Upto 6 July 2021)
   Dr. Sumer Singh Puniya
2. Jr. Pathologist : Sh. G. L. Kumawat
3. Jr. Agronomist : Dr. A. C. Shivran
4. Technical Assistant : Mr. S. R. Kumawat

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

1. Pathologist : Dr. N. R. Patel
2. Jr. Breeder : Dr. Surabhi S. Chauhan
3. Technical Assistant : Mrs. Rekha Chaudhari

14. Department of Vegetable Crops, (CCS HAU), Hisar

1. Pathologist : Dr. Suresh K. Tehlan
2. Horticulturist : Dr. T. P. Malik

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

1. Jr. Horticulturist : Dr. C. Mukhim
2. Jr. Pathologist : Dr. A. K. Mishra
3. Technical Assistant : Sh. A. N. Mishra

16. Department of Vegetable Science (NDUAT), Kumarganj

1. Jr. Pathologist : Dr. Pradip Kumar
2. Horticulturist : Dr. C. N. Ram (w.e.f. 1 November 2021)
3. Technical Assistant : Sh. R. K. Gupta

17. Department of Horticulture (UBKV), Pundibari

1. Jr. Pathologist : Dr. Anamika Debnath
2. Technical Assistant : Sh. Murari Krishna Roy

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

1. Horticulturist : Dr. P. C. Mali
2. Jr. Breeder : Dr. J. P. Devmore (Upto 12 July 2021)
   Dr. S. B. Thorat (Upto
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

XXIV TRAININGS & CAPACITY BUILDING

Training attended by staff members of AICRPS

S. No	Name of Scientist	Details of training	Venue	Duration
1	Dr. Preethi Verma, AUK, Kota	Plant Genetic Resources Management and Utilization (online training) organized by ICAR-NBPGR	Pusa Campus, New Delhi	19.07.2021 to 01.08.2021
2	Dr. Nimisha Mathews, CRS, Pampadumpara	Faculty Induction Programme	UGC-HRDC, Kannur University	01.01.2021 to 30.01.2021
3	Ms. Airina C. K, PRS, Panniyur	Excel in Research	UGC-HRDC, Kannur University	21.10.2021
4	Ms. Airina C. K. PRS, Panniyur	Faculty Induction Programme	UGC-HRDC, Kannur University	01.01.2021 to 30.01.2021.
5	Dr. B. Senthamizh Selvi, TNAU, Coimbatore	Entrepreneur Development and Skill Training for Ripening Chamber	Ministry of Agriculture, Government of India	20.03.2021
6	Dr. B. Senthamizh Selvi, TNAU, Coimbatore	Emotional Intelligence for Personal and Professional Success	Directorate of Planning and Monitoring, TNAU, Coimbatore	05.08.2021 to 06.08.2021

XXV WEATHER 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-21	214.2	13	19.90	10.33	71.70	6	93.16	34.31	23.59
Feb-21	0.00	0	21.53	11.98	7.00	1	92.61	35.71	22.83
Mar-21	2.00	2	23.80	13.91	6.60	1	93.51	37.46	25.63
Apr-21	8.00	8	24.98	14.70	96.20	7	93.43	36.59	26.19
May-21	315.0	17	23.55	12.66	705.0	24	94.00	34.01	25.70
June-21	250.8	21	22.66	11.73	534.4	21	94.28	31.82	25.18
July-21	376.8	27	21.50	10.59	657.8	25	93.83	31.04	25.58
Aug-21	226.8	22	21.66	11.14	477.9	29	94.74	31.18	25.30
Sept-21	125.8	16	22.26	11.53	401.2	21	94.30	32.01	25.29
Oct-21	426.0	21	21.19	10.67	524.7	22	93.41	32.84	25.62
Nov-21	25.00	363	21.51	10.05	339.5	18	94.13	31.89	25.07
Dec-21	4.00	23	21.93	10.45	18.00	2	93.63	34.77	23.59

MUDIGERE						SIRSI				
Month	Rain fall (mm)	RH (%)		Temperature (°C)		Rain fall (mm)	RH (%)		Temperature (°C)	
		I	II	Max.	Min.		I	II	Max.	Min.
Jan-21	90.70	53.19	60.41	19.48	28.93	90.60	87.00	62.00	30.20	16.90
Feb-21	41.90	60.07	80.10	17.35	29.32	2.00	82.00	59.00	31.10	14.50
Mar-21	0.00	60.58	80.64	18.77	32.29	51.80	86.00	45.00	34.10	18.20
Apr-21	143.1	48.66	69.63	18.78	30.00	24.20	89.40	46.70	34.30	20.90
May-21	166.4	40.90	61.03	19.96	27.87	197.4	88.40	56.20	32.10	20.20
June-21	572.5	37.00	62.83	26.61	26.16	540.8	88.30	71.50	28.90	20.40
July-21	535.7	42.83	64.67	19.37	24.54	964.6	89.40	76.40	27.00	20.40
Aug-21	228.5	60.35	64.90	18.95	25.70	159.2	89.80	77.10	28.00	20.90
Sept-21	242.0	57.43	82.00	18.33	20.43	332.2	90.30	76.40	27.70	20.70
Oct-21	293.2	45.00	84.54	18.45	24.80	173.8	90.20	70.80	30.00	20.70
Nov-21	-	-	-	-	-	160.2	87.90	69.40	29.80	19.70
Dec-21	-	-	-	-	-	-	-	-	-	-

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-21	0.00	0	83.70	53.70	30.50	13.20	168.30	68.00	15.70	2.50
Feb-21	8.00	1	90.80	59.40	32.10	18.80	38.50	57.00	20.20	4.10
Mar-21	0.00	0	88.40	49.40	37.60	19.90	171.80	62.00	21.20	7.20
Apr-21	41.30	2	83.20	61.10	37.80	20.50	47.70	51.00	27.60	10.70
May-21	82.00	4	75.00	51.30	37.00	20.20	54.90	42.00	30.70	16.10
June-21	134.2	10	83.10	51.30	35.20	20.80	190.0	62.00	29.70	18.90
July-21	169.2	11	91.60	66.40	31.50	20.20	340.2	81.00	26.70	20.20
Aug-21	264.2	9	95.50	70.50	31.80	23.70	216.6	79.00	27.60	20.00
Sept-21	154.6	9	96.30	73.50	30.50	24.60	224.3	76.00	26.50	16.90
Oct-21	146.2	5	94.10	72.10	31.10	24.40	26.00	53.00	25.10	9.10
Nov-21	80.50	8	92.90	83.10	28.20	22.00	24.80	59.00	21.70	6.50
Dec-21	3.800	1	97.70	61.50	28.60	17.80	21.60	58.00	18.10	1.60

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-21	0.00	0	30.5	14.10	0	0	19.90	7.80	92.7	59.9
Feb-21	0.00	0	31.3	13.20	0	0	20.00	10.20	80.1	43.8
Mar-21	7.30	1	35.9	19.70	0	0	30.29	15.00	79.3	43.4
Apr-21	35.80	5	36.6	21.80	0	0	36.80	18.50	61.8	30.3
May-21	123.8	10	36.0	23.90	140.8	6	33.90	24.0	77.3	52.6
June-21	151.0	10	30.1	23.40	214.6	10	33.00	26.2	86.2	76.5
July-21	192.2	14	29.9	23.10	114.8	9	34.70	27.0	90.8	66.8
Aug-21	415.9	16	30.5	22.90	172.0	10	32.70	26.0	91.3	74.8
Sept-21	401.9	13	29.9	23.00	352.8	9	32.40	25.5	92.5	72.5
Oct-21	59.20	6	31.2	21.90	42.00	6	32.20	24.9	90.9	62.2
Nov-21	91.20	8	29.7	19.30	0.00	0	28.20	13.0	86.5	63.3
Dec-21	6.00	1	27.2	13.70	15.00	2	24.60	9.30	92.8	64.0

DAPOLI						PUNDIBARI				
Month	Rain fall (mm)	Temperature (°C)		RH (%)		Rain fall (mm)	Temperature (°C)		RH (%)	
		Max.	Min.	I	II		Max.	Min.	I	II
Jan-21	0.00	30.5	14.5	92.4	55.2	0.00	22.80	8.30	86.00	65.0
Feb-21	0.00	32.8	14.4	91.6	48.9	0.00	28.00	9.00	79.00	45.0
Mar-21	0.00	32.6	16.7	86.1	51.4	50.0	31.00	15.00	68.00	46.0
Apr-21	0.10	34.0	20.8	87.5	52.4	130.0	32.00	17.00	67.00	55.0
May-21	0.20	34.2	23.3	85.4	59.9	269.0	31.00	19.00	84.00	72.0
June-21	25.7	30.8	23.6	93.3	84.2	574.0	32.00	22.00	88.00	76.0
July-21	46.9	29.0	23.5	95.2	89.5	695.1	32.00	23.00	90.00	78.0
Aug-21	45.0	28.4	23.5	94.2	90.7	869.0	31.00	22.00	94.00	84.0
Sept-21	11.3	30.1	23.1	94.5	80.2	323.0	34.00	22.00	84.00	70.0
Oct-21	5.50	30.8	22.4	94.2	79.2	267.8	32.00	20.00	82.00	69.0
Nov-21	0.00	33.1	17.3	87.0	50.9	0.00	29.00	12.00	74.00	51.0
Dec-21	0.30	32.5	14.9	92.5	67.1	0.00	28.00	12.40	80.00	54.0

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-21	65.90	26.60	17.00	91.0	61.0	130.5	6	30.50	23.50	78.00
Feb-21	27.00	28.60	16.60	88.0	42.0	0.00	0	35.00	24.00	72.00
Mar-21	34.30	30.60	18.70	92.0	46.0	68.10	3	32.40	23.00	73.00
Apr-21	112.7	29.50	18.70	92.0	64.0	22.80	7	34.21	24.49	80.00
May-21	215.0	27.40	17.20	93.0	77.0	717.0	17	29.40	24.00	75.00
June-21	224.2	26.10	16.20	90.0	78.0	263.7	18	30.00	23.20	74,00
July-21	504.9	24.90	15.70	93.0	87.0	227.8	9	29.00	23.00	75.00
Aug-21	225.5	25.10	16.20	96.0	88.0	141.9	9	30.00	24.20	79.50
Sept-21	140.1	25.90	15.90	96.0	78.0	223.4	10	30.20	24.00	85.00
Oct-21	325.1	26.20	16.50	96.0	80.0	556.0	7	29.50	23.90	80.00
Nov-21	187.4	24.70	17.10	95.0	85.0	600.2	8	29.50	24.00	82.00
Dec-21	10.90	26.50	15.80	94.0	65.0	0.00	-	34.20	24.17	82.80

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-21	267.20	12	22.84	13.35	93.15	38.0	4	11.0	4.0
Feb-21	34.40	2	26.16	12.52	87.07	73.0	4	14.0	5.0
Mar-21	30.30	5	27.90	13.80	86.70	281.0	14	18.0	6.0
Apr-21	207.5	11	28.40	15.10	89.35	317.0	11	20.0	9.0
May-21	452.4	17	26.10	15.30	93.48	511.0	21	25.0	11.0
June-21	278.1	16	25.80	14.50	92.65	704.0	28	22.0	14.0
July-21	524.1	24	22.30	14.30	94.60	679.0	26	22.0	15.0
Aug-21	322.3	22	24.10	14.30	94.60	875.0	26	22.0	15.0
Sept-21	191.8	15	24.70	14.80	93.90	483.0	23	22.0	14.0
Oct-21	505.0	25	23.53	17.46	93.85	357.0	14	21.0	10.0
Nov-21	481.1	22	23.90	14.40	94.80	32.00	2	14.0	7.0
Dec-21	-	-	-	-	-	-	-	13.0	6.0

BARAPANI						KAHIKUCHI				
Month	Rain fall (mm)	Temperature (°C)		RH (%)		Rain fall (mm)	Temperature (°C)		RH (%)	
		Max.	Min.	I	II		Max.	Min.	I	II
Jan-21	0.00	21.2	7.20	82.5	51.9	12.0	21.7	9.60	79.0	70.0
Feb-21	20.40	23.6	9.30	78.9	48.8	5.00	25.3	10.7	73.0	66.0
Mar-21	29.60	27.3	12.9	82.2	39.0	9.00	27.9	13.2	70.9	63.0
Apr-21	57.70	29.1	16.3	79.4	48.4	147.0	30.2	18.5	78.0	70.3
May-21	334.9	26.8	17.9	88.0	79.0	199.0	32.7	21.9	80.4	72.6
June-21	226.2	28.0	20.3	89.3	79.1	256.0	32.8	23.9	85.0	79.5
July-21	352.8	27.9	20.5	87.9	80.9	277.0	32.4	26.2	89.3	81.0
Aug-21	400.6	27.7	20.3	88.6	83.7	187.0	34.6	26.2	89.5	81.7
Sept-21	353.8	28.5	19.6	85.7	78.8	131.0	33.1	25.4	86.4	82.6
Oct-21	230.9	27.5	19.2	85.4	73.3	59.00	32.8	24.6	81.7	79.3
Nov-21	0.00	24.5	-	76.8	54.5	25.00	29.7	17.1	79.7	73.8
Dec-21	-	-	-	-	-	2.00	22.4	10.2	78.7	71.5

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-21	57.00	4	23.98	8.18	64.53	54.80	0.00	0	26.8	7.7
Feb-21	0.00	-	25.85	9.43	83.98	67.18	0.00	0	32.0	10.7
Mar-21	7.00	-	34.44	13.62	79.46	46.04	0.00	0	37.1	15.5
Apr-21	-	3	39.58	15.80	55.00	46.28	0.00	0	40.0	18.0
May-21	65.00	-	40.88	19.86	52.48	37.94	28.0	3	38.4	25.3
June-21	-	-	41.65	21.78	41.18	36.95	80.0	6	36.4	25.6
July-21	54.75	14	38.30	20.88	61.38	57.30	77.4	7	34.5	26.3
Aug-21	175.4	22	31.02	20.18	75.82	74.30	29.0	3	33.7	25.4
Sept-21	25.25	13	32.53	21.18	53.08	46.18	166.5	17	32.5	24.8
Oct-21	32.00	1	32.08	21.98	52.55	43.83	0.00	0	34.3	20.1
Nov-21	54.00	-	27.50	16.92	67.42	47.86	0.00	0	32.0	13.6
Dec-21	-	1	22.10	11.03	76.80	66.50	0.00	0	27.9	13.6

XXVI AICRPS CENTRE WISE BUDGET

	Salary		RC		TSP	SCSP	NEH		Capital		Total		Grand
Regular Centres	**ICAR**	**State**	**ICAR**	**State**	**100%**	**100%**	**ICAR**	**State**	**ICAR**	**State**	**ICAR**	**State**	**Total**
Pampadumpara (KAU)	7.37	2.46	9.10	3.03	-	0.55	-	-	-	-	17.02	5.49	22.51
Panniyur (KAU)	38.00	12.67	7.04	2.35	-	-	-	-	-	-	45.04	15.02	60.06
Mudigere (UAHS)	17.00	5.67	5.35	1.78	-	-	-	-	-	-	22.35	7.45	29.80
Sirsi (UHS)	10.00	3.33	3.15	1.05	-	-	-	-	-	-	13.15	4.38	17.53
Yercaud (TNAU)	21.00	7.00	4.19	1.40	-	5.48	-	-	-	-	30.68	8.40	39.08
Coimbatore (TNAU)	33.50	11.17	10.10	3.37	-	-	-	-	-	-	43.60	14.54	58.14
Chintapalle (Dr. YSRHU)-TSP	6.69	2.23	5.60	1.86	5.00	-	-	-	-	-	17.29	4.09	21.38
Kammarpally (SKLTSHU)	23.50	7.83	12.75	4.25	-	6.00	-	-	-	-	42.25	12.08	54.33
Guntur (Dr. YSRHU)	35.00	11.67	9.60	3.20	-	-	-	-	-	-	44.60	14.87	59.47
Solan (YSPUHF)	17.50	5.83	4.65	1.55	-	2.00	-	-	-	-	24.15	7.38	31.53
Pottangi (OUAT)-TSP	4.10	1.37	3.60	1.20	5.00	6.75	-	-	-	-	19.45	2.57	22.02
Jobner (SKNAU)	63.69	21.23	7.71	2.57	-	-	-	-	-	-	71.40	23.80	95.20
Jagudan (SDAU)	2.00	0.67	2.35	0.78	-	-	-	-	-	-	4.35	1.45	5.80
Hisar (HAU)	44.83	14.94	3.10	1.03	-	1.89	-	-	-	-	49.82	15.87	65.69
Dholi (RAU)	-	-	4.55	-	-	-	-	-	-	-	4.55	-	4.55
Kumarganj (NDUAT)	18.50	6.17	3.60	1.20	-	-	-	-	-	-	22.10	7.37	29.47
Pundibari (UBKVV)	-	-	2.99	1.00	-	0.63	-	-	-	-	3.62	1.00	4.62
Dapoli (BSKKV)	22.44	7.48	6.95	2.32	-	-	-	-	-	-	29.40	9.80	39.20
Raigarh (IGKV)	31.92	10.64	5.10	1.70	6.74	2.00	-	-	2.00	-	47.76	12.34	60.10
Total	**397.04**	**132.36**	**111.48**	**35.64**	**16.74**	**25.30**	**-**	**-**	**2.00**	**-**	**552.56**	**168.00**	**720.56**
Coopting Centres													
Ambalavayal (KAU)	-	-	1.45	0.48	-	-	-	-	-	-	1.45	0.48	1.93
Pechiparai (TNAU)	-	-	2.89	0.96	-	-	-	-	-	-	2.89	0.96	3.85
Gangtok (ICRI)-NEH	-	-	-	-	-	8.84	9.55	3.18	3.00	1.00	21.39	4.18	25.57
Sakleshpur (ICRI)	-	-	4.41	1.47	-	-	-	-	-	-	4.41	1.47	5.88
Myladumpara (ICRI)	-	-	7.96	2.65	-	-	-	-	-	-	7.96	2.65	10.61
ICAR RC NEHR, Barapani-NEH	-	-	-	-	-	-	7.10	-	7.50	-	14.60	-	
ICAR RC NEHR, Mizoram-NEH	-	-	-	-	-	-	10.05	-	5.00	-	15.05	-	
ICAR RC NEHR, Gangtok-NEH	-	-	-	-	-	4.41	37.56		4.20	-	46.17	-	
Nagaland (AU)	-	-	-	-	-	-	2.85	-	8.61	-	11.46	-	
Kahikuchi (AAU)	-	-	-	-	-	-	8.85	2.95	0.69	0.23	9.54	3.18	12.72
Pasighat (CAU)-NEH	-	-	-	-	-	-	4.04	-	-	-	4.04	-	
Total	-	-	**16.71**	**5.56**	**-**	**13.25**	**80.00**	**6.13**	**29.00**	**1.23**	**138.96**	**12.92**	**151.88**
Voluntary Centres													
Pantnagar (GBPUAT)	-	-	1.60	0.53	-	-	-	-	-	-	1.60	0.53	2.13
Kanke (BIRSAAU)-TSP	-	-	2.10	0.70	1.25	-	-	-	-	-	3.35	0.70	4.05
Kalyani (BCKVV)	-	-	5.51	1.84	-	-	-	-	-	-	5.51	1.84	7.35
Kota (AUK)	-	-	1.60	0.53	-	-	-	-	-	-	1.60	0.53	2.13
Navsari (NAU)	-	-	3.09	1.03	-	-	-	-	-	-	3.09	1.03	4.12
Jabalpur (JNKV)	-	-	5.55	1.85	-	4.00	-	-	-	-	9.55	1.85	11.40
Mandor (AUJ)	-	-	3.45	1.15	-	2.45	-	-	-	-	5.90	1.15	7.05
Sanand (AAU)	-	-	0.60	0.20	-	-	-	-	-	-	0.60	0.20	0.80
Total	-	-	**23.50**	**7.83**	**1.25**	**6.45**	**-**	**-**	**-**	**-**	**31.20**	**7.83**	**39.03**
Project Mode centres													
Thrissur	-	-	2.95	-	-	-	-	-	-	-	2.95	-	2.95
SRS Pampore	-	-	2.99	-	-	-	-	-	-	-	2.99	-	2.99
Total	-	-	**5.94**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**5.94**	**-**	**5.94**
XXXI Annual Group Meeting	-	-	0.75	-	-	-	-	-	-	-	0.75	-	0.75
Pesticide residue analysis	-	-	11.52	-	-	-	-	-	-	-	11.52	-	11.52
Micronutrients	-	-	21.88	-	-	-	-	-	-	-	21.88	-	21.88
PC Contingency	-	-	3.10	-	-	-	-	-	-	-	3.10	-	3.10
Total	**397.04**	**132.36**	**194.87**	**49.03**	**17.99**	**45.00**	**80.00**	**6.13**	**31.00**	**1.23**	**765.90**	**188.75**	**954.65**

XXVI I AICRPS Centres

AICRPS CENTRES

HEAD QUARTERS
Project Coordinator (Spices)
ICAR-All India Coordinated Research Project on Spices
ICAR-Indian Institute of Spices Research, Kozhikode-673 012, Kerala
Phone: Off. (0495) 2731794, Fax: 0495-2731794
E-mail: aicrp.spices@icar.gov.in, aicrpspices@gmail.com
Website: www.aicrpspices.icar.gov.in

COORDINATING CENTRES

Sl. No.	Centre and Contact address	Telephone	Fax/E. mail
	Regular Centers		
Andhra Pradesh			
1	**Horticultural Research Station** (Dr. Y.S. R Horticultural University), **CHINTAPALLE**-531 111, Visakhapatnam, Andhra Pradesh	08937-238057 (O)	08937-238057 headhrs_chintapalle@drysrhu.edu.in siva200619@gmail.com
2	**Horticultural Research Station** (Dr. Y.S. R Horticultural University), **GUNTUR** – 522 034, Andhra Pradesh	0863-2524017 /2524644(O)	0863-2524073 aphuhrslam@gmail.com gkalidasu@yahoo.com
Bihar			
3	**Department of Horticulture** Dr. Rajendra Prasad Central Agricultural University) **DHOLI**-843 121, Bihar	0621-2293227(O)	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)	07762- 222402 /215235 singh_ajit8@rediffmail.com shrikant.sawargaonkar@gmail.com
Gujarat			
5	**Centre for Research on Seed Spices** (Sardarkrushinagar Dantiwada Agricultural University), **JAGUDAN** – 382 710 Dist. Mehsana, Gujarat	02762-285337 (O)	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)	01662-234952/284306 aicrpspices@hau.ernet.in tpmalik63@gmail.com sktehlan07@gmail.com

Himachal Pradesh			
7	**Department of Vegetable Crops** (Dr. YS Parmar University of Horticulture & Forestry), Nauni, **SOLAN**-173 230, Himachal Pradesh	01792-252329 (O)	01792- 252329 solanspices@yahoo.com meenugupta1@gmail.com
Karnataka			
8	**Zonal Agricultural and Horticultural Research Station** (University of Agricultural and Horticultural Sciences, Shimoga), **MUDIGERE**-577 132, Chikkamagalur, Karnataka	08263- 228246/ 228135	08263-228403 /228246 aicrpszahrsm@gmail.com adrzahrsm@gmail.com mudreje_sp@rediffmail.com
9	**Horticultural Research Station** AICRP on Spices, (University of Horticultural Sciences, Bagalkot) **SIRSI**-581 401, Karnataka	08384-247787 (O)	08384- 226797 hrspepper@gmail.com sudheesh.kulkarni@gmail.com
Kerala			
10	**Cardamom Research Station** (Kerala Agricultural University) **PAMPADUMPARA**-685 553 Idukki, Kerala	04868- 236263 (O)	04868-236263 crspam@kau.in muthupeyan@gmail.com
11	**Pepper Research Station** (Kerala Agricultural University) **PANNIYUR**, PB No.113 Kanjirangadu (P.O), Taliparamba -670 142, Kannur, Kerala	0460-2227287 (O)	0460-2227287 prspanniyur@kau.in airina.ck@kau.in
Maharashtra			
12	**Department of Horticulture** (Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth) **DAPOLI**-415 712, Ratnagiri, Maharashtra	02358-280244 (O) 02358-282563/282868	02358-282074/282414 rgk.bskkv@rediffmail.com prafulcm@rediffmail.com
Odisha			
13	**High Altitude Research Station** (Odisha University of Agriculture and Technology), **POTTANGI**-764 039, Koraput, Odisha	06853-252565 (O)	06853-223348 parsuramsial@gmail.com
Rajasthan			
14	**Dept. of Genetics & Plant Breeding**, SKN College of Agriculture (Sri Karan Narendra Agriculture University), **JOBNER**-303 329, Jaipur, Rajasthan	01425-254036/254041(O)	01425-254022 dean.skncoa@sknau.ac.in acs_shivran@rediffmail.com
Telangana			
15	**Turmeric Research Station** [Sri Konda Laxman Telangana State Horticultural University (SKLTSHU)], **KAMMARPALLY**-503 308, Nizamabad Telangana	08463-272026 (O)	08463-272026 hrskammarapalli@gmail.com mahenderb9@gmail.com

Tamil Nadu			
16	**Horticultural Research Station** (Tamil Nadu Agricultural University) **YERCAUD**-636 602, Salem, Tamil Nadu	04281-222456	04281-222234 hrsycd@tnau.ac.in prkamalkumaran@yahoo.in
17	**Department of Spices and Plantation Crops,** Horticultural College and Research Institute TNAU, **COIMBATORE**-641 003, Tamil Nadu	0422-6611284/ 2430781(O)	0422-6611371 /2430781 spices@tnau.ac.in gsselvihort@gmail.com
Uttar Pradesh			
18	**Department of Vegetable Science** (Narendra Dev University of Agriculture and Technology), **KUMARGANJ**-224 229, Faizabad, Uttar Pradesh	05270-262076 (O)	05270- 262097/262331 pradipnduat07@gmail.com
West Bengal			
19	**Department of Horticulture** (Uttar Banga Krishi Viswavidyalaya, North Bengal Campus **PUNDIBARI**-736 165, Dist. Cooch Behar, West Bengal	03582-270588 (O)	03582-270143 pundibari@rediffmail.com, pundibari@yahoo.co.in suchanddatta@gmail.com
Co-opting Centres			
Assam			
1	Director of Research, Horticultural Research Station, (Assam Agricultural University), **KAHIKUCHI**-781 017, Guwahati, Assam		dekakkdr4@gmail.com
Karnataka			
2	The Scientist-in-charge Regional Research Station, Spices Board (Govt. of India), Donigal Post, **SAKALESHAPURA**-573 134, Karnataka	08173-244281 (O)	08173-244124 sbicriskp@gmail.com sk9bhat@gmail.com
Kerala			
3	The Associate Director Regional Agricultural Research Station (Kerala Agricultural University) **AMBALAVAYAL**-673 593, Wayanad, Kerala	04936-260421/ 260561 / 260777 (O)	04936-260421 adramb@kau.in najeeb.naduthodi@kau.in
4	The Director Indian Cardamom Research Institute **MYLADUMPARA**-685 553, Kailasanadu, Idukki, Kerala	04868-237206/ 237207 (O)	04868-237285 icrimyla@yahoo.com pradipknair@rediffmail.com
Meghalaya			
5	The Principal Scientist & Head ICAR Research Complex for NEH Region, Umroi Road, Ri-bhoi, **BARAPANI**-793 103, Umiam, Meghalaya	0364-2570257 /2570678(O)	0364-2570257 /2570678 verma.veerendra@gmail.com

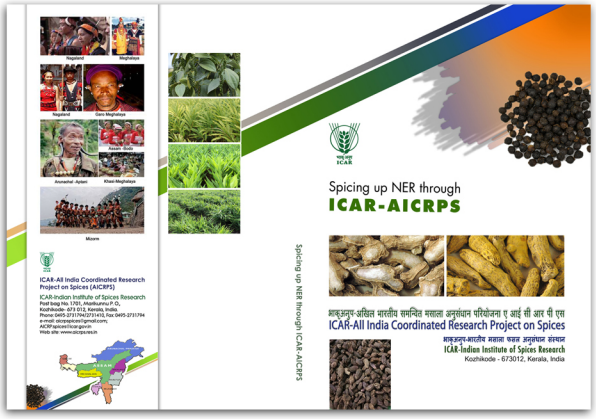
Mizoram			
6	The Joint Director ICAR Research Complex for NEH Region, **Mizoram Centre,** **KOLASIB**-796 081, Mizoram	03837-220041 / 220056 (O)	03837-220560 Jeetu.soni1991@gmail.com
Nagaland			
7	The Head, Department of Horticulture, SASRD, Nagaland University, **MEDZIPHEMA**-797 106, Dimapur, Nagaland	03862-247212 (O)	03862-247113 csmaiti@yahoo.co.in csmaiti@nagalanduniversity.ac.in
Sikkim			
8	The Dy. Director (Res.) ICRI Regional Station (Spices Board), Yakthung, Tadong, **GANGTOK**-737 102, Sikkim	03592-231307/237301/(O)	03592-231307 rrspicesgtk@yahoo.com tikendrandeka@gmail.com
9	Joint Director ICAR Res. Complex For NEH Region, Regional Station, **Sikkim Center**, Tadong, **GANGTOK**-737 102, Sikkim	03592-231030//232125 (O)	03592-231238 amit.kumar4@icar.gov.in amitkumaricar13@gmail.com
Tamil Nadu			
10	The Professor & Head Horticultural Research Station (Tamil Nadu Agricultural University) **PECHIPARAI** – 629 161 Kanyakumari Dist., Tamil Nadu	04652-281191(O)	hrsppi@tnau.ac.in nimmyrajasekhar@gmail.com
Arunachal Pradesh			
11	The Dean Central Agricultural University College of Horticulture & Forestry, **PASIGHAT**-791 102, Arunachal Pradesh	0368-2224887 (O)	0368-2225066 chandranduat@rediffmail.com
Voluntary Centres			
Gujarat			
1	The Director of Research and Dean Faculty of PG Studies, N.M. College of Agriculture, Navsari Agricultural University, **NAVASARI**-396 450, Gujarat	02637-283160 /282145 (O)	02637-283452 /282765 ritesh147@gmail.com
2	Assistant Research Scientist Castor-Seed Spices Research Station, Anand Agricultural University, Ahmedabad, **SANAND**-382 110, Gujarat	02717-294325 (O)	arssanand@aau.in

Jharkand			
3	The Director of Research, BIRSA Agricultural University **KANKE**, Ranchi-834 006, Jharkhand	0651-2450610/ 2451011 (O)	0651-2451011 aruntiwary40@gmail.com
Madhya Pradesh			
4	The Sr. Scientist/Head (Hort.), Department of Horticulture, College of Agriculture, Jawaharlal Nehru Krishi Vishwavidyalaya, **JABALPUR**-482 004, Madhya Pradesh	0761-2680771 Extn: 345(O)	0761-2681074/2681236 /2681389 horticulturehead@gmail.com reena_nair2007@rediffmail.com
Rajasthan			
5	Associate Professor Agricultural Research Station, (Agriculture University Kota) Ummedganj Farm, **KOTA**-324 001 Rajasthan	0744-2844369 (O)	0744-2844306 arskota@hotmail.com preetiarskota2005@hotmail.com
6	Assistant Professor (Agronomy) Agricultural Research Station (Agriculture University Jodhpur), **MANDOR**, Jodhpur-342 304, Rajasthan	0291-2571347 (O)	0291-2571813 mlmehriya@gmail.com
Uttarakhand			
7	Professor and Joint Director, Govind Ballabh Pant University of Agriculture & Technology, College of Agriculture, **PANTNAGAR**-263 145, Udham Singh Nagar, Uttarakhand	05944-233363 (O)	05944-233473 dheer_singh72@yahoo.com
West Bengal			
8	The Director of Research, Bidhan Chandra Krishi Viswavidyalaya, Directorate of Research, Faculty of Horticulture, **KALYANI**-741 235, Nadia, West Bengal	033-25828407 (O) 03473-2222269/70 03473-222659	033-25828407/ 03473-222275 03473-222273/222277 dranupariari@gmail.com

PUBLICATIONS RELEASED DURING XXXII ANNUAL GROUP MEETING OF AICRPS

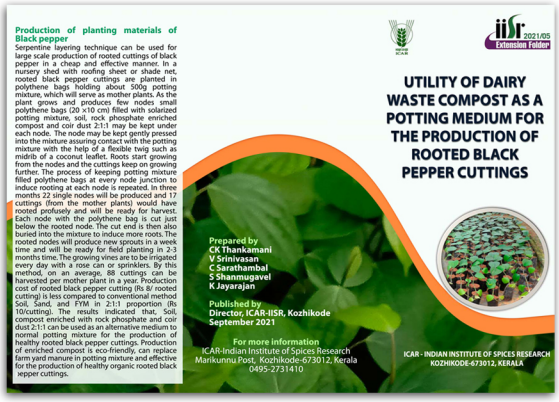
Diseases of spices and their management

Advanced production technologies of seed spices

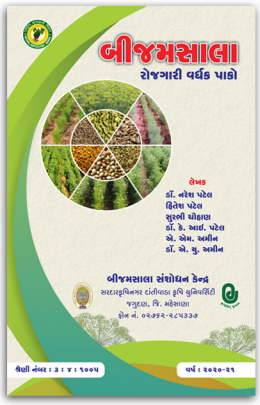


Spicing up NER through ICAR-AICRPS

Package of practices of turmeric

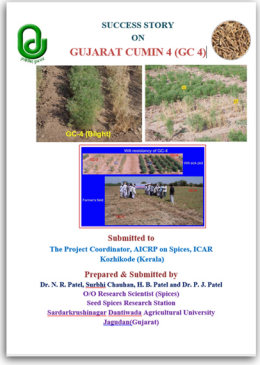


Utility of dairy waste compost as a potting medium for the production of rooted black pepper cuttings

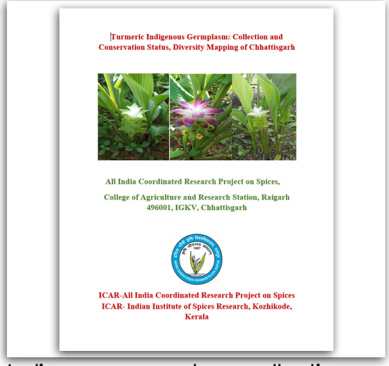


Seed spices-
Job oriented crops

Dwarf wire-net drum method
of black pepper cultivation



Success story on
Gujarat Cumin-4



Indigenous germplasm collection
and conservation status and diversity
mapping of turmeric in Chhattisgarh

Processing and value
addition in black pepper

Good agricultural
practices
in black pepper

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

ICAR-Indian Institute of Spices Research
Post bag No. 1701, Marikunnu P. O.,
Kozhikode- 673 012, Kerala, India.
Phone: 0495-2731794/2731410, Fax: 0495-2731794,
e-mail: aicrpspices@gmail.com; AICRP.spices@icar.gov.in
Web site: www.aicrpspices.icar.gov.in