



वार्षिक प्रतिवेदन Annual Report 2020



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

ICAR-AICRIPS

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



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ANNUAL REPORT 2020



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Indian Institute of Spices Research
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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, aicrspices@gmail.com

Website : www.aicrps.res.in

Compiled and Edited by

Sharon Aravind

John George

K. S. Krishnamurthy

E. Radha

Santhosh J Eapen

Hindi Translation

N. Prasannakumari

Cover Design

A. Sudhakaran

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Sharon Aravind, John George, Krishnamurthy K. S.

Radha E. & Santhosh J Eapen

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CONTENTS

कार्यकारीसारांश	01
Executive Summary	07
Profile of AICRP on Spices	14
Technical Program 2020	17
Black pepper	22
Small cardamom	27
Large cardamom	32
Ginger	34
Turmeric	39
Tree spices	45
Coriander	48
Cumin	54
Fennel	61
Fenugreek	63
Ajwain	68
Nigella	69
Saffron	70
Kalazeera	72
Monitoring	74
Annual Group Meeting	75
Activities during lock down	76
Popularization of Technology	80
Success Stories	82
Krishi Melas & Farmers Trainings	85
Publications	89
Awards & Recognitions	99
Staff Position	100
Training and Capacity Building	102
Weather Data	103
AICRPS centres	109

FAKHRUDDIN ALI AHAMMED AWARD FOR OUTSTANDING RESEARCH IN TRIBAL FARMING SYSTEMS

(ICAR Awards-2019, 92nd Foundation day)
16 August 2020



Dr. P. Rajeev Dr. V. Sivakumar Dr. D. Prasath Dr. E. Jayashree Mrs. Valadi
Chandrasekaran Aliveni

FAKHRUDDIN ALI AHMED AWARD 2019
Dr. Rajeev P., Dr. V. Dr. V. Sivakumar¹, Dr. D. Prasath
Dr. E. Jayashree and Mrs. Valadi Chandrasekaran Aliveni²

ICAR-Indian Institute of Spices Research, Kozhikode, Kerala-673 012
¹All India Coordinated Research Project on Spices
Horticultural Research Station, YSR Horticultural University
Vishakapatnam,
Andhra Pradesh-531 111
²Giri Chaitanya Farming and Marketing Mutually Aided Cooperative
Society, Visakhapatnam, Andhra Pradesh 531133

ICAR Indian Institute of Research, Kozhikode along with All India Coordinated Research Project on Spices, Horticultural Research Station, YSR Horticultural University, Vishakapatnam, Andhra Pradesh, Giri Chaitanya Farming and Marketing Mutually Aided Cooperative Society, Vishakapatnam, Andhra Pradesh has implemented a multi institutional project leveraging several technologies which are already available with the organization for immediate benefit to the tribal community at Vishakapatnam. Eight technologies defined as GAP were tested through AICRPS on Spices at Horticulture Research station, Chintappalle and disseminated adopting a multi institutional value chain approach. Two technologies namely improved varieties of turmeric and black pepper and mechanization of primary processing in turmeric had significant impact on increasing productivity, income and quality. The project supported Maathota Tribal Farming FPO involving 500 tribal farmers in 800 ha of turmeric and obtained organic certification by TQ Cert Services Private Limited. Another FPO, Andhra Kashmir with 500 farmers has completed organic cultivation of turmeric in two seasons in 683 ha. Women farmer

कार्यकारी सारांश

मसालों पर आईसीएआर-एआईसीआरपी भारत की सबसे बड़ी मसाला अनुसंधान प्रणाली है, जिसमें वर्तमान में 17 अधिदेश फसलों पर ध्यान केंद्रित किया गया है, जो 19 नियमित, 11 सहयोजित, 8 स्वैच्छिक और 2 परियोजना मोड के केंद्रों का एक नेटवर्क है। मसाले पर एआईसीआरपीएस ने अपनी स्थापना के बाद से, वांछनीय सस्य विज्ञान के लक्षणों के साथ उच्च उपज देने वाली किस्मों को विकसित करने, उत्पादन और उत्पादकता बढ़ाने के लिए प्रौद्योगिकियों और कीटों और रोगजनकों का मुकाबला करने के लिए प्रबंधन रणनीतियों को विकसित करने में काफी योगदान दिया है, जिससे फसल के नुकसान को काफी कम किया जा सकता है।

मसाले वस्तुतः फसलों का एक मिश्रित बैग हैं जिसमें पौधों के स्वभाव/कद और जीवन काल में वैविध्य के साथ, मांसल तुच्छ और जड़ी-बूटियों के वार्षिक से लेकर वर्षों तक जीने वाले पेड़ों पर बढ़ने वाले तथा पेड़ भी होते हैं, जिसके आकृति विज्ञान, उपयोगी भागों/उपयोगों और घटकों/सक्रिय अवयवों में भिन्नता है और सब मिलाकर भारत की कृषि निर्यात टोकरी को पर्याप्त योगदान देते हैं। उनमें से, एआईसीआरपीएस काली मिर्च, बड़ी इलायची, छोटी इलायची, अदरक, हल्दी, आम अदरक, दालचीनी, जायफल, लोंग, धनिया, जीरा, सोंफ, मेथी, अजवाइन, निगेला, केसर और कालाजीरा पर शोध गतिविधियों का समन्वय करता है। मिर्ची जैसी नई फसलों को लाने का प्रयास किया जा रहा है, जो मसाला फसलों में से एक सबसे बड़ा निर्यातकर्ता है। वर्ष 2020 के लिए मसालों पर एआईसीआरपी का वार्षिक बजट 676.86 लाख रुपए (ICAR शेयर) था। जनजातीय क्षेत्र में अपने महत्वपूर्ण योगदान के कारण, आईसीएआर-आईआईएसआर कोषिकोड के सहयोग से आईसीएआर-एआईसीआरपीएस चिंतापल्ली केंद्र ने 2019-20 के दौरान आदिवासी क्षेत्र में उत्कृष्ट अनुसंधान के लिए प्रतिष्ठित फकरुद्दीन अली अहमद पुरस्कार प्राप्त किया।

नई पहल

बीज मसालों के रोगों और इनसेक्ट कीटों के लिए पूर्वानुमान मॉडल का विकास, उच्च उपज और आय के लिए अदरक आधारित अलग-अलग अंतर फसल प्रणाली का मूल्यांकन, अदरक और हल्दी में प्ररोह बेधक (कोनोगीथस पक्विटफेरालिस) के लिए प्रभावी कीटनाशकों का पर्याप्त छिड़काव, इलायची में अलग-अलग उपज लक्ष्य के लिए मृदा परीक्षण आधारित साइट-विशिष्ट सिफारिशों का विकास, उच्च उपज और आय के लिए सब्जियों के साथ बीज मसालों के लिए अंतर फसल प्रणालियों का विकास और सोंफ के बेहतर विकास, उपज और गुणवत्ता के लिए सूक्ष्म पोषक पैकेज का विकास आदि को लक्षित करके नई अनुसंधान परियोजनाओं को शुरू किया गया।

विभिन्न मसाल फसलों के लिए फसल मानकों को तैयार किया गया है और किस्मों का विमोचन एवं अधिसूचना के लिए सीवीआरसी को प्रस्तुत किया गया है।

मेघा हल्दी के शुद्ध बीजों की उपलब्धता के लिए उत्तर पूर्व क्षेत्र में स्थित सभी केंद्रों में मेघा हल्दी के शुद्ध ब्लॉक की एक प्रदर्शन-सह-बीज उत्पादन इकाई स्थापित की जा रही है।

XXXI एआईसीआरपीएस कार्यशाला में विमोचित करने के लिए सिफारिश की गई किस्मों

दिनांक 29-30 सितंबर, 2020 के दौरान आईसीएआर-आईआईएसआर, कोषिकोड में आयोजित XXXIवीं एआईसीआरपीएस कार्यशाला के दौरान चार

नई विशिष्ट किस्मों को विमोचित करने का लिए सिफारिश की गई थी, जिसमें हल्दी की दो और अदरक और मेथी की एक-एक किस्म शामिल होती हैं।

वाणिज्यिक रूप से समृद्ध किस्मों

आईआईएसआर वज्रा (अक्से. 247): आईसीएआर-आईआईएसआर, कोषिकोड द्वारा विकसित एक उच्च गुणवत्ता वाली मोटे और प्लंबी अदरक किस्म को केरल, कर्नाटक, ओडिशा और पश्चिम बंगाल जैसे राज्यों में विमोचित करने के लिए सिफारिश की गई है।

लैम हल्दी 1 (एलटीएस2) : डॉ.वाईएसआरएचयु, गुंटूर द्वारा विकसित एक हल्दी किस्म जो मसाला उद्योग के लिए उपयुक्त है और मौजू जैसे पीले रंग का पाउडर और उच्च सूखी वसूली के है, जिसे आंध्र प्रदेश, तेलंगाना और तमिलनाडु राज्यों में विमोचित करने की सिफारिश की गई है।

राजेंद्र हल्दी 1: डॉ. आरपीसीएयू, धोली द्वारा विकसित उच्च कुरकुमिन सामग्री के साथ एक उच्च उपज वाली हल्दी किस्म को बिहार, ओडिशा और आंध्र प्रदेश राज्यों में विमोचित करने के लिए सिफारिश की गई है।

तनाव सहनशील किस्म

हिसार मेथी 257 (एचएम-257): सीसीएसएचयु, हिसार द्वारा विकसित एक उच्च उपज, पाउडरी मिल्ड्यू और डाउनी मिल्ड्यू प्रतिरोधी मेथी की किस्म को बिहार, राजस्थान, छत्तीसगढ़ और गुजरात में रिलीज करने के लिए सिफारिश की गई है।

XXXI एआईसीआरपीएस कार्यशाला के दौरान अनुसंधित तकनीकों

जैव कीटनाशकों और जैविक रूप से अनुमत कीटनाशकों (स्पिनोसैड (45 एससी @ 0.3 मिली लिटर/लिटर) या नीम आधारित तेल (आज़ादिरेक्टिन 0.15% ईसी: 1500 पीपीएम @ 3 मिली लिटर/लिटर) का उपयोग करके बड़ी इलायची के इनसेक्ट कीट के प्रबंधन के लिए एक प्रौद्योगिकी पैकेज को जैविक सुरक्षा अभ्यास के तहत सिफारिश की गई थी।

अनुसंधान उपलब्धियां

काली मिर्च

एआईसीआरपीएस के अम्बलावयल, पन्नियूर, सिरसी, चिन्तापल्ली, दापोली, पुंडिबारी और यरकाड केंद्र में काली मिर्च के आनुवांशिक संसाधनों के प्रबंधन पर काम करने के लिए प्रमुखता दी गयी है। वर्तमान में, पीआरएस, पन्नियूर और 265 सिरसी में काली मिर्च के 403 अक्सेशनों (403 संवर्धित प्रकार, 57 जंगली और संबंधित प्रकार और 3 विदेशी प्रकार) का रखरखाव किया जा रहा है, जिसमें सात संबंधित स्पीसीस जैसे पी. कोलुब्रिनम, पी. आर्बोरियम, पी. छाबा, पी. लोंगम, पी. एटेन्युवाटम, पी. हाइमनोफिलम और पी. हुकेरी और वियतनाम से एक विदेशी संग्रह शामिल है।

पन्नियूर में मूल्यांकन किए गए जर्मप्लाज्म अक्सेशनों के बीच, पीआरएस 14 को 2.30 किलोग्राम सूखे बेरी की उपज और 1512 स्पाइक्स / बेल के साथ पहले स्थान पर रखा गया; दो जीनोटाइप, पीआरएस 183 (150-170 दिन) और पीआरएस 162 (204 दिन) को जल्दी परिपक्व होने वाले के रूप में पहचाना गया है, जबकि पीआरएस 184 को छाया सहिष्णु के रूप में पहचाना गया है। इसकी समग्र श्रेष्ठता को ध्यान में रखते हुए, संकर पीआरएस 161, उच्च उपज, लंबी स्पाइक्स और मोटे बेरियों के साथ एक जलवायु लचीला किस्म को 28 वीं राज्य बीज समिति द्वारा केरल के लिए पन्नियूर -10 के रूप में विमोचित किया गया था। यह किस्म सूखे और फाइटोफथोरा संक्रमण के

प्रति भी सहिष्णु है और इसमें ओलियोरेसिन और पाइपरिन की मात्रा अधिक होती है।

स्थायी उत्पादकता और खाद्य सुरक्षा सुनिश्चित करने के लिए काली मिर्च आधारित मिश्रित फसल प्रणाली परीक्षण में, अंतरफसल के बीच, जमीनकंद ने अधिकतम उपज 7.55 किलोग्राम और 3.13 के उच्च बी:सी अनुपात दर्ज किया, तत्पश्चात् पन्निनूर में काली मिर्च के बीच 4 मीटर x 2 मीटर अंतराल के एक अंतर स्थान में गेटर याम (4.04 के उच्चतम बी:सी अनुपात के साथ 6.46 किलोग्राम)। मृदा विश्लेषण डेटा स्पष्ट रूप से इंगित करता है कि उपलब्ध पोषक तत्व की मात्रा अधिक थी और इसलिए यह निष्कर्ष निकाला जा सकता है कि मिश्रित फसल प्रणाली मृदा पोषक तत्व की स्थिति को समाप्त नहीं करती थी।

खाद्य सुरक्षा आश्वासन और मसालों में कीटनाशक अवशेषों का कम प्रयोग करने के साथ-साथ, काली मिर्च में खुर गलन और धीमी गिरावट के प्रबंधन के लिए स्ट्रोबिल्यूरिन कवकनाशी और एक्टिनोमाइसेट्स का मूल्यांकन शुरू की गई है।

छोटी इलायची

जीन बैंकों में अब कुल 329 इलायची अक्सेशनों को संरक्षित किया जाता है, जिसमें 198 अक्सेशनों पांपाडुमपारा में और 132 मुदिगेरे में हैं। मूल्यांकन के तहत छोटी इलायची की किसानों की आठ किस्में (*अर्जुन, वंडर इलायची, पानिकुलंगरा, तिरुताली, एलाराजन, पचकाई, पप्पलू, न्जल्लानी और पीएनएस गोपीनाथ*) के बीच उनके साकलेशपुर, मुदिगेरे, मैलाडुमपारा और पांपाडुमपारा में वनस्पति गुणों के संबंध में महत्वपूर्ण अंतर थे। इलायची में थिप्स सहिष्णु लाइनों का बहु-स्थानीय मूल्यांकन शुरू किया गया है और मैलाडुमपारा में प्रारंभिक निरीक्षणों से पता चलता है कि छह जीनोटाइप्स (आईसी 349362, आईसी349364, आईसी349370, आईसी349606, न्जल्लानी ग्रीन गोल्ड और आईसीआरआई 8), आईसी 349606 में थिप्स की आबादी कम है।

बड़ी इलायची

बड़ी इलायची में, गंगटोक, सिक्किम के दो एआईसीआरपीएस केंद्रों में 61 जर्मप्लाज्म अक्सेशनें बनाए जा रहे हैं। सिक्किम के दक्षिण और पश्चिम जिलों में दस बागानों की खोज की गई और तीन अद्वितीय संग्रह को एकत्र करके आईसीआरआई के अनुसंधान फार्म में संगरोध सुविधा में बनाए रखा गया। आईसीआरआई, गांगटोक से सात अक्सेशनें और आईसीएआर रिसर्च कॉम्प्लेक्स फॉर एनईएचआर रिसर्च स्टेशन, गंगटोक से एक अद्वितीय अक्सेशन (हरे कैप्सूल के साथ सांविनी) को आईसी नंबर आवंटित करने के लिए एनबीपीजीआर, नई दिल्ली को प्रस्तुत किया गया है।

जैव कीटनाशियों (नीम का तेल, बेवेरिया बैसियाना, मेटेरिहिज़ियम एनिसोप्लाए, वर्टिसिलियम लीकेनी), खनिज आधारित तेल, बेसिलस तुरिंजेनसिस और स्पिनोसैड का मूल्यांकन बड़ी इलायची के इनसेक्ट कीटों (तना बंधक, प्ररोह मक्खी, पत्ते खाने वाले कैटरपिलर और चाय मच्छर बग) को एससी @ 0.3 मिली लीटर/लीटर सभी कीटों को नियंत्रित करने में सबसे प्रभावी है, तत्पश्चात् नीम का तेल (1500 पीपीएम) @ 3 मिली लीटर/लीटर है।

अदरक

विविध कृषि-जलवायु क्षेत्रों में स्थित धोली, कुमारगंज, पुंडिबारी, कमारपल्ली, बारापानी, पोडुंगी, रायगढ़ बारापानी, पोडुंगी, रायगढ़ और सोलन केंद्रों में अदरक जर्मप्लाज्म के संग्रह, लक्षण, मूल्यांकन और संरक्षण गतिविधियों की जा रही हैं। वर्ष के दौरान, बारापानी केंद्र ने किसानों के खेतों से अदरक के छह नए विशिष्ट संग्रह (उपज और गुणवत्ता के लक्षण के लिए) और सुगंधित अदरक (*काम्पफेरिया गलांगा एल.*) के एक अक्सेशन का संग्रह किया है। धोली

में बनाए गए 67 अक्सेशनों में, ग्यारह प्रकारों ने चेक किस्म की तुलना में उच्च उपज दर्ज की, नादिया (5.43 टन/हेक्टर) ने, आरजी-38 के साथ सबसे अधिक उपज (10.44 टन/हेक्टर) अंकित की, इसके बाद आरजी-4 (10.24 टन/हेक्टर) और आरजी-34 (9.38 टन/हेक्टर)। कुमारगंज, में संग्रह करके मूल्यांकन किए गए 63 जर्मप्लाज्म अक्सेशनों में से एनडीजी -55 (432 ग्राम / पौधे), इसके बाद एनडीजी -6 (145 ग्राम / पौधे) और एनडीजी 23 (142 ग्राम / पौधे) को आशाजनक होते देख लिया था।

मोटे और सब्जी अदरक के 7 जीनोटाइप्स जैसे, गोरुबथन (पुंडीबारी), बोल्ड नादिया (नागालैंड), भैसे (सिक्किम), जॉन के अदरक (आईआईएसआर), पीजीएस 121 (पोडुंगी), पीजीएस 95 (पोडुंगी) और पीजीएस 102 (पोडुंगी) में, सबसे अधिक पैदावार पोडुंगी (18.55 टन/हेक्टर) और नगालैंड (25.50 टन/हेक्टर) में बोल्ड नादिया में दर्ज की गई। हालांकि, बोल्ड नादिया में 1.90% एसनश्यल तेल के साथ फाइबर का सबसे कम प्रतिशत 4.40% थे, जबकि एसनश्यल तेल का उच्चतम प्रतिशत (2.40) नागालैंड के उप-नमी, अम्लीय मिट्टी के तहत कृष्ट, जॉन्स जिंजर में देखा गया था।

हल्दी

जर्मप्लाज्म में 173 संवर्धित प्रकार और 35 संबंधित स्पीसीस को पुंडीबारी केंद्र में बनाए रखा जा रहा है, जिसमें तराई क्षेत्र से एकत्र किए गए दो नए हल्दी अक्सेशन (टीसीपी 278 और टीसीपी 279) भी शामिल होते हैं। जर्मप्लाज्म अक्सेशनों की रूपरेखा उच्च पैदावार होने के लिए जीनोटाइप की एक अच्छी संख्या दर्शाती है और उनमें से कई को पूर्ण रोगों के लिए मध्यम प्रतिरोधी के रूप से प्रतिरोधी के तहत वर्गीकृत किया गया है। सीएआरएस, रायगढ़ में प्रकंदों की उपज और उपज की विशेषताओं के लिए हल्दी जर्मप्लाज्म का मूल्यांकन करने पर आईटी 38 (53.3 टन/हेक्टर), आईटी 42 (44.7 टन/हेक्टर) और आईटी 36 (44.7 टन/हेक्टर) की उच्च उपज क्षमता का पता चला और एचएआरएस, पोडुंगी में, 152 *कुरकुमा लोंगा* अक्सेशनों में से 88 अक्सेशनों का मूल्यांकन किया गया, जो 5 किलो ग्राम/3 मी² से अधिक उपज और 12 अक्सेशनों ने 10 किलो ग्राम / 3 मी² से अधिक ताजा उपज दर्ज किया गया।

धोली में मूल्यांकन किए गए 67 अक्सेशनों में से, 17 अक्सेशनों ने उच्च उपज दी, जिसमें चेक किस्म, राजेंद्र सोनाली और राजेंद्र सोनिया (क्रमशः 45.23 और 44.10 टन/हेक्टर) की तुलना में 45.31 से 53.10 टन/हेक्टर था, आरएच -16 के साथ उच्चतम उपज (53.10 टन/हेक्टर) अंकित किया, इसके बाद आरएच-3 (52.88 टन/हेक्टर)। कोयम्बतूर में मूल्यांकन किए गए 275 जीनोटाइप्स में, सीएल18 ने प्रति पौधे (926.29 ग्राम) में उच्चतम ताजा प्रकंद उपज दर्ज की, सीएल 115 ने अधिकतम शुष्क उपज (25.93 प्रतिशत) दर्ज की, सीएल 258 उच्चतम कुरकुमिन सामग्री (5.79 प्रतिशत) के साथ, सीएल 73 उच्चतम ओलेरोसिन सामग्री (11.58 प्रतिशत) और सीएल 112 उच्चतम एसनश्यल तेल सामग्री (2.17 प्रतिशत) दर्ज की गई। धोली में पूर्ण रोगों के खिलाफ हल्दी के 67 जर्मप्लाज्म अक्सेशनों की जांच की गयी थी, जिसमें से 62 को *टफ्रीना माकुलान* की वजह से पत्ती धब्बा रोग के खिलाफ स्पष्ट रूप से प्रतिरोधी या मध्यम प्रतिरोधी पाया गया था, जबकि सभी जर्मप्लाज्म अक्सेशनों को *कोलेटोट्राइकम कैप्सीसी* की वजह से पूर्ण दाग रोग के लिए अत्यधिक प्रतिरोधी पाया गया था।

वर्तमान साल, हल्दी में वर्धित अंकुरण, ताकत और भंडारण सड़न का दमन करने के लिए ट्राइकोप्राइम, मेटलेक्सिल-मैन्कोज़ेब और इमिडाक्लोप्रिड के संयोजन के साथ, टेबुकोनाज़ोल के साथ इमिडाक्लोप्रिड को अनुशंसित पीओपी के साथ-साथ प्राइमिंग प्रकंदों की प्रभावकारिता का मूल्यांकन करने के लिए एक नया प्रयोग शुरू किया गया है और उसकी वृद्धि के पैरामीटर्स को अंकित किया गया। मिजोरम केंद्र में, अधिकतम उपज टी2 (मेटालक्सिल-मैन्कोज़ेब @ 1.25 ग्राम/लीटर+इमिडाक्लोप्रिड 0.5 मिली लीटर/लीटर 30 मिनट के लिए) के लिए 35.58 टन/हेक्टर की उपज के साथ दर्ज की गई थी, इसके बाद

31.90 टन/ हेक्टर उपज के साथ टी1 (ट्राइकोप्राइम)। मेघालय केंद्र में भी, टी1 में अधिकतम उपज प्रति पौधा (270 ग्राम / पौधा) देखी गई, पोटांगी में प्रारंभिक परिणाम भी ट्राइकोप्राइम (टी. हर्ज़ियानम) के साथ प्रकंद उपचार को सबसे अच्छा बताते हैं, इसके बाद मेटालक्सिल-मैन्कोजेब के साथ का प्रकंद उपचार।

वृक्ष मसाले

पीचीपराई में संरक्षण और मूल्यांकन किये गये 28 जायफल अक्सेशनों बीच, एमएफ-1 में अधिकतम पेड़ की ऊंचाई (10.15 मीटर) और स्टेम गर्थ (64.47 से.मी.) और एमएफ 4 में अधिकतम पत्ती की लंबाई (20.31 से. मी.), पत्ती की चौड़ाई (9.2 से. मी.), फलों की संख्या (679.7), एकल फल वजन (53.5 ग्राम) और जावित्री की उपज (288.86 ग्राम/पेड़) दर्ज की गई। जायफल (वर्ष 1996-97 के दौरान लगाए गए) के जर्मप्लाज़म संग्रह के बीच सोलह होनहार जीनोटाइप्स का मूल्यांकन दापोली में किया जा रहा है और डीबीएसकेकेवीएमएफ 19 को फलों के पैदावार मानकों (3146.0 ग्राम की सूखे फलों की उपज और 786.5 ग्राम सूखी जावित्री की पैदावार) को देखते हुए एक आशाजनक जीनोटाइप देखा गया है। जीनोटाइप, ए-9 / 150 को विकास मापदंडों के लिए समन्वित प्रजातीय परीक्षण और प्रति पौधा फल की संख्या (दापोली में 228.67 और पीचीपराई में 221.76) के तहत जीनोटाइप के बाकी हिस्सों से काफी बेहतर पाया गया

1996-97 के दौरान दापोली में लगाए गए लॉग के जर्मप्लाज़म में चार होनहार जीनोटाइप चुने गए थे। पौधे की ऊंचाई में 6.15 से 7.40 मी. अंतर है, परिधि 44-52 से. मी. से लेकर 2.85 मीटर से 3.65 मीटर तक फैली हुई है। पीचीपराई के 24 अक्सेशनों में से, एसए-1 (12.10 मीटर) ने 12.26 मीटर की उच्चतम पेड़ की ऊंचाई दर्ज की, इसके बाद एसए-3 ने स्थानीय जांच (9.69 मीटर) की तुलना में दर्ज की। अक्सेशन, एसए-3 ने सबसे अधिक पत्ती की लंबाई (12.84 से. मी.), पत्ती की चौड़ाई (7.69 से. मी.), शाखाओं की संख्या (19.58) और सूखी कली की उपज (1.67 कि.ग्रा./वृक्ष/वर्ष) दर्ज की।

धनिया

कोयम्बटूर में मूल्यांकन किए गए 120 जीनोटाइप्स में, प्रति पौधे के अमबल्स की संख्या में 11.00 (सीएस165 में) से 47.00 (सीएस 24) भिन्न होती है और जीनोटाइप में, सीएस 273 से, जिसमें 3मी² के 305 ग्राम/प्लॉट की उच्चतम बीज उपज दर्ज की गई। रायगढ़ में संरक्षित और मूल्यांकित 32 जर्मप्लाज़म लाइनों में, हिसार आनंद (10.5 क्विंटल/हेक्टर) और गुजरात धनिया 1 (10 क्विंटल/हेक्टर) के चेकों की तुलना में, सीजीडी -1 (14.5 क्विंटल/हेक्टर), सीजीएससीडी-2 (14.2 क्विंटल/हेक्टर), आईसीएस 29 (13.8 क्विंटल/हेक्टर), आईसीएस 10 (13.5 क्विंटल/हेक्टर) में उच्च बीज उपज दर्ज की गई।

जगुदान में, बीज की पैदावार 6.75 से 19.33 क्विंटल/हेक्टर तक थी और 61 प्रविष्टियों के बीच, बारह जीनोटाइप ने चेक GCori-3 की तुलना में अधिक बीज उपज दी। जोबनेर में मूल्यांकन किए गए 134 अक्सेशनों में से, 24 अक्सेशनों ने सर्वश्रेष्ठ चेक किस्म RCr-480 (40.5 ग्राम) से बेहतर प्रदर्शन किया। धोली में, 74 अक्सेशनों में, RD-424 ने प्रति हेक्टर (19.52 क्विंटल) उच्चतम उपज दी, इसके बाद RD-440 (19.40 क्विंटल) और उनमें से नौ को प्राकृतिक स्थिति में स्टेम गाल रोग के प्रति अत्यधिक प्रतिरोधी पाया गया।

जोबनेर में धनिया के एकीकृत कीट और रोग प्रबंधन पर किए गए प्ररीक्षण में, दो साल के आंकड़ों के विश्लेषण से पता चला कि धनिया में पाउडरी मिल्ड्यू, ब्लाइट और एफिड की बाधा में नियंत्रण की अपेक्षा काफी कमी हुई है। प्रोपिकोनाज़ोल 25 ईसी @ 0.05% (10 मि. लि./10 लिटर) (पहला और दूसरा छिड़काव) का पत्तों पर छिड़काव + एसिटामिप्रिड 20 एसपी (0.004%) के दो बार पत्तों पर छिड़काव (टी 2) के संयोजित उपचार के फलस्वरूप पाउडरी

मिल्ड्यू का न्यूनतम आपतन (7.83%) और सबसे कम एफिड इन्डक्स (2.94, 2.14, 1.05 और 0.75) और अधिकतम बीज उपज (1824.57 कि. ग्रा./हेक्टर) (3.83 का बी:सी अनुपात) दर्ज की गई। हालांकि, सबसे कम आपतन (6.00%) और धनिया के ब्लाइट रोग में उच्चतम (80.33%) कमी एसएयु(टी9) द्वारा विकसित पैकेज के पर्ण छिड़काव में पाई गई, जो कार्बेन्डाजिम 50 WP@0.1% (20 ग्राम / 10 लीटर पानी) (पहला और दूसरा छिड़काव) + एसिटामिप्रिड 20 एसपी (0.004%) (टी 4) के दो पर्ण छिड़काव के बराबर थी।

जबलपुर में एफिड बाधा पर डेटा का विश्लेषण करने पर कम कीट आपतन और उच्च बीज उपज का संकेत टी 6 (लीकेनिसिलियम लीकेनी के दो पर्ण छिड़काव (1×109 cfu/g) + कार्बेन्डाजिम का @ 0.1% (पहला छिड़काव) का छिड़काव+प्रोपिकोनाज़ोल का @ 0.05% (दूसरा छिड़काव) का छिड़काव और टी 7 यानी एसिटामिप्रिड (0.004%) का पत्तों पर दो छिड़काव + प्रोप्रिकेज़ोल @ 0.05% (पहला छिड़काव)+कार्बेन्डाजिम का @ 0.1% (दूसरा छिड़काव) के छिड़काव में देता है।

जीरा

जगुदान में मूल्यांकन किये गये 126 जर्मप्लाज़म लाइनों के बीच, बीज की पैदावार में चेक, GC-4 की तुलना में 1.79-15.58 क्विंटल/हेक्टर का अंतर से लेकर, 50 जीनोटाइप के साथ, उच्च बीज उपज दर्ज की गयी। मंडोर में मूल्यांकन किये गये 490 जर्मप्लाज़म लाइनों में से, 12 लाइनों ने सर्वोत्तम चेक, जीसी -4 (3.97 क्विंटल/हेक्टर) की अपेक्षा बीज की पैदावार में महत्वपूर्ण लाभ दिखाया, जबकि सानंद में, मूल्यांकन किये गये 62 अक्सेशनों के बीच एक सफेद फूलों के साथ सफेद बालों वाले बीज के एक अद्वितीय अक्सेशन को देखे गए।

जगुदान में पाउडरी मिल्ड्यू रोग के खिलाफ प्रतिरोध के लिए जीरे की सस्ताईस प्रविष्टियों में जांच करने पर, जे सी 16-07 और जे सी -18-11 (9.0%) में न्यूनतम रोग की तीव्रता देखी गई। सीवीटी के तहत दस प्रविष्टियों को जोबनेर में विल्ट और ब्लाइट रोगों के खिलाफ जांच किया गया था, जिसमें जी सी -4 को विल्ट रोग के खिलाफ प्रतिरोधी पाया गया था। सीवीटी के तहत मूल्यांकन की गई दस प्रविष्टियों में से, जी सी 4 को म्लानी रोग के प्रति प्रतिरोधी पाया गया। जोबनेर में सीवीटी के तहत दस प्रविष्टियों का मूल्यांकन किया गया, जहां सीयुएम 41 ने जोबनेर में 8.82 क्विंटल/हेक्टर की अधिकतम बीज उपज दर्ज की, जबकि सीयुएम 40 ने भी जगुदान में (7.08 क्विंटल/हेक्टर), अजमेर (5.80 क्विंटल/हेक्टर) तथा मंडोर में (7.32 क्विंटल/हेक्टर) अच्छा प्रदर्शन किया।

सूक्ष्म पोषक तत्वों के चार संयोजनों (Zn अकेले, Zn+Fe, Zn+Fe +Mn और Zn+Fe+Mn+B) और तीन प्रयोग विधियों (मृदा अनुप्रयोग, पर्ण अनुप्रयोग और मृदा + पर्ण अनुप्रयोग) के साथ जीरा में सूक्ष्म पोषक तत्वों के प्रबंधन पर परीक्षण करने पर, समय परिणामों से संकेत मिलता है कि सूक्ष्म पोषक तत्वों के अनुप्रयोग के परिणामस्वरूप सभी विकास और उपज मापदंडों (पौधे की ऊंचाई, शाखाओं / पौधों, अम्बल्स / पौधों, अम्बल्लट्स/ अम्बल, प्रति अम्बल में बीज, परीक्षण वजन और बीज की उपज) में उल्लेखनीय वृद्धि हुई है और जीरा में नियंत्रण की तुलना में ब्लाइट और पाउडरी मिल्ड्यू के आपतन में कमी हुई है।

सौंफ

कुमारगंज में मूल्यांकन किये सौंफ के 168 जर्मप्लाज़म संग्रहों में से, अधिकतम उपज एनडीएफ-46 (52 ग्राम/पौधा) में दर्ज की गई, इसके बाद एनडीएफ-52 (51.9 ग्राम/पौधा) और एनडीएफ-49 (50.4 ग्राम/पौधा) में है। जगुदान में, बीज की पैदावार में 100 से 880 ग्राम/प्लॉट तक अंतर है और 162 प्रविष्टियों के बीच, बाईस जीनोटाइप ने जीएफ -12 की तुलना में उच्च बीज

उपज दर्ज की। धोली में मूल्यांकन किये गये 43 जर्मप्लाज़म अक्सेशनों में से बारह अक्सेशनों ने चेक किस्म, राजेंद्र सौरभ और उनके बीच, सबसे अधिक उपज आरएफ-13 (18.03 क्विंटल/हेक्टर) और आरएफ-14 (17.77 क्विंटल/हेक्टर) में दर्ज की गई। जोबनेर में एक सौ छब्बीस इंचेड लाइनों को बढ़ाया गया था।

सौंफ पर सीवीटी में, 2018-19 से 2019-20 तक 14 प्रविष्टियों के औसत प्रदर्शन से एफएनएल-126 के उपज 21.06 क्विंटल/हेक्टर का बेहतर प्रदर्शन दर्शाता है, इसके बाद एफएनएल-118 (20.42 क्विंटल/हेक्टर) और एफएनएल-127 (19.74 क्विंटल/हेक्टर) है। नवसारी में, जीनोटाइप एफएनएल-123 (28.33 क्विंटल/हेक्टर) ने उच्च बीज उपज दर्ज की, इसके बाद एफएनएल-118 (26.32 क्विंटल/हेक्टर) और एफएनएल-119 (25.60 क्विंटल/हेक्टर) है। हिसार में अधिकतम बीज की पैदावार एफएनएल-116 में 20.97 क्विंटल/हेक्टर दर्ज की गई, इसके बाद एफएनएल-117 (20.62 क्विंटल/हेक्टर) और एफएनएल-120 (19.32 क्विंटल/हेक्टर) है। जबकि कुमारगंज में, एफएनएल-125 में अधिकतम उपज (14.32 क्विंटल/हेक्टर) दर्ज की गई। उसके बाद 123 (13.66 क्विंटल/हेक्टर) और एफएनएल-121 (13.39 क्विंटल/हेक्टर) है।

मेथी

जोबनेर में मूल्यांकन किये गये 104 अक्सेशनों में से, 19 अक्सेशनों ने सर्वश्रेष्ठ चेक किस्म आरएमटी-143 (41.9 ग्राम) से बेहतर उपज दर्ज की। कुमारगंज में बनाए रखे गये और मूल्यांकन किये गये 204 जर्मप्लाज़म लाइनों में से सबसे अधिक उपज एनडीएम-49 (6.1 ग्राम/प्लांट) से प्राप्त हुई, इसके बाद एनडीएम-45 (5.7 ग्राम/प्लांट) है। धोली में मूल्यांकन किए गए 50 अक्सेशनों में से 12 अक्सेशनों को उपज और गुणवत्ता के संबंध में आशाजनक पाए गए। गुंटूर में मूल्यांकन की गई 124 प्रविष्टियों में से 13 प्रविष्टियों ने सर्वश्रेष्ठ चेक एलएम-2 (3.70 ग्राम/पौधा) की तुलना में काफी अधिक उपज दर्ज की है।

जोबनेर और अजमेर के प्रारंभिक परिणाम (2019-20) से संकेत मिलता है कि ड्रिप सिंचाई अंतराल ने मेथी के विकास मानकों, उपज विशेषताओं, पैदावार और जल उपयोग दक्षता को काफी प्रभावित किया है। 4 दिनों के अंतराल पर ड्रिप सिंचाई करने से अधिकतम फली/पौधा (35.57), बीज/फली (18.26), फली की लंबाई (12.30 से. मी.), परीक्षण वज़न (14.86 ग्राम), बीज की उपज (18.74 क्विंटल/हेक्टर), पुआल की पैदावार (37.29 क्विंटल/हेक्टर), शुद्ध प्राप्ति (2.33 बी:सी अनुपात के साथ रु. 74764 / हेक्टर) और जल उपयोग दक्षता (8.35 किलो ग्राम/हेक्टर-एमएम) दर्ज किया। 4 दिन के अंतराल पर ड्रिप सिंचाई करने से हाउनी मिल्ड्यू और पाउडरी मिल्ड्यू का कम आपतन दर्ज किया गया।

माइक्रोन्यूट्रिएंट के अनुप्रयोग तरीकों ने भी विकास मापदंडों, उपज विशेषताओं, पैदावार, अर्थशास्त्र और जल उपयोग दक्षता को काफी प्रभावित किया है। पर्ण छिड़काव ने अधिकतम अंकुरण (74.94%), फली/पौधा (34.09), फली की लंबाई (11.80 से. मी.), बीज की उपज (17.91 क्विंटल/हेक्टर), पुआल की पैदावार (36.79 क्विंटल/हेक्टर), शुद्ध प्राप्ति (2.15 बी: सी अनुपात के साथ रु.67451/हेक्टर) और पानी के उपयोग की दक्षता (8.17 किलो ग्राम/ हेक्टर-एमएम) दर्ज किया। पर्ण छिड़काव ने पाउडरी मिल्ड्यू के न्यूनतम आपतन को भी दर्ज किया।

अजवाइन

सीवीटी के तहत परीक्षण किए गए अजवाइन की 10 प्रविष्टियों में से कुमारगंज में, एनडीएजे-30 (8.37 क्विंटल/हेक्टर) में अधिकतम पैदावार दर्ज की गई, इसके बाद एचएजे-54 (8.10 क्विंटल/हेक्टर) और जेए-18-05 (7.89-8/हेक्टर) है, जबकि गुंटूर में, उच्च उपज जेए-17-06 (9.07 क्विंटल/हेक्टर),

जेए-18-05 (9.01 क्विंटल/हेक्टर) और एए-27 (8.98 क्विंटल/हेक्टर) दर्ज की गई, जो एक दूसरे के बराबर थे। जोबनेर में, एए-96 ने 8.41 क्विंटल/हेक्टर की अधिकतम बीज उपज दर्ज की, इसके बाद एनडीएजे-21 (8.03 क्विंटल/हेक्टर) और जेए-17-06 (7.78 क्विंटल/हेक्टर), जबकि रायगढ़ में, इंदिरा अजवाइन-1 (स्थानीय जांच) ने अधिकतम बीज उपज (13 क्विंटल/हेक्टर) दर्ज की, इसके बाद एए-3 (11 क्विंटल/हेक्टर) और एनडीएजी 21 (10 क्विंटल/हेक्टर) दर्ज किया गया। जगुदान में, एचएजे-24 (14.51 क्विंटल/हेक्टर), जेए 17-06 (13.30 क्विंटल/हेक्टर), एए-96 (13.11 क्विंटल/हेक्टर) और जेए-18-05 (12.96 क्विंटल/हेक्टर) चेक किस्म, एए-1 (9.15 क्विंटल/हेक्टर) की तुलना में काफी अधिक उपज दर्ज किए गए।

निगेला

कोटा में किये गये सीवीटी में, बीज की पैदावार 4.56 से 9.90 क्विंटल/हेक्टर तक हुई, एएन-1 में 9.90 क्विंटल/हेक्टर के साथ, और एएन-23 और रायगढ़ केंद्र में, इंदिरा निगेला -1 ने अधिकतम बीज उपज (13.4 क्विंटल/हेक्टर) दर्ज की, उसके बाद एनडीबीसी 7 (12.5 क्विंटल/हेक्टर) है। अजमेर में सभी विकास मापदंडों के बीच महत्वपूर्ण अंतर देखे गए, जिसमें पौधे की ऊंचाई में 56.80 से 68.90 से. मी., सिलिका/पौधा की संख्या में 82.4 से 52.2 तक और बीज / सिलिका की संख्या में 91.1 से 71.3 तक अंतर है। हिसार में, अधिकतम बीज उपज (15.03 क्विंटल/हेक्टर) को पंत कृष्णा में दर्ज की गई, उसके बाद एएन-20 (14.91 क्विंटल/हेक्टर) और एनडीबीसी-7 (14.62 क्विंटल/हेक्टर) है।

केसर

वर्ष के दौरान, जम्मू और कश्मीर के विभिन्न केसर बढ़ते क्षेत्रों से 15 अक्सेशनों को एकत्र करके रपोजिटरी को 215 (36 विदेशी संग्रह सहित) में बढ़ाया गया था। मूल्यांकन के तहत 200 जर्मप्लाज़म अक्सेशनों को 23 पर्णसमूह और फूलों के लक्षणों के संबंध में चित्रित किया गया था और उनमें से 22 जर्मप्लाज़म अक्सेशनों को फूलों की उपज, स्टिग्मा की लंबाई, पत्ते के मापदंडों और गुणवत्ता के लक्षण जैसे, क्रोसिन, पिक्रो-क्रोसिन और सफरानल के संबंध में आशाजनक पाये गये।

कालाजीरा

वर्ष के दौरान उत्तरी हिमालय की पैदल पहाड़ियों से दस नई जर्मप्लाज़म लाइनें एकत्र की गईं, जिससे जर्मप्लाज़म संग्रह 80 हो गया। एसकेयुएसटी-कश्मीर में मूल्यांकन किए गए 70 संग्रहों में से 7 लाइनों का चयन विकास, उपज और उपज विशेषताओं के आधार पर किया गया। विभिन्न गुणात्मक लक्षणों के लिए डीयुएस लक्षण भी दर्ज किए गए थे।

गुणवत्ता रोपण सामग्री का उत्पादन और वितरण

एआईसीआरपीएस केंद्रों ने काली मिर्च के 2.62 लाख कतरनों, इलायची के 17376 सकेर्स, 22.44 टन हल्दी, 3.15 टन अदरक, 5000 जायफल के ग्राफ्ट्स और दालचीनी के 2000 ग्राफ्ट्स को बहुगुणित करके वितरण किया गया। बीज मसालों में, 356.5 क्विंटल धनिया, 56.5 क्विंटल जीरा, 42.63 क्विंटल सौंफ, 126.73 क्विंटल मेथी, 10 क्विंटल अजवाइन और 12 क्विंटल निगेला का उत्पादन और वितरण किया गया।

प्रौद्योगिकी का हस्तांतरण

वैज्ञानिक खेती के तरीकों और सुस्थिर मसाला उत्पादन के बारे में कृषि समुदाय के बीच जागरूकता पैदा करने के लिए एआईसीआरपीएस केंद्रों के वैज्ञानिकों ने नवीनतम तकनीकों को लोकप्रिय बनाने में सक्रिय रूप से भाग लिया है। वर्ष के दौरान प्रदर्शित कुछ प्रौद्योगिकियां इस प्रकार हैं

अधिक उपज देने वाली किस्में- किसानों को वरदान

- * उच्च उपज वाली हल्दी किस्म सीओ2 (कोयंबत्तूर) का प्रदर्शन।
- * 2.0 हेक्टर (पासीघाट) में मेघा हल्दी 1, एनडीएच 98 और राजेंद्र सोनिया का प्रदर्शन।
- * उच्च उपज वाली धनिया किस्म सीएस 38 (कोयंबत्तूर) का प्रदर्शन
- * उच्च उपज वाली मेथी की किस्म आरएमटी- 361 का 3.0 हेक्टेयर (जोबनेर) में प्रदर्शन।
- * 3.0 हेक्टर (जोबनेर) में अधिक उपज देने वाली सौंफ की किस्म RF 205 का प्रदर्शन।
- * काली मिर्च की पन्नियूर किस्मों का प्रदर्शन (पन्नियूर)
- * काली मिर्च की 15 किस्मों का प्रदर्शन (पोट्टांगी)

रोपण सामग्री का तेजी से गुणन- न्यूनतम व्यय के लिए

- * केवीके, कोंडम्पुडी, विशाखापत्तनम (चिन्तापल्ली) के सहयोग से पड़ेरु, डुम्बरीगुडा और अरुकु में हल्दी में प्रोट्टे तकनीकी का प्रचलन।
- * अदरक और हल्दी (काम्मरपल्ली, पोटांगी, नागाळेंड) के गुणवत्तापूर्ण बीज उत्पादन के लिए प्रोट्टे खेती की तकनीक।
- * अदरक और हल्दी के लिए प्रोट्टे प्रवर्धन तकनीक का प्रदर्शन, जायफल और कोकुम में नरम लकड़ी ग्राफिटिंग तकनीक, झाड़ी काली मिर्च उत्पादन तकनीक (दापोली)।
- * 2.0 एकड़ (कोयंबत्तूर) में हल्दी प्रत्यारोपण का प्रदर्शन।

प्रसंस्करण और मूल्य संवर्धन - बाजार पर कब्जा करने के लिए

- * जायफल के छिलके का संरक्षण और चटनी तैयार करना (दापोली)।
- * काली मिर्च का प्रसंस्करण (दापोली)।

पौधों की सुरक्षा- पौधों के स्वास्थ्य में सुधार के लिए

- * हल्दी में 0.5 एकड़ (धोली) में, प्रोपिकोनाज़ोल @0.2% के साथ राइज़ोम का उपचार + रोपण के 90, 105 और 120 दिनों के बाद प्रोपिकोनाज़ोल @0.1% का पत्तों पर छिड़काव।
- * अज़ोक्सिस्ट्रोबिन +टेबुकोनाज़ोल @ 0.1% के वाणिज्यिक कवकनाशी संयोजन को रोपण के 45, 60 और 75 दिनों के बाद पत्तों पर छिड़काव(धोली) द्वारा धनिया के स्टम गाल रोग का प्रबंधन।

उपर्युक्त खेतीगत प्रदर्शनों के अलावा, वैज्ञानिकों ने वरचुअल प्रशिक्षणों को आयोजित करके और वरचुअल प्रशिक्षणों और संगोष्ठियों में विशेषज्ञ के रूप में भाग लेकर और विभिन्न मीडिया (समाचार पत्र, रेडियो वार्ता और टीवी कार्यक्रमों) के माध्यम से प्रौद्योगिकी को लोकप्रिय बनाया।

लॉकडाउन के दौरान गतिविधियाँ

भारत के विभिन्न हिस्सों के आईसीएआर- एआईसीआरपीएस केंद्रों ने न केवल कृषक समुदाय का समर्थन करने के लिए पहल की, बल्कि फ्रंट लाइन हेल्पर्स को भी कोविड 19 महामारी की स्थिति से हुए "लॉकडाउन" की अवधि के दौरान विभिन्न सहायता प्रदान की। एआईसीआरपीएस केंद्र ने स्वास्थ्य और परिवार कल्याण मंत्रालय द्वारा प्रयोग में लाये गये निवारक और सुरक्षा उपायों को अपनाकर रोपण सामग्री के उत्पादन और वितरण में शामिल किया। सभी आईसीएआर-एआईसीआरपीएस केंद्रों में फार्म संचालन करते समय सर्जिकल मास्क, अल्कोहल आधारित सैनिटाइज़र और नियमित रूप से हाथ धोने के रूप में सामाजिक गड़बड़ी और व्यक्तिगत स्वच्छता उपायों को अनिवार्य रूप से लागू किया गया था। आरोग्य सेतु ऐप को सभी आईसीएआर-एआईसीआरपीएस केंद्रों के कर्मचारियों और उनके परिवार के सदस्यों द्वारा डाउनलोड करके उपयोग किया गया था। डॉ. श्रीकांत सवरगांवकर, आईजीकेवीवी, रायगढ़ के एआईसीआरपीएस वैज्ञानिक ने जिला कलेक्टर के

आदेशानुसार तीन महीने के लिए मेडिकल कॉलेज, रायगढ़ के कोरोना वायरोलॉजी लैब में काम किया।

सफलता की कहानियाँ

विशाखापत्तनम जिले में आदिवासी समुदाय में मसालों में मूल्य श्रृंखला विकास

एनआईटीआई-आयोग द्वारा आंध्र प्रदेश राज्य में एस्पिरेशनल जिले के रूप में विशाखापत्तनम की पहचान की जाती है। चिन्तापल्ली क्षेत्र के आदिवासी किसानों ने चिन्तापल्ली स्थानीय हल्दी की खेती की जा रही थी, जिसे वे दो साल में एक बार काटते थे और पैदावार भी कम थी। आईसीएआर-इंडियन इंस्टीट्यूट ऑफ़ स्पाइसेस रिसर्च, कोषिकोड, आईसीएआर-एआईसीआरपीएस, चिन्तापल्ली ने आईटीडीए, पड़ेरु और एसईआरपी के सहयोग से इन आदिवासी किसानों को उच्च उपज के साथ उच्च मूल्य की किस्मों में शिफ्ट करने में सक्षम थे, जिनमें उच्च उपज के अलावा उन्नत कुरकुमिन भी है और यह अच्छी तरह इस क्षेत्र के अनुकूल भी है। वे किसानों को उच्च कुरकुमिन सामग्री के महत्व के बारे में शिक्षित करने में सफल रहे और वार्षिक फसल भी जो किसानों ने महसूस की है और अब आंध्र प्रदेश के चिन्तापल्ली में आदिवासी क्षेत्र के हल्दी उगाने वाले क्षेत्रों में लगभग 2000 हेक्टर में रोमा की खेती कर रहे हैं।

आदिवासियों की आजीविका की स्थिति में सुधार करने के लिए, एआईसीआरपीएस के सहयोग के साथ किसानों को हल्दी और काली मिर्च की उन्नत किस्मों जैसे हल्दी की खेती के लिए बेड सिस्टम में भूमि तैयार करने, आईसीएआर- आईआईएसआर द्वारा विकसित जैविक और सूक्ष्म पोषक तत्व योगों को अपनाने के लिए, हल्दी में अंतर फसल करने के लिए प्रेरित किया है। काली मिर्च की जैव सघन नर्सरी को बढ़ावा देने के लिए, हल्दी में प्राथमिक प्रसंस्करण का मशीनीकरण और मूल्यवर्धित उत्पादों के उत्पादन और उद्यमिता विकास के लिए ब्रांडिंग करने हेतु प्रेरित किया है।

आईआईएसआर- प्रगति-भारतीय हल्दी में कुरकुमिन उन्नयन

उच्च उपज (38 टन/ हेक्टर), छोटी अवधि (180 दिन) जैसे जड़ गांठ सूत्रकुमि बाधा के प्रति मध्यम प्रतिरोधक और हल्दी उगाने वाले सभी क्षेत्रों के लिए उपयुक्त है अपने बेहतर गुणों वाले हल्दी किस्म आईआईएसआर प्रगति। इसमें स्थानों के अनुसार स्थिर और उच्च कुरकुमिन सामग्री (5.02%) है और यह सबसे पसंदीदा किस्म है और 20000-25000 एकड़ के क्षेत्र को कवर करते हुए देश के सभी हल्दी उगाने वाले क्षेत्रों में फैल गई है। यह किस्म उच्च मूल्य के कुरकुमिन निष्कर्षण के लिए सफल किसान-उद्योग के प्रत्यक्ष जुड़ाव स्थापित कर सकती है, जहां किसानों को खुले बाजार की तुलना में लगभग दोगुना मूल्य मिल सकता है। वर्ष 2018-19 और 2019-20 के दौरान क्रमशः लगभग 300 टन और 500 टन बीज प्रकंदों को वितरित किए गए थे। गुणवत्ता वाले बीज प्रकंदों का गुणन और वितरण के लिए, आंध्र प्रदेश और तेलंगाना में पांच किसानों को गैर-अनन्य लाइसेंस प्रदान किया गया था।

सहयोग और नेटवर्किंग

मसालों पर एआईसीआरपी केंद्र निम्न लिखित के सहयोग से काम करते हैं

- आईसीएआर-आईआईएसआर, कोषिकोड और आईसीएआर-एनआरसीएसएस, अजमेर (प्रौद्योगिकियों के लिए)।
- जनजातीय क्षेत्रों में प्रौद्योगिकियों को लोकप्रिय करने के लिए मसाला बोर्ड।
- मसालों की गुणवत्ता वाले रोपण सामग्री के उत्पादन और आपूर्ति के लिए एमआईडीएच (बागवानी विज्ञान के लिए एकीकृत विकास मिशन)।
- जनजातीय क्षेत्रों में उच्च उत्पादन प्रौद्योगिकियों को लोकप्रिय बनाने और मूल्य श्रृंखला विकास के लिए एनजीओ।

- किसानों के उत्पादन, उत्पादकता और आय बढ़ाने के लिए राज्य कृषि/बागवानी विभाग।
- कॉफी आधारित काली मिर्च फसल प्रणाली की स्थापना के लिए कॉफी बोर्ड।

निगरानी

परियोजना समन्वयक और पीसी यूनिट के वैज्ञानिकों ने व्यक्तिगत दौरा करके विभिन्न एआईसीआरपीएस केंद्रों और प्रयोगात्मक भूखंडों के काम की निगरानी की। ई-मेल और फोन कॉल के माध्यम से भी लगातार निगरानी की गई। केंद्रों से भेजी जाने वाली मासिक प्रगति रिपोर्ट और बजट उपयोग प्रमाणपत्रों की गंभीर रूप से समीक्षा की गई और सुधार के लिए उचित मार्गदर्शन दिया गया। बीज मसालों की निगरानी करने वाली टीम में डॉ. गोपाल

लाल (निदेशक, आईसीएआर-एनआरसीएसएस, अजमेर), डॉ. वाई. के. शर्मा (आईसीएआर-एनआरसीएसएस, अजमेर), एआईसीआरपीएस कोषिकोड के डॉ. के. एस. कृष्णमूर्ति और डॉ. शारोन अरविंद ने प्रयोगों की प्रगति की समीक्षा के लिए बीज मसाला केंद्रों का दौरा किया।

केंद्रों की गतिविधियों की निगरानी मासिक त्रैमासिक, और अर्धवार्षिक रिपोर्ट के माध्यम से की जाती है। केंद्र की उपलब्धियों की मुख्य रूप से वार्षिक कार्यशाला के दौरान समीक्षा की जाती है और कार्यक्रमों के सुधार के लिए सुझाव दिए जाते हैं। XXXIवीं वार्षिक कार्यशाला लगभग 29 और 30 सितंबर 2020 के दौरान आईसीएआर-आईआईएसआर, कोषिकोड में वरचुअल रूप से आयोजित की गई थी।



Fig 1: Variation in dried rhizomes & powder of turmeric genotypes at Coimbatore

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 2020 was Rs. 676.86 lakhs (ICAR share). Owing to its significant contributions in tribal area, ICAR-AICRPS centre at Chintapalle in collaboration with ICAR-IISR Kozhikode bagged the prestigious Fakruddin Ali Ahmed Award for the outstanding research in tribal sector during 2019-20.

New initiatives

New research projects have been initiated targeting development of prediction models for diseases and insect pests of seed spices, evaluation of different ginger based intercropping systems for higher yield and income, spray schedule optimization of effective insecticides for shoot borer (*Conogethes punctiferalis*) in ginger and turmeric, developing soil test based, site-specific recommendations for varying yield targets in cardamom, intercropping systems for seed spices with

vegetables for higher yield and income and development of a micronutrient package for better growth, yield and quality of fennel.

Crop standards for various spice crops have been prepared and submitted to CVRC for facilitating release and notification of varieties.

A demonstration-cum-seed production unit of pure block of Megha Turmeric is being established in all the centres located in the NE region to facilitate the availability of pure seeds of Megha Turmeric.

Varieties recommended for release in XXXI AICRPS workshop

Four new trait-specific varieties, two in turmeric and one each in ginger and fenugreek, were recommended for release during XXXI AICRP on Spices Workshop held at ICAR-IISR, Kozhikode during 29-30 September 2020. They are,

Industrially rich varieties

IISR Vajra (Acc. 247): A high quality bold and plump ginger variety developed by the ICAR-IISR, Kozhikode and recommended for release in the states of Kerala, Karnataka, Odisha and West Bengal.

Lam Turmeric 1 (LTS 2): A turmeric variety with lemon yellow coloured powder and high dry recovery suitable for masala industry, developed by Dr. YSRHU, Guntur and recommended for release in the states of Andhra Pradesh, Telangana and Tamil Nadu.

Rajendra Haldi 1: A high yielding turmeric variety with high curcumin content developed by Dr. RPCAU, Dholi and recommended for release in the states of Bihar, Odisha and Andhra Pradesh.

Stress tolerant variety

Hisar Methi 257 (HM-257): A high yielding, powdery mildew and downy mildew resistant fenugreek variety developed by CSHAU, Hisar and recommended for release in the states of Bihar, Rajasthan, Chhattisgarh and Gujarat.

Technologies recommended during XXXI AICRPS workshop

A technology package for management of insect pest of large cardamom using biopesticides and organically permitted insecticides (spinosad (45 SC @ 0.3 ml L⁻¹) or neem based oil (Azadirachtin 0.15% EC) 1500 ppm @ 3 ml L⁻¹) was recommended under organic protection practice.

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 265 at Sirsi including seven related species viz., *P. colubrinum*, *P. arborium*, *P. chaba*, *P. longum*, *P. attenuatum*, *P. hymenophyllum* and *P. hookeri*) and one exotic collection from Vietnam.

Among the germplasms accessions evaluated at Panniyur, PRS 14 ranked first with 2.30 kg dry berry yield and 1512 spikes/vine; two genotypes, PRS 183 (150-170 days) and PRS 162 (204 days) have been identified as early maturing, while PRS 184 has been identified as shade tolerant. Considering its overall superiority, the hybrid PRS 161, a climate resilient variety with high yield, long spikes and bold berries, was released by the 28th State Seed Committee for Kerala as Panniyur-10. This variety is also field tolerant to drought and *Phytophthora* infection and has high oleoresin and piperine contents.

In the black pepper based mixed cropping system trial for ensuring sustainable productivity and food security, among the intercrops, elephant foot yam recorded maximum yield of 7.55 kg and higher B:C ratio of 3.13, followed by greater yam (6.46 kg with the highest B:C ratio of 4.04) from an inter space of 4 m x 2 m spacing between black pepper at Panniyur. The soil analysis data clearly indicates that the available nutrient content was high and hence it can be concluded that mixed cropping system did not deplete soil nutrient status.

Small cardamom

A total of 329 cardamom accessions are presently conserved in the gene banks, 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 characters at Sakleshpur, Mudigere, Myladumpara and Pampadumpara. Multi-location evaluation of thrips tolerant lines in cardamom has been initiated and preliminary observations at Myladumpara indicate that among the six genotypes (IC 349362, IC 349364, IC 349370, IC 349606, Njallani Green Gold and ICRI 8), IC 349606 has low thrips population.

Large cardamom

In large cardamom, 61 germplasm accessions are being maintained at the two AICRPS centres at Gangtok, Sikkim. Ten plantations in South and West districts of Sikkim were explored and three unique accessions were collected and maintained in quarantine facility at the research farm of ICRI. Seven accessions from ICRI, Gangtok and an unique accession (Sawney with green capsule) from the ICAR Research Complex for NEHR RS, Gangtok have been submitted to NBPGR, New Delhi for allotment of IC number.

The evaluation of biopesticides (neem oil, *Beauveria bassiana*, *Metarhizium anisopliae*, *Verticillium leccani*, mineral based oil, *Bacillus thuringiensis* and spinosad against insect pests of large cardamom (stem borer, shoot fly, leaf eating caterpillar and tea mosquito bug) indicate that spinosad 45 SC @ 0.3 ml L⁻¹ to be the most effective in controlling all the pests, followed by neem oil (1500 ppm) @ 3 ml L⁻¹.

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. During the year, Barapani centre has collected six new trait-specific collections of the ginger (for yield and quality traits) and one accession of aromatic ginger (*Kaempferia galanga* L.) from the farmers' fields. 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 recording 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 accessions 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.

Among the 7 genotypes of bold and vegetable ginger viz., Gorubathan (Pundibari), Bold Nadia (Nagaland), Bhaise (Sikkim), John's Ginger (IISR), PGS 121(Pottangi), PGS 95 (Pottangi) and PGS 102 (Pottangi), the highest yield was recorded in Bold Nadia at Pottangi (18.55 t ha⁻¹), and Nagaland (25.50 t ha⁻¹). However, Bold Nadia had the lowest per cent of fibre 4.40 % with 1.90% essential oil, while the highest per cent of essential oil (2.40) was observed in the cultivar, Johns Ginger, under the sub-humid, acidic soil of Nagaland.

Turmeric

Germplasm of 173 cultivated types and 35 related spp. are being maintained at Pundibari centre, including two new turmeric accessions (TCP 278 and TCP 279) collected from Terai region. Profiling of the germplasms accessions shows a good number of genotypes to be high yielding and many of them are grouped under resistant to moderately resistant to the foliar diseases. Evaluation of turmeric germplasm for rhizome yield and yield attributing traits at CARS, Raigarh revealed the higher yield potential of IT 38 (53.3 t ha⁻¹), IT 42 (44.7 t ha⁻¹) and IT 36 (44.7 t ha⁻¹) and at HARS, Pottangi, 88 accessions out of 152 *Curcuma longa* accessions evaluated, recorded more than 5 kg/3m² and 12 accessions more than 10 kg/3m² fresh rhizome yield.

Out of 67 accessions evaluated at Dholi, 17 accessions gave higher yield, ranging from 45.31 to 53.10 t ha⁻¹ compared to check variety, Rajendra Sonali and Rajendra Sonia (45.23 & 44.10 t ha⁻¹, respectively), with RH-16 recording the highest yield (53.10 t ha⁻¹), followed by RH-3 (52.88 t ha⁻¹). Among the 275 genotypes evaluated at Coimbatore, CL 18 recorded the highest fresh rhizome yield per plant (926.29 g), CL 115 recorded maximum dry recovery (25.93 per cent), CL 258 with highest curcumin content (5.79 per cent), CL 73 with highest oleoresin content (11.58 per cent) and CL 112 recorded highest essential oil content (2.17 per cent). Among 67 germplasm accessions of turmeric screened against foliar diseases at Dholi, 62 were found to be apparently resistant or moderately resistant against leaf blotch disease caused by *Taphrina maculans*, whereas all the germplasm accessions were found to be highly resistant to leaf spot disease caused by *Colletotrichum capsici*.

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 and the growth parameters were recorded during the current year. At the Mizoram centre, the maximum yield was recorded for T₂ (metalaxyl-mancozeb @ 1.25g/L + Imidacloprid 0.5 ml/L for 30 minutes), with a yield of 35.58 t ha⁻¹, followed by T₁ (Trichoprime) with a yield of 31.90 t ha⁻¹. At Meghalaya centre also, maximum yield per plant (270 g/plant) was observed in T₁, initial results at Pottangi also indicate rhizome treatment with Trichoprime (*T. harzianum*) to be the best, followed by rhizome treatment with metalaxyl-mancozeb.

Tree spices

Among the 28 nutmeg accessions conserved and evaluated at Pechiparai, MF- 1 recorded maximum tree height (10.15 m) and stem girth (64.47 cm) and MF 4 recorded maximum leaf length (20.31 cm), leaf breadth (9.2 cm), no. of fruits (679.7), single fruit weight (53.5 g) and mace yield (288.86 g/ tree). Sixteen promising genotypes among the germplasm collections of nutmeg (planted during the year 1996-97) are being evaluated at Dapoli and DBSKKVMF 19 has been found to be a promising genotype considering its fruit yield parameters (dry nut yield of 3146.0 g and dry mace yield of 786.5 g). The genotype, A-9/150 was found to be significantly superior over rest of the genotypes under the coordinated varietal trial for the growth parameters and the number of fruits per plant (228.67 at Dapoli and 221.76 at Pechiparai).

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 from 44 -52 cm and spread from 2.85 m to 3.65 m. Among the 24 accessions at Pechiparai, SA-1 recorded the highest tree height of 12.26 m, followed by SA-3 (12.10 m), as compared with the local check (9.69 m). The accession, SA-3 recorded the highest leaf length (12.84 cm), leaf breadth (7.69 cm), number of branches (19.58 nos) and dry bud yield (1.67 kg/tree/year).

Coriander

Among the 120 genotypes evaluated at Coimbatore, the number of umbels per plant

varied from 11.00 (in CS165) to 47.00 (CS 24) and the genotype, CS 273 registered the highest seed yield of 305 g/plot of 3 m². Among the 32 germplasm lines conserved and evaluated at Raigarh, higher seed yield was recorded in CGD -1 (14.5 q ha⁻¹), CGSCD-2 (14.2 q ha⁻¹), ICS 29 (13.8 q ha⁻¹), ICS 10 (13.5 q ha⁻¹) compared to the checks, Hisar Anand (10.5 q ha⁻¹) and Gujarat Dhaniya 1 (10 q ha⁻¹).

At Jagudan, the seed yield ranged from 6.75 to 19.33 q ha⁻¹ and among the 61 entries, twelve genotypes recorded higher seed yield than check GCori-3. Out of 134 accessions evaluated at Jobner, 24 accessions performed better than best check variety RCr-480 (40.5 g). At Dholi, among the 74 accessions, RD-424 gave the highest yield per hectare (19.52 q), followed by RD-440 (19.40 q) and nine of them were found to be highly resistant against stem gall disease under natural condition.

In the experiment on integrated pest and disease management of coriander at Jobner, pooled analysis of two years data revealed that application of fungicides, insecticides and bio-pesticides significantly decreased incidence of powdery mildew, blight and infestation of aphid in coriander as compared to control. The treatment combination of foliar spray of Propiconazole 25 EC @ 0.05% (10 ml/10 lit.) (first & second spray) + two foliar sprays of Acetamiprid 20 SP (0.004%) (T₂) recorded significantly minimum incidence of powdery mildew (7.83%) and lowest aphid index (2.94, 2.14, 1.05 and 0.75) and maximum seed yield (1824.57kg ha⁻¹) (BC ratio of 3.83). However, lowest incidence (6.00%) and highest (80.33%) disease reduction in case of blight of coriander was found in foliar spray of package developed by the SAU (T₉), which was at par with foliar spray of Carbendazim 50 WP @ 0.1% (20 gm/10 lit.water) (first & second spray)+ two foliar sprays of Acetamiprid 20 SP (0.004%) (T₄).

Analysis of data on aphid infestation at Jabalpur indicate low pest incidence and high seed yield in treatment T₆ (Two foliar sprays of *Lecanicillium lecanii* (1×10⁹ cfu/g) + spray of carbendazim @ 0.1% (first spray) + spray of propiconazole @ 0.05% (second spray) and T₇ i.e. two foliar sprays of acetamiprid (0.004%) + propiconazole @ 0.05% (first spray) + spray of carbendazim @ 0.1% (second spray).

Cumin

Among the 126 germplasm lines evaluated at Jagudan, the seed yield ranged from 1.79-15.58 q ha⁻¹, with 50 genotypes among them recording higher seed yield compared to the check, GC-4. Out of the 490 germplasm lines evaluated at Mandor, 12 lines showed significant gain in seed yield over the best check, GC-4 (3.97 q ha⁻¹), while at Sanand, among the 62 accessions evaluated, an unique accession with white flowers and white hairy seeds was noticed.

Among the twenty seven entries of cumin screened for resistance against powdery mildew disease at Jagudan, the minimum disease intensity was noticed in JC 16-07 and JC-18-11 (9.0 %). Ten entries under the CVT were screened at Jobner against wilt and blight diseases, wherein GC-4 was found to be resistant against wilt disease. Of the ten entries evaluated under CVT, CUM-41 recorded maximum seed yield of 8.82 q ha⁻¹ at Jobner and 8.91 q ha⁻¹ at Jagudan, while CUM-40 also performed well at Jagudan (7.08 q ha⁻¹), Ajmer (5.80 q ha⁻¹) as well as at Mandor (7.32 q ha⁻¹).

In the experiment on micronutrient management in cumin 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), the overall results 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.

Results from the integrated management of pests and diseases of cumin indicate that lowest incidence and maximum control of powdery mildew and blight diseases/aphids of cumin were found in the treatment T₄ with three foliar sprays of kresoxym methyl 44.3 SC @ 0.044% (10 ml/ 10 L water) + two foliar sprays of thiamethoxam 25WG (0.0084%). However, minimum disease incidence (9.87%) and maximum (18.57%) disease control of wilt were recorded with package developed by the respective SAUs (T₁₃).

Fennel

Among the 168 germplasm collections of fennel evaluated at Kumarganj, maximum yield was recorded in NDF-46 (52 g/plant), followed by NDF-52 (51.9 g/plant) and NDF -49 (50.4 g/plant). At Jagudan, the seed yield ranged from 100 to 880 g/plot and among 162 entries, twenty two genotypes recorded higher seed yield than the check, GF-12. Among the 43 germplasm accessions evaluated at Dholi, twelve accessions out yielded the check variety, Rajendra Saurabh and among them, the highest yield was recorded in RF-13 (18.03 q ha⁻¹) and RF -14 (17.77 q ha⁻¹). One hundred twenty nine inbred lines were raised at Jobner.

In the CVT on fennel, mean performance of the 14 entries over 2018-19 to 2019-20 indicate superior performance of FNL-126 yielding 21.06 q ha⁻¹, followed by FNL-118 (20.42 q ha⁻¹) and FNL-127 (19.74 q ha⁻¹). At Navsari, the genotype FNL-123 (28.33 q ha⁻¹) recorded significantly higher seed yield, followed by FNL-118 (26.32 q ha⁻¹) and FNL-119 (25.60 q ha⁻¹). Maximum seed yield recorded at Hisar was 20.97 q ha⁻¹ in FNL-116, followed by FNL-117 (20.62 q ha⁻¹) and FNL-120 (19.32 q ha⁻¹) while at Kumarganj, FNL-125 recorded maximum yield (14.32 q ha⁻¹), followed by FNL-123 (13.66 q ha⁻¹) and FNL-121 (13.39 q ha⁻¹).

Fenugreek

Out of 104 accessions evaluated at Jobner, 19 accessions recorded better yield than best check variety RMT-143 (41.9 g). Among the 204 germplasm lines maintained and evaluated at Kumarganj, the highest yield was obtained in NDM-49 (6.1 g/plant), followed by NDM-45 (5.7 g/plant). Among the 50 accessions evaluated at Dholi, 12 accessions were found to be promising with respect to yield and quality. Among the 124 entries evaluated at Guntur, 13 entries recorded significantly higher yield than the best check LM-2 (3.70 g plant⁻¹)

The initial results (2019-20) from Jobner and Ajmer indicate that drip irrigation interval significantly affected growth parameters, yield attributes, yields and water use efficiency of fenugreek. Drip irrigation at an interval of 4 days produced maximum pods/plant (35.57), seeds/pod (18.26), pod length (12.30 cm), test weight (14.86 g), seed yield (18.74 q ha⁻¹), straw yield (37.29 q ha⁻¹), net returns (Rs 74764/ha with a B:C ratio of 2.33) and water use efficiency (8.35 kg/ha-mm). The 4 day drip irrigation

interval also recorded lesser incidence of downy mildew and powdery mildew.

The application methods of micronutrient also significantly affected growth parameters, yield attributes, yields, economics and water use efficiency. The foliar spray recorded maximum germination (74.94%), pods/plant (34.09), pod length (11.80 cm), seed yield (17.91 q ha⁻¹), straw yield (36.79 q ha⁻¹), net returns (Rs 67451/ha with a B:C ratio 2.15) and highest water use efficiency (8.17 kg/ha-mm).

Ajwain

Among the 10 entries of ajwain tested under CVT, maximum yield was recorded in NDAJ-30 (8.37 q ha⁻¹), followed by HAJ-54 (8.10 q ha⁻¹) and JA-18-05 (7.89 q ha⁻¹) at Kumarganj, while at Guntur, higher yield was recorded in JA-17-06 (9.07 q ha⁻¹), JA-18-05 (9.01 q ha⁻¹) and AA-27 (8.98 q ha⁻¹), on par with each other. At Jobner, AA-96 recorded maximum seed yield of 8.41 q ha⁻¹, followed by NDAZ-21 (8.03 q ha⁻¹) and JA-17-06 (7.78 q ha⁻¹), while at Raigarh, Indira Ajwain -1 (local check) recorded maximum seed yield (13 q ha⁻¹), followed by AA-3 (11 q ha⁻¹) and NDAG 21 (10 q ha⁻¹). At Jagudan, HAJ- 24 (14.51 q ha⁻¹), JA 17-06 (13.30 q ha⁻¹), AA-96 (13.11 q ha⁻¹) and JA-18-05 (12.96 q ha⁻¹) recorded significantly higher yield compared to the check variety, AA-1 (9.15 q ha⁻¹).

Nigella

In the CVT at Kota, the seed yield ranged from 4.56 to 9.90 q ha⁻¹, with 9.90 q ha⁻¹ in AN-1, and AN-23 and at Raigarh centre, Indira Nigella -1 recorded maximum seed yield (13.4 q ha⁻¹), followed by NDBC 7 (12.5 q ha⁻¹). Significant differences were observed for all the growth parameters at Ajmer, with plant height ranging from 56.80 to 68.90 cm, number of silique/ plant from 82.4 to 52.2 and number of seeds/ silique from 91.1 to 71.3. At Hisar, maximum seed yield (15.03 q ha⁻¹) was recorded in Pant Krishna, followed by AN-20 (14.91 q ha⁻¹) and NDBC-7 (14.62 q ha⁻¹).

Saffron

During the year, 15 accessions were collected from various saffron growing areas of J&K, augmenting the repository to 215 (including 36 exotic collections). The 200 germplasm accessions under evaluation were characterized with respect to 23 foliage and floral traits and among them, 22 germplasm accessions were found promising with regard to flower yield, stigma length, foliage parameters and quality

traits viz., crocin, picro-crocin and saffranal content.

Kalazeera

Ten new germplasm lines were collected from the foot hills of Northern Himalayas during the year, making up the germplasm collections to 80. Out of the 70 collections evaluated at SKUAST-Kashmir, 7 lines were selected on the basis of growth, yield and yield attributes. DUS traits were also recorded for various qualitative traits.

Production and distribution of quality planting material

The AICRPS centres have multiplied and distributed 2.62 lakhs rooted cuttings of black pepper, 27376 suckers of cardamom, 22.44 tons of turmeric, 3.15 tons of ginger, 5000 grafts of nutmeg and 2000 grafts of cinnamon. In seed spices, 356.5 q of coriander, 56.5 q of cumin, 42.63 q of fennel, 126.73 q of fenugreek, 10 q of ajwain and 12 q of nigella were produced and distributed.

Transfer of technology

Scientists from AICRPS centres have actively involved in popularization of the latest technologies to create awareness among the farming community about scientific cultivation practices and sustainable spices production. Some of the technologies demonstrated during the year are as follows

High yielding varieties- boon to farmers

- ❖ Demonstration of high yielding turmeric variety CO 2 (Coimbatore)
- ❖ Demonstration of Megha Turmeric 1, NDH 98 & Rajendra Sonia in 2.0 ha (Pasighat)
- ❖ Demonstration of high yielding coriander variety CS 38 (Coimbatore)
- ❖ Demonstration of high yielding fenugreek variety RMT- 361 in 3.0 ha (Jobner)
- ❖ Demonstration of high yielding fennel variety RF 205 in 3.0 ha (Jobner)
- ❖ Demonstration of Panniyur varieties of black pepper (Panniyur)
- ❖ Demonstration of 15 varieties of black pepper (Pottangi)

Rapid multiplication of planting materials- for minimal expenditure

- ❖ Protray technology popularization in turmeric in Paderu, Dumbiguda 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)
- ❖ Demonstration of performance of turmeric transplants in 2.0 acres (Coimbatore)

Processing and value addition- for capturing market

- ❖ Preparation of preserve and chutney from nutmeg rind (Dapoli)
- ❖ Processing of black pepper (Dapoli)

Plant protection- for improving plant health

- ❖ Rhizome treatment with propiconazole @0.2% + foliar spray with propiconazole @0.1% at 90, 105 & 120 DAP in turmeric in 0.5 acres (Dholi)
- ❖ Management of stem gall disease of coriander by foliar spray of a commercial fungicidal formulation containing azoxystrobin + tebuconazole @0.1% at 45, 60 & 75 DAS (Dholi)

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).

Activities during lockdown

ICAR- AICRPS centres at various parts of India took the initiative to support not only the farming community but also front line helpers by providing various supports during the period of "Lockdown " owing to COVID 19 pandemic conditions. The AICRPS centres were also involved in the production and distribution of planting materials by adopting the preventive and safety measures as advocated by the Ministry of Health and Family Welfare. Social distancing and personal hygiene measures such as use of surgical mask, alcohol based sanitizers and regular hand washing were made compulsory while doing farm operations at all ICAR- AICRPS centres. Arogya Setu app was downloaded and used by the staff and their family members of all ICAR-AICRPS centres. Dr. Shrikant Sawargaonkar, AICRPS scientist at IGKVV, Raigarh served in Corona Virology Lab of

Medical College, Raigarh for three months as per District Collector's order.

Success stories

Value chain development in spices in tribal community in Visakhapatnam district

Visakhapatnam is identified by the NITI-AYOG as Aspirational district in the state of Andhra Pradesh. The tribal farmers of Chintapalle region were cultivating Chintapalle Local turmeric which they used to harvest once in two years and the yield was also low. ICAR-Indian Institute of Spices Research, Kozhikode, ICAR-AICRPS, Chintapalle in collaboration with ITDA, Paderu and SERP were able to convince these tribal farmers to shift to high value varieties like Roma which has high curcumin in addition to high yield and is well suited to the region also. They were successful in educating the farmers about the importance of high curcumin content and also yearly harvest which farmers have realized and are now cultivating Roma in around 2000 ha of turmeric growing regions of tribal area in Chintapalle, Andhra Pradesh.

In order to improve the livelihood status of the tribals, AICRPS in collaboration with, has motivated the farmers to adopt various technologies like improved varieties of turmeric and black pepper, raised bed system land preparation for turmeric cultivation, organic and micro nutrient formulations developed by ICAR-IISR, intercropping in turmeric, promotion of bio intensive nurseries of black pepper, mechanization of primary processing in turmeric and production of value added products and branding for entrepreneurship development.

IISR Pragati - Curcumin upgradation in Indian Turmeric

The turmeric variety IISR Pragati with its superior characters like high yield (38 t/ha), short duration (180 days), moderately resistant to root knot nematode infestation is suitable for all turmeric growing areas. It has stable and high curcumin content (5.02%) across locations, is the most preferred variety and has spread to all turmeric growing regions of the country covering an area of 20000-25000 acres. This variety could establish successful farmer-industry direct linkage for high value curcumin extraction wherein farmers could get almost

double the price compared to open market. About 300 t and 500 t of seed rhizomes were distributed during 2018-19 and 2019-20 respectively. For quality seed rhizome multiplication and distribution, non-exclusive license was granted for five farmers in Andhra Pradesh and Telangana.

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 production and supply of quality planting materials of spices
- NGOs for popularizing high production technologies in tribal areas and value chain development
- State Department of Agriculture / Horticulture for increasing production, productivity and income of farmers
- Coffee Board for establishing coffee based black pepper cropping system

Monitoring

The Project coordinator and the scientists from PC unit monitored the working of various AICRPS centres and experimental plots by personal visits. 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. Y.K. Sharma (ICAR-NRCSS, Ajmer), Dr. K. S. Krishnamurthy and Dr. Sharon Aravind from AICRPS Kozhikode visited the seed spices centres for reviewing the progress of the experiments.

The activities of the centres were also monitored through monthly reports, quarterly, half yearly and annual report sent by the centres. The achievements of the centres are mainly reviewed during the annual workshop and suggestions are offered for improvement of the programmes. The XXXI annual workshop was conducted virtually at ICAR- IISR, Kozhikode during 29 and 30 September 2020.

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.

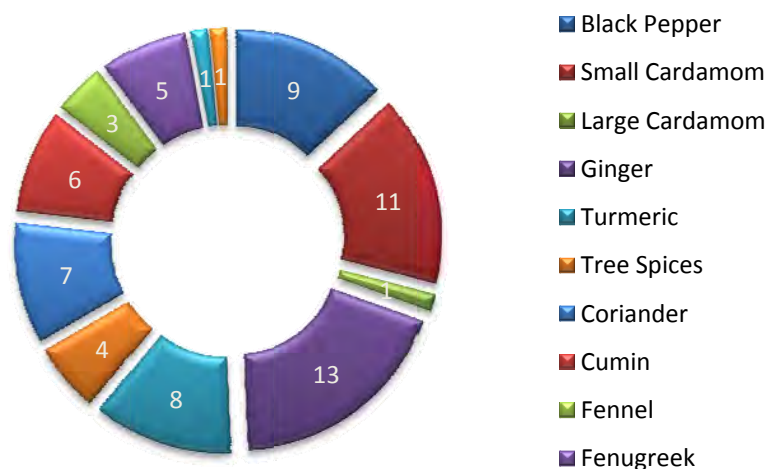


Fig 2: Number of ongoing research programs-Crop wise

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	Ginger, Turmeric, 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	Orissa	OUAT	Pottangi	1975	Turmeric, Ginger
14	Rajasthan	SKNAU	Jobner	1975	Cumin, Coriander, Fennel, Fenugreek
15	Telangana	SKLTSHU	Kamarpally	1986	Turmeric
16	Tamil Nadu	TNAU	Coimbatore	1975	Coriander, Fenugreek, Turmeric
17	Tamil Nadu	TNAU	Yercaud	1981	Clove, Nutmeg, Cinnamon, Black pepper
18	Uttar Pradesh	NDUAT	Kumarganj	1995	Turmeric, Ginger, Fennel, Coriander, Fenugreek
19	West Bengal	UBKV	Pundibari	1996	Black pepper, Turmeric, Ginger
Co-opting centres					
1	Assam	AAU	Kahikuchi	2014	Black pepper, Turmeric, Nutmeg
2	Karnataka	ICRI	Sakaleshapura	2008	Cardamom
3	Kerala	KAU	Ambalavayal	2008	Black pepper, Ginger, Turmeric,
4	Kerala	ICRI	Myladumpara	2008	Cardamom
5	Meghalaya	ICAR RC NEHR	Barapani	2008	Ginger, Turmeric
6	Mizoram	ICAR RC NEHR	Mizoram	2008	Ginger, Turmeric
7	Nagaland	SASRD	Medziphema	2014	Black pepper, Ginger, Turmeric
8	Sikkim	ICRI	Gangtok	2008	Large cardamom
9	Sikkim	ICAR RC NEHR	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

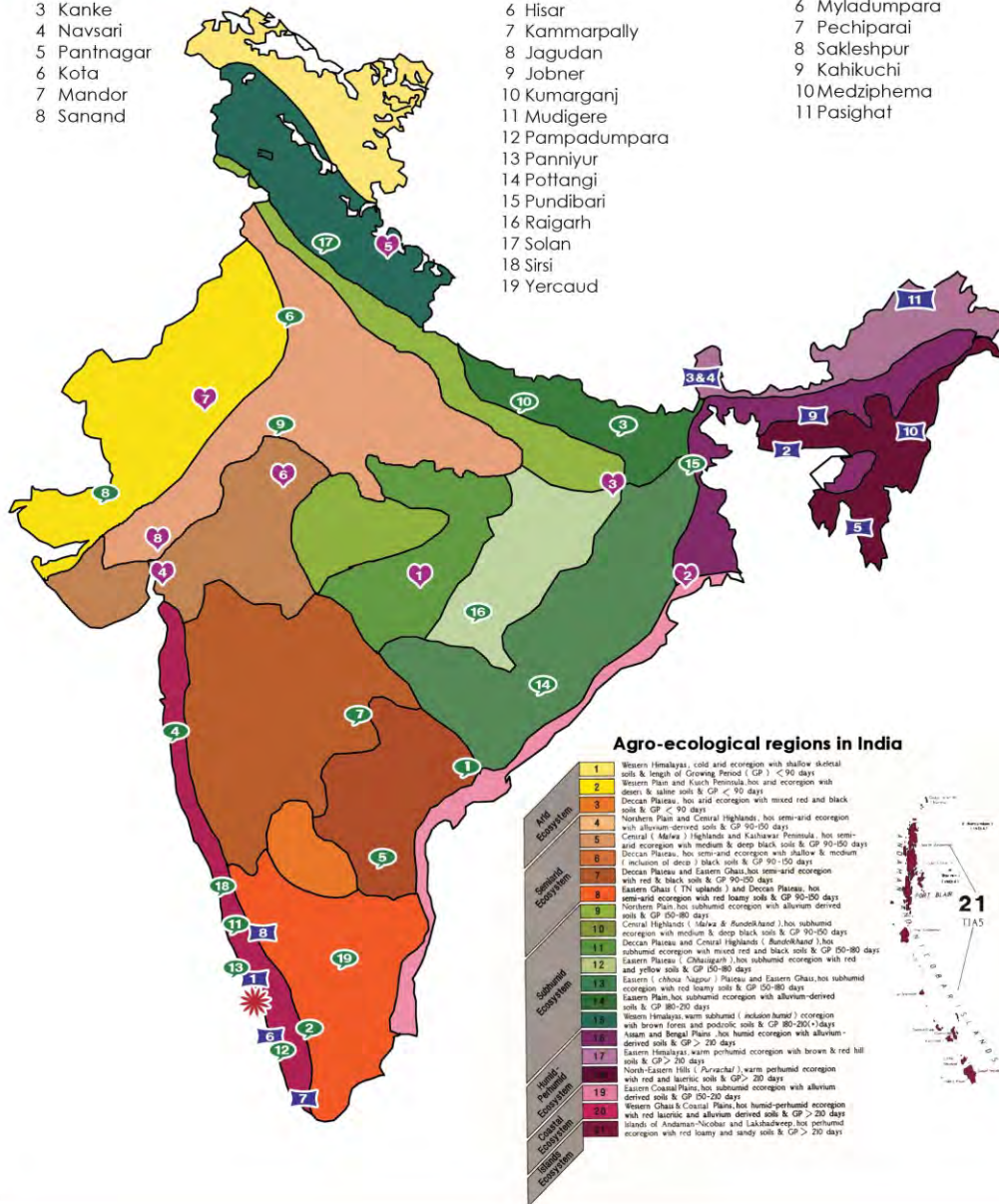
- 1 Jabalpur
- 2 Kalyani
- 3 Kanke
- 4 Navsari
- 5 Pantnagar
- 6 Kota
- 7 Mandor
- 8 Sanand

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 (2020)

Project Code	Title	Centres
Black pepper		
PEP/CI/1	Genetic Resources	
PEP/CI/1.1	Germplasm collection, characterization, evaluation and conservation	Ambalavayal, Chintapalle, Dapoli, Panniyur, Pundibari, Sirsi, Yercaud
PEP/CI/2	Hybridization trial	
PEP/CI/2.1	Inter-varietal hybridization to evolve high yielding varieties	Panniyur
PEP/CI/2.2	Hybridization to evolve varieties tolerant to biotic and abiotic stresses	Panniyur
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
Small cardamom		
CAR/CI/1	Genetic Resources	
CAR/CI/1.1	Germplasm collection, characterization, evaluation and conservation	Mudigere, Pampadumpara
CAR/CI/2	Hybridization	
CAR/CI/2.1	Hybridization and selection in cardamom	Mudigere
CAR/CI/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/4.3	Initial Evaluation Trial – 2012	Pampadumpara

CAR/CI/4.4	Multilocation evaluation of thrips tolerant cardamom lines	Appangala, Pampadumpara, Sakleshpur	Mudigere, Myladumpara
CAR/CI/4.5	MLT of leaf blight tolerant lines of small cardamom 2018	Appangala, Pampadumpara, Sakleshpur	Mudigere, Myladumpara
CAR/CM/5	Nutrient Management Trial		
CAR/CM/5.5	Effect of micronutrients on growth and yield of small cardamom	Appangala, Pampadumpara, Sakleshpur	Mudigere, Myladumpara
CAR/CP/6	Pest and Disease Management Trial		
CAR/CP/6.11	Evaluation of fungicides against rhizome rot in small cardamom	Appangala, Pampadumpara, Myladumpara	Mudigere
CAR/CP/6.12	Evaluation of fungicides against leaf blight in small cardamom	Appangala, Pampadumpara, Myladumpara	Mudigere
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	
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/3	Varietal Evaluation Trial		
GIN/CI/3.4	Initial Evaluation Trial of bold / vegetable ginger	Pottangi	
GIN/CI/3.5	Initial Evaluation Trial – 2015	Kumarganj	
GIN/CI/3.6	Initial Evaluation Trial – 2016	Pundibari, Pottangi, Solan	
GIN/CI/4	Quality Evaluation Trial		
GIN/CI/4.1	Evaluation of germplasm for quality	Solan	
GIN/CI/4.2	Evaluation of germplasm from other centres	Solan	
GIN/CI/4.3	Evaluation of genotypes of ginger for vegetable purpose (observational trial)	Kozhikode, Mizoram, Gangtok, Chintapalle, Pottangi, Pundibari, Nagaland	
GIN/CM/5	Nutrient Management Trial		
GIN/CM/5.6	Organic production of ginger	Barapani, Mizoram	
GIN/CM/5.9	Organic production of ginger	Ambalavayal	
GIN/CM/5.10	Effect of micronutrients on growth and yield of ginger	Ambalavayal	
GIN/CP/6	Disease Management Trial		
GIN/CP/6.13	Effect of PGPR biocapsule on growth and yield of ginger	Ambalavayal	

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
Turmeric		
TUR/CI/1	Genetic Resources	
TUR/CI/1.1	Germplasm collection, characterization, evaluation and conservation	Barapani, Coimbatore, Dholi, Guntur, Kammarpally, Kumarganj, Solan, Pasighat, Pottangi, Pundibari, Raigarh
TUR/CI/2	Coordinated Varietal Trial	
TUR/CI/2.7	CVT on mango ginger	Ambalavayal, Pottangi, Kozhikode, Dholi, Barapani, Pundibari, Raigarh, Navsari
TUR/CI/2.8	CVT on high yield and high curcumin	Kozhikode, Coimbatore, Guntur, Kammarpally, Pottangi, Kanke, Pasighat, Raigarh, Navsari
TUR/CI/2.9	CVT on light yellow colour turmeric for specialty market	Kozhikode, Coimbatore, Guntur, Kammarpally, Pottangi, Kanke, Pasighat
TUR/CI/3	Varietal Evaluation Trial	
TUR/CI/3.7	Initial Evaluation Trial 2015	Kumarganj
TUR/CI/3.9	Initial Evaluation Trial 2018	Guntur
TUR/CM/5	Nutrient Management Trial	
TUR/CM/5.10	Organic production of turmeric	Barapani, Mizoram
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
Tree spices		
TSP/CI/1	Genetic Resources	
TSP/CI/1.1	Germplasm collection, characterization, evaluation and conservation of clove, nutmeg and cinnamon	Dapoli, Pechiparai
TSP/CI/1.2	Collection of unique germplasm in tree spices	Dapoli, IISR, KAU, Pechiparai
TSP/CI/2	Coordinated Varietal Trial	
TSP/CI/2.2	CVT 2001 - Nutmeg	Dapoli, Pechiparai
TSP/CI/2.4	Coordinated Varietal Trial on farmer's varieties of nutmeg	Dapoli, Pechiparai, Thrissur
Project Mode	Evaluation of nutmeg genotypes	KAU
Coriander		
COR/CI/1	Genetic Resources	
COR/CI/1.1	Germplasm collection, description, characterization, evaluation, conservation and screening against diseases	Coimbatore, Dholi, Guntur, Hisar, Jagudan, Jobner, Kumarganj, Raigarh
COR/CI/1.3	Identification of drought/alkalinity tolerant source in coriander	Jobner

COR/CI/2	Coordinated Varietal Trial	
COR/CI/2.7	Coordinated Varietal Trial on coriander 2018-Series X	Ajmer, Coimbatore, Dholi, Guntur, Hisar, Jabalpur, Kota, Jagudan, Jobner, Kumarganj, Navsari, Pantnagar, Raigarh
COR/CI/3	Varietal Evaluation Trial	
COR/CI/3.9	Initial Evaluation Trial 2016	Dholi
COR/CI/4	Quality Evaluation Trial	
COR/CI/4.1	Quality evaluation in coriander	Jobner
COR/CM/5		
COR/CM/5.5	Response of coriander varieties to various levels of fertility under multi cut management practice	Dholi
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/2.4	Coordinated Varietal Trial – 2017	Ajmer, Jagudan, Jobner, Mandor
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/4	Quality Evaluation Trial	
FNL/CI/4.1	Quality Evaluation in fennel	Jobner
Fenugreek		
FGK/CI/1	Genetic Resources	
FGK/CI/1.1	Germplasm collection, characterization, evaluation, conservation and screening against diseases	Dholi, Guntur, Hisar, Jagudan, Jobner, Kumarganj, 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/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/2.2	Coordinated Varietal Trial- 2019	Ajmer, Guntur, Hisar, Jobner, Jagudan, Kumarganj, Raigarh
Nigella		
NGL/CI/2	Coordinated Varietal Trial	
NGL/CI/2.2	Coordinated Varietal Trial-2019	Ajmer, Hisar, Kota, 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

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 2020, the genotypes PRS 14 and PRS 124 were the top yielders. PRS 14 ranked first with 2.30 kg dry

berry yield and 1512 spikes per vine (Table 1). Spike length was maximum in PRS 155 (15.3 cm) while the number of developed berries per spike was more in PRS 124 (82). PRS 154 (12.4 g) recorded the maximum 100 berry weight while the highest dry recovery was recorded in PRS 124 (39 %). Two genotypes, PRS 183 (150-170 days) and PRS 162 (204 days) have been identified as early maturing, while PRS 184 has been identified as shade tolerant.

The details of germplasm collections of black pepper maintained at various AICRPS centres are presented in Table 1.



PRS 183



PRS 162

Fig 3: Early maturing genotypes of black pepper identified at PRS, Panniyur

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	257	7	1	265
Yercaud	34	3	-	37
Pampadumpara	52	-	-	52
Total	824	67	4	895

Table 2. Yield attributing characters of promising germplasm lines at PRS, Panniyur

Cultivar	Dry berry yield (kg/vine)	No. of spikes/vine	Spike length (cm)	No. of developed berries/spike	100 berry wt (g)	Dry recovery (%)
PRS 14	2.30 ^a	1512 ^a	8.0 ^e	73.7 ^b	11.3 ^{bcd}	34.0 ^{cde}
PRS 124	2.25 ^a	1426 ^b	14.2 ^b	82.3 ^a	12.1 ^{ab}	39.0 ^a
PRS 137	1.92 ^b	721 ^g	7.3 ^{ef}	74.7 ^b	11.1 ^d	34.7 ^{bcd}
PRS 155	1.67 ^c	798 ^f	15.2 ^a	51.3 ^{de}	10.9 ^d	33.7 ^{cde}
PRS 64	1.65 ^c	1282 ^c	7.8 ^{ef}	69.7 ^b	11.1 ^d	36.3 ^{abc}
PRS 136	1.55 ^{cd}	1122 ^d	13.2 ^c	63.3 ^c	12.0 ^{abc}	37.3 ^{ab}
PRS 154	1.50 ^{cd}	1045 ^e	10.1 ^d	51.7 ^{de}	12.4 ^a	35.7 ^{bc}
PRS78	1.39 ^{de}	700 ^g	6.4 ^g	53.7 ^d	11.5 ^{bcd}	31.3 ^e
PRS131	1.24 ^{ef}	612 ^h	6.5 ^g	50.0 ^{de}	10.9 ^d	35.0 ^{bcd}
PRS 151	1.22 ^{ef}	600 ^{hi}	9.8 ^d	48.0 ^e	11.2 ^{cd}	32.3 ^{de}
PRS 39	1.21 ^f	541 ⁱ	7.0 ^{fg}	60.3 ^c	11.3 ^{cd}	31.3 ^e
CD (5%)	0.18	69.4	0.79	5.5	0.81	3.2
CV	6.40	4.33	4.80	5.2	4.20	5.4

AICRPS centre at Sirsi collected two genotypes from Yellapur and Sirsi taluks of Uttara Kannada district of Karnataka, enhancing the germplasm accessions maintained at Sirsi centre to 265, 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. The trial was initiated during 1987 at Chintapalle and 26 germplasm accessions have been maintained. Among them Panniyur-1 recorded the highest number of spikes per vine (676), fresh berry yield per vine (4.35 kg), dry yield (1.37 kg), fresh yield per ha (4.38 t), whereas the highest number of berries per spike was recorded in Neelamundi (87.0) and highest dry recovery was recorded in Perambamundi (31.74%).

Among the accessions maintained and evaluated at Dapoli, DBSKKVPN 4 (IC 0611291) and DBSKKVPN 5 (IC 0611294) recorded a height of over 5.0 m while DBSKKVPN 2 (IC 0611289), DBSKKVPN 3 (IC 0611290) and DBSKKVPN 19 recorded 600 g vine⁻¹ fresh yield. 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.

At Yercaud, berry set was observed in 28 accessions. Among the yield characters, the spike length ranged from 8.15 to 13.22 cm, with the highest spike length observed in PN 74 (13.22 cm) and the lowest in PN 58 (8.15 cm). The accession PN 47 recorded maximum mean number of berries per spike (71.00), followed by PN 33 (69.30) and PN 60 (69.10). The accession PN 80 recorded the highest 100 green berry weight (13.15 g) and PN 78 recorded the lowest green berry weight (10.11g). Dry berry weight for 100 berries ranged from 2.70 (PN 60) to 3.77 g (PN 55). The accession PN 11 recorded the highest green and dry berry yield per vine (3.80 kg and 1.15 kg), followed by PN 55 (3.56 kg and 1.10 kg).

Crop Improvement

PEP/CI/2 Hybridization trial

PEP/CI/2.1 Inter-varietal hybridization to evolve high yielding varieties (Centres : Panniyur)

The hybrids viz., PRS 160, PRS 161 and PRS 165 were found to be promising with mean green berry yield of 6.23 kg vine⁻¹, 6.31 kg vine⁻¹ and 5.61 kg vine⁻¹ respectively. Maximum spike length (20.4 cm) and higher number of spikes/vine (894), 100 berry weight (19.1g) and dry recovery (38%) were recorded in PRS 161.

Table 3. Yield and yield attributing traits of promising new hybrids at PRS, Panniyur

Variety/ Hybrid	Green berry yield (kg/vine)	Spikes / vine	Spike length (cm)	Developed berries/ spike	100 berry weight (g)	Dry recovery (%)
PRS 160	6.23	750	14.6	82	11.5	33
PRS 161	6.31	894	20.4	101	19.1	38
PRS 165	5.61	584	13.8	94	16.3	37

Considering its overall superiority, the hybrid PRS 161, a climate resilient variety with high yield, long spikes and bold berries, was released by the 28th State Seed Committee for Kerala as Panniyur-10. This variety is field tolerant to drought and *Phytophthora* infection and has high oleoresin and piperine contents.

PEP/CI/2.2 Hybridization to evolve varieties tolerant to biotic and abiotic stresses

(Centre: Panniyur)

In the hybridization trial to evolve varieties tolerant to biotic and abiotic stresses, seedlings of all the crosses are being maintained at Panniyur. Besides, 350 open pollinated progenies derived from different accessions have also been maintained for evaluating them for stress tolerance.

PEP/CI/3 Coordinated Varietal Trial (CVT)

PEP/CI/3.3 CVT 2006 Series VI

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

In this trial (Series VI) at Panniyur (started during 2007), HB 20052 (Panniyur-8) recorded the highest green berry yield of 5.57 kg vine⁻¹, which was on par with Acc. No.53 (5.4 kg vine⁻¹). The highest plant height was recorded in Panniyur 1 (5.47 m). At Chintapalle, the maximum plant height was recorded in C-1090 (741.21 cm), followed by HP-39 (729.60 cm) whereas, the minimum plant height was noticed in ACC 33 (497.98 cm) which also recorded maximum number of branches per plant (34.01), followed by C-1090 (27.26) and ACC 57 (26.62). Fresh berry yield was the highest in Panniyur-1 (1042.5 g) followed by P-8 (850.4 g) and ACC 33 (829.85 g). It was observed that all varieties were susceptible to *Phytophthora* foot rot disease. At Sirsi, the accession PRS 88 (208.40 g of dry berries/vine) yielded more compared to other accessions and lowest yield was observed in C

1090 (101.57 g) under arecanut mixed cropping system.

At Dapoli, four accessions, namely, HB 20052 (713.0 g vine⁻¹), Acc. No. 33 (470.89 g vine⁻¹), Acc. 53 (437.78 g vine⁻¹) and Acc. 57 (393.05 g vine⁻¹) were the best performers in terms of their yield /vine, though statistically at par with each other. At Pampadumpara also, HB 20052 recorded highest fresh yield (2.247 kg vine⁻¹), while HB 20052 (0.657 kg) and Panniyur 1 (0.586 kg) recorded highest yield on dry weight basis. Among the accessions, Acc 53 recorded the maximum vine length (8.24 m) and dry berry yield (4.31 kg vine⁻¹) compared to the local check (6.83 m and 2.52 kg vine⁻¹) at Pechiparai.

At Yercaud, the yield attributing characters viz., number of spikes per meter square, number of berries per spike, green and dry berry yield varied significantly among the genotypes tested. The number of spikes per meter square ranged from 22.15 to 62.50, with the highest number of spikes per meter square (62.50) recorded in IISR Sakthi. The number of berries per spike was highest in the variety (88.10) IISR Shakthi. The green berry and dry berry yield were also the highest in the variety, IISR Shakthi with 4.10 kg and 1.20 kg, followed by IISR Thevam with 3.90 kg of green berry and 0.99 kg of dry berry yield, respectively.

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

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

In the CVT at Panniyur, Panniyur 5 (additional check) recorded the highest green berry yield (2.1 kg) and dry berry yield (0.70 kg) followed by Zionmundi (1.2 kg green and 0.4 kg dry yield) and Kumbakkal (1.0 kg green and 0.4 kg dry yield). Spike length was the highest in Panniyur 1 (17.0 cm) and it was on par with Panniyur 5 (16.6 cm). Zionmundi recorded a spike length of 15 cm which was on par with Kumbakkal (14.6 cm). Number of berries/ spike was the highest in

Panniyur 1 (84.7) followed by Panniyur 5 (69.3) and Kumbakkal (52.4).

At Yercaud, the highest vine length (1.45 m) and maximum number of branches per vine (11.00) were recorded in Panniyur-1. 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. The highest number of spikes per meter square (35.00) as well as the number of berries per spike was highest in Kumbakkal (38.00). However, the green berry and dry berry yield were the highest in Panniyur-1 (with 0.51 kg and 0.16 kg, respectively), followed by Kumbakkal (with 0.50 kg green berry and 0.15 kg of dry berry yield, respectively).

At Sirsi, the national check variety (Panniyur 1) recorded the highest mean height (2.60 m), number of branches (6) and number of leaves (89). The maximum number of spikes (12.) was recorded by the farmer variety, Zionmundi. At Chintapalle, the genotype Kumbakkal recorded

the maximum plant height (2.94 m) followed by Zionmundi (2.16 m). The number of branches were maximum in Kumbakkal (14.32), followed by Panniyur-1 (11.37). At Dapoli, the genotype Thekken, recorded the maximum plant height (1.52 m), whereas genotype Zionmundi 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)**

All the plants are in vegetative stage at Chintapalle. Among the different accessions studied at Sirsi, all plants have established well but none of the accessions have flowered. With respect to plant height, the accession SV 17 recorded maximum height (1.74 m) followed by SV 11 (1.58 m). At Panniyur, the genotype PRS 161 recorded highest green berry yield of 1.92 kg per vine (0.73 kg dry berry yield), highest spike length (19.7 cm), maximum berries/spike (95.3) and highest dry recovery (38.2%).

Table 4: CVT 2015 - Yield data at PRS, Panniyur during 2020

Sl. No	Treatment	Plant height (m)	No of branches/vine	Average spike length (cm)	No. of berries/spike	Fresh berry yield (kg)	Dry berry yield (kg)	Dry recovery (%)
1	PRS 161 (T1)	5.1 ^{ab}	26.3 ^{abc}	19.7 ^a	95.3 ^a	1.92 ^a	0.73 ^a	38.2 ^a
2	PRS 160 (T2)	3.8 ^c	26.7 ^{abc}	13.5 ^c	52.0 ^d	1.13 ^d	0.37 ^e	33.1 ^b
3	SV 17 (T3)	3.7 ^c	20.3 ^e	16.1 ^b	86.3 ^b	1.13 ^d	0.25 ^f	22.6 ^c
4	SV 11(T4)	3.6 ^c	23.0 ^{cde}	12.6 ^{cd}	72.7 ^c	1.61 ^b	0.57 ^b	35.3 ^{ab}
5	Panniyur 1 (T5)	3.5 ^c	29.3 ^a	16.6 ^b	84.4 ^b	1.38 ^c	0.50 ^c	36.3 ^{ab}
6	Panniyur 5 (T6)	4.8 ^b	20.7 ^e	11.7 ^{cde}	69.3 ^c	1.07 ^d	0.36 ^e	33.6 ^{ab}
7	Karimunda (T7)	5.5 ^a	28.0 ^{ab}	11.2 ^{de}	51.6 ^d	1.39 ^c	0.43 ^d	31.4 ^b
8	Arka Coorg Excel (T8)	3.5 ^c	21.0 ^{de}	16.2 ^b	52.6 ^d	0.84 ^e	0.26 ^f	31.3 ^b
9	Vijay (T9)	3.4 ^c	24.7 ^{bcd}	10.4 ^e	52.7 ^d	0.98 ^{de}	0.33 ^e	33.9 ^{ab}
	CD (0.05)	0.61	3.7	1.9	6.1	0.2	0.06	5.1
	CV (%)	8.58	8.7	7.6	5.2	8.7	7.9	8.9

The highest vine length was recorded in the genotype SV 17 (1.72 m) followed by Vijay (1.63 m) at Yercaud. The maximum number of berries/spike was recorded in PRS 160 (6.3). At Dapoli, due to Nisarga cyclone, the standards along with black pepper plants were uprooted and collapsed on the ground surface. The planting materials of the same trial were procured and its multiplication and raising on standards are in progress.

**PEP/CI/3.7 CVT 2018 on Black pepper Series IX
(Centres: Ambalavayal, Chintapalle, Sirsi, Panniyur, Kozhikode, Dapoli, Yercaud)**

The genotypes viz., HP 780, HP 1411,OPKM, HP 117 X *Thommankodi*, IISR Thevam, *Kumbakkal*, *Ponmani*, PRS 137, SV 7, *Kurimalai* and Panniyur 1 (check) are under vegetative stage at Ambalavayal, Yercaud, Panniyur, Kozhikode and Sirsi.

The plant height of all the varieties significantly differed from each other at Dapoli. The genotype OPKM was found to be significantly superior over rest of the varieties and recorded maximum height of 1.26 m whereas the lowest was recorded in IISR Thevam (0.28 m).

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 4 centres (Ambalavayal, Sirsi, Panniyur and Dapoli) with colocasia, arrowroot, greater yam, elephant foot yam and tapioca as intercrops.

Among the intercrops, elephant foot yam recorded maximum yield of 7.55 kg, followed by greater yam (6.46 kg) from an inter space of 4 m x 2 m spacing between black pepper at Panniyur. With regard to black pepper, the treatment T₁ (black pepper + colocasia + pineapple), recorded maximum height of the vine (4.50 m), T₆ (black pepper alone), recorded maximum number of leaves per branch of black pepper (9.70), number of laterals/ 50 cm² (3.44), number of spikes/ 50 cm² (7.97) and yield per vine (0.55 kg), but yield per vine was on par with T₅- (black pepper + greater yam+ pineapple (0.52 kg). Based on the yield data of 2020 of the main crop and the intercrops, highest BC ratio was obtained for the treatment, T₅ (4.04), followed by T₃ (elephant foot yam + black pepper) (3.13) and T₆ (3.07). The soil analysis data clearly indicates that the available nutrient content was high and hence it can be concluded that mixed cropping system did not deplete soil nutrient status.

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 T₁, in black pepper as compared to monocrop (T₆) (1.42 m), whereas the maximum yield of black pepper was recorded in treatment T₃ (0.489 kg plot⁻¹). However, there was no significant variation in the black pepper yield among the treatments at Ambalavayal. Among the intercrops evaluated, highest yield was obtained in elephant foot yam, which was on par with tapioca.

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).

Crop Protection

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

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

The trial was initiated and treatments were imposed in Panniyur, Sirsi and Yercaud.

At Appangala, initial observations of soil microbes were assessed and isolated more than 8 different types of bacteria from soil and rhizosphere.

At Dapoli the soil analysis was completed. The treatment will be imposed in April, 2021 onwards as the delivery of chemicals was delayed due to Covid-19 issues.

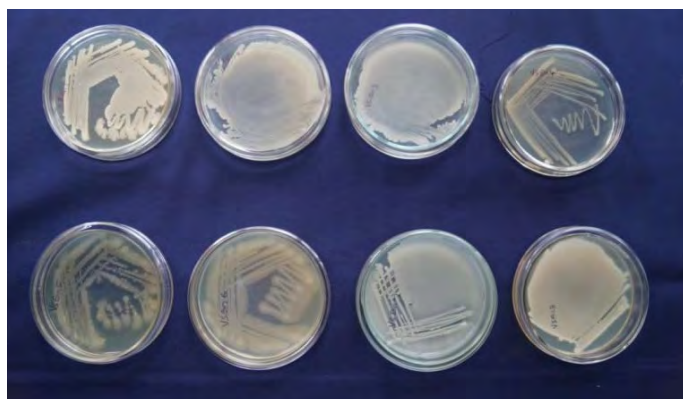


Fig 4: Rhizosphere bacterial isolates of black pepper from ICAR-IISR RS, Appangala

Small Cardamom

02

Genetic Resources

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

(Centres: Mudigere, Pampadumpara)

A total of 198 cardamom accessions are presently conserved in the gene bank of Pampadumpara and 132 accessions at Mudigere (Table 5). Among the germplasm accessions

evaluated at Mudigere, M2 recorded maximum plant height (320.63 cm) and 12-7-D-11 recorded maximum tillers per clump (38.60). SKP-170 was found to be the best performing in terms of bearing tillers per clump (23.73), panicles per clump (23.73) and yield per plant (370.1g). At Pampadumpara, the plants are replanted to another site and harvesting is yet to be done.

Table 5: 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/2 Hybridization

CAR/CI/2.1 Hybridization and selection in cardamom

(Centre: Mudigere)

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

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. Moisture stress was imposed in summer from February to April 2020 in stress block by withholding irrigation. The control block was irrigated by sprinkler (25mm) 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) recorded significant variation between control and stress treatments. Plant height and number of green leaves per tiller recorded significant variation among genotypes. Dry capsule yield (kg ha⁻¹) ranged from 314.58 (CL 668) to 542.3 (IC 584078) in control and in stress, it ranged from 159.7 (Appangala 1) to 231.5 (GGXNKE-12). Accession IC 584090 recorded 61.86 per cent 8mm bold capsules followed by IC 584058 which recorded 57.90 per cent in control. In stress, accession IC 584090 recorded 48.25 per cent 8 mm bold capsules. Essential oil content did not vary significantly between treatments and genotypes. It ranged from 8.05 (IC 584078) to 8.97 (IC 584058) with a mean 8.51 % in control and in stress, it ranged from 8.37 (IC 584058) to 9.18 (IC 584078) with a mean of 8.73 %.



Fig 5: IC 584058 under drought trial at Appangala

Photosynthetic rate (μ moles) ranged from 3.14 (Appangala 1) to 5.94 (IC 584090) in control and in stress, it ranged from 1.95 (CL 668) to 3.60 (IC 349537). Fruit set per cent ranged from 55.28 (IC 584078) to 84.77 (Appangala 1) in control and in stress it ranged from 32.31 (IC 349537) to 45.86 (IC 584058). Stomatal count ranged from 8.25 (IC 349537) to 12.75 (Cl-668) with a mean of 10.5 per microscopic field at 40 x.

Observations recorded at Sakleshpur and Myladumpara clearly indicated that yield contributing characters like number of panicles, length of panicles, number of racemes/ panicle and number of capsules/ raceme were significantly more in T₁ (without moisture stress) than T₂ (moisture stress). At Myladumpara, IC 349537 performed better (429.58 kg/ha) in the control plot, whereas it could yield only 280.77 kg ha⁻¹ under moisture stress.

At Mudigere, among 8 genotypes, maximum plant height was observed in IC-584078 (289.21cm) under sufficient moisture, while it was only 248.90 cm under moisture stress. The number of suckers/plant was more in IC-349537(46.90) under moisture stress condition, while IC-584090 (54.17) produced more number of suckers/plant under normal condition. Maximum yield was obtained in IC-584090 (340.33 kg/ha) followed by Appangala-1(300.12 kg/ha), while it was 520.33 kg/ha in IC-584090 and 430.13 kg/ha in Appangala-1, under normal (irrigated) conditions. Biometric observations recorded at Pampadumara indicate that maximum plant height (160.33cm) and maximum leaf length (57.66 cm) were recorded in IC 584058 while the least height (85.00 cm) and lowest leaf length (32.66 cm) were recorded in CL 668. The maximum number of tillers was recorded in accession IC 349537 (26.00) and the least was recorded in CL668 (8.33).

Table 6: Data on growth and yield attributes of small cardamom genotypes at Myladumpara

T1 Control										
Genotype	No. of tillers / clump	Tiller height (cm)	No. of leaves of tallest tiller	No. of veg. buds	No. of bearing tillers	No. of panicles	Length of panicle (cm)	No. of racemes / panicle	No. of capsules / raceme	Yield (kg/ha)
IC 349537	24.50	220.50	13.50	4.33	7.33	12.33	65.28	24.33	7.16	429.58
IC 584096	23.50	200.82	12.66	3.50	6.50	10.16	55.33	22.66	7.00	322.31
IC 584058	12.66	195.28	9.33	4.00	4.66	9.00	50.22	18.00	6.66	216.21
IC 584078	16.00	198.46	11.50	5.50	5.33	9.50	45.00	17.16	7.00	228.22
CL 668	14.33	200.67	12.50	4.50	6.00	12.33	50.42	19.33	6.33	301.73
HS 1	18.16	185.00	11.50	3.33	7.00	12.66	60.28	16.66	6.00	253.09
Appangala 1	20.33	190.66	10.50	3.00	6.33	10.00	62.50	18.33	5.66	207.49
IC 584090	22.50	172.00	11.33	5.00	5.66	8.33	72.66	20.00	7.33	244.23
CV	6.70	1.92	8.45	24.36	10.99	8.15	3.61	9.29	19.12	1.87
CD @ 5%	2.23	6.56	1.72	1.77	1.17	1.50	3.65	3.18	2.22	9.00
T2 Moisture stress										
IC 349537	17.33	170.63	12.50	3.33	6.50	11.50	50.86	18.33	6.66	280.77
IC 584096	18.16	166.85	10.50	2.50	4.16	8.33	48.62	16.50	5.33	146.51
IC 584058	16.50	180.48	11.00	3.00	6.33	12.33	55.98	12.16	6.00	179.10
IC 584078	18.00	160.83	9.16	2.66	7.00	12.50	52.26	14.50	4.16	150.80
CL 668	14.00	136.24	12.00	2.00	6.50	11.33	48.28	11.50	5.66	147.50
HS 1	13.66	188.00	10.50	3.33	5.33	9.83	55.32	14.00	5.16	142.02
Appangala 1	14.83	194.40	11.33	2.50	6.33	12.83	60.88	14.50	6.33	235.52
IC 584090	15.33	172.38	12.16	3.50	7.33	12.50	55.56	15.50	4.66	180.58
CV	7.95	1.19	13.84	22.55	19.86	14.90	5.46	9.32	11.65	3.05
CD @ 5%	2.22	3.57	2.70	1.13	2.15	2.97	5.11	2.39	1.12	9.78

CAR/CI/3.8 Evaluation of farmers' varieties of cardamom (Centres: Appangala, Pampadumpara, Myladumpara) Mudigere, 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. There were significant differences among these varieties with respect to their vegetative

characters at Sakleshpur, Mudigere, Myladumpara and Pampadumpara.

Biometric observations recorded at Sakleshpur indicate that while the number of tillers were significantly more in *Elarajan* (21.40), followed by *Arjun* and *ICRI-8* (19.33), the plant height was significantly more in *Thiruthali* (232.50), followed by *Pappalu* (223.33). While the number of panicles was significantly more in *Thiruthali* (19.23), followed by *Elarajan* (17.50), the length of panicle (24.73) and the number of capsules/raceme (5.63) were significantly high in *Pappalu*.

At Myladumpara, number of tillers (64.42), plant height (301.24) and number of leaves (15.42) were significantly more in *Panikulangara* 1. More number of panicles were found in *Arjun* (28.68), followed by *Thiruthali* (28.55), while the number of racemes per panicle and number of capsules per raceme were more in *Thiruthali* (24.72 and 9.06 respectively). The genotype, *Thiruthali* performed better with regard to yield (895.81 kg ha⁻¹) followed by the clone, *Arjun* (770.14 kg ha⁻¹). At Pampadumpara, superiority in terms of plant height was observed in varieties such as *Arjun* (165.7 cm), *Wonder Cardamom* (170.5 cm) and *Patchakai* (172.2 cm). Maximum number of tillers was produced by *Panikulangara* 1, which was on par with *Elarajan*, *Thiruthali* and *Wonder Cardamom*. At Appangala, yield and yield contributing traits viz., number of bearing tillers, number of panicles and panicle length (cm) were higher in *Pappalu*, followed by *Thiruthali*. Plants are in vegetative stage at Mudigere and preliminary results indicate superiority of genotypes like *Arjun*, *Wonder Cardamom* and *Patchakai*.

CAR/CI/3.9 Comparative varietal trial (CVT) on hybrids of small cardamom

(Centres: 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), Bold x GG x CC-1 (Appangala), GG x NKE 19 (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.

All the genotypes are established well in the field at Myladumpara, with 10-12 tillers developed in each clump and plants attaining the height ranging from 1-1.5 m. At Pampadumpara, the plants are at vegetative phase since replanting is done recently. The experiment was initiated at ICRI, Sakleshpur during September 2019. Due to heavy rainfall and high wind velocity, the experiment has been completely damaged at Mudigere and therefore the experiment will be reinitiated in the coming year. Gap filling was taken up during the current season and 100 % crop stand is being maintained at Appangala.

CAR/CI/4 Varietal Evaluation Trial (VET)

CAR/ CI/4.3 Initial Evaluation Trial - 2012

(Centres: Pampadumpara)

Biometric observations in the Initial Evaluation Trial at Pampadumpara (initiated in 2015) indicate that maximum number of tillers was produced in accessions such as PV 2 (33.33), BEP 2 (35.33) and HY 6 (30.66). The accession HY 6 recorded maximum number of panicles per tiller (41.667).

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 observation on nymph/thrips population at Sakleshpur indicate that both nymph and thrips population were high in IC 349370, followed by ICRI 8 (Fig 5). The experiment has been started at Pampadumpara and Mudigere during the current year.

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 with 85 % establishment. The trial is yet to be initiated at Pampadumpara and Myladumpara due to the non receipt of the planting materials from the contributing centres.

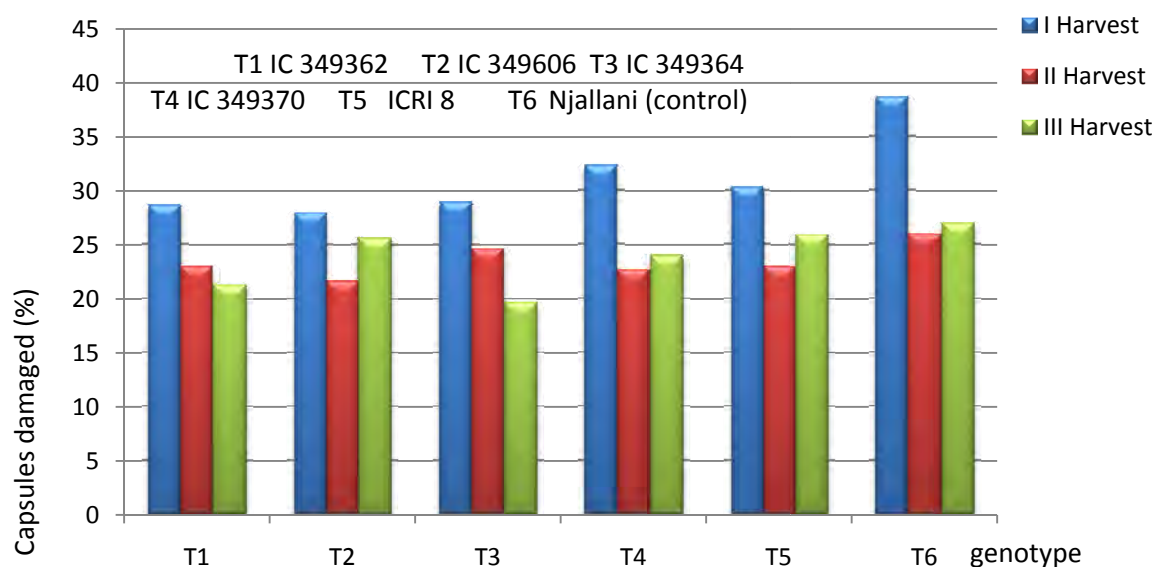


Fig 6: Percentage of capsules damaged by thrips at Myladumpara

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 with two main treatments (T1- Recommended package of practice (control), T2- Recommended package of practice (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. Treatments were imposed after establishment and growth parameters like plant height, number of tillers and number of leaves per tillers were recorded during June 2020 at Appangala. Initial results indicated non significant differences between treatments and varieties.

The project has also been initiated at Pampadumpara with PV-3, PV-5 and *Green Gold*, laid out in RBD design. The experiment was laid out by planting ICRI-5, Thiruthali and MCC 260 at Myladumpara and data on morphological characters were recorded.

Crop Protection

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

(Centres: Appangala, Mudigere, Pampadumpara and Myladumpara)

The project has been initiated in the station's farm at Pampadumpara with *Green Gold* variety and the experimental plot has been laid out in RBD design with four replications and 12 plants per plot with 3x 3 spacing. Two rounds of application of fungicides have been completed and initial observations were recorded on rhizome rot during June 2020 at Appangala and Myladumpara.

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

(Centres: Appangala, Mudigere, Pampadumpara, Myladumpara)

The new experiment has been initiated at Pampadumpara with *Green Gold* variety in RBD design with four replications and 12 plants per plot with 3x 3 spacing. The experiment has also been initiated at ZAHRS, Mudigere and all the treatments were imposed and the observations are being recording periodically. Two rounds of fungicide application has been completed and initial observations were recorded on leaf blight during August, September and October 2020 at Appangala and Myladumpara.

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

Ten plantations in South and West districts of Sikkim were explored and three unique accessions were collected and maintained in quarantine facility at ICRI, Research farm at Gangtok. Details of germplasm accessions

maintained at AICRPS centres are given in Table 6.

Seven accessions (SCC-302 to SCC-308) from ICRI, Gangtok have been submitted to NBPGR, New Delhi for allotment of IC number. Also, an unique accession of Sawney with green capsule (Table 7) maintained at ICAR RC NEH, RS, Gangtok, has been submitted to NBPGR, New Delhi for allotment of IC number.

Table 7: Large cardamom collections maintained at AICRPS centres

AICRPS Centre	No. of collections
ICAR- RC NEH, RS, Gangtok	7
ICRI RRS, Gangtok	54
Total	61

Table 8: Unique accession of large cardamom maintained at ICAR RC NEH, RS, Gangtok

Particulars	Mean value
a) Yield attributes	
Number of spikes/clump	10
Number of capsules/spike	9.4
Number of seeds / capsule	40.86
Fresh weight of capsule	3.98 g
Dry weight of capsule (shade dry)	0.85 g
Recovery per cent	21.35
Weight of 100 seeds-Fresh	2.71 g
Weight of 100 seeds-Dry	1.45 g
Diameter of capsule	28.16 mm
Length of capsule	33.43 mm
b) Morphological attributes	
Colour of pseudostem	Maroonish green
Colour of matured fresh capsule	Light pink with green top
Length of pseudostem	116.45 cm
Girth of pseudostem	10.70 mm
Length of leaf	42.39 cm
Width of leaf	6.62 cm

Preliminary observations from the trial at Kohima, Nagaland showed that Varlangey cultivar of large cardamom has better productivity (103.6 g clump⁻¹) as compared to Golsey cultivar (48.3 g clump⁻¹). Varlangey also showed better dry recovery (22%) in comparison with the Golsey (16%). Oil profiling of 10 cultivars of large cardamom from ICRI, Gangtok showed that ICRI Sikkim 2 has the highest oil content (2.8%) and SCC-234 (Seremna) has lowest oil content (1.6%) while the rest of the cultivars have the oil content in the range of 2.0-2.4 per cent. The principle component of essential oil in large cardamom is 1,8-cineole which forms 70.0-77.0 per cent of total available oil content, while A-thuene contribute the least (in range of 0.19-0.35 %) in cultivated accessions.

Crop Protection

LCA/CP/1.2 Integrated pest and disease management in large cardamom (Centre: ICAR Regional Station, Gangtok, ICRI Regional Station, Gangtok)

The experiment was conducted to evaluate the efficacy of biopesticides viz., neem oil (1500 ppm) @ 4 ml L⁻¹, *Beauveria bassiana* 7 g L⁻¹, *Metarhizium anisopliae* 5 ml L⁻¹, petroleum oil based agrospray @ 10 ml L⁻¹, petroleum oil based horticultural spray @ 10 ml L⁻¹, *Bacillus thuringiensis* @ 2 g L⁻¹, and spinosad 45 SC @ 0.3 ml L⁻¹ against insect pests of large cardamom viz., stem borer, shoot fly, leaf eating caterpillar and tea mosquito bug. The results revealed that spinosad 45 SC @ 0.3 ml L⁻¹ was found to be the most effective to control all the pests followed by neem oil (1500 ppm) @ 4 ml L⁻¹.



Fig 7: View of large cardamom plants at Gangtok

Genetic Resources

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

(Centres: Barapani, Dholi, Kammarpally, 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 67 accessions maintained at Dholi, eleven accessions recorded higher yield ranging from 5.45 to 10.44 t ha⁻¹ compared to check variety, Nadia (5.43 t ha⁻¹). Among promising accessions, RG-38 recorded highest yield 10.44 t ha⁻¹, followed by RG-4 (10.24 t ha⁻¹) and RG-34 (9.38 t ha⁻¹) (Table 8). Of the 63 germplasm accessions evaluated at Kumarganj, NDG-55 (432 g plant⁻¹), followed by NDG-6 (145 g plant⁻¹) and NDG-23 (142 g plant⁻¹) were found to be promising.

Among the 35 germplasm accessions evaluated at Pundibari, highest rhizome yield was recorded in GCP 10 (13.50 t ha⁻¹), followed by GCP25 (13.01 t ha⁻¹), GCP23 (12.50 t ha⁻¹), GCP 52 (12.50 t ha⁻¹) GCP 57 (12.00 t ha⁻¹) and GCP

14 (11.87 t ha⁻¹). Lowest rhizome rot and wilt disease incidence were recorded in the germplasm GCP 14 (9.80%), followed by GCP57 (10.00%), GCP 25(10.00), GCP 10 (11.11%) and GCP-23 (12.00%).

Out of 181 ginger germplasm accessions evaluated at Pottangi, 45 accessions yielded more than 5 kg 3m⁻² fresh rhizomes. The range and mean characters along with 3 best accessions are given in the Table 9.

At Raigarh, Indira Ginger -1 (14.7 t ha⁻¹) recorded maximum yield over two national checks Suprabha (10.9 t ha⁻¹) and Suruchi (9.4 t ha⁻¹). Evaluation of ginger genotypes for rhizome rot revealed that out of 19 genotypes, seven genotypes are moderately resistant to rhizome rot disease. During the year, Barapani centre made six new trait-specific collections (for yield and quality traits) and one accession of aromatic ginger (*Kaempferia galanga* L.) from the farmers' fields. Among the accessions, wider variability was observed for all the agromorphological traits. Further, yield per plant ranged from 50.0- 350 g per plant with the highest yield realized from the accession IC-584354 (350 g), followed by IC-584364 (308.0 g) and IC-584327(233g).

Table 9: Ginger germplasm collections in AICRPS centres

Centre	Cultivated	Wild & related spp	Exotic	Total
Dholi	67		-	67
Kumarganj	63	-	-	63
Pundibari	38	-	-	38
Pottangi	202	3	3	208
Nagaland	24			24
Solan	231	-	-	231
Barapani	46	1		47
Total	671	4	3	678

Table 10: Characteristics of evaluated ginger germplasm accessions at HARS, Pottangi

Sl. No.	Character	Range	Mean	Best accessions with value in parenthesis
1	Plant height (cm)	52.4-95.3 (PGS-119- Banspal)	68.7	Banspal (95.3), PGS-18 (88.4), PGS-161 (87.9)
2	Number of tillers per clump	5.0-13.0 (V ₁ S ₁ -2-Zo-9-1)	8.7	Zo-9-1 (13.0), PGS-18-2 (12.8), PGS-2-1 (11.6)
3	Length of fully opened last leaf (cm)	14.7-28.8 (PGS-36-1-KG-41)	23.9	KG-41 (28.8), Banspal (28.5), S-692 (28.3)
4	Width of fully opened last leaf (cm)	1.1-3.7 (Taphringia-S-642-1)	2.9	S-642-1 (3.7), S-682 (3.7), VS (3.7)
5	Rhizome yield (kg/3m ²)	0.38-8.6 (V ₁ K ₁ -1- S-62)	3.8	S-62 (8.6), Zo-9 (8.3), PGS-150 (8.1)
6	Rhizome yield (t/ ha)	0.8-19.1 (V ₁ K ₁ -1- S-62)	8.3	S-62 (19.1), Zo-9 (18.4), PGS-150 (18.0)
7	Clump weight (g)	54-297 (V ₁ K ₁ -1- S-62)	166.3	S-62 (297), Zo-9 (277), PGS-150 (231)
8	Rhizome rot (%)	17.9-95.4 (V ₁ K ₁ -1- IG-3-1)	54.8	V ₁ K ₁ -1 (17.9), S-666 (18.0), Tura local -3 (20.4)

Crop Improvement

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

Initial results of Coordinated Varietal Trial (CVT) of ginger for yield and disease reaction at Raigarh revealed that V1E45 genotype from Pottangi recorded 24.7 t ha⁻¹ fresh rhizome yield, followed by Indira Ginger-1 (23.7 t ha⁻¹) over the control IISR Varada (20.3 t ha⁻¹). In fact, Raigarh is identified as a hotspot area for soft rot of ginger. At Pottangi, Indira Local and IISR M₅ showed bacterial wilt symptoms. The genotype V1 E4-1 recorded the highest fresh rhizome yield (10.2 t ha⁻¹) followed by V₁ E4-5 (9.3 t ha⁻¹).

Initial results from Gangtok, indicated that maximum sprouting percentage (98.9%) was recorded in HP 05/15, which was on par with R 1.25/4, V 0.5/2, V1E4-1 and Bhaise. Plant population at 50 DAS of different genotypes did not show any significant difference among the genotypes. The lowest incidence of disease (13.1%) was recorded in HP 05/15 which was statistically at par with R 1.25/4 and Bhaise. At Pundibari, highest rhizome yield was obtained in case of Pundibari Local (12.00 t ha⁻¹) which was closely followed by IISR M-1 (11.30 t ha⁻¹). Lowest rhizome rot and wilt incidence were

recorded in IISR-M1 (10%) and Pundibari Local (10%).

The CVT on disease tolerance of ginger accessions was initiated during 2019-20 under foot hill agro-climatic conditions of Nagaland. Initial observations indicate that sprouting per cent of seed rhizomes varied significantly from 46 to 86% and the lower rate of sprouting as well as plant population recorded with IISR series might be due to late planting. Among the genotypes, the highest projected yield per ha was recorded with V1E4-1 (20.67 t), followed by IISR-M2 and Local ginger (Raigarh) (20.34 t). While IISR-M2, M3, M4 and M5 were free from rhizome rot 30% plants of IISR-M1 were infected with rhizome rot. It was also noticed that all the genotypes were susceptible to shoot borer infestations (18-26%).

GIN/CI/3.4 Initial Evaluation Trial of bold/vegetable ginger (Centres: Pottangi)

In the ongoing initial evaluation trial of bold/vegetable ginger at Pottangi, the highest yield (18.55 t ha⁻¹) was recorded in Bold Nadia followed by PGS 121 (18.05 t ha⁻¹).

GIN/CI/3.5 Initial Evaluation Trial - 2015 (Centre: Kumarganj)

Maximum yield was recorded in NDG-24 (14.44 t ha⁻¹) followed by NDG-13 (14.11 t ha⁻¹) and NDG-23 (13.67 t ha⁻¹) in IET.

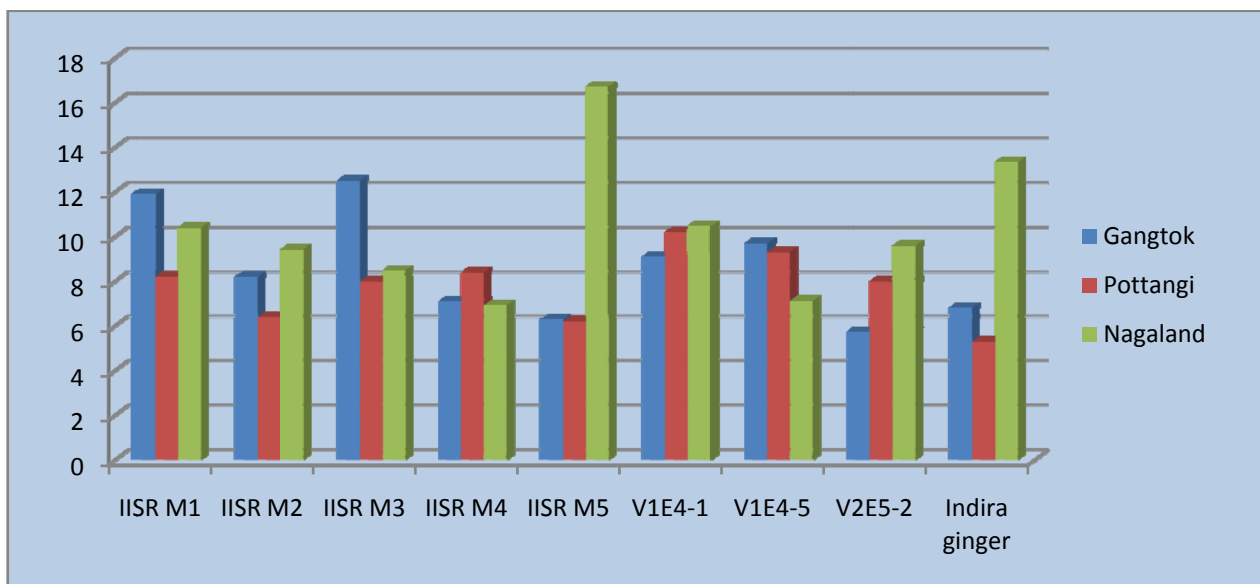


Fig 8: Performance of ginger genotypes at Gangtok, Nagaland and Pottangi

GIN/CI/3.6 Initial Evaluation Trial 2016 (Centres: Pundibari, Pottangi, Solan)

Among the different genotypes evaluated at Pundibari, the highest yield was recorded in GCP-39 (12.30 t ha⁻¹) and lowest in GCP-46 (9.23 t ha⁻¹). The lowest rhizome rot and fungal wilt disease severity were found in GCP-14 (14.67 PDI) followed by GCP-39 (14.90 PDI) and GCP-36 (15.20 PDI) and highest in GCP-56 (23.37 PDI).

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

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

Under Kozhikode conditions, maximum yield was recorded by Nadia (26.28 t ha⁻¹) followed by Johns ginger (22.28 t ha⁻¹) and Bhaise (20.00 t ha⁻¹) while lowest yield was recorded by *Gorubathan* (13.70 t ha⁻¹). Plant height, number of tillers and rhizome yield varied significantly among the varieties at Pundibari. The highest yield was recorded in Bold Nadia (12.72 t ha⁻¹), followed by *Gorubathan* (GCP-5) (11.67 t ha⁻¹) and PGS 102 (10.95 t ha⁻¹). Significant difference was observed among genotypes for all characters except for sprouting percentage and plant population at 50 DAS at Chintapalle. The highest plant height was recorded in PGS 102 (46.70 cm) followed by PGS 95 (42.90 cm). The highest fresh yield per plant (278.55 g) and per hectare (12.63 t) were recorded in Bold Nadia

followed by PGS 95 (250.79 g, 11.37 t respectively).

Among the seven genotypes, *Gorubathan*, Bold Nadia, Bhaise, John's Ginger, PGS 121, PGS 95 and PGS 102 evaluated at Pottangi, the highest yield (18.55 t ha⁻¹) was recorded in Bold Nadia, followed by PGS 121 (18.05 t ha⁻¹). At Mizoram, maximum plant population was found in John's Ginger (31), followed by PGS-121 (27) and *Gorubathan* (20.6). Highest number of tillers per plant was recorded in PGS-121 (3.50), followed by *Gorubathan* (3.46) and PGS-102 (3.30), while plant height was highest in *Gorubathan* (38.73cm) followed by PGS-102 (33.18 cm) and PGS-95 (32.77 cm). The maximum fresh weight of clump was recorded in PGS-102 (263.03 g plant⁻¹), followed by *Gorubathan* (183.32 g plant⁻¹) and PGS-121 (133.60 g plant⁻¹). The maximum yield was also recorded in PGS-102, with a yield of 6.40 t ha⁻¹ followed by *Gorubathan* with a yield of 5.66 t ha⁻¹. Plant population of different cultivars showed non-significant effect but growth, yield attributes and yield showed significant effect at Gangtok. Significantly highest fresh rhizome yield was noticed in *Gorubathan* but it remained statistically at par with PGS-121.

Observations on growth and yield performance of bold and vegetable ginger types under the trial at Nagaland centre reveal that Bold Nadia had highest sprouting per cent (94.33%) of rhizomes, highest rhizome weight per clump (282.67 g), highest yield/ha (25.50 t) and dry

recovery (22%) under foothill condition of Nagaland. However, Bold Nadia had the lowest per cent of fibre (4.40) with 1.90% essential oil

while the highest per cent of essential oil (2.40) was observed in the genotype John's Ginger.

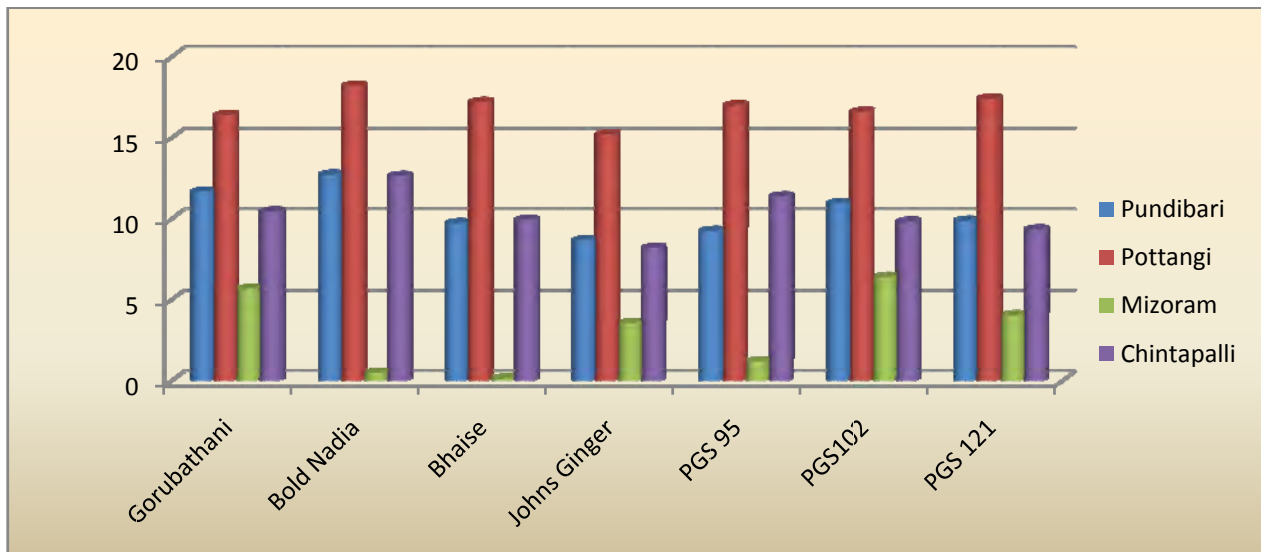


Fig 9: Performance of ginger genotypes at Pundibari, Pottangi, Mizoram and Chintapalle



PGS-95



PGS-121



PGS-102



Gorubathan



John's Ginger



Bold Nadia

Fig 10: Performance of vegetable type of ginger at ICAR Kolasib, Mizoram

Crop Management
GIN/CM/5 Nutrient Management Trial
GIN/CM/5.6 Organic production of ginger
(Centres: Mizoram, Barapani)

Maximum yield of 22.55 t ha⁻¹ was recorded in T₃ (100% organic manures + micronutrients) followed by 20.99 t ha⁻¹ in T₅ (175% N requirement of ginger from FYM +

micronutrients) at Barapani. Highest dry recovery of 20.03% was recorded in T₅ (75% N requirement of ginger from FYM + micronutrients). Whereas at Mizoram, the maximum yield was recorded in T₇ (recommended package by SAU; ginger-NPK 100:90:90 kg ha⁻¹), with a yield of 12.99 t ha⁻¹, followed by T₁ (100% organic manure

equivalent to 100% N requirement of ginger) with a yield of 12.66 t ha⁻¹, T3 (100% organic manure + (micronutrients) with a yield of 12.23 t ha⁻¹.

GIN/CM/5.9 Organic production of ginger (Centre: Ambalavayal)

The results from Ambalavayal indicate that both the organic packages (developed by Kerala Agricultural University and ICAR-Indian Institute of Spices Research) were statistically on par, in terms of fresh clump weight as well as dry ginger yield.

GIN/CM/5.10 Effect of micronutrients on growth and yield of ginger (Centre: Ambalavayal)

The result from Ambalavayal indicated that foliar application of IISR ginger micronutrient at 60th and 90th DAP @ 5g L⁻¹ significantly enhanced fresh weight of clumps and ginger yield in all the three varieties.

Crop Protection

GIN/CP/6.13 Effect of PGPR biocapsule on growth and yield of ginger (Centre: Ambalavayal)

Efficacy of talc and capsule formulations of *Trichoderma* and GRB 35, singly and in combination, were evaluated in three varieties at Ambalavayal. The treatments, T1 (POP + talc formulations of *Trichoderma* and GRB 35) and T2 (POP + capsule formulations of *Trichoderma* and GRB 35) were found to be superior in terms of higher clump weight in Rio de Janeiro (248.67 g and 233.0 g) and Maran (208.67 g and 200.67 g).

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, T₁: Rhizome treatment with *Trichopri*; T₂: Rhizome treatment with metalaxyl-mancozeb @ 1.25 g L⁻¹ + Imidacloprid 0.5 ml L⁻¹ for 30 minutes; T₃: Rhizome treatment with tebuconazole @ 1ml L⁻¹ + Imidacloprid 0.5 ml L⁻¹ for 30 minutes; T₄: Recommended state package of practices (POP) was initiated during the current year. Preliminary results at Dholi indicate all the treatments to have significant effect on different

parameters viz., sprouting (%), plant population at 50 DAP (%), plant height, number of tillers per clump and rhizome rot incidence at 90 DAP (%). Maximum sprouting (74.38%), plant population 74.38%), plant height (37.86 cm), numbers of tillers per clump (8.30) and lowest rhizome rot incidence (16.61%) were recorded in treatment T₄, where recommended state package of practices was adopted. There were no significant differences between the treatments for the clump yield at Ambalavayal.

At Solan, rhizome treatment with metalaxyl-mancozeb @ 1.25 g L⁻¹ + imidacloprid (0.5 ml L⁻¹ for 30 minutes) resulted in highest rhizome germination (77.25%), number of tillers per plant (5.50), plant height (69.25 cm) and yield (98.50 q ha⁻¹) and minimum rhizome rot incidence (25.67%), followed by rhizome treatment with tebuconazole @ 1ml L⁻¹ + imidacloprid 0.5 ml L⁻¹ for 30 minutes. Rhizome treatment with *Trichopri* (*T. harzianum*) was found to be best followed by rhizome treatment with metalaxyl mancozeb @1.25g L⁻¹ + imidacloprid @ 0.5ml L⁻¹ for 30 minutes at Pottangi. Among the treatments, the maximum plant height (67.60 cm) was observed in T₁ (*Trichopri*), followed by the treatment T₅ at Barapani. The leaf length and width were statistically on par in T₁ and T₅. Moreover, the yield per plant was maximum (270 g) in T₁ followed by T₅ (266.0g).

The maximum plant height (41 cm) and number of tillers per plant (3.97) were recorded in the treatment T₁ (*Trichopri*) which did not vary significantly with T₂ (metalaxyl-mancozeb) (39 cm and 3.38 respectively) and T₃ (tebuconazole) (38 cm and 3.30 respectively) but differed with T₄ (POP) with a plant height of 35 cm and no. of tillers (3.0) at Pasighat. The minimum incidence of rhizome rot disease (10.30 % and 11.06% respectively) was found in T₁ (*Trichopri*) and it was at par with T₂ (metalaxyl-mancozeb) (13.0 % and 14.47 % respectively). The maximum shoot borer attack (9.67 %) was recorded in T₄ (POP) which was on par with T₂ (8.19%).

The treatments viz., rhizome treatment with *Trichopri* and rhizome treatment with metalaxyl-mancozeb @ 1.25 g L⁻¹ + Imidacloprid 0.5 ml L⁻¹ for 30 minutes produced highest sprouting percentage, plant height, more tiller and lowest rhizome rot and wilt disease at Pundibari.

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 vegetative 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 for 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 173 cultivated types and 35 related sp. are maintained at Pundibari centre, including two new turmeric accessions (TCP 278 and TCP 279) collected from Terai region (Table 10). Profiling of the germplasm accessions shows a good number of genotypes to be high yielding and many of them resistant or moderately resistant to the foliar diseases, leaf blotch and leaf spot (Table 11).

Table 11: Turmeric germplasm collections maintained at various AICRPS centres

Centre	Cultivated	Wild & related species	Exotic	Total
Coimbatore	275	-	-	275
Dholi	67	-	-	67
Kammarpally	280	-	-	280
Kumarganj	180	-	-	180
Pottangi	178	23	-	201
Pundibari	173	35	-	208
Raigarh	93	-	-	93
Guntur	308	-	-	308
Pantnagar	52	-	-	52
Pasighat	56	2	-	58
Total	1656	60	-	1718

Table 12: Profile of germplasm accessions maintained at Pundibari

Yield range	Name of the genotypes
25 to 30 t ha ⁻¹	TCP58 TCP70 TCP90 TCP92 TCP111 TCP170 TCP173 TCP179 TCP191 TCP 201 TCP217, TCP225
30 to 35 t ha ⁻¹	TCP 29 TCP42 TCP45 TCP52 TCP93 TCP190, TCP198
Above 35 t ha ⁻¹	TCP 48 TCP 52, TCP123
Genotypes with low leaf blotch disease incidence (PDI 0 to 10)	TCP4 TCP5 TCP7 TCP13 TCP16 TCP24 TCP33 TCP40 TCP41 TCP42 TCP45 TCP48 TCP51 TCP55 TCP56 TCP57 TCP58 TCP66 TCP67 TCP70 TCP71 TCP73 TCP74 TCP78 TCP87 TCP88 TCP90 TCP92 TCP93 TCP109 TCP111 TCP112 TCP115 TCP130 TCP136 TCP137 TCP140 TCP146 TCP160 TCP165 TCP170 TCP173 TCP244 TCP250 TCP276
Genotypes with low leaf spot disease incidence (PDI 0 to 10)	TCP3 TCP5 TCP6 TCP11 TCP12 TCP14 TCP18 TCP23 TCP36 TCP42 TCP43 TCP44 TCP46 TCP47 TCP48 TCP50 TCP52 TCP54 TCP58 TCP62 TCP70 TCP74 TCP79 TCP81 TCP84 TCP87 TCP93 TCP101 TCP124 TCP136 TCP137 TCP139 TCP153 TCP154 TCP159 TCP169 TCP172 TCP173 TCP179 TCP190 TCP191 TCP198 TCP200 TCP209 TCP214 TCP221 TCP224 TCP225 (48 Nos.)

Evaluation of turmeric germplasm accessions for rhizome yield and yield attributing traits at CARS, Raigarh revealed the higher yield potential of IT 38 (53.3 t ha⁻¹), IT 42 (44.7 t ha⁻¹) and IT 36 (44.7 t ha⁻¹) over the checks, IISR Prathibha (30.7 t ha⁻¹), CGH 1 (30 t ha⁻¹), Roma (21.7 t ha⁻¹), BSR 2 (17.8 t ha⁻¹), Narendra Haldi (15.3 t ha⁻¹) and Suranjana (18.7 t ha⁻¹). Out of 152 *Curcuma longa* accessions evaluated at HARS, Pottangi, 88 accessions recorded more than 5 kg 3m⁻² and 12 genotypes recorded more than 10 kg 3m⁻² fresh rhizome yield. In *Curcuma aromatica*, the fresh rhizome yield varied from 1.4 kg 3 m⁻² to 8.0 kg 3 m⁻² with 12 among the 23 accessions recording more than 5 kg/3m² fresh rhizome yield.

Out of 67 accessions evaluated at Dholi, only 17 accessions recorded higher yield, ranging from 45.31 to 53.10 t ha⁻¹ compared to check variety, Rajendra Sonali and Rajendra Sonia (45.23 and 44.10 t ha⁻¹, respectively). Among them, RH-16 recorded the highest yield (53.10 t ha⁻¹), followed by RH-3 (52.88 t ha⁻¹). Among the 275 genotypes evaluated at Coimbatore for growth, yield and quality parameters, CL 18 recorded the highest fresh rhizome yield per plant (926.29 g). Estimation of quality and biochemical parameters showed that the genotype CL 115 had the maximum dry recovery (25.93%), CL 258 had the highest curcumin content (5.79%), CL 73 had the highest oleoresin content (11.58%) and CL 112 had more essential oil content (2.17 %).

At Kammarpally, 280 turmeric germplasm accessions were maintained. Evaluation of these accessions revealed that Chintaguda Local-4 (66.66 t ha⁻¹), CLI-36 (53.99 t ha⁻¹), CL-136 (43.73 t ha⁻¹) and CL-54 (40.83 t ha⁻¹) performed well compared to local check, Duggirala Red (35.23 t ha⁻¹) and IISR Prathibha (national check) (59.9 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 the maximum yield in NDH-74 (280 g plant⁻¹). NDH-86 (260 g plant⁻¹) was classified as early maturing type; NDH-98 (315 g plant⁻¹) and NDH-135 (265 g plant⁻¹) as medium, and NDH-8 (268 g plant⁻¹), NDH-7 (262 g plant⁻¹) and NDH-56 (262 g plant⁻¹) as late maturing types.

Among the 55 genotypes evaluated at Guntur, only two genotypes, LTS-23 (776.3 g) and LTS-29 (759.3 g) recorded significantly higher clump weight as compared to the best check, Mydukur (692.5 g). Among 43 genotypes under evaluation at Barapani, the highest plant height was recorded in IC-586780 (101.0 cm), leaf length (65.0 cm) and width (17.57 cm) in IC-586780 and the number of leaves in Narendra Haldi-1 (31.0). The genotypes, Suranjana (433.3 g plant⁻¹), IC-586769 (366.67g plant⁻¹) and Megha Turmeric-1 and Suvarna (333.3 g plant⁻¹ each) recorded higher yield. Among the 58 genotypes evaluated at Pasighat, maximum rhizome yield was recorded in CHFT-8 (39.83 t ha⁻¹) and minimum in CHFT-28 (11.63 t ha⁻¹).

Crop Improvement

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

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

In the ongoing coordinated varietal trial (CVT) on mango ginger (initiated during 2019), plant height, number of tillers and rhizome yield varied significantly among the genotypes. At Pundibari, the highest yield was recorded in Acc 265 (36.09 t ha⁻¹), followed by Acc 347 (33.30 t ha⁻¹) and NVMG-11 (32.18 t ha⁻¹), while at CARS, Raigarh, Indira Mango Ginger 1 recorded highest rhizome yield (35.3 t ha⁻¹), followed by Acc 347 (30 t ha⁻¹) and CAM 3 (29.5 t ha⁻¹) over control Amba (29 t ha⁻¹).

At Dholi, RH-408 recorded significantly higher yield 10.52 t ha⁻¹, followed by Indira Mango Ginger 1 (8.68 t ha⁻¹), Acc 347 (8.63 t ha⁻¹), NVMG-2 (8.52 t ha⁻¹), NVMG-10 (8.40 t ha⁻¹) and Acc 265 (7.37 t ha⁻¹), as compared to the national check variety, Amba (4.62 t ha⁻¹) while at Ambalavayal, NVMG 9 recorded highest clump weight (381.6 g), followed by Acc 347 (302.3 g). At Navsari, trial condition is very good and some of entries have attained physiological maturity. Genotype CAM-3 (32.9 t ha⁻¹) was the top yielder followed by check Amba (31.1 t ha⁻¹) at Pottangi whereas the genotype Acc. 347 was the top yielder (37.08 t ha⁻¹) followed by NVMG 10 (28.75 t ha⁻¹) and Amba (28.58 t ha⁻¹) under Kozhikode conditions.

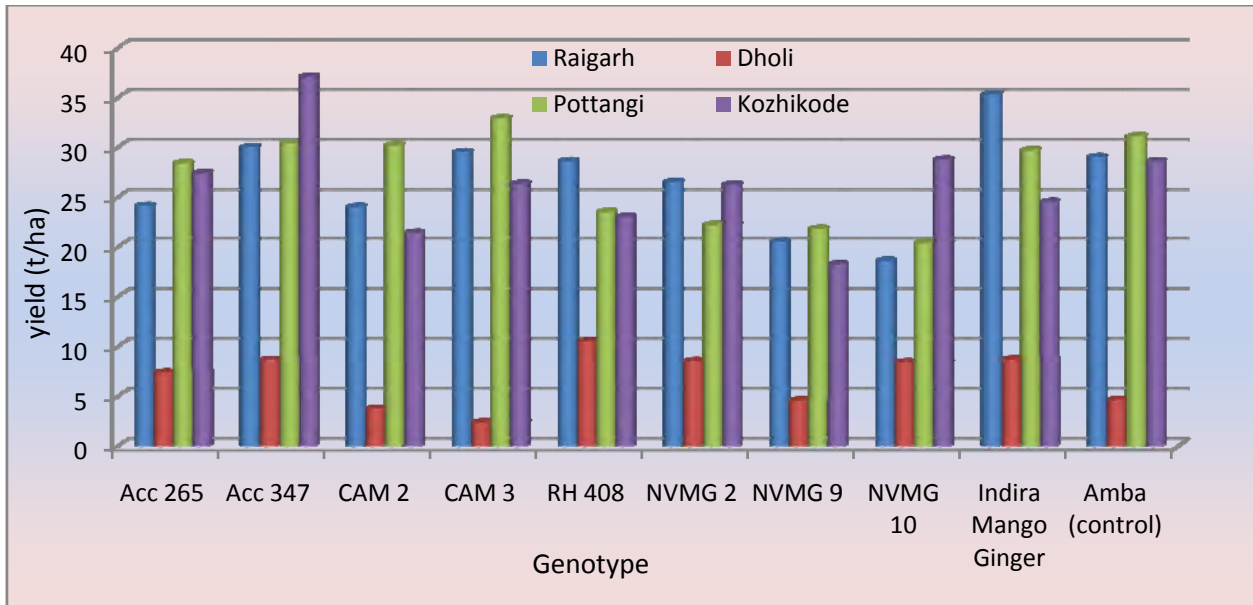


Fig 11: Variation in the performance of mango ginger genotypes at various AICRPS centres



Fig 12: Field view of mango ginger variety (NVMG-3) and turmeric (GNT-2) at Navsari

TUR/CI/2.8 Co-ordinated Varietal Trial on high yield and high curcumin turmeric (Centres: 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

also. Preliminary observations recorded at Coimbatore on plant growth characters at 120 DAP revealed that the genotype IT 26 registered the maximum plant height of 62.40 with a pseudostem girth of 9.06 cm and an average of 2.00 tillers per plant. However, at Pottangi, the checks Roma and IISR Prathibha were more robust in growth.



Fig 13: Field view of CVT of turmeric at Coimbatore

The trial is in the vegetative stage at Navsari, Kanke and Kozhikode.

Data revealed that among the eight genotypes, significant variation in sprouting and plant height were observed at Pasighat. The maximum sprouting (100%) and plant population (12) were observed in CL 258 and CL272 and the minimum was recorded in NVST 56 (19 % and 2 respectively). The significantly tallest plant was observed in the check IISR Pragati (98.7 cm) and the shortest plant in RRN1 (42.4 cm). The maximum number of tillers per plant was observed in the cultivar CL258 (3.9) which was on par with NVST 56 (3.5) and IISR Pragati (3.3). The minimum incidence of leaf blotch was found in CIM Pitamber (4.66%) which was on par with CL 272 (8.25%). The minimum incidence of leaf spot was recorded in RRN1 (0%), CL 258 (0%), IISR Prathibha (0%) and CIM Pitamber (0%). Similarly the minimum incidence of stem borer was observed in RRN1 (0%) and IT26 (0%) respectively.

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

(Centres: 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 IISR, CL-223 and CL-21 from Coimbatore and KPS -611 from Kammarpalli) 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 611 registered the maximum plant height of

63.94 cm, highest pseudostem girth (8.60 cm) with an average of two tillers per plant at 60 DAP. However, the checks, Roma and IISR Prathiba grew taller at Pottangi.

The trial is in the vegetative stage at Kanke and Kozhikode

The data revealed that the maximum sprouting (%) and plant population was recorded in IISR Prathiba (100% and 16 respectively) and Mydukur (100% and 16 respectively), however, insignificant variation was observed with RRN3 (83 % and 13 respectively), CL223 (83 % and 13 respectively) and KPS 611 (83 % and 13 respectively) at Pasighat. The maximum plant height was found in CL 21 (78.3 cm) which remained at par to Acc 849 (75 cm) but significantly taller to the other cultivars. The lowest plant height was observed in RRN3 (40 cm) and it did not differ with RRN2 (43.7 cm). Maximum number of tillers per plant was recorded in RRN3 (4.0) and Acc 849 (4.0) which remained at par to KPS 611 (3.9) and Prathiba (3.8). The minimum leaf blotch incidence (5.03%) was found in CL 223 and it did not differ significantly with CL 21 (9.94%), KPS 611 (7.22%) and Mydukur (Control) (8.50%). Maximum leaf spot incidence was observed in Acc 849 (28.22%) followed by PTS 50 (23.50%) and RRN 2 (1.63%). There was no incidence of leaf spot in RRN3, RRN3, Acc 1545, CL 223, CL 21, KPS 611, IISR Prathiba (control) and Mydukur (control) respectively. The stem borer incidence was significantly lower in KPS 611 (4.06%) and the maximum in Acc 1545 (29.86%).

TUR/CI/3 Varietal Evaluation Trial

TUR/CI/3.7 Initial Evaluation Trial 2015 (Centre: Kumarganj)

Ten entries were tested under IET and found maximum rhizome yield in NDH-53 (31.22 t ha⁻¹) followed by NDH-126 (30.55 t ha⁻¹) and NDH-88 (30.33 t ha⁻¹).

TUR/CI/3.9 Initial Evaluation Trial (IET) 2018

(Centre: Guntur)

During the year 2019-20, ten genotypes along with one check were evaluated in RBD. All the genotypes recorded significantly higher yield than check Mydukur (27.2 t ha⁻¹). The first three promising genotypes were LTS-19-4 (54.7 tha⁻¹), LTS-19-1 (48.3 t ha⁻¹) and LTS-19-3 (47.9 tha⁻¹).

Crop Management TUR/CM/5 Nutrient Management Trial

TUR/CM/5.10 Organic production of turmeric

(Centres: Mizoram, Barapani)

The maximum yield was recorded in T2 (100% organic manure equivalent to 75% N requirement of turmeric), with a yield of 28.29 t ha⁻¹, followed by T1 (100% organic manure equivalent to 100% N requirement of turmeric) with a yield of 27.42 t ha⁻¹, T6 (75% N requirement of turmeric + micronutrients) with a yield of 26.39 t ha⁻¹ at Mizoram. Whereas at Barapani, maximum yield (22.00 t ha⁻¹) was recorded in T3 (100% organic manures + micronutrients).

Crop Protection

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

(Centres: Chintapalle, Coimbatore, Dholi, Kammarpally, Pundibari, Raigarh, Solan,

Pasighat, Ambalavayal, Mizoram, Kahikuchi, Kanke, Pottangi)

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 and the growth parameters were recorded during the current year. At Mizoram centre, the maximum plant population (at 50 DAP) of 36.83 was found in T2 (rhizome treatment with metalaxyl-mancozeb @ 1.25 g L⁻¹ + imidacloprid 0.5 ml L⁻¹ for 30 minutes), with sprouting percentage of 92.08, followed by T3 (tebuconazole @ 1ml L⁻¹ + imidacloprid 0.5 ml L⁻¹ for 30 minutes), with plant population of 35 and sprouting percentage of 87.50. The plant height and number of tillers per plant (at 120 DAP) were higher in T₁(Trichoprime) (75.00 cm, 5.17), followed by T₂ (74.00 cm, 4.83). The maximum yield was recorded for T₂ (metalaxyl-mancozeb @ 1.25 g L⁻¹ + Imidacloprid 0.5 ml L⁻¹ for 30 minutes), with a yield of 35.58 t ha⁻¹, followed by T₁ (Trichoprime) with a yield of 31.90 t ha⁻¹.

Table 13: Performance of priming treatments in turmeric at ICAR-RC Mizoram

Treatment	Plant population	No. of tillers/plant	Plant height (cm)	Fresh wt of clump(g)	Yield (t/ha)	Dry recovery (%)	Sprouting %
T ₁	27.67	5.17	75.00	365.17	31.90	18.00	69.17
T ₂	36.83	4.83	74.00	441.17	35.58	16.00	92.08
T ₃	35.00	4.67	68.67	309.83	30.25	19.00	87.50
T ₄	33.83	4.33	63.83	303.33	24.54	21.01	84.58
Average	33.33	4.75	70.38	354.88	30.57	18.50	83.33
SEm	1.27	0.35	2.73	27.40	1.50	0.43	3.18
C D at 5%	3.87	N/A	8.30	83.34	4.55	1.29	9.68
C.V	9.35	17.89	9.50	18.91	12.00	5.63	9.35

T1-Rhizome treatment with Trichoprime

T2-Rhizome treatment with metalaxyl-mancozeb @ 1.25g/L+ imidacloprid 0.5 ml/L for 30 minutes

T3-Rhizome treatment with tebuconazole @ 1ml /L+ imidacloprid 0.5 ml/L for 30 minutes

T4- Recommended state package of practices

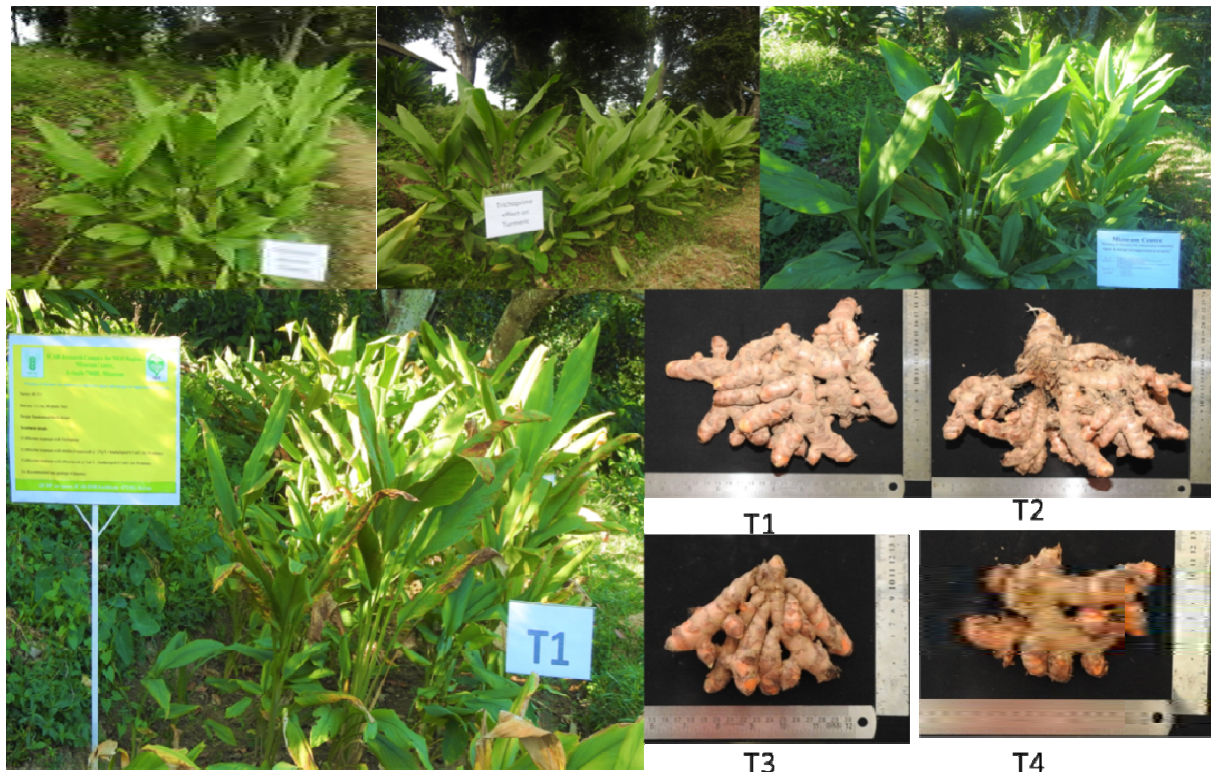


Fig 14: Performance of priming treatments in turmeric at ICAR-RC Mizoram

At Barapani centre, all the four treatments were imposed, along with T5 (*Trichoderma* sp. local strain). Initial observations indicate that among the treatments, the maximum plant height (67.60 cm) was observed in T₁ (Trichoprime), followed by T₅ (*Trichoderma* spp. local strain), while the leaf length and width were statistically at par in T₁ and T₅. However, the yield per plant was maximum (270 g plant⁻¹) in T₁, followed by T₅ (266.0 g). Initial results at Pottangi indicate rhizome treatment with Trichoprime (*T. harzianum*) to be the best, followed by rhizome treatment with metalaxyl-mancozeb @ 1.25 g L⁻¹ + imidacloprid @ 0.5 ml L⁻¹ for 30 minutes. Preliminary observations at Dholi indicate that all the treatments were on par with respect to various parameters viz., sprouting (%), plant population at 50 DAS (%), plant height (cm) and number of tillers per clump. No rhizome rot incidence was recorded in all treatments. At Ambalavayal, the treatment T₂ recorded highest clump yield per bed followed by T₁ and T₃ which were on par.

Rhizome treatment with metalaxyl-mancozeb @ 1.25 g L⁻¹ + imidacloprid 0.5 ml L⁻¹ for 30 minutes resulted in highest rhizome germination (79.77%), number of tillers per plant (5.62),

plant height (125.67 cm), yield (197 q ha⁻¹) and minimum leaf blotch severity (12.50 %) at Solan. This was followed by rhizome treatment with tebuconazole @ 1ml L⁻¹ + imidacloprid 0.5 ml L⁻¹ for 30 minutes giving the next best increase in horticultural parameters. Different priming treatments did not significantly influence the plant population and the sprouting percentage of turmeric at Pasighat. The tallest plant (103.4 cm) was observed in the treatment T₂ (metalaxyl-mancozeb) which remained at par to T₁ (Trichoprime) and T₃ (tebuconazole) with a plant height of 97.4 cm and 101.8 cm respectively. Days to maturity was observed to be lowest (159) in both T₂ and T₃ compared to T₁ and T₄ which took 160 days to mature in both the treatments. The Projected yield per hectare was found to be highest in T₁ (29.67 t) but remained at par with T₂ (28.78 t) and T₃ (28.44 t). T₄ recorded the lowest yield per hectare (21.36 t).

The treatments viz., rhizome treatment with *Trichoprime* and rhizome treatment with metalaxyl-mancozeb @ 1.25 g L⁻¹ + Imidacloprid 0.5 ml L⁻¹ for 30 minutes produced highest sprouting percentage, plant height and more number of tillers at Pundibari and Coimbatore.

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 (10.15 m) and stem girth (64.47 cm) and MF 4 recorded maximum leaf length (20.31 cm), leaf breadth (9.2 cm), no. of fruits (679.7), single fruit weight (53.5 g) and mace yield (288.86 g tree⁻¹). Sixteen promising genotypes among the germplasm collections of nutmeg (planted during the year 1996–97) are being evaluated 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.

The details of germplasm of tree spices being conserved at the AICRPS Centres are presented in Table 14.

Table 14: Tree spices germplasm collections at AICRPS Centres

Crop/Centre	Collection	Crop/Centre	Collection
Clove		Cinnamon	
Dapoli	02	Dapoli	11
Pechiparai	24	Pechiparai	14
Yercaud	01	Yercaud	02
Total	27	Total	27
Nutmeg		Cassia	
Dapoli	99	Dapoli	06
Pechiparai	28	Pechiparai	4
Total	127	Total	10

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

The different 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 recorded in genotype, Yellow mace (3.66,

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 accessions at Pechiparai, SA-1 recorded the highest tree height of 12.26 m, followed by SA-3 (12.10 m) when compared with local check (9.69 m). The accession SA-13 was significantly superior to other accessions and recorded highest stem girth (51.09 cm) compared with local check (41.80 cm). The accession SA-3 recorded the highest leaf length (12.84 cm), leaf breadth (7.69 cm), number of branches (19.58 nos) and dry bud yield (1.67 kg/tree/year).

Cinnamon

Among twelve accessions evaluated at Pechiparai, CV-5 recorded maximum tree height (5.68 m), number of shoots (41.60) and stem girth (17.11 cm) compared to the local check (4.98 m, 24.96 and 16.51 cm, respectively).

49.8 and 2.59 m respectively), whereas the maximum plant spread was recorded in Nova (1.85 m). Among the unique types planted at Pechiparai, the maximum plant height (6.97 m), numbers of branches (13.44 nos.), number of fruits (28.56), single fruit weight (39.99) and mace yield/ tree (13.81g) were recorded in IISR Vishwasree.

Table 15. Growth and yield parameters of unique nutmeg types at Pechiparai

Sl. No	Name of the variety	Plant height (m)	No of branches	No. of fruits	Single fruit weight (g)	Mace yield/ tree (g)
1	Konkan Swad	5.11	10.08	23.52	35.90	7.21
2	Yellow Nutmeg	5.24	11.76	18.48	31.86	6.01
3	IISR Vishwasree	6.97	13.44	28.56	39.99	13.81
4	Konkan Suganda	4.54	10.08	25.20	27.81	7.81
5	Konkan Shrimanthi	4.81	11.76	21.84	26.54	7.21
6	ACC-3	4.88	15.12	25.20	34.98	9.01
7	ACC-5	4.52	13.44	25.20	38.57	8.41
8	ACC-7	4.67	11.76	20.16	34.65	6.61
9	ACC-13	5.75	11.76	23.52	37.62	7.21
10	ACC-17	3.80	8.40	23.52	33.87	10.81
	SEd	0.13	0.28	0.57	0.79	0.18
	CD	0.27	0.60	1.20	1.66	0.39

Crop Improvement

TSP/CI/2.2 Coordinated Varietal Trial in Nutmeg

(Centres: Dapoli, Pechiparai)

Growth observations recorded at Dapoli indicate significant differences among 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 A 9/150 was found

to be significantly superior over rest of the genotypes for all the parameters (except plant height), especially with regard to the number of fruits per plant (228.67). At Pechiparai also, A9/150 recorded the highest plant height (7.78 m), stem girth (34.75 cm), maximum number of branches (20.16) and no. of fruits (221.76) and mace yield/ tree (169.30 g) compared to the local check.



Fig 15: Superior character of nut and mace of nutmeg genotype A9/150 over Konkan Sugandha

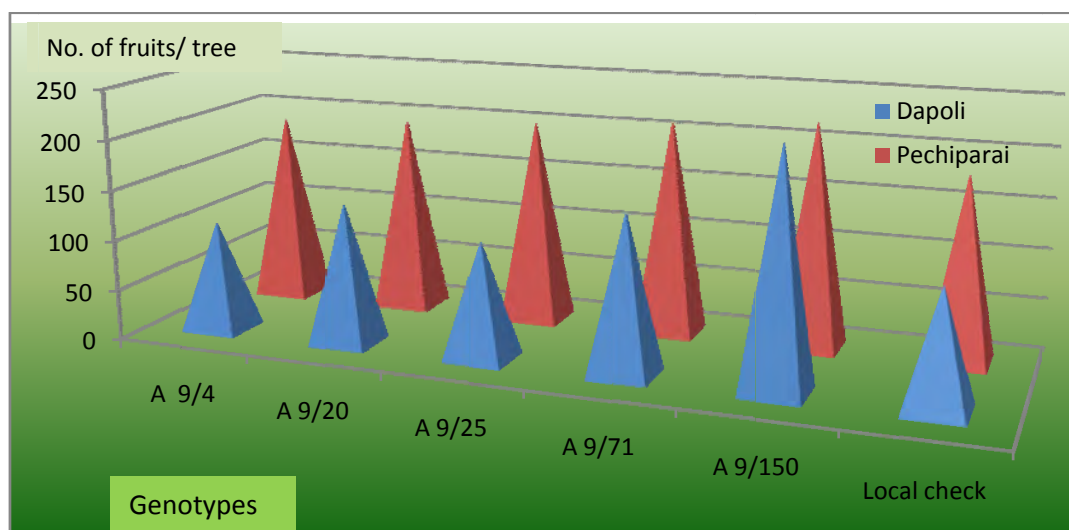


Fig 16: Performance of nutmeg genotypes at Dapoli and Pechiparai

TSP/CI/2.4 Coordinated Varietal Trial (CVT) on farmer’s varieties of nutmeg (Centres: 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. Plants have established well 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.

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

Budded plants of all the genotypes were made and trial laid out. Plants have established well. Few accessions have started flowering and fruiting.

Table 16: Morphological parameters of nutmeg genotypes

Genotype	Plant height mean value (cm)	No. of branches	Plant spread (cm)		No. of flowers per tree	No. of fruits per tree
			EW	NS		
Acc.1	199	24.8	154.8	151	-	1.2
Acc.5	265.6	27.4	195.8	196.8	0.6	1.2
Acc.12	134	19	130.2	120.2	-	-
Acc.13	205.2	22.8	176.2	151.4	0.2	0.6
Acc.14	233	31.2	206.8	203	7.2	3
Acc.17	147.75	19.25	139.25	131.75	-	0.6
Acc.20	158	21	102	93.3	-	-
Acc.21	199.5	28.75	144.75	119.25	4	0.5
Acc.23	256.6	39.4	234.4	242	-	17
Acc.28	146.3	13	139	121.3	-	-
Check	100.6	14.2	119.8	95.4	-	-

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.

Among the 276 genotypes of coriander maintained in the germplasm collection at Coimbatore, 120 genotypes were evaluated during the year. The number of umbels per plant varied from 11.00 (CS165) to 47.00 (CS 24), with an overall mean of 30.01. The genotype CS 273 registered the highest seed yield of 305 g/plot of 3 m², followed by CS 147 (300.00 g/plot), CS 157 (280 g/plot), CS 163 (260 g/plot), CS 2 and CS 180 (255 g/plot).

At Dholi, among the 74 accessions, RD-424 recorded the highest yield per hectare (19.52 q), followed by RD-440 (19.40 q).

Among the entries evaluated at Guntur, LCC-343 (5.66 g/plant), LCC-316 (5.64 g/plant), LCC-324 (5.56 g/ plant), LCC-337 (5.56 g/plant) and LCC-320 (5.46 g/ plant) were found significantly

superior over the best check, Suguna (3.28 g/ plant). Of the 142 accessions evaluated at Hisar, the mean seed yield ranged from 40.5 g/plant (DH-261) to 96.0 g/plant (DH-306). The most promising lines for seed yield were DH-206, DH-211, DH-216, DH-221, DH-226, DH-295, DH-306, DH-314, DH-332 and DH-342.

At Jagudan, the seed yield ranged from 6.75 to 19.33 q ha⁻¹ and among the 61 entries, twelve genotypes recorded higher seed yield than check GCor-3. Out of 134 accessions evaluated at Jobner, 24 accessions performed better than best check variety RCr-480 (40.5 g) and the accessions, UD-7279 (68 g), UD-335 (68 g), UD-788 (65 g), UD-270 (464 g), Tanwar Singh Hada (61 g), UD-122 (59 g), UD-744 (58 g), UD-370 (56 g), UD-733 (55 g), UD-146 (55 g), UD-740 (54 g), UD-789 (53 g), UD-82 (53 g), UD-342 (52 g) and UD-330 (51 g) were identified as promising.

Higher yield was recorded in NDCor-11 (28.70 g/plant), NDCor-22 (27.50 g/plant), NDCor-12 (26.40g/plant) and NDCor-32 (26.40g/plant) among the 200 germplasm accessions evaluated at Kumarganj. Among the 32 germplasm lines conserved and evaluated at Raigarh, higher seed yield was recorded in CGD -1 (14.5 q ha⁻¹), CGSCD-2 (14.2 q ha⁻¹), ICS 29 (13.8 q ha⁻¹), ICS 10 (13.5 q ha⁻¹) as compared to the checks, Hisar Anand (10.5 q ha⁻¹) and Gujarat Dhaniya 1 (10 q ha⁻¹).

Table 17: 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	193	-	193
Pantnagar	85	-	85
Raigarh	32	-	32
Kota	100	-	100
Total	2320	121	2441



Maintenance of pure seeds of coriander



Nucleus seed production block of coriander

Fig 17: Field view of coriander plots at Raigarh

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 (1m²), followed by CS 242 (48.6 PDI) with an yield of 41.50 g/plot. The highest intensity of powdery mildew was recorded in CS 210 (85.50 PDI) with the yield of 32.50 g/ plot. Among the 142 genotypes of coriander screened at Jobner, only six entries (UD-126, UD-144, UD-282, UD-342, UD-334 and RCr-435) showed moderate resistance.

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

Thirty genotypes randomly selected from the germplasm being maintained at Jobner were sown in two environments, irrigated (normal irrigation) and drought (staggered irrigation with half of that given in normal irrigation). The genotypes, RCr-20, RCr-475, RCr-436, UD-40 and UD-77 performed better under normal conditions, while UD-123, UD-87, RCr-435, UD-246 and UD-431 were the better yielders under stress conditions. Based on stress indices, UD-248, UD-220, UD-431, UD-123 and UD-81 were found to be the promising lines under moisture stress 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 ranged from 6.20 (COR-184) to 24.53 q ha⁻¹ (COR-177) with COR-192 (23.14 q ha⁻¹), COR-189 (23.02 q ha⁻¹), COR-187 (22.56 q ha⁻¹), COR-179 (21.96 q ha⁻¹), COR-191 (21.46 q ha⁻¹) and COR-190 (21.44 q ha⁻¹) also showing higher yields. Mean performance of the entries evaluated in CVT over 2018-19 and 2019-20 revealed superior performance of COR-190 yielding 24.06 q ha⁻¹, followed by COR-189 (23.91 q ha⁻¹) and COR-177 (23.41 q ha⁻¹).

At Coimbatore, the genotypes like COR 186 (97.67 g/plot of 1 m²), COR 185 (80.00 g), COR 174 (77.78 g), COR 190 (73.33 g), COR 175 (66.00 g), COR 184 (61.67 g), COR 192 (55.33 g) and COR 189 (49.33 g) registered significantly higher yield over the national check, Hisar Anand (45.33 g/plot). COR-186 also recorded higher yield at Guntur (12.92 q ha⁻¹) and Raigarh (13.5 q ha⁻¹). Highest yield was recorded in COR-187 (22.57 q ha⁻¹) at Ajmer, followed by COR-174 (21.79 q ha⁻¹). At Jagudan, COR 190 (16.08 q ha⁻¹), COR 186 (14.44 q ha⁻¹) and COR 184 (14.35 q ha⁻¹) were the top three entries among the coded genotypes, though lesser than the local check G.Co-3 (16.48 q ha⁻¹), while at Dholi

only two entries (COR-183 with 21.22 q ha⁻¹ and COR-178 with 20.6 q ha⁻¹) recorded significantly higher yield over the check variety Rajendra Dhania-1 (17.18 q ha).

Among the genotypes evaluated at Hisar, highest seed yield (20.77 q ha⁻¹) was recorded in COR-175 followed by COR-176 (20.37 q ha⁻¹) and COR-174 (19.73 q ha⁻¹), whereas COR - 183 (19.31 q ha⁻¹) and COR-187 (18.13 q ha⁻¹) recorded better yield at Jabalpur. At Kota, COR -186 (13.76 q ha⁻¹) and COR-189 (13.37 q ha⁻¹) were the best

performers in terms of seed yield, while at Kumarganj, the promising entries were Cor-178 (15.41 q ha⁻¹), Cor-179 (13.75 q ha⁻¹) and Cor-188 (13.26 q ha⁻¹). At Navsari, COR-186 (17.19 q ha⁻¹), COR-187 (17.00 q ha⁻¹), COR-176 (16.39 q ha⁻¹) and COR-175 (16.05 q ha⁻¹) were found to be significantly superior over both the national checks, H. Anand (12.78 q ha⁻¹) and Rcr-728 (11.54 q ha⁻¹) for seed yield and its related characters.

Table 18: Coordinated varietal trial of coriander at Jobner

S. No.	Entry	Days to flowering	Plant height (cm)	Branches per plant	Umbels per plant	Umbellets per plant	Seeds per umbel	Biological yield (kg/ha)	Seed yield (kg/ha)	Rank
1	COR-174	77.00	88.40	9.07	48.40	5.13	37.33	5648.15	1730.09	14
2	COR-175	80.33	107.73	9.40	34.93	5.60	42.53	5092.60	1953.71	10
3	COR-176	82.00	98.67	8.87	30.80	6.07	42.07	5277.78	1882.41	11
4	COR-177	85.67	94.87	8.53	40.13	5.80	39.87	6435.19	2452.78	1
5	COR-178	100.00	105.73	9.80	36.47	5.53	39.27	5879.63	1799.54	13
6	COR-179	97.00	117.40	9.33	32.80	4.93	42.80	6435.19	2195.84	5
7	COR-180	55.33	73.67	8.07	48.13	4.73	21.93	3472.23	942.59	17
8	COR-181	55.33	66.93	7.33	35.60	4.53	28.07	3009.26	799.54	18
9	COR-182	89.33	50.40	7.07	32.93	6.20	43.60	4629.63	1723.61	15
10	COR-183	86.33	95.27	8.87	42.67	5.07	37.07	4583.34	1603.24	16
11	COR-184	54.67	74.80	7.07	38.73	4.20	15.13	2962.97	620.37	20
12	COR-185	54.33	75.13	7.07	38.20	3.93	17.93	3101.85	766.20	19
13	COR-186	80.00	85.87	8.60	49.80	5.94	28.00	5879.63	1861.11	12
14	COR-187	81.00	85.80	8.67	45.67	6.20	28.73	6250.01	2255.56	4
15	COR-188	98.00	113.73	10.33	37.67	5.33	34.40	6018.52	1974.54	9
16	COR-189	80.00	91.80	8.60	57.07	5.33	27.60	6666.67	2302.32	3
17	COR-190	79.00	91.93	9.40	56.60	5.33	28.40	6342.60	2144.45	7
18	COR-191	95.00	117.80	8.60	30.80	5.60	44.07	6111.12	2145.84	6
19	COR-192	84.00	105.47	8.27	34.00	6.07	41.13	6620.38	2314.35	2
20	Rcr-728	100.00	110.40	9.60	41.33	5.27	43.67	6250.01	2120.84	8
	Mean	80.72	92.59	8.63	40.64	5.34	34.18	5333.34	1779.45	
	CD at 5%	3.24	12.18	1.12	6.24	0.79	5.43	796.45	305.98	
	CV (%)	2.43	7.96	7.84	9.29	8.91	9.61	9.03	10.40	



Fig 18: Leafy types & late maturing types identified in CVT coriander

COR/CI/3.9 Initial evaluation trial (IET) in coriander (Centres: Dholi)

Among nine promising entries and two check varieties under evaluation at Dholi, only two entries, RD-419 (22.14 q ha⁻¹) and RD-424 (21.05 q ha⁻¹) recorded significantly higher yield as compared to the best check variety Rajendra Dhania-1 (17.65 q ha⁻¹).

COR/CI/4.1 Quality evaluation in coriander (Centres: Jobner)

Estimation of volatile oil content of the 19 entries of coriander under CVT at Jobner revealed significant differences among them. The volatile oil content ranged from 0.50% (COR-182) to 0.80% in COR-177, COR-181, COR-188, COR-189 and COR-190. The entry COR-177 ranked first in terms of volatile oil yield (19.62 l ha⁻¹), followed by COR-189 (18.42 l ha⁻¹), COR-190 (17.16 l ha⁻¹) and COR-192 (16.20 l ha⁻¹), while lowest volatile oil yield of 3.72 l ha⁻¹ was recorded in COR-184.

The volatile oil content in the entries under IET ranged from 0.40% (UD-717) to 0.80% (UD-565). The entry UD-565 ranked first in terms of volatile oil yield (17.22 l ha⁻¹), followed by RCr-435 (14.80 l ha⁻¹) & UD-706 (12.78 l ha⁻¹).

Crop Management

COR/CM/5.5 Response of coriander varieties to various levels of fertility under multi-cut management practice (Centre: Dholi)

In the experiment at Dholi with five varieties (M₁- DH 228, M₂- DH 228-L, M₃- DH-202, M₄-

Pant Haritima and M₅- Rajendra Dhania-1) with three modes of cutting (S₁: no cutting, S₂: one cutting at 45 DAS and S₃: two cuttings at 45 & 60 DAS), Pant Haritima recorded significantly higher grain yield (12.33 q ha⁻¹), followed by Rajendra Dhania 1 (12.28 q ha⁻¹), as compared to other varieties. Irrespective of levels of cutting, two cutting of leaves recorded significantly higher leaf yield (75.31 q ha⁻¹). However, leaf cutting lead to significantly lesser grain yield, with only 11.28 q ha⁻¹ under one cutting and 10.29 q ha⁻¹ under two cuttings, as against 12.66 q ha⁻¹ without leaf cutting.

Crop Protection

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

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

In the trial on integrated pest and disease management in coriander at Coimbatore, seed germination ranged between 83.33 to 89 %. 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 (8.13 PDI), which was on par with T5 (two foliar sprays of *Lecanicillium lecanii* followed by a spray of propiconazole and carbendazim) (10.13 PDI) and T12 (two foliar sprays of *Lecanicillium lecanii* followed by a spray of carbendazim and propiconazole) (12.00 PDI) and T6 (two foliar sprays of acetamiprid followed by carbendazim and propiconazole) (15.30 PDI), as against the PDI of 76.83 in control.

However at Raigarh, the minimum disease intensity (7.99 %) of powdery mildew and minimum aphid population (average 7.78) were found in the treatment package developed by the SAU while at Dholi, lowest incidence of stem gall disease (22.67%) and average population of aphid per 5 twigs (9.60) were recorded in treatment T9 (seed treatment & foliar spray with hexaconazole @ 0.1% at 45, 60 & 75 DAS + spraying of dimethoate (30%EC) @ 0.1% at appearance of aphid, followed by 2 sprays at 10 days interval (package developed by Dholi centre). Analysis of data on aphid infestation at Jabalpur indicate lower PDI and higher seed yield in treatment T6 (Two foliar sprays of *Lecanicillium lecanii* (1×10^9 cfu/g) + spray of carbendazim @ 0.1% (first spray) + spray of propiconazole @ 0.05% (second spray). Treatment T7 i.e. two foliar sprays of acetamiprid (0.004%) + propiconazole @ 0.05% (first spray) + spray of carbendazim @ 0.1% (second spray) was also found to be effective.

In the experiment on integrated pest and disease management of coriander at Jobner, lowest incidence of powdery mildew (7.83%), highest (75.77%) disease reduction and maximum (18.50 q/ha) 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%) (T₂), 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 (1×10^9 cfu/g) (40

g/10 L) (T₁). Lowest incidence (6.00%) and highest (80.33%) disease reduction in case of blight of coriander was found in foliar spray of package developed by the SAUs (T₉), which was at par with foliar spray of carbendazim 50 WP @ 0.1% (20 gm/10 L water) (first & second spray)+ two foliar sprays of acetamiprid 20 SP (0.004%) (T₄). Mean population of *coccinellids* differed significantly among the treatments from 0.95 (spray of propiconazole 25 EC @ 0.05% (10 ml/10 L.) (first & second spray)+ two foliar sprays of acetamiprid 20 SP (0.004%) (T₂)] to 3.01 per plant in non protected plots (untreated control (T₁₀)).

At Kumarganj, minimum disease intensity of stem gall (11.31%) and seed gall (10.31 %) was recorded in treatment T6 (two foliar sprays of *Lecanicillium lecanii* 1.15WP (1×10^9 cfu/g) (40g/10 L) + spray of carbendazim 50 WP @ 0.1% (20 g/10 L water) (first spray) + spray of propiconazole 25 EC @ 0.05% (10 ml/10 L) (second spray), while minimum powdery mildew disease severity (12.03 %) was recorded in treatment T2 (spray of propiconazole 25 EC @ 0.05% (10 ml/10 L) (first & second spray) + two foliar sprays of acetamiprid 20SP (0.004%). At Jagudan, lowest disease intensity with respect to powdery mildew and aphid infestation (0.21 aphid index) and consequently, the highest seed yield of coriander (21.02 q ha^{-1}) were observed in the treatment T₂, i.e. spray of propiconazole 25 EC @ 0.05% (10 ml/10 L) (first & second spray) + two foliar sprays of acetamiprid 20 SP (0.004%).



Fig 19: Drying of harvested coriander at Raigarh

Table 19: Effect of various treatments on aphid infestation and population of *coccinellids* in coriander at Jobner

S. No.	Treatment	Aphid index (0-5 scale)					Mean population of predatory <i>Coccinellids</i> plant ⁻¹			Seed yield (kg ha ⁻¹)
		Before spray	1 st spray		2 nd spray		Before spray	3 DAS	7 DAS	
			3 DAS	7 DAS	3 DAS	7 DAS				
1	T1	4.12 (2.15) *	3.50 (2.00)*	3.51 (2.00)*	2.43 (1.71)*	2.07 (1.60)*	2.74 (1.80)*	2.07 (1.60)*	1.97 (1.57)*	1538.89
2	T2	4.08 (2.14)	2.85 (1.83)	2.05 (1.59)	0.70 (1.09)	0.82 (1.15)	2.63 (1.77)	1.06 (1.25)	0.95(1.21)	1849.54
3	T3	4.19 (2.17)	3.66 (2.04)	3.62 (2.03)	2.30 (1.67)	2.21 (1.65)	2.50 (1.73)	2.09 (1.61)	2.01(1.58)	862.96
4	T4	4.02 (2.13)	2.98 (1.87)	2.23 (1.65)	0.83 (1.15)	1.13 (1.27)	2.22 (1.65)	1.16 (1.29)	1.01(1.23)	1442.13
5	T5	4.14 (2.15)	3.82 (2.08)	3.59 (2.02)	2.52 (1.74)	2.14 (1.62)	2.41 (1.70)	2.05 (1.60)	1.91(1.55)	1152.32
6	T6	4.26 (2.18)	3.73 (2.06)	3.67 (2.04)	2.66 (1.78)	2.19 (1.64)	2.48 (1.73)	2.13 (1.62)	2.06(1.60)	1122.69
7	T7	4.18 (2.16)	2.91 (1.85)	2.69 (1.78)	0.97 (1.21)	1.22 (1.31)	2.47 (1.72)	1.12 (1.27)	0.98(1.22)	1665.28
8	T8	4.23 (2.18)	3.05 (1.88)	2.42 (1.71)	0.88 (1.17)	1.38 (1.37)	2.41 (1.71)	1.19 (1.30)	1.03(1.24)	1634.72
9	T9	4.12 (2.15)	3.02 (1.87)	2.77 (1.81)	1.09 (1.26)	1.30 (1.34)	2.16 (1.63)	1.32 (1.35)	1.14(1.28)	1447.22
10	T10	4.06 (2.13)	4.19 (2.16)	4.40 (2.21)	4.55 (2.25)	4.89 (2.32)	2.46 (1.72)	2.67 (1.78)	3.01(1.87)	789.35
S. Em. ±		0.02	0.04	0.04	0.04	0.04	0.053	0.027	0.028	75.61
CD at 5%		NS	0.11	0.13	0.12	0.11	NS	0.08	0.08	224.62
CV (%)		1.43	3.25	3.95	4.50	4.12	5.32	3.18	3.39	9.70

*Figures in parenthesis are square root ($\sqrt{x+0.5}$) transformed values.

**Fig 20: Pigmented seed of coriander**

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

A wide range of variability was found for all the characters among the germplasm accessions evaluated at Jobner. Out of 78 accessions, 12 accessions (UC-296 (24 g), UC-247 (22 g), UC-270 (22 g), UC-285 (22 g), UC-254 (20 g), UC-272 (20 g), UC-343 (20 g), UC-342 (19 g), UC-231 (17 g), UC-294 (17 g), UC-315 (16 g) and

UC-332 (16 g) were identified as promising on the basis of seed yield per 5 plants.

Among the 126 germplasm lines evaluated at Jagudan (with GC-4 as check), the seed yield ranged from 1.79-15.58 q ha⁻¹ with 50 genotypes producing higher seed yield when compared to the check, GC-4. Out of the 490 germplasm lines evaluated at Mandor, 12 entries showed significant gain in seed yield over the best check, GC-4 (3.97 q ha⁻¹), while at Sanand, among the 62 accessions evaluated, an unique accession with white flowers and white hairy seeds was noticed.

Table 20. Promising genotypes identified at Mandor for different characters

S.No.	Character studied	Range	Promising genotypes
1.	Days to flowering	56 - 82 days	GP - 512, RZ - 19, IC - 574094, GP - 153, RZ - 231, MCU - 109, IC - 54355, GP - 481, MCU - 27, GP - 90, GP - 42, IC - 595365, MCU - 121, GP - 212, GP - 469, GP - 477, MCU - 63, MCU - 80, GP - 359, MCU - 81, MCU - 118, IC - 595372, GP - 371 and GP - 484
2.	No. of branches/ Plant	2.2 - 6.9	GP-10, GC-4, MCU 2, GP-253, GP-26, GP-403, SPS-246, GP-25, GP-417, GP-190, GP-286
3.	Plant height (cm)	24.5 - 44.6 cm.	GP-46, GP-332, GP-26, GP-25, GP-10, GP-13, GP-201, GP-35, GP-204, GP-338, GP-254, GP-73, GP-48, GP-205, GP-45, GP-223, GP-253, GP-307, GP-42, GP-16, IC-595353
4.	Test weight (g)	4.0 - 7.0	GP - 42, GP - 207, GP - 316, GP - 313, GP - 458, MCU - 112, GP - 359, MCU - 109, GP - 512 and MCU - 117
5.	Seed yield (q/ha)	1.04 - 4.79 q/ha	GP - 188, GP - 207, MCU - 116, MCU - 93, MCU - 121, GP - 153, MCU - 112, MCU - 24, MCU - 32, MCU - 46, MCU - 52, and GP - 458

Table 21: Germplasm collection of cumin in various AICRPS centres

Centre	Indigenous	Exotic	Total
Jagudan	334	-	334
Jobner	370	6	376
Sanand	84	-	84
Mandor	490	-	490
Total	1278	-	1284

Screening of cumin entries for resistance against powdery mildew disease

Among the twenty seven (24+3) entries of cumin screened for resistance against powdery mildew disease at Jagudan, the minimum disease intensity was noticed in JC 16-07 and JC-18-11 (9.0 %), while the maximum disease intensity was recorded in CVT-42 (20.0 %).

Screening of cumin entries for resistance against wilt and blight diseases

Ten entries under CVT were screened at Jobner against wilt and blight diseases, wherein GC-4 was found to be resistant against wilt disease. Four entries (CUM-42, CUM-43, RZ-19 and RZ-345) showed susceptible reaction against wilt disease and CUM-38, GC-4, RZ-223 and RZ-345 showed moderate resistance, while CUM-42 showed susceptible reaction against blight disease and rest of the entries highly susceptible against both the wilt and blight diseases.

Among the ten IET entries at Jobner screened against wilt and blight diseases, none of them were found to be resistant against wilt disease, while four of them (UC-322, UC-247, RZ-209 and RZ-223) were observed to be moderately resistant against blight disease. Among the 83 germplasm accessions screened at Jobner, 21 entries were found to be moderately resistant to wilt disease and 22 of them were moderately resistant to blight disease and rest of them were either susceptible or highly susceptible against the wilt and blight diseases.

Among the 27 entries screened for resistance against blight disease at Jagudan, the minimum disease intensity was noticed in JC-18-11 (20.0 %), while the maximum disease intensity was recorded in the entry, JC 16-10 (65.0 %).

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

One hundred and fifty 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 JC -18-11 and GC-5-1(5%), followed by JC-18-1(17%) and JC-18-07 (18.0%), while the maximum disease intensity was recorded in the entry CUM-38, GP-9 to 40, GP-44 to 50, Mutation-1,3,4 and Mutation-11 to 64 (100.0 %).

CUM/CI/1.3 Identification of drought tolerant lines in cumin (Centre: Jobner)

In this experiment for identifying moisture stress/drought tolerant lines in cumin, 30 genotypes 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 indicate that the genotypes, UC-282, UC-335, UC-286 and UC-287 performed well under normal conditions, while UC-282, UC-323, UC- 229 and UC-276 under moisture stress. Based on stress indices, UC-323 was found to be the desirable entry for drought conditions, followed by UC-326, UC-309 and UC-327.

Crop Improvement

CUM/CI/2 Coordinated Varietal Trial

CUM/CI/2.4 Coordinated varietal trial (CVT) in cumin

(Centres: Ajmer, Jagudan, Jobner, Mandor)

The analysis of variance revealed significant differences among the entries for seed yield and yield attributing characters at Jobner. 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 over the three years (2017-18 to 2019-20) confirmed the consistently superior performance of CUM-41 yielding 5.17 q ha⁻¹ followed by CUM-39 (5.09 q ha⁻¹) and GC-4 check (5.00 q ha⁻¹). The performance of CUM-41 (8.91 q ha⁻¹) was significantly superior over the national check GC-4 (5.65 q ha⁻¹) by 57.7 per cent at Jagudan also, while CUM-40 (7.08 q ha⁻¹) and CUM-43 (6.88 q ha⁻¹) also performed well. The entry, CUM-40 recorded the maximum seed yield at Ajmer (5.80 q ha⁻¹) as well as at Mandor (7.32 q ha⁻¹).

The ancillary data recorded at Mandor show that CUM-42 and CUM-43 were early flowering (58 days to 50% flowering). Number of umbels/plant varied from 23.7 (CUM-43) to 31 (CUM-39), number of umbellets per umbel from 5.3 (CUM-38) to 5.7 (CUM-41), the 1000 seed weight from 4.54 (CUM-39) to 5.66 (CUM-42) and plant height from 29 cm (GC-4) to 40.5 cm (CUM-39).

Table 22: Seed yield and other ancillary characters under the CVT at Mandor

S. No.	Entry	Days to flowering	Plant height	Branches/plant	No. of umbels/plant	Umbellets/umbel	Seeds/umbel	1000 SW (g)	Yield (q/ha)
1	CUM-38	59	37.9	6.1	30.4	5.3	6.6	5.57	463
2	CUM-39	61	40.5	7.0	31.0	5.6	6.7	4.54	486
3	CUM-40	60	35.7	6.5	27.2	5.3	6.8	4.56	732
4	CUM-41	60	38.4	6.1	25.3	5.7	6.7	4.67	531
5	CUM-42	58	37.2	6.3	28.2	5.5	6.7	5.66	388
6	CUM-43	58	37.0	6.3	23.7	5.6	7.1	4.59	417
7	GC-4 (C)	62	29.0	6.7	26.2	5.5	6.9	4.61	472
	G. Mean	60	36.5	6.4	27.4	5.5	6.8	4.89	498
	SEm±	0.6	1.1	0.2	2.2	0.1	0.2	0.16	38.2
	CD at 5%	1.7	3.3	0.6	6.6	0.4	0.6	0.47	113.6
	CV (%)	1.9	6.1	6.5	16.3	4.5	5.6	6.5	15.3

CUM/CI/4 Quality evaluation Trial

CUM/CI/4.1 Quality evaluation in cumin (Centres: 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 4.80% was observed in CUM-43, followed by 4.79% in GC-4, 4.59% in CUM-41 and RZ-223, while minimum of 3.62% was recorded in RZ-19. The entry GC-4 ranked first in terms of volatile oil yield (41.85 l ha⁻¹), followed by CUM-41 (40.50 l ha⁻¹). The mean performance over the last three years indicate that the mean volatile oil content ranged from 3.27% to 4.06% and the mean volatile oil yield from 18.41 l ha⁻¹ to 20.02 l ha⁻¹.

Among the 10 IET entries, the volatile oil content ranged from 3.00% (UC-257) to 3.85% (RZ-223), closely followed by UC-250 (3.63%), RZ-19 (3.61%) and UC-249 (3.60%). RZ-223 also ranked first in terms of volatile oil yield (31.54 l ha⁻¹), followed by UC-250 (30.74 l ha⁻¹) and UC-249 (29.82 l ha⁻¹) and the mean performance over the last three years indicated consistently higher volatile oil content in RZ-223 (3.68%), followed by UC-250 (3.49%), UC-247 (3.48%) and UC-249 (3.47%).

Crop Management

CUM/CM/5.5 Micronutrient management in cumin

(Centres: Jobner, Jagudan, 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 (plant height, branches/plant, umbels/plant, umbellets/umbel, seeds/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 (3.95 – 4.10 q ha⁻¹) over rest of the treatments as well as control. The application of 50% micronutrients in soil along with foliar spray yielded significant increase in the umbels/plant, umbellets/umbel and seed yield (3.82 q ha⁻¹) of cumin as compared to sole soil application or 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, umbels/plant, umbellets/umbel, seeds/umbel and test weight.

The application of all micronutrients (zinc, iron, manganese and boron) at Jobner also resulted in significantly higher plant height (33.89 cm),

branches/ plant (8.84), umbels/plant (22.98), umbellets/umbel (5.96), seeds/umbel (28.66), test weight (4.79 g), seed yield (8.21 q ha⁻¹), net returns (Rs. 97150 ha⁻¹), B:C ratio (3.35) and minimum incidence of blight (10.83%) and powdery mildew (12.84%). The application of 50% micronutrient in soil application along with foliar spray significantly increased the plant height (32.03 cm), branches/ plant (7.87), umbels/plant (21.18), umbellets/umbel (5.47), seeds/umbel (27.20), test weight (4.52 g), seed yield (7.58 q ha⁻¹), net returns (Rs. 92354 ha⁻¹), B:C ratio (3.55) and minimum incidence of blight (22.63%) and powdery mildew (20%).

Similarly, in the trial at Ajmer, the application of all micronutrients (zinc, iron, manganese and boron) resulted in significantly higher plant

height (31.43 cm), primary branches/ plant (9.72), secondary branches/ plant (17.09), umbels/plant (40.0), umbellets/umbel (5.96), seeds/umbel (33.06), test weight (4.69 g), seed yield (12.48 q ha⁻¹), net returns (Rs.1,55,385 ha⁻¹), B:C ratio (3.74) and minimum incidence of blight (9.43%) and powdery mildew (2.84%). The soil application of 50% micronutrients along with foliar spray significantly increased the plant height (29.42 cm), umbellets/umbel (5.47), seeds/umbel (8.83), seeds/umbel (30.95), test weight (4.57 g), seed yield (9.24 q ha⁻¹), net returns (Rs. 1,02,715 ha⁻¹), B:C ratio (2.86) and lesser incidence of powdery mildew (9.89%), though slightly higher incidence of blight (21.48%).

Table 23: Effect of micronutrient management on yield of cumin at various AICRPS centres

Treatment	Seed yield (q ha ⁻¹)		
	Mandor	Jobner	Ajmer
Control	2.90	5.73	3.28
Zn	3.34	6.58	7.64
Zn + Fe	3.62	7.24	8.73
Zn + Fe + Mn	3.95	7.78	10.48
Zn + Fe + Mn + B	4.10	8.21	12.48
SEm±	8.3	16.98	34.0
CD (P= 0.05)	23.9	48.63	97.3
Soil application	3.30	7.05	789.3
Foliar application	3.62	7.53	843.6
Soil + foliar application	3.82	7.87	924.1
SEm±	6.4	0.11	26.3
CD (P= 0.05)	18.5	0.31	75.4



Fig 21: Field view of micronutrient management in cumin at Ajmer

Crop Protection

CUM/CP/6.8 Integrated pest and disease management in cumin

(Centres: 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 per cent 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 water) + two foliar sprays of thiamethoxam 25WG (0.0084%) (T₄) (6.43%, 73.41% and 17.07%, 57.76%), followed by three foliar sprays of kresoxym methyl 44.3 SC @ 0.044% (10 ml/ 10 L water) + first foliar spray of thiamethoxam 25WG (0.0084%) and second foliar spray of *Lecanicillium lecanii* 1.15WP (1x10⁹ cfu/gm) (40g/10 L) (T₁₀) (7.01%, 70.99% and 18.13%, 55.12%), as compared to control (T₁₄). The maximum seed yield was also recorded in the T₄ treatment (6.75 q ha⁻¹), as compared to control (T₁₄) (2.66 q ha⁻¹). Among the treatments, minimum (9.87%) disease incidence and maximum (18.57%) disease control of wilt were recorded with package developed by respective SAUs (T₁₃).

Treatment combination of three foliar sprays of kresoxym methyl + two foliar sprays of thiamethoxam (T₄) showed significantly lowest aphid index (2.74, 2.09, 1.18 and 0.58) at both sprays (3rd and 7th day) and was significantly superior to all the other treatments. Pooled analysis of two years data revealed the consistently superior results under the treatment combination of three foliar sprays of kresoxym methyl 44.3 SC @ 0.044% (10 ml/ 10 L water) + two foliar sprays of thiamethoxam 25WG (0.0084%) (T₄), in terms of minimum incidence of powdery mildew (11.71%), blight (19.43%) and lowest aphid index (2.86, 2.14, 1.25 and 0.59) and maximum seed yield (5.13 q ha⁻¹) along with highest B:C ratio (2.36). However, mean population of predatory coccinellids varied from 0.85 in the package

developed by respective SAUs (T₁₃) to 2.77 per plant in non-protected plots.

Data from Mandor showed that lowest incidence and maximum disease control in respect of blight, powdery mildew and wilt of cumin were found in three foliar sprays of kresoxym methyl 44.3 SC @ 0.044% (10 ml/ L water) + two foliar sprays of thiamethoxam 25WG (0.0084%) (T₄) (5.0 and 83.58; 2.6 and 72.02; 4.2 and 75.0%), as compared to control (T₁₆). Concomitantly, the maximum seed yield was also recorded in the T₄ treatment (10.27 q ha⁻¹), as compared to control (T₁₆) (5.55 q ha⁻¹). At Ajmer, all the treatments could reduce the blight PDI significantly, as compared to untreated control and among the treatments, T₇ was found most effective. Maximum reduction in aphid population was observed in T₇, T₉, and T₁₀ at 7 days after 2nd spray.

At Jagudan, the difference in wilt incidence (%) under different treatments was non-significant, as wilt incidence was generally lower in all the treatments, as compared to untreated control. However, there were significant differences in percent disease intensity of blight and powdery mildew. Lower blight intensity was observed in T₄ (three sprays of kresoxym methyl 44.3 SC @ 0.044% (10 ml/ 10 /L water) + two foliar sprays of thiamethoxam 25WG (0.0084%). Lower intensity of powdery mildew disease was observed in T₁ (three sprays of hexaconazole 5 EC @ 0.005% (10 ml/ 10 lit water) + two foliar sprays of thiamethoxam 25WG (0.0084%). Among the 14 treatments including the control, the treatment T₄ has registered the least aphid infestation (0.99 aphid index) and the highest seed yield (7.05 q ha⁻¹), followed by T₁₃ (1.19 aphid index and yield of 7.02 q ha⁻¹), T₁₀ (1.47 aphid index and 6.60 q ha⁻¹) and T₈ (1.78 aphid index), whereas, non-protected plots of cumin exhibited the highest aphid infestation (3.45 aphid index). Mean population of predatory coccinellids remained higher in the control treatment (T₁₄) (2.74 per plant) as well as in T₈ (2.74), T₁₃ (2.67), T₁₀ (2.67) and T₁₂ (2.74).

Table 24: Effect of biopesticides and insecticides against cumin diseases. (2019-20) at Jobner

S. No.	Treat. No.	Powdery mildew (PDI)	Disease reduction over check	Blight (PDI)	Disease reduction over check	Wilt (%)	Disease reduction over check	Seed yield (q ha ⁻¹)	Test weight (g)	Volatile oil (%)
1	T ₁	7.22 (15.56)*	70.14	24.27 (29.51)*	39.93	14.79 (22.61)*	20.34	5.42	5.37	3.70
2	T ₂	10.45 (18.85)	56.74	26.07 (30.69)	35.48	12.50 (20.67)	32.68	3.40	5.03	3.64
3	T ₃	9.29 (17.73)	61.56	25.40 (30.26)	37.13	12.92 (21.02)	30.43	3.32	5.30	3.17
4	T ₄	6.43 (14.67)	73.41	17.07 (24.37)	57.76	13.22 (21.29)	28.80	6.72	6.03	4.06
5	T ₅	9.40 (17.85)	61.10	19.47 (26.05)	51.82	12.38 (20.56)	33.30	2.88	4.85	3.01
6	T ₆	8.69 (17.13)	64.03	18.87 (25.73)	53.30	13.02 (21.13)	29.89	4.18	5.08	3.38
7	T ₇	10.25 (18.66)	57.59	27.13 (31.39)	32.84	13.56 (21.57)	26.97	4.22	5.29	3.39
8	T ₈	9.88 (18.29)	59.12	19.93 (26.49)	50.66	14.18 (22.09)	23.63	5.97	5.46	3.20
9	T ₉	11.05 (19.40)	54.28	25.80 (30.52)	36.14	13.98 (21.94)	24.70	4.53	5.02	3.17
10	T ₁₀	7.01 (15.32)	70.99	18.13 (25.20)	55.12	13.69 (21.71)	26.25	6.38	5.71	3.12
11	T ₁₁	11.02 (19.37)	54.40	24.40 (29.58)	39.60	15.23 (22.94)	17.97	3.22	5.42	3.31
12	T ₁₂	10.98 (19.32)	54.57	23.27 (28.76)	42.41	16.14 (23.66)	13.09	3.66	5.43	3.09
13	T ₁₃	7.92 (16.32)	67.23	19.07 (25.79)	52.81	9.87 (18.29)	46.82	5.84	5.47	3.71
14	T ₁₄	24.17 (29.40)	-	40.40 (39.46)	-	18.57 (25.52)	-	2.66	4.53	3.01
S.E.m \pm		0.73		1.17		0.79		25.89	0.26	0.22
CD at 5%		2.12		3.41		2.31		75.26	NS	NS
CV (%)		6.87		7.05		6.30		10.06	8.54	11.20

*Figures in parenthesis are angular transformed values

Table 25: Effect of biopesticides and insecticides against cumin aphid and *Coccinellids*. (2019-20) at Jobner

S. No.	Treat. No.	Aphid index (0-5 Scale)							Mean population of predatory <i>Coccinellids</i> plant ⁻¹			Seed yield (q ha ⁻¹)
		Before spray	1 st spray		2 nd spray		7 DAS		Before spray	3 DAS	7 DAS	
1	T ₁	4.12(2.15) *	2.86(1.83) *	2.19(1.64) *	1.26(1.33) *	0.63(1.06) *	2.28(1.67) *	1.45(1.40) *	0.97(1.21) *	5.41		
2	T ₂	4.34(2.20)	3.93(2.10)	2.65(1.77)	2.39(1.70)	2.21(1.64)	2.16(1.63)	2.18(1.64)	2.17(1.63)	3.40		
3	T ₃	4.25(2.18)	3.82(2.08)	2.81(1.82)	2.19(1.64)	1.82(1.52)	2.12(1.62)	1.95(1.57)	1.90(1.55)	3.32		
4	T ₄	3.97(2.11)	2.74(1.80)	2.09(1.61)	1.18(1.30)	0.58(1.04)	1.97(1.57)	1.57(1.44)	1.05(1.25)	6.72		
5	T ₅	4.15(2.15)	3.82(2.08)	2.58(1.76)	2.35(1.69)	2.10(1.61)	2.24(1.65)	2.11(1.61)	1.98(1.57)	2.88		
6	T ₆	4.04(2.13)	3.56(2.01)	2.78(1.81)	2.16(1.63)	1.60(1.45)	2.14(1.62)	1.97(1.57)	1.90(1.55)	4.18		
7	T ₇	4.27(2.18)	3.07(1.89)	2.43(1.71)	1.99(1.58)	1.42(1.38)	2.11(1.61)	1.74(1.50)	1.33(1.35)	4.22		
8	T ₈	4.13(2.15)	3.15(1.91)	2.45(1.72)	1.92(1.55)	1.39(1.37)	2.28(1.67)	1.67(1.47)	1.50(1.42)	5.97		
9	T ₉	4.15(2.15)	3.19(1.92)	2.50(1.73)	1.71(1.49)	1.03(1.24)	2.09(1.61)	1.50(1.41)	1.17(1.29)	4.53		
10	T ₁₀	4.21(2.17)	3.10(1.90)	2.40(1.70)	1.68(1.48)	0.95(1.20)	2.21(1.64)	1.45(1.40)	1.24(1.32)	6.38		
11	T ₁₁	4.11(2.15)	3.95(2.11)	2.69(1.79)	2.30(1.67)	1.96(1.57)	2.15(1.63)	2.06(1.60)	2.04(1.59)	3.22		
12	T ₁₂	4.35(2.20)	3.92(2.10)	2.62(1.77)	2.50(1.73)	1.85(1.53)	2.22(1.65)	2.14(1.62)	2.11(1.62)	3.67		
13	T ₁₃	4.02(2.13)	3.31(1.95)	2.31(1.68)	1.36(1.36)	0.90(1.18)	2.20(1.64)	1.38(1.37)	0.85(1.16)	5.84		
14	T ₁₄	4.00(2.12)	4.24(2.18)	4.38(2.21)	4.64(2.27)	4.83(2.31)	2.32(1.68)	2.55(1.75)	2.77(1.81)	2.67		
S.Em.±		0.046	0.040	0.031	0.031	0.033	0.035	0.028	0.029	25.89		
CD at 5%		NS	0.116	0.090	0.090	0.095	NS	0.081	0.084	75.26		
CV (%)		3.706	3.468	3.029	3.350	3.958	3.675	3.169	3.465	10.06		

*Figures in parenthesis are square root ($\sqrt{x+0.5}$) transformed values.

DAS=Day After Spray

Genetic Resources

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

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

Among the 168 germplasm collections of fennel evaluated at Kumarganj, maximum yield was recorded in NDF-46 (52 g/plant), followed by NDF-52 (51.9 g/plant) and NDF -49 (50.4 g/plant). At Jagudan, the seed yield ranged from 100 to 880 g/plot and among 162 entries, twenty two genotypes recorded higher seed yield than the check, GF-12. The seed yield ranged from 40.3 g/plant (HF179) to 97.3 g/plant (HF-185) at Hisar and among the 155 accessions evaluated, the most promising

accessions were HF-103, HF-104, HF-130, HF-155, HF-157, HF-159 HF-165 HF-167, HF-185 and HF-186.

One hundred 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 out of 261 accessions, 55 accessions performed better than best check variety RF-281 on the basis of seed yield per 5 plants. Among 43 germplasm accessions evaluated at Dholi, twelve of them (RF-13, RF-14, RF-60, RF-28, RF-71, RF-9, RF-68, RF-5, RF-31, RF-10, RF-65 and RF-21) out yielded the check variety, Rajendra Saurabh and among them, highest yield was recorded in RF-13 (18.03 q ha⁻¹) and RF -14 (17.77 q ha⁻¹).

Table 26. Germplasm collection of fennel in various AICRPS centres

Centre	Indigenous collections	Exotic collections	Total collections
Dholi	43	-	43
Hisar	180	-	180
Jagudan	162	-	162
Jobner	290	20	310
Kumarganj	168	-	168
Total	843	20	863

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 6.81 (FNL-120) to 17.06 q ha⁻¹ (FNL-126). Mean performance of the entries over 2018-19 to 2019-20 also indicate

superior performance of FNL-126 yielding 21.07 q ha⁻¹, followed by FNL-118 (20.43 q ha⁻¹), FNL-127 (19.74 q ha⁻¹) and FNL-122 (18.86 q ha⁻¹). Plant height ranged from 116.51cm (FNL-116) to 143.08 cm (FNL-120) at Jabalpur, number of umbels per plant ranged from 13.81 in FNL-127 to 19.91 in FNL-129, and number of umbellets per umbel from 11.20 (FNL-127) to 18.54 (FNL-118). Higher seed yield was recorded in FNL-129 (16.01 q ha⁻¹) followed by FNL-123 (15.83 q ha⁻¹) and FNL- 128 (15.14 q ha⁻¹). At Ajmer, highest yield was recorded in FNL-125 (21.14 q ha⁻¹), followed by FNL-124 (19.82 q ha⁻¹).

Among the 14 entries evaluated under coordinated varietal trial at Navsari, the

genotype FNL-123 (28.33 q ha⁻¹) recorded significantly higher seed yield over both the national checks, followed by FNL-118 (26.32 q ha⁻¹), FNL-119 (25.60 q ha⁻¹), FNL-125 (25.27 q ha⁻¹), FNL-126 (25.20 q ha⁻¹), FNL-122 (25.07 q ha⁻¹) and FNL-127 (25.00 q ha⁻¹). FNL-123 was also found significantly superior in umbellets per plant (31.67), umbellates per umbel (49.80) and seeds per umbellate (38.93). Maximum seed yield recorded at Hisar was 20.97 q ha⁻¹ in FNL-116, followed by FNL-117 (20.62 q ha⁻¹) and FNL-

120 (19.32 q ha⁻¹) while at Kumarganj, FNL-125 recorded maximum yield (14.32 q ha⁻¹), followed by FNL-123 (13.66 q ha⁻¹) and FNL-121 (13.39 q ha⁻¹). FNL-126 (21.39 q ha⁻¹), FNL-129 (18.12 q ha⁻¹) and FNL-128 (17.38 q ha⁻¹) were the top three entries at Jagudan while at Dholi, FNL-121 recorded higher yield (17.37 q ha⁻¹), followed by FNL-123 (16.39 q ha⁻¹) and FNL-116 (16.26 q ha⁻¹), as compared to check variety Rajendra Saurabh (14.02 q ha⁻¹).

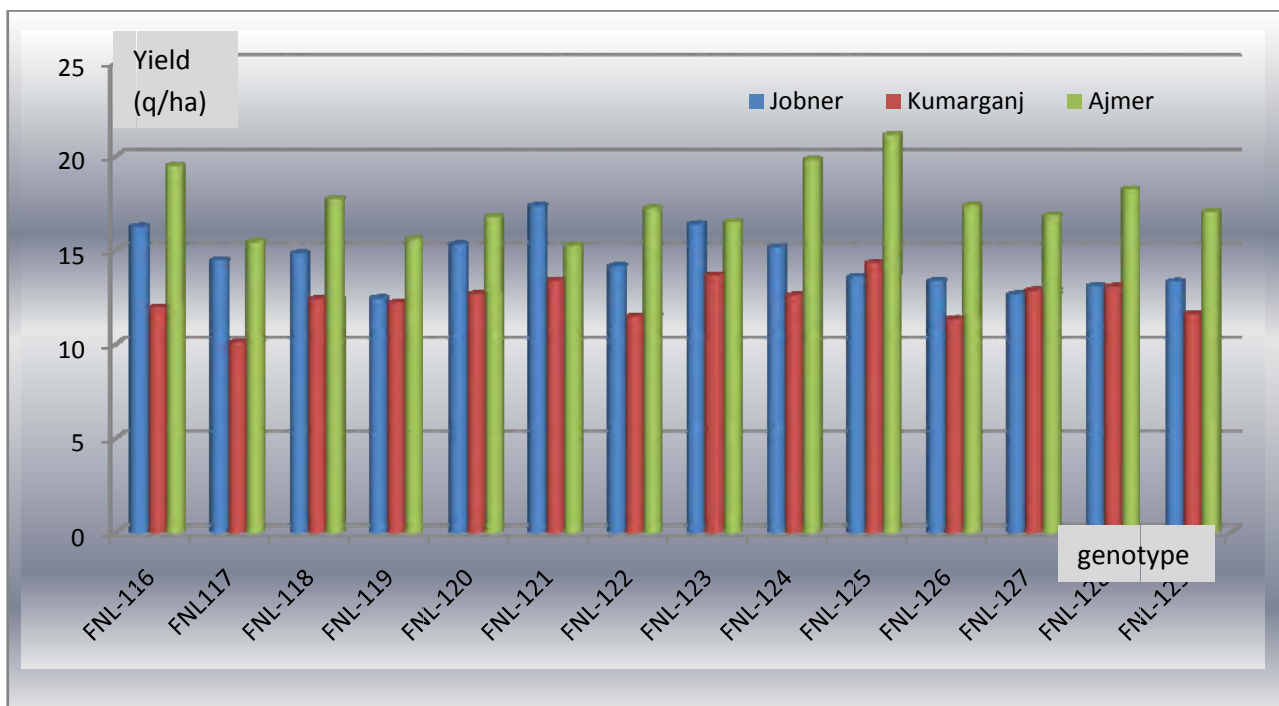


Fig 22: Performance of fennel entries at Jobner, Kumarganj and Ajmer

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

The volatile oil content among the 14 entries under the CVT ranged from 1.80% in FNL-126 to 2.80% in FNL-116. The entry FNL-123 ranked first in terms of volatile oil yield (34.90 l ha⁻¹), followed by FNL-118 (32.75 l ha⁻¹). The mean of two-year data indicate that the highest mean volatile oil content of 2.31% was found in FNL-123, followed by FNL-116, FNL-118, FNL-120, FNL-122 and FNL-129 (2.30%), while the

highest mean volatile oil yield of 46.99 l ha⁻¹ was obtained from FNL-118, followed by FNL-126 (43.93 l ha⁻¹), FNL-127 (43.34 l ha⁻¹) and FNL-122 (43.29 l ha⁻¹). The volatile oil content in the 10 entries under IET at Jobner ranged from 1.80% to 2.42%. The maximum volatile oil of 2.42% was recorded in UF-232, followed by UF-294 (2.41%) and UF-231 (2.21%), whereas highest volatile oil yield was recorded in UF-232 (43.48 l ha⁻¹), followed by UF-231 (41.39 l ha⁻¹) and RF-125 (39.06 l ha⁻¹).

Fenugreek

Genetic Resources

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

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

Out of 104 accessions evaluated at Jobner, 19 accessions recorded better yield than best check variety RMt-143 (41.9 g). On the basis of seed yield per 5 plants, accessions LFC-68 (48.4 g), LFC-95 (46.6 g), LFC-47 (46.3 g), LFC-61 (45.3 g), LFC-88 (44.8 g), LFC-38 (44.5 g), LFC-90 (44.3 g), LFC-81 (44.1 g), LFC-5 (44.0 g), LFC-74 (43.9 g) and LFC-8 (43.8) were identified as promising.

Among the 204 germplasm lines being maintained and evaluated in Kumarganj, the highest yield was obtained in NDM-49 (6.1 g/plant), followed by NDM-45 (5.7 g/plant), NDM-51 (5.7 g/plant) and NDM-42 (5.6 g/plant). Among the 50 accessions of fenugreek evaluated at Dholi, 12 lines were found to be

promising with respect to yield and quality, with the highest yield recorded in RM-217 (17.80 q ha⁻¹), followed by RM-201 (17.60 q ha⁻¹) as against check varieties, Rajendra Kanti (14.84 q ha⁻¹) and Hisar Sonali (14.64 q ha⁻¹). Among the 13 germplasm accessions maintained at CARS, Raigarh, IFGS-11 recorded maximum seed yield (27.5 q ha⁻¹) over the best check RMT 305 (23.3 q ha⁻¹) and GM-2 (15.3 q ha⁻¹).

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-232-3, HM-240, HM-246-1, HM-281-6, HM-291, HM-332, HM-342-1, HM-355, HM-359, HM-373, HM-407, HM-409, HM-418, HM-419, HM-426 and HM-430 were identified as promising lines for seed yield.

Table 27. 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

Screening of fenugreek germplasm entries against powdery mildew disease

One hundred and ten entries of fenugreek were screened against powdery mildew disease at Jobner. Among them, thirty entries (LFC-9, LFC-12, LFC-17, LFC-19, LFC-20, LFC-22, LFC-24, LFC-25, LFC-36, LFC-37, LFC-40, LFC-46, LFC-52, LFC-64, LFC-67, LFC-72, LFC-73, LFC-74, LFC-77, LFC-78, LFC-85, LFC-92, LFC-93, LFC-100, LFC-103, LFC-113, LFC-115, LFC-119 and LFC-125)

showed moderate resistance and the rest were either susceptible or highly susceptible to the powdery mildew disease.

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-80, UM-81, UM-95, RMT-354 and UM-85 were the better yielders under normal conditions, while UM-80, UM-73, UM-95, UM-83 and UM-79

were good yielders under stress conditions. Based on stress indices, UM-73, UM-79, UM-87, UM-72 and UM-80 were found to be the desirable entries for drought conditions.



Fig 23: Screening of fenugreek germplasm at Jagudan

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 the *rabi* season of 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 41.17 cm (FGK 121) to 55.30 cm (FGK 127) at Coimbatore. The genotype FGK 123 (46.54) recorded maximum number of pods per plant

and FGK 126 recorded the maximum seed yield per plot (97.00 g/ 1 m²).

Among the 17 promising entries and checks under evaluation at Jabalpur, FGK-135 was observed to be flowering early (41.00 days) and growing taller (122.73 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 25.81 q ha⁻¹ was recorded in FGK-123, followed by FGK-132 (24.63 q ha⁻¹) and FGK-138 (23.91 q ha⁻¹). At Kota, the seed yield ranged from 11.03 (FGK 123) to 17.21 q ha⁻¹ (FGK 129). The mean days to flowering ranged from 74 days (FGK 127) to 84 days (FGK 133) and test weight from 7.93 g (FGK-126) to 16.07 g (FGK 135).



Fig 24: Field view of CVT fenugreek at Jabalpur

The analysis of variance revealed significant differences among the entries for seed yield and yield attributing characters at Jobner. The seed yield ranged from 19.33 (FGK-132) to 34.82 q ha⁻¹ (FGK-126), while high yield was recorded in FGK-123 (15.83 q ha⁻¹), followed by FGK-128 (15.07 q ha⁻¹) and FGK-122 (14.72 q ha⁻¹) at Kumarganj. Significant differences were observed among the genotypes for all the parameters in the CVT at Hisar. Plant height ranged from 91.7 to 112.6 cm, pods per plant ranged from 90.1 to 115.5 and seeds per pod ranged from 15.2 to 17.5. Maximum seed yield (28.84 q ha⁻¹) was recorded in FGK-124 followed by FGK-125 (27.76 q ha⁻¹) and FGK-137 (24.60 q ha⁻¹).

At Jagudan, the genotypes FGK -130 (20.96 q ha⁻¹), FGK -136 (19.47 q ha⁻¹) and FGK -138 (19.38 q ha⁻¹) recorded higher yield over the national check variety GM-2 (14.76 q ha⁻¹) by 42.0 %, 31.9 % and 31.3 %, respectively, while at

Navsari, FGK-124 (14.52 q ha⁻¹) and FGK-135 (13.94 q ha⁻¹) recorded a significantly higher seed yield over both national checks HM-444 (11.69 q ha⁻¹) and Hissar Sonali (11.65 q ha⁻¹). At Raigarh, the evaluation of CVT Fenugreek revealed that FGK 25 (23.6 q ha⁻¹) recorded maximum seed yield followed by FGK 24 (21.7 q ha⁻¹) and FGK 26 (21.3 q ha⁻¹) over the check Hisar Sonali (20.7 q ha⁻¹).

Among seventeen entries at Dholi, two entries, FGK-132 (23.88 q ha⁻¹) and FGK-138 (23.29 q ha⁻¹), were found significantly superior, as compared to check variety Rajendra Kanti (19.95 q ha⁻¹). At Guntur, FGK-135 (14.57 q ha⁻¹), FGK-136 (14.40 q ha⁻¹), FGK-132 (14.28 q ha⁻¹) and FGK-127 (14.14 q ha⁻¹) recorded significantly higher yield over the check Lam Methi-3 (11.09 q ha⁻¹), while highest yield was recorded in FGK-128 (23.12 q ha⁻¹), followed by FGK-133 (22.38 q ha⁻¹) at Ajmer.

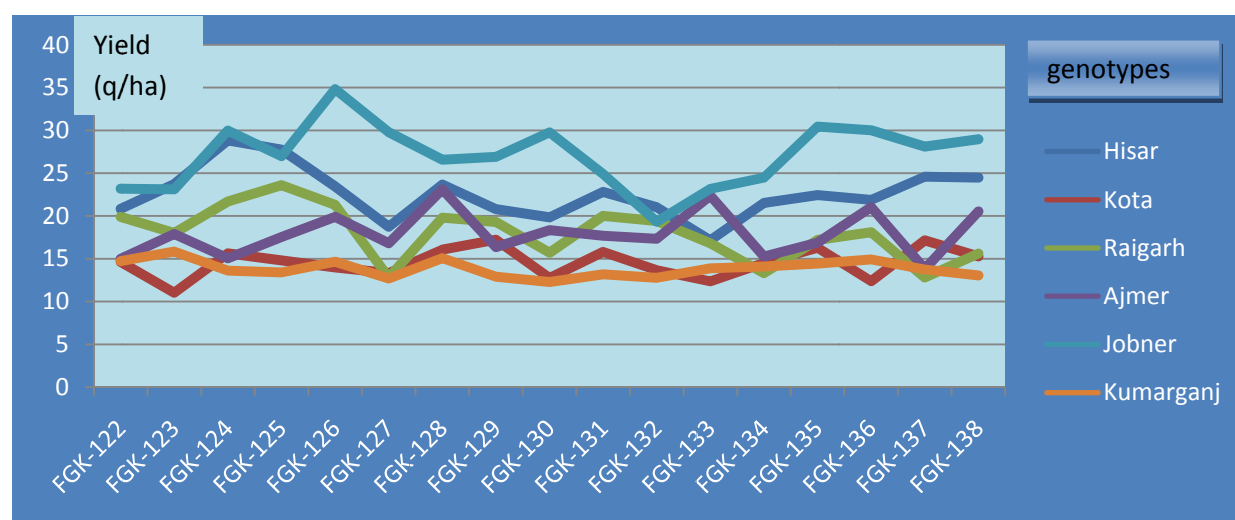


Fig 25: Performance of fenugreek genotypes at various AICRPS centres

FGK/CI/3.7 Chemo-profiling for identification of industrial types among the released varieties of fenugreek (Centres: Ajmer, Coimbatore, Guntur, Dholi, Hisar, Jobner, Kumarganj)

Fenugreek is one of the important spice crop grown in India for its green leaf as well as seed. In industries, the seed is used as dye and for extraction of alkaloids and steroids and hence this project aims at identifying the varieties suitable for industrial purpose. In the proximate analysis for nutrients viz., carbohydrates, protein, fat, crude fibre, ash, moisture, calcium,

iron, zinc and beta carotene, there was not much difference in the nutrient composition of the two varieties released from TNAU, Coimbatore (CO 1 and CO 2); however, CO 2 registered the highest beta carotene content of 1777.83 µg/100 g compared to CO 1 (1305.42 µg/100g) (Table 28).The seed samples of Lam Selection-1, LM-2 and LM-3 from Guntur were analyzed at IISR, Kozhikode for oleoresin, crude fiber, carbohydrate, fat and protein contents. Among these three, highest crude fiber content was observed in LS-1 (11%).

Table 28: Proximate analysis of the seed samples of fenugreek var. CO1 and CO2

S. No.	Parameters	CO1	CO 2
1.	Carbohydrates (%)	29.97	30.70
2.	Protein(%)	27.82	27.44
3.	Fat (%)	5.98	6.63
4.	Crude fibre (%)	10.98	10.56
5.	Ash (%)	4.28	4.11
6.	Moisture (%)	20.97	20.56
7.	Calcium (mg/100g)	257.81	238.44
8.	Iron (mg/100g)	19.68	19.81
9.	Zinc (mg/100g)	8.15	9.51
10.	Beta carotene (µg/100g)	1305.42	1777.83

Crop Management

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

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

The new experiment for standardizing drip irrigation interval and method of micro nutrient 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 initial results from Jobner and Ajmer indicate that drip irrigation interval significantly affected growth parameters, yield attributes, yields and water use efficiency of fenugreek (Table 29). The results reveal that the drip irrigation at an interval of 2 days produced maximum germination (80.20%), plant height (71.32 cm), number of primary branches/plant (8.33) and number of secondary branches/plant (15.07); however, number of days to maturity was more (145.4), besides higher incidence of downy mildew (34.67%) and powdery mildew (40.63%). Drip irrigation at an interval of 4 days produced maximum pods/plant (35.57), seeds/pod (18.26), pod length (12.30 cm), test weight (14.86 g), seed yield (18.74 q ha⁻¹), straw yield (37.29 q ha⁻¹), net returns (Rs 74764/ha with a B:C ratio of 2.33) and water use efficiency (8.35 kg/ha-mm). The 4 day drip irrigation interval also recorded lesser incidence of downy mildew and powdery mildew on fenugreek.

The application methods of micronutrient also significantly affected growth parameters, yield attributes, yield, economics and water use efficiency of fenugreek. The foliar spray recorded maximum germination (74.94%), pods/plant (34.09), pod length (11.80

cm), seed yield (17.91 q ha⁻¹), straw yield (36.79 q ha⁻¹), net returns (Rs 67451/ha with a B:C ratio of 2.15) and water use efficiency (8.17 kg/ha-mm). The foliar spray also recorded minimum incidence of powdery mildew on fenugreek. The fertigation, being at par with foliar spray of micronutrients, also recorded higher plant height (71.42 cm), number of primary branches/plant (8.17), number of secondary branches/plant (13.86), seeds/pod (17.25), test weight (14.70 g) and minimum incidence of downy mildew on fenugreek.

Similarly, the drip irrigation at an interval of 2 days produced maximum germination (83.06 %), days to maturity (154.1), plant height (84.9 cm), number of primary branches/plant (4.73), number of secondary branches/plant (7.72) with higher incidence of downy mildew (31.60%) and powdery mildew (42.16%) at Ajmer. The results indicated that the drip irrigation at an interval of 2 days produced maximum pods/plant (41.17), seeds/pod (18.37), pod length (13.67 cm) with test weight (15.94 g), seed yield (25.19 q ha⁻¹), straw yield (52.35 q/ha), net returns (Rs 109418/ha), B:C ratio (1.95) and water use efficiency (11.3 kg/ha-mm) over 4, 6, and 8 days intervals.

The methods of application also significantly affected growth parameters, yield attributes, yield, economics and water use efficiency of fenugreek. The foliar spray recorded maximum germination (75.9%), maximum plant height (86.0 cm), number of secondary branches (7.75), pods/plant (41.9), seeds per pod (18.25), pod length (13.60 cm), test weight (17.46 g), seed yield (26.73 q ha⁻¹), straw yield (55.70 q ha⁻¹), net returns (Rs 117586 /ha), B:C ratio (2.01) and water use efficiency (12.0 kg/ha-mm). The foliar spray recorded minimum incidence of powdery

mildew on fenugreek. The fertigation, being at par with foliar spray of micronutrients, also recorded higher days to 50% flowering (54.2), days to maturity (148.1), plant height (85.2 cm), number of primary branches/plant (4.5),

number of secondary branches/plant (7.47), seeds/pod (18.18), test weight (16.56 g) and minimum incidence of downy mildew on fenugreek with the seed, straw and biological yield of 24.77, 51.89 and 76.66 q ha⁻¹.

Table 29: Effect of drip irrigation interval and method of micronutrient fertigation on yield of fenugreek at Jobner

Treatment	Jobner			Ajmer		
	Seed yield (q ha ⁻¹)	Straw yield (q ha ⁻¹)	B:C ratio	Seed yield (q ha ⁻¹)	Straw yield (q ha ⁻¹)	B:C ratio
Drip irrigation interval						
2 days	17.40	35.53	2.17	2,519	52.35	1.95
4 days	18.74	37.29	2.33	2,440	50.32	1.85
6 days	15.77	33.26	1.98	2,462	50.73	1.88
8 days	15.33	32.66	1.92	2,472	50.97	1.89
SEm±	0.37	1.22	0.05	52	69	0.03
CD (P= 0.05)	1.31	4.23	0.17	156	208	0.09
Method of application						
Control	14.55	30.48	2.09	2,314	47.54	2.08
Soil application	16.98	34.90	2.03	2,428	49.23	1.69
Foliar application	17.91	36.79	2.15	2,673	55.70	2.01
Fertigation	17.80	36.57	2.13	2,477	51.89	1.78
SEm±	0.25	0.65	0.03	47	60	0.02
CD (P= 0.05)	0.75	1.91	0.10	139	187	0.07



Fig 26: Field view of micronutrient trial of fenugreek at Ajmer

Crop Improvement

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

The trial was started during the rabi season of 2019-20 and is in progress at Ajmer, Kumarganj Guntur, Jobner and Jagudan centres. Among the ten entries of ajwain tested under CVT, maximum yield was recorded in NDAJ-30 (8.37 q ha⁻¹), followed by HAJ-54 (8.10 q ha⁻¹) and JA-18-05 (7.89 q ha⁻¹) at Kumarganj, while at Guntur, higher yield was recorded in JA-17-06 (9.07 q ha⁻¹), JA-18-05 (9.02 q ha⁻¹) and AA-27 (8.99 q ha⁻¹), which were on par.

The analysis of variance revealed significant differences among the entries for seed yield and yield attributing characters at Jobner. Among the accessions, AA-96 recorded maximum seed yield of 8.42 q ha⁻¹, followed by NDAZ-21 (8.04 q ha⁻¹), JA-17-06 (7.78 q ha⁻¹), JA-18-05 (7.62 q ha⁻¹) and NDAZ-30 (6.63 q ha⁻¹), while at Raigarh, Indira Ajwain -1 (local check) recorded maximum seed

yield (13 q ha⁻¹), followed by AA-3 (11 q ha⁻¹) and NDAG 21 (10 q ha⁻¹).

At Jagudan, HAJ- 24 (14.51 q ha⁻¹), JA 17-06 (13.30 q ha⁻¹), AA-96 (13.11 q ha⁻¹) and JA-18-05 (12.96 q ha⁻¹) recorded significantly higher yield compared to the check variety, AA-1 (9.15 q ha⁻¹). Significant differences were observed among the genotypes for all the parameters at Hisar with plant height ranging from 99.1 to 127.0 cm, umbels per plant from 217.9 to 369.4 and seeds per umbel from 157.1 to 224.9. Maximum seed yield (13.32 q ha⁻¹) was recorded in HAJ-29, followed by AA-3 (13.27 q ha⁻¹) and AA-96 (12.84 q ha⁻¹).

Significant differences were observed among the genotypes for all the growth parameters at Ajmer, with plant height ranging from 115 to 133.60 cm, number of umbels/plant from 295.8 to 469 and number of seeds/ umbellate from 18.9 to 20. Maximum seed yield (16.85 q ha⁻¹) was recorded in AA-96, followed by HAJ-24 (14.54 q ha⁻¹) and HAJ-29 (13.25 q ha⁻¹).

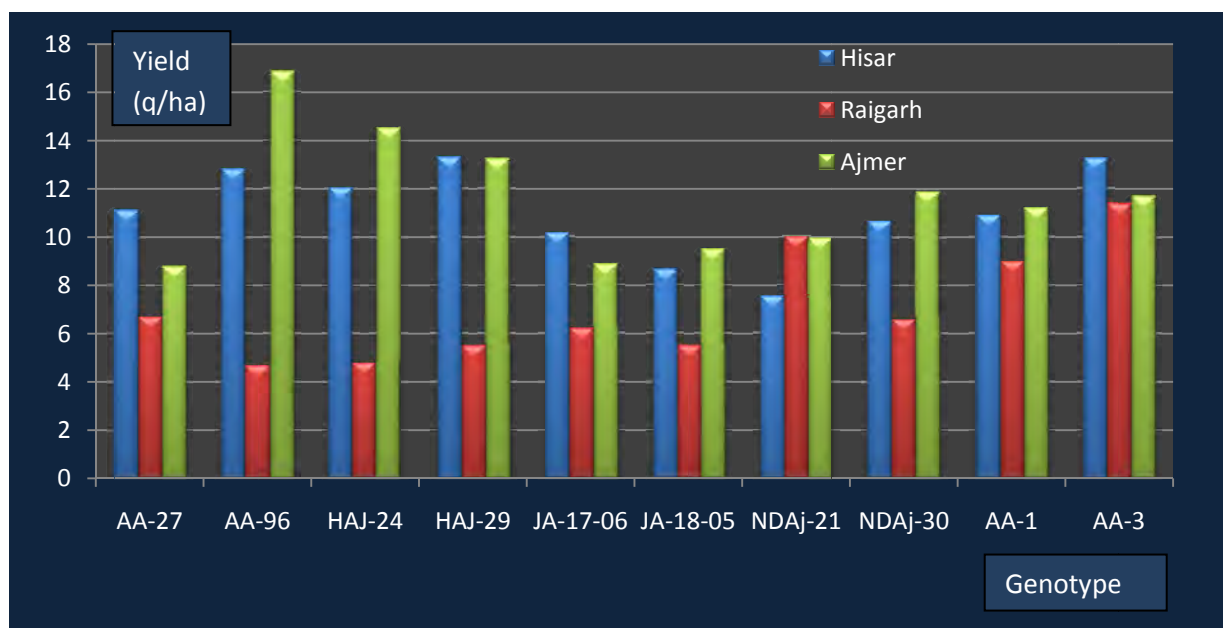


Fig 27: Performance of ajwain genotypes at Hisar, Raigarh & Ajmer

Crop Improvement

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. The seed yield ranged from 4.56-9.90 q ha⁻¹ at Kota, with 9.90 q ha⁻¹ in AN-1, followed by AN-23 (9.00 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 8.12 g (HKL-7). At Raigarh centre, Indira Nigella -1

recorded maximum seed yield (13.4 q ha⁻¹), followed by NDBC 7 (12.5 q ha⁻¹) compared to the check AN 20 (9.2 q ha⁻¹).

Significant differences were observed for all the growth parameters at Ajmer, with plant height ranging from 56.80 to 68.90 cm, number of sillequa/ plant from 82.4 to 52.2 and number of seeds/ sillequa from 91.1 to 71.3. Maximum seed yield (12.0 q ha⁻¹) was recorded in AN-19, followed by AN-4 (11.11 q ha⁻¹). Significant differences were observed for all the parameters (except plant height) at Hisar also, with plant height ranging from 81.9 to 90.1 cm, pods per plant from 77.8 to 110.0 and seeds per pod 87.2 to 99.1. Maximum seed yield (15.03 q ha⁻¹) was recorded in Pant Krishna, followed by AN-20 (14.91 q ha⁻¹) and NDBC-7 (14.62 q ha⁻¹).

Table 30: Co-ordinated Varietal Trial in nigella at Ajmer

Genotype	Days to germination	Plant height (cm)	No. of primary branches/ plant	No. of secondary branches/ plant	No. sillequa/ plant	No of seeds/ sillequa	Seed yield /plant (g.)	Test weight (g)	Seed yield/ha (q ha ⁻¹)
PK	10.67	61.30	8.20	17.50	52.20	71.30	24.00	2.29	5.40
NDBC-7	10.00	60.10	8.20	18.30	63.50	76.60	33.25	2.30	9.69
AN-9	11.33	66.20	9.40	21.80	70.70	78.90	35.75	2.33	9.77
AN-20	11.00	67.50	8.60	18.60	72.90	82.40	47.25	2.44	10.45
HKL-12	20.00	64.20	8.00	18.90	68.10	77.30	34.50	2.31	9.73
AN-4	11.33	61.20	8.20	20.00	73.20	83.50	49.50	2.44	11.11
NDBC-11	10.00	56.80	7.50	17.10	61.00	73.90	32.50	2.46	7.85
PK-3	11.00	65.00	8.20	19.90	71.90	79.60	45.50	2.49	10.18
AN-19	11.00	68.90	9.90	24.90	82.40	91.10	61.75	2.37	12.00
Mean	11.81	63.47	8.47	19.67	68.43	79.40	40.44	2.38	9.57
CV (%)	7.38	5.46	8.06	8.84	1.86	1.52	24.62	3.37	11.75
SEm ±	0.711	2.827	0.557	1.420	1.039	0.982	8.132	0.065	91.845

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

During the year, 15 lines were collected from various saffron growing areas of J&K, augmenting the repository to 215 (including 36 exotic collections), being maintained at Saffron

Research Station, SKUAST, Kashmir. The 200 germplasm accessions under evaluation were characterized with respect to 23 foliage and floral traits (Table 31).

Among these accessions, 22 germplasm lines were found promising with regard to flower yield, stigma length, foliage parameters and three important quality traits viz., crocin, picro-crocin and saffranal content

Table 31: Evaluation of germplasm of saffron for morpho-floral traits

S. No	Trait	Trait expression range
1.	Foliage colour	Light green (19), Green (155), Dark green (26)
2.	Leaf tip shape	Pointed (178) Round (22)
3.	Location of hairs on leaf	Absent
4.	Presence of white or pale stripe	Present
5.	No. of leaves in main sprout	5-10
6.	Leaf lamina thickness (mm)	0.11 - 0.37
7.	Number of days from sowing to 50% sprouting [d]	101 - 105 (1 st week of July sowing)
8.	Number of days from sowing to 50% flowering [d]	105 - 117 (1 st week of July sowing)
9.	Presence of leaves at flowering	Yes (25)
10.	Number of flowers per corm	1 - 2
11.	Tepal shape	Elliptic (9), Linear (15), Oblanceolate (35), Obovate (141)
12.	Tepal apex shape	Acuminate (16), Acute (30), Obtuse (147), Rounded (7)
13.	Outer tepals length [cm]	3-4.6
14.	Outer tepals width [cm]	1.1 - 2.1
15.	Inner tepals length [cm]	2.4 - 4.2
16.	Inner tepals width [cm]	1.1 - 1.7
17.	Style branching	Non visible branching
18.	Stigma colour	Light red (41), Red (97), Dark Red (62)
19.	Style length (cm)	0.97 - 2.83
20.	Pistil length (cm)	3.89 - 6.68
21.	Fresh weight of pistil (mg)	23.16 - 66.58
22.	Dry weight of pistil (mg)	4.65 - 8.56
23.	Stigma length (cm)	2.53 - 5.09



Fig 28: Trait expression in different saffron collections

Genetic Resources**KAZ/CI/1.1 Exploration, collection and conservation of kalazeera from high altitudes of northern Himalayas (Centres: Pampore)**

Ten new germplasm lines were collected from the foot hills of Northern Himalayas during the year, making up the germplasm collections being maintained at the Pampore station to 80.

Screening for tuber characteristics

Initial screening of tubers collected from hot spots to evaluate tuber variability (Table 32) and inherent production potential through participatory rural appraisal (PRA). Subsequently, the collected tuber samples were analyzed for various parameters, including disease / pest aspects before planting.

Table 32: Tuber characteristics of collected germplasm

S.No	Traits	Range
1.	Tuber tunic (coat) colour	Blackish (48), Brownish (26)
2.	Tuber shape	Irregular (63), Round (11)
3.	Tuber length [cm]	0.9 – 2.1 (3 rd year)
4.	Tuber width [cm]	1.2 – 2.5 (3 rd year)
5.	Weight of tubers (g)	2.82 - 4.78 (3 rd year)

Evaluation of germplasm

The germplasm comprising of 70 lines collected from foot hills of Northern Himalayas as well as germplasm available at Advanced Research Station for Saffron and Seed Spices, SKUAST-Kashmir were evaluated for various morphological and yield related traits.

Significant variability was observed among the accessions with regard to tuber, foliage, flower, yield and yield attributing traits (Table 32). DUS traits were also recorded for various qualitative traits (Fig.----). Out of 70 lines, 7 lines were selected on the basis of growth, yield and yield attributes.

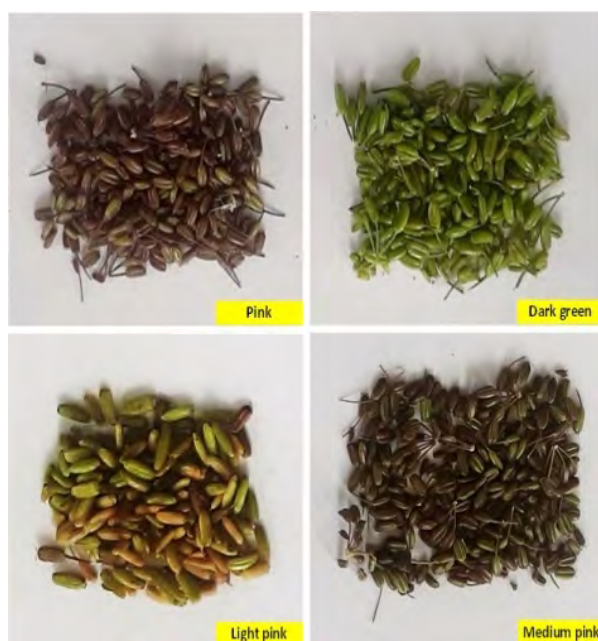


Fig 29: Seed colour variability in kalazeera



Fig 30: Seed size variability in kalazeera

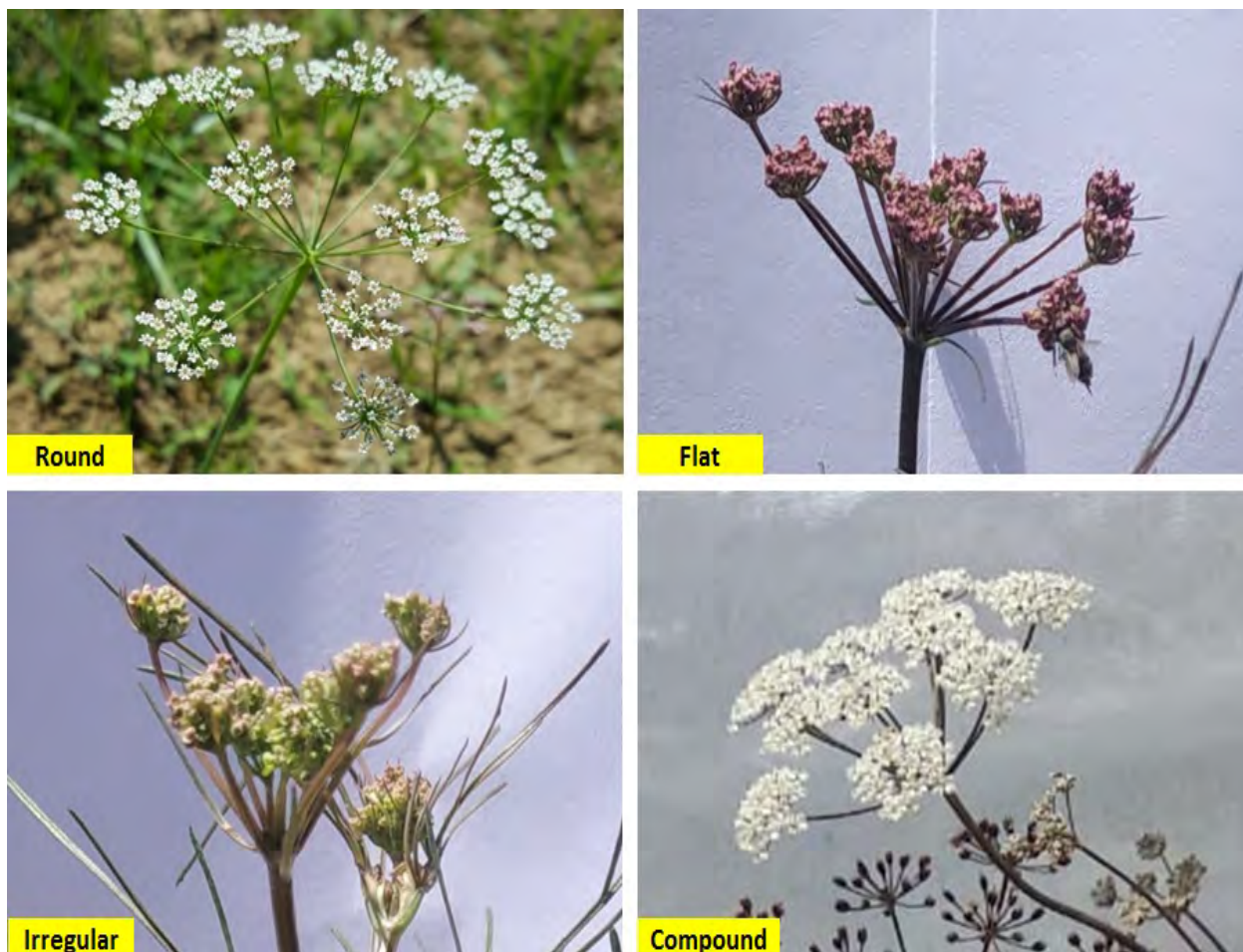


Fig 31: Umbel variability in kalazeera

The Project coordinator and the scientists from PC unit monitored the working of various AICRPS centres and experimental plots by personal visits. 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. Y.K. Sharma (ICAR-NRCSS, Ajmer), Dr. K. S. Krishnamurthy and Dr. Sharon Aravind from AICRPS, Kozhikode visited the seed spices centres for reviewing the progress of the experiments.



Jagudan



Jobner



Hisar



Kumarganj

Fig 32: Visit of Seed spices monitoring team to various AICRPS centres

Annual Group Meeting

The XXXI Workshop of ICAR-All India Coordinated Research Project on Spices (AICRPS) was conducted during 29-30 September 2020 at ICAR- Indian Institute of Spices Research, Kozhikode through virtual platform. The workshop was inaugurated by Dr. R. Chandra Babu, Hon'ble Vice Chancellor, Kerala Agricultural University, Thrissur on 29 September 2020. In his inaugural address, he emphasized on the necessity to facilitate adoption of technologies by the farming community and to develop climate resilient and high quality spice varieties with minimal pesticide residue so as to improve the export potential. Dr. A. K. Singh, Deputy Director General (Horticultural Science), Indian Council of Agricultural Research, New Delhi presided over the function. He pointed out the rise in export demand of spices at the global level despite the COVID-19 pandemic situation and urged the scientific community to utilize the opportunity to produce quality spices suitable for export market. Dr. Vikramaditya Pandey, Assistant Director General (Horticultural Science), ICAR, New Delhi was the Guest of Honour and he highlighted the various researchable issues related to spices and the need to work on problem solving mode to satisfy farmers, industry as well as consumers. Dr. Santhosh J Eapen, Project Coordinator, AICRPS welcomed the gathering. During the inaugural session the "Best AICRPS Centre Award 2019-20" was presented to AICRPS centre at IGKV, Raipur (Raigarh), Chhattisgarh. Ten

booklets/pamphlets on spices production technologies in English and local languages from different AICRPS centres were released during the occasion. Also one video showcasing the activities of AICRPS centre at Pasighat, Arunachal Pradesh was released. Dr. Homey Cheriyan, Director, DASD, Kozhikode, Dr. Gopal Lal, Director, ICAR-NRC for Seed Spices, Ajmer and Dr. K. Nirmal Babu, Former Director, ICAR-IISR & Project Coordinator (Spices), Kozhikode 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, four varieties (1 ginger, 2 turmeric and 1 fenugreek) viz., IISR Vajra (high quality bold and plumpy ginger variety by ICAR-IISR, Kozhikode), Lam Turmeric 1 (lemon yellow colour turmeric powder and high dry recovery by Dr. YSRHU, Guntur), Rajendra Haldi 1 (high yield and high curcumin turmeric variety by Dr. RPCAU, Dholi) and HM-257 (high yielding powdery mildew and downy mildew resistant fenugreek variety by CCSHAU, Hisar) were recommended for release. In addition, one technology on the management of insect pest of large cardamom using spinosad (45 SC @ 0.3 ml L⁻¹) or neem based oil (Azadirachtin 0.15% EC) 1500 ppm @ 3 ml L⁻¹) was recommended under organic protection practice.



Fig 33: Glimpses of AICRPS workshop held on virtual mode

ICAR- AICRPS centres at various parts of India took the initiative to support not only the farming community but also front line helpers by providing various supports during the period of “Lockdown” owing to COVID 19 pandemic conditions. The AICRPS centres were also involved in the production and distribution of planting materials by adopting the preventive and safety measures as advocated by the Ministry of Health and Family Welfare. Social distancing and personal hygiene measures such as use of surgical mask, alcohol based sanitizers and regular hand washing were made compulsory during farm operations at all ICAR-AICRPS centres. Arogya Setu app was downloaded and used by the staff and their family members of all ICAR-AICRPS centres.

Dr. Shrikant Sawargaonkar, AICRPS scientist at IGKVV, Raigarh worked in Corona Virology Lab of Medical College, Raigarh as per the District Collector’s order for three months.

Activities during lockdown

a. Advisories given through online mode

- Crop advisories to the farmers for various spice crops were prepared by AICRPS and uploaded in the website
- A total of 1052 advisories were given through newspaper in various local languages by different AICRPS centres
- Advisory to the farmers through whatsapp group (4489) of various centres by the concerned scientists in their local language
- 15000 advisories were given through phone call by various AICRPS centres
- Farmers’ advisory was also broadcasted by AIR, Raigarh
- AICRPS centre, Pottangi uploaded advisory on dry ginger production in You tube
- Planting material availability of spices at different regions was compiled and uploaded in AICRPS website
- Helpline was started at PRS, Panniyur to cater to the needs of farmers during lockdown
- Online class on black pepper cultivation was taken by RARS Ambalavayal through whatsapp

- Project Coordinator and scientists of PC Cell participated in virtual workshop on challenges and solution: organic cultivation in NE region held on 22 April 2020 and clarified doubts of farmers. Project Coordinator emphasized on maintenance of purity of genotypes, availability of quality planting materials and value chain development in spices.

b. Help/ Infrastructure provided by AICRPS centres

- SDAU Jagudan handed over two RTPCR and JNKVV, Jabalpur handed over one RTPCR and one refrigerated micro centrifuge to State Government for testing COVID 19 samples
- Spices, fruits, vegetables and foods were supplied to Muncipal workers, policemen and poor people by various AICRPS centres
- 1200 black pepper cuttings, 5 q of ginger and 5.5 t turmeric were distributed to farmers by various AICRPS centres
- Planting materials of ginger var. Nadia were distributed to farmers of Namsai district, Arunachal Pradesh for seed production under Front Line Demonstration (1 hectare).
- Planting materials of turmeric var. NDH-98, Megha Turmeric and Rajendra Sonia were distributed to farmers of East Siang district, Arunachal Pradesh for seed production under Front Line Demonstration (2 hectares).
- AICRPS, Chintapalle in collaboration with ITDA, Paderu distributed turmeric seed material to the tribal people.
- 354 kg of bio control agents (*Trichoderma viride*, *Pseudomonas fluorescens* and *Paceilomyces lilacinus*) were distributed for an area of 8 ha cardamom plantations in the CHR area of Pampadumpara.
- Created awareness on hygiene and distributed masks and sanitizers to the contractual staff and farm labourers of various AICRPS centres

c. Breeder's seed produced by various AICRPS centres

Crop	AICRPS Centre	Quantity of planting materials	Total
Black pepper	PRS, Panniyur	8250 cuttings 400 single node layers of Panniyur 9 100 single node layers of Panniyur 10	58250 cuttings 6855 seedlings
	RARS, Ambalavayal	5000 cuttings	500 layers
	HRS, Yercaud	6855 seedlings	
	UBKV, Pundibari	30000 cuttings	1000 bush pepper
	BSKV, Dapoli	15000 cuttings 1000 bush pepper	
Small cardamom	HRS, Sirsi	2000 seedlings	2000 seedlings
Vanilla	HRS, Sirsi	15000 cuttings	15000 cuttings
Ginger	UBKV, Pundibari	Gorubathan - 4 t	10 tons
	HARS, Pottangi	Suprabha -5 t	
	SASRD, Nagaland	Nadia- 1 t	
Turmeric	HARS, Pottangi	Roma - 8 t Surama- 7 t	149 tons
	UBKV, Pundibari	Suranjana - 20 t	
	RPCAU, Dholi	Rajendra Sonia- 35 t Rajendra Sonali- 35 t	
	TNAU, Coimbatore	CO 2 - 2 t	
	CAU, Pasighat	40 t	
	ICAR- RC-NER, Mizoram	Megha Turmeric-1 - 2 t	
Clove	HRS, Pechiparai	Clove seeds- 1000 kg	1000 kg seeds
Nutmeg	BSKV, Dapoli	Grafts- 500	500 grafts
Cumin	ARS, Mandor	GC 4 - 40 q	44.4 q
	SDAU, Jagudan	GC4 - 4.4 q	
Fennel	SDAU, Jagudan	GF 11- 1.1 q	1.1 q
Fenugreek	ARS, Mandor	RMt 305- 30 q	30 q



Fig 34: Newspaper clippings from AICRPS centres reporting the activities



Distribution of seed materials of turmeric at Chintapalle



Distribution of turmeric at Pasighat



Production of seed materials of turmeric at IGKV, Raigarh



Making masks at Ajmer



Uploaded video in You tube on value addition of ginger by HARS, Pottangi



Online training on black pepper cultivation by RARS Ambalavayal

Fig 35: Glimpses of activities of AICRPS centres

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

High yielding varieties- boon to farmers

- ❖ Demonstration of high yielding turmeric variety CO 2 (Coimbatore)
- ❖ Demonstration of Megha Turmeric 1, NDH 98 & Rajendra Sonia in 2.0 ha (Pasighat)
- ❖ Demonstration of high yielding coriander variety CS 38 (Coimbatore)
- ❖ Demonstration of high yielding fenugreek variety RMt- 361 in 3.0 ha (Jobner)
- ❖ Demonstration of high yielding fennel variety RF 205 in 3.0 ha (Jobner)
- ❖ Demonstration of Panniyur varieties of black pepper (Panniyur)
- ❖ Demonstration of 15 varieties of black pepper (Pottangi)

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 demonstration of turmeric transplants in 2.0 acres (Coimbatore)

Processing and value addition- for capturing market

- ❖ Preparation of preserve and chutney from nutmeg rind (Dapoli)
- ❖ Processing of black pepper (Dapoli)

Plant protection- for improving plant health

- ❖ Rhizome treatment with propiconazole @0.2% + foliar spray with propiconazole @0.1% at 90, 105 & 120 DAP in turmeric in 0.5 acres (Dholi)
- ❖ Management of stem gall disease of coriander by foliar spray of a commercial fungicidal formulation containing azoxystrobin + tebuconazole @0.1% at 45, 60 & 75 DAS (Dholi)

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).



FLD of ginger



FLD of turmeric



FLD of ginger



Pro tray propagation of turmeric



FLD of coriander



FLD of cumin

Fig 36: FLD of various crops conducted by different AICRP centres

Value chain development in spices in tribal community in Visakhapatnam district

Visakhapatnam is identified by the NITI-AYOG as Aspirational district in the state of Andhra Pradesh. It has a sizable proportion of tribal population, about 14.5% of the total tribal population in the state. The tribal farmers of Chintapalle region were cultivating Chintapalle Local turmeric which they used to harvest once in two years and the yield was also low. ICAR-Indian Institute of Spices Research, Kozhikode, ICAR-AICRPS, Chintapalle in collaboration with ITDA, Paderu and SERP were able to convince these tribal farmers to shift to high value varieties like Roma which has high curcumin in addition to high yield and is well suited to the region also. They were successful in educating the farmers about the importance of high curcumin content and also yearly harvest which farmers have realized and are now cultivating Roma in around 2000 ha of turmeric growing regions of tribal area in Chintapalle, Andhra Pradesh. To enhance the production further, AICRPS centre at Chintapalle in collaboration with ITDA, Paderu has distributed 80 t of turmeric seed materials to the tribal people. AICRPS centre located at Pottangi in Odisha was also successful in educating the farmers about the high value turmeric variety and now about 1000 tonnes of organically grown Roma is produced in Odisha also.

In order to improve the livelihood status of the tribals AICRPS in collaboration with ICAR- IISR, Kozhikode, has motivated the farmers to adopt various technologies like improved varieties of turmeric and black pepper, raised bed system land preparation for turmeric cultivation, use of organics and micronutrient formulations developed by ICAR-IISR, intercropping in turmeric, promotion of bio intensive nurseries of black pepper, mechanization of primary processing in turmeric and production of value added products and branding for entrepreneurship development.

The introduction of simple operated farm machinery for turmeric boiling and polishing

helped to improve the standards of farm primary processing operations. The establishment of four pilot units for turmeric processing gained wide acceptance among the target tribal communities. The polished turmeric sold in the local markets fetched the farmers a higher price of Rs. 3-5 /kg. The reported advantages were easiness of operation, reduced processing time and fuel use, enhancement in the quality of the produce to ensure food safety and nutritional security. Women self help groups supported by Giri Chaitanya Farming & Marketing Mutually Aided Cooperative Society launched four value added products two each in black pepper and turmeric which were marketed in niche markets.

An area of 1,483 ha. of turmeric involving 1,050 farmers organized under two FPO's was brought under organic cultivation adopting the technologies developed by ICAR-IISR. Out of these FPO's, Maathota FPO, was provided with organic certification by TQ Cert Services Private Limited. This FPO is selling organic products at premium price to spice industries operating in Kerala.

IISR Pragati - Curcumin upgradation in Indian turmeric

The turmeric variety IISR Pragati with its superior characters like high yielding (38 t/ha), short duration (180 days), moderately resistant to root knot nematode infestation is suitable for all turmeric growing areas. It has stable and high curcumin content (5.02%) across locations, is the most preferred variety and has spread to all turmeric growing regions of the country covering an area of 20000-25000 acres. This variety could establish successful farmer-industry direct linkage for high value curcumin extraction wherein farmers could get almost double the price compared to open market. About 300 t and 500 t of seed rhizomes were distributed during 2018-19 and 2019-20 respectively. For quality seed rhizome multiplication and distribution, non-exclusive license was granted to five farmers in Andhra Pradesh and Telangana.



Fig 37: IISR Pragati



Fig 38: Distribution of seed rhizomes



Fig 39: Varietal spread & quality planting material availability

NDH-98 for higher farm income in Arunachal Pradesh

The turmeric variety NDH-98 performed well for the past 4 years of experimental trials under AICRP on Spices, Pasighat. It recorded highest yield per clump and hectare (Av. 240 g and 30.75 t ha⁻¹ respectively), however, its potential yield goes upto 401 g and 45.02 t ha⁻¹ respectively. Its curcumin content is in the range of 5.2 to 6.0%, essential oil 7.4%, oleoresin 12.91% and dry recovery 20.67%. It is tolerant to pests and diseases. The distinct characteristic of this variety is extra-large mother rhizome with more numbers of fingers.

To popularize this improved variety and also to fetch higher income to the farmers, planting materials of 100 kg were distributed to the identified farmers during the year 2019-20. Among them, Mrs. Hema Taki of Rune village, East Siang, Arunachal Pradesh grows this turmeric variety in her kitchen garden and harvested about 44 t ha⁻¹ of fresh rhizome. She kept some rhizomes for seed purpose and sold 200 kg @ Rs. 20 per kg and earned Rs. 4000/-. She was surprised and remarked that with less effort she could earn Rs. 4000/- whereas she has to struggle hard to earn the same amount with vegetable cultivation. Luxuriant growth and bumper yield of turmeric created curiosity in her neighbourhood. Some of the pictures related to farmer are depicted below:



Fig 40: Planting material of turmeric var. NDH-98 distributed to farmers



Fig 41: Sprouting rhizomes of turmeric var. NDH-98



Fig 42: Early crop stage at Mrs. Hema Taki field



Fig 43: Turmeric farmer Mrs. Hema Taki at her field



Fig 44: Vigour rhizome at harvest



Fig 45: Harvesting of crop

Krishi Melas & Farmer's Trainings

Krishi Melas/exhibition organized

Kisan Mela was organized by at Regional Horticultural Research Station, Chintapalle and demonstrated new technologies available in spice crops which were more suitable to tribal area of Visakhapatnam at Chintapalle on 28.02.2020

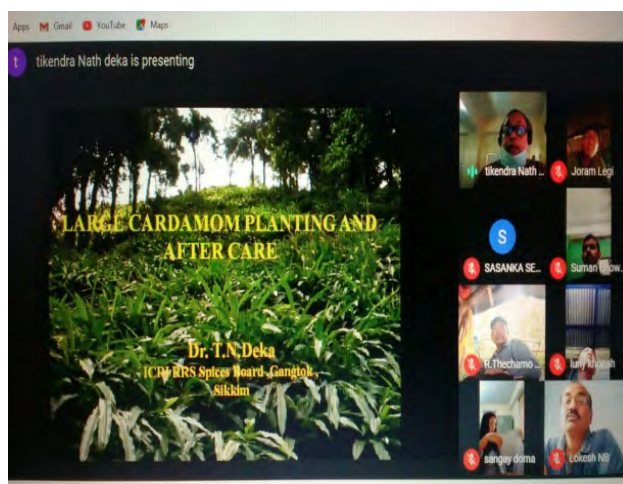
AICRPS centre at Dholi organised stall of Spices Exhibits in "Kisan Mela" held at Sport Ground

Complex of RPCAU, Pusa, Samastipur, Bihar during 16 to 18 February, 2020.

AICRPS centre at Kumarganj organized exhibition and participated in Kisan gosthi in Virat Kisan Mela avam Krishi Pradarshani-2020, organised by NDUAT, Ayodhya and Agricultural Department of Uttar Pradesh at the campus of the university from 20-22 December 2020.



Farmers training at Pottangi



Online training conducted at Sikkim



Exhibition at Raigarh



Exhibition at Dholi

Fig 46: Training programme and exhibitions conducted by various AICRPS centres

Table 33: Training organized by various AICRPS centres

Sl. No	Date	AICRPS centre	Details of training	No. of Participants
1	13.01.2020	Ouat, Pottangi	Scientific cultivation of black pepper	30
2	14.01.2020	HRS, Yercaud	Black pepper production technology	35
3	18.01.2020	HRS, Sirsi	Awareness and importance of improved technology in black pepper cultivation	25
4	28.01.2020	SKLTSHU, Kammarpally	Training program on Scientific cultivation of turmeric and distribution of seed materials of turmeric to FPO groups of NABARD.	125
5	28.01.2020	ICRI Gangtok	Cultivation aspects of large cardamom and post harvest management” for the farmers of Ziro, Lower Subansiri, Arunachal Pradesh.	35
6	28.01.2020	ICRI Gangtok	Mobile spice clinic program at Soreng, West Sikkim	30
7	29.01.2020	ICRI Gangtok	Doubling the farmers income through organic practices in large cardamom	52
8	30.01.2020	PRS, Panniyur	New strategies in integrated management of black pepper	20
9	03.02.2020	SKNCOA, Jobner	“Crop production with pressurized irrigation for water saving”	60
10	05.02.2020	SKNAU, Jobner	Farmers training on “Improved cultivation practices of seed spices crops”	35
11	11.02.2020	ICRI, Gangtok	Scientific cultivation practices, post harvest management and value addition for better returns in large cardamom at Kalimpong district of West Bengal.	51
12	14.02.2020	SKNCOA, Jobner	“Importance of medicinal and aromatic plants”	43
13	16.02.2020 to 18.02.2020	RPCA, Dholi	Kisan Mela held at Dr. Rajendra Prasad Central Agricultural University, Pusa	3000
14	19.02.2020	CCSHAU, Haryana	Production technology of spice crops	96
15	22.02.2020	CRS, KAU. Pampadumpara	Problems in the production and protection aspects of cardamom and black pepper cultivation in Idukki district	50
16	26.02.2020	CCSHAU, Haryana	Production technology of spice crops	78
17	05.03.2020	UBKV, Punibari	“Spice Production Scenario in the Terai Zone of West Bengal”	9
18	07.03.2020	SKNCOA, Jobner	Farmers training on “Water conservation and its effective utilization”	36

19	01.06.2020 to 02.06.2020 10.08.2020 to 12.08.2020 06.10.2020 to 07.10.2020	RPCAU, Dholi	Training imparted to farmers from different blocks/villages of Dholi through virtual platform	386
20	14.08.2020	OUAT, Pottangi	Organic ginger cultivation and value addition in collaboration with Pradan NGO.	25
21	22.9.2020 & 30.9.2020	HRS, Yercaud	Training on production technology of black pepper in collaboration with IWMP-X, Vellore District.	40
22	15.10.20 to 16.10.20	KAU, Pampadu mpara	“Climate change on spice crops” through Google meet as a part of Diploma in Agriculture Extension Services for Input Dealers (DAESI) Programme 2020-21 organized by Nedumkandam and Kattappana centers of Idukki	80
23	06.10.2020	PRS, Panniyur	Disease management in spice crops	60
24	10.10.2020	KAU, Pampadu mpara	Ginger and Turmeric cultivation as a part of Farm School programme conducted by RATTC Malampuzha	50
25	27-10-2020	PRS, Panniyur	Krishipadhasala Training on Black pepper cultivation for farmers of Koodali Grama Panchayath under Dept. of Agriculture & Farmers' Welfare	20
26	05-12-2020	HRS, Chintapalle	World Soil Health Day at adopted village Gondipakalu, Chintapalli Mandal on and explained different organic and biological approaches to improve soil health	50
27	22.12 2020	HARS, Pottangi,	Organic ginger and turmeric Cultivation” to farmers and 14 SHGs at Daringibadi, Simmanbadi, Kandhamala and Sonepur , Subarnapur district	12

Training program for SC farmers

Newly introduced Scheduled caste Sub Plan aims to empower the scheduled caste farmers by creating awareness on advantages of spices cultivation, good agricultural practices. Training programmes were organized by various AICRPS centres in the areas having more than 30% SC population and planting material of various spices were distributed for the cultivation of spices.

During 2020, AICRPS centres viz., Pundibari, Solan, Sirsi and Pottangi conducted SCSP training programmes benefitting 1600 SCSP farmers. Also distributed planting materials of black pepper, ginger, turmeric, fertilizers, micro nutrients and plant protection chemicals.



SCSP training at Kandaghat Block, Solan



Distribution of planting materials at Sirsi



Distribution of turmeric pro trays



SC beneficiary in turmeric plot at Raigarh

Fig 47: SCSP activities conducted by various AICRPS centres

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- Sivakumar V 2020 Ginger cultivation (Telugu) in Udyana Panchangam, Dr. YSRHU, A.P.
- Sivakumar V 2020 Black pepper cultivation (Telugu) in Udyana Panchangam, Dr. YSRHU, A.P.
- Sivakumar V 2020 Cardamom cultivation (Telugu) in Udyana Panchangam, Dr. YSRHU, A.P.

Panniyur

- Yamini Varma C K Agri Advisory bulletin from RARS, Pilikode.

Pottangi

- Parsuram Sial 2020 Ginger cultivation (in Odiya).

Kammarpally

Mahender B 2020 Turmeric cultivation in Annadata (May 2020).

Mahender B 2020 Turmeric cultivation in Rythu nestham (July 2020).

Navsari

Ritesh K Patel 2020 Haldar ni Vaigyanik Kheti Paddhati.

Ritesh K Patel 2020 Aadu ni Vaigyanik Kheti Paddhati.

Ritesh K Patel 2020 Vanaspati ni Jato ane Kheduto na Hako nu Rakshan (PPV&FR).

Folder

Shivran A C, Dudwal B L, Kumawat G L & Jat R D 2020 Folder on Effective use of water from drip and sprinkler irrigation system. RKVY, SKN COA, Jobner.

Practical manual

Jobner

Dudwal B L, Shivran A C, Jajoria D K & Meena B R 2020 Manual on rainfed agriculture and watershed management. Department of Agronomy, SKN COA, Jobner.

Dudwal B L, Shivran A C & Jajoria D K 2020 Manual on principles of organic farming. Department of Agronomy, SKN COA, Jobner.

Popular article

AICRPS Headquarters, Kozhikode

Sharon Aravind, Krishnamurthy K S, Santhosh J Eapen, Radha E & John George 2020 New spice varieties for release. *Spice India* 33 (12): 4-5.

Ankegowda S J, Krishnamurthy K S & Alagupalamuthirsolai M 2020 Drought mitigation-Production technologies with special emphasis on cardamom and black pepper. *Spice India* 33 (11): 10-15.

Panniyur

Airina C K & Yamini Varma C K 2020 Management of viral diseases of black pepper. *Kerala karshakan* pp 33-34.

Yercaud

Anand M, Kamalkumaran P R, Sankari A & Nandhakumar S 2020 Production technology of Cinnamon. *Pachai Boomi*, August 2020: 20-21.

Anand M, Kamalkumaran P R, M Velumurugan & A Sankari Multitier cropping system for eastern ghats 2020 *Popular Khentic*. 6(6): 411-413.

Solan

Gupta Meenu & Gupta Bhupesh 2019 Lahsun ke rog aur unki roktham. Department of Plant Pathology, University website. <https://www.yspuniversity.ac.in> , 4p.

Gupta Meenu, Shalini Verma & Manisha Kaushal 2020 PR proteins and their effect on disease management (In Hindi). *Zigyasa Vigyan Patrika* 34: 11-14.

Leharwan Munish, Gupta Meenu & Leharwan Sanjeev 2020 *In vitro* evaluation of six bio-products against coriander stem gall disease. *Bhartiya Krishi Anusandhan Patrika* (In Hindi). *Bhartiya Krishi Anusandhan Patrika* 35(1&2): 33-38.

Meenu, Vikram Amit & Sharma Hem Raj 2020 Covid ka baagvani fasalon par prabhav nivaran. *Audyani ki avam Vaniki* 30(1): 25-29.

Jobner

Bana R C, Shivran A C & Singh P Jaivik kheti me taral khado ki upyogita. In: *Harit Kranti*, July 10, 2020, pp. 10.

Kamalkumaran P R, Anand M & Nandhakumar S 2020 Vetrilai valikizhangu sagupadi uyar thozhilnutpam. *Uzhavarin Valarum Velanmai*, 11(11): 31-35.

Publications in Seminar/Conference/ Symposium

Coimbatore

Suresh R, Ramar A, Senthamizh Selvi B & Vithya K 2020 Evaluation of turmeric genotypes for quality traits. In: National webinar on Spice Improvement, Processing and Marketing organized by Regional Agricultural Research Station, Southern Zone during 07-08 October 2020.

Chintapalle

Sivakumar V 2020 Germplasm collection, characterization, evaluation and conservation of black pepper under eastern Ghat region of Andhra Pradesh E-book of Abstract on National Conference on Agricultural Resource Management for Atmanirbhar Bharat organized by Central Agricultural University, Impal from 17-19 July 2020.

Yercaud

Anand M, Kamalkumaran P R & Nanthakumar S 2020 Germplasm collection, characterization, evaluation of pepper for yield under Yercaud condition. **In** Book of abstracts of national seminar on Climate smart agriculture for sustaining crop production and improving livelihood security (p. 77-78). Department of Genetics and Plant Breeding, Annamalai University, Tamil Nadu.

Jabalpur

Bhavana Yadav, Ms. Nazneen Husain & Reena Nair 2020 Biopesticide – A Sustainable Solution for Pest Management. **In:** National Conference on Scientific & Environmental Innovation and Implementation of Sustainable Development Goals (CLIMATE CONCLAVE- 2020), held during March 7- 8, 2020 at MPCST, Bhopal pp: 31.

Nazneen Hussain, Bhawna Yadav & Reena Nair 2020 Bio-Fertilizer – A Key Player in Sustainable Agriculture **In:** National Conference on Scientific & Environmental Innovation and Implementation of Sustainable Development Goals (CLIMATE CONCLAVE- 2020), held during March 7- 8, 2020 at MPCST, Bhopal pp: 146.

Jobner

Choudhary M, Shivran A C, Ghaswa R D & Netwal M 2020 Effect of plant geometry and weed management on seed and straw yield of fennel (*Foeniculum vulgare* Mill.). **In:** E-book of abstracts: National conference on agricultural resource management for atma nirbhar bharat, Published by College of Agriculture, Iroisemba Central Agricultural University, Imphal, Mamipur held during 17-19 July 2020, pp. 58.

Bhukhar O S, Shivran A C, Bana, R C, Dudwal B L, Meena B R & Kumawat S K 2020 Effect of drip irrigation level and micronutrient application method on yield of Indian mustard (*Brassica juncea* L.). **In:** E-book of abstracts: National conference on agricultural resource management for atma nirbhar bharat, Published by College of Agriculture, Iroisemba Central Agricultural University, Imphal, Manipur held during 17-19 July 2020, pp. 58.

Pampadumpara

Nimisha Mathews, Dhanya M K Murugan M, Ashokkumar K, Surya R, Maya T, Deepthy K B & Shaana O 2020 Evaluation of promising small cardamom (*Elettaria cardamomum* (L.) Maton) cultivars/varieties for organic cultivation under high ranges of Idukki, Kerala. **In:** National webinar on “Spice Improvement, Processing and Marketing” & poster competition held on 7 – 8 October, 2020, Kerala Agricultural University, Regional Agricultural Research Station, College of Agriculture, Vellayani.

Aparna Joseph, Ambily Paul & Dhanya M K 2020 Pesticide residue management in dry small cardamom (*Elettaria cardamomum* (L.) Maton) in the National webinar on “Spice Improvement, Processing and Marketing” & poster competition held on 7 – 8 October, 2020, Kerala Agricultural University, Regional Agricultural Research Station, College of Agriculture, Vellayani.

Dhanya M K, Indhu P, Bisnamol J, Murugan M, Ashokkumar K, Nimisha M & Sajeena A 2020 Comparative account of some defence related biochemical in resistant and susceptible black pepper varieties/cultivars in response to infection by *Colletotrichum gloeosporioides*, **In:** International E-Conference on Multidisciplinary approaches for plant disease management in achieving sustainability in agriculture held on 6-9 October, 2020, Dept. of Plant Pathology, College of Horticulture, Bengaluru, University of Horticultural Science, Bagalkot, India.

Pasighat

Mariam Anal P S & Chandra Deo 2020 Performance of different varieties of turmeric under the influence of micro nutrient management at the foot hills of Eastern Himalayas. E-book of abstract on National Conference on Agricultural Resource Management for Atmanirbhar Bharat organized by Central Agricultural University, Impal during 17-19 July 2020.

Radio talk

Raigarh

A K Singh of IGKV, Raigarh delivered Radio talk on 4 June 2020 on “हल्दी एवं अदरक का भंडारण कैसे करे”.

A K Singh of IGKV, Raigarh delivered Radio talk on 13 June 2020 on “पोस्ट-हार्वेस्ट तकनीक से हल्दी एवं अदरक की नर्सरी कैसे तैयार करे”.

A K Singh, IGKV, Raigarh delivered Radio talk on 10 July 2020 on “बीजोपचार के लाभ”.

A K Singh, IGKV, Raigarh delivered Radio talk on 27 July 2020 on “हल्दी, अदरक एवं खरीफ फसलो की समसामयिक सलाह”.

A K Singh provided input to AIR, Raigarh on 20 June 2020 on “अदरक एवं हल्दी में पौध रोपण एवं बीजोपचार which was broadcasted on 22 and 27 June 2020”.

Sawargaonkar S L, of AICRPS centre at Raigarh delivered lecture on Techniques of cultivation of groundnut in summer and harvesting of turmeric and ginger in live recording programme of All India Radio, Raigarh on 30 January 2020.

Scientist of AICRP on Spices, Raigarh centre provided online technical input on “खरीफ मसाला फसलो अदरक, हल्दी एवम अन्य फसलो में समसामयिक सलाह एवं रोग प्रबंधन” to All India Radio for Broadcast in Kisan Vani Programme (submitted on 29 August 2020 to AIR, Raigarh for broadcasting).

Shrikant Sawargaonkar delivered a live programme in All India Radio Raigarh on 18 April, 2020 on Processing and storage of ginger and turmeric.

Kammarpally

B Mahender, SKLTSU, Kammarpally delivered Live phone in programme on turmeric varieties, turmeric protected cultivation through All India Radio Station, Adilabad on 15 June 2020.

Chintapalle

V Sivakumar, HRS, attended phone in programme organized by Dr. YSRHU and advised to farmers on black pepper cultivation as intercrop and management practices on 05 August 2020.

Hisar

T P Malik Masale wali phaslon ki dekhbhal delivered Radio talk on 24.11.2020.

ICRI, Gangtok

Ashutosh Gautam, organized Mobile spice clinic programme at Soreng, West Sikkim and about 30 large cardamom growers attended.

Ashutosh Gautam conducted farmers training programme on Altitude specificity cultivars & quality planting material through virtual mode on 10 July 2020 and 53 farmers participated from NE regions.

Ashutosh Gautam conducted a webinar “Maturity Indices and harvesting of large cardamom” on 28 August 2020 and 53 farmers attended the programme.

Ashutosh Gautam conducted three days workshop cum training programme on quality organic spices through virtual mode and 120 farmers attended.

AICRPS Headquarters, Kozhikode

Sharon Aravind delivered a radio talk on Cultivar diversity of spices (Malayalam) in Njattuvella programme of All India Radio, Kozhikode broadcasted on 4 March 2020.

Sharon Aravind conducted on line farmers class in Facebook live for FTC, Vengeri, Dept. of Agriculture, on the topic- “Improved varieties of spices” on 4 September 2020.

Guntur

Dr. K Giridhar attended Farmers Advisory Cell - Phone-in Program on 19 September 2020.

Webinars

AICRPS centre, Jagudan conducted a webinar on Recent advances in seed spices production which was attended by 243 participants across the country on 4 August 2020. The Project Coordinator delivered a lecture on “An overview of seed spices- The Indian Scenario” and emphasized on the need to produce food safe spices with minimum pesticide residues.

Coimbatore

Dr. B Senthamizh Selvi attended webinar on Vision on Doubling Farmers' Income: 'Opportunities and Challenges on 22 July 2020 and webinar on Indian Citation Index on 25 July 2020.

Dr. B Senthamizh Selvi attended the inaugural session of GoTN sponsored FAW R & D Project and Methodology Workshop on 28 July 2020.

Dr. Sundravadana attended International webinar Series on Plant Genomics organized by the Department of Botany, Savitribai Phule Pune University, Pune from 31 July - 2 August 2020.

Dr. Sundravadana attended webinar on Bioinformatic analysis on soil microbial community sequence data confirmation on 12 & 13 August 2020.

Dr. Senthamizh Selvi attended webinar on 'CRISPR/Cas 9: Basics and applications' on 17 August 2020 in the ICAR-IISR Lecture Series on Spicing up Science organized by IISR, Kozhikode.

Dr. Sundravadana attended National webinar on Boosting immunity through horticulture during 1-9 September, 2020 organized by Society for Horticultural Research and Development (SHRD), Ghaziabad, Uttar Pradesh through virtual platform.

Dr. Sundravadana attended webinar on Pesticides, Health and Safety during 03- 04 September 2020 organized by Horticultural College and Research Institute for Women, Trichy.

Dr. Sundravadana attended webinar on How to access Taylor & Francis Journals & How to publish Open Access on 16 September 2020.

Dr. Senthamizh Selvi B attended the TNAIMP Interface Workshop and delivered lecture on coconut & curry leaf – production technology, value addition and marketing opportunities organized by FC&RI, Mettupalayam on held during 28 to 30 September 2020.

Dr. B. Senthamizh Selvi participated in the webinar on “Turmeric processing: A spice to boost immunity” organized by ICAR-Central Institute of Agrl. Engineering, Regional Centre, Coimbatore on 16 October 2020.

Dr. Sundravadana attended the 'International Colloquium on Crop Physiology (ICCP 2020)' on November 26 and 27, 2020.

Dr. Senthamizh Selvi attended webinar on Historical and current classification systems' and plant genetic resources for breeding crops with enhanced productivity and quality' jointly organized by Centre for Plant Breeding and Genetics & Indian Society of Plant Breeders on 28 November 2020.

Jagudan

Dr. N R Patel & Dr. Surabhi Chauhan, AICRPS centre, participated webinar on Recent advances in seed spices production which was organized by SDAU, Jagudan on 4 August 2020.

Kumarganj

Dr. Pradeep Kumar participated in the National webinar on Spice Improvement, processing & marketing organized by Regional Agricultural Research Station, Southern Zone (Kerala Agricultural University) on 07-08 October 2020.

Dr. Pradeep Kumar attended webinar on Prime Minister formalization of Micro Food Processing Enterprises (PMFME) Scheme organised by College of Horticulture and Forestry, NDUAT, Ayodhya (UP) on 22 October 2020.

Guntur

Dr. B Tanuja Priya participated in two day national webinar on “Application of biotechnological tools in crop Improvement” organized by RajmataVijayaraje Scindia Krishi Vishwa Vidhyalaya, Gwalior, M P held during 10 & 11 June 2020.

Dr. B Tanuja Priya participated in one day national webinar on “Nutraceuticals and medicinal herbs for health & immunity” organized by the Department of Botany & IQAC, St. Joseph's College for Women (A), Visakhapatnam, Andhra Pradesh on 20.06.2020.

Dr. B Tanuja Priya attended National webinar on “Recent biotechnological tools for crop improvement” organized by Advanced P.G. Centre, Lam, Guntur, ANGRAU on 24 June 2020.

- Dr. B Tanuja Priya attended webinar on “Agricultural marketing amidst covid-19: Issues and implications” organized by ASPEE Agribusiness Management Institute, NAU, Navsari, Gujarat on 30 June 2020.
- Dr. K Giridhar, Dr. B Tanuja Priya & Dr. N Hariprasad Rao attended webinar on Registration of germplasm at ICAR-NBPGR-Procedures and Guidelines on 31st July, 2020.
- Dr. B Tanuja Priya attended National webinar on Strategies and technological interventions for sustainable horticulture in North-eastern regions organized by Central Agricultural University, Imphal from 5 to 7 August 2020.
- Dr. Giridhar, attended a webinar on registration of elite genotypes of horticulture crops conducted by NBPGR on 31 August 2020.
- Dr. K Giridhar attended the farmers meeting and briefed about Best management practices in Turmeric through Zoom platform conducted by KVK, Vonipenta, Kadapa district on 8 September 2020
- Dr. B Tanuja Priya attended a National webinar on Micro-irrigation and improved efficiency in farming conducted by ANGRAU on 10 October 2020.
- Dr. K Giridhar & Dr. B Tanuja Priya attended a webinar on Imaging sensor based phenotyping on crops-Lecture series under spicing of science on 14 October 2020, conducted by ICAR-IISR, Kozhikode.
- Dr. K Giridhar attended webinar on Ameliorative measures for horticultural crops after heavy rains on 23 October 2020, conducted by Dr. Y.S.R. Horticultural University and delivered a lecture on Ameliorative measures for turmeric after heavy rains.
- Dr. K Giridhar & Dr. B Tanuja Priya attended 28th Central Sub-Committee on Crop Standards, Notification and Release of Varieties on 28 October 2020.
- Dr. K Giridhar & Dr. B Tanuja Priya attended a webinar on Soil borne plant pathogens – management with special emphasis on biocontrol agents on 5 November 2020 organized by Dr. YSRHU, VR. Gudem.
- Dr. K Giridhar & Dr. B Tanuja Priya attended a webinar on Nematodes and its management on 9 November 2020 organized by Dr. YSRHU, VR. Gudem.
- Dr. K Giridhar attended a webinar Buyer Seller meet on Turmeric (Odisha), conducted by Spices Board on 17-11-2020.
- Dr. K Giridhar attended RytuSadassu at Kanteru to implement Vice-chancellor’s Village programme on 17-11-2020.
- Dr. B Tanuja Priya, participated in E-conference on “Advances and future outlook in biotechnology and crop improvement for sustainable productivity” from 24 to 27 November 2020 organized by COH, UHS, Bengaluru.

Panniyur

- Dr. Airina C K participated in the webinar organized by the Indian Society for Spices in collaboration with ICAR-Indian Institute of Spices Research, Kozhikode on the thematic area, Improved production technologies in black pepper on 27 August 2020.
- Dr. Airina C K participated in the International webinar on Horticulture Industry under Covid-19 Pandemic organized jointly by Department of Horticulture and College of Horticulture, Assam Agricultural University, Jorhat 27-28 August 2020.
- Dr. Ajith P M, participated in the webinar on “Turmeric processing: A spice to boost immunity” organized by ICAR-Central Institute of Agrl. Engineering, Regional Centre, Coimbatore on 16 October 2020.
- Dr. Ajith P M & Dr. Airina C K participated in 2 days International webinar on Advances in Experimental Designs and Regression Analysis organized by Dept. of Agricultural Statistics, College of Horticulture, Vellanikkara, KAU during 20-21 October 2020 in connection with World Statistics Day 2020.
- Dr. Ajith P M attended the International webinar on Genomic Selection in Crop Plants by Dr. Bernados Ordas conducted by Plantgenomia on 24 October 2020.
- Dr. Ajith P M attended as a faculty member for 64th Krishipadhasala of Dept. of Agriculture and Farmers’ Welfare, RATTC, Kazhakkootam, on Black pepper cultivation on 28 October 2020.
- Dr. Ajith P M was Panel Expert for 6th Enwenar Series on Genome Saviours (Black pepper) of NAATTI (Nature Agro biodiversity Action and Technology Transfer Initiative) under Pulari NGO on 30 October 2020.

Jobner

- Sh. G L Kumawat attended webinar on Spices in the Post-Covid-19 organized by ICAR-IISR in collaboration with Indian society for spices (ISS), IISR, Kozhikode, Kerala on 27 May 2020.
- Sh. G L Kumawat attended International webinar on “Conservation & Safety of Environment: Current Scenario & future strategies” organized by Dept. of Botany, J.N. Vyas Univ., Jodhpur, Rajasthan on 05 June 2020.
- Sh. G L Kumawat attended webinar on Role of organic farming in quality production during post covid-19 Era conducted by COA, AU, Ummedganj, Kota on 10 June 2020.
- Sh. G L Kumawat attended one day webinar training on Medicinal & Aromatic plants suitable for Rajasthan conducted by KVK-Dholpur, (SKNAU), Rajasthan on 11 June 2020.

- Sh. G L Kumawat attended webinar on Agripreneurship- A step towards self reliant India”organized by SKNAU, Jobner on 12 June 2020.
- Sh. G L Kumawat attended National webinar on Technological advances in crop production during COVID-19 organized by MPUA&T, Udaipur, Rajasthan in 22 June 2020.
- Dr. A C Shivran attended National webinar on strategy for strengthening agriculture education under changing scenario of COVID-19 organised by SKRAU, Bikaner, Rajasthan during 26 & 27 June 2020.
- Dr. A C Shivran & Sh G L Kumawat attended webinar on Management strategies for the desert locust organized by SKNAU, Jobner, Rajasthan on 27 June 2020.
- Dr. A C Shivran attended webinar on Boosting up your emotional immunity organized by IQAC, Jagannath University, Jaipur, Rajasthan on 03 July 2020.
- Dr. A C Shivran attended a webinar titled From mendelian genetic to modern genomics organized by IARI, New Delhi on 11 July 2020.
- Sh. G L Kumawat attended webinar on Plant Viral Diseases: Economic Implications & Their Management organized by Founder, Bioingene.com on 15 July 2020.
- Sh. G L Kumawat attended online seminar on Understanding plant-virus interaction to identify novel antiviral weapon in the plant arsenal organized by Founder, Bioingene.com on 15 July 2020.
- Dr. A C Shivran attended webinar on Intellectual property right in agriculture sector organised by SKRAU on 17.07.2020.
- Sh. G L Kumawat attended National webinar on Role of medicinal plants in daily life organized by USWS, Bareilly (UP) & NMPB, Ministry of Ayush, GOI on 19 July 2020.
- Dr. A C Shivran & Sh G L Kumawat attended Recent advances in seed spices production organized by Sardarkrushinagar Dantiwada Agricultural University, Jagudan on 04 August 2020.
- Dr. D K Gothwal, Dr. A C Shivran & Sh G L Kumawat attended webinar on Combating salt stress: opportunity to enhance livelihood security of affected farmers organized by ICAR-CSSRI, Karnal & SKNAU, Jobner, Rajasthan on 10 August 2020.
- Sh. G L Kumawat attended National webinar on Recent trends in horticultural entomology organized by Sardarkrushinagar Dantiwada Agricultural University, Jagudan on 27 August 2020.
- Sh. G L Kumawat attended International webinar on CRISPR in Agriculture : Context of improving WUE organized by Founder, Bioingene.com on 12 September 2020.
- Dr. A C Shivran attended Utilization of organic waste for soil health management and energy production under changing climate scenario organized by SKNAU, Jobner, Rajasthan on 6 October 2020.
- Sh. G L Kumawat attended National webinar on Integrated disease management in horticultural crops Organized by Sardarkrushinagar Dantiwada Agricultural University, Jagudan on 22 October 2020.

Yercaud

- Dr. Anand delivered a lecture on production technology of black pepper in 6th International coffee day at Technology Evaluation Center, Coffee Board, Yercaud on 7 October 2020.
- Dr. Anand participated in the webinar on “Turmeric processing: A spice to boost immunity” organized by ICAR-Central Institute of Agrl. Engineering, Regional Centre, Coimbatore on 16 October 2020.

Pampadumpara

- Dr. Dhanya M K attended International E-Conference on Multidisciplinary approaches for plant disease management in achieving sustainability in agriculture organized by Dept. of Plant Pathology, College of Horticulture, Bengaluru, University of Horticultural Sciences, Bagalkot during 6-9 October, 2020.
- Dr. Murugan M, AICRPS centre at Pampadumpara handled a session on Impact of climate change on spice crops in the National webinar on Spice Improvement, Processing and Marketing held at Kerala Agricultural University, Regional Agricultural Research Station, College of Agriculture, Vellayani during 7 – 8 October, 2020.
- Dr. M Murugan, Dr. Dhanya M K & Dr. Nimisha Mathews attended National webinar on Spice Improvement, Processing and Marketing & poster competition organized by Kerala Agricultural University, Regional Agricultural Research Station, College of Agriculture, Vellayani during 7 – 8 October, 2020.
- Dr. Dhanya M K attended IPS South Zone Virtual Symposium 2020 on Advances in crop health management organized by The Indian Phytopathological Society (Southern zone chapter) in association with ICAR-Indian Agricultural Research Institute, Regional Station, Wellington, Tamil Nadu during 1– 2 December, 2020.

Chintapalle

- Dr. Sivakumar V attended national conference on Recent trends and new frontiers in Biotechnology, Agriculture, Science and Environment supported by Department of Biotechnology (DBT) during 22-23 February 2020 at St. John College, Agra.

- Dr. Sivakumar V attended National conference on Agricultural Resource Management for Atmanirbhar Bharat on 17-19 July, 2020 through virtual mode organized by Central Agriculture University, Imphal.
- Dr. Sivakumar V attended National webinar on Agri Entrepreneur Business Summit (AEBS)-2020 on Re-inventing rural entrepreneurship and agri business possibilities - challenges and opportunities on 8-9 August 2020 through virtual mode.

AICRPS Headquarters, Kozhikode

- Scientists of PC cell attended the webinar Spices in the post-COVID scenario organized by Indian Society for Spices on 27 May 2020.
- Dr. Sharon Aravind attended 4th Y R Sarma Memorial Lecture by Prof. M. S. Reddy on Nano based microbial technologies for 21st century's sustainable spices cultivation on 29 June 2020
- Dr. Sharon Aravind attended webinar on Improved production technologies of cardamom organized by ICAR-KVK, Kodagu and ICAR-IISR, RS, Appangala on 28 July 2020.
- Dr. Sharon Aravind attended Webinar on Recent advances in seed spices production organized by SDAU, Jagudan on 4 August 2020.
- Dr. Sharon Aravind attended webinar on CRISPR/Cas 9: Basics and applications on 17.08.2020 in ICAR-IISR Lecture Series on Spicing up Science organized by ICAR-IISR, Kozhikode.
- Dr. Sharon Aravind attended International webinar on Omics in crop Improvement organized by Annamalai University on 21 August 2020.
- Dr. Sharon Aravind participated in the webinar organized by the Indian Society for Spices in collaboration with ICAR-Indian Institute of Spices Research, Kozhikode on the thematic area Improved production technologies in black pepper on 27 August 2020.
- Dr. Sharon Aravind attended webinar on Turmeric processing: A spice to boost immunity, organized by ICAR-CIAE Regional centre, Coimbatore on 16 October 2020.
- Dr. Sharon Aravind attended consultative meeting on quality planting material production in the NE region, jointly organized by the Mission Organic Value Chain Development for NE Region (MOVCD-NER) and ICAR- IISR/ ICAR-AICRPS, Kozhikode on 16 October and 4 November 2020
- Dr. Sharon Aravind attended webinar on Prospects of Horticulture in South India, organized by Dr. YSRHU, Andhra Pradesh on 07 November 2020.
- Dr. Sharon Aravind attended International E-Conference on Advances and Future Outlook in Biotechnology and Crop Improvement for Sustainable Productivity organized by UHS, Bagalkot during 24-27 November 2020

Fakhrudin Ali Ahmed Award for outstanding research in tribal farming systems

Dr. V. Sivakumar, Scientist (Hort.) & Head, HRS, Chintapalle received **ICAR-Fakhruddin Ali Ahmed Award** in association with Scientists of ICAR-IISR, Kozhikode for Outstanding Research in Tribal Farming Systems during 92nd foundation day of ICAR, New Delhi.

Best AICRPS Centre Award

AICRP on Spices centre, Indira Gandhi Krishi Viswavidyalaya University, Raigarh

Recognition

Dr. V. Sivakumar, Dr. YSRHU, Chintapalle bagged **Young Scientist Award** during national conference on Recent trends and new frontiers in Biotechnology, Agriculture, Science and Environment supported by Department of Biotechnology (DBT) during 22-23 February 2020 at St. John College, Agra.

Dr. M. Anand, HRS, Yercaud received **Research Excellence Award 2020** conferred by the Institute of Scholars

Dr. Ritesh K. Patel, NAU, Navsari was recognized with **Sadvichar Parivar Award** for the significant contribution in the development of coriander variety Gujarat Coriander-3 (GCO-3) by The Gujarat Association for Agricultural Sciences on 3 October 2020.

Project Coordinator's Office

- | | |
|-------------------------------------|---|
| 1. Project Coordinator | : Dr. K. Nirmal Babu (upto 31 May 2020)
Dr. Santhosh J Eapen |
| 2. Principal Scientist (Physiology) | : Dr. K.S. Krishnamurthy |
| 3. Scientist (SPMAP) | : Dr. Sharon Aravind |
| 4. Chief Technical Officer | : Mr. John George (joined on 4 October 2020) |
| 5. 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. Anil Kumar |

2. Pepper Research Station, KAU, Panniyur

- | | |
|------------------------|---------------------------|
| 1. Jr. Breeder | : Dr. P. M. Ajith |
| 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. Jr. Horticulturist | : Dr. M. Shivaprasad |
| 2. Technical Assistant | : Vacant |

4. Horticultural Research Station (UHS), Sirsi

- | | |
|------------------------|--------------------------------|
| 1. Jr. Horticulturist | : Mr. Sudeesh Kulkarni |
| 2. Jr. Pathologist | : Dr. Abdul Kareem |
| 3. Technical Assistant | : Smt. Sharanamma Basanagowdar |

5. Horticultural Research Station (TNAU), Yercaud

- | | |
|-----------------------|-----------------|
| 1. Jr. Horticulturist | : Dr. M. Anand |
| 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), Kammarapally

- | | |
|------------------------|-----------------------|
| 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. Jr. Horticulturist | : Dr V. Siva Kumar |
| 2. Technical Assistant | : Vacant (Contract basis) |

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

- | | |
|------------------------|--------------------|
| 1. Jr. 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 Altitude Research Station (OUAT), Pottangi

1. Jr. Breeder : Dr. Parshuram Sial
2. Technical Assistant : Vacant

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

1. Sr. Breeder : Dr. D. K. Gothwal
2. Jr. Pathologist : Sh. G. L. Kumawat
3. Jr. Agronomist : Dr. A. C. Shivran
4. Technical Assistant : Sh. S. R. Kumawat

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

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

14. Department of Vegetable Crops, CCS HAU, Hisar

1. Jr. Pathologist : Dr. Suresh Tehlan
2. Jr. 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. Technical Assistant : Sh. R.K. Gupta

17. Department of Horticulture (UBKV), Pundibari

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

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

1. Jr. Horticulturist : Dr. P. C. Mali
2. Jr. Breeder : Dr. J. P. Devmore
3. Technical Assistant : Shri. R.G. Nachare

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

1. Jr. Pathologist : Dr. Ajit Kumar Singh
2. Jr. Breeder : Dr. Shrikant Laxmikant Sawargaonkar
3. Technical Assistant : Mr. D. S. Kshatri

Trainings attended by the Staff of AICRPS

S. No	Name of scientist	Details of training	Venue	Duration
1.	Dr. Nimisha Mathews, CRS, Pampadumpara, Kerala	Foundation course on "Research education and extension management" for the newly recruited assistant professors of Kerala Agricultural University	KAU, Thrissur	13.01.2020 to 18.01.2020
2.	Dr. Najeeb Naduthodi, Assistant Professor, RARS, Ambalavayal	Foundation course on Research, education and extension management	KAU, Thrissur	10.02.2020 to 15.02.2020
3.	Ms. Airina C. K, PRS, Panniyur, Kerala	Foundation course on "Research, education and extension management"	KAU, Thrissur	10.02.2020 to 15.02.2020
4.	Dr. K. S. Krishnamurthy & Dr. Sharon Aravind, PC cell	Basics of e - office system	ICAR - IISR, Kozhikode	04.06.2020 to 18.06.2020
5.	Dr. S K Pandey & Dr. Reena Nair, JNKVV, Jabalpur	Remote Sensing & GIS Technology and Applications for University Teachers & Government Officials C	Indian Institute of Remote Sensing, Dehradun	13.06.2020 to 01.07.2020
6.	Dr. M Anand, HRS, Yercaud	Research Support Tools: Effective e-Learning with Smart tools & Techniques	JNKVV, Jabalpur	15.06.2020 to 18.06.2020
7.	Dr. V. Sivakumar, HRS, Chintapalle	International online short course on "Precision Agriculture: A Technology for Income Augmentation & Entrepreneurship Development"	CAU, Lembucherra, Tripura	07.07.2020 to 18.07.2020
8.	Dr. Parshuram Sial, HARS, Pottangi, Odisha	Online training programme on " Analysis of data"	NAARM, Hyderabad	05.08.2020 to 11.08.2020
9.	Dr. V. Sivakumar, HRS, Chintapalle	Massive Open Online Course (MOOC) on Information handling skills for teaching, learning & research	PJTSAU, Rajendranagar, Hyderabad under NAHEP	26.08.2020 to 16.09.2020
10.	Dr. Airina C. K, PRS, Panniyur, Kerala	Online HRD training programme on "Innovations in Educational technology and Change management"	Central Training Institute, Mannuthy, KAU	22.10.2020 to 23.10.2020
11.	Dr. Nimisha Mathews, CRS, Pampadumpara, Kerala	Online training on "Rodent Pests Management "	NIPHM, Hyderabad	26.10.2020 to 30.10.2020
12.	Dr. Sundravadana, TNAU, Coimbatore	Online training on "Pest Surveillance "	NIPHM, Hyderabad	07.12.2020 to 11.12.2020
13.	Dr. Parshuram Sial, HARS, Pottangi, Odisha	Training programme on "Emerging Trends in Seed Production Technology and Quality Control Framework for Effective Seed Supply Chain of Horticulture Crops"	DBT and Crop Improvement, CoH, Bidar Karnataka	28.12.2020 to 06.01.2021

Weather Data

25

PANNIYUR						PAMPADUMPARA			
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-20	-	-	35.04	22.96	92.80	4.4	1	21.30	11.75
Feb-20	4	1	36.47	23.43	93.13	-	-	22.08	12.48
Mar-20	2	1	37.52	25.31	92.35	15.0	2	24.33	14.90
Apr-20	34.6	4	38.49	26.43	92.33	45.2	6	25.03	15.48
May-20	162.5	14	36.83	26.89	92.09	53.0	7	25.08	15.51
June-20	904.8	26	32.24	25.48	93.9	123.7	21	22.06	12.31
July-20	946.1	27	31.36	25.57	94.74	307.4	19	21.66	12.06
Aug-20	928.6	22	30.60	25.55	93.45	441.6	15	21.54	11.83
Sept-20	738.4	23	31.24	25.40	94.56	300.2	23	21.21	11.43
Oct-20	252.3	12	31.92	24.61	93.64	202.0	17	21.88	12.16
Nov-20	59.6	6	34.49	24.25	93.73	239.6	13	21.65	11.90
Dec-20	18	2	34.77	23.59	93.63	35.8	10	20.48	11.05

SANAND					RAIGARH				
Month	Rain fall (mm)	No. of rainy days	Temperature (°C)		Rain fall (mm)	Temperature (°C)		RH (%)	
			Max.	Min.		Max.	Min.	I	II
Jan-20	0.0	0.0	25.9	9.2	30.6	25.8	12.9	85.5	61.8
Feb-20	0.0	0.0	31.1	11.0	35.6	28.0	14.1	84.5	53.9
Mar-20	3.0	2.0	33.7	14.3	102.8	31.4	20.9	86.8	56.5
Apr-20	0.0	0.0	40.3	19.0	54.6	36.1	24.8	81.9	43.7
May-20	0.0	0.0	43.2	23.3	10.4	39.9	28.8	71.4	42.9
June-20	58.0	5.0	38.0	25.9	380.4	33.1	27.0	84.4	67.8
July-20	79.0	9.0	35.4	25.9	302.8	32.4	27.1	85.2	71.1
Aug-20	183.0	18.0	32.5	24.9	621.6	30.5	26.3	88.6	78.4
Sept-20	44.0	2.0	34.3	25.4	273.2	32.7	26.6	85.2	68.8
Oct-20	-	-	-	-	29.4	32.8	23.8	83.4	60.4
Nov-20	0.0	0.0	32.6	13.0	13.6	30.4	18.9	82.6	48.6
Dec-20	1.0	1.0	30.4	11.6	1.2	29.0	14.1	83.0	51.9

MUDIGERE						SIRSI				
Month	Rain fall (mm)	Temperature (°C)		RH (%)		Rain fall (mm)	Temperature (°C)		RH (%)	
		Max.	Min.	I	II		Max.	Min.	I	II
Jan-20	0	29	18.06	80	60.12	0.0	30.9	15.1	87.0	62.0
Feb-20	0	30.27	17.344	80.413	60.827	0.0	32.3	14.5	85.3	56.8
Mar-20	2.3	32.70	18.61	80.25	60.64	0.0	34.0	17.0	85.2	50.1
Apr-20	60.6	30.866	18.766	80.533	60.4	28.6	35.0	20.7	87.4	43.0
May-20	113.7	28.61	20.61	76.16	61.06	77.8	33.5	21.4	89.6	55.0
June-20	257.2	25.36	20.3	71.6	60.26	456.6	28.5	21.1	89.9	76.1
July-20	553.5	25.37	20.3	69.87	36.12	503.4	27.2	21.2	90.9	78.4
Aug-20	769.9	24.64	20.0	70.67	45.16	971.4	26.5	21.0	92.2	83.0
Sept-20	417.8	25.4	19.9	61.23	43.46	282.6	28	21.0	90.3	76.1
Oct-20	195.7	26.5	19.61	54.70	38.03	225.4	29.1	20.3	89.5	72.5
Nov-20	16.0	28.53	19.56	62.06	46.73	0.0	30.1	17.4	84.6	66.0
Dec-20	43.2	28.74	19.12	60.90	45.06	0.0	30.2	15.4	85.0	64.9

CHINTAPALLE							GUNTUR					
Month	Rain fall (mm)	No. of rainy days	Temperature (°C)		RH (%)		Rain fall (mm)	No. of Rainy days	Temperature (°C)		RH (%)	
			Max.	Min.	I	II			Max.	Min.	I	II
Jan-20	0	0	27.90	5.61	92.23	59.26	7.6	1	31.1	19.3	88.9	77.5
Feb-20	0	0	30.30	6.07	89.68	58.25	4.8	1	33.4	20.1	86.7	60.6
Mar-20	32.00	3.0	30.09	15.41	75.03	55.19	0.8	0	35.4	24.2	85.7	46.2
Apr-20	105.60	7.0	33.39	18.23	67.23	64.00	2.0	0	37.2	26.0	89.4	43.3
May -20	128.90	5.0	32.29	19.80	80.74	80.67	14.3	1	38.7	26.7	89.0	33.0
June -20	290.60	9.0	31.80	22.86	86.20	85.03	188.6	10	37.0	27.9	87.9	51.9
July -20	172.20	9.0	26.54	21.64	90.61	91.67	308.2	14	34.1	24.9	94.5	77.0
Aug-20	307.00	13.0	26.87	21.35	90.19	91.16	163.4	13	32.1	23.2	92.5	72.3
Sept-20	218.40	10.0	27.16	21.30	89.53	88.20	172.8	8	33.8	25.0	89.7	67.1
Oct-20	225.60	8.0	27.38	18.32	91.45	91.29	162.0	7	30.1	20.8	90.4	82.7
Nov-20	0	5.0	26.83	14.08	90.56	91.66	145.0	5	31.2	17.2	81.2	67.4
Dec-20	0	0.0	25.32	10.12	89.54	91.12	0	0	30.9	15.2	75.4	54.5

DAPOLI							POTTANGI				
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-20	0.0	0.0	30.5	14.5	92.4	55.2	8.2	1	29	14	
Feb-20	0.0	0.0	32.8	14.4	91.6	48.9	2.0	1	30	15	
Mar-20	0.0	0.0	32.6	16.7	86.1	51.4	41.2	4	34	20	
Apr-20	0.1	0.0	34.0	20.8	87.5	52.4	210.0	12	36	22	
May -20	0.2	0.0	34.2	23.3	85.4	59.9	17.4	4	37	23	
June-20	25.7	0.8	30.8	23.6	93.3	84.2	265	15	32	23	
July -20	46.9	0.8	29.0	23.5	95.2	89.5	357.8	21	31	24	
Aug-20	45.0	1.0	28.4	23.5	94.2	90.7	196.9	19	31	23	
Sept-20	11.3	0.6	30.1	23.1	94.5	80.2	125.4	11	32	27	
Oct-20	5.5	0.3	30.8	22.4	94.2	79.2	261.2	17	31	26	
Nov-20	0.0	0.0	33.1	17.3	87.0	50.9	43.0	3	29	23	
Dec-20	0.3	0.0	32.5	14.9	92.5	67.1	0	0	28	19	

KUMARGANJ						DHOLI				
Month	Rain fall (mm)	Temperature (°C)		RH (%)		Rain fall (mm)	Temperature (°C)		RH (%)	
		Max.	Min.	I	II		Max.	Min.	I	II
Jan-20	5	19.1	8.6	91.7	70.8	6.2	19.6	9.4	92	75
Feb-20	2	23.4	9.1	90.7	53.2	24.0	24.6	10.9	92	64
Mar-20	4	28.4	16.7	80.8	50.4	29.6	29.0	16.2	86	57
Apr-20	4	35.3	19.5	74.8	33.9	143.8	33.8	19.9	84	63
May -20	5	36.4	23.0	76.3	41.5	106.0	33.2	21.5	85	71
June-20	4	33.5	19.5	74.8	33.9	288.6	32.1	19.6	90	81
July -20	20	32.9	26.9	91.0	74.5	646.8	32.3	21.1	92	85
Aug-20	9	33.5	26.5	87.4	65.2	154.8	33.1	24.7	91	82
Sept-20	5	31.4	25.0	91.9	82.8	233.4	32.4	25.8	92	84
Oct-20	1	32.7	19.4	90.8	68.7	0.0	33.1	24.3	88	70
Nov-20	00	27.0	14.5	93.5	60.5	0.0	28.7	16.0	86	56
Dec-20	00	18.7	9.0	89.8	75.7	-	-	-	-	-

PUNDIBARI						NAGALAND					
Month	Rain fall (mm)	Temperature (°C)		RH (%)		Rain fall (mm)	Temperature (°C)		RH (%)		
		Max.	Min.	I	II		Max.	Min.	I	II	
Jan-20	0.8	22.8	9.9	91.1	59.7	1.2	21.2	7.6	76	53	
Feb-20	11.0	26.0	10.8	84.0	49.7	8.6	24.2	10.2	87	54	
Mar-20	43.4	29.0	16.1	74.7	51.2	76.2	30.2	16.2	95	59	
Apr-20	107.4	30.8	18.5	70.5	56.4	173.6	34.6	18.8	94	56	
May-20	393.5	30.6	21.6	83.0	71.5	188.8	35.4	22.2	94	65	
June-20	1107.8	31.3	24.3	93.0	82.0	205.0	37.2	24.2	94	74	
July-20	1368.9	30.6	24.7	96.5	86.0	276.0	37.0	24.2	93	72	
Aug-20	409.8	33.2	25.4	89.0	76.0	318.2	37.6	24.0	94	72	
Sept-20	1426.7	30.2	23.9	93.4	84.0	105.7	30.2	20.4	94	67	
Oct-20	90.2	32.9	22.2	80.0	67.0	54.0	28.4	21.1	86	57	
Nov-20	0.0	29.6	14.0	71.0	49.0	24.4	28.2	19.2	76	58	
Dec-20	0.0	26.2	11.2	81.4	58.7	29.6	22.2	16.3	76	54	
MIZORAM						AMBALAVAYAL					
Month	Rain fall (mm)	No. of rainy days	Temperature (°C)		RH (%)		Rain fall (mm)	Temperature (°C)		RH (%)	
			Max.	Min.	I	II		Max	Min	I	II
Jan-20	0.60	0.00	76.50	71.50	23.25	14.75	2	28.6	16.5	94	64
Feb-20	0.00	0.00	88.00	54.50	24.55	13.05	0	29.9	16.8	96	56
Mar-20	0.00	0.00	57.50	31.50	29.80	17.25	46.3	30.7	19.4	96	63
Apr-20	1.50	0.50	73.55	48.48	29.10	18.25	180.6	30.5	19.5	93	62
May-20	0.40	0.00	92.89	70.61	27.75	17.35	180.4	29.9	20.6	92	69
June-20	5.40	1.00	90.05	77.00	28.80	19.80	211.2	25.9	19.6	93	80
July-20	20.50	1.00	94.00	85.50	28.05	22.35	303.3	25.3	19.5	96	87
Aug-20	6.20	0.50	98.71	84.73	28.40	23.35	601.5	25.2	19.2	95	88
Sept-20	7.80	0.50	98.68	82.33	29.75	19.25	389	25	19	95	82
Oct-20	5.60	0.50	94.79	91.78	27.50	18.85	127	26	18.9	93	74
Nov-20	14.90	0.50	96.19	76.75	26.25	16.60	115.2	27	18.1	93	79
Dec-20	0.00	0.00	95.50	56.50	23.90	11.90	30.6	26.4	16.9	93	73
GANGTOK						PASIGHAT					
Month	Rain fall (mm)	No. of rainy days	Temperature (°C)		Rain fall (mm)	No. of rainy days	Temperature (°C)		RH (%)		
			Max.	Min.			Max.	I	II		
Jan-20	57.0	05	12.0	1.0	97.25	3	15.79	90.97	86.16		
Feb-20	39.0	05	14.0	3.0	48.85	3	18.36	95.86	95.00		
Mar-20	164.0	14	18.0	6.0	377.04	5	21.87	91.61	90.58		
Apr-20	346.0	17	18.0	9.0	172.00	8	25.62	89.03	95.67		
May-20	405.0	21	23.0	10.0	439.00	15	25.14	92.30	90.07		
June-20	784.0	27	23.0	12.0	1470.27	22	26.7	93.5	92.8		
July-20	970.0	31	23.0	15.0	1414.72	19	27.3	94.3	93.0		
Aug-20	644.0	27	24.0	16.0	581.83	11	27.3	92.7	91.3		
Sept-20	729.0	25	22.0	13.0	991.31	18	27.91	86.17	85.57		
Oct-20	137.0	09	21.0	09.0	183.48	10	29.92	77.84	76.77		
Nov-20	-	-	16.0	07.0	48.00	5	22.97	78.37	69.5		
Dec-20	42.0	03	12.0	05.0	15.38	3	18.58	83.61	66.58		



MYLADUMPARA						KOTA				
Month	Rain fall (mm)	No. of rainy days	Temperature (°C)		RH (%)	Rain fall (mm)	Temperature (°C)		RH (%)	
			Max	Min			Max	Min	I	II
Jan-20	14.60	1	25.54	11.83	87.81	0	22.765	8.08	85.07	72.64
Feb-20	-	-	26.75	12.06	86.26	0	25.0875	11.75	85.10	69.42
Mar-20	39.00	3	28.90	14.20	87.00	19	28.36	15.55	80.14	63.85
Apr-20	132.20	8	29.50	14.50	85.95	3.2	39.23	18.21	60.25	38.17
May -20	132.40	7	28.00	16.10	88.87	0	42.27	20.84	35.74	22.628
June-20	144.40	21	25.60	14.80	92.43	93.5	39.30	23.21	64.85	44.11
July -20	390.35	20	25.10	14.50	93.20	97.5	37.25	23.64	72.85	47.5
Aug-20	711.50	14	24.10	14.70	93.90	335.6	34.89	22.87	78.79	64.54
Sept-20	546.75	24	23.50	14.60	95.20	117.6	35.15	23.14	84.03	78.07
Oct-20	249.00	18	24.70	14.10	92.20	0	35.17	20.71	78.46	77.07
Nov-20	310.10	14	25.00	14.10	93.00	0	31.51	14.72	86.04	70.22
Dec-20	62.60	11	23.45	13.20	92.05	0	26.65	10.05	85.52	66.42
PEECHIPARAI						SAKLESHPUR				
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-20	2.2	0	33.5	23.6	77	-	-	27.92	14.76	
Feb-20	12	1	35.0	23.5	71.5	-	-	30.94	16.21	
Mar-20	26.8	3	34.4	24.0	73.0	-	-	33.15	18.00	
Apr-20	247.4	12	30.2	24.4	80.1	39.0	4	33.83	19.08	
May-20	389.9	17	29.4	24.0	76	34.0	3	32.75	19.05	
June-20	251.3	11	30.0	24.0	77	317.2	21	27.31	18.93	
July-20	127.3	8	29.0	24.0	75	987.3	25	24.05	18.05	
Aug-20	143.1	12	30.0	24.2	80	1779.7	26	23.55	18.27	
Sept-20	364.3	20	30.2	24.0	85	582.45	19	24.64	18.52	
Oct-20	166.7	7	29.5	23.9	80	324.0	16	26.73	18.53	
Nov-20	90.3	6	30.5	24.2	82	68.0	3	27.44	17.44	
Dec-20	72.1	4	30.2	24.1	80	24.0	1	23.66	16.33	
SOLAN						HISAR				
Month	Rain fall (mm)	Temperature (°C)		RH (%)	Rain fall (mm)	Temperature (°C)		RH (%)		
		Max	Min			Max	Min	I	II	
Jan-20	168.30	15.70	2.50	68	10.4	17.1	5.2	97	66	
Feb-20	38.50	20.20	4.10	57	10.9	22.7	6.8	93	51	
Mar-20	171.80	21.20	7.20	62	95.2	25.9	12.4	92	56	
Apr-20	47.70	27.60	10.70	51	5.3	34.1	17.6	74	33	
May-20	54.9	30.7	16.1	42	36.2	39.4	22.6	61	27	
June -20	190.0	29.7	18.9	62	48.8	38.2	26.1	72	42	
July -20	340.2	26.7	20.2	81	172.9	36.0	26.9	87	63	
Aug-20	216.6	27.6	20.0	79	62	34.8	26.6	89	69	
Sept-20	224.3	26.5	16.9	76	39.5	36.0	24.3	88	52	
Oct-20	26.0	25.1	9.1	53	0	34.4	14.8	81	26	
Nov-20	24.8	21.7	6.5	59	19.9	26.1	9.9	89	40	
Dec-20	21.6	18.1	1.6	58	0	21.6	5.0	93	51	

JOBNER						BARAPANI				
Month	Rain fall (mm)	No. of rainy days	Temperature (°C)		RH (%)	Rain Fall (mm)	Temperature (°C)		RH (%)	
			Max	Min			Max	Min	I	II
Jan-20	-	-	23.7	4.9	70	14.5	18.8	6.5	87.9	58.3
Feb-20	-	-	28.2	5.3	57	54.0	20.8	7.9	85.6	54.6
Mar-20	6.8	4	32.7	11.2	65	75.4	24.6	11.3	81.2	52.6
Apr-20	6.4	3	39.9	16.9	51	223.5	26.2	14.3	82.0	64.3
May-20	8.8	5	43.2	21.8	48	578.5	26.1	17.0	85.5	78.4
June-20	8.8	4	41.9	22.5	57	463.5	27.0	20.4	89.8	79.7
July-20	28.8	7	40.9	23.1	77	627.7	26.7	20.9	91.5	87.6
Aug-20	57.4	14	36.0	21.5	87	197.6	28.6	21.1	89.4	76.2
Sept-20	24.4	6	37.3	14.3	84	695.2	27.1	20.0	89.4	81.8
Oct-20	-	-	37.0	10.5	48	484.6	26.9	18.1	88.1	76.7
Nov-20	1.0	1	31.0	7.7	77	79.0	24.7	10.9	82.1	52.3
Dec-20	2.0	-	30.2	2.3	83	25.4	21.2	8.3	83.3	53.4
ICAR GANGTOK						KALYANI				
Month	Rain fall (mm)	Temperature (°C)		RH (%)		Rain fall (mm)	Temperature (°C)		RH (%)	
		Max	Max	I	II		Max	Min	I	II
Jan-20	40.7	15.5	6.68	86	53	42.10	29.05	6.90	97.19	67.38
Feb-20	21.9	18.1	9.19	86	51	2.30	30.04	8.00	95.24	57.34
Mar-20	160.0	21.5	11.90	84	50	89.80	36.20	10.06	92.26	62.21
Apr-20	198.2	23.3	14.10	87	53	28.60	38.00	12.04	88.69	89.00
May-20	252.2	25.0	16.53	89	61	308.90	38.60	12.80	91.09	82.52
June-20	444.4	26.1	20.43	92	71	169.40	37.00	17.50	93.80	84.06
July-20	814.4	25.7	20.91	92	77	375.02	35.60	19.20	92.61	85.26
Aug-20	415.6	27.6	21.12	93	91	370.80	36.40	19.80	93.93	86.93
Sept-20	553.6	25.4	20.20	92	78	205.90	35.60	19.40	93.60	81.36
Oct-20	60.8	27.3	17.88	87	55	53.10	35.60	17.50	91.90	83.42
Nov-20	0.2	21.9	11.16	87	50	0.00	35.40	6.80	90.10	68.33
Dec-20	22.0	17.1	9.57	87	54	0.00	29.60	7.00	94.52	62.51

AICRPS CENTREWISE BUDGET 2019-2020

Regular centres	Salary		TA		RC		Capital		SCSP		Total		Grand Total
	ICAR	State	ICAR	State	ICAR	State	ICAR	State	ICAR	State	ICAR	State	
Pampadumpara (KAU)	8.70	2.90	0.50	0.17	1.80	0.60	-	-	-	-	11.00	3.67	14.67
Panniyur (KAU)	27.40	9.13	1.50	0.50	3.00	1.00	-	-	-	-	31.90	10.63	42.53
Mudigere (UAHS)	13.50	4.50	0.50	0.17	1.00	0.33	-	-	-	-	15.00	5.00	20.00
Sirsi (UHS)	21.70	7.23	0.50	0.17	2.00	0.67	-	-	1.50	-	25.70	8.07	33.77
Yercaud (TNAU)	14.64	4.88	0.50	0.17	1.00	0.33	-	-	-	-	16.14	5.38	21.52
Coimbatore (TNAU)	24.00	8.00	1.00	0.34	2.00	0.67	-	-	-	-	27.00	9.01	36.01
Chintapalli (Dr.YSRHU)-TSP	9.90	3.30	0.50	0.17	4.00	1.33	6.70	-	-	-	21.10	4.80	25.90
Kammarpally (SKLTSHU)	23.00	7.67	0.50	0.17	2.00	0.67	-	-	-	-	25.50	8.51	34.01
Guntur (Dr.YSRHU)	32.34	10.78	0.50	0.17	2.00	0.67	-	-	-	-	34.84	11.62	46.46
Solan (YSPUHF)	16.50	5.50	0.50	0.17	1.00	0.33	-	-	1.80	-	19.80	6.00	25.80
Pottangi (OUAT)-TSP	10.50	3.50	0.50	0.17	4.00	1.33	-	-	2.00	-	17.00	5.00	22.00
Jobner (SKNAU)	69.92	23.31	1.00	0.34	3.50	1.17	-	-	-	-	74.42	24.82	99.24
Jagudan (SDAU)	20.00	6.67	1.00	0.34	2.00	0.67	-	-	-	-	23.00	7.68	30.68
Hisar (HAU)	32.40	10.80	1.00	0.34	2.00	0.67	-	-	-	-	35.40	11.81	47.21
Dholi (RAU)			1.00		3.00		-	-	-	-	4.00		4.00
Kumarganj (NDUAT)	31.50	10.50	1.00	0.34	2.00	0.67	-	-	-	-	34.50	11.51	46.01
Pundibari (UBKVV)	14.40	4.80	1.00	0.34	2.00	0.67	-	-	1.20	-	18.60	5.81	24.41
Dapoli (KKV)	19.80	6.60	1.00	0.34	2.00	0.67	-	-	-	-	22.80	7.61	30.41
Raigarh (IGKVV)-TSP	22.80	7.60	0.50	0.17	4.00	1.33	-	-	-	-	27.30	9.10	36.40
Total	413.00	137.67	14.50	4.58	44.30	13.78	6.70	-	6.50	-	485.00	156.03	641.03
Coopting Centres													
Ambalavayal (KAU)	-	-	0.50	0.17	2.00	0.67	-	-	1.00	-	3.50	0.84	4.34
Pechiparai (TNAU)	-	-	0.50	0.17	2.00	0.67	-	-	-	-	2.50	0.84	3.34
Gangtok (ICRI)-NEH	-	-	0.50	0.17	4.00	1.33	10.00	-	-	-	14.50	1.50	16.00
Sakleshpur (ICRI)	-	-	0.50	0.17	2.00	0.67	-	-	-	-	2.50	0.84	3.34
Myladumpara (ICRI)	-	-	0.50	0.17	2.00	0.67	-	-	-	-	2.50	0.84	3.34
ICAR RC NEHR, Barapani-NEH	-	-	0.50	0.17	4.26	1.42	-	-	-	-	4.76	1.59	6.35
ICAR RC NEHR, Mizoram-NEH	-	-	0.50	0.17	4.00	1.33	-	-	-	-	4.50	1.50	6.00
ICAR RC NEHR, Gangtok-NEH	-	-	0.50	0.17	3.00	1.00	4.50	-	-	-	8.00	1.17	9.17
Nagaland (AU)	-	-	0.50	0.17	3.91	1.30	8.30	-	-	-	12.71	1.47	14.18
Kahikuchi (AAU)	-	-	0.50	0.17	3.64	1.21	10.00	-	2.50	-	16.64	1.38	18.02
Pasighat (KAU)-NEH	-	-	0.50		5.00		21.50	-	-	-	27.00		27.00
Total	-	-	5.50	1.70	35.81	10.27	54.30	-	3.50	-	99.11	11.97	111.08
Voluntary Centres													
Pantnagar (GBPUAT)	-	-	0.50	0.17	1.50	0.50	-	-	-	-	2.00	0.67	2.67
Kanke (BIRSAU)	-	-	0.50	0.17	1.50	0.50	-	-	-	-	2.00	0.67	2.67
Kalyani (BCKVV)	-	-	0.50	0.17	1.50	0.50	-	-	-	-	2.00	0.67	2.67
Kota	-	-	0.50	0.17	1.50	0.50	-	-	-	-	2.00	0.67	2.67
Navasari (NAU)	-	-	0.50	0.17	1.50	0.50	-	-	-	-	2.00	0.67	2.67
Jabalpur (JNKV)	-	-	0.50	0.17	1.50	0.50	-	-	-	-	2.00	0.67	2.67
Mandor	-	-	0.50	0.17	1.50	0.50	-	-	-	-	2.00	0.67	2.67
Sanand	-	-	0.50	0.17	1.50	0.50	-	-	-	-	2.00	0.67	2.67
Total	-	-	4.00	1.36	12.00	4.00	-	-	-	-	16.00	5.36	21.36
Project Mode centres													
Thrissur	-	-	-	-	2.00	-	-	-	-	-	2.00	-	2.00
SRS Pampore	-	-	-	-	2.00	-	-	-	-	-	2.00	-	2.00
Total	-	-	-	-	4.00	-	-	-	-	-	4.00	-	4.00
Workshop release	-	-	-	-	1.89	-	-	-	-	-	1.89	-	1.89
Total	413.00	137.67	24.00	7.64	98.00	28.05	61.00	-	10.00	-	606.00	173.36	779.36

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, aicrspices@gmail.com
Website: www.aicrps.res.in

COORDINATING CENTRES

Sl. No.	Centre and Contact address	Telephone	Fax/E. mail
Regular Centers			
Andhra Pradesh			
1	Horticultural Research Station (Dr. YSR Horticultural University), CHINTAPALLE -531 111, Visakhapatnam, Andhra Pradesh	08937-238057 (0)	08937-238057 headhrs_chintapalle@drysru.edu.in siva200619@gmail.com
2	Horticultural Research Station (Dr. YSR Horticultural University), GUNTUR – 522 034, Andhra Pradesh	0863-2524017 /2524644(0)	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(0)	0621-2293227 pi.spices@rpcau.ac.in ashim_sigatoka@yahoo.com
Chhattisgarh			
4	Regional Agricultural Research Station (Indira Gandhi Krishi Viswavidyalaya University), RAIGARH – 496 001 Dist. Chhattisgarh	07762-222402/215235(0)	07762-222402 /215235 singh_ajit8@rediffmail.com shrikant.sawargaonkar@gmail.com
Gujarat			
5	Centre for Research on Seed Spices (Sardarkurshinagar Dantiwada Agricultural University), JAGUDAN – 382 710 Dist. Mehsana, Gujarat	02762-285337 (0)	02762-285337 rsspices@sdau.edu.in nrp_dax@sdau.edu.in
Haryana			
6	Department of Vegetable Crops (Chaudharay Charan Singh Haryana Agricultural University) HISAR – 125 004, Haryana	01662-289207 (0)	01662-234952/284306 aicrspices@hau.ernet.in tpmalik63@gmail.com sktehlant07@gmail.com
Himachal Pradesh			
7	Department of Vegetable Crops (Dr. YS Parmar University of Horticulture & Forestry), Nauni, SOLAN -173 230, Himachal Pradesh	01792-252329 (0)	01792-252329 solanspices@yahoo.com meenu Gupta1@gmail.com
Karnataka			
8	Zonal Agricultural and Horticultural Research Station (University of Agricultural and Horticultural Sciences, Shivamogga), MUDIGERE -577 132, Chikkamagalur, Karnataka	08263-228246/228135	08263-228403 /228246 aicrpszahrs@gmail.com adrzahrs@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 Dist. Idukki, Kerala	04868- 236263 (O)	04868-236263 crspam@kau.inmuthupeyan@gmail.com
11	Pepper Research Station (Kerala Agricultural University) PANNIYUR, PB No.113Kanjirangadu (P.O), Taliparamba -670 142, Cannanore, Kerala	0460-2227287 (O)	0460-2227287 ajith.pm@kau.in prspanniyur@kau.in
Maharashtra			
12	Department of Horticulture (Dr. BS 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 (Orissa 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, Dist. Jaipur, Rajasthan	01425-254036/254041(O)	01425-254022 gothwaldkskn@gmail.com acs_shivran@rediffmail.com
Telangana			
15	Turmeric Research Station [Sri Konda Laxman Telangana State Horticultural University (SKLTSHU)], KAMMARPALLY-503 308, Nizamabad Dist., 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 anandhort@gmail.com
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 Viswa Vidyalaya, North Bengal Campus PUNDIBARI-736 165, Dist. Cooch Behar, West Bengal	03582-270588 (O)	03582-270143 pundibari@rediffmail.com, pundibari@yahoo.co.in dr.anamikadebnath@rediffmail.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 (0)	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 (0)	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(0)	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 (0)	03837-220560 sunilsunani11@gmail.com
Nagaland			
7	The Head, Department of Horticulture, SASRD, Nagaland University, MEDZIPHEMA -797 106, Dimapur, Nagaland	03862-247212 (0)	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/(0)	03592-231307 rrspicesgtk@yahoo.com ashutoshgtm9@gmail.com
9	Joint Director ICAR Res. Complex For NEH Region, Regional Station, Sikkim Center , Tadong, GANGTOK -737 102, Sikkim	03592- 231030//232125 (0)	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(0)	hrsppi@tnau.ac.in tprabhuphd@gmail.com
Voluntary Centres			
Arunachal Pradesh			
1	The Dean Central Agricultural University, College of Horticulture & Forestry, PASIGHAT -791 102, Arunachal Pradesh	0368-2224887 (0)	0368-2225066 psmariamlui@gmail.com
Gujarat			
2	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 (0)	02637-283452 /282765 ritesh147@gmail.com
3	Assistant Research Scientist Castor-Seed Spices Research Station, Anand Agricultural University, Ahmedabad, SANAND - 382 110, Gujarat	02717-294325 (0)	arssanand@aau.in
Jharkhand			
4	The Director of Research, Birsra Agricultural University KANKE , Ranchi-834 006, Jharkhand	0651-2450610/ 2451011 (0)	0651-2451011 aruntiway40@gmail.com

Madhya Pradesh

5	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
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Rajasthan

6	Associate Professor Agricultural Research Station, (Agricultural University Kota) Ummedganj Farm, KOTA -324 001 Rajasthan	0744-2844369 (O)	0744-2844306 arskota@hotmail.com preetiarskota2005@hotmail.com
7	Assistant Professor (Agronomy) Agricultural Research Station (Agricultural University Jodhpur), MANDOR , Jodhpur-342 304, Rajasthan	0291-2571347 (O)	0291-2571813 mlmehriya@gmail.com

Uttarakhand

8	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
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West Bengal

9	The Director of Research, Bidhan Chandra Krishi Vishwa Vidhyalaya, Directorate of Research, Faculty of Horticulture, KALYANI -741 235, Nadia, West Bengal	033-25828407 (O) 03473-222269/70 03473-222659	033-25828407 / 03473-222275 03473-222273/222277 dranupariari@gmail.com
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PUBLICATIONS RELEASED DURING XXXI AICRPS WORKSHOP



Compendium of black pepper varieties



ICAR-AICRPS Varieties



ICAR-AICRPS Technologies



Production technology of black pepper (Tamil)



Production technology of cardamom (Tamil)



Production technology of ginger (Tamil)



Production technology of ginger (Odia)



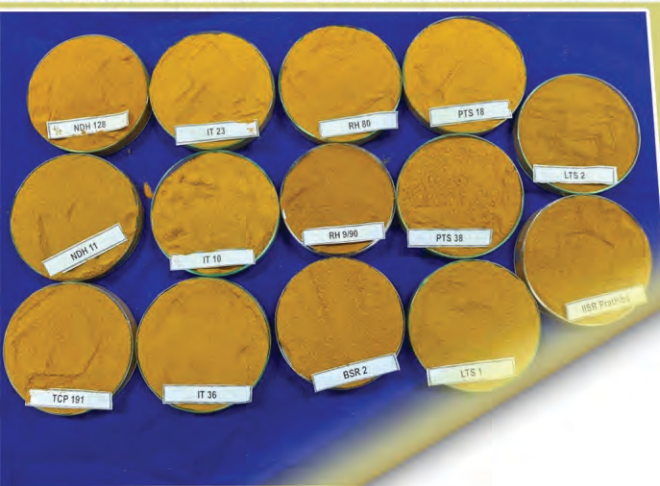
Advanced Package of Practices of Ginger



Package of Practices for Turmeric Cultivation in Arunachal Pradesh



Disease management of turmeric (Telugu)



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: aicrspices@gmail.com; AICRP.spices@icar.gov.in

Web site: www.aicrps.res.in

