भाकृअनुप
ICAR

वार्षिक रिपोर्ट
ANNUAL REPORT
2017 - 2018

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

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

New Varieties

VARIETIES RECOMMENDED FOR RELEASE DURING 28TH AICRPS WORKSHOP

ACr-2 (Ajmer Coriander-2)

AFg-5 (Ajmer Fenugreek-5)

Gujarat Coriander 3 (GCo 3)

Narendra Saryu (NDH-8)

CL 34

IISR CASSIA

ICAR-ALL INDIA COORDINATED RESEARCH PROJECT ON SPICES

ANNUAL REPORT 2017-18

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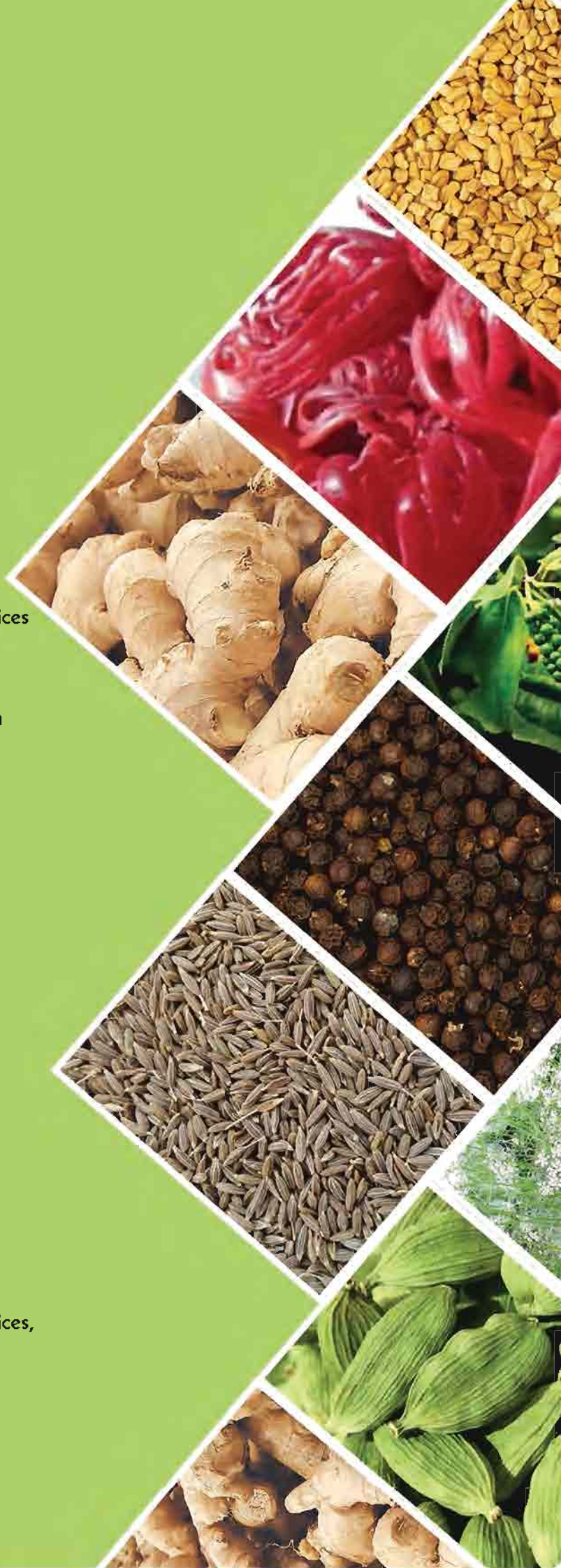








CONTENTS







VARIATION IN OVEN DRIED POWDERS FROM RHIZOMES OF SOME GERMPLASM LINES

कार्यकारी सारांश

भाकृअनुप-अखिल भारतीय समन्वित मसाला अनुसंधान परियोजना (एआईसीआरपी-मसाला) के देश के 23 राज्यों में 14 कृषि जलवायु क्षेत्रों में 38 केंद्र (19 नियमित, 10 सहयोगी और 9 स्वैच्छिक केंद्र) हैं। एआईसीआरपी-मसाला परियोजना मसाला फसलों, जैसे कि काली मिर्च, बड़ी इलायची, छोटी इलायची, अदरक, हल्दी, दालचीनी, जायफल, लोंग, धनिया, जीरा, सौंफ, मेथी, अजवाइन और कलौंजी पर अनुसंधान कार्यकलापों में समन्वयन करती है। वर्ष 2017-18 के लिए, भाकृअनुप के अंश के रूप में, वार्षिक बजट 637 लाख रुपए था।

नई पहलें

खाद्य सुरक्षा अनुपालन तथा मसालों में कीटनाशक अवशिष्ट के न्यूनतमीकरण के लिए, एआईसीआरपी-मसाला के विभिन्न बीज मसाला केंद्रों में धनिया एवं जीरे में दक्षता परीक्षण आरंभ किए गए।

मसालों के स्थायी उत्पादन के लिए, भिन्न कृषि जलवायु क्षेत्रों के विभिन्न एआईसीआरपी-मसाला केंद्रों में रासायनिकों और जैव-अभिकारकों के माध्यम से जीवाणिक मुरझान के प्रबंधन पर नई कार्यक्रम आरंभ किए गए।

विशिष्ट गुणों वाले जीनप्ररूपों के मूल्यांकन के लिए, विभिन्न एआईसीआरपी-मसाला केंद्रों ने कालीमिर्च, इलायची, धनिया, जीरा, सौंफ और मेथी जैसी मसाला फसलों में समन्वित किस्मगत परीक्षण आरंभ किए।

28वीं एआईसीआरपी-मसाला कार्यशाला में विमोचन के लिए संस्तुत किस्में

बागवानी अनुसंधान केंद्र, डॉ. वाई. एस. आर. बागवानी विश्वविद्यालय, लाम, गुंटूर, आंध्र प्रदेश में आयोजित 28वीं एआईसीआरपी-मसाला कार्यशाला में विमोचन हेतु छः उच्च उपज वाली मसाला किस्मों (हल्दी में 2, धनिया में 2, मेथी में 1 तथा केसिया में 1) की संस्तुति की गई।

उच्च गुणवत्ता वाली किस्में - उद्योग की आवश्यकता

- **एनडीएच-8** (नरेन्द्र सरयू) - नरेन्द्र देव कृषि और प्रौद्योगिकी विश्वविद्यालय, कुमारगंज, फैजाबाद, उत्तर प्रदेश की हल्दी किस्म को राष्ट्रीय स्तर पर विमोचन के लिए संस्तुत किया गया। इस किस्म में उच्च हल्दी तत्व (5-6%), अधिक संख्या में प्राइमरीज तथा 10% उपज लाभ है।
- **गुजरात धनिया - 3** - यह बीज मसाला अनुसंधान केंद्र (सीआरएसएस), एसडीएयू, जागुदन की एक धनिया किस्म है जिसे गुजरात में खेती करने के लिए विमोचन हेतु संस्तुत किया गया। इस किस्म में उच्च मात्रा में तेल तत्व (0.52 %), उच्च लिनालूल (72.16%) तथा उच्च उपज क्षमता (16.94 क्विं. प्रति हैक्टे.) है।
- **अजमेर मेथी-5** - यह भाकृअनुप-एनआरसी बीज मसाला, अजमेर द्वारा विकसित एक मेथी किस्म है जिसे राष्ट्रीय स्तर पर विमोचन हेतु संस्तुत किया गया। इस किस्म में उच्च बीज उपज (17.21 क्विं. प्रति हैक्टे.),
- उच्च ऐंटीऑक्सीडेंट तत्व (66.428 मि. ग्रा./ बीएचटीई/ पीपीएम) है और यह ग्रीष्म मौसम में छायादार जाल स्थिति के तहत हरी पत्ती उत्पादन के लिए उपयुक्त है।
- **आईआईएसआर केसिया (डी1)** को भाकृअनुप-आईआईएसआर द्वारा विकसित किया गया और इसका मूल्यांकन डॉ. बी. एस. के. वी. वी., दापोली एवं टी. एन. ए. यू., एचआरएस, पेचिपराई द्वारा संयुक्त रूप से किया गया। इस किस्म को देश के सभी केसिया उत्पादक क्षेत्रों में खेती करने हेतु विमोचन के लिए संस्तुत किया गया।

खाद्य सुरक्षो को ध्यान में रखते हुए मसाला उत्पादन के लिए जैविक दबाव वाली किस्में

- **अजमेर धनिया 2** को भाकृअनुप-एनआरसी बीज मसाला, अजमेर द्वारा स्टेम गाल प्रतिरोध, उच्च लिनालून तत्व (71.7%) तथा अगेती परिपक्वता के लिए विकसित किया गया। इसे राष्ट्रीय स्तर पर विमोचन हेतु संस्तुत किया गया।
- **सीएल 34** - इस हल्दी किस्म को तमिलनाडु कृषि विश्वविद्यालय, कोयम्बतूर द्वारा पत्ती धब्बा रोग एवं पत्ती छाला रोग से सहिष्णुता तथा 3% जीरा तत्व के साथ विकसित किया गया। इसे तमिलनाडु में खेती करने के लिए विमोचन हेतु संस्तुत किया गया।

प्रौद्योगिकियां विकसित करने के लिए 28वीं एआईसीआरपी-मसाला कार्यशाला में संस्तुतियां

एआईसीआरपी-मसाला की 28वीं कार्यशाला में विभिन्न राज्यों के लिए भिन्न मसाला फसलों में स्थान विशिष्ट प्रौद्योगिकियां विकसित करने हेतु संस्तुतियां की गईं।

प्रति बूंद अधिक उपज - जल का दक्षतापूर्ण उपयोग

- **केरल की पारिस्थितिकियों के तहत काली मिर्च में ड्रिप उर्वरीकरण का मानकीकरण**

  सिंचाई की पारंपरिक विधि तथा बेसल उर्वरक प्रयोग की तुलना में जून, सितंबर और फरवरी माहों के दौरान साप्ताहिक अंतरालों पर 3 बराबर भागों में 50 प्रतिशत आरडीएफ (तरल उर्वरक के रूप में उर्वरक की संस्तुत खुराक की आधी मात्रा - 19:19:19 अनुपात में मिश्रण) और प्रति दिन 8 लीटर जल की दर से काली मिर्च में ड्रिप सिंचाई को लाभकारी पाया गया जिसमें सर्वाधिक लागत लाभ अनुपात (2.07) दर्ज किया गया।
- **कर्नाटक में इलायची में उर्वरीकरण का मानकीकरण**

  इलायची में ड्रिप सिंचाई के माध्यम से 100% संस्तुत उर्वरक खुराक के साथ 9 लीटर प्रति पौधा प्रति दिन सिंचाई किए जाने से सर्वाधिक कैप्सूल उपज (316.16 कि. ग्रा. प्रति हैक्टे.) प्राप्त की गई जिसका लागत लाभ अनुपात 3.37 था।

स्थायी मसाला उत्पादन के लिए जैविक पोषकतत्व प्रबंधन

- **कर्नाटक में छोटी इलायची में उपज बढ़ाने के लिए जैविक पदार्थों का प्रयोग**

  छोटी इलायची में जीवामृता (20 ली. प्रति पौधा) + *एजोस्परिलुम* (10 ग्राम प्रति वृक्ष) + पीएसबी (10 ग्राम प्रति वृक्ष) + *ट्राइकोडर्मा* (10 ग्रा. प्रति वृक्ष) का प्रयोग किए जाने से उपज में वृद्धि (318.26 कि. ग्रा. प्रति हैक्टे.) हुई जिसका लागत लाभ अनुपात 1:5.09 था।

संतुलित पोषकतत्व के लिए सूक्ष्म पोषक तत्व अनुपूरकता

- **गुजरात में सौंफ में सूक्ष्म पोषकतत्व का प्रबंधन**

लौह तत्व और जिंक तत्व की कमी वाली हल्के रंग की बनावट वाली मृदाओं के लिए खूंड (फरो) में बेसल अनुप्रयोग के रूप में 3.0 कि. ग्रा. लौह तत्व + 1.5 कि. ग्रा. जिंक तत्व प्रति हैक्टे. से समृद्ध 200 कि. ग्रा. एफवाईएम सहित 90 + 30 कि. ग्रा. नाइट्रोजन/फास्फोरस प्रति हैक्टे. की दर से उर्वरक का सौंफ फसल में प्रयोग किए जाने से अधिकतम उपज (14.27 क्विं. प्रति हैक्टे.) की उपज प्राप्त की गई जिसका लागत लाभ अनुपात 2.11 था।

मृदा स्वास्थ्य को कायम रखने के लिए मृदा पोषकतत्व में सुधार

- **केरल के लिए इलायची में लाइमिंग**

केरल की अम्लीय दुमट मृदाओं में 3 वर्षों तक 2 कि. ग्रा. डोलोमाइट का प्रयोग किए जाने से इलायची में उपज में सुधार (2763. 30 ग्राम प्रति पादप) पाया गया जिसका लागत लाभ अनुपात 2.42 था।

- **गुजरात में जीरे में पोटाश का प्रयोग तथा पंक्ति अंतराल के जरिए अंगमारी और चूर्णिल फफूंद का प्रबंधन**

संस्तुत उर्वरक खुराक के साथ 20 कि. ग्रा. प्रति हैक्टे. की दर से पोटाश का प्रयोग तथा 30 x 10 से. मी. की दर से जीरे में पंक्तिबद्ध बुवाई किए जाने से अंगमारी (पीडीआई - 17.3) और चूर्णिल फफूंद (पीडीआई - 5.7) का आपतन कम हुआ और अधिकतम उपज (363 कि. ग्रा. प्रति हैक्टे.) प्राप्त की गई जिसका लागत लाभ अनुपात 2.41 था।

श्रमिकों के अभाव से निपटने हेतु खरपतवार प्रबंधन

- **आंध्र प्रदेश के लिए अदरक में खरपतवारों के प्रभावकारी नियंत्रण के लिए शाकनाशकों का उपयोग**

खरपतवार को हाथों से निकालने में श्रमिकों की भारी कमी से निपटने के लिए, बुवाई के पश्चात दूसरे दिन में पूर्व-उद्गमन शाकनाशी @ 500 मि. ली. प्रति हैक्टे. के रूप में ऑक्सीफ्लूरोफेन का प्रयोग किए जाने और उसके बाद बुवाई के पश्चात 30 दिनों की फसल पर 1 लीटर प्रति हैक्टे. की दर से पश्च-उद्गमन शाकनाशी के रूप में क्वाजिलोफोप इथाइल का प्रयोग किए जाने तथा 90 दिनों की फसल अवधि पर हाथों से खरपतवार निकाले जाने से 3-4 बार हाथों से खरपतवार निकाले जाने की आवश्यकता कम की गई और इस विधि के अनुसार 22.79 टन प्रति हैक्टे. की उपज प्राप्त की गई जिसका लागत लाभ अनुपात 2.96 था। इस विधि को चिंतापल्ली की पारिस्थितिकी के तहत अदरक के लिए संस्तुत किया गया है।

काली मिर्च

वर्ष 2017-18 के दौरान काली मिर्च अनुसंधान केंद्र, पन्नियूर ने पांच काली मिर्च सूखा सहिष्णु वंशावलियों को संग्रहित किया और एचआरएस, सिरसी ने 14 वंशावलियों का संग्रहण किया जिसके फलस्वरूप काली मिर्च का कुल जननद्रव्य भंडार बढ़कर 844 हो गया है। सिरसी केंद्र में गुणत्ता गुणों के लिए काली मिर्च की बाईस (22) वंशावलियों के मूल्यांकन में यह पाया गया कि एसवी-7 में सर्वाधिक पाइपेराइन (5.49%) और ओलियोरेसिन (10.74%) तत्व दर्ज किया गया। काली मिर्च के समन्वित किस्मगत परीक्षण में पन्नियूर में सबसे अधिक ताजी बेरी उपज एचबी 20052 (4500 ग्रा. प्रति बेल) में तथा उसके बाद वंशावली सं. 53 (4380 ग्रा. प्रति बेल) में दर्ज की गई और चिंतापल्ली में पन्नियूर-1 (637.76 ग्रा. प्रति बेल) में तथा उसके बाद पी-8 (507.44 ग्रा. प्रति बेल) में दर्ज की गई, जबकि दापोली में एचपी 813 (17.4 ग्रा. प्रति बेल) में पन्नियूर 1 (1230 ग्रा. प्रति बेल) में दर्ज की गई। आरएआरएस, अम्बालावायल में एचपी 813 (17.4 ग्रा.) में तथा उसके बाद पीआरएस 17 (17 ग्रा.) में 100 बेरी वजन सबसे अधिक पाया गया। 100 बेरी वॉल्यूम के संबंध में, सबसे अधिक वैल्यू Coll 1041 (24.41 ग्रा. प्रति बेल) में तथा उसके बाद पन्नियूर 1 (21.50) में दर्ज किया गया।

वर्ष 2017-18 के दौरान पीआरएस, पन्नियूर में काली मिर्च आधारित मिश्रित फसल प्रणाली में अच्छी उपज प्राप्त की गई। अंतर-फसलों में, काली मिर्च फसल की पंक्तियों के बीच 4 मी. x 2 मी. के आंतरिक अंतराल में जिमीकंद में 8.53 कि. ग्रा. की सबसे अधिक उपज दर्ज की गई जिसके बाद बड़ा रतालू (7.25 कि. ग्रा.) में दर्ज की गई। जबकि, आरएआरएस, अम्बालावायल में किशोर काली मिर्च बगीचों के विभिन्न अंतर-फसलों के उत्पादों के आर्थिक आकलन में यह पाया गया कि टेपियोका तथा उसके बाद जिमीकंद में क्रमशः 4.81 टन प्रति हैक्टे. और 3.62 टन प्रति हैक्टे. की अधिकतम उपज दर्ज की गई।

दापोली में काली मिर्च की उपज में धीमी गिरावट के लिए जैविक प्रबंधन पर किए गए एक परीक्षण में उस उपचार में न्यूनतम प्रतिशत रोग उग्रता (6.78) दर्ज की गई जिसमें 2 कि. ग्रा. प्रति बेल की दर से *पोचोनिया क्लेमाइडोस्पोरिया* का मृदा में प्रयोग किया गया था और उसके बाद *स्यूडोमोनस फ्लयूरोसेंस* आईआईएसआर-6 @ 2% (10^6cfu) (ड्रेंच 3 ली. प्रति बेल) के साथ मृदा की ड्रेंचिंग की गई थी। इस उपचार को दापोली में शेष उपचारों की तुलना में काफी श्रेष्ठ पाया गया।

छोटी इलायची

इलायची अनुसंधान केंद्र, पामाडुमपाड़ा में जीन बैंक में कुल 188 इलायची वंशावलियां वर्तमान में संरक्षित की जा रही हैं। उनमें से 73 इलायची वंशावलियों (सीआरएसपी 1-73) के संबंध में, राष्ट्रीय पादप आनुवंशिक संसाधन ब्यूरो, नई दिल्ली से आईसी संख्याएं (547920 से 547992) प्राप्त कर ली गई हैं। *अझुकाल* आपतन को छोड़कर, उपज एवं जैविक दबाव गुणों सहित समस्त गुणों ने 5% कंफिडेंस स्तर पर सभी वंशावलियों में काफी अंतर प्रदर्शित किए। एचवाई 13 (3.4 कि. ग्रा. प्रति पादप) में तथा उसके बाद एचवाई 12 (2.7 कि. ग्रा. प्रति पादप) में सबसे अधिक ताजी उपज दर्ज की गई।

छोटी इलायची में काष्ठकीटों (थ्रिप्स) के नियंत्रण के लिए नए कीटनाशकों के मूल्यांकन में यह पाया गया कि फिप्रोनिल 5 SC @ 0.005% का प्रयोग किए जाने से संक्रमण (88.26%) की सबसे अधिक प्रतिशत गिरावट पाई गई तथा उसके बाद इमिडाक्लोप्रिड 17.8 SL @ 0.0089% का प्रयोग किए जाने में पाई गई (78.74%). संक्रमण को कम करने में स्पिनोसेड 45 SC @ 0.0135% और क्विनलफोस 25 EC @ 0.05% को भी प्रभावकारी (क्रमशः 75.29% एवं 70.31%) पाया गया, जिनका प्रभाव एक दूसरे के समतुल्य था।

बड़ी इलायची

सिक्किम में विभिन्न भागों से बड़ी इलायची के कुल 10 जीनप्ररूपों को संचित किया गया जिन्हें भाकृअनुप उत्तर पूर्व पर्वतीय क्षेत्र अनुसंधान परिसर के गंगटोक में स्थित प्रादेशिक केंद्र में अनुरक्षित किया जा रहा है। भाकृअनुप-एनओएफआरआई, अनुसंधान फार्म, टाडोंग में सिक्किम की बड़ी इलायची पर कीट-नाशीकीटों की निगरानी में यह पया गया कि भिन्न रोयेदार कैटरपिलर का संक्रमण नवंबर-दिसंबर माह के दौरान अधिक था।

बड़ी इलायची के नाशीकीटों, अर्थात तना बेधक, प्ररोह मक्खी, पत्ती भक्षक कैटरपिलर और टी मॉस्क्यूटो बग के विरूद्ध विभिन्न

जैवकीटनाशकों, जैसे कि नीम तेल, *बीवेरिया बेसियाना, मेटाहर्जियुम ऐनिसोप्लिए,* पेट्रोलियम तेल आधारित एग्रोस्प्रे, पेट्रोलियम तेल आधारित बागवानी छिड़काव, *बेसिलस थुरिंजिन्सिस* और स्पिनोसेड की दक्षता का मूल्यांकन करने हेतु किए गए एक परीक्षण में यह पाया गया कि कंट्रोल की तुलना में नाशकीटों को नियंत्रण करने के लिए सभी उपचारों ने प्रभावशाली परिणाम प्रदर्शित किए। तथापि, सभी नाशीकीटों को नियंत्रित (कंट्रोल की तुलना में संक्रमण में 69.91 से 81.32% की गिरावट) करने हेतु स्पिनोसेड 45 SC @ 0.3 मि. ली. प्रति ली. को तथा उसके बाद नीम तेल (1500 पीपीएम) @ 4 मि. ली. प्रति ली. (कंट्रोल की तुलना में संक्रमण में 61.32 ls 67.64% की गिरावट) और पेट्रोलियम एग्रोस्प्रे @ 10 मि. ली. प्रति ली. (कंट्रोल की तुलना में संक्रमण में 52.22 से 59.47% की गिरावट) को सबसे अधिक प्रभावकारी पाया गया।

अदरक

पोटांगी में मूल्यांकन किए गए 181 अदरक जननद्रव्यों में से, 4 वंशावलियों में 10 कि. ग्रा. प्रति 3 वर्ग मी. से अधिक की ताजा राइजोम उपज प्राप्त की गई और 30 वंशावलियों में 5 कि. ग्रा. प्रति 3 वर्ग मी. से अधिक उपज प्राप्त की गई। *खरीफ* 2017-18 के दौरान मूल्यांकन किए गए जननद्रव्य में 3.7 कि. ग्रा. प्रति 3 वर्ग मी. की औसत उपज के साथ भूखंड में उपज की रेंज 0.15 कि. ग्रा. (la- 6) से 13.0 कि. ग्रा. प्रति 3 वर्ग मी. (KG-132) के बीच थी। सबसे अधिक ताजा राइजोम उपज केजी-132 (28.9 टन प्रति हैक्टे.) में तथा उसके बाद पीजीएस-41-1 (25.3 टन प्रति हैक्टे.) और जेडओ-9 (25.1 टन प्रति हैक्टे.) में दर्ज की गई।

तीन लगातर वर्षो, यानी 2015, 2016 और 2017 के दौरान औसत ताजा राइजोम उपज 5.15 टन प्रति हैक्टे. से 18.25 टन प्रति हैक्टे. के बीच थी। स्थानीय जीनप्ररूप सोलन गिरिगंगा (IC-593889 /SG-26-04) में 18.25 टन प्रति हैक्टे. की अधिकतम उपज दर्ज की गई, जबकि स्थानीय जांच किस्म हिमगिरी में 13.25 टन प्रति हैक्टे. और राष्ट्रीय जांच किस्म आईआईएसआर वाराडा में 8.57 टन प्रति हैक्टे. की उपज दर्ज की गई। राइजोम विगलन रोग आपतन 8.93-22.20 % के बीच था और सोलन गिरिगंगा (IC-593889/ SG-26-04) में सबसे कम था। गुणवत्तात्मक घटकों, अर्थात शुष्क पदार्थ रिकवरी (21.01%), मूल तेल तत्व (1.45%), ओलियोरेसिन (4.69%) और कच्चा रेशा तत्व (4.47%) के आधार पर, उच्च उपजशील आशाजनक जीनप्ररूप को जांच किस्म हिमगिरी की तुलना में सर्वश्रेष्ठ/तुलनीय पाया गया। अतः, निरंतर अच्छे निष्पादन को ध्यान में रखते हुए, आशाजनक जीनप्ररूप सोलन गिरिगंगा (IC-593889/ SG-26-04) को देश के पश्चिमी हिमालयी क्षेत्रों के लिए एक आशाजनक किस्म के रूप में चिन्हित किया गया।

हल्दी

जननद्रव्य मूल्यांकन परीक्षणों में, 270 हल्दी जननद्रव्य वंशक्रमों को काम्मारपल्ली अनुसंधान केंद्र में अनुरक्षित एवं संरक्षित किया गया है। डीयूएस डिसक्रिप्टरों का प्रयोग करते हुए हल्दी वंशक्रमों के लक्षणवर्णन में विभिन्न वंशावलियों, यानी मानापासुपा (74.80 टन प्रति हैक्टे.), पीसीटी 17 (67.66 टन प्रति हैक्टे.), सीएलआई-366 (66.67 टन प्रति हैक्टे.), पश्चिम बंगाल (65.73 टन प्रति हैक्टे.), एनएच-1 (65.0 टन प्रति हैक्टे.), सीएलआई-ज्योति (64 टन प्रति हैक्टे.), वंशावली सं. 585 (63.73 टन प्रति हैक्टे.) को राष्ट्रीय जांच किस्म, आईआईएसआर प्रतिभा (55.0 टन प्रति हैक्टे) की तुलना में अधिक उपजशील पाया गया। इन वंशक्रमों की जांच प्रमुख पर्णिल रोगों के विरूद्ध भी की गई।

हल्दी के समन्वित किस्मगत परीक्षण में, दो जांच किस्मों (आईआईएसआर प्रतिभा और बीएसआर 2) के साथ 12 जीनप्ररूपों (रायगढ़ से IT 10, IT 23, IT 36); धोली से RH 9/90, RH 80; पुडिंबारी से TCP 19; कुमारगंज से NDH 11, NDH 128; पोटांगी से PTS 18, PTS 38 तथा गुंटूर से LTS 1, LTS 2) का विभिन्न केंद्रों में मूल्यांकन किया गया। पुंडिबेरी (42.59 टन प्रति हैक्टे.) और चिंतापल्ली (48.49 टन प्रति हैक्टे.) में जीनप्ररूप टीसीपी 191 उच्च उपजशील था, जबकि जीनप्ररूप एनडीएच 11 (45.00 टन प्रति हैक्टे.) का निष्पादन कोयम्बतूर में; एलटीएस 2 (62.0 टन प्रति हैक्टे.) का कामारपल्ली में; एलटीएस 1 (26.2 टन प्रति हैक्टे.) का कुमारगंज में; पीटीएस 18 (15.3 टन प्रति हैक्टे.) का पोटोंगी में; आईटी 10 (28.00 टन प्रति हैक्टे.) का रायगढ़ में तथा आईटी 23 (26.67 टन प्रति हैक्टे.) का नवसारी में निष्पादन अच्छा पाया पाया गया।

हल्दी में रोगों की पहचान करने और उनकी उग्रता का पता लगाने के लिए पश्चिम बंगाल के कूचबिहार एवं जलपाईगुड़ी में एक सर्वेक्षण किया गया। सर्वेक्षण के लिए चिन्हित क्षेत्रों के अंतर्गत तीन सुस्थापित विभाजित स्थलों का चयन किया गया। इन क्षेत्रों में हल्दी के दो प्रमुख रोगों, यानी लीफ ब्लॉच (*टाफरिना प्रजा.*) और पत्ती धब्बा (*कोलिटोट्रिचुम प्रजा.*) की मौजूदगी पाई गई। सर्वेक्षण में यह पाया गया कि कूचबिहार में लीफ ब्लॉच रोग उग्रता औसतन रूप से 13.89 पीडीआई है और जलपाईगुड़ी में औसतन 12.61 पीडीआई है। हल्दी के पत्ती धब्बा रोग के संबंध में, यह पाया गया कि कूचबिहार और जलपाईगुड़ी में रोग उग्रता औसतन रूप से क्रमशः 19.87 पीडीआई और 18.57 पीडीआई थी।

वृक्ष प्रजातियां

दापोली में जांच किए गए जायफल जननद्रव्य में फलों की औसत संख्या 180-560 के बीच थी। जीनप्ररूप DBSKKVMF 24 (325), DBSKKVMF 23 (310), DBSKKVMF 19 (280) में फलों की औसत संख्या उच्च थी। जीनप्ररूप DBSKKV 9772 में अधिकतम शुष्क गिरी उपज (5152 ग्रा.) तथा शुष्क जावित्री वजन दर्ज किया गया। पेचिपराई में, जायफल वंशावली एमएफ-4 में सर्वाधिक फल संख्या (330 फल प्रति वृक्ष), एकल फल वजन (46 ग्रा.) और जावित्री उपज (140 ग्रा. प्रति वृक्ष) दर्ज की गई।

पिचिपराई में लोंग वंशावली, एसए-3 में सबसे अधिक पत्ती लंबाई (18.50 सें. मी.), पत्ती चौड़ाई (7.50 से. मी.) और शुष्क तना वजन (1.25 कि. ग्रा. प्रति वृक्ष) दर्ज की गई। दापोली में चार आशानजक जीनप्ररूपों को चयनित किया गया जिनकी पादप ऊंचाई 4.90 से 5.50 मी., परिधि 33.10 से 38.10 से. मी. और फैलाव 3.5 से 5.20 मी. के बीच थी।

दालचीनी के संबंध में, पिचिपराई में मूल्यांकन की गई 12 वंशावलियों में से, सीवी-5 में अधिकतम तना परिधि (26.00 से. मी.), पत्ती उपज (7.40 कि. ग्रा. प्रति पादप) और शुष्क छिलका उपज (630 ग्रा. प्रति पादप) दर्ज की गई, जबकि स्थानीय जांच किस्म में तना परिधि 25.00 से मी., पत्ती उपज 6.80 कि. ग्रा. प्रति पादप तथा शुष्क छिलका उज 285 ग्रा. प्रति पादप दर्ज की गई।

धनिया

धनिया के समन्वित किस्मगत परीक्षण में, कोयम्बतूर (18.95 क्विं. प्रति हैक्टे.) और जबलपुर (14.55 क्विं. प्रति हैक्टे.) में वंशावली सीओआर 159 में अधिकतम बीज उपज दर्ज की गई। सीओआर 164 का निष्पादन कुमारगंज (15.97 क्विं. प्रति हैक्टे.) और रायगढ़ (18.8 क्विं. प्रति हैक्टे.) बेहतर पाया गया। अन्य केंद्रों, यानी जगुदान, नवसारी, कोटा और जोबनर में शीर्ष वंशावलियां क्रमशः COR 170 (9.41 क्विं. प्रति हैक्टे.), COR 99 (15.09 क्विं. प्रति हैक्टे.), COR 160 (16.66 क्विं. प्रति हैक्टे.) और COR 125 (17.50 क्विं. प्रति हैक्टे.) थीं।

धनिया की चूर्णिल फफूंद के विरूद्ध नई पीढ़ी के कवकनशकों की दक्षता पर जोबनर में एक परीक्षण किया गया। सात उपचारों में से, हेक्साकोनाजोल 5% SC @ 0.1% के पर्णिल छिड़काव के साथ न्यूनतम (21.67%) रोग उग्रता और अधिकतम बीज उपज (15.13 क्विं. प्रति हैक्टे.) दर्ज की गई, जबकि जगुदान में न्यूनतम प्रतिशत T_7 में, डाइनाकार्प के छिड़काव में, जो T_6 के समतुल्य था, प्रोपिकोनाजोल 0.1% के छिड़काव में, T_5, हेक्साकोनोजोल 0.1% के छिड़काव में, T_4 तथा 0.2 % आर्द्र सल्फर और 0.1 % ऐजोक्सीस्ट्रोबिन के छिड़काव में पाई गई।

जीरा

जगुदान में *अल्टरनेरिया* अंगमारी, चूर्णिल फफूंद और मुरझान रोग के विरूद्ध प्रतिरोध के लिए जीरे की कुल 18 वंशावलियों की जांच की गई। सानंद जीरा-5 में न्यूनतम अंगमारी रोग और चूर्णिल फफूंद रोग उग्रता (क्रमशः 12.0 % और 5.0 %) देखी गई। अंगमारी आपतन 32.5 से 81.0 प्रतिशत के बीच था।

जीरे में जैविक पोषकतत्व और रोग प्रबंधन पर किए गए एक परीक्षण में 13 परीक्षित उपचारों में से, उस उपचार में न्यूनतम मुरझान आपतन (11.1 %) और अधिकतम बीज उपज (2.05 क्विं. प्रति हैक्टे.) पाई गई जिनमें 6 ग्रा. प्रति कि. ग्रा. की दर से *ट्राइकोडर्मा* + 5 % की दर से एनएसकेई के छिड़काव के साथ 2 टन प्रति हैक्टे. की दर से वर्मीकम्पोसट का मृदा प्रयोग + बीज उपचार किया गया था। इसके बाद उस उपचार में न्यूनतम मुरझान आपतन (15.6%) और अधिकतम बीज उपज (1.88 क्विं. प्रति हैक्टे.) पाई गई जिसमें 6 ग्रा. प्रति कि. ग्रा. की दर से *ट्राइकोडर्मा* + 5 % की दर से एनएसकेई के छिड़काव के साथ 6 टन प्रति हैक्टे. की दर से एफवाईएम के मृदा उपचार किया गया था। ये दोनों उपचार कंट्रोल की तुलना में, जिसमें अधिकतम मुरझान आपतन (29.5%) और न्यूनतम उपज (1.11 क्विं. प्रति हैक्टे.) पाई गई, काफी अधिक श्रेष्ठ पाए गए।

सौंफ

वर्ष के दौरान सीवीटी में सर्वश्रेष्ठ निष्पादन करने वाली वंशावलियां थीं : जोबनर में FNL 106 (24.84 क्विं. प्रति हैक्टे.), जगुदान में FNL 105 (16.88 क्विं. प्रति हैक्टे.), कुमारगंज में FNL 112 (15.34 क्विं. प्रति हैक्टे.) तथा जबलपुर में FNL-109 (11.91 क्विं. प्रति हैक्टे.)।

जोबनर में 75 प्रतिशत आरडीएफ के साथ ड्रिप सिंचाई किए जाने से काफी उच्च पादप ऊंचाई (121.3 से. मी.), प्रति पादप पुष्पछत्र सं. (29.22), प्रति पुष्पछत्र पुष्प संख्या (24.04), बीज प्रति पुष्पछत्र (391.5), टेस्ट वेट (6.15 ग्रा.), बीज उपज (24.78 क्विं. प्रति हैक्टे.) और जल उपयोग दक्षता (5.72 कि. ग्रा. प्रति हैक्टे.-मि. मी.) प्राप्त की गई और जल में 18.9% की बचत हुई। तथापि, यह 100% आरडीएफ के साथ ड्रिप उर्वरीकरण और 100% आरडीएन के साथ ड्रिप उर्वरीकरण के समतुल्य थी।

मेथी

मेथी के 30 जीनप्ररूपों को दो पर्यावरणों में, अर्थात सिंचित (पूर्ण सिंचाई के साथ) और सूखा (कम सिंचाई के साथ (सिंचाई की आधी मात्रा सिंचित उपचार के लिए उपयोग की गई थी) स्थिति में बुवाई की गई। सामान्य सिंचाई के साथ जीनप्ररूप UM 55, UM 38, UM 58, और UM 46 तथा कम सिंचाई स्थितियों में UM 40, UM 52, UM 54 और UM 56 उच्च उपजशील पाए गए। दबाव सूचकांकों के आधार पर, UM 53, UM 54, UM 56 और UM 65 को नमी दबाव/सूखा स्थितियों के लिए वांछित वंशावलियों के रूप में पाया गया।

समन्वित किस्मगत परीक्षण में दो जांच किस्मों के साथ मेथी की 14 वंशावलियों के मूल्यांकन में सबसे अधिक बीज उपज जगुदान और कोटा में एफजीके-118 में दर्ज की गई, जबकि कुमारगंज, नवसारी, रायगढ़ और जोबनर में उच्च उपजशील वंशावलियां क्रमशः FGK 108 (13.33 क्विं. प्रति हैक्टे.), FGK 83 (14.19 क्विं. प्रति हैक्टे.), FGK 117 (22.20 क्विं. प्रति हैक्टे.) एवं FGK 109 (21.22 क्विं. प्रति हैक्टे.) थीं।

अजवाइन

रायगढ़ में अजवाइन 1 में दो जांच किस्मों, यानी AA-1 (4.9 क्विं. प्रति हैक्टे.) एवं AA -2 (4.7 क्विं. प्रति हैक्टे.) की तुलना में अधिकतम बीज उपज (6.1 क्विं. प्रति हैक्टे.) दर्ज की गई, जबकि जगुदान में जीनप्ररूप JA-187 (15.96 क्विं. प्रति हैक्टे.) को सर्वश्रेष्ठ जीनप्ररूप के रूप में पाया गया। कुमारगंज में मूल्यांकन की गई 13 अजवाइन वंशावलियों में से, NDAJ-10 (8.26 क्विं. प्रति हैक्टे.) में तथा उसके बाद AA-6 (7.99 क्विं. प्रति हैक्टे.) और JA-187 (7.71 क्विं. प्रति हैक्टे.) में अधिकतम उपज प्राप्त की गई।

जोबनर में वर्ष 2016-17 और 2017-18 के दौरान अजवाइन के सीवीटी में मूल्यांकन की गई वंशावलियों के औसत निष्पादन में जांच किस्म AA-2 (7.96 क्विं. प्रति हैक्टे.), HAJ-18 (7.59 क्विं. प्रति हैक्टे.) और IA-1 (7.54. क्विं. प्रति हैक्टे.) का निष्पादन श्रेष्ठ पाया गया।

कलौंजी

कलौंजी के समन्वित किस्मगत परीक्षण में, अधिकतम बीज उपज (6.39 क्विं. प्रति हैक्टे.) कोटा में वंशावली AN-23 और AN-1 में, कुमारगंज में NDBC-20 (8.19 क्विं. प्रति हैक्टे.) में, रायगढ़ में इन्दिरा निगेला-1 (7.7 क्विं. प्रति हैक्टे.) में तथा कल्याणी में HKL-T (7.7 क्विं. प्रति हैक्टे.) में दर्ज की गई।

गुणवत्ता रोपण सामग्री का उत्पादन और वितरण

एआईसीआरपी-मसाला के केंद्रों ने डीएएसडी के साथ काली मिर्च की 4.16 लाख जड़युक्त कलमों, इलायची के 10338 सकर्स, हल्दी की 50 टन, अदरक की 30 टन, जायफल की 1258 कलमों, जायफल की 247 पौधों, दालचीनी की 265 कलमों तथा दालचीनी की 3000 पौधों का बहुगुणन और वितरण किया। बीज मसाला में, धनिया के 324 क्विं. का उत्पादन, जीरे का 70 क्विं., सौंफ का 27.6 क्विं., मेथी का 80 क्विं. तथा अजवाइन बीज सामग्री का 60.5 कि. ग्रा. का उत्पादन और वितरण किया गया।

प्रौद्योगिकी का हस्तांतरण

विभिन्न केंद्रों के वैज्ञानिकों ने अत्याधुनिक प्रौद्योगिकियों के प्रसार हेतु समर्पित प्रयास किए, क्योंकि कोई भी अनसुधान तभी सार्थक कहा जा सकता है जब उसके परिणाम किसानों तक पहुंचते हैं और किसान उनसे लाभान्वित होते हैं। वर्ष के दौरान प्रदर्शित कुछ प्रौद्योगिकियां निम्नानुसार हैं :

उच्च उपजशील किस्में - किसानों के लिए बरदान

❖ ओडिशा (पोटांगी) में 34 हैक्टे. में काली मिर्च की उन्नत किस्मों पर प्रदर्शन।

- ❖ उच्च उपजशील अदरक किस्मों पर चार प्रदर्शन (सोलन)।
- ❖ हल्दी की 11 उच्च उपजशील किस्मों पर एफएलडी (गुंटूर)।
- ❖ उच्च उपजशील हल्दी किस्म सीओ 2 का प्रदर्शन (कोयम्बतूर)।
- ❖ हल्दी, धनिया, सौंफ और मेथी की विभिन्न उच्च उपजशील किस्मों का प्रदर्शन (कुमारगंज)
- ❖ मेथी, जीरा और सौंफ की उच्च उपजशील किस्मों पर छः प्रदर्शन (जोबनर)

न्यूनतम व्यय के लिए रोपण सामग्रियों का त्वरित बहुगुणन

- ❖ हल्दी में प्रोट्रे प्रौद्योगिकी, दो कलिकाओं वाले हल्दी बीज राइजोम का बीज उपचार और रोपण की उथली क्यारी विधि (कामारापल्ली)।
- ❖ 3.00 एकड़ क्षेत्रफल में हल्दी प्रतिरोपण के निष्पादन पर एफएलडी (कोयम्बतूर)।
- ❖ डीएसएडी के सहयोग से हल्दी, अदरक, धनिया और करी पत्ता क लिए हाई-टेक उत्पादन प्रौद्योगिकी पर प्रशिक्षण (कोयम्बतूर)।
- ❖ अदरक और हल्दी के लिए प्रोट्रे प्रसारण तकनीक, जायफल में सॉफ्ट वुड ग्राफ्टिंग तकनीक तथा कोकुम, बुश पैपर उत्पादन प्रौद्योगिकी का प्रदर्शन (दापोली)।

मदर नेचर विकसित करने के लिए जैविक कृषि

- ❖ काली मिर्च में जैविक कृषि पर प्रदर्शन (यरकौड)
- ❖ ओडिशा के कोरापुट, गजापति एवं कंधमाल जिलों में 4.5 हैक्टे. में जैविक अदरक उत्पादन का प्रदर्शन (पोटांगी)।
- ❖ दालचीनी, शिमला मिर्च, जायफल कलमों तथा शिमला मिर्च के लिए उपयुक्त मानक के साथ नारियल, सुपारी और बहु फसल प्रणाली में अंतर-फसल पर चार प्रदर्शन (पन्नियूर)।

जल के संरक्षण के लिए ड्रिप सिंचाई

- ❖ छोटी इलायची में ड्रिप सिंचाई प्रणाली पर प्रदर्शन (मुदुगेरी)
- ❖ काली मिर्च में ड्रिप सिंचाई प्रणाली पर प्रदर्शन (पन्नियूर)

प्रचालन व्ययों के न्यूनतमीकरण के लिए यांत्रिकीकरण

- ❖ डीजल चालित हल्दी बॉयलर और हल्दी डिगर का प्रदर्शन (गुंटूर)
- ❖ दालचीनी के छिलके हटाना, काली मिर्च और हल्दी के प्रसंस्करण की तकनीक का प्रदर्शन (दापोली)

उपरोक्त फील्ड स्तरीय प्रदर्शनों के अलावा, वैज्ञानिकों को प्रौद्योगिकियों के बारे में और अधिक अवगत कराया गया जिसके लिए प्रशिक्षण, सेमिनार आयोजित किए गए जिनमें वैज्ञानिकों ने संसाधन व्यक्ति के रूप में भाग लिया। विभिन्न मीडिया माध्यमों (समाचार-पत्र, रेडिया वार्ता और टी. वी. कार्यक्रम) से भी उन्हें अवगत कराया गया।

सफल गाथाएं

किसानों की आय में वृद्धि करने के लिए काली मिर्च की खेती

काली मिर्च कर्नाटक के उत्तर कन्नड़ की एक महत्वपूर्ण मसाला फसल है। वर्तमान परिदृश्य में, जहाँ अधिकतर किसान बागवानी को कम लाभप्रद व्यवसाय मानते हैं और कई युवा बेहतर जीवन की खोज में महानगरीय शहरों की ओर पलायन कर लेते हैं, ऐसे में भी श्री रविन्द्र जी. भट, कनागोडु गांव, येलापुर, उत्तर कन्नड़ जिला, कर्नाटक ने अपने 4 एकड़ क्षेत्रफल वाले बगीचे में (पुराने एवं नए क्षेत्र सहित) काली मिर्च की खेती कर बड़ी सफलता हासिल की है। उन्होंने पन्नियूर 5, पिनजार मुंडा और पन्नियूर 1 का रोपण किया। उन्होंने अपने 700 पुरानी काली मिर्च बेलों से 15 क्विं. काली मिर्च की उपज प्राप्त की और जून 2016 के दौरान उन्होंने 1700 नई बेलें रोपित कीं। वह वैज्ञानिक विधियों से काली मिर्च की खेती कर रहे हैं और बागवानी विशेषज्ञों की सलाह के अनुसार उन्होंने अपनी भूमि में उपयुक्त ड्रिप सिंचाई प्रणाली स्थापित की है। उनके काली मिर्च के रोपण में, धीमा मुरझान रोग नियंत्रण में है क्योंकि उन्होंने विश्वविद्यालय द्वारा संस्तुत कृषि क्रियाओं के पैकेज के अनुसार, पादप संरक्षण उपायों को नियमित रूप से अपनाया। उन्होंने बरसात के दिनों में अधिक से अधिक पानी के निष्कासन के लिए छिद्रिल पीवीसी पाइपों का प्रयोग करते हुए उपयुक्त भूमिगत जल निकासी प्रणाली स्थापित की है। यद्यपि, पहले उन्हें काली मिर्च की वैज्ञानिक खेती के बारे में कोई जानकारी नहीं थी, लेकिन अब वह काली मिर्च की सफलतापूर्वक खेती कर एक युवा उद्यमी तथा ऐसे युवाओं के लिए एक आदर्श बन चुके हैं, जो स्वयं का उद्यम स्थापित करना चाहते हैं और स्वयं का बॉस बनना चाहते हैं।

मिश्रित फसल प्रणाली - किसानों के लिए अतिरिक्त आय की प्रबल संभावना

मिश्रित फसल प्रणाली किसानों के लिए अतिरिक्त आय सुनिश्चित करती है। दापोली तालुक के उसगांव के श्री माधव मराठे ने बी. एस. के. के. वी, दापोली में आयोजित अनेक प्रशिक्षणों में भाग लेकर काली मिर्च में मिश्रित फसल प्रणाली की संकल्पना के बारे में जानकारी प्राप्त की। उनके दिमाग में अपने सुपारी रोपण में काली मिर्च की खेती करने का विचार आया। बी. एस. के. के. वी, दापोली के वैज्ञानिकों से बातचीत कर श्री माधव ने वर्ष 2012 के दौरान लगभग 0.50 हैक्टे. क्षेत्रफल में सुपारी आधारित मिश्रित फसल प्रणाली का रोपण किया। काली मिर्च की खेती से उन्हें अब अच्छे लाभ प्राप्त हो रहे हैं क्योंकि उन्होंने प्रति बेल 10 कि. ग्रा. ताजी बेरी की उच्च उपज प्राप्त की। उन्होंने अपने उत्पाद को मुंबई के बाजार में बेचा। हरी काली मिर्च की स्पाइक (ताजा वजन के आधार पर) का औसत मूल्य लगभग रु. 200 से 225 प्रति कि. ग्रा. है। बड़े आभार के साथ वह आज भी बी. एस. के. के. वी, दापोली के उस वैज्ञानिक को याद करते हैं जिसने उन्हें कृषि क्रियाओं के पैकेज, छाया का विनियमन, अंतर-कृषि, प्रशिक्षण, छंटाई कार्यों और पादप संरक्षण उपायों के बारे में सलाह देने हेतु उनके बगीचे का नियमित रूप से दौरा किया।

उच्च लाभ प्राप्त करने हेतु उच्च उपजशील अरदक और हल्दी किस्मों की खेती

वर्ष 1995 से, पोटांगी के युवा उद्यमी कृषि क्रियाओं के बेहतर पैकेज के साथ अरदक और हल्दी के खेती करने के लिए आगे आए। अदरक (सुप्रभा) और हल्दी (रोमा) की उच्च उपज वाली किस्मों की रोपण सामग्री छः उन्नतशील किसानों को दी गई और एचएआरएस, पोटांगी में एआईसीआरपी-मसाला केंद्र के वैज्ञानिकों द्वारा बेहतर प्रौद्योगिकी के साथ उन्हें प्रशिक्षण दिया गया। उच्च लाभ प्राप्त कर सफलता हासिल करने के बाद अनेक बेरोजगार युवा और किसान अदरक तथा हल्दी की खेती करने के लिए आकर्षित हुए हैं। उन्होंने 16.6 हैक्टे. भूमि से अरदक के 16.12 टन का तथा हल्दी के 4.22 टन का उत्पादन किया। उन्होंने 3000 रुपए प्रति क्विंटल की दर से अदरक और 2500 रुपए प्रति क्विंटल की दर से हल्दी (टीएल बीज) को बेचा।

वारांगल से रामाकृष्ण रेड्डी एक प्रगतिशील किसान हैं और उन्होंने डुगिराला रेड किस्म के साथ प्रति एकड़ क्षेत्रफल से लगभग 18.0 टन हल्दी की उपज प्राप्त की। उन्होंने हल्दी की कृषि क्रियाओं के पैकेज, जैसा कि हल्दी अनुसंधान केंद्र, कामारपल्ली द्वारा एक पुस्तक (पसुपु सागु) में प्रकाशित किया गया था, को पूरी तरह अपनाया।

निजामाबाद के चिन्ना रेड्डी मागिडी ने हल्दी की आठ किस्मों (राजेन्द्र सोनिया, राजेन्द्र सोनाली, वंशावली सं. 48, वंशावली सं. 79, सलेम, डुगिराला रेड, पीटीएस-10 और राजापुरी) की खेती की। उनके भूखंड में एक प्रदर्शन किया गया। उन्होंने प्रति एकड़ क्षेत्रफल 20 से 22 टन की उपज प्राप्त की और उनके हल्दी उत्पाद को आगामी मौसम के लिए बीज सामग्री के रूप में उपयोग किया गया।

अभी तक उपेक्षित जनजातीय किसानों के लिए कल्याणकारी उपाय

जनजातीय उपयोजना के अंतर्गत भाकृअनुप-एआईसीआरपी-मसाला के तीन केंद्र हैं, अर्थात ओडिशा केपोटांगी, आंध्र पद्रेश के चिंतापल्ली और छत्तीगढ़ के रायगढ़ में। ये केंद्र निम्नलिखित के बारे में किसान प्रशिक्षण कार्यक्रमों का आयोजन कर जनजातीय किसानों के उत्थान के लिए कार्य करते हैं जिसके परिणामस्वरूप 2008 जनजातीय किसान लाभान्वित हुए हैं।

- अदरक में फसलोत्तर प्रबंधन विधियां
- हल्दी, काली मिर्च और लंबी काली मिर्च में मसाला किस्मों और फसलोत्तर प्रसंस्करण की बेहतर उपलब्धता।
- बागवानी फसलों में आईपीएम प्रौद्योगिकियां।
- दालचीनी में छिलका उतारने की तकनीक और दालचीनी एवं जायफल में बहुगुणन तकनीकें।
- जैविक अदरक और हल्दी की खेती।
- बेमौसम धनिया की खेती।
- झंकारगुडा, पोटांगी में जैविक अदरक की खेती तथा गजापति में काली मिर्च की खेती के निष्पादन पर प्रदर्शन।
- काली मिर्च की 4500 कलमें, दालचनी की 1500 पौधें, इलायची की 1000 पौधें, हल्दी के 15 टन, अदरक के 15 टन तथा धनिया के 1.5 क्विंटल का उत्पादन किया गया।

अभी तक दोहन नहीं किए उत्तर पूर्व में अन्वेषण

अदरक के जीवाणविक मुरझान रोग के प्रबंधन के लिए, स्थायी मसाला उत्पादन हेतु उत्तर पूर्व में बायोएजेंटों के साथ एक सौरीकरण परीक्षण आरंभ किया गया।

बारापानी में, उस उपचार में 37.49 टन प्रति हैक्टे. की अधिकतम उपज दर्ज की गई जिसमें एफवाईएम + सूक्ष्म पोषकतत्वों को शामिल किया गया था। इसके बाद एफवाईएम + 10% वर्मीवाश से 100% जैविक खाद के उपचार में 36.85 टन प्रति हैक्टे. की उपज प्राप्त की गई। एफवाईएम + सूक्ष्म पोषकतत्वों से 100% जैविक खादों के उपचार में 20.37% की उच्च शुष्क रिकवरी दर्ज की गई तथा किसानों की विधि के अनुसार 19.37 % की न्यूनतम शुष्क पदार्थ रिकवरी दर्ज की गई। अदरक + 10% वर्मीवाश के साथ 75% नाइट्रोजन वाले उपचार में 3.94% का उच्च रेशा तत्व पाया गया, जबकि एसएयू द्वारा संस्तुत कृषि-क्रिया पैकेज में 3.55% का न्यूनतम रेशा तत्व पाया गया। एसएयू द्वारा संस्तुत कृषि क्रिया पैकेज में ओलियोरेसिन तत्व सबसे अधिक (4.31%) दर्ज किया गया और एफवाईएम + 10% वर्मीवाश से अदरक में 75% आवश्यकता के साथ किए गए उपचार में 3.82% का न्यूनतम ओलियोरेसिन तत्व दर्ज किया गया।

मिजोरम में हल्दी में जैविक कृषि के लिए किए गए परीक्षण में यह पाया गया कि सबसे अधिक उपज (34.44 टन प्रति हैक्टे.) उस उपचार के साथ दर्ज की गई जिसमें हल्दी के लिए 75 प्रतिशत नाइट्रोजन आवश्यकता के बराबर 100 प्रतिशत जैविक खाद को शामिल किया गया था। इसके बाद हल्दी के लिए 100 प्रतिशत नाइट्रोजन आवश्यकता के बराबर 100 प्रतिशत जैविक खाद प्रयोग किए गए उपचार में 33.21 टन हैक्टे. की उपज तथा हल्दी के लिए 75 प्रतिशत नाइट्रोजन आवश्यकता + सूक्ष्म पोषकतत्व उपचार में 32.69 टन हैक्टे. की उपज दर्ज की गई। इसके अलावा, सबसे अधिक शुष्क पदार्थ तत्व (13.95%) उस उपचार में प्राप्त किया गया जिसमें हल्दी के लिए 100 प्रतिशत नाइट्रोजन आवश्यकता के बराबर 100 प्रतिशत जैविक खाद को शामिल किया गया था। इसके बाद 100 प्रतिशत जैविक खाद + (10 प्रतिशत वर्मीवाश) वाले उपचार में तथा 100 प्रतिशत जैविक खाद + सूक्ष्म पोषकतत्व वाले उपचार में क्रमशः 13.43% और 13.37% की उच्च शुष्क पदार्थ रिकवरी प्राप्त की गई।

सहयोग

एआईसीआरपी-मसाला ने निम्नलिखित के साथ सहयोग स्थापित किए हैं

- भाकृअनुप-आईआईएसआर, कोझीकोड द्वारा विमोचित प्रौद्योगिकियां
- जनजातीय क्षेत्रों में प्रौद्योगिकियों के प्रसार के लिए मसाला बोर्ड
- गुणवत्तात्मक रोपण सामग्री के उत्पादन और आपूर्ति के लिए एमआईडीएच (एकीकृत बागवानी विकास मिशन)
- जनजातीय क्षेत्र में उच्च उत्पादन प्रौद्योगिकियां के प्रसार के लिए एनजीओ
- बढ़ते उत्पादन, उत्पादकता और किसानों की आय बढ़ाने के लिए राज्य कृषि विभाग।
- कॉफी उत्पादक क्षेत्रों में कॉफी आधारित काली मिर्च फसल प्रणाली स्थापित करने हेतु कॉफी बोर्ड।

निगरानी

एआईसीआरपी-मसाला केंद्रों द्वारा संचालित अनुसंधान परियोजनाओं और कार्यक्रमों की निगरानी पीसी यूनिट के परियोजना समन्वयक और वैज्ञानिकों द्वारा की गई जिन्होंने विभिन्न केंद्रों और परीक्षणात्मक भूखंडों का दौरा किया। इस वर्ष के दौरान 11 केंद्रों का दौरा किया गया जिनमें नियमित, सहयोगी, स्वैच्छिक और परियोजना मोड केंद्र शामिल हैं। केंद्रों के कार्यकलापों की निगरानी केंद्रों द्वारा भेजी गई मासिक रिपोर्टों, अर्द्ध-मासिक एवं वार्षिक रिपोर्ट के आधार पर भी की गई। वार्षिक कार्यशाला का आयोजन डॉ. वाई. एस. आर. बागवानी विश्विद्यालय, लाम, गुंटूर, आंध्र प्रदेश के बागवानी अनुसंधान केंद्र में दिनांक 10 से 12 अक्तूबर, 2017 के दौरान किया गया।

EXECUTIVE SUMMARY

ICAR-All India Coordinated Research Project on Spices with 38 centres (19 regular, 10 co-opting and 9 voluntary centres) spread over 14 agro climatic zones in 23 states of the country coordinates the research activities on spice crops like black pepper, large cardamom, small cardamom, ginger, turmeric, cinnamon, nutmeg, clove, coriander, cumin, fennel, fenugreek, ajwain and nigella. Annual budget for the year 2017/18 was Rs. 637 lakhs as ICAR share.

New Initiatives

In line with food safety assurance and minimization of the pesticide residue in spices, efficacy trials in coriander and cumin were initiated in various seed spice centres of AICRPS.

For sustainable production of spices, new programme on the management of bacterial wilt of ginger through chemicals and bioagents have been undertaken in various AICRPS centres of different agro climatic regions.

For the evaluation of genotypes for specific traits, various AICRPS centres have undertaken Coordinated varietal trials in spice crops like black pepper, cardamom, coriander, cumin, fennel and fenugreek.

Varieties recommended for release in 28th AICRPS workshop

Six high yielding varieties of spices (2 in turmeric, 2 in coriander, 1 fenugreek and 1 cassia) were recommended for release in XXVIII AICRP on Spices workshop held at Horticultural Research Station, Dr. Y. S. R. Horticultural University, Lam, Guntur, Andhra Pradesh.

High quality varieties- industries need

- **NDH-8 (**Narendra Saryu**) –** turmeric variety from Narendra Dev University of Agriculture & Technology, Kumarganj, Faizabad, Uttar Pradesh with high curcumin content (5-6%), more number of primaries with yield advantage of 10 % was recommended for release at national level
- **Gujarat Coriander -3** – coriander variety from Centre for Research on Seed Spices (CRSS), SDAU, Jagudan with high volatile oil (0.52 %), high linalool (72.16 %) and high yield potential (16.94 q ha^{-1}) was recommended for release in Gujarat
- **Ajmer Fenugreek 5-** fenugreek variety developed by ICAR-NRC on Seed Spices, Ajmer with high seed yield (17.21 q ha^{-1}), high antioxidant content (66.428 mg/ BHTE/ ppm) and suitable for green leaf production under shade net condition in summer season was recommended for release at national level.
- **IISR Cassia (D1)-** a new selection of cassia with low coumarin content was developed for the first time in the country by Dr. BS Konkan Krishi Vidhyapeeth, Dapoli in collaboration with ICAR-IISR, Kozhikode and TNAU, HRS, Pechiprai.

Biotic stress varieties- for food safe spice production

- **CL 34 –** turmeric variety developed by Tamil Nadu Agricultural University, Coimbatore with tolerance to leaf spot and leaf blotch and curcumin content of 3% was recommended for release in Tamil Nadu.
- **Ajmer Coriander 2** developed by ICAR-NRC on Seed Spices, Ajmer for stem gall resistance, high linalool content (71.7 %) and and early maturing type was recommended for release at national level.

Technologies developed in 28th AICRPS workshop

Seven location specific technologies in different spice crops for various states were developed in XXVIII Annual workshop of AICRPS.

More crop per drop- for efficient utilization of water

- **Standardization of drip fertigation in Black pepper under Kerala conditions**

  Drip irrigation in black pepper @ 8 litres of water daily and 50 RDF (half the Recommended Dose of Fertilizer as liquid fertilizer – 19:19:19 mixture) in 3 equal splits at weekly intervals during the months of June, September and February was beneficial than the conventional method of irrigation and basal fertilizer application with the highest benefit cost ratio (2.07).

- **Standardization of fertigation in cardamom for Karnataka**

  Application of irrigation 9 litres per clump per day along with 100% recommended dose of fertilizers through drips gives the highest capsule yield (316.16 kg ha^{-1}) in cardamom with BC ratio of 3.37.

Organic nutrient management- for sustainable spice production

- **Organics for yield enhancement in small cardamom in Karnataka**

  Application of Jeevamrutha (20 l per clump) +*Azosprillum* (10 g/clump) + PSB (10 g/clump) + *Trichoderma* (10 g/clump) improved the yield of cardamom (318.26 kg ha^{-1}) with BC ratio of 1:5.09.

Micro nutrient supplementation- for balanced nutrition

- **Micro nutrient management in fennel in Gujarath**

  Application of fertilizer to fennel with RDF of 90 + 30 kg NP per ha along with 200 kg FYM enriched with 3.0 kg Fe + 1.5 kg Zn per hectare as basal application in furrow for light textured soils deficient in iron and zinc produces maximum yield (14.27 q/ha) with a BC ratio of 2.11.

Soil nutrient amendment- for maintaining soil health

- **Liming in cardamom for Kerala**

  In acidic loamy soils of Kerala, application of 2 kg dolomite for 3 years improves the yield (2763.30 g $plant^{-1}$) in cardamom with B: C ratio of 2.42.

- **Management of blight and powdery mildew by spacing and potash application in cumin in Gujarath**

  Line sowing of cumin @ 30 x 10 cm and application of Potash @ 20 kg/ha along with recommended dose of fertilizers reduces the incidence of blight (PDI- 17.3) and powdery mildew (PDI- 5.7) with maximum yield (363 kg / ha) and BC ratio of 2.41.

Weed management- for mitigating labour shortage

- **Utilization of herbicides for the effective control of weeds in ginger for Andhra Pradesh**

  Under severe shortage of labour for hand weeding, application of Oxyflurofen as pre-emergent herbicide @ 500 ml per ha at second day after sowing followed by application of Quazilophop ethyl as post-emergent herbicide @1 litre per ha at 30 days of crops stage followed by hand weeding at 90 days of crop stage reduces 3-4 manual hand weeding required and gives a BC ratio of 2.96 with a yield of 22.79 t/ ha was recommended for ginger in Chinthapalle condition.

Reaserch Achievements

Black Pepper

During 2017-18, Pepper Research Station, Panniyur has collected five black pepper drought tolerant lines and HRS, Sirsi has collected 14 accessions of black pepper bringing the total germplasm holding of black pepper to 873. On evaluating twenty two accessions of black pepper for quality characters at Sirsi centre revealed that SV-7 recorded highest piperine (5.49%) and oleoresin (10.74%) content. In Coordinated Varietal Trial of black pepper, maximum fresh berry yield was recorded HB 20052 (4500 g vine^{-1}) followed by Acc.no.53 (4380 g vine^{-1}) at Panniyur, Panniyur-1 (637.76 g vine^{-1}) followed by P-8 (507.44 g vine $^{-1}$) at Chintappalle and Panniyur 1 (1230 g vine^{-1}) at Dapoli. In RARS, Ambalavayal, 100 berry weight was also found to be maximum in HP 813 (17.4g) followed by PRS 17 (17 g). In the case of 100 berry volume, highest value was recorded in Coll 1041 (24.41) followed by Panniyur 1 (21.50).

During 2017-18 good yield was obtained in black pepper based mixed cropping system in PRS, Panniyur. Among the intercrops, elephant foot yam recorded maximum yield of 8.53 kg followed by greater yam (7.25) kg) from an inter space of 4 m x 2 m spacing between black pepper. Whereas in RARS, Ambalavayal, on quantifying the economic produce of different intercrops of juvenile black pepper garden revealed that tapioca (10.18 t ha^{-1}) recorded maximum yield followed by arrowroot and elephant foot yam with 4.81 t ha^{-1} and 3.62 t ha^{-1} yield respectively.

In an experiment on the biological management of slow decline in black pepper at Dapoli, minimum per cent disease intensity was recorded (6.78) in the treatment with soil application of *Pochonia chlamydosporia* @ 2 kg vine^{-1} followed by soil drenching with *Pseudomonas fluorescens* IISR-6 @ 2% (10^6 cfu) (drench 3 L vine^{-1}) and was significantly superior to rest of the treatments at Dapoli.

Small Cardamom

A total of 189 cardamom accessions are presently conserved in the gene bank at Cardamom Research Station, Pampadumpara. Among them 73 cardamom accessions (CRSP 1-73) received IC numbers (547920 to 547992) from the National Bureau of Plant Genetic Resources, New Delhi. All the characters including yield and biotic stress characters, except *Azhukal* incidence had shown significant difference among the accessions at 5% confidence levels. HY 13 recorded the highest fresh yield (3.4 kg/plant) followed by HY 12 (2.7 kg/ plant)

Evaluation of new insecticides for thrips control in small cardamom revealed that fipronil 5 SC @ 0.005% showed highest per cent reduction of infestation (88.26%) followed by Imidacloprid 17.8 SL @ 0.0089% with 78.74% infestation. Spinosad 45 SC @ 0.0135% and quinalphos 25 EC @ 0.05% were also found effective in reducing the infestations (75.29% and 70.31% respectively) and were on par with each other.

Large Cardamom

A total of 10 genotypes of large cardamom were collected from different part of Sikkim and are being maintained at ICAR Research Complex for NEH Region, Regional Stationat Gangtok. Surveillance of insect-pests on large cardamom in Sikkim at ICAR- NOFRI, Research farm, Tadong revealed that the infestation of different hairy caterpillar was more during the month of November-December.

In an experiment to evaluate the efficacy of biopesticides *viz.*, neem oil, *Beauveria*

bassiana, *Metarhizium anisopliae*, petroleum oil based agrospray, petroleum oil based horticultural spray, *Bacillus thuringiensis* and spinosad against insect pests of large cardamom *viz*., stem borer, shoot fly, leaf eating caterpillar and tea mosquito bug revealed that all the treatments showed effective results to control insect pests over the control. However, spinosad 45 SC @ 0.3 ml L^{-1} was found to be most effective to control all the pests (69.91 to 81.32% reduction of infestation over control) followed by neem oil (1500 ppm) @ 4 ml L^{-1} (61.32 to 67.64 % reduction of infestation over control) and petroleum agrospray @ 10 ml L^{-1} (52.22 to 59.47 % reduction of infestation over control).

Ginger

Out of 181 ginger germplasm evaluated at Pottangi, 4 accessions gave more than 10 kg per $3m^2$ of fresh rhizome yield and 30 accessions yielded more than 5 kg per $3m^2$. The range of plot yield being 0.15 Kg (No.6) to 13.0 kg per 3 m^2 (KG-132) with the mean yield of 3.7 kg per 3 m^2 in tested germplasms during *Kharif* 2017-18. The highest fresh rhizome yield was recorded by KG-132 (28.9 t ha^{-1}) followed by PGS-41-1 (25.3 t ha^{-1}) and Zo-9 (25.1t ha^{-1}).

The average fresh rhizome yield for three consecutive years 2015, 2016 and 2017 varied from 5.15 t ha^{-1} to 18.25 t ha^{-1}. The local genotype Solan Giriganga (IC-593889/SG-26-04) recorded maximum yield 18.25t ha^{-1} whereas, local check variety Himgiri yielded 13.25 t $ha^{-1}$and National check variety IISR Varada 8.57t ha^{-1}. The rhizome rot disease incidence varied from 8.93-22.20 % with minimum in Solan Giriganga (IC-593889/ SG-26-04). The high yielding promising genotype is superior/ comparable for quality attributes *viz*., dry matter recovery (21.01 %), essential oil (1.45 %), oleoresin (4.69 %) and crude fibre content (4.47 %) to the check variety Himgiri. Therefore, keeping in view the consistently good performance, the promising genotype Solan Giriganga (IC-593889/SG-26-04) has been identified as promising variety for Western Himalayan Regions of the country.

Turmeric

In germplasm evaluation trails, 270 turmeric germplasm lines were maintained and conserved at Kammarpally research station. On characterising turmeric lines using DUS descriptors, the accessions *viz*., Manapasupu (74.80 t ha^{-1}) PCT-17 (67.66 t ha^{-1}), CLI-366 (66.67 t ha^{-1}), West Bengal (65.73 t ha^{-1}), NH-1 (65.0 tha^{-1}), CLI-Jyothi (64 t ha^{-1}) and ACC No. 585 (63.73 t ha^{-1}) were the high yielders as compared to national check, IISR Prathibha (55.0 t ha^{-1}). These lines were also screened against major foliar diseases.

In the coordinated varietal trial of turmeric, twelve genotypes (IT 10, IT 23, IT 36 from Raigarh; RH 9/90, RH 80 from Dholi; TCP 191 from Pundibari, NDH 11, NDH 128 from Kumarganj, PTS 18, PTS 38 from Pottangi and LTS 1, LTS 2 from Guntur) along with two checks (IISR Prathiba and BSR 2) were evaluated at different centres. The genotype TCP 191 was the top yielder at Pundibari (42.59 t ha^{-1}) and Chintapalle (48.49 t ha^{-1}) whereas the genotypes like NDH 11 (45.00 t ha^{-1}) performed well in Coimbatore, LTS 2 (62.0 t ha^{-1}) in Kammarpally, LTS1 (26.2 t ha^{-1}) at Kumarganj, PTS 18 (15.3 t ha^{-1}) at Pottangi, IT 10 (28.00 t ha^{-1}) at Raigarh and IT 23 (26.67 t ha^{-1}) at Navsari.

Survey was conducted in Coochbehar and Jalpaiguri districts of West Bengal to identify and to assess the severity of the diseases in turmeric. Three well distributed locations within the identified areas were selected for the survey. Two major diseases of turmeric

namely leaf blotch (*Taphrina spp.*) and leaf spot (*Colletotrichum spp.*) were found to be prevalent in these areas. The survey revealed that leaf blotch disease severity in Coochbehar is on an average PDI of 13.89 and Jalpaiguri is on an average PDI of 12.61. Regarding leaf spot of turmeric it was found that disease severity in Coochbehar and Jalpaiguri block is on an average PDI of 19.87 and 18.57 respectively.

Tree Spices

Among the nutmeg germplasm screened at Dapoli, average no. of fruits ranged from 180-560. The average number of fruits was high in genotypes DBSKKVMF 24 (325), DBSKKVMF 23 (310), DBSKKVMF 19 (280). The genotype DBSKKV 9772 recorded maximum dry nut yield (5152 g) and dry mace yield (599.2 g). The genotype DBSKKVMF 29 is found to be promising considering its fruit weight, nut weight and mace weight. At Pechiparai, the nutmeg accession MF- 4 recorded maximum number of fruits (330 fruits /tree), single fruit weight (46 g) and the mace yield (140 g tree^{-1}).

The clove accession, SA-3 recorded the highest leaf length (18.50 cm), leaf breadth (7.50 cm) and dry bud yield (1.25 kg/ tree) at Pechiparai. Four promising genotypes were selected at Dapoli whose plant height varied from 4.90 to 5.50 m, girth ranged from 33.10 to 38.10 cm and spread varied from 3.5 m to 5.20 m.

In case of cinnamon, among the twelve accessions evaluated at Pechiparai, CV-5 recorded maximum stem girth (26.00 cm), leaf yield (7.40 kg plant^{-1}) and dry bark yield (630 g plant^{-1}) while local check recorded stem girth (25.00 cm), leaf yield (6.80 kg per plant) and dry bark yield (285 g per plant).

Coriander

In Coordinated Varietal Trial of coriander, maximum seed yield was recorded in the entry COR 159 at Coimbatore (18.95q ha^{-1}) and Jabalpur (14.55q ha^{-1}). COR 164 performed better in Kumarganj (15.97q ha^{-1}) and Raigarh (18.8q ha^{-1}). The top entries in other centres *viz.*, Jagudan, Navsari, Kota and Jobner are COR 170 (9.41 q ha^{-1}), COR 99 (15.09 q ha^{-1}), COR 160 (16.66 q ha^{-1}) and COR 125(17.50 q ha^{-1}) respectively.

An experiment on efficacy of new generation fungicides against powdery mildew of coriander was conducted at Jobner. Out of seven treatments, minimum (21.67%) disease intensity and maximum seed yield of 15.13 q ha^{-1} was recorded with foliar spray of Hexaconazole 5% SC @ 0.1% whereas at Jagudan, the minimum percent disease intensity was observed in T_7, spraying of Dinocap and was at par with T_6, spraying of Propiconazole 0.1%, T_5, Spraying of Hexaconazole 0.1%, T_4, spraying of wettable sulphur 0.2% and spray of Azoxystrobin 0.1 %.

Cumin

Total eighteen entries of cumin were screened for the resistance against *Alternaria* blight, powdery mildew and wilt disease at Jagudan. The minimum blight disease and powdery mildew disease intensity was noticed in Sanand Cumin-5 (12.0 % and 5.0 % respectively). The blight disease incidence ranged from 32.5 to 81.0 per cent.

In a trial on organic nutrient and disease management in cumin, out of thirteen treatments tested, minimum wilt incidence (11.1%) and maximum seed yield (2.05 q ha^{-1}) were observed in the treatment containing soil application of vermi compost @ 2 t ha^{-1} + seed treatment with *Trichoderma* @ 6g kg^{-1} + spray

of NSKE @ 5% followed by the treatment of soil application of FYM @ 6t ha^{-1} + seed treatment with *Trichoderma* @ 6 g kg^{-1} + spray of NSKE @ 5%, exhibited 15.6% wilt incidence and 1.88 q ha^{-1} seed yield. Both these treatments were significantly superior over control, where maximum wilt incidence (29.5%) and minimum yield (1.11 q ha^{-1}) were observed.

Fennel

The best performed entries in the CVT during the year were FNL 106 (24.84 q ha^{-1}) at Jobner, FNL 105 (16.88 q ha^{-1}) at Jagudan, FNL 112 (15.34 q ha^{-1}) at Kumarganj and FNL-109 (11.91 q ha^{-1}) at Jabalpur.

The drip fertigation with 75% RDF recorded significantly higher plant height (121.3 cm), umbels per plant (29.22), umbellets per umbel (24.04), seeds per umbel (391.5), test weight (6.15g), seed yield (24.78 q ha^{-1}) and water use efficiency (5.72 kg/ha-mm) along with 18.9 % of water saving at Jobner. However it remained *at par* to drip fertigation with 100 % RDF and drip fertigation with 100 % RDN.

Fenugreek

Thirty genotypes of fenugreek were sown in two environments namely irrigated (full supplement of irrigations) and drought (staggered irrigations (half of that given in irrigated treatment).The genotypes *viz*., UM 55, UM 38, UM 58, and UM 46 in normal irrigation while UM 40, UM 52, UM 54 and UM 56 in staggered irrigation conditions were top yielders. Based on stress indices UM 53, UM 54, UM 56 and UM 65 were found to be the desirable entries for moisture stress/ drought conditions.

On evaluating fourteen entries of fenugreek along with two checks in coordinated varietal trial, the highest seed yield was recorded in FGK-118 at Jagudan and Kota whereas the top yielders at different centres like Kumarganj, Navsari, Raigarh and Jobner are FGK 108 (13.33 q ha^{-1}), FGK 83 (14.19 q ha^{-1}), FGK 117 (22.20 q ha^{-1}) and FGK 109 (21.22 q ha^{-1}) respectively.

Ajwain

Ajwain 1 recorded maximum seed yield (6.1 q ha^{-1}) over two checks AA-1 (4.9 q ha^{-1}) and AA -2 (4.7 q ha^{-1}) at Raigarh whereas at Jagudan, the genotype JA-187 (15.96 q ha^{-1}) was found to be the paramount genotype. Out of 13 entries of Ajwain evaluated at Kumarganj, maximum yield was found in NDAJ-10 (8.26 q ha^{-1}) fallowed by AA-6 (7.99 q ha^{-1}) and JA-187 (7.71 q ha^{-1}).

Mean performance of the entries evaluated in CVT of ajwain over 2016-17 and 2017-18 at Jobner revealed superior performance of AA-2 check yielding 7.96 q ha^{-1} followed by HAJ-18 (7.59 q ha^{-1}) and IA-1 (7.54. q ha^{-1}).

Nigella

In coordinated varietal trial of Nigella, maximum seed yield (6.39 q ha^{-1}) was recorded in the entry AN-23 and AN-1 at Kota, NDBC-20 (8.19 q ha^{-1}) at Kumarganj, Indira Nigella -1 (7.7 q ha^{-1}) at Raigarh and HKL-T (7.7 q ha^{-1}) at Kalyani.

Production and distribution of quality planting material

The AICRPS centres along with DASD have multiplied and distributed 4.16 lakhs rooted cuttings of black pepper, 10338 suckers of cardamom, 50 t of turmeric, 30 t of ginger, 1258 grafts of nutmeg, 247 seedlings of nutmeg, 265 grafts of cinnamon and 3000 seedlings of cinnamon. In seed spices 324 q of coriander, 70 q of cumin, 27.6 q of fennel, 80q

of fenugreek and 60.5 kg of Ajwain seed material were produced and distributed.

Transfer of Technology

The scientists of various centres has taken earnest effort to popularize the latest technologies as the research is meaningful only when it reaches to farmers and are benefited out of that. Following are some of the technologies demonstrated during the year.

High yielding varieties- boon to farmers

- Demonstrations on improved varieties of black pepper in 34 ha at Odisha (Pottangi).
- Four demonstrations on high yielding ginger varieties (Solan)
- FLD on 11 high yielding varieties of turmeric (Guntur).
- Demonstration of high yielding turmeric variety CO 2 (Coimbatore).
- Demonstrations of high yielding varieties of turmeric, coriander, fennel and fenugreek (Kumarganj).
- Six demonstrations on high yielding varieties of fenugreek, cumin and fennel (Jobner).

Rapid multiplication of planting materials- for minimal expenditure

- Demonstration on protray technology, seed treatment of two budded turmeric seed rhizomes and raised bed method of planting in turmeric (Kammarapally)
- FLD on performance of turmeric transplants in an area of 3.00 acres (Coimbatore)
- Training on "Hi- tech production technology for turmeric, ginger, coriander and curry leaf" in collaboration with DASD (Coimbatore)
- Demonstration of protray propagation technique for ginger and turmeric, soft wood grafting technique in nutmeg and kokum, Bush pepper production technology (Dapoli).

Organic farming

- Demonstration on organic farming in black pepper (Yercaud).
- Demonstrations on organic ginger production in 4.5 ha at Koraput, Gajapati and Kandhamala districts of Odisha (Pottangi).
- Four demonstrations on intercrop in coconut, arecanut and multitier cropping system along with cinnamon, pepper, nutmeg grafts and suitable standard for pepper (Panniyur).

Drip Irrigation- for conserving water

- Demonstration on drip irrigation system in small cardamom (Mudegere).
- Demonstration on drip irrigation in black pepper (Panniyur).

Mechanization- for minimizing operational expenses

- Demonstration of diesel operated turmeric boiler and turmeric digger (Guntur)
- Demonstration of technique of removing bark of cinnamon, processing of black pepper, Processing of turmeric (Dapoli)

Apart from the above field level demonstrations, the scientists made technologies more popular by conducting and attending as resource persons in trainings, seminar and also through various media (newspaper, radio talks and TV programs).

Success stories

Intensification of Black pepper- for increased income

Black pepper is one of the important spice crops of Uttara Kannada district of Karnataka.

In a present scenario where majority of the farmers consider horticulture as less remunerative and many youngsters migrate towards metros in search of better life, Mr. Ravindra G. Bhat, Kanagodu village of Yellapur, U. Kannada dist, finds success in black pepper cultivation in an area of 4 acres of areca garden (including old and new areas). He has planted Panniyur 5, Pinjar munda and Panniyur 1 in his plantation. He got 15q of black pepper from his 700 old vines and 1700 new vines were planted during June 2016. He has been following scientific cultivation methods and proper drip irrigation system has been laid out as per the advice from horticultural experts. In his plantation, the slow wilt disease is under check as plant protection measures have been taken up regularly as per the package of practices recommended by the University. Proper underground drainage system is laid out using perforated PVC pipes to drain off excess water during rainy season. Though he had no knowledge of scientific cultivation of black pepper before, now he has turned into a young entrepreneur with successful cultivation of pepper and a model for youngsters who would like to become the 'boss to himself'.

Mixed cropping- bonus to farmers

The mixed cropping system ensures additional income to the farmers. Shri. Madhav Marathe of Usgaon, Taluk of Dapoli learned about the concept of mixed cropping system in black pepper in one of the trainings conducted at B.S.K.K.V, Dapoli. He got the idea of planting black pepper in his arecanuts plantation. After discussing with the scientists of B.S.K.K.V, Dapoli, Shri. Madhav planted Black pepper (Panniyur-1) on arecanut based mixed cropping system in an area of about 0.50 ha during the year 2012. The black pepper has started bearing now and he obtained a high yield of 10 kg of green berries per vine. He has sold the produce in the Mumbai market. The average price of green pepper spikes (fresh weight) is about Rs. 200-225 per kg. With gratitude, he remembers the scientist of B.S.K.K.V, Dapoli who has regularly visited the garden to give guidance about package of practices, shade regulation, interculture, training, pruning operations and plant protection measures.

High yielding ginger and turmeric varieties- for reaping profit

Since 1995, young enterprising youths of Pottangi came forward for cultivation of ginger and turmeric with improved package of practices. The planting material of the high yielding varieties of ginger (Suprabha) and turmeric (Roma) were supplied to six progressive farmers and provided with all improved technology by the scientists of AICRPS centre at HARS, Pottangi. After they became successful in getting a very high return, many unemployed youth and farmers were attracted towards the cultivation of ginger and turmeric. They produced 16.12 tonnes of ginger and 4.22 tonnes of turmeric from 16.6 ha of land. They sold ginger Rs. 3000/- per quintal and turmeric (TL seed) @ Rs. 2500/- per quintal.

Ramakrishna Reddy from Warangal, is a progressive farmer and produced about 18.0 tonnes of turmeric per acre with the variety Duggirala Red. He adopted completely the package of practices of turmeric as published in the booklet (Pasupu Sagu) by Turmeric Research Station, Kammarpally.

Chinnareddy Maggidi of Nizamabad has raised the eight varieties of turmeric (Rajendra Sonia, Rajendra sonali, Ac No.48. Acc. No.79. Salem, Duggirala Red, PTS-10 and Rajapuri). A demonstration was also arranged in his field. He obtained a yield of 20 to 22 t per acre

and his turmeric crop produce was used for seed material for next season.

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 2008 tribal farmers.

- Post harvest management practices in ginger.
- Improving availability of spice varieties and post harvest process in turmeric, pepper and long pepper.
- IPM technologies in horticultural crops
- Techniques of bark peeling in cinnamon and propagation techniques in cinnamon and nutmeg.
- Organic ginger and turmeric cultivation
- Off season coriander cultivation.
- Demonstration of the performance of organic ginger cultivation in Jhankarguda, Pottangi and black pepper cultivation in Gajapati.

Around 4500 black pepper cuttings, 1500 seedlings of cinnamon, 1000 seedlings of cardamom, 15 t of turmeric, 15 t of ginger and 1.5 q of coriander were produced by AICRPS centres under Tribal Sub Plan.

North East - exploring the unexplored

For the management of bacterial wilt of ginger, a solarization trial combined with bioagents has been initiated in North east for sustainable spice production.

At Barapani, maximum yield of 37.49 t ha^{-1} was recorded in the treatment of 75% N requirement of gingerfrom FYM + micronutrients followed by 36.85 t ha^{-1} in the treatment of 100% organic manures from FYM + Vermiwash 10%. Dry recovery of 20.37% was recorded highest in the treatment of 100% organic manures from FYM + micronutrients and lowest at 19.37 by farmers practice. The treatment 75% N requirement of ginger + vermiwash 10% have the highest fiber content of 3.94% while lowest was recorded in recommended package by SAU with 3.55%. Oleoresin content was recorded highest (4.31%) in recommended package by SAU and lowest in the treatment of 75% N requirement of ginger from FYM + vermiwash 10% with 3.82%.

The experiment on organic farming in turmeric at Mizoram revealed that the maximum yield (34.44t ha^{-1}) was recorded the treatment of 100% organic manure equivalent to 75% N requirement of turmeric, followed by the treatment of 100% organic manure equivalent to 100% N requirement of turmeric with a yield of 33.21t ha^{-1} and 75% N requirement of turmeric + micronutrients with a yield of 32.69 t ha^{-1}. Moreover, dry matter content (13.95%) was found to be highest in the treatment of 100% organic manure equivalent to 100% N requirement of turmeric followed by the treatment of 100% organic manure + (Vermiwash 10%) and the treatment of 100% organic manure + micronutrients with a dry recovery 13.43% and 13.37% respectively.

Collaboration

AICRP on Spices centres works in collaboration with

- Technologies released from ICAR- IISR, Kozhikode
- 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 to tribal region
- State Department of Agriculture for increasing production, productivity and income for farmers
- Coffee Board for establishing coffee based black pepper cropping system wherever coffee is grown

Monitoring

The research projects and programs undertaken by various AICRPS centres were monitored by Project Coordinator and Scientists from PC unit's visit to various centres and the experimental plots. In this year visits taken up to 11 centres which includes regular, co-opting, voluntary and project mode centres. The activities of the centres were also monitored through monthly reports, half yearly and annual report sent by the centres. The annual workshop was conducted during 10th to 12th October 2017 at Horticultural Research Station, Dr. Y. S. R. Horticultural University, Lam, Guntur, Andhra Pradesh.

Rhizomes of 275 genotypes of turmeric exhibited at AICRPS centre of TNAU Coimbatore

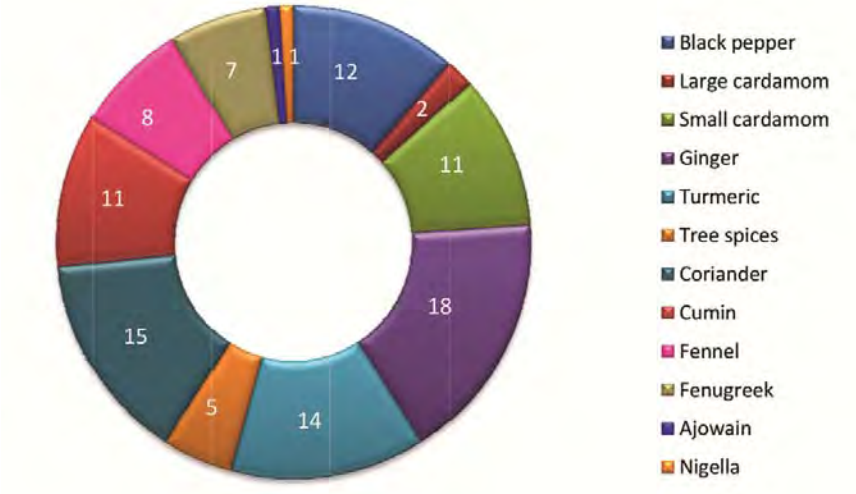
PROFILE OF AICRP ON SPICES

ICAR- All India Coordinated Research Project on Spices (ICAR-AICRPS) is the largest spices research network in the country through which a nationwide collaborative and interdisciplinary research is being carried out, linking ICAR system with the State Agricultural Universities and central institutions. AICRPS was initiated in 1971 as All India Spices and Cashew nut Improvement Project (AISCIP). In 1986 it has become a full-fledged coordinating unit for spices (major spices and seed spices) with its headquarters at Indian Institute of Spices Research, Kozhikode, Kerala. In VII plan (1986) it was having 12 centres and subsequently grew into 19 regular centres by the end of VIII Plan. AICRPS is working on 14 mandate crops *viz.*, Black Pepper, Small Cardamom, Large Cardamom, Ginger, Turmeric, Nutmeg, Cinnamon, Clove, Coriander, Cumin, Fennel Fenugreek, Ajowan and Nigella. Presently the network has 38 centres including 10 co-opting centres and 9 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

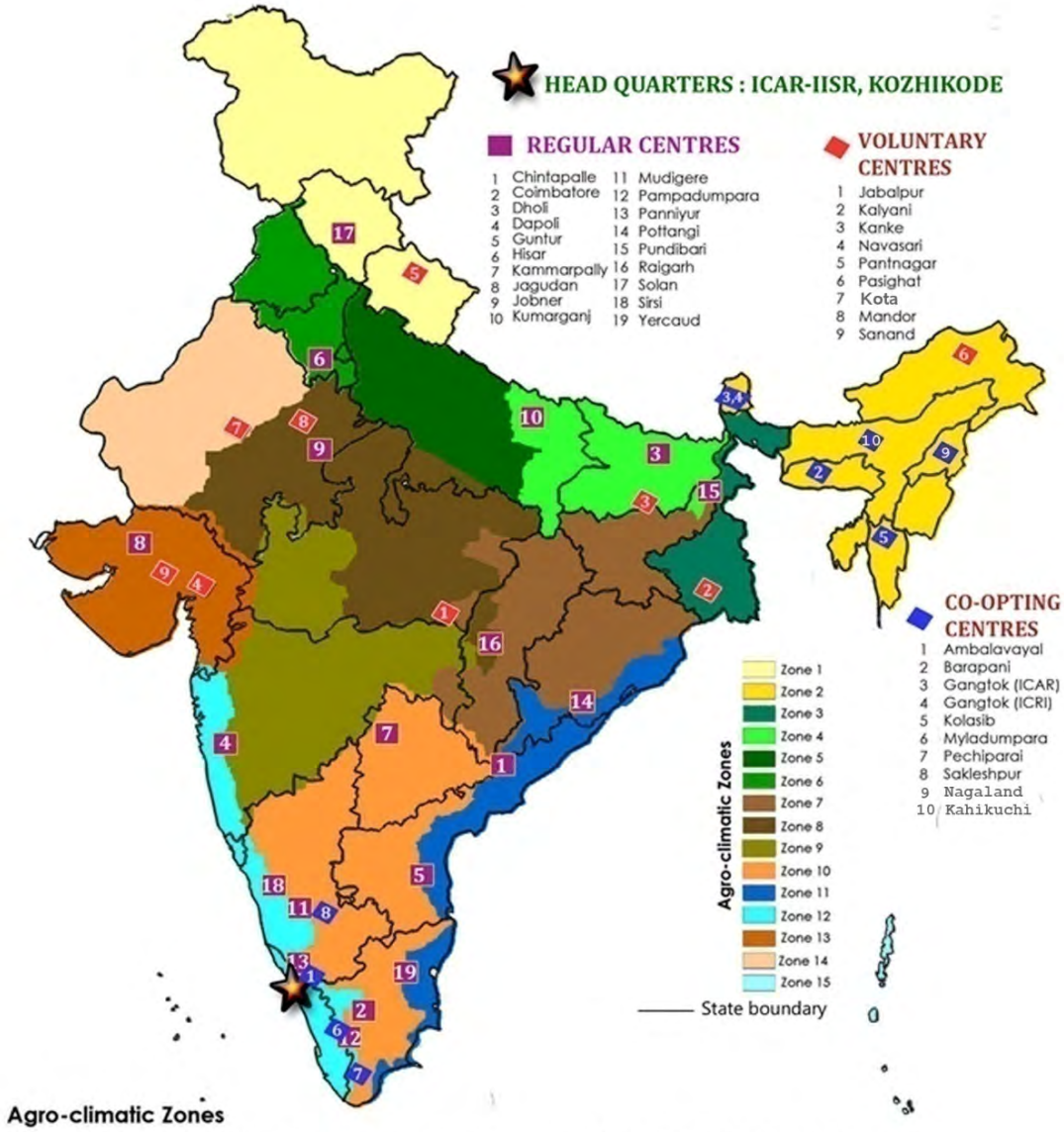


AICRPS centres, year of start and crops handled by the centre

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	Kamarpally	1986	Turmeric
16	Tamil Nadu	TNAU	Coimbatore	1975	Coriander, Fenugreek, Turmeric
17	Tamil Nadu	TNAU	Yercaud	1981	Clove, Nutmeg, Cinnamon, Black pepper
18	Uttar Pradesh	NDUAT	Kumarganj	1995	Turmeric, Ginger, Fennel, Coriander, Fenugreek
19	West Bengal	UBKV	Pundibari	1996	Black pepper, Turmeric, Ginger
Co-opting centres					
1	Assam	AAU	Kahikuchi	2014	Black pepper, Turmeric, Nutmeg
2	Karnataka	ICRI	Sakaleshapura	2008	Cardamom
3	Kerala	KAU	Ambalavayal	2008	Black pepper, Ginger, Turmeric,
4	Kerala	ICRI	Myladumpara	2008	Cardamom
5	Meghalaya	ICAR RC NEHR	Barapani	2008	Ginger, Turmeric
6	Mizoram	ICAR RC NEHR	Mizoram	2008	Ginger, Turmeric
7	Nagaland	SASRD	Medziphema	2014	Black pepper, Ginger, Turmeric
8	Sikkim	ICRI	Gangtok	2008	Large Cardamom
9	Sikkim	ICAR RC NEHR	Gangtok	2008	Large Cardamom, Ginger, Turmeric
10	Tamil Nadu	TNAU	Pechiparai	2008	Black pepper, Cinnamon, Clove, Nutmeg
Voluntary centres					
1	Arunachal Pradesh	CAU	Pasighat	2008	Large Cardamom, Ginger, Turmeric
2	Gujarat	NAU	Navasari	2008	Black pepper, Turmeric, Coriander
3	Gujarat	AAU	Sanand	2014	Cumin
4	Jharkhand	BIRSA AU	Kanke	2008	Ginger, Turmeric
5	Madhya Pradesh	JNKVV	Jabalpur	2008	Coriander, Fennel, Fenugreek
6	Rajasthan	AUK	Kota	2008	Coriander, Cumin, Fennel, Fenugreek
7	Rajasthan	AUJ	Mandor	2014	Cumin
8	Uttarkhand	GBPUA&T	Pantnagar	2008	Turmeric, Coriander, Fennel, Fenugreek
9	West Bengal	BCKV	Kalyani	2008	Ginger, Turmeric

Agro-climatic zones in India

CENTRES OF AICRP ON SPICES



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 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 (2017-18)

Project Code	Title	Centres
	Black Pepper	
PEP/CI/1	**Genetic Resources**	
PEP/CI/1.1	Germplasm collection, characterization, evaluation and conservation	Ambalavayal, Chintapalle, Dapoli, Panniyur, Pundibari, Sirsi, Yercaud
PEP/CI/2	**Hybridization trial**	
PEP/CI/2.1	Inter-varietal hybridization to evolve high yielding varieties	Panniyur
PEP/CI/2.2	Hybridization to evolve varieties tolerant to biotic and abiotic stresses	Panniyur
PEP/CI/3	**Coordinated Varietal Trial (CVT)**	
PEP/CI/3.3	CVT 2006 Series VI	Chintapalle, Dapoli, Panniyur, Pampadumpara, Sirsi, Yercaud
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/5.3	Trial on management of *Phytophthora* foot rot of black pepper in new plantation	Chintapalle, Mudigere, Dapoli
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 cardamom* 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/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 and 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/2.4	CVT 2015-Series IX	IISR, Dholi, Pottangi, Pundibari, Kalyani, Solan, Nagaland
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 EvaluationTrial2016(IET2016)	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/5.5	Source sink relationship	IISR, Kanke, Mizoram, Pundibari, Solan, Barapani
GIN/CM/5.6	Organic production of ginger	Barapani, Mizoram
GIN/CM/5.7	Effect of micronutrients on growth and yield of ginger (Demonstration trial)	Pottangi, Chintapalle
GIN/CM/5.8	Effect of organic manures and bio fertilizers on partitioning of dry matter in ginger	Dholi
GIN/CM/5.9	Organic production of ginger	Ambalavayal, Pottangi, Chinthapalle, Dholi, Barapani, Kammarpally, Kumarganj, Pundibari, Raigarh, Solan, Kalyani, Mizoram

GIN/CM/5.10	Effect of micronutrients on growth and yield of ginger	Pottangi, Chinthapalle, 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, Chinthapalle, 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, Pundibari, Pottangi, 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 (IET 2016)	Solan, Pottangi, Pundibari
TUR/CM/5	**Nutrient Management Trial**	
TUR/CM/5.9	Source sink relationship in turmeric	Coimbatore, IISR, Guntur, Kammarpally, Dholi, Barapani
TUR/CM/5.10	Organic production of turmeric	Barapani, Mizoram
TUR/CM/5.14	Organic production of turmeric 2017	Barapani, Chinthapalle Coimbatore, Dholi, Guntur, Kammarpally, Kumarganj, Mizoram, Pantnagar, Pasighat, Pottangi, Pundibari, Raigarh, Solan
TUR/CM/5.15	Effect of micronutrients on growth and yield of turmeric	Chinthapalle , Coimbatore, Dholi, Kammarpally, Kumarganj, Pantnagar, Pasighat, Pottangi, Pundibari, Raigarh, Solan
TUR/CP/7	**Disease Management Trial**	
TUR/CP/7.1	Survey and identification of disease causing organisms in turmeric and screening of turmeric germplasm against diseases (Disease Surveillance)	Coimbatore, Pundibari, Dholi, Raigarh
TUR/CP/7.3	Assessment of fungicide and biological control agents against foliar disease of turmeric	Coimbatore
TUR/CP/7.4	Management of foliar diseases in turmeric using tolerant lines	Kumarganj, Pundibari, Raigarh, Kammarapally, Solan, Guntur
TUR/CP/7.5	Eco-friendly management of foliar diseases of turmeric	Kumarganj
TUR/CP/7.6	Field screening of different varieties of turmeric against leaf spot and rhizome rot	Dapoli

TUR/CP/7.7	Effect of PGPR biocapsule on growth and yield of turmeric	Chinthapalle , Coimbatore, Dholi, Kammarpally, Solan Kumarganj, Pantnagar, Raigarh, Pasighat, Pottangi, Pundibari,
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	CVT on farmers varieties of Nutmeg	Dapoli, Pechiparai, Thrissur
Project Mode	Evaluation of nutmeg genotypes	KAU, Thrissur
	Coriander	
COR/CI/1	**Genetic Resources**	
COR/CI/1.1	Germplasm collection, description, characterization, evaluation, conservation and screening against diseases	Coimbatore, Dholi, Guntur, Hisar, Jagudan, Jobner, Kumarganj, Raigarh
COR/CI/1.3	Identification of drought/alkalinity tolerant source in coriander	Jobner
COR/CI/1.4	Multilocation evaluation of coriander germplasm - 2015	Ajmer, Guntur, Coimbatore, Dholi, Hisar, Jobner, Jagudan, Kota, Kumarganj, Raigarh
COR/CI/2	**Coordinated Varietal Trial**	
COR/CI/2.6	Coordinated Varietal Trial on coriander 2015-Series IX	Ajmer, Coimbatore, Dholi, Guntur, Hisar, Jabalpur, Kota, Jagudan, Jobner, Kumarganj, Navsari, Pantnagar, Raigarh
COR/CI/2.7	Coordinated Varietal Trial on coriander 2018-Series X	Ajmer, Coimbatore, Dholi, Guntur, Hisar, Jabalpur, Jagudan, Jobner, Kumarganj, Navsari, Pantnagar, Raigarh Kota,
COR/CI/3	**Varietal Evaluation Trial**	
COR/CI/3.8	Initial Evaluation Trial 2015	Guntur, Jagudan, Kumarganj, Dholi, Raigarh
COR/CI/3.9	InitialEvaluationTrial–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 multicut management practice	Jagudan
COR/CM/5.7	Standardization of drip irrigation and fertigation in coriander	Ajmer, Jobner, Guntur, Kumarganj
COR/CP/6	**Disease Management Trial**	
COR/CP/6.2	Survey to identify the disease incidence, collection and identification of causal organism in coriander	Dholi
COR/CP/6.4	Studies on the management of coriander powdery mildew using new generation fungicides (Observational trial)	Coimbatore, Raigarh, Jobner, Jagudan and Kumarganj
COR/CP/6.5	Eco-friendly management of stem gall of coriander (Observational trial)	Kumarganj
COR/CP/6.6	Integrated management of stem gall disease of coriander	Dholi

COR/CP/6.7	Integrated pest & disease management in coriander	Ajmer, Coimbatore, Dholi, Guntur, Hisar, Jabalpur, Jagudan, Jobner, Kumarganj, Navsari, Pantnagar, Kota, Raigarh
Cumin		
CUM/CI/1	**Genetic Resources**	
CUM/CI/1.1	Germplasm collection, characterization, evaluation, conservation and screening against diseases	Jagudan, Jobner, Mandor, Sanand
CUM/CI/1.2	Multilocation evaluation of cumin germplasm	Ajmer
CUM/CI/1.3	Identification of drought tolerance	Jobner
CUM/CI/2	**Coordinated Varietal Trial**	
CUM/CI/2.5	Coordinated Varietal Trial – 2017	Ajmer, Jagudan, Jobner, Mandor
CUM/CI/3	**Varietal Evaluation Trial**	
CUM/CI/3.5	IET on Cumin 2013	Jagudan
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 & disease management in cumin	Ajmer, Jagudan, Jobner, 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, Jobner, Kumarganj, Hisar
FNL/CI/2	**Coordinated Varietal Trial**	
FNL/CI/2.6	Coordinated Varietal Trial on Fennel 2015 Series – Series IX	Ajmer, Dholi, Hisar, Jabalpur, Jagudan, Jobner, Kumarganj, Pantnagar
FNL/CI/2.7	Coordinated Varietal Trial on Fennel 2018 Series – Series X	Ajmer, Dholi, Hisar, Jabalpur, Jagudan, Jobner, Kumarganj, Pantnagar
FNL/CI/3	**Varietal Evaluation Trial**	
FNL/CI/3.4	Initial Evaluation Trial 2014	Jobner, Pantnagar, Hisar
FNL/CI/3.5	Initial Evaluation Trial 2015	Jagudan, Kumarganj, Dholi
FNL/CI/4	**Quality Evaluation Trial**	
FNL/CI/4.1	Quality Evaluation in Fennel	Jobner
FNL/CM/5	**Nutrient Management Trial**	
FNL/CM/5.5	Standardization of drip fertigation in fennel	Jobner

Fenugreek		
FGK/CI/1	**Genetic Resources**	
FGK/CI/1.1	Germplasm collection, characterization, evaluation, conservation and screening against diseases	Dholi, Guntur, Hisar, Jagudan, Jobner, Kumarganj, Raigarh
FGK/CI/1.2	Multilocation evaluation of fenugreek germplasm	Ajmer, Jobner, Hisar, Kumarganj
FGK/CI/1.3	Identification of drought tolerance source in fenugreek	Jobner
FGK/CI/2	**Coordinated Varietal Trial**	
FGK/CI/2.4	Coordinated Varietal Trial of fenugreek 2015 – Series IX	Ajmer, Coimbatore, Dholi, Guntur, Hisar, Jagudan, Jabalpur, Jobner, Kumarganj, Pantnagar, Navsari, Raigarh, Kota
FGK/CI/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/3.6	Initial Evaluation Trial 2014	Dholi, Hisar
FGK/CI/3.7	Chemo-profiling for identification of industrial types among the released varieties of fenugreek	Ajmer, Coimbatore, Guntur, Dholi, Hisar, Jobner, Kumarganj
FGK/CI/3.8	Initial Evaluation Trial 2015	Kumarganj, Jagudan, Jobner
Project Mode	Evaluation of coriander, fenugreek and fennel for growth, yield and quality parameters under Bengaluru conditions	COH, Bengaluru
Ajowain		
AJN/CI/2	**Coordinated Varietal Trial**	
AJN/CI/2.1	Coordinated Varietal Trial–2016	Ajmer, Jobner, Jagudan, Raigarh, Hisar, Kumarganj, Guntur
Nigella		
NGL/CI/2	**Coordinated Varietal Trial**	
NGL/CI/2.1	CoordinatedVarietalTrial–2016	Ajmer, Raigarh, Hisar, Kumarganj, Kota, Kalyani, Pantnagar

I. 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)

At present 313 cultivated types, 54 wild types and 3 exotic types of black pepper are being maintained at PRS, Panniyur. The number of genotypes of black pepper maintained at AICRPS centres of Panniyur, Sirsi, Chintapalle, Ambalavayal, Pundibari and Dapoli are 370, 238, 26, 30, 31and 54 respectively (Table 1).

The Pepper Research Station, Panniyur has surveyed the back pepper growing regions of Kerala and collected five drought tolerant genotypes. HRS, Sirsi has collected 14 new accessions of black pepper from the regions of Yellapur, Sirsi and Siddapur in Karnataka. Dapoli centre has collected 2 elite types of black pepper during 2017-18.

During the year 2017, the genotypes PRS 64, PRS 136 and PRS 154 were the top yielders. PRS 64 ranked first with 4.95 kg green berry yield and 1250 spikes per vine. Spike length was maximum for PRS 155 (15.2 cm). The number of developed berries/spike was more for PRS 137 (68.0). The 100 berry weight was high for PRS 154 (12.4 g). The dry recovery % was more for PRS 136 (37 %).

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

Centres	Indigenous				Exotic	Total
	Cultivated		Wild and related species			
	Existing	Addition (2017-18)	Existing	Addition (2017-18)		
Pampadumpara	51	1	-	-	-	52
Ambalavayal	30	-	-	-	-	30
Chintapalle	26	-	-	-	-	26
Dapoli	52	2	-	-	-	54
Panniyur	308	5	54	-	3	370
Pundibari	19	-	11	1	-	31
Sirsi	217	14	6	1	-	238
Yercaud	69	-	3	-	-	72
Total	**772**	**22**	**74**	**2**	**3**	**873**

Twenty two accessions were evaluated for quality characters; maximum essential oil content was recorded in P-1, SV-7, SV-12 and SV-16at HRS, Sirsi. Highest oleoresin (10.74%) and piperine (5.49%) content was seen in SV-7 (Fig 1). Panniyur -1 recorded the highest number of spikes per vine (712), fresh berry yield per vine (4.32 kg), dry yield (1.40 kg), fresh yield per ha (4.80 t ha^{-1}) whereas Neelamundi recorded the highest number of berries per spikes (87) at Chintapalle.

Among the 78 germplasm accessions maintained at Yercaud, berry setting was observed in 28 accessions and significant difference was observed for the characters like spike length, number of berries per spike, 100 green berry weight, 100 dry berry weight, green berry yield and dry berry yield. Spike length was observed to be the highest in PN 54 (12.9 cm) (Fig 1) and lowest in PN 5 (7.2 cm).The accession PN 60 had more number of berries per spike (78.3) where as only 28.3 berries were observed in the accession PN 6. Dry berry weight for 100 berries was highest in the accession PN 46 (3.85 g) followed by PN 55 (3.81 g) and the lowest in the accession PN 80 (2.82 g). The accession PN 51 recorded the highest green berry yield per vine (2.66 kg) followed by PN 55 (2.64 kg) and the lowest in PN 58 (1.76 kg) and the accession PN 5 recorded the highest dry berry yield per vine (1.016 kg) followed by PN 11 (0.888 kg) and the lowest in PN 33 (0.521 kg).

Fig 1: Promising accession from Yercaud & Sirsi

Crop Improvement

PEP/CI/2 Hybridization trial

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

(Centre: West coast plains and ghat region - Panniyur)

The hybrids PRS 160, PRS 161 and PRS 165 were found to be promising with mean green berry yield of 5.90 kg vine^{-1}, 6.32 kg vine^{-1} and 4.93 kg vine^{-1} respectively at Panniyur centre. Number of spikes per vine was higher for PRS 161 (895). Spike length was maximum for PRS 161 (18.1 cm). 100 berry weight was higher for PRS 161 (19.0).

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

(Centre: West coast plains and ghat region - Panniyur)

The seedlings of PRS 4 x PRS 8 and P 1 x PRS 78 were planted. The hybridization of P1 x PRS 4 and P1 x PRS 48 were carried out during the year.

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 Chintappalle, fresh berry yield was highest in Panniyur-1 (637.77g) followed by P-8 (507.44 g) and C-1090 (472.02g) (Table 2). It was observed that all varieties are susceptible to *Phytophthora* foot rot disease. At Dapoli, Panniyur 1 recorded highest yield 1.23 kg per plant followed by ACC 53 (0.750 kg plant^{-1}) whereas at Panniyur, the genotype HB 20052 recorded the highest green berry yield of 4.57 kg per vine followed by Acc.no.53 (4.38kg vine^{-1}). While at Sirsi, maximum dry berry yield per vine was recorded in Panniyur-1 (650.4g) followed by PRS-88 (456.3 g).

Fig 2: Black pepper trailed on arecanut at Sirsi

Table 2: Variation in green berry yield (g per vine) of black pepper at various centres

Black pepper accessions	Chintapalle	Dapoli	Panniyur	Pampadumpara	Mean
HB20052 (P-8)	507.44	72.33	4500	1200	1569.94
PRS-88	103.26	55.00	3780	1100	1259.57
ACC.53	105.53	75.00	4380	700	1315.13
ACC 106	127.89	60.67	3400	1000	1147.14
ACC 33	472.02	78.67	3800	1000	1337.67
ACC 57	354.67	54.33	3410	700	1129.75
C-1090	476.40	38.33	3700	600	1203.68
HP-39	260.23	35.00	3710	500	1126.31
Panniyur-1	663.77	123.33	4160	1500	1611.78
Mean	341.25	65.85	3871.11	922.22	1300.11

Among characters studied at Pampadumpara, highest fresh and dry (1.5 kg and 0.494 kg) weight of berries per vine was registered for *Panniyur-1* which is on par with *Karimunda* (1.4 kg and 0.457 kg).The yield attributing characters had significant difference between the accessions. In Yercaud, the green berry and dry berry yield were highest in the variety IISR Shakthi with 0.510 kg and 0.163 kg respectively. Also, the number of spikes per meter square was highest in the variety (50) IISR Shakthi.

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 hill region - Yercaud)

Three farmer varieties of black pepper *viz.*, Zion Mundi, Pepper Thekken and Kumpukkal along with a local check and national check Panniyur-1 are evaluated at different AICRPS centres

During 2017, all the vines except Kumbukkal and Zion mundi are in the vegetative stage and there was no significant difference between the treatments for morphological characters at Panniyur centre. Kumbukkal recorded a mean dry berry yield of 112 g and mean spike length of 8.56 cm. Zion mundi recorded a mean dry berry yield of 25 g and mean spike length of 8.62 cm.

At Dapoli, Sirsi and Yercaud centre the growth of all genotypes was found to be satisfactory. The genotype Panniyur 1 recorded highest plant height (0.90 m) followed by Pepper Thekken (0.65 m) at Dapoli whereas at Chintappalli, Kumpukkal variety recorded maximum plant height (57.33 cm) followed by Panniyur-1 (52.33 cm).

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; East coast plains and hill region – Yercaud; Eastern Himalayan Region –Kahikuchi)

Crop is at vegetative stage in the centres like Chintapalle, Dapoli, Panniyur, Sirsi, Yercaud and Kahikuchi.

Crop Management

PEP/CM/4 Nutrient Management Trial

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)

The intercrops such as tapioca, arrowroot, and elephant foot yam, greater yam and colocasia are suited for intercropping in juvenile black pepper garden which evidently adds to the income generated. From the yield data at Ambalavayal, tapioca (10.18 t ha^{-1}) recorded maximum yield followed by arrowroot and elephant foot yam with 4.81 t ha^{-1} and 3.62 t ha^{-1} yield respectively.

During 2017-18 good yield was obtained at Panniyur except in arrow root and tapioca. Among the intercrops T_3- elephant foot yam recorded maximum yield of 8.53 kg followed by T_5 -greater yam (7.25 kg) from an inter space of 4m x 2 m spacing between black pepper. Similarly in Sirsi centre, elephant foot yam recorded maximum yield of 4.6 kg pre plant followed sweet potato (2.1 kg $plant^{-1}$).

At Dapoli, the yield of intercrops varied as colocasia 3.98 t, arrow root 4.30 t, elephant foot yam 12.83 t, tapioca 10.42 t and greater yam 9.97 t (Table 3). The yield obtained in different mixed crop blocks for pineapple varied as 3.54 t in colocasia, 3.68 t in arrow root, 3.68 t in elephant foot yam and 3.10 t in tapioca Monocrop black pepper did not produced additional yield in the initial pre bearing stage in black pepper plantations.

Table 3: Yield of mixed crops in juvenile black pepper based mixed cropping system (2015-2018) at Dapoli.

Sl. No.	Treatment	2015-16 Yield (t/ ha)		2016-17 Yield (t/ ha)		2017-18 Yield (t/ ha)	
		Tuber crop	Pineapple	Tuber crop	Pineapple	Tuber crop	Pineapple
1	T_1- Black pepper + Colocasia + Pineapple	3.35	--	4.29	12.20	3.98	3.54
2	T_2- Black pepper + Arrow root + Pineapple	3.59	--	4.66	12.46	4.30	3.68
3	T_3- Black pepper + Elephant foot yam + Pineapple	9.91	--	12.83	14.02	12.11	3.68
4	T_4- Black pepper + Tapioca + Pineapple	9.92	--	10.67	13.76	10.42	3.10
5	T_5- Greater yam	6.85	--	10.19	–	9.97	–
6	T_6- Monoblock (Black pepper alone)	--	--	-	–	–	–

Crop Protection

PEP/CP/5 Disease Management Trial

PEP/CP/5.3 Trial on management of *Phytophthora* foot rot of black pepper in new plantation

(Centres: East coast plains and hill region – Chintapalle; West coast plains and ghat region Mudigere; Western plateau and hills region - Dapoli)

Application of *Trichoderma* (MTCC 5179)+ consortium of bacteria (IISR-6+ IISR-859) (T4) at Chintappalli recorded less incidence of yellowing, defoliation, death of vines and higher yield as compared with remaining treatments in all three varieties of Black pepper. Among three varieties tested, IISR Shakti recorded lowest yellowing and defoliation.

At Mudigere, the plants did not established properly and it requires replanting with IISR Thevam and IISR Shakthi.

The disease intensity of *Phytophthora* leaf blight was minimum on IISR Thevam (4.64%), IISR Shakthi (6.40%) and Panniyur-1 (6.64%) in the treatment T_4, *Trichoderma harzianum* (10^8cfu @ 50g/vine) mixed with one kg of neem cake + Consortium of bacteria (*Pseudomonas fluorescens* IISR-6 (10^6 cfu) & IISR-859 (10^8 cfu) @ 1 g L^{-1} each 3 L per vine and was at par with Potassium phosphonate (@ 0.3 per cent) as spray (@ 2 l per vine) + *Trichoderma harzianum* (10^8cfu @ 50g per vine) mixed with one kg of neem cake at Dapoli

PEP/CP/5.6 Biological Management of Slow Decline in Black Pepper

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

During 2017-18, all the treatments were significantly superior in reducing yellowing due to slow decline disease in black pepper. Application of *Trichoderma viride* + Neem cake @ 2 kg per vine (T1) recorded

maximum yield of 3.109 kg per vine, disease intensity of 5.63 % at Panniyur centre. Whereas at Sirsi, soil application of copper oxy chloride @ 0.3% + Cartap hydrochloride @ 15g/vine showed positive response against slow decline.

Minimum per cent disease intensity was recorded (6.78) in the treatment with soil application of *Pochonia chlamydosporia* @ 2kg per vine followed by soil drenching with *Pseudomonas fluorescens* IISR-6 @ 2% maximum spike number and minimum (10^6cfu) (drench 3 l per vine) and was significantly superior to rest of the treatments at Dapoli (Fig 3). Maximum per cent reduction (68.33) in the disease was observed in vines treated during onset of monsoon, June and again during third week of August with soil application of *Pochonia chlamydosporia* @ 2kg per vine followed by soil drenching with *Pseudomonas fluorescens* @ 2%.

Fig 3: Experimental plot of biological management of slow decline in black pepper at Dapoli

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

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

At Dapoli, the treatment T_3, application of fungicide (Fosetyl - Al) amended fertilizer briquettes (0.3%) was found to be effective with minimum PDI of 6.64% and 78.76 % per cent disease reduction over control. Soil application of *Trichoderma harzianum* + *Pochonia chlamydosporia* with PDI of 7.11% *was* at par with each other

The biometric characters *viz.*, plant height and no of leaves and percentage disease incidence did not show significant variation among different treatments at Panniyur and the experiment is in the initial stage.

Application of copper oxychloride drenching + Bordeaux mixture spray and soil application of *T. harzianum* (IISR) + *P. chlamydosporia* found effective compared to other treatmentsat Sirsi.

II. SMALL CARDAMOM

Genetic Resources

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

(Centres: West coast plains and ghat region - Mudigere, Pampadumpara)

Germplasm of small cardamom is maintained at Mudigere and Pampadumpara (Table 4)

Among the 189 cardamom accessions conserved in the gene bank of Pampadumpara, 73 accessions (CRSP 1-73) received IC numbers (547920 to 547992) from the National Bureau of Plant Genetic Resources, New Delhi. All the characters including yield and biotic stress characters, except *Azhukal* incidence had shown significant difference among the accessions at 5% confidence levels. HY 13 recorded the highest fresh yield (3.4 kg/plant) followed by HY 12 (2.7 kg/plant) and they were significantly different from each other. The same trend was also observed for dry yield of capsules per plant.

132 cardamom germplasm lines conserved at Mudegere consists of 67 local collections, 35 collections from other institutions and 30 breeding materials (Fig 4).

Fig 4: Field repository of cardamom germplasm at Mudegere

Table 4: Cardamom germplasm collections of AICRPS centres

Centre	Indigenous				Total
	Cultivated		Wild & related spp.		
	Existing	Addition (2017-18)	Existing	Addition (2017-18)	
Mudigere	127	-	5	-	**132**
Pampadumapra	184	4	1	-	**189**
Total	**311**	**4**	**6**		**321**

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 cardamom* Maton) cultivars/varieties for organic cultivation in the high ranges of Idukki district

(Centre: West coast plains and ghat region - Pampadumpara)

In this experiment, maximum fresh weight (1618.70 g plant^{-1}) of capsules was recorded by PV1 which is on par with PV2 (1528.7 g plant^{-1}) but the maximum dry weight was observed in PV 2 (363.8 g plant^{-1}). The lowest wet and dry yield was registered in GG and was significantly inferior to all others. The incidence of thrips, shoot borer and *azhukal* was more in GG whereas *Azhukal* incidence was less in PV2.

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)

Eight varieties viz., IC 349537, IC 584058, GG X NKE- 12, IC 584078, CL 668, HS 1, Appangala 1 and IC 584090 were planted at Appangala, Mudigere, Myladumpara, Pampadumpara and Sakleshpur (Table 5). Morphological observation revealed that in general plants in the control (without moisture strss, T_1) recorded vigorous growth as compared to the moisture stress plot (T_2).

Table 5: Variation in small cardamom genotypes with regard to moisture stress and without stress at Sakleshpur

T_1 Control- Without stress								
Genotypes	No. of tillers	Height of tallest tiller	No. of leaves /tiller	No. bearing tillers	No. of panicles /clump	Length of panicles (cm)	No. of Raceme /panicles	No. of capsule /raceme
IC-349537	17.10	171.50	14.00	6.10	7.55	31.41	10.99	5.10
IC-584058	6.20	143.42	12.80	2.71	1.58	7.20	3.01	1.35
GG x NKE 12	8.10	125.14	13.25	2.50	1.10	6.91	3.11	0.95
IC-584078	5.20	139.24	11.60	1.90	1.05	6.10	2.00	1.10
CL-668	9.20	128.52	10.10	1.95	5.90	6.88	3.10	0.90
HS-1	12.6	135.62	12.80	4.70	10.21	9.92	5.10	1.71
Appangala -1	13.8	132.97	12.35	4.21	10.90	12.01	6.10	1.95
IC-584090	7.20	148.60	12.50	2.90	13.10	15.10	7.62	3.89
T_2 Moisture stress								
Genotypes	No. of tillers	Height of tallest tiller	No. of leaves /tiller	No. bearing tillers	No. of panicles /clump	Length of panicles (cm)	No. of Raceme /panicles	No. of capsule /raceme
IC-349537	6.81	130.19	12.01	2.10	0.39	2.65	1.72	0.30
IC-584058	3.80	105.13	10.18	1.55	0.21	2.42	1.78	0.92
GG x NKE 12	4.7	118.34	10.79	1.61	0.29	2.20	1.52	0.52
IC-584078	3.90	144.72	11.85	1.15	0.26	1.51	1.2	0.36
CL-668	4.50	85.50	9.29	1.20	0.28	1.52	1.4	0.39
HS-1	5.50	110.52	10.55	1.75	0.32	2.14	1.66	0.56
Appangala -1	3.56	124.34	10.59	1.05	0.18	0.67	0.46	0.15
IC-584090	3.52	135.65	10.80	1.10	0.20	1.54	1.04	0.35

At Mudegere, more number of tillers was observed in the varieties viz., HS-1 (32) and IC 349537 (29) in control plot than in moisture stress plot of HS-1 (17) and IC 349537 (14).

At Sakleshpur, under moisture stress the genotype, IC 349537 registered more number of bearing tillers (2.10), number of panicles (0.39) and long panicles (2.65 cm). Also, under control (without moisture stress), IC 349537 has registered more number of bearing tillers (6.10), long panicles (31.41 cm), number of racemes per panicle (10.99) and number of capsules per racemes (5.10) (Table 5).

Morphological parameters observed at Appangala revealed that plant height ranged from 162.7 to 175cm and 169.3 to 184.7 cm in control and in stress treatment respectively. Total tillers ranged from 19.5 to 24.5 and in stress ranged from 21.3 to 27.4. Number of capsules ranged from 22.7 to 36.0 in control and stress ranged from 24.1 to 36.2. The genotype, IC 584058 recorded bold capsule with early bearing of capsule.

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

(Centres: West coast plains and ghats region – Appangala, Mudigere, Myladumpara, Pampadumpara)

Eight farmer's varieties of small cardamom *viz., Arjun, Wonder Cardamom, Panikulangara, Thiruthali, Elarajan, Pachakai, Paupali, Njallani* supplied by National Innovation Foundation (NIF) which were put for multiplication in the last year were planted in a completely randomized design along with Local check variety Appangala-1. One more farmer's variety *i.e.*, PNS Gopinath supplied by NIF is also included in the trial this year. Plants are establishing well at Appangala, Mudegere, Myladumpara and Pampadumpara.

CAR/CI/4 Varietal Evaluation Trial (VET)

CAR/ CI/4.3 Initial Evaluation Trial – 2012

(Centre: West coast plains and ghats region – Pampadumpara)

Observations revealed that maximum number of tillers was produced by BEP 2 (39.3) which is on par with PV 2 (35.0). Maximum leaf length (65 cm) and leaf width (12.2 cm) was observed in PV 2 which is on par with HY 6, PPK 2 and HY 9. Number of panicle was more in GG (29.7) but the length of panicle was maximum in PV2 (41.8 cm).

CAR/CI/4.4 Multilocation evaluation of thrips tolerant cardamom lines

(Centres: West coast plains and ghats region –Mudigere, Myladumpara, Pampadumpara; Southern plateau and hills region - Sakleshpur)

Thrips tolerant lines *viz.*, IC 349362, IC 349364, IC 349370, IC 349606 along with Njallani Green Gold and local check was planted at Mudegere, Myladumpara, Pampadumpara and Sakleshpur. The plants were established in the field and 6-7 new tillers were formed. The experiment was started in this year and plants are in early vegetative stage.

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 ghats region –Mudigere, Myladumpara, Pampadumpara; Southern plateau and hills region - Sakleshpur)

At Mudigere, all the treatments were found effective when compared to control. The minimum tiller infection of (3 %) with higher yield of 740.00 g plant^{-1} was recorded in T_1 *i.e.* spraying of 0.2 % Bavistin which is followed by T_5 *i.e.,* application of *T. harzianum* with Neem cake and spraying of 0.2 % *Pseudomonas fluorescens* gave disease incidence of 4.5%.

At Myladumpara, two rounds (February and March) of insecticide spray were given. Thrips population on leaf sheath and capsule damage (fresh) were recorded.The pooled data for the observation on thrips infestation after seven sprays at Pampadumpara revealed that, fipronil 5 SC @ 0.005% applied plants showed highest per cent reduction of infestation (88.26%), whereas Imidacloprid 17.8 SL @ 0.0089% stood next (78.74%) in its effectiveness. Spinosad 45 SC @ 0.0135% and quinalphos 25 EC @ 0.05% were also found effective in reducing the infestations (75.29% and 70.31% respectively) and were on par with each other.

After 30 days of insecticide spray at Sakleshpur, maximum reduction in capsule damage was recorded in T2-Imidaclorpid (22%) followed by T3- Fipronil (20%).The samples of cardamom from different treatments are being analyzed for residue levels in quality evaluation laboratory, Spices Board, Kochi.

Fig 5: Full bearing plant of small cardamom variety Appangala 1

III. 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)

A total of 313 germplasm accessions of large cardamom are maintained at ICAR (RS), Gangtok and ICRI (RRS), Gangtok (Table 6).

A total of 10 genotypes of large cardamom *viz*., Ramsey, Sawney, Dzongu Golsey, Varlangey, Seramney, Madhusai and Dudhe Golsai of large cardamom are being maintained at ICAR RS, Gangtok.

Survey was conducted during April and July, 2017 at different areas of North districts of Sikkim, Sumsing, Chingsa, Riew Longkey Upper Siangin Arunachal Pradesh for collection of germplasm. Fourteen germplasm accessions were collected and planted under AICRPS at ICRI, RRS, Spices Board, Tadong, Gangtok research farm. Characterizations of the collected germplasm were made as per descriptor.

Table 6: Large cardamom collections maintained at AICRPS centres

Centre	Existing	Addition (April 2017 to March 2018)	Total
ICAR RS, Gangtok	7	10	17
ICRI RRS, Gangtok	285	14	299
Total	292	24	316

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 survey has been initiated in the large cardamom plantations at ICAR- NOFRI, Research farm, Tadong to determine the pest occurrence of the previously recorded as well as new pests. From the survey it was observed that the infestation of different hairy caterpillar (Fig 6) was more during the month of Nov- December.

An experiment was conducted to evaluate the efficacy of biopesticides *viz*., neem oil (1500 ppm) @ 4 ml L^{-1}, *Beauveria bassiana* 7 g L^{-1}, *Metarhizium anisopliae* 5 ml L^{-1}, petroleum oil based agrospray @ 10 ml L^{-1}, petroleum oil based horticultural spray @ 10 ml L^{-1}, *Bacillus thuringiensis* @ 2 g L^{-1}, and spinosad 45 SC @ 0.3 ml L^{-1} against insect pests of large cardamom *viz*., stem borer, shoot fly, leaf eating caterpillar and tea mosquito bug. All the treatments showed effective results to control insect pests over the control. However, spinosad 45 SC @ 0.3 ml $L^{-1}$was found to be the most effective to control all the pests (69.91 to 81.32% reduction of infestation over control) followed by neem oil (1500 ppm) @ 4 ml L^{-1} (61.32 to 67.64% reduction of infestation

over control) and petroleum agrospray @ 10 ml L^{-1} (52.22 to 59.47% reduction of infestation over control).

The experiment was started in 2011 in farmer's field at Singhik, North Sikkim. It was observed that the incidence of the pests, blight and viral disease was less in treated plot than in the control plot (Table 7).

Table 7: Incidence (%) of pests and diseases in the field trial plots at Singhik, North Sikkim

Pests	Incidence %	
	Control	Phytosanitation and application of bio- agents,
Shoot fly	15.2	8.2
Leaf caterpillar	7.5	2.2
Blight	10.2	3.3
Chirke	1.5	-
Foorkey	1.0	-

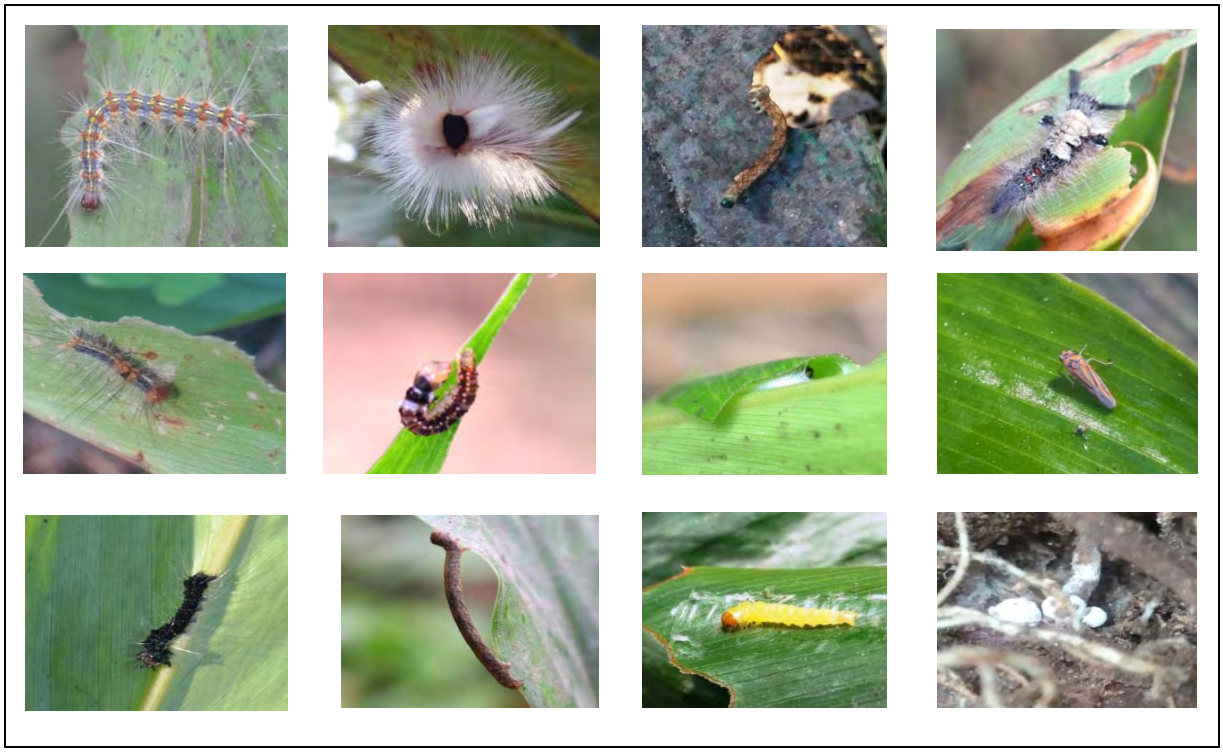


Fig 6: Hairy caterpillar & semi loopers found in large cardamom plantation

IV. 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 - Pottangi, Raigarh; Western Himalayan Region - Solan)

Ginger germplasm maintained at different AICRPS centres (Table 8).

Out of seventy four accessions at Dholi, only fifteen accessions namely RG-9, RG-60, RG-34, RG-17, RG-39, RG-22, RG-24, RG-65, RG-14, RG-38, RG-43, RG-56, RG-1, RG-35 and RG-29 recorded high yield ranging from 0.11 to 0.22 kg per plant and per plot 6.25 kg to 12.30 kg $6m^{-2}$ as compared to check variety Nadia *with* 0.09 kg per plant and per plot 5.27 kg $6m^{-2}$. Among fifteen promising accessions, RG-9 gave the highest fresh rhizome yield of 0.22 kg per plant and per plot 12.30 kg $6m^{-2}$ followed by RG-60 with fresh rhizome yield per plant 0.21kg and per plot 12.00 kg $6m^{-2}$.

A total of 63 germplasm of ginger were evaluated during 2017-18 at Kumarganj and the genotype NDG-55 was found to be promising in terms of high yield (442.00 g $plant^{-1}$). In different maturity groups of turmeric, maximum yield was obtained in NDH- 86 (270 g $plant^{-1}$), NDH-84 (255 g $plant^{-1}$) in early maturing types, NDH-98 (295 g $plant^{-1}$), NDH-49 (267 g $plant^{-1}$) in medium maturing and NDH-2 (285 g $plant^{-1}$), NDH-92 (265 g $plant^{-1}$) in late maturing types.

Among the 75 accessions of ginger evaluated at Pundibari centre, highest rhizome yield per plot was recorded in GCP-49 (7.26 kg per plot) and the lowest rhizome was recorded in GCP-61 (0.98 kg per plot). Maximum rhizome rot and wilt disease incidence was recorded in the accession GCP-74 (46.67 %) followed by GCP-45 (36.67) whereas lowest disease incidence was recorded in GCP-19 (10.13 %).

At Pottangi, out of 181 ginger germplasm evaluated, four accessions gave more than 10 $kg/3m^2$ fresh rhizome yield and 32 accessions yielded more than 5 $kg/3m^2$. The range of plot yield being 0.15 kg (No.6) to 13 $kg/3\ m^2$ (KG 132) with the mean yield of 3.7 kg /3 m^2. The highest fresh rhizome yield was recorded by KG 132 (28.9 t ha^{-1}) followed by PGS 41-1 (25.3 t ha^{-1}) and Zo 9 (25.1 t ha^{-1}).

At Raigarh, seven new germplasm were collected and tested for its performance for yield and disease conditions during *Kharif* 2017. For rhizome yield, the genotype RGC 2017-1 (8.9 t ha^{-1}), recorded maximum yield followed by RGC 2017- 3 (8.2 t ha^{-1}), RGC 2017-4 (7.4 t ha^{-1}), over two national checks Suprabha (2.5 t ha^{-1}) and Suruchi (1.7 t ha^{-1}).

One hundred and eighty five ginger genotypes were evaluated at Solan for rhizome yield and other horticultural traits. The yield range varied from 9.21 t ha^{-1} (SG-865) to 13.49 t ha^{-1} (SG-1134). Yield of five lines *viz.*, SG-1134 (13.49 t ha^{-1}), SG-247 (13.34t ha^{-1}), SG-1083 (13.24t ha^{-1}), SG BDJR 1088 (13.21 t ha^{-1}) and SG-857 (13.12t ha^{-1}) excelled the check Himgiri which yielded 12.06 t ha^{-1}. The rhizome rot disease incidence varied from 10.95-23.65% with 10.95% and 15.79 % in SG-857 and Himgiri, respectively.

Table 8: Ginger germplasm collections in AICRPS centres

Centre	Indigenous				Exotic	Total
	Cultivated		Wild & related spp.			
	Existing	Addition (2017-18)	Existing	Addition (2017-18)		
Dholi	74	-	-	-	-	74
Kumarganj	63	1	-	-	-	64
Pundibari	75	-	-	-	-	75
Pottangi	181	-	2	-	3	186
Solan	185	-	-	-	-	185
Total	**578**	**1**	**2**	**-**	**3**	**584**

Crop Improvement

GIN/CI/2 Coordinated Varietal Trial (CVT)

GIN/CI/2.4 CVT 2015-Series IX

(Centres: West coast plains and ghat region – Kozhikode; Middle gangetic plain region – Dholi, Pundibari; Eastern plateau and hills region – Pottangi; Western Himalayan Region – Solan; Lower Gangetic Plain Region – Kalyani; Eastern Himalayan Region - Nagaland)

The experiment was laid out at IISR Experimental Farm, Peruvannamuzhi, Kerala with seven different entries and a national check IISR Varada. Among the ginger accessions studied, maximum yield (pooled) was recorded in Acc. 247 (20.69 t ha^{-1}) followed by Rio-de-Janeiro (17.75 t ha^{-1}) and SE 8681 (15.81 t ha^{-1}) (Fig 7).

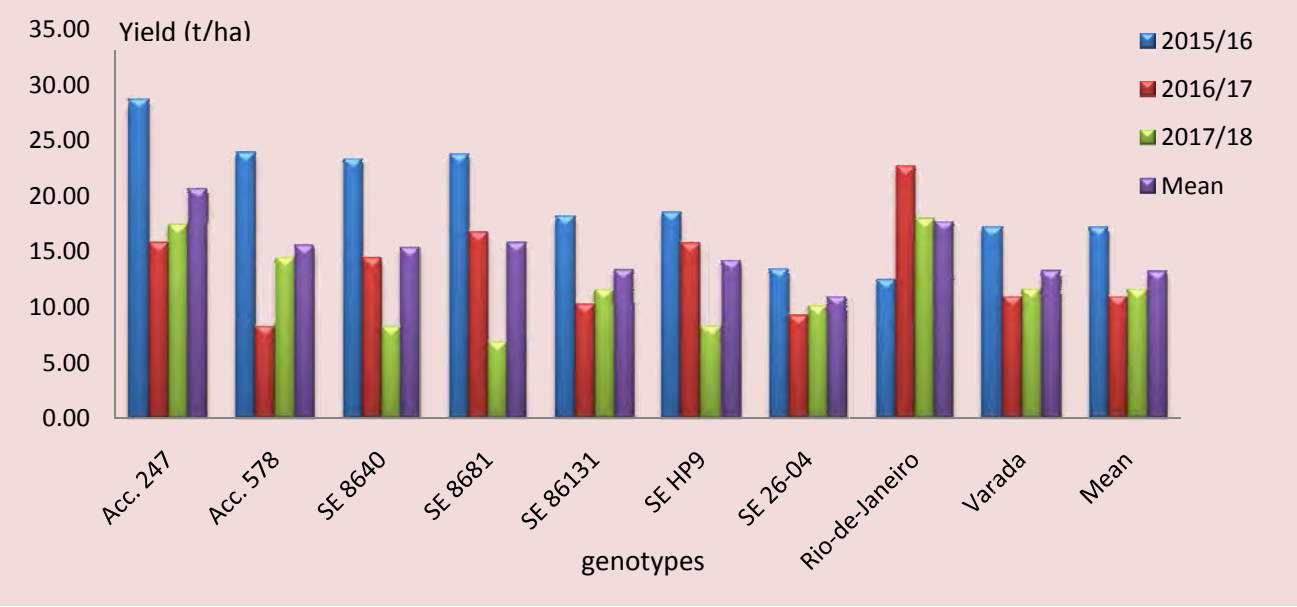


Fig 7: Performance of genotypes of ginger at Kozhikode for three years

The genotype SE-8681 showed the highest projected yield (12.33 t ha^{-1}) at Pundibari, followed by Acc-247 (11.20 t ha^{-1}). Lowest yield was found in ACC-578 (6.33 t ha^{-1}). The highest disease incidence was recorded in the genotype IISR Varada (32.27 PDI) and lowest in ACC 247 (11.19 PDI).

The entry SE-8640 (13.3 t ha^{-1}) was the top yielder at Pottangi, followed by PGS-121 (12.2 t ha^{-1}), SEHP-9 (12.2 t ha^{-1}) and SE86-131(10.4 t ha^{-1}). The highest clump weight was observed in SE 86-40 (188 g). These genotypes were also characterized by DUS guidelines (Table 9).

Table 9: DUS characters of rhizomes of Coordinated ginger entries at Pottangi

Entries	Clump length(cm)	Clump diameter (cm)	Clump shape	Outer core colour	Inner core colour
SE86-40	19	9	Curved	Yellow	Greenish Yellow
SE86-81	16	12	Zigzag	Greenish Yellow	Yellow
SE86-131	21	11	Curved	Greenish Yellow	White Yellow
SEHP-9	18	15	Zigzag	Greenish Yellow	White Yellow
SG-26-04	17	15	Zigzag	Greenish Yellow	Yellow
PGS-121	15	16	Zigzag	White Yellow	Yellow
ACC-247	16	12	Zigzag	Yellow	Greenish Yellow
Ranchi Local	17	14	Zigzag	Yellow	Greenish Yellow
Varada	17	8	Straight	Golden Yellow	Golden Yellow
Suprabha	17	11	curved	Yellow	Greenish Yellow

The average fresh rhizome yield for three consecutive years 2015, 2016 and 2017 at Solan centre varied from 5.15 t ha^{-1} to 18.25 t ha^{-1}. The local genotype Solan Giriganga (IC-593889/ SG-26-04) recorded maximum yield 18.25 t ha^{-1} by statistically excelling all other entries, whereas, local check variety Himgiri yielded 13.25 t/ha and National check variety IISR Varada 8.57t/ha. The rhizome rot disease incidence varied from 8.93-22.20 % with minimum in Solan Giriganga (IC-593889/SG-26-04). The high yielding promising genotype is superior/ comparable for quality attributes *viz,*. dry matter recovery (21.01%), essential oil (1.45%), oleoresin (4.69%) and crude fibre content (4.47%) to the check variety Himgiri. Therefore, keeping in view the consistently good performance, the promising genotype Solan Giriganga(IC-593889/SG-26-04) (Fig 8) has been identified for cultivation under Western Himalayan Regions of the country.

Fig 8: Solan Giriganga

At Kalyani, the genotype ACC-702 recorded maximum plant height (46.78cm), number of leaves per clump (23.21), number of tillers per clump (16.67), leaf length (23.95cm), yield per clump (192.83g), yield per plot (7.71kg) and yield per hectare (20.12t). Acc-713 recorded highest number of fingers per clump (8.93). Acc-219 recorded maximum length of fingers (8.34cm) and finger girth (3.90cm).

Average fresh rhizome yield varied from 9.42 t ha^{-1} to 22.40 t ha^{-1}at Nagaland. The local variety Nadia recorded maximum yield 22.40 t ha^{-1} closely followed by SG-26-04 (21.93 t ha^{-1}) which are statistically at par with each other. The national check variety IISR Varada yielded 15.04 t ha^{-1} whereas, another local check variety Local Red (pungent) gave minimum fresh rhizome yield of 9.42 t ha^{-1}.

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

(Centres: Middle gangetic plain region – Dholi; Eastern plateau and hills region – Pottangi)

The three years analyzed pooled data at Pottangi revealed that that the entry PGS-121(19.2 t ha^{-1}) as the top yielder followed by PGS-95(16.4 t $ha^{-1)}$ and PGS102 (15.6 t ha^{-1}) .

GIN/CI/3.5 Initial Evaluation Trial – 2015

(Centre: Middle Gangetic Plain Region – Kumarganj)

In IET for ginger consisting of seven entries, the maximum yield was observed in the genotype NDG-59 (14.77 t ha^{-1}) followed by NDG-9 (14.66 t ha^{-1}) and NDG-56 (13.78 t ha^{-1}). Three years pooled data showed maximum yield in the genotype NDG-9 (14.16 t ha^{-1}) followed by NDG-59 (14.00 t ha^{-1}) and NDG-56 (13.37 t ha^{-1}).

GIN/CI/3.6 Initial EvaluationTrial 2016

(Centres: Middle Gangetic Plain Region - Pundibari; Eastern plateau and hills region – Pottangi); Western Himalayan Region - Solan)

At Pundibari, a wide range of variability was found among the genotypes for different yield characters. GCP-39 recorded highest yield of 5.16 kg per plot (10.40 t ha^{-1}) and lowest yield was found in GCP 30 (3.42 kg per plot) (6.89 t ha^{-1}).The lowest rhizome root rot and fungal wilt disease severity was found in GCP-12 (12.44) whereas the disease severity was high in GCP-51 (23.67). The lowest *Phyllosticta* leaf spot disease was found in GCP-14 (5.81 PDI) whereas highest was found in GCP-51 (19.80 PDI).

Out of 25 entries evaluated at Pottangi, the entry PGS-8 (14.2 t ha^{-1}) was the top yielder followed by Varada (13.8 t ha^{-1}), PFLR (12.2 t ha^{-1}) and PGS-58 (11.7 t ha^{-1}).

Average yield at Solan varied from11.18 t ha^{-1} to 17.42 t ha^{-1}. The genotype SG-15-03 (SG-707) recorded maximum yield 17.42 t ha^{-1} followed by SG-15-08 (13.37 t ha^{-1}), SG-1083 (13.40 t ha^{-1}) and SG-1088 (13.30t ha^{-1}) whereas the check Himgiri yielded 14.76 t ha^{-1}. The rhizome rot disease incidence varied from 8.650-19.623% with minimum in SG-15-03 (SG-707).

GIN/CI/4 Quality Evaluation Trial

GIN/CI/4.1 Evaluation of germplasm for quality

(Centre: Western Himalayan Region - Solan)

Forty four best performing genotypes were analyzed. The dry matter content (%) and crude fibre (%) ranged between 16.900 (SG-15-07(SG-1124)) to 22.293 (SG-1130) and 3.867 (SG-1095) to 5.600 (Ranchi Local), respectively. Essential oil (%) and oleoresin contents (%) varied from 0.813 (SG-939) to 1.587 (SG-12/04) and 3.530 (SG-1079) to 4.770 (SG-26-04 (Giriganga) and Mahima), respectively. The high yielding genotype SG-26-04 (Giriganga) was found superior/ comparable for dry matter content, essential oil, oleoresin and crude fibre contents to the check Himgiri.

GIN/CI/4.2 Evaluation of germplasm from other centres

(Centre: Western Himalayan Region - Solan)

Eight samples of ginger were received for quality analysis from OUAT- HARS, Pottangi (Odisha) during 2017-18 and estimated for essential oil content. The results revealed that the genotype Suprabha possess more oil content (1.15%) followed by the genotype V_1S_1-2 (1.10%) and ACC 219 (1.02%).

Crop Management

GIN/CM/5 Nutrient Management Trial
GIN/CM/5.5 Source sink relationship

(Centres: West coast plains and ghat region – Kozhipode; Middle Gangetic Plain Region – Kanke; Eastern Himalayan Region – Mizoram, Barapani; Middle Gangetic Plain Region – Pundibari; Western Himalayan Region - Solan)

The results of the experiment on source sink relationship in ginger with the varieties *viz.*, IISR Mahima, Gorubathani, Mizoram Local and Ranchi Local at six different centres indicated that the partitioning efficiency was slightly better in IISR Mahima (Fig 9). In general, rhizome yield per plant was higher in local variety followed by IISR Mahima and quality parameters were better in Gorubathani as compared to other varieties which indicates that IISR Mahima could be a stable variety for yield and Gorubathani for quality (Fig 9).

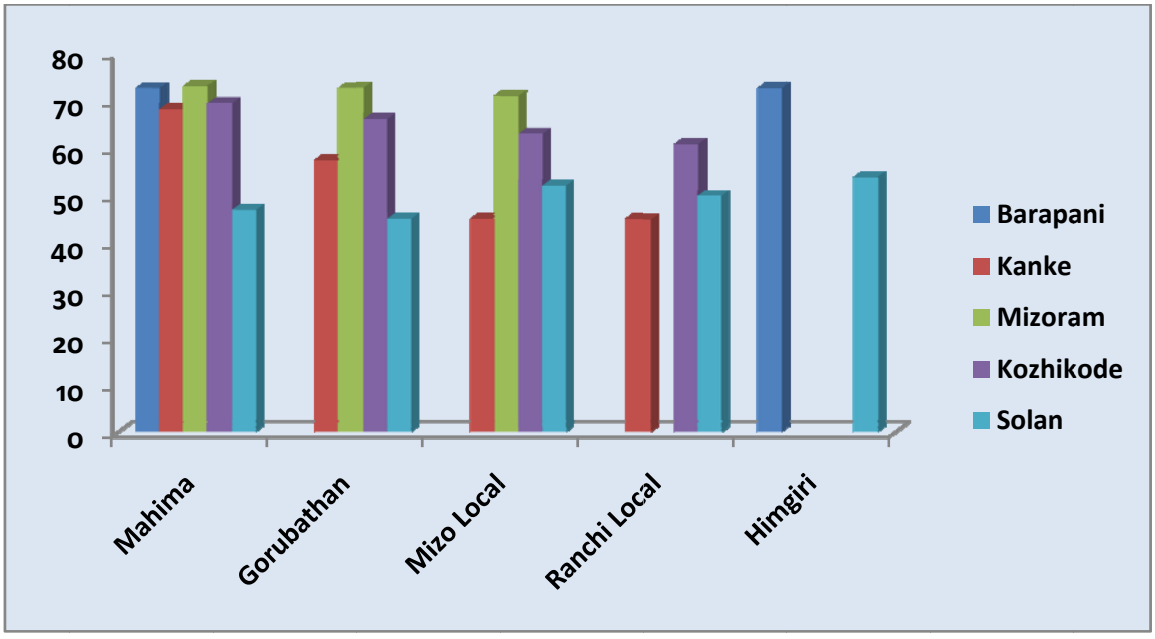


Fig 9: Dry matter partitioning of ginger varieties at different locations

From the data at Kanke centre, it was found that the variety IISR Mahima recorded maximum tiller per plant (7.2) whereas the entry Ranchi Local registered maximum fresh weight of leaves per plant (23.54 g) dry weight of leaves per plant (2.78 g), fresh weight of stem per plant (17.60 g). IISR Mahima also recorded highest rhizome fresh weight (122.74g) and dry weight (24.14g) followed by Ranchi Local (103.8g and 20.10g), GCP-5 (89.96 and 17.44g) and Mizoram Local (78.72g and 15.0g).

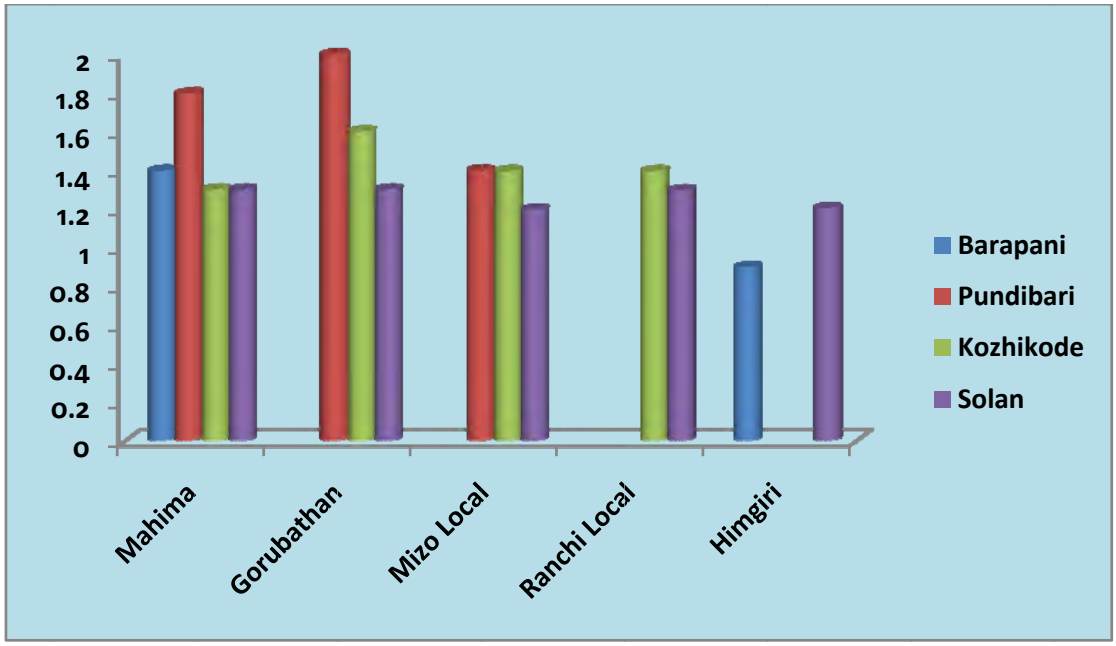


Fig 10: Essential oil content of ginger varieties at different locations

At Pundibari, analysis of the data showed that the genotype IISR Mahima produced the highest fresh yield of 6.33 kg per plot (12.76 t ha^{-1}) and dry yield of 1.44 kg per plot followed by Mizoram Local (fresh yield of 5.98 kg per plot and 12.06 t ha^{-1}) and it was lowest in Himgiri (fresh yield of 4.54 kg per plot and 9.15 t ha^{-1}).

At Barapani, the highest fresh rhizome weight at 120 DAP (107.04 g per plant), 180 DAP (175.78 g per plant) and at harvest (290.13 g per plant) was recorded in Himgiri, whereas at 60 DAP, Nadia recorded highest fresh rhizome weight with 17.05 g per plant.

At Solan, the observations on five varieties for eleven parameters of ginger plant under fresh and dry conditions were recorded at 60 days after planting (DAP), 120 DAP, 180 DAP and at harvest stage and the samples were analyzed for quality parameters viz. dry matter content (%), essential oil (%), oleoresin contents (%) and crude fibre (%) and reported to IISR Kozhikode (Kerala).

GIN/CM/5.6 Organic production of ginger

(Centres: Eastern Himalayan Region – Mizoram, Barapani)

At Mizoram, all ginger was lost due to soft rot disease.

At Barapani, maximum yield of 37.49 t ha^{-1} was recorded in T_5 (75% N requirement of gingerfrom FYM + micronutrients) followed by 36.85 t ha^{-1}in T_4 (100% organic manuresfrom FYM + Vermiwash 10%). Dry recovery of 20.37 % was recorded highest in T_3 (100% organic manures from FYM + micronutrients) and lowest at 19.37 in T_8 (Farmers practice). T_6 (75% N requirement of ginger + vermiwash 10%) have the highest fiber content of 3.94% while lowest (3.55%) was recorded in T_7 (Recommended Package by SAU). Oleoresin content was recorded highest (4.31%) in T_7 (Recommended Package by SAU) and lowest in T_6 (75% N requirement of ginger from FYM + vermiwash 10%) with 3.82%.

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)

There were 2 treatments T_1 is recommended package of practice and T_2 is recommended package of practice + IISR micronutrient formulation.

Application of micro nutrients showed significant effect on growth and yield on all ginger varieties at Chintapalle. Nadia variety with micro nutrient application recorded the maximum plant height (59.45 cm), fresh weight of rhizome (273.20 g), and yield per ha (29.13 t ha^{-1}).

Data analysis of three years at Pottangi centre (2015-16 to 2017-18) revealed that the fresh rhizome yield of 19.6t ha^{-1}, 20.2t $ha^{-1}$and 20.6t ha^{-1} was recorded in the varieties *viz.*, Suprabha, Suravi and Varada, respectively in the treatment, T1(Recommended package of practice + IISR micronutrient formulation) over T2 (Recommended package of practice).

Fig: 11 Ginger variety Nadia cultivated in poly house at Chintapalle

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

(Centres: Middle Gangetic Plain Region - Dholi)

All the treatment were found significantly higher regarding height of the plant, number of tillers per plant, number of leaves per tiller and yield per hectare over control. None of the treatments were found significantly high regarding dry matter recovery from fresh rhizome as compared to control. Among the treatments, T_{11}- FYM @ 30 t ha^{-1} + *Trichoderma* gave highest plant height (97.33cm), number of tillers per plant (77.03) and yield per hectare (15.63t ha^{-1}) followed by T_{12}- FYM @ 30t ha^{-1} + PSB with plant height (91.40cm), number of tillers per plant (72.93) and yield per hectare (14.30t ha^{-1}). However, none of the treatments were significantly higher regarding dry recovery from fresh rhizome.

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)

Among the three ginger varieties (Nadia, Surabhi and Suprabha) evaluated at Dholi, none of the varieties were significantly different regarding yield. Between two organic package (IISR organic package and RPCAU, Bihar organic package), both organic package were recorded as non-significant.

At Kumarganj, the maximum yield was observed in V1T3 treatment (13.50 t ha^{-1}) followed by V2T3 (13.00 t ha^{-1}) and V3T3 (12.75 t ha^{-1}).

In organic production of ginger trial at Pundibari, the highest fresh yield of ginger was recorded in Nadia (12.67 t ha^{-1}) followed by GCP-5 (11.98 t ha^{-1}). Organic package developed by IISR recorded the highest yield (12.32 t ha^{-1}). Considering the interaction effect, it was found that Nadia variety along with organic package developed by IISR recorded the highest fresh yield (12.94 t ha^{-1}). Dry recovery percentage varied significantly among the varieties but organic package of practices had no influence. Among the cultivars, the lowest wilt incidence was recorded in GCP-5 (21.12 %) and organic package developed by IISR recorded the lowest wilt incidence (22.94%).

At Kalyani, O_1V_2 (Organic package developed by IISR + Nadia) recorded highest plant population (38.25). Number of tillers per clump was recorded highest (18.50) in O_2V_3 (Recommended package by SAU + Suprabha) treatment. O_2V_2 (Recommended package by SAU + Nadia) recorded highest fresh yield per clump (244.37 g) and highest estimated yield per hectare (18.05 t).

Among the treatments, T2 (Nadia + Inorganic) recorded the maximum plant height (63.70 cm), fresh weight of rhizome (197.60 g), yield per ha (17.79 tha^{-1}) and dry recovery percentage (25.55) followed by T1 (Nadia + IISR OPP) at Chintapalle. The lowest yield was recorded in Treatment T5 (CTPL Local + IISR OPP) (9.02 t ha^{-1}).

At Raigarh, among the varieties, V3 (Local) gave maximum plant population (88.44 %), plant height (37.72 cm), number of leaves per plant (3.83), rhizome weight per plant (40.26 g), number of primary and secondary rhizome (3.53 and 5.83, respectively) and yield (7.90 t/ha). As per

treatment effect T1 (Organic package developed by IISR) gave maximum plant population (89.37 %), plant height (37.39 cm), number of tillers per plant (2.82), number of leafs per plant (3.83), rhizome weight per plant (40.82 g), number of primary and secondary rhizome (3.45 and 5.61, respectively) and yield (6.48 t ha^{-1}).

In Mizoram, all ginger was lost due to soft rot disease.

Maximum yield of 37.49 tha^{-1} was recorded in T_5 (75% N requirement of ginger from FYM + micronutrients) followed by 36.85 tha^{-1} in T_4 (100% organic manures from FYM + Vermiwash 10%) at Barapani. Highest dry recovery of 20.37 % was recorded in T_3 (100% organic manures from FYM + micronutrients) and lowest of 19.37 in T_8 (Farmers practice). T_6 (75% N requirement of ginger + vermiwash 10%) recorded the highest fiber content of 3.94% while lowest was recorded in T_7 (Recommended Package by SAU) with 3.55%. Oleoresin content was highest (4.31%) in T_7 (Recommended Package by SAU) and lowest in T_6 (75% N requirement of gingerfrom FYM + vermiwash 10%) with 3.82%.

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)

Among three ginger varieties (Nadia, IISR Varada and Surabhi) evaluated at Dholi, Nadia

Fig 12. Organic farming plot at Pottangi

variety gave significantly higher yield per hectare (12.38 t) as compared to other two varieties IISR Varada and Surabhi. Between two micro-nutrients package *i.e.*, IISR micro-nutrients package and RPCAU (Bihar) micro-nutrients package, RPCAU (Bihar) micro-nutrients package produced significantly higher yield per hectare (11.15t ha^{-1}) as compared to IISR micro-nutrients package (10.11 t ha^{-1}).

Data analysis at Kumarganj revealed that the maximum yield (13.33 t ha^{-1}) was observed in the variety Barua Sagar in the treatment (Seed treatment with micronutrients IISR + IISR micronutrients spray @ 5 gm/ litre of water at 60 and 90 days after planting).

In micronutrient trial of ginger at Pundibari, rhizome yield of ginger varied significantly among the varieties and micronutrient based package of practices. The highest fresh yield of ginger was recorded in Nadia (12.68 t ha^{-1}) followed by GCP-5 (12.42 t ha^{-1}). Micronutrient package developed by IISR recorded significantly highest yield (12.59 t ha^{-1}). Considering the interaction effect, it was found that Nadia cultivar along with micronutrient package developed by IISR recorded the highest fresh yield (13.07 t ha^{-1}).

Highest fresh yield per clump was recorded by M_2V_2 (251.62 g) followed by M_2V_1 (246.79 g) at Kalyani. The highest estimated yield per hectare was observed in M_2V_2 (19.21 t) followed by M_2V_3 (18.74 t). The lowest fresh yield per hectare was recorded by M_1V_3 (16.23 t).

Foliar application of IISR micro nutrient mixture showed marked increase in rhizomes yield per hectare as compared to control at Chinthapalle. Among the treatments T2 (Nadia + IISR Micro nutrients application) recorded maximum plant height (59.45 cm), fresh weight of rhizome (273.20 g), yield/ha (29.13 t ha^{-1}) followed by T6 (Surabhi + IISR Micro nutrients application) and all the treatments were on par with each other with respect to yield. The highest dry recovery was observed in T6 (Surabhi + IISR Micro nutrients application) (22.70 %) followed by T2 (21.50 %).

At Pottangi, it was revealed from pooled data analysis of three years (2015-16 to 2017-18) that the fresh rhizome yield of 19.6 t ha^{-1}, 20.2 t $ha^{-1}$and 20.6 t ha^{-1} in Suprabha, Suravi and IISR Varada, respectively with the yield advantages of 5.9%, 3.9% and 4.4% of T1 (Recommended package of practice + IISR micronutrient formulation) over T2 (Recommended package of practice).

In Raigarh, variety V3 (local) recorded maximum plant population (86.56 %), plant height (31.91 cm), number of tillers per plant (2.97), fresh rhizome weight (41.21 g), number of secondary rhizome (6.18) and yield (6.86 t ha^{-1}).

Three genotypes of ginger *viz.*, Jorhat, Suprabha and Hiching were evaluated at Barapani and found that the application of recommended package of practice along with IISR micronutrients (T_2) produced higher yield of 36.78 t ha^{-1}, 22.68 t ha^{-1} and 30.51 t ha^{-1} in Hiching, Himgiri and Nadia respectively. Also the oleoresin content were higher in T_2 (recommended package of practice +IISR micronutrients) in all the varieties.

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)

Data of percent disease severity of soft rot of ginger showed that lowest incidence was found in soil solarization + plastic mulching + rhizome treatment with 2% neem oil (39.30) followed by soil solarization + plastic mulching (48.30) and soil solarization + rhizome treatment with 2% neem oil (51.34) as compared by control (75.60). The maximum yield was recorded in soil solarization + plastic mulching + rhizome treatment with 2% neem oil (35.42 q ha^{-1}) and minimum in plastic mulching (13.25 t ha^{-1}) in comparison to control (10.50 t ha^{-1}).

GIN/CP/6.12 Field screening of different varieties of ginger against leaf spot and rhizome rot

(Centre: Western plateau and hills region – Dapoli)

All nine varieties of ginger screened against leaf spot were observed resistant except the variety Athira which was found to be moderately resistant against leaf spot disease. Whereas, against rhizome rot two varieties were moderately resistant and remaining were found tolerant. On yield basis all varieties performed well but on the basis of percent disease intensity the varieties *viz.*, Rejatha and Mahima were found superior over other varieties screened.

GIN/CM/6.13 Effect of PGPR biocapsules 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)

Among three varieties (Nadia, Varada & Suprabha) evaluated for the effect of PGPR biocapsules at Dholi, highest germination (73.88%), plant height (40.45cm), number of tillers/ plant (11.42), yield (32.22 q ha^{-1}) and lowest disease incidence (26.13%) were recorded with variety, Nadia. Among variety and treatment interaction, highest plant height (42.65cm) was recorded in variety, Nadia with treatment having POP + *Trichoderma* capsule.

Data analysis at Kumarganj revealed that the maximum yield was observed in the three varieties, V1 (13.83 t ha^{-1}), V3 (13.58 t ha^{-1}) and V2 (13.33 t ha^{-1}) in the treatment, POP + trichoderma capsule+GRB 35 capsule.

At Pundibari, talc formulation of *Trichoderma* and GRB 35 increased the tiller number irrespective of variety. The genotype Pundibari Local-1 in combination with *Trichoderma* and GRB 35 capsule recorded highest clump weight and fresh yield (130.67g, 11.63 t ha^{-1}) followed by GCP-5 in combination with talc formulation of *Trichoderma* and GRB 35 (124.00 g, 11.27 t ha^{-1}).

At Kalyani, highest fresh yield per clump (240.48 g) was recorded by P_1V_2 (Nadiya + POP + *Trichoderma* (Talc formulation) + GRB 35 (Talc formulation) followed by P_2V_2 , Nadiya + POP + *Trichoderma* capsule + GRB 35 capsule (238.53 g). The highest estimated yield per hectare was observed in P_1V_2 (19.93 t) followed by P_2V_2 (19.53 t).

The effect of bio capsules on growth and yield parameters on three varieties of turmeric *viz.*, Nadia, Suprabha and Suravi differed at Chintapalle. In Nadia variety T5 (POP) recorded the highest yield (22.95 t ha^{-1}), in Suprabha T3 (POP + *Trichoderma* capsule + GRB 35 capsule) recorded the highest yield (7.80 t ha^{-1}) whereas in Suravi T1 (POP + *Trichoderma* talc + GRB 35 talc) recorded the highest yield (8.50 t ha^{-1}).

At Raigarh, local ginger performed best in respect of average yield 8.60 t ha^{-1} and minimum rhizome rot incidence 14.60 % in comparison to the variety Surabhi (6.80 t ha^{-1}). In the treatment POP+ *Trichoderma* (Talc Formulation) + GRB 35 (talc) recorded 9.04 t ha^{-1} yield in local variety and 11.45 percent disease incidence.

Experiment was conducted with three genotypes *viz.*, Himgiri, Nadia and Hitching at Barapani. For Himgiri and Nadia the highest yield was recorded in T_2 (POP + *Trichoderma* capsule + GRB 35 capsule) with 32.87 t ha^{-1} and 30.01 t ha^{-1} respectively. Oleoresin content was highest in T_2 (POP + *Trichoderma* capsule + GRB 35 capsule) in all the three varieties.

In all the three genotypes evaluated at Solan, combined treatments of *Trichoderma* in combination with talc formulation of GRB-35 resulted in highest germination (91.37%) in LC-1 followed by Himgiri (90.63%) and LC-2 (90.37%). Similarly, combined talc formulations resulted in highest number of tiller per plant, height, yield and other biochemical parameters in all three genotypes and reduced incidence of rhizome rot.

V. 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)

Table 10 shows the turmeric germplasm conserved at various AICRPS centres.

Out of 275 accessions in the germplasm, 55 high yielding lines were evaluated at Coimbatore (Fig 13).The fresh rhizome yield per plant ranged between 90.00 g to 780.00 g. The genotype CL 195 recorded the highest fresh rhizome yield of 798.00 g per plant which was influenced by more number of primary rhizomes (17 nos; 473 g per plant) secondary rhizomes (17 nos; 198g per plant) and mother rhizomes (6 nos.; 127 g per plant). Whereas in CL 74, the fresh rhizome yield per plant (793 g per plant) was greatly influenced by mother rhizomes (7 nos.; 400g per plant), primary rhizomes (12 nos.; 326 g per plant) and secondary rhizomes (12 nos.; 67 g per plant). However, the dry recovery percentage in CL 74 and CL 195 was 19.33 and 18.67 respectively. Highest dry recovery was recorded in CL 100 (27.50%) and CL 43 (26.79%) which recorded a fresh rhizome of yield of 127 g per plant and 401g per plant respectively.

Fig 13: Field view of turmeric germplasm conservation under shade net at Coimbatore

A total of two hundred and seventy germplasm collections are being maintained at TRS Kammarpally (Fig 14). Characterisation of these germplasm using DUS guidelines revealed that Manapasupu (74.80 t ha^{-1}) PCT-17 (67.66 t ha^{-1}), CLI-366 (66.67 t ha^{-1}), West Bengal (65.73 t ha^{-1}), NH-1 (65.0 t ha^{-1}), CLI-Jyothi (64 t ha^{-1}), ACC No. 585 (63.73 t ha^{-1}) were the good yielders as compared to local check Duggirala Red (70.0 t ha^{-1}) and National check, IISR Prathibha (55.0 t ha^{-1}). These lines were also screened against major foliar diseases.

Fig 14: Field view of turmeric germplasm plot at Kammarpally

Out of one hundred accessions evaluated at Dholi, only sixteen accessions namely- RH-14, RH-421, RH-413, RH-5/80, RH-412, RH-7, RH-429, RH-427, RH-434, RH-401, RH-403, RH-431, RH-417, RH-406, RH-438 and RH-12 gave high fresh rhizome yield which ranged from 1.06 kg to 0.78 kg per plant (Yield per plot 36.53kg to 31.58kg $6m^{-2}$) as compared to best check variety Rajendra Sonali and Rajendra Sonia with a yield of 0.75kg and 0.62 kg per plant and per plot (30.12 and 27.50 kg $6m^{-2}$ respectively). Among the sixteen promising accessions, RH-14 produced higher fresh rhizome yield of per plant (1.06 kg per plant) and yield per plot (36.53 kg $6m^{-2}$) followed by RH-421 *i.e.*, yield per plant (1.00kg) and yield per plot (35.50kg $6m^{-2}$).

All the 180 germplasm of turmeric were evaluated at Kumarganj and found that the maximum yield in NDH-86 (270 g per plant), NDH-84 (255 g per plant) which are early maturing types, NDH-98 (295 g per plant), NDH-49 (267 g per plant) in medium and NDH-2 (285 g per plant), NDH-92 (265 g per plant) in late maturing types.

A total of 186 turmeric germplasm were evaluated at Pundibari centre. Considering plot yield and projected yield, 12 genotypes were found to give yield of more than 50 tonnes of projected yield. They are TCP-7 (52.34 t ha^{-1}), TCP-10 (52.84 t ha^{-1}), TCP-28 (53.28 t ha^{-1}), TCP-92 (55.74 t ha^{-1}), TCP-97 (57.29 t ha^{-1}), TCP- 130 (55.82 t ha^{-1}), TCP-149(60.70 t ha^{-1}), TCP-152(61.63 t ha^{-1}), TCP-153 (57.92 t ha^{-1}), TCP-159 (59.39 t ha^{-1}), TCP-166 (59.86 t ha^{-1}) and TCP-175 (58.06 t ha^{-1}). Leaf blotch disease was absent in the genotypes *viz.*, TCP-4, TCP-58, TCP-62, TCP-67, TCP-70, TCP-90, TCP-94, TCP-96 , TCP-100, TCP-114, TCP-123, TCP-140, TCP-143, TCP-152, TCP-191, TCP-192, TCP-200, TCP-206, TCP-215.

During 2017-18, one hundred and thirty eight germplasm lines were evaluated with six checks at Guntur. Among the germplasm lines evaluated, only four entries, IC-394903 (531.1 g), AC-94 (480.1 g), CLI-342-1 (479.4 g) and CL-1 (459.1 g) recorded significantly higher clump weight when compared to the best check Mydukur (370.1 g).

One hundred and thirty five turmeric collections were maintained and evaluated at Solan for rhizome yield and other horticultural traits. The yield range varied from 18.43 t ha^{-1} (PCT 13) to 39.42 t ha^{-1} (ST-908). Yield of three lines *viz*., ST-908 (39.42 t ha^{-1}), CO-1 (35.31 t ha^{-1}) and ST-20 (34.67 t ha^{-1}) excelled the checks Palam Lalima and Palam Pitamber which yielded 33.17 t ha^{-1} and 34.67 t ha^{-1} respectively. The curcumin content varied from 3.44 to 6.06 % with maximum in BDJR-1144.

Fifty two diverse genotypes of turmeric collected from entire NE region were evaluated at Pasighat along with check variety Megha Turmeric-1 during 2017-18. Among the genotypes evaluated, maximum rhizome yield was recorded in CHFT-8 (43.19 t ha^{-1}), which was statistically *at par* with CHF-4 (42.75 t ha^{-1}), CHFT-24 (40.10 t ha^{-1}), CHF-36 (41.51 t ha^{-1}), CHF-52 (38.57 t ha^{-1}), CHF-102 (40.56 t ha^{-1}) and CHFT-103 (38.57 t ha^{-1}). Lowest rhizome yield was recorded in genotype CHFT-28 (8.72 t ha^{-1}).

Among 179 turmeric accessions evaluated in 2017-18 at Pottangi, 152 were *Curcuma longa*, 23 were *Curcuma aromatica* and 4 were *Curcuma amada*. The projected yield ranged from 1.0 t ha^{-1} (CLS-29) to 18.2 t ha^{-1} (PTS-21) with the mean of 7.6 t ha^{-1} whereas clump weight ranged from 50 g (RH-80) to 225 g (PTS-60). In *Curcuma aromatica* the range in fresh rhizome yield varied from 1.1 kg/3 m^2 to 6.1 Kg/3 m^2.

A total of 77 genotypes of turmeric were evaluated at Raigarh (Table 10). It was observed that the genotype IT 10 recorded maximum rhizome yield (28.07 t ha^{-1}) followed by IT 24 (24.3 t ha^{-1}) and IT 2 (24.2 t ha^{-1}) over the national check, IISR Prathibha (14.3 t ha^{-1}).

Thirty two genotypes of turmeric with IC No. IC-586749 to IC-586780 were maintained and evaluated at Barapani. IC-586767 recorded the maximum yield with 41.56 t ha^{-1} and IC-586762 recorded highest curcumin content of 6.44% while highest oleoresin content was recorded in IC-586771 (19.23 %).

Table 10: Turmeric germplasm collections at various AICRPS centres

Centre	Indigenous			Exotic	Total
	Cultivated		Wild and related species	Existing	
	Existing	Addition (2017-18)	Existing		
Coimbatore	266	3	7	2	278
Dholi	96	2	2	-	100
Kammarpally	244	26	-	-	270
Kumarganj	180	2	-	-	182
Pantnagar	50	2	-	-	52
Pasighat	50	-	2	-	52
Pottangi	155	-	24	-	179
Pundibari	186	1	26	-	213
Raigarh	77		-	-	77
Guntur	175	20	-	-	195
Total	**1479**	**56**	**61**	**2**	**1598**

In the tribal areas of Chintapalle, turmeric is grown as a biennial crop and the crop is harvested only after two years (Fig. 15). New system of mechanization in turmeric is also not followed and the farmers resort to conventional method of boiling and drying.

Fig 15: Turmeric harvested after two years at Chintapalle

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 among the genotypes yield per ha was highest in TCP-191 (48.49 t) followed by IT-23 (40.53 t). Dry recovery % was highest in LTS-2 (27.94 %) followed by Roma (27.65%).

The projected rhizome yield per hectare differed significantly among the twelve genotypes tested at Coimbatore, which ranged from 34.90 t ha^{-1} (RH 80) to 45.00 t ha^{-1} (NDH 11) with a mean of 39.03 t ha^{-1}. The accession LTS- 2 recorded the highest dry recovery percentage of 27.20 with the estimated yield of 41.33 t $ha^{-1.}$

A coordinated variety trail was conducted at Kammarpally with 16 pre-release varieties *viz.*, IT-10, IT-23, IT-36, RH-9/90, RH-80, TCP-191, PTS-18, LTS-1, LTS-2, CLS-38, LTS-1, LTS-2, NDH-98, NDH-79, Duggirala Red (Local Check) and IISR Prathibha (National Check). Among the varieties, LTS-2 recorded highest fresh rhizome yield (62.0 t ha^{-1}) followed by CLS-38 (60.22 t ha^{-1}) in comparison to Duggirala red (49.10 t ha^{-1}) and IISR Prathibha (50.67 t ha^{-1}).

During 2017-18, twelve entries from different coordinated centres were evaluated along with two checks at Guntur. Among the entries evaluated, LTS-1 recorded significantly higher yield (55.0 t ha^{-1}) followed by LTS-2 (53.4 t ha^{-1}) which were on par with each other and significantly superior to the best check Mydukur (46 t ha^{-1}).

Among ten promising entries and two checks IISR Pratibha and Rajendra Sonali evaluated at Dholi, the genotypes RH-9/90 and RH-80 gave significantly higher yield per hectare (54.73t ha^{-1} and 53.94 t ha^{-1}, respectively) as compared to best local check variety Rajendra Sonali (yield 43.37 t ha^{-1}) and other promising entries.

At Kumarganj, maximum rhizome yield was obtained in LTS 1 (26.2 t ha^{-1}) followed by NDH 128 (25.33 t ha^{-1}), NDH - 11 (24.44 t ha^{-1}), IT-23 (24.11 t ha^{-1}) and NDH-1 (24.00 t ha^{-1}).

At Pundibari, TCP-191 recorded highest yield of 42.59 t ha^{-1} followed by IT-10 (29.34 t ha^{-1}). Rhizome yield over local check was found highest in TCP-191 which is 77.86% and lowest was found in IT-10 (22.47%). The lowest leaf blotch disease severity of (0.00 PDI) was found in TCP-191 and LTS-1 where no leaf blotch was found which is followed by LTS-2 (2.22 PDI) and NDH-11, NDH-128 (PDI 4.44). The lowest leaf spot disease severity was found in TCP-191 (0.00 PDI) followed by NDH-11 (PDI 4.44).

It was revealed from the analyzed data at Pottangi, that the entry PTS-18 (15.3 t ha^{-1}) was the top yielder with the yield advantages of 31.9 % than the local check variety Roma (11.6 t ha^{-1}) followed by RH-9/90 (14.8 t ha^{-1}) and CLS-38 (14.6 t ha^{-1}). The range of projected yield varies from 8.7 t ha^{-1} to 15.3 t ha^{-1}among the tested entries (Fig 16). The heaviest clump was observed in PTS-18 (290 g).

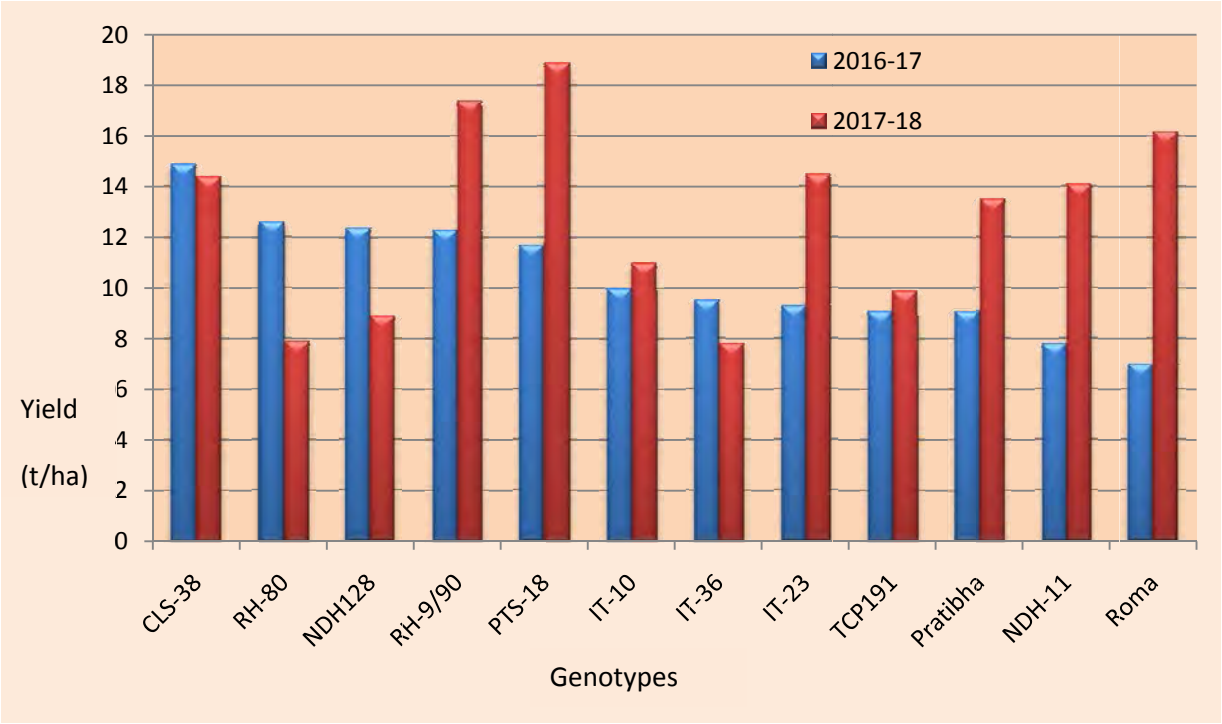


Fig 16: Mean performance of genotypes of turmeric in Coordinated Varietal Trial during 2016-17 and 2017-18 at HARS, Pottangi.

The genotype IT10 recorded maximum rhizome yield (28.00 t ha^{-1}) followed by IT 36 (24.1 t ha^{-1}) and TCP 19/14 (23.3 t ha^{-1}) over national check IISR Prathibha (17.9 t ha^{-1}) and local check Chhattisgarh haldi-1(21.4 t ha^{-1}) at Raigarh.

Eleven genotypes along with one national and two standard checks were evaluated in randomized block design at Navsari. IT-36 (26.17 t ha^{-1}) and IT-23 (26.67 t ha^{-1}) were observed numerically superior in mean performance for green rhizome yield over national check IISR Prathibha. None of the genotypes exhibited higher rhizome yield than local checks GNT-1 and GNT-2.

TUR/CI/3 Varietal Evaluation Trial

TUR/CI/3.7 Initial Evaluation Trial 2015

(Centres: Middle Gangetic Plain Region - Kumarganj)

Ten entries were evaluated under IET, highest yield was observed in NDH-68 (31.88 t ha^{-1}) followed by NDH-115 (31.77 t ha^{-1}) and NDH-136 (30.33 t ha^{-1}). Three years pooled data showed maximum yield in NDH-68 (30.76 t ha^{-1}) followed by NDH-115 (30.55 t ha^{-1}) and NDH-136 (30.51 t ha^{-1}).

TUR/CI/3.8 Initial Evaluation Trial 2016

(Centres: Middle Gangetic Plain Region - Pundibari; Western Himalayan Region – Solan; Eastern plateau and hills region – Pottangi)

A wide range of variability was found among the genotypes for different yield characters at Pundibari. TCP-58 recorded highest yield (50.93 t ha^{-1}) and lowest yield was found in TCP-2 (31.62 t ha^{-1}). The lowest leaf blotch and leaf spot disease severity was found in all genotypes except TCP-2 with PDI of 11.11and 14.07 respectively.

The genotype ST-15-02 (ST-907) recorded maximum yield of 40.00t ha^{-1}followed by ST-15-04(PCT-53) (36.51t ha^{-1}) and ST-15-01(ST-12M) (34.38t ha^{-1}) at Solan whereas the checks Palam Lalima and Palam Pitamber yielded 33.77t ha^{-1} and 34.60 t ha^{-1} respectively. The curcumin content varied from 3.56 -6.13% with maximum in ST-15-03 (PCT-14) whereas, Palam Lalima and Palam Pitamber recorded 3.82 % and 3.57% respectively.

It was revealed from the analyzed pooled data of Pottangi that the entry PTS-22 (21.2 t ha^{-1}) was the top yielder with the yield advantages of 16.4 % than the Local check variety Roma (18.2t ha^{-1}) followed by PTS-56 (19.0 t ha^{-1}) and PTS-57 (19.0 t ha^{-1}). The heaviest clump was observed in PTS-22 (251 g).

Crop Management

TUR/CM/5 Nutrient Management Trial.

TUR/CM/5.9 Source sink relationship in turmeric

(Centres: Southern plateau and hills region – Coimbatore, Kammarpally;West coast plains and ghat region – Kozhikode; East coast plains and hill region – Guntur; Middle Gangetic Plain Region – Dholi;Eastern Himalayan Region - Barapani)

The experiment on source sink relationship in turmeric is being carried out in different centres with the following varieties like IISR Prathiba, Rajendra Sonia, Duggirala Red, Mydkur and BSR-2. Results on source sink relationship in turmeric during the year revealed that IISR Prathiba had slightly higher partitioning efficiency and was lowest in Duggirala Red. In general, Mydkur had the highest yield per plant followed by local variety in most of the places. Mydkur also was more stable for oil, oleoresin and curcumin followed by BSR 2 while Rajendra Sonia had lowest values in most of the places. This suggests that Mydkur could be a stable variety over places both for yield and quality followed by BSR 2 (Fig 17).

The study on rhizome bulking pattern of turmeric at Coimbatore revealed that fresh weight of whole rhizomes increased considerably from September to February. Among the varieties evaluated, IISR Prathiba registered vigorous growth and the highest fresh rhizome weight (230.00 g per plant)

followed by Rajendra Sonia (206.33 g per lant) which were significantly different from each other at 240 DAS. Mydukur Red registered 184.67 g of fresh rhizome yield per plant.

In Kammarpally, at 40 and 90 DAP, the rhizome fresh weight (gram per plant) was more in Rajendra Sonia (24.86 and 40.60 respectively) whereas at 120 DAP, Duggirala Red recorded maximum fresh weight of rhizomes (73.66 g). At harvest, the maximum yield was registered in Duggirala Red (50.70 t ha^{-1}) followed by Rajendra Sonia (30.80 t ha^{-1}).

At Guntur, five varieties were sown in the first week of June and evaluated for rhizome bulking with periodical sampling. Fresh weight of whole rhizome increased considerably from September to December. Among the five varieties evaluated, Mydukur was found to be vigorous in growth and recorded highest fresh rhizome weight (531.2 g per plant) followed by BSR-2 (525.0 g per plant) and Duggirala Red (520.80 g per plant) which were on par with each other and significantly superior IISR Prathibha (479.80 g per plant) and Rajendra Sonia (279.6 g per plant). The observations were recorded at 60, 120, 180 DAP and at harvest stage at Barapani and the dried samples were sent to IISR for further analysis. Mydukur variety recorded highest fresh rhizome weight at 60 DAP (18.57 g per plant) while IISR Prathiba recorded highest fresh rhizome weight at 120 DAP (217.17 g per plant) and 180 DAP (367.89 g per plant). At harvest, Megha Turmeric-1 recorded highest rhizome weight with 369.98 g per plant.

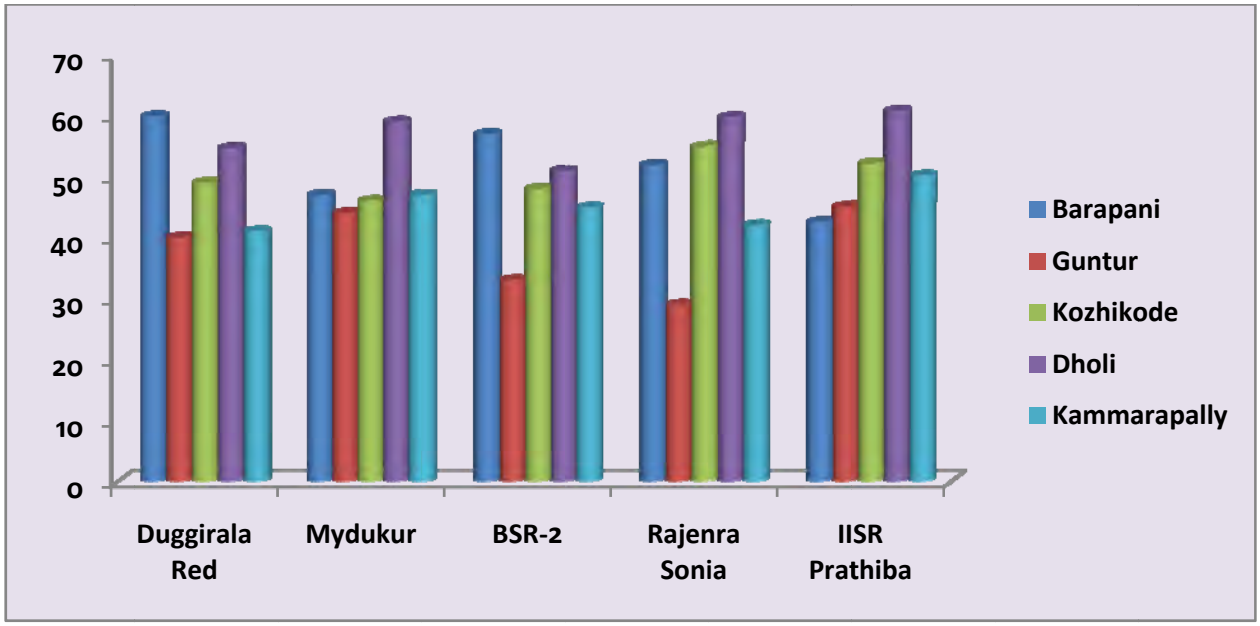


Fig 17: Dry matter % partitioning of turmeric varieties at different locations

TUR/CM/5.10 Organic production of turmeric

(Centres: Eastern Himalayan Region – Mizoram; Eastern Himalayan Region – Barapani)

At Mizoram, the maximum yield (34.44 t ha^{-1}) was recorded for T_2 (100% organic manure equivalent to 75% N requirement of turmeric), followed by T_1 (100% organic manure equivalent to 100% N requirement of turmeric) with a yield of 33.21t ha^{-1}, T_5 (75% N requirement of turmeric + micronutrients) with a yield of 32.69 t ha^{-1}. Moreover, dry matter content of 13.95 % was found to be

highest in T_1 (100% organic manure equivalent to 100% N requirement of turmeric); followed by T4 (100% organic manure + Vermiwash 10%) and T_3 (100% organic manure + micronutrients) with a dry recovery of 13.95 % and 13.37 %.

At Barapani, maximum yield of 44.08 t ha^{-1} was recorded in T_7 (Recommended Package by SAU) followed by 41.43 t ha^{-1} in T_8 (Farmers practice). Dry recovery of 22.05 % was recorded highest in T_7 (Recommended Package by SAU) and lowest at 21.28 % in T_5 (75% N requirement of turmeric from FYM + micronutrients). Treatment T_5 (75% N requirement of turmeric from FYM + micronutrients) had highest curcumin content of 6.42% and highest oleoresin (14.35 %) was recorded in T_7 (Recommended Package by SAU).

TUR/CM/5.10 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)

At Coimbatore, the experiment was conducted with three varieties *viz*., BSR 2, CO 2 and IISR Pragthi. The highest fresh rhizome yield per plant (456.50 g) was recorded in the Variety IISR Pragthi treated with organic package developed by IISR, Kozhikode. The highest fresh rhizome yield per plot of 3m^2 was however recorded in CO2 (8.33 kg per plot) treated with organic package developed by IISR, Kozhikode. The dry recovery percentage was higher in IISR Pragthi (22.73) with a plot yield of 7.86 kg per plot of 3 $m^{2.}$

This experiment was conducted using three varieties (V1- Duggirala Red, V2 - IISR Pragathi and V3 –IISR Prathibha) at Kammarpally. Generally, maximum yield was obtained in T1 (Organic package of developed by IISR) as compared to T2 (Recommended package by SAU). The interaction effect revealed maximum yield in T1V3 (IISR-Prathibha - 73.05 t ha^{-1}) followed by T1V1 (Duggirala Red-57.08 t ha^{-1}).

Among the three varieties of turmeric (Rajendra Sonia, Pratibha and Rajendra Sonali) evaluated at Dholi, Rajendra Sonia and Rajendra Sonali produced significantly higher yield per hectare (61.75 & 61.38t ha^{-1}) as compared to IISR Prathibha with a yield of 40.14t ha^{-1}. Between two organic package (IISR organic package and RPCAU, Bihar organic package), RPCAU, Bihar organic package gave significantly higher yield per plot (56.31 t ha^{-1}) as compared to IISR organic package (52.50 t ha^{-1}).

The maximum yield (31.16 t ha^{-1}) was observed in V3T1, NDH 98 with organic package developed by IISR followed by V3T2, NDH 98 with recommended package by SAU (30.91t ha^{-1}) at Kumarganj.

In organic production trial of turmeric at Pundibari, the highest fresh yield of turmeric was recorded in PTS-8 (30.83 t ha^{-1}) and lowest in TCP-2 (28.54 t ha^{-1}). Organic package developed by IISR recorded the highest yield (31.62 t ha^{-1}). Considering the interaction effect, it was found that PTS-8 genotype along with organic package developed by IISR recorded the highest yield of 33.56 t ha^{-1}. Dry recovery percentage, leaf blotch and leaf spot incidence varied significant among the varieties but organic package of practices had no influence on the dry recovery percentage, leaf blotch and leaf spot incidence in turmeric.

The trial was initiated during 2017-18 and conducted in FRBD with six replications at Guntur (Fig 18). The effect of production system, variety and their interactions on growth and yield attributes was found to be significant. Among the two production systems, IISR- Organic production system recorded significantly higher yield (44.2 t ha^{-1}). Among the varieties evaluated, Mydukur (43.5 t ha^{-1}) was on par with BSR-2 (41.7 t ha^{-1}), but superior to IISR Prathibha (38.8 t ha^{-1}). Among the interaction between production system and variety, maximum yield was recorded in Mydukur with IISR-Organic production system (47.3 t ha^{-1}), which was significantly superior to all other combinations except with BSR-2 (44.1 t ha^{-1}) with IISR-Organic production system.

Among the treatments at Chintapalle, T4 (NDH-98 + Inorganic) recorded the maximum plant height (158.45 cm), fresh weight of rhizome (625.5 g), yield per ha (51.78 t ha^{-1}) and dry recover percentage (25.55) followed by T3 (NDH-98 + IISR POP). Among the treatments at Chintapalle, T4 (NDH-98 + Inorganic) recorded the maximum plant height (158.45 cm), fresh weight of rhizome (625.5 g), yield per ha (51.78 t ha^{-1}) and dry recovery percentage (25.55) followed by T3 (NDH-98 + IISR POP).

Data from Pasighat revealed that significantly high yield per hectare (27.48 t ha^{-1}) was recorded with the organic package developed by IISR (T1) as compared to recommended package of SAU (T2). Among the three varieties evaluated, significantly high yield per hectare (39.52 t ha^{-1}) was recorded with the variety NDH 98. However, the dry recovery was significantly higher in IISR Prathibha (23.23%) as compared to NDH 98 and Megha Turmeric-1. The interaction of treatment and variety was found to be insignificant.

At Raigarh, variety V1 (Chhattisgarh Haldi-1) recorded maximum plant population (100%), plant height (146.42 cm) and yield (23.75 t ha^{-1}) while, V2 (Suranjana) recorded maximum number of tiller per plant (4.05) and number of primary rhizomes (4.90) and V3 (Narendra Haldi-1) recoded maximum number of leaves per plant (5.07). Fresh rhizome weight per plant (195.12 g) and number of secondary rhizomes (10.05).

Fig 18: Turmeric organic production trial at Guntur

In Barapani, three genotypes of turmeric *viz.*, Megha Turmeric-1, Rajendra Sonia and IISR Prathibha were evaluated. T_2 (Recommended Package by SAU) produced higher yield of 39.40 t ha^{-1} and 34.79 t ha^{-1} in Megha Turmeric-1 and IISR Prathiba, respectively. The dry recovery percentage were higher in T_1 (Organic package developed by IISR) in all the three varieties.

TUR/CM/5.5 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)

The experiment on the effect of micro nutrients on turmeric at Coimbatore was conducted with three varieties *viz*., BSR 2, CO 2 and IISR Pragthi. Turmeric variety, CO 2 cultivated with the recommended package of practices and IISR turmeric micronutrient spray at 60 and 90 DAP @ 5 g per litre recorded the highest fresh weight of the clump (416.67 g) and fresh rhizome yield per plot of 3 m^2 (8.91 kg). Whereas, turmeric variety IISR Pragthi recorded the highest dry recovery percentage of 20.40%.

At Kammarpally, the experiment was conducted with three varieties *viz*., Duggirala Red, IISR Pragathi and IISR Prathibha (Fig 19). The maximum yield wad recorded in T2 (Recommended package of practice + IISR turmeric micronutrients) compared to T1 (Recommended package of practice). The highest yield was recorded in T2V1 (Duggirala Red – 66.66 t ha^{-1}) followed by T2V3 (IISR Prathibha-56.60 t ha^{-1}).

Fig 19: Field view of micro nutrient trial at Kammarpally

Among three varieties of turmeric (Rajendra Sonia, IISR Pratibha and Rajendra Sonali) evaluated at Dholi, Rajendra Sonia and Rajendra Sonali gave significantly higher yield per hectare (50.05 & 55.61 t ha^{-1} respectively) as compared to Pratibha *i.e.*, yield per hectare (32.59t ha^{-1}). Between two package of micro-nutrients (IISR micro-nutrients package and RPCAU, Bihar micro-nutrients package), RPCAU (Bihar) micro-nutrients package recorded significantly higher yield (48.20 t ha^{-1}) as compared to IISR micro-nutrients package (43.97t ha^{-1}).

At Kumarganj, the maximum yield (31.58 t ha^{-1}) was observed in V2T2, NDH 98 with recommended package of practice + IISR turmeric micronutrients followed by V2T1, NDH 98 with recommended package of practice.

Among three varieties of turmeric (Rajendra Sonia, IISR Pratibha and Rajendra Sonali) evaluated at Dholi, Rajendra Sonia and Rajendra Sonali gave significantly higher yield per hectare (50.05 & 55.61t ha^{-1} respectively) as compared to Pratibha *i.e.*, yield per hectare (32.59t ha^{-1}). Between two

package of micro-nutrients (IISR micro-nutrients package and RPCAU, Bihar micro-nutrients package), RPCAU (Bihar) micro-nutrients package recorded significantly higher yield (48.20 t ha^{-1}) as compared to IISR micro-nutrients package (43.97t ha^{-1}). Foliar application of IISR micro nutrient mixture showed marked increase in height of the plants and rhizomes yield as well as dry recovery as compared to control at Chintapalle. Among the treatments, T6 (BSR-2+ IISR Micro nutrients application) recorded maximum plant height (136.45 cm), fresh weight of rhizome (363.58 g), yield per ha (28.61 t ha^{-1}) followed by T2 (Roma+ IISR Micro nutrients application) and these were on par with each other. T2 (Roma+ IISR Micro nutrients application) recorded highest dry recover percentage (24.23).

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)

Survey was conducted in different places of Erode, Coimbatore, Tiruppur and Salem districts. The leaf blotch and leaf spot intensity was minimum in surveyed areas. The maximum incidence of leaf spot (8.2 PDI) and leaf blotch (8.4 PDI) was noticed in Sivagiri area of Erode district. The incidence of leaf spot was noticed only in few areas of Erode district and was totally absent in Coimbatore, Salem and Tiruppur districts. The poor incidence of the diseases was due to the climatic factors (high temperature and low RH).

Crop survey was conducted in the major turmeric growing areas of Telangana in collaboration with the scientists of ICAR-Indian Institute of spices Research, Kozhikode. Survey (Fig 20) revealed that most of the turmeric growing areas were flood irrigated in excess leading to the incidence of rhizome rot. The crops were grown on ridges and furrows instead of resorting to raised bed cultivation. The purity of seed materials of turmeric is also of major concern.

Fig 20 : Crop survey at Nizamabad & Jagtial districts of Telangana with IISR scientists

Survey was conducted in Coochbehar and Jalpaiguri districts of West Bengal to identify and to assess the severity of the diseasesin turmeric. Three well distributed locations within the identified areas were selected for the survey. Two major diseases of turmeric namely Leaf Blotch (*Taphrina spp.*) and *Colletotrichum* Leaf spot (*Colletotrichum spp.*) were found to be prevalent in these areas (Fig 21 and 22). The survey revealed that leaf blotch disease severity in Coochbehar is on an average PDI of 13.89 and Jalpaiguri is on an average PDI of 12.61. Regarding leaf spot of turmeric it was found that disease severity in Coochbehar and Jalpaiguri block is on an average PDI of 19.87 and 18.57 respectively.

During the survey in the village Supa of Raigarh it was found that 43.78 and 38.78 per cent of disease intensity of *Colletotrichum* leaf spot and *Taphrina* leaf blotch respectively followed by 34.78 and 27.34 % incidence of *Colletotrichum* leaf spot and *Taphrina* leaf spot respectively in Gerwani Village. Out of ninety entries screened none of the entries were found to be falling under highly resistant or resistant categories (Fig 23).

Fig 21: *Colletotrichum* leaf spot in turmeric

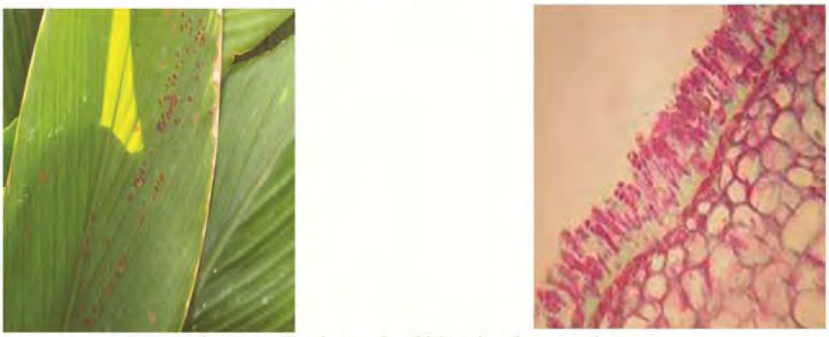


Fig 22 : *Taphrina* leaf blotch of turmeric

Fig 23 : Scale for turmeric leaf blotch & leaf spot disease

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

(Centres: Southern plateau and hills region - Coimbatore)

A field trial was laid out to test the efficacy of fungicides and biocontrol agents on the incidences of foliar diseases in turmeric at Coimbatore. Among the various fungicides tested, rhizome treatment with propiconazole (0.1%) + foliar spray with 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. This treatment recorded minimum leaf spot (4.27 PDI) and leaf blotch (11.07 PDI) followed by rhizome treatment with Dithane Z-78 (0.1%) + FS with Dithane Z-78 (0.1%) which recorded PDI for leaf spot and leaf blotch as 5.10 and 12.40 respectively, while in control the incidence was 16.7 and 28.17 respectively.

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 lines were tested (RH-9, RH-40, RH-406, IISR Prathibha, CL-52, CL032, CL-34, CL-54 and Duggirala Red) for their resistance or tolerance or susceptibility to leaf blotch and leaf spot diseases under natural conditions. 0 - 9 scale were used for leaf spot (*Colletotrichum falcatum*) where as 0 - 6 scale was used for leaf blotch (*Taphrina maculans*).

It was found that all the lines were susceptible to the foliar diseases. For the leaf spot disease severity, all the lines *viz.*, RH-9, RH-40, RH-406, IISR Prathibha, CL-52, CL032, CL-34, CL-54 and Duggirala Red were in the severity range of 5 grading scale (11-25%) whereas maximum lines were grouped under 20-30 % of leaf blotch disease severity.

At Pundibari, TCP 129 recorded lowest leaf blotch (PDI 14.81) and leaf spot (PDI 7.41) disease severity among the 11 germplasm tested including the local check (Table 11). The highest leaf blotch disease severity (PDI 35.38) was recorded by RH 410 and highest leaf spot disease severity (PDI 18.52) was recorded by RH 406. TCP 129 produced 25.01% and 56.08% less leaf blotch and leaf spot disease over local check respectively. The highest yield of 13.70 kg per plot (27.62 t ha^{-1}) was obtained by TCP 129.

For the management of foliar diseases of turmeric by using tolerant linesat Raigarh, none of the entries were found to be in the highly resistant category.

In the evaluation of disease tolerant lines in turmeric, during 2017-18, low percent incidence of leaf spot was recorded at Guntur. There was no incidence of leaf blotch in any accession under study. The disease tolerant lines scored in November and December recorded the incidence of leaf spot ranging from 0-10.0 %. NDH-74 showed field tolerance to the leaf spot. The accessions CL 54 (1.0 %), NDH-10 (1.0%) and CL-52 (1.2 %) recorded the lowest PDI and were on par with each other. RH 407 (7.9 %) recorded the maximum PDI among the tolerant lines evaluated.

In the trial for the management of foliar diseases in turmeric using tolerant lines at Solan, minimum leaf spot disease severity (8.19 %) was observed in CL-54 genotype

followed by CL-34 with 10.23 % disease severity. Leaf blotch severity in disease tolerant lines ranged from 7.89 to 21.10 percent and was minimum in CL-52 (7.89 %) followed by CL-54 (9.27%). Yield was maximum in CL-34 (22.18 t ha^{-1}) out of disease tolerant lines and was minimum in CL-3 (21.46 t ha^{-1}) genotype.

Table 11: Evaluation of turmeric lines for tolerance to foliar diseases at Pundibari (pooled mean of four years) 2013-17

Genotypes	Germination %	Leaf Blotch (PDI)	% disease reduction over local check	Leaf Spot (PDI)	% disease reduction over local check	Projected yield (t/ha)
CL 32	94.23 (77.62)	22.27 (28.06)	1.07	19.13 (25.74)	13.40	21.33
CL 34	93.63 (78.24)	21.35 (27.47)	5.15	17.97 (24.94)	18.65	18.83
CL 52	93.43 (76.48)	16.33 (23.69)	27.45	11.57 (19.51)	47.62	20.68
CL 54	89.50 (72.88)	25.02 (29.91)	---	21.22 (27.22)	---	17.16
RH 406	92.23 (75.88)	34.61 (37.41)	---	26.16 (32.73)	---	19.19
RH 407	91.67 (75.06)	31.02 (35.66)	---	24.79 (31.45)	---	16.81
RH 410	89.93 (77.14)	30.58 (26.92)	---	30.22 (22.34)	---	22.31
TCP 14	96.40 (82.85)	14.51 (22.31)	35.54	11.05 (19.19)	49.98	23.18
TCP 129	97.03 (81.89)	13.43 (21.44)	35.53	7.57 (15.85)	61.20	28.98
TCP 161	94.87 (78.22)	22.12 (27.92)	1.73	21.44 (27.02)	---	19.94
TCP 2 (Local check)	91.20 (74.28)	22.51 (28.44)	---	21.09 (27.13)		20.84
SEm±	2.800	1.172	---	1.422	---	---
CD (at 5%)	7.880	3.298	---	4.003	---	---
CV (%)	10.722	21.381	---	29.441	---	---

TUR/CP/7.5 Eco-friendly management of foliar disease of turmeric

(Centre: Middle Gangetic Plain Region - Kumarganj)

The minimum leaf blotch incidence (27.3%) was observed in foliar spray of Argimone oil @ 1.0% followed by Mahuwa oil (27.9%) and Jatropha oil (29.1%). Leaf spot incidence was highest in control (73.2%) and lowest in Propiconazole (19.3%). The rhizome fresh yield was recorded highest in Jatropha oil (17.9 0 t ha^{-1}) followed by Argimone oil (17.51 t ha^{-1}) and neem oil (17.43 t ha^{-1}).

TUR/CP/7.6 Field screening of different varieties of turmeric against leaf spot and rhizome rot

(Centre: Western plateau and hills region – Dapoli)

All twenty nine varieties were observed moderately resistant except the variety Kanti which was found susceptible against leaf spot disease. Whereas, twenty nine varieties were tolerant against rhizome rot and variety Krishna was found to be moderately resistant. On the yield basis all varieties performed well but on basis of per cent disease intensity incidence and yield the varieties *viz*., Krishna, IISR Pratibha, Narendra Haldi and Sudharsana were found superior over other varieties under study.

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 – Chintapalle; Eastern plateau and hills region - Pottangi, Raigarh; Southern plateau and hills region - Kammarpally; Eastern Himalayan Region – Pasighat; Western Himalayan Region – Solan)

A field trial was laid out at Coimbatore to test the efficacy of bio capsules of turmeric under field condition. Talc and capsule formulations of *Trichoderma* and GRB 35 were tested for their performance in three varieties *viz*., BSR-2, CO-2 and IISR Pragathi under field condition. Among the various treatments, combined application of capsule formulation of *Trichoderma* and GRB 35 promoted growth and yield parameters followed by combined application of talc formulation of *Trichoderma* and GRB 35. The combined application of capsule formulation of *Trichoderma* and GRB 35 in BSR-2 recorded highest plant height (63.2 cm), fresh clump weight (350 g) and more yield (8.35 kg per plot) as compared to control, that recorded 34.5 cm plant height, 135 g clump weight with an yield of 3.10 kg per plot. This treatment also recorded minimum incidence of leaf spot (6.35 PDI) and leaf blotch (9.30 PDI) when compared to control that recorded 13.9 and 16.78 PDI of leaf spot and leaf blotch respectively.

At Dholi, among varieties (R. Sonia, R. Sonali & Morangia), highest germination (99.75 %), plant height (109.38 cm) were recorded with turmeric variety, Morangia. While highest number of tillers per plant (3.75), lowest disease intensity (24.17%) and highest yield (41.88 t ha^{-1}) were recorded with turmeric variety, Rajendra Sonia and Rajendra Sonali respectively.

At Kumarganj, the maximum yield (13.83 t ha^{-1}) was observed in V1T2 treatment, NDH2 + POP + *Trichoderma* capsule + GRB 35 capsule followed by V3T2, NDH 98 + POP + *Trichoderma* capsule + GRB 35 capsule (135.83 t ha^{-1}) and V2T2, NDH 8 + POP + *Trichoderma* capsule + GRB 35 capsule (133.33 t ha^{-1}).

Effect of PGPR biocapsule on growth and yield of turmeric at Pundibari showed that application of talc formulation of *Trichoderma* and GRB 35 irrespective of the variety showed lowest leaf spot and leaf blotch (PDI 13.90, PDI 11.89 respectively) disease incidence. Considering the interaction, the lowest leaf bloch disease severity was observed in TCP-70 in combination with the application of talc formulation of *Trichoderma* and GRB 35 (0.99%) and TCP-70 in combination with the application of *Trichoderma* and GRB 35 capsule (0.99%). Highest yield was recorded with TCP-70 in combination with the

application of *Trichoderma* and GRB 35 capsule (14.33 kg per plot).

The effect of bio capsules on growth and yield parameters on three varieties of turmeric *viz.*, Roma, Chintapalli Local and NDH-98 differed at Chintapalle. In Roma variety, T3 (POP + *Trichoderma* capsule) recorded the highest yield (30.17 t ha^{-1}), in Chintapalli Local T4 (POP + GRB 35 capsule) recorded the highest yield (25.45 t ha^{-1}) whereas in NDH-98 T3 (POP + *Trichoderma* capsule + GRB 35 capsule) recorded the highest yield (49.43 t ha^{-1}). It was observed that in three varieties dry recovery percentage was highest in T4 (POP + GRB 35 capsule).

At Raigarh, the treatment POP+ *Trichoderma* (Talc Formulation) + GRB 35 (Talc) produced high yield (24.58t ha^{-1}) in the variety Chhattisgarh Haldi 1.

Among the PGPR biocapsule trial at Pasighat (Fig 24), significantly higher fresh weight of clump and yield per hactere was recorded with T2 (POP+*Trichoderma* capsule+ GRB 35 capsule) with a value of 316.42 g and 36.61 t ha^{-1} respectively. Significant variation in growth and yield was recorded among the varieties. Higher number of tiller, fresh weight of clump and yield per hactere were recorded with the variety NDH 98 (2.67, 361.45g, 41.93 t ha^{-1} respectively). The highest dry recovery (%) was associated with Prathibha (22.54%) and the lowest with NDH 98 (18.64%).

In all the three genotypes, 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. The talc formulation of *Trichoderma* in combination with talc formulation of GRB-35 resulted the highest germination (91.37%) in LC-1 followed by LC-2 (90.37%).

Fig 24: Biocapsule trial at Pasighat

VI. 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)

Tree spices *viz.*, clove, nutmeg, cinnamon and cassia germplasm maintained at various AICRPS centres (Table 12).

a. Nutmeg

Among the germplasm collections of nutmeg planted at Dapoli, sixteen promising genotypes have been identified (Fig 25). Average no. of fruits ranged from 180-560 g. The genotypes *viz.*, DBSKKV9772, DBSKKVMF 19, DBSKKVMF 26 (405 average number of fruits) recorded highest average number of fruits per tree of 560, 450 and 405 respectively. The genotype DBSKKV 9772 recorded maximum dry nut yield (5152 g) and dry mace yield (599.2 g) per tree. The genotype DBSKKVMF 29 was found to be promising for total yield, considering its fruit weight, nut weight and mace weight.

Fig 25: A promising nutmeg line identified at Dapoli

Among the accessions maintained at Pechiparai, MF- 4 recorded maximum number of fruits (330 fruits tree^{-1}), mean fruit weight (46.0 g per fruit) and the total mace yield (140 g tree^{-1}) whereas local check recorded only 120.0 fruits tree^{-1} with mean fruit weight (42.50 g per fruit) and total mace yield (45 g tree^{-1}).

b. Clove

Among the germplasm of clove maintained at Dapoli, four promising genotypes were identified. The plant height varied from 4.90 to 5.50 m, girth ranged from 33.10 to 38.10 cm and spread varied from 3.50 m to 5.20 m. No flowering was observed at Dapoli during the year 2017-18.

Among the 24 accessions evaluated at Pechiparai, the accession, SA-1 recorded the highest tree height of 11.70 m, followed by SA-3 (11.55 m) when compared with Local check tree height (9.20 m). The accession SA-3 was significantly superior than other accessions and recorded highest stem girth (49.50 cm). The accession SA-3 recorded the highest leaf length (18.50 cm), leaf breadth (7.50 cm) and dry bud yield (1.25 kg/tree) whereas the local check recorded a dry bud yield of 0.20 kg per tree.

c. Cinnamon

Among the twelve accessionsevaluated at Pechiparai, the accession CV-5 recorded maximum stem girth (26.00 cm), leaf yield (7.40 kg per plant) and dry bark yield (630 g per plant) while local check recorded stem girth (25.00 cm), leaf yield (6.80 kg per plant) and dry bark yield (285 g per plant).

Table 12: Tree spices germplasm collection at AICRPS centres

Crop / Centre	Indigenous		Total
	Cultivated		
	Existing	Addition (2017 -18)	
Clove			
Dapoli	4	-	04
Pechiparai	24	-	24
Yercaud	01	-	01
Total	**29**	**-**	**29**
Nutmeg			
Dapoli	95	01	96
Pechiparai	28	-	28
Yercaud	**01**	**02**	**03**
Total	**124**	**03**	**127**
Cinnamon			
Dapoli	11	-	11
Pechiparai	14	-	14
Yercaud	02	-	02
Total	**27**	**-**	**27**
Cassia			
Dapoli	6	-	6
Pechiparai	4	-	4
Total	**10**	**-**	**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. The Red 12 months type (Fig 26) is in fruiting at one year growth stage. The addition of new genotypes in unique nutmeg block is in progress.

One accession of little leaf clove and six seedlings of Madagascar clove were collected from Nagercoil region of Tamil Nadu by IISR and added to the germplasm.

Among the various unique type of nutmegs planted at Pechiparai, the maximum plant height (5.2 m) and number of branches (9) were recorded in IISR Viswashree.Whereas Acc-17 recorded lowest plant height (2.8 m) and number of branches (4).

Fig 26: Accession flowering through out year with deep red mace

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, in Nutmeg CVT trial no significant variation was observed for all parameters. The plant height ranged from 1.95 to 2.77 m, the girth ranged from 18.83 to 27.50 cm and the spread from 1.07 to 2.40 m. All accessions have started bearing and the

accession, A 9/150 produced 165 fruits per plant followed by A 9/20 (120 fruits /plant).

Among the different accessions of nutmeg evaluated at Pechiparai, A9/150 has recorded the highest plant height (7.7 m), stem girth (36.50 cm) , maximum number of branches (15) and number of fruits (95 fruits /tree) when compared with local check (Plant height (5.1 m), stem girth (32.0), maximum number of branches (8) and number of fruits (40 fruits per tree) (Table 13).

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 at Dapoli. The initial growth of all genotypes is found to be satisfactory. The genotype Kochukudy recorded highest plant height (1.58 m) followed by Punnathanam Jathy (1.13 m) whereas at Pechiparai, the improved nutmeg variety recorded the maximum plant height (1.90 cm) and no. of branches (8).

Budded plants of the farmer's varieties were planted at Thrissur in existing coconut plantation at a spacing of 8m x 8m. The gap filling was carried out and the plants have established. All the cultural operations have been carried out and the trial is in progress

Fig 27: Planting material production of nutmeg at Thrissur

VII. 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)

Coriander germplasm collection and conservation at different AICRPS centres (Table 13)

Among the 276 genotypes (Fig 27) of coriander maintained at Coimbatore, 42 genotypes were evaluated based on genetic divergence, yield and quality assessment. The plant height at harvest varied significantly from 60.64 cm to 85.84 cm with a mean value of 72.04. The genotype CS 221 recorded the highest plant height of 85.84 cm whereas the lowest plant height was recorded in CS 224 (60.64 cm). The number of umbels per plant varied from 15.60 and 41.60 with an overall mean of 24.24. The highest number of umbels per plant was recorded in CS 27 (41.60) and the lowest number of umbels per plant was recorded in CS 57 (15.60). Similarly, the number of fruits per umbel ranged between 23.40 and 41.40 with an overall mean of 30.48 among the genotypes evaluated. The highest number of fruits per umbel was observed in CS 229 (41.40) and the lowest number of fruits per umbel was recorded in CS 134 (23.40).The genotype CS 46 registered the highest seed yield of 43.50 g per plot of 1 m^2 which was on par with CS 118 (41.50 g per plot) and CS 242 (56.66 g per plot) followed by CS 24 (39.50 g per plot), CS 266 (38.50 g per plot), CS 37 (37.50 g per plot) and CS 116 (36.50 g per plot).

Fig 27: Coriander germplasm at Coimbatore

Table 13: Coriander germplasm collections at various AICRPS centres

Centre	Indigenous			Total
	Cultivated		Wild and related species	
	Existing	Addition (2017 -18)	Existing	
Coimbatore	276	-	-	276
Dholi	160	-	-	160
Guntur	350	-	-	350
Hisar	307	7		314
Jagudan	101	31	19	151
Jobner	355	-	-	355
Kumarganj	196	-	-	196
Pantnagar	132	-	-	132
Total	1877	38	19	1934

Out of one hundred sixty accessions maintained at Dholi, only seventeen accessions gave the highest yield ranging from 81.00 g to 98.00 g per five plants (yield per plot 1.58 to 1.44kg 7.2m^{-2}) as compared to best check variety Rajendra Swati (yield 79.00 g per five plant) and yield per plot (1.40 kg 7.2 m^{-2}). Among the seventeen promising accessions, RD-434 gave the highest yield 98.00 g per five plant and yield per plot 1.58 kg 7.2m^{-2} followed by RD-422, yield per five plant 95.00 g and per plot 1.55 kg 7.2m^{-2}.

One hundred ninety six accessions of coriander were evaluated at Kumarganj. The highest yield was recorded in ND Cor-11 (29.20 g plant^{-1}) followed by ND Cor-12 (28.40g plant^{-1}) and ND Cor-9 (27.30 g plant^{-1}).

During 2017-18, thirty five germplasm lines were evaluated with four checks at Guntur. Among the entries evaluated, LCC-344 (5.94g plant^{-1}), LCC-319 (5.33 g plant^{-1}) and LCC-343 (4.01 g plant^{-1}) were found significantly superior in yield over the best check Suguna (3.36 g plant^{-1}).

At Jagudan, 30 new collections of coriander were evaluated with GCo-3 as checks for yield performance. The seed yield ranged from 6 to 45.66 q ha^{-1}. Among the tested genotypes, 24 genotypes gave higher seed yield per plant than check GCo-2.

At Jobner, three hundred thirty five (335) germplasm accessions (Fig 27) were evaluated along with nine checks namely RCr-20, RCr-41, RCr-435, RCr-436, RCr-475, RCr-480, RCr-684, RCr-728 and Local check. Out of 355 accessions, 28 accessions were better than best check variety RCr-20 (43.2 g) on the basis of seed yield per 5 plants. Promising accessions identified on the basis of seed yield per 5 plants were UD-636 (65.0 g), UD-640 (60.0 g), UD-7 (58.0 g), UD-684-3 SPS (57.5 g) and UD-616 (56.0 g).

Among 22 accessions evaluated for seed yield at Raigarh, ICS 4 recorded maximum seed yield (22.8 q ha^{-1}) followed by entry RCC 12-7 (21.8 q ha^{-1}) and RCC 12-11 (21.7 q ha^{-1}) over three checks Hisar Anand (2.20 q ha^{-1}), ICS 1 (1.67 q ha^{-1}) and Rajendra Swati (1.58 q ha^{-1}).

Fig 28: Dr. T. Janakiram, ADG (Hort.) visiting coriander germplasm at Jobner

Screening of coriander germplasm against powdery mildew

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

A total of forty three (41+2) entries of coriander were screened at Jagudan under natural condition. None of the entry was found free from the powdery mildew incidence. The minimum disease intensity was noticed in JCr-2013-22 (19.0%) and the maximum disease intensity was recorded in the entry Cor-164(43.0 %). The per cent disease intensity was ranged between 19.0 and 43.0 per cent.

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

(Centres: Central plateau and hills region – Jobner)

TOL (stress tolerance), SSI (Stress susceptibility index) and STI (Stress tolerance index) were estimated in coriander. The genotypes *viz;* UD-704, UD-23, UD-472, UD-529, and UD-208 were top yielders in normal conditions, while UD-472, UD-705, UD-23, UD-461 and UD-709 were top yielders in stress conditions. Based on stress indices UD -705, UD-461, UD-627, UD-32, and UD-751 were found to be the desirable entries for drought conditions during 2017-18.

Based on stress indices, three years data of coriander indicated that the genotype UD 580 was found to be the desirable entry for moisture stress/ drought conditions, followed by UD 489, UD 747, UD 717 and UD 573.

COR/CI/1.4 Multilocation evaluation of germplasm in coriander – 2015

(Centres: Central plateau and hills region – Ajmer, Jobner; Southern plateau and hills region – Coimbatore; East coast plains and hill region – Guntur; Trans Gangetic Plain Region – Hisar; Middle Gangetic Plain Region – Kumarganj, Dholi; Gujarat plains and hills region – Jagudan; Western dry region – Kota; Eastern plateau and hills region - Raigarh)

Out of the 50 accessions evaluated under multi locational testing at Jobner,14 accessions were found to be better than best check variety RCr-435 (26.2 g). Some of the promising accessions identified on the basis of yield per 5 plants were RD-407 (65.2 g), NDCOR-110 (52.0 g), CS-161 (41.5 g), CS-141 (40 g), CS-196 (39.5 g) , NDCOR-120 (36 g), DH-283 (34 g), NDCOR-109 (31.5 g), CS-131 (31.5 g), CS-198 (30 g), CS-142 (28.5 g) and RD-408 (27 g).

A trial on multi location evaluation of coriander genotypes was laid out at Coimbatore with 72 genotypes from eight centres and four checks. The mean performance of the genotypes for plant height ranged from 37.10 cm to 70.56 cm. The number of primary branches per plant varied significantly from 2.40 to 4.40. The highest number of primary branches per plant (4.40) was observed in three genotypes *viz.*, DH 261, JCR 5 and RCR 684.The maximum number of umbels per plant was recorded in the genotype JCR 5 (38.40) and the lowest in CS 104 (11.60). The seed yield per plot of 2 m^2 ranged from 10.00 g to 185.00 g.The highest seed yield was observed in RKC 54 (185.00 g per plot of 2 m^2) which was better than the check variety Hisar Anand (137.00 g per plot of 2 m^2).

Fig 29: Gujarath Coriander 3 flowering at Jagudan

During 2017-18, forty germplasm lines from different coordinating centres were evaluated with five checks at Guntur. Among the entries evaluated, six entries (NDCOR-111, NDCOR-118, CS-142, LCC-247, DH-279 and LCC-250) were found significantly superior in yield over the best check Suguna (3.67 g $plant^{-1}$)

Under multi location of trials at Kumarganj, 94 entries were evaluated and the highest seed yield was recorded from NDCor-102 (14.40 q ha^{-1}) followed by RD-385 (14.15 q ha^{-1}) and NDCor-106 (14.10 q ha^{-1}). The three years pooled data showed maximum seed yield in NDCor -102 (13.35 q ha^{-1}) followed by RD -385 (13.20 q ha^{-1}) and DH-261(13.07 q ha^{-1}).

Among the sixty entries of germplasm evaluated at Dholi, five entries namely- RD-399, RD-423, RD-426, RD-425 and ND Cor-109 produced higher grain yield (29, 28, 28, 26 and 25 g per plant respectively) as compared to both check varieties Hisar Anand and Rajendra Swati (22 and 24 g respectively). Among five promising entries

RD-399 produced the highest grain yield (29.0 g per plant) followed by RD-423 and RD-426 with a grain yield of 28 g per plant each entry (RD-423 & RD-426).

Under multi location of trials at Jagudan, a total of 40 entries with local check (GCo-2) were evaluated. However none of the entry was found superior than latest released variety Gujarat Coriander-3 (Fig 29)

At Raigarh centre, ICS- 4 (16.8 q ha^{-1}) recorded maximum seed yield followed by ICS 5-3 (14.62 q ha^{-1}) and ICS 5 (13.54 q ha^{-1}) over checks Gujarat Coriander 2 (9.72 q ha^{-1}) and Chhattisgarh Dhaniya -1 (ICS-1) 8.42 q ha^{-1}.

Fig 30 : Performance of coriander germplasm at UHS, Bagalkot

Crop Improvement

COR/CI/2 Coordinated Varietal Trial
COR/CI/2.6 Coordinated Varietal Trial on coriander 2015 - IX 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 the early first flowering was noted in COR-160 (50.33 days). The plant height was recorded highest in COR-148 (117.40 cm). Maximum number of branches per plant was recorded in COR-152 (6.56) whereas maximum number of umbels per plant was noticed in COR-159 (18.05). The highest yield per plant was exhibited in genotype COR-173 (4.82 g) and yield q per hectare was highest in COR-159 (14.55).

The coordinated varietal trial on coriander at Coimbatore was conducted for third year during 2017-18. The trial was laid out with twenty six genotypes along with two national checks and one local check. The plant height of the genotypes ranged from 35.10 cm to 60.97 cm. The highest number of umbels per plant was recorded by the genotypes COR 153 (21.33) followed by COR 148 (20.00), COR 163 (19.80) and COR 151 (19.67). The seed yield per plot of 1 m^2 was high in the genotype COR 159 (131.67 g per plot of 1 m^2) which was however less than CO (CR) 4 with a yield of 141.67 g per plot.

At Dholi, among twenty six entries and three checks, two national checks (Rcr-728 and Hisar Anand) and one local check (Rajendra Swati), COR-169 gave significantly higher grain yield (25.83 q ha^{-1}) as compared to best check variety Rajendra Swati (23.55 q ha^{-1}).

At Kumarganj, total 29 entries were evaluated under CVT coriander. The maximum yield was observed from COR-164 (15.97q ha^{-1}) followed by COR-172 (15.90 q ha^{-1}) and COR-165 (15.83 q ha^{-1}).

During 2017-18, twenty six coded entries along with four checks were evaluated at Guntur. Among the entries evaluated, only COR-157 (14.82 q ha^{-1}) was found significantly superior to the best check Suguna (11.58 q ha^{-1}).

The yield differences among the entries were found significant at Jagudan. None of the entries were significantly superior over best national check variety Hisaar Anand. However the entry COR-170 (9.41 q ha^{-1}) yielded numerically higher yield than national check *i.e.* Hisar Anand (8.12 q ha^{-1}).

Based on seed yield at Navsari, COR-99 (15.09 q ha^{-1}), COR-100 (14.50 q ha^{-1}), COR-95 (14.35 q ha^{-1}) and COR-105 (13.95 q ha^{-1}) were found significantly superior over a national check Hisar Anand and a local check GC-2 for seed yield.

At Kota, COR – 160 was found to be the best performing entry in terms of seed yield (16.66 q ha^{-1}) followed by COR – 154 (15.05 q ha^{-1}). COR–154 and COR-153 were the earliest in days to 50 % flowering (51 days) and maturity (105 days). RCr – 728 was the most late entry with days to 50 % flowering of 72 and maturing in 116 days. COR – 168 and COR- 130 had the highest test weight of 17.40 g while COR-166 had the lowest test weight of 14.01 g.

At Raigarh, evaluation of coriander entries for seed yield revealed that COR 164 (18.8 q ha^{-1}) recorded maximum seed yield followed by COR 171 (17.2 q ha^{-1}) and COR 153 (17.2 q ha^{-1}) over national checks RCR 728 (7.7 q ha^{-1}), Rajendra Swathi (16.9 q ha^{-1}) and Hisar Anand (14.8 q ha^{-1}).

The seed yield ranged from 7.40 q ha^{-1} (COR-147) to 17.50 q ha^{-1} (COR-125) at Jobner (Fig 31). Of the thirty entries evaluated, COR-125 recorded maximum seed yield of 17.50 q ha^{-1} followed by RCr-435 check (17. 47 q ha^{-1}), Hisar Anand check (17.29 q ha^{-1}), COR-123 (16.15 q ha^{-1}), RCr-436 check (15.07 q ha^{-1}), COR-137 (15.02 q ha^{-1}) and COR-138 (15.00 q ha^{-1}), while lowest seed yield of 7.40 q ha^{-1} was recorded in COR-147.

Fig 31: Coordinated varietal trial of Coriander at Jobner

COR/CI/3 Varietal Evaluation Trial

COR/CI/3.6 Initial Evaluation Trial in coriander

(Centres: Trans Gangetic Plain Region – Hisar, Central plateau and hills region - Jobner)

The analysis of variance revealed significant differences among the entries for all the traits evaluated at Jobner. The seed yield ranged from 6.75 (NS-2017-3) to 18.00 q ha^{-1} (UD-565). Of the ten entries evaluated, UD-565 recorded maximum seed yield of 18.00 q ha^{-1} followed by UD-706 (15.78. q ha^{-1}), RCr-435 (14.99 q ha^{-1}), RCr-728 (13.33 q ha^{-1}) and UD-705 (13.14 q ha^{-1}), while lowest seed yield of 6.75 q ha^{-1} was recorded in NS-2017-3.

COR/CI/3.8 Initial Evaluation Trial - 2015

(Centres: East coast plains and hill region – Guntur; Gujarat plains and hills region – Jagudan; Middle Gangetic Plain Region – Kumarganj; Middle Gangetic Plain Region – Dholi; Eastern plateau and hills region - Raigarh)

During 2017-18, ten entries along with three checks were evaluated in RBD at Guntur (Table 14). Among the ten entries tested, LCS-12-5 recorded highest yield (15.75 q ha^{-1}) followed by LCS-12-7 (15.74 q ha^{-1}) which were on par with each other and significantly superior to the best check Susthira (13.10 q ha^{-1}). The three years pooled data indicated that among the entries evaluated, maximum yield was recorded by the entry LCS-12-7 (10.13 q ha^{-1}) followed by LCS-12-5 (9.77 q ha^{-1}), which were on par with each other and significantly superior to the best check Suguna (854.6 q ha^{-1}).

The entries tested at Jagudan under the trial were found to have significant differences for yield and other characters like plant height, umbel per plant and seeds per umbel. The entries JCr-2013-14 (9.36 q ha^{-1}) maintained its superiority for yield over the check GCr-3 (9.19 q ha^{-1}).

At Kumarganj, 11 entries were selected for IET coriander. The highest seed yield was recorded in NDCor-111 (19.79 q ha^{-1}) followed by NDCor-110 (19.30 q ha^{-1}) and NDCor-102 (18.40 q ha^{-1}). Three years pooled data showed maximum yield in NDCor-110 (18.39q ha^{-1}) followed by NDCor-102 (17.64q ha^{-1}) and NDCor-111 (16.52q ha^{-1}).

Table 14: Pooled yield of three years of IET on Coriander at Guntur

S.No.	Genotype	Yield (q/ha)	Rank
1	LCS-12-1	8.107	10
2	LCS-12-2	7.918	11
3	LCS-12-3	8.794	5
4	LCS-12-4	8.606	6
5	LCS-12-5	9.779	2
6	LCS-12-6	9.465	3
7	LCS-12-7	10.134	1
8	LCS-12-8	8.303	9
9	LCS-12-9	9.326	4
10	LCS-12-10	8.533	8
11	AD-1 (C)	7.566	12
12	Suguna (C)	8.546	7
CD (p=0.05)		96.5	
CV%		10.8	

At Dholi, among seven promising entries and two check varieties (Hisar Anand & Rajendra Swati), RD-437 and RD-383 produced significantly higher yield (30.76 and 25.93 q ha^{-1}) as compared to best check variety Hisar Anand (20.45 q ha^{-1}) and other promising entries. Both entries RD-437 and RD-383 were selected for coordinated varietal trial due to 50.13 and 26.83 percent more yield over best check variety Hisar Anand.

The initial evaluation trial of coriander at Raigarh revealed that ICS 4 (22.5 q ha^{-1}) recorded maximum seed yield followed by ICS-5-1 (21.3 q ha^{-1}) over the checks Hisar Anand (14.6 q ha^{-1}) and Rajendra Swati (20.9 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)

Effect of multi-cut management and variety did not emerge any significant effect on equivalent yield, but fertility levels affected significantly on it. Each increase in fertility leavels significantly increased equivalent seed yield. The maximum equivalent yield was recorded with the application of 60:30:00 kg NPK / ha. Interaction effect between cutting management x variety, cutting management x fertility levels and variety x fertility levels were found significant on equivalent seed yield of coriander.

COR/CM/5.7 Standardization of drip irrigation and fertigation in coriander

(Centres: Central plateau and hills region - Jobner; Middle Gangetic Plain Region – Kumarganj; East coast plains and hill region – Guntur)

Drip fertigation significantly increased the plant height, umbels/ plant, umbellets /umbel, seeds per umbel, test weight, seed yield and water use efficiency of coriander as compared to surface irrigation with conventional fertilization at Jobner (Fig 32).The drip fertigation at 0.8 IW/CPE ratio recorded significantly higher plant height (112.17 cm), umbels per plant (28.22), umbellets per umbel (5.68), seeds per umbel (46.50), test weight (12.84 g), seed yield (20.86 q ha^{-1}) and water use efficiency (6.09 kg per ha-mm) with the water saving of 18.7% (Table 15). However it remained at par to drip fertigation at 1.0 IW/CPE ratio.

Five treatments of drip irrigation were given in coriander at Kumarganj. The highest yield was observed in drip fertigation at 1.6 IW/CPE ratio (21.30 g $plant^{-1}$) followed by drip fertigation at 1.4 IW/CPE ratio (18.80 g $plant^{-1}$), drip fertigation at 1.0 IW/CPE (cumulative per evaporation) ratio (16.63 g $plant^{-1}$) and drip fertigation at 0.8 IW/CPE ratio (14.10 g $plant^{-1}$).

At Guntur, the total potential evapo transpiration was 445 mm during the crop period. Irrigation treatments were fixed month wise after germination from November to a week before harvest, for 1, 0.8, 06, 0.4 IW/CPE and surface irrigation as check. Highest yield was recorded in T_1-1.0 IW/CPE (18.97q ha^{-1}) and was significantly superior over all other treatments and control.

Fig 32: Field view of water management trial of coriander at Jobner

Table 15: Effect of drip fertigation on yield and water use efficiency of coriander (Pooled data)

Treatment	Seed yield (q/ha)	Water used (mm)	CU (mm)	Water use efficiency (kg/ha-mm)	Water saving (%)
Surface irrigation with conventional fertilization	14.40	465.3	398.3	3.66	0.0
Drip fertigation at 1.0 IW/CPE ratio	21.26	465.3	429.2	5.01	0.0
Drip fertigation at 0.8 IW/CPE ratio	20.86	378.2	346.9	6.09	18.7
Drip fertigation at 0.6 IW/CPE ratio	18.83	290.8	265.4	7.18	37.5
Drip fertigation at 0.4 IW/CPE ratio	16.41	203.8	186.6	8.88	56.2
SEm±	0.39			0.13	
CD (P= 0.05)	1.11			0.38	

Crop Protection

COR/CP/6 Disease Management Trial
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)

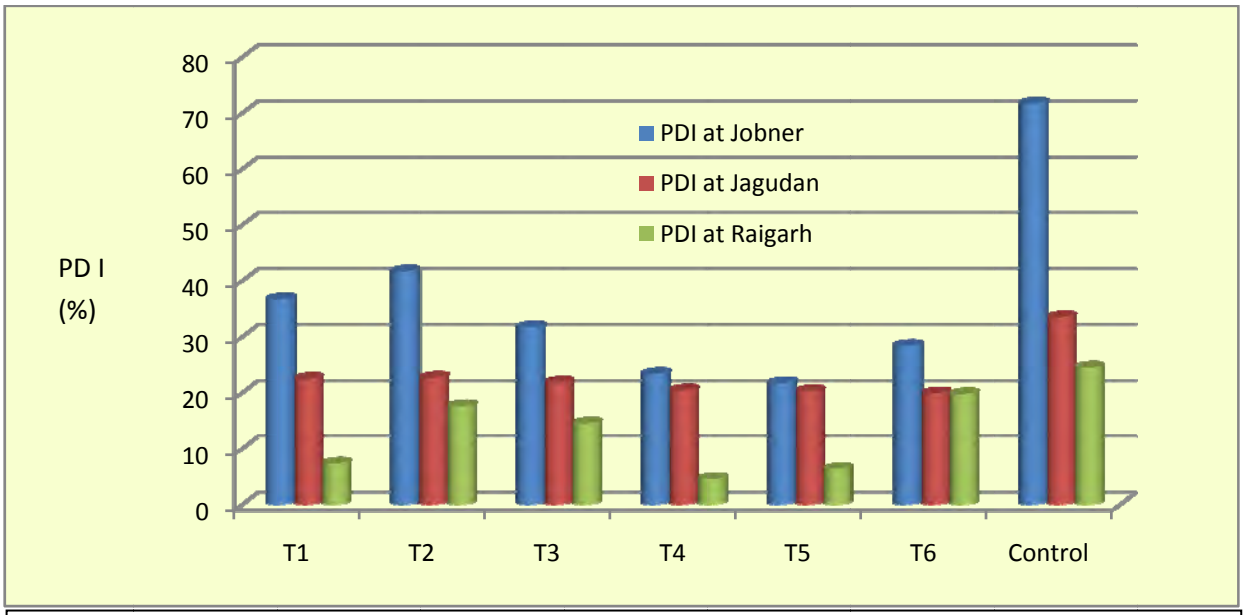
A field trial was laid out at Coimbatore to test the efficacy of different new generation fungicides for the management of coriander powdery mildew. Among the six fungicides tested, propiconazole effectively controlled the powdery mildew incidence. The disease incidence in propiconazole sprayed plants was (5.30 PDI) followed by tebuconazole (6.83 PDI), while in control the incidence was 87.83 PDI. This treatment recorded the highest seed yield (9.54 q ha^{-1}) as compared to control (6.92 q ha^{-1}).

An experiment on efficacy of new generation fungicides against powdery mildew of coriander was conducted at Jobner. Out of seven treatments, minimum (21.67%) disease intensity (Fig 33) and maximum seed yield of 15.13 q ha^{-1} was recorded with foliar spray of Hexaconazole 5% SC @ 0.1%. It was statistically at par with foliar spray of Wettable Sulphur 80% WP @ 0.2% followed by Propiconazole 25% EC @ 0.1% where, 23.33 and 28.33 per cent disease intensity and 14.722 and 13.519 q ha^{-1} seed yield was observed. Maximum (71.67%) disease intensity and minimum seed yield (11.806 q ha^{-1}) was recorded under the untreated control (Fig 33).

There was significant difference in percent disease intensity at Jagudan (Fig 33). The minimum percent disease intensity was observed in T_7, spraying of Dinocap and was

at par with T_6, spraying of Propiconazole 0.1%, T_5, Spraying of Hexaconazole 0.1%, T_4, spraying of wettable sulphur 0.2 and spray of Azoxystrobin 0.1 %. Significantly higher yield was recorded in treatment T_6, spray of Propiconazole 0.1% and remain at par with treatment T_7, Spraying of Dinocap, T_5 i.e. spraying of Hexaconazole 0.1% and spraying of wettable sulphur 0.2%.

Minimum disease intensity 4.5 per cent and maximum yield (12.56 q ha^{-1}) was found in the treatment foliar spray of wettbale sulphur 0.2% at Raigarh (Fig 33).



T1- Foliar spray of Tebuconazole 0.1% T2- Foliar spray of Propineb 0.2%
T3- Foliar spray of Azoxystrobin 0.15% 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 33: Effect of different treatments on powdery mildew of Coriander

COR/CP/6.5 Eco-friendly management of stem gall of coriander

(Centres: Middle Gangetic Plain Region – Kumarganj)

The most effective treatment for the management of stem gall of coriander at Kumarganj was soil solarization by polythene covering (60 days) + Plastic mulching (from sowing to harvest) + seed treatment and three foliar spray at 45, 60 and 90 days with 1.0 % neem oil (8 %) followed by soil solarization by polythene covering (60 days) + Seed treatment and three foliar spray at 45, 60 and 90 days with 1.0% neem oil (8.1%), plastic mulching (from sowing to harvest)+ seed treatment and three foliar spray at 45, 60 and 90 days with 1.0% neem oil (8.20%) and soil solarization by polythene sheet (60days) + plastic mulching (from sowing to harvest) (9.1%). But when treated with propiconazole @0.2% propiconazole severity of stem gall was 7.6%. In case of seed yield, soil solarization by polythene covering (60 days) + plastic mulching (from sowing to harvest) + seed treatment and three foliar spray at 45,60 and 90 days with 1.0% neem oil recorded maximum seed yield (10.31 q ha^{-1}) followed by seed treatment with propiconazole @0.2% (9.2 q ha^{-1}) and soil solarization by polythene sheet (60 days) (8.59 q ha^{-1}).

VII. 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)

Germplasm of cumin conserved at Jagudan, Jobner, Sanand and Mandor (Table 16 and Fig 34).

The 100 new germplasm collections were made by Jagudan during 2017-18 which includes hairy types and white flower types (Fig 35).

Table 16: Cumin germplasm collections at various AICRPS centres

Centre	Indigenous		Exotic	Total
	Cultivated			
	Existing	Addition (2017-18)		
Jagudan	211	100	7	**318**
Jobner	370		6	**376**
Sanand	62	-	-	**62**
Total	**643**	**100**	**13**	**756**

Fig 34: Cumin germplasm plot at Sanand Centre

Fig 35: Hairy type cumin and white flower cumin

A wide range of variability was found for all the characters studiedat Jobner. Out of 30 accessions, 5 accessions were better than best check variety RZ-223 (10.50 g) on the basis of seed yield per 5 plants. Promising accessions identified on the basis of seed yield per 5 plants were UC-264 (15.7 g), UC-254 (14.78 g), UC-262 (13.06 g), UC-274 (12.66 g) and UC-265 10.52 g).

Screening for resistance against *Alternaria* blight disease

Total sixteen (14+2) entries of cumin were screened at Jagudan for the resistance against blight disease. The maximum disease intensity was recorded in the entry Jc-95-119 (60.0 %) while the minimum disease intensity was noticed in Sanand Cumin-5 (12.0 %). The blight disease incidence ranged from 32.5 to 81.0 per cent.

Screening for resistance against powdery mildew disease

Total sixteen (14+2) entries of cumin were screened for the resistance against powdery mildew disease at Jagudan. The minimum disease intensity was noticed in Sanand Cumin-5 (5.0 %) (Fig 36), while the maximum disease intensity was recorded in the entry Jc-95-119 (25.0 %). The powdery mildew incidence ranged from 5.0 to 25.0 %.

Fig 36: Promising entry Sanand Cumin 5

Screening for resistance against wilt disease

Total fifty seven (57) entries of cumin were screened for the resistance against wilt disease under wilt sick plot conditions at Jagudan. Overall wilt incidence was very high. The minimum disease intensity was noticed in GC-3-5 (20.0 %), while the maximum disease intensity was recorded in the entry J.Cum-GC-4-3-2017 (94.0 %).The wilt disease incidence ranged from 20.0 to 94.00 %.

CUM/CI/1.3 Identification of drought tolerance

(Centre: Central plateau and hills region - Jobner)

An experiment was conducted during *Rabi* 2017-18 to identify drought tolerance in cumin. 30 genotypes were randomly selected from the germplasm being maintained at Jobner. The genotypes *viz*., UC-276, UC-287, UC-282, UC-319 and UC-332 in normal conditions while UC-319, UC-332, UC-329, UC-286, UC- 320 and UC-328 in stress conditions were top yielders. Based on stress indices UC-327 was found to be the desirable entry for moisture stress/ drought conditions, followed by UC-327, UC-329, UC-320, UC-277 and UC-229

Crop Improvement

CUM/CI/3.5 Initial Evaluation Trial 2013

(Centres: Gujarat plains and hills region – Jagudan)

At Jagudan, the IET trial was heavily infected by blight and plant population also suffered, trials should be repeated for one more year.

CUM/CI/4.1 Quality evaluation in Cumin

(Centre: Central plateau and hills region - Jobner)

Analysis of samples for quality is in progess.

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)

Out of thirteen treatments tested, minimum wilt incidence (11.1 %) and maximum seed yield (2.05 q ha^{-1}) were observed in the treatment containing soil application of vermicompost @ 2 t ha^{-1} + seed treatment with *Trichoderma* @ 6g kg^{-1} + spray of NSKE @ 5% followed by the treatment of soil application of FYM @ 6t ha^{-1} + seed treatment with *Trichoderma* @ 6g kg^{-1} + spray of NSKE @ 5%, exhibited 15.6% wilt incidence and 1.88 q ha^{-1} seed yield. Both these treatments were significantly superior over control, where maximum wilt incidence (29.5%) and minimum yield (1.11 q ha^{-1}) were observed. The effect of treatments on yield attributing characters and blight disease was found to be non significant.

Fig 37: Field view of GC-4 at Ajmer

CUM/CM/5.4 Standardization of drip irrigation and fertigation in cumin

(Centre: Gujarat plains and hills region – Jagudan; Central plateau and hills region – Jobner, Mandor)

The experiment was started in 2016-17 for three years at Jobner. The ten treatments consisted of surface irrigation at 0.8 IW/CPE ratio with 100% RDF, and drip fertigation at 0.8, 0.6 and 0.4 IW/CPE ratio with 60, 80 and 100% RDF were evaluated in RBD with 3 replications (Table 17). The results showed that drip irrigation as well as drip fertigation significantly increased the plant height, umbels per plant, umbellets per umbel, seeds per umbel, seed yield and water use efficiency of cumin as compared to surface irrigation with conventional fertilization. The drip fertigation at 0.6 IW/CPE ratio with 80% RDF recorded significantly higher plant height (29.34 cm), umbels per plant (19.59), umbellets per umbel (5.22), seeds per umbel (26.66), seed yield (4.56 q ha^{-1}) and water use efficiency (2.42 kg ha-mm^{-1}) and water saving (22.1%). However it remained at par to drip fertigation at 0.8 IW/CPE ratio with 100% RDF.

Table 17: Effect of drip irrigation and fertigation on yield and water use efficiency of cumin (Pooled)

Treatment	Seed yield (kg/ha)	Water used (mm)	CU (mm)	Water use efficiency (kg/ha-mm)	Water saving (%)
1. Standard check (Surface irrigation at 0.8 IW/CPE ratio with 100% RDF)	311.86	255.0	210.5	1.47	0.0
2. Drip fertigation at 0.4 IW/CPE ratio with 60 % RDF	351.05	142.5	138.4	2.52	44.1
3. Drip fertigation at 0.4 IW/CPE ratio with 80 % RDF	397.39	142.5	137.9	2.86	44.1
4. Drip fertigation at 0.4 IW/CPE ratio with 100 % RDF	419.65	142.5	138.4	3.01	44.1
5. Drip fertigation at 0.6 IW/CPE ratio with 60 % RDF	399.72	198.5	184.6	2.14	22.1
6. Drip fertigation at 0.6 IW/CPE ratio with 80 % RDF	456.26	198.5	185.5	2.42	22.1
7. Drip fertigation at 0.6 IW/CPE ratio with 100 % RDF	475.26	198.5	187.0	2.50	22.1
8. Drip fertigation at 0.8 IW/CPE ratio with 60 % RDF	365.21	255.0	236.8	1.52	0.0
9. Drip fertigation at 0.8 IW/CPE ratio with 80 % RDF	402.54	255.0	236.0	1.68	0.0
10. Drip fertigation at 0.8 IW/CPE ratio with 100 % RDF	413.82	255.0	237.5	1.71	0.0
SEm±	10.31			0.06	
CD (P= 0.05)	30.89			0.19	

Fig 38: Dr. T. Janakiram, ADG (Hort.) visiting seed spices trial at Jobner

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)

A total of ten treatments including untreated control were evaluated during rabi 2017-18 for the management of cumin aphid at Jagudan. Among them, thiamethoxam 25WG @ 25g a.i./ha followed by thiacloprid 21.7SC @ 25g a.i/ha had registered the least per cent umbels aphid infestation (0. 64%) at 7 days after second spray and it was followed by thiamethoxam 25WG @ 25g a.i./ha followed by clothianidin 50WDG @ 20g a.i./ha (1.89 %) as compared to untreated control (35.11 %) at 7 days after second spray. Mean population of predatory coccinellids varied from 2.00 (carbosulfan 25EC (250g a.i/ha) followed by thiacloprid 21.7SC (25g a.i/ha) to 3.32 (untreated control) per plant at seven days after second spray. Seed yield of cumin was low due to adverse climatic conditions; however found to be highest in thiamethoxam 25WG @ 25g a.i./ha followed by thiacloprid 21.7SC@ 25g a.i./ha (3.04 q ha^{-1}), whereas, non protected plots of cumin had obtained only 1.48 q ha^{-1} seed yield of cumin.

At Jobner, among ten treatments of different insecticidal sprays, the treatment of spray with Thiamethoxam 25 WG @ 25 g a.i./ha followed by Clothianidin 50 WDG @ 20 g a.i./ha proved most effective against cumin aphid, where 78.18% mean reduction in aphid population was recorded as compared to control and rendered highest seed yield (2.28q ha^{-1}). This treatment 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, exhibited 73.92% mean reduction in aphid population over control and 2.18 kg ha^{-1} seed yield. In all the treatments, the percentage of volatile oil differed non-significantly.

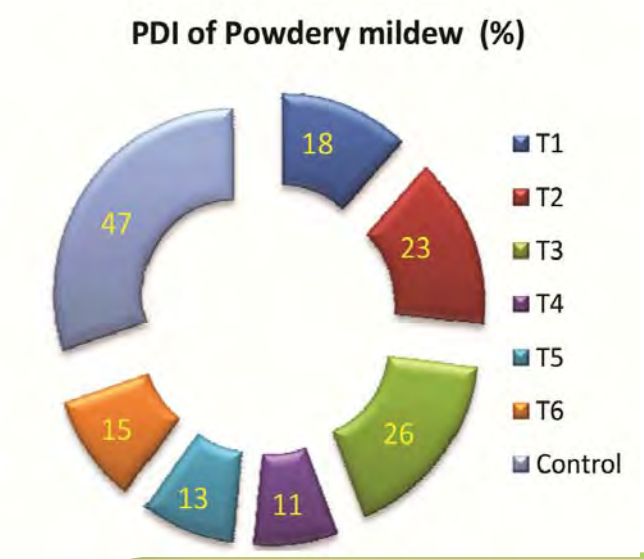
T1- Foliar spray of Tebuconazole 0.1% , T2- Foliar spray of Propineb 0.2%, T3- Foliar spray of Azoxystrobin (0.15%), T4- Foliar spray of wettable sulphur 0.2%, T5- Foliar spray of Hexaconazole 0.1%, T6- Foliar spray of Propiconazole 0.1% , T7-Control

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

(Centre: Central plateau and hills region – Jobner)

The result revealed that out of seven treatments, minimum (11.67%) disease intensity and maximum seed yield (1.93q ha^{-1}) was recorded with foliar spray of Hexaconazole @ 0.1%. It was statistically at par with foliar spray of Dinocap @ 0.1% followed by Wettable Sulphur @ 0.2 % where, respectively 13.33 and 15.00 per cent disease intensity and 1.90and 1.88q ha^{-1}seed yield was observed. Maximum (46.67%) disease intensity and minimum seed yield (1.63q ha^{-1}) was recorded under the untreated control (Fig 39).

Fig 39: Management of powdery mildew in cumin through new chemicals



IX. FENNEL

Genetic Resources

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)

Table 18 shows the germplasms collection maintained at various AICRPS centres.

Out of sixty accessions, only twelve accessions namely RF-67, RF-2, RF-20, RF-23, RF-74, RF-4, RF-55, RF-34, RF-29, RF-9, RF-16 and RF-66 gave the highest yield ranging from 133g to 108g per plant and per plot 1.93 to 1.40kg 7.2m^{-2} as compared to the best check variety GF-11 with yield per plant (106g) and per plot 1.30kg 7.2m^{-2} and other accessions. Among twelve promising accessions, RF-67 produced the highest yield 133g per plant and per plot 1.93kg 7.2m^{-2} followed by RF-2 with yield per plant (130g per plant) and yield per plot (1.80kg 7.2m^{-2}) (Fig 40).

At Kumarganj, 161 germplasm of fennel were evaluated and the maximum yield was recorded in NDF-46 (55.80 g $plant^{-1}$) followed by NDF-51 (52.30 g $plant^{-1}$) and NDF-45 (50.20 g $plant^{-1}$).

One hundred thirty three (133) inbred lines were raised at Jobner in single row plot of 3 x 0.5 sq.m. size. In each row of a plot inbreeding was achieved by bagging individual umbel with muslin cloth and on maturity seeds were harvested separately to raise the lines for next season (Table 18).

Fig 40 : Visit of Rajasthan Agriculture Minister, Sri. Prabhu Lal Siani to fennel germplasm

Table 18: Germplasm collection of fennel in various AICRPS centres

Centre	Indigenous		Exotic	Total
	Cultivated			
	Existing	Addition (2016-17)	Existing	
Dholi	60	0	-	60
Guntur	2	-	-	2
Hisar	170	4	-	174
Jagudan	80	50	2	132
Jobner	271	-	20	291
Kumarganj	164	-	-	164
Pantnagar	96	-	-	96
Sanand	6	-	-	6
Total	849	54	22	925

Screening for resistance against *Ramularia* blight disease (Caused by: *Ramularia foeniculi*)

During *kharif* season, total twelve (9+3) entries of fennel were screened under natural conditions. None of the entry was found free from the *Ramularia* blight intensity. The minimum intensity of *Ramularia* blight was noticed in JF-2012-09 (8.0 %) while the maximum intensity of *Ramularia* blight was recorded in entry JF-2012-11 (20.0 %). The per cent disease intensity was ranged between 8.0 to 20.0 per cent.

During *rabi* season, total twenty nine (25+4) entries of fennel were screened under natural conditions. None of the entry was found free from the *Ramularia* blight. The minimum intensity of *Ramularia* blight was noticed in FNL-104 (8.0 %) while the maximum intensity of *Ramularia* blight was recorded in entry JF-2012-9 (24.0%). The per cent disease intensity was ranged between 8.0 per cent to 24.0 percent.

Crop Improvement

FNL/CI/2 Coordinated Varietal Trial
FNL/CI/2.6 Coordinated Varietal Trial on Fennel 2015 Series – Series IX

(Centres: Central plateau and hills region - Ajmer, Jabalpur, Jobner; Middle Gangetic Plain Region – Dholi, Kumarganj; Trans Gangetic Plain Region – Hisar; Gujarat plains and hills region - Jagudan; Western Himalayan Region - Pantnagar)

The results of CVT trials at Jabalpur showed that the days to early flowering was noted in genotype FNL -111 (82.67 days). The maximum plant height was observed in FNL -114 (182.68 cm) and number of branches per plant in FNL-112 (8.54). The maximum seed yield (11.91 q ha^{-1}) was recorded in genotype FNL -109.

The analysis of variance revealed significant differences among the entries for all the traits at Jobner. The seed yield ranged from 13.77 to 24.84 q ha^{-1}. Of the fifteen entries evaluated, entry FNL-106 recorded maximum seed yield of 24.84 q ha^{-1} followed by RF-205 check (23.86 q ha^{-1}), FNL-103

(21.28 q ha^{-1}), FNL-108 (20.37 q ha^{-1}), and FNL-111 (20.33 q ha^{-1}), while lowest seed yield of 13.77 q ha^{-1} was recorded in FNL-109.

At Dholi, among thirteen entries and three checks (two national check RF-101 and RF-205) and one local check variety Rajendra Saurabh, none of the entries were found significantly regarding yield as compared to best check variety Rajendra Saurabh.

Out of 16 genotypes of fennel tested at Kumarganj under CVT, the highest yield was observed in FNL-112 (15.34 q ha^{-1}) followed by FNL-110 (14.58 q ha^{-1}) and FNL-108 (13.88 q ha^{-1}).

At Hisar, the maximum seed yield was recorded as 21.27 q ha^{-1} in FNL-113 followed by FNL-112 (20.17 q ha^{-1}) and FNL-111(19.17q ha^{-1}) respectively (Fig 42).

The experiment comprised 16 (13+3C) entries at Jagudan. All characters showed significant difference among the genotypes. The entires namely, FNL-105 (16.88 q ha^{-1}) and FNL-108 (16.74 q ha^{-1}) proved their superiority overall checks varieties at Jagudan.

Fig 41: Field view of fennel at Ajmer

Fig 42: Visit of Seed spices Monitoring team at Hisar

FNL/CI/3 Varietal Evaluation Trial

FNL/CI/3.5 Initial Evaluation Trial 2015

(Centre: Gujarat plains and hills region – Jagudan; Middle Gangetic Plain Region – Kumarganj, Dholi)

Four entries of *Rabi* fennel were found significantly superior over check variety GF-12. Entry JF-2013-16 (20.15 q ha^{-1}) was found superior with 52.31 per cent higher yield than GF-12 (13.23 q ha^{-1}) at Jagudan.

At Kumarganj, eleven entries were tested under IET. The maximum yield were recorded in NDF-84 (15.83 q ha^{-1}) followed by NDF-77 (14.37 q ha^{-1}) and NDF-74 (13.75. q ha^{-1}). Three years pool data showed highest yield in NDF-84 (15.55 q ha^{-1}) followed by NDF-77 (14.28 q ha^{-1}) and NDF-68 (13.58 q ha^{-1}).

Crop Management

FNL/CM/5 Nutrient Management Trial

FNL/CM/5.5 Standardization of drip fertigation in fennel

(Centres: Central plateau and hills region - Jobner)

The experiment was conducted during *Rabi* 2017-18. The ten treatments consisted of surface irrigation with conventional fertilization, drip irrigation with 50, 75 and 100% conventional fertilization and drip fertigation with 50, 75 and 100% recommended dose of nitrogen and recommended dose of fertilizers were evaluated. The results showed that drip irrigation as well as drip fertigation significantly increased the plant height, umbels per plant, umbellets per umbel, seeds per umbel, test weight, seed yield and water use efficiency of fennel as compared to surface irrigation with conventional fertilization. The drip fertigation with 75% RDF recorded significantly higher plant height (121.3 cm), umbels per plant (29.22), umbellets per umbel (24.04), seeds per umbel (391.5), test weight (6.15g), seed yield (24.78 q ha^{-1}) and water use efficiency (5.72 kg/ha-mm) along with 18.9% of water saving. However it remained *at par* to drip fertigation with 100% RDF and drip fertigation with 100% RDN (Table19).

Table 19: Effect of drip irrigation and fertigation on yield and water use efficiency of fennel (Pooled data)

Treatment	Seed yield (q/ha)	Water used (mm)	CU (mm)	Water use efficiency (kg/ha-mm)	Water saving (%)
Surface irrigation with CF (100% RDF)	16.44	576.3	457.0	3.67	0
Drip irrigation with CF (50% RDF)	17.84	467.2	432.4	4.17	18.9
Drip irrigation with CF (75%RDF)	20.35	467.2	436.7	4.71	18.9
Drip irrigation with CF (100%RDF)	21.28	467.2	436.4	4.92	18.9
Drip fertigation with (50%RDN)	19.67	467.2	430.2	4.63	18.9
Drip fertigation with (75%RDN)	22.39	467.2	433.9	5.21	18.9
Drip fertigation with (100%RDN)	23.60	467.2	433.4	5.50	18.9
Drip fertigation with (50%RDF)	21.80	467.2	434.5	5.07	18.9
Drip fertigation with (75%RDF)	24.78	467.2	437.9	5.72	18.9
Drip fertigation with (100% RDF)	25.51	467.2	434.2	5.94	18.9
SEm+	0.47		2.3	0.12	
CD (P= 0.05)	1.34		6.4	0.34	

X. 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)

Germplasm of fenugreek maintained at various AICRPS centres (Table 20) (Fig 43).

Two hundred and two germplasm of fenugreek were maintained and evaluated at Kumarganj. The highest yield was found in NDM-47 (5.9 g per plant) followed by NDM-119 (5.8 g per plant) and NDM-49 (5.7 g per plant).

During the year 2017-18, one hundred and twenty four germplasm lines along with seven checks were evaluated at Guntur. Among the entries evaluated, the following entries, LFC-115 (4.96 g plant^{-1}), LFC-122 (4.93 g plant^{-1}), LFC-32 (4.74 g plant^{-1}), LFC-82 (4.63 g plant^{-1}), LFC-38 (4.56 g plant^{-1}), LFC-76 (4.47 g plant^{-1}) and LFC-51 (4.46 g plant^{-1}) were found significantly superior in yield to the best check APHU Methi-1 (4.09 g plant^{-1}).

Fig 43: Dr. T. Janakiram ADG (Hort.) & Dr. Gopal Lal, Director, NRCSS monitoring the performance of fenugreek germplasm at Jobner

Table 20: Germplasm collection of fenugreek in various AICRPS centres

Centre	Indigenous		Total
	Existing	Addition (2017 -18)	
Dholi	166	-	166
Guntur	124	-	124
Hisar	389	12	401
Jagudan	76	-	76
Jobner	385	-	385
Kumarganj	202	-	202
Pantnagar	139	-	139
Total	1481	12	1493

In fenugreek, 50 genotypes in augmented design were evealuated at Jagudan and the range of seed yield varied between 32.33 q ha^{-1} (JFg-226) and 68.66 q ha^{-1} (JFg-203).

Out of 378 germplams collections maintained at Jobner, one hundred and eleven germplasm accessions were evaluated along with nine checks namely RMt-1, RMt-143, RMt-303, RMt-305, RMt-351, RMt-354, RMt-361, RMt-365 and Local in augmented design in 4 blocks A wide range of variability was found for all the characters studied. Out of 111 accessions, 11 accessions were better than best check variety RMt-361 (30.3 g.). Some of the promising accessions identified on the basis of seed yield per 5 plants were LFC-36 (39.0 g), LFC-34 (36.5 g), LFC-9 (35.0 g), LFC-62 (35.0 g), LFC-23 (34.0 g), LFC-105 (34.0 g), LFC-50 (33.5 g), LFC-114 (33.0 g), LFC-38 (31.5 g) and LFC-49 (31.5 g).

Screening of germplasm

Powdery mildew disease (Caused by: *Erysiphe polygoni* and *Leveillula taurica*)

Total eleven (10+1) entries of fenugreek were screened under natural condition for powdery mildew disease at Jagudan. None of the entry was found free from the powdery mildew incidence. The minimum incidence was noticed in JFg-194 (8.0 %), while the maximum per cent disease intensity was recorded in entry GM-2 (25.0 %). The per cent disease intensity ranged between 8.0 to 25.

Fig 44 : Fenugreek germplasm at Raigarh

One hundred and twenty entries of fenugreek were screened at Jobner under this trial against powdery mildew disease. Forty one entries *viz.*, LFC-9, LFC-12, LFC-17, LFC-19, LFC-20, LFC-21, LFC-22, LFC-24, LFC-25, LFC-33, LFC-34, LFC-36, LFC-37, LFC-40, LFC-43, LFC-46, LFC-52, LFC-55, LFC-64, LFC-67, LFC-72, LFC-73, LFC-74, LFC-76, LFC-77, LFC-78, LFC-85, LFC-91, LFC-92, LFC-93, LFC-100, LFC-103, LFC-106, LFC-107, LFC-113, LFC-115, LFC-119, LFC-125, RMt-305, RMt-351 and RMt-361 were observed as moderately resistant against powdery mildew disease.

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

(Centres: Central plateau and hills region - Jobner)

Thirty genotypes were randomly selected from the germplasm maintained at Jobner. These lines were sown in two environments namely irrigated (full supplement of irrigations given) and drought (staggered irrigations (half of that given in irrigated treatment).The genotypes *viz*., UM 55, UM 38, UM 58, and UM 46 in normal irrigation while UM 40, UM 52, UM 54 and UM 56 in staggered irrigation conditions were top yielders. Based on stress indices UM 53, UM 54, UM 56 and UM 65 were found to be the desirable entries for moisture stress/ drought conditions.

Three years data of fenugreek indicated that the genotypes UM 40, UM 38, UM 50, UM 37 and UM 64 in normal while UM 38, UM 66, Rmt 361, UM 46 and UM 55 in stress conditions were top yielders. Based on stress indices, UM 61 was found to be the desirable entry for moisture stress/ drought conditions, followed by UM 66, UM 57, UM 44 and UM 38.

Crop Improvement

FGK/CI/2 Coordinated Varietal Trial
FGK/CI/2.4 Coordinated Varietal Trial 2015 Series IX

(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 analysis of variance revealed significant differences among the entries for seed yield at Jobner. The seed yield ranged from 12.81 to 21.22 q ha^{-1}. Of the eighteen entries evaluated, entry FGK-109 recorded maximum seed yield of 21.22 q ha^{-1} followed by FGK-110 (21.13 q ha^{-1}), FGK-115 (20.25 q ha^{-1}) and FGK-117 (20.09. q ha^{-1}), FGK-119 (19.88 q ha^{-1}) and FGK-108 (19.18.q ha^{-1}), while lowest yield of 12.81 q ha^{-1} was recorded in FGK-112 (Fig 45).

Fig 45: Coordinated varietal Trial on fenugreek at Jobner

In the Coordinated varietal trial on fenugreek, fourteen fenugreek genotypes along with two checks were evaluated at Coimbatore. The plant height of the genotypes ranged from 36.30 cm (FGK 113) to 42 .71 cm (FGK 118). The genotype FGK 108 (22.67) recorded maximum number of pods per plant and the genotype FGK 109 (11.33) recorded lesser number of pods per plant. Seed yield per plot (2 m^2) varied from 89.33 g to 174.67 g with a mean of 120.29 g.

At Kumarganj, maximum yield was recorded in FGK-108 (13.33 q ha^{-1}) followed by FGK-111 (13.33 q ha^{-1}) and FGK-110 (13.05 q ha^{-1}).

During 2017-18, fourteen coded entries were evaluated along with three checks at Guntur. Among the entries evaluated, none of the entries were found significantly superior in yield to the best check APHU Methi-1 (861.2 kg ha^{-1}).

Fourteen entries of fenugreek were evaluated at Jagudan along with checks viz. Hissar Sonali, GM-2 and RMT-361. Significant yield differences were observed among the entries however none of the entries were significantly superior over any check varieties. The entry FGK-118 (17.76 q ha^{-1}) gave numerically higher yield than RMT-361 (11.40 q ha^{-1}).

Out of 16 entries evaluated during *Rabi* season at Navsari, FGK-83 (14.19 q ha^{-1}), FGK-86 (13.82 q ha^{-1}), FGK-81 (13.64 q ha^{-1}), FGK-87 (13.45 q ha^{-1}), FGK-89 (13.33 q ha^{-1}) and FGK-91 (12.96 q ha^{-1}) recorded significantly higher seed yield over HM-57.

At Raigarh, the results revealed that FGK-117 (22.20 q ha^{-1}), FGK-118 (21.40 q ha^{-1}) and FGK-116 (20.90 q ha^{-1}) recorded high seed yield of fenugreek over national check Hisar Sonali (18.1 q ha^{-1}).

The seed yield ranged from 7.81 to 18.05 q ha^{-1} in the third year of evaluation at Kota. FGK 118 was found to be the best performing entry in terms of seed yield (16.70 q ha^{-1}) showing 19.65 per cent higher yield over the check Hisar Sonali. The mean days to flowering ranged from 57 days (FGK 99) to 69.67 days (FGK 107); days to maturity from 125 days (FGK 115) to 133 days (FGK 119) and test weight ranged from 10.61 g (FGK - 118) to 13.76 (Hisar Sonali).

Fig 46: Field view of fenugreek at Raigarh

FGK/CI/3 Varietal Evaluation Trial
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)

In the trial on chemo-profiling of fenugreek varieties, two varieties *viz*., CO 1 and CO 2 were evaluated during 2017-18 at Coimbatore. The seed shape of both varieties is angular in shape. The seed colour of the variety CO 1 is light brownish yellow and CO 2 is dark brownish yellow in colour (Table 21). The variety CO 2 recorded highest thousand seed weight (12.38 g) when compared to CO 1 (11.61 g). The seed samples were sent to Jobner centre for quality analysis. However quality analysis of the fenugreek seed is in progress at Coimbatore centre.

During 2017-18, seed samples of Lam Selection-1 and AM-1 were submitted to

AICRPS, Jobner for analysis by Guntur centre. The current year results are awaited.

The chemo-profiling of the varieties of fenugreek from other centres are in progress.

Table 21. Seed characteristics of fenugreek varieties at Coimbatore

S.No.	Seed characters	CO 1	CO 2
1.	Seed shape	Angular	Angular
2.	Seed colour	Light brownish yellow	Dark brownish yellow
3.	1000 seed weight (g)	11.61 g	12.38 g

FGK/CI/3.8 Initial Evaluation Trial 2015

(Centres: Middle Gangetic Plain Region – Kumarganj; Gujarat plains and hills region – Jagudan; Central plateau and hills region - Jobner)

Under IET of Fenugreek at Kumarganj a total of 11 entries were tested. Maximum yield was recorded in NDM-120 (15.00 q ha^{-1}) followed NDM-80 (14.40 q ha^{-1}) and NDM-112 (13.33 q ha^{-1}).Three years pool data showed highest yield in NDM-120 (14.67 q ha^{-1}) followed by NDM -80 (14.18 q ha^{-1}) and NDM-112 (12.54 q ha^{-1}).

At Jagudan, JFg-2013-5 (21.98 q ha^{-1}), JFg-2013-16 (21.78 q ha^{-1}) and JFg-2013-6 (21.03 q ha^{-1}) gave numerically higher yield than GM-2 (19.46 q ha^{-1}), which were 12.94, 11.89 and 8.02 per cent higher over GM-2 respectively.

The analysis of variance revealed significant differences among the entries for all the traits including seed yield at Jobner. The seed yield ranged from 13.28 to 19.71 q ha^{-1}. Of the ten entries evaluated, entry UM-411 recorded maximum seed yield of 19.71 q ha^{-1} followed by UM-393 (19.30 q ha^{-1}), UM 415 (19.02 q ha^{-1}) and UM 410 (17.40 q ha^{-1}) while lowest yield of 13.28 q ha^{-1} was recorded in UM 398. Mean performance of the entries evaluated in IET of fenugreek over 2015-16 to 2017-18 revealed superior performance of UM-411 yielding 20.20 q ha^{-1} followed by UM-393 (16.85.19 q ha^{-1}). The entries UM-411 and UM-393 may be promoted to next CVT.

XI. 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 found in NDAJ-10 (8.26 q ha^{-1}) followed by AA-6 (7.99 q ha^{-1}) and JA-187 (7.71 q ha^{-1})

During 2017-18, eleven genotypes from different coordinating centers were evaluated along with four checks at Guntur. Among the entries evaluated, highest yield was recorded with LS-14-3 (11.19 q ha^{-1}) followed by LS-14-8 (11.09 q ha^{-1}) and AA-73 (11.06 q ha^{-1}), which were on par with each other and significantly superior to the best check Lam Selection-1 (9.63 q ha^{-1}) (Table22).

Table 22: Growth and yield of Ajwain genotypes in Coordinated Varietal Trial at Guntur

S.No	Genotypes	Plant height (cm)	Umbels per plant	Umbellets per umbel	No. of Seeds per umbel	Days to 50% flowering	Days to maturity	Yield (kg/ha)	Rank
1	JA-219	105.6	156.4	12.9	244.3	84.0	149.0	833.3	7.0
2	JA-187	111.3	178.9	13.7	206.8	81.0	145.0	880.7	6.0
3	IA-1	109.9	275.6	14.5	295.3	83.0	147.0	562.5	12.0
4	HAJ-7	116.6	179.3	13.3	172.3	86.0	148.0	494.8	13.0
5	HAJ-18	100.7	181.0	12.3	170.0	80.5	145.0	651.0	10.0
6	AA-6	115.3	287.5	14.7	194.6	79.5	142.0	1041.7	4.0
7	AA-73	113.0	263.6	16.4	306.4	84.5	148.0	1106.8	3.0
8	LS-14-3	114.2	245.9	12.8	283.3	84.5	149.0	1119.3	1.0
9	LS-14-8	117.7	212.8	12.3	286.4	85.5	149.0	1109.4	2.0
10	NDAT-20	94.9	252.9	13.3	250.5	73.0	137.0	390.6	15.0
11	NDAT-21	98.6	257.1	13.9	228.5	84.5	148.0	572.9	6.0
12	AA-1 (c)	107.0	152.4	14.4	242.6	84.0	148.0	494.8	13.0
13	AA-2 (c)	114.9	227.6	13.4	207.0	88.0	150.0	833.3	7.0
14	LS-1 (c)	112.6	257.8	13.4	135.5	85.0	148.0	963.5	5.0
15	GA-1 (c)	117.3	257.7	15.8	252.5	83.5	147.0	729.2	9.0
CD (p=0.05)		20.4	44.5	2.6	58.1	8.3	8.6	121.3	-
CV (%)		8.7	9.2	9.0	11.7	4.7	2.7	7.2	-

At Raigarh, Ajwain 1 recorded maximum seed yield (6.1 q ha^{-1}) over checks AA-1 (4.9 q ha^{-1}) and AA -2 (4.7 q ha^{-1}) (Fig 47).

Fig 47: Field view of Ajwain at Raigarh

Statistical difference for all characters was found to be significant at Jagudan where a total of six genotypes recorded significantly higher yield than check variety AA-1 (11.50 q ha^{-1}). The genotype JA-187 (15.96 q ha^{-1}) was found to be the paramount genotype.

In *Rabi* 2017-18, twelve entries were evaluated at Jobner. The analysis of variance revealed significant differences among the entries for seed yield. The seed yield ranged from 8.00 to 15.92 q ha^{-1}. Of the fourteen entries evaluated, HAJ-7 recorded maximum seed yield of 15.92 q ha^{-1} followed by HAJ-18 (15.18 q ha^{-1}), IA-1 (15.09 q ha^{-1}), Local (14.53 q ha^{-1}) and JA-187 (13.72 q ha^{-1}), while lowest yield of 8.00 q ha^{-1} was recorded in HAJ-7. Mean performance of the entries evaluated in CVT of ajowain over 2016-17 and 2017-18 revealed superior performance of AA-2 check yielding 7.96. q ha^{-1} followed by HAJ-18 (7.59 q ha^{-1}) and IA-1 (7.54. q ha^{-1}), while lowest seed yield of 4.00. q $ha^{-1}$was recorded in HAJ-7.

Fig 48: Ajwain threshing by using modified Paddy thresher/ Harvester at Andhra Pradesh

XII. NIGELLA

Crop Improvement

NGL/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; Trans Gangetic Plain Region - Hisar; Western Himalayan Region – Pantnagar; Eastern plateau and hills region – Raigarh; Western dry region – Kota; Lower Gangetic Plain Region – Kalyani)

The seed yield ranged from 1.94 to7.98 q ha^{-1} in the second year of evaluation at Kota. AN-23 and AN-1 were found to be the best performing entries in terms of seed yield, yielding 6.39 q ha^{-1} followed by AN-1 (6.08 q ha^{-1}) and showing 7.39 per cent higher yield over the check Pant Krishna. The mean days to flowering ranged from 81 days (AN-20) to 85 days (NBC-20, PK-2 and Pant Krishna); days to maturity from 121 days (AN-20) to 125 days (IN-1, PK-2) and test weight from 4.10 g (AN-20) to 4.92 (AN-1).

At Kumarganj, 10 entries of nigella were tested and the highest yield was recorded in NDBC-20 (8.19 q ha^{-1}) followed by AN-1 (7.64 q ha^{-1}) and IN-1(7.29 q ha^{-1}) whereas at Raigarh, Indira Nigella -1 (IN-1) recorded (7.7 q ha^{-1}) followed by entry AN 20 (7.6 q ha^{-1}) over checks AA-1 (6.6 q ha^{-1}) and Pant Krishna (7.1 q ha^{-1})

At Kalyani, HKL-T recorded maximum plant height (62.13 cm), number of primary branches per plant (7.44), number of secondary branches per plant (8.43), number of capsules per plant (25.78), seeds per capsule (67.65), test weight (2.61 g) and yield per hectare (6.07 q). With regard to days to 50 % flowering (on plot basis), lowest days to 50 % flowering was recorded in AN-23 (63.04 days).

Table 23: Growth, yield and yield parameters of nigella genotypes for coordinated trial at Kalyani

Treatment	Days to 50% flowering	Plant height (cm)	No. of Primary branches	No. of Secondary branches	No. of Capsules per plant	No. of Seeds per capsule	Test Weight (g)	Projected seed yield (q/ha)
AN-1	63.56	55.56	6.39	7.03	20.34	62.14	2.48	5.42
AN-20	63.45	58.78	6.78	7.56	20.89	62.73	2.52	5.53
AN-23	63.04	54.67	7.05	7.86	19.68	57.92	2.39	5.04
HKL-T	67.27	62.13	7.44	8.43	25.78	67.65	2.61	6.07
Pant Krishna	62.76	57.23	6.21	7.34	21.78	57.34	2.42	5.17
PK-1	63.21	52.23	7.23	8.12	23.34	60.56	2.44	5.21
PK-2	66.48	54.34	6.57	7.12	23.89	64.87	2.58	5.74
SE(m)	0.874	0.957	0.158	0.211	0.399	0.393	0.080	0.146
C.D.	2.722	2.980	0.519	0.670	1.243	1.223	N/A	0.456

XIII. MONITORING

The Project coordinator and the Scientists from PC unit's monitored the working of various AICRPS centres and experimental plots by personal visits. Frequent monitoring was done also through e-mail and phone calls. Monthly progress report and budget utilization certificates sent from the centres were reviewed critically and proper guidance were given for improvement. A seed spices monitoring team involving Dr. Dhirendra Singh from SKNAU, Jobner, Dr.Y. K. Sharma from NRCSS, Ajmer and Dr. A. M. Amin from Jagudan visited the seed spices centres for reviewing the progress of the experiments.

Visit to AICRPS centres from 1st April 2017 to 31st March 2018

Sl. No.	Dates of visit	Centre visited
1.	12.05.2017-13.05.2017	AICRPS Centre at CSHAU Hisar
2	19.07.2017	AICRPS Centre at Dr. BSKKV Dapoli
3	09.10.2017	AICRPS Centre at Dr.YSRHU Guntur
4	18.11.2017	AICRPS Centre at Dr.YSRHU Chintapalle
5	08.12.2017	AICRPS Centre at KAU Thrissur
6	10.01.2018	AICRPS Centre at KAU Ambalavayal
7	01.02.2018-03.02.2018	AICRPS Centre at TNAU Pechiparai
8	03.02.2018	AICRPS Centre at RAU Jobner
9	13.03.18-15.03.2018	AICRPS Centre at SASRD Nagaland
10	13.03.2018-17.03.2018	Seed spice monitoring team-Jobner, Hisar, Ajmer , Jagudan and Udaipur
11	21.3.2018-22.03.2018	AICRPS Centre at AAU Kahikuchi

Fig 50: Visit of Project Coordinator & Scientists to AICRPS Centres

XIV. ANNUAL GROUP MEETING

The 28th Workshop of ICAR-All India Coordinated Research Project on Spices was conducted during 10-12 October 2017 at Horticultural Research Station, Dr. Y. S. R. Horticultural University, Lam, Guntur, Andhra Pradesh. The workshop was inaugurated by Sri. Chiranjiv Choudhary, IFS, Hon'ble Vice-Chancellor, Dr. Y.S.R Horticultural University, Andhra Pradesh on 10th October 2017 who opined that efforts should be channelized to evolve climate resilient varieties in the regime of global climate change. Dr. T. Janakiram, Assistant Director General (Horticulture Science II), Indian Council of Agricultural Research (ICAR), New Delhi was the Chief Guest during the occasion and appraised the relevance of value chain in assuring farmer's income through interventions at various phases of production chain including quality planting material, protected cultivation and value addition. The "Best AICRPS Centre Award 2016-17" was presented to three AICRPS centres *viz.*, Rajendra Prasad Central Agricultural University, Dholi, Dr. Y. S. R. Horticultural University Centres at Guntur and Chintapalle. Ten booklets / pamphlets and one DVD on spices production technologies in English and local languages from different AICRPS centres were released (Fig 51).

Fig 51: Glimpses of AICRPS workshop held at Dr. YSRHU, Guntur

Dignitaries like Dr. H. P. Maheswarappa, Project Coordinator, AICRP on Palms, CPCRI, Kasaragod, Dr. James George, Project Coordinator, AICRP on Tuber Crops, CTCRI, Trivandrum, Dr. Gopal Lal, Director, NRC for Seed Spices, Ajmer, Dr. Homey Cheriyan, Director, Directorate of Arecanut & Spices Development, Kozhikode, Dr. P.S. Sreekantan Thampi, Deputy Director, Spices Board were present to help and guide us through the proceedings.

The workshop was organized in six Technical Sessions – Genetic Resources and Crop Improvement, Crop Management, Crop Protection, Variety Release, Technology Transfer and Plenary, besides a special session on 'Brain Storming on Turmeric" in which varietal wealth, marketing, value chain development, crop production and protection technologies in turmeric were discussed.

Some important decisions taken in the workshop are

1. Germplasm needs to be strengthened in all crops through extensive survey especially in unexploited areas and with international collaboration particularly for specific traits and stress tolerance
2. DNA finger printing has to be done for all the released varieties and unique germplasm has to be registered
3. IC number has to be obtained for all the germplasm accessions and cataloging has to be done
4. Target variety based on market requirement like high curcumin, lemon yellow colour, low oil and good yield.
5. There is a huge gap between technologies developed and adaptation which necessitates to undertake demonstration in effective manner to augment turmeric production
6. Soil mineral may influence the curcumin and other quality parameters, hence, soil mapping of turmeric growing areas for nutrient status and heavy metal contaminations should be initiated
7. Model for value chain in turmeric should be developed region specific.
8. The expertise of ICAR-IISR, Kozhikode and identified institutes may be utilized for the identification of pathogens associated with major spices.
9. Research on safer fungicide with minimal spray for food safety issues
10. Promotion of tribal horticulture seminar including spice components should be organized

Some important New Projects initiated from this year are

In line with food safety assurance and minimization of the pesticide residue in spices, efficacy trials in coriander and cumin were initiated in various seed spice centres of AICRPS.

For sustainable production of spices, new programme on the management of bacterial wilt of ginger through chemicals and bioagents have been undertaken in various AICRPS centres of different agro climatic regions.

For the evaluation of genotypes for specific traits, various AICRPS centres have undertaken Coordinated varietal trials in spice crops like black pepper, cardamom, coriander, cumin, fennel and fenugreek

Technologies developed

Seven location specific technologies for various states were developed

1. **Standardization of drip fertigation in Black pepper under Kerala conditions**
   Drip irrigation in black pepper @ 8 litres of water daily and 50 RDF (half the Recommended Dose of Fertilizer as liquid fertilizer – 19:19:19 mixture) in 3 equal splits at weekly intervals during the months of June, September and February was beneficial than the conventional method of irrigation and basal fertilizer application with the highest benefit cost ratio (2.07).

2. **Liming in cardamom for Kerala**
   In acidic loamy soils of Kerala, application of 2 kg dolomite for 3 years improves the yield (2763.30 g plant^{-1}) in cardamom with B: C ratio of 2.42.

3. **Utilization of herbicides for the effective control of weeds in ginger for Andhra Pradesh**
   Under severe shortage of labour for hand weeding, application of Oxyflurofen as pre-emergent herbicide @500 ml/ha at second day after sowing followed by application of Quazilophop ethyl as post-emergent herbicide @1 litre per ha at 30 days of crops stage followed by hand weeding at 90 days of crop stage reduces 3-4 manual hand weeding required and gives a BC ratio of 2.96 with a yield of 22.79 t ha^{-1} was recommended for ginger in Chinthapalle condition.

4. **Micro nutrient management in fennel in Gujarath**
   Application of fertilizer to fennel with RDF of 90 + 30 kg NP per ha along with 200 kg FYM enriched with 3.0 kg Fe + 1.5 kg Zn per ha as basal application in furrow for light textured soils deficient in iron and zinc produces maximum yield (14.27 q ha^{-1}) with a BC ratio of 2.11.

5. **Management of blight and powdery mildew by spacing and potash application in cumin in Gujarath**
   Line sowing of cumin@ 30 x10 cm and application of Potash @ 20 kg per ha along with recommended dose of fertilizers reduces the incidence of blight (PDI- 17.3) and powdery mildew (PDI- 5.7) with maximum yield (363 kg ha^{-1}) and BC ratio of 2.41.

6. **Organics for yield enhancement in small cardamom in Karnataka**
   Application of Jeevamrutha (20 l clump^{-1}) +*Azosprillum* (10 g clump^{-1}) + PSB (10 g clump^{-1}) + *Trichoderma* (10 g clump^{-1}) improved the yield of cardamom (318.26 kg ha^{-1}) with BC ratio of 1:5.09

7. **Standardization of fertigation in cardamom for Karnataka**
   Application of irrigation 9 L/clump/day along with 100% Rec. dose of fertilizer through drips gives the highest capsule yield (316.16 kg ha^{-1}) in cardamom with BC ratio of 3.37.

Release of varieties

Six high yielding varieties of spices were recommended for release in XXVIII AICRP on Spices workshop held at Horticultural Research Station, Dr. Y. S. R. Horticultural University, Lam, Guntur, Andhra Pradesh. Two turmeric varieties *viz.*, **NDH-8 (**Narendra Saryu**)** from Narendra Dev University of Agriculture & Technology, Kumarganj, Faizabad, Uttar Pradesh with high curcumin content (5-6%), more number of primaries with yield advantage of 10% over the national check was recommended for release at national level and **CL 34** developed by Tamil Nadu Agricultural University, Coimbatore

with tolerance to leaf spot and leaf blotch and curcumin content of 3% was recommended for release in turmeric growing areas of Tamil Nadu. Two coriander varieties *viz.*, **Gujarat Coriander -3** from Centre for Research on Seed Spices (CRSS) , (SDAU), Jagudan with high yield potential (16.94 q/ha), high volatile oil (0.52 %) and high linalool (72.16%) was recommended for release in Gujarat and **Ajmer Coriander 2** developed by ICAR-NRC on Seed Spices, Ajmer for stem gall resistance, high linalool content (71.7%) and early maturing type was recommended for release at national level. **Ajmer Fenugreek 5,** a fenugreek variety developed by ICAR-NRC on Seed Spices, Ajmer with high seed yield (17.21 q/ha), high antioxidant content (66.428 mg/ BHTE/ ppm) and suitable for green leaf production under shade net condition in summer season was recommended for release at national level. **IISR Cassia (D1)** developed by Dr. BSKVV, Dapoli with low coumarin content was recommended for release in all the cassia growing regions of the country

The workshop came to an end on 12th October 2017. The plenary session was chaired by Dr. T. Janakiram, ADG (HS-II) and Dr. J. Dilip Babu, Director of Research, Dr. Y.S.R. Horticultural University. The Project Coordinator presented the Action Taken Report of 27th workshop and the research highlights and it was approved by the workshop.

Dr. T. Janakiram, ADG (HS-II) in his remarks congratulated the Best AICRPS centre and the scientists involved in developing new varieties & technologies which were approved in the workshop. The action points are as follows:

- After completion of third year of the project, proposal for the transfer of technologies may be prepared and submitted in the same year itself.
- In the demonstration of the technologies especially micro nutrient trials, KVK s may be included and state department may be informed about the technologies.
- Status report of each AICRPS centres may be published.
- Digitization and online submission of AICRPS reports may be strengthened.
- Value chain development of turmeric may be initiated.

XV. POPULARIZATION OF TECHNOLOGY

Scientist 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.

- Demonstrations of improved varieties of black pepper in 34 ha at Odisha (Pottangi)
- Demonstration on organic farming in black pepper (Yercaud)
- Four demonstrations on intercrop in coconut, arecanut and multitier cropping system along with cinnamon, pepper, nutmeg grafts and suitable standard for pepper (Panniyur)
- Demonstration on drip irrigation system in small cardamom (Mudegere)
- Demonstrations on organic ginger production in 4.5 ha at Koraput, Gajapati and Kandhamala districts of Odisha (Pottangi)
- Four demonstrations on high yielding ginger varieties (Solan)
- FLD on 11 high yielding varieties of turmeric (Guntur)
- Demonstration on protray technology, seed treatment of two budded turmeric seed rhizomes and raised bed method of planting in turmeric (Kammarapally)
- Demonstrations of high yielding varieties of turmeric, coriander, fennel and fenugreek (Kumarganj)
- FLD on performance of turmeric transplants in an area of 3.00 acres (Coimbatore)
- Demonstration of high yielding Turmeric variety CO 2 (Coimbatore)
- Training on "Hi- tech production technology for turmeric, ginger, coriander and curry leaf" in collaboration with DASD (Coimbatore)
- Demonstration of Diesel operated Turmeric boiler (Fig 53) and Turmeric digger (Guntur)
- Demonstration of technique of removing bark of cinnamon, protray propagation technique for ginger and turmeric, Processing of black pepper , processing of turmeric, soft wood grafting technique in nutmeg and kokum, bush pepper production technology (Dapoli)
- Six demonstrations on high yielding varieties of fenugreek, cumin and fennel (Jobner).

Apart from the above, the scientists interacted with farmers as resource persons in trainings, seminar and also through various media (newspaper, radio talks and TV programs) to disseminate knowledge about the latest technologies.

Fig 53: Demonstration of Diesel operated Turmeric boiler

Fig 54: Dr. P. S. Sreekantan Thampi, Deputy Director, Spices Board observing the harvest of coriande

XVI. SUCCESS STORIES

Black pepper for increased farm income

Black pepper is one of the important spice crops of Uttara Kannada district of Karnataka. In a present scenario where majority of the farmers consider horticulture as less remunerative and many youngsters migrate towards metros in search of better life, Mr. Ravindra G. Bhat, Kanagodu village of Yellapur, U. Kannada dist, finds success in black pepper cultivation in an area of 4 acres of areca garden (including old and new areas). He has planted Panniyur 5, Pinjar munda and Panniyur 1 in his plantation. He got 15q of black pepper from his 700 old vines and 1700 new vines were planted during June 2016. He has been following scientific cultivation methods and proper drip irrigation system has been laid out as per the advice from horticultural experts. In his plantation, the slow wilt disease is under check as plant protection measures have been taken up regularly as per the package of practices recommended by the University. Proper underground drainage system is laid out using perforated PVC pipes to drain off excess water during rainy season. Though he had no knowledge of scientific cultivation of black pepper before, now he has turned into a young entrepreneur with successful cultivation of pepper and a model for youngsters who would like to become the 'boss to himself'.

Fig 56: Black pepper crop in Mr. Ravindra Bhat's Farm

Mixed cropping- bonus to farmers

The mixed cropping system ensures additional income to the farmers. Shri. Madhav Marathe of Usgaon, Taluk of Dapoli learned about the concept of mixed cropping system in black pepper in one of the trainings conducted at B.S.K.K.V, Dapoli. He got the idea of planting black pepper in his arecanut plantation. After discussing with the scientists of B.S.K.K.V, Dapoli, Shri. Madhav planted Black pepper (Panniyur-1) on arecanut based mixed cropping system in an area about 0.50

ha during the year 2012. The balck pepper has started bearing now and he obtained a high yield of 10 kg of green berries per vine. He has sold the produce in the Mumbai market. The average price of green pepper spikes (fresh weight) is about Rs. 200-225 per kg. With gratitude he remembers the scientist of B.S.K.K.V, Dapoli who has regularly visited the garden to give guidance about package of practices, shade regulation, interculture, training, pruning operations and plant protection measures.

High yielding varieties of ginger and turmeric- for reaping profit

Since 1995, young enterprising youths of Pottangi came forward for cultivation of ginger and turmeric with improved package of practices. The planting material of the high yielding varieties of ginger (Suprabha) and turmeric (Roma) were supplied to six progressive farmers and provided with all improved technology by the scientists of AICRPS centre at HARS, Pottangi. After they became successful in getting a very high return, many unemployed youth and farmers were attracted towards the cultivation of ginger and turmeric. They produced 16.12 tonnes of Ginger and 4.22 tonnes of turmeric from 16.6 ha of land. They sold ginger Rs. 3000/- per quintal and turmeric (TL seed) @ Rs.2500/- per quintal.

Ramakrishna Reddy from Warangal, is a progressive farmer and produced about 18.0 tonnes of turmeric per acre with the variety Duggirala Red. He adopted completely the package of practices of Turmeric as published in the booklet (Pasupu Sagu) by Turmeric Research Station, Kammarpally.

Chinnareddy Maggidi of Nizamabad has raised the eight varieties of turmeric (Rajendra Sonia, Rajendra sonali, Ac No.48. Acc. No.79. Salem, Duggirala Red, PTS-10 and Rajapuri). A demonstration was also arranged in his field. He obtained a yield of 20 to 22 t per acre and his turmeric crop produce was used for seed material for next season.

Fig 57: Turmeric farmer at Adilabad

XVII. KRISHI MELAS & FARMER'S TRAININGS

Krishi Melas/exhibition organized

i. HRS Sirsi has organized Krishi Mela 2017 at UAS, Dharwad from 22-27 September 2017 in which 3 lakh farmers participated
ii. AICRPS centres *viz.,* Coimbatore, Kammarpally, Chintapalle, Dholi, Barapani and Guntur in collaboration with ICAR- Indian Institute of Spices Research has organized a "Turmeric Fest" showcasing the varietal wealth of turmeric on 20th January 2018 at ICAR- IISR, Kozhikode (Fig 58 and 59)
iii. SKLTSHU, Kammarpally centre has organized a massive Turmeric Festival on 2nd February 2018 in which about 250 farmers participated and 50 prominent turmeric varieties were exhibited in the festival.
iv. Farmers rally was conducted by Dr. BSKVV, Dapoli centre in different villages of Maharashtra like Asond, Vanand, Asud, Usgaon, Agarwayangani and Shirawane from 7th to 20th March 2018. Various topics like Spices cultivation and processing, Soil testing role and its importance, Demonstration on Bordeaux mixture preparation and grafting technique of black pepper and nutmeg were covered benefitting 308 farmers.
v. Exhibition in North East and Agri-Expo, 2018 on 6th to 9th January 2018 at ICAR-NEH Region, Barapani, Meghalaya.
vi. Exhibition and Regional Agri Fair, 2017 on the theme "Doubling the income of Farmers" on 22nd December, 2017 at College of Fisheries, Tripura.

Fig 58: Kerala Minister of Agriculture, Adv. Sunil Kumar inaugurating Turmeric Fest at ICAR- IISR

Fig 59: Exhibition held during Turmeric Fest

Trainings organized by various AICRPS centres

Sl. No.	Date	AICRPS centre	Title of Training	No. of participants
1.	15-04-2017	High Altitude Research Station, OUAT, Pottangi	Turmeric and black pepper cultivation	25
2	30-07-2017	Horticultural Research Station, Chintapalli	Organic cultivation of turmeric and ginger	50
3	17-08-2017	Cardamom Research Station, Pampadumpara	Organic farming in small cardamom	100
4	22-08-2017	High Altitude Research Station, OUAT, Pottangi	Marketing of spices	45
5	24-08-2017	High Altitude Research Station, OUAT, Pottangi	Offseason coriander cultivation	175
6	26-08-2017	Cardamom Research Station , Pampadumpara	Climate change and soil health management in small cardamom	75
7	14-09-2017	Cardamom Research Station Pampadumpara	Climate change and soil health management in small cardamom	150
8	17-10-2017	Horticultural Research Station, Dr. Y.S.R. HU, Chintapalli	Integrated Pest Management in horticultural crops	50
9	01-11-17	Regional Agricultural Research Station, (IGKV) Raigarh	Seed distribution cum Training programme at Jurda village of Raigarh	85
10	08-11-2017	High Altitude Research Station, OUAT, Pottangi	Organic ginger and turmeric cultivation	25
11	09-11-2017	Horticultural Research Station, Chintapalli in collaboration with Department of Horticulture & ATMA.	Post harvest management practices of spices	85
12	14-11-2017	Horticultural Research Station Yercaud	Black pepper cultivation technology	100
13	15-11-2017	Cardamom Research Station , Pampadumpara	Pest and disease management in cardamom	70
14	16-11-2017	Horticultural Research Station Yercaud	Black pepper training programme	85
15	17-11-2017 to 19-11-2017	Horticultural Research Station Chintapalle in collaboration with Spices Board, Guntur, ICAR-IISR, Kozhikode	Scientific cultivation of black pepper and turmeric in the tribal regions of Andhra Pradesh	235
16	18-11-2017	ITDA office, Paderu in colloboration with Spice Board, Guntur & IISR, Calicut	Scientific management of black pepper and Turmeric	150
17	22-11-2017	High Altitude Research Station, OUAT Pottangi	Offseason Coriander cultivation	48
18	29-11-17 to 30-11-17	Horticultural Research Station, Chintapalli in collaboration with DASD, Calicut	Scientific management of black pepper, ginger & turmeric	275
19	21-12-2017	Tamil Nadu Agricultural University	Organic cultivation of spices	45
20	22-12-2017	Tamil Nadu Agricultural University	Climate change and soil health management in small cardamom	150
21	29-12-2017	Horticultural Research Station,	Post harvest management practices	100

		Chintapalle in collaboration with RARS, Chintapalle	in spice crops	
22	30-12-2017 - 29-01-2018	Central Agricultural University, Pasighat	Skill development programme for Vermicompost Producer	45
23	04-01-2018	ICRI Regional Station, Sakleshpur	Scientific cultivation of spices	40
24	05-01-2018	ICRI Regional Station, Sakleshpur	Production technology of spice crops	38
25	10-01-2018	High Altitude Research Station, OUAT, Pottangi	Organic ginger and turmeric cultivation	52
26	10-01-2018	Cardamom Research Station, Pampadumpara	Organic farming in cardamom	100
27	11-01-2018- 12-01-2018	Faculty of Horticulture, UBKVV, Pundibari	Increasing farmers income	75
28	14-01-2018	Cardamom Research Station, KAU, Pampadumpara	Pesticide usage in cardamom	150
29	18-01-2018	ICRI Regional Station, Sakleshpur	Scientific cultivation of spices	40
30	22.01.2018	Dept. of Extension Education, DBSKKV, Dapoli	Advances in spices cultivation	20
31	24-01-2018	Dr.YSR Horticultural Research Station, Chintapalle	Training programme cum field day on post harvest management practices in ginger	100
32	29-01-2018	Cardamom Research Station , Pampadumpara	Importance of soil testing and balanced nutrition in black pepper	200
33	30-01-2018	High Altitude Research Station, OUAT, Pottangi	Black pepper cultivation	56
34	02-02-2018 - 06-03-2018	UBKV, Pundibari	Skill Development Programme on Vermicompost Producers	25
35	06-02-2018 - 08-02-2018	Dr. Y.S.R. Horticultural University, Chintapalli	Improving availability of spice varieties and imparting training on post harvest in turmeric, pepper and long pepper	110
36	27-02-2018	Dr. Y.S.R. Horticultural University, Chintapalli	IPM technologies in horticultural crops	128
37	28-02-2018	Horticultural Research Station, Dr. Y.S.R. HU, Chintapalli	Judicious Water Management	80
38	28-02-2018	Cardamom Research Station , Pampadumpara	Impact of climate change in spices	80
39	07-03-2018 to 09-03-2018	Central Experiment Station, Wakawali and AICRPS	Production technology and Inter cropping of spices in arecanut and coconut	243
40	01-02-2018	DASD, Calicut, Kerala Hosted by UAHS Shivamoga, ZAHRS, Mudigere	Accreditation of spices nursery and scientific method of multiplication of black pepper cuttings	45
41	15-02-2018	Regional Agricultural Research Station, (IGKV) Raigarh	Kisan training on spices crop	50
42	15-02-2018	ICRI Regional Station, Spices Board, Sakaleshpura	Cultivation and management of disease/ pests in cardamom.	35
43	27-02-2018	Horticultural Research Station, Dr. Y.S.R. HU, Chintapalli	Production technology of spice crops	75
44	27-02-2018	Horticultural Research Station, Dr. Y.S.R. HU, Chintapalli	IPM technologies in Horticultural Crops	50

45	09-03-2018	Cardamom Research Station , Pampadumpara	Climate change and soil health management in spices	80
46	13-03-2018	Cardamom Research Station , Pampadumpara	Commodity Futures and Price Risk Management for cardamom growers	50
47	19-03-2018	Dr. Y.S.R. Horticultural University, Chintapalli	Best management practices of black pepper	150
48	23-03-2018	College of Horticulture & Forestry Kumarganj	Cardamom and cinnamom cultivation	81
49	25-03-2018	Regional Station, Sikkim Centre, Tadong, Gangtok	Capacity building of large cardamom farmers	28
50	25-03-2018	Navbharat Chhatralay Pariwar, Dapoli	Advances in black pepper production	37
51	26-03-2018	Dr.Y.S.R. Horticultural University, Chintapalli	Techniques in bark peeling in cinnamon and propagation techniques in cinnamon	50
52	27-03-2018	Cardamom Research Station , Pampadumpara	Integrated pest and disease management in cardamom and black pepper	60

Fig 60: Demonstration cum distribution of turmeric seed rhizomes at Raigarh

Fig 61: Farmers Awareness program on turmeric at Guntur

XVIII. PUBLICATIONS

Research Publications

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AMBALAVAYAL

Simi S & Safia N E 2018 Injikrishi Wayanattil. In: Inji-Ulppaadanavum Samskaranavum. Jalaja S Menon (Eds.), Kerala Agricultural University: Integrated Horticulture Development Mission pp: 50-52.

HISAR

Kumar V, Tehlan S K & Kumar A 2018 Quality seed production of seed spices. In: Advances in Agriculture Sciences Akinik Publications. pp :93-106

PANNIYUR

Neema V P & Ajith PM 2017 Black Pepper. In: Peter K V (Eds.), Genesis and Evolution of Horticultural Crops. Kruger Brentt Publishers, UK, pp:35-46.

SOLAN

Dev H & Sharma V 2017 Advances in seed production technology of ginger and turmeric. In: Advances in seed production of vegetable crops (Eds.), under ICAR- CAFT, Hort (Veg), Dep of Vegetable Science, Dr YSPUHF, Nauni, Solan-173 230 (HP) India, w e f September 06-26, 2017. Pp: 124-135.

YERCAUD

Nageswari K, Pugalendhi L, Kavitha P S, Durairaj C & Jayalakshmi V 2017 Recent trends in Black pepper production technology, Special officer (Publication and Public Relation) ODL, TNAU.

LEAFLET/FOLDER /BOOKLET /BULLETINS

AMBALAVAYAL

Karuvappatta (Cinnamon) samskaranam Simi S, Sruthi Krishnan KV, Suvija N V, Aparna V S, Safia N E

Kurumulakinte vilaveduppum samskaranavum Suvija N V, Sruthi Krishnan K V, Simi S, Aparna V S, Safia N E

CHINTAPALLI

Major constraints in spice crops at tribal area and their management (Telugu)

Post harvest practices in turmeric (Telugu)

Success story on turmeric var. Roma cultivation under tribal area of Visakhapatnam (English)

JAGUDAN

Amin A M & Patel N R 2017 Shakbhaji pakoma sanklit Krumi vyavashthapan. In. Shakbhaji Pakoni Vaigyanik Kheti Paddhati, Pp: 34-35 (Prakashak; R.S.(Spices), SSRS,SDAU,Jagudan.

Patel N R & Amin A M 2017 Shakbhaji pakoma sanklit rog vyavashthapan In. Shakbhaji Pakoni Vaigyanik Kheti Paddhati, Book page No: PP: 31-33 and (Prakashak; R.S.(Spices), SSRS, SDAU, Jagudan).

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Patel H B, Prajapati B G & Amin A U 2017 Beej masala pakoni vigyanik kheti paddhati. Krushijivan 50(1): 73.

Prajapati B G 2017 Sanklit jivat vyavasthapanma xamya matranu mahatva. Krushigovidhya 70(5): 63-68.

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SIRSI

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LEAF FOLDERS

MUDIGERE

Malenadinalli sampradayika bathada thaligalu 2017 Dhushyanth kumar B M, Shivaprasad M, Ravi C S, Swamy A V, Shilp Malaghan, Pavithra N R, Rashmi C, Ramya T S, Manya H M.

Mudigere enda bidugade ada Bathada hosa thaligalu 2017 Dhushyanth kumar B M, Shivaprasad M, Ravi C S, Swamy A V, Shilp Malaghan, Pavithra N R, Rashmi C, Ramya T S, Manya H M.

BOOKLETS

PANNIYUR

Multicolour leaflet : 'Panniyur Black Pepper Varieties'

PASIGHAT

Anal Mariam P S, Sarma P, Deo C & Warade S D 2018 Turmeric - Package of practices.

Deo C, Sarma P, Mishra B P, Mariam Anal P S, Kumar S, Kumawat M M & Warade S D 2018 Chilli Package of practices for N. E. Region.

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POTTANGI

Disease and Insect pest management in turmeric and ginger

A Compendium of 40 years of spices research in Odisha 1975-2016

POPULAR ARTICLE

AICRPS Head Quarters, Kozhikode

Ankegowda S J, Sharon Aravind, Alagupalamuthirsolai M & Krishnamoorthy K S 2017 Triumph of small cardamom growers in Idukki. Spice India, 30 (4): 33-34.

Janakiram T, Nirmal Babu K , Dinesh R , Srinivasan V , & Sheeja T E 2017 Exploring spices production at suatainable basis. Indian Hort 7: 3-12.

Nirmal Babu, K., Kandiannan, K., Nissar, M. & Sharon, A. 2017. Black pepper column method for orthotropic shoot production. Nursery today 6 (5): 40-51

Rajeev P, Kandiannan K, Srinivasan V, Biju C N & Vijeeshna V. 2017. How to tap black pepper potential of Arunachal Pradesh. Spice India 30(4): 17-19.

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DAPOLI

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GANGTOK, ICAR

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Deswal S, Malik T P & Tehlan S K 2017 Rhizobium culture se methi mai beej upchar. Haryana Kheti. 50 (11): 20

Kumar V & Tehlan S K 2017 Ajowain ki unnat kethi.Sarshti Agro. 5 (6): 20

KUMARGANJ

Maury R , Pandey V P , Mishra D P , Lakra K,Verma S K & Bahadur S 2017 Haldi ki vaigyanik kheti evam iske aushdhiy gun. Kisan Kheti. April-June pp.20-21.

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PAMPADUMPARA

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PANNIYUR

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SOLAN

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Peter K V, RavindranP N, Nirmal Babu K & Minoo Divakaran 2017 Biotechnology of spices - challenges and opportunities **In** Singh H P , Pathak A R , Tyagi R K , Sumangala H P , Sumangala H P , Sherry R Jacob, Rajeev K Singh (Eds.), National conference on technological changes and innovations in agriculture for enhancing farmers' income, JAU, Junagadh Westville publishing house, New Delhi, Shodh Chintan 9 P: 124- 135

Prasath D, Kandiannan K, Chitra R, Muhammed Nissar V A, Suresh J & Nirmal Babu K 2017 Quality seed production in ginger and turmeric: present status and future prospects **In** Singh H P , Pathak A R , Tyagi R K , Sumangala H P , Sumangala H P , Sherry R Jacob, Rajeev K Singh (Eds.), National conference on technological changes and innovations in agriculture for enhancing farmers' income, JAU, Junagadh, Westville publishing house, New Delhi, Shodh Chintan 9 P: 163-170.

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Zachariah T J & Nirmal Babu K 2017 Chemoprofiling and *in vitro* anti oxidant activity in selected spices National conference on spices, challenges and oppurtunities, towards 2020 – strategoes for sustainable spice processing, CSIR – CFTRI, Mysore, India. Souveneer and Abstracts P: 33-34

AICRPS CENTRES

Guntur

Surya Kumari S, Giridhar K, Rajani A , Sarada C & Naram Naidu L 2017 Integrated Crop Management for year round production of coriander (*Coriandrum sativum* L.). for greens National Conference on 'Adaptation Interventions for Climate Resilient Agriculture in Coastal Agro-ecosystems' Organised by A.N.G.R. Agricultural University & NABARD on 9-10, March, 2017 at R.A.R.S., Lam.

ICAR - GANGTOK

Gudade B A, Dhanapal K, Aage A B, Ashutosh Gautam, Bora S S & Rema Shree A B 2017 "Soil application of Mg, Zn and Mn: Effect on Growth, Nutrient and Soil Fertility Status of Large Cardamom in North East India" published in Proceedings of lnternational Conference On Contemporary Issues in Integrating Climate. The Emerging Areas of Agriculture, Horticulture, Biodiversity, Forestry; Engineering Technology, Fundamental/ Applied Science and Business Management for Sustainable Development (AGROTECH-2017).

Dhanapal K, Anu Anie Mathews, Ajay D, Shadanaika, Vijayan A K & Rema Shree A B 2017 "Evaluation of fungicides for the management of rot disease of small cardamom (*Elletatia cardamomum*.L.)." in National Symposium of IPS (SZ) on "Emerging Trends in Plant Health management in Relation to Climate Change" at Dept. of Plant Pathology, College of Horticulture, UHS Campus, GKVK, Bangalore and accepted for presentation.

Dhanapal K, Gudade B A, Ashutosh Gautam, Bora S S, Remashree A B & Chhetri R 2018 "Improved Agro-Techniques on Organic Cultivation of Large Cardamom" published in souvenir cum abstract during National Conference on Floriculture for Rural and Urban Prosperity in the Scenario of Climate Change.

Dhanapal K, Gudade B A, Ashutosh Gautam & Remashree A B 2017 "Effect on Boron on Large Cardamom (*Ammomum subulatum* Roxb.). at Sikkim, East India" published in compendium of abstract during International Conference on Bio-resource and Stress Management.

HISAR

Yadav P, Tehlan S K & Deswal S 2017 Assessment of genetic divergence in fenugreek (*Trigonella foenum-graecum* L.). based on biological characters. In: Proceedings of National conference on "Climate change and Agricultural production- Adapting crops to climate variability and uncertainty" (April 6-8, 2017) held at Bihar Agricultural University, Sabour, Bagalpur. Pp.104-105.

Deswal S & Tehlan S K 2017 Rhizobium inoculation effect on seed quality of fenugreek (*Trigonella foenum- graecum* L.). In abstr. Of papers Golden Jubilee International Conference on "Gender Issues and Socio- Economic Perspectives for Sustainable Rural Development (October 23-25, 2017) held at I.C. College of Home Science, CCS HAU, Hisar, Haryana. pp. 152-153.

PAMPADUMPARA

Sathyan T, Dhanya M K, Aswathy T S, Murugan M & Ambika Menon R 2018 Evaluation of biocontrol agents and chemical nematicides on the management of nematode pest of small cardamom'. Abstract of symposium on Zoology congress 2018, Palayamnkotti, Tamil Nadu.pp. 67.

Sathyan T, Dhanya M K, Manoj V S, Aswathy T S & Murugan M 2018 Influence of Meteorological parameters on the population dynamics of mealy bugs (*Ferrisiavirgata*) in black pepper. Extended Abstract of International conference on biocontrol and sustainable insect pest management.pp.500-502.

Murugan M 2018 Impact of climate change in cardamom cultivation In: Krishnamurthy K S, Biju C N, Prasad D, Senthil Kumar C M, Kandiannan K, Maiti C S, Pauline Alila, Akali Sema, Aviboli Zhimomi & Nirmal Babu K (Eds.),2018. Souvenir and Abstracts, National Symposium on Spices and Aromatic Crops (SYMSAC IX): Spices for doubling farmer's income. Indian Society for Spices, Kozhikode, Kerala, India.pp.130-135.

Murugan M, Sathyan T, Dhanya M K & Aswathy T S 2018 Empirical evidences on the ecological nexus of the tropical cardamom production system In: Krishnamurthy K S, Biju C N, Prasad D, Senthil Kumar C M, Kandiannan K, Maiti C S, Pauline Alila, Akali Sema, Aviboli Zhimomi & Nirmal Babu K (Eds.), 2018. Souvenir and Abstracts, National Symposium on Spices and Aromatic Crops (SYMSAC IX): Spices for doubling farmer's income. Indian Society for Spices, Kozhikode, Kerala, India.pp .174.

PANNIYUR

Heera G, Ajith P M & Neema V P 2017 Integrated disease management of Fusarium and Sclerotium in black pepper. National Symposium on "Emerging trends in plant health management in relation to climate change" by Indian Phytopathological Society. College of Horticulture, Bengaluru from 12-13 September, 2017 pp.152.

PANTNAGAR

Singh J P & Singh Dhirendra 2017 Correlation and path coefficient study in turmeric (*Curcuma longa* L.) . National Symposium on Innovations in horticulture: Production to Consumption, Sept. 14-15, 2017 at GBPUA&T, Pantnagar. Pp.27

PASIGHAT

Anal Mariam P S, Pandey A K & Sarma P 2017 Influence of different varieties of ginger (*Zingiber officinale* L.) on yield and quality. The 4th International Symposium on Minor Fruits, Medicinal and Aromatic Plants (ISFM & AP) Pp.60 (dated 5-6.12.2017 at CHF, CAU, Pasighat, Arunachal Pradesh).

Anal Mariam P S, Vikash Kumar Singh & Pandey A K 2018 Performance of turmeric genotypes in Arunachal Pradesh for yield and quality. The National Symposiun on Spices and Aromatic Pp.70. (dated 15-17.03.2018 at SASRD, Nagaland University, Medziphema).

RAIGARH

Ajit Kumar Singh, Shrikant Sawargaonkar, Sarita Sahu & Sandip Paikara 2017 Managment of Phyllosticta leaf spot of Ginger *(Zingiber officinale Rose.).*by fungicide. National Symposium and Delhi Chapter Meeting on Innivative strategies for the management of Plant Disease Under Climate Change Scenario. Indian Phytopathological Society Tues Day , December 19, 2017.

Ajit Kumar singh, shrikant sawargaonkar, singh S P & Paraye P M 2017 Prediction model Suitable cutivars, Disease progress and Fungicidal Managment Against Colletotrichum Leaf spot of Turmeric (*Curcuma longa* L.). National Conference on Advance in Global Reserach In Agriculture and Technology . Organized by Society of Human Resource and Innovation Agra (UP) India

Ajit Kumar singh, Sarita Sahu , Singh S P & Choubey N K 2017 Evaluation of Coriander entries for yield , Disease Resistance and regression for Disease prediction against Powdery Mildew of Coriander. National Conference on Advance in Global Research In Agriculture and Technology organized by Society of Human Resource and Innovation Agra (UP) India

SOLAN

Gupta M, Leharwan M, Bharat N K, Chauhan A & Shukla A 2017 Morphological, pathological and molecular characterization of stem gall pathogen, *Protomyces macrosporus.* In: Proceedings of ISMPP International Conference on "Plant Health for Human Welfare" organized by Department of Botany,

Sharma S K, Gupta M, Verma S, Gautam HR. & Gupta S K 2017 Compiled and edited Souvenir and Abstracts of National Symposium, "Biorational Approaches in Plant Disease Management" organized by Indian Society of Plant Pathologists, Ludhiana and Himalayan Phytopathological Society, Nauni w.e.f. October 27-28, 2017, 130p.

XIX. AWARDS AND RECOGNITIONS

Best AICRPS Centre Award

AICRP on Spices centre at Rajendra Prasad Central Agricultural University, Dholi and Dr. Y. S. R. Horticultural University Centres at Guntur and Chintapalle

Recognition

Regional Agricultural Research Station, Ambalavayal, spice nursery was accredited with two star status in 2016-17 by Directorate of Arecanut & Spices Development, Kozhikode.

ICAR RC for NEHR, Gangtok has bagged second runner up in "Best Stall Award" in North Eastern zone Regional agricultural Fair 2017-18.

Dr. Soorya Kumari of Dr. YSRHU, Guntur was awarded "**Inspiring Women award**" for Excellance in Research conferred by State minister of U.P for Social Welfare, Govt. of UP along with SamagraVikasWelfare Society at Lucknow, U.P on 5th June 2017 (Fig 62).

Mr. B.A. Gudade of ICRI Regional Station, Gangtok was recognized with **ISEE Fellow Award-2017** by Indian Society of Extension Education IARI, New Delhi during National Seminar on "Doubling Farmers Income and Farm Production through Skill Development and Technology Application" held at Bihar Agricultural University, Sabour, Bhagalpur, Bihar on 29th November, 2017.

Mr. Ashutosh Gautam of ICRI Regional Station, Gangtok was honored **with S& T SIRI Fellow Award 2017** by Science & Technology Society for Integrated Rural Improvement, Warangal (TS) during National Conference on "Doubling Farmers Income for Sustainable and Harmonious Agriculture DISHA 2017" held at Shri Venkteshwara University, Tirupati (AP) during Sept 9th-10th, 2017.

Dr. A. K. Jha of ICAR- RC for NEHR, Barapani was recognized as **ISS Fellow** during National Symposium on Spices and Aromatic Crops (SYMSAC IX): Spices for doubling farmer's income, held at SASRD, Nagaland on 15 March 2018.

Dr. R.G. Khandekar of Dr. B.S.K.V Dapoli has conferred **Babasaheb Kunal Award 2017-18** for contribution in the field of Research and extension in Horticulture for the benefit of farmer's community held at Dr. B.S.K.V Dapoli on May 2018

Dr. Meenu Gupta of Dr. Y. S. Parmar University of Horticulture & Forestry, Solan has been appointed as **Zonal Councilor** of Indian Phytopathological Society, New Delhi for North Zone for the year 2018-19.

Oral / Poster Presentation Awards

Ashutosh Gautam 2017 Large cardamom: a boon for farmers in Sikkim. In. National Conference on "Doubling Farmers Income for Sustainable and Harmonious Agriculture DISHA 2017" Shri Venkteshwara University, Tirupati (AP) , 9th-10th Sept 2017. **(Best Oral Presentation Award).**

Jha A K, Deshmukh N A, Verma V K, Rymbai H, Assumi S r, Devi M B & Talang H D 2018 Developing spice business in NE region focus: Doubling farmer's income In. National Symposium on Spices and Aromatic Crops (SYMSAC IX): Spices for doubling farmer's income, held at SASRD, Nagaland on 15 March 2018. **(Best Poster Presentation Award).**

Fig 62: Dr. Sooryakumari of AICRPS centre at Guntur receiving "Inspiring women award 2017"

XX. STAFF POSITION

PROJECT COORDINATOR'S OFFICE

1.	Project Coordinator	: Dr. K. Nirmal Babu Dr. K. Kandiannan (In-charge from 5th September 2016)
2.	Scientist (SPMAP)	: Mr. Muhammed Nissar V.A (till 16-08-2017)
3.	Scientist (SPMAP)	: Dr. Sharon Aravind
4.	Technical Officer	: Dr. Radha .E (Joined on 07-08-2017)
5.	Personal Assistant	: Mrs. Shyna Deepesh
6.	Skilled Supporting Staff	: Vacant

COORDINATING CENTRES

1. Cardamom Research Station, KAU, Pampadumpara

1.	Assistant Professor (Ag. Entomology)	: Vacant
2.	Associate Professor (Agron / Hort.)	: Vacant
3.	Assistant Professor (Pl. Breeding)	: Vacant
4.	Farm Manager Gr. I	: Mr. Muhammed K
5.	Laboratory Assistant Gr. II	: Mr. Anil Kumar
6.	Peon	: Mr. Shinoj Antony

2. Pepper Research Station, KAU, Panniyur

1.	Asst. Professor/ Jr. Breeder (Pl. Breeding)	: Dr. P. M. Ajith
2.	Asst Professor (Plant Pathology)	: Dr. Heera.G
3.	Asst. Professor (Agron / Hort)	: Vacant
4.	Associate. Professor (Pl. Pathology)	: Vacant
5.	Farm Manager Gr I	: Vacant
6.	Farm Manager Gr II	: Mr. P. Krishnan
7.	Lab Asst. Gr.III	: Mr. K. Rajeev
8.	Peon Gr II	: Vacant

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

1.	Associate Professor (Agronomy)	: Dr. M. Shivaprasad
2.	Associate Professor (Plant Breeding)	: Vacant
3.	Associate Professor (Plant Pathology)	: Vacant
4.	Associate Professor (Entomology)	: Vacant
5.	Technical Assistant	: Mr. Mahadevappa
6.	Technical Assistant	: Ms. H. R. Manjula
7.	Messenger	: Ms. Savithri

4. Horticultural Research Station (UHS), Sirsi

1.	Professor (Hort.)	: Dr. Laxminarayan Hegde
2.	Associate Professor (Plant Pathology)	: Mr. A. Prashantha

3. Technical Assistant : Sri. Santosh Kumar Bommanagi

5. Horticultural Research Station (TNAU), Yercaud

1.Agronomist (Hort.) : Dr. L. Pugalendhi
2.Jr. Breeder (Hort.) : Dr. M.Palani Kumar
3. Lab Assistant : Mrs. P. Pappa

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

1. Breeder (Horticulture) : Dr. B. Senthamizh Selvi
2. Jr. Pathologist (Pathology) : Dr. C. Ushamalini
3. Agricultural Assistant : Th. R. Swaminathan

7. Turmeric Research Station (SKLTSHU), Kammarpally

1. Scientist (Plant Pathology) : Dr. B. Mahender
2. Jr. Horticulturist : Vacant
3. Technical Assistant : Vacant

8. Horticultural Research Station (Dr.YSR Horticultural University), Chintapalle

1. Senior Scientist (Horticulture) : Dr. V. Siva Kumar
2. Scientist (Plant Pathology) : Vacant
3. Technical Assistant : Vacant

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

1. Jr. Breeder (Horticulture) : Dr. K. Giridhar
2. Horticulturist : Dr. S. Suryakumari
3. Technical Assistant : Vacant

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

1. Professor (Vegetable Science) : Dr. Happy Dev Sharma
2. Jr. Pathologist : Dr. Meenu Gupta
3. Jr. Biochemist : Dr. Vipin Sharma
4. Field Assistant : Mr. Chunni Lal Sharma

11. High Altitude Research Station (OUAT), Pottangi

1. Sr. Breeder & Officer-in-charge : Dr. Parsuram Sial
2. Breeder : Vacant
3. Technical Assistant : Vacant
4. Technical Assistant : Vacant

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

1. Sr. Breeder : Dr. Dhirendra Singh
2. Breeder : Dr.D.K.Gothwal
3. Senior Pathologist : Vacant
4. Asst. Biochemist : Dr. Girish Kumar Mittal
5. Agronomist : Dr. A. C. Shivran
6. Senior Technical Assistant : Dr. R.N. Sharma
7. Junior Technical Assistant : Sh. S. R. Kumawat

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

1. Assoc. Research Scientist (Pl. Path.) : Dr. A.M. Amin
2. Asst. Research Scientist (Pl. Br.) : Prof. D. G. Patel
3. Agril. Asst. (HG) : Kum. Rekha Chaudhari

14. Department of Vegetable Crops, CCS HAU, Hisar

1. Junior Pathologist : Dr. Suresh Tehlan
2. Horticulturist (Olericulture) : Dr. T. P. Malik

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

1. Horticulturist : Dr. S. P. Singh
2. Jr. Pathologist : Dr. A. K. Mishra
3. Technical Assistant : Sh. A. N. Mishra

16. Department of Vegetable Science (NDUAT), Kumarganj

1. Horticulturist : Dr. V. P. Pandey
2. Jr.Breeder : Vacant
3. Jr. Pathologist : Dr. R.S.Mishra
4. Tech. Asst. : Sh. R.K.Gupta
5. Tech. Asst. : Sh. V.K Singh

17. Department of Horticulture (UBKV), Pundibari

1. Horticulturist : Vacant
2. Jr. Pathologist : Dr. (Mrs.) Anamika Debnath
3. Jr.Breeder : Dr. Soumendra Chakraborty
4. Technical Assistant : Sh. Murari Krishna Roy
5. Technical Assistant : Vacant

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

1. Horticulturist : Dr. R.G. Khandekar
2. Jr. Pathologist : Dr. R. R. Rathod
3. Jr. Breeder : Prof. U. B. Pethe
4. Technical Assistant : Sh. D. D. Bhandari
5. Technical Assistant : Shri. R.G. Nachare

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

1. Horticulturist : Dr. Sarita Sahu
2. Jr. Breeder : Dr. Shrikant Laxmikant Swargaonkar
3. Jr. Pathologist : Dr. Ajit Kumar Singh
4. Technical Assistant : Mr. D. S. Kshatri
5. Technical Assistant : Vacant

XXI. TRAINING AND CAPACITY BUILDING

Trainings attended by the Staff of AICRPS

Sl.No.	Name and Designation	Details of training	Venue	Duration
1	Dr. Uday B. Pethe Jr. Spice Breeder Dr.BSKKV, Dapoli	Techniques for estimation of nutraceutical properties from crops	College of Agriculture, AAU, Anand, (Gujarat).	16.01.2018 - 25.01.2018
2	Dr. A. K. Singh , Sr.Scientist, IGKV, Raigarh	Nano technological approached in pest and disease management	NBAIR, Bangalore	15.11.2017 - 24.11.2018
3	Dr . Shrikant Sawargaonkar, Scientist, IGKV, Raigarh	Mutation breeding for crop improvement	IGKV, Raipur	06.11.2017 - 15.11.2017
4	Dr. G. K. Mittal Asst. Biochemist SKNAU, Jobner	CAFT training course on “Application of molecular markers for assessment of genetic purity and crop diversity”	Centre of Advanced Faculty Training in Plant Biotechnology, Rajasthan	01.11.2017 - 21.11.2017
5	Dr. Heera, G, Asst. Professor PRS, Panniyur	ICAR sponsored short course on Prospecting biological agents for the management of diseases in Horticultural crops	College of Horticulture, UHS Campus, Bengaluru	13.11.2017- 22.11.2017
6	Dr. Ajith, P.M, Asst. Prof PRS, Panniyur	CAFT Training programme on Recent advances and accomplishments in heterosis breeding of crops	TNAU, Coimbatore	31.01.2018- 20.02.2018
7	Dr. Simi Assistant Professor, KVK, Ambalavayal	CAFT training programme on ‘Exploitation and conservation of Plant genetic resource in major, minor and underutilized fruits	College of Horticulture, Mysuru.	04.12.2017- 024.12.2017
8	Dr. Simi Assistant Professor, KVK, Ambalavayal	Training of trainer programme for the job role Gardener	ASCI at SAMETI, Trivandrum	29.10.2017- 01.11.2017

XXII. AICRPS CENTREWISE BUDGET 2017-18

(Rs. in Lakhs)

Regular Centres	Salary		TA		RC		Tech. A	Total RC	Works		Total		Grand Total
	ICAR	State	ICAR	State	ICAR	State	ICAR	ICAR	ICAR	State	ICAR	State	
Pampadumpara (KAU)	22.64	7.55	1.00	0.33	3.00	1.00	0.10	3.1	-	-	26.74	9.00	36.00
Panniyur (KAU)	42.71	14.24	1.00	0.33	3.00	1.00	0.10	3.1	-	-	46.81	16.00	62.00
Mudigere (UAHS)	12.56	4.19	0.5	0.17	3.50	1.17	0.10	3.6	-	-	16.66	6.00	22.00
Sirsi (UHS)	28.81	9.60	0.5	0.17	1.60	0.53	0.10	1.7	-	-	31.01	10.00	41.00
Yercaud (TNAU)	28.96	9.65	0.5	0.17	1.50	0.50	0.10	1.6	-	-	31.06	10.00	41.00
Coimbatore (TNAU)	19.56	6.52	0.5	0.17	1.50	0.50	0.10	1.6	-	-	21.66	7.00	29.00
Chintapalli (Dr YSRHU)-TSP	22.93	7.64	0.5	0.17	4.84	1.61	0.10	4.94	-	-	28.37	9.00	38.00
Kamarpally (SKLTSHU)	8.565	2.86	0.5	0.17	0.50	0.17	0.10	0.6	-	-	9.665	3.00	13.00
Guntur(Dr YSRHU)	31.3	10.43	0.5	0.17	2.40	0.80	0.20	2.6	-	-	34.4	11.00	46.00
Solan (YSPUHF)	39.65	13.22	0.5	0.17	2.60	0.87	0.10	2.7	-	-	42.85	14.00	57.00
Pottangi (OUAT)*-TSP	22.14	7.38	0.25	0.08	4.08	1.36	0.10	4.18	-	-	26.57	9.00	35.00
Jobner (SKNAU)	79.68	26.56	0.5	0.17	3.73	1.24	0.10	3.83	-	-	84.01	28.00	112.00
Jagudan (SDAU)	19.02	6.34	0.5	0.17	1.40	0.47	0.10	1.5	-	-	21.02	7.00	28.00
Hisar (HAU)	32.81	10.94	0.5	0.17	1.76	0.59	0.10	1.86	-	-	35.17	12.00	47.00
Dholi (RAU)	10.25	3.43	0.5	0.00	2.50	0.00	0.10	2.6	-	-	13.35	3.00	17.00
Kumarganj (NDUAT)	26.06	8.69	0.5	0.17	1.86	0.62	0.10	1.96	-	-	28.52	9.00	38.00
Pundibari (UBKVV)	15.56	5.20	0.5	0.17	2.40	0.80	0.10	2.5	-	-	18.56	6.00	25.00
Dapoli (KKV)	32.97	10.99	0.75	0.25	2.27	0.76	0.10	2.37	-	-	36.09	12.00	48.00
Raigarh (IGKVV)-TSP	28.75	9.58	0.75	0.25	5.58	1.86	0.10	5.68	-	-	35.18	12.00	47.00
Total	**525**	**175**	**10.75**	**3.41**	**50.02**	**15.84**	**2.00**	**52.02**	-	-	**587.70**	**194.00**	782.00

Coopting Centres	Salary		TA		RC		Tech. A	Total RC	Works		Total		Grand Total
	ICAR	State	ICAR	State	ICAR	State	ICAR	ICAR	ICAR	State	ICAR	State	
Ambalavayal (KAU)	-	-	0.50	0.17	0.20	0.07	0	0.2	-	-	0.70	0.23	0.93
Pechiparai (TNAU)	-	-	0.50	0.17	1.70	0.57	0	1.7	-	-	2.20	0.73	2.93
Gangtok (ICRI)-NEH	-	-	0.50	0.00	4.00		0	4	-	-	4.50	0.00	4.50
Sakleshpur (ICRI)	-	-	0.50	0.00	2.60		0	2.6	-	-	3.10	0.00	3.10
Myladumpara (ICRI)	-	-	0.50	0.00	2.60		0	2.6	-	-	3.10	0.00	3.10
ICAR R C NEHR, Barapani-NEH	-	-	0.50	0.00	2.60		0	2.6	-	-	3.10	0.00	3.10
ICAR R C NEHR, Mizoram-NEH	-	-	0.50	0.00	4.00		0	4	-	-	4.50	0.00	4.50
ICAR R C NEHR, Gangtok-NEH	-	-	0.50	0.00	3.53		0	3.53	-	-	4.03	0.00	4.03
Nagaland (Nagaland AU)	-	-	0.50	0.17	4.00	1.33	0	4	-	-	4.50	1.50	6.00
Kahikuchi (AAU)	-	-	0.50	0.17	3.60	1.20	0	3.6	-	-	4.10	1.37	5.47
Total	-	-	**5.00**	**0.67**	**28.83**	**3.17**	**0**	**28.83**	-	-	**33.83**	**3.83**	**37.66**
Voluntary Centres													
Pantnagar (GBPUAT)	-	-	0.50	0.17	0.70	0.23	0	0.70	-	-	1.20	0.40	1.60
Kanke (BIRSAAU)	-	-	0.15	0.05	0.26	0.09	0	0.26	-	-	0.41	0.14	0.55
Kalyani (BCKVV)	-	-	0.50	0.17	0.70	0.23	0	0.70	-	-	1.20	0.40	1.60
Kota	-	-	0.50	0.17	1.38	0.46	0	1.38	-	-	1.88	0.63	2.51
Navasari (NAU)	-	-	0.50	0.17	0.65	0.22	0	0.65	-	-	1.15	0.38	1.53
Jabalpur (JNKV)	-	-	0.50	0.17	0.31	0.10	0	0.31	-	-	0.81	0.27	1.08
Mandor	-	-	0.50	0.17	0.41	0.14	0	0.41	-	-	0.91	0.30	1.21
Sanand	-	-	0.10	0.03	0.00	0.00	0	0.00	-	-	0.11	0.03	0.13
Pasighat (CAU)-NEH	-	-	0.50	0.00	1.46		0	1.46	-	-	1.96	0.00	1.96
Total	-	-	**3.75**	**1.08**	**5.87**	**1.47**	**0**	**5.87**	-	-	**9.62**	**2.55**	**12.17**
Project Mode Centres	-	-							-	-			
UHSB, Bangalore	-	-			1.00	0.33	0.00	1.00	-	-	1.00	0.33	1.33
Thrissur-KAU	-	-			2.00	0.67	0.00	2.00	-	-	2.00	0.67	2.67
Total	-	-			3.00	1.00	0.00	3.00	-	-	3.00	1.00	4.00
Workshop release	-	-			1.83	0.00	0.00	1.83	-	-	1.83	0.00	1.83
Seed Spices Monitoring-NRCSS	-	-			1.00	0.00	0.00	1.00	-	-	1.01	0.00	1.00
Total	**525.00**	**175.00**	**19.50**	**5.16**	**90.55**	**21.48**	**2.00**	**92.55**	-	-	**637.00**	**201.64**	**838.62**

XXIII. WEATHER DATA

PANNIYUR

Month	Rain Fall (mm)	No. of Rainy days	Temperature (°C)		RH (%)
			Max.	Min.	
Apr-17	62.2	6	39.72	26.13	90.46
May-17	131.5	10	39.07	26.04	92.19
Jun-17	788.4	29	33.42	25.1	94
Jul-17	723	29	32.83	24.96	93.8
Aug-17	631.1	25	31.09	25.35	91.74
Sep-17	516.7	17	32.59	25.36	92.36
Oct-17	210	12	32.58	24.94	92.8
Nov-17	11.2	1	33.95	24.35	91.26
Dec-17	4.6	2	34.14	22.75	89.09
Jan-18	-	-	35.11	21.71	90.06
Feb-18	-	-	36.73	22.87	91.07
Mar-18	34.2	3	37.55	25.02	90.74

PAMPADUMPARA

Month	Rain Fall (mm)	No. of Rainy days	Temperature (°C)	
			Max.	Min.
Apr-17	49.4	4	25.71	23.3
May-17	65.8	6	24.67	22.08
Jun-17	295.3	21	21.6	19.41
Jul-17	113.8	22	21.46	19.06
Aug-17	341.6	24	21.29	19.09
Sep-17	343	22	21.91	19.7
Oct-17	224.2	15	22.56	20.41
Nov-17	163.4	13	21.85	19.36
Dec-17	198.6	7	20.59	18.75
Jan-18	2	1	20.38	18.77
Feb-18	24	3	21.37	19.89
Mar-18	83	5	24.5	23

COIMBATORE

Month	Rain Fall (mm)	No. of Rainy days	Temperature (°C)		RH (%)	
			Max.	Min.	I	II
Apr-17	20.5	1	36.4	24.4	86	44
May-17	38.6	3	35.4	24.6	85	49
Jun-17	16.7	2	32.5	24.2	82	58
Jul-17	27.8	3	32.3	23.5	83	56
Aug-17	38.5	4	31.4	23.4	86	61
Sep-17	218.1	9	30.6	23.1	88	65
Oct-17	132.6	5	31.3	22.5	89	59
Nov-17	55.5	5	30.4	22.3	89	58
Dec-17	27.8	2	29.5	20.7	87	53
Jan-18	2.2	-	30.3	18.7	86	46
Feb-18	0	-	32.4	19.5	85	41
Mar-18	18.2	2	34.3	22.3	84	41

YERCAUD

Month	Rain Fall (mm)	No. of Rainy days	Temperature (°C)
			Max.
Apr-17	63	9	27.4
May-17	150.5	14	27.7
Jun-17	32.3	6	25.9
Jul-17	76.4	6	25.9
Aug-17	238	14	24.4
Sep-17	283.2	18	22.79
Oct-17	306.1	16	22.48
Nov-17	109.6	12	19.89
Dec-17	55.4	3	18.03
Jan-18	3	2	19.4
Feb-18	5	1	22.1
Mar-18	62.9	5	22.99

MUDIGERE

Month	Rain Fall (mm)	No. of Rainy days	Temperature (°C)		RH (%)	
			Max.	Min.	I	II
Apr-17	40.8	4	33.76	23.23	75.1	33.76
May-17	158.1	9	31.54	19.9	84.6	76.2
Jun-17	303.4	22	25.36	20.66	85.4	79.63
Jul-17	410.2	25	25.35	20.32	85.9	79.93
Aug-17	393.9	19	25.5	20.4	85.2	80.3
Sep-17	200	15	24.56	20.13.	85.2	79.6
Oct-17	66.3	8	29.03	20.06	85.2	78.03
Nov-17	12	1	29.7	20.06	84.4	73
Dec-17	10.6	1	28.7	20.03	80	71.19
Jan-18	-	0	31.19	20.32	80.5	71.19
Feb-18	-	0	31.5	20.35	81.9	68.71
Mar-18	29.4	3	32.41	20.58	87.8	69.8

SIRSI

Month	RainFall (mm)	No. of Rainy days	Temperature		RH (%)
			Max.	Min.	
Apr-17	0	0	35.3	36.2	71.9
May-17	66.6	6	33.4	34.6	72.1
Jun-17	417.4	24	28.5	28.8	74.8
Jul-17	553	25	26.6	27.2	82
Aug-17	264.2	16	26.7	27.7	85.2
Sep-17	224.4	14	28.3	29.2	80.2
Oct-17	94.6	5	34	29.8	85
Nov-17	10.6	1	29	30.7	80.1
Dec-17	0	0	23	30.3	74.3
Jan-18	0	0	21	30.9	72.7
Feb-18	0	0	25	32.7	67.9
Mar-18	44.8	2	35	34.8	68.2

CHINTAPALLE

Month	Rain Fall (mm)	No. of Rainy days	Temperature (°C)		RH (%)	
			Max.	Min.	I	II
Apr-17	105.6	7	33.9	19.67	89.5	64.87
May-17	128.9	5	32.87	21.02	87.7	65.42
Jun-17	290.6	9.4	28.13	22.17	90.7	79.43
Jul-17	172.2	9	26.39	22.35	88.1	79.19
Aug-17	307	13	26.77	21.77	89.7	83.97
Sep-17	218.4	10	28.5	20.24	92.3	77.23
Oct-17	225.6	8	27.19	19.06	91.8	77.71
Nov-17	0.2	5	26.7	14.87	89.7	70.03
Dec-17	0	0	26.66	7.79	87.2	67.48
Jan-18	0	1	27.9	5.61	92.2	59.26
Feb-18	0	2	30.3	6.07	89.7	58.25
Mar-18	18	7	34.34	9.82	89.2	63

GUNTUR

RainFall (mm)	No. of Rainy days	Temperature (°C)		RH(%)	
		Max.	Min.	I	II
0	0	37.5	23	84	35
43.6	4	41.2	27	78.7	43.5
151.7	12	37.4	25.5	80.4	64.2
4.9	10	35.8	25	80.7	67.5
96.7	13	34.1	24.5	83.7	75.1
118.8	9	35.1	24.8	83.4	70
106.5	6	34.3	22.6	84.2	72.6
2.5	1	33.6	19.8	80.5	66.5
0	0	32	15.7	79.9	67.8
0	0	31.8	15.7	82.7	56.5
0	0	34	18.7	86.4	39.8
47.6	0	37.2	22	29.6	80.2

DAPOLI

Month	Rain Fall (mm)	No. of Rainy days	Temperature (°C)		RH (%)	
			Max.	Min.	I	II
Apr-17	0	0	33.01	20.25	88.37	61
May-17	27.9	3	33.65	23.24	86.32	66.42
Jun-17	1014.7	23	30.52	24.56	89.77	77.7
Jul-17	1096.8	31	28.7	24.2	92.3	86.3
Aug-17	576	29	28.8	23.8	95.2	84.7
Sep-17	758.8	16	29.7	23.2	95.6	84.4
Oct-17	135.7	8	31.6	22.8	94.5	75.5
Nov-17	0	0	33	16.4	93	45.8
Dec-17	23.6	2	31.2	14.9	92.9	53
Jan-18	0	0	31.49	13.69	96.29	71.81
Feb-18	0	0	33.42	14.14	94.68	64.04
Mar-18	0	0	33.81	17.65	93.61	68.87

POTTANGI

RainFall (mm)	No. of Rainy days	Temperature (°C)		RH (%)	
		Max.	Min.	I	II
50	2	41	19	55	45
52.3	5	42	22	62	55
287.8	15	38	22	80	59
231.8	14	33	22	85	60
332.2	14	29	22	87	70
172.8	10	31	23	80	66
289.8	13	31	21.4	78	67
19	3	29.5	15.4	65	60
Nil	-	29.1	10.2	59	51
Nil	-	29.3	10.7	58	50
Nil	-	32.1	14.5	57	49
Nil	-	33.4	18.6	56	49

JAGUDAN

Month	Rain Fall (mm)	No. of Rainy days	Temperature (°C)		RH (%)
			Max.	Min.	
Apr-17	-	-	40.59	19.66	70.86
May-17	-	-	41.26	23.35	76.99
Jun-17	-	-	39.26	24.03	85.44
Jul-17	138.20	4.20	31.57	24.67	93.48
Aug-17	38.25	2.50	32.76	23.51	89.36
Sep-17	2.75	0.25	34.10	23.48	88.03
Oct-17	-	-	36.82	21.93	69.66
Nov-17	-	-	30.77	18.46	69.75
Dec-17	-	-	26.83	15.36	66.86
Jan-18	-	-	27.72	17.29	68.19
Feb-18	-	-	31.23	22.12	68.40

NAVSARI

RainFall (mm)	No. of Rainy days	Temperature (°C)		RH (%)	
		Max.	Min.	I	II
0.0	0	35.6	22.1	80.2	45.7
0.1	0	35.0	26.2	83.9	57.6
9.8	0	33.0	26.1	89.3	73.5
19.7	1	30.2	25.2	92.8	83.5
0.0	0	30.3	25.0	92.9	81.5
0.0	0	32.4	24.3	94.6	74.1
0.0	0	35.5	22.1	91.5	56.2
0.0	0	33.7	15.3	79.7	32.4
0.0	0	29.5	15.2	79.0	46.4
0.0	0	30.8	13.4	81.3	32.9
0.0	0	33.4	15.4	74	27.8

JOBNER

Month	Rain Fall (mm)	Temperature (°C)		RH (%)	
		Max.	Min.	I	II
Apr-17	0	39.7	20	61	23
May-17	17.2	41.6	25.2	61	29
Jun-17	39.4	38.6	26.6	68	43
Jul-17	91.6	34.7	25.3	83	64
Aug-17	38.4	33.6	23.7	79	59
Sep-17	17.6	35.5	21.7	79	40
Oct-17	0	34.8	13.9	59	21
Nov-17	0	29	8.6	71	28
Dec-17	2.2	25.2	5.6	80	78
Jan-18	0	25.5	3.5	78	26
Feb-18	0	29	9.5	73	24
Mar-18	0	34.2	12.8	62	16

JABALPUR

RainFall (mm)	No. of Rainy days	Temperature (°C)		RH (%)	
		Max.	Min.	I	II
98.6	7	33.8	24.3	87	66
86.3	6	28.8	22.9	90	74
72.4	3	31.6	23.9	90	67
98.3	3	30.7	22.4	90	73
0	0	33.6	17.9	87	40
0	0	28.9	11.9	87	42
0	0	27.5	9	88	35
0	0	24.7	12.6	88	29
0	0	26.6	12.4	81	52
1	0	30.9	14.1	75	33
2.83	0.00	34.02	15.18	67.33	20.67
0.00	0	36.68	13.00	56.33	17.67

SOLAN

Month	Rain Fall (mm)	Temperature (°C)		RH (%)
		Max.	Min.	
Apr-17	57.8	29.3	13.2	44.0
May-17	100.8	30.5	15.8	53.0
Jun-17	197.8	28.7	17.9	68.0
Jul-17	162.3	27.6	20.4	81.0
Aug-17	233.8	26.7	20.1	82.0
Sep-17	133.8	27.2	16.8	72.0
Oct-17	0.0	27.3	10.8	60.0
Nov-17	2.4	22.2	5.9	69.0
Dec-17	19.4	20.4	4.5	60.0
Jan-18	122.2	16.4	3.1	60.0
Feb-18	76.0	21.3	6.1	49.0
Mar-18	33.2	22.9	7.8	45.0

HISAR

RainFall (mm)	Temperature (°C)		RH (%)	
	Max.	Min.	I	II
8.6	40.8	24.4	57.2	28.1
7.3	37.2	25.6	77.1	49.6
6.8	35.1	27.0	88.3	66.9
6.3	34.7	26.3	89.7	69.3
6.8	34.9	23.5	87.2	49.5
6.6	35.0	17.2	84.8	28.0
3.4	27.2	10.8	90.1	39.8
5.2	21.7	6.1	90.7	42.9
5.4	20.3	4.8	96.4	55.8
6.7	24.5	7.9	91.3	54.6
6.9	30.9	12.2	82.0	35.9
7.7	24.3	7.8	91.9	45.9

DHOLI

Month	Rain Fall (mm)	Temperature (°C)		RH (%)	
		Max.	Min.	I	II
Apr-17	63.6	34.2	21.8	76	54
May-17	119.2	34.2	23.9	83	65
Jun-17	64.2	35.1	26.7	86	66
Jul-17	442.2	32.5	26.3	89	75
Aug-17	387.3	32.6	26.4	91	77
Sep-17	44	33.8	26.3	89	68
Oct-17	3.5	32.6	23	89	66
Nov-17	0.0	28.7	15.3	87	59
Dec-17	0.0	24.1	10.9	94	69
Jan-18	0.0	16	7.7	93	77
Feb-18	0.0	25.6	11.9	9.0	6.5
Mar-18	0.0	32.2	16.0	7.9	5.5

KANKE

Rain Fall (mm)	Temperature (°C)		RH (%)	
	Max.	Min.	I	II
1.0	37.7	19.9	83.6	67.3
1.0	38.3	21.9	84.8	69.3
9.0	32.6	20.6	84.4	69.4
19.0	27.7	18.8	86.0	70.5
13.0	30.8	20.7	86.4	70.7
4.0	30.4	21.8	86.1	66.8
8.0	29.3	18.2	85.2	68.7
0.0	25.3	10.5	85.0	67.6
0.0	24.3	6.6	85.5	68.2
0.0	23.4	4.0	84.8	60.5
1.0	27.7	10.2	86.0	35.9
0.0	31.6	15.0	84.7	35.6

PUNDIBARI						KALYANI				
Month	Rain Fall (mm)	Temperature (°C)		RH (%)		Rain Fall (mm)	Temperature (°C)		RH (%)	
		Max.	Min.	I	II		Max.	Min.	I	II
Apr-17	177.7	30.3	20.01	90	65	0.11	38.21	23.74	89.9	48.33
May-17	391.6	31.78	22.34	90	72	5.45	35.36	22.61	91.35	65.23
Jun-17	502.5	32.8	24.66	92	76	5.36	34.55	23.91	93.57	74.2
Jul-17	413.1	32.12	25.49	91	78	12.86	32.37	24.16	96.42	87.06
Aug-17	979.5	32.22	25.64	97	81	13.94	32.63	24.14	96.39	82.23
Sep-17	532.4	32.88	25.1	96	76	4.04	33.53	24.16	93.7	78.47
Oct-17	224.5	30.84	22.31	96	74	5.39	32.3	21.64	94.42	68.55
Nov-17	0	29.51	15.69	95	55	0.57	36.83	15.33	92.9	58.17
Dec-17	0	26.94	12.78	97	55	0	26.25	10.9	96.77	57.71
Jan-18	0	21.86	9.25	95	60	0	25.4	8.55	96.32	46.52
Feb-18	3.8	26.18	12.57	84	53	0	29.48	12.61	92.25	42.61
Mar-18	101.2	30.03	16.54	71	49	0.61	32.29	17.64	92.1	48.81

MIZORAM						BARAPANI				
Month	Rain Fall (mm)	No. of Rainy days	Temperature (°C)		RH (%)		RainFall (mm)	Temperature (°C)		RH (%)	
			Max.	Min.	I	II		Max.	Min.	I	II
Apr-17	519.8	15.0	27.3	19.0	84.6	71.2	36.35	26.85	14.45	84.00	52.45
May-17	371.0	18.0	29.4	20.9	89.2	71.1	46.18	28.02	16.44	86.48	66.64
Jun-17	623.4	23.0	28.4	22.1	94.5	83.6	114.83	27.93	18.48	89.25	78.78
Jul-17	477.5	25.0	28.7	22.6	94.7	83.3	90.38	28.48	20.50	88.73	73.80
Aug-17	616.1	25.0	28.5	22.6	95.5	83.0	135.7	27.90	20.56	90.34	76.46
Sep-17	395.2	18.0	28.9	22.7	96.0	82.3	83.05	27.98	19.95	88.83	76.25
Oct-17	268.8	13.0	27.9	20.9	93.7	78.4	62.73	27.00	17.40	87.40	70.78
Nov-17	0.0	0.0	27.0	16.9	84.6	73.1	5.00	25.20	11.65	84.55	56.73
Dec-17	93.2	3.0	23.7	14.4	88.3	64.7	1.4	22.82	9.70	86.26	55.00
Jan-18	8.3	1.0	20.9	11.4	88.6	58.3	1.72	20.66	6.78	88.48	49.52

GANGTOK					PASIGHAT				
Month	Rain Fall (mm)	No. of Rainy days	Temperature (°C)		RainFall (mm)	No. of Rainy days	Temperature (°C)	RH(%)	
			Max.	Min.	450.2	17	Max.	I	II
Apr-17	218.1	15	24.6	9.2	858.2	19	26.65	92.2	89.6
May-17	493.2	13	25.1	11.2	749.5	18	26.70	88.8	82.3
Jun-17	649.1	22	23.6	10.5	784.3	22	29.15	88.6	81.5
Jul-17	710.8	28	25.2	9.5	953.4	18	30.35	94.5	91.9
Aug-17	799.7	31	25.1	8.3	604.0	14	29.9	92.8	89.5
Sep-17	306.6	29	24.5	7.2	296.4	11	29.75	89.6	89.2
Oct-17	188.4	10	25.4	11.0	00.0	00	29.50	88.6	86.9
Nov-17	0.0	Nil	23.3	11.4	3.0	01	25.45	87.2	76.6
Dec-17	39.2	04	20.6	10.1	24.5	5	23.40	82.8	78.0
Jan-18	74.8	05	23.6	12.3	71.06	4	20.09	84.3	77.9
Feb-18	62.2	07	19.7	9.5	203	9	20.08	85.8	75.1
Mar-18	172.4	15	25.3	9.4	450.2	17	22.42	73.8	64.6

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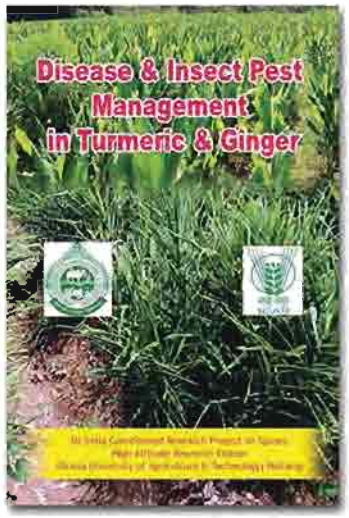
PUBLICATIONS RELEASED DURING 28TH AICRPS WORKSHOP

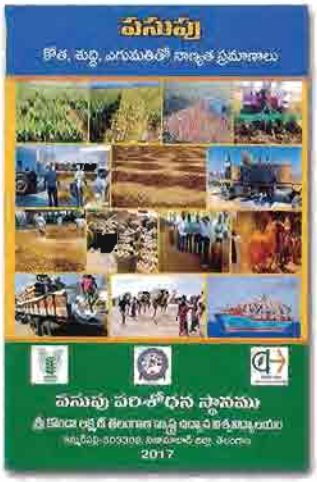
Compendium of 40 Years of Spices Research in Odisha 1975-2016



Disease & Insect Pest of Ginger & Turmeric

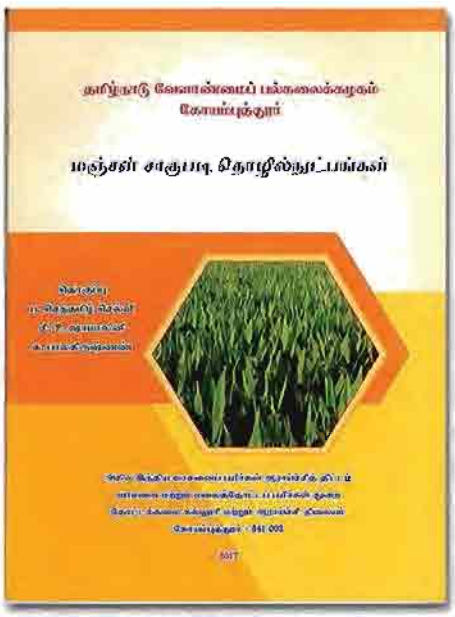
Major Problems in Spices Cultivation & Their Management

Panniyur Black Pepper Varieties

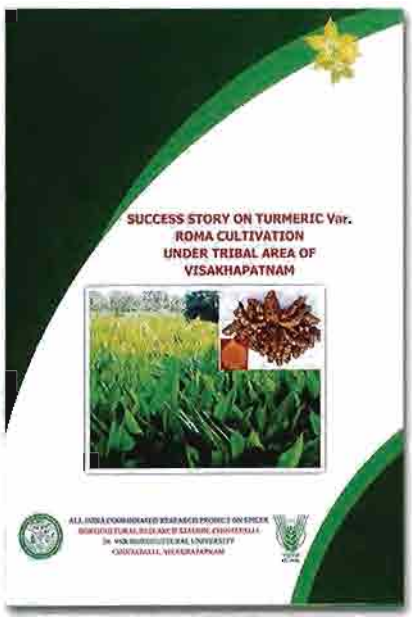


Post Harvest Processing of Turmeric (Telugu)

Turmeric Cultivation (Telugu)



Turmeric Production Technology (Tamil)



Success Story on Turmeric Var. Roma Cultivation Under Tribal Area of Visakhapatianam

Organic spice production Black pepper,Turmeric & Ginger

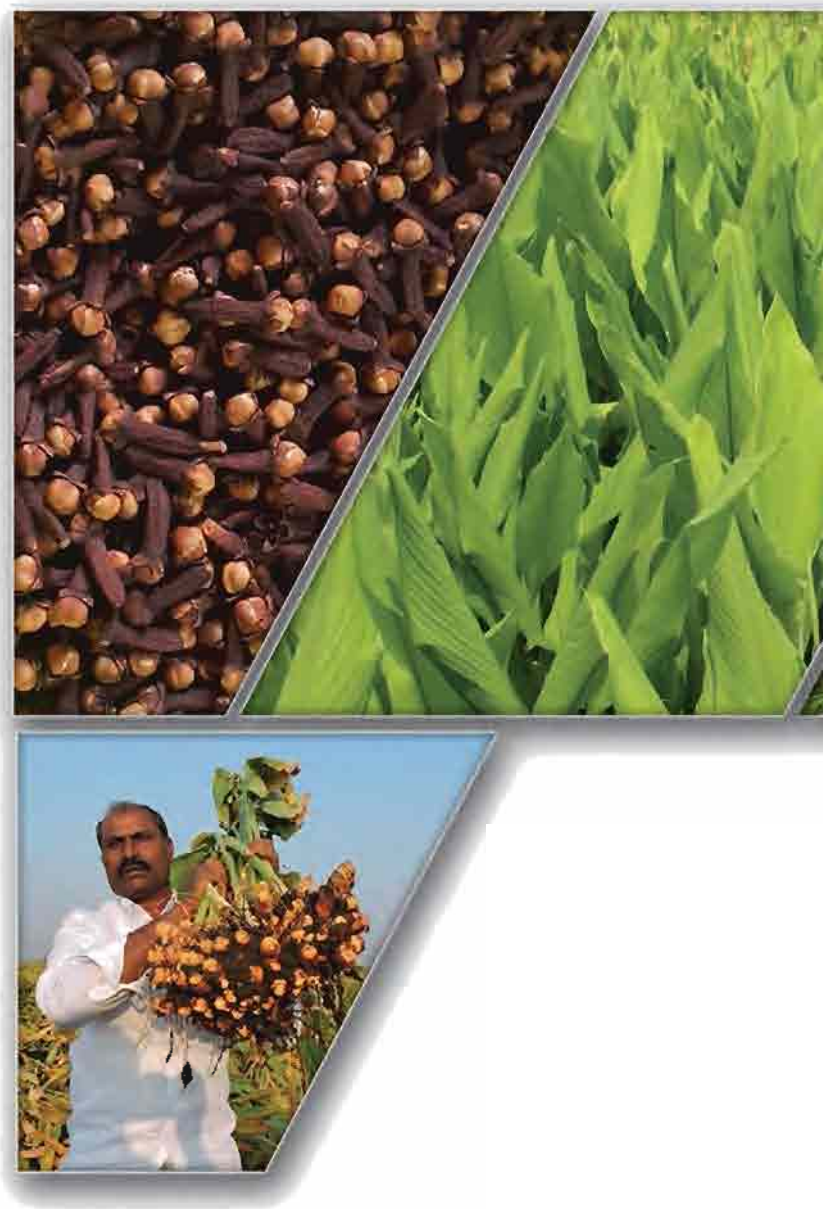
Black pepper nursery at Panniyur

Germplasm maintenance of Cumin at AAU Sanand

Drying of large cardamom

Fennel field at Ajmer

Field view of coriander variety SUSTHIRA



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