वार्षिक प्रतिवेदन
Annual Report
2019

भाकृअनुप
ICAR

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

ICAR-Indian Institute of Spices Research
Kozhikode - 673012, Kerala, India

VARIETIES RECOMMENDED FOR RELEASE DURING 30TH AICRPS WORKSHOP

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Ajmer Nigella 1

Ajmer ajwain 73

Front cover photos

Turmeric yield at Raigarh

Germplasm of Coriander at Jobner

Fenugreek variety
Narendra Richa-1

Back cover photos

With new ginger variety -Solan giriganga

Large Cardamom
of Gangtok

Bumper harvest of turmeric
at Raigarh

ICAR-ALL INDIA COORDINATED RESEARCH PROJECT ON SPICES

ANNUAL REPORT 2019

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Indian Institute of Spices Research
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CONTENTS


அண்ணா அரங்கம்
ANNA AUDITORIUM

कार्यकारी सारांश

भाकृअनुप-अखिल भारतीय समन्वित मसाला अनुसंधान परियोजना देश के 25 राज्यों में 14 कृषि जलवायु क्षेत्रों में फैले हुए 38 केंद्रों (19 नियमित, 11 सहयोगी तथा 8 स्वैच्छिक केंद्र) में प्रमुख मसाला फसलों जैसे काली मिर्च, बड़ी इलायची, छोटी इलायची, अदरक, हल्दी, आम अदरक, दालचीनी, जायफल, लौंग, धनिया, जीरा, सौंफ, मेथी, अजवाईन, निगेला, केसर और काला जीरा पर अनुसंधान कार्यों का समन्वय करता है। वर्ष 2019 की वार्षिक बजट में भारतीय कृषि अनुसंधान परिषद का आबंटन 607.76 लाख रुपए थे।

नई पहल

- मसाला फसलों की इक्कीस किस्मों जैसे छोटी इलायची (आईआईएसआर अविनाश), अदरक (सुप्रभा, सुरूचि, सुरवी), हल्दी (रोमा, सुरमा, रश्मि, युबीकेवी हल्दी 2), जायफल (आईआईएसआर केरलश्री), धनिया (राजेंद्र धनिया-1, राजेंद्र धनिया-2, अजमेर धनिया-2, अजमेर धनिया-3, सुगुणा, सुस्थिरा, गुजरात धनिया 3, छत्तीसगढ़ श्री चंद्रहासिनी धनिया 2), जीरा (गुजरात जीरा 5), सौंफ (अजमेर सौंफ 3) और मेथी (अजमेर मेथी 5, लाम सोनाली) को बागवानी फसलों के फसल मानक, अधिसूचना और प्रजाति विमोचन पर केंद्रीय उप-समिति, नई दिल्ली द्वारा अधिसूचित किए गए थे।
- खाद्य सुरक्षा आश्वासन और मसालों में कीटनाशक अवशेषों को कम करने के लिए, एआईसीआरपीएस के विभिन्न काली मिर्च केंद्रों पर काली मिर्च में स्ट्रोबिल्यूरिन कवकनाशी और एक्टिनोमाइसेट्स का मूल्यांकन शुरू किया गया था।
- स्थायी मसाला उत्पादन के लिए, अदरक और हल्दी में वर्धित अंकुरण, ताक़त और भंडारण सड़न का दमन करने के लिए प्रकंदों के प्राइमिंग पर नए कार्यक्रम विभिन्न कृषि जलवायु क्षेत्रों के विभिन्न एआईसीआरपीएस केंद्रों में किए गए।

XXX वीं एआईसीआरपीएस कार्यशाला में विमोचित करने के लिए संस्तुत किस्में

तमिलनाडु कृषि विश्वविद्यालय, कोयम्बटतोर, तमिलनाडु में आयोजित XXXवीं एआईसीआरपीएस कार्यशाला में विशिष्ट लक्षणों के लिए मसालों की तीन किस्में (सौंफ, अजवाईन और निगेला में एक-एक) विमोचित करने के लिए संस्तुत की गई थी।

जलवायु लचीला किस्म

आरएफ 290: एसकेएनएयु, जोबनर से सौंफ की किस्म, जो लंबे और मोटे बीज, अधिक अम्बलट्स और प्रति अम्बल में अधिक बीज के साथ उच्च उपज के लिए (20.65 क्विंटल/ हेक्टेयर) है।

व्यावसायिक प्राधान्य वाले किस्में

अजमेर अजवाइन 73: उच्च उपज (10.66 क्विंटल/ हेक्टेयर) और उच्च एसनशियल तेल (6.38%) के लिए आईसीएआर-एनआरसीएसएस, अजमेर से अजवाईन किस्म।

अजमेर निगेला 1: उच्च उपज (9.09 क्विंटल/ हेक्टेयर) और उच्च ओलिक एसिड (3.32%) सामग्री के लिए आईसीएआर-एनआरसीएसएस, अजमेर से निगेला किस्म।

XXX वीं एआईसीआरपीएस कार्यशाला के दौरान संस्तुत की गई तकनीकियां

एआईसीआरपीएस के XXX वीं वार्षिक कार्यशाला में विभिन्न राज्यों के लिए विभिन्न मसाला फसलों में वर्ष के दौरान विकसित पांच स्थान विशिष्ट तकनीकियों को संस्तुत किया गया।

जल उपयोग दक्षता - प्रति बूंद अधिक फसल

जीरे में ड्रिप सिंचाई और उर्वरता: 4 दिनों के अंतराल पर 60% वास्तविक वाष्पीकरण (0.6 आईडब्ल्यु/सीपीई अनुपात) के बराबर पानी के साथ उर्वरकता और विभिन्न विकास चरणों (बोने के 10, 20, 40, 50, 70 और 80 दिनों के बाद) में घुलनशील उर्वरकों के माध्यम से 80% उर्वरकों की खुराक की सिफारिश की गई, जिससे 20% पानी की बचत और बी:सी का 1.50 के अनुपात के साथ भारत की हल्की बनावट वाली मिट्टी में जीरे की पैदावार और डब्ल्युयुई में सुधार के लिए अनुशंसित है।

मृदा पोषक तत्व प्रबंधन- खेत की उपज बढ़ाने के लिए मल्टीकट धनिया के लिए उर्वरक प्रबंधन- फास्फोरस की पूर्ण खुराक के रूप में 60:30:00 किलोग्राम/हेक्टेयर के रूप में एनपीके डालना और नाइट्रोजन की आधी खुराक पौधे के आधारीय भाग में और पहली कटाई के बाद नाइट्रोजन की शेष आधी खुराक यानी अधिकतम उपज (18 क्विंटल/हेक्टेयर) हासिल करने के लिए रोपण के 40-45 दिनों के बाद और बी:सी अनुपात (2.5) में डालना अनुशंसित है।

एकीकृत कीट और रोग प्रबंधन-स्थायी मसाला उत्पादन के लिए जीरे में जैविक पोषक तत्व और रोग प्रबंधन- वर्मीकम्पोस्ट (2 टन/हेक्टेयर) का मृदा में प्रयोग करने के साथ *ट्राइकोडर्मा* (6ग्राम/किलोग्राम) के साथ बीज उपचार और नीम के बीज करनल एक्स्ट्राक्ट 5% के छिड़काव को जीरा के जैविक उत्पादन तथा ब्लाइट और विल्ट जैसे रोगों के प्रबंधन के लिए बी:सी का 2.29 अनुपात में प्रयोग करने के लिए सिफारिश की गई।

नई पीढ़ी के कवकनाशकों का उपयोग करते हुए धनिया में पाउडरी मिल्ड्यू का प्रबंधन- रोग की प्रारंभिक स्थिति में हेक्साकोनाज़ोल 5% एससी (1.0 मिली लीटर -1 पानी) को पत्तों पर छिड़कना और 15 दिनों के अंतराल में दूसरा स्प्रे, बी:सी 4.75 के अनुपात में छिडकने पर धनिया के पाउडरी मिल्ड्यू का नियंत्रण कर सकते हैं।

अदरक में जीवाणुक म्लानी का प्रबंधन- जैविक कृषि प्रणाली के लिए, जैवनियंत्रण कारक, बैसिलस लीकेनिफॉर्मिस (जीएपी107

एमटीसीस12725) के बैसिलिक का बी:सी 3.23 अनुपात के साथ मिट्टी के सौरकरण को अपनाने पर अदरक के जीवाणुक म्लानी को नियंत्रित कर सकते है। अजैविक कृषि प्रणाली में मृदा सौरीकरण के साथ बी:सी 2.88 (दोनों उपचार रोपण के समय तथा रोपण के 30,45, 60 तथा 90 दिनों के बाद करना चाहिए) अनुपात में सीएसीएल2 का प्रयोग करने पर रोग का नियन्त्रण कर सकते हैं।

अनुसंधान उपलब्धियां

काली मिर्च

वर्ष 2019 के दौरान, पेप्पर रिसर्च स्टेशन, पन्नियुर ने 343 कल्टिवेटड प्रकार, 57 वन्य और संबंधित प्रकार तथा 3 विदेशी प्रकारों के काली मिर्च को बनाए रखा। कोंकण क्षेत्र से एकत्रित जर्मप्लाज्म एक्सेशन (58) को बागवानी विभाग, डॉ. बी.एस.केकेवी, दापोली में जर्मप्लाज्म ब्लॉक में बनाए रखा गया है। येरकाड में 28 अक्सेशनों पर बेरी सेट का अवलोकन किया गया। पन्नियूर में आयोजित अंतर प्रजातीय संकरण परीक्षण में, संकर जैसे, पीआरएस 160, पीआरएस 161 और पीआरएस 165 को क्रमशः 6.12 किलोग्राम/बेल, 6.63 किलोग्राम/बेल और 4.84 किलोग्राम/बेल की औसत हरी बेरी उपज के साथ आशाजनक पाया गया। संकर पीआरएस 161, उपज एवं उपज गुणों के लिए सबसे अधिक आशाजनक था।

परीक्षण के लिए, काली मिर्च में धीमी गति से गिरावट के जैविक प्रबंधन, ट्राइकोडर्मा विरिडे के मृदा अनुप्रयोग + नीम केक @ 2 कि.ग्रा. / बेल (टी 1), पोचोनिया क्लैमिडोस्पोरिया 50 ग्राम/ बेल का मिट्टी में प्रयोग करने के साथ पी. फ्लूरसेन्स 2% (टी4) की दर से मिट्टी में ड्रेंचिंग करना पन्नियुर में काली मिर्च में धीमी गिरावट के कारण होने वाले पीलापन को कम करने में काफी बेहतर था। सिरसी में, कोपर ऑक्सी क्लोराइड 0.3% और कार्टैप हाइड्रोक्लोराइड 15ग्राम /बेल (टी6) के साथ मिट्टी में मॉनसून (जून) की शुरुआत में और अगस्त के तीसरे सप्ताह में ड्रेंचिंग करने पर रोग तीव्रता का प्रतिशत न्यूनतम (39.17) थे और अन्य उपचार की तुलना में ट्राइकोडर्मा हर्ज़ियानम 50ग्रा./बेल और नीम केक 2कि. ग्रा./बेल (टी1) मृदा में डालने पर रोग आपतन बराबर (40.83) थे।

छोटी इलायची

कुल 320 इलायची अक्सेशनों को बनाए रखा गया है, जिसमें मुडिगेरे के 132 और पांपाडुमपारा के 188 अक्सेशनें शामिल हैं। अप्पंगला, सकलेशपुर, मैलाडुमपारा और पांपुमपारा के किसानों के छोटी इलायची अक्सेशनों में उसके चरित्र में महत्वपूर्ण अंतर थे। अपंगला में, तिरुताली जीन प्रकार ने पौधे की उच्चतम ऊंचाई (208.74 से.मी.), टिलर की अधिक संख्या (24.26), फलदार टिलर की संख्या (11.39), पनिकिल्स की संख्या (18.53) और पनिकिल की लंबाई (49.15 सेमी) अंकित की। सकलेशपुर में, आईसीआरआई 8 में टिलर की संख्या काफी अधिक (16.50) थी, तिरुताली में पनिकिल की संख्या (5.17) काफी अधिक थी। पोपुली में रेसिम्स पनिकिल्स की संख्या (16.33) भी काफी अधिक थी।

पांपाडुमपारा में, जीन प्रकार न्जल्लानी ग्रीन गोल्ड और तिरुताली ने पौधे की उच्चतम ऊंचाई क्रमशः166.30 और 160.63 अंकित की। टिल्लर्स की अधिकतम संख्या में उत्पादन तिरुताली (16.53) और तत्पश्चात् पचाकाइ (14.97) के द्वारा हुआ था जबकि बड़े पैमाने पर टिलर्स का उत्पादन मैलाडुमपारा के वंडर इलायची (47.00), नजल्लानी ग्रीन गोल्ड (46.00) और तिरुताली (45.33) में हुआ था। तिरुताली (18) और पनिकुलंगरा1 (17.33) में अधिक पनिकिल का उत्पादन अंकित किया गया।

बडी इलायची

आईसीआरआई, गंगटोक में कुल 308 अक्सेशनों में से, 301 को एनबीपीजीआर, नई दिल्ली के साथ पंजीकृत किया गया है और उसी के लिए आईसी नंबर प्राप्त किया है। शेष सात अक्सेशनों (एससीसी 302-308) के पासपोर्ट डेटा एनबीपीजीआर, नई दिल्ली को आईसी नंबर के आवंटन के लिए भेजा गया है। सिक्किम राज्य में नए अक्सेशनों को संचित करने के लिए सर्वेक्षण किया गया था। आईसीआरआई, गांगटोक ने भी बड़ी इलायची की 1650 रोपण इकाइयां आईसीएआर-एनओएफआरआई, तडोंग, आईसीएआर-आरसी एनईएच, बारापानी और अरुणाचल प्रदेश और नागालैंड के लाभार्थियों को आपूर्ति की।

अदरक

पोटांगी में अध्ययन किये गये 198 अदरक जर्मप्लाज्म में, 34 प्रविष्टियों में 5 किलोग्राम/ 3मी^{2} से अधिक ताजे फल मिले। खरीफ 2019 के दौरान परीक्षण किए गए जर्मप्लाज्म में 3.1 कि.ग्रा./3मी^{2} की औसत उपज के साथ प्लॉट यील्ड 0.10 कि.ग्रा. (पीजीएस-119) से 9.5 कि.ग्रा. /3मी^{2} (पीजीएस-163) का अंतर है। रायगढ़ में, इंदिरा जिंजर-1 (9.9) टन/हेक्टेयर) ने दो राष्ट्रीय जाँच सुप्रभा (7.5 टन/हेक्टेयर) और सुरुचि (8.3 टन/हेक्टेयर) पर अधिकतम उपज दर्ज की, उसके बाद आईएन-4 (7.2 टन/हेक्टेयर) और IN-3 (6.4 टन/हेक्टेयर) है। बारापानी में, 43 जीनप्रकारों में से, आईसी-584354 ने 20.95 टन/हेक्टेयर के साथ सबसे अधिक उपज दर्ज की। उच्चतम शुष्क पदार्थ (25.09%) और ओलिओरसिन (7.07%) क्रमशः आईसी-584353 और आईसी-584343 में दर्ज की गई।

वनस्पति उद्देश्य के लिए अदरक के मूल्यांकन परीक्षण में, यह पाया गया कि उच्चतम उपज (19.00 टन/हेक्टेयर) बोल्ड नादिया में दर्ज की गई, उसके बाद गोरुबथान (16.00 टन/हेक्टेयर) और भैसे (16.00 टन/हेक्टेयर), नागालैंड में है। जबकि पोटांगी में, जॉन की अदरक में उच्चतम उपज (19.20 टन/हेक्टेयर) दर्ज की गई, इसके बाद बोल्ड नादिया (18.90 टन/हेक्टेयर) और पीजीएस 121 (18.70 टन/हेक्टेयर) दर्ज किया गया। मिजोरम के भैसे में 24.60 टन/हेक्टेयर की अधिकतम पैदावार दर्ज की गई, इसके बाद गोरुबथान (19.35 टन/हेक्टेयर) और बोल्ड नादिया (16.75 टन/हेक्टेयर) शामिल हुए। गांगटोक में, जीनप्रकारों के बीच, पीजीएस 95 में जीवाणुक म्लानी का आपतन नहीं देख लिया।

हल्दी

कोयंबतोर में कुल 275 जीनप्रकारों का संरक्षण किया गया और सभी जीनप्रकारों का मूल्यांकन और चरित्रांकन किया गया। आंकड़ों के सांख्यिकीय विश्लेषण से पता चला कि विकास, पैदावार और गुणवत्ता के मापदंडों में व्यापक विविधताएं है। धोली में बनाए गए सतसाठ अक्सेशनों में से चौदह अक्सेशनों ने अधिकतम उपज अंकित की जिसमें राजेंद्र सोनाली (52.33 टन/हेक्टेयर) की तुलना में चैक प्रजाति राजेंद्र सोनिया (49.83 टन/हेक्टेयर) के प्रति 50.25 से लेकर 54.17

टन तक का अंतर दर्ज किया गया। कुमारगंज में संरक्षण और मूल्यांकन किये गये 180 अक्सेशनों में से अधिकतम उपज एनडीएच -74 (275 ग्राम/पौधा) में दर्ज की गई, उसके बाद एनडीएच-86 (265 ग्राम/पौधा)। पुंडिबारी में, 176 जर्मप्लाज्म अक्सेशनों का संरक्षण किया गया। पांच जीनप्रकारों ने 40 टन/ हेक्टेयर से अधिक उपज दिखाया गया, 16 जीनप्रकारों ने 31 टन/ हेक्टेयर से 40 टन/ हेक्टेयर और 22 जीनप्रकारों ने 25 टन/ हेक्टेयर से 30 टन/ हेक्टेयर दिखाया।
हल्दी के जैविक परीक्षण में, अधिकतम उपज टी$_2$ (हल्दी की 75% नाइट्रोजन आवश्यकता के बराबर 100% जैविक खाद) में दर्ज की गई, जिसकी उपज 28.29 टन/हेक्टेयर है तत्पश्चात् मिजोरम में टी1 (हल्दी की 100% जैविक खाद 100% नाइट्रोजन के बराबर है) जीसकी उपज 27.42 टन/हेक्टेयर, टी6 (हल्दी की 75% नाइट्रोजन आवश्यकता + सूक्ष्म पोषक तत्व) जिसकी उपज 26.39 टन/हेक्टेयर है जबकि बारापानी में अधिकतम उपज (22.00 टन/हेक्टेयर) थी जो टी3 (100% जैविक खाद + सूक्ष्म पोषक) में दर्ज की गयी। ।

कोयम्बतोर में, बीएसआर -2 में *ट्राइकोडर्मा* और जीआरबी 35 के कैप्सूल फॉर्मूलेशन के संयुक्त प्रयोग ने पर्ण दाग (5.5 पीडीआई) और पत्ती धब्बा (14.0 पीडीआई) का न्यूनतम आपतन अंकित की, जो कि नियंत्रण की तुलना में क्रमशः 19.9 और 26.2 पीडीआई पत्ती दाग और पत्ती धब्बा दर्ज की गई। कुमारगंज में वी2टी2 उपचार (32.00 टन/हेक्टेयर) में अधिकतम उपज अंकित की गई जिसके बाद वी2टी1 (30.92 टन/हेक्टेयर) और वी2टी3 (30.67 टन/ हेक्टेयर)। धोली में नियंत्रण (पीडीआई 58.52) में राजेंद्र सोनिया (पीडीआई = 28.89) और राजेंद्र सोनाली (पीडीआई = 30.00) में सबसे कम पत्ती ब्लाइट रोग दर्ज किया गया था।

आम अदरक के समन्वित प्रजाति परीक्षण में, अम्बलवयल में, एनवीएमजी 2 ने प्रति पौधे की उच्च उपज (142.7 ग्रा.)दर्ज की, इसके बाद अंबलवयल में अक्से. 347 (136.7ग्रा.) और एनवीएमजी 10 (134.7ग्रा.)है। जबकि रायगढ़ में, इंदिरा मैंगो जिंजर1 (आईएमजी1) ने अधिकतम प्रकंद उपज 28.6 टन/हेक्टेयर दर्ज की गयी जिसके बाद आईएमजी 2 (27.5 टन/ हेक्टेयर) और आईएमजी 4 (25.4 टन/हेक्टेयर) है।

वृक्ष मसाले

पीचिपराई में संरक्षित जायफल अक्सेशनों में, एमएफ-1 ने पेड़ की अधिकतम ऊंचाई (9.14 मीटर) और स्टम विस्तार (58.55 से.मी.) अंकित की और एमएफ 4 ने पत्तों की अधिकतम लंबाई (20.14 से.मी.), पत्तों का विस्तार (9.15 से.मी.) फलों की संख्या (667), एकल फल वजन (53.0 ग्राम) और जावित्री उपज (286 ग्राम/पेड़) दर्ज की गई। दापोली में, जीनप्रकार डीबीएसकेकेवीएमएफ 29 (972), डीबीएसकेकेवीएमएफ 9772 (507) और डीबीएसकेकेवीएमएफ 22 (498) ने क्रमशः फलों की अधिकतम औसत संख्या दर्ज की। जीनप्रकार डीबीएसकेकेवी 29 ने अधिकतम शुष्क अखरोट की उपज (9817.20 ग्राम) और सूखी जावित्री की उपज (2721.60 ग्राम) दर्ज की।

दापोली में वर्ष 1996-97 के दौरान लगाए गए लौंग के जर्मप्लाज्म में चार आशाजनक जीनप्रकारों का चयन किया गया। पौधे की ऊँचाई में 5.89 से 7.15 मीटर का अंतर है, व्यास में 35-40 से. मी. का अंतर और विस्तार में 2.50 मी. से 3.05 मी. तक अंतर है। पीचीपरई में 24 अक्सेशनों में एसए -1 ने उच्चतम पेड़ की ऊँचाई 11.78 से. मीटर दर्ज की गई, इसके बाद स्थानीय चेक के पेड़ की ऊंचाई (9.31 मीटर) की तुलना में एसए-3 (11.63 मीटर)।

पीचिपराई में मूल्यांकन किए गए दालचीनी के बारह अक्सेशनों मं से सीवी-5 में पेड़ की अधिकतम ऊंचाई (2.81 मीटर), प्ररोह की संख्या (10) और स्टेम गर्थ (16.84 से. मी.) दर्ज की गई।

धनिया

हिसार में चेक के रूप में हिसार सुगंध, हिसारभूमित और हिसार आनंद के साथ धनिया के एक सौ चालीस अक्सेशनों का मूल्यांकन किया गया था। बीज की उपज में 32.4 ग्राम प्रति पौधा (डीएच -292) से 97.5 ग्राम प्रति पौधा (डीएच -227) तक अंतर है। बीज की पैदावार के लिए सबसे आशाजनक अक्सेशऩ डीएच -218, डीएच -224, डीएच -227, डीएच -240, डीएच -244, डीएच-280, डीएच -293, डीएच -313, डीएच-316 और डीएच -329 थे। जॉबनेर में, प्रत्येक 5 पौधों के बीज उपज के आधार पर 230 अक्सेशनों का मूल्यांकन करने पर 25 अक्सेशनें श्रेष्ठ चैक प्रजाति आरसीआर-475 (33.14 ग्रा.) से बेहतर थे। कटाई प्रबंधन, किस्मों और उर्वरता के स्तर ने धनिया के बीज के बराबर उपज पर महत्वपूर्ण प्रभाव डाला। 45 डीएएस में अपनाये गये एक कट ने अधिक धनिया बीज अंकित किया जो दो कट और बिना कट के उच्च धनिया के बीज के बराबर उपज दर्ज की गई। जीडीएलसी 1 ने जीसीओ2 से अधिक धनिया बीज के बराबर उपज का उत्पादन किया। 60:30:00 किलोग्राम एनपीके / हे. के प्रयोग ने अन्य उपचारों से भी अधिक धनिया बीज के बराबर उपज दर्ज की।

परीक्षण किए गए छह कवकनाशकों के बीच, प्रोपिकोनाज़ोल के छिड़काव वाले पौधों में रोग का आपतन कोयम्बतोर (5.30 पीडीआई) और जगुदन (18.94 पीडीआई) में कम थे, जबकि कुमारगंज और रायगढ़ में वेटबिल सल्फर (0.2%) पत्तों पर छिड़कनो पर न्यूनतम रोग आपतन क्रमशः 4.25 और 5.4% दिखाई। जोबनेर में हेक्साकोनाज़ोल 5% एससी 0.1% के पर्ण छिड़काव करने पर न्यूनतम (10.80%) रोग आपतन और 17.183 क्विंटल/हेक्टेयर की अधिकतम बीज उपज दर्ज की गई।

जीरा

वर्ष 2018-19 के रबी के दौरान वाष्पशील तेल सामग्री के लिए सीवीटी और आईईटी के तहत जीरे की दस प्रविष्टियों का परीक्षण किया गया। विश्लेषण के अंतर से सीवीटी और आईईटी दोनों में वाष्पशील तेल (%) के लिए प्रविष्टियों के बीच महत्वपूर्ण अंतर का पता चला। सीयुएम -42 और आरज़ेड-345 में 4.33% का अधिकतम वाष्पशील तेल देखा गया, तत्पश्चात् सीयुएम -38 में 3.60% जबकि c सीवीटी में न्यूनतम 2.80% और सीयुएम -39 में जीसी-4 दर्ज किया गया।
जोबनेर के तीन साल के आंकड़ों के विश्लेषण से पता चला है कि एफिड आबादी में अधिकतम औसत कमी (79.09%) और बीज की उपज (2.59 क्विंटल/हेक्टेयर) को 25 डब्ल्यूजी 25 ग्राम एआई / हेक्टेयर के साथ दर्ज किया गया था, इसके बाद क्लोथियानिडिन 50 डब्ल्यूडीजी 20 ग्राम एआई/हेक्टेयर (टी2) 1.74 बी:सी अनुपात के साथ है। यह थियामेथोक्साम 25 डब्ल्यु जी 25 ग्राम एआई/हेक्टेयर के साथ छिड़काव के उपचार के साथ सांख्यिकीय रूप से बराबर था।

इसके बाद थियाक्लोप्रिड 21.7 एससी 25 ग्राम एआई/हेक्टेयर(टी1) ने प्रदर्शन किया गया, जिसमें एफिड आबादी में 76.01% औसत कमी और बीज की उपज (2.44 क्विंटल/हेक्टेयर) बी: सी का 1.64 अनुपात के साथ दर्शायी। जबकि प्रति पौधे की औसत एफिड आबादी अधिकतम (39.00) और न्यूनतम बीज उपज (1.35 क्विंटल/हेक्टेयर) अनुपचारित नियंत्रण (टी10) में दर्ज किया गया था। सभी उपचारों में, वाष्पशील तेल का प्रतिशत उतना महत्वपूर्ण नहीं था।

सौंफ

खरीफ के मौसम में, जगुदान में प्राकृतिक परिस्थितियों में सौंफ की तेरह प्रविष्टियों की जांच की गई थी। रामुलरिया ब्लाइट की न्यूनतम तीव्रता जेएफ-2012-8 (10.0%) में देखी गई जबकि अधिकतम तीव्रता जेएफ-2016-05 (30.0%) में दर्ज की गई। रोग की तीव्रता 10.0 से 30.0 प्रतिशत तक थी।

कुमारगंज में सीवीटी में 14 प्रविष्टियों का परीक्षण किया गया, जिसमें एफएनएल-125 ने अधिकतम उपज (15.06 क्विंटल/हेक्टेयर) दर्ज की और उसके बाद एफएनएल-123 (14.37 क्विंटल/हेक्टेयर) और एफएनएल-121 (14.02 क्विंटल/हेक्टेयर)। हिसार में, अधिकतम बीज उपज एफएनएल-116 (21.51 क्विंटल/हेक्टेयर) में दर्ज की गई, इसके बाद एफएनएल-117 (20.10 क्विंटल/हेक्टेयर) और एफएनएल-123 (19.30 क्विंटल/हेक्टेयर)। जगुदान में सीवीटी ने प्रकट किया कि एफएनएल-124, 127 और एफएनएल-119 शीर्ष तीन स्थानों पर रहे। पंतनगर में सौंफ के पंद्रह जीन प्रकारों का मूल्यांकन किया गया और पाया गया कि एफएनएल-128 (19.91क्विंटल/हेक्टेय) में सबसे ज्यादा बीज की पैदावार हुई, इसके बाद एफएनएल-121 (19.49 क्विंटल/हेक्टेयर। नवसारी में, एफएनएल-123 (28.04 क्विंटल/हेक्टेयर), एफएनएल-118 (25.52 क्विंटल/हेक्टेयर), एफएनएल-126 (25.34 क्विंटल/हेक्टेयर), एफएनएल-119 (25.22 क्विंटल/हेक्टेयर) और एफएनएल-127 (25.12 क्विंटल/हेक्टेयर) को उनकी उच्च बीज उपज के कारण आशाजनक जीन प्रकार माना गया।

मेथी

जॉबनेर और कुमारगंज में एफजीके 123 ने अधिकतम बीज उपज 21.23 क्विंटल /हेक्टेयर और 16.25 क्विंटल/हेक्टेयर अंकित की गयी। जबकि नवसारी में एफजीके -122 ने सबसे अधिक बीज की पैदावार (20.78 क्विंटल/हेक्टेयर) और रायगढ़ में (16.1 क्विंटल/हेक्टेयर) अंकित की। कोयम्बटूर में एफजीके 124 (22.66) ने प्रति पौधे अधिकतम फली और एफजीके 134 (11.60) ने सबसे कम दर्ज किया गया। प्रति प्लॉट (2एम^2) बीज की उपज में 124.06 ग्राम के औसत के साथ 98.07 ग्राम से 174.67 ग्राम तक भिन्नता होती है।

अजवायन

कुमारगंज में मूल्यांकन किए गए अजवाईन की 13 प्रविष्टियों में से, अधिकतम उपज आईए-1 (8.53 क्विंटल/हेक्टेयर) में दर्ज की गई, इसके बाद एनडीएजे-10 (8.26 क्विंटल/हेक्टेयर) और एचएजे-7-187 (8.19 हेक्टेयर) । गुंटूर में मूल्यांकन की गई प्रविष्टियों में, एलएस-14-3 (9.66 क्विंटल/हेक्टेयर) में उच्चतम उपज दर्ज की गई, उसके बाद एलएस-14-8 (9.38 क्विंटल/हेक्टेयर), एए-73 (9.38 क्विंटल/हेक्टेयर) और एए-6 (8.73 क्विंटल/हेक्टेयर) जो एक-दूसरे के बराबर थे और सबसे अच्छे चेक लैम सेलेक्शन -1 (7.93 क्विंटल/हेक्टेयर) से काफी बेहतर थे।

निगेला

कुमारगंज में, अधिकतम उपज एनडीबीसी -20 (8.88 क्विंटल/हेक्टेयर) में दर्ज की गई, इसके बाद एएन-1 (7.77 क्विंटल/हेक्टेयर) और आईएन-1 (7.29 क्विंटल/हेक्टेयर) है और तीन साल के संयुक्त डेटा में अधिकतम उपज एनडीबीसी-20 (8.40 क्विंटल/हेक्टेयर) दिखाई गई इसके बाद एएन-1 (7.61 क्विंटल/हेक्टेयर) और आईएन-1 (7.24 क्विंटल/हेक्टेयर) है। कल्याणी में, प्रति हेक्टेयर उच्चतम उपज आईएन1 (7.00 क्विंटल/हेक्टेयर) दर्ज की गई थी। कोटा में, बीज की उपज में 4.56-9.90 क्विंटल/हेक्टेयर अंतर थे।

केसर

केसर के 200 जर्मप्लाज्म अक्सेशनों को जम्मू और कश्मीर के विभिन्न गरम स्थानों से एकत्र किए गए, जिनमें 36 विदेशी संग्रह शामिल हैं, जिसको सफरोन रिसर्च स्टेशन, एसकेयुएएसटी, कश्मीर में संरक्षित किया गया हैं। 200 अक्सेशनों में से, 22 अक्सेशनों को उपज और गुणवत्ता के संबंध में आशाजनक पाए गए।

केसर के घनकन्द सड़न रोगज़नक़ (*फ्यूसेरियम ऑक्सिस्पोरम*) की माइसेलियल वृद्धि के खिलाफ अलग-अलग राइज़ोस्फेरिक कवक (केसर की फसल के लिए नॉनपैथोजेनिक) के इन विट्रो प्रभावकारिता से पता चला है कि ट्राइकोडरमा विरिडे ने नियंत्रण सहित अन्य आइसोलेट्स की अपेक्षा काफी बेहतर प्रदर्शन किया है।

कालाजीरा

उत्तरी हिमालय की पैदल पहाड़ियों के साथ-साथ सफरोन रिसर्च स्टेशन, एसकेयुएएसटी-के में उपलब्ध जर्मप्लाज्म से एकत्र किए गए 70 अक्सेशनों युक्त जर्मप्लाज्म का संरक्षण किया जाता है। उपज और एसनशियल तेल सामग्री की पहचान के संबंध में कुछ आशाजनक दृष्टिकोण हैं एसआरए-केज़ेड-192, एसआरए-केज़ेड-158, एसआरए-केज़ेड-172, एसआरए-केज़ेड-177, एसआरए -केज़ेड-170, एसआरए-केज़ेड-149 और एसआरए-केज़ेड -167।

गुणवत्ता रोपण सामग्री का उत्पादन और वितरण

एआईसीआरपीएस केंद्रों ने काली मिर्च के 4.16 लाख जड़ लगाए कतरन, इलायची के 10338 सकेर्स, 50 टन हल्दी, 30 टन अदरक, जायफल के 1294 ग्राफ्ट, जायफल के 1048 बीजपौधे, दालचीनी के 150 ग्राफ्ट और दालचीनी के 250 बीजपौधे का वितरण किया है। बीज मसालों में, 324 क्विंटल धनिया, 70 क्विंटल जीरा, 30.5 क्विंटल सौंफ, 61.71 क्विंटल मेथी और 10 किलो अजवाईन बीज सामग्री का उत्पादन और वितरण किया गया।

प्रौद्योगिकी का हस्तांतरण

विभिन्न केंद्रों के वैज्ञानिकों ने नवीनतम तकनीकियों को लोकप्रिय बनाने के लिए भरसक प्रयास किया है क्योंकि अनुसंधान तभी सार्थक होता है जब इन प्रौद्योगिकियों के माध्यम से किसान लाभान्वित होता है। वर्ष के दौरान प्रदर्शित कुछ प्रौद्योगिकियां निम्नलिखित हैं।

अधिक उपज देने वाली किस्में - किसानों को वरदान

- हल्दी की राजेंद्रसोनिया किस्म (गुंटूर) की रोपाई का प्रदर्शन।
- उच्च उपज वाली हल्दी किस्म सीओ2 (कोयंबतोर) का प्रदर्शन।
- उपज और पर्ण रोग सहय हल्दी किस्म टीसीपी -129 का प्रदर्शन (पुंडिबारी)।

रोपण सामग्रियों का तेजी से गुणन - न्यूनतम व्यय के लिए

- तेजी से गुणन करने की विधि द्वारा काली मिर्च के पौधों का उत्पादन (पीचीपराई)।
- हल्दी में पडेरु, डुम्बरीगुडा और अरकु में केवीके, कोंडम्पुडी, विशाखपत्तनम (चिन्तापल्ली) के सहयोग से प्रो-ट्रै तकनीकी को लोकप्रिय बनाना।

• अदरक और हल्दी के लिए प्रो-ट्रै प्रवर्धन प्रविधि की प्रदर्शनी, जायफल और कोकम में नरम लकड़ी की ग्राफ्टिंग तकनीक, बुश पेप्पर उत्पादन तकनीक (दापोली)।

प्रसंस्करण और मूल्य संवर्धन- बाजार पर कब्जा करने के लिए

- जायफल के छिलके से मुरब्बा और चटनी तैयार करना (दापोली)
- हल्दी का प्रसंस्करण (दापोली)

पादप सुरक्षा- पौध स्वास्थ्य में सुधार के लिए

- कराडियुर गांव (येरकाड) में काली मिर्च के म्लानी के नियंत्रण के लिए बायोकन्ट्रोल एजेंटों का प्रदर्शन।
- हल्दी में 0.5 एकड़ (धोली) में रोपण के 90, 105 और 120 दिनों के बाद प्रोपिकोनाज़ोल 0.2% के साथ राइज़ोम उपचार + प्रोपीकोनाज़ोल 0.1% के साथ पत्तों पर छिड़कना।

उपरोक्त खेत स्तर की प्रदर्शनों के अलावा, वैज्ञानिकों ने प्रशिक्षण आयोजित करके और प्रशिक्षण और संगोष्ठियों में रिसोर्स व्यक्तियों के रूप में भाग लेकर और विभिन्न मीडिया (समाचार पत्र, रेडियो वार्ता और टीवी कार्यक्रमों) के माध्यम से प्रौद्योगिकी को लोकप्रिय बनाया।

सफलता की कहानियां

अधिक उपज देने वाली किस्में- आय अधिकतम करने के लिए

धोली केंद्र में मसालों पर एआईसीआरपी के तहत, विभिन्न मसाला फसलों जैसे हल्दी (राजेंद्र सोनिया और राजेंद्र सानाली), धनिया (राजेंद्र धनिया-1, राजेंद्र धनिया -2 और राजेंद्र स्वाती), मेथी (राजेंद्र कांती और राजेंद्र अभा) निगेला (राजेंद्र श्यामा), सौंफ (राजेंद्र सौरभ) और अजवाइन (राजेंद्र मणि) को विकसित किए गए हैं। वर्ष 2019 के दौरान, लगभग 43.3 टन हल्दी बीज का उत्पादन किया गया था जो कि बिहार के साथ-साथ आस-पास के राज्यों के प्रगतिशील किसानों, विभिन्न सरकारी और गैर-सरकारी संगठनों द्वारा खरीदा गया था। राजेंद्र सोनिया और राजेंद्र सोनाली जैसे हल्दी किस्मों की उच्च उत्पादकता और उच्च कुरकुमिन सामग्री के कारण, इसे अन्य राज्यों जैसे, उत्तर प्रदेश, गुजरात, झारखंड, तेलंगाना और आंध्र प्रदेश के किसानों द्वारा खरीदा गया था। मसालों की खेती के तहत क्षेत्र के विस्तार के लिए बीज मसालों (धनिया, मेथी, सौंफ, निगेला और अजवाईन) में प्रत्येक के 15 क्विंटल का उत्पादन किया गया और कृषि समुदाय के लिए उपलब्ध कराया गया था। मसालों की अधिकांश पारंपरिक किस्मों की खेती उपरोक्त जारी की गई किस्मों द्वारा प्रतिस्थापित की गई और इस प्रकार राज्य के अधिकांश क्षेत्र और दूसरे राज्यों के कुछ खेतों में मसालों की खेती हो रही है।

बायोकंट्रोल एजेंट- स्थायी मसाला उत्पादन के लिए

एसएचएम द्वारा वित्त पोषित जैव नियंत्रण प्रयोगशाला वर्ष 2012 से पांपाडुमपारा में इलायची अनुसंधान स्टेशन में कार्य कर रही है। इस प्रयोगशाला के माध्यम से, बायोकंट्रोल एजेंट जैसे कि स्यूडोमोनस फ्लूरसेंस, ट्राइकोडर्मा विरिडे, मेटारहिज़ियम एनिसोप्लाय, लीकेनीसिलियम लीकेनी, पेसिलोमाइसेस लिलासिनस और बीवेरिया बेसियाना का उत्पादन बड़े पैमाने पर किया गया है और इसे किसानों को आपूर्ति की जा रही है। वर्ष 2019 के दौरान, किसानों को लगभग 17038 किलोग्राम बायोकंट्रोल एजेंट वितरित किए गए। होनहार बात यह है कि अधिक से अधिक किसान इलायची और काली मिर्च के कीट और रोग प्रबंधन के लिए बायोकेन्ट्रोल एजेंटों का उपयोग कर रहे हैं। प्राप्त प्रतिक्रिया के अनुसार, किसान लोग आपूर्ति की जा रही बायोकोन्ट्रोल एजेंटों की गुणवत्ता और प्रभाव के बारे में अधिक आश्वस्त थे। यह केंद्र जैव-रासायनिक एजेंटों के उपयोग के माध्यम से पर्यावरण के अनुकूल कीट / रोग प्रबंधन के बारे में अधिक किसानों को जागरूक करने के लिए आगे देख रहा है और इस प्रकार इलायची पहाड़ी आरक्षित (सीएचआर) क्षेत्र के पर्यावरणीय रासायनिक संदूषण और गिरावट को काफी हद तक कम कर सकता है।

अदरक बीज भंडारण- समृद्धि के लिए

अदरक को हिमाचल प्रदेश के किसानों की गरीब आदमी की नकदी फसल के रूप में जाना जाता है, खासकर सिरमौर और सोलन जिलों में। अदरक की खेती में मुख्य समस्या यह है कि राज्य में इसकी खेती कम हो रही है, क्योंकि अदरक की खेती में मुख्य समस्या अगले सीजन के लिए स्वस्थ बीजों के भंडारण की है। इसलिए, स्वस्थ अदरक के बीज राइज़ोम के लिए एक संशोधित भंडारण विधि को कार्यान्वित किया गया और यह प्रदर्शित किया गया कि अदरक का उत्पादन और किसानों की आय में वृद्धि हुई है।

संशोधित भंडारण विधि में शामिल हैं

• नमी मुक्त क्षेत्र में 1x1एम^3 आकार के गड्ढे खोदना और पार्श्व में पत्थर बिछाना।

• गड्ढे में 10-15 से.मी. मोटाई की रेत की परत डालना।

• एक घंटे के लिए 250 ग्राम मैन्कोज़ेब 100 लीटर पानी के मिश्रण में स्वस्थ प्रकंदों का उपचार करना और फिर नमी की अधिकता को दूर करने के लिए राइज़ोम को 48 घंटों के लिए छाया में सुखाना।

• उपचारित प्रकंदों को वातन के लिए ऊपर से 10-15 सेंटीमीटर क्षेत्र छोड़ कर गड्ढों में रखा जाता है और फिर गोबर के लेप से ढक दिया जाता है।

• तापमान 65 प्रतिशत (गड्ढे) के सापेक्ष आर्द्रता के साथ 12-13°C पर बना हुआ है।

• प्रकंदों को गड्ढों से बाहर निकाला जाता है, छाया में सुखाया जाता है और रोपाई के टुकड़ों को अप्रैल और मई-जून में क्रमशः मध्य और निम्न पहाड़ियों में उखाड़कर रोपण से पहले चुना जाता है।

• रोगग्रस्त प्रकंदों को मिट्टी में दफन किया जाता हैं।
• पानी के धब्बे वाले राइजोम को 30 मिनट के लिए स्ट्रेप्टोसाइक्लिन घोल (20 ग्रा।/100 लि. पानी) में डुबोया जाता है और फिर छाया में सुखाया जाता है। उपचारित प्रकंदों को फिर से रोपण तक गड्ढों में रखा जाता है।

अदरक की इस भंडारण विधि को अपनाने के साथ ही राज्य में अदरक के उत्पादन में नाटकीय वृद्धि हुई है और राज्य के गैर-पारंपरिक अदरक उगाने वाले क्षेत्र जैसे कि कांगड़ा, मंडी, हमीरपुर, ऊना, चंबा और बिलासपुर जिलों में भी इसका उत्पादन देखा गया है। ।

आदिवासी कल्याण उपाय - अप्राप्त तक पहुँचना

जनजातीय उप योजना के तहत मसालों पर आईसीएआर-एआईसीआरपी के 3 केंद्र हैं, ओडिशा में पोटांगी, आंध्र प्रदेश में चिंतापल्ली और छत्तीसगढ़ में रायगढ़। ये केंद्र 2000 आदिवासी किसानों को लाभान्वित करते हुए निम्नलिखित पहलुओं पर किसान प्रशिक्षण कार्यक्रम आयोजित करके आदिवासियों का उत्थान करते हैं। इसके अलावा, अनुसूचित जाति/अनुसूचित जनजाति की योजना भी अनुसूचित जाति/अनुसूचित जनजाति की आबादी की बेहतरी के लिए शुरू की गई थी।

• काली मिर्च, अदरक और हल्दी की खेती पर प्रशिक्षण कार्यक्रम।
• हल्दी के फसलोत्तर प्रबंधन पद्धतियों पर प्रशिक्षण कार्यक्रम।
• गुणवत्ता रोपण सामग्री, बीज मसालों की खेती और उत्पादन तकनीकों का महत्व।
• बागवानी फसलों में आईपीएम प्रौद्योगिकियां।
• जैविक अदरक और हल्दी की खेती पर प्रशिक्षण
• ऑफ सीजन में धनिया की खेती।

विभिन्न एआईसीआरपीएस केंद्रों पर संपत्ति निर्माण

• पोटांगी में सूक्ष्म सिंचाई सुविधाओं के साथ 792 वर्गमीटर का शेड नेट घर।
• पॉली हाउस के लिए माइक्रो स्प्रिंकलर, पॉली हाउस के लिए घास की चटाई, एचआरएस,
चिंतापल्ली में शेड नेट का प्रतिस्थापन किया गया
• रायगढ़ में रोपण सामग्री के उत्पादन के लिए नेट हाउस का निर्माणा हो रहा है।
• पासीघाट में पॉली हाउस का निर्माण

उत्तर पूर्व देश - अस्पष्टीकृत की खोज

उत्तर पूर्व में सब्जी अदरक की खेती की काफी संभावना है। अदरक के जीनप्रकारों के सब्जी उद्देश्य के मूल्यांकन में , उच्चतम उपज (19.00 टन/हेक्टेयर) बोल्ड नादिया में दर्ज की गई, इसके बाद गोरुबथन (16.00 टन/हेक्टेयर) और नागालैंड में भैसे (16.00 टन/हेक्टेयर), जबकि अधिकतम उपज 24.60 टन/हेक्टेयर) को मिज़ोरम के भैसे में दर्ज किया गया, इसके बाद गोरुबथन (19.35 टन/हेक्टेयर) और बोल्ड नादिया (16.75 टन/हेक्टेयर) में अंकित किया गया। यह स्पष्ट रूप से उच्च उपज क्षमता और वनस्पति उद्देश्य के लिए इन जीनप्रकारों की उपयोगिता को सूचित करता है। बारापानी और मिजोरम केंद्रों द्वारा जैविक अदरक उत्पादन और सूक्ष्म पोषक परीक्षणों का सहारा लिया गया और दोनों केंद्रों पर दोनों परीक्षणों में बहुत अच्छी अदरक की पैदावार दर्ज की गई, इस प्रकार सूक्ष्म पोषक तत्वों के उपयोग के साथ जैविक उत्पादन के लिए एक महान प्रोत्साहन प्रदान किया गया। पासीघाट में भी, हल्दी में सूक्ष्म पोषक तत्वों का छिड़काव करने से उत्पादन में काफी वृद्धि हुई। इससे यह दर्शाता है कि राज्य में हल्दी के उत्पादन स्तर को सूक्ष्म पोषक तत्वों के छिड़काव के माध्यम से सफलतापूर्वक बढ़ाया जा सकता है।

सहयोग

मसालों पर एआईसीआरपी केंद्र निम्नांकित के सहयोग से काम करते हैं

• आईसीएआर-आईआईएसआर, कोषिक्कोड और आईसीएआर-एनआरसीएसएस, अजमेर (प्रौद्योगिकियों के लिए)।
• जनजातीय क्षेत्रों में प्रौद्योगिकियों को लोकप्रिय करने के लिए स्पाइसेस बोर्ड।
• गुणवत्ता रोपण सामग्री का उत्पादन करने और आपूर्ति करने के लिए एमआईडीएच (मिशन फॉर इंटीग्रेटेड डेवलपमेंट फॉर हॉर्टिकल्चर)।
• जनजातीय क्षेत्रों में उच्च उत्पादन प्रौद्योगिकियों को लोकप्रिय बनाने के लिए गैर-सरकारी संगठन।
• किसानों के उत्पादन, उत्पादकता और आय बढ़ाने के लिए राज्य कृषि विभाग।
• कॉफी आधारित काली मिर्च फसल प्रणाली की स्थापना के लिए कॉफी बोर्ड

निगरानी

केंद्र द्वारा किए गए अनुसंधान परियोजनाओं और कार्यक्रमों की निगरानी परियोजना समन्वयक और पीसी यूनिट के वैज्ञानिकों ने विभिन्न केंद्रों और प्रायोगिक प्लोट की यात्रा करके की थी। इस वर्ष के दौरान, 5 केंद्रों का दौरा किया गया जिसमें नियमित, सहयोगी, स्वैच्छिक और परियोजना मोड के केंद्र शामिल थे। केंद्रों की गतिविधियों की निगरानी केन्द्र द्वारा भेजी गयी मासिक रिपोर्ट, त्रैमासिक, अर्धवार्षिक और वार्षिक रिपोर्ट के माध्यम से की जाती है। आईसीएआर-अखिल भारतीय समन्वित मसाला अनुसंधान परियोजना की XXXवीं कार्यशाला 14-16 नवंबर, 2019 के दौरान तमिलनाडु कृषि विश्वविद्यालय, कोयम्बतोर में आयोजित की गई थी।

वर्ष 2013-2018 की अवधि के लिए मसालों पर एआईसीआरपी के काम की समीक्षा करने के लिए एक क्विनक्विनियल रिव्यू टीम (क्युआरटी) का गठन किया गया था। एआईसीआरपीएस ने एआईसीआरपीएस गतिविधियों और उपलब्धियों पर इनपुट डॉक्यूमेंट क्युआरटी टीम को प्रदान की और टीम द्वारा इसकी समीक्षा की गई। इस टीम द्वारा विभिन्न एआईसीआरपीएस केंद्रों के वैज्ञानिकों, जिन्होंने विभिन्न पहलुओ जैसे, केन्द्र का अधिदेश, बजट आवंटन, विकसित किस्मों और तकनीकियों, प्रकाशनों, एचआरडी और विस्तार गतिविधियों, भविष्य के कार्यक्रमों और बाधाओं आदि के बारे में विस्तृत प्रस्तुतियाँ दीं है, के साथ विस्तृत चर्चा हुई। क्युआरटी ने क्षेत्रीय कृषि अनुसंधान संस्थान, दुर्गापुरा, जयपुर के कुछ एआईसीआरपीएस केंद्रों, प्रयोगात्मक क्षेत्रों, प्रयोगशालाओं, कीटनाशक अवशेष प्रयोगशाला और कुछ किसानों के खेतों में भी दौरा किया ।

Executive Summary

ICAR-All India Coordinated Research Project on Spices with 38 centres (19 regular, 11 co-opting and 8 voluntary centres) spread over 14 agro climatic zones in 25 states of the country coordinates the research activities on spice crops like black pepper, large cardamom, small cardamom, ginger, turmeric, mango ginger, cinnamon, nutmeg, clove, coriander, cumin, fennel, fenugreek, ajwain, nigella, saffron and kalazeera. Annual budget for the year 2019 was Rs. 460.57 lakhs as ICAR share.

New initiatives

- Twenty one varieties of spice crops *viz.,* small cardamom (IISR Avinash), ginger (Suprabha, Suruchi, Suravi), turmeric (Roma, Surama, Rashmi, UBKV Turmeric 2), nutmeg (IISR Keralashree), coriander (Rajendra Dhania-1, Rajendra Dhania-2, Ajmer Coriander-2, Ajmer Coriander-3, Suguna, Susthira, Gujarat Coriander 3, Chhattisgarh Sri Chandrahasini Dhania 2), cumin (Gujarat Cumin 5), fennel (Ajmer Fennel 3) and fenugreek (Ajmer Fenugreek 5, Lam Sonali) were gazette notified by Central Sub-Committee on Crop Standards, Notification and Release of varieties for horticultural crops, New Delhi.
- In line with food safety assurance and minimization of the pesticide residue in spices, evaluation of *strobilurin* fungicides and *actinomycetes* was initiated in black pepper at various black pepper centres of AICRPS.
- For sustainable spice production, new programme on priming of rhizomes for enhanced germination, vigour and storage rot suppression in ginger and turmeric were undertaken in various AICRPS centres of different agro climatic regions.

Varieties recommended for release in XXX AICRPS workshop

Three varieties of spices for specific traits (one each in fennel, ajwain and nigella) were recommended for release in XXX AICRP on Spices workshop held at Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu.

Climatic resilient variety

RF 290: Fennel variety from SKNAU, Jobner for high yield (20.65 q ha^{-1}) with long and bold seeds, more umbellets and seeds per umbel.

Varieties with industrial application

Ajmer Ajwain 73: Ajwain variety from ICAR-NRCSS, Ajmer for high yield (10.66 q ha^{-1}) and high essential oil (6.38%).

Ajmer Nigella 1: Nigella variety from ICAR-NRCSS, Ajmer for high yield (9.09 q ha^{-1}) and high oleic acid (3.32%) content.

Technologies recommended during XXX AICRPS workshop

Five location specific technologies in different spice crops for various states developed during the year were recommended during XXX Annual workshop of AICRPS.

Water use efficiency - more crop per drop

Drip irrigation and fertigation in cumin: Fertigation with water equal to 60% of actual evaporation (0.6 IW/CPE ratio) at an interval of 4 days and 80% recommended dose of fertilizers through soluble fertilizers at different growth stages (10, 20, 40, 50, 70 & 80 DAS) is recommended for improving the yield and WUE in cumin in light textured soils of India with 20% water saving and B:C ratio of 1.50.

Soil nutrient management- for boosting farm yield

Fertilizer management for multi cut coriander- Application of NPK as 60:30:00 kg ha^{-1} as full dose of phosphorus and half dose of nitrogen as basal as well as remaining half dose of nitrogen after first cut i.e. 40-45 DAS for securing maximum yield (18q ha^{-1}) and B:C ratio (2.5) is recommended.

Integrated pest and disease management- for sustainable spice production

Organic nutrient and disease management in cumin- Soil application of vermicompost (2 t ha^{-1}) + seed treatment with *Trichoderma* (6 g kg^{-1}) and spray of neem seed kernel extract 5% were recommended for organic production and management of diseases like blight and wilt of cumin with B:C ratio of 2.29.

Management of powdery mildew in coriander using new generation fungicides- Foliar spray of hexaconazole 5% SC (1.0 ml $litre^{-1}$ of water) at the time of initial appearance of disease and second spray after 15 days interval controls powdery mildew of coriander with B:C ratio of 4.75.

Bacterial wilt management in ginger- For organic system of cultivation, adopting soil solarization along with the biocontrol agent, *Bacillus licheniformis* (GAP107 MTCC12725) launched as *Bacillich* controls bacterial wilt in ginger with B:C ratio of 3.23. For inorganic system of cultivation, $CaCl_2$ along with soil solarization controls the disease with B:C ratio of 2.88 (both treatments to be imposed at the time of planting and at 30, 45, 60 and 90 days after planting).

Research Achievements

Black pepper

During 2019, Pepper Research Station, Panniyur maintained 343 cultivated types, 57 wild and related types and 3 exotic types of black pepper. The collected germplasm accessions (58) from Konkan region has been maintained in the germplasm block at Department of Horticulture, Dr. BSKKV, Dapoli. Berry set was observed in 28 accessions at Yercaud. In the inter varietal hybridization trial conducted at Panniyur, the hybrids *viz.,* PRS 160, PRS 161 and PRS 165 were found to be promising with mean green berry yield of 6.12 kg/vine, 6.63 kg/vine and 4.84 kg/vine respectively. The hybrid PRS 161 was the most promising with respect to yield and yield attributing characters.

For the trial, biological management of slow decline in black pepper, soil application of *Trichoderma viride* + neem cake @ 2 kg/vine (T1), soil application of *Pochonia chlamydosporia* @ 50g/vine followed by soil drenching with *P. fluorescens* @ 2% (T4) were significantly superior in reducing yellowing due to slow decline disease in black pepper at Panniyur. At Sirsi, percent disease intensity was minimum (39.17) in soil drenching with copper oxy chloride @ 0.3% and cartap hydrochloride @ 15g/vine (T_6) during onset of monsoon (June) and again during the third week of august and it was on par (40.83) with soil application of *Trichoderma harzianum* @ 50g/vine and neem cake @ 2kg/vine (T_1) as compared to other treatments.

Small cardamom

A total of 320 cardamom accessions have been maintained which includes 132 at Mudigere and 188 at Pampadumpara. There was significant difference among the accessions of farmer's varieties of small cardamom with respect to their vegetative characters at Appangala, Sakleshpur, Myladumpara and Pampadumpara. At Appangala, the genotype *Thiruthali* recorded highest plant height (208.74 cm), more number of tillers (24.26), number of bearing tillers (11.39), number of panicles (18.53) and panicle length (49.15 cm). In Sakleshpur, number of tillers was significantly more in ICRI 8 (16.50), number of panicles (5.17) was significantly more in *Thiruthali* and number of racemes/panicles (16.33) was significantly more in *Paupali.*

At Pampadumpara, the genotypes *viz., Njallani* Green Gold and *Thiruthali* registered highest plant height of 166.30 and 160.63 respectively. Maximum number of tillers was produced by *Thiruthali* (16.53) followed by Patchakai (14.97) whereas more number of tillers were produced in Wonder cardamom (47.00), *Njallani* Green Gold (46.00) and *Thiruthali* (45.33) at Myladumpara. Significantly more panicles were found in *Thiruthali* (18) and *Panikulangara*1 (17.33).

Large cardamom

Out of total 308 accessions at ICRI, Gangtok, 301 have been registered with NBPGR, New Delhi and obtained IC number for the same. Passport data of remaining seven accessions (SCC 302-308) has been sent to NBPGR, New Delhi for the

allotment of IC numbers. Survey was conducted in the state of Sikkim to collect new accessions. ICRI, Gangtok also supplied 1650 planting units of large cardamom to ICAR- NOFRI, Tadong, ICAR- RC NEH, Barapani and beneficiaries from Arunachal Pradesh and Nagaland.

Ginger

Out of 198 ginger germplasm studied at Pottangi, 34 entries yielded more than 5 kg/3m^2 fresh rhizome. The range of plot yield being 0.10 kg (PGS-119) to 9.5 kg/3 m^2 (PGS-163) with the mean yield of 3.1 kg /3 m^2 in tested germplasm accessions during Kharif 2019. At Raigargh, Indira Ginger -1 (9.9 t ha^{-1}) recorded maximum yield over two national checks Suprabha (7.5 t ha^{-1}) and Suruchi (8.3 t ha^{-1}) followed by IN-4 (7.2 t ha^{-1}) and IN-3 (6.4 t ha^{-1}). At Barapani, out of 43 genotypes**,** IC-584354 recorded the highest yield with 20.95 t ha^{-1}. Highest dry matter (25.09%) and oleoresin (7.07%) content were recorded in IC-584353 and IC-584343 respectively.

The variety Maran recorded the maximum yield of 26.75 t ha^{-1} and 25.92 t ha^{-1} in IISR organic package and KAU organic package respectively at Ambalavayal. Between two organic packages (IISR organic package and RPCAU, Bihar organic package), both were on par. Among the three varieties evaluated at Dholi, (Nadia, Surabhi and Suprabha), all the varieties were on par for yield. At Kumarganj, the maximum yield was observed in V1T3 treatment (14.75 t ha^{-1}) followed by V2T3 (13.00 t ha^{-1}) and V3T3 (12.67 t ha^{-1}).

Turmeric

A total of 275 genotypes were conserved at Coimbatore and all the genotypes were evaluated and characterized. Statistical analysis of data revealed wide variations for growth, yield and quality parameters. Fourteen out of sixty seven accessions maintained at Dholi recorded high yield ranging from 50.25 to 54.17 t ha^{-1} against the check variety Rajendra Sonia (49.83 t ha^{-1}) and eight accession compared to Rajendra Sonali (52.33 t ha^{-1}). Out of the 180 accessions maintained and evaluated at Kumarganj, maximum yield was recorded in NDH-74 (275 g/plant) followed by NDH-86 (265 g/plant). At Pundibari, 176 germplasm accessions were maintained. Five genotypes showed above 40 t ha^{-1} yield, 16 genotypes showed 31 t ha^{-1} to 40 t ha^{-1} and 22 genotypes showed 25 t ha^{-1} to 30 t ha^{-1}.

In turmeric organic trial, the maximum yield was recorded in T_2 (100% organic manure equivalent to 75% N requirement of turmeric), with a yield of 28.29 t ha^{-1}, followed by T_1 (100% organic manure equivalent to 100% N requirement of turmeric) with a yield of 27.42 t ha^{-1}, T_6 (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 T_3 (100% organic manures + micronutrients).

At Coimbatore, combined application of capsule formulation of *Trichoderma* and GRB 35 in BSR-2 recorded minimum incidence of leaf spot (5.5 PDI) and leaf blotch (14.0 PDI) compared to control that recorded 19.9 and 26.2 PDI of leaf spot and leaf blotch respectively. Maximum yield was observed in V2T2 treatment (32.00 t ha^{-1}) followed by V2T1 (30.92 t ha^{-1}) and V2T3 (30.67 t ha^{-1}) at Kumarganj. Significantly lowest leaf blotch disease was recorded in Rajendra Sonia (PDI=28.89) and Rajendra Sonali (PDI=30.00) against control (PDI=58.52) at Dholi.

In the coordinated varietal trial of mango ginger, NVMG 2 registered high per plant yield (142.7 g) followed by Acc 347 (136.7 g) and NVMG 10 (134.7 g) at Ambalavayal whereas at Raigarh, Indira Mango Ginger 1 (IMG 1) recorded highest rhizome yield 28.6 t ha^{-1} followed by IMG 2 (27.5 t ha^{-1}) and IMG 4 (25.4 t ha^{-1}).

Tree spices

Among the nutmeg accessions conserved at Pechiparai, MF- 1 recorded maximum tree height (9.14 m) and stem girth (58.55 cm) and MF 4 recorded maximum leaf length (20.14 cm), leaf breath (9.15 cm), no. of fruits (667), single fruit weight (53.0 g) and mace yield (286 g/ tree). At Dapoli, the genotypes DBSKKVMF 29 (972), DBSKKVMF 9772 (507) and DBSKKVMF 22 (498) recorded maximum average number of fruits respectively. The genotype DBSKKV 29 recorded maximum dry nut yield (9817.20 g) and dry mace yield (2721.60 g).

Among the germplasm of clove planted during the year 1996-97 at Dapoli, four promising genotypes were selected. The plant height varied from 5.89 to 7.15 m, girth ranged from 35-40 cm and spread varied from 2.50 m to 3.05 m. Among the 24 accessions at Pechiparai, SA-1 recorded the highest tree height of 11.78 m, followed by SA-3 (11.63 m) compared with local check tree height (9.31 m).

Among the twelve accessions of cinnamon evaluated at Pechiparai, CV-5 recorded maximum tree height (2.81 m), number of shoots (10) and stem girth (16.84 cm).

Coriander

One hundred forty accessions of coriander were evaluated along with Hisar Sugandh, Hisar Bhoomit and Hisar Anand as checks at Hisar. The seed yield ranged from 32.4 g per plant (DH-292) to 97.5 g per plant (DH-227). The most promising accessions for seed yield were DH-218, DH-224, DH-227, DH-240, DH-244, DH-280, DH-293, DH-313, DH-316 and DH-329. Out of 230 accessions, 45 accessions were better than best check variety RCr-475 (33.14 g) on the basis of seed yield per 5 plants at Jobner.

Cutting management, varieties and fertility levels affected significantly on coriander seed equivalent yield. Adopted one cut at 45 DAS recorded significantly higher coriander seed equivalent yield over two cut and without cut. GDLC 1 produced significantly higher coriander seed equivalent yield over GCo2. Application of 60:30:00 kg NPK / ha recorded significantly the highest coriander seed equivalent yield over rest of the treatments.

Among the six fungicides tested, the disease incidence in propiconazole sprayed plants was less at Coimbatore (5.30 PDI) and Jagudan (18.94 PDI) whereas at Kumarganj and Raigarh foliar spray of wettable sulphur (0.2%) showed minimum disease intensity of 4.25 and 5.4% respectively. The minimum (10.80%) disease intensity and maximum seed yield of 17.183 q ha^{-1} were recorded with foliar spray of hexaconazole 5% SC @ 0.1% at Jobner.

Cumin

Ten entries of cumin under CVT and IET were tested for volatile oil content during Rabi 2018-19. The analysis of variance revealed significant differences among the entries for volatile oil (%) both in CVT and IET. The maximum volatile oil of 4.33% was observed in CUM-42 and RZ-345 followed by 3.60% in CUM-38, while minimum of 2.80% was recorded in CUM-39 and GC-4 in CVT. Pooled analysis of three years data from Jobner, revealed that maximum mean reduction in aphid population (79.09 %) and seed yield (2.59 q ha^{-1}) were recorded with thiamethoxam 25 WG @ 25 g a.i./ha followed by clothianidin 50 WDG @ 20 g a.i./ha (T_2) with 1.74 B:C ratio. It was statistically at par with treatment of spray with thiamethoxam 25 WG @ 25 g a.i./ha followed by thiacloprid 21.7 SC @ 25 g a.i./ha (T_1) which exhibited 76.01 % mean reduction in aphid population and seed yield (2.44 q ha^{-1}) with a B:C ratio of 1.64. Whereas maximum (39.00) mean aphid population per plant and minimum seed yield (1.35 q ha^{-1}) was recorded in untreated control (T_{10}). The percentage of volatile oil did not differ significantly among treatments.

Fennel

During *Kharif* season, thirteen entries of fennel were screened under natural conditions at Jagudan. The minimum intensity of *Ramularia* blight was noticed inJF-2012-8 (10.0%) while the maximum intensity was recorded in JF-2016-05 (30.0%). The disease intensity ranged from 10.0 to 30.0 per cent.

Among 14 entries tested in CVT at Kumarganj, FNL-125 recorded maximum yield (15.06 q ha^{-1}) followed by FNL-123 (14.37 q ha^{-1}) and FNL-121 (14.02 q ha^{-1}). At Hisar, maximum seed yield was recorded in FNL-116 (21.51 q ha^{-1}) followed by FNL-117 (20.10 q ha^{-1}) and FNL-123 (19.30 q ha^{-1}). The CVT at Jagudan revealed that FNL-124, 127 and FNL-119 ranked in top three positions. Fifteen genotypes of fennel were evaluated at Pantnagar and found that the highest seed yield was observed in FNL-128 (19.91q ha^{-1}) followed by FNL-121 (19.49 q ha^{-1}). At Navsari, FNL-123 (28.04 q ha^{-1}), FNL-118 (25.52 q ha^{-1}), FNL-126 (25.34 q ha^{-1}), FNL-119 (25.22 q ha^{-1}) and FNL-

127 (25.12 q ha^{-1}) were regarded as promising genotypes due to their higher seed yield.

Fenugreek

FGK 123 recorded maximum seed yield of 21.23 q ha^{-1} and 16.25 q ha^{-1} at Jobner and Kumarganj whereas FGK-122 recorded significantly highest seed yield at Navsari (20.78 q ha^{-1}) and Raigarh (16.1 q ha^{-1}). At Coimbatore FGK 124 (22.66) recorded maximum number of pods per plant and FGK 134 (11.60) recorded the lowest. Seed yield per plot (2 m^2) varied from 98.07 g to 174.67 g with a mean of 124.06 g.

Ajwain

Out of 13 entries of ajwain evaluated at Kumarganj, maximum yield was recorded in IA-1 (8.53 q ha^{-1}) followed by NDAJ-10 (8.26 q ha^{-1}) and HAJ-7-187 (8.19 q ha^{-1}). Among the entries evaluated at Guntur, highest yield was recorded in LS-14-3 (9.66 q ha^{-1}) followed by LS-14-8 (9.38 q ha^{-1}), AA-73 (9.38 q ha^{-1}) and AA-6 (8.73 q ha^{-1}) which were on par with each other and significantly superior to the best check Lam Selection-1 (7.93 q ha^{-1}).

Nigella

At Kumarganj, maximum yield was recorded in NDBC-20 (8.88 q ha^{-1}) followed by AN-1 (7.77 q ha^{-1}) and IN-1 (7.29 q ha^{-1}) and three years pooled data showed maximum yield in NDBC-20 (8.40 q ha^{-1}) followed by AN-1 (7.61 q ha^{-1}) and IN-1 (7.24 q ha^{-1}). At Kalyani, highest yield per hectare was recorded by IN1 (7.00 q ha^{-1}). At Kota, the seed yield ranged from 4.56-9.90 q ha^{-1}.

Saffron

200 germplasm accessions of saffron collected from various hot spots of Jammu and Kashmir including 36 exotic collections are maintained at Saffron Research Station, SKUAST, Kashmir. Among 200 accessions, 22 were found promising with regard to yield and quality.

The results on *in vitro* efficacy of isolated rhizospheric fungi (nonpathogenic to saffron crop) against mycelial growth of corm rot pathogen (*Fusarium oxysporum*) of saffron revealed that *Trichoderma viride* showed significantly superior performance as compared to other isolates including the control.

Kalazeera

The germplasm comprising of 70 accessions collected from foot hills of Northern Himalayas as well as germplasm available at Saffron Research Station, SKUAST-K are conserved. Some of the promising accessions with regard to yield and essential oil content identified are SRS-KZ-192, SRS-KZ-158, SRS-KZ-172, SRS-KZ-177, SRS-KZ-170, SRS-KZ-149 and SRS-KZ-167.

Production and distribution of quality planting material

The AICRPS centres have multiplied and distributed 4.16 lakh rooted cuttings of black pepper, 10338 suckers of cardamom, 50 tons of turmeric, 30 tons of ginger, 1294 grafts of nutmeg, 1048 seedlings of nutmeg, 150 grafts of cinnamon and 250 seedlings of cinnamon. In seed spices, 324 q of coriander, 70 q of cumin, 30.5 q of fennel, 61.71 q of fenugreek and 10 kg of ajwain seed material were produced and distributed.

Transfer of technology

The scientists of various centres have taken earnest effort to popularize the latest technologies as the research is meaningful only farmers are benefited through technologies. Following are some of the technologies demonstrated during the year.

High yielding varieties- boon to farmers

- Demonstration of transplanting of Rajendra Sonia variety of turmeric (Guntur)
- Demonstration of high yielding turmeric variety CO 2 (Coimbatore)
- Demonstration of TCP-129 turmeric variety for yield and tolerance to foliar diseases (Pundibari)

Rapid multiplication of planting materials- for minimal expenditure

- Production of black pepper plants using rapid multiplication method (Pechiparai)
- 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 (Pottangi, Nagaland)
- Demonstration of pro-tray propagation technique for ginger and turmeric, soft wood grafting technique in nutmeg and kokum, bush pepper production technology (Dapoli)

Processing and value addition- for capturing market

- Preparation of preserve and chutney from nutmeg rind (Dapoli)
- Processing of turmeric (Dapoli)

Plant protection- for improving plant health

- Demonstration of biocontrol agents for black pepper wilt control at Karadiyur village (Yercaud)
- Rhizome treatment with propiconazole @0.2% + foliar spray with propiconazole @0.1% at 90, 105 & 120 DAP in turmeric in 0.5 acres (Dholi)

Apart from the above field level demonstrations, the scientists popularised technologies by conducting trainings and attending as resource persons in trainings and seminars and also through various media (newspaper, radio talks and TV programmes). ICAR-IISR in collaboration with AICRPS has developed ICAR Turmeric, ICAR Ginger and ICAR Black pepper mobile apps to help the farmers by providing relevant information on varietal wealth, cultivation, management and protection aspects.

Success stories

High yielding varieties- for income maximization

Under AICRP on Spices at Dholi centre, high yielding varieties of different spice crops *viz.*, turmeric (Rajendra Sonia and Rajendra Sonali), coriander (Rajendra Dhania-1, Rajendra Dhania-2 and Rajendra Swati), fenugreek (Rajendra Kanti and Rajendra Abha), nigella (Rajendra Shyama), fennel (Rajendra Saurabh) and ajwain (Rajendra Mani) have been developed. During 2019, about 43.3 tonnes of turmeric seed was produced which was procured by progressive farmers, various government and non-governmental organizations of Bihar as well as adjoining states. Because of high productivity and high curcumin content of turmeric varieties like Rajendra Sonia and Rajendra Sonali, it was procured by the farmers of other states *viz.*, Uttar Pradesh, Gujarat, Jharkhand, Telangana, and Andhra Pradesh. Seed spices (coriander, fenugreek, fennel, nigella and ajwain) 15 q each were produced and made available to farming community for area expansion under spices cultivation. Cultivation of most of traditional varieties of spices were replaced by above mentioned released varieties and thus occupying major area under spices cultivation in the state and in some pockets in other state.

Biocontrol agents- for sustainable spice production

The bio control laboratory funded by the SHM is functioning in the Cardamom Research Station at Pampadumpara from 2012 onwards. Through this laboratory, biocontrol agents such as, *Pseudomonas flourescens*, *Trichoderma viride*, *Metarhizium anisopliae*, *Lecanicillium lecanii*, *Paecilomyces lilacinus* and *Beauveria bassiana* have been produced on a large scale and is being supplied to the farmers. During 2019, about 17038 kg of biocontrol agents were distributed to the farmers. Promising aspect is that more and more farmers are using biocontrol agents for pest and disease management of cardamom and black pepper. As per the feedback received, the farmers were more convinced about the quality and effect of biocontrol agents being supplied. The centre is looking forward to make more farmers aware about eco-friendly pest/disease management through the use of biocontrol agents and thus reduce the environmental chemical contamination and degradation of cardamom hill reserve (CHR) area to a greater extent.

Ginger seed storage- for prosperity

Ginger is known as poor man's cash crop of farmers of Himachal Pradesh especially of Sirmour and Solan districts. The area under its cultivation is reducing in the state year after year as the main problem in ginger cultivation is storage of healthy seed for next season as rhizome rot is the major menace resulting in poor rhizome yield. Hence, a modified storage method for healthy ginger seed rhizomes was

employed and demonstrated which enhanced ginger production and income of farmers.
Modified storage method consists of

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

With the adoption of this storage method of ginger, a dramatic increase in area and production of ginger in the state has been observed even in the non-conventional ginger growing areas of the state like Kangra, Mandi, Hamirpur, Una, Chamba and Bilaspur districts.

Tribal welfare measures – Reaching the unreached

ICAR-AICRP on spices under Tribal Sub Plan has 3 centres *viz.,* Pottangi in Odisha, Chintapalle in Andhra Pradesh and Raigarh in Chhattisgarh. These centres uplift the tribals through conducting Farmers training programmes on the following aspects benefitting 2000 tribal farmers. In addition to this, scheduled caste sub plan was also launched for the betterment of the SC/ST population.

- Training programmes on black pepper, ginger and turmeric cultivation
- training programme on Post Harvest management practices in turmeric
- Importance of quality planting materials, cultivation of seed spices and production techniques
- IPM technologies in horticultural crops
- Training on organic ginger and turmeric cultivation
- Off season coriander cultivation

Asset creation at various AICRPS centres

- Shade net house of 792 sq m with micro-irrigation facilities at Pottangi
- Micro sprinklers for poly house, weed mat for poly house, shade net replacements was done at HRS, Chintapalle
- Net house under construction for planting material production at Raigarh
- Poly house construction at Pasighat

North East- exploring the unexplored

North East has a great potential for cultivation of vegetable ginger. In a trial on the evaluation of ginger genotypes for vegetable purpose, highest yield (19.00 t ha^{-1}) was recorded in bold Nadia followed by *Gorubathani* (16.00 t ha^{-1}) and *Bhaise* (16.00 t ha^{-1}) at Nagaland, whereas maximum yield of 24.60 t ha^{-1} was recorded in *Bhaise* at Mizoram followed by *Gorubathani* (19.35 t ha^{-1}) and bold Nadia (16.75 t ha^{-1}). This clearly indicates high yield potential and the utility of these genotypes for vegetable purpose. Organic ginger production and micronutrient trials were taken up by Barapani and Mizoram centres and very good ginger yields were recorded in both the trials at both the centres, thus providing a great encouragement for organic production and also with the use of micronutrients. At Pasighat also, micronutrients spray in turmeric produced significantly higher yield, indicating that production levels of turmeric in the state can be enhanced successfully through micronutrients spray.

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

Monitoring

The research projects and programmes undertaken by the centres were monitored by Project Coordinator and Scientists from PC unit's visit to various centres and the experimental plots. During this year, five centres were visited which included regular, co-opting, voluntary and project mode centres. The activities of the centres were also monitored through monthly reports, quarterly, half yearly and annual report sent by the centres. The XXX Workshop of ICAR-All India Coordinated Research Project on Spices was conducted at Tamil Nadu Agricultural University, Coimbatore during 14-16 November 2019.

A Quinquennial Review Team (QRT) was constituted to review the work of AICRP on Spices for the period 2013-2018. The AICRPS has provided QRT team with input document on AICRPS activities and achievements and the same was reviewed by the team. Detailed interactions were held with the scientists of various AICRPS centres who made detailed presentations on various aspects such as mandate of the centre, budget allocation, varieties and technologies developed, publications, HRD and extension activities, future programmes and the constraints etc. QRT also visited some of the AICRPS centres, experimental fields, laboratories, Pesticide Residue Laboratory at Regional Agricultural Research Institute, Durgapura, Jaipur and some farmer's fields also.

Fig 1: Accredited black pepper nursery at Pottangi

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 ICAR - 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. At present, AICRPS is working on 17 mandate crops *viz.,* Black pepper, Small cardamom, Large cardamom, Ginger, Turmeric, Nutmeg, Cinnamon, Clove, Coriander, Cumin, Fennel Fenugreek, Ajowan, 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.

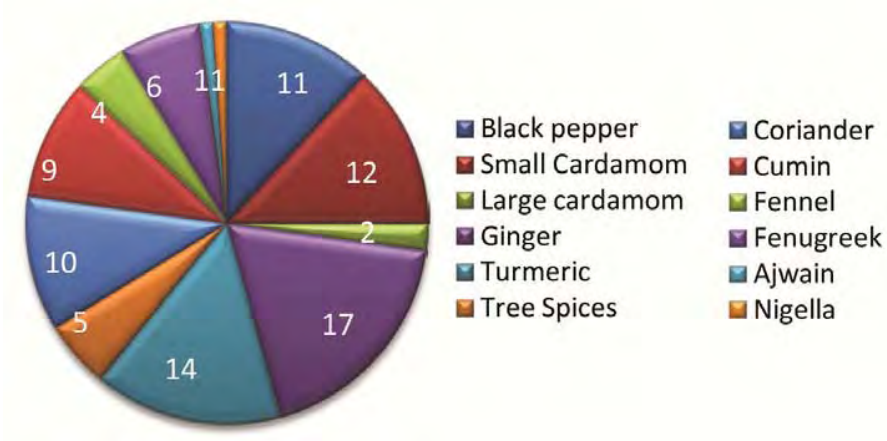
Development of location specific green agro technologies for improved production with water and nutrient management, organic farming, ecologically sound control measures against pests and through mechanisation for production of quality clean spices and spice products.

Facilitate faster adoption of proven technologies/varieties developed through technology dissemination, Field Level Demonstrations and attract youth to agriculture and agro enterprise.

Working as an interface between State Agricultural Universities (SAUs) and Indian Council of Agricultural Research (ICAR).

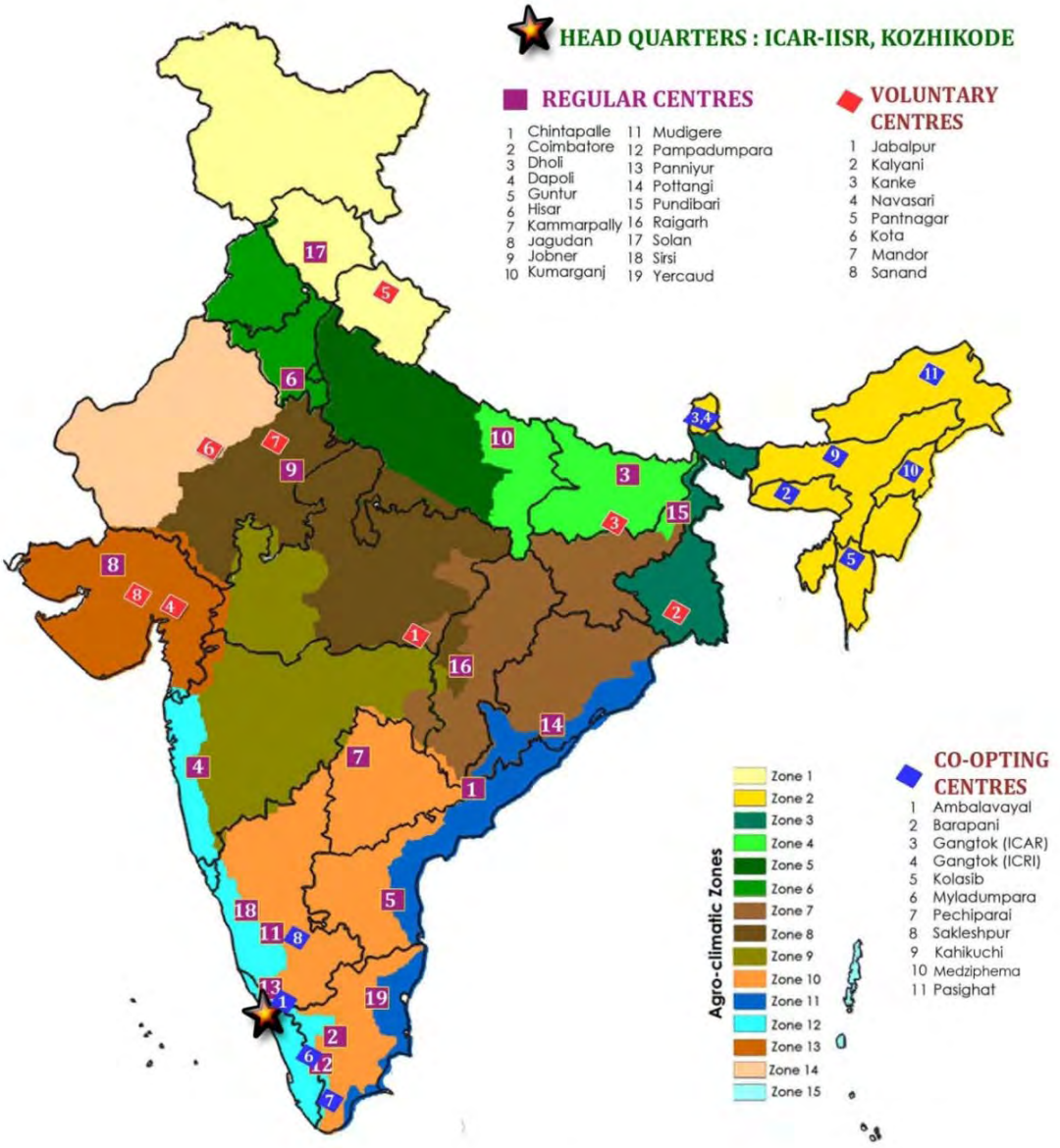
Spread the cultivation of spices to non traditional areas, North East and tribal areas for increased production. Tribal empowerment and identification of most suitable areas (crop mapping) for each of the crop.

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	DrYSRHU	Chintapalle	1981	Black pepper, Ginger, Turmeric
2	Andhra Pradesh	DrYSRHU	Guntur	1975	Coriander, Fennel, Fenugreek
3	Bihar	RAU	Dholi	1993	Turmeric, Coriander, Fenugreek
4	Chhattisgarh	IGKV	Raigarh	1996	Coriander, Turmeric, Ginger
5	Gujarat	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	Kammarpally	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



Agro-climatic Zones

Zone 1 – W. Himalayan region
Zone 2- E. Himalayan region
Zone 3- L. Gangetic plain region
Zone 4- M. Gangetic plain region
Zone 5- U. Gangetic plain region
Zone 6- T. Gangetic plain region
Zone7- E. plateau and hills region
Zone8- C. Plateau and hills region
Zone9- W. Plateau and hills region
Zone 10- S. plateau and hills region
Zone 11- E. coast plains and hills region
Zone 12- W.coast plains and ghat region
Zone 13- Gujarat plains and hills region
Zone14- Western dry region
Zone15- Island region

Technical Programme (2019)

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 tolerantto 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
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, Dapoli, Panniyur, Sirsi, Yercaud, Kahikuchi
PEP/CI/3.7	CVT 2018 on Black pepper Series IX	Ambalavayal, Chintapalle, Dapoli, IISR, Panniyur, Sirsi, 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/CM/4.8	Management of *Phytophthora* foot rot by mulching	Sirsi
PEP/CP/5	**Disease Management Trial**	
PEP/CP/5.6	Biological Management of Slow Decline in Black Pepper	Panniyur, Sirsi, Dapoli
PEP/CP/5.7	Studies on management of *Phytophthora* causing foot rot in black pepper	Panniyur, Sirsi, Dapoli, Mudigere
Small cardamom		
CAR/CI/1	**Genetic Resources**	
CAR/CI/1.1	Germplasm collection, characterization, evaluation and conservation	Mudigere, Pampadumpara
CAR/CI/2	**Hybridization**	
CAR/CI/2.1	Hybridization and selection in cardamom	Mudigere
CAR/CI/2.2	Evaluation of promising small cardamom (*Elettaria cardamomum* L. Maton) cultivars/varieties for organic cultivation in the high ranges of Idukki district	Pampadumpara

CAR/CI/3	**Coordinated Varietal Trial**	
CAR/CI/3.7	CVT of drought tolerance in cardamom – Series VII	Appangala, Mudigere, Sakaleshapura, Pampadumpara, Myladumpara
CAR/CI/3.8	CVT 2015 on Farmers varieties of cardamom-Series VIII	Appangala,Mudigere, Pampadumpara, Myladumpara, Sakaleshapura
CAR/CI/3.9	CVT 2018 on hybrids of cardamom-Series IX	Appangala, Mudigere, Pampadumpara, Myladumpara, Sakaleshapura
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	Mudigere, Pampadumpara, Myladumpara, Sakaleshapura
CAR/CM/5	**Nutrient Management Trial**	
CAR/CM/5.5	Effect of micronutrients on growth and yield of small cardamom	Appangala, Mudigere, Pampadumpara, Myladumpara, Sakaleshapura
CAR/CP/6	**Pest and Disease Management Trial**	
CAR/CP/6.8	Comparison of effect of chemical treatments as well as bio-control agents against pseudostem rot of cardamom	Mudigere
CAR/CP/6.9	Evaluation of new insecticides for thrips control	Mudigere, Pampadumpara, Myladumpara, Sakaleshapura
CAR/CP/6.10	MLT on leaf blight tolerant lines of small cardamom–2018	Appangala, Mudigere, Pampadumpara, Myladumpara, Sakaleshapura
Large cardamom		
LCA/CI/1.1	Germplasm collection and evaluation of large cardamom	ICAR Regional Station, Gangtok, ICRI Regional Research Station, Gangtok
LCA/CP/1.2	Integrated pest and disease management in large cardamom	ICAR Regional Station, Gangtok, ICRI Regional Research Station, Gangtok
Ginger		
GIN/CI/1	**Genetic Resources**	
GIN/CI/1.1	Germplasm collection, characterization, evaluation and conservation	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 Pottangi, Pundibari, Kalyani, 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	Pottangi, Pundibari, 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)	IISR, Chintapalle, Pottangi, Pundibari, Nagaland, Gangtok, Mizoram
GIN/CM/5	**Nutrient Management Trial**	
GIN/CM/5.6	Organic production of ginger	Barapani, Mizoram
GIN/CM/5.7	Effect of micronutrients on growth and yield of ginger (Demonstration trial)	Pottangi, Chintapalle
GIN/CM/5.8	Effect of organic manures and bio-fertilizers on partitioning of dry matter in ginger	Dholi
GIN/CM/5.9	Organic production of ginger	Ambalavayal, Pottangi, Chintapalle, Dholi, Barapani, Kammarpally, Kumarganj, Pundibari, Raigarh, Solan, Kalyani, Mizoram
GIN/CM/5.10	Effect of micronutrients on growth and yield of ginger	Pottangi, Chintapalle, Dholi, Barapani, Kammarpally, Kumarganj, Pundibari, Raigarh, Solan, Kalyani, Ambalavayal
GIN/CP/6	**Disease Management Trial**	
GIN/CP/6.11	Eco-friendly management of rhizome rot of ginger	Kumarganj
GIN/CP/6.12	Field screening of different varieties of ginger against leaf spot and rhizome rot	Dapoli
GIN/CP/6.13	Effect of PGPR biocapsule on growth and yield of ginger	Pottangi, Chintapalle, Dholi, Barapani, Kammarpally, Kumarganj, Pundibari, Raigarh, Solan, Kalyani, Ambalavayal
GIN/CP/6.14	Management of bacterial wilt of ginger through chemicals and bioagents	IISR, Dholi, Pottangi, Pundibari, Kalyani, Solan, Nagaland, Pasighat, Gangtok
Turmeric		
TUR/CI/1.1	Germplasm collection, characterization, evaluation and conservation	Barapani, Coimbatore, Dholi, Guntur, Kammarpally, Kumarganj, Pantnagar, Pasighat, Pottangi, Pundibari, Raigarh, Solan

TUR/CI/2	**Coordinated Varietal Trial**	
TUR/CI/2.6	CVT on turmeric-2016	Chintapalle, Coimbatore, Dholi, Guntur, Kammarpally, Kumarganj, Pottangi, Pundibari, Raigarh, Navsari
TUR/CI/2.7	CVT on mango ginger	Ambalavayal, Pottangi, Kozhikode, Dholi, Barapani, Pundibari, Raigarh, Navsari
TUR/CI/3	Varietal Evaluation Trial	
TUR/CI/3.7	Initial Evaluation Trial 2015	Kumarganj
TUR/CI/3.8	Initial Evaluation Trial 2016	Pundibari, Pottangi, Solan
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/CM/5.14	Organic production of turmeric	Barapani, Solan. Dholi, Chintapalle, Coimbatore, Guntur, Kammarpally, Kumarganj, Mizoram, Pantnagar, Raigarh, Pasighat, Pottangi, Pundibari
TUR/CM/5.15	Effect of micronutrients on growth and yield of turmeric	Chintapalle, Solan, Dholi, Coimbatore, Kammarpally, Kumarganj, Pantnagar, Pasighat, Pottangi, Pundibari, Raigarh
TUR/CP/7	**Disease Management Trial**	
TUR/CP/7.1	Survey and identification of disease causing organisms in turmeric and screening of turmeric germplasms against diseases	Coimbatore, Pundibari, Dholi, Raigarh
TUR/CP/7.3	Assessment of fungicide and biological control agents against foliar disease of turmeric	Raigarh, Coimbatore
TUR/CP/7.4	Management of foliar diseases in turmeric using tolerant lines	Dholi, Kumarganj, Pundibari, Raigarh, Kammarpally, Solan, Guntur
TUR/CP/7.5	Eco-friendly management of foliar diseases of turmeric	Kumarganj
TUR/CP/7.7	Effect of PGPR biocapsule on growth and yield of turmeric	Chintapalle, Coimbatore, Dholi, Kumarganj, Pantnagar, Pasighat, Pottangi, Pundibari, Raigarh, Solan, Kammarpally
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	**Nutrient Management trial**	
COR/CM/5.5	Response of coriander varieties to various levels of fertility under multi cut management practice	Jagudan
COR/CP/6	**Disease Management Trial**	
COR/CP/6.4	Studies on the management of coriander powdery mildew using new generation fungicides	Coimbatore, Raigarh, Jobner, Jagudan, Kumarganj
COR/CP/6.5	Eco-friendly management of stem gall of coriander (Observational trial)	Kumarganj
COR/CP/6.6	Integrated management of stem gall disease of coriander	Dholi
COR/CP/6.7	Integrated pest and disease management in coriander	Ajmer, Coimbatore, Dholi, Hisar, Jabalpur, Raigarh, Jobner, Jagudan, Kumarganj, Navsari, 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/3	**Varietal Evaluation Trial**	
CUM/CI/4	**Quality Evaluation Trial**	
CUM/CI/4.1	Quality Evaluation in cumin	Jobner
CUM/CM/5	**Nutrient Management Trial**	
CUM/CM/5.2	Organic nutrient and disease management in cumin	Jobner
CUM/CM/5.4	Standardization of drip irrigation and fertigation in cumin	Jobner, Jagudan, Mandor
CUM/CP/6	**Disease Management Trial**	
CUM/CP/6.6	Bio-efficacy of newer molecules of insecticides against cumin aphid	Jagudan, Jobner, Ajmer
CUM/CP/6.7	Management of powdery mildew in cumin through new chemicals	Jobner
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
FNL/CI/1.2	Multilocation evaluation of fennel germplasm	Ajmer, Hisar, Jobner, Kumarganj
FNL/CI/2	**Coordinated Varietal Trial**	
FNL/CI/2.6	Coordinated Varietal Trial on fennel 2018 – Series X	Ajmer, Dholi, Hisar, Jabalpur, Jagudan, Jobner, Kumarganj, Pantnagar
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/1.2	Multilocation evaluation of fenugreek germplasm	Ajmer, Hisar, Jobner, Kumarganj
FGK/CI/1.3	Identification of drought tolerance source in fenugreek	Jobner
FGK/CI/2	**Coordinated Varietal Trial**	
FGK/CI/2.5	Coordinated Varietal Trial 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 micro nutrient fertigation in fenugreek	Ajmer, Coimbatore, Hisar, Jagudan, Jabalpur, Jobner, Kumarganj, Pantnagar, Navsari, Raigarh, Kota
Ajwain		
AJN/CI/2	**Coordinated Varietal Trial**	
AJN/CI/2.1	Coordinated Varietal Trial- 2016	Ajmer, Guntur, Hisar, Jobner, Jagudan, Kumarganj, Raigarh
Nigella		
NGL/CI/2	**Coordinated Varietal Trial**	
NGL/CI/2.1	Coordinated Varietal Trial-2016	Ajmer, Hisar, Kota, Kalyani, Kumarganj, Raigarh, Pantnagar
Saffron		
Project mode	Conservation, evaluation and utilization of exotic and indigenous saffron germplasms lines	
Kalazeera		
Project mode	Exploration, collection and conservation of kalazeera from high altitudes of northern Himalayas	Pampore

01 Black pepper

GENETIC RESOURCES

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

(Centres: West Coast Plains and Ghat Region - Ambalavayal, Panniyur, Sirsi; East Coast Plains and Hill Region – Chintapalle; Western Plateau and Hills Region – Dapoli; Middle Gangetic Plain Region – Pundibari; East coast plains and hill region - Yercaud)

Germplasm of black pepper maintained at various AICRPS centres is presented in Table 1. At present 343 cultivated types, 57 wild and related types and 3 exotic types of black pepper are being maintained at PRS, Panniyur including the 13 new genotypes collected during the year. During 2019, the genotypes PRS 64, PRS 136 and PRS 154 were the top yielders. PRS 64 ranked first with 5.0 kg green berry yield and 1260 spikes/vine. Spike length was maximum in PRS 155 (15.1 cm). The number of developed berries/spike was more in PRS 137 (75). The 100 berry weight was highest in PRS 154 (12.4 g). The dry recovery % was maximum in PRS 136 (38 %). Ambalavayal maintains 10 accessions of black pepper (Fig 3).

Fig 3: Germplasm collection at Ambalavayal

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

Centres	Indigenous				Exotic	Total
	Cultivated		Wild and related species			
	Existing	Addition	Existing	Addition		
Ambalavayal	10	-	-	-	-	10
Chintapalle	26	-	-	-	-	26
Dapoli	57	1	-	-	-	58
Panniyur	343	13	57	-	3	416
Pundibari	31	-	-	-	-	31
Sirsi	253	10				263
Yercaud	34	-	3	-	-	37
Total	754	24	60		3	841

Table 2: Variation in genotypes of black pepper at Chintapalle

Sl.No.	Variety	No. of spikes/ vine	Spike length (cm)	No. of berries / spike	Fresh weight kg/vine	Dry weight kg/vine	Yield (t/ha)	Recovery percentage (%)
1	Neelamundi	258.00	13.27	84.00	1.26	0.37	1.18	29.37
2	Thevarmundi	482.00	11.85	61.00	2.34	0.65	2.08	27.28
3	Aimpiriyan	142.00	11.30	52.00	0.48	0.15	0.48	31.25
4	Vellanamban	255.00	11.46	70.00	2.84	0.88	2.82	30.99
5	Narayakodi	208.00	11.30	63.00	1.24	0.36	1.15	29.03
6	Uddaghere	436.00	12.39	70.00	1.98	0.62	1.98	31.31
7	Kureilmundi	128.00	11.36	48.00	0.59	0.15	0.48	25.42
8	Perambramundi	120.00	11.47	51.00	0.49	0.16	0.51	32.65
9	Malamundi	502.00	12.02	49.00	1.63	0.48	1.54	29.45
10	Kottanadan	139.00	10.75	45.00	0.38	0.11	0.35	28.95
11	Panniyur-1	639.00	13.58	79.00	4.04	1.29	4.13	31.93
12	Karimunda	87.00	10.48	50.00	0.43	0.11	0.35	25.58
13	Arakulmunda	53.00	9.42	30.00	0.34	0.10	0.32	29.41
14	Balankotta	378.00	11.56	52.00	2.21	0.69	2.21	31.22
15	Punjaramunda	204.00	10.69	63.00	0.42	0.11	0.35	26.19
16	HP1411	159.00	9.52	53.00	0.47	0.13	0.42	27.66
17	HP105	227.00	11.30	80.00	0.23	0.05	0.16	21.74
18	HP34	246.00	9.60	65.00	0.76	0.24	0.77	31.58
19	PRS22	84.00	11.27	60.00	0.32	0.09	0.29	28.13
20	PRS-21	92.00	9.96	53.00	0.24	0.07	0.22	29.17
21	PRS-17	100.00	9.31	39.00	0.36	0.10	0.32	27.78
22	Cul.5489	113.00	10.58	44.00	0.17	0.05	0.16	29.41
23	KOP	138.00	12.23	56.00	0.63	0.19	0.61	30.16
24	Cu1041	239.00	9.59	40.00	0.34	0.10	0.32	29.41
25	Cu 5308	583.00	11.62	59.00	2.83	0.90	2.88	31.80
26	HP813	63.00	9.57	27.00	0.45	0.13	0.42	28.89

The trial was initiated during 1987 at Chintapalle (Fig 4) and 26 germplasm accessions have been maintained. Among them Panniyur -1 recorded highest number of spikes per vine (639), fresh berry yield/vine (4.04 kg), dry yield (1.29 kg), fresh yield (4.13 t ha^{-1}) whereas the highest no. of berries per spike was recorded in Neelamundi and highest dry recovery was recorded in Perambramundi (32.65 %).

The collected germplasm accessions from Konkan region has been maintained in the germplasm block at Department of Horticulture, Dr.B.S.KKV, Dapoli. Among the accessions, DBSKKVPN 28 recorded maximum plant height (5.1 m) followed by DBSKKVPN 4 (4.7 m). Thirty one germplasm accessions (6 land races, 3 farmers varieties, 10 released varieties and 12 related) have been collected and maintained by the Punaibari centre.

During year 2019, berry set was observed in 28 accessions at Yercaud. The highest spike length was observed in PN 74 (13.20 cm) followed by PN 46 (12.17 cm), PN 1 (11.97 cm) and PN 62 (11.73 cm) and the lowest in PN 58 (8.07 cm). The mean number of berries/spike ranged from 33.33 to 69.00. PN 47 recorded maximum berries/spike (69.00) followed by PN 60 (68.67) and PN 33 (65.67) and PN 55 recorded the lowest (33.33). Test weight (100 green berry weight) ranged from 10.33 to 12.93 g and accession PN 80 (12.93 g) recorded the highest followed by PN 58 (12.92 g). Dry weight of 100 berries was highest in PN 55 (3.66 g) and PN 60 recorded the lowest (2.60 g). The accession PN 55 recorded the highest green berry yield/vine (3.70 kg) followed by PN 11 (3.47 kg) and PN 46 (3.42 kg). The accession PN 55 recorded the highest dry berry yield/vine (1.04 kg) followed by PN 11 (1.01 kg) and PN 33 recorded the lowest (0.46 kg).

Fig 4: View of black pepper nursery at Chintapalle

Crop Improvement

PEP/CI/2 Hybridization trial

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

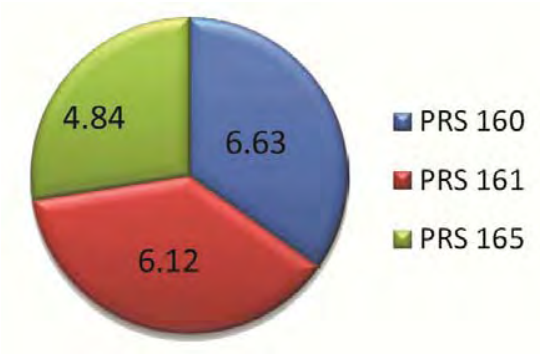
(Centres: West Coast Plains and Ghat Region - Panniyur)

The hybrids *viz.,* PRS 160, PRS 161 and PRS 165 (Fig 5) were found to be promising with mean green berry yield of 6.12 kg/vine, 6.63 kg/vine and 4.84 kg/vine respectively. Number of spikes/vine was highest in PRS 161 (902). Spike length was maximum in PRS 161 (21.9 cm). 100 berry weight and dry recovery were also higher in PRS 161 (19.1 g and 38%). The hybrid PRS 161 was the most promising with respect to yield and yield attributing characters.

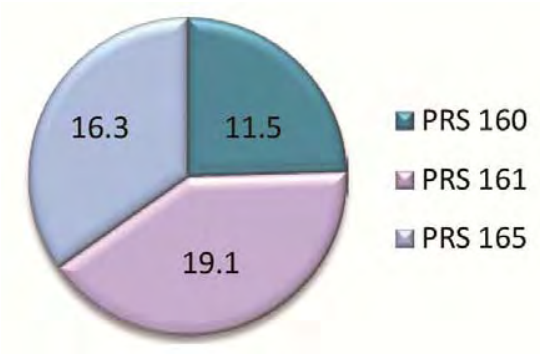
PEP/CI/2.2 Hybridization to evolve varieties tolerant to biotic and abiotic stresses

(Centres: West Coast Plains and Ghat Region - Panniyur)

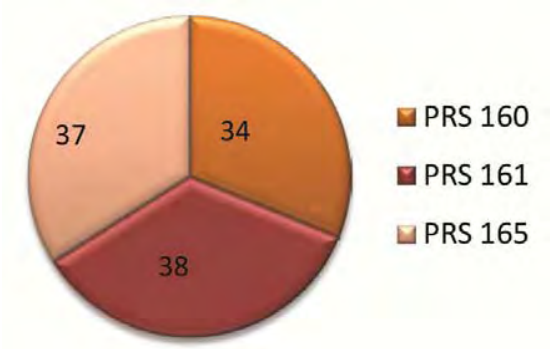
In the hybridization trial to evolve varieties tolerant to biotic and abiotic stress, seedlings of all the crosses are being maintained.



Fresh yield (kg/vine)



100 berry wt (g)



Dry recovery (%)

Promising hybrid PRS 161

Fig 5: Promising black pepper hybrids

PEP/CI/3 Coordinated Varietal Trial (CVT)

PEP/CI/3.3 CVT 2006 Series VI

(Centres: East Coast Plains and Hill Region – Chintapalle; Western Plateau and Hills Region – Dapoli; West Coast Plains and Ghat Region - Panniyur, Pampadumpara, Sirsi; East Coast Plains and Hill Region - Yercaud)

At Chintapalle, the maximum plant height was recorded in C-1090 (675.87 cm) followed by HP-39 (622.63 cm) whereas the minimum plant height was noticed in ACC 33 (402.90 cm). ACC-

33 recorded maximum number of branches per plant (28.96) followed by C-1090 (21.91) and ACC 57 (21.56) and these two were on par with each other. Fresh berry yield was the highest in Panniyur-1 (830.05 g) followed by P-8 (638.45 g) and ACC 33 (615.49 g). It was observed that all varieties are susceptible to *Phytophthora* foot rot disease.

At Dapoli, plant growth parameters of different black pepper varieties did not differ significantly from each other. Plant height ranged between 2.21 to 6.29 m whereas significant differences were observed among the entries for plant height and branches per vine at Yercaud. Maximum number of spikes per meter square (62.00) was recorded in IISR Shakthi followed by IISR Thevam (59.00) and the lowest in Acc. no.106 (21.0). The number of berries per spike was highest in IISR Shakthi (85.00). The green berry and dry berry yield were also highest in IISR Shakthi (3.90 kg and 1.10 kg/ vine respectively).

All the accessions of black pepper have initiated spike at Sirsi and crop will be harvested during the first fortnight of February 2020. The genotype HB 20052 recorded the highest green berry yield of 5.20 kg/vine which was on par with acc.no.53 (4.97 kg/ vine) at Panniyur. Among the characters studied at Pampadumpara, highest fresh weight (0.975 kg/vine) of berries per vine was registered for HB 20052 which was on par with *Karimunda* (0.932 kg/vine) followed by ACC-53 (0.756 kg/vine). *Karimunda* recorded the highest dry weight of berries (0.528 kg/vine) followed by HB 20052 (0.525 kg/vine).

Table 3: Performance of various accessions of black pepper at Pampadumpara

Accession	Fresh wt. (kg/vine)	Dry wt. (kg/vine)	Spike length(cm)	100 berry wt. (g)	Number of berries per spike
HB 20052	0.98 ^{a}	0.53^{ab}	10.23 ^{c}	9.16 ^{e}	57.63 ^{bc}
ACC 106	0.56 ^{cde}	0.31 ^{def}	4.90 ^{f}	12.33 ^{b}	31.35 ^{e}
ACC 33	0.50^{cde}	0.27 ^{ef}	12.33 ^{b}	11.16 ^{bc}	51.42 ^{bcd}
ACC 57	0.37 ^{e}	0.20 ^{f}	14.56 ^{a}	9.66 ^{de}	81.29 ^{a}
ACC-1090	0.49 ^{de}	0.27^{ef}	11.50 ^{bc}	10.66 ^{cd}	34.03 ^{de}
HP-39	0.64 ^{cd}	0.22 ^{f}	7.03 ^{e}	15.10 ^{a}	40.20 ^{cde}
P-1	0.74 ^{abcd}	0.42^{abc}	15.16 ^{a}	11.00 ^{c}	68.96 ^{ab}
Karimunda	0.93 ^{ab}	0.53 ^{a}	12.13 ^{b}	10.66 ^{cd}	41.68^{cde}
PRS -88	0.68 ^{bcd}	0.37 ^{cde}	8.56 ^{d}	9.00 ^{e}	36.33 ^{de}
ACC-53	0.76 ^{abc}	0.41 ^{bcd}	14.90 ^{a}	11.50^{bc}	65.87 ^{ab}
CD(0.05)	0.25	0.11	1.39	1.30	19.21
CV	22.44	18.54	7.28	6.90	22.01

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

(Centres: East Coast Plains and Hill Region – Chintapalle; Western Plateau and Hills Region – Dapoli; West Coast Plains and Ghat Region - Panniyur, Sirsi; East Coast Plains and HillRegion - Yercaud)

The genotype, *Kumbakkal* recorded the highest green berry yield (2.20 kg) and dry berry yield (0.70 kg) at Panniyur and was on par with Panniyur 1. Spike length was the highest for Panniyur 1 (17.03 cm) and on par with Panniyur 5 (16.6 cm). Number of berries/spike was highest for Panniyur 1 (84.66) whereas higher

dry recovery percentage of 35 was recorded in Zion mundi, Panniyur 5 and Panniyur 1.

At Chintapalle, *Kumbakkal* recorded maximum plant height (165.78 cm) followed by Zion mundi (164.97 cm) whereas at Dapoli, *Thekkan* recorded maximum plant height (114 cm). In Sirsi, the genotypes *viz.,* Zion mundi and Panniyur 1 have initiated the spikes during the year. The gap filling of the farmer's varieties *viz.*, Zion mundi, *Kumbakkal* and *Thekkan* was done at Yercaud and plants are in the vegetative stage.

PEP/CI/3.6 CVT 2015 on Black pepper Series VIII

(Centres: East Coast Plains and Hill Region – Chintapalle; Western Plateau and Hills Region – Dapoli; West Coast Plains and Ghat Region - Panniyur, Sirsi; Eastern Himalayan Region – Kahikuchi)

All the plants are in vegetative stage at Chintapalle, Dapoli and Sirsi. At Panniyur, the genotype PRS 161 recorded highest green berry yield of 1.93 kg per vine (0.73 kg dry berry yield), highest spike length (21.93 cm), maximum berries/spike (118) and highest dry recovery (38%).

PEP/CI/3.7 CVT 2018 on Black pepper Series IX

(Centres: East Coast Plains and Hill Region – Chintapalle; Western Plateau and Hills Region – Dapoli; West Coast Plains and Ghat Region - Ambalavayal, Panniyur, Kozhikode, Sirsi; East Coast Plains and Hill Region - 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) were planted at Ambalavayal, Yercaud, Panniyur, Kozhikode, Sirsi and are being taken care.

In Chintapalle the planting materials are under multiplication and the experiment will be executed in field level during *Kharif* 2019.While in Dapoli, OPKM was found to be significantly superior over rest of the varieties and recorded maximum height of 1.26 m.

Crop Management

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

(Centres: West Coast Plains and Ghat Region - Ambalavayal, Sirsi, Panniyur; Western Plateau and Hills Region - Dapoli)

During 2019, observations were recorded on morphological characters of intercrops at Panniyur. Greater yam recorded maximum plant height of 3.85 m followed by elephant foot yam (1.06 m).

At Ambalavayal and Sirsi, elephant foot yam out yielded (2.43 kg plant^{-1}) other intercrops. The yield of intercrops at Dapoli was as follows; colocasia 4.02 tons, arrow root 4.11 tons, elephant foot yam 11.17 tons, tapioca 9.31 tons and greater yam 10.0 tons.

Crop Protection

PEP/CP/5.6 Biological management of slow decline in black pepper

(Centres: West Coast Plains and Ghat Region – Panniyur, Sirsi, Dapoli)

Soil application of *Trichoderma viride* + neem cake @ 2 kg/vine (T1), soil application of *Pochonia chlamydosporia* @ 50 g/vine followed by soil drenching with *P. fluorescens* @ 2% (T4) was significantly superior in reducing yellowing due to slow decline disease in black pepper at Panniyur. At Sirsi, per cent disease intensity was minimum (39.17) in soil drenching with Copper oxy chloride @ 0.3% and Cartap hydrochloride @ 15 g/vine (T_6) during onset of monsoon (June) and again during the third week of August and it was on par (40.83) with soil application of *Trichoderma harzianum* @ 50 g/vine and neem cake @ 2 kg/vine (T_1) as compared to other treatment. Minimum per cent disease intensity (6.78) was recorded in the treatment with soil application of *Pochonia chlamydosporia* @

2kg/vine followed by soil drenching with *Pseudomonas fluorescens* IISR-6 @ 2% (10^6cfu) and was significantly superior to rest of the treatments at Dapoli.

Table 4: Disease intensity of slow decline in black pepper at Sirsi and Panniyur

Treat. No.	Treatment details	Disease intensity (%) at Sirsi	Disease intensity (%) at Panniyur
1	Soil application of *Trichoderma harzianum* @ 50 g/vine+ neem cake @ 2kg/vine	40.83 (39.71)**	9.38(3.02)
2	Soil application of *Trichoderma harzianum* @ 50 g/vine followed by soil drenching with *P. fluorescens* @ 2%	47.50 (43.56)	8.13(2.77)
3	Soil application of *Pochonia chlamydosporia* @ 2 kg/vine followed by soil drenching with *P. fluorescens* @ 2%	55.00 (47.89)	9.38(3.02)
4	Soil application of *Pochonia chlamydosporia* @ 50 g/vine followed by soil drenching with *P. fluorescens* @ 2%	61.67 (51.75)	18.0(4.17)
5	Soil application with Cartap hydrochloride @ 15 g/vine	69.17 (56.39)	20.0(4.35)
6	Soil drenching with Copper oxy chloride @ 0.3% + Cartap hydrochloride @ 15g/vine	39.17 (38.72)	23.13(4.62)
	Control	79.17 (62.90)	23.75(4.70)
	CD (P=0.05)	3.85	0.831

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

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

The percentage disease incidence (8.3%) was minimum in T3 (Application of Fosetyl Aluminium amended fertilizer brickets at the onset of rain and post monsoon) and T5 (RIL070/F1 -72% WP 100 ppm soil drenching) at Panniyur whereas at Sirsi, per cent disease intensity was minimum (29.38) in application of RIL~070/F1 @ 400 ppm /vine (T_1) at the onset of rain and post monsoon and it was followed by the treatment, Copper oxychloride @ 0.25% drenching and Bordeaux mixture @ 1% spray (T_3) (33.75). Maximum disease intensity (75.63) was observed in control (T_6). In Dapoli also, the treatment T3, application of fungicide (Fosetyl-Al) amended fertilizer briquettes (0.3%) was found to be effective with minimum PDI 6.64% and maximum percent (78.76%) disease reduction over control. The treatment, soil application of *Trichoderma harzianum* + *Pochonia chlamydosporia* at par with PDI (7.11%).

02 Small cardamom

Genetic Resources

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

(Centres: West Coast Plains and Ghat Region - Mudigere, Pampadumpara)

A total of 188 cardamom accessions are presently conserved in the gene bank of Pampadumpara. Characterization of small cardamom accessions revealed that the genotype HY 13 registered highest yield (1.83 kg/clump) whereas the genotype HY 12 showed least incidence of thrips (21.94%), stem borer (1.41%) and *Azhukal* disease (1.41%). At Mudigere, 132 cardamom germplasm lines have been replanted during the 2010 as the plantation (trial) was very old and the observation on different growth and yield parameters were recorded in three year old plants.

Table 5: Cardamom germplasm collections of AICRPS centres

Centre	Indigenous		Total
	Cultivated	Wild and related sp.	
Mudigere	132	Nil	**132**
Pampadumapra	188	Nil	**188**
Total	320	Nil	**320**

Crop Improvement

CAR/CI/2 Hybridization

CAR/CI/2.1 Hybridization and selection in cardamom

(Centres: West Coast Plains and Ghat Region – 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/2.2 Evaluation of promising small cardamom (*Elettaria cardamomum* Maton) cultivars/varieties for organic cultivation in the high ranges of Idukki district

(Centre: West Coast Plains and Ghat Region - Pampadumpara)

The main objective of the experiment was to screen and recommend cardamom types suitable for organic farming systems in the high ranges of Idukki district. The treatments of the experiment include four high yielding *Malabar* types (PV -1, S1, PS 27 & ICRI-2), and three *Vazhukka* types (PV-2, Pl No14 and *Njallani*). There was significant difference among accessions with respect to their vegetative characters (plant height, leaf width and no. of productive tillers, leaf length, no of panicles per tiller and shoot borer infestation) while no statistical difference was observed for incidence of shoot borers.

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

(Centres: West Coast Plains and Ghats Region – Appangala, Mudigere, Myladumpara, Pampadumpara; Southern Plateau and Hills Region - Sakleshpur)

Six genotypes of cardamom (IC 349537, IC 584058, GG×NKE-12, IC 584078, CL 668, HS 1, IC

584090) with one check (Appangala 1) were evaluated for drought tolerance at Appangala. Mositure stress was imposed in summer from February to April in stress block by withholding irrigation. The control block was irrigated by sprinkler (25 mm) once 12-15 days interval. Plant height, number tillers, panicle length and yield was reduced under moisture stress. The genotype, IC 584058 recorded maximum yield (400.34 kg ha^{-1}) in control than in stress (278.78 kg ha^{-1}) which was followed by the genotype IC 584090 (307.32 kg ha^{-1}) in control and in stress (166.33 kg ha^{-1}). Accession IC 584058 recorded 80 per cent bold capsules (>7mm) and syncrony in flowering and harvesting could be completed in four harvest. Essential oil per cent ranged from 6.81 to 8.18 and oleoresin per cent ranged from 3.61 to 5.55.

The experiment was started during last year at Pampadumpara and plants are in their early vegetative stage. At Myladumpara, only few plants from each treatment were established during the season and hence gap filling was done by using the multiplied plants. Observations on vegetative and yield contributing characters were recorded at Sakleshpur. Yield contributing characters like number of panicles, length of panicles, number of racemes/ panicles and number of capsules/ racemes were significantly more in T_1 (without moisture stress) than T2 (moisture stress).

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

(Centres: West Coast Plains and Ghats Region – Appangala, Mudigere, Sakleshpur, Myladumpara, Pampadumpara)

The trial with nine farmer's varieties of small cardamom *viz*., *Arjun,* Wonder Cardamom, *Panikulangara, Thiruthali, Elarajan, Patchakai, Paupali, Njallani,* PNS *Gopinath* supplied by National Innovation Foundation (NIF) and a local check variety Appangala-1 was planted during June 2017.

There was significant difference among the accessions of farmer's varieties of small cardamom with respect to their vegetative characters at Appangala, Sakleshpur, Myladumpara and Pampadumpara. At Appangala, the genotype *Thiruthali* recorded highest plant height (208.74 cm), more number of tillers (24.26), number of bearing tillers (11.39), number of panicles (18.53) and panicle length (49.15 cm). In Sakleshpur, number of tillers was significantly more in ICRI 8 (16.50), number of panicles (5.17) was significantly more in *Thiruthali* and number of racemes/panicle (16.33) was significantly more in *Paupali.*

At Pampadumpara, the genotypes *viz., Njallani* and *Thiruthali* registered highest plant height of 166.30 and 160.63 cm respectively. Maximum number of tillers was produced by *Thiruthali* (16.53) followed by *Patchakai* (14.97) at Pampadumpara whereas more number of tillers were produced in Wonder cardamom (47.00), *Njallani* Green Gold (46.00) and *Thiruthali* (45.33) at Myladumpara. Significantly more panicles were found in *Thiruthali* (18) and *Panikulangara* 1 (17.33) at Pampadumpara.

CAR/CI/3.9 CVT on hybrids of small cardamom-2018 – Series IX

(Centres: West Coast Plains and Ghats Region – Appangala, Mudigere, Sakaleshapura, Myladumpara, Pampadumpara)

Experiment was taken up at Appangala, Mudigere, Sakleshpur, Myladumpara using nine hybrids and two standard checks namely GG X NKE 19) X bold (Appangala), Bold x(GG X CCS 1) (Appangala), GG X NKE 19 (Appangala), MHC-1 (Myladumpara), MHC-2 (Myladumpara), SHC-1 (Sakleshpura), SHC-2 (Sakleshpur), PH-13 (Pampadumpara), PH-14 (Pampadumpara), *Njallani* Green Gold (check) and Mudigere 1 (check) with RCBD design.

CAR/CI/4 Varietal Evaluation Trial (VET)
CAR/ CI/4.3 Initial Evaluation Trial – 2012
(Centres: West Coast Plains and Ghats Region –Pampadumpara)

There was significant difference among the accessions of small cardamom with respect to their vegetative characters except plant height, leaf length and number of panicle. Maximum number of tillers was produced by PPK 2 (55.6) which on par with Pl. no. 14 and HY 6 (49.3 and 48.3respectively).

CAR/CI/4.4 Multilocation evaluation of thrips tolerant cardamom lines
(Centres: West coast plains and ghats region – Appangala, Mudigere, Myladumpara, Pampadumpara; Southern Plateau and Hills Region - Sakleshpur)

The experiment on evaluation of thrips tolerant lines in cardamom was initiated at Sakleshpur and morphological data was recorded. Observation on thrips population was recorded at monthly intervals at Myladumpara. Among the accessions, IC 349606 has low thrips population (0.22 %) than other accessions.The experiment was started last year at Pampadumpara and plants were in early vegetative stage. The crop was affected by severe drought and the experiment requires gap filling for the maintenance of the population. In Mudigere, cardamom genotypes were planted for multiplication.

Crop Management
CAR/CM/5 Nutrient Management Trial
CAR/CM/5.5 Effect of micro nutrients on growth and yield of small cardamom
(Centres: West coast plains and ghats region – Appangala, Mudigere, Myladumpara, Pampadumpara; Southern Plateau and Hills Region - Sakleshpur)

The trial on effect of micronutrients on growth and yield of small cardamom is initiated at Appangala. Three varieties *viz.,* Appangala-1, IISR Avinash and *Njallani* Green Gold were planted in randomized complete block design

Crop Protection
CAR/CP/6 Pest and disease management trial
CAR/CP/6.8 Comparison of effect of chemical treatments as well as bio-control agents against pseudostem rot of cardamom
(Centres: West Coast Plains and Ghat Region – Mudigere)

The minimum tiller infection of (4.63%) with higher yield of 711.25 g/plant was recorded in T_1 (Carbendezim (0.2%) followed by T_5, (*T. harzianum* (50 g with 1kg neem cake) + *Pseudomonas fluorescens* (2%) with the incidence of 5.16% (Fig 6).

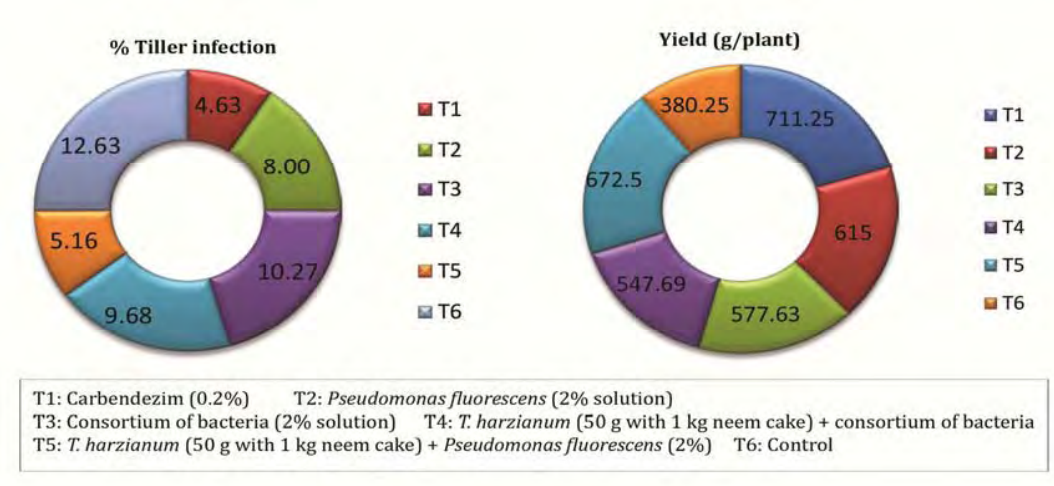


Fig 6: Effect of chemical treatments on pseudostem rot of small cardamom

CAR/CP/6.9 Evaluation of new insecticides for thrips control

(Centres: West Coast Plains and Ghats Region –Mudigere, Myladumpara, Pampadumpara; Southern Plateau and Hills Region - Sakleshpur)

The pooled data for observation on thrips infestation after seven sprays revealed that Fipronil 5 SC @ 0.005% applied plants showed highest per cent reduction of infestation at Pampadumpara (63.59%), Sakleshpur (38.44%), Mudigere (89.30%) and Myladumpara (40.79%) followed by Spinosad 45 SC @ 0.0135% applied plants at Pampadumpara (58.56%), Sakleshpur (34.4%) and Myladumpara (31.96%).

Table 6: Effect of new insecticides on *S. cardamomi* of cardamom

S. No.	Treatment	Per cent reduction of thrips infestation over control			
		Sakleshpur	Mudigere	Pampadumpara	Myladumpara
1	Spinosad 45 SC @ 0.0135%	34.40	76.30	58.56	31.96
2	Imidacloprid 17.8 SL @ 0.0089%	25.13	78.70	56.20	27.99
3	Fipronil 5 SC @ 0.005%	38.44	89.30	63.59	40.79
4	Quinalphos 25 EC @ 0.05%	22.13	70.21	39.36	29.52

CAR/CP/6.10 MLT on leaf blight tolerant lines of small cardamom

(Centres: West Coast Plains and Ghats Region – Appangala, Mudigere, Myladumpara, Pampadumpara; Southern Plateau and Hills Region - Sakleshpur)

Five moderately resistant leaf blight genotypes of small cardamom viz., IC 349648, IC 349649, IC 349650, IC 347156 and IC 547222 are under multiplication at Appangala (Fig 7).

Fig 7: Field visit of NE farmers to cardamom block at Appangala

03 Large cardamom

Genetic Resources

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

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

Out of total 308 accessions at ICRI, Gangtok, 301 have been registered with NBPGR, New Delhi and received IC number for same. Passport data of remaining seven accessions (SCC 302-308) have been sent to NBPGR, New Delhi for the allotment of IC numbers. Survey was conducted in the state of Sikkim to collect new accessions. All the collections were characterized and maintained in the germplasm. ICRI, Gangtok also supplied 1650 planting units of large cardamom to ICAR- NOFRI, Tadong, ICAR- RC NEH, Barapani and beneficiaries from Arunachal Pradesh and Nagaland.

At ICAR, RS, Gangtok, a total of six germplasm accessions of large cardamom was collected this year in which two are having unique character of green capsule colour and long peduncle size.

Table 7: Large cardamom collections maintained at AICRPS centres

Centre	Existing	Addition	Total
ICAR RS, Gangtok	7	6	14
ICRI RRS, Gangtok	285	14	308
Total	292	21	313

Crop Protection

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

(Centre: Eastern Himalayan Region - 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, *Beauveria bassiana* 7 g/l, *Metarhizium anisopliae* 5 ml/l, petroleum oil based agrospray @ 10 ml/l, petroleum oil based horticultural spray @ 10 ml/l, *Bacillus thuringiensis* @ 2 g/l, and spinosad 45 SC @ 0.3 ml/l against insect pests of large cardamom *viz*., stem borer, shoot fly, leaf eating caterpillar and tea mosquito bug. All the treatments showed effective results to control insect pests over the control. However, spinosad 45 SC @ 0.3 ml/l was found to be the most effective to control all the pests (63.33 to 76.33% reduction of infestation over control) followed by neem oil (1500 ppm) @ 4 ml/l (48.33 to 59.67% reduction of infestation over control) and petroleum agrospray @ 10 ml/l (39.67 % to 53.33% reduction of infestation over control).

04 Ginger

Genetic Resources

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

(Centres: Middle Gangetic Plain Region - Dholi, Kumarganj, Pundibari; Southern Plateau and Hills Region - Kammarpally; Eastern Plateau and Hills Region – Barapani, Pottangi, Raigarh; Western Himalayan Region - Solan)

Among 75 accessions maintained at Dholi, sixteen accessions recorded higher yield ranging from 8.51 to 18.42 t ha^{-1} compared to check variety Nadia (8.23 t ha^{-1}). RG-39 recorded highest yield (18.42 t ha^{-1}) followed by RG-56 (18.00 t ha^{-1}) and RG-9 (17.87 t ha^{-1}) under shade condition. At Kumarganj, among 63 germplasm accessions evaluated, NDG-55 (440 g/plant) was promising followed by NDG-6 (143 g/plant) and NDG-23 (140 g/plant).

At Pundibari, among 35 accessions evaluated, highest rhizome yield was recorded in GCP 10 followed by GCP-49 (13.81 t ha^{-1} and 13.41 t ha^{-1} respectively) GCP 9 and GCP 43 (13.08 t ha^{-1}). Lowest rhizome rot and wilt disease incidence were recorded in GCP- 49, GCP 23 and GCP 25 (10%) followed by GCP-10 (12.50%).

Table 8: Ginger germplasm collections in AICRPS centres

Centre	Indigenous				Exotic	Total
	Cultivated		Wild & related spp.			
	Existing	Addition	Existing	Addition		
Dholi	75			-	-	**75**
Kumarganj	63	-	-	-	-	**63**
Pundibari	67	-	-	-	-	**67**
Pottangi	198	-	2	-	3	**203**
Solan	231	-	-	-	-	**231**
Total	**634**	**-**	**2**	**-**	**3**	**639**

Out of 198 ginger germplasm accessions evaluated at Pottangi, 34 accessions yielded more than 5 kg/3m^2 fresh rhizome. The range of plot yield being 0.10 kg (PGS-119) to 9.5 kg/3 m^2 (PGS-163) with the mean yield of 3.1 kg /3 m^2 in tested germplasm accessions during Kharif 2019. At Raigarh, Indira Ginger -1 (9.9 t ha^{-1}) recorded maximum yield over two national checks Suprabha (7.5 t ha^{-1}) and Suruchi (8.3 t ha^{-1}) followed by IN-4 (7.2 t ha^{-1}) and IN-3 (6.4 t ha^{-1}).

Out of 43 genotypes of ginger evaluated at Barapani, IC-584354 recorded the highest yield with 20.95 t ha^{-1}. Highest dry matter (25.09%) and oleoresin (7.07%) content were recorded in IC-584353 and IC-584343 respectively.

Crop Improvement

GIN/CI/2 Coordinated Varietal Trial (CVT)

GIN/CI/2.5 CVT on disease tolerance trial in ginger

Centres: (West coast plains and ghat region – Kozhikode; Middle Gangetic Plain Region - Pundibari; East coast plains and hill region – Chintapalle; Eastern Plateau and Hills Region – Barapani, Pottangi, Raigarh; Eastern Himalayan Region - ICAR Regional Station, Gangtok, Nagaland)

Among the ten genotypes of ginger evaluated for disease tolerance at Gangtok, G 1.00/4 (IISR) showed no disease incidence (0.00%) followed by R 1.25/4 (IISR) with disease incidence of 4.35 % and HP 05/15 (IISR) with disease incidence

Of 5.88%. The genotypes are under multiplication at other centres.

GIN/CI/3.4 Initial Evaluation Trial of bold/vegetable ginger

(Centres: Eastern Plateau and Hills Region – Pottangi)

At Pottangi, the pooled analyzed data for three years revealed that the entry PGS-8 (11.8 t ha^{-1}) was the top yielder with the yield advantages of 11% over IISR Varada (10.6 t ha^{-1}) followed by 7.3% over V_1E_4-5 (11.0 t ha^{-1}).

Table 9: Characterization of ginger germplasm at HARS, Pottangi

Parameter		Category		
Character	Plant height (cm)	Short (< 75)	Medium (75- 90)	Tall (>90)
No. of germplasm		125	14	1
Character	Length of leaf (cm)	Short (< 25)	Medium (25- 30)	Long (>30)
No. of germplasm		93	47	0
Character	Width of leaf (cm)	Narrow (< 2.5)	Medium (2.5- 3.5)	Broad (>3.5)
No. of germplasm		6	128	6
Character	Tillers per clump	Few (< 10)	Medium (10-15)	Many (>15)
No. of germplasm		136	4	0
Character	Plot yield (kg/3m^2)	Low (< 3)	Medium (3-5)	High (>5)
No. of germplasm		73	37	30

Table 10: Morphological characters and bacterial wilt incidence of ginger genotypes at Gangtok

Genotype	Sprouting percentage	Plant population (3m^2 area) at 50 DAS	Plant height (cm) at 50 DAS	Number of tillers per clump	Bacterial wilt incidence (%)
R 1.25/4	57.50	23.00	31.16	1.2	4.35
G 1.00/4	80.00	16.00	33.62	1.8	0.00
HP 05/15	56.70	17.00	31.44	3.0	5.88
HP 0.5/2	52.50	21.00	27.82	1.8	9.52
V 0.5/2	95.00	19.00	37.36	2.6	22.81
V1E4-1	78.30	18.00	31.60	2.2	12.96
V1E4-5	68.75	21.50	31.50	2.6	13.89
V2E5-2	75.00	30.00	28.94	2.2	6.67
Indira	68.35	20.50	29.29	3.3	27.59
Bhaise	63.33	25.33	40.75	3.0	68.06

Table 11: DUS characters of rhizomes of ginger at Pottangi

Genotype	Rhizome length(cm)	Rhizome diameter(cm)	Rhizome shape	Outer core colour	Inner core colour
Suprabha	14	8	Curved	Golden yellow	Golden yellow
ZO-9	15	12	Zigzag	Golden yellow	Golden yellow
S-600	14	9	Curved	Whitish yellow	Yellow
V_2E_5-2	18	9	Curved	Golden yellow	Whitish yellow
PGS-7	20	11	Curved	Whitish yellow	Greenish yellow
Singjhara	23	7	Straight	Golden yellow	Yellow
V_1E_4-1	17	11	Zigzag	Yellow	Yellow
V_1E_4-5	22	9	Curved	Greenish yellow	Yellow
IISR Varada	20	11	Curved	Yellow	Yellow
V_1S_1-4	20	10	Zigzag	Golden yellow	Greenish yellow
PGS-8	19	11	Zigzag	Yellow	Yellow
Renga Local	17	6	Curved	Greenish yellow	Greenish yellow
V_1E_7-5	18	14	Zigzag	Greenish yellow	Yellow
V_1K_1-1	21	11	Curved	Whitish yellow	Greenish yellow
V_3S_1-8	19	8	Straight	Golden yellow	Whitish yellow
S-666	21	9	Zigzag	Yellow	Whitish yellow
VS	19	14	Zigzag	Yellow	Yellow
KG-49	20	9	Straight	Yellow	Yellow
PGS-95	16	10	Zigzag	Yellow	Yellow
S-641	18	13	Zigzag	Greenish yellow	Yellow
S-692	19	18	Zigzag	Whitish yellow	Greenish yellow
PFLR	19	9	Curved	Whitish yellow	Greenish yellow
PGS-58	16	15	Zigzag	Yellow	Yellow
Zo-17	17	12	Zigzag	Whitish yellow	Greenish yellow
V_1E_8-2	19	13	Zigzag	Whitish yellow	Greenish yellow

GIN/CI/3.5 Initial Evaluation Trial – 2015

(Centre: Middle Gangetic Plain Region – Kumarganj)

Maximum yield was recorded in NDG-24 (15.33 t ha^{-1}) followed by NDG-13 (15.0 t ha^{-1}) and NDG-23 (13.22 t ha^{-1}) in IET for ginger.

GIN/CI/3.6InitialEvaluationTrial2016

(Centres: Middle Gangetic Plain Region – Pundibari; Eastern Plateau and Hills Region – Pottangi; Western Himalayan Region - Solan)

Among the different genotypes evaluated at Pundibari, the highest yield was recorded in GCP-39 (11.76 t ha^{-1}) and lowest in GCP-56 (7.94 t ha^{-1}). The lowest rhizome rot and fungal wilt disease severity was found in GCP-46 (11.72 PDI) followed by GCP-14 (13.75 PDI) and GCP-39 (14.17 PDI).

Table : 12 Growth, yield characters and disease incidence of ginger entries at Pundibari

Genotype	Plant height (cm)	Tiller number	Leaf number	Leaf length (cm)	Leaf breadth (cm)	Rhizome yield/plot (kg/3m²)	Projected yield (t/ha)	Rhizome rot and wilt incidence (PDI)
GCP-51	74.44	9.53	15.20	20.52	3.08	4.67	9.41	20.37
GCP-56	61.45	8.27	13.60	21.73	3.36	3.94	7.94	24.56
GCP-5	64.04	8.73	15.33	21.52	2.94	4.95	9.99	15.55
GCP-46	71.09	9.87	15.40	22.02	2.77	4.30	8.67	11.72
GCP-30	76.74	10.20	16.53	23.18	3.03	4.57	9.22	17.54
GCP-36	77.70	11.40	15.00	20.57	2.77	4.11	8.28	14.87
GCP-39	68.37	10.33	17.40	22.76	2.95	5.83	11.76	14.17
GCP-14	60.86	9.60	15.60	18.52	2.78	4.91	9.89	13.75
SE(m)±	1.87	0.41	0.50	0.70	0.06	0.16	0.32	0.58
C.D. (P= 0.05)	5.74	1.27	1.53	2.15	0.19	0.48	0.96	1.76
CV%	4.69	7.37	5.37	5.70	3.55	5.79	5.80	6.02

GIN/CI/4.3 Evaluation of genotypes of ginger for vegetable purpose (Observation trial)

(Centres: West Coast Plains and Ghat Region – Kozhikode; Eastern Himalayan Region – Mizoram, Nagaland, Gangtok; Middle Gangetic Plain Region – Pundibari; Eastern Plateau and Hills Region – Pottangi, Chintapalle)

At Nagaland, highest yield (19.00 t ha^{-1}) was recorded in bold Nadia followed by Gorubathan (16.00 t ha^{-1}) and Bhaise (16.00 t ha^{-1}) whereas at Pottangi, highest yield (19.20 t ha^{-1}) was recorded in John's ginger followed by bold Nadia (18.90 t ha^{-1}) and PGS 121 (18.70 t ha^{-1}). Maximum yield of 24.60 t ha^{-1} was recorded in the genotype Bhaise at Mizoram (Fig 8) followed by the genotype Gorubathan (19.35 t ha^{-1}) and bold Nadia (16.75 t ha^{-1}). At Gangtok, it was found that among all the genotypes, bacterial incidence was nil in the genotype PGS 95.

Bhaise

Gorubathan

Bold Nadia

Fig 8: Performance of vegetable type of ginger at Mizoram

Crop Management

GIN/CM/5 Nutrient Management Trial

GIN/CM/5.6 Organic production of ginger

(Centres: Eastern Himalayan Region – Mizoram, Barapani)

Maximum yield of 22.55 t ha^{-1} was recorded in T_3 (100% organic manures + micronutrients) followed by 20.99 t ha^{-1} in T_5 (175% N requirement of ginger from FYM + micronutrients) at Barapani. Highest dry recovery of 20.03% was recorded in T_5 (75% N requirement of ginger from FYM + micronutrients). Whereas at Mizoram, the maximum yield was recorded in T_7 (recommended package by SAU; ginger-NPK 100:90:90 kg ha^{-1}), with a yield of 12.99 t ha^{-1}, followed by T_1 (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} (Fig 9).

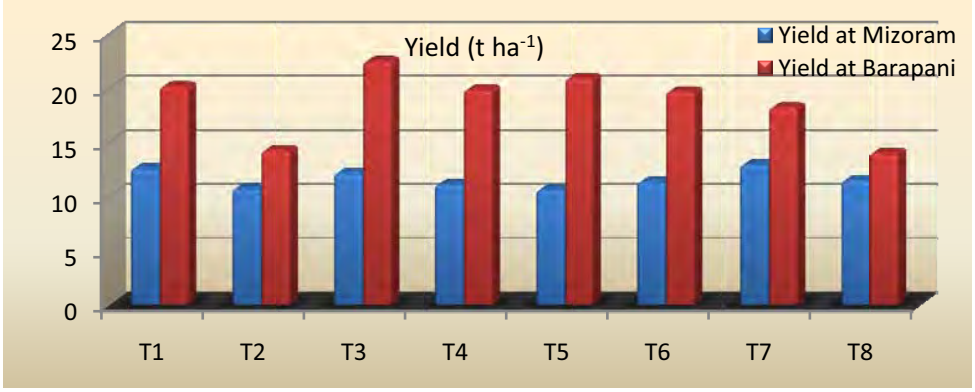


Fig 9: Effect of various organic treatments on the yield of ginger at Mizoram and Barapani

T1: 100% organic manure equivalent to 100% N requirement of ginger
T2: 100% organic manure equivalent to 75% N requirement of ginger
T3: 100% organic manure + micronutrients
T4: 100% organic manure + vermiwash 10%
T5: 75% N requirement of ginger + micronutrients
T6: 75% N requirement of ginger + vermiwash 10%
T7: Recommended package by SAU
T8: Farmers practice

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

(Centres: East Coast Plains and Hill Region – Chintapalle; Eastern Plateau and Hills Region - Pottangi)

At Chintapalle, foliar application of IISR micro nutrient mixture showed marked increase in rhizomes yield per hectare as compared to control. Among the treatments T2 (Nadia + IISR micro nutrients application) recorded maximum plant height (64.91 cm), fresh weight of rhizome (320.40 g), yield/ha (24.54 t ha^{-1}) followed by T1 (Nadia).

GIN/CM/5.8 Effect of organic manures and bio-fertilizers on partitioning of dry matter in ginger

(Centres: Middle Gangetic Plain Region - Dholi)

Among the treatments, T_{12} (FYM @ 30 t ha^{-1} + PSB @10 kg ha^{-1}) recorded the highest yield (11.85 t ha^{-1}) followed by T_{11} (FYM @ 30 t ha^{-1}+ *Trichoderma* @10 kg ha^{-1}) (11.16 t ha^{-1}) and T_7 (Vermicompost @10 t ha^{-1} + *Trichoderma* @10 kg ha^{-1}) (10.70 t ha^{-1}).

GIN/CM/5.9 Organic production of ginger

(Centres: West Coast Plains and Ghat Region – Ambalavayal; Middle Gangetic Plain Region - Dholi, Kumarganj, Pundibari; Lower Gangetic Plain Region – Kalyani; East Coast Plains and Hill Region – Chintapalle; Eastern Plateau and Hills Region - Pottangi, Raigarh; Eastern Himalayan Region – Mizoram, Barapani; Southern Plateau and Hills Region - Kammarpally; Western Himalayan Region – Solan)

The variety Maran recorded the maximum yield of 26.75 t ha^{-1} and 25.92 t ha^{-1} in IISR organic package and KAU organic package respectively at Ambalavayal. Among the three varieties evaluated at Dholi, (Nadia, Surabhi and Suprabha), all the varieties were on par for yield. Between two organic packages (IISR organic package and RPCAU, Bihar organic package), both were also on par. At Kumarganj, the maximum yield was observed in V1T3 treatment (14.75 t ha^{-1}) followed by V2T3 (13.00 t ha^{-1}) and V3T3 (12.67 t ha^{-1}).

In organic production of ginger trial at Pundibari, the highest fresh yield of ginger was recorded in Nadia (11.58 t ha^{-1}) followed by GCP-5 (10.95 t ha^{-1}). Organic package developed by IISR recorded the highest yield (11.30 t ha^{-1}). Considering the interaction effect, it was found that Nadia cultivar along with organic package developed by IISR recorded the highest fresh yield (11.73 t ha^{-1}). At Kalyani, O_2V_2 (recommended package by SAU + Nadia) recorded highest fresh yield per clump (248.54 g) and highest estimated yield per hectare (18.55) whereas at Chintapalle, among the treatments, T2 (Nadia + inorganic) recorded the maximum fresh weight of rhizomes (230.38 g), yield per hectare (23.16 t ha^{-1}) and dry recovery percentage (22.25) followed by T1 (Nadia + IISR OPP).

There was significant difference among the treatments for fresh rhizome yield of Ginger at Pottangi. Application of recommended organic packages and practices in ginger produced the less fresh rhizome yield than inorganic packages in all three varieties like, Suprabha, Suravi and IISR Varada. At Raigarh, among the varieties, V1 (local) recorded maximum rhizome weight per plant (39.26 g), number of primary and secondary rhizome (3.48 and 5.34, respectively) and yield (7.82 t/ha). Among the treatments,T1 (organic package developed by IISR) recorded maximum rhizome yield per plant (40.82 g), number of primary and secondary rhizomes (3.45 and 5.61, respectively) and yield (6.8 t ha^{-1}) but both the treatments were at par.

In Mizoram, maximum yield was recorded in T_2 (recommended package by SAU), with a yield of

24.09, 28.06 and 22.15 t ha^{-1}, for the varieties Nadia, Gorubathan and Mizoram Local respectively. Dry matter content was also found to be highest in T_2 with a dry recovery of 9.07, 18.97and 18.82% for the varieties Nadia, Gorubathan and Mizoram Local respectively. At Barapani, three genotypes of ginger *viz.,* Jorhat, Suprabha and Hitching were evaluated and data analysis revealed high yield in Hitching (23.51 t ha^{-1}) in the treatment T_1 (organic package developed by IISR).

Table 13: Performance of organic production of ginger at Chintapalle

Treatment	Plant population (3 m² area)	Plant height (cm)	No. of tillers	Fresh wt of rhizome (g)	Yield/ ha (t)	Dry recovery (%)
T1(Nadia + IISR OPP)	38.00	59.31	8.85	208.33	20.56	20.81
T2 (Nadia + Inorganic)	37.50	62.05	9.00	230.38	23.16	22.25
T3 (IISR Rejatha+ IISROPP)	38.25	48.10	9.40	197.99	16.93	18.66
T4(IISR Rejatha+ Inorganic)	38.00	51.50	10.05	224.08	21.16	18.76
T5 (CTPL Local +IISROPP)	37.75	37.16	10.15	122.00	13.18	15.70
T6 (CTPL Local +Inorganic)	36.50	49.32	11.85	146.85	15.88	16.61
C.D.(5%)	NS	NS	1.18	65.32	4.34	1.87
SE(m)	0.94	5.61	0.39	21.47	1.43	0.62
C.V.(5%)	5.00	21.89	7.82	22.18	15.43	6.35

GIN/CM/5.10 Effect of micro nutrients on growth and yield of ginger

(Centres: West Coast Plains and Ghat Region – Ambalavayal; Middle Gangetic Plain Region - Dholi, Kumarganj, Pundibari; Lower Gangetic Plain Region – Kalyani; East Coast Plains and Hill Region – Chintapalle; Eastern Plateau and Hills Region - Pottangi, Raigarh; Eastern Himalayan Region –Barapani; Southern Plateau and Hills Region - Kammarpally; Western Himalayan Region – Solan)

At Ambalavayal, foliar application of IISR ginger micronutrient mixture at 60th and 90th DAP @ 5g/litre significantly enhanced fresh weight of clumps and ginger yield in three varieties *viz.,* Maran (29.44 t ha^{-1}), Rio de Janerio (24.56 t ha^{-1}) and Himachal (17.22 t ha^{-1}). Among three varieties (Nadia, IISR Varada, Surabhi) evaluated at Dholi, Nadia produced significantly higher yield (12.66 t ha^{-1}) as compared to Surabhi and IISR Varada (10.48 & 7.20 t ha^{-1} respectively). Between two packages of micronutrients (IISR & RPCAU), micronutrient package of IISR showed significantly higher yield (10.94 t ha^{-1}) compared to micronutrients package of RPCAU (9.28 t ha^{-1}).

Maximum yield was observed in V1T3 treatment (13.83 t ha^{-1}) followed by V2T3 (12.25 t ha^{-1}) and V3T3 (12.08 t ha^{-1}) at Kumarganj whereas at Pundibari, highest fresh yield of ginger was recorded in Nadia (13.10 t ha^{-1}) followed by GCP-5 (11.36 t ha^{-1}). Micronutrient package developed by IISR recorded the significantly highest yield (12.38 t ha^{-1}). In Kalyani, M_2V_2 (recommended package of practice + IISR ginger micronutrient mixture, two sprays at 60 and 90

days after planting @ 5g/litre + Nadia) recorded highest fresh yield per clump (252.24 g) and estimated yield per hectare (19.77 t ha^{-1}). While in Pottangi, highest fresh rhizome yield of 21.0 t ha^{-1}, 21.8 t ha^{-1} and 22.0 t ha^{-1} was recorded respectively in Suprabha, Suravi and IISR Varada for the treatment application of recommended package practices along with IISR-micronutrients (Fig 10).

The maximum plant height (33.71 cm), number of tillers per plant (3.25), number of leaves per plant (4.00), fresh rhizome weight (39.57 g), number of primary (3.47), secondary rhizomes (5.78) and yield (8.33 t ha^{-1}) were recorded in T2 (recommended package of practice + IISR ginger micronutrient sprays at 60 and 90 days after planting @ 5g/litre) at Raigarh. Whereas at Barapani, recommended package of practice along with IISR micronutrients (T_2) produced higher yield of 23.67 t ha^{-1}, 19.76 t ha^{-1} and 18.55 t ha^{-1} in Hitching, Himgiri and Nadia, respectively. Also the oleoresin content was higher in T_2 (recommended package of practice+ IISR micronutrients) in all the varieties. Foliar application of IISR micronutrient mixture showed marked increase in rhizome yield per hectare at Chintapalle as compared to control. Among the treatments T2 (Nadia + IISR micronutrients application) recorded maximum plant height (64.91 cm), fresh weight of rhizome (320.40 g) and yield per hectare (24.54 t ha^{-1}).

Fig 10: Field view of micronutrient trial at Pottangi

Crop Protection

GIN/CP/6 Disease management trial

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

(Centres: Middle Gangetic Plain Region – Kumarganj)

Eight treatments were tested. T-7 (soil solarization + plastic mulching + neem oil) recorded highest yield (32.77 t ha^{-1}) followed by T-5 (soil solarization + neem oil) (28.15 t ha^{-1}) and T-6 (Plastic mulching + neem oil) (25.72 t ha^{-1}).

GIN/CP/6.13 Effect of PGPR biocapsule on growth and yield of ginger

(Centres: West Coast Plains and Ghat Region – Ambalavayal; Middle Gangetic Plain Region - Dholi, Kumarganj, Pundibari; Lower Gangetic Plain Region – Kalyani; East Coast Plains and Hill Region – Chintapalle; Eastern Plateau and Hills Region - Pottangi, Raigarh; Eastern

Himalayan Region –Barapani; Southern Plateau and Hills Region - Kammarpally; Western Himalayan Region – Solan)

The treatment, POP+ *Trichoderma* (talc formulation) + GRB 35 (talc formulation) recorded highest yield in the varieties *viz.,* Maran (30.44 t ha^{-1}), Rio de Janerio (29. 89 t ha^{-1}) and Himachal (27.33 t ha^{-1}) at Ambalavayal (Fig 11). Significantly higher yield (9.13 t ha^{-1}) was recorded in the ginger variety Nadia at Dholi. The treatment POP + *Trichoderma* capsule + GRB 35 capsule registered highest yield (8.69 t ha^{-1}) with lowest incidence of bacterial wilt disease.

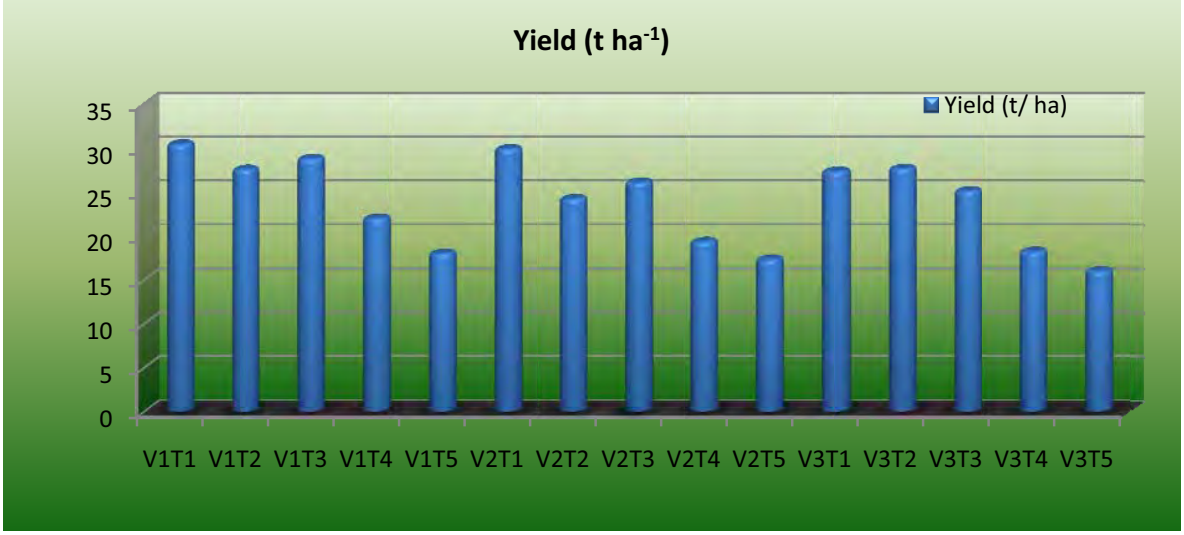


Fig 11: Effect of biocapsules on yield of ginger at Ambalavayal

T_1- POP + *Trichoderma* (talc formulation) + GRB 35 (talc formulation) T_2- POP + *Trichoderma* capsule + GRB 35 capsule
T_3- POP + *Trichoderma* capsule T_4- POP + GRB 35 capsule T_5- POP V1- Maran V2- Rio de Janerio V3 Himachal

Evaluation of PGPR bio-capsule at Kumarganj revealed maximum yield in V1T2 treatment (13.58 t ha^{-1}) followed by V3T2 (13.25 t ha^{-1}) and V2T2 (12.5 t ha^{-1}) whereas at Pundibari, highest yield was recorded with capsule formulation of *Trichoderma* and GRB 35 in case of Nadia and TCP2 (13.17 t ha^{-1}). In case of Gorubathan and Pundibari Local, highest yield was recorded with talc formulation of *Trichoderma* and GRB 35 (11.52 t ha^{-1} and 11.94 t ha^{-1} respectively). In Kalyani, P_2V_2 (*Trichoderma* capsule + GRB 35 capsule + Nadia) recorded highest fresh yield per clump (241.79 g) and estimated yield per hectare (20.58 t).

The effect of bio capsules on growth and yield parameters on three varieties *viz.*, Nadia, Suprabha and Suravi differed at Chintapalle. In Nadia T2 (POP + *Trichoderma* capsule + GRB 35 capsule) recorded the highest yield (20.13 t ha^{-1}), in Suprabha T1 (POP + *Trichoderma* talc + GRB 35 talc) recorded the highest yield (14.73 t ha^{-1}) whereas in Suravi T5 (POP) recorded the highest yield (13.32 t ha^{-1}). At Pottangi, per cent disease intensity significantly reduced from 27.41 (control) to 6.21 and highest rhizome yield was observed (17.8 t ha^{-1}) in treatment T5 (Trichopower liquid @ 5 ml/l) whereas at Raigarh, POP+ *Trichoderma* (talc formulation) + GRB 35 (talk formulation) recorded highest yield with lowest disease incidence (13.14 t ha^{-1} and 13.04% respectively).

Experiment was conducted with three genotypes *viz.,* Himgiri, Nadia and Hitching at Barapani. For Himgiri and Hitching the highest yield (16.34,

18.76 t ha^{-1}) was recorded in T_2 (POP + Trichoderma capsule +GRB 35) while for Nadia, highest yield (20.12 t ha^{-1}) was recorded in T_3 (POP + GRB 35 capsule). At Solan, the talc formulation of *Trichoderma* in combination with talc formulation of GRB-35 resulted in highest germination (84.63%) in Himgiri followed by LC-1 (83.84%) and LC-2 (83.36%). Similarly, combined talc formulations resulted in highest number of tillers per plant, height, yield and other biochemical parameters in all three genotypes and reduced incidence of rhizome rot.

GIN/CP/6.14 Management of bacterial wilt of ginger through chemicals and bio agents

(Cenres: West Coast Plains and Ghat Region – Kozhikode; Western Himalayan Region – Solan; Lower Gangetic Plain Region Kalyani; Eastern Plateau and Hills Region - Pottangi, Dholi, Pundibari, Nagaland, Pasighat, Gangtok)

In solarised treatments at Solan, Calcium chloride treatment resulted in highest plant height (55.20 cm), number of tillers per clump (5.67), fresh rhizome yield (9.50 t ha^{-1}) and dry rhizome yield (2.45 t ha^{-1}). This treatment also recorded highest dry recovery (22.15%), oleoresin (4.50%), essential oil (1.30%) and minimum incidence of rhizome rot. However, in non solarised treatments, biocontrol agent recorded the highest sprouting percentage and other growth and yield parameters and minimum incidence of rhizome rot. The treatment M1T2 (solarization + biocontrol agent (*Bacillus* spp.) was found to produce highest number of fingers (5.50), root length (9 cm), finger length (5.75 cm), rhizome length (12.37 cm), fresh weight per rhizome (243.12g) and rhizome yield (16.37 t ha^{-1}). *Bacillus licheniformis* treated beds at Kozhikode showed significantly higher growth and yield followed by calcium chloride (3%) treatment as compared to control. Solarization showed significant growth and yield ascompared to non-solarization.

The lowest percent disease intensity (6.6%) and highest fresh rhizome yield (17.21 t ha^{-1}) was found in the treatment (biocontrol agent + solarization) at Pottangi whereas at Dholi, bacterial wilt incidence was found significantly low in all the soil solarization treatments compared to non-soil solarization. However, significantly lowest incidence of bacterial wilt (14.34%) was recorded in soil solarization treatment of RPCAU POP.

At Nagaland, under solarized and non solarized treatments, biocontrol agent (*Bacillus*) recorded maximum yield (26.8 t ha^{-1} and 24.12 t ha^{-1}) respectively. Bacterial wilt incidence was less in calcium chloride + solarization treatment (0.11%) and biocontrol agent + non solarized treatments (0.44%). Solarisation treatment (M1) recorded significantly higher dry rhizome yield (2.73 t ha^{-1}) and dry recovery (22.95 %) as compared to non-solarisation (M2) treatment at Pasighat. The incidence of disease was significantly higher in non-solarisation (M2) treatment as compared to solarisation (M1) treatment. At Sikkim, the treatment (*Bacillus* + solarization) showed less incidence of bacterial wilt (65.64%) followed by treatment $CaCl_2$ + non-solarization with 69.29% disease incidence. This result suggests the complimentary role of soil solarization with *Bacillus* spp. in management of disease.

Table 14: Performance of ginger under solarization and non solarization treatments at Nagaland

Sl No	Observations	Solarisation (M1)			Non solarization (M2)		
		T1-Chemical ($CaCl_2$@3%)	T2-Bio control agent (*Bacillus* sp.)	T3-Control	T1-Chemical ($CaCl_2$@3%)	T2-Bio control agent (*Bacillus* sp.)	T3-Control
1	Sprouting (%)	92.11	96.22	66.63	49.33	58.33	44.43
2	Plant height (cm)	22.00	29.13	32.55	21.75	32.57	26.40
3	No of tillers/clump	10.84	10.99	10.79	6.5	7.38	6.7
4	Fresh weight of clump(g)	604.0	718.93	472.0	265.6	291.13	266.66
5	Fresh rhizome yield (t/ha)	24.48	26.8	23.0	20.87	24.12	16.00
6	Dry rhizome yield (t/ha)	2.95	3.15	3.07	3.06	3.10	3.02
7	Dry recovery (%)	1.96	2.28	1.33	1.87	2.21	2.01
8	Bacterial wilt (%)	0.11	0.33	1.22	0.77	0.44	1.73
9	Rhizome rot (%)	15.0	14.16	24.66	31.66	33.66	43.0
10	Shoot borer (%)	32.0	34.0	36.3	40.6	39.0	38.3

Fig 12: View of trial on bacterial wilt of ginger at Kozhikode

05 Turmeric

Genetic resources

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

(Centres: Southern Plateau and Hills Region - Coimbatore, Kammarpally; Middle Gangetic Plain Region - Dholi, Kumarganj, Pundibari; East Coast Plains and Hill Region – Guntur; Western Himalayan Region – Pantnagar, Solan; Eastern Himalayan Region – Pasighat; Eastern Plateau and Hills Region - Pottangi, Raigarh; Eastern Himalayan Region - Barapani)

A total of 275 genotypes were conserved at Coimbatore (Fig 14) and all the genotypes were evaluated and characterized. Statistical analysis of data revealed wide variations for growth, yield and quality parameters. The genotypes were further grouped into high yielding genotypes and high curcumin genotypes. Among the 50 high curcumin yielding genotypes identified, 7 genotypes registered curcumin content in the range of 5.00 to 5.79 % and the remaining 43 genotypes registered curcumin content in the range of 4.14 % to 4.99 %. CL 258 recorded the highest curcumin content of 5.79 %. However, the fresh rhizome yield of this genotype was 381.54 g/plant.

At Kammarpally (Fig 15), 280 turmeric germplasm accessions are conserved. The genotype Nizamabad Local (62.34 t ha^{-1}), Chennur Local (62 t ha^{-1}), NDH-4 (61.69 t ha^{-1}), NDH-9 (62.13 t ha^{-1}) and JTS-332 (60.69 t ha^{-1}) were superior compared to local check Duggirala Red (43.25 t ha^{-1}) and IISR Pratibha- national check (59.92 t ha^{-1}). These accessions were also screened against major foliar diseases.

Fourteen out of sixty seven accessions maintained at Dholi recorded high yield ranging from 50.25 to 54.17 t ha^{-1} against the check variety Rajendra Sonia (49.83 t ha^{-1}) and eight accession compared to Rajendra Sonali (52.33 t ha^{-1}). Out of the 180 accessions maintained and evaluated at Kumarganj, maximum yield was recorded in NDH-74 (275 g/plant) followed by NDH-86 (265 g/plant). At Pundibari, 176 germplasm accessions were maintained. Five genotypes recorded yield above 40 t ha^{-1}, 16 genotypes recorded 31 to 40 t ha^{-1} and 22 genotypes recorded 25 to 30 t ha^{-1}. With respect to disease resistance, 28 accessions showed low leaf botch (PDI 0.00 to 15) and 27 showed low leaf spot (PDI 0.00 to 15) disease incidence.

Among the 48 genotypes evaluated at Guntur, only seven accessions i.e. Kasturi (665.4 g), KTS-18 (561.4 g), KTS-5 (537.4 g), CLI-328 (53.6.4 g), CL-5 (533.4 g), SLM-1 (531.4 g) and IC-211641 (527.4 g) recorded significantly higher clump weight compared to the best check *Tekurpet* (480.5 g). Among the genotypes evaluated at Pasighat, maximum rhizome yield was recorded in the genotype CHFT-8 (39.83), which was statistically at par with CHFT-4 (38.82 t ha^{-1}), CHFT-16 (37.21 t ha^{-1}), CHFT-24 (39.21 t ha^{-1}), CHFT-36 (39.01 t ha^{-1}), CHFT-40 (38.89 t ha^{-1}), CHFT-52 (37.17 t ha^{-1}), CHFT-102 (37.42 t ha^{-1}), CHFT-103 (38.96 t ha^{-1}), CHFT-107 (37.34 t ha^{-1}) and CHFT-108 (39.78 t ha^{-1}). The lowest rhizome yield was recorded in genotype CHFT-28 (11.63 t ha^{-1}).

Fig 13: View of per plant yield of 3.5 kg fresh rhizomes

Fig 14: Field view of turmeric germplasm at Coimbatore

Fig 15: Variation in the colour of turmeric powder at Kammarpally

Out of 152 *Curcuma longa* accessions evaluated at HARS, Pottangi, 77 accessions recorded more than 5 kg/3m^2 fresh rhizome yield. Highest yield was obtained in the genotypes *viz.,* CLS-20 (8.6 kg/3m^2), VK-5 (8.5 kg/3m^2), PTS-60 (8.3 kg/3m^2) and Tu-3 (8.2 kg/3m^2). In *Curcuma aromatica,* fresh rhizome yield varied from 1.4 kg/3 m^2 to 8.0 kg/3 m^2. Among 23 accessions, 12 accessions recorded more than 5 kg/3m^2 fresh rhizome yield at Pottangi. A total of 86 genotypes were evaluated at Raigarh. IT 34 recorded maximum rhizome yield (28.2 t ha^{-1}) followed by IT 35 (25.7 t ha^{-1}) and IT 20 (24.8 t ha^{-1}) over all the national checks BSR 2 (19.2 t ha^{-1}), Narendra Haldi (12.2 t ha^{-1}), Roma (12 t ha^{-1}), IISR Pratibha (12 ton/ha) and Suranjana (10 t ha^{-1}). On evaluating thirty two genotypes (IC-586749 to IC-586780) at Barapani, it was found that the genotype IC-586773 recorded the maximum yield with 57.22 t ha^{-1}.

Table 15. Turmeric germplasm collections maintained at various AICRPS centres

Centre	Indigenous			Exotic	Total
	Cultivated		Wild and related species	Existing	
	Existing	Addition	Existing		
Coimbatore	275	-	-	-	275
Dholi	67	-	-	-	67
Kammarpally	280		-	-	280
Kumarganj	180		-	-	180
Pantnagar	52	-	-	-	52
Pasighat	50	-	2	-	52
Pottangi	152	-	24	-	176
Pundibari	176	-	-	-	176
Raigarh	86	-	-	-	86
Guntur	280		-	-	280
Total	1598	-	26	-	1624

Crop Improvement

TUR/CI/2 Coordinated Varietal Trial

TUR/CI/2.6 CVT on Turmeric 2016

(Centres: East Coast Plains and Hill Region – Chintapalle; Southern Plateau and Hills Region Coimbatore, Kammarpally; East Coast Plains and Hill Region – Guntur, Middle Gangetic Plain Region - Dholi, Kumarganj, Pundibari; Eastern Plateau and Hills Region - Pottangi, Raigarh ; Gujarat Plains and Hills Region – Navsari)

At Chintapalle, it was observed that the genotype IT-36 recorded the highest fresh weight per plant (508.13 g), yield per plot (12.66 kg) and yield (37.97 t ha^{-1}). Dry recovery % was highest in PTS-2 (27.87) followed by LTS-2 (27.40%) and Roma (26.20%). At Coimbatore, the fresh rhizome yield per plot (3 m^2) ranged from 8.32kg in RH 80 to 12.37 kg in NDH 11. The accession LTS- 2 recorded the highest dry recovery (27.20 %) with an estimated yield of 40.92 t ha^{-1}.

Among the entries evaluated at Guntur, LTS-2 recorded maximum yield (37.8 t ha^{-1}) followed by LTS-4 (36.6 t ha^{-1}), LTS-3 (36.5 t ha^{-1}) and LTS-1 (33.54 t ha^{-1}), which were significantly superior to the check Mydukur (31.1 t ha^{-1}) whereas at Kammarpally, NDH 11 recorded maximum yield (37.50 t ha^{-1}).

The three years pooled data at Dholi revealed that RH-9/90 and RH-80 (57.98 t ha^{-1} and 53.13 t ha^{-1} respectively) were significantly superior compared to national check IISR Pratibha (34.32 t ha^{-1}) and statistically at par with local check Rajendra Sonali (49.05 t ha^{-1}). The three years pooled data analysis at Kumarganj revealed maximum yield in LTS-1 (26.11 t ha^{-1}) followed by NDH-128 (25.22 t ha^{-1}) and NDH-11 (24.33 t ha^{-1}).

At Pundibari, highest projected yield was recorded in TCP-191 (39.78 t ha^{-1}) followed by IT-10 (25.07 t ha^{-1}). TCP-191 and LTS-1 showed no leaf blotch incidence. The lowest leaf spot disease severity was found in TCP-191 (0.00 PDI) followed by LTS-1 (5.93 PDI) and it was highest in RH-9/90 (15.92 PDI).

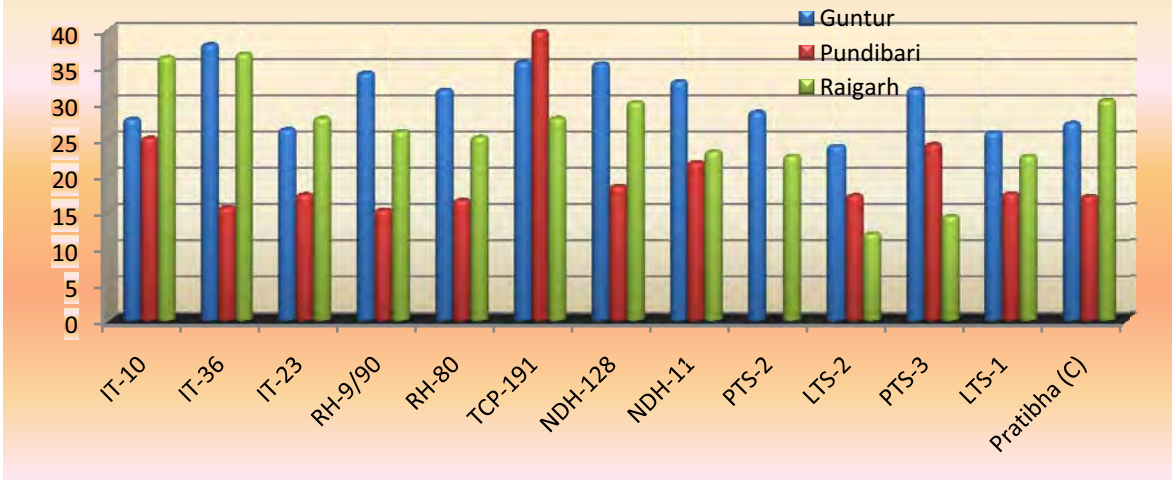


Fig 16: Variation in yield of turmeric genotypes at Guntur, Pundibari and Raigarh

At Navsari, it was observed that the genotypes *viz.,* LTS-2 (30.06 t ha^{-1}) and LTS-1 (24.85 t ha^{-1}) had significantly higher fresh rhizome yield over national check IISR Pratibha. LTS-2 was also

found significantly superior for rhizome weight (395.00 g), mother rhizomes per plant (4.70), finger rhizomes per plant (27.30), leaf width (18.90 cm) and plant height (128.67 cm) over the national check IISR Pratibha.

The genotype PTS-18 (15.2 t ha^{-1}) was the top yielder with the yield advantages of 23.6% over the national check IISR Pratibha (12.3 t ha^{-1}) followed by RH-9/90 (14.8 t ha^{-1}) and CLS-38 (15.1 t ha^{-1}) at Pottangi. At Raigarh, IT 34 recorded maximum rhizome yield (28.2 t ha^{-1}) followed by IT 35 (25.7 t ha^{-1}) and IT 20 (24.8 t ha^{-1}) over all the national checks BSR 2 (19.2 t ha^{-1}), Narendra Haldi (12.2 t ha^{-1}), Roma (12 t ha^{-1}), IISR Pratibha (12 t ha^{-1}) and Suranjana (10 t ha^{-1}).

TUR/CI/2.7 CVT on mango ginger

(Centres: West Coast Plains and Ghat Region – Kozhikode Ambalavayal; Middle Gangetic Plain Region –Dholi, Pundibari; Plains and Hills Region - Navsari; Eastern Himalayan Region- Barapani; Eastern Plateau and Hills Region –Pottangi, Raigarh)

At Ambalavayal, NVMG 2 registered highest yield per plant (142.7 g) followed by Acc 347 (136.7 g) and NVMG 10 (134.7 g) whereas at Raigarh, Indira Mango Ginger 1 (IMG 1) recorded highest rhizome yield (28.6 t ha^{-1}) followed by IMG 2 (27.5 t ha^{-1}) and IMG 4 (25.4 t ha^{-1}). At Barapani, data analysis revealed that the genotype, Acc. 265 registered highest per plant yield of 69.44 g. Highest oleoresin and essential oil was recorded in the genotype, Indira mango ginger 1(5.28 %) and Acc. 347 (1.96%) respectively.

TUR/CI/3 Varietal Evaluation Trial

TUR/CI/3.7 Initial Evaluation Trial 2015

(Centres: Middle Gangetic Plain Region - Kumarganj)

Ten entries were tested under IET, Turmeric 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/3.8 Initial Evaluation Trial 2016

(Centres: Middle Gangetic Plain Region - Pundibari; Eastern Plateau and Hills Region – Pottangi, Raigarh)

It was observed that IT 55 recorded maximum rhizome yield (35.9 t ha^{-1}) followed by IT 54 (34.8 t ha^{-1}) and IT 29 (32.2 t ha^{-1}) over all the checks Suranjana (22.2 t ha^{-1}) and BSR 2 (26.7 t ha^{-1}) at Raigarh. Analyzed pooled data from Pottangi revealed that the entry PTS-22 (18.7 t ha^{-1}) was the top yielder with the yield advantages of 14.2% over the local check variety Roma (16.4 t ha^{-1}) followed by PTS-56 (16.8 t ha^{-1}) and PTS-57 (16.7 t ha^{-1}).

A wide range of variability was found among the genotypes for different yield characters at Pundibari. With respect to the projected yield, the highest yield was recorded in TCP-58 (38.45 t ha^{-1}) followed by TCP-90 (35.91 t ha^{-1}) and lowest in TCP-32 (24.99 t ha^{-1}). Most of the genotypes were free from leaf blotch and leaf spot diseases incidence except TCP-2.

Crop Management

TUR/CM/5 Nutrient Management Trial

TUR/CM/5.10 Organic production of turmeric

(Centres: Eastern Himalayan Region – Mizoram, Barapani)

The maximum yield was recorded in T_2 (100% organic manure equivalent to 75% N requirement of turmeric), with a yield of 28.29 t ha^{-1}, followed by T_1 (100% organic manure equivalent to 100% N requirement of turmeric) with a yield of 27.42 t ha^{-1}, T_6 (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 T_3 (100% organic manures + micronutrients).

Table 16: Performance of genotypes of turmeric at Pundibari

Genotype	Plant height (cm)	Tiller number	Leaf number	Rhizome yield/plot (kg/3m²)	Yield (t ha⁻¹)	Leaf blotch (PDI)	Leaf spot (PDI)
TCP-111	151.11	3.33	8.07	12.73	26.23	0.00	0.00
TCP-235	146.78	3.20	8.40	15.90	32.75	0.00	0.00
TCP-120	152.11	3.07	7.80	15.87	32.69	0.00	0.00
TCP-190	166.34	3.27	8.07	14.27	29.39	0.00	0.00
TCP-90	150.36	3.13	8.33	17.43	35.91	0.00	0.00
TCP-32	146.44	3.07	8.40	12.13	24.99	0.00	0.00
TCP-2	127.22	2.93	7.87	12.60	25.96	21.27	15.69
TCP-94	148.67	2.93	8.27	14.20	29.25	0.00	0.00
TCP-232	157.44	3.07	8.20	13.07	26.92	0.00	0.00
TCP-246	150.56	2.93	8.00	16.67	34.33	0.00	0.00
TCP-58	158.33	3.33	8.93	18.67	38.45	0.00	0.00
SE(m)±	3.09	0.14	0.20	1.04	2.14	0.25	0.22
C.D. (P= 0.05)	9.17	N.S.	0.60	3.09	6.36	1.04	0.36
CV%	3.55	7.56	4.25	12.11	12.11	31.28	27.17

TUR/CM/5.14 Organic production of turmeric

(Centres: Southern Plateau and Hills Region - Coimbatore, Kammarpally; Middle Gangetic Plain Region - Dholi, Kumarganj, Pundibari; Western Himalayan Region – Pantnagar, Solan; East Coast Plains and Hill Region – Guntur, Chintapalle; Eastern Himalayan Region – Pasighat; Eastern Plateau and Hills Region - Pottangi, Raigarh; Eastern Himalayan Region - Mizoram, Barapani)

The organic production of turmeric was experimented by imposing two treatments T1 (organic package developed by IISR, Kozhikode) and T2 (recommended package by SAU) at various AICRPS centres. At Coimbatore, the highest fresh rhizome yield per plant (469.00 g) was recorded in IISR Pragati treated with organic package developed by IISR, Kozhikode. The highest fresh rhizome yield per plot of 3m² was however recorded in CO2 (8.33 kg/plot) treated with organic package developed by IISR, Kozhikode. Among three varieties (V1- Duggirala Red, V2 - IISR Pragati and V3 –IISR Pratibha) at Kammarpally, IISR Pragati (48.40 t ha^{-1}) and IISR Pratibha (47.20 t ha^{-1}) responded to organic package (T_1) with maximum yield, where as Duggirala Red (38.90 t ha^{-1}) responded to SAU package (T_2).

At Dholi, Rajendra Sonia and Rajendra Sonali recorded significantly higher yield (67.13 & 66.36 t ha^{-1}, respectively) as compared to IISR Pratibha (57.52 t ha^{-1}). Between two organic packages, (IISR-Kozhikode & RPCAU) organic package of RPCAU recorded significantly higher yield (64.68 t ha^{-1}) compared to organic package of IISR (62.65 t ha^{-1}). Interaction effect on yield was found non-significant. Whereas at Kumarganj, maximum yield was observed in V3T3 treatment (31.33 t ha^{-1}) followed by V3T1 (31.00 t ha^{-1}) and V3T2 (30.92 t ha^{-1}). At Pundibari, organic package developed by IISR recorded the highest yield 33.48 t ha^{-1}). Considering the interaction effect, it was found that ACC-48 with organic package developed by IISR recorded the highest yield of 35.95 t ha^{-1}.

Table 17: Performance of organic treatments in turmeric at Mizoram and Barapani

S. No.	Treatment	Plant population		No. of tillers/ plant		Fresh wt of clump (g)		Yield (t ha^{-1})		Dry recovery (%)	
		Mizoram	Barapani	Mizoram	Barapani	Mizoram	Barapani	Mizoram	Barapani	Mizoram	Barapani
1	T_1	42.00	23.77	2.33	2.00	195.63	187.57	27.42	13.55	18.95	21.54
2	T_2	43.25	20.00	2.00	1.57	196.33	106.88	28.29	12.47	17.92	21.64
3	T_3	36.75	26.00	2.00	2.60	132.30	244.00	15.52	22.00	18.37	21.35
4	T_4	40.50	24.33	1.67	1.77	191.63	218.83	25.74	15.68	18.43	21.44
5	T_5	43.75	25.63	2.00	2.10	134.50	228.00	19.59	18.20	17.48	21.28
6	T_6	44.00	25.07	1.33	1.87	179.88	224.00	26.39	14.82	16.90	21.74
7	T_7	41.75	22.00	1.67	1.23	171.00	204.33	23.55	11.88	17.00	21.86
8	T_8	44.00	23.35	1.33	1.57	173.50	110.83	25.47	10.77	17.90	21.33
Average		42.00	23.76	1.79	1.83	171.84	190.55	23.99	14.92	17.86	21.52

T_1: 100% organic manures equivalent to 100% N requirement of turmeric
T_2: 100% organic manures equivalent to 75% N requirement of turmeric
T_3: 100% organic manures + micronutrients
T_4: 100% organic manures + vermiwash 10%
T_5: 75% N requirement of turmeric + micronutrients
T_6: 75% N requirement of turmeric + vermiwash 10%
T_7: Recommended Package by SAU (Turmeric – NPK 120:90:90 NPK kg/ha)
T_8: Farmers practice

During 2019, it was observed that the organic production system significantly influenced number of tillers, number of leaves, weight of mother and primary rhizomes, clump weight and yield at Guntur. All the three varieties tested performed better under the organic production system. At Chintapalle, among the treatments, T4 (NDH-98 + inorganic) recorded the maximum plant height (148.43 cm), fresh weight of rhizome (507.93 g), yield ha^{-1} (40.52 t ha^{-1}) and dry recovery percentage (25.04) followed by T3 (NDH-98 + IISR OPP).

Analysed data from Pasighat revealed that significantly taller plants (113.2 cm), higher fresh weight of clump (300.0 g), yield per plot (12.0 kg) and yield per hectare (36.35 t) were recorded with the organic package developed by IISR (T1 as compared to recommended package of SAU (T2). There was significant difference among the two treatments for fresh rhizome yield of turmeric at Pottangi. Recommended package of practices along with IISR micronutrients produced the highest fresh rhizome yield of 26.0 t ha^{-1}, 26.8 t ha^{-1} and 25.7 t ha^{-1} in Roma, Pratibha and Surama respectively with the yield advantages of 11.0%,11.5% and 11.8% in T1 over T2. At Raigarh, the maximum fresh rhizome weight (206.65 g) was recorded in V3T1 (Narendra Haldi X organic package developed by IISR) and maximum yield (21.19 t ha^{-1}) was recorded in V1T1 (Chhattisgarh Haldi - 1 X organic package developed by IISR). In Barapani, the treatment, T_1 (organic package developed by IISR) produced higher yield of 29.89 t ha^{-1} and 27.23 t ha^{-1} in Megha Turmeric-1 and IISR Pratibha, respectively. The dry recovery percentage was higher in T_1 compared to T_2 in all the three varieties.

Table 18: Soil nutrient analysis at HARS, Pottangi

Period	pH	Org. C (%)	Av. N (kg ha^{-1})	Av. P (kg ha^{-1})	Av. K (kg ha^{-1})	Av. Fe (mg kg^{-1})	Av. Mn (mg kg^{-1})	Av. Cu (mg kg^{-1})	Av. Zn (mg kg^{-1})	Av. B (mg kg^{-1})
Pre sowing	5.96	0.88	300	20.16	180	16.0	15.12	1.10	0.45	0.35
Post harvest	5.96	0.90	302	21.00	186	19.0	18.00	1.30	0.58	0.43

TUR/CM/5.15 Effect of micro nutrients on growth and yield of turmeric

(Centres: Southern Plateau and Hills Region - Coimbatore, Kammarpally; Middle Gangetic Plain Region - Dholi, Kumarganj, Pundibari; Western Himalayan Region – Pantnagar, Solan; East Coast Plains and Hill Region – Chintapalle; Eastern Himalayan Region – Pasighat; Eastern Plateau and Hills Region - Pottangi, Raigarh).

In general, the treatment, recommended package of practice + IISR turmeric micronutrients produced significantly higher yield at Coimbatore (16.2 g /3m^2), Pasighat (37.77 t ha^{-1}), Pundibari (31.62 t ha^{-1}), Chintapalle (26.62 t ha^{-1}), Raigarh (24.7 t ha^{-1}), Pottangi (21.8 t ha^{-1}) (Fig 17) but in Dholi, it was observed that both micronutrients package of RPCAU and micronutrients package of IISR Calicut were on par regarding yield. At Coimbatore, the experiment was conducted with BSR 2, CO 2 and IISR Pragati. CO 2 with recommended package of practices and IISR turmeric micronutrient spray at 60 and 90 DAP @ 5 g/litre recorded the highest fresh weight of the clump (416.67 g) and fresh rhizome yield per plot of 3 m^2 (16.20 g).

Table 19: Nutrient status of soil following micro nutrient application at Chintapalle & Raigarh

Centres	pH	EC	OC %	N (kg/ha)	P (kg/ha)	K (kg/ha)	S (mg/kg)	Zinc (mg/kg)	Iron (mg/kg)	Cu (ppm)	Mn (ppm)	Boron (ppm)
Chintapalle	6.74	0.02	0.4	204.5	3.575	734.6	10.0	0.55	31.9	0.3	3.46	0.24
Raigarh	7.7	0.32	0.46	326	6.63	187.06	13.75	0.90	81.40	1.66	28.78	7.0

Fig 17: Field view of micronutrient trial at Raigarh and Coimbatore

Table 20: Effect of micronutrient spray on growth, yield and disease incidence at Pundibari

Treatment	Plant population	Number of tillers/plant	Plant height (cm)	Fresh yield/ Clump (g)	Yield (t/ha)	Dry recovery (%)	Leaf blotch (PDI)	Leaf spot (PDI)
Variety								
TCP-2 (V_1)	48.13	3.05	84.42	286.34	28.54	21.04	20.42	18.78
PTS-8 (V_2)	48.25	3.18	138.12	313.31	30.83	20.86	24.13	22.49
ACC-48 (V_3)	48.38	3.23	124.93	294.63	28.99	22.74	28.53	19.90
S. Em (±)	0.19	0.07	1.64	5.14	0.46	0.19	0.50	0.46
CD (at 5%)	N.S.	N.S.	5.00	15.63	1.39	0.57	1.53	1.41
Package								
IISR (T_1)	48.33	3.18	119.95	319.79	31.62	21.60	24.06	20.32
SAU (T_2)	48.17	3.12	111.70	276.40	27.29	21.50	24.65	20.53
S. Em (±)	0.16	0.06	1.34	4.20	0.37	0.15	0.41	0.38
CD (at 5%)	N.S.	N.S.	4.08	12.76	1.14	N.S.	N.S.	N.S.
Interaction								
V_1T_1	48.50	3.10	87.16	304.05	30.31	21.12	20.14	18.50
V_1T_2	47.75	3.00	81.68	268.62	26.77	20.96	20.70	19.07
V_2T_1	48.25	3.20	143.29	339.28	33.55	20.89	24.18	22.58
V_2T_2	48.25	3.15	132.95	287.34	28.11	20.83	24.09	22.40
V_3T_1	48.25	3.25	129.39	316.05	31.00	22.78	27.88	19.86
V_3T_2	48.50	3.20	120.47	273.22	26.99	22.71	29.17	20.12
S. Em (±)	0.27	0.10	2.33	7.27	0.65	0.27	0.71	0.66
CD (at 5%)	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

Crop Protection

TUR/CP/7 Disease Management Trial

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

(Centres: Southern Plateau and Hills Region – Coimbatore; Middle Gangetic Plain Region - Pundibari, Dholi; Eastern Plateau and Hills Region - Raigarh)

A survey was conducted by Pundibari centre in Mathabhanga to assess the severity of different diseases of turmeric in this area. Two major diseases of turmeric were found to be prevalent in this area, namely, leaf blotch (*Taphrina* spp.) and *Colletotrichum* leaf spot (*Colletotrichum* spp.) Most of the area is covered with local varieties which are highly susceptible to leaf blotch and leaf spot diseases. In the survey it was found that average leaf blotch disease severity in Mathabhanga was 18.35PDI and that of leaf spot was 20.53PDI.

In a survey conducted by Coimbatore centre in different turmeric growing areas of Erode and Coimbatore districts, it was found that the maximum incidence of leaf spot (14.3 PDI) was noticed in Perunthurai area of Erode district and maximum leaf blotch was noticed in Gobi (24.6 PDI) followed by Perunthurai (22.9 PDI) area of Erode district. In Coimbatore district, maximum

leaf blotch (25.7 PDI) incidence was noticed in Thondamuthur and the leaf spot incidence was 8.9 PDI in Karamadai.

Raigarh centre during the survey, found that village Bhikhari Mal at Raigarh developmental block had 43.78 per cent *Colletotrichum* leaf spot and 38.78 per cent *Taphrina* leaf blotch disease intensity followed by Amalidih village with 34.78% *Colletotrichum* leaf spot and 22.57% *Taphrina* leaf blotch disease intensity.

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

(Centres: Southern Plateau and Hills Region - Coimbatore)

Among the various fungicides tested, rhizome treatment with propiconazole (0.1%) + foliar spray with propiconazole (0.1%) at 90, 105 & 120 DAP was found to be effective in reducing the incidence of both leaf spot and leaf blotch.

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

(Centres: Southern Plateau and Hills Region – Kammarpally; Middle Gangetic Plain Region - Kumarganj, Pundibari; Eastern Plateau and Hills Region – Raigarh; East Coast Plains and Hill Region – Guntur; Western Himalayan Region - Solan)

In disease evaluation trail at Kammarpally, nine germplasm accessions were tested and found that all were susceptible to foliar diseases. For the leaf spot disease, all the accessions were in the severity range of 5 grading scale (11-25%) whereas most of the accessions are in 20-30 % for leaf blotch disease severity. At Raigarh, none of the accessions were found to be in the highly resistant category. At Solan, minimum leaf spot disease severity (8.75%) was observed in CL-54 genotype followed by TCP161 with 11.67 per cent disease severity. Leaf blotch severity in disease tolerant lines ranged from 7.25 to 11.20 per cent and was minimum in TCP 129 (7.25%) followed by CL-52 (7.50%). Yield was maximum in CL-54 (21.52 t ha^{-1}) among disease tolerant genotypes.

TUR/CP/7.7 Effect of PGPR biocapsules on growth and yield of turmeric

(Centres: Southern Plateau and Hills Region – Coimbatore, Middle Gangetic Plain Region - Dholi, Kumarganj, Pundibari; Lower East Coast Plains and Hill Region – Kammarpally, Chintapalle; Eastern Himalayan Region – Pasighat; Eastern Plateau and Hills Region - Pottangi, Raigarh; Western Himalayan Region – Solan)

In general, combined application of capsule formulation of *Trichoderma* and GRB 35 recorded highest yield in Coimbatore (5.0 kg $plot^{-1}$), Pasighat (40.12 t ha^{-1}), Raigarh (24.59 t ha^{-1}), and Pundibari (25.20 t ha^{-1}).

At Coimbatore, combined application of capsule formulation of *Trichoderma* and GRB 35 in BSR-2 recorded minimum incidence of leaf spot (5.5 PDI) and leaf blotch (14.0 PDI) compared to control that recorded 19.9 and 26.2 PDI of leaf spot and leaf blotch respectively. At Kumarganj, maximum yield was observed in V2T2 treatment (32.00 t ha^{-1}) followed by V2T1 (30.92 t ha^{-1}) and V2T3 (30.67 t ha^{-1}). Significantly lower leaf blotch disease was recorded in Rajendra Sonia (28.89 PDI) and Rajendra Sonali (30.00 PDI) compared to control (58.52 PDI) at Dholi.

Fig 18: AICRPS scientists interacting with the farmers on diseases of turmeric

Table 21: Effect of PGPR biocapsule on growth and yield of turmeric at Dholi

Treatment	Germination (%)	Plant height (cm)	No. of tillers /plant	Leaf blotch (PDI)	Yield (t/ha)
V_1- Rajendra Sonia	97.33	114.99	3.67	28.89	38.83
V_2- Rajendra Sonali	98.50	102.98	4.20	30.00	43.85
V_3- Morangia	97.50	111.04	3.27	58.52	31.48
SEm (±)	0.40	1.38	0.22	1.07	1.12
CD (5%)	NS	4.02	0.63	3.12	3.27
T_1: POP + *Trichoderma* (talc formulation) + GRB 35 (talc formulation)	97.78	113.98	3.78	38.89	36.71
T_2: POP + *Trichoderma* capsule + GRB 35 capsule	97.50	108.42	3.78	39.81	38.69
T_3: POP + *Trichoderma* capsule	98.33	109.07	3.67	39.81	37.92
T_4: POP + GRB 35 capsule	97.50	109.42	3.56	37.04	37.79
T_5: POP	97.78	107.47	3.78	40.12	39.16
SEm (±)	0.52	1.78	0.28	1.38	1.45
CD (5%)	NS	NS	NS	NS	NS
V1 X T1	97.50	115.17	3.33	30.55	37.42
V1 X T2	99.17	113.50	4.33	30.55	40.42
V1 X T3	95.83	118.20	3.00	25.00	35.33
V1 X T4	98.33	116.49	4.67	25.00	41.20
V1 X T5	95.83	111.59	3.00	33.33	39.77
V2 X T1	95.83	109.56	4.33	30.55	41.85
V2 X T2	98.33	104.14	3.67	30.55	43.93
V2 X T3	100.00	96.54	4.67	36.11	45.59
V2 X T4	98.33	105.96	3.33	27.78	42.72
V2 X T5	100.00	98.72	5.00	25.00	45.18
V3 X T1	100.00	117.20	3.67	55.55	30.85
V3 X T2	95.00	107.63	3.33	58.33	31.72
V3 X T3	99.17	112.47	3.33	58.33	32.85
V3 X T4	95.83	105.81	2.67	58.33	29.45
V3 X T5	97.50	112.09	3.33	62.04	32.53
SEm (±)	0.90	3.09	0.48	2.39	2.51
CD (*p*=5%)	2.62	NS	1.40	6.97	NS
CV (%)	1.59	4.88	22.45	10.59	11.43

POP of RPCAU: Rhizome treatment with Propiconazole (0.1%) + foliar spray with Propiconazole (0.1%) at 90, 105 and 120 DAP.

At Raigarh, minimum disease intensity of *Colletotrichum* leaf spot was 24.13% and *Taphrina* leaf spot was 24.85%. Combined treatments of *Trichoderma* and GRB 35 talc formulation were found superior in increasing the plant growth parameters and reducing the incidence of leaf blotch over other treatments at Solan.

At Kammarpally, Duggirala Red recorded maximum yield (36.9 t ha^{-1}) in the treatment POP + GRB 35 capsule (T4), IISR Pragati responded for -POP + *Trichoderma* (talc formulation) + GRB 35 (talc formulations (T1) and recorded 58.7 t ha^{-1} yield (T1), where as IISR Pratibha recorded higher yield (48.9 t ha^{-1}) for POP +*Trichoderma* capsules+GRB35capsule (T2).

At Pasighat, the maximum fresh weight of clump was recorded in T2 (POP + *Trichoderma* capsule + GRB 35 capsule) but remained at par with T1. Application of capsule formulation of *Trichoderma* and GRB 35 in TCP 129 showed lowest leaf spot (PDI 1.23) disease severity at Pundibari. Application of talc formulation of *Trichoderma* and GRB 35 showed lowest leaf blotch disease severity (PDI 10.49 and PDI 12.35) in TCP 2 and TCP 70 respectively. Lowest leaf spot severity was recorded in talc formulation of *Trichoderma* and GRB 35 in all the three genotypes (PDI 7.41, PDI 13.17 and PDI 12.35 respectively).

Fig 19: PGPR trial of turmeric at Pasighat

Fig 20: Turmeric variety Rajendra Sonia

06 Tree spices

Genetic Resources

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

(Centres: Western Plateau and Hills Region – Dapoli; Southern Plateau and Hills Region - Pechiparai)

a. Nutmeg

Among the accessions conserved at Pechiparai, MF- 1 recorded maximum tree height (10.24 m) and stem girth (59.16 cm) and MF 4 recorded maximum leaf length (20.72 cm), leaf breath (9.66 cm), no. of fruits (678), single fruit weight (59.0 g) and mace yield (291 g/ tree). At Dapoli, average weight of fruit recorded in 2019 ranged from 43.5 – 92.5 g. The genotype DBSKKV 20 recorded maximum dry nut yield (5229.21g) and dry mace yield (932.40 g). From overall performance, the genotype DBSKKVMF 20 was found to be promising considering its fruit yield parameters.

b. Clove

Among the germplasm of clove planted during the year 1996-97 at Dapoli, four promising genotypes were selected. The plant height varied from 6.00 to 7.25m., girth ranged from 39 - 43 cm and spread varied from 2.55 to 3.55 m. No flowering was observed during the year 2019.

Among the 24 accessions at Pechiparai, SA-1 recorded the highest tree height of 12.65 m, followed by SA-3 (12.49 m) as compared to local check tree height (12.34 m). The accession SA-13 was significantly superior than other accessions and recorded highest stem girth (50.19 cm) compared with local check (40.99 cm). The accession SA-3 recorded the highest leaf length (12.98 cm), leaf breadth (7.97 cm), number of branches (17 nos.) and dry bud yield (1.67 kg/tree/year) followed by accession SA-13 (1.67 kg/tree/year) when compared with local check (1.67 kg/tree/year).

Fig 21: Dwarf clove at Nagercoil

c. Cinnamon

Among the twelve accessions evaluated at Pechiparai, CV-5 recorded maximum tree height (3.41 m), number of shoots (12) and stem girth (17.24 cm) and local check recorded 3.8 m tree height, 8 shoots and 16.76 cm stem girth. The germplasm conserved at AICRPS centre is presented in table 28.

Table 22. Tree spices germplasm collection at AICRPS centres

Crop/Centre	Collection	Crop/Centre	Collection
Clove		***Cinnamon***	
Dapoli	2	Dapoli	11
Pechiparai	24	Pechiparai	14
Yercaud	01	Yercaud	02
Total	**30**	Total	**27**
Nutmeg		***Cassia***	
Dapoli	94	Dapoli	6
Pechiparai	28	Pechiparai	4
Total	**122**	Total	**10**

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

(Centres: Western Plateau and Hills Region – Dapoli; West Coast Plains and Ghat Region - IISR; Southern Plateau and Hills Region – Pechiparai)

The different genotypes have been planted in germplasm block of nutmeg at Dapoli. The growth of plants is satisfactory. Maximum height and no. of branches were recorded in genotype seedless (2.52 m and 28.9 respectively). Whereas the maximum plant spread was recorded in genotype Nova (1.85 m). Planting of new genotypes in unique nutmeg block is in progress.

Among the various unique type of nutmegs planted at Pechiparai, the maximum plant height (5.79 m), numbers of branches (11), number of fruits (26), single fruit weight (50.55 g) and mace yield/ tree (16.50 g) were recorded in IISR Viswashree.

Crop Improvement

TSP/CI/2 Coordinated Varietal Trial

TSP/CI/2.2 CVT 2001-Nutmeg

(Centres:Western Plateau and Hills Region – Dapoli; Southern Plateau and Hills Region - Pechiparai)

At Dapoli, the plant height ranged from 1.24 to 3.27 m., girth from18.50 to 34.50 cm, branches from 34.77 to 117.67and spread from 1.41 to 3.74 m. The number fruits per plant significantly differed from each other. Among the various accessions, A-9/150 produced maximum number of fruits per plant (152.00) and was significantly superior over rest of the accessions. Among the different accessions, A9/150 recorded highest plant height (6.59 m), stem girth (25.59 cm), maximum number of branches (15) and no. of fruits (271) and mace yield/ tree (178g) as compared to local check with plant height (5.78 m), stem girth (19.15 cm), number of branches (14), no. of fruits (218) and mace yield/ tree **(**147 g) (Fig 22).

TSP/CI/2.4 CVT on farmers varieties of nutmeg

(Centres: Western Plateau and Hills Region – Dapoli; Southern Plateau and Hills Region – Pechiparai; Thrissur)

The trial was planted in August- 2016 Data analysis indicates non-significant differences for all the growth parameters among the genotypes. The genotype Kochukudy recorded highest plant height (2.44 m) followed by Punnathanam Jathy (1.91 m). The genotype Punnathanam Jathy produced maximum branches (32.00) followed by Kochukudy while maximum spread was recorded by Kochukudy (2.07 m) followed by local check (1.23 m) and Cheripuram (1.66 m). The improved nutmeg variety recorded the maximum plant height (2.61 m) and numbers of branches (12 Nos.) at Pechiparai.

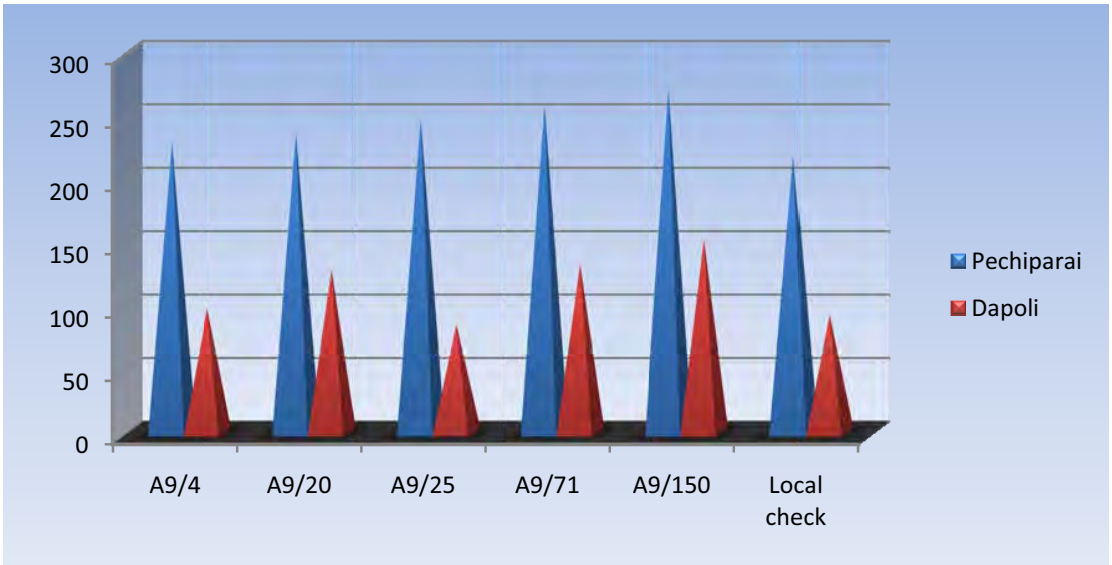


Fig 22: Variation in number of fruits per tree of nutmeg at Pechiparai & Dapoli

Fig 23: Newly released monoecious nutmeg variety Konkan Sanyukta

07 Coriander

Genetic Resources

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

(Centres: Southern Plateau and Hills Region – Coimbatore; Middle Gangetic Plain Region - Dholi, Kumarganj; East Coast Plains and Hill Region – Guntur; Trans Gangetic Plain Region – Hisar; Gujarat Plains and Hills Region – Jagudan; Central Plateau and Hills Region – Jobner; Eastern Plateau and Hills Region - Raigarh)

At Coimbatore, 276 genotypes are maintained in the germplasm collection, and the highest number of umbels per plant was recorded in CS 2 (45.00) and the lowest in CS1 (11.00). Similarly, the number of fruits per umbel ranged between 17.67 and 34.67 with an overall mean of 25.04 among the genotypes evaluated. The highest number of fruits per umbel was observed in CS 275 (34.67) and the lowest number of fruits per umbel was recorded in CS 156 (17.67). Seventy four accessions along with three checks (Rajendra Swati, Hisar Anand and Pant Haritima) were collected and evaluated at Dholi. Out of seventy four accessions, only seventeen accessions recorded the highest yield ranging from 81.51g to 98.58g per five plants and 1.43 kg to 1.59 kg yield per plot (7.2 m^2) as compared to best check variety Rajendra Swati (80.94g per five plants) and yield per plot (1.42 kg).

One hundred forty accessions of coriander were evaluated along with Hisar Sugandh, Hisar Bhoomit and Hisar Anand as checks at Hisar. The seed yield of the germplasm material ranged from from 32.4 g per plant (DH-292) to 97.5 g per plant (DH-227). The most promising lines for seed yield were DH-218, DH-224, DH-227, DH-240, DH-244, DH-280, DH-293, DH-313, DH-316 and DH-329. Out of 230 accessions, 45 accessions were better than best check variety RCr-475 (33.14 g) on the basis of seed yield per 5 plants at Jobner, promising accessions identified on the basis of seed yield per 5 plants were UD-70 (70.61 g), UD-169 (52.32 g), UD-855 (49.96 g), UD-412 (49.34 g), UD-211 (47.23 g), UD-429 (46.23 g), UD-96 (44.63 g), UD-803 (43.49 g), UD-406 (42.51 g), UD-831 (41.54 g), UD-436 (41.04 g) and UD-823 (41.03 g).

Seventy four accessions of coriander along with three checks (Rajendra Swati, Hisar Anand and Pant Haritima were evaluated at Kumarganj. The highest yield was recorded in NDCor-11 (30 g/plant) followed by NDCor-22 (28.30 g/plant) and ND Cor-32 (27.50 g/plant). Among the thirty five accessions evaluated at Guntur, LCC-316 (5.49 g $plant^{-1}$), LCC-319 (5.09 g $plant^{-1}$), LCC-336 (5.09 g $plant^{-1}$), LCC-343 (5.09 g $plant^{-1}$) and LCC-344 (4.89 g $plant^{-1}$) were found significantly superior in yield over the best check Suguna (2.92 g $plant^{-1}$). At Jagudan, 91 entries were evaluated with GCo-3 as check for yield performance. The seed yield ranged from 3.9 to 11 q ha^{-1}. Among them, eight genotypes recorded higher seed yield than check GCo-3. Germplasm was affected by adverse environmental condition, which lead to severe yield loss.

Table 23. Coriander germplasm collections at various AICRPS centres

Centre	Total		
	Cultivated	Wild and related species	
Coimbatore	276	-	276
Dholi	74	-	74
Guntur	350	-	350
Hisar	322		322
Jagudan	132	19 (Exotic)	151
Jobner	230	-	230
Kumarganj	200	-	200
Pantnagar	85	-	85
Raigarh	37		37
Total	1706	19	1725

Fig 24: Visit of seed spice monitoring team at Dholi and Jobner

Among 33 accessions of coriander evaluated at Raigarh, ICS 54 and 15 recorded maximum seed yield (15 q ha^{-1}) followed by ICS 9 (14.9 q ha^{-1}) over checks Hisar Anand (14.9 q ha^{-1}) and RCr 728 (9.8 q ha^{-1}), Gujarat 2 (9.3 q ha^{-1}) and Rajendra Swati (5.4 q ha^{-1}).

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

(Centres: Central Plateau and Hills Region – Jobner)

The germplasm was evaluated for drought tolerance. The genotypes *viz.,* UD-35, UD-76, RCr- 436, UD-27 and UD-39 in normal conditions while UD-27, UD-86, UD-77, UD-73 and UD-87 in stress conditions were the top yielders. Based on stress indices UD-87, RCr-20, UD-86, UD-77 and UD-30 were found to be the desirable entries for drought conditions.

Crop Improvement

COR/CI/2.7 Coordinated Varietal Trial on coriander 2018 - X series

(Centres: Central Plateau and Hills Region - Ajmer, Jabalpur, Jobner ; Southern Plateau and Hills Region – Coimbatore; Middle Gangetic Plain Region – Dholi, Kumarganj; East coast Plains and Hill Region – Guntur; Trans Gangetic Plain Region – Hisar; Gujarat plains and Hills Region - Jagudan, Navsari;

Western Himalayan Region – Pantnagar; Western Dry Region – Kota; Eastern Plateau and Hills Region - Raigarh)

At Jabalpur, COR-185 was the highest yielder (23.98 q ha^{-1}) whereas; lowest yield was reported in COR-189 (14.26 q ha^{-1}). At Jobner, the seed yield ranged from 15.64 q ha^{-1} (COR-181) to 26.67 q ha^{-1} (COR-190). The highest number of umbels per plant was recorded by COR 183 (26.00) followed by COR 185 (23.67), COR 184 (23.33) and COR 174 (23.33) at Coimbatore. The seed yield was highest in COR 185 (131.67 g/ plot of 1 m^2). Among the genotypes evaluated at Dholi, none of them was found to give significant higher yield over check variety Rajendra Dhania-1 except COR-176 which obtained maximum yield of 1.85kg $6m^{-2}$ plot and 2816.67kg ha^{-1} followed by check variety Rajendra Dhania-1 (1.70 kg$6m^{-2}$ and 2272.22 kg ha^{-1}).

At Kumarganj, the promising accessions were Cor-188 (16.25 q ha^{-1}) followed by Cor-192 (16.04 q ha^{-1}) and Cor-189 (14.16 q ha^{-1}).Twenty one genotypes of coriander including two checks were evaluated at Navsari. Data analysis revealed that COR-186 (17.18 q ha^{-1}), COR-187 (17.00 q ha^{-1}), COR-176 (16.38 q ha^{-1}) and COR-175 (16.04 q ha^{-1}) were found significantly superior over both the national checks *viz.,* Hisar Anand (12.77 q ha^{-1}) and RCr-728 (11.54 q ha^{-1}). At Raigarh, none of the entries performed well over national check RCr 728 (18.2 q ha^{-1}) while COR 184 (18 q ha^{-1}) was at par with RCr 728.

Among the entries evaluated at Guntur, COR-190 (24.69 q ha^{-1}), COR-185 (23.61 q ha^{-1}) and COR-174 (23.51 q ha^{-1}) were significantly superior to the check Susthira (17.19 q ha^{-1}). At Kota, COR–187 was found to be the best performing entry in terms of seed yield (20.05 q ha^{-1}) followed by COR–185 (18.60 q ha^{-1}). At Hisar, maximum seed yield (21.94 q ha^{-1}) was recorded in COR- 175 followed by COR-174 (20.86 q ha^{-1}) and COR-177 (19.29 q ha^{-1}).

Fig. 25. CVT coriander entries at Guntur

Table 24: Growth, yield attributes and yield of coriander entries in CVT

Sr. No.	Accession number	Plant height (cm)		Branches / plant		Umbels / plant		Umbellate/ umbel		seeds/ umbel		Seed yield (q/ha)	
		Hisar	Guntur	Hisar	Guntur	Hisar	Guntur	Hisar	Guntur	Hisar	Guntur	Hisar	Guntur
1	COR174	156.1	74.5	9.3	6.7	76.3	41.5	7.0	7.3	50.1	46.2	20.86	23.51
2	COR175	148.6	75.4	8.5	4.6	75.1	25.6	6.6	5.7	48.5	30.1	21.94	15.05
3	COR176	134.8	66.8	7.2	3.6	63.6	20.7	5.9	5.5	42.2	27.6	18.89	6.68
4	COR177	145.8	71.4	7.9	4.6	74.4	27.0	6.1	6.3	48.3	33.0	19.29	15.90
5	COR178	144.1	71.7	7.5	3.7	53.5	25.4	6.2	5.2	45.1	28.2	16.45	15.35
6	COR179	109.2	78.3	6.9	4.9	68.5	36.2	6.6	5.9	39.5	37.8	17.43	20.00
7	COR180	91.5	59.1	6.9	4.0	50.1	21.3	5.7	5.0	42.1	20.6	13.02	11.56
8	COR181	90.7	53.3	6.2	4.4	44.2	20.8	6.5	4.9	38.5	21.7	14.43	10.71
9	COR182	137.4	29.0	6.9	2.5	55.6	8.0	5.8	3.7	40.7	15.3	13.70	3.49
10	COR183	134.5	55.8	7.7	3.6	56.6	12.2	5.6	4.4	47.9	20.9	18.34	7.44
11	COR184	76.5	64.3	6.7	4.2	52.1	30.0	5.9	5.7	33.3	28.4	13.14	18.35
12	COR185	101.6	58.5	6.4	4.7	53.0	34.7	6.5	4.7	39.8	33.2	16.33	23.61
13	COR186	120.3	72.8	7.2	4.2	56.4	25.5	6.0	5.7	41.4	29.4	16.10	15.24
14	COR187	122.2	68.4	7.9	4.9	59.3	35.3	6.4	4.8	42.8	26.2	15.25	18.97
15	COR188	143.5	77.0	7.9	5.7	65.6	37.9	6.3	5.8	52.5	33.0	14.12	18.65
16	COR189	130.0	74.0	7.6	5.0	67.2	31.0	6.3	5.1	36.8	23.5	15.33	18.06
17	COR190	125.2	78.9	7.1	5.4	69.0	37.0	5.5	6.1	42.3	39.6	15.76	24.68
18	COR191	137.6	71.3	8.7	3.7	54.9	23.8	6.6	5.8	42.1	24.0	17.05	13.20
19	COR192	145.0	71.2	8.2	3.7	56.8	24.5	6.2	5.5	36.9	22.5	17.98	12.80
C.D. at 5%		8.0	13.2	0.8	1.1	8.0	6.5	0.8	1.2	8.3	7.8	70.0	3.77
CV %		8.0	9.5	0.8	11.7	8.0	11.0	7.8	10.5	11.7	12.7	3.5	11.6

COR/CI/3 Varietal Evaluation Trial

COR/CI/3.9 Initial Evaluation Trial - 2016

(Centres: Middle Gangetic Plain region – Dholi)

Hisar Anand recorded higher yield per hectare (19.10 q ha^{-1}) compared to check variety Rajendra Dhania-1 (18.68 q ha^{-1}). Among nine promising entries and two check varieties, four entries, RD-392 showed the maximum yield (27.78 q ha^{-1}) followed by RD-434 (27.56 q ha^{-1}), RD- 412 (26.39 q ha^{-1}) and RD-414 (24.23 q ha^{-1}).

Crop Management

COR/CM/5 Nutrient management trial

COR/CM/5.5 Response of coriander varieties to various levels of fertility under multi-cut management practice

(Centre: Gujarat Plains and Hills Region - Jagudan)

Cutting management, varieties and fertility levels significantly affected coriander seed equivalent yield. Adopted one cut at 45 DAS recorded significantly higher coriander seed equivalent yield over two cut and without cut. GDLC 1 produced significantly higher coriander seed equivalent yield over GCo2. Application of 60:30:00 kg NPK / ha recorded significantly the highest coriander seed equivalent yield over rest of the treatments.

Interaction effect between cuttings management and variety was significant. Cultivation of GDLC 1 with two cuttings of leaves recorded the maximum seed equivalent yield and was at par with one cut of GDLC 1, but significantly

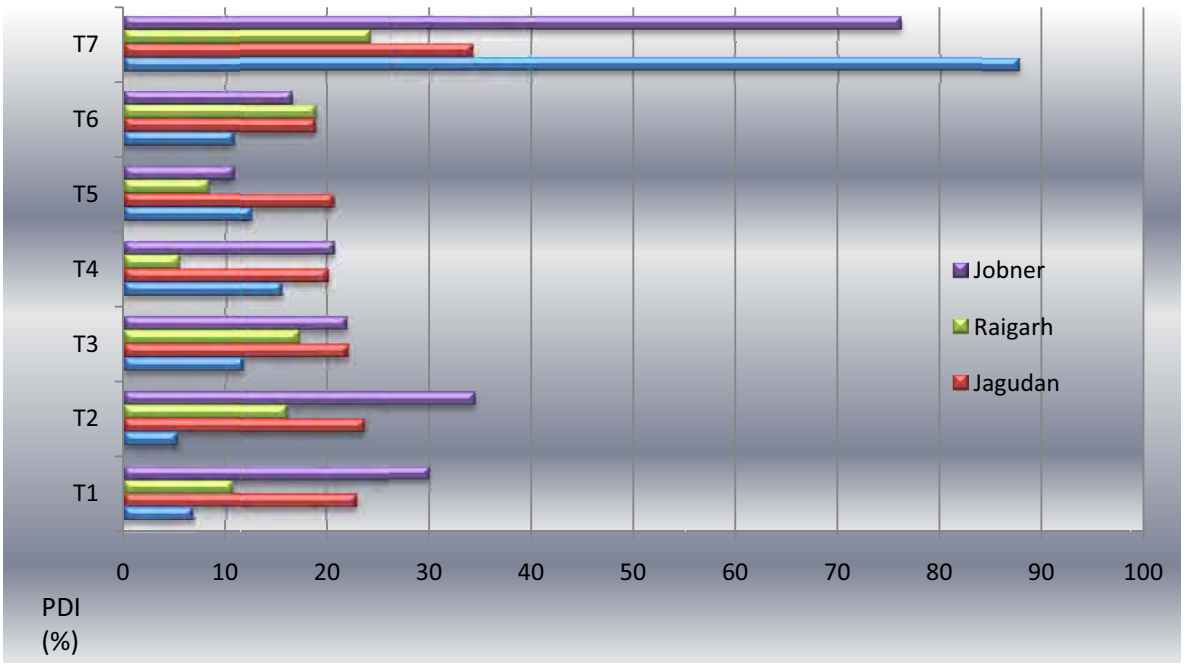
superior over rest of the treatment combinations. Under no cut system, GCo 2 recorded significantly higher coriander seed equivalent yield than GDLC 1. Interaction effect between cuttings management and fertility levels was significant. Application of 60+30 kg NPK/ha under one cut practices recorded the maximum equivalent seed yield over rest of the treatment combinations.

Crop Protection

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

(Centres: Southern Plateau and Hills Region – Coimbatore; Central Plateau and Hills Region - Jobner; Gujarat Plains and Hills Region - Jagudan, Middle Gangetic Plain Region – Kumarganj; Eastern Plateau and Hills Region – Raigarh)

Among the six fungicides tested, the disease incidence in propiconazole sprayed plants was less at Coimbatore (5.30 PDI) and Jagudan (18.94 PDI) whereas at Kumarganj and Raigarh foliar spray of wettable sulphur (0.2%) showed minimum disease intensity of 4.25 and 5.4% respectively. The minimum (10.80%) disease intensity and maximum seed yield of 17.18 q ha^{-1} was recorded with foliar spray of hexaconazole 5% SC @ 0.1% at Jobner.



T1- Foliar spray of tebuconazole 0.1%
T2- Foliar spray of propineb 0.2%
T3- Foliar spray of azoxystrobin 0.1 %
T4- Foliar spray of wettable sulphur 0.2%
T5- Foliar spray of hexaconazole 0.1%
T6- Foliar spray of propiconazole 0.1%
T7- control

Fig 26: Effect of fungicides on powdery mildew of coriander

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

(Centre: Middle Gangetic Plain Region – Dholi)

Out of 71 genotypes tested, 15 were found highly resistant against stem gall disease under natural condition. Susceptible check (Rajendra Swati) also showed highly resistant reaction against stem gall disease under natural condition.

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

(Centres: Central Plateau and Hills Region - Jabalpur, Jobner; Southern Plateau and Hills Region – Coimbatore; Middle Gangetic Plain Region – Dholi, Kumarganj; Gujarat Plains and Hills Region - Jagudan, Navsari; Western Himalayan Region – Pantnagar; Western Dry Region – Kota; Eastern Plateau and Hills Region - Raigarh)

At Jabalpur, T5 (two foliar sprays of *Lecanicillium lecan*ii + spray of propiconazole (first spray) + spray of carbendazim (second spray) was found to be superior. However T8, T7 and T5 were on par after the first spray. At Raigarh, spray of carbendazim 50 WP @ 0.1% (20 g /10 l water) (first & second spray) + two foliar sprays of acetamiprid 20SP (0.004 %) showed minimum disease intensity (7.12 %), minimum population of aphid (4.2) and maximum yield (13.49 q ha^{-1}). At Jobner and Coimbatore, lowest incidence (17.50%), highest disease reduction (71.31%) and maximum seed yield (1799.61 kg/ha) were recorded in foliar spray of propiconazole 25 EC @ 0.05% (10 ml/10 lit.) (first & second spray)+ two foliar sprays of acetamiprid 20 SP (0.004%). Results from Coimbatore revealed that aphid index (0-5 scale) (Table 29) in coriander differed significantly among treatments. T2 had the lowest aphid infestation (1.05 aphid index) followed by T9 (1.19 aphid index). Also, the treatments viz., T10, T2, T9 and T3 had recorded 2.92, 2.72, 2.53 and 2.46 predatory coccinellids per plant, respectively at 7days after second spray.

Table 25: Mean population of aphids & predatory *coccinellids* in different treatments

Treatment	Aphid index (0-5 Scale)					Predatory *Coccinellids*			Seed Yield (q/ha)
	Before spray	1st spray		2nd spray					
		3DAS	7DAS	3DAS	7DAS	Before spray	3DAS	7DAS	
T_1	2.24*(4.53)	1.95*(3.32)	1.87*(2.98)	1.66*(2.26)	1.60*(2.06)	1.72*(2.46)	1.70*(2.39)	1.68*(2.32)	20.11
T_2	2.24(4.53)	1.83(2.85)	1.62(2.12)	1.58(2.00)	1.25(1.05)	1.76(2.59)	1.76(2.59)	1.79(2.72)	23.63
T_3	2.23(4.46)	1.83(2.85)	1.70(2.39)	1.62(2.12)	1.47(1.66)	1.81(2.79)	1.66(2.26)	1.72(2.46)	18.33
T_4	2.24(4.53)	1.92(3.19)	1.74(2.52)	1.68(2.32)	1.47(1.66)	1.76(2.60)	1.64(2.19)	1.64(2.19)	19.85
T_5	2.24(4.53)	2.00(3.51)	1.79(2.70)	1.74(2.52)	1.60(2.06)	1.76(2.59)	1.60(2.06)	1.58(2.00)	19.61
T_6	2.21(4.38)	1.92(3.19)	1.72(2.46)	1.66(2.26)	1.45(1.60)	1.79(2.72)	1.74(2.52)	1.70(2.39)	19.31
T_7	2.21(4.38)	1.95(3.32)	1.70(2.39)	1.64(2.19)	1.43(1.54)	1.81(2.78)	1.70(2.39)	1.64(2.19)	21.34
T_8	2.23(4.46)	1.99(3.45)	1.87(3.00)	1.76(2.59)	1.62(2.12)	1.79(2.72)	1.58(2.00)	1.47(1.66)	20.54
T_9	2.16(4.18)	1.85(2.92)	1.64(2.19)	1.62(2.12)	1.30(1.19)	1.79(2.72)	1.74(2.53)	1.74(2.53)	23.07
T_{10}	2.24(4.53)	2.09(3.85)	2.02(3.58)	1.97(3.38)	1.92(3.19)	1.81(2.78)	1.89(3.06)	1.85(2.92)	16.08
S.Em. ±	0.017	0.021	0.037	0.034	0.016	0.018	0.027	0.022	13.0
C.D. at 5%	NS	0.062	0.11	0.101	0.048	0.053	0.080	0.065	3.86
C.V.%	1.33	1.86	3.64	3.51	1.84	1.79	2.75	2.23	11.14

* $\sqrt{X+0.5}$ transformed values Figures in parenthesis are retransformed values

All the treatments significantly reduced the stem gall disease incidence and average population of aphids per 5 twigs of coriander plant over control at Dholi. However, lowest stem gall disease incidence (25.58%) and average population of aphids per 5 twigs (6.40) was recorded in seed treatment & foliar spray with hexaconazole @ 0.1% at 45, 60 & 75 DAS (package developed by RPCAU) and two foliar sprays of acetamiprid 20 SP (0.004%) + 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) respectively over control. At Jagudan, two foliar sprays of flonicamid 50WG @ 0.015% registered significantly the lowest aphid infestation (2.85 aphid index) at 3 and 7 days after first and second sprays.

Fig 27: Seed production of ICS-4 at Raigarh

Fig 28: Field view of management of powdery mildew of coriander at Raigarh

08 Cumin

Genetic Resources

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

(Centres: Gujarat Plains and Hills Region – Jagudan, Sanand; Central Plateau and Hills Region - Jobner, Mandor)

Out of 93 accessions evaluated at Jobner, 16 accessions were better than best check variety RZ-19 (10 g) on the basis of seed yield per 5 plants. At Mandor, 134 germplasm accessions along with checks GC 4, RZ 223 and RZ 209 were evaluated in augmented design. Maximum coefficient of variability (CV%) was observed for seed yield (41.2%) followed by number of umbels per plant (28.6 %), number of branches per plant (21.8%), plant height (15.2%), number of umbellets per umbel (12.4%), seeds per umbel (10.1), days to 50% flowering (4.5%) and days to maturity (2.1%). It indicated that seed yield, number of umbels per plant, number of primary branches per plant, seeds per umbel and number of umbellets per umbel are the important characters and maximum weightage should be given to these traits while selecting genotypes for further breeding programme for improving the seed yield. 330 germplasm accessions were evaluated with GC-4 as check for yield performance at Jagudan (Fig 29). The seed yield ranged from 0.21 - 4.17 q ha^{-1}. Among them fifty five genotypes showed higher seed yield than check GC-4. Germplasm was affected by adverse environmental condition, which leads to severe yield loss.

Table 26: Germplasm collection of cumin in various AICRPS centres

Centre	Indigenous	Exotic	Total
Jagudan	330	-	330
Jobner	93	-	93
Sanand	84	-	84
Mandor	134		134
Total	641	-	641

Screening for resistance against powdery mildew disease

A total of thirty (27+3) entries were screened for the resistance against powdery mildew disease at Jagudan. The minimum disease intensity was noticed in JC 16-07 (5.0%), while the maximum disease intensity was recorded in JC-18-02 and CVT-42 (15.0%). The powdery mildew incidence ranged from 5.0 to 15.0 per cent.

Screening of cumin entries for resistance against blight disease

A total of thirty (27+3) entries were screened for the resistance against blight disease at Jagudan. The minimum disease intensity was noticed in JC-18-11 (5.0%), while the maximum disease intensity was recorded in JC-18-01 (20.0%). The blight disease incidence ranged from 5.0 to 20.0 per cent.

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

At Jobner, ten (IET) entries of cumin were screened against wilt and blight diseases. None of entries was found resistant against wilt disease. Seven entries *viz.,* UC-250, UC-257, UC-287, UC-322, UC-327, Rz-19 and Rz-209 were

susceptible against wilt disease and four entries *viz.,* UC-250, UC-322, Rz-19 and Rz-209 were susceptible against blight disease. Rest of the entries was highly susceptible against wilt and blight diseases. Sixty six entries of cumin were screened for the resistance against wilt disease at Jagudan. The minimum disease intensity was noticed in JC-95-103 GC-5)-1 (10%) followed by JC-95-103 (GC-5)-2, GC-3 and JC-18-11 (12.0%), while the maximum disease intensity was recorded in the CVT-38, CVT-42, GP-57, 58, 60, 62,65, 66, 71, 72, 74, 75,76 and JC 16-07 (100%). The wilt disease incidence ranged from 10.0 to 100%

Fig 29: Field view of cumin at Jagudan

CUM/CI/1.3 Identification of drought tolerant source

(Centre: Central Plateau and Hills Region - Jobner)

Data analysis revealed that the genotypes *viz.,* UC-436, UC-319, UC-332, UC-333 and UC-342 in normal conditions while UC-323, UC-330, UC-270, UC-229 and UC-346 in stress conditions were top yielders. Based on stress indices, UC-270 was found to be the desirable genotype for drought conditions, followed by UC-323, UC-330, UC-280 and UC-282.

Crop Improvement

CUM/CI/2 Coordinated Varietal Trial

CUM/CI/2.4 Coordinated Varietal Trial-2017

(Centres: Gujarat Plains and Hills Region – Jagudan; Central Plateau and Hills Region - Jobner, Ajmer, Mandor)

This experiment was affected by adverse environmental condition at harvesting stage at Jagudan whereas at Jobner, seed yield ranged from 1.52 q ha^{-1} (CUM-42) to 3.02 q ha^{-1} (CUM-40). Of the ten entries evaluated, CUM-40 recorded maximum seed yield of 3.02 q ha^{-1} followed by RZ-19 (2.70 q ha^{-1}), CUM-41 (2.63 q ha^{-1}), GC-4 (2.62 q ha^{-1}) and CUM-39 (2.46 q ha^{-1}). At Mandor, only one test entry CUM-41 (5.29 q ha^{-1}) was found significantly superior over check variety GC-4 (4.07 q ha^{-1}).

CUM/CI/2 Quality evaluation Trial

CUM/CI/2.4 Quality evaluation in cumin

(Centres: Central Plateau and Hills Region - Jobner)

Ten entries of cumin under CVT and IET were tested for volatile oil content during *Rabi* 2018-19, The analysis of variance revealed significant differences among the entries for volatile oil (%) both in CVT and IET. The maximum volatile oil of 4.33% was observed in CUM-42 and RZ-345 followed by 3.60% in CUM-38, while minimum of

2.80% was recorded in CUM-39 and GC-4 in CVT. The entry CUM-40 ranked first in terms of volatile oil yield (9.46 l ha^{-1}) followed by RZ-19 (8.65 l ha^{-1}) while lowest volatile oil yield of 6.46 l ha^{-1} was recorded in RZ-223.

In IET, the volatile oil content in the entries ranged from 3.20% to 3.60%. The maximum volatile oil of 3.60% was observed in UC-247, UC-250, UC-287, UC-322, RZ-19, UC-249 and RZ-223 while minimum of 3.20% was recorded in UC-249, UC-257, UC-327 and RZ-209.

Crop Management

CUM/CM/5 Nutrient Management Trial

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

(Centre: Central Plateau and Hills Region - Jobner)

Pooled analysis of three years data from Jobner revealed that out of thirteen treatments, minimum (11.08%) disease intensity and maximum (2.68 q ha^{-1}) seed yield were recorded with soil application of vermicompost @ 2 t ha^{-1} + seed treatment with *Trichoderma* @ 6 g/kg + spray of NSKE @ 5% (T_4) with B:C ratio of 2.29.

Crop Protection

CUM/CP/6 Disease Management Trial

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

((Centres: Gujarat Plains and Hills Region – Jagudan; Central Plateau and Hills Region – Jobner, Ajmer)

Pooled analysis of three years data from Jobner revealed that maximum mean reduction in aphid population (79.09 %) and seed yield (2.59 q ha^{-1}) were recorded with thiamethoxam 25 WG @ 25 g a.i./ha followed by clothianidin 50 WDG @ 20 g a.i./ha (T_2) with 1.74 B:C ratio. It was statistically at par with thiamethoxam spray 25 WG @ 25 g a.i./ha followed by thiacloprid 21.7 SC @ 25 g a.i./ha (T_1) which exhibited 76.01 % mean reduction in aphid population and seed yield (2.44 q ha^{-1}) with 1.64. Whereas maximum (39.00) mean aphid population per plant and minimum seed yield (1.35 q ha^{-1}) were recorded in untreated control (T_{10}). Volatile oil content did not differ among the treatments.

Table 27 : Bio-efficacy of newer molecules of insecticides against cumin aphid

Treatment No.	Mean aphid population per plant					Mean population of predatory *Coccinellids* per plant			Yield (q ha^{-1})
	Before spray	1st spray		2nd spray		Before spray	2nd spray		
		3 DAS	7 DAS	3 DAS	7 DAS		3 DAS	7 DAS	
T_1	34.47	11.60	11.20	9.67	8.60	2.17(1.64)*	1.82(1.52)	1.71(1.49)	3.17
T_2	31.97	11.00	10.13	7.60	7.00	2.30(1.67)	1.67(1.47)	1.48(1.41)	3.42
T_3	30.40	13.47	12.67	13.33	10.60	2.22(1.65)	2.03(1.59)	1.91(1.55)	2.80
T_4	31.73	12.67	11.47	9.87	10.27	2.29(1.67)	1.40(1.38)	1.12(1.27)	2.82
T_5	32.93	12.33	11.53	10.00	9.40	2.25(1.66)	1.45(1.39)	1.36(1.36)	3.04
T_6	33.00	15.33	14.20	15.10	15.13	2.19(1.64)	2.08(1.61)	1.95(1.56)	2.65
T_7	32.17	18.87	17.60	15.13	13.20	2.35(1.69)	1.95(1.56)	1.79(1.51)	2.62
T_8	31.73	13.60	12.53	9.27	10.07	2.33(1.68)	1.60(1.45)	1.45(1.40)	2.71
T_9	35.73	20.33	18.07	16.87	15.67	2.35(1.69)	2.27(1.67)	2.03(1.59)	2.58
T_{10}	33.00	37.80	43.67	44.00	41.93	2.30(1.67)	2.39(1.70)	2.24(1.66)	2.07
CD at 5%	NS	2.64	2.39	2.41	2.43	NS	0.08	0.06	5.9
CV (%)	13.91	9.21	8.54	9.30	10.00	2.03	2.85	2.33	12.47

*figures in parenthesis are transformed values

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

(Centre: Central Plateau and Hills Region – Jobner)

Pooled analysis of two years data from Jobner revealed that, out of seven treatments minimum (11.25%) disease intensity and maximum (2.81 q ha^{-1}) seed yield were recorded with foliar spray of hexaconazole 5% SC @ 0.1% with highest B:C ratio of 2.21.

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

(Centres: Gujarat Plains and Hills Region – Jagudan; Central Plateau and Hills Region – Jobner, Ajmer, Mandor)

Significantly higher yield was recorded in treatment T_4 (three sprays of kresoxym methyl 44.3 SC @ 0.044% (10 ml/ 10 l) + two foliar sprays of thiamethoxam 25WG (0.0084%) and was at par with T_{13}, T_{10}, T_1 and T_8 at Jagudan.The data from Jobner centre revealed that aphid infestation differed significantly at 3 and 7 days in both sprays. Treatment combination of three foliar sprays of kresoxym methyl 44.3 SC @ 0.044% (10 ml/ 10 lit. water) + two foliar sprays of thiamethoxam 25WG (0.0084%) (T_4) showed significantly lowest aphid index (2.98, 2.19, 1.31 and 0.60) at 3 and 7 days in both sprays and found significantly superior over rest of the treatments. Unprotected plot registered the highest 4.67 and 4.25 aphid index at 3 and 7 days after second spray. Mean population of *coccinellids* differed significantly among the treatments. However, mean population of predatory *coccinellids* varied from 0.89 (package developed by respective SAUs -T_{13}) to 2.57 per plant in non protected plots of cumin.

At Mandor, data on per cent disease severity of powdery mildew and blight of cumin showed that lowest incidence and maximum disease control were found in three foliar sprays of kresoxym methyl 44.3 SC @ 0.044% (10 ml/ 10 lit. water) + two foliar sprays of thiamethoxam 25WG (0.0084%) (T4) (4.90, 71.39 and 4.710, 72.02). The maximum seed yield was recorded in three foliar sprays of kresoxym methyl 44.3 SC @ 0.044% (10 ml/ 10 lit. water) + two foliar sprays of thiamethoxam 25WG (0.0084%) (T4) (7.32 q ha^{-1} as compared to control (T14) (4.45q ha^{-1}). Among the treatments, minimum (4.43%) disease incidence and maximum (74.33%) disease control of wilt were recorded with package developed by respective SAUs (T13).

Table 28: Integrated pest and disease management in cumin (Genetic Resources)

Treat. no.	Qty. of insecticide (l/ml/g/kg ha^{-1})	Price of insecticide (Rs. ha^{-1})	Labour cost (Rs.)	Total cost of treatment (Rs. ha^{-1})	Common cost of cultivation (Rs. ha^{-1})	Total cost of cultivation (Rs. ha^{-1})	Seed Yield (kg ha^{-1})	Gross return (Rs. ha^{-1})	Net return (Rs. ha^{-1})	Net gain (Rs. ha^{-1})	B:C Ratio
T_1	100g+115ml	180+380=560	800	1360	28300	29660	243.80	48760	21718	19988	1.64
T_2	100g+40g	180+520=700	800	1500	28300	29800	259.23	51846	24804	23124	1.74
T_3	100g+1.6 lit.	180+1025=1205	800	2005	28300	30305	221.44	44288	17246	15146	1.46
T_4	100g+115ml	145+380=525	800	1325	28300	29625	229.20	45840	18798	17208	1.55
T_5	100g+40g	145+520=665	800	1465	28300	29765	235.55	47110	20068	18528	1.58
T_6	100g+1.6 lit	145+1025=1170	800	1970	28300	30270	201.16	40232	13190	11230	1.33
T_7	1.0 lit+115ml	950+380=1330	800	2130	28300	30430	195.62	39124	12082	9702	1.29
T_8	1.0 lit+40g	950+520=1470	800	2270	28300	30570	210.86	42172	15130	12800	1.38
T_9	1.0 lit+1.6 lit	950+1025=1975	800	2770	28300	31070	187.97	37594	10552	7802	1.21
T_{10}	-	0	0	0	28300	28300	135.21	27042	-	-	0.96

09 Fennel

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

(Centres: Middle Gangetic Plain Region - Dholi, Kumarganj; Trans Gangetic Plain Region – Hisar; Gujarat Plains and Hills Region – Jagudan; Central Plateau and Hills Region - Jobner)

Among 43 germplasm accessions maintained at Dholi, only 23 accessions out yielded check variety, Rajendra Saurabh. Highest yield was recorded in RF-10 (24.53 q ha^{-1}) followed by RF - 65 (23.75 q ha^{-1}). At Kumarganj, 168 germplasm accessions were evaluated. NDF-46 (52 g/plant) recorded maximum yield followed by NDF-52 (51.9 g/plant) and NDF-49 (50.4 g/plant). 80 entries were evaluated with GF-12 as check for yield performance at Jagudan. The seed yield ranged from 3.33 to 24.44 q ha^{-1}.

Table 29: Germplasm collection of fennel in various AICRPS centres

Centre	Indigenous		Exotic	Total
	Cultivated			
	Existing	Addition	Existing	
Dholi	43	-	-	43
Hisar	174	6	-	180
Jagudan	80	-	-	80
Jobner	133	-	-	133
Kumarganj	168	-	-	168
Total	598	6	-	604

Screening for resistance against *Ramularia* blight disease

During *Kharif* season, thirteen (11+2) entries were screened under natural conditions at Jagudan. The minimum intensity of *Ramularia* blight was noticed in JF-2012-8 (10.0%) while the maximum intensity was recorded in JF-2016-05 (30.0%). The disease intensity ranged from 10.0 to 30.0 per cent.

Crop Improvement

FNL/CI/2 Coordinated Varietal Trial

FNL/CI/2.6 Coordinated Varietal Trial on Fennel 2018 Series – Series X

(Centres: Central Plateau and Hills Region - Ajmer, Jabalpur, Jobner; Middle Gangetic Plain Region – Dholi, Kumarganj, Navsari; Trans Gangetic Plain Region – Hisar; Gujarat Plains and Hills Region - Jagudan; Western Himalayan Region - Pantnagar)

At Jabalpur (Fig 30), seed yield ranged from 8.10-17.66 q ha^{-1}. FNL-129 was reported to be the highest yielder (13.44 q ha^{-1}) followed by FNL-118 (16.44 q ha^{-1}) and FNL-128 (15.97 q ha^{-1}) which were also statistically at par. FNL-122 was found to be the poor yielder (8.10 q ha^{-1}). At Jobner, the seed yield ranged from 13.17 q ha^{-1} to 25.65 q ha^{-1}. FNL-118 recorded maximum seed yield of 25.97 q ha^{-1} followed by FNL-127 (25.65 q ha^{-1}), FNL-126 (25.08 q ha^{-1}), FNL-122 (24.46 q ha^{-1}), and FNL-129 (22.87 q ha^{-1}), while lowest seed yield of 13.17 q ha^{-1} was recorded in FNL-121. Fourteen promising entries with check Rajendra Saurabh were tested under coordinated varietal trial at Dholi. Three entries FNL-124, FNL-117 and FNL-116 recorded significantly higher yield per ha (19.02, 18.70 and 18.29 q ha^{-1} respectively) compared to check variety Rajendra Saurabh (14.83 q ha^{-1}).

Among 14 entries tested in CVT at Kumarganj (Fig 31), FNL-125 recorded maximum yield (15.06 q ha^{-1}) followed by FNL-123 (14.37 q ha^{-1}) and FNL-121 (14.02 q ha^{-1}). At Hisar, maximum seed yield was recorded in FNL-116 (21.51 q ha^{-1}) followed by FNL-117 (20.10 q ha^{-1}) and FNL-123 (19.30 q ha^{-1}). The CVT at Jagudan revealed that FNL-124, 127 and FNL-119 ranked in top three positions. Fifteen genotypes of fennel were evaluated at Pantnagar and the highest seed yield was observed in FNL-128

(19.91q ha^{-1}) followed by FNL-121 (19.49 q ha^{-1}). At Navsari, FNL-123 (28.04 q ha^{-1}), FNL-118 (25.52 q ha^{-1}), FNL-126 (25.34 q ha^{-1}), FNL-119 (25.22 q ha^{-1}) and FNL-127 (25.12 q ha^{-1}) were regarded as promising genotypes by virtue of exhibiting higher seed yield and other related seed yield contributing traits.

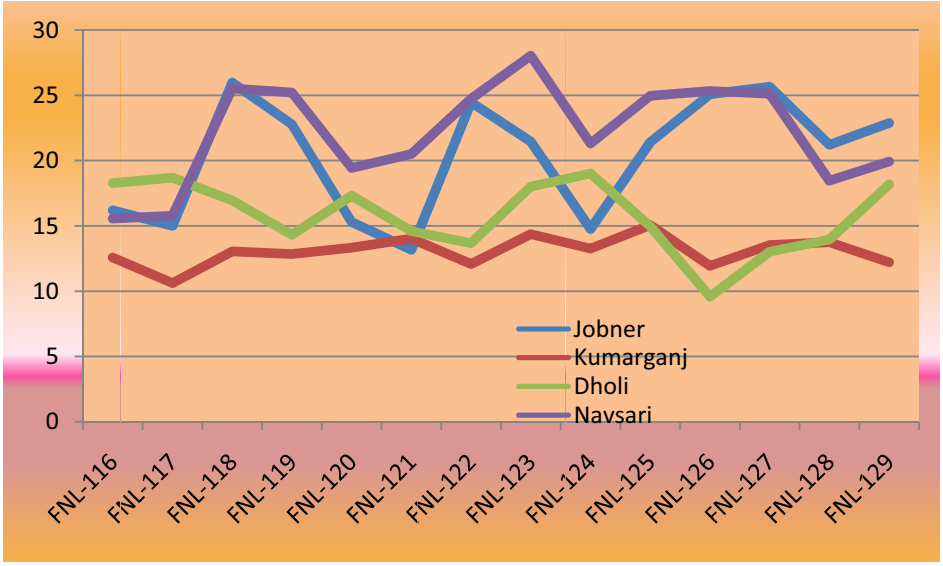


Fig 30: Performance of fennel genotypes at different locations

Fig 31: Field view of CVT of fennel at Kumarganj and Jobner

FNL/CI/4Quality Evaluation Trial

FNL/CI/3.5 Quality Evaluation in fennel

(Centres:, Central Plateau and Hills Region - Jobner)

Fourteen entries under CVT were tested for volatile oil content. Volatile oil content ranged from 1.80 to 2.40%. The maximum volatile oil of 2.40% was observed in FNL-118, FNL-122, FNL-127 and FNL-129 followed by 2.37% in FNL-124 and FNL-126, 2.33% in FNL-121.

Ten entries under IET were tested for volatile oil content. Volatile oil content ranged from 1.60 to 2.80%. The maximum volatile oil of 2.80% was recorded in UF-230 and UF-231 followed by UF-232 (2.40%) and RF-205 (2.40%).

10 Fenugreek

Genetic Resources

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

(Centres: Middle Gangetic Plain Region - Dholi, Kumarganj; East Coast Plains and Hill Region – Guntur; Trans Gangetic Plain Region – Hisar; Gujarat Plains and Hills Region – Jagudan; Central plateau and Hills Region - Jobner)

One hundred and eleven germplasm accessions were evaluated along with nine checks namely RMt-1, RMt-305, RMt-354 and RMt-361 at Jobner and found that 44 accessions were better than best check variety RMt-354 (51.01 g.). Among 58 germplasm accessions, only 11 accessions out yielded check variety Rajendra Kanti at Dholi. Highest yield was recorded in RM-170 (23.15 q ha^{-1}) followed by RM -198 (22.66 q ha^{-1}). Two hundred and four germplasm accessions are maintained and were evaluated at Kumarganj. The highest yield was found in NDM-49 (6 g/plant) followed by NDM-97 (5.8 g/plant), NDM-80 (5.7 g/plant) and NDM-143 (5.7 g/plant).

Seventy six germplasm accessions are maintained at Jagudan among which 26 were evaluated and IC number was obtained for 30 accessions. At Guntur, 124 accessions were evaluated. Among them, eleven accessions recorded significantly higher yield than the best check LM-2 (4.87 g $plant^{-1}$). The top five performing accessions were LFC-82 (6.27 g $plant^{-1}$), LFC-115 (6.19 g $plant^{-1}$), LFC-122 (6.11 g $plant^{-1}$), LFC-6 (5.95 g $plant^{-1}$) and LFC-14 (5.95 g $plant^{-1}$). At Hisar, one hundred thirty two accessions were evaluated along with Hisar Sonali, Hisar Suvarna and Hisar Mukta. The seed yield ranged from 11.1 g/plant (HM-573) to 28.2 g/plant (HM-431). The most promising accessions for seed yield were HM-403, HM-421, HM-426, HM-430, HM-431, HM-443, HM-451, HM-453, HM-476, HM-479 and HM-482.

At Raigarh, IFGS-11 (18.2 q ha^{-1}) recorded higher seed yield over national checks RMT 305 (15.6 q ha^{-1}) and Hisar Sonali (14.1 q ha^{-1}). While IFGS -9 (16.5 q ha^{-1}) and IFGS-6 (15.3 q ha^{-1}) recorded higher seed yield over Hisar Sonali (13.8 q ha^{-1}).

Table 30: Germplasm collection of fenugreek in various AICRPS centres

Centre	Indigenous		Total
	Existing	Addition	
Dholi	58	-	58
Guntur	124	-	124
Hisar	406	-	406
Jagudan	76	-	76
Jobner	111	-	111
Kumarganj	204	-	204
Pantnagar	139	-	139
Total	1118	-	1118

Screening of germplasm

Powdery mildew disease

Three hundred and fifty entries were screened under this trial against powdery mildew disease at Jobner. Among them, twenty one entries showed moderately resistant and rest of the entries showed susceptible and highly susceptibl e reaction against the powdery mildew disease.

At Jagudan, thirty four (33+1) entries were screened under natural condition at Seed Spices Research Station, Jagudan. The minimum incidence was noticed in the genotypes like J Fg – 16-01 and Fgk-122 (2.0 %), whereas the maximum per cent disease intensity was recorded in the genotype J Fg – 16-07 (20.0 %).

Fig 32: Field view of fenugreek trial at Kumarganj and Guntur

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

(Centres: Central Plateau and Hills Region - Jobner)

An experiment was conducted during *Rabi* 2018-19 to identify drought tolerant genotypes at Jobner. The genotypes; UM 88, UM 87, UM 73, UM 71 and UM 69 in normal conditions and UM 80, UM 92, UM 89, UM 75 and UM 93 in stress conditions were top yielders. Based on stress indices UM 80, UM 75, UM 89, UM 92 and UM 93 were found to be the desirable entries for drought conditions.

Crop Improvement

FGK/CI/2 Coordinated Varietal Trial

FGK/CI/2.5 Coordinated Varietal Trial 2018 Series X

(Centres: Central Plateau and Hills Region – Ajmer, Jabalpur, Jobner; Southern Plateau and Hills Region – Coimbatore; Middle Gangetic Plain Region - Dholi, Kumarganj; East Coast Plains and Hill Region – Guntur; Trans Gangetic Plain Region - Hisar; Gujarat Plains and Hills Region - Jagudan, Navsari; Western Himalayan Region – Pantnagar; Eastern Plateau and Hills Region – Raigarh; Western Dry Region - Kota)

The genotype FGK 123 recorded maximum seed yield of 21.23 q ha^{-1} and 16.25 q ha^{-1} at Jobner and Kumarganj whereas the genotype FGK-122 recorded significantly highest seed yield at Navsari (20.78 q ha^{-1}) and Raigarh (16.1 q ha^{-1}) (Fig 33). At Coimbatore (Fig 34) the genotype FGK 124 (22.66) recorded maximum number of pods per plant and the genotype FGK 134 (11.60) recorded the lowest. Seed yield per plot (2 m^2) varied from 98.07 g to 174.67 g with a mean of 124.06 g.

Fig 33: Field view of CVT of fenugreek at Raigarh

Fig 34: Variation in the seed characters of fenugreek at Coimbatore

Table 31: Yield and ancillary observation of CVT on Fenugreek at Kumarganj

S. No	Entry	Plant height (cm)	No. of branches /plant	No. of pods /plant	Length of pod (cm)	No. of grains/ Pod	Days to maturity	Yield (q/ha)
1	FGK-122	77.30	3.44	44.20	13.87	22.76	132.33	15.48
2	FGK-123	75.93	3.22	46.40	12.87	20.16	124.67	16.25
3	FGK-124	76.77	3.44	55.05	13.73	20.80	125.33	14.09
4	FGK-125	86.13	3.33	54.43	13.20	22.43	125.00	13.75
5	FGK-126	76.20	3.22	47.95	12.90	22.73	123.67	15.20
6	FGK-127	74.43	3.29	45.06	13.10	17.94	130.33	12.91
7	FGK-128	84.77	3.18	59.39	13.07	23.20	128.00	15.97
8	FGK-129	75.30	3.28	46.34	13.00	22.53	125.67	13.19
9	FGK-130	83.40	3.36	36.27	13.57	19.50	127.00	12.63
10	FGK-131	76.17	3.55	43.16	12.17	20.16	126.67	13.77
11	FGK-132	86.30	3.44	60.03	12.30	17.53	128.00	13.47
12	FGK-133	94.37	3.31	35.40	13.43	20.17	126.00	14.23
13	FGK-134	85.37	3.62	65.68	12.90	23.06	123.00	14.79
14	FGK-135	79.43	3.30	43.73	12.47	22.06	124.33	15.00
15	FGK-136	81.13	3.40	41.95	12.97	21.83	127.33	15.41
16	FGK-137	71.73	3.27	52.76	13.43	19.76	126.00	14.44
17	FGK-138	84.53	3.24	44.40	12.77	21.50	128.67	13.61
	SEM	1.034		1.108	0.295	0.940	0.900	0.282
	CD	2.993		3.205	0.855	2.721	2.606	0.817
	CV (%)	2.224		3.967	3.922	7.731	1.232	3.404

Among seventeen entries and one check variety evaluated at Dholi, none of the entries were found significantly superior regarding yield per plot and yield per ha as compared to check Rajendra Kanti. However, FGK-137 and FGK-132 recorded the highest yield per hectare (26.27 & 25.53 q ha^{-1} respectively) as compared to check variety Rajendra Kanti (23.51 q ha^{-1}). Among the

entries evaluated at Guntur, FGK-136 (21.68 q ha^{-1}), FGK-135 (19.50 q ha^{-1}), FGK-132 (18.77 q ha^{-1}), FGK-137 (18.57 q ha^{-1}) and FGK-127 (18.29 q ha^{-1}) recorded significantly higher yield over the check Lam Methi-3 (14.80 q ha^{-1}). Maximum seed yield (27.91 q ha^{-1}) was recorded in FGK-125 followed by FGK-124 (26.24 q ha^{-1}) and FGK-137 (25.39 q ha^{-1}) at Hisar.

At Jagudan, FGK -131 (15.57 q ha^{-1}), FGK -130 (14.75 q ha^{-1}), FGK -135 (13.91 q ha^{-1}), FGK -134 (13.50 q ha^{-1}) and FGK -133 (13.33 q ha^{-1}) were found numerically superior over national check variety GM-2 (11.85 q ha^{-1}) by 31.4%, 24.5%, 17.4%, 14.0% and 12.5% respectively. Maximum yield was observed in FGK-124 (19.31 q ha^{-1}) followed by FGK-136 (18.75 q ha^{-1}) at Pantnagar. Data on seed yield at Jabalpur revealed that FGK-128 was the highest yielder with an average yield of 25.01 q ha^{-1} while, FGK-137 was the lowest yielder with 11.53 q ha^{-1}.

At Kota, the seed yield ranged from 7.81-18.05 q ha^{-1}. During the first year of evaluation, FGK 130 was found to be the best performing entry in terms of seed yield, yielding 23.93 q ha^{-1}. The mean days to flowering ranged from 59 days (FGK 99) to 73 days (FGK 137); days to maturity from 125 days (FGK 124 and FGK 125) to 133 days (FGK 119) and test weight from12.38g (FGK-126) to 16.51g (FGK 129).

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

(Centres: Central Plateau and Hills Region – Ajmer, Jobner; Southern Plateau and Hills Region – Coimbatore; Middle Gangetic Plain Region - Dholi, Kumarganj; East Coast Plains and Hill Region – Guntur; Trans Gangetic Plain Region - Hisar)

The analysis of variance revealed significant differences among the varieties for crude fat (total oil) %. The total oil content in the varieties ranged from 2.68% to 3.95%. The maximum total oil of 3.95% was observed in RMt-1 followed by 3.88% in RMt-43, while minimum of 2.68% was recorded in RMt-305 followed by 2.80% in RMt-35. The saponine content in the varieties ranged from 4.68% to 6.44%. The maximum saponine content of 6.44% was observed in RMt-1 followed by 6.11% in RMt-43, while minimum of 4.68% was recorded in RMt-305 followed by 4.75% in RMt-351.

11 Ajwain

Crop Improvement

AJN/CI/2 Coordinated Varietal Trial

AJN/CI/2.1 Coordinated Varietal Trial 2016

(Centres: Central Plateau and Hills Region – Ajmer; Middle Gangetic Plain Region - Kumarganj; East Coast Plains and Hill Region – Guntur; Trans Gangetic Plain Region - Hisar; Eastern Plateau and Hills Region – Raigarh; Gujarat Plains and Hills Region – Jagudan; Central Plateau and Hills Region - Jobner)

Out of 13 entries of Ajwain evaluated at Kumarganj, maximum yield was recorded in IA-1 (8.53 q ha^{-1}) followed by NDAJ-10 (8.26 q ha^{-1}) and HAJ-7-187 (8.19 q ha^{-1}). Among the entries evaluated at Guntur, highest yield was recorded in LS-14-3 (9.66 q ha^{-1}) followed by LS-14-8 (9.38 q ha^{-1}), AA-73 (9.38 q ha^{-1}) and AA-6 (8.73 q ha^{-1}) which were on par with each other and significantly superior to the best check Lam Selection-1 (7.93 q ha^{-1}).

Table 32: Growth, yield attributes and yield of Ajwain entries at Guntur

S.No	Entry	Plant height (cm)	Primary branches	Umbels per plant	Umbellets per umbel	No. of seeds per umbel	Days to 50% flowering	Days to maturity	Yield (q/ha)	Rank
1	JA-219	102.9	6.0	153.3	10.6	242.1	81.5	141.0	6.63	8.0
2	JA-187	107.8	7.2	176.5	11.9	203.5	78.5	137.5	7.14	6.0
3	IA-1	105.9	11.1	271.3	12.4	290.4	80.5	140.0	3.96	11.0
4	HAJ-7	111.9	6.9	173.6	11.6	166.9	84.0	140.5	3.33	13.0
5	HAJ-18	98.4	5.9	176.9	10.7	165.3	78.0	137.5	4.81	9.0
6	AA-6	112.0	6.8	282.9	12.2	192.7	77.0	134.0	8.72	4.0
7	AA-73	108.2	8.7	259.7	15.2	298.8	82.0	141.0	9.37	3.0
8	LS-14-3	108.9	9.5	241.4	10.5	278.9	82.5	141.5	9.66	1.0
9	LS-14-8	113.6	6.2	206.9	10.1	280.9	82.5	141.5	9.38	2.0
10	NDAT-20	91.0	7.3	246.5	11.7	248.0	70.5	129.0	2.29	14.0
11	NDAT-21	96.5	7.1	252.4	11.8	221.4	81.5	140.0	4.01	10.0
12	AA-1 (C)	102.7	6.9	148.2	12.4	234.9	82.0	140.5	3.34	12.0
13	AA-2(C)	112.8	5.4	223.3	10.9	202.2	85.5	143.0	6.68	7.0
14	LS-1(C)	108.9	5.0	255.0	11.6	132.4	83.0	140.5	7.93	5.0
CD (p=0.05)		21.1	2.7	45.6	3.3	55.8	8.1	8.6	1.21	
CV (%)		9.2	17.3	9.6	13.1	11.5	4.6	2.9	9.0	

At Raigarh, IA-1 (10.8 q ha^{-1}) recorded maximum seed yield followed by AA-1 (9.60 q ha^{-1}) and AA-2 (9.4 q ha^{-1}). At Hisar, maximum seed yield (12.08 q ha^{-1}) was recorded in HAJ-18 followed by NDA-11 (10.59 q ha^{-1}) and IA-1 (10.50 q ha^{-1}). None of the genotypes recorded significantly higher yield than local check variety GA-2 (11.57 q ha^{-1}) at Jagudan. Of the fourteen entries evaluated at Jobner (Fig 35), entry LS-14-3 recorded maximum seed yield of 12.88 q ha^{-1} followed by local variety (12.31 q ha^{-1}), NDAJ-10 (9.25 q ha^{-1}), AA-73 (8.94 q ha^{-1}) and AA-6 (8.39 q ha^{-1}) while lowest yield of 6.54 q ha^{-1} was recorded in NDAJ-11. Mean performance of the entries revealed the superior performance of local variety yielding 10.21 q ha^{-1} followed by LS-14-4 (9.94 q ha^{-1}) and IA-1 (9.24 q ha^{-1}), while lowest seed yield of 6.99 q ha^{-1} was recorded in HAJ-7.

Fig 35: Field view of ajwain trial at Jobner

12 Nigella

Crop Improvement

NGL/CI/2 Coordinated Varietal Trial

NGL/CI/2.1 Coordinated Varietal Trial 2016

(Centres: Central Plateau and Hills Region – Ajmer; Middle Gangetic Plain Region - Kumarganj; Trans Gangetic Plain Region - Hisar; Western Himalayan Region – Pantnagar; Eastern Plateau and Hills Region – Raigarh; Western Dry Region – Kota; Lower Gangetic Plain Region – Kalyani)

At Kumarganj, maximum yield was recorded in NDBC-20 (8.88 q ha^{-1}) followed by AN-1 (7.77 q ha^{-1}) and IN-1 (7.29 q ha^{-1}) and three years pooled data showed maximum yield in NDBC-20 (8.40 q ha^{-1}) followed by AN-1 (7.61 q ha^{-1}) and IN-1 (7.24 q ha^{-1}). At Kalyani, HKL-T recorded highest number of capsules per plant (24.37) and seeds per capsule (68.82), AN-1(C) recorded highest test weight (2.86 g) and IN1 recorded highest yield per hectare (7.00 q ha^{-1}). At Kota, the seed yield ranged from 456-990 kg/ha. During its third and final year of evaluation, AN-1 was found to be the best performing entry in terms of seed yield (9.90 q ha^{-1}) followed by AN-23 (9.00 q ha^{-1}) and showing 8.14 per cent higher yield over the check AN-20. At Hisar plant height ranged from 83.4 to 93.4 cm, pods per plant from 49.8 to 65.0 and seeds per umbel from 83.0 to 98.0. Maximum seed yield (1038.0 kg ha^{-1}) was recorded in NDBC-21 followed by AN-23 (10. 30 q ha^{-1}) and AN-20 (10.04 q ha^{-1}).

Ten genotypes were evaluated along with 2 checks at Pantnagar. Maximum yield was observed in PK-1 (11. 16 q ha^{-1}) followed by PK-2 (10.79 q ha^{-1}). For seed yield Indira Nigella -1 (IN-1) recorded (9.1 q ha^{-1}) followed by entry NDAZ-21 (8.7 q ha^{-1}) over checks AN-1 (7.58 q ha^{-1}) and Pant Krishna (7.23 q ha^{-1}) at Raigarh (Fig 36). At Kumarganj, maximum yield was recorded in NDBC-20 (8.88 q ha^{-1}) followed by AN-1 (7.77 q ha^{-1}) and IN-1 (7.29 q ha^{-1}) and three years pooled data showed maximum yield in NDBC-20 (8.40 q ha^{-1}) followed by AN-1 (7.61 q ha^{-1}) and IN-1 (7.24 q ha^{-1}).

Fig 36: Field view of nigella at Raigarh and Kalyani

13 Saffron - Kalazeera

SAFFRON

Genetic Resources

Conservation, evaluation and utilization of exotic and indigenous saffron germplasm lines

(Centres: Pampore)

Two hundred germplasm accessions of saffron collected from various hot spots of Jammu and Kashmir including 36 exotic collections are maintained at Saffron Research Station, SKUAST, Kashmir. Among them, 22 were found promising with regard to yield and quality.

To study the impact of organic sources on saffron yield and quality

(Centre: Pampore)

The treatment, T_{12} (FYM 20 t ha $^{-1}$+ vermicompost 10 q ha^{-1} + *Azatobacter* + *Trichoderma viride*) recorded maximum yield (8.7 kg ha^{-1}) followed by the treatment T_8 (FYM 15 t ha^{-1} + vermicompost 10 q ha^{-1}) + *Azatobacter* + *Trichoderma viride*) (7.9 kg ha^{-1}) while the lowest yield (4.6 kg ha^{-1}) was recorded in the treatment T_{13} (FYM 15 t ha^{-1}).

Population dynamics of rhizosphere mycoflora and their efficacy on corm rot pathogens of saffron

The results on *in vitro* efficacy of isolated rhizospheric fungi (nonpathogenic to saffron crop) against mycelial growth of corm rot pathogen (*Fusarium oxysporum*) of saffron revealed that *Trichoderma viride* was significantly superior as compared to other isolates including the control against *Fusarium*.

KALAZEERA

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

(Centres: Pampore)

The germplasm comprises of 70 accessions collected from foot hills of Northern Himalayas as well as germplasm accessions available at Saffron Research Station, SKUAST-K. Significant variability was noticed among the accessions for yield and oil content. Some of the promising accessions identified are SRS-KZ-192, SRS-KZ-158, SRS-KZ-172, SRS-KZ-177, SRS-KZ-170, SRS-KZ-149 and SRS-KZ-167.

KAZ/CM/2.1 Evaluation of saffron-kalazeera intercropping system module for improving profitability and livelihood of farmers

(Centre: Pampore)

Saffron & kalazeera intercropping recorded significantly higher returns as compared to sole cropping of saffron or kalazeera.

KAF/CP/3.1 Status of major prevalent diseases of kalazeera (*Bunium persicum* Bioss) under Kashmir conditions

Three districts *viz.,* Pulwama, Doda and Badipora were surveyed and found that the fields were infested with *Pythium* spp., *F. solani, F. oxysporium* and unknown fungal and bacterial pathogens were recorded and their identification is in progress.

14 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 from ICAR-NRCSS, Ajmer, Dr. Dhirendra Singh from SKNAU, Jobner, Dr. N. R. Patel from Jagudan and Dr. S. K. Tehlan, Hisar visited the seed spices centres for reviewing the progress of the experiments.

Visit of PC unit scientists to various AICRPS centres

S. No.	Date of visit	Centre visited
1	18.01.2019 – 19.01.2019	AICRPS Centre at IGKV Raigarh
2	27.02.2019 – 01.03.2019	AICRPS Centre at Chintapalle, OUAT, Pottangi
3	25.06.2019	AICRPS Centre at KAU, Thrissur
4	18.10.2019	AICRPS Centre at TNAU, Coimbatore
5	21.10.2019 – 23.10.2019	AICRPS Centre at Kammarpally

Fig 37: AICRPS scientists at Pottangi and Chintapalle

15 Annual Group Meeting

The XXX Workshop of All India Co-ordinated Research Project on Spices was held at Tamil Nadu Agricultural University, Coimbatore during 14-16 November 2019. The Workshop was inaugurated by Dr T. Janakiram, ADG (Hort. Sci.). He highlighted the importance of spices in Indian economy and emphasised the need to develop trait specific varieties. Dr N. Kumar, Vice-Chancellor, TNAU presided over the function and he asserted that with little modification in cultivation practices and adoption of scientific practices, productivity of spices can be enhanced. Dr K. Nirmal Babu, Project Co-ordinator highlighted the achievements made during the year and remarked that still a long way to go to meet the challenges faced by spice growers as well as spice industry. Dr Homey Cheriyan, Director, Directorate of Arecanut and Spices Development and Dr Gopal Lal, Director, ICAR-National Research Centre on Seed Spices spoke during the occasion. Dr K.S. Subramanian, Director of Research, TNAU welcomed the gathering and Dr L. Pugalendhi, Dean (Hort.), TNAU proposed vote of thanks. Dr P. Rethinam (former Director, ICAR-IIOPR and former ADG (Hort. Sci.) was the special guest during the plenary session. He also emphasised that Indian spices should maintain the quality to meet the global challenge for which united efforts of spices sector including research, development and industry is necessary.

During the workshop three varieties, one in fennel (RF- 290) with high yield and more umbels (from SKNAU, Jobner), one in ajwain with high yield and quality (Ajmer Ajwain-73) and one in nigella (Ajmer Nigella-1) with high yield and quality (both from ICAR-NRCSS, Ajmer) were recommended for release.

The following technologies were also recommended for adoption

- Technology for the management of bacterial wilt in ginger caused by *Ralstonia pseudosolanacearum* (ICAR-IISR, Calicut)
- Response of coriander varieties to various levels of fertilizer management under different cutting management (Jagudan)
- Micro irrigation and fertigation management in cumin (Jobner)
- Management of coriander powdery mildew using new generation fungicides (Jobner)
- Organic nutrients and disease management in cumin (Jobner)

Some of the major recommendations emerged during the discussion were,

- Unique types must be registered with NBPGR
- Development of trait specific varieties has to be given priority
- Mutation breeding should be explored for creating variability particularly for biotic and abiotic stress resistance.
- Seed chain must be followed for maintaining varietal purity.
- Soil, plant and quality analysis must be included in all nutrient management trials.
- Economics has to be worked out in all crop production experiments.
- Based on the guidance from Joint Secretary pesticides, bioefficacy trials of pesticides in different crops may be conducted at AICRPS centres for multilocation data generation.
- Generation of residue data in all pesticide evaluation trials need to be emphasized.

Inuagurating XXX AICRPS Workshop at TNAU, Coimbatore

Best AICRPS Centre Award for NDUAT, Kumarganj and OUAT, Pottangi

Release of publications

Exhibitions held at TNAU, Coimbatore

Fig 38: Glimpses of AICRPS workshop held at TNAU, Coimbatore

16 Quinquennial Review Team

Quinquennial Review Team (QRT) headed by Prof. K.V. Peter as chairman, Dr. K.D. Kokate, Dr. V.S. Korikanthimath, Dr. R.T. Patil, Dr. Harikesh Bahadur Singh, Dr. S.R. Bhat as members and Dr. Santhosh J. Eapen as member secretary visited AICRPS Headquarters as well as AICRPS centres during July to October 2019 to review the work done during the period from 01.04.2013 to 31.03.2018 at All India Coordinated Research Project on Spices (AICRPS) as per ICAR's letter F. No. 1(6)/2018-IA.V dated 13 March 2019 and F.No. HS/1-6/2018-IA-V dated 23 May 2019. Detailed interactions were held with the scientists of various AICRPS centres who made detailed presentations on various aspects such as mandate of the centre, budget allocation, varieties and technologies developed, publications, HRD and extension activities, future programmes and the constraints etc. QRT also visited some of the AICRPS centres, experimental fields, laboratories, Pesticide Residue Laboratory at Regional Agricultural Research Institute, Durgapura, Jaipur and some farmer's fields also. Input documents were also supplied by AICRPS Headquarters.

QRT also considered the inputs received from other stakeholders including Spices Board, Directorate of Arecanut and Spices Development, farming community, Farmer Producer Organizations, and representatives from traders association, exporters and spices industry like All India Spices Export Promotion Forum, World Spice Organization etc. Based on all these visits, interactions and discussions, QRT would submit a few recommendations to ICAR for approval.

Fig 39: QRT visit at RARI Durgapura, Jaipur

Fig 40: QRT interacting with Scientist of ICAR RC NEH Umiam, Barapani

17 Popularization of Technology

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

High yielding varieties- boon to farmers

- ❖ Demonstration of transplanting of Rajendra Sonia variety of turmeric (Guntur)
- ❖ Demonstration of high yielding turmeric variety CO 2 (Coimbatore)
- ❖ Demonstration of TCP-129 turmeric variety for yield and tolerance to foliar diseases (Pundibari)

Rapid multiplication of planting materials- for minimal expenditure

- ❖ Production of black pepper plants using rapid multiplication method (Pechiparai)
- ❖ 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 (Pottangi, Nagaland)
- ❖ Demonstration of pro-tray propagation technique for ginger and turmeric, soft wood grafting technique in nutmeg and kokum, bush pepper production technology (Dapoli)

Processing and value addition- for capturing market

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

Plant protection- for improving plant health

- ❖ Demonstration of biocontrol agents for black pepper wilt control at Karadiyur village (Yercaud)
- ❖ Rhizome treatment with propiconazole @0.2% + foliar spray with propiconazole @0.1% at 90, 105 & 120 DAP in turmeric in 0.5 acres (Dholi)

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

18 Success Stories

High yielding varieties- for income maximization

Under AICRP on Spices at Dholi centre, high yielding varieties of different spices crop *viz.*, turmeric (Rajendra Sonia and Rajendra Sonali), coriander (Rajendra Dhania-1, Rajendra Dhania-2 and Rajendra Swati), fenugreek (Rajendra Kanti and Rajendra Abha), nigella (Rajendra Shyama), fennel (Rajendra Saurabh) and ajwain (Rajendra Mani) have been developed. During 2019, about 43.3 tonnes of turmeric seed was produced which was procured by progressive farmers, various government and non-governmental organizations of Bihar as well as adjoining states. Because of high productivity and high curcumin content of turmeric varieties like Rajendra Sonia and Rajendra Sonali, it was procured by the farmers of other states *viz.,* Uttar Pradesh, Gujarat, Jharkhand, Telangana, and Andhra Pradesh. Seed spices (coriander, fenugreek, fennel, nigella and ajwain) 15q each were produced and made available to farming community for area expansion under spices cultivation. Cultivation of most of traditional varieties of spices were replaced by above mentioned released varieties and thus occupying major area under spices cultivation in the state and in some pockets in other states.

Fig 41: A bumper harvest of turmeric

Biocontrol agents- for sustainable spice production

The bio control laboratory funded by the SHM is functioning in the Cardamom Research Station at Pampadumpara from 2012 onwards. Through this laboratory, biocontrol agents such as, *Pseudomonas flourescens*, *Trichoderma viride*, *Metarhizium anisopliae*, *Lecanicillium lecanii, Paecilomyces lilacinus* and *Beauveria bassiana* have been produced on a large scale and is being supplied to the farmers. During 2019, about 17038 kg of biocontrol agents were distributed to the farmers. Promising thing is that more and more farmers are using biocontrol agents for

pest and disease management of cardamom and black pepper. As per the feedback received, the farmers were more convinced about the quality and effect of biocontrol agents being supplied. The centre is looking forward to make more farmers aware about eco-friendly pest/disease management through the use of biocontrol agents and thus reduce the environmental chemical contamination and degradation of cardamom hill reserve (CHR) area to a greater extent.

Ginger seed storage- for prosperity

Ginger is known as poor man's cash crop of farmers of Himachal Pradesh especially of Sirmour and Solan districts. The area under its cultivation is reducing in the state year after year as the main problem in ginger cultivation is storage of healthy seed for next season as rhizome rot is the major menace resulting in poor rhizome yield. Hence, a modified storage method for healthy ginger seed rhizomes was employed and demonstrated which enhanced ginger production and income of farmers.

Modified storage method consists of

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

With the adoption of this storage method of ginger, a dramatic increase in area and production of ginger in the state has been observed even in the non-conventional ginger growing areas of the state like Kangra, Mandi, Hamirpur, Una, Chamba and Bilaspur districts.

Fig 42: Ginger harvest at Pottangi

Fig 43: Turmeric harvest at Dholi

19 Krishi Melas & Farmer's Trainings

Krishi Melas/exhibition organized

- NDUAT, Kumarganj conducted exhibition on spices at CFC, NDUAT, Kumarganj on 28 January 2019.
- RPCAU, Dholi organized a three days farmers training on Spices Production in collaboration with DASD, Calicut, Kerala during which 40 farmers (ST community) from W–Champaran district of Bihar were given training from 18-20 Febuarary, 2019.
- RARS, Ambalavayal organised training program on Spices for SC population at Ambalavayal on 28 March 2019.
- NDUAT, Kumarganj conducted exhibition on spices at College of Horticulture & Forestry, Kumarganj on 31 March 2019.
- One day Farmers training on Scientific cultivation of Spices for SCST farmers was organized at DRI Jayprabha gram Gonda UP on 24 May 2019.
- CCS Haryana Agricultural University, Hisar organized Krishi Mela (Rabi) during 11-12 September, 2019 during which 2000 farmers from states like Rajasthan, Punjab, Uttar Pradesh and Haryana attended.
- RPCAU, Dholi organized a three days Farmers training on Spices Production in collaboration with DASD, Calicut, Kerala during which 44 farmers from Samastipur, Madhubani, Sheohar and E-Champaran districts of Bihar were given training from 26-28 December,2019.

Fig 44: Training conducted at Kammarpally & Pottangi

Trainings organized by various AICRPS centres

Sl. No.	Date	AICRPS centre	Details of training	No. of participants
1	10.01.2019	HRS, Yercaud	Cultivation practices of Black Pepper at Kolli hills	50
2	15.01.2019	PRS,Panniyur	Green protocol for staff and labourers of PRS, Panniyur under Harithakeralam programme of Govt. of Kerala	26
3	16.01.2019	ICRI Gangtok	Production technologies of large cardamom at ICRI, RRS, Research Farm, Pangthang	12
4	23.01.2019	ICRI Gangtok	Quality improvement training programme on large cardamom at Buriakhop, Jorethang, West Sikkim	52
5	29.01.2019	ICRI Gangtok	Scientific production technologies and post harvest management of large cardamom at Gairigaon, East Sikkim	28
6	29.01.2019	PRS, Panniyur	pepper cultivation at Merchant Association Hall, Kudiyanmala, Kannur	100
7	05.02.2019	ICRI Gangtok	Production technologies of large cardamom at Research farm, Pangthang Pithoragarh district, Uttarakhand	16
8	6-2-2019	PRS, Panniyur	Black pepper cultivation at Taliparamba block Panchayath, Kannur	25
9	12.02.2019	ICRI Gangtok	Doubling the income of tribal farmers in Darjeeling hills: strategies & policies at Tindhury village, Kalimpong	50
10	13.02.2019	ICRI Gangtok	Quality improvement in large cardamom at Lower Mirik, Darjeeling district of West Bengal	40
11	14.2.2019 & 26.2.2019	TNAU, Yercaud	Scientific spice cultivation practices to watershed level user group members under TAWDEVA, Chennai at Trichy district	160
12	15.02.2019	PRS, Panniyur	Black pepper cultivation to farmers of Padiyur Grama Panchayath , Kannur	120
13	15.02.2019 to 28.02.19	UBKV, Pundibari	Training for vermicompost producers under MIDH Scheme	25
14	15.02.2019	CAU, Pasighat	Scientific production technology of ginger and turmeric under CSS-MIDH at Ziro, Lower Subansiri district, Arunachal Pradesh	105
15	20.2.2019	PRS, Panniyur	Black pepper cultivation to farmers from Kooveri, Chapparappadavu Panchayath, Panniyur, Kannur	30
16	27.02.2019	CCHSAU, Hisar	Production technology of spice crops at Hisar	75
17	06 .03.2019	CCSHAU, Hisar	Production technology of spice crops for farmers of Haryana	80
18	15.02.2019 to 15.03.2019	UBKV Pundibari	Skill development training for vermicompost producers under MIDH scheme	25
19	22-03-2019	Dr.YSRHU Chintapalle.	Production, processing and post harvest management in spice crops in collaboration with ICAR-IISR, Kozhikode, Kerala	45
20	23.3.2019	ICRI, Sakaleshpur	Scientific cultivation of small cardamom	50

21	23.03.19	OUAT, Pottangi	Spices cultivation technologies at Pottangi	108
22	26.03.2019	UBKV, Pundibari	Scope for spices cultivation in multistoried cropping in collaboration with MIDH scheme	80
23	28-03-2019	DR.YSRHU, Chintapalle	Seed storage and post harvest management in turmeric and ginger	30
24	03.06.2019	SKLTSHU, Kammarpally	SC training, "Modern techniques for turmeric cultivation". at Yergatla village of Nizamabad district,Telangana and distributed turmeric seeds kits (5kg of IISR Pragati) to participants	125
25	20.06.2019	SKLTSHU, Kammarpally	SC training "Modern techniques for turmeric cultivation" at Warangal, Nizamabad and Jagtyal district and distributed turmeric seeds kits (5kg of IISR Pragati) to participants	150
26	26.06.2019	CARS, Raigarh	Training on Pro-tray technology to minimise seeds of turmeric and ginger at College of Agriculture and Research Station, Raigarh	30
27	28.06.2019	OUAT, Pottangi	Training on Black pepper cultivation at Sagar, Lamataput	90
28	03.06.2019	SKLTSHU, Kammarpally	SC training on Modern techniques for turmeric cultivation at Yergatla village of Nizamabad district,Telangana and distributed turmeric seeds kits (5kg of IISR Pragati) to participants	125
29	02.07.2019	ICRI Gangtok	Monsoon and onset of disease in large cardamom at Devithang, South Sikkim	9
30	03.07.2019	ICRI Gangtok	Spice Clinic programme at Deu village, South Sikkim	20
31	20.08.2019	ICRI, Gangtok	Practices in large cardamom cultivation, seed to produce at Rahung, West Kameng, Arunachal Pradesh	4
32	22-08-2019	HRS, Chintapalle	Best management practices in spices at Chintapalle	30
33	27.08.2019	NDUAT, Kumarganj	Training of SC/ST farmers on spices cultivation. Distributed seed material of turmeric and seed spices to all participants	166
34	30-08-2019	HRS, Chintapalle	Good Agricultural Practices in turmeric under tribal area of Visakhapatnam" with the financial assistance from Society for Elimination of Rural Poverty (SERP), Andhra Pradesh	40
35	03.09.2019 to 06.09.2019	HRS, Yercaud	Micro irrigation and organic farming to tribal farmers from Kolli hills	40
36	05.09.2019 to 07.09.2019	CAU, Pasighat, Arunachal Pradesh.	Enhancing the productivity of spices in Arunachal Pradesh through scientific approach under "Marketing and Value-Chain Analysis on Spices in Arunachal Pradesh" sponsored by CCS National Institute of Agricultural Marketing (NIAM), Jaipur, Rajasthan at College of Horticulture & Forestry	105
37	09.09.2019 to 12.09.2019	HRS, Yercaud	Micro irrigation and organic farming to tribal farmers from Kolli hills	40
38	13.09.2019	NDUAT, Kumarganj	Spice cultivation training and distribution of spices seeds to the SCST farmers of Kundasar village Bahraich, district of U.P.	35

39	16.09.2019	HREC Sirsi	Rejuvenation of horticulture crops in flood affected area of Siddapur taluk of Uttara kannada in association with Horticulture Extension Education Unit, Sirsi and Dept. of Horticulture, Siddapur	30
40	17.09.2019	ICRI, Gangtok	Doubling the farmer's income through organic practices in large cardamom at KVK, Namthang, South Sikkim	74
41	22.09-2019 to 25.09.2029	HRS, Yercaud	Integrated farming system, soil conservation, micro irrigation and organic farming training	56
42	27.09.2019 to 29.09.2019	CAU, Imphal	Value addition of spices (in ginger) during three days Off-campus training programme at Basikhong, Imphal East, Manipur sponsored by CCS National Institute of Agricultural Marketing, MoA & FW, Govt. of India, Jaipur organized by Directorate of Research & Directorate of Extension Education, CAU, Imphal	50
43	30.09.2019	HREC Sirsi	Precision farming and processing of black pepper by solar tunnel drier in association with Green Vyali Organic Spices and Dept. of Horticulture, Siddapur	66
44	2.12.2019 to 5.12.2019	HRS, Yercaud	Training conducted on the following topics to ATMA farmers of Villupuram district • Production technology of black pepper Intercropping in spice crops • Pest and disease management in spice crops • Post harvest technology on black pepper • Marketing technology on black pepper	150
45	12.12.2019	ICRI, Myladumpara	Climate change, mitigation and appropriate practices for sustaining cardamom yield	100
46	12.12.2019	ICRI Research Farm, Pangthang	Self sustainable farming system, biodiversity in large cardamom cultivation, on-farm production technology of bio-inputs	25
47	16.12.2019.	HRS, Yercaud	Interstate training KRISHI to ATMA farmers of Idukki district, Kerala	38
48	19.12.2019	CRS, Pampadumpara	Organic preparations and pest and disease management in cardamom and black pepper	50
49	26.12.2019 to 28.12. 2019	RPCAU, Dholi	Spices Production training programme in collaboration with DASD, Calicut, Kerala	42

20 Publications

Research Papers

Chintapalle

Vamshikrishna S, Sivakumar V, Umajyothi K, Dorajeerao A V D & Umakrishna K 2019 Evaluation of turmeric (*Curcuma longa* L.) genotypes for yield & quality characters under high altitude & tribal zone of Andhra Pradesh. *International Journal of Chemical Studies*, 7(1): 1480-1483.

Vamshikrishna S, Sivakumar V, Umajyothi K, Dorajeerao A V D & Umakrishna, K 2019 Genetic variability, heritability & genetic advance as per cent mean in turmeric (*Curcuma longa* L.) genotypes. *Journal of Pharmacognosy & Phytochemistry* 8(1): 1799-1801.

Vamshikrishna S, Sivakumar V, Umajyothi K, Dorajeerao A V D & Umakrishna K 2019 Performance of turmeric (*Curcuma longa* L.) genotypes for growth & yield under high altitude & tribal zone of Andhra Pradesh. *International Journal of Current Microbiology and Applied Sciences 8*(2): 156-162.

Sivakumar V, Chandrasekhar Rao C, Ravindra Kumar K & Bhagavan B V K 2019 Performance of turmeric (*Curcuma longa* L.) genotypes for yield & yield attributing traits under high altitude conditions of Andhra Pradesh. *Journal of Pharmacognosy & Phytochemistry* 8(4): 1586-1589.

Sivakumar V, Ravindrakumar K, Chandrasekhar C, Bhagavan B V K & Nirmal Babu K 2019 Evaluation of pre & post emergence herbicides for effective weeds control in Ginger. *International Journal of Chemical Studies* 7(4): 2597-2599.

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Ashokkumar K, Pandiyan A, Murugan M, Dhanya MK, Sathyan T, Sivakumar P, Surya R, Warkentin TD 2019 Profiling bioactive flavonoids & carotenoids in select south Indian spices & nuts. *Natural Product Research* https://doi.org/10.1080/14786419.2018.1557179

Ashokkumar K, Murugan M, Dhanya MK, Surya R, Kamaraj D 2019 Phytochemical variations among four distinct varieties of Indian cardamom *Elettaria cardamomum* (L.) Maton. *Natural Product Research* https://doi.org/10.1080/14786419.2018.1561687.

Sathyan T, Dhanya M K , Manoj VS, Aswathy TS, Preethy TT & Murugan M 2018 Population dynamics of whitefly (*Dialeurodes cardamom* David & Subr.) & lacewing bug (*Stephanitis typicus* DIST.) on cardamom in relation to meteorological parameters. *Journal of Insect Science* 31(1-2): 74-79.

Pasighat

Mariam Anal PS 2019 Evaluation of turmeric (*Curcuma longa* L.) genotypes for growth, yield & quality under rainfed condition of Arunachal Pradesh. *International Journal of Current Microbiology and Applied Sciences* 8(9): 619-626.

Coimbatore

Kamali R, Senthamzih Selvi B, Shoba N & Meenakshi P 2019 Studies on nutritional composition of coriander leaf powder as influenced by different drying methods. *International Journal of Chemical Studies* 7 (3):1711-1714.

Vinodhini V, Senthamizh Selvi B, Balakrishnan S & Suresh R 2019 Evaluation of turmeric genotypes (*Curcuma longa* L.) for yield & curcumin content. *Journal of Agriculture and Ecology* 7: 88-95.

Suresh R, Ramar A, Balakrishnan S & Senthamizh Selvi B 2019 Character association in turmeric (*Curcuma longa* L.) genotypes. *The Pharma Innovation Journal* 8(8): 76-79.

Ushamalini C, Arunkumar K & Mohanalakshmi M 2019 Beneficial microbial application for the management of ginger rhizome rot. *Pharmacognosy & Phytochemistry* 8(2): 430-432.

Arunkumar K, Jegadeeswari V & Ushamalini C 2019 Seed priming technology in spice crops. *Journal of Phytology* 11: 21-24.

Aswathi S, Ushamalini C & Arunkumar K 2019 Induction of plant defence mechanism by effective isolate of *Bacillus subtillus* in coriander. *International Journal of Chemical Studies* 7: 324-328.

Hisar

Telugu R K, Tehlan S K, Srikanth M & Mamtha N C 2019 Mean performance of fifty genotypes of fennel *(Foeniculum vulgare* L.) for yield & yield attributing traits. *International Journal Current Microbiology and Applied Sciences* 8 (1): 387-392.

Amit Malik T P & Tehlan S K 2019 Development of identification tools for distinguishing different coriander (*Coriandrum sativum* L.) genotypes based on its stem & branches characteristics. *International Journal Current Microbiology and Applied Sciences* 8 (4): 594-599

Telugu R K, Tehlan S K & More V S 2019 Assessment of seed quality & vigour in fifty genotypes of fennel *(Foeniculum vulgare* L.). *International Journal of Chemical Studies* 7 (1): 362-366.

Kumar V, Tehlan S K, Kumar V, More V S, Kumar S & Kumar A 2019 Influence of integrated nutrient management on seed quality of coriander (*Coriandrum sativum* L.). *Indian Journal Agricultural Sciences* 89 (5): 856-860.

Kumar V, Malik T P, Kumar V, More V S & Vikram 2019 Effect of integrated nutrient management on seed quality of fennel (*Foeniculum vulgare* Mill.). *Journal of Pharmacognosy & Phytochemistry* 8 (1): 511-515.

Yadav P, Tehlan, S K & Deswal S 2018 Assessment of genetic divergence in fenugreek (*Trigonella foenum-graecum* L.) based on biological characters. *Journal of Pharmacognosy & Photochemistry* 7 (2): 1257-1260.

Yadav P, Tehlan S K & Kumar M 2018 Genetic variability & association analysis for seed yield & its components in fenugreek (*Trigonella foenum-graecum* L.). *Indian Journal of Genetics & Plant Breeding* 78 (2): 275-278.

Talugu R K, Tehlan S K, Kumar M & Mamtha N C 2018 Variability studies on yield & yield attributing characters in fennel *(Foeniculum vulgare* L.). *International Journal of Pure and Applied Biosci*ence 6 (5): 954-959.

Kumar S, Malik T P & Tehlan S K 2018 Effect of gibberellic acid on growth & seed yield of coriander (*Coriandrum sativum* L.). *International Journal Current Microbiology and Applied Sciences* 7 (9): 2558-2566

Kumar P, Phor S K, Tehlan S K & Mathur A K 2018 Effect of seed rate & row spacing on growth & yield of fenugreek (*Trigonella foenum-graecum*). *Journal of Pharmacognosy & Photochemistry* 7 (4): *93-9.*

Panigrahi I, Duhan D S, Panghal V PS, Tehlan S K & Yadav A C 2018 Correlation coefficient analysis between yield defining traits of cultivated genotypes of bottle gourd (*Lagenaria siceraria* (Mol.) Stdl). *Journal of Pharmacognosy & Photochemistry* 7 (2): 1378-1380.

Kota

Preeti Verma R K, Solanki, Abhay Dashora & R K Kakani 2019 Genetic variability & correlation analysis in Nigella (*Nigella sativum* L.) assessed in South Eastern Rajasthan. *International Journal of Current Microbiology and Applied Sciences* 8(3): 1858-64.

Abhilasha Sharma, Deepak Rajpurohit, Devendra Jain, Preeti Verma & Arunabh Joshi 2019 Molecular characterization of coriander (*Coriandrum sativum* L.) genotypes using random amplified polymorphic DNA (RAPD) markers. *Journal of Pharmacognosy & Phytochemistry* 8(3): 4770-4775.

Sirsi

Laxminarayan Hegde 2019 Kokum (*Garcinia indica*): Its status, problems & prospects of cultivation & processing. *International Journal of Agricultural Sciences* 11(7): 8239-41

Jagudan

Chauhan S P, Patel N R, Aliya V N & Thakkar R V 2019 Effect of date of sowing on *Alternaria* blight of cumin & its correlation with weather parameters. *AGRES – An International e. Journal* 8 (1): 081-084.

Chauhan S P, Patel N R, Aliya V N & Thakkar R V 2019 Evaluation of fungicides & phyto-extracts on *Alternaria blight* of cumin. *AGRES – An International e. Journal* 8 (1): 032-036

Solan

Leharwan Munish & Gupta Meenu. 2019 Stem gall of coriander- a review. *Agricultural Reviews* 40(2): 121-128.

ICRI Gangtok

Gudade B A, Ashutosh Gautam, Bora S S, Deka T N, Chhetri R, Subhash Babu K, Dhanapal, Remashree A B, Amit Kumar & Raghavendra Singh (2019). Study on awareness about organic Turmeric (*Curcuma longa* L.) production technology among tribal farmers of North Sikkim published in *Multilogic in Science* 9(30): 85–87.

Book

Chintapalle

Sivakumar V, Ravindra Kumar K, Bhagavan B V K & J Dilip Babu 2019 Integrated crop management in Spices crops (Telugu).

Leaflet/Folder/Booklet/Bulletins

Ambalavayal

Renjan, B 2019 Krishiyum Kudumbavum. In. *Mathapithakkalum kuttikalum ariyan*. Kuzhinappurath, T. (ed.) Commission for theology & publication, Trivandrum

Booklet

Coimbatore

Balakrishnan S , Shoba N, Ramar A, Mohanalakshmi M, Ushamalini C, Jegadeeswari V, Senthamizh Selvi B & Pugalendhi L 2019 Curry leaf – Production technology.

Balakrishnan S , Shoba N, Ramar A, Mohanalakshmi M, Ushamalini C, Jegadeeswari V, Senthamizh Selvi B & Pugalendhi L 2019 Turmeric – Production Technology.

Solan

Gupta Meenu & Bharat Narender 2019 Tamatar ke pramukh rog aur unki roktham. Department of Plant Pathology, Himalyan Phytopathological Society, Kisanon ke naidanik pramarsh hetu- Technical Bulletin on tomato diseases, University website. https://www.yspuniversity.ac.in, 15p.

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ICRI Gangtok

Thankamani C K, Srinivasan V, Hemza S, Anjani Kumar Jha, Chandan Maiti, Chandramani Raj R, Marimam Annal, Vishambhar Dayal, Kusum K Deka & Ashutosh Gautam Eds, 2019 Organic production technologies of major spices for North Eastern States published by ICAR- Indian Institute of Spices Research, Kozhikode-673012, Kerala India.

Book Chapters

Hisar

Kumar V, Tehlan S K & Kumar S 2019 Post harvest technology & value addition in spices. In: Advances in Horticultural Crops (Singh J, Nigam R, Kumar A & Singh H) Weser Books, Zittau, Germany. Pp 278-288.

Pasighat

Mariam Anal P S, Deo C & Sarma P 2019 Advances in Spice Production Technology under North East Region. Souvenir of Arunachal Agri-Expo, 2019, College of Horticulture & Forestry, Central Agricultural University, Pasighat, Arunachal Pradesh, pp 44-58.

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Gupta Meenu 2019 Management of bacterial wilt of ginger in Himachal Pradesh. In: Souvenir & Abstract book of National Seminar on "Doubling Income through Sustainable & Holistic Agriculture (DISHA)" held at Dr YS Parmar University of Horticulture & Forestry, Nauni, Solan, India during 5-7 June, 2019, pp 120-121.

Arunesh Kumar, RS Jarial, Kumud Jarial, Savita Jandaik & Meenu Gupta 2019 Evaluation of substrate supplements for spawn run production & yields of *Pleurotus cornucopiae* (Paulet) Roll. In: Souvenir & Abstract book of National Seminar on "Doubling Income through Sustainable & Holistic Agriculture (DISHA)" held at Dr YS Parmar University of Horticulture & Forestry, Nauni, Solan, India during 5-7 June, 2019, pp 65.

ICRI Gangtok

Gudade B A, Ashutosh Gautam, Bora S S, Deka T N, Dhanapal K, Remashree A B, Subhash Babu, Amit Kumar & Raghavendra Singh 2019 Post Harvest Management of Large Cardamom in India published in training manual of ICAR-National Organic Farming Research Institute Tadong, pp 368-374.

Gudade B A, Amit Kumar, Ashutosh Gautam, Bora S S, Deka T N, Dhanapal K, Remashree A B, Subhash Babu & Raghavendra 2019. Organic Nutrient Management in Large Cardamom published in training manual of ICAR-National Organic Farming Research Institute Tadong, pp 375-381.

Chintapalle

V. Sivakumar 2019 Turmeric cultivation (Telugu)in Udyana Panchangam, Dr. YSRHU, A.P.
V. Sivakumar 2019 Ginger cultivation (Telugu) in Udyana Panchangam, Dr. YSRHU, A.P.
V. Sivakumar 2019 Black pepper cultivation (Telugu) in Udyana Panchangam, Dr. YSRHU, A.P.
V. Sivakumar 2019 Cardamom cultivation (Telugu) in Udyana Panchangam, Dr. YSRHU, A.P.
V. Sivakumar 2019 Coffee cultivation (Telugu) in Udyana Panchangam, Dr. YSRHU, A.P.

Pampadumpara

Dhanya M K, Rini C R, Ashok Kumar K, Murugan M, Surya R, Sathyan T 2019 Bio-intensive approaches for management of pests & diseases in small cardamom & black pepper. In: Bio-intensive approaches: Application & effectiveness in the management of plant nematodes, insects & weeds, Indian Phytopathological Society, Today & Tomorrow Printers & Publishers, pp: 549-585.

Popular Article

Pampadumpara

Murugan M, Dhanya M K, Surya R, & Ashok Kumar K 2019 Varietal wealth of cardamom for sustainability. *Spice India* 32: 24-27.

ICRI Gangtok

Ashutosh Gautam, Gudade B A, Bora S S, Rayel Chhetri, Dhanapal K & Remashree A B 2019 Lesson of Success from lab to field. *Spice India* 32 (3): 7–10.

Jagudan

Patel S M, Amin A U, Patel N R & Patel H B 2019 Bij Masala Pako. Krushi Margdarsika published by DEE, AAU, Anand : 27-31.

Solan

Gupta Meenu & Gupta Bhupesh 2019 Lahsun ke rog aur unki roktham. Department of Plant Pathology, Himalyan Phytopathological Society, Kisanon ke naidanik pramarsh hetu- Technical Bulletin on garlic diseases, University website. https://www.yspuniversity.ac.in, 4p.

Kumarganj

Kumar S, Singh D, Pandey V P, Yadav H & Kumar M 2019 Jivamrat: ghol ek laabh anek. *Krishak Aradhana*.

Singh D, Pandey V P, Gautam S K, Verma P K & Verma A K 2019 Parval ki unnat Kheti. *Krishak Aradhana*.

Gautam S K, Kumar S, Singh D, Kumar Y, Pandey V P 2019 Methi ki unat va vazyanik kheti kase kare. *Krishak Aradhana*.

21 Awards and Recognitions

Best AICRPS Centre Award

AICRP on Spices centre at Narendra Deva University of Agriculture & Technology, Kumarganj and High Altitude Research Station, OUAT, Pottangi.

Recognition

Horticultural Research Station, Yercaud has bagged **Best Article Award** from Agriculture & Food e-Newsletter on 22 August 2019.

Dr. Ajith P. M. of PRS Panniyur was awarded **Achiever Award -2018** from 'SADHNA' foundation of Dr Y.S Parmar University of Horticulture & Forestry, Solan, Himachal Pradesh on 28 February 2019.

Dr. Pradip Kumar of NDUAT Kumarganj received **Best Scientist Award** conferred by Society for Science and Nature (SFSN), Lucknow at International Conference on Recent Trends in Science, Technology, Agriculture and Management (RSTAM-2019) on 20-21October, 2019 at FDDI, Fursatganj, Amethi.

Dr. Reena Nair of JNKVV Jabalpur has received **Scientist of the Year Award** conferred by International conference on Global Research Initiatives for Sustainable Agriculture and Allied Science held at ICAR- NAARM, Rajendranagar, Hyderabad from 20-22 October 2019.

Dr. A. K. Mishra of RAU Dholi was awarded **Young Scientist Award** conferred by Green Agri. Professional Society, Dhanbad, Jharkhand on 25 December 2019.

Dr. Anamika Debnath of UBKV Pundibari received Outstanding presentation award at 4 Regional Science and Technology Congress at Alipurduar Collage, West Bengal on 18 -19 December 2019.

22 Staff Position

Project Coordinator's Office

1.	Project Coordinator	: Dr. K. Nirmal Babu
2.	Principal Scientist (Plant Physiology)	: Dr. K.S. Krishnamurthy
3.	Scientist (SPMAP)	: Dr. Sharon Aravind
4.	Technical Officer	: Dr. E. Radha
5.	Personal Assistant	: Vacant
6.	Skilled Supporting Staff	: Vacant

Coordinating Centres

1. Cardamom Research Station, KAU, Pampadumpara

1.	Jr. Horticulturist	: Dr. Nimisha Mathews
2.	Laboratory Assistant	: Mr. R. 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. Agronomist	: 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	:Dr. Laxminarayan Hegde (upto 28 July 2019)
		: Mr. Sudeesh Kulkarni (Joined on 21 August 2019)
2.	Jr. Pathologist	: Mr. A. Prashantha
3.	Technical Assistant	: Sri. Santosh Kumar Bommanagi

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. Breeder	: 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. Breeder : Dr. K. Giridhar
2. Jr. Horticulturist : Dr. N. Hariprasad Rao
3. Technical Assistant : Vacant

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

1. Jr. Pathologist : Dr. Meenu Gupta
2. Technical Assistant : Mr. Jogindhar Bansal

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. Dhirendra Singh
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. Chauahn
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. Mukhin
2. Jr. Pathologist : Dr. A. K. Mishra
3. Technical Assistant : Sh. A. N. Mishra

16. Department of Vegetable Science (NDUAT), Kumarganj

1. Jr. Horticulturist : Dr. V. P. Pandey
2. Jr. Pathologist : Dr. Pradip Kumar
3. Technical Assistant : Sh. R.K.Gupta

17. Department of Horticulture (UBKV), Pundibari

1. Jr. Horticulturist : Dr. Suchand Dutta
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 Swargaonkar
3. Technical Assistant : Mr. D. S. Kshatri

23 Training and Capacity Building

Trainings attended by the Staff of AICRPS

S.No.	Name and Designation	Details of training	Venue	Duration
1	Dr. Pradip Kumar, NDUAT, Kumarganj	ICAR sponsored training programme on Modern concepts in plant disease management for enhancing quality and productivity	GBPUAT, Pantnagar, Uttarakhand	08.02.2019 to 28.02.2019
2	Dr. B. Senthamizh Selvi, TNAU, Coimbatore	Automated Agro Advisory - Web cum Mobile App	Agro climate Research Centre, TNAU, Coimbatore	15.02.2019
3	Dr. S. Sundravadana TNAU, Coimbatore	User awareness programme on e learning resources of TNAU Library	TNAU, Coimbatore	01.10.2019
4	Dr. Airina, C.K, PRS, Panniyur	Breeding and genomic tools for stress resistance in vegetable crops	ICAR-IARI, New Delhi	23.10.19 to 12.11.19
5	Dr. V. Sivakumar, HRS, Dr. YSR HU, Chintapalle	Breeding and genomic tools for stress resistance in vegetable crops	ICAR-IARI, New Delhi	23.10. 2019 to 12.11.2019
6	Dr. B. Renjan, RARS, Ambalavayal	Innovative extension approaches for horticultural crops with special reference to tuber crops	CTCRI, Thiruvananthapuram	19.11.2019 to 22.11.2019

24

Weather Data

PANNIYUR

Month	Rain Fall (mm)	No. of Rainy days	Temperature (°C)		RH (%)
			Max.	Min.	
Jan-19	-	-	35.32	20.8	91.09
Feb-19	-	-	37.28	22.67	92.28
Mar-19	-	-	37.95	24.76	92.83
Apr-19	14.4	3	38.74	26.35	91.63
May -19	6.4	2	38.10	26.96	91.09
June -19	453.3	19	34.62	26.28	93.23
July -19	1015.2	30	30.42	25.13	94.22
Aug-19	1203.4	29	30.24	25.01	95.03
Sept-19	587.9	21	31.25	25.34	94.93
Oct-19	399.8	16	32.59	25.019	94.096
Nov-19	108.2	5	34.08	24.96	93.76
Dec-19	101.0	2	34.15	23.62	93.16

PAMPADUMPARA

Rain Fall (mm)	No. of Rainy days	Temperature (°C)	
		Max.	Min.
0	0	20.01	15.58
7.6	2	22.58	13.21
10.6	3	24.32	15.01
21.2	8	25.89	16.37
28	3	25.48	15.98
92.2	16	22.95	13.4
231.6	19	21.5	11.83
524.8	27	20.83	11.17
277.6	20	21.68	12.11
177.4	17	22.08	12.43
177.4	30.2	21.88	12.26
7.2	1	20.31	10.74

COIMBATORE

Month	Rain Fall (mm)	No. of Rainy days	Temperature(°C)		RH (%)	
			Max.	Min.	I	II
Jan-19	0.00	-	29.90	17.90	88	42
Feb-19	0.00	-	33.10	21.40	85	44
Mar-19	0.00	-	35.70	23.5	82	41
Apr-19	23.60	2	36.70	24.5	85	43
May -19	77.80	6	35.80	24.9	85	51
June -19	21.80	3	33.50	24.8	79	55
July -19	8.50	-	31.8	23.7	82	58
Aug-19	221.30	7	29.9	23.0	84	66
Sept-19	57.30	9	30.9	23.4	84	65
Oct-19	246.90	13	30.7	22.7	87	62
Nov-19	167.10	9	29.6	22.2	87	60
Dec-19	36.00	5	27.8	21.2	86	62

YERCAUD

Rain Fall (mm)	No. of Rainy days	RH (%)	Temperature (°C)	
			Max.	Min
20.00	1	73.17	16.39	15.92
3.00	1	78.16	18.00	17.86
-	-	58.04	22.74	21.69
20.00	5	58.10	23.64	22.67
117.5	10	83.47	24.35	23.40
133.00	9	85.75	22.60	21.07
108.50	7	94.16	21.27	19.36
262.50	17	93.73	20.40	18.66
328.00	19	88.02	22.00	19.40
225.50	18	96.61	20.84	19.31
93.00	11	93.21	21.00	19.21
53.00	7	93.46	18.00	16.30

MUDIGERE

Month	Rain Fall (mm)	No. of Rainy days	Temperature (°C)		RH (%)	
			Max.	Min.	I	II
Jan-19	2	1	31.19	20.32	80.48	71.19
Feb-19	Nil	-	31.15	20.35	81.89	68.71
Mar-19	34.5	3	32.41	20.58	87.80	69.80
Apr-19	40.8	4	29.43	20.40	69.76	62.70
May -19	158.1	9	27.41	19.96	84.80	58.09
June -19	303.4	22	24.16	20.76	82.06	72.96
July -19	410.2	25	22.83	19.51	84.67	72.03
Aug-19	393.9	19	23.16	18.38	84.70	61.70
Sept-19	200	15	25.73	18.60	84.33	45.16
Oct-19	66.3	8	27.06	18.54	84.54	44.93
Nov-19	12	1	29.46	24.03	84.50	38.90
Dec-19	10.6	1	27.80	18.35	81.74	24.80

SIRSI

RainFall (mm)	No. of Rainy days	Temperature (°C)		RH (%)	
		Max.	Min.		
-	0	30.9	12.8		
-	0	32.7	13.5		
-	3	34.9	16.6		
29.8	-	35.3	21.2	86.1	38.9
0.0	-	34.9	22.0	86.3	41.6
225.4	-	30.0	21.7	89.7	69.6
982.6	-	26.3	21.5	91.5	79.6
1092.0	-	26.3	20.9	93.4	80.8
471.4	-	27.4	21.1	94.0	76.7
286.8	-	29.6	20.8	91.0	72.0
36.8	-	30.4	18.4	91.0	68.3
-	-	-	-	-	-

CHINTAPALLE

Month	Rain Fall (mm)	No. of Rainy days	Temperature (°C)		RH (%)	
			Max.	Min.	I	II
Jan-19	9.00	1.00	25.19	7.96	89.83	90.64
Feb-19	8.00	1.00	27.89	10.32	87.67	88.07
Mar-19	32.00	3.00	30.09	15.41	75.03	55.19
Apr-19	40.20	5.00	33.39	18.23	67.23	64.00
May -19	90.20	5.00	32.29	19.80	80.74	80.67
June -19	54.80	4.00	31.80	22.86	86.20	85.03
July -19	140.00	14.00	26.54	21.64	90.61	91.67
Aug-19	233.20	15.00	26.87	21.35	90.19	91.16
Sept-19	139.00	10.00	27.16	21.30	89.53	88.20
Oct-19	259.4	10.00	27.38	18.32	91.45	91.29
Nov-19	4.00	1.00	26.83	14.08	90.56	91.66
Dec-19	0.0	0.00	25.32	10.12	89.54	91.12

GUNTUR

Rain Fall (mm)	No. of Rainy days	Temperature (°C)		RH (%)	
		Max.	Min.	I	II
6.0	1	29.8	16.2	92.5	57.6
0.0	0	33.1	24.5	89.3	39.3
0.0	0	36.6	26.6	85.3	34.0
0.4	0	39.2	26.6	81.6	38.4
0.0	0.0	41.9	30.0	78.5	40.1
56.0	2.0	39.8	29.7	87.0	55.9
101.0	10.0	35.5	27.2	90.4	65.3
136.6	9.0	35.4	26.1	85.2	67.8
252.0	13.0	33.9	25.5	89.3	75.5
218.8	12	32.1	24.9	91.9	77.8
3.8	1.0	32.1	22.4	92.3	76.0
1.6	0.0	30.8	18.7	90.8	82.1

DAPOLI

Month	Rain Fall (mm)	No. of Rainy days	Temperature (°C)		RH (%)	
			Max.	Min.	I	II
Jan-19	0.0	0.0	31.8	11.5	88.6	59.2
Feb-19	0.0	0.0	31.8	12.8	88.7	62.0
Mar-19	0.0	0.0	32.4	15.5	88.5	59.8
Apr-19	0.0	0.0	33.9	21.2	88.8	57.3
May -19	0.0	0.0	33.5	22.2	82.2	56.6
June -19	24.5	0.5	32.0	24.8	90.7	76.8
July -19	55.2	1.0	28.7	24.0	96.1	91.1
Aug-19	42.3	0.9	28.4	23.4	95.9	87.7
Sept-19	40.2	0.8	28.3	23.6	96.2	89.6
Oct-19	5.0	0.3	30.9	22.6	91.8	72.9
Nov-19	0.4	0.1	32.5	20.2	91.9	60.5
Dec-19	0.0	0.0	31.9	18.5	91.7	57.7

POTTANGI

RainFall (mm)	No. of Rainy days	Temperature (°C)	
		Max.	Min.
0.0	0.0	27.9	10.7
0.0	0.0	31.7	14.4
4.2	1.0	35.0	20.2
33.7	4.0	36.8	22.2
100.2	8.0	38.8	24.5
141.7	9.0	34.8	24.1
585.0	25	29.0	22.2
235.4	18	29.7	21.8
270.0	14	30.0	21.0
285.8	15	30.4	21.2
14.2	2	29.8	16.0
0.0	0	25.6	12.0

JOBNER

Month	Rain Fall (mm)	Temperature (°C)		RH (%)	
		Max.	Min.	I	II
Jan-19	006.0	23.0	3.1	81.0	36.3
Feb-19	000.0	24.1	6.4	81.0	33.5
Mar-19	000.0	29.6	10.7	67.4	26.4
Apr-19	004.8	38.0	19.3	62.0	31.8
May -19	001.8	40.2	21.2	61.8	33.5
June -19	008.2	41.6	22.6	62.2	29.8
July -19	167.7	35.9	22.0	77.3	56.5
Aug-19	206.0	32.7	20.2	90.6	72.8
Sept-19	018.8	34.5	23.9	86.0	59.8
Oct-19	000.9	33.6	17.8	81.3	34.8
Nov-19	006.0	29.1	12.6	83.8	48.6
Dec-19	003.1	21.4	3.8	91.3	45.8

RAIGARH

RainFall (mm)	Temperature (°C)		RH (%)	
	Max.	Min.	I	II
26.9	26.9	10.4	82	62.1
29.8	29.8	15.8	82.6	46.0
34.9	34.9	21.7	81.6	51.7
39.5	39.5	26.9	73.1	34.3
43.2	43.2	30.1	58.3	28.6
38.8	38.8	29.2	71.9	38.4
31.3	31.3	26.4	87.2	72.8
31.4	31.4	26.1	87.4	76.5
31.1	31.1	26.2	89.7	76.7
31	31	23.4	89.7	68.5
29.6	29.6	17.8	87	59.7
25.9	25.9	13.6	86.6	59.7

KUMARGANJ

Month	Rain Fall (mm)	Temperature (°C)		RH (%)	
		Max.	Min.	I	II
Jan-19	41	23.5	6.3	94.3	47.3
Feb-19	13.5	21.8	11.7	92.0	57.4
Mar-19	5.0	28.8	12.8	88.4	46.3
Apr-19	2.0	35.5	21.0	76.0	43.0
May -19	0.0	41.0	24.9	65.3	28.6
June -19	24	38.8	26.8	69	41.8
July -19	396.5	33.9	26.2	87.7	72.8
Aug-19	123.2	34.4	27.2	86.4	74.2
Sept-19	319.5	31.4	25.2	92.1	82.0
Oct-19	10	29.7	20.2	91.8	63.5
Nov-19	00	28.5	14.1	90.4	61.5
Dec-19	22	19.9	9.1	93.3	63.0

DHOLI

Month	Rain Fall (mm)	Temperature (°C)		RH (%)	
		Max.	Min.	I	II
Jan-19	1.20	22.80	8.10	85.00	56.00
Feb-19	25.4	25.0	10.7	84.00	55.00
Mar-19	4.2	30.3	13.5	75.00	44.00
Apr-19	41.40	33.70	20.60	79.00	59.00
May -19	94.40	34.00	24.30	82.00	64.00
June -19	44.40	36.00	26.50	81.00	60.00
July -19	170.00	33.60	26.00	87.30	71.40
Aug-19	388.40	32.70	26.10	89.00	74.00
Sept-19	118.60	33.30	25.40	87.00	73.00
Oct-19	12.60	32.00	19.00	85.00	56.00
Nov-19	0.00	29.00	13.30	83.00	59.00
Dec-19	0.00	24.30	8.80	82.00	55.00

PUNDIBARI

Month	Rain Fall (mm)	Temperature (°C)		RH (%)	
		Max.	Min.	I	II
Jan-19	0.50	26.0	9.0	79	43
Feb-19	13.60	26.1	12.0	81	54
Mar-19	81.10	29.5	15.5	70	45
Apr-19	137.00	30.9	20.3	77	61
May -19	254.80	30.4	22.7	87	75
June -19	427.10	33.1	24.8	87	74
July -19	1135.70	30.9	25.4	92	83
Aug-19	349.70	34.3	26.1	86	73
Sept-19	343.20	24.10	21.20	100	100
Oct-19	54.90	30.7	21.5	84.5	69.0
Nov-19	4.20	30.1	17.7	79.8	57.6
Dec-19	0.0	23.62	11.05	84.65	59.60

KALYANI

Rain Fall (mm)	Temperature (°C)		RH (%)	
	Max.	Min.	I	II
0.11	37.81	21.54	89.90	48.33
5.45	35.36	22.61	91.35	65.23
5.36	34.55	23.91	93.57	74.20
12.86	32.37	24.16	96.42	87.06
13.94	32.63	24.14	96.39	82.23
4.04	33.53	24.16	93.70	78.47
5.39	32.30	21.64	94.42	68.55
0.57	36.83	15.33	92.90	58.17
0.00	26.25	10.90	96.77	57.71
0.00	25.40	8.55	96.32	46.52
0.00	29.48	12.61	92.25	42.61
0.61	32.29	17.64	92.10	48.81

MIZORAM

Month	Rain Fall (mm)	No. of Rainy days	Temperature (°C)		RH (%)	
			Max.	Min.	I	II
Jan-19	0.0	0	23.3	12.4	85	56
Feb-19	31.60	3	24.7	14.5	82	64
Mar-19	56.60	4.0	27.0	16.3	74	61
Apr-19	9.8	15.0	28.7	19.0	84	67
May -19	15.5	16.0	29.5	20.8	90	70
June -19	15.2	18.0	29.4	22.6	89	76
July -19	14.5	27.0	28.4	22.6	95	86
Aug-19	19.5	20.0	29.3	22.9	95	84
Sept-19	14.2	15.0	29.0	22.1	96	84
Oct-19	6.9	14.0	27.9	20.5	96	81
Nov-19	2.1	4.0	26.5	17.4	96	73
Dec-19	0.1	1.0	22.5	12.0	89	64

BARAPANI

Rain Fall (mm)	Temperature (°C)		RH (%)	
	Max	Min	I	II
22.8	21.2	6.6	83.4	45.6
13.6	22.6	8.9	84.6	50.7
19.9	25.1	11.9	77.7	39.3
180.9	26.6	15.2	85.4	65.3
203.3	28.1	18.0	83.5	69.0
380.4	28.1	19.9	87.3	78.9
396.7	27.9	20.4	89.2	79.8
290.6	29.6	20.6	84.4	74.6
429.7	27.1	19.3	92.7	86.3
259.1	25.1	16.1	92.4	78.4
33.2	24.2	12.8	87.2	66.3
24.8	20.5	6.9	85.9	58.9

GANGTOK

Month	Rain Fall (mm)	No. of Rainy days	Temperature (°C)		RH (%)	
			Max.	Min.	I	II
Jan-19	4.0	01	12.0	3.0	80.6	61.8
Feb-19	8.0	08	13.0	3.0	81.2	70.6
Mar-19	178.0	17	17.0	3.0	82.8	71.1
Apr-19	268.0	18	22.0	8.0	81.3	76.7
May -19	812.0	28	22.0	17.0	92.5	88.5
June -19	633.0	21	24.0	15.0	87.1	79.3
July -19	903	22	24.0	9.0	93.4	89.8
Aug-19	405.0	20	22.0	9.0	84.6	80.7
Sept-19	701.0	25	24.0	13.0	91.2	88.7
Oct-19	145.0	10.0	18.0	10.0	-	-
Nov-19	7.0	02	17.0	8.0	-	-
Dec-19	4.0	02	11.0	4.0	-	-

PASIGHAT

Month	Rain Fall (mm)	No. of Rainy days	Temperature (°C)	RH (%)	
			Max.	I	II
Jan-19	17.00	1	25.1	80.6	61.8
Feb-19	136.00	9	24.6	81.2	70.6
Mar-19	129.00	12	25.6	82.8	71.1
Apr-19	35.6	5	23.7	81.3	76.7
May -19	118.3	4	23.1	92.5	88.5
June -19	72.4	3	27.4	87.1	79.3
July -19	313.5	5	26.1	93.4	89.8
Aug-19	76.5	2	28.4	84.6	80.7
Sept-19	132.6	2	27.1	91.2	88.7
Oct-19	-	-	-	-	-
Nov-19	-	-	-	-	-
Dec-19	-	-	-	-	-

MANDOR

Month	RainFall (mm)	No. of Rainy days	Temperature (°C)		RH (%)	
			Max	Min	I	II
Jan-19	3.3	2	21.8	11.1	60.6	37.8
Feb-19	8.6	3	24.3	13.9	55.5	36.2
Mar-19	0	0	30.9	20.7	44.6	27.9
Apr-19	0	0	42.8	19.2	65.7	11.6
May -19	24.1	2	43.9	22.0	85.3	11.2
June -19	52.6	3	45.4	24.7	45.4	24.7
July -19	130.4	3	39.6	26.2	81.8	37.1
Aug-19	151.8	9	35.3	25.2	87.5	51.8
Sept-19	4.6	0	36.5	25.3	86.4	50.0
Oct-19	0	0	35.0	18.1	81.7	28.1
Nov-19	0	0	31.6	15.6	82.6	34.2
Dec-19	0	0	25.3	5.5	82.7	24.1

KOTA

Month	Rain Fall (mm)	Temperature (°C)		RH (%)
		Max	Min	
Jan-19	0	23.8	5.25	92.00
Feb-19	0	25.55	9.47	88.9
Mar-19	0.2	31.16	13.38	76.64
Apr-19	-	-	-	-
May -19	-	-	-	-
June -19	-	-	-	-
July -19	-	-	-	-
Aug-19	-	-	-	-
Sept-19	-	-	-	-
Oct-19	-	-	-	-
Nov-19	-	-	-	-
Dec-19	-	-	-	-

PEECHIPARAI

Month	Rain Fall (mm)	No. of Rainy days	Temperature (°C)		RH (%)
			Max	Min	
Jan-19	18.2	-	34.3	24.2	75
Feb-19	103.6	6	34.2	23.6	75
Mar-19	45.4	2	34.9	24.3	72.7
Apr-19	307.6	19	34.2	23.6	71.6
May -19	362.9	19	34.7	23.3	72.2
June -19	376.9	23	34.1	23.4	72.8
July -19	115.8	16	33	25.2	75.4
Aug-19	323.0	19	30.6	24	80.3
Sept-19	334.3	18	31.9	23.2	83.1
Oct-19	428.9	17	31.5	23.7	84.1
Nov-19	227.9	8	33	23.2	77.4
Dec-19	63.2	4	32.5	23.2	78.5

SAKLESHPUR

Month	Rain Fall (mm)	No. of Rainy days
Jan-19	-	-
Feb-19	-	-
Mar-19	-	-
Apr-19	39	4
May -19	34	3
June -19	317.2	21
July -19	987.3	25
Aug-19	1779.7	26
Sept-19	582.45	19
Oct-19	324	16
Nov-19	68	3
Dec-19	24	1

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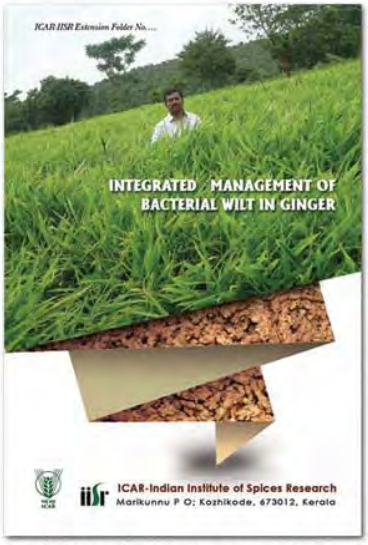
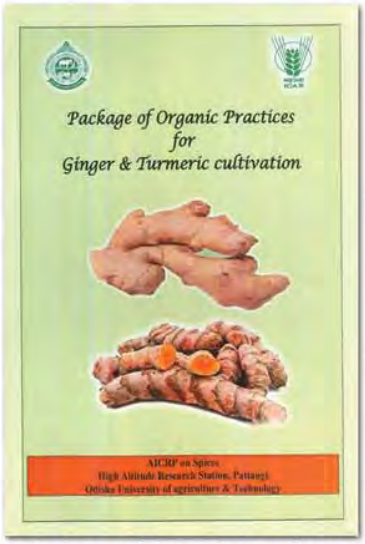
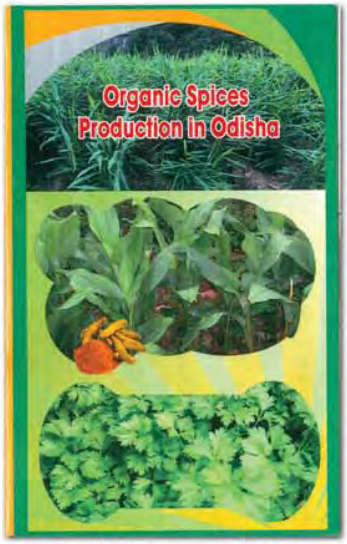
PUBLICATIONS RELEASED DURING 30TH AICRPS WORKSHOP



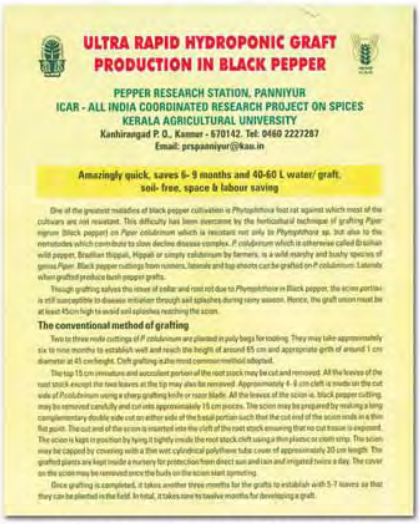
integrated managment of Bacterial wilt in Ginger



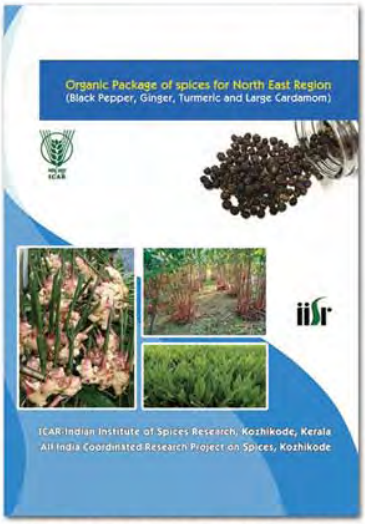
Package of Organic Practices for Ginger & Turmeric cultivation



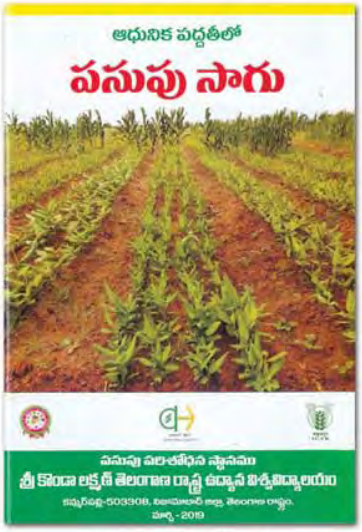
Organic Spices Production in odisha



Ultra rapid hydroponics graft production in Black pepper



Organic Package of Spices for North East Region



Crop production & cultivation (Telugu)

Rapid Planting Material Production of Ginger (Bengali)

Cultivation of Seed Spices (Hindi)

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