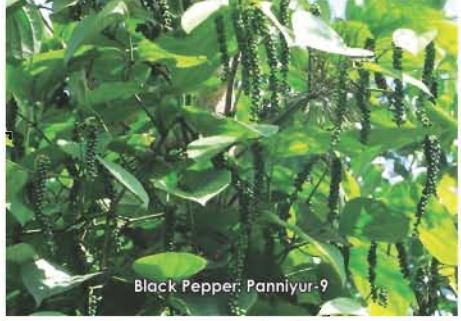
भाकृअनुप
ICAR

# वार्षिक रिपोर्ट
# Annual Report
# 2016-17

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

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

# VARIETIES RECOMMENDED FOR RELEASE DURING 27TH AICRPS WORKSHOP


Black Pepper: Panniyur-9


Ginger: V1 S1-2 (Sourabh)

Ginger: GCP-49 (Mohini)

Turmeric: IISR Pragati (Acc.48)


Turmeric: NDH-98


Coriander: RD 385 (Dr. RPCAU Dhania-1)

Fenugreek- HM 444 (Hisar Manohar)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# Contents



# कार्यकारी सारांश

भाकृअनुप - अखिल भारतीय समन्वित मसाला अनुसंधान परियोजना (ए आई सी आर पी एस) देश के सबसे बडे मसाला अनुसंधान नेटवर्क है। जिसके लिए देश के 23 राज्यों में फैले हुए 38 केन्द्रों (19 नियमित, 10 सहयोगी तथा 9 अवैतनिक केन्द्रों) के अतिरिक्त पांच अन्य परियोजना केन्द्र भी विभिन्न कृषि जलवायु क्षेत्रों में कार्यान्वित है। इसकी प्रमुख अधिदेश फसलें काली मिर्च, बडी इलायची, छोटी इलायची, अदरक, हल्दी, दालचीनी, जायफल, लौंग, धनिया, जीरा, सौंफ, मेथी, अजवाइन, कलौंजी आदि है। वर्ष 2016-17 की वार्षिक बजट में भारतीय कृषि अनुसंधान परिषद का आबंटन 452.5 लाख रुपए थे।

## नवीन कार्यक्रम

बीज मसालों के अनुसंधान कार्यों को विस्तृत करने के लिए परियोजना के अन्तर्गत कलौंजी तथा अजवाइन जैसे दो नये फसलों के कार्यक्रम को परीक्षणार्थ आरंभ किया गया। खाद्य सुरक्षा वाले मसाला उत्पादन तकनीकी के विकास के लिए थ्रिप्स सह्य इलायची प्रकारों को कई स्थानों में परीक्षण तथा छोटी इलायची के थ्रिप्स नियन्त्रण के लिए नये कीटनाशियों का मूल्यांकन किया गया।

मसाला उत्पादन में उत्पादकता को बढाने तथा संवहनीयता के लिए विभिन्न कृषि जलवायु क्षेत्रों में मसालों का जैविक उत्पादन तकनीकी, अदरक एवं हल्दी में सूक्ष्म पोषण तथा पीजी पी आर कैप्स्यूल का मूल्यांकन आदि पर नये कार्यक्रम आरंभ किये।

सूचना का तुरंत प्रसार करने के लिए ए आई सी आर पी एस के वेब आधारित सूचना के अतिरिक्त फेसबुक एवं वाट्सएप ग्रूप का सृजन किया गया।

## ए आई सी आर पी एस की सत्ताईसवीं कार्यशाला में विमोचित करने के लिए संस्तुत प्रजातियां

भाकृअनुप-राष्ट्रीय बीज मसाला अनुसंधान केन्द्र, अजमेर, राजस्थान में संपन्न हुई सत्ताईसवीं ए आई सी आर पी एस कार्यशाला में विमोचित करने के लिए मसालों की सात उच्च उपज वाली प्रजातियों को संस्तुत किया गया। काली मिर्च अनुसंधान स्टेशन (केरल कृषि विश्व विद्यालय), पन्नियूर, केरल से उन्नत उत्पादन क्षमता वाली काली मिर्च प्रजाति **पन्नियूर-9** को केरल, करनाटक एवं आन्ध्र प्रदेश के काली मिर्च उगाने वाले क्षेत्रों में विमोचित करने के लिए संस्तुत किया गया। अदरक के उन्नत उपज वाली दो प्रजातियों, जैसे उत्तर बंगा कृषि विश्व विद्यालय, पुंडिबारी, पश्चिम बंगाल द्वारा राष्ट्रीय स्तर पर विकसित **जी सी पी -49 (यु बी के वी ए ए डी ए 1)** तथा ओडीशा के लिए उच्च तुंगता अनुसंधान स्टेशन (ओ यु ए टी) द्वारा विकसित **वी 1 एस 1-2** (सौरभ) को विमोचित करने के लिए संस्तुत किया गया। हल्दी में नरेन्द्र देव कृषि एवं तकनीकी विश्वविद्यालय, कुमारगंज, फैसाबाद, उत्तर प्रदेश से उच्च उत्पादन क्षमता वाली, विस्तृत अनुकूलनशीलता एवं खारा हालत के सहनशील **एन डी एच-98** को तथा भाकृअनुप-भारतीय मसाला फसल अनुसंधान संस्थान, कोषिक्कोड, केरल द्वारा विकसित अल्प अवधि की, उन्नत कुरकुमिन वाली जड़ गांठ सूत्रकृमि के सह्य हल्दी प्रजाति **आई आई एस आर प्रगति (अक्सेशन 48)** को केरल, करनाटक, आन्ध्र प्रदेश, तमिल नाडु, छत्तीसगढ़ तथा तेलंगाना में विमोचित करने के लिए संस्तुत किया गया। आई आई एस आर प्रगति देश के हल्दी का उत्पादन करने वाले सबसे प्रमुख क्षेत्रों में कुरकुमिन के उन्नयन में 2-5% वृद्धि लाने में महत्वपूर्ण योगदान देंगे। बीज मसालों में डा. राजेन्द्र प्रसाद केन्द्रीय कृषि विश्वविद्यालय, धोली, बिहार से धनिया की एक उच्च उपज वाली प्रजाति **आर डी 385 (डा. आर पी सी ए यु धनिया-1)** को राष्ट्रीय स्तर पर विमोचित करने के लिए तथा चौधरी चरण सिंह हरियाणा कृषि विश्व विद्यालय, हिसार, हरियाणा में विकसित उच्च उपज वाली तथा विशिष्ट हरे रंग की बीज वाली एक मेथी प्रजाति **एच एम 444 (हिसार मनोहर)** को हरियाणा में विमोचित करने के लिए संस्तुत किया गया।

## काली मिर्च

प्रस्तुत वर्ष काली मिर्च के 30 अक्सेशनों को अखिल भारतीय समन्वित मसाला अनुसंधान परियोजना के विभिन्न केन्द्रों के काली मिर्च जननद्रव्यशाला में अनुरक्षित किया गया। काली मिर्च के समन्वित प्रजाति परीक्षण में अधिकतम साफ बेरी की उपज चिंतापल्ली (आन्ध्र प्रदेश) में, पन्नियूर-1 (995.34 ग्राम प्रति बेल) तत्पश्चात् अक्सेशन 33 (630-78 ग्राम प्रति बेल) तथा सी -1090 (603-47 ग्राम प्रति बेल), पन्नियूर (केरल) में एच बी 20052 (3270 ग्राम प्रति बेल) तत्पश्चात् अक्सेशन 53 (3260 ग्राम प्रति बेल), दापोली (महाराष्ट्र) में पन्नियूर -1 (99.67 ग्राम प्रति बेल), पाम्पाडुमपारा (केरल) में करिमुंडा (429 ग्राम प्रति बेल) तत्पश्चात् एच बी 20052 (1.076 ग्राम प्रति बेल) को अंकित किया गया।

पन्नियूर (केरल) में ड्रिप फरटिगेशन के मानकीकरण पर परीक्षण करने पर रोज़ाना 8 लिटर पानी की दर से ड्रिप सिंचाई 50 आर डी एफ फरटिगेशन के फलस्वरूप आपेक्षिकतया उन्नत स्पाइक उपज (3.72 कि. ग्राम /बेल), 925 स्पाइक /बेल, हरी बरी की उपज (2.75 कि. ग्राम/बेल) तथा कम रोग आपतन (9.25%) अंकित की गयी।

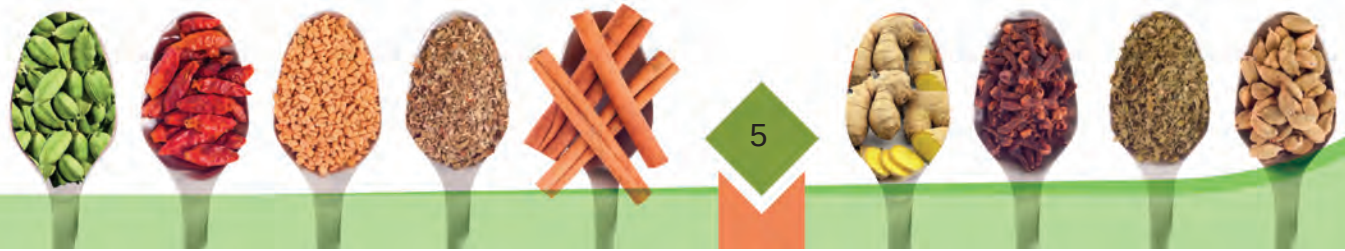
काली मिर्च की मिश्रित फसलन प्रणाली के आधार पर अध्ययन करने पर टैपियोका, एरोरूट, एलिफन्ट फूट याम, कोलोकैशिया तथा ग्रेटर याम अम्बलवयल (केरल), पन्नियूर (केरल), सिरसी (करनाटक) तथा दापोली (महाराष्ट्र) में काली मिर्च बागों में मिश्र फसल के रूप में खेती करने योग्य है।

चिंतापल्ली (आन्ध्र प्रदेश) के वर्तमान बाग में *फाइटोफ्थोरा* खुर गलन के प्रति कवक विषाक्त के नये अणुओं के प्रभाव का मूल्यांकन परीक्षण में *ट्राइकोडेरमा* (एम टी सी सी 5179) अ जीवाणुओं का संघ (आई आई एस आर-6 आई आई एस आर 859) का प्रयोग करने पर उच्च उपज के साथ पीलापन एवं विपर्णन के आपतन में कमी अंकित की गयी।

## छोटी इलायची

मुडिगरे (करनाटक) तथा पाम्पाडुमपारा (केरल) केन्द्रों में कुल 309 इलायची अक्सेशनों का संरक्षण किया जा रहा है। मुडिगरे में इलायची के आशाजनक प्रकारों का मूल्यांकन करने पर, आई सी - 346951 (372 कि. ग्राम / हेक्टेयर) में उच्चतम कैप्स्यूल की मात्रा अंकित की गयी तत्पश्चात् सी एल -726 (334 कि. ग्राम / हेक्टेयर)।

पाम्पाडुमपारा में विभिन्न लाइमिंग के प्रभाव का अध्ययन के लिए परीक्षण करने पर, डोलोमाइट प्रति पौधे 2 कि. ग्राम की दर से डालने पर पौधों की ऊंचाई में वृद्धि (399 से. मी.), प्रति क्लंप अधिक टिलेर्स (49.66), प्रति क्लंप में पनिकिल (46.66), प्रति पनिकिल में कैप्स्यूल (39.33), साफ उपज (2763 ग्राम / पौधा) तथा शुष्क कैप्स्यूल (573 ग्राम /पौधा) उपज अंकित की गयी। अन्य उपचारों की अपेक्षा डोलोमाइट 2 कि. ग्राम /पौधा की



दर के साथ इस उपचार में कीट एवं रोग आपतन कम था।

मुडिगरे, करनाटक में प्स्यूडोस्टम गलन के प्रति रासायनिक उपचार एवं जैव नियन्त्रण कारकों के प्रभाव की तुलना के लिए परीक्षण करने पर बाविस्टिन 0.2% डालने पर 698 ग्राम प्रति पौधे की उच्च उपज के साथ न्यूनतम टिल्लर बाधा (3.41%) अंकित की गयी तत्पश्चात् टी. *हरज़ियानम* के साथ नीम केक तथा 0.2% *प्स्यूडोमोनास फ्लूरोसन्ट* का छिड़काव था।

## बडी इलायची

बडी इलायची में, सिक्किम तथा तिवारी गांवों के उत्तर पूर्व जिलों तथा लोवर डिबोंग जिले के हनली, एतिपानी, केबाबोली, न्यू एलोप क्षेत्रों, अंजाउ जिले के हवाइ, अरबन टोप क्षेत्रों तथा अरुणाचल प्रदेश के मेटनग्लियां क्षेत्रों में सर्वेक्षण आयोजित किया तथा उनमें से 14 अक्सेशनों को आई सी आर आई क्षेत्रीय स्टेशन, गांगटोक (सिक्किम) द्वारा संचित किया गया।

आई सी ए आर रिसर्च कोम्प्लक्स, सिक्किम केन्द्र तटांग के बडी इलायची का उत्पादन करने वाले विभिन्न क्षेत्रों में टी मोस्किटो बग, *हेलोपेल्टिस थिवोरा* वाटरहाउस तथा मीली बग, *परापुटो थियाकोला* (हरे) की बाधा के अध्ययन का सर्वेक्षण किया है। टी मोस्किटो बग का आक्रमण लोवर ड्ज़ोन्गु क्षेत्र, उत्तर सिक्किम में अधिकतम (24.62 से 42.28ऽ आपतन) थे तत्पश्चात् पूर्व सिक्किम, आई सी ए आर फार्म (18.82 से 34.76%)। बडी इलायची का सर्वेक्षण किये पश्चिम सिक्किम के क्षेत्रों को कीट बाधा से मुक्त देखा गया। मीली बग का आक्रमण पूर्व सिक्किम के क्षेत्रों में अधिकतम (16.46 से 22.64%) अंकित किया तत्पश्चात् दक्षिण सिक्किम।

बडी इलायची के इनसेक्ट कीड जैसे तना बेधक, शूट फ्लाई, पत्ते खाने वाले केटरपिलर तथा टी मोस्किटो बग के प्रति गांगटोक, सिक्किम में जैवकीट नाशकों के प्रभाव का मूल्यांकन परीक्षण करने पर स्पिनोसाद 45 एस सी ऋ 0.3 मि. लि. / लि. को बडी इलायची में सभी कीटों के नियन्त्रण के लिए (नियन्त्रण में 62.84 से 80.76% संख्या में कमी) अधिक प्रभावी देखा गया तत्पश्चात् नीम तेल (1500 पी पी एम) ऋ4 मि. लि. / लि. (नियन्त्रण में 56.38 से 74.34ऽ संख्या में कमी) तथा पेट्रोलियम एग्रोस्प्रे ऋ10 मि. लि. / लि. (नियन्त्रण में 52.76 से 72. 2% संख्या में कमी)।

## अदरक

पश्चिम बंगाल के इकहत्तर अदरक जननद्रव्य को मूल्यांकन के लिए उगाया गया। इनमें प्रति खेत उच्चतम प्रकन्द उपज जी सी पी -49 (7.55 कि. ग्राम/खेत-1) में अंकित किया गया। जहां अधिकतम रोग आपतन जर्मप्लासम जी सी पी -53 (40.00%) में तत्पश्चात् जी सी पी -45 (36.67) तथा निम्नतम रोग आपतन जी सी पी -23 (3.33%) में अंकित किया गया।

पोटांगी (ओडीशा) में अदरक के समन्वित प्रजाति परीक्षण में एस ई-8640 उत्तम उत्पादक (14.9 टन / हेक्टेयर) है जो राष्ट्रीय चेक आई आई एस आर वरदा (8.9 टन / हेक्टेयर) की अपेक्षा 67.5ऽ है तत्पश्चात् पी जी एस -121 (14.7 टन / हेक्टेयर), एस- 646 (14.4 टन / हेक्टेयर) तथा जी सी पी-49 (14.2 टन / हेक्टेयर)। जबकि पुंडिबारी (पश्चिम बंगाल) में, जीन प्रकार जी सी पी -49 ने अधिकतम उपज (20.88 टन /हेक्टेयर) अंकित की तत्पश्चात् अश्वति (17.26 टन/हेक्टेयर) तथा आतिरा (15.62 टन/हेक्टेयर)।

धोली (बिहार) में नियन्त्रण तथा अन्य उपचारों की अपेक्षा जैविक खाद एवं जैव उर्वरकों के प्रयोग के प्रभाव पर अध्ययन करने पर शुष्क अदरक के उपज पर एफ वाई एम (30 टन / हेक्टेयर) अ *ट्राइकोडेरमा* उपचार करने पर पौधों की उच्चतम ऊंचाई (81.53 से. मी.), प्रति पौधे में टिलर की संख्या (52.03), प्रति टिलर में पत्तों की संख्या (30.96) तथा प्रति हेक्टेयर की उपज (7.28 टन /हेक्टेयर) अधिकतम थी तत्पश्चात् एफ वाई एम (30 टन /हेक्टेयर) अ पी एस बी उपचार करने पर पौधे की ऊंचाई (70. 60 से. मी.), प्रति पौधे में टिलर की संख्या (51.87), प्रति टिलर में पत्तों की संख्या (28.40) तथा प्रति हेक्टेयर की उपज (7.07 टन /हेक्टेयर)।

पोटांगी (ओडीशा) में अदरक के प्रकन्द गलन रोग प्रबन्धन के लिए परीक्षण करने पर, रासायनिक उपचार (मेटालक्सिल मैंकोज़ेब 2 ग्राम/लिटर की दर से तथा स्ट्रेप्टोसाइक्लिन 1 ग्राम /लिटर की दर से उपचारित) करने पर तथा बुआई के 45 दिनों के बाद तथा बुआई के 90 दिनो के बाद मृदा ड्रेंचिंग करने पर निम्नतम आपतन (5.75%) तथा अधिक साफ प्रकन्द उपज (17.65टन/हेक्टेयर) अंकित की गयी।

## हल्दी

पोटांगी में, हल्दी की समन्वित प्रजाति परीक्षण करने पर, सी एल एस -38 (14.9 टन/हेक्टेयर) उच्चतम शुष्क उत्पादक थे जिसकी उपज जो राष्ट्रीय चैक प्रजाति आई आई एस आर प्रतिभा (9.1 टन /हेक्टेयर) की अपेक्षा 63.7ऽ है। टी सी पी -191 ने अधिकतम साफ उपज 31.58 टन / हेक्टेयर अंकित किया तत्पश्चात् पुंडिबारी की एल टी एस - 2 (25.24 टन/हेक्टेयर) तथा धोली में आर एच-9/90 (64.15टन/हेक्टेयर) तथा आर एच - 80 (59.33 टन/हेक्टेयर), कोयम्बतोर (तमिलनाडु) में टी सी पी 191 (49.87 टन/हेक्टेयर), एल टी एस -1 (68.56 टन/हेक्टेयर) तत्पश्चात् कामरपल्ली (तेलंगाना) में एल टी एस-2 (56.18 टन/हेक्टेयर) एल टी एस -2 (23.7 टन/हेक्टेयर) ने प्रति हेक्टेयर अधिकतम साफ उपज अंकित की गयी तत्पश्चात् गुंटूर (आन्ध्र प्रदेश) में एल टी एस-1 (23.1 टन /हेक्टेयर)।

हल्दी में स्रोत सिंक संबन्ध पर परीक्षण दक्षिण, उत्तर तथा उत्तर पूर्व राज्यों के छः विभिन्न केन्द्रों में निम्न लिखित प्रजातियों जैसे आई आई एस आर प्रतिभा, दुग्गिराला रेड, माइदुकुर एवं बी एस आर -2 पर किया गया। इसका फल यह हुआ कि परीक्षण किये लगभग सभी केन्द्रों में सितम्बर से फरवरी की अवधि में संपूर्ण साफ प्रकन्दों की वज़न में काफी वृद्धि हुई है। कोयंबतोर, गुंटूर तथा कामरपल्ली में प्रजातियों का मूल्यांकन करने पर माइदुकुर को वृद्धि में ज़ोरदार देखा तथा उच्चतम साफ प्रकन्द की वज़न क्रमशः 890 ग्राम/पौधा, 317.2 ग्राम/पौधा तथा 618.50 ग्राम/पौधा अंकित किया।

गुंटूर में हल्दी के पर्ण रोग प्रबन्धन के लिए परीक्षण करने पर पर्ण चित्ती आपतन में 0-13.3ऽ का अन्तर अंकित किया। एन डी एच -74 दोनों पर्ण रोगों जैसे पर्ण चित्ती एवं पर्ण ब्लोच के लिए खेत सह्य होते हैं। अक्सेशन सी एल 32 (1.2%), टी सी पी 129 (1.7%) तथा टी सी पी 14 (2.2%) ने निम्नतम पी डी आई अंकित किया तथा दोनों बराबर थे। कोयंबतोर केन्द्र के सी एल 34 ने 32.91 टन / हेक्टेयर उपज के साथ यूनतम पर्ण चित्ती (5.40 पी डी आई) एवं पर्ण ब्लोच (3.50 पी डी आई) आपतन अंकित किया तत्पश्चात् टी सी पी 129 ने 30.58 टन /हेक्टेयर उपज के साथ पर्ण चित्ती (5.68 पी डी आई) तथा पर्ण ब्लोच (3.96 पी डी आई) की प्रतिरोधकता अंकित की। सोलन (हिमाचल प्रदेश) में, सी एल 54 ने न्यूनतम पर्ण चित्ती (6.56%) तथा पर्ण ब्लोच (7.09%) आपतन के साथ अधिकतम उपज (32.87 टन /हेक्टेयर) दिया। धोली में, टी सी पी -14 को *कोलेटोट्राइकम* तथा *टफ्रीना* पर्ण चित्ती रोग मुक्त देख लिया जहां पुंडिबारी में टी सी पी 129 ने निम्नतम पर्ण ब्लोच (पी डी आई 13.99) तथा पर्ण चित्ती (पी डी आई 8.66) की तीव्रता अंकित की। वैकल्पिक रूप से कामरपल्ली में, पर्ण चित्ती एवं पर्ण ब्लोच की तीव्रता के कारण

कोई भी प्रजाति पर्ण रोग प्रतिरोधक नहीं थे।

### वृक्ष मसाले

दापोली में छानबीन किये जायफल जननद्रव्य में फलों की औसत संख्या में 110-325 अन्तर थे। फलों की औसत संख्या जीनप्रकार DBSKKVMF 24 (325), DBSKKVMF 23 (310), DBSKKVMF 19 (280) में अधिक थी। जीन प्रकार DBSKKVMF 23 ने अधिकतम शुष्क फल उपज (1714.30 ग्राम) तथा शुष्क जावित्री उपज (381.3 ग्राम) अंकित किया गया। पीचिपराई (तमिलनाडु) में, जायफल अक्सेशन एम एफ-4 ने अधिकतम फल (420 फल/वृक्ष), एक ही फल की वज़न (108 ग्राम) तथा जावित्री उपज (220 ग्राम /वृक्ष) अंकित किया।

पीचीपाराई में संरक्षित 24 लौंग अक्सेशनों में से अक्सेशन एस ए -3 ने अधिकतम पर्ण लंबाई (18.00 से. मी.) पर्ण चौडाई (7.50 से. मी.) तथा शुष्क मुकुलों की उपज (3.0 कि. ग्राम / वृक्ष) अंकित की गयी। दापोली में चार आशाजनक जीन प्रकारों का चयन किया गया जिसके पौधों की लंबाई में 4.80 से 5.90 मी. अन्तर है, उसकी परिधि में 32.40 से 38.01 से. मी. अन्तर तथा विस्तार में 3.75 मी. से 5.40 मी. अन्तर है।

पीचीपाराई में, दालचीनी के बारह अक्सेशनों का मूल्यांकन करने पर, सी वी-5 ने अधिकतम पौधों की ऊंचाई (9.00 मीटर), तना परिधि (31.50 से. मी.), पर्ण उपज (7.50कि. ग्राम / पौधे) तथा शुष्क छाल की उपज (620.00 ग्राम / प्रति पौधे) अंकित की गयी जबकि साधारण चैक ने पौधे की ऊंचाई (7.80 मी.), तना परिधि (22.50 से. मी.), पर्ण उपज (7.00 कि. ग्राम / पौधे) तथा शुष्क छाल की उपज (290.00 ग्राम / प्रति पौधे) अंकित किये।

पीचीपाराई में, कैसिया के जीन प्रकार के के वी सी टी एस एच2 ने उन्नत परिधि (49.38 से. मी.) अंकित की तत्पश्चात् के के वी सी टी एस एच1 (45.88 से. मी.)। पर्णों के तेल के प्रतिशत में 6.14-7.34 अन्तर है। जीन प्रकार के के वी सी टी एस एच1 (7.34%) तथा के के वी सी टी एस एच 2 (7.12%) में अधिक छाल तेल प्रतिशत अंकित किया।

### धनिया

कोयम्बतूर में धनिया के जीनोटाइप का बहुस्थानीय मूल्यांकन करने पर जीनोटाइप एल सी सी 233 (750 कि. ग्राम/ हेक्टर) में अधिकतम बीज उपज अंकित किया जो चैक प्रजाति हिसार आनन्द (457.50 कि. ग्राम/ हेक्टेयर) से श्रेष्ठ था। आर डी -393 (6870 कि. ग्राम/ हेक्टेयर), एन डी धनिया-94 (4889 कि. ग्राम/हेक्टेयर) तथा एन डी धनिया-118 (4593 कि. ग्राम/हेक्टेयर) जगुदान (गुजरात) में आशाजनक थे।

समन्वित प्रजाति परीक्षण में, अधिकतम बीज उपज कोयम्बतोर में सी ओ आर-141 (8.05 कुन्टल / हेक्टेयर), जबलपुर (मध्य प्रदेश) में सी ओ आर-141 (28.69 कुन्टल / हेक्टेयर), सी ओ आर-138 (15.97 कुन्टल / हेक्टेयर) अंकित किया तत्पश्चात् कुमारगंज (पश्चिम बंगाल) में सी ओ आर-146 (15.90 कुन्टल / हेक्टेयर), सी ओ आर-139 (15.83 कुन्टल / हेक्टेयर) तथा सी ओ आर-130 (15.06 कुन्टल / हेक्टेयर), गुंटूर में सी ओ आर-134 (7.78 कुन्टल / हेक्टेयर), सी ओ आर-130 (7.53 कुन्टल / हेक्टेयर), सी ओ आर-135 (7.46 कुन्टल / हेक्टेयर), सी ओ आर-129 (7.36 कुन्टल / हेक्टेयर) तथा सी ओ आर-133 (7.18 कुन्टल / हेक्टेयर), जगुदान में सी ओ आर-122 (25.15 कुन्टल / हेक्टेयर), सी ओ आर-142 (25.27 कुन्टल / हेक्टेयर) तत्पश्चात् कोटा (राजस्थान) में सी ओ आर-146 (23.61 कुन्टल/हेक्टेयर) तथा आई सी एस 1 (30.76 कुन्टल/ हेक्टेयर) तत्पश्चात् सी ओ आर-135 (25.4 कुन्टल / हेक्टेयर), सी ओ आर-129 (24.58 कुन्टल / हेक्टेयर) तथा सी ओ आर-136 (23.13 कुन्टल / हेक्टेयर) इसके अलावा राष्ट्रीय चैक आर सी आर 728 (17.36 कुन्टल / हेक्टेयर), राइगढ (छत्तीसगढ) में गुजरात 2 (16.60 कुन्टल / हेक्टेयर) तथा हिसार आनन्द (15.83 कुन्टल / हेक्टेयर) में अंकित किया।

कोयम्बतूर तथा जोबनर (राजस्थान) में धनिया के पाउडरी मिल्ड्यू के प्रति नये कवकनाशियों का मूल्यांकन अध्ययन करने पर प्रोपिकोनाज़ोल का छिड़काव करने पर अधिकतम नियन्त्रण था। जबकि राइगढ में वेटबिल सल्फर 0.2% डालने पर उत्तम नियन्त्रण में आशावान थे।

### जीरा

जगुदान में जीरा की अठारह प्रजातियों को *अल्टरनेरिया* ब्लाइट रोग तथा पाउडरी मिल्ड्यू के प्रति छानबीन की गयी। परिणामस्वरूप, न्यूनतम ब्लाइट रोग जी सी-4 (32.5%) में तत्पश्चात् जी सी -2000-28 (40%), जबकि न्यूनतम पाउडरी मिल्ड्यू का आपतन जे सी -4 (17.5%) में तथा न्यूनतम म्लानी रोग जी सी -3 (40%) में अंकित किया गया।

जगुदान में कुमिन एफिड के प्रति कीटनाशियों के नये मोलीक्यूल्स के बायोएफिकसी का मूल्यांकन अध्ययन करने पर, थियामेथोक्साम 25 डब्ल्यु 25 ग्राम ए आई /हेक्टेयर की दर तत्पश्चात् थियाक्लोप्रिड 21.7 एस सी 25 ग्राम ए आई /हेक्टेयर की दर से डालने पर दूसरी छिडकाव के 7 दिन बाद अमबेट्स एफिड की बाधा का प्रतिशत सबसे कम (3.34%) अंकित किया।

### सौंफ

प्रस्तुत वर्ष सी वी टी में उत्तम दक्षतावाली प्रजातियां कुमारगंज की एफ एन एल -99 (13.61 कुन्टल / हेक्टेयर), तत्पश्चात् एफ एन एल–97 (13.19 कुन्टल / हेक्टेयर), एफ एन एल -95 (12.77 कुन्टल / हेक्टेयर), तथा एफ एन एल -98 (120.50 कुन्टल / हेक्टेयर), एफ एन एल -97 (21.24 कुन्टल / हेक्टेयर) तत्पश्चात् हिसार की एफ एन एल -98 (20.15 कुन्टल / हेक्टेयर) तथा एफ एन एल -99 (19.89 कुन्टल / हेक्टेयर) तथा जगुदान की आर एफ-101 (19.15 कुन्टल / हेक्टेयर) थे।

संस्तुत मात्रा के 75% उर्वरकों के साथ ड्रिप फरटिगेशन करने पर पौधे की उन्नत ऊंचाई (122.90 से. मी.), प्रति पौधे की अम्बेल (24.51), प्रति अम्बेल की बीज (400.88), जांच किये वज़न (6.01 ग्राम), बीज उपज (25.16 कुन्टल/ हेक्टेयर) एवं पर्याप्त जल उपयोग (6.08 कि. ग्राम/ हेक्टेयर- मि. मी.1) को अंकित किया गया। लेकिन यह 100% संस्तुत मात्रा के साथ ड्रिप फरटिगेशन तथा नाईट्रोजन की 100% संस्तुत मात्रा के साथ ड्रिप फरटिगेशन के बराबर थे।

### मेथी

मेथी के लिए एक सी वी टी करने पर, उच्चतम बीज उपज जबलपुर में एफ जी के 103 (13.89 कुन्टल / हेक्टेयर) में अंकित किये, तत्पश्चात् एफ जी के 106 (11.74 कुन्टल / हेक्टेयर), एफ जी के 96 (11.57 कुन्टल / हेक्टेयर) तथा एफ जी के 97 (11.57 कुन्टल / हेक्टेयर), कोयंबतोर में एफ जी के 103 (8.33 कुन्टल / हेक्टेयर), एफ जी के 94 (13.40 कुन्टल / हेक्टेयर) तत्पश्चात् कुमारगंज के एफ जी के 97 (13.33 कुन्टल / हेक्टेयर), एफ जी के 96 (13.12 कुन्टल / हेक्टेयर) तथा एफ जी के 101 (13.05 कुन्टल / हेक्टेयर), जगुदान के एफ जी के -99 (21.48 कुन्टल / हेक्टेयर), राइगढ के एफ जी के -96 (17.06 कुन्टल / हेक्टेयर) तथा एफ जी

के - 98 (15.22 कुन्टल / हेक्टेयर) तथा एफ जी के 105 (21.83 कुन्टल / हेक्टेयर), तत्पश्चात् हिसार (हरियाणा) के एफ जी के -106 (21.25 कुन्टल / हेक्टेयर) तथा एफ जी के -104 (20.49 कुन्टल / हेक्टेयर)।

जोबनर में, मेथी के पाउडरी मिल्ड्यू के लिए उन्नीस प्रजातियों की जांच की गयी। एफ जी के -94 तथा एफ जी के -99 सामान्यतया पाउडरी मिल्ड्यू रोग के प्रतिरोधक थे। जबकि यु एम-393 तथा यु एम -398 को जांच किये दस आई ई टी में से सामान्य प्रतिरोधक अंकित किया गया। तीन सौ उनसठ जर्मप्सालम अक्सेशनों में से सैंतालीस प्रविष्टियों को रोग के प्रति सामान्यतया प्रतिरोधक के रूप में पहचान की गयी।

### अजवाइन

राइगढ में अजवाइन के लिए किये गये सी वी टी परीक्षण में अजवाइन 1 को अधिकतम बीज उपज (2.57 कुन्टल / हेक्टेयर) अंकित किया तत्पश्चात् एल एस-14-8 (2.40 कुन्टल / हेक्टेयर)। गुंटूर में एल एस-14-3 (9.84 कुन्टल / हेक्टेयर), ए ए -6 (9.80 कुन्टल / हेक्टेयर), एल एस -14-8 (9.54 कुन्टल / हेक्टेयर) तथा ए ए-73 (8.70 कुन्टल / हेक्टेयर), जगुदान में आई ए -2 (11.06 कुन्टल / हेक्टेयर), एन डी ए जे-10 (8.12 कुन्टल / हेक्टेयर) तत्पश्चात् कुमारगंज में ए ए -6 (7.91 कुन्टल / हेक्टेयर), ए ए 73 (7.70 कुन्टल / हेक्टेयर) तथा जे ए -187 (7.50 कुन्टल / हेक्टेयर) तथा एन डी ए जे-11 (7.70 कुन्टल / हेक्टेयर), एच ए जे-7 (6.40 कुन्टल / हेक्टेयर) तत्पश्चात् जोबनर में एन डी ए जे-11 (5.90 कुन्टल / हेक्टेयर), आई ए -1 (5.26 कुन्टल / हेक्टेयर), एन डी ए जे -10 (5.11 कुन्टल / हेक्टेयर) तथा ए ए -93 (5.10 कुन्टल / हेक्टेयर), एन डी ए -11 (8.34 कुन्टल / हेक्टेयर) तत्पश्चात् एच ए जे -18 (8.20 कुन्टल / हेक्टेयर) तथा एच ए जे - 7 (7.62 कुन्टल / हेक्टेयर) उन्नत उत्पादक थे।

### कलौंजी

कलौंजी के समन्वित प्रजाति परीक्षण में कोट्टा में ए एन-23 (7.99 कुन्टल / हेक्टेयर) तथा ए एन -1 (7.71 कुन्टल / हेक्टेयर), एन डी बी सी -20 (8.12 कुन्टल / हेक्टेयर) को अधिकतम बीज उपज अंकित किया तत्पश्चात् कुमारगंज के ए एन-112 (7.43 कुन्टल / हेक्टेयर) तथा आई एन -1 (7.15 कुन्टल / हेक्टेयर)।

### गुणवत्ता युक्त रोपण सामग्रियों का उत्पादन एवं वितरण

सात लाख सोलह हज़ार जड़ लगाए काली मिर्च कतरनें, 1622 इलायची बीज पौधे/सकेर्स, 50 टन हल्दी, 16 टन अदरक, 518 जायफल कलमी पौधे, 247 जायफल बीज पौधे, 256 दालचीनी कलमी पौधे, 1000 दालचीनी बीज पौधे तथा 150 लौंग बीज पौधे को सुपारी व मसाला विकास निदेशालय की सहायता से ए आई सी आर पी एस केन्द्रों में बहुगुणित करके वितरण किया गया। बीज मसालों में 501.75 कि. ग्राम धनिया, 6400 कि. ग्राम जीरा, 719 कि. ग्राम सौंफ, 60.5 कि. ग्राम अजवाइन तथा 261 कि. ग्राम मेथी की बीज सामग्रियों का उत्पादन करके वितरण किया था।

### तकनीकी स्थानान्तरण

ए आई सी आर पी एस केन्द्रों के वैज्ञानिकों ने नवीन तकनीकियों को लोकप्रिय करने के लिए परिश्रम किया। प्रस्तुत वर्ष प्रदर्शित कुछ नवीन तकनीकियां निम्न प्रकार है।

- ❖ हल्दी की ग्यारह उच्च उपज वाली प्रजातियों पर प्रदर्शनी (गुंटूर)।
- ❖ दालचीनी के छाल को निकालने की तकनीकी, अदरक एवं हल्दी की प्रो ट्रे प्रवर्धन तकनीकी, काली मिर्च का संसाधन, हल्दी का संसाधन, जायफल एवं कोकुम में मृदु काठ ग्राफ्टिंग, बुश पेप्पर उत्पादन तकनीकी, जायफल की छाल से चटनी बनाकर संरक्षित करना (दापोली) आदि की प्रदर्शनी।
- ❖ मेथी, जीरा तथा सौंफ के उच्च उपज वाली प्रजातियों पर आठ प्रदर्शनी (जोबनर)।
- ❖ दो मुकुल वाले हल्दी बीज प्रकन्दों के बीज उपचार, चार कतारों पर उठाये बेड प्रणाली, ट्राक्टर द्वारा हल्दी फसलन पर प्रदर्शनी (कामारपल्ली)।
- ❖ एम आई डी एच (पाम्पाडुमपारा) के अन्तर्गत खेत स्तर पर छोटी इलायची उत्पादन के लिए तकनीकियों की प्रदर्शनी।
- ❖ एक हेक्टेयर में हल्दी को अन्तरण करने की दक्षता पर खेती गत प्रदर्शनी (कोयंबतोर)।
- ❖ अदरक एवं हल्दी की जैविक खेती, धनिया, मिर्च एवं काली मिर्च खेती तथा मसाला उत्पादन की नई विधियां पर अभिज्ञान कार्यक्रम आदि पर किसानों के लिए प्रशिक्षण (पोटांगी)।
- ❖ सुपारी व मसाला विकास निदेशालय के सहयोग से हल्दी, अदरक, धनिया तथा करी पत्ती के लिए हाइ -टेक उत्पादन तकनीकी पर प्रशिक्षण (कोयंबतोर)।

उपरोक्त खेती गत प्रदर्शनियों के अलावा, वैज्ञानिकों ने प्रशिक्षण तथा संगोष्ठी आयोजित करके तथा प्रसार माध्यम (समाचार पत्र, आकाशवाणी में व्याख्यान तथा दूरदर्शन कार्यक्रम) से तकनीकियों को अधिक लोकप्रिय बनाया।

### सफल गाथा

श्री. देवराजभाय अमताभाय पटेल, गुजरात के बानसकान्त जिले के वरसादा गांव के निवासी है, उन्होंने अपने 25 एकड भूमि में वर्ष 2004 तक सरसों, कपास, कैस्टर तथा जीरा की खेती की थी। यद्यपि उनकी भूमि उपजाऊ थी, श्री पटेल परंपरागत विधि से खेती करने से या स्थानीय या बहुत पुरानी प्रजातियों का इस्तेमाल करने से वह इन खेतों से वर्ष में केवल 3 लाख रुपए ही कमा सकते थे। सौंफ को एक नये फसल के रूप में अपनाने के लिए तथा जीरा की तकनीकियों को प्रदर्शित करने के लिए हाल में विमोचित गुजरात सौंफ -11 प्रजाति की खेत प्रदर्शनी के साथ गुजरात सौंफ - 2 तथा गुजरात जीरा -4 के साथ गुजरात जीरा 2 की प्रदर्शनियां अखिल भारतीय समन्वित मसाला अनुसंधान परियोजना के अन्तर्गत सी आर एस एस, जगुदान द्वारा 2004 में आयोजित कीं। दिलचस्प यह है कि इन प्रदर्शनियों के फल से प्रेरित होकर श्री पटेल अपने सरसों के स्थान पर सौंफ की खेती करने तथा जीरा की खेती को बढाने का निर्णय किया। सी आर एस एस, जगुदान द्वारा आयोजित प्रशिक्षण से प्रेरित होकर श्री पटेल गुजरात सौंफ -11 तथा गुजरात जीरा -4 के बीजों का उत्पादन करने लगे। पिछले वर्ष उन्होंने लगभग 5000 कि. ग्राम जी सी -4 के प्रमाणित /टी एफ बीजों का तथा 2000 कि. ग्राम जी एफ -11 का उत्पादन करके किसानों को वितरण किया। ऐसे फसल विविधीकरण एवं बीज उत्पादन कार्यक्रम द्वारा उनकी कृषि की आमदनी 3 लाख से 15 लाख बन गयी। श्री पटेल को फसल विविधीकरण एवं बीज उत्पादन के लिए एस. डी कृषि विश्वविद्यालय, सरदार कृषि नगर द्वारा वर्ष 2011 में उत्तम किसान पुरस्कार प्राप्त हुए।

आन्ध्र प्रदेश के प्रतिकूल कृषि जलवायु क्षेत्रों (दक्षिण अंचल, वर्षा की

कमी वाले क्षेत्र तथा कृष्णा-गोदावरी अंचल के पश्चिम भाग) में धनिया की खेती करने वाले किसानों की सफल गाथा से यह ज्ञात होता है कि जलवायु परिवर्तन के प्रभाव को अनुकूल तकनीकियों का प्रयोग करके कम किया जा सकता है। प्रकाशम जिले (दक्षिण अंचल) के पेडचेरलोपल्ले मंडल के किसान अखिल भारतीय समन्वित मसाला अनुसंधान परियोजना के गुंटूर केन्द्र में शुष्क क्षेत्रों में रबि खेती करने के बारे में सलाह लेने के लिए आये थे। किसानों को धनिया की दो श्रेष्ठ प्रजातियों जैसे सुगुणा तथा ए पी एच यु धनिया -1 को दिया गया। यद्यपि वहां वर्षा बहुत कम है तो भी इन फसलों को अच्छी तरह स्थापित किया गया। दो किसानों ने मार्च के तीसरे सप्ताह में, जब फोडर फसल, जोअर मृदा में पर्याप्त नमी के अभाव से ठीक न हुए, फसलन किया। ए पी एच यु धनिया-1 प्रजाति की उपज 125 कि.ग्राम /एकड अंकित किया गया। इस सुगुणा तथा ए पी एच यु धनिया-1 प्रजाति से प्राप्त लाभ का अनुपात 2.46 से 2.76 थे।

आन्ध्र प्रदेश के परंपरागत धनिया की खेती करने वाले वेम्पल्ले मंडल के एक अन्य प्रगामी किसान, श्री. विश्वनाथ रेड्डी, अखिल भारतीय समन्वित मसाला अनुसंधान परियोजना के गुंटूर केन्द्र में वर्षा की कमी वाले क्षेत्रों में खेती करने के बारे में सलाह लेने के लिए आये थे। उन्होंने पहचान किया कि उचित प्रजाति का चयन करने से उत्पादन में बडा अन्तर होगा तथा अपने आठ एकड खेत में खेती करने के लिए ए पी एच यु धनिया -1 की बीज प्राप्त किये। उन्हें पौधा पुष्पित होते समय दिन में कम से कम तीन घंटे स्प्रिंक्लर सिंचाई (लगभग 30 मी. मी. पानी) करने की सलाह दी। यह फसल कोई कीट या रोग समस्या के बिना प्रचुरता से बढने लगे। उन्हें 1875 कि. ग्राम धनिया बीज प्राप्त हुए जो राष्ट्रीय औसत उपज (835 कि. ग्राम/हेक्टेयर) के 1.44 गुना अधिक थे। उन्हें प्रति एकड से कुल 57, 500 रुपए प्राप्त हुए।

अन्य सफल गाथा कृष्णा गोदावरी अंचल के पश्चिम भाग की है जहां रबी के समय वर्षा केवल 44 मि.मी. थी। ए आई सी आर पी एस, गुंट ूर केन्द्र की सलाह से डचेपल्ले मंडल के श्री एटुकोंडलु ने नवंबर के अंतिम सप्ताह में धनिया की सुगुणा प्रजाति की बुआई की। इस किसान ने मोबाइल एवं वाट्स एप से तकनीकियों की जानकारी लेकर उचित ढंग से फसल का देखभाल किया। उन्हें 85 दिनों के अन्दर प्रति एकड से 450 कि. ग्राम बीज प्राप्त हुए। इससे यह ज्ञात होता है कि उचित समय पर अनुकूल फसल का चयन सफलता की कुजी है।

### आदिवासी कल्याण उपाय

आन्ध्र प्रदेश के चिंतापल्ली, ओडीशा के पोट्टांगी तथा छत्तीसगढ के राइगड क्षेत्र के 15 गांवों में 1290 आदिवासी किसानों को उन्नत उत्पादन तकनीकी एवं मसालों की गुणवत्ता उन्नयन पर अवगत कराने के लिए पन्द्रह प्रशिक्षण कार्यक्रम आयोजित किये।

### उत्तर पूर्व में नयी पहल

भारतीय कृषि अनुसंधान परिषद की क्षेत्रीय समिति की सिफारिश के अनुसार धनिया की 13 तथा मेथी की 14 प्रजातियों को मूल्यांकन के लिए आई सी ए आर रिसर्च काम्प्लक्स, अगरतला में प्रयोग किया गया। भाकृअनुप-भारतीय मसाला फसल अनुसंधान संस्थान से काली मिर्च की 6 उच्च उपज वाली, उन्नत गुणवत्ता वाली केन्द्रक रोपण सामग्रियों को आई सी ए आर रिसर्च काम्प्लक्स, अगरतला, त्रिपुरा में प्रवर्धन एवं खेत में रोपण करने हेतु अतिरिक्त प्रवर्धन के लिए कृषि विज्ञान केन्द्र को वितरण करने हेतु रोपण किया गया।

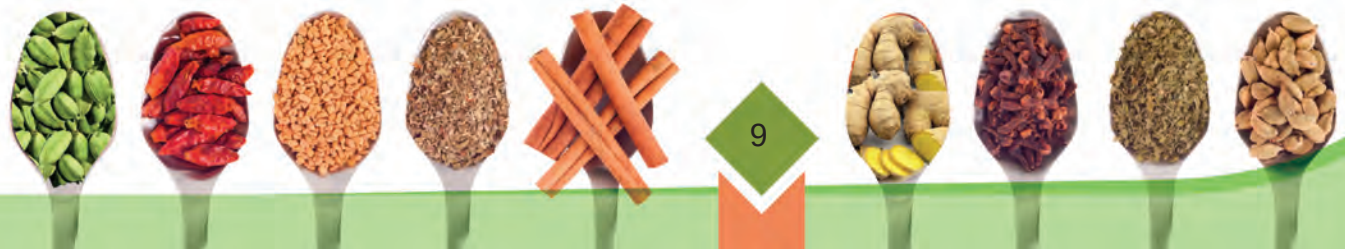
अदरक एवं हल्दी में पी जी पी आर जैवकैप्स्यूल तथा आई आई एस आर सूक्ष्म पोषण के प्रभाव का मूल्यांकन करने के लिए बारापानी, पासीघट तथा मिसोराम केन्द्रों में नये परीक्षण शुरू किये। इसके अलावा अदरक एवं हल्दी के जैविक उत्पादन पर नया परीक्षण भी किया गया।

### सहयोग

भाकृअनुप-भारतीय मसाला फसल अनुसंधान संस्थान, कोषिक्कोड, राष्ट्रीय बीज मसाला अनुसंधान केन्द्र, अजमेर तथा राज्य कृषि विश्वविद्यालयों के अलावा सुपारी व मसाला विकास निदेशालय, स्पाइसेस बोर्ड, केन्द्रीय बागवानी संस्थान, सी एफ टी आर आई, डब्ल्यु एस ओ, आई डी एच, कोडेक्स, आई एस ओ तथा अन्य एन जी ओ के साथ ए आई सी आर पी एस सहयोगी कार्य कर रहे हैं।

### निरीक्षण

केन्द्रों द्वारा संचालित अनुसंधान कार्यक्रमों का प्रबोधन परियोजना समन्वयक एवं परियोजना समन्वयक यूनिट के वैज्ञानिकों ने केन्द्रों तथा प्रायोगिक क्षेत्रों का भ्रमण करके किया। इस वर्ष 14 केन्द्रों का भ्रमण किया जिनमें नियमित, सहकारी, स्वैच्छिक एवं परियोजना स्तर के केन्द्र भी शामिल थे। कार्यों की प्रगति का निरीक्षण केन्द्रों द्वारा भेजी गयी मासिक रिपोर्ट, अर्ध वार्षिक रिपोर्ट एवं वार्षिक रिपोर्ट द्वारा किया गया। वार्षिक कार्यशाला 24-26 अक्तूबर 2016 को भाकृअनुप-राष्ट्रीय बीज मसाला अनुसंधान केन्द्र, अजमेर, राजस्थान में आयोजित की गयी।



# EXECUTIVE SUMMARY

ICAR-All India Coordinated Research Project on Spices (AICRPS) is the largest spice research network in the country with 38 centres (19 regular, 10 co-opting and 9 voluntary centres) supplemented by five more in project mode funding, spread over various agro climatic zones in 23 states of the country. Black Pepper, Large Cardamom, Small Cardamom, Ginger, Turmeric, Cinnamon, Nutmeg, Clove, Coriander, Cumin, Fennel and Fenugreek, Ajowan and Nigella are the mandate crops. Annual budget for the year 2016/17 was Rs. 452.5 lakhs as ICAR share.

## New Initiatives

To broaden the research activities in seed spices, trials on two new crops like Nigella and Ajowan were initiated in the AICRPS. For the development of food safe spice production technologies, multilocation trials on thrips tolerant cardamom lines and evaluation of new insecticides for thrips control in small cardamom were undertaken.

New programmes on organic production technologies of spices, evaluation of micronutrients and PGPR biocapsules in ginger and turmeric have been initiated in different agro climatic regions to enhance productivity and sustainability in spice cultivation.

For the fast communication and information dissemination, facebook page and WhatsApp group of AICRPS has been created in addition to its web based information flow.

## Varieties recommended for release in 27$^{th}$ AICRPS workshop

Seven high yielding varieties of spices were recommended for release in XXVI AICRP on Spices workshop held at ICAR-National Research Centre on Seed Spices (NRCSS), Ajmer, Rajasthan. One black pepper variety, Panniyur-9 from Pepper Research Station (KAU), Panniyur, Kerala with high yield potential was recommended for release in Black pepper growing areas of Kerala, Karnataka and Andhra Pradesh. Two high yielding ginger varieties viz; GCP-49 (UBKV AADA 1) developed by Uttar Banga Krishi Viswavidyalaya, Pundibari, West Bengal at national level and V1S1-2 (Sourabh) developed by High altitude Research Station (OUAT), Pottangi for Odisha were recommended for release. In turmeric NDH-98 from Narendra Dev University of Agriculture & Technology, Kumarganj, Faizabad, Uttar Pradesh with high yield potential, wide adaptability and tolerance to saline condition for release at national level and a short duration, high curcumin, root-knot nematode tolerant, variety IISR Pragati (Acc. 48) developed by ICAR-Indian Institute of Spices Research, Kozhikode, Kerala, for release in turmeric growing areas of Kerala, Karnataka, Andhra Pradesh, Tamil Nadu, Chhattisgarh and Telangana were recommended. IISR Pragati will contribute significantly to the curcumin up gradation from 2 to 5% in the most important turmeric growing regions in the country. In seed spices, RD 385 (Dr. RPCAU Dhania-1) a high yielding coriander variety from Dr. Rajendra Prasad Central Agricultural University, Dholi, Bihar for release at national level and HM 444 (Hisar Manohar), a fenugreek variety with high yield and unique green seed colour developed by Chowdhary Charan Singh Haryana Agricultural University, Hisar, Haryana for release at Haryana were recommended.

## Black Pepper

During the year, 30 accessions of black pepper were added to germplasm maintained at various centres. In Coordinated Varietal Trial of black pepper, maximum fresh berry yield was recorded in Panniyur-1 (995.34 g vine$^{-1}$) followed by ACC-33 (630.78 g vine $^{-1}$) and C-1090 (603.47 g vine $^{-1}$) at Chintappalle (Andhra Pradesh), HB 20052 (3270 g vine-1) followed by Acc.no.53 (3260 g vine$^{-1}$) at Panniyur (Kerala), Panniyur1 (99.67 g vine$^{-1}$) at Dapoli (Maharashtra), Karimunda (429 g vine$^{-1}$) followed by HB 20052

(1.076 g vine$^{-1}$) at Pampadumpara (Kerala).

In a trial on standardization of drip fertigation at Panniyur (Kerala), drip irrigation @ 8 litres of water daily at 50 RDF fertigation recorded comparatively higher spike yield (3.72 kg vine$^{-1}$), 925 spikes vine$^{-1}$, green berry yield (2.75 kg vine$^{-1}$) and with low disease intensity (9.25 %) .

A study on black pepper based mixed cropping system showed that crops such as tapioca, arrowroot, elephant foot yam, colocasia and greater yam are suitable as intercrops in juvenile black pepper garden at Ambalavayal (Kerala), Panniyur (Kerala), Sirsi (Karnataka) and Dapoli (Maharastra).

In an experiment to evaluate the effectiveness of new molecules of fungi toxicants against *Phytophthora* foot rot in existing plantation at Chintappalli (Andhra Pradesh), application of *Trichoderma* (MTCC 5179) + consortium of bacteria (IISR-6+ IISR-859) recorded lesser incidence of yellowing and defoliation with high yield.

## Small Cardamom

A total of 309 cardamom accessions are presently conserved in the gene bank of Mudegere (Karnataka) and Pampadumpara (Kerala). In a trial to evaluate the promising lines of cardamom at Mudigere, IC-346951 (372 kg ha$^{-1}$) recorded highest capsule yield followed by CL-726 (334 kg ha$^{-1}$).

Application of dolomite @ 2 kg plant$^{-1}$ was found to be the best treatment with increased plant height (399 cm), more number of tillers clump$^{-1}$ (49.66), panicles clump$^{-1}$(46.66) and capsules panicle$^{-1}$ (39.33), fresh (2763 g plant$^{-1}$) and dry capsule (573 g plant$^{-1}$) yield in an experiment at Pampadumpara to study the effect of different liming materials. The incidence of pest and disease in this treatment was lowest in the treatment with dolomite @ 2 kg plant$^{-1}$.

Minimum tiller infection of (3.41 %) with higher yield of 698 g plant$^{-1}$ was obtained with the application of 0.2 % Bavistin followed by the application of *T. harzianum* with Neem cake and spraying of 0.2 % *Pseudomonas fluorescens* in a trial to compare the effect of chemical treatments and bio-control agents against pseudostem rot at Mudigere, Karnataka.

## Large Cardamom

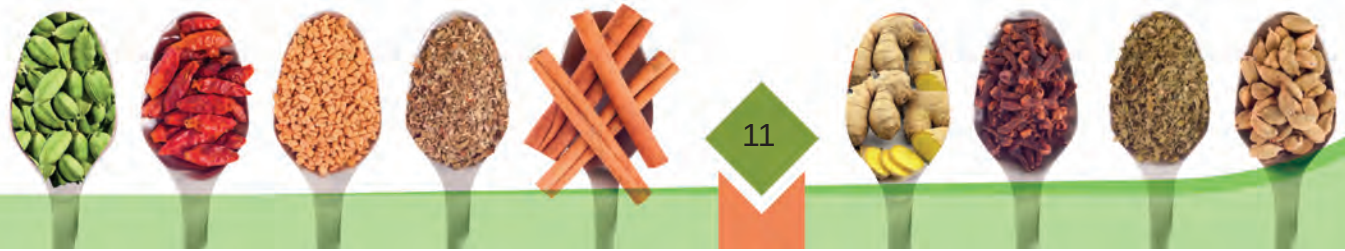
In large cardamom, survey was conducted at different areas of East and West districts of Sikkim and Tiwari Gaon, Hunli, Ethipani, Kebaboli, New Elope area of Lower Dibong Dist. Hawai, Urban top area of Anjau Dist. and Metengliang area in Arunachal Pradesh and collected 14 accessions by ICRI, Regional Station, Gangtok (Sikkim).

ICAR Research Complex, Sikkim Centre, has conducted a survey to study the intensity of infestation of tea mosquito bug, *Helopeltis theivora* Waterhouse and mealy bug, Paraputo theaecola (Green) in different large cardamom growing areas of Sikkim Tadong. The infestation of tea mosquito bug was maximum in Lower Dzongu area, North Sikkim (24.62 to 42.28 % incidence) followed by East Sikkim, ICAR Farm (18.82 to 34.76%). The surveyed fields of large cardamom of West Sikkim were found almost free of infestation of this pest. The infestation of mealy bug was found maximum in the fields of East Sikkim (16.46 to 22.64%) followed by South Sikkim.

Spinosad 45 SC @ 0.3 ml l$^{-1}$was found to be the most effective control to all the pests (62.84 to 80.76% reduction of population over control) in large cardamom followed by neem oil (1500 ppm) @ 4 ml l$^{-1}$ (56.38 to 74.34% reduction of population over control) and petroleum agrospray @ 10 ml l$^{-1}$ (52.76 to 72.28% reduction of population over control) in an experiment to evaluate the efficacy of biopesticides against insect pests of large cardamom *viz.,* stem borer, shoot fly, leaf eating caterpillar and tea mosquito bug at Gangtok, Skkim.

## Ginger

Seventy one germplasms of ginger were grown for evaluation at Pundibari centre at West Bengal. Highest rhizome yield per plot was recorded



in GCP-49 (7.55 Kg plot$^{-1}$) whereas maximum disease incidence was recorded in the germplasm GCP- 53 (40.00%) followed by GCP-45 (36.67) and the lowest disease incidence was recorded in GCP-23 (3.33%).

In Coordinated Varietal Trial of ginger at Pottangi(Odhisa) the entry SE-8640 was the top yielder (14.9 t ha$^{-1}$) with the yield advantages of 67.5% than the national check IISR Varada (8.9t ha$^{-1}$) followed by PGS-121 (14.7 t ha$^{-1}$), S-646(14.4 t ha$^{-1}$) and GCP-49(14.2 t ha$^{-1}$). Whereas, at Pundibari(West Bengal), the genotype GCP-49 showed the highest projected yield (20.88 t ha$^{-1}$) followed by Aswathy (17.26 t ha$^{-1}$) and Athira (15.62 t ha$^{-1}$).

Application of FYM (30 t ha$^{-1}$) + *Trichoderma* gave the highest plant height (81.53 cm), number of tillers per plant (52.03), number of leaves per tiller (30.96) and yield per hectare (7.28 t ha$^{-1}$) followed by the application of FYM (30 t ha$^{-1}$) + PSB produced plant height (70.60 cm), number of tillers per plant (51.87), number of leaves per tiller (28.40) and yield per hectare (7.07 t ha$^{-1}$) as compared to control and other treatments in the study on the effect of organic manures and bio fertilizers on partitioning of dry mater of ginger at Dholi (Bihar).

In a trial for the management of rhizome rot of ginger at Pottangi (Odhisa), lowest incidence (5.75 %) and high fresh rhizome yield (17.65 t ha$^{-1}$) was found in the chemical treatment (rhizome treated with metalaxyl mancozeb @ 2g l$^{-1}$ and streptocycline @ 1g l$^{-1}$ and soil drenching at 45 DAS and 90 DAS) followed by the application of *Trichoderma viride* @ 10g l$^{-1}$ (rhizome treatment and foliar spray at 45 DAS and 90 DAS).

## Turmeric

In a Coordinated Varietal Trial of turmeric at Pottangi, CLS-38 (14.9 t ha$^{-1}$) was the top dry yielder with the yield advantages of 63.7 % than the national check variety IISR Pratibha (9.1t ha$^{-1}$) TCP-191 recorded highest fresh yield of 31.58 t ha$^{-1}$ followed by LTS -2 (25.24 t ha$^{-1}$) at Pundibari, RH-9/90 (64.15 t ha$^{-1}$) and RH-80 (59.33 t ha$^{-1}$) gave significantly high fresh yield per hectare at Dholi, TCP 191 (49.87 t ha$^{-1}$) at Coimbatore (Tamil Nadu), LTS-1 (68.56 t ha$^{-1}$) followed by LTS -2 (56.18 t ha$^{-1}$) at Kammarapally (Telengana), LTS-2 (23.7 t ha$^{-1}$) followed by LTS-1 (23.1 t ha$^{-1}$) at Guntur (Andhra Pradesh).

The experiment on source sink relationship in turmeric is being carried out in six different centres spread over South, North and North Eastern states with the following varieties *viz.*, IISR Prathibha, Rajendra Sonia, Duggirala Red, Mydukur and BSR-2. The results showed that fresh weight of whole rhizome increased considerably from September to February in almost all the tested Centres. Among the varieties evaluated at Coimbatore, Guntur and Kammarapally, Mydukur was found to be vigorous in growth and recorded highest fresh rhizome weight of 890 g plant$^{-1}$, 317.2 g plant$^{-1}$ and 618.50 g plant$^{-1}$ respectively.

In a trial on the management of foliar diseases of turmeric using tolerant lines, leaf spot incidence ranged from 0-13.3 % at Guntur. NDH-74 showed field tolerance to both the foliar diseases like leaf spot and blotch .The accessions CL 32 (1.2%), TCP 129 (1.7%) and TCP 14 (2.2%) recorded the lowest PDI and were on par with each other. CL 34 of Coimbatore centre recorded minimum leaf spot (5.40 PDI) and leaf blotch (3.50 PDI) incidence with a yield of 32.91 t ha$^{-1}$ followed by TCP 129 with a yield of 30.58 t ha$^{-1}$, recorded resistant reaction to both leaf spot (5.68 PDI) and leaf blotch (3.96 PDI). At Solan (Himachal Pradesh), CL-54 gave the maximum yield (32.87 t ha$^{-1}$) along with minimum leaf spot (6.56 %) and leaf blotch (7.09 %) incidence. In Dholi, TCP-14 was found free from *Colletotrichum* and *Taphrina* leaf spot disease whereas in Pundibari, TCP 129 has recorded lowest leaf blotch (PDI 13.99) and leaf spot (PDI 8.66) disease severity. Alternatively at Kammarapally, none of the varieties was found to be resistant to foliar diseases due to severe incidence of leaf spot and leaf blotch.

## Tree Spices

Among the nutmeg germplasm screened at Dapoli, average number of fruits ranged from 110-325. The average number of fruits was high in genotypes DBSKKVMF 24 (325), DBSKKVMF 23 (310), DBSKKVMF 19 (280). The genotype DBSKKVMF 23 recorded maximum dry nut yield (1714.30 g) and dry mace yield (381.3 g). The genotype DBSKKVMF 29 is found to be promising considering its fruit weight, nut weight and mace weight. At Pechiparai (Tamil Nadu), the nutmeg accession MF- 4 recorded maximum number of fruits (420 fruits /tree), single fruit weight (108 g) and the mace yield (220 g tree$^{-1}$).

The clove accession, SA-3 recorded the highest leaf length (18.00 cm), leaf breadth (7.500 cm) and dry bud yield (3.0 kg tree$^{-1}$) when 24 clove accessions were evaluated at Pechiparai. Four promising genotypes were selected at Dapoli whose plant height varied from 4.80 to 5.90 m, girth ranged from 32.40 to 38.01 cm and spread varied from 3.75 m to 5.40 m.

In case of cinnamon, among the twelve accessions evaluated at Pechiparai, CV-5 recorded maximum tree height (9.00 m), stem girth (31.50 cm), leaf yield (7.50 kg plant$^{-1}$) and dry bark yield (620 g plant$^{-1}$) while local check recorded plant height (7.80 m), stem girth (22.50 cm), leaf yield (7.00 kg/plant) and dry bark yield (290 g/plant).

The genotype KKVCTSH2 of Cassia recorded high girth (49.38 cm) followed by KKVCTSH1 (45.88 cm) at Pechiparai. The oil percentage in leaf varied from 6.14 - 7.34 %. The genotype KKVCTSH1 (7.34 %) and KKVCTSH2 (7.12 %) recorded high bark oil percentage.

## Coriander

In a multi location evaluation of coriander genotypes, maximum seed yield was recorded in the genotype LCC 233 (750.00 kg ha$^{-1}$) which was better than the check variety Hissar Anand (457.50 kg ha$^{-1}$) at Coimbatore. RD-393 (6870 kg ha$^{-1}$), NDCor-94 (4889 kg ha$^{-1}$) and NDCor-118 (4593 kg ha$^{-1}$) were found to be the promising entries at Jagudan (Gujarat).

In Coordinated Varietal Trial of coriander, maximum seed yield was recorded in the entry COR 141 (8.05 q ha$^{-1}$) at Coimbatore, COR 141 (28.69 q ha$^{-1}$) at Jabalpur (Madhya Pradesh), COR-138 (15.97 q ha$^{-1}$) followed by COR-146 (15.90 q ha$^{-1}$), COR-139 (15.83 q ha$^{-1}$) and COR-130 (15.06 q ha$^{-1}$) at Kumarganj (West Bengal), COR-134 (7.78 q ha$^{-1}$), COR-130 (7.53 q ha$^{-1}$), COR-135 (7.46 q ha$^{-1}$), COR-129 (7.36 q ha$^{-1}$) and COR-133 (7.18 q ha$^{-1}$) at Guntur, COR-122 (25.15 q ha$^{-1}$) at Jagudan, COR-142 (25.27 q ha$^{-1}$) followed by COR- 146 (23.61q ha$^{-1}$) at Kota (Rajasthan) and ICS 1 (30.76 q ha$^{-1}$) followed by COR 135 (25.4 q ha$^{-1}$), COR 129 (24.58 q ha$^{-1}$) and COR 136 (23.13 q ha$^{-1}$) over national checks RCR 728 (17.36 q ha$^{-1}$), Gujarat 2 (16.60 q ha$^{-1}$) and Hisar Anand (15.83 q ha$^{-1}$) at Raigarh (Chhattisgarh).

In a study to evaluate new generation fungicides against powdery mildew in coriander at Coimbatore and Jobner (Rajasthan), spraying of Propiconazole gave maximum level of control whereas at Raigarh, foliar spray of wettbale sulphur 0.2% were found to be the best controlling agent.

## 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 intensity was noticed in GC-4 (32.5%) followed by GC-2000-28 (40 %), while minimum powdery mildew disease intensity was noticed in GC-4 (17.5 %) and minimum wilt disease intensity was noticed in GC-3 (40.0 %).

In a study to evaluate the bio-efficacy of newer molecules of insecticides against cumin aphid, thiamethoxam 25WG @ 25g a.i./ha followed by thiacloprid 21.7SC @ 25g a.i/ha had registered the least per cent umbels aphid infestation (3.34%) at 7 days after second spray at Jagudan.

## Fennel

The best performed entries in the CVT during the year were FNL-99 (13.61 q $ha^{-1}$) followed by FNL-97 (13.19 q $ha^{-1}$), FNL-95 (12.77 q $ha^{-1}$) and FNL-98 (120.50 q $ha^{-1}$) at Kumarganj, FNL-97 (21.24 q $ha^{-1}$) followed by FNL-98 (20.15 q $ha^{-1}$) and FNL-99 (19.89 q $ha^{-1}$) at Hisar and RF-101 (19.15 q $ha^{-1}$) at Jagudan.

The drip fertigation with 75% recommended dose of fertilizers recorded significantly high plant height (122.90 cm), umbels per plant (29.72), umbellets per umbel (24.51), seeds per umbel (400.88), test weight (6.01 g), seed yield (25.16 q $ha^{-1}$) and water use efficiency (6.08 kg ha-$mm^{-1}$). However it remained at par to drip fertigation with 100% recommended dose of fertilizers and drip fertigation with100% recommended dose of nitrogen.

## Fenugreek

In a CVT for fenugreek, the highest seed yield was recorded in FGK-103 (13.89 q $ha^{-1}$) followed by FGK-106 (11.74 q $ha^{-1}$), FGK-96 (11.57 q $ha^{-1}$) and FGK-97 (11.57 q $ha^{-1}$) at Jabalpur, FGK-103 (8.33 q $ha^{-1}$) at Coimbatore, FGK-94 (13.40 q $ha^{-1}$) followed by FGK-97 (13.33 q $ha^{-1}$), FGK-96 (13.12 q $ha^{-1}$) and FGK-101 (13.05 q $ha^{-1}$) at Kumarganj, FGK-99 (21.48 q $ha^{-1}$) at Jagudan, FGK-96 (17.06 q $ha^{-1}$), FGK-98 (15.22 q $ha^{-1}$) at Raigarh and FGK-105 (21.83 q $ha^{-1}$) followed by FGK-106 (21.25 q $ha^{-1}$) and FGK-104 (20.49 q $ha^{-1}$) at Hisar (Haryana).

Nineteen (CVT) entries of fenugreek were screened against powdery mildew at Jobner. Entries FGK-94 and FGK-99 were observed as moderately resistant against powdery mildew disease whereas the entries UM-393 and UM-398 were observed as moderately resistant amongst the ten IET entries tested. Forty seven entries among the three hundred and fifty nine germplasm accessions were also identified as moderately resistant lines against the disease.

## Ajwain

Ajwain 1 recorded maximum seed yield (2.57 q $ha^{-1}$) followed by entry LS-14-8 (2.40 q $ha^{-1}$) in CVT for Ajwain at Raigarh. LS-14-3 (9.84 q $ha^{-1}$), AA-6 (9.80 q $ha^{-1}$), LS-14-8 (9.54 q $ha^{-1}$) and AA-73 (8.70 q $ha^{-1}$) were the top yielders at Guntur, IA-2 (11.06 q $ha^{-1}$) at Jagudan, NDAJ-10 (8.12 q $ha^{-1}$) followed by AA-6 (7.91 q $ha^{-1}$), AA-73 (7.70 q $ha^{-1}$) and JA-187 (7.50 q $ha^{-1}$) and NDAJ-11 (7.70 q $ha^{-1}$) at Kumarganj, HAJ-7 (6.40 q $ha^{-1}$) followed by NDAJ-11 (5.90 q $ha^{-1}$), $IA^{-1}$ (5.26 q $ha^{-1}$), NDAJ-10 (5.11 q $ha^{-1}$) and AA-93 (5.10 q $ha^{-1}$) at Jobner, NDA-11 (8.34 q $ha^{-1}$) followed by HAJ-18 (8.20 q $ha^{-1}$) and HAJ-7 (7.62 q $ha^{-1}$).

## Nigella

In Coordinated Varietal Trial of Nigella, maximum seed yield was recorded in the entry AN-23 (7.99 q $ha^{-1}$) and AN-1 (7.71 q $ha^{-1}$) at Kota, NDBC-20 (8.12 q $ha^{-1}$) followed by AN-112 (7.43 q $ha^{-1}$) and IN-1(7.15 q $ha^{-1}$) at Kumarganj.

## Production and distribution of quality planting material

The AICRPS centres along with DASD have multiplied and distributed 7.16 lakhs rooted cuttings of black pepper, 1622 seedlings/suckers of cardamom, 50 t of turmeric, 16 t of ginger, 518 grafts of nutmeg, 247 seedlings of nutmeg, 256 grafts of cinnamon, 1000 seedlings of cinnamon and 150 seedlings of clove. In seed spices 501.75 kg of coriander, 6400 kg of cumin, 719 kg of fennel, 60.5 kg of Ajwain and 261 kg of fenugreek seed material were produced and distributed.

## Transfer of Technology

Scientist from AICRPS centres have actively involved in popularization of the latest technologies to reach it effectively in to the farming community. Some of the technologies demonstrated during the year as follows.

- FLD on 11 high yielding varieties of turmeric(Guntur)
- Demonstration of technique of removing bark of cinnamon, Pro tray 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, Preparation of preserve and chutney from nutmeg rind (Dapoli)

❖ Eight demonstrations on high yielding varieties of fenugreek, cumin and fennel (Jobner).

❖ Demonstration on seed treatment of two budded turmeric seed rhizomes, four rows of raised bed method, and tractor mounted harvesting of turmeric (Kammarapally)

❖ Demonstrations of high yielding varieties of turmeric, coriander, fennel and fenugreek (Kumarganj).

❖ Demonstration of technologies for small cardamom production at farm level under MIDH (Pampadumpara)

❖ FLD on performance of turmeric transplants in an area of 1.00 ha (Coimbatore)

❖ Farmers' Training on " Organic ginger and turmeric cultivation", "Coriander, chilli and black pepper cultivation" and awareness training on "Improved Spices Cultivation" (Pottangi)

❖ Training on "Hi- tech production technology for turmeric, ginger, coriander and curry leaf" in collaboration with DASD (Coimbatore)

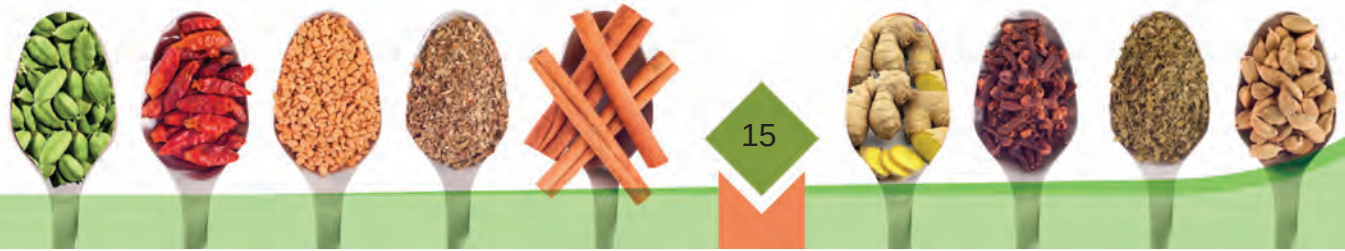
Apart from the above, the scientists interacted with farmers as resource persons in trainings, seminar and also through various media (newspaper, radio talks and TV programs) to disseminate knowledge among spice farmers.

## Success stories

Mr. Devrajbhai Amthabhai Patel, resident of Varsada village of Banaskantha district in Gujarat holds 25 acres of land in which he has been cultivating mustard, cotton, castor and cumin upto 2004. Even though blessed with high fertile land, Mr. Patel earns only about Rs. 3.0 lakhs from the cultivation of these crops annually due to traditional method of cultivation and use of either local or very old varieties. In order to introduce fennel as a new cash crop and to demonstrate the technologies of cumin, field demonstrations of recently released variety Gujarat Fennel – 11 with Gujarat Fennel – 2 and Gujarat Cumin – 4 with Gujarat Cumin-2 was conducted in this area under All India Coordinated Research Project on Spices by CRSS, Jagudan in 2004. Interestingly, encouraging results obtained from these demonstrations motivated Mr. Patel to replace mustard crop by fennel and also to extend the area of cumin. Inspired from the trainings organized by CRSS, Jagudan, Mr. Patel started seed productions of Gujarat Fennel – 11 and Gujarat Cumin – 4. Last year, he produced about 5000 kg of Certified/TF seeds of GC-4 and 2000 kg of GF-11 and distributed among the farmers. His farm income has thus increased from Rs. 3.0 to 15.0 lakhs by crop diversification and seed production programme. Mr. Patel was awarded as the best farmer for crop diversification and seed production by S. D. Agricultural University, Sardarkrushinagar in the year 2011.

The success story of farmers in coriander cultivation from the adverse agro climatic regions of Andhra Pradesh (Southern Zone, Scarce Rainfall Zone and western part of Krishna-Godavari zone) reveals that the effect of climate change can be mitigated by the use of appropriate technologies. The farmers from Pedacherlopalle mandal of the Prakasam district (Southern Zone) approached All India Coordinated Research Project on Spices, Guntur for advice on raising rabi crops in drought prone areas. The farmers were provided with two elite varieties of coriander, Suguna and APHU Dhania-1. The crop established well even though the rainfall was meager. Two farmers harvested the crop during the third week of March when the fodder crop, jowar has failed due to insufficient soil moisture. The variety APHU Dhania-1 recorded 125 kg $acre^{-1}$, whereas Suguna recorded a yield of 115 kg $acre^{-1}$. The Benefit Cost Ratio was 2.46 and 2.76 for the variety Suguna and APHU Dhania-1 respectively.

Another progressive farmer, Sri Viswanadha Reddy from Vempalle mandal, the traditional



coriander growing area of Andhra Pradesh, under the Scarce Rainfall Zone has approached the AICRPS centre at Guntur. He realized that choosing the appropriate variety can make a huge difference and procured seed of APHU Dhania-1 for raising crop in eight acres. He was advised to go for sprinkler irrigation at least for three hours daily, approximately delivering 30 mm of water at the critical stage of flower initiation. The crop grew exuberantly without any pest or disease problem. He harvested 1875 kg $ha^{-1}$ coriander grains, which was 1.44 times higher than the national average (835 kg $ha^{-1}$). The net income per acre was Rs. 57,500/-.

Another success story was from the western part of Krishna-Godavari zone, where the rainfall during rabi was only 44 mm. With the advice of AICRPS at Guntur centre, Sri Edukondalu, of Dachepalle mandal has sown coriander variety Suguna in the last week of November. The farmer took the advantage of mobile and WhatsApp technology to ensure proper care to the crop. He could harvest 450 kg $acre^{-1}$, in 85 days. The net income was Rs. 34000/-with a Benefit Cost Ratio of 5.2. This story highlights that the right choice of crop at appropriate time is the key for success.

## Tribal welfare measures

Fifteen farmers training programmes were conducted in 15 villages in Chintapalle of Andhra Pradesh, Pottangi of Odisha and Raigarh of Chhattisgarh benefiting 1290 tribal farmers to make awareness on high production technologies and quality up gradation in spices.

## New Initiatives in North East

As per the recommendations of ICAR Regional Committee, 13 coriander varieties and 14 fenugreek varieties were introduced to ICAR Research Complex, Agartala for evaluation. Nucleus planting material of 6 high yielding, high quality varieties of black pepper from ICAR- IISR were supplied and planted in ICAR RC, Agartala, Tripura for further multiplication and distribution to KVKs for multiplication and field planting.

To evaluate the effect of PGPR Biocapsules and IISR micronutrients in ginger and turmeric, new trials were initiated at Barapani, Pasighat and Mizoram centres. New trial on organic production in ginger and turmeric was also undertaken.

## Collaboration

In addition to IISR-Kozhikode, NRCSS-Ajmer and State Agricultural Universities, AICRPS have collaboration with DASD, Spices Board, Central Institute of Horticulture, CFTRI, WSO, IDH, Codex , ISO and various NGOs.

## Monitoring

The research programmes undertaken by the centres were monitored by Project Coordinator and the Scientists from PC unit's through visits to various centres and the experimental plots. In this year 12 visits were taken up to centres including regular, co-opting, voluntary and project mode centres. The progresses of activities were also monitored through monthly, half yearly and annual reports from centres. The annual workshop was conducted during 24$^{th}$ to 26$^{th}$ October 2016 at ICAR-National Research Centre on Seed Spices (NRCSS), Ajmer, Rajasthan.

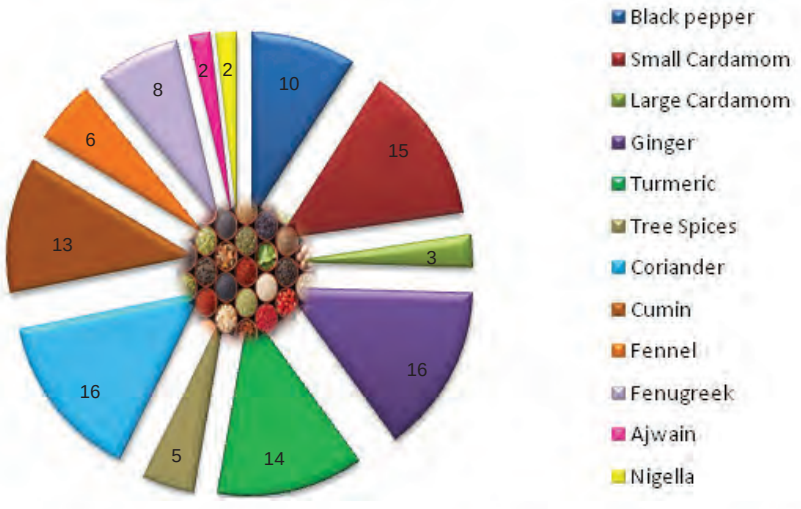
# PROFILE OF AICRP ON SPICES

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, Ajwain 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.

## 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 programmes - Crop wise

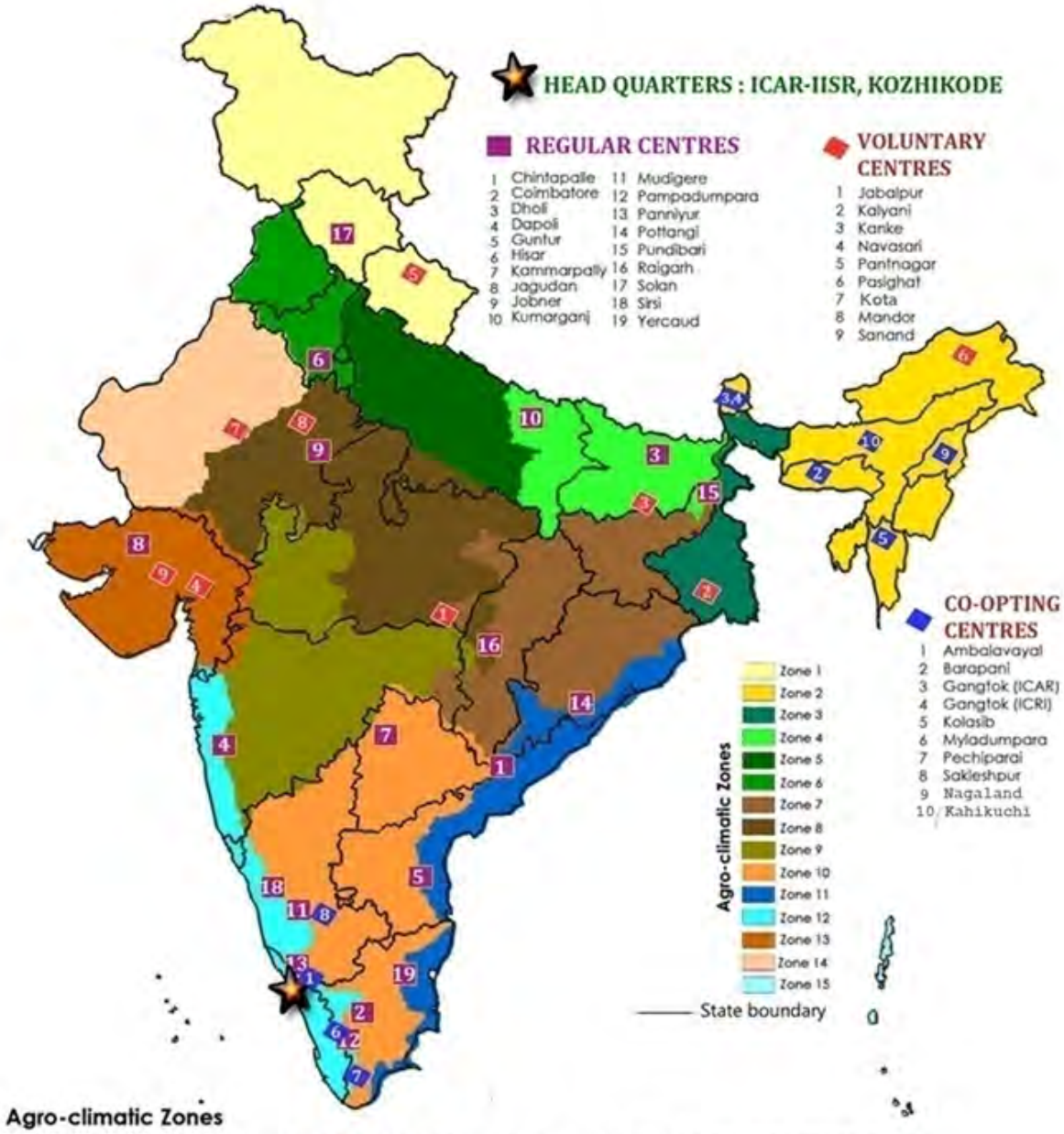


## AICRPS centres, year of start and crops handled by the centre

| 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



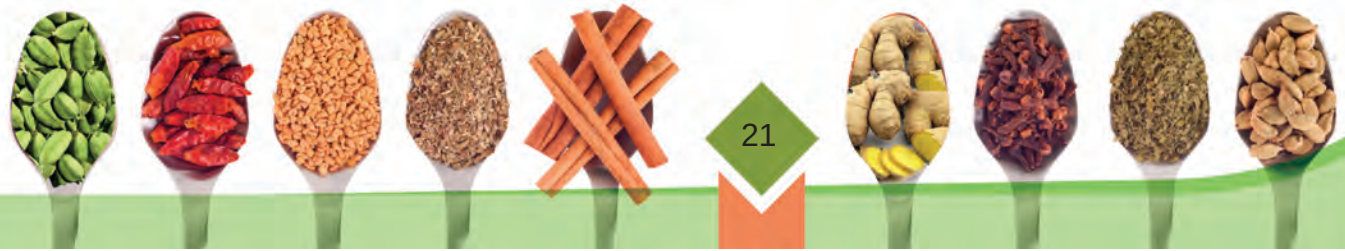

**Agro-climatic Zones**

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

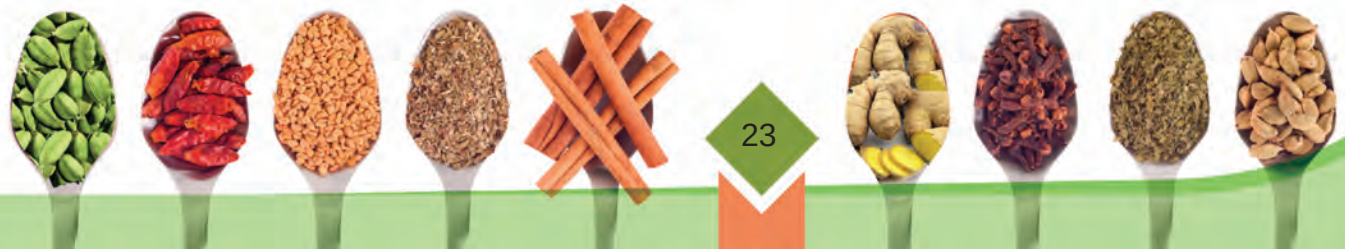
| Project Code | Title | Centres |
|---|---|---|
| **Black Pepper** | | |
| PEP/CI/1 | **Genetic Resources** | |
| PEP/CI/1.1 | Germplasm collection, characterization, evaluation and conservation | Ambalavayal, Chintapalle, Dapoli, Panniyur, Pundibari, Sirsi, Yercaud |
| PEP/CI/2 | **Hybridization trial** | |
| PEP/CI/2.1 | Inter-varietal hybridization to evolve high yielding varieties | Panniyur |
| PEP/CI/3 | **Coordinated Varietal Trial (CVT)** | |
| PEP/CI/3.3 | CVT 2006 Series VI | Chintapalle, Dapoli, Panniyur, Pampadumpara, Sirsi, Yercaud |
| PEP/CI/3.4 | Evaluation of grafts, orthotropic and runner shoots in black pepper | Ambalavayal, Panniyur, 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/CM/4 | **Nutrient Management Trial** | |
| PEP/CM/4.6 | Standardization of drip fertigation in black pepper | Panniyur |
| PEP/CM/4.7 | Black pepper based mixed cropping system for sustainable productivity and food security | Ambalavayal, Sirsi, Panniyur, Dapoli |
| PEP/CP/5 | **Disease Management Trial** | |
| PEP/CP/5.3 | Trial on management of *Phytophthora* foot rot of black pepper in new plantation | Chintapalle, Mudigere, Dapoli, Sirsi, Panniyur |
| PEP/CP/5.6 | Biological Management of Slow Decline in Black Pepper | Panniyur |
| PEP/CP/5.7 | Studies on management of *Phytophthora*causing foot rot in black pepper | Panniyur, Sirsi, Dapoli, Mudigere |
| PEP/CP/5.8 | Management of *Phytophthora*foot rot by mulching | Sirsi |
| **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 (*Elettariacardamom* L. Maton) cultivars/varieties for organic cultivation in the high ranges of Idukki district | Pampadumpara |
| CAR/CI/3 | **Coordinated Varietal Trial** | |
| CAR/CI/3.6 | CVT 2007/2009-Series VI | Mudigere, Pampadumpara |
| 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 |
| CAR/CI/4 | **Varietal Evaluation Trial (VET)** | |
| CAR/CI/4.1 | Initial Evaluation Trial – I | Mudigere |
| CAR/CI/4.2 | Initial Evaluation Trial – II | Mudigere |
| CAR/ CI/4.3 | Initial Evaluation Trial – 2012 | Pampadumpara |
| CAR/ CI/4.4 | Multilocationevaluationofthripstolerantcardamomlines | Mudigere, Pampadumpara, Myladumpara, Sakaleshapura |
| CAR/CM/5 | **Nutrient Management Trial** | |
| CAR/CM/5.3 | Organic farming in cardamom | Mudigere, Pampadumpara |
| CAR/CM/5.4 | Liming in cardamom | Pampadumpara |
| CAR/CP/6 | **Pest and Disease Management Trial** | |
| CAR/CP/6.7 | Evaluation of new insecticides / biopesticides in cardamom against thrips and capsule borer | Mudigere, Pampadumpara |
| 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 |
| **Large Cardamom** | | |
| LCA/CI/1.1 | Germplasm collection and evaluation of large cardamom | ICAR Regional Station, Gangtok, ICRI Regional Research Station, Gangtok |
| LCA/CP/1.1 | Evolving disease and pest tolerant lines in 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 | 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/3.3 | Initial Evaluation Trial – 2013 | Pottangi, Dholi |
| GIN/CI/3.4 | Initial Evaluation Trial of bold/vegetable ginger | Pottangi |
| GIN/CI/3.5 | Initial Evaluation Trial - 2015 | Kumarganj |
| GIN/CI/3.6 | Initial Evaluation Trial 2016 (IET2016) | 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/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 |



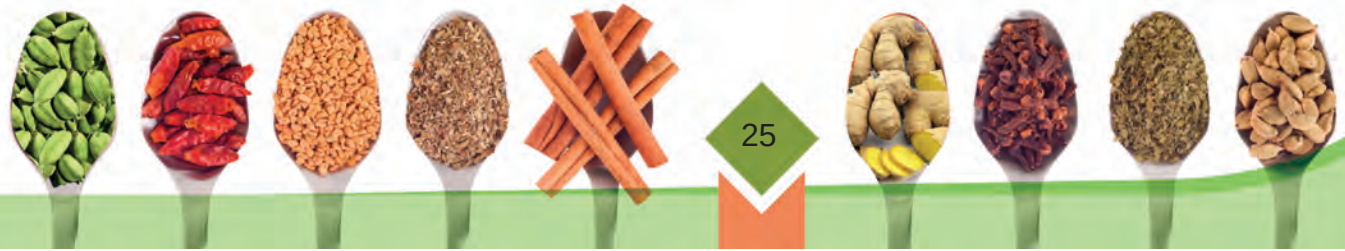
| | | |
|---|---|---|
| GIN/CM/5.9 | Organic production of ginger | Ambalavayal, Pottangi, Chinthapalle, Dholi, Barapani, Kammarpally,Kumarganj, Pundibari, Raigarh, Solan, Kalyani, Mizoram |
| GIN/CM/5.10 | Effect of micronutrients on growth and yield of ginger | Pottangi, Chinthapalle, Dholi, Barapani, 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 |
| **Turmeric** | | |
| TUR/CI/1 | **Genetic Resources** | |
| TUR/CI/1.1 | Germplasm collection, characterization, evaluation and conservation | Barapani, Coimbatore, Dholi, 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, 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/5.13 | Comparative performance of turmeric entries under polyhouse and field conditions | Raigarh |
| TUR/CM/5.14 | Organic production of turmeric | 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/CM/5.16 | Effect of PGPR biocapsule 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 | Coimbatore, Dholi, Kumarganj, Pundibari, Raigarh, Kammaraplly, 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 |
| **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/2.3 | CVT-2001-Cassia | Dapoli, Pechiparai |
| TSP/CI/2.4 | CVT on farmers varieties of Nutmeg | Dapoli, Pechiparai,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 |
| 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, Jagudan, Jobner, Kumarganj, Navsari, Pantnagar, Kota, Raigarh |
| COR/CI/3 | **Varietal Evaluation Trial** | |
| COR/CI/3.7 | Initial Evaluation in coriander | Hisar, Jobner |
| COR/CI/3.8 | Initial Evaluation Trial 2015 | Guntur, Jagudan, Kumarganj, Dholi, Raigarh |
| COR/CI/3.9 | Initial Evaluation Trial – 2016 | Dholi |
| COR/CI/4 | **Quality Evaluation Trial** | |
| COR/CI/4.1 | Quality Evaluation in coriander | Jobner |
| COR/CM/5 | **Nutrient management trial** | |
| COR/CM/5.5 | Response of coriander varieties to various levels of fertility under multicut management practice | Jagudan |



| | | |
|---|---|---|
| COR/CM/5.6 | Effect of using varying levels of NPK and bio-fertilizers on growth and yield of coriander | Dholi |
| COR/CM/5.7 | Standardization of drip irrigation and fertigation in coriander | Jobner, Guntur, Kumarganj |
| COR/CM/5.9 | Comparative performance of coriander entries under polyhouse, field and selfing net | Raigarh |
| 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 |
| **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/2.4 | Coordinated Varietal Trial – 2013 | Ajmer, Jagudan, Jobner |
| CUM/CI/3 | **Varietal Evaluation Trial** | |
| CUM/CI/3.4 | IET on Cumin 2012 | Jobner |
| 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/5.3 | Response of sulphur and bio regulators on yield and quality of cumin | Mandor |
| 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 |
| **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/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/5.4 | Effect of ferrous and zinc enriched FYM on yield and quality of fennel | Jagudan |
| 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 |
| 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/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 | Guntur, Kumarganj, Jagudan, Jobner |
| FGK/CI/3.9 | Initial evaluation trial 2016 | Dholi |
| **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 | Coordinated Varietal Trial – 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)***

Germplasm of black pepper maintained at various AICRPS centres (Table 1).

At present 299 cultivated types, 54 wild types and 3 exotic types of black pepper are being maintained at Panniyur station. The survey work was carried out and 9 new genotypes were collected during the year. The genotypes PRS 64, PRS 154 and PRS 137 were the top yielders. PRS 64 ranked first with 4.68 kg green berry yield and 1110 spikes per vine. Spike length was maximum for PRS 155 (15.3 cm). The number of developed berries per spike was more for PRS 64 (60.0). The 100 berry weight was high for PRS 154 (12.1 g). The dry recovery % was more for PRS 154 and PRS 137 (36 %).

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

| Centres | Indigenous | | | | Exotic | Total |
|---|---|---|---|---|---|---|
| | Cultivated | | Wild and related species | | | |
| | Existing | Addition (April 2016 to March 2017) | Existing | Addition (April 2016 to March 2017) | | |
| Ambalavayal | 30 | - | - | - | - | **30** |
| Chintapalle | 38 | - | - | - | - | **38** |
| Dapoli | 47 | 5 | - | - | - | **52** |
| Panniyur | 299 | 9 | 54 | - | 3 | **365** |
| Pundibari | 19 | - | 11 | 1 | - | **31** |
| Sirsi | 209 | 16 | 6 | - | | **231** |
| Yercaud | 75 | - | 3 | - | - | **78** |
| Total | **717** | **30** | **74** | **1** | **3** | **825** |

At Sirsi centre, 231 accessions of black pepper are being maintained including the sixteen new collections during this year. Twenty two accessions were evaluated for morphological, growth, yield and quality characters. Among the collections, SV- 15 recorded maximum bulk density (650g $l^{-1}$), maximum oleoresin was in SV-7 (10.74 %) and SV-15 recorded maximum piperine content (5.5 %) (Table 2, Fig.1).

Among the 26 accessions evaluated during 2016-17, at Chintapalle, the number of spikes per vine is maximum in Panniyur-1 (928) followed by Cu 5308 (723) and Thevarmundi (673). The spike length was highest in Neelamundi (14.6cm) followed by PRS (14.54cm) and Panniyur-1 (14.38 cm). Maximum number of berries per spike was observed in Neelamundi (90) and HP 105 (84). Maximum recovery percentage was observed in Permabramundi (34.7) followed by Uddagare (33.7).

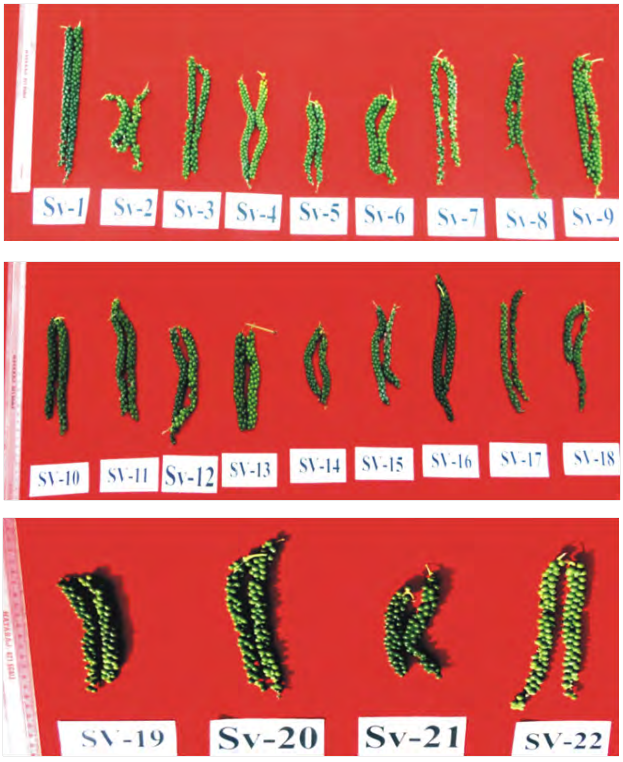



**Fig.1: Spike variability in the germplasm evaluated at Sirsi centre**

A total of 30 accessions are maintained in the germplasm at Ambalavayal

At present 52 germplasm accessions are being maintained at Dapoli. Five elite types of black pepper were collected from south Konkan region of Maharashtra during this year.

At Pundibari, 31 accessions of black pepper are being maintained.

A total of 78 accessions are being maintained at Yercaud centre. Berry set was observed in 28 accessions only due to the uneven distribution of rainfall. 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. The spike length was highest in PN 77(12.4 cm) and lowest in PN 5(7.7 cm).The accession PN 77 has recorded highest number of berries per spike (78) whereas PN 8 showed lowest number of berries (36). The 100 green and dry berry weight was the highest in the accession PN 64 (16.1 g and 5.5 g) and lowest in the accession PN 73(8.2 g and 2.74 g). The accession PN 11 recorded the highest green berry yield per vine (3.11 kg) and dry berry yield per vine (1.048 kg). The accession PN 58 recorded the lowest green berry yield per vine (1.2 kg ) and dry berry yield per vine (0.418 kg).


**Fig. 2: Field view of black pepper at a. Yercaud and b. Panniyur**

**Table 2: Quality attributes in different genotypes evaluated at Sirsi**

| Genotype | Essential oil (%) | Oleoresin (%) | Piperine content (%) |
|---|---|---|---|
| Panniyur-1 | 2.80 | 8.88 | 3.39 |
| SV-2 | 2.40 | 7.36 | 2.90 |
| SV-3 | 2.00 | 7.34 | 2.79 |
| SV-4 | 2.40 | 9.39 | 4.30 |
| SV-5 | 2.00 | 7.35 | 3.07 |
| SV-6 | 1.60 | 6.75 | 2.62 |
| SV-7 | 2.80 | 10.74 | 5.49 |
| SV-8 | 1.60 | 6.68 | 2.87 |
| SV-9 | 2.40 | 4.27 | 3.29 |
| SV-10 | 2.40 | 8.06 | 3.49 |
| SV-11 | 1.60 | 7.17 | 2.69 |
| SV-12 | 2.80 | 8.79 | 2.93 |
| SV-13 | 1.80 | 6.08 | 2.85 |
| SV-14 | 1.80 | 7.62 | 3.01 |
| SV-15 | 2.00 | 8.00 | 5.50 |
| SV-16 | 2.80 | 8.79 | 4.08 |
| SV-17 | 1.80 | 7.46 | 3.20 |
| SV-18 | 2.00 | 7.55 | 3.75 |
| SV-19 | 1.60 | 8.10 | 3.39 |
| SV-20 | 2.00 | 8.44 | 3.33 |
| SV-21 | 2.40 | 9.31 | 3.99 |
| SV-22 | 2.00 | 7.52 | 3.94 |

## 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 5.3 kg vine$^{-1}$, 5.12 kg vine$^{-1}$ and 4.91 kg vine$^{-1}$ respectively at Panniyur centre. Number of spikes per vine was higher for PRS 160 (510). Spike length was maximum for PRS 161 (20.0 cm). 100 berry weight was higher for PRS 165 (16.0) (Table 3).

**Table 3. Yield data of promising new hybrids – PRS, Panniyur during 2016-17**

| Variety/ Hybrid | Green berry yield (kg/vine) | Spikes/vine | Spike length (cm) | Developed berries /spike | 100 Berry weight (g) | Drying % |
|---|---|---|---|---|---|---|
| PRS 160 | 5.30 | 510 | 14.7 | 110 | 11.7 | 34 |
| PRS 161 | 5.12 | 499 | 20 | 101 | 14.5 | 36 |
| PRS 165 | 4.91 | 398 | 14.5 | 105 | 16.0 | 38 |

**Fig. 3: Spikes of promising hybrid PRS 160**

### 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, maximum plant height was recorded in Panniyur -8 (HB20052) (493.80 cm) followed by Panniyur-1 (388.28 cm) and minimum plant height was noticed in Karimunda (225.77 cm). ACC-33 recoded maximum number of branches per plant (27.14 cm) followed by C-1090 (18.57) and Panniyur-1 (18.30) and these two were on par with each other. Fresh berry yield was the highest in Panniyur-1 (995.34) followed by ACC-33 (630.78) and C-1090 (603, 47). It was observed that all varieties are susceptible to Phytophthora foot rot disease.

At Panniyur station, HB 20052 recorded the highest green berry yield of 3.27 kg vine$^{-1}$ followed by Acc.no.53 (3.26 kg vine$^{-1}$). The highest plant height was recorded for Panniyur - 1 (4.87 m).

Among the entries evaluated at Sirsi, plant height varied between 4.5m and 7.8 m. Maximum height was recorded in Sirsi selection (6.6 m). Accession HB – 20052 recorded maximum number of spikes per vine (158) and dry berry yield of 500 g per vine.

At Dapoli, the plant height varied from 2.51 – 4.72 m in different varieties. Panniyur 1 recorded higher plant height (4.72 m) followed by HB 20052 (4.50m) and PRS 64 (4.13 m) and Panniyur 1 recorded highest yield 99.67 g vine$^{-1}$ in 2016-17.

At Pampadumpara, the fresh and dry weight of berries per vine didn't show any significant difference between the accessions. Highest fresh (1.273 kg vine$^{-1}$) and dry weight (429 g vine$^{-1}$) of berries per vine was registered for Karimunda followed by HB 20052 for fresh weight (1.076 kg vine$^{-1}$) and ACC 106 for dry weight (274 g vine$^{-1}$).

Among the nine accessions planted during 2011 at Yearcuad centre, IISR Sakthi recorded the highest mean number of spikes/0.5 m$^2$ (25.0) and IISR Thevam (20.0), whereas the accession Acc. 106 recorded the lowest mean number of spikes per 0.5 m$^2$ (8.0).

### PEP/CI/3.4 Evaluation of grafts, orthotropic and runner shoots in black pepper

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

At Dapoli centre, the planting of standard *Thespecia populnea* has been done in September 2016. The trial will be planted in August 2017 by procuring planting material for the trial from AICRP on Spices Sirsi, Karnataka.

The trial will be laid afresh during this year at Panniyur centre as grafts on Sakthi and Thevam could not be established. Panniyur - 1 grafted on *Piper colubrinum* recorded a mean green berry yield of 3.7 kg vine$^{-1}$.

At Yercuad centre, the grafts of Panniyur - 1 (Orthotropic shoot and runner shoot) on the rootstocks of *Piper colubrinum,* IISR Sakthi and

IISR Thevam were planted in the field along with rooted cuttings.

New grafts were planted during the year at the Sirsi centre and the morphological observations are being recorded.

The grafted plants did not establish well in the field at Ambalavayal. Hence, the trial will be started fresh as per the recommendation of XXVII ICAR- AICRP on spices workshop held at NRCSS, Ajmer.

### 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, Pampadumpara, Sirsi; East coast plains and hill region - Yercaud)***

This trial is in collaboration with National Innovation Foundation. Three farmer varieties of black pepper *viz.,* Zion Mundi, Thekken and Kumpukkal along with a local check and national check Panniyur-1 were included in the trial.

The entries were planted in August 2016 at Dapoli, and the growth of all genotypes were satisfactory.

At Chintappalli, two farmers varieties were planted along with local check and the plants were under vegetative stage.

The plants were in the vegetative stage at Panniyur centre and there was no significant difference between the treatments for morphological characters.

At Sirsi centre, three farmer's varieties; Zion Mundi, Kumpakkal and Pepper Thekkan provided by NIF were planted in 3 replications along with Panniyur -1 as check. The plants established well.

The pepper varieties *viz.,* Zion mundi, Kumpakkal, Karimunda (local check) and Panniyur -1 (National check) were planted in the field at Yercaud and the crop is in vegetative phase.

### 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)***

The trial started during 2015 at Panniyur. The highest plant height was recorded by Karimunda (1.91 cm). Number of leaves per plant and number of flushes were the highest for PRS 161 (22.5 and 1.41 respectively). Number of nodes per plant was the highest for Panniyur 5 (31.0).

This trial was initiated in August 2016 at Dapoli centre, and the growth of all genotypes are satisfactory.

## Crop Management

### PEP/CM/4 Nutrient Management Trial

### PEP/CM/4.6 Standardization of drip fertigation in black pepper

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

The trial is continuing at Panniyur from 2012-13 onwards. During 2016-17, T5 (50 RDF + 8 l drip) recorded comparatively higher spike yield (3.72 kg vine$^{-1}$), 925 spikes vine$^{-1}$ , green berry yield (2.75 kg vine$^{-1}$) and with low disease intensity – yellowing was significantly low (9.25 %). The treatments T5, T4 and T1 were statistically on par for yield and associated characters . Maximum disease intensity (%) was noticed in T3 (27.55 %). (Table 4).

**Table 4. Effect of drip irrigation on yield and yellowing of pepper - PRS, Panniyur during 2016-17**

| Treatments | Spike yield (kg vine$^{-1}$) | Number of spikes (No. vine$^{-1}$) | green berry yield (kg vine$^{-1}$) | Disease intensity – yellowing (%) |
|---|---|---|---|---|
| $T_1$ Conventional irrigation @100 litres of water once in 10 days100 RDF basal | 3.21 | 885.00 | 2.34 | 19.78 (4.41) |
| $T_2$ Drip irrigation @ 8 litres of water daily 100 RDF basal + drip | 2.75 | 829.00 | 1.79 | 15.98 (3.98) |
| $T_3$ Drip irrigation @ 8 litres of water daily100 RDF fertigation | 2.84 | 836.5 | 1.87 | 27.55 (5.19) |
| $T_4$ Drip irrigation @ 8 litres of water daily75 RDF fertigation | 3.54 | 903.00 | 2.52 | 23.03 (4.78) |
| $T_5$ Drip irrigation @ 8 litres of water daily50 RDF fertigation | 3.72 | 925.25 | 2.75 | 9.25 (2.98) |
| CD 5% | 0.69 | 67.24 | 0.674 | 0.970 |
| CV | 14.11 | 4.98 | 19.39 | 14.74 |

### 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)***

Different intercrops of juvenile black pepper garden (2 year old) were harvested at Ambalavayal. Among the intercrops elephant foot yam (35.14 t ha$^{-1}$) recorded maximum yield followed by tapioca and arrow root with (25.06 t ha$^{-1}$) and 19.27 t ha$^{-1}$ yield respectively. The lowest yield was recorded by colocasia (7.3 t ha$^{-1}$).

The trial started during 2013-14 at Panniyur. The pepper vines were at the initial stages of growth during 2016-17, and good yield was obtained from the intercrops in black pepper garden except tapioca. Among the intercrops elephant foot yam recorded maximum yield of 8.42 kg followed by greater yam (6.75 kg) from an inter space of 4m x 2 m between black pepper. Colocasia (T1) yielded 3.59 kg and arrowroot (T2) - 2.13 kg.

At Dapoli, the interspaces of 3 x 1 m was utilized for planting different tuber crops like colocasia, arrowroot, elephant foot yam, tapioca, greater yam and pineapple was planted as border crop. The black pepper was at pre-bearing stage. During the second year (2016-17) the yield in different inter crops kg ha$^{-1}$ were; colocasia 4.29 tons, arrow root 4.66 t, elephant foot yam 12.83 t, tapioca 10.67 t and greater yam 10.19 t. The yield obtained in different mixed crop blocks for pineapple varied as 12.20 t in colocasia 12.46 t in arrow root 14.02 t in elephant foot yam and 13.76 t in tapioca block. The initial soil analysis experimental plot has been done in the year 2015). The final nutrient status and economics will be calculated after completion of three years. Results of two year experiment revealed that intercropping of different tuber crops *i.e.* colocasia, arrow root, elephant foot yam, tapioca along with pineapple and greater yam will give additional income in black pepper.

## 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, Sirsi, Panniyur; Western plateau and hills region - Dapoli)***

At Chintapalli, application of *Trichoderma* (MTCC 5179) + consortium of bacteria (IISR-6+ IISR-859) (T4) recorded lesser 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, Shakti recorded lowest yellowing and defoliation. Potassium Phosphonate (0.3%) + *Trichoderma harzianum* (MTCC-5179) was also recorded less disease incidence which was on par with application of *Trichoderma* (MTCC 5179) + consortium of bacteria. Among three varieties, Panniyur-1 recorded higher disease incidence in terms of yellowing, defoliation and death of vines. Maximum yield was obtained for Panniyur-1 in spite of higher disease incidence.

At Mudigere plants were not established properly and the experiment was vitiated.

At Dapoli centre, incidence of *Phytophthora capsici* was not noticed since the period from 2010-11 to 2015-16. However in 2016-17, it was noticed on all three varieties *viz.,* IISR-Shakthi, IISR-Thevam and Panniyur-1. Among the three varieties, low incidence was recorded on Panniyur-1. Spraying of potassium phosphonate (0.3%) + *T. harzianum* (50 g/vine) recorded minimum PDI of 7.14%, 8.94% and 3.54% on IISR- Shakthi, IISR-Thevam & Panniyur-1, respectively. Whereas, in control plots, PDI was recorded as 30.82%, 31.71% and 18.49% on IISR-Shakthi, IISR-Thevam and Panniyur-1 respectively. Treatment mean of T1 was also recorded minimum of 6.54% and found at par with treatment-T4.

## PEP/CP/5.4 Effectiveness of new molecules of fungi toxicants against *Phytophthora* foot rot of black pepper in existing plantation

***(Centres: East coast plains and hill region - Chintapalle, West coast plains and ghat region -Mudigere, Sirsi)***

Experiment results at Chintappalli revealed that application of *Trichoderma* (MTCC 5179) + consortium of bacteria (IISR-6+ IISR-859) was recorded lesser incidence of yellowing and defoliation and higher yield when compared with remaining treatments in all three verities of Black pepper. Among the three varieties, IISR-Shakti showed less disease severity in terms of yellowing, defoliation and mortality of vines. Yield wise, Panniyur-1 recorded maximum returns.

All the treatments were found effective in reducing the incidence of the disease when compared to control at Mudigere. The treatment T3 *i.e.*, Spraying and drenching of 0.2 % Kocide 10 days after application of *T. harzianum* @ 50g + 1 kg Neem Cake vine$^{-1}$ was found more effective in reducing the disease incidence with higher yield of 776.44 g vine$^{-1}$. This is on par with T2 *i.e.,* Spraying and drenching of 0.1% Sectin + *T. harzianum* (50 g) + Neem cake 1 kg vine$^{-1}$.

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

***(Centres: West coast plains and ghat region – Panniyur, Sirsi)***

During 2016-17, all the treatments were significantly superior in reducing yellowing due to slow decline disease in black pepper at Panniyur Station (Fig.4). Application of *Trichoderma viride* + Neem cake @ 2 kg vine$^{-1}$ (T1) recorded maximum yield of 4.296 kg vine$^{-1}$. Among the various biocontrol agents tested, intensity of disease was minimum recorded (3.13 %) in T1 (*Trichoderma viride* + Neem cake @ 2 kg vine$^{-1}$).

**Fig. 4: The experimental plot for biological management of Slow Decline in Black Pepper at Panniyur**

Experiment was carried out to study the efficacy of bio-agents and chemicals against slow decline of black pepper at Sirsi. Soil application with bio-agents *viz., Trichoderma* and *P. fluorescens* was not effective in management of slow decline. Soil drenching with Copper oxy chloride @ 0.3% + Cartap hydrochloride @ 15g vine$^{-1}$ is found comparatively effective in control of the disease.

At Dapoli, treatment T3 - Soil application of *Pochonia chlamydosporia* @ 2 kg vine$^{-1}$ followed by soil drenching with *P. fluorescens* @ 2% recorded minimum per cent disease intensity (6.50%) with 67.41% reduction over control. It was significantly superior over control (19.96% PDI). *Radopholus similis* was identified in soil samples, which were tested at ICAR - Indian Institute of Spice Research, Kozhikode, Kerala. The physico-chemical composition of experimental soil based on composite sample was done in College of Forestry, Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri.

### 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 T3- application of fungicide (Fosetyl - Al) amended fertilizer briquettes (0.3%) were found to be effective with minimum PDI 7.36% and 72.15% per cent disease reduction over control (26.43%).

The experiment is in the initial stage at Panniyur Centre. There is no difference in growth and establishment with respect to treatments, all the plants are well maintained.

# 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 5)

A total of 177 cardamom accessions are presently conserved in the gene bank of Pampadumpara. Among the germplasm evaluated, HY 13 recorded the highest fresh yield (3310 g plant$^{-1}$) followed by HY 12 (2428.5 g plant$^{-1}$) and they were significantly different from each other.

132 cardamom germplasm lines at Mudegere have been replanted during 2010 as the plants became aged. Observation on different growth and yield parameters were recorded from the third year after planting.

**Table 5: Cardamom germplasm collections of AICRPS centres**

| Centre | Indigenous | | Total |
|---|---|---|---|
| | Cultivated | Wild and related sp. | |
| Mudigere | 132 | Nil | **132** |
| Pampadumapra | 177 | Nil | **177** |
| Total | 309 | Nil | **309** |

## Crop Improvement

### CAR/CI/2 Hybridization

### 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)***

PV1 has recorded the highest plant height (269.33 cm), panicles per clump (34.66) and capsules per panicle (34) followed by PV2. Number of tillers per clump was more for PV2 (56) which were on par with PV 1 (50.33). Accession GG recorded the lowest growth parameters. Significant and comparable variations have been recorded for all biometric characters. Maximum fresh (2113.33 g plant$^{-1}$) and dry weight (422.66 g plant$^{-1}$) of capsules was recorded by PV1 followed by PV2. The lowest wet and dry yield was registered in GG which was significantly inferior to all others. The incidence of thrips and azhukal was more in GG. Thrips incidence was high in PV 1 even though its yield potentials were comparable. There was no significant difference among accessions with respect to stem borer incidence levels.

### CAR/CI/3 Coordinated Varietal Trial

### CAR/CI/3.6 CVT 2007/2009-Series VI

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

Among 12 genotypes evaluated at Mudigere, IC-346951 (372 kg ha$^{-1}$) recorded highest capsule yield followed by CL-726 (334 kg ha$^{-1}$) than the check GG (321 kg ha$^{-1}$).

At Pampadumpara, highest variability was recorded for fresh weight (34.17%) which ranged from 2797.33 g to 176 g plant$^{-1}$. IC 547185 recorded highest fresh weight which was on par with SKP 104. Lowest dry and fresh yield of capsules were recorded in MCC 346. Variability was minimum for 100 capsule volume followed by the weight of 100 capsules. Among the biotic stress characters, borer and thrips incidence were recorded very least in IC 547167. However

the same accession recorded highest *Azhukal* incidence.

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

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

Trial has been laid out at Appangala with the genotypes IC 349537, IC 584058, GG×NKE-12, IC 584078, CL 668, HS 1, Appangala 1 and IC 584090 and observation on morphological characters has been taken.

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 ZAHRS, Mudigere.

Most of the plants established in the field at Sakleshpur. Gap filling was done where causalities were observed. Eight to ten tillers emerged from all the treatments and attained a height of one meter. Disease / pest incidence was not noticed during the season.

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

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

This trial started in 2015 and is in collaboration with National innovation Foundation. Eight farmers varieties *viz.,* Pappalu, Arjun, Elarajan, Thiruthali, Wonder Cardamom, Njallani, Panikulangara green bold no.1, Patchaikai along with national check green gold and a local check are included in the trial. Planting of these varieties was taken up at the centres like Appangala, Mudegere, Myladumpara and Pampadumpara. As the survival per cent was less, the genotypes were put for multiplication at Appangala. Most of the plants established in the field at Mudegere. Gap filling was done where causalities were observed. Seven to nine tillers were produced in all the plants and attained a height of one meter.

**Fig.5: Farmers varieties of cardamom planted at Appangala**

### CAR/CI/4 Varietal Evaluation Trial (VET)

### CAR/CI/4.1 Initial Evaluation Trial – I

***(Centre: West coast plains and ghat region - Mudigere)***

Entry HS-1 has recorded high yield (363 kg $ha^{-1}$) followed by CL-691 (334 kg $ha^{-1}$) at Mudigere. Total number of suckers per plant was more in HS-1 (13.36) followed by Sel-800 (11.52).

### CAR/CI/4.2 Initial Evaluation Trial – II

***(Centre: West coast plains and ghat region - Mudigere)***

Among the 10 genotypes evaluated at Mudigere, maximum plant height was found in the entry 2-4-D11 (273.35 cm) while more number of suckers per plant was observed in 2-5-D11 (16.32) followed by 2-4-D11 (14.16). Maximum yield was recorded in 2-5-D11 (290 kg $ha^{-1}$) followed by 2-4-D11 (283 kg $ha^{-1}$).

### CAR/ CI/4.3 Initial Evaluation Trial – 2012

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

Plants at Pampadumpara are in vegetative stage hence one more year is required to take observations on yield attributing characters.

## Crop Management

### CAR/CM/5 Nutrient Management Trial

### CAR/CM/5.2 Effect of fertigation on yield of cardamom through drips

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

At Mudigere, experiment showed significant difference among the treatments. Application of irrigation 9 l/clump/day along with 100% recommended dose of fertilizer through drips recorded the highest capsule yield (372.56 kg $ha^{-1}$) which was on par with irrigation 9 l/clump/day with 75% recommended fertilizer dose (358.25 kg $ha^{-1}$). The conventional method of irrigation recorded a yield of 314.02 kg $ha^{-1}$. The yield attributing parameters also showed similar trend.

### CAR/CM/5.3 Organic farming in cardamom

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

Application of organics with bio-fertilizers gave significantly higher yield compared to organic only at Mudigere centre. The maximum dry capsule yield (354.2 kg $ha^{-1}$) was obtained with recommended package which is superior over all other treatments. Among organic treatments application of *Jeevamrutha* recorded the highest capsule yield (320.65 kg $ha^{-1}$) which is on par with vermicompost (310.76 kg $ha^{-1}$) & FYM (302.06 kg $ha^{-1}$). Significant improvement in soil N.P.K. content was observed. Quality parameter did not change as influenced by the organics.

Application of *Jeevamrutha* plus *Azospirillum* (10 g $clump^{-1}$) as well as PSB (10 g $clump^{-1}$) and *Trichoderma* (10 g $clump^{-1}$) resulted in more number of tillers $clump^{-1}$ (48.33), panicles $clump^{-1}$ (41) and capsules $panicle^{-1}$ (29) at Pampadumpara. There was no significant difference with regard to capsules $panicle^{-1}$ for the treatments T1 (Rec. dose of FYM 30 t/ha), T2 (Rec. dose of CPC 15 t/ha) and T3 (Rec. dose of vermicompost 15 t/ha). The results of the experiment showed that application of *Jeevamrutha* + *Azospirillum* (10 g / clump) + 10 g PSB/clump + *Trichoderma* 10/clump (T8) was found to be the best treatment with highest fresh (2677 g $plant^{-1}$) and dry capsule yield (607 g $plant^{-1}$). Also, the incidence of thrips was low in this treatment. There was no significant difference among treatments with respect to stem borer and azhukal disease incidence.

### CAR/CM/5.4 Liming in cardamom

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

Application of dolomite @ 2 kg $plant^{-1}$ was found to be the best treatment with increased plant height (399 cm), more number of tillers $clump^{-1}$ (49.66), panicles $clump^{-1}$ (46.66) capsules $panicle^{-1}$ (39.33), wet (2763 g $plant^{-1}$) and dry capsule (573 g $plant^{-1}$) yield (Table 6). The incidence of pest and disease was less in this treatment when compared to other treatments. The effect of liming on dry weight of capsule was found to be non significant. The next best treatment was the application of dolomite @ 1 kg $plant^{-1}$. The incidence of thrips and *azhukal* was lowest in the treatment with dolomite @ 2 kg $plant^{-1}$.

**Table 6. Effect of liming materials on yield, pest and disease incidence in small cardamom variety PV2 at Pampadumpara**

| Treatments | Fresh weight (g/plant) | Dry weight (g/plant) | *Thrips incidence (%) | *Borer incidence (%) | *Azhukal incidence (%) |
|---|---|---|---|---|---|
| burnt lime (1kg/ plant) | 1177$^{e}$ | 236$^{e}$ | 42 (6.478)$^{a}$ | 3.33 (1.82)$^{bc}$ | 4.16 (2.00) |
| burnt lime (2 kg/ plant) | 1063$^{ef}$ | 233$^{e}$ | 43.16 (6.569)$^{a}$ | 3.5 (1.86)$^{b}$ | 3.63 (1.87) |
| dolomite (1 kg/plant) | 2286$^{b}$ | 466$^{b}$ | 36.16 (6.014)$^{bc}$ | 3 (1.72)$^{cd}$ | 2.33 (1.52) |
| dolomite (2 kg/plant) | 2763$^{a}$ | 573$^{a}$ | 34.5 (5.879)$^{c}$ | 2.5 (1.63)$^{d}$ | 2.33 (1.51) |
| ground lime stone (1 kg/plant) | 1593$^{d}$ | 316$^{d}$ | 43.83 (6.607)$^{a}$ | 3.33 (1.82)$^{bc}$ | 3.5 (1.83) |
| ground lime stone (2 kg/plant) | 1776$^{c}$ | 353$^{c}$ | 40.5 (6.362)$^{ab}$ | 3.33 (1.82)$^{bc}$ | 4 (1.99) |
| Control | 1004$^{f}$ | 196$^{f}$ | 39.33 (6.27)$^{abc}$ | 4.16 (2.04)$^{a}$ | 2.83 (1.66) |
| CD (0.01%) | 0.191 | 0.026 | 0.048 | 0.195 | Non-significant |
| CV | 4.575 | 2.547 | 3.635 | 4.306 | 16.86 |

**Figures in parentheses are square root transformed*

## Crop Protection

### CAR/CP/6 Pest and Disease Management Trial

### CAR/CP/6.7 Evaluation of new insecticides/ biopesticides in cardamom against thrips and capsule borer

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

The treatments significantly influenced the total health of the capsules when compared to untreated control at Mudigere. All the harvests indicated maximum damage with thrips when compared to borers. For the control of thrips and capsule borer, methomyl @ 1.5 g $l^{-1}$ of water and Acetamiprid @ 0.5g and Imidacloprid @ 0.5ml was found to be effective and superior over the standard check, Mudigere practices.

### CAR/CP/6.8 Comparison of effect of chemical treatments as well as bio-control agents against pseudostem rot of cardamom

***(Centres: West coast plains and ghat region – Mudigere)***

At Mudigere, all the treatments were found effective when compared to control. The minimum tiller infection of (3.41%) with higher yield of 698.00 g $plant^{-1}$ was recorded in T1 *i.e.* spraying of 0.2 % Bavistin which is followed by T5 *i.e.,* application of *T. harzianum* with Neem cake and spraying of 0.2 % *Pseudomonas fluorescens.*

# 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 7).

ICAR RS, Gangtok is maintaing 7 different germplasm *viz.,* Ramsey, Sawney, Dzongu Golsey, Varlangey, Seramney, Madhusai and Dudhe Golsai of large cardamom. Seven different germplasm have been collected from ICRI, Spices Board, for maintenance of the same at ICAR Tadong.

Survey was conducted by ICRI Regional Research Station, Gangtok at different areas of East and West districts of Sikkim and Tiwari Gaon, Hunli, Ethipani, Kebaboli, New Elope area of Lower Dibong Dist. Hawai, Urban top area of Anjau Dist. and Metengliang area in Arunachal Pradesh for collection of germplasm. Fourteen accessions were collected and planted under AICRPS at ICRI, RRS, Spices Board, Tadong, Gangtok.

**Table 7: Large cardamom collections maintained at AICRPS centres**

| Centre | Existing | Addition (April 2016 to March 2017) | Total |
|---|---|---|---|
| ICAR RS, Gangtok | 7 | 7 | **14** |
| ICRI RRS, Gangtok | 285 | 14 | **299** |
| **Total** | **292** | **21** | **313** |

## Crop Protection

### LCA/CP/1.1 Evolving disease and pest tolerant lines in large cardamom

***(Centre: Eastern Himalayan Region - ICRI Regional Station, Gangtok, ICAR Regional Station, Gangtok)***

Moderately tolerant and moderately susceptible germplasm accessions were planted in disease hot spot area (Kabi), North Sikkim for field evaluation. ICRI Sikkim 2 was taken as control. Blight incidence was noticed in all the accessions however no viral diseases were recorded.

ICAR Research Complex, Sikkim Centre, has conducted a survey to study the intensity of infestation of tea mosquito bug *(Helopeltis theivora)* and mealy bug, *Paraputo theaecola* (Green) in different large cardamom growing areas of Sikkim Tadong. The infestation of tea mosquito bug was maximum in Lower Dzongu area, North Sikkim (24.62 to 42.28 % incidence) followed by East Sikkim, ICAR Farm (18.82 to 34.76%). The surveyed fields of large cardamom of West Sikkim were found almost free of infestation of this pest. The infestation of mealy bug was found to be maximum in the fields of East Sikkim (16.46 to 22.64 %) followed by South Sikkim.

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

***(Centre: Eastern Himalayan Region - ICRI Regional Station, Gangtok)***

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 diseases were less in treated plots than in the control plot (Table 8, Fig.6).

**Table 8: 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 | 16.5 | 8.9 |
| Leaf caterpillar | 8.2 | 3.0 |
| Blight | 11.6 | 4.2 |
| Chirke | 2.0 | - |
| Foorkey | 1.5 | - |

**Fig. 6. Disease free Farmers' field of large cardamom**

# 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 9)

Thirteen new collections were made at Dholi during this year. Out of the seventy four accessions, nine accessions namely- RG-77, RG-74, RG-60, RG-42, RG-19, RG-34, RG-71, RG-75 and RG-24 were recorded higher yielder ranging from 0.175 to 0.142 kg per plant as compared to check variety Nadia (0.139 kg plant$^{-1}$). Among ten promising accessions, RG-77 gave the highest fresh rhizome yield of 0.175 kg plant$^{-1}$ followed by RG-74 (0.162 kg plant$^{-1}$).

Out of 61 germplasm of ginger evaluated during 2016-17 at Kumarganj, maximum yield per plant was recorded in NDG-55 (340.00 g plant$^{-1}$) followed by NDG-58 (160.0 g plant$^{-1}$), NDG-31 (155.00 g plant$^{-1}$) and NDG-28 (145.00 g plant$^{-1}$). In case of soft rot incidence, minimum disease intensity was recorded in NDG-6 (7.8 %) and NDG-7 (12.75 %).

Among the 71 accessions of ginger evaluated at Pundibari centre, highest rhizome yield per plot was recorded in GCP-49 (7.55 kg/plot) and the lowest rhizome was recorded in GCP-60 (1.88 Kg/plot). Maximum disease incidence was recorded in the accession GCP- 53 (40.00%) followed by GCP-45 (36.67) whereas lowest disease incidence was recorded in GCP-23 (3.33%).

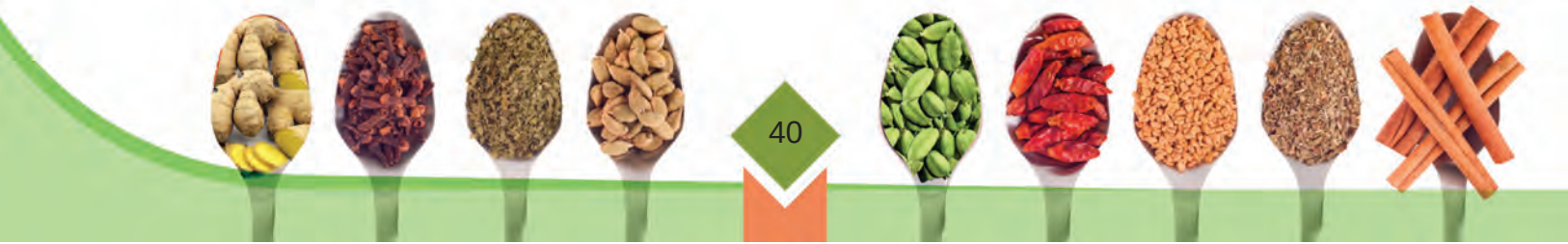
Out of 200 ginger germplasm evaluated at Pottangi, 41 accessions gave more than 10 Kg 3m$^2$ fresh rhizome yield and 62 entries yielded more than 5 Kg 3m$^2$. The range of plot yield being 1.0 kg (Wild ginger) to 18.8 Kg 3 m$^2$ (Zo-9-1) with the mean yield of 5.5 Kg 3 m$^2$. The highest fresh rhizome yield was recorded by Phiringia (24.4 kg 3 m$^2$) followed by Wild ginger (23.1 kg 3 m$^2$) and PGS - 41-1 (22.9 kg 3 m$^2$) etc.

At Raigarh, the accession IG 3 (4.7 t ha$^{-1}$), IG 9 (4.3 t ha$^{-1}$), IG 4 (3.6 t ha$^{-1}$) and IG 1 (2.3 t ha$^{-1}$) recorded maximum rhizome yield compared to the check varieties Suprabha (3 t ha$^{-1}$) and Suruchi (2.3 t ha$^{-1}$).

**Table 9: Ginger germplasm collections in AICRPS centres**

| Centre | Indigenous | | | | Exotic | Total |
|---|---|---|---|---|---|---|
| | Cultivated | | Wild & related spp. | | | |
| | Existing | Addition (2016-17) | Existing | Addition (2016-17) | | |
| Dholi | 61 | 13 | - | - | - | **74** |
| Kumarganj | 61 | - | - | - | - | **61** |
| Pundibari | 67 | - | - | - | - | **67** |
| Pottangi | 195 | - | 2 | - | 3 | **200** |
| Solan | 231 | - | - | - | - | **231** |
| **Total** | **615** | **13** | **2** | **-** | **3** | **633** |

One hundred and eighty five ginger collections were evaluated for rhizome yield and other horticultural traits at Solan. The yield range varied from 102.48 q ha$^{-1}$ (SG-1118) to 137.28 q ha$^{-1}$ (SG-1024). Yield of three lines *viz.,* SG-1024 (137.28 q ha$^{-1}$), SG-1095 (135.78 q ha$^{-1}$) and SG-1287 (130.47 q ha$^{-1}$) excelled the check Himgiri which yielded 129.24 q ha$^{-1}$. The rhizome rot disease incidence varied from 10.17-21.82 % with 10.17 % and 12.62 % in SG-24-4 and Himgiri, respectively.



## Crop Improvement

### GIN/CI/2 Coordinated Varietal Trial (CVT)

### GIN/CI/2.4 CVT 2015-Series IX

***(Centres: West coast plains and ghat region – IISR; 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 was recorded in Rio-de-Janeiro (22.75 t ha$^{-1}$) followed by SE 8681 (16.75 t ha$^{-1}$), Acc. 247 (15.83 t ha$^{-1}$) and SE HP9 (15.71 t ha$^{-1}$).

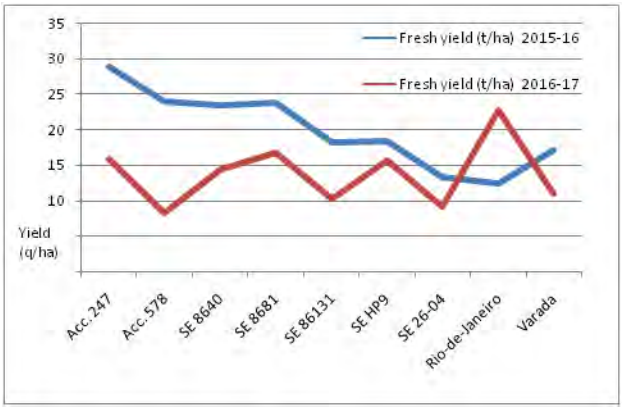



**Fig 7: Performance of genotypes of ginger at IISR for two years**

At Pundibari, the genotype SE-8681 showed the highest yield (12.94 t ha$^{-1}$), followed by Acc-247 (11.32 t ha$^{-1}$). Lowest yield was found in SG-26-04 (4.95t ha$^{-1}$). Highest disease incidence was recorded in Varada (36.67%) and the lowest incidence was in SE-86-131 (14.44%).

At Pottangi, the entry SE-8640 (14.9 t ha$^{-1}$) was the top yielder with the yield advantages of 67.5% than the national check Varada (8.9 t ha$^{-1}$) followed by PGS-121 (14.7 t ha$^{-1}$), S-646 (14.4 t ha$^{-1}$) and GCP-49 (14.2 t ha$^{-1}$). The highest clump weight was observed in SE -86-40 (218.3 g).

At Solan centre, average yield varied from 5.17 t ha$^{-1}$ to 19.26 t ha$^{-1}$. The local genotype SG-26-04 (Giriganga) recorded maximum yield 19.26 t ha$^{-1}$ followed by local check variety Himgiri 12.92 t ha$^{-1}$ and National check variety Varada 8.58 t ha$^{-1}$. The rhizome rot disease incidence varied from 8.550-23.333 % with minimum in SG-26-04 (Giriganga).

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

***(Centres: Eastern plateau and hills region – Pottangi)***

The two years analyzed pooled data revealed that that the entry PGS-121(18.8 t ha$^{-1}$) as the top yielder with the yield advantages of 15.2 % than the check variety Nadia (8.9 t ha$^{-1}$) followed by PGS-95(17.4 t ha$^{-1}$ and PGS102 (16.8 t ha$^{-1}$).

### GIN/CI/3.5 Initial Evaluation Trial – 2015

***(Centre: Middle Gangetic Plain Region – Kumarganj)***

Seven entries have been tested in IET for ginger and the maximum yield was observed in NDG-9 (14.33 t ha$^{-1}$ followed by NDG-59 (13.78 t ha$^{-1}$), NDG-56 (13.3. t ha$^{-1}$) and NDG-61 (12. t ha$^{-1}$). In case of rhizome rot incidence, the lowest disease intensity was observed in NDG-61 followed by NDG-9 and NDG-59.

### GIN/CI/3.6 Initial Evaluation Trial 2016

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

The lowest rhizome root rot and wilt disease severity was found in GCP-14 (14.00) at Pundibari. The lowest leaf spot disease severity was found in GCP-39 (PDI 15.48). GCP-36 recorded highest yield of 8.93 kg plot$^{-1}$ (18.01 t ha$^{-1}$). Lowest yield was found in GCP-5 (10.94 t ha$^{-1}$). Highest percentage of reduction of rhizome rot disease over control was found in GCP-36

(10.24) and in leaf spot disease it was recorded in GCP 39 (9.42).

At Pottangi, the entry PGS-8 (12.8 t $ha^{-1}$) was the top yielder with the yield advantages of 44.2 % than the national check variety Varada (8.9 t $ha^{-1}$) followed by PGS-58 (11.2 t $ha^{-1}$, PFLR (10.7 t $ha^{-1}$), V1S1-2 (10.7 t $ha^{-1}$) etc.

Average yield at Solan varied from11.13 t $ha^{-1}$ to 18.25 t $ha^{-1}$. The genotype SG-15-03 (SG-707) recorded maximum yield 18.25 t $ha^{-1}$ followed by SG-1134 (13.57 t $ha^{-1}$), SG-1083 (13.21 t $ha^{-1}$) and SG-1088 (13.20 t $ha^{-1}$) whereas the check Himgiri yielded 12.92 t $ha^{-1}$. The rhizome rot disease incidence varied from 9.650-19.513% 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)***

One hundred and one samples of ginger were received for quality analysis from two centers *viz.* OUAT- HARS, Pottangi (Odisha) and UBKV Pundibari, Cooch Behar (WB) during 2016-17.

## Crop Management

### GIN/CM/5 Nutrient Management Trial

### GIN/CM/5.4 Evaluation of herbicide for the effective control of weeds in ginger

***(Centre: East coast plains and hill region - Chintapalle)***

Maximum per plant yield (416.32 g $plant^{-1}$) was recorded in T12 (weed free treatment) followed by 386.33 g in T9 (Oxyflurofen 23.5 % E.C, 0.3 kg a.i $ha^{-1}$).

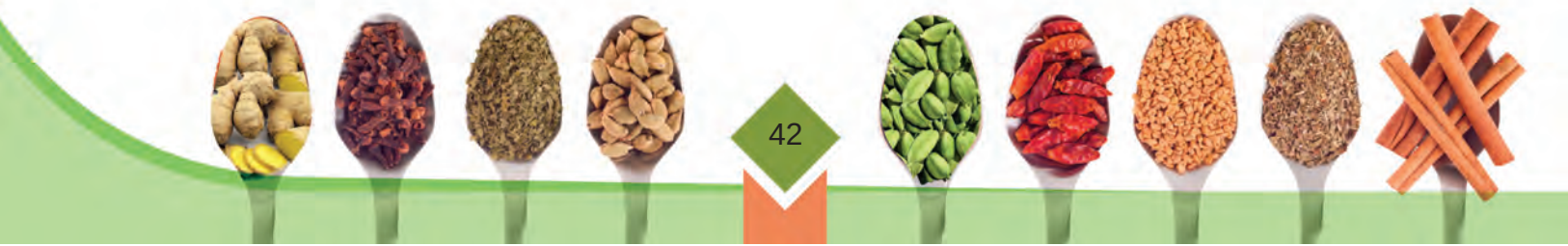
### GIN/CM/5.5 Source sink relationship

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

At Kanke centre, Mahima recorded maximum tiller per plant (6.6), fresh weight of leaves per plant (21.66 g) and dry weight of leaves per plant (2.08 g), fresh and dry weight of stem per plant (21.27 g & 2.6 g, respectively). The variety Mahima was also highest in fresh weight (109.64 g) and dry weight (15.94 g) of rhizome, followed by Ranchi Local (102.64 g & 15.34 g), GCP-5(100.14g & 14.60g) and Mizoram Local (79.9 g & 12.5 g).

At Mizoram, maximum number of tillers per plant was found in IISR Mahima (3.33) at 60 DAP and in IISR Mahima (4.67) and Mizoram Local (4.67) in 120 DAP. Leaf area per plant ($cm^2$) was found to be highest in Mizoram Local (147.67) at 60 days after planting, whereas IISR Mahima (266.67 $cm^2$) recorded highest at 120 DAP. Total dry weight per plant was maximum in Gorubathan (12.33 and 39.73 g) both at 60 and 120 DAP. Rhizome dry weight (g) was highest in Mizoram Local (12.43 and 22.20 g) both at 60 and 120 days after planting.

At Pundibari, the genotype Mahima produced the highest fresh yield of 6.18 kg $plot^{-1}$ (12.73 t $ha^{-1}$) and highest dry yield of 1.45 kg $plot^{-1}$ in 2016-17.



At Barapani, highest fresh rhizome weight at 120 DAP (110.63 g plant$^{-1}$),180 DAP (187.35 g plant$^{-1}$) and at harvest (305.85 g plant$^{-1}$) was recorded in Himgiri, whereas at 60 DAP Nadia recorded highest fresh rhizome weight (14.78 g plant$^{-1}$).

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 ICAR - IISR Calicut (Kerala).

### GIN/CM/5.6 Organic production of ginger

***(Centres: Eastern Himalayan Region – Mizoram, Barapani)***

At Mizoram, maximum yield was recorded for T7 (Recommended package by SAU; Ginger-NPK100: 90:90 kg ha$^{-1}$), with a yield of 14.88 t ha$^{-1}$, followed by T3 (100% organic manure + (micronutrients) with a yield of 13.9.2 t ha$^{-1}$, T 8 (Farmers practice) with a yield of 137.53 t ha$^{-1}$. Dry matter content was found to be highest in T6 (75% N requirement of ginger + Vermiwash 10%) with a dry recovery 18.60% followed by T5 (75% N requirement of ginger + micronutrients) with 18.50%, dry recovery and T8 (dry recovery 18.400%). The maximum fresh weight of clump was recorded for T7 (109.80 g plant$^{-1}$), followed by T6 (103.83 g plant$^{-1}$) and T2 (102.90 g plant$^{-1}$). The incidence of leaf spot (*Colletotrichum curcumae* and *C. capsici*) was more acute than leaf blotch (*Taphrina maculans*). Incidence of leaf spot was reported in all treatments, whereas T4, T5 and T6 recorded tolerance to leaf blotch.

At Barapani, maximum yield of 48.37 t ha$^{-1}$ was recorded in T6 (75% N requirement of ginger + vermiwash 10%) followed by 26.54 t ha$^{-1}$ in T5 (75% N requirement of ginger + micronutrients). Dry recovery of 20.55% was recorded highest in T3 (100% organic manures + micronutrients) and lowest at 19.44 in T8 (Farmers practice). T6 (75% N requirement of ginger + vermiwash 10%) had the highest fiber content of 4.33% while lowest was recorded in T3 (100% organic manures + micronutrients) with 3.49%. Oleoresin content was recorded highest in Treatment T7 (Recommended Package by SAU (Ginger – NPK 100:90:90 NPK kg/ha) and lowest in T3 (100% organic manures + micronutrients) with 3.93%.

### 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)***

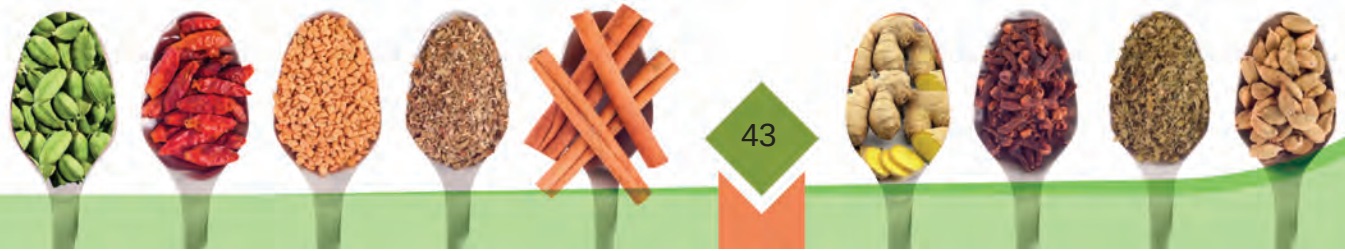
There were 2 treatments T1 is recommended package of practice and T2 is recommended package of practice + IISR micronutrient formulation.

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 highest yield per plant (474.88 g plant $^{-1}$), yield per plot (7.35 kg plot$^{-1}$) and yield per ha (24.49 t ha$^{-1}$).

### 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 treatments were found significantly superior in yield and growth parameters compared to control (2.89 t ha$^{-1}$). Among the treatments, T11- FYM (30 t ha$^{-1}$) + *Trichoderma* gave the highest plant height (81.53cm), number of tillers per plant (52.03), number of leaves per tiller (30.96) and yield (7.28 t ha$^{-1}$) followed by T12- FYM (30 t ha$^{-1}$) + PSB with a plant height (70.60 cm), number of tillers per plant (51.87), number of leaves per tiller (28.40) and yield per hectare (7.07 tonnes). None of the treatments were found to be significantly superior in dry recovery.



## Crop Protection

### GIN/CP/6 Disease Management Trial

### GIN/CP/6.1 Disease surveillance and etiology of rhizome rot in ginger

***(Centre: Middle Gangetic Plain Region - Dholi)***

Diseased rhizome of ginger collected from Darbhanga districts of Bihar were found to be associated with Bacterial wilt and Soft rot disease. Bacterial wilt incidence of ginger ranged from 10 to 40% with mean disease incidence of 21%. Whereas soft rot disease incidence ranged from 0 to 35% with mean disease incidence of 15%. The crop was also found to be infected with Phyllosticta leaf spot disease. Disease severity was in the range of 5 to 60% with mean disease severity of 30%.

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

***(Centres: Middle Gangetic Plain Region – Kumarganj)***

The soft rot incidence was minimum in the treatment of soil solarization by polythene covering (60 days) + Plastic mulching (From sowing to harvest )+ Rhizome treatment with 2.0% neem cake (PDS 10.40%) followed by Soil solarization by polythene covering (60days) + Plastic mulching (From sowing to harvest (PDS 14.76%), Soil solarization by polythene covering (60days) + Rhizome treatment with 2.0% neem cake(PDS 16.6%) and Soil solarization by polythene covering (60days) ( PDS 19.80%). The highest yield was recorded in Soil solarization by polythene covering (60 days) + Plastic mulching (From sowing to harvest (18.82 t $ha^{-1}$) and Soil solarization by polythene covering (60days) + Plastic mulching (From sowing to harvest)+ Rhizome treatment with 2.0% neem cake (14.85 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 the ten varieties of ginger screened against leaf spot (*Phyllosticta zingiberi*) found to be moderately resistant to leaf spot with PDI in the range of 11.34% - 22.61%. Whereas, rhizome rot (*Pythium aphanidermatum*) PDI recorded in the range 3.07% – 5.93% (Moderately Resistant).

# 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; 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. The plant height of the genotypes ranged from 36.10 cm to 82.30 cm and the number of tillers per plant ranged between 1.60 and 4.20. The genotype CL 75 had the highest estimated fresh rhizome yield (30.00 t $ha^{-1}$) followed by CL 147 (27.44 t $ha^{-1}$) and CL 89 (26.11 t $ha^{-1}$).

Two hundred and forty four germplasm collections are being maintained at TRS Kammarpally. About 62 new germplasm lines were collected from the different parts of India during 2016-17. Among the lines JTS-313 (90.30 t $ha^{-1}$) recorded the highest yield followed by JTS-9 (76.80t $ha^{-1}$) as compared to local check (JTS-6-52.06 t $ha^{-1}$) and national check (52.06 t $ha^{-1}$). These lines were also screened against major foliar diseases.

Out of ninety six accessions evaluated at Dholi, nineteen accession *viz.,* RH-24, RH-12, RH-426, RH-5/80, RH-405, RH-2, RH-423, RH-50, RH-414, RH-80, RH-417, RH-403, RH-441, RH-13/90, RH-415, RH-421, RH-9/90, RH-424, and RH-413 gave high fresh rhizome yield ranging from 1.30 kg to 0.98 kg per plant as compared to best check variety Rajendra Sonali and Rajendra Sonia with a yield of 0.90 and 0.85 kg per plant respectively.

**Fig. 8: Field view of turmeric germplasm conservation site at Dholi**

At Kumarganj 172 genotypes were evaluated and the promising entries were NDH-74 (265 g $plant^{-1}$) and NDH-79 (260 g $plant^{-1}$) in early maturing entries, NDH-98 (290 g $plant^{-1}$), NDH-134 (250 g $plant^{-1}$) and NDH-134 (250 g $plant^{-1}$) in medium and NDH-8 (260 g $plant^{-1}$), NDH-7 (250 g $plant^{-1}$) in late maturity types. Leaf blotch severity was found minimum in NDH-62 and NDH- 63 (20.6%) followed by NDH-67 (24.4%) and NDH-70 (25.0%). Whereas in the case of leaf spot of turmeric, minimum disease intensity was observed in NDH- 68 (7.61%) followed by NDH-11 (10.5%) and NDH-53 (14.0%) and NDH-59 (14.1%).

A total of 212 turmeric germplasm were evaluated at Pundibari centre. A unique genotype of turmeric was registered in NBPGR for its tolerance against leaf spot and leaf blotch diseases. (Reg. No. - INGR-16033). When the genotypes were evaluated, highest yield was recorded from TCP-251 (58.55 t $ha^{-1}$) and lowest in TCP-240 (8.85t $ha^{-1}$). Maximum leaf spot incidence was found in TCP 262 (PDI 37.14) and minimum in TCP-6 while the highest leaf blotch incidence was found in TCP 192-(PDI- 40.74) and lowest in TCP-5, TCP-14, TCP-18, TCP-47, TCP-58, TCP-62, TCP-63, TCP-78, TCP-TCP-92, TCP-93, TCP-136, TCP-139, TCP-173, TCP-181, TCP-185, TCP-189, TCP-201, TCP203, TCP-210,

TCP-217, TCP224, TCP 273 and TCP-276 with PDI of 5.56.

At Solan, 135 turmeric collections were evaluated 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.

Forty nine diverse genotypes of turmeric collected from entire NE region were evaluated at Pasighat along with check variety Megha Turmeric-1 during 2016-17. Among the genotypes evaluated, maximum rhizome yield was recorded in CHFT-8 (30.66 t $ha^{-1}$), which was statistically at par with CHFT-24 (27.00 t ha-1) and CHFT-36 (26.10 t $ha^{-1}$). Lowest rhizome yield was recorded in genotype CHFT-28 (8.11 t $ha^{-1}$).

Among 179 turmeric accessions evaluated in 2016-17 at HARS, Pottangi, 152 were Curcuma longa, 23 were Curcuma aromatica and 4 were Curcuma amada. The projected yield ranged from 3.3 t $ha^{-1}$ (Raikia Local) to 32.4 t $ha^{-1}$ (CLS-29) with the mean of 15.8 t $ha^{-1}$ whereas clump weight ranged from 56 g (PCS-5) to 408 g (PTS-15). In *Curcuma aromatica* the range in fresh rhizome yield varied from 1.6 kg $3m^{-2}$ to 10.6 Kg $3m^{-2}$ . Among 23 accessions in *Curcuma aromatica*, 18 entries gave more than 5 Kg $3m^{-2}$ fresh rhizome yield.

A total of 93 genotypes of turmeric were evaluated at CARS, Raigarh. 30 out of 93 germplasm were susceptible to water logging. It was observed that for rhizome yield IT 10 recorded maximum rhizome yield (24.08 t $ha^{-1}$) followed by IT 36 (23.3 t $ha^{-1}$) and IT 23 (22.2 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 20.81 t $ha^{-1}$ and IC-586762 recorded highest curcumin content of 6.53% while highest oleoresin content was recorded in IC-586771 (19.37 %).

**Table 10: Turmeric germplasm collections at various AICRPS centres**

| Centre | Indigenous | | | Exotic | Total |
|---|---|---|---|---|---|
| | Cultivated | | Wild and related species | Existing | |
| | Existing | Addition (2016 - 17) | Existing | | |
| Coimbatore | 266 | - | 7 | 2 | **275** |
| Dholi | 92 | 2 | 2 | - | **96** |
| Kammarpally | 182 | 62 | - | - | **244** |
| Kumarganj | 155 | 17 | - | - | **172** |
| Pantnagar | 36 | 14 | - | - | **50** |
| Pasighat | 64 | - | 2 | - | **66** |
| Pottangi | 155 | - | 24 | - | **179** |
| Pundibari | 186 | - | 26 | - | **212** |
| Raigarh | 42 | 13 | - | - | **55** |
| Guntur | 175 | 45 | - | - | **220** |
| Total | **1353** | **153** | **61** | **2** | **1569** |

## 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)***

The projected rhizome yield per hectare differed significantly among the twelve genotypes tested at Coimbatore, which ranged from 31.00 t $ha^{-1}$ (PTS 18) to 49.87 t $ha^{-1}$ (TCP 191) with a mean of 38.56 t $ha^{-1}$. PTS 18 recorded maximum plant height (73.55 cm) whereas the lowest plant height was recorded in the genotype LTS 1 (54.66 cm). The genotype TCP 191 recorded the lowest number of tillers per plant (2.00), while genotype LTS 1 recorded the highest number of tillers per plant (4.27).

Among the varieties evaluated at Kammarpally, LTS-1 recorded highest fresh rhizome yield (68.56 t $ha^{-1}$) followed by LTS -2 (56.18 t $ha^{-1}$) in comparison to Duggirala red (47.25 t $ha^{-1}$) and IISR Prathibha (34.77 t $ha^{-1}$ ).

At Kumarganj, maximum rhizome yield was obtained in LTS 1 (26.0 t $ha^{-1}$) followed by NDH 128 (25.33 t $ha^{-1}$) NDH-11 (24.44 t $ha^{-1}$), IT-23 (241.11 t $ha^{-1}$) and NDH-1 (240 t $ha^{-1}$).

At Pundibari, PTS-8 recorded highest yield (35.40 t $ha^{-1}$) followed by TCP- 64 (35.53 t $ha^{-1}$). Dry recovery (%) was found highest in NDH-98 (24.67) and lowest in NDH - 8 and NDH -79 (21.33). Days to maturity were found highest in PTS-55 (236.33 days) and lowest was found in TCP-64 (217.67 days). The lowest leaf blotch disease severity of 17.70 was found in PTS-12 which was followed by NDH - 79 (PDI 20.99). The lowest leaf spot disease severity was found in NDH-8 (PDI 6.40) followed by NDH - 79 (PDI 6.58).

It was revealed from the analyzed data at Pottangi, that the entry CLS-38 (14.9 t $ha^{-1}$) was the top yielder with the yield advantages of 63.7 % than the national check variety Pratibha (9.1 t $ha^{-1}$) followed by PRH-80(12.6 t $ha^{-1}$) , NDH-128 (12.4 t $ha^{-1}$). The range of projected yield varies from 7.0 t $ha^{-1}$ to 14.9 t $ha^{-1}$ among the tested entries. The heaviest clump was observed in CLS-38 (254.6 g).

The genotype IT10 recorded maximum rhizome yield (33.2 t $ha^{-1}$) followed by IT 36 (28.0 t $ha^{-1}$) and IT 23 (23.6 t $ha^{-1}$) over national check Prathibha (9.1 t $ha^{-1}$) and local check Chhattisgarh haldi-1(4.9 t $ha^{-1}$) at Raigarh.


**Fig. 9: Field view of CVT of turmeric a. Raigarh b.Pottangi**

Among the ten promising entries and two checks *viz;* national check variety Pratibha and local check variety Rajendra Sonali evaluated at Dholi, RH-9/90 and RH-80 gave significantly higher yield per hectare (64.15 and 59.33 t ha$^{-1}$, respectively) as compared to best local check variety Rajendra Sonali (51.85 t ha$^{-1}$).

During 2016-17, 12 entries from different coordinated centres were evaluated at Guntur along with three checks. LTS-2 recorded highest yield (23.7 t ha$^{-1}$) followed by LTS-1 (23.1 t ha$^{-1}$) which were signficnatly superior to the best check Mydukur (21.0 t ha$^{-1}$).

### TUR/CI/3 Varietal Evaluation Trial

### TUR/CI/3.6 Initial Evaluation Trial 2013

***(Centre: Eastern plateau and hills region – Pottangi)***

It was revealed from the analyzed pooled data that the entry PTS-56 (20.9 t ha$^{-1}$) was the top yielder with the yield advantages of 20.1 % than the local check variety Roma (17.4 t ha$^{-1}$) followed by PTS-12 (18.4 t ha$^{-1}$) and PTS-4 (18.4 t ha$^{-1}$). The heaviest clump was observed in PTS-56 (272.2 g).


**Fig. 10: Field view of turmeric IET at Pottangi**

### TUR/CI/3.7 Initial Evaluation Trial 2015

***(Centres: Middle Gangetic Plain Region - Kumarganj)***

At Kumarganj, 10 entries were evaluated under IET, highest yield was observed in NDH-115 (31.66 t ha$^{-1}$) followed by NDH-68 (30.77 t ha$^{-1}$) and NDH-136 (30.22 t ha$^{-1}$). Minimum disease severity of leaf spot was recorded in NDH-45 (6.46 %) followed by NDH-115 (7.4 %) and NDH-68 (7.61 %) whereas minimum percent of leaf blotch disease intensity was found in NDH-45 (16.1%) and Prathibha ( 17.51%), NDH-130 (17.51%).

## 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 – IISR; East coast plains and hill region – Guntur; Middle Gangetic Plain Region – Dholi; Eastern Himalayan Region - Barapani)***

During 2016-17, an experiment was conducted to study the rhizome bulking pattern of the five varieties *i.e.* BSR 2, Rajendra Sonia, Duggirala Red, Mydukur and Prathiba at Coimbatore. Fresh weight of whole rhizome increased considerably from September to February. Among the varieties evaluated, Mydukur registered vigorous growth and the highest fresh rhizome weight (890 g plant$^{-1}$) followed by Rajendra Sonia (680 g plant$^{-1}$) which were significantly different from each other at 240 DAS.

Duggirala Red recorded highest fresh rhizome yield (10.83 g plant$^{-1}$) at 60 DAS at Kammarpally followed by IISR Prathibha (9.57 g plant$^{-1}$). At 90 DAS, BSR-2 recorded highest fresh rhizome yield (164.43 g plant$^{-1}$) followed by Rajendra Sonia (112.63 g plant$^{-1}$). At harvest Mydukur recorded highest fresh rhizome weight (618.5 g plant$^{-1}$) followed by IISR Prathibha (616.08 g plant$^{-1}$).

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 (317.2

g plant$^{-1}$) and significantly superior to all other varieties evaluated which was followed by BSR-2 (268.0 g plant$^{-1}$), Duggirala Red (264.2 g plant$^{-1}$) and Pratibha (244.2 g plant$^{-1}$) and were on par with each other.

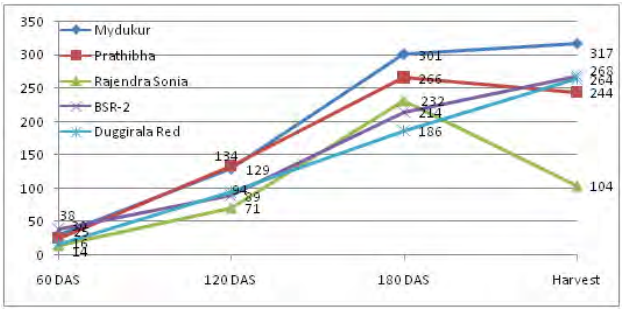



**Fig. 11: Changes in rhizome bulking (fresh weight of rhizome in grams) at Guntur**

Six genotypes of turmeric were taken for evaluation at Barapani. The observations were recorded at 60, 120, 180 DAP and at harvest stage and the dried samples were sent to IISR for further analysis. Mydukur variety recorded highest fresh rhizome weight at 60 DAP (18.79 g plant$^{-1}$), 180 DAP (350.04 g plant$^{-1}$) and at harvest (409.26 g plant$^{-1}$), whereas at 120 DAP Rajendra Sonia recorded highest fresh rhizome weight (250.39 g plant$^{-1}$).

## TUR/CM/5.10 Organic production of turmeric

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

At Mizoram, the maximum yield (34.77 t ha$^{-1}$) was recorded for T2 (100% organic manure equivalent to 75% N requirement of turmeric), followed by T1 (100% organic manure equivalent to 100% N requirement of turmeric) with a yield of 33.55 t ha$^{-1}$, T5 (75% N requirement of turmeric + micronutrients)) with a yield of 32.99 t ha$^{-1}$. Moreover, dry matter content of 15.43% was found to be highest in T4 (100% organic manure + Vermiwash 10%); followed by T1 (100% organic manure equivalent to 100% N requirement of turmeric) and T3 (100% organic manure + micronutrients) with a dry recovery of 15.28% and 14.70%.

Maximum yield of 50.97 t ha$^{-1}$ was recorded in T3 (100% organic manures + micronutrients) followed by 44.4 t ha$^{-1}$ in T5 (75% N requirement of turmeric + micronutrients) at Barapani. High dry recovery of 22.49 % was recorded in T2 (100% organic manures equivalent to 75% N requirement of turmeric) and lowest at 21.05 % in T8 (Farmers practice). Treatment T7 (Recommended Package by SAU (Turmeric – NPK 120:90:90 NPK kg ha$^{-1}$) had highest curcumin content of 6.35% as well as highest oleoresin of 14.35 %.

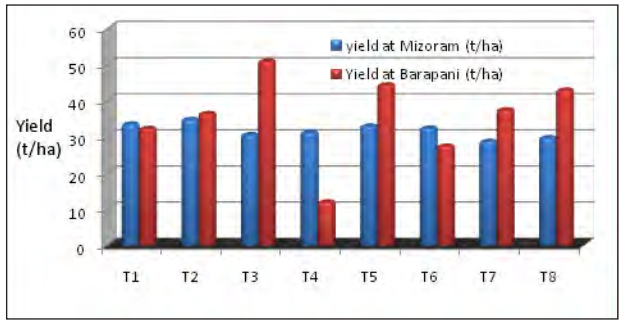



**Fig.12: Organic production of turmeric at Mizoram and Barapani**

**Treatments:**
*T1: 100% organic manures equivalent to 100% N requirement of turmeric*
*T2: 100% organic manures equivalent to 75% N requirement of turmeric*
*T3: 100% organic manures + (micronutrients)*
*T4: 100% organic manures + (vermiwash 10%)*
*T5: 75% N requirement of turmeric + (micronutrients)*
*T6: 75% N requirement of turmeric + (vermiwash 10%)*
*T7: Recommended Package by SAU (Turmeric – NPK 120:90:90 NPK kg/ha)*
*T8:Farmers practice*

## TUR/CM/5.13 Comparative performance of turmeric entries under polyhouse and field conditions

***(Centre: Eastern plateau and hills region - Raigarh)***

The entry IT -10 showed high rhizome yield (20.6 t ha$^{-1}$) both in field as well as under poly house condition (11.10 t ha$^{-1}$) followed by entry IT- 36 (18.2 t ha$^{-1}$) and IT 16 (18.6 t ha$^{-1}$) at field conditions and the entries IT 36 (8.2 t ha$^{-1}$), IT 38 (8 t ha$^{-1}$) and IT 40 (7.3 t ha$^{-1}$) under poly house conditions. Hence, it was observed that in poly house, yield performance was less than field conditions.

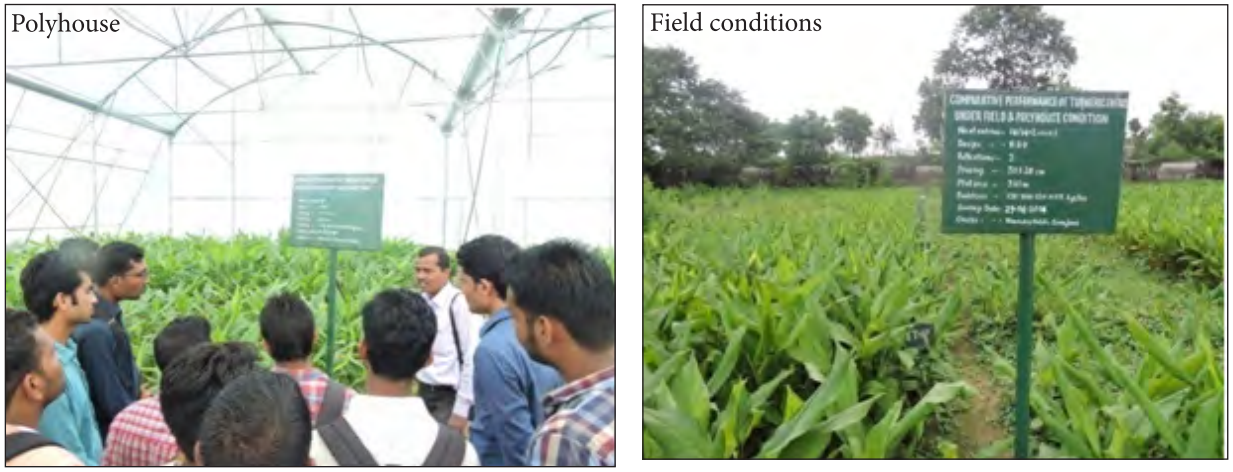



**Fig. 13: Comparative performance of Turmeric entries under field and polyhouse conditions**

## 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).

Survey conducted by Dholi centre revealed that *Colletorichum* leaf spot incidence of turmeric was found in the range of 0 to 15 % with mean disease incidence of 6 %. *Taphrina* leaf spot incidence of turmeric ranged from 5 to 55% with mean disease incidence of 26 %. Among 124 genotypes of turmeric screened under natural condition against foliar diseases, the accession 21, 38 and 51 were found to be highly resistant, resistant and moderately resistant against *Taphrina* leaf spot whereas the accessions *viz.*, 89, 7 and 12 were found to be highly resistance, resistant and moderately resistant against *Colletotrichum* leaf spot disease respectively.

At Raigarh during the survey in the village Khokhra of Tamnar Developmental block 52.45 per cent of disease intensity of *Colletotrichum* leaf spot and *Taphrina* leaf blotch was observed and none of the local entries were found to be highly resistant or resistant against both foliage diseases.

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

***(Centres: Eastern plateau and hills region – Raigarh; 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 (2.9 PDI) and leaf blotch (4.9 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 4.1 and 5.6 respectively, while in control the incidence was 9.6 and 12.7 respectively.

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

***(Centres: Southern plateau and hills region – Coimbatore, Kammarpally; Middle Gangetic Plain Region - Dholi, Kumarganj, Pundibari; Eastern plateau and hills region – Raigarh; East coast plains and hill region – Guntur; Western Himalayan Region - Solan)***

The results of three years pooled data indicated that all the disease tolerant lines of turmeric recorded 83.0 to 97.0 per cent sprouting at Coimbatore (Table 11).

The entry CL 34 recorded minimum leaf spot (5.40 PDI) and leaf blotch (3.50 PDI) incidence with an yield of 32.91 t $ha^{-1}$ followed by TCP 129 that recorded resistant reaction to both leaf spot (5.68 PDI) and leaf blotch (3.96 PDI) with an yield of 30.58 t $ha^{-1}$.

**Table 11: Evaluation of turmeric lines for tolerance to foliar diseases (pooled mean of three years) 2013-16**

| S.No. | Accessions | Germination (%) | Leaf spot (PDI) | Leaf blotch (PDI) | Rhizome yield (t/ha) |
|---|---|---|---|---|---|
| 1 | CL 32 | 90.59 | 7.21 | 15.27 | 31.92 |
| 2 | CL 34 | 84.04 | 5.40 | 3.50 | 32.91 |
| 3 | CL 52 | 86.63 | 7.22 | 12.88 | 30.26 |
| 4 | CL 54 | 90.30 | 7.57 | 13.83 | 31.01 |
| 5 | TCP 14 | 83.11 | 5.92 | 9.67 | 29.02 |
| 6 | TCP 129 | 86.66 | 5.68 | 3.96 | 30.58 |
| 7 | TCP 161 | 91.11 | 9.11 | 8.00 | 27.72 |
| 8 | RH 406 | 85.44 | 7.84 | 11.42 | 29.17 |
| 9 | RH 407 | 86.56 | 6.72 | 11.37 | 25.19 |
| 10 | RH 410 | 93.70 | 5.53 | 6.06 | 27.21 |
| 11 | NDH 10 | 92.78 | 5.62 | 19.47 | 27.34 |
| 12 | NDH 40 | 86.11 | 5.43 | 10.79 | 29.50 |
| 13 | NDH 74 | 93.39 | 6.34 | 21.23 | 30.10 |
| 14 | NDH 128 | 92.73 | 7.75 | 21.35 | 28.33 |
| 15 | BSR-2 | 88.45 | 19.26 | 30.58 | 29.25 |
| | SEd | 2.54 | 0.98 | 2.06 | - |
| | cv | 4.378 | 2.00 | 4.21 | - |

At Dholi, among 16+1 (Susceptible check var. Morangia) germplasm of turmeric screened against leaf spot and leaf blotch disease, the genotypes *viz.,* RH-7, RH-406, RH-410, Rajendra Sonia, Rajendra Sonali, TCP-14 and TCP-14 were found free from *Colletotrichum* and *Taphrina* leaf spot diseases. Highest yield of 46.38 followed by 45.06 t $ha^{-1}$ was recorded in Rajendra Sonali and RH-7 respectively.

In case of foliar diseases, minimum leaf spot incidence has been observed in NDH-11 (7.14%) followed by LTS-1 (12.55 %), LTS-2 (13.88 %) and NDH-128 (14.98 %) whereas in case of

**Fig. 14: Field view of evaluation of turmeric lines against foliar diseases at Dholi**

leaf blotch, minimum severity was found in Prathibha ( (17.3 %) followed by NDH-11 (19.8 %) and LTS-10( 24.0 %) at Kumarganj.

At Pundibari, TCP 129 recorded lowest leaf blotch (PDI 13.08) and leaf spot (PDI 7.54) disease severity among the 11 germplasm tested including the local check. Over all five genotypes produced lower leaf blotch disease severity and 6 genotypes produced lower leaf spot disease severity than local check (TCP 2). The highest yield of 28.73 t $ha^{-1}$ was obtained by TCP 129 followed by TCP 14 (23.08 t $ha^{-1}$) and CL 34 (19.70 t $ha^{-1}$). The lowest yield (15.42 t $ha^{-1}$) was recorded by TCP 2.


**Fig. 15: Leaf spot and Leaf blotch tolerant line TCP-129 at Pundibari**

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

Generally, low percent incidence of leaf spot and no incidence of leaf blotch was recorded at Guntur in the accessions taken under study. NDH-74 showed field tolerance to the foliar diseases like leaf spot and blotch .The accessions CL 32 (1.2%), TCP 129 (1.7%) and TCP 14 (2.2%) recorded the lowest PDI and were on par with each other. RH 406 (13.3%) recorded the maximum PDI among the tolerant lines evaluated.

At Kammarapally, all the lines evaluated were susceptible to the foliar diseases. The lines namely IISR Prathibha, CL-52, Duggirala Red have the disease ratings of 26 to 50 percent, where as RH-7, RH-40. RH-46, CL-32, CL-34, CL-54 have the disease ratings more than 51 percent for leaf spot diseases (*Colletotrichum* sps). Leaf blotch (*Taphrina maculans*) of 30 to 40 per cent necrotic leaf area was recorded in Duggirala Red, 40 to 50 per cent necrotic leaf area in CL-32 and more than 50 per cent in RH-7, RH-40, RH-46, IISR Prathibha, CL-52, CL-34, CL-54. So during the year 2016-17, none of the variety was found to show resistance to foliar diseases.

In the trial for the management of foliar diseases in turmeric using tolerant lines at Solan, the turmeric line CL-54 gave the maximum yield (32.87 t $ha^{-1}$) along with minimum leaf spot (6.56 %) and leaf blotch (7.09%) severity.

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

***(Centre: Middle Gangetic Plain Region - Kumarganj)***

The minimum leaf spot disease incidence at Kumarganj was observed in spray of 0.2% propiconazole (19.4%) followed by Argimone oil (23.45%), Neem oil (24.40%) and Jatropha oil (26.39%). Whereas leaf blotch disease incidence was found minimum in propiconazole (19.50%) and Argimone oil (24.73%) and maximum in Marigold oil (37.55%) and *Trichoderma* (37.50%) in comparison to control (44.83%). Highest fresh yield of rhizome was recorded in the spray with Argimone oil (15.49 t $ha^{-1}$) followed by Propiconazole (14.89 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)***

Out of thirty varieties of turmeric screened against leaf spot (*Colletotrichum capsici*), twenty three were observed as moderately tolerant with PDI in the range of 11.24% - 20.68%. However, reactions of varieties against rhizome rot were noticed as resistant with PDI in the range of 3.20% - 5.87%.

# 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, fifteen promising genotypes have been identified. Average number of fruits ranged from 110-325. The genotypes *viz.*, DBSKKVMF 24 (325), DBSKKVMF 23 (310), DBSKKVMF 19 and 28 (280) recorded high average number of fruits per tree. Maximum dry nut yield (1714.30 g) and dry mace yield (381.3 g) was recorded in the genotype DBSKKVMF 23. The best performed nutmeg trees were multiplied. A monoecious tree with bold nut (9.88 g) and high mace yield (2.38 g) was shortlisted for further evaluation.

At Pechiparai, MF-4 recorded maximum number of fruits (420 fruits tree$^{-1}$), fruit weight (120.0 g) and the mace yield (210 g tree$^{-1}$) whereas local check recorded only 110.0 fruits tree$^{-1}$ with single fruit weight (62.00 g tree$^{-1}$) and mace yield (60 g tree$^{-1}$).

#### b. Clove

Among the germplasm of clove maintained at Dapoli, four promising genotypes were identified. The plant height varied from 4.80 to 5.90 m, girth ranged from 32.30 to 37.5 cm and spread varied from 3.70 m to 5.30 m. No flowering was observed at Dapoli during the year 2016-17.

Among the 24 accessions (26 years old) maintained at Pechiparai, SA-1 recorded the highest tree height of 10.50 m, followed by SA-2 (10.0 m). The accession SA-13 was significantly superior to other accessions and recorded highest stem girth (44.50 cm) compared with local check (33.50 cm). Accession SA-3 recorded the highest leaf length (18.00 cm), leaf breadth (7.50 cm) and dry bud yield (3.0 kg tree$^{-1}$). The local check recorded a dry bud yield of 2.20 kg tree$^{-1}$.

**Fig. 16: Promising clove accession SA 3 at Pechiparai**

#### c. Cinnamon

Among the twelve accessions (26 years old) evaluated at Pechiparai, CV-5 recorded maximum plant height (9.00 m), stem girth (31.50 cm), leaf yield (7.50 kg plant$^{-1}$) and dry bark yield (620.00 g plant$^{-1}$) while local check recorded plant height (7.80 m), stem girth (22.50 cm), leaf yield (7.00 kg plant$^{-1}$) and dry bark yield (290.00 g plant$^{-1}$).

**Fig.17: Cinnamon germplasm maintained at Pechiparai**

**Table 12: Tree spices germplasm collection at AICRPS centres**

| Crop/Centre | Indigenous | | Total |
|---|---|---|---|
| | Cultivated | | |
| | Existing | Addition (2016 -17) | |
| ***Clove*** | | | |
| Dapoli | 2 | - | 02 |
| Pechiparai | 27 | - | 27 |
| Yercaud | 01 | - | 01 |
| **Total** | **30** | **-** | **30** |
| ***Nutmeg*** | | | |
| Dapoli | 94 | - | 94 |
| Pechiparai | 28 | - | 28 |
| **Total** | **122** | **-** | **122** |
| ***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, KAU; Southern plateau and hills region – Pechiparai)***

Twenty unique nutmeg types were collected and planted at Dapoli centre. The performance is satisfactory and yellow mace type has started bearing.

Among unique nutmegs at Pechiparai, the maximum plant height was recorded in Viswashree (3.50 m) and maximum number of branches were recorded in Konkan Sugandha (16 nos). Whereas Acc-17 recorded lowest plant height (1.20 m) and number of branches (8). The nutmeg accessions viz., Acc. No. 1, Acc. No. 3, Acc. No. 5, Acc. No. 7, Acc. No. 8, Acc. No. 9, Acc. No. 11, Acc. No. 12, Acc. No. 13, Acc. No. 14, Acc. No. 20 and Acc. No. 23 were received from IISR, Calicut and planted in main farm at HRS, Pechiparai.

The identified dwarf clove and king clove from Castle Rock estate is being maintained in the germplasm at HRS, Pechiparai. Madagasgar clove, Dwarf clove and Potted clove from Blackrock Estate is also being maintained at HRS, Pechiparai.

Morphological and biochemical characterization of the mother trees of the twenty accessions of nutmeg were identified at KAU. unique accessions of nutmeg were identified with respect to tree shape, branching pattern, leaf size, sex form, fruit, mace and kernel characters (Fig.18, 19 and 20). Budded plants (orthotrops) of 15 unique accessions (Acc.1, 3, 5, 7, 8, 9, 10, 11, 12, 13, 14, 17, 20, 23, 24) were made and five each of these accessions have been supplied to IISR Kozhikode, DBSKKV Dapoli and TNAU Pechipparai for evaluation.

**Fig. 18: Conical nutmeg tree**

**Fig. 19 : Clustered fruit nutmeg**

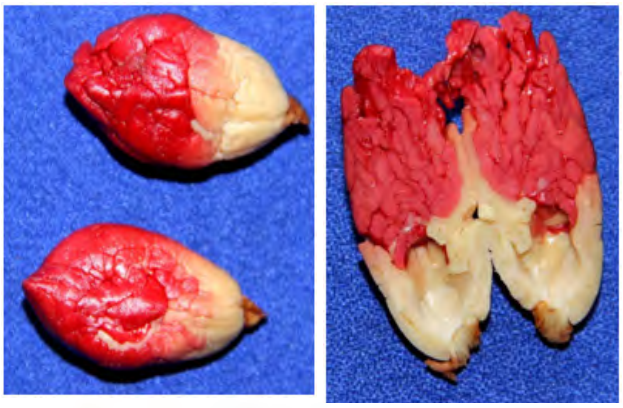


**Fig. 20: Seedless nutmeg**

## 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)***

No significant variation was observed for all parameters except number of branches at Dapoli. The plant height ranged from 1.83 to 2.77 m, the girth from 18.83 to 26.67 cm and the tree spread varied from 1.07 – 2.40 m. All the accessions have started bearing.

Among the different accessions of nutmeg evaluated at Pechiparai, A9/150 has recorded the highest plant height (7.0 m), stem girth (31.50 cm), number of branches (28) and number of fruits (102 fruits /tree) when compared with local check (Plant height (4.70 m), stem girth (28.5), maximum number of branches (13) and number of fruits (85 fruits / tree) (Table 13).

**Table 13: Morphological and yield performance of nutmeg accessions at Pechiparai**

| Sl.No. | Accessions | Plant height (m) | Stem girth (cm) | Number of branches | Number of fruits per tree |
|---|---|---|---|---|---|
| 1. | A9/4 | 5.9 | 28.5 | 12 | 55 |
| 2. | A9/20 | 3.9 | 28.0 | 21 | 62 |
| 3. | A9/25 | 5.1 | 28.5 | 20 | 68 |
| 4. | A9/71 | 5.0 | 29.0 | 19 | 92 |
| 5. | A9/150 | 7.0 | 31.50 | 28 | 102 |
| 6. | M.L. | 4.9 | 21.5 | 15 | 50 |
| 7. | Local check | 4.7 | 28.5 | 13 | 85 |
| | **SEd** | 0.37 | 0.94 | 3.9 | 3.95 |
| | **CD (p=0.05)** | 0.64 | 1.57 | 6.92 | 8.95 |

### TSP/CI/2.3 CVT-2001-Cassia

***(Centres: Western plateau and hills region – Dapoli; Southern plateau and hills region - Pechiparai)***

No significant difference was observed in plant height, girth and number of branches at Dapoli. The genotype KKVCTSH2 recorded higher girth (49.38 cm) followed by KKVCTSH1 (45.88 cm). The oil percentage in leaf varied from 6.14 - 7.34 %. The genotype KKVCTSH1 and KKVCTSH2 recorded higher oil percentage 7.34 % and 7.12 % respectively. Treatment D5 record highest leaf area of 98.90 $cm^2$

The accession D3 recorded the maximum plant height (9.50 m), stem girth (52.50 m), leaf yield ( 430 g $tree^{-1}$) and bark yield ( 280 g $tree^{-1}$) compared with local check (Plant height (6.8 m), stem girth (34.50 m), Leaf yield ( 350 g $tree^{-1}$) and bark yield ( 220 g $tree^{-1}$) at Pechiparai centre.

### TSP/CI/2.4 CVT on farmers varieties of Nutmeg

***(Centres: Western plateau and hills region – Dapoli; Southern plateau and hills region – Pechiparai; Thrissur)***

At Pechiparai, the nutmeg grafts *viz.*, Punnathanam jathy (from Mr. Varkey Thomman), Kochukudy (from Mr. Jose Mathew), Kadukkamakkan jathy (from Mr. Abraham Mathew) and improved nutmeg variety (from Mr. Tom C Antony) were collected and planted in main farm, HRS, Pechiparai.

Trial has been laid out with four farmer varieties and one local check 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 14)

**Fig. 21: Coriander germplasm plot at Dholi**

Among the 276 genotypes of coriander maintained at Coimbatore, 42 genotypes were evaluated based on genetic divergence, yield and quality assessment. Plant height at harvest varied significantly from 50.36 cm to 75.33 cm with a mean value of 62.23 cm. The genotype CS 210 recorded the highest plant height of 75.33 cm, which was on par with the genotype CS 271 (74.36 cm). The number of umbels per plant varied from 8.66 to 25.33 and over all mean was 13.40. The maximum number of umbels per plant was recorded in CS 29 (25.33) and lowest was recorded in the genotype CS 210 (8.66). The genotype CS 212 registered the highest seed yield of 2.33 g which was on par with the genotypes CS 180 (2.23 g) and CS 29 (2.20 g). The estimated seed yield per hectare varied from 2.31 q to 6.98 q with a mean of 455.44 kg. The genotype CS 212 recorded the highest seed yield of 6.98 q per hectare followed by the genotypes CS 180 (6.69 q) and CS 29 (6.60 q).

Out of one hundred fifty six accessions maintained at Dholi, thirteen accessions namely RD-422, RD-414, RD-417, RD-443, RD-400, RD-427, RD-395, RD-154, RD-380, RD-421, RD-391, RD-121 and RD-389 recorded higher yield ranging from 92 to 73 g per five plants as compared to best check variety Hisar Anand (70 g per five plant). Among seventeen promising accessions, RD-442 gave the highest yield 92 g per five plant followed by RD-414 (88 g per five plants).

One hundred ninety three accessions of coriander were evaluated at Kumarganj. The highest yield was recorded in NDCor-11 (30.40 g plant$^{-1}$) followed by NDCor-32 (28.45g plant$^{-1}$), and NDCor-9 (28.20 g plant$^{-1}$). The stem gall severity was found less in NDCor-118, NDCor-110, NDCor-102 and NDCor-1.

Thirty five germplasm lines were evaluated in Augmented Block Design with six checks at Guntur. Among the entries evaluated, LCC-324 (2.59 g plant$^{-1}$), LCC-316 (2.14 g plant$^{-1}$), LCC-326 (2.03 g plant$^{-1}$), LCC-317 (1.83 g plant$^{-1}$) and LCC-320 (1.80 g plant$^{-1}$) were identified as superior in yield over the best check APHU Dhania-1 (1.33 g plant$^{-1}$).

At Hisar, 8 new collections of coriander were collected in this year and added to the germplasm. A total of 307 germplasm lines are maintained at the centre. One hundred twenty two accessions of coriander were evaluated in two row plots of 3.0 meter length each using Hisar Sugandh, Hisar Bhumit and Hisar Anand as checks. The mean seed yield of the germplasm

material ranged from 32.4 g plant$^{-1}$ (DH-296) to 97.2 g plant$^{-1}$ (DH-239-1). The most promising lines for seed yield were DH-231, DH-232, DH-239-1, DH-239-2, DH-275, DH-276-1, DH-277, DH-280, DH-287, and DH-324.

**Fig. 22: Visit of Seed spices monitoring team at Coriander germplasm plot of Hisar**

At Jagudan, 79 entries were evaluated with G Co-2 as checks for yield performance. The seed yield ranged from 789 to 2889 kg ha$^{-1}$. Among the tested genotypes, 18 genotypes gave higher seed yield per plant than check G Co-2.

At Jobner, one hundred thirty eight (138) germplasm accessions were evaluated along with eight checks namely RCr-20, RCr-41, RCr-435, RCr-436, RCr-475, RCr-480, RCr-728 and Local check. Out of 138 accessions, 6 accessions were better than best check variety RCr-20 (46.67 g) on the basis of seed yield per 5 plants. Promising accessions identified were UD-136 (58 g), UD-402 (55.0 g), UD-124 (53.0 g), UD-665 (501 g) and UD-213 (47 g).

Among 22 accessions evaluated for seed yield at Raigarh, ICS 4 recorded maximum seed yield (5.33 q ha$^{-1}$) followed by entry RCC 12-10 (4.60 q ha$^{-1}$) and ICS 30 (4.42 q ha$^{-1}$) over three checks Hisar Anand (2.20 q ha$^{-1}$), ICS 1 (1.67q ha$^{-1}$) and Rajendra Swati (1.58 q ha$^{-1}$).

### 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 38.90 PDI to 89.20 PDI. The accessions *viz.,* CS 134 recorded lowest incidence of 38.90 PDI with yield of 960.0 kg ha$^{-1}$ followed by CS 244 (52.30 PDI) with yield of 860.0 kg ha$^{-1}$. The highest intensity of powdery mildew was recorded in CS 212 (89.20 PDI) with the yield 500.00 kg ha$^{-1}$.

Out of forty one entries of coriander screened under natural condition, at Jagudan, none of the entries were found free from the powdery mildew incidence. The minimum disease intensity was noticed in COR 136 (25 %). The maximum disease intensity was recorded in the entry COR 123 (52 %). The per cent disease intensity ranged between 25 and 52 per cent.

**Table 14 : Coriander germplasm collections at various AICRPS centres**

| Centre | Indigenous | | | Total |
|---|---|---|---|---|
| | Cultivated | | Wild and related species | |
| | Existing | Addition (2016 -17) | Existing | |
| Coimbatore | 276 | - | - | **276** |
| Dholi | 156 | - | - | **156** |
| Guntur | 350 | - | - | **350** |
| Hisar | 299 | 8 | | **307** |
| Jagudan | 95 | - | 21 (Exotic) | **116** |
| Jobner | 230 | - | - | **230** |
| Kumarganj | 170 | - | - | **170** |
| Pantnagar | 85 | - | - | **85** |
| **Total** | **1661** | **8** | **21** | **1690** |

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

***(Centre: Central plateau and hills region – Jobner)***

The genotypes *viz;* UD 554, UD 566, UD 783, UD 769, UD 32 and UD 280 were top yielders in normal conditions, while UD 492, UD 489, UD 580, UD 520, UD 705 and UD 554 were top yielders in stress conditions. Based on stress indices UD-520, UD-580, UD-747, UD-472, UD-489 and UD-492 were found to be the desirable entries for drought conditions.

### 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 72 accessions evaluated under multi locational testing at Jobner, five accessions *viz.,* NDCOR-118 (46.0 g per 5 plants), JCr-2013-18(43.0 g per 5 plants), NDCOR-109 (38.0 g per 5 plants), NDCOR-94 (34.0 g per 5 plants), and NDCOR-110 (32.0 g per 5 plants) were better than best check variety RCr-435 (28.67 g).

A trial on multi location evaluation of coriander genotypes was laid out at Coimbatore with 80 genotypes from nine centres and four checks. The mean performance of the genotypes for plant height ranged from 34.30 cm to 63.30 cm. The number of primary branches varied significantly from 3.67 to 8.00. The genotype LCC 244 recorded maximum primary branches (8.00) when compared with check varieties RCr 728 (6.67) and Hissar Anand (6.00). Maximum number of umbels per plant was recorded in ND COR 111 (24.00). The seed yield varied from 2.07 to 7.50 q $ha^{-1}$ and the maximum seed yield was recorded in the genotype LCC 233 (7.50 q $ha^{-1}$) which was better than the check variety Hisar Anand (4.57q $ha^{-1}$).

At Guntur centre, one hundred germplasm lines from ten centers were evaluated in Augmented Block Design with seven checks. Among the entries evaluated, fifteen entries were found significantly superior in yield over the best check AD-1 (1.37 g $plant^{-1}$). The top five entries were LCC-250 (2. 40 g $plant^{-1}$), CS-142 (2.34 g $plant^{-1}$), LCC-229 (2.04 g $plant^{-1}$), LCC-230 (2.01 g $plant^{-1}$) and CS-196 (1.92 g $plant^{-1}$).

Under multi location of trials at Kumarganj, 97 entries were evaluated and the highest seed yield was recorded from NDCor-90 (13.50 g $plant^{-1}$), NDCor-102 (13.45 g $plant^{-1}$), RD-365 (13.35 g $plant^{-1}$) and CS-196 (13.30 g $plant^{-1}$). Out of 97 entries evaluated, three entries were found to be tolerant to stem gall *viz.,* 4 JCR-2013-12, NDCor-1 and RKC-MLT-2 .

Among the eighty accessions and two check varieties Hisar Anand and Rajendra Swati evaluated at Dholi, wide range of variability was found for all the characters studied. Out of 80 accessions, 9 accessions namely RD-385, RD-377, RD-401, RD-417, RSR/RSM-4, RD-365, RSR/RSM-2, ND Cor-109 and RD-397 recorded superior yield per plant (28, 23, 22, 22, 22, 20, 20, 20 and 19 g respectively) as compared to both check varieties. Among the tested entries, only eight entries were found to be highly resistant against stem gall disease. Rest of the entries including check varieties were found to be highly susceptible to the disease.

Under multi location trials at Jagudan, a total of 83 entries with local check (GCo-2) was evaluated in single row. RD-393 (68.70 q $ha^{-1}$), NDCor-94 (48.89 q $ha^{-1}$) and NDCor-118 (45.93 q $ha^{-1}$) were found to be the promising entries.

At Raigarh centre, ICS-4 (17.7 q $ha^{-1}$) recorded maximum seed yield followed by ICS 5 (16.7 q $ha^{-1}$) and ICS 5-2 (16.7 q $ha^{-1}$) over checks Gujarat 2 (14.6 q $ha^{-1}$) and Chhattisgarh Dhaniya -1 (ICS-1) 15.6 q $ha^{-1}$.

## Crop Improvement

### COR/CI/2 Coordinated Varietal Trial

### COR/CI/2.5 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 flower initiation was noted in COR-128 (48 days). The highest plant height was recorded in COR-123 (135.18 cm). Maximum number of branches per plant (7) was recorded in COR-136 whereas maximum number of umbels per plant was noted in COR-124 (35.67). The highest seed yield per plant and seed yield per hectare was recorded by the genotype COR-141 (10.07 g) and (28.69 q $ha^{-1}$), respectively.

The coordinated varietal trial was laid out at Coimbatore with twenty six genotypes along with two national checks and one local check. The plant height of the genotypes ranged from 38.32 cm to 65.19 cm. The highest number of umbels per plant was recorded by the genotypes COR 137, COR 142 and COR 144 (14.33) followed by COR 141 (14.22) and COR 136 (14.11) which were on par with check variety Hisar Anand (13.78). The seed yield per hectare differed significantly among the 26 genotypes tested, which ranged from 419.44 kg $ha^{-1}$ (COR 131) to 805.56 kg $ha^{-1}$ (COR 141) with a mean of 567.05 kg $ha^{-1}$. The genotype COR 141 has recorded significantly the highest yield when compared with CO (CR)-4 (6.41 q $ha^{-1}$) as local check and RCr-728 (5.41 q $ha^{-1}$) as national check.

**Fig. 23: Coordinated varietal trial of Coriander at Coimbatore**

At Dholi, COR-142, COR-143 and COR-138 gave significantly higher yield per plot (1.86, 1.83 and 1.59 kg $6m^{-2}$, respectively) as compared to best check variety Rajendra Swati (1.47 kg $6m^{-2}$). Among the twenty six test entries and three check varieties screened for stem gall disease, seven entries were found to be highly resistant against stem gall disease. All the entries including check varieties were found to be highly susceptible to the disease.

At Kumarganj, total 29 entries were evaluated under CVT coriander. The maximum yield was observed from Cor-138 (15.97q $ha^{-1}$) followed by Cor-146 (15.90 q $ha^{-1}$) Cor-139(15.83q $ha^{-1}$) and Cor-130 (15.06 q $ha^{-1}$). Out of the 29 entries, Cor-124, Cor-125, Cor-127, Cor-123, Cor-146, Cor-143 and Cor-141 were found to be tolerant against stem gall infestation whereas rests of the entries were either moderately resistant or susceptible to stem gall.

During Rabi season, twenty five genotypes of Coriander from different coordinating centers were tested with Hisar Anand, Rcr-728 and Suguna as checks at Guntur centre. Among the entries evaluated, only five entries, COR-134 (7.78 q $ha^{-1}$), COR-130 (7.53 q $ha^{-1}$), COR-135 (7.46 q $ha^{-1}$), COR-129 (7.36 q $ha^{-1}$) and COR-133 (7.18 q $ha^{-1}$) were found significantly superior to the best check Suguna (5.68 q $ha^{-1}$).

At Hisar, significant difference was observed for all the parameters. Plant height ranged from 90.2 to 117.8, number of branches 5.2 to 10.1, umbels per plant 31.2 to 64 and seeds per umbel 33 to 64.3. Maximum seed yield (22.61 q $ha^{-1}$) was recorded in COR- 141 followed by COR-142 (21.64 q $ha^{-1}$) and COR-140 (20.81 q $ha^{-1}$).

The yield differences among the entries were found significant at Jagudan. The entry COR-122 (25.15 q ha$^{-1}$) yielded significantly higher than all three checks, Hisar Anand (20.29 q ha$^{-1}$), Rcr-728 (16.28 q ha$^{-1}$) and G.Co-2 (18.57 q ha$^{-1}$) which was 23.9, 54.5 and 35.4 per cent higher than all respective checks. Entry COR-132 (20.16 q ha$^{-1}$) recorded significantly higher yield than Rcr-728 (16.28 q ha$^{-1}$).

Based on seed yield, 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$^{-1}$) observed as promising genotypes at Navsari. COR-99 (15.09 q ha$^{-1}$), COR-100 (14.50 q ha$^{-1}$) and COR-95 (14.35 q ha$^{-1}$) were found significantly superior over a national check H. Anand (11.35 q ha$^{-1}$) and a local check GC-2 (10.98 q ha$^{-1}$) for seed yield.

At Kota, COR – 142 was found to be the best performing entry in terms of seed yield (25.27 q ha$^{-1}$) followed by COR – 146 (23.61 q ha$^{-1}$). COR – 127 and COR-128 were the earliest in days to 50 % flowering (51 days) while COR – 127 was the earliest maturing entry (105 days). RCr – 728 followed by COR – 143 were the late entries with days to 50 % flowering of 77 and maturing in 114 and 112 days, respectively. COR – 128 and COR-130 had the highest test weight of 15.55 g while RCr - 728 had the lowest test weight of 12.28 g.

At Raigarh, ICS 1 (30.76 q ha$^{-1}$) has recorded maximum seed yield followed by COR 135 (25.4 q ha$^{-1}$), COR 129 (24.58 q ha$^{-1}$) and COR 136 (23.13 q ha$^{-1}$) over national checks RCR 728 (17.36 q ha$^{-1}$), Gujarat 2 (16.60 q ha$^{-1}$) and Hisar Anand (15.83 q ha$^{-1}$).

The trial was started in the year 2015-16 and is in the second year of progress at Jobner. The analysis of variance revealed significant differences among the entries for all the traits except Umbellets/umbel. The seed yield ranged from 4.21 q ha$^{-1}$ (COR-128) to 22.45 q ha$^{-1}$ (COR-144). Of the thirty entries evaluated, RCr-144 recorded maximum seed yield of 22.45 q ha$^{-1}$ followed by COR-138 (22.17 q ha$^{-1}$), RCr-435 (22.08 q ha$^{-1}$), RCr-728 (20.78 q ha$^{-1}$) and COR-146 (20.37 q ha$^{-1}$).

## 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 initial evaluation trial (IET) in coriander was conducted with ten accessions along with Hisar Anand as check during 2014-2015, 2015-2016 and 2016-17. The results indicated that DH-208 and DH-312 gave significantly better yield over Hisar Anand (check) showing 22.8 and 19.6 % increase in yield, from two years mean respectively (Table 15).

**Table 15: Performance of coriander germplasm under IET at Hisar and Jobner**

| Entries | Seeds yield (q ha$^{-1}$) at Hisar | Entries | Seeds yield (q ha$^{-1}$) at Jobner |
|---|---|---|---|
| DH-208 | 20.36 | UD-808 | 13.33 |
| DH-213 | 19.48 | UD-814 | 11.48 |
| DH-236 | 18.86 | UD-815 | 21.87 |
| DH-240 | 18.35 | UD-826 | 14.58 |
| DH-279 | 18.36 | UD-835 | 11.01 |
| DH-298 | 18.62 | UD-848 | 11.01 |
| DH-302 | 19.28 | UD-851 | 10.46 |
| DH-312 | 19.88 | RCr-435 | 11.01 |
| DH-315 | 19.08 | RCr-436 | 10.50 |
| Hisar Anand | 16.54 | RCr-728 | 12.29 |

The analysis of variance revealed significant differences among the entries for all the traits evaluated at Jobner. The seed yield ranged from 10.46 to 21.87 q ha$^{-1}$. Of the ten entries evaluated, UD-815 recorded maximum seed yield of 21.87 q ha$^{-1}$ followed by UD-826 (14.58 q ha$^{-1}$), UD-808 (13.33 q ha$^{-1}$), RCr-728 (12.29 q ha$^{-1}$), UD-814 (11.48 q ha$^{-1}$), RCr-435 and UD-835 (11.01 q ha$^{-1}$)

### 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 2016-17, ten promising coriander accessions from germplasm entries were tested at Guntur with APHU Dhania, Suguna and Susthira as checks. Among the ten entries tested, LCS-12-10 recorded highest yield of (7.70 q $ha^{-1}$) followed by LCS-12-4 (7.22 q $ha^{-1}$) which were on par with each other and significantly superior to the best check Susthira (6.14.5 q $ha^{-1}$).

The entries tested under the trial were found to have no differences for yield and other characters like plant height, umbel per plant and seeds per umbel at Jagudan. However, entries like JCr-2013-06 (24.70 q $ha^{-1}$), JCr-2013-15 (23.82 q $ha^{-1}$) and JCr-2013-23(23.17 q $ha^{-1}$) reordered higher yield over the check GCr-2 (17.55 q $ha^{-1}$).

At Kumarganj, 11 entries were selected for IET coriander. The highest seed yield was recorded in NDCor-110 (19.61 q $ha^{-1}$) followed by NDCor-102 (19.44 q $ha^{-1}$). Stem gall infestation was maximum in NDCor-119, NDCor-120 and minimum in NDCor-90 and NDCor-110 and NDCor-111.

At Dholi, RD-437 and RD-383 gave higher yield per hectare (29.23 and 24.37 q $ha^{-1}$) as compared to best check variety Hisar Anand (22.01 q $ha^{-1}$). RD-437 and RD-383 recorded significantly higher number of primary branches (9.78 and 9.89) and number of secondary branches per plant (33.67 and 33.56). Among the seven promising entries and two checks (Hisar Anand and Rajendra Swati) screened for stem gall, only three entries were found to be highly resistant against stem gall disease. Rest of the entries including check varieties were found to be highly susceptible against the disease.

At Raigarh, ICS 4 (18.47 q $ha^{-1}$) recorded maximum seed yield followed by RCC 12-11 (15.42 q $ha^{-1}$) and ICS 5-11 (9.65 q $ha^{-1}$) over the checks Hisar Anand (9.58 q $ha^{-1}$) and Rajendra Swati (7 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)***

Interaction effect between number of cuttings and variety was significant at Jagudan centre. Cultivation of GDLC 1 with two cuttings of leaves recorded the maximum seed equivalent yield (20.47 q $ha^{-1}$) and was at par with one cut of GDLC 1 (20.05 q $ha^{-1}$), but significantly superior over rest of the treatment combinations. Under no cut system, GCo 2 gave significantly higher seed equivalent yield (9.11 q $ha^{-1}$) than GDLC1 (4.96 q $ha^{-1}$). Also, interaction effect between cuttings management and fertility levels was found to be significant. Application of 60+30 Kg NPK/ha gave significantly maximum seed equivalent yield (21.09 q $ha^{-1}$), when coriander cultivar GDLC 1 grown. Raising of coriander under single cut practice produced significantly higher seed equivalent yield than other leaf cutting practices in each of the fertility levels.

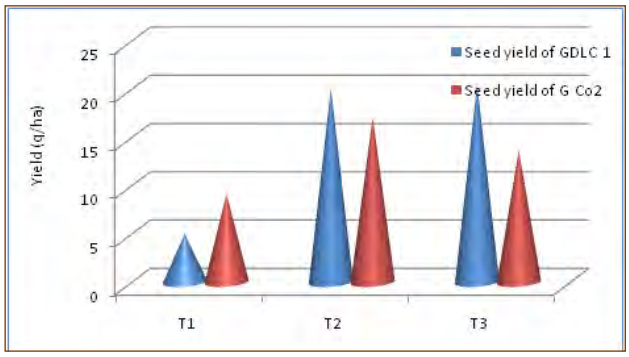



**Fig. 24: Interaction effect of cutting management and variety on coriander equivalent seed yield (q/ha)**

T1- No cutting (Top dressing at 30 DAS),
T2- One cutting at 40 – 45 DAS (Top dressing after first cut),
T3- Two cutting at 40 – 45 DAS and

### COR/CM/5.6 Effect of different level of fertilizers with bio-fertilizer on coriander

***(Centre: Middle Gangetic Plain Region - Dholi)***

All the treatments were found to be significantly superior to control with respect to plant height, number of primary branches per plant, number of secondary branches per plant, number of umbellets per umbel, number of grains per umbel, number of grains per umbellet and yield per plot/yield per hectare. Among the treatments, T6: 100% NPK (80:50:80kg $ha^{-1}$) + Azotobactor and T8: 100% N.P.K (80:50:80 kg $ha^{-1}$) + PSB gave significantly higher yield per hectare (27.83 and 27.72 q $ha^{-1}$) as compared to other treatments and control.

### 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. The drip fertigation at 0.8 IW/CPE ratio recorded significantly higher plant height (108.6 cm), umbels/plant (29.12), umbellets/ umbel (5.73), seeds/umbel (47.65), test weight (13.09 g), seed yield (21.94 q $ha^{-1}$) and water use efficiency (5.44 kg/ha $mm^{-1}$) . 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 (20.57 g $plant^{-1}$) followed by drip fertigation at 1.4 IW/CPE ratio (18.83 g $plant^{-1}$), drip fertigation at 1.0 IW/CPE (cumulative per evaporation) ratio (16.37 g $plant^{-1}$) and drip fertigation at 0.8 IW/ CPE ratio (14.00 g $plant^{-1}$).

At Guntur, five irrigation treatments were evaluated. The total potential evapo-transpiration was 307 mm during the crop period. Irrigation treatments were fixed month wise for 1, 0.8, 06, 0.4 IW/CPE and surface irrigation as check. Highest yield was recorded in T2-0.8 IW/CPE (18.73 q $ha^{-1}$) and it was significantly superior over all other treatments and control.

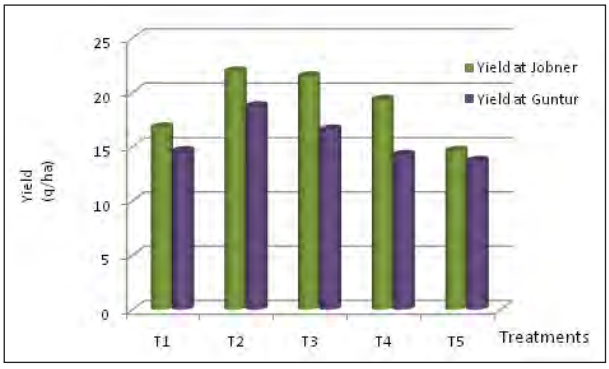



**Fig. 25: Effect of drip fertigation on seed yield of coriander at Jobner and Guntur**

Treatments:
T1 - Drip irrigation at 1.0 IW/CPE ratio
T2 - Drip irrigation at 0.8 IW/CPE ratio
T3 - Drip irrigation at 0.6 IW/CPE ratio
T4 - Drip irrigation at 0.4 IW/CPE ratio
T5 - Standard check
(Surface irrigation)

### COR/CM/5.9 Comparative performance of coriander entries under polyhouse, field and selfing net

***(Centre: Eastern plateau and hills region - Raigarh)***

In an evaluation trial of coriander genotypes for leaf yield, ICS 5-2 recorded maximum leaf yield of 51 g and 67.3 g respectively in polyhouse and field conditions. Under polyhouse conditions, germination of coriander seed was fast whereas growth and plant stand was good under field conditions.

## Crop Protection

### COR/CP/6 Disease Management Trial

### COR/CP/6.2 Survey to identify the disease incidence, collection and identification of causal organism in coriander

***(Centre: Middle Gangetic Plain Region - Dholi)***

Out of 159 collections in the germplasm, 54 accessions found to be highly resistant against stem gall disease under natural condition. Susceptible check (Rajendra Swati) also showed Highly Resistant reaction against stem gall disease under natural condition. Coriander field surveyed under Darbhanga district of Bihar were found to be infested with stem gall disease caused by *Protomyces macrosporus*.

### 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 were (5.40 PDI) followed by tebuconazole (7.68 PDI), while in control the incidence was 84.20 PDI. The plant height was 49.6 cm in propiconazole sprayed plants. This treatment recorded the highest seed yield of 918.5 kg $ha^{-1}$ as compared to control( 7.07q $ha^{-1}$).

Control (84.20PDI)

Propiconazole (5.40PDI)

**Fig. 26: Management of powdery mildew of coriander at Coimbatore**

An experiment on efficacy of new generation fungicides against powdery mildew of coriander was conducted at Jobner. First spray of fungicides itself has given at initial scantly appearance of disease. But, thereafter the disease did not develop on the crop and therefore, the observations on powdery mildew could not be taken. Seed yield was recorded in the treatments, which was found statistically at par.

There was significant difference in percent disease intensity at Jagudan. The minimum percent disease intensity (17.75 %) was observed in T6 , spraying of Propiconazole 0.1% and was at par with T7, spraying of Dinocap, T5 *i.e.*

spraying of Hexaconazole 0.1%, T4 *i.e.* spraying of wettable sulphur 0.2% and T1 *i.e.* spraying of Tebuconazole 0.1%. Effect of different trearments on coriander yield was found significant. Spraying of various fungicides was at par and recorded significantly higher yield than control. Significantly highest seed yield was recorded in T5 i.e. spraying of Hexaconazole 0.1% and remain at par with treatments T6 (Spraying of Propiconazole 0.1%), T4 (sprayng of wettable sulphur 0.2%), T7 (spraying of Dinocap) and T1 (spraying of Tebuconazole 0.1%).

Six fungicides were evaluated against powdery mildew of coriander at Kumarganj. The minimum per cent severity was observed in foliar spray of Tebuconazole 0.1 % (8.3 %) followed by foliar spray of Propineb 0.2% (9.1 %), foliar spray of wettable sulphur 0.2% (9.2%), and foliar spray of Azoxystrobin 0.1 %(10.6%). Whereas the highest yield was recorded in foliar spray of Azoxystrobin 0.1 % (6.24 q $ha^{-1}$), foliar spray of wettable sulphur 0.2% (5.74 q $ha^{-1}$) foliar spray of Tebuconazole 0.1% (5.73 q $ha^{-1}$) and foliar spray of Propiconazole 0.1% (5.56 q $ha^{-1}$) and minimum in control (3.82 q $ha^{-1}$).

Minimum disease intensity 2.5 per cent and maximum yield (15.3 q $ha^{-1}$) was found in the treatment, foliar spray of wettbale sulphur 0.2% at Raigarh.

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

***(Centre: 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 (60 days) + 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 (60days) + 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 (60days) (8.59 q $ha^{-1}$).

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

***(Centre: Middle Gangetic Plain Region - Dholi)***

Lowest disease (PDI 16.61) and highest yield (17.91 q $ha^{-1}$) was recorded in treatment of soil drenching with copper oxychloride @0.3% + seed treatment with carboxin + thiram @0.40% followed by foliar spray with Azoxystrobin + Tebuconazole @ 0.1% at 45, 60 & 75 DAS.

**Fig. 27: Symptom of stem gall disease**

**Fig. 28: Field view of coriander stem gall management trial**

# VIII. 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).

The 215 entries of cumin germplasm at Jagudan centre were sown for seed multiplication. Evaluation of gremplasm was carried out during the year 2016-17. Eight genotypes *viz.,* JC-95-13, JC-95-30, JC-2000-60, JC-95-130, JC-95-131, JC-96-42, JC-2000-60 and JC-99-39 were found superior for all traits under study.

**Table 16: Cumin germplasm collections at various AICRPS centres**

| Centre | Indigenous | Exotic | Total |
|---|---|---|---|
| Jagudan | 208 | 7 | **215** |
| Jobner | 370 | 6 | **376** |
| Sanand | 62 | - | **62** |
| **Total** | **640** | **13** | **653** |

**Fig. 29: Cumin seed production plot at Jagudan Centre**

Out of 108 accessions evaluated at Jobner, 8 accessions *viz.,* UC-287(12 g), UC-322 (10 g), UC-327 (10 g), UC-328 (10 g), UC-228 (9 g), UC-339 (9 g), UC-285 (8 g) and UC-325 (8 g) were better than best check variety RZ -223 (7.0 g) on the basis of seed yield per 5 plants.

### Screening for resistance against *Alternaria* blight disease

Total eighteen (16+2) entries of cumin were screened for the resistance against blight disease at Jagudan. The minimum disease intensity was noticed in GC-4 (32.5%) followed by GC-2000-28 (40.0 %), while the maximum disease intensity was recorded in the entry CUM-32 (81.0 %). The blight disease incidence ranged from 32.5 to 81.0 %.

The entries *viz.,* CUM-32 and CUM-36 were observed as moderately resistant against blight disease at Jobner.

### Screening for resistance against powdery mildew disease

At Jagudan, eighteen (16+2) entries of cumin were screened for the resistance against powdery mildew disease. The minimum disease intensity was noticed in GC-4 (17.5 %), while the maximum disease intensity was recorded in the entry CUM-32 (36.0 %). The powdery mildew incidence ranged from 17.5 to 36.0 %.

### Screening for resistance against wilt disease

Total thirty seven (34+3) 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 (40.0 %) followed by GC-4 (50.0 %). The wilt disease incidence ranged from 40.0 to 100.00 %.

At Jobner, three entries (CUM-36, GC-4,

RZ-223) were found moderately resistant against wilt disease.

### CUM/CI/1.3 Identification of drought tolerance

***(Centre: Central plateau and hills region - Jobner)***

An experiment was conducted during Rabi 2016-17 to identify drought tolerance in cumin. 30 genotypes were randomly selected from the germplasm maintained at Jobner. The genotypes; UC-260, UC-336, UC-339, RZ-19 and UC-272 in normal conditions while UC-339, UC-292, RZ-19, RZ-341, UC-293 and UC-272 in stress conditions were the top yielders. Based on stress indices, UC 253 was found to be the desirable entry for drought conditions, followed by UC-254, UC-256, UC-259, UC-240 and UC-241.

## Crop Improvement

### CUM/CI/2 Coordinated Varietal Trial

### CUM/CI/2.4 Coordinated Varietal Trial – 2013

***(Centres: Central plateau and hills region – Ajmer; Gujarat plains and hills region - Jagudan, Central plateau and hills region - Jobner)***

All entries gave significantly high yield over check, except Cum-37 at Jagudan. The top three entries *viz.,* Cum-33 (68.77 q $ha^{-1}$), Cum-32 (4.88 q $ha^{-1}$) and Cum-35 (4.80 q $ha^{-1}$) were recorded 247.12, 146.79 and 142.74 per cent higher yield than GC-4, respectively.

The trial was started in the year 2013-14 and is in the 3rd year of progress at Jobner. The analysis of variance revealed significant differences among the entries for seed yield. The seed yield ranged from 1.82 (RZ-223) to 2.87 (CUM-33) q $ha^{-1}$. Of the ten entries evaluated, CUM-33 recorded maximum seed yield of 2.87 q $ha^{-1}$ followed by CUM-37 (2.81 q $ha^{-1}$), GC-4 (2.72 q $ha^{-1}$), RZ-19 (2.71 q $ha^{-1}$) and CUM-34 (2.46 q $ha^{-1}$), while lowest seed yield of 182.64 q $ha^{-1}$ was recorded in RZ-223.

### CUM/CI/3 Varietal Evaluation Trial

### CUM/CI/3.4 IET on Cumin 2012

***(Centre: Central plateau and hills region - Jobner)***

The trial was started at Jobner, in the year 2013-14 and is in the 3rd year of progress. During rabi season of this year, ten entries were evaluated. The analysis of variance revealed significant differences among the entries for seed yield. It ranged from 1.84 to 3.57 q $ha^{-1}$. Of the ten entries evaluated, UC-242 recorded maximum seed yield of 3.57 q $ha^{-1}$ followed by UC-238 (3.55 q $ha^{-1}$), RZ-19 (3.54 q $ha^{-1}$), UC-234 (3.28 q $ha^{-1}$) and Local Check (3.26 q $ha^{-1}$), while lowest seed yield of 1.84 q $ha^{-1}$ was recorded in UC-260.

Mean performance of the entries evaluated in IET of cumin over 2013-14, 2014-15 and 2016-17 revealed superior performance of UC-242 yielding 2.67 q $ha^{-1}$ followed by UC-238 (2.60 q $ha^{-1}$), RZ-19 (2.42 q $ha^{-1}$), and UC-260 (2.36 q $ha^{-1}$), while lowest seed yield of 1.88 q $ha^{-1}$ was recorded in JC-95-136.

### CUM/CI/3.5 Initial Evaluation Trial 2013

***(Centres: Gujarat plains and hills region – Jagudan)***

At Jagudan, ten genotypes of cumin were evaluated with national check GC-4. The yield differences were found significant among entries. Four entries *viz.,* JC-2000-57 (7.37 q $ha^{-1}$), JC-2010-2 (6.11 q $ha^{-1}$), JC-2010-4 (6.68 q $ha^{-1}$) and JC-2010-5 (6.93 q $ha^{-1}$) gave significant high yield over check variety.

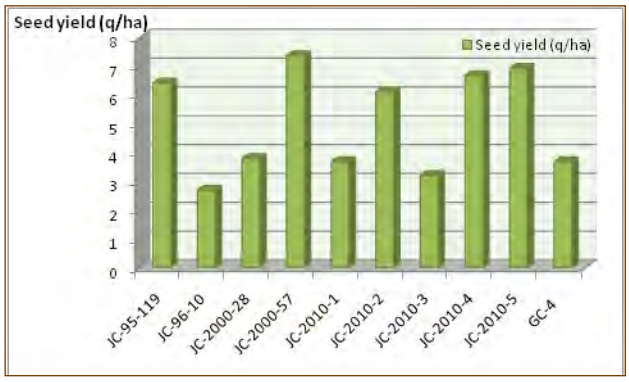



**Fig. 30: Evaluation of genotypes of cumin at Jagudan**

## 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 (13.6%) and maximum seed yield (2.03 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 @ 6 t $ha^{-1}$ + seed treatment with *Trichoderma* @ 6 g $kg^{-1}$ + spray of NSKE @ 5%, exhibited 15.6% wilt incidence and 1.85 q $ha^{-1}$ seed yield. Both these treatments were significantly superior over control, where maximum wilt incidence (33.5%) 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.

### 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. 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 0.4 IW/CPE ratio with 80% RDF recorded significantly higher plant height (30.41cm), umbels per plant (18.09), umbellets per umbel (4.19), seeds per umbel (22.47), seed yield (3.22 q $ha^{-1}$) and water use efficiency (2.46 kg ha-$mm^{-1}$). However it remained at par to drip fertigation with 100% RDF.

## Crop Protection

### CUM/CP/6 Disease Management Trial

### CUM/CP/6.5 Management of blight and powdery mildew by spacing and potash application

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

The crop sown by line sowing either 30 cm or 45 cm showed its superiority over broadcasting method with respect to increasing overall yield and reducing percent disease intensity of blight. The powdery mildew intensity was reported to be low during the season and it ranged from 11.53 to 18.46 percent. In case of application of potash, there was significant difference among different treatments. The application of potash either 10 kg or 20 kg reduced the percent disease intensity of blight and powdery mildew and increased the yield. The interaction effect of spacing and potash levels were found to be non significant.

At Jobner, the intensity of blight and incidence of wilt was low in line sowing as compared to broadcasting. It is inferred from the results that line sowing at 30 cm x 10 cm with recommended PoP resulted in low intensity of blight whereas low incidence of wilt and high seed yield of cumin were recorded in line sowing at 45 cm x 10 cm spacing over other line sowing, spacing and broadcasting. Also, increased level of potash application up to 20 kg $ha^{-1}$ significantly reduced blight intensity, wilt incidence and increased the seed yield of cumin.

## 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 2016-17 for the management of cumin aphid at Jagudan,. Among them, thiamethoxam 25 WG @ 25g a.i. $ha^{-1}$ followed by thiacloprid 21.7 SC @ 25g a.i $ha^{-1}$ had registered the least per cent umbels aphid infestation (3.34%) at 7 days after second spray and it was followed by thiamethoxam 25WG @ 25g a.i. $ha^{-1}$ followed by clothianidin 50WDG @ 20g a.i. $ha^{-1}$ (6.66%) as compared to untreated control (37.63%) at 7 days after second spray. Mean population of predatory Coccinellids varied from 1.72 (acetamiprid 20SP @ 20g a.i $ha^{-1}$ followed by thiacloprid 21.7SC @ 25g a.i. $ha^{-1}$) to 3.25 (untreated control) per plant. Seed yield of cumin was low due to adverse climatic conditions; however found to be highest in thiamethoxam 25 WG @ 25g a.i. $ha^{-1}$ followed by thiacloprid 21.7 SC@25g a.i. $ha^{-1}$ (1.88 q $ha^{-1}$), whereas, non protected plots of cumin had obtained only 0.28 q ha-1 seed yield of cumin.

At Jobner, spray with Thiamethoxam 25 WG @ 25 g a.i. $ha^{-1}$ followed by Clothianidin 50 WDG @ 20 g a.i. $ha^{-1}$ proved to be the most effective against cumin aphid and rendered highest seed yield (2.06 q $ha^{-1}$) which was on par with the treatment of spray with Thiamethoxam 25 WG @ 25 g a.i. $ha^{-1}$ followed by Thiacloprid 21.7 SC @ 25 g a.i. $ha^{-1}$.

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

***(Centre: Central plateau and hills region – Jobner)***

An experiment on the management of powdery mildew in cumin through new chemicals was conducted. First spray of fungicides was given at initial appearance of disease. But, thereafter the disease did not develop on the crop and therefore, the observations on powdery mildew could not be taken. Seed yield was recorded in the treatments, which was found to be statistically at par.

# 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 17 shows the germplasms collection maintained at various AICRPS centres.

Out of sixty accessions evaluated at Dholi, only nine accessions namely RF61, RF-62, RF-68, RF-60, RF-65, RF-63, RF-38, RF-29 and RF-10 gave the highest yield ranging from 112 g to 88 g per plant as compared to the best check variety GF-11 (82 g plant$^{-1}$). Among the nine promising lines, RF-61 gave the highest yield of 112 g per plant followed by RF-62 (100 g plant$^{-1}$).

**Fig. 31: Field view of Fennel germplasm at Dholi**

At Kumarganj, 161 germplasm of fennel were evaluated and the maximum yield was recorded in NDF-45 (56.90 g plant$^{-1}$) followed by NDF-5 (52.65 g plant$^{-1}$), NDF-51 (51.65 g plant$^{-1}$) and NDF-45 (50.40 g plant$^{-1}$). Incidence of Powdery mildew was maximum in NDF-87, NDF-85 and NDF-41 and minimum in NDF-84, NDF-68, NDF-74 and NDF-51.

At Hisar, 143 accessions of fennel were evaluated using GF-2, Hisar Sawrup and Raj-Saurabh as checks. The seed yield of the germplasm ranged from 32.5 g plant$^{-1}$ (HF-178) to 96.8 g plant$^{-1}$ (HF-104). The most promising lines were HF-104, HF-108, HF-111, HF-112, HF-132, HF-157, HF-163, HF-164, HF-214 and HF-228.

During the Rabi season, the 80 indigenous fennel accessions were evaluated for different yield attributes with GF-12 as check at Jagudan. Among them, ten entries were dwarf types, having less than 92 cm plant height. Fourteen entries had good branches *i.e.* more than 10 branches per plant. Nine entries recorded more than 17 Umbellates per umbel. Eleven entries were promising for more seeds per umbellate *i.e.* > 21 seed per umbellate. Sixteen entries observed early maturity (< 150 days) while fifteen entries recorded more than 30 g plant$^{-1}$ grain yield.

Two hundred sixty three germplasm accessions were evaluated at Jobner along with six checks namely RF-101, RF-125, RF-143, RF-157, RF-205 and RF-281 in augmented design. Out of 263 accessions, 98 accessions were better than best check variety RF - 157 (90.4 g) on the basis of seed yield per 5 plants. Promising accessions identified on the basis of seed yield per 5 plants were UF-281 (180.0 g), UF-44 (177.0 g), UF-234 (170.0 g), UF-7 (165 g),UF-27 (165.0 g), UF-64 (163.0 g), UF-65 (159.0 g), UF-155 (146.0 g), UF-80 (146.0 g), and UF-133 (143.0 g).

**Table 17: 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 | 166 | 4 | - | 170 |
| Jagudan | 161 | - | 2 | 163 |
| Jobner | 271 | - | 20 | 291 |
| Kumarganj | 140 | - | - | 140 |
| Pantnagar | 21 | - | - | 21 |
| Total | 821 | 4 | 22 | 847 |

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

During Kharif season, total thirty eight (36 +2) entries of fennel were screened under natural conditions at Jagudan. None of the entries were found free from the *Ramularia* blight. The minimum intensity of *Ramularia* blight was noticed in JF-2013-28 (22.5%). The per cent disease intensity ranged between 22.5 and 80 %. Among the twenty eight (26+2) entries of fennel screened during Rabi season at Jagudan, none of the entry was found free from the *Ramularia* blight intensity. The minimum intensity of Ramularia blight was noticed in FNL-90 (11%) while the maximum intensity of Ramularia blight was recorded in entry FNL-96 (45.0%). The per cent disease intensity ranged between 11.0 and 45.0 %.

## 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)***

Among the fifteen genotypes of fennel tested at Jabalpur, FNL 92 gave early flwering (94.67 days). Maximum plant height was noted in FNL 96 (189.20 cm) and number of branches per plant in RF-101 (NC) (10). In terms of yield, the check variety FNL 97 recorded maximum yield (15.22 q $ha^{-1}$).

The analysis of variance revealed significant differences among the entries for all the traits at Jobner. The seed yield ranged from 11.64 to 19.02 q $ha^{-1}$. Of the fourteen entries evaluated, the entry RF-205 recorded maximum seed yield of 19.02 q $ha^{-1}$ followed by FNL-100 (18.35 q $ha^{-1}$), FNL-92 (18.11 q $ha^{-1}$), FNL-93 (17.95 q $ha^{-1}$) and FNL-95 (17.42 q $ha^{-1}$), while lowest seed yield of 5.74 q $ha^{-1}$ was recorded in FNL-88.

Among thirteen entries and three check varieties tested at Dholi, FNL-101, FNL 99 and FNL-100 recorded significantly yield per hectare (17.68, 1667.00 and 15.27 q $ha^{-1}$) respectively as compared to best check variety Rajendra Saurabh (12.87 q $ha^{-1}$).

Out of 15 genotypes of fennel tested at Kumarganj under CVT, the highest yield was observed in FNL-99 (13.61 q $ha^{-1}$) followed by FNL-97 (13.19 q $ha^{-1}$), FNL-95 (12.77 q $ha^{-1}$) and FNL-98 (120.50 q $ha^{-1}$). The incidence of powdery mildew was meager.

At Hisar, significant differences were obtained for all the parameters studied. Plant height ranged from 144.8 cm to 188.7 cm, number of branches 7.8 to 10.9, umbels per plant 20.3 to 40.4, umbellate per umbel 25.8 to 35.3 and seeds per umbel 427 to 649.1 Maximum seed yield was recorded as 21.24. q $ha^{-1}$ in FNL-97 followed by FNL-98 (20.15 q $ha^{-1}$) and FNL-99 (19.89 q $ha^{-1}$) respectively.

**Fig. 32: View of fennel field at Hisar**

The yield differences among the entries were found significant at Jagudan. However, none of the entries were found either numerically or statistically superior over any check varieties. Only RF-101 (19.15 q $ha^{-1}$) recorded 4.5 percent higher yield than check varieties GF-11 (18.33 q $ha^{-1}$).

### FNL/CI/3 Varietal Evaluation Trial

### FNL/CI/3.4 Initial Evaluation Trial 2014

***(Centre: Central plateau and hills region – Jobner; Western Himalayan Region – Pantnagar; Trans Gangetic Plain Region – Hisar)***

The trial is in the third year of progress at Jobner. The analysis of variance revealed significant differences among the entries for all the traits. The seed yield ranged from 22.84 to 31.15 q $ha^{-1}$. Of the ten entries evaluated, RF 125 recorded maximum seed yield of 31.15 q $ha^{-1}$ followed by RF 205 (30.22 q $ha^{-1}$), UF- 289 (29.99 q $ha^{-1}$), UF-285 (28.22 q $ha^{-1}$) and UF-287 (27.42 q $ha^{-1}$) while lowest seed yield of 22.84 q $ha^{-1}$ was recorded in UF-284.Mean performance of the entries evaluated in IET of fennel over 2014-15 to 2016-17 revealed superior performance of RF-125 yielding 25.87 q $ha^{-1}$ followed by UF-286 (25.74 q $ha^{-1}$), UF-287 (25.19 q $ha^{-1}$) and UF- 289 (24.85. q $ha^{-1}$), while lowest seed yield of 21.22 q $ha^{-1}$ was recorded in UF-285.

At Hisar, the initial evaluation trial (IET) in fennel was conducted with ten accessions along with HF-33 as check during 2014-15, 2015-2016 and 2016-2017 in plots measuring 3.0 x 2.4 m. The results indicated maximum seed yield in HF-179 (21.04 q $ha^{-1}$) followed by HF-146 (19.89 q $ha^{-1}$) showing an increase of 29.2 and 22.2 % over HF-33 (check), from three years mean respectively.

### FNL/CI/3.5 Initial Evaluation Trial 2015

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

Ten entries were evaluated including check GF-12 at Jagudan. The yield differences among the entries were found non significant, however, JF-2013-16 (29.20 q $ha^{-1}$) had maintained its higher numeracy value for yield.

At Kumarganj, eleven entries were tested under IET. The maximum yield were recorded in NDF-84 (0.15 q $ha^{-1}$) followed by NDF-77 (0.14 q $ha^{-1}$), NDF-68 (0.13 q $ha^{-1}$) and NDF-74 (0.13. q $ha^{-1}$).

Nine entries and two checks viz., GF-11 and Rajendra Saurabh were tested at Dholi. Among the nine entries and two checks, RF-31 gave significant high yield per hectare (27.16 q $ha^{-1}$) as compared to best check variety Rajendra Saurabh (24.07 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 2016-17. 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 (121.16 cm), umbels per plant (30.64), umbellets per umbel (25.08), seeds per umbel (411.1), test weight (6.07g), seed yield (25.80 q $ha^{-1}$) and water use efficiency (5.86 kg $ha^{-mm}$). However it remained at par to drip fertigation with 100% RDF and drip fertigation with 100% RDN.

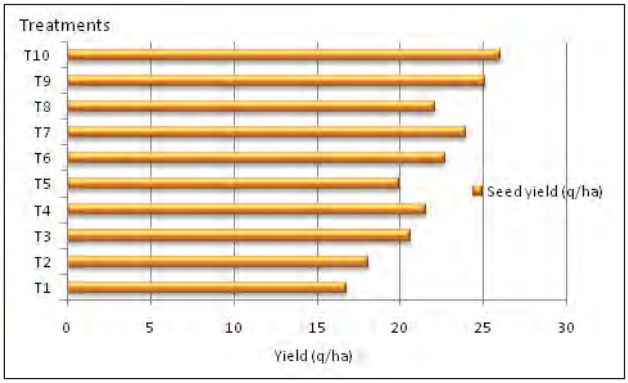



**Fig. 33: Standardization of drip fertigation in fennel**

| | |
|---|---|
| T1 | - Surface irrigation with 100% RDF |
| T2 | - Drip irrigation with 50% RDF |
| T3 | - Drip irrigation with 75% RDF |
| T4 | - Drip irrigation with 100% RDF |
| T5 | - Drip fertigation with 50% RDN |
| T6 | - Drip fertigation with 75% RDN |
| T7 | - Drip fertigation with 100% RDN |
| T8 | - Drip fertigation with 50% RDF (N-P) |
| T9 | - Drip fertigation with 75% RDF |
| T10 | - Drip fertigation with 100% RDF |
| RDF | - Recommended dose of fertilizer (90-40-0) |
| RDN | - Recommended dose of nitrogen |

# 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 18)

**Fig. 34: Field view of fenugreek germplasm at Pantnagar**

Out of one hundred sixty three accessions of fenugreek evaluated at Dholi, only eleven accessions namely- RM-209, RM-208, RM-205, RM-206, RM-199, RM-28, RM-201, RM-194, RM-191, RM-188 and RM-112 gave the highest yield ranging from 66 g to 58 g per five plants as compared to best check variety Rajendra kanti and Hisar Sonali with yield per five plant of 56 g of each check variety. Among the eleven best promising accessions, RM-209 gave the highest yield per five plants (66 g) followed by RM-208 (65g five plants$^{-1}$).

One hundred and ninety nine accessions of fenugreek were maintained and evaluated at Kumarganj. The highest yield was found in MDM-15 (4.8 g plant$^{-1}$) followed by NDM-17 (4.6 g plant$^{-1}$), NDM-11 (4.5 g plant$^{-1}$). Data on incidence of *Cercospora* leaf spot was also recorded and found minimum disease intensity in NDM-7 (12.32 %) followed by NDM-2 (17.5 %), NDM-6 (19.5 %), NDM-27 (21.2 %) and NDM-29 (24.9 %) in comparison to Hisar Sonali (42.5 %) and PGB-2 (40.0 %).

At Guntur 124 germplasm lines along with ten checks were evaluated in Augmented Block Design. Among the entries evaluated, only four entries *i.e.* LFC-82 (5.95 g plant$^{-1}$), LFC-38 (5.03 g plant$^{-1}$), LFC-122 (4.51 g plant$^{-1}$) and LFC- 51 (4.45 g plant$^{-1}$) were significantly superior to the best check APHU Methi-1 (3.82 g plant$^{-1}$).

**Table 18: Germplasm collection of fenugreek in various AICRPS centres**

| Centre | Indigenous | | Total |
|---|---|---|---|
| | Existing | Addition (2016 -17) | |
| Dholi | 175 | 7 | **182** |
| Guntur | 124 | - | **124** |
| Hisar | 381 | 8 | **389** |
| Jagudan | 75 | - | **75** |
| Jobner | 348 | 25 | **373** |
| Kumarganj | 190 | - | **190** |
| Pantnagar | 65 | - | **65** |
| **Total** | **1358** | **40** | **1398** |

One hundred fifty six accessions of fenugreek were evaluated along with Hisar Sonali, Hisar Suvarna and Hisar Mukta as checks at Hisar. The seed yield ranged from 9.4 g plant$^{-1}$ (HM-537) to 20.6 g plant$^{-1}$ (HM-429). The most promising lines for seed yield were HM-403, HM-407, HM-407, HM-413, HM-429, HM-452, HM-465, HM-486, HM-530, HM-541 and HM-543.

Three hundred forty seven accessions of fenugreek were evaluated at Jobner, along with eight checks namely RMt-1, RMt-143, RMt-303, RMt-305, RMt-351, RMt-354, RMt-361 and RMt-365. A wide range of variability was found for all the characters studied. Out of 347 accessions, 94 accessions were better than best check variety RMt-303 (27.5 g 5 plants$^{-1}$). Some of the promising accessions identified on the basis of grain yield per 5 plants were UM-221 (54.0 g), UM-210 (48.0 g), UM-167 (46.0 g), UM-187 (46.0 g), UM-15 (44.0 g), UM-163 (44.0 g), UM-76 (43.0 g), UM-208 (43.0 g), UM-202 (42.0 g) and UM-57 (41.0 g).

## Screening of germplasm

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

Total twenty five (22+3) entries of fenugreek were screened under natural condition for powdery mildew disease at Jagudan. None of the entries were found free from the powdery mildew incidence. The minimum incidence was noticed in FGK-97 (18.0 %), while the maximum per cent disease intensity was recorded in entry FGK-102 (50.0 %).

At Jobner, three hundred and fifty nine entries of fenugreek were screened against powdery mildew disease. Forty seven entries *viz.,* UM-5, UM-26, UM-28, UM-30, UM-32, UM-38, UM-76, UM-80, UM-81, UM-87, UM-132, UM-135, UM-136, UM-145, UM-146, UM-148(2), UM-150(2), UM-151, UM-157, UM- 161, UM-162, UM-164, UM-166, UM-179, UM-196, UM-199, UM-217, UM-236, UM-251, UM-254, UM-255, UM-279, UM-293, UM-297, UM-330, UM-349, UM-352, UM-353, UM-363, UM-364, UM-366, UM-376, UM-382 and UM-385 (2) were observed as moderately resistant against powdery mildew disease.

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

***(Centre: Central plateau and hills region - Jobner)***

Thirty genotypes were randomly selected from the germplasm being 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 40, UM 38, UM 50, UM 55, UM 64, UM 37 and UM 52 in normal conditions while UM 38, UM 66, RMt 361, UM 55 and UM 46 in stress conditions were top yielders. Based on stress indices UM 66, UM 57, UM 61, RMt 361, UM 44

and UM 38 were found to be the desirable entries for drought conditions.

## 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)***

At Jabalpur, early flowering was observed in FGK-94 (46.67 days). The maximum seed yield of 13.89 q $ha^{-1}$ was recorded in the genotype FGK-103 followed by FGK-106 (11.74 q $ha^{-1}$), FGK-96 (11.57 q $ha^{-1}$) and FGK-97 (11.57 q $ha^{-1}$).

The analysis of variance revealed significant differences among the entries for seed yield at Jobner. The seed yield ranged from 6.15 to 18.37 q $ha^{-1}$. Of the nineteen entries evaluated, entry FGK-102 recorded maximum seed yield of 18.37. q $ha^{-1}$ followed by RMt-351 (17.26 q $ha^{-1}$), Hisar Sonali (16.87 q $ha^{-1}$), FGK-96 (16.64. q $ha^{-1}$) and FGK-104 (16.48 q $ha^{-1}$), while lowest yield of 6.15 q $ha^{-1}$ was recorded in FGK-107.

**Fig. 35: Coordinated varietal Trial on fenugreek at Coimbatore**

Fourteen fenugreek genotypes along with two checks were evaluated at Coimbatore. The plant height of the genotypes ranged from 35.00 cm (FGK 106) to 44.88 cm (FGK 107). The genotype FGK 94 (27.89) recorded maximum number of pods per plant and the genotype FGK 99 (18.67) recorded lesser number of pods per plant. The genotype FGK 99 recorded the highest seed yield of 8.33. q $ha^{-1}$ as compared to the check varieties RMt-361 and Hisar Sonali which recorded the seed yield of 6.08.33 q $ha^{-1}$ and 6.66 q $ha^{-1}$ respectively.

Among fourteen promising entries and three check varieties (two national check- RMt-361 and Hisar Sonali, local check- Rajendra Kanti) tested at Dholi, none of the entries were found significantly superior regarding growth and yield parameters as compared to best check variety Hisar Sonali. However, among the entries FGK-106 and FGK-105 gave the highest yield per hectare (32.66 and 32.55 q $ha^{-1}$) over other promising entries and check varieties.

At Kumarganj, maximum yield was recorded in FGK-94 (13.40 q $ha^{-1}$) followed by FGK-97 (13.33 q $ha^{-1}$), FGK-96 (13.12 q $ha^{-1}$) and FGK-101 (13.05 q $ha^{-1}$). During the year, only very few spots of *Cercospora* leaf spot disease has been observed.

At Guntur, thirteen genotypes from different coordinating centers were evaluated along with two checks in RBD replicated twice. Among the entries evaluated, none of the entries were found significantly better than the best check APHU Methi-1. However, the entries FGK-104 (9.56 q $ha^{-1}$), FGK-101 (9.43 q $ha^{-1}$) and FGK-100 (9.22 q $ha^{-1}$) recorded significantly higher yield over national check Rmt-361 (5.00 q $ha^{-1}$).

Significant differences were obtained for all the parameters at Hisar. Plant height ranged from 81 to 110.2 cm, number of pods per plant 84.7 to 108.2, length of pods 8.0 to 9.2 cm and number of seeds per pod 15.9 to 17.8. Maximum seed yield (21.83 q $ha^{-1}$) was recorded in FGK-105 followed by FGK-106 (21.25 q $ha^{-1}$) and FGK-104 (20.49 q $ha^{-1}$).

At Jagudan, significant yield differences were observed among the entries but none of the entries found significantly superior over best check GM-2. However, entry FGK-99 (21.48 q $ha^{-1}$) gave numerically higher yield than RMT-361 (20.10 q $ha^{-1}$) and GM-2 (19.91 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, FGK-96 (17.06 q $ha^{-1}$) and FGK-98 (15.22 q $ha^{-1}$) recorded high seed yield of fenugreek over national check Hisar Sonali (9.83 q $ha^{-1}$).

The seed yield ranged from 7.81-18.05 q $ha^{-1}$ in the second year of evaluation at Kota. FGK 104 was found to be the best performing entry in terms of seed yield (18.05 q $ha^{-1}$) followed by FGK – 94 (15.97 q $ha^{-1}$) showing 30 per cent higher yield over the check Hisar Sonali. The mean days for flowering ranged from 57 days (FGK 99) to 69.67 days (FGK 107); days to maturity from 118 days (FGK 99) to 122.67 days (FGK 96) and test weight from 12.79 g (FGK -94) to 15.10 (FGK-100).

### FGK/CI/3 Varietal Evaluation Trial

### FGK/CI/3.6 Initial Evaluation Trial on fenugreek

(***Centre: Middle Gangetic Plain Region – Dholi; Trans Gangetic Plain Region - Hisar)***

Among eight entries and two check varieties tested at Dholi, RM 196 (32.22 q $ha^{-1}$) and RM-201 (31.11 q $ha^{-1}$) were found significantly superior in yield per hectare as compared to best check variety Hisar Sonali (13.33 q $ha^{-1}$).

The initial evaluation trial (IET) in fenugreek was conducted at Hisar with eight accessions along with Hisar Sonali and Hisar Suvarna as check during 2014- 2015, 2015-2016 and 2016-2017. The results indicated that maximum mean seed yield was recorded in HM-273 (25.16 q $ha^{-1}$) followed by HM-355 (25.06 q $ha^{-1}$) showing an increase of 15.04 and 14.58 % over Hisar Sonali (check) respectively (Table 19).

**Table 19 : Yield of fenugreek entries in IET at Hisar**

| S. No. | Accession number | Seed yield ( q / ha) | | | Mean | % increase over check |
|---|---|---|---|---|---|---|
| | | 2014-2015 | 2015-2016 | 2016-17 | | |
| 1. | HM-273 | 26.97 | 24.84 | 23.68 | 25.16 | 15.04 |
| 2. | HM-291 | 26.07 | 23.47 | 22.78 | 24.11 | 10.24 |
| 3. | HM-355 | 26.8 | 24.77 | 23.61 | 25.06 | 14.58 |
| 4. | HM-357 | 24.47 | 20.83 | 20.58 | 21.96 | 0.41 |
| 5. | HM-396 | 24.72 | 22.25 | 21.9 | 22.96 | 4.98 |
| 6. | HM-411 | 23.84 | 20.53 | 19.28 | 21.22 | -2.97 |
| 7. | HM-456 | 25.55 | 21.74 | 21.7 | 23.00 | 5.16 |
| 8. | HM-523 | 26.72 | 22.27 | 22.07 | 23.67 | 8.32 |
| 9. | Hisar Suvarna | 23.77 | 20.43 | 19.9 | 21.37 | - |
| 10. | Hisar Sonali | 23.46 | 21.51 | 20.64 | 21.87 | - |
| C.D. at 5% | | 236 | 157 | 137 | - | - |
| CV | | 5.4 | 4.0 | 3.7 | - | - |

### 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)***

At Guntur, the two entries, APHU Methi-1 and Lam Selection-1 were analysed for moisture, fixed oil (total fat) and Saponin content. The results revealed that APHU Methi-1 was low in saponin content (6.81 %) and Lam Selection-1 (8.37 %) was medium in saponin content. The total oil content was high in Lam Selection-1(5.65 %), whereas medium in APHU Methi-1 (5.1 %). The moisture content in both the varieties was recorded to be in the recommended range of 7.0-8.0 %.

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

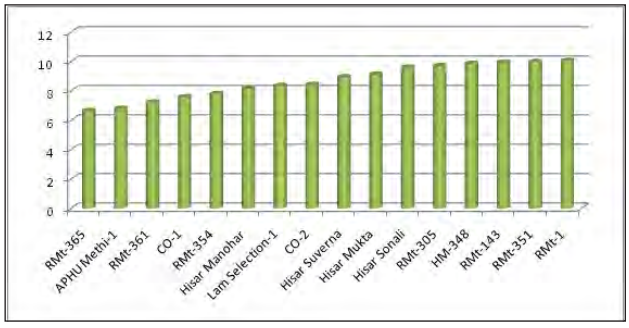



**Fig. 36: Saponin (%) in different released varieties of fenugreek**

### 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 (14.65 q $ha^{-1}$) followed NDM-80 (14.23 q $ha^{-1}$), NDM-112 (13.19 q $ha^{-1}$), NDM-83 (12.35 q $ha^{-1}$) and NDM-83 (12.35 q $ha^{-1}$). In case of leaf spot, minimum disease intensity was observed in NDM-112 (8.5 %) followed by NDM-111 (11.0 %), NDM-80 (13.6 %) and NDM-83 (14.5 %) in comparison to Hisar Sonali (24.5 %).

At Jagudan, JFg-2013-16 (24.44 q $ha^{-1}$), JFg-2013-7 (23.62 q $ha^{-1}$) and JFg-2013-7 (20.85 q $ha^{-1}$) gave numerically higher yield than GM-2, which were 21.8, 17.8 and 3.9 per cent higher yield over check variety 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 11.98 to 21.59 q $ha^{-1}$. Of the ten entries evaluated, entry UM-411 recorded maximum seed yield of 21.59 q $ha^{-1}$ followed by UM-393 (19.95 q $ha^{-1}$), RMt-1 (18.70 q $ha^{-1}$) and UM 415 (18.28 q $ha^{-1}$), while lowest yield of 11.98 q $ha^{-1}$ was recorded in RMt-361. Ten (IET) entries of fenugreek were screened against powdery mildew disease. Entries UM-398 and UM-393 were observed moderately resistant against powdery mildew disease.

# 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)***

At Guntur, nine genotypes from different coordinating centers were evaluated along with four checks in RBD replicated twice. Among the entries evaluated, only four entries *viz.,* LS-14-3 (9.84 q $ha^{-1}$), AA-6 (9.80 q $ha^{-1}$), LS-14-8 (9.54 q $ha^{-1}$) and AA-73 (8.70 q $ha^{-1}$) were found significantly superior to the best check GA-1 (6.60 q $ha^{-1}$).

Among13 accessions evaluated for seed yield at Raigarh, Ajwain 1 recorded maximum seed yield (2.57 q $ha^{-1}$) followed by entry LS-14-8 (2.40 q $ha^{-1}$) over two checks AA-1 (1.50 q $ha^{-1}$) and AA -2 (1.45 q $ha^{-1}$).

Statistical difference for all characters were found to be non significant except plant height at Jagudan where a total of 14 entries including checks were evaluated during the year 2016-17. Despite of non significant difference, IA-2 (11.06 q $ha^{-1}$) was found to be the paramount genotype. Eight genotypes recorded numerically high yield than check variety AA-2.

Out of 10 entries of Ajwain evaluated at Kumarganj, maximum yield was found in NDAJ-10 (8.12 q $ha^{-1}$) fallowed by AA-6 (7.91 q $ha^{-1}$), AA-73 (7.70 q $ha^{-1}$) and JA-187 (7.50 q $ha^{-1}$) and NDAJ-11 (7.70 q $ha^{-1}$).

The significant differences were obtained for all the parameters at Hisar. Plant height ranged from 91.0 to 105.8 cm, umbels per plant 64.8 to 117.7, umbellets per umbel 17.4 to 22.0 and seeds per umbel 207.8 to 296.8. Maximum seed yield (8.34 q $ha^{-1}$) was recorded in NDA-11 followed by HAJ-18 (8.20 q $ha^{-1}$) and HAJ-7 (7.62 q $ha^{-1}$).

In Rabi 2016-17, twelve entries were evaluated at Jobner. The analysis of variance revealed significant differences among the entries for seed yield. The seed yield ranged from 2.95 to 6.40 q $ha^{-1}$. Of the twelve entries evaluated, HAJ-7 recorded maximum seed yield of 6.40 q $ha^{-1}$ followed by NDAJ-11 (5.90 q $ha^{-1}$), IA-1 (5.26 q $ha^{-1}$), NDAJ-10 (5.11 q $ha^{-1}$) and AA-93 (5.10 q $ha^{-1}$), while lowest yield of 2.95 q $ha^{-1}$ was recorded in LS-14-8.

# 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 first year of evaluation at Kota. AN-23 and AN-1 were found to be the best performing entries in terms of seed yield, yielding 7.99 q $ha^{-1}$ followed by AN-1 (7.71 q $ha^{-1}$) and showing 6.48 per cent higher yield over the check AN-20. The mean days to flowering ranged from 89 days (AN-1) to 95.67 days (PK-1, PK-2 and Pant Krishna); days to maturity from 129 days (AN-23) to 135 days (AN-20) and test weight from 6.34 g (AN-23) to 7.34 (IN-1).

At Kumarganj, 10 entries of nigella were tested which revealed maximum plant height in AN-23 (78.66 cm) and minimum in AN-I (59.44 cm). Number of branch per plant was highest in AN-23 (6) and lowest in IN-1 (4.33). Number of capsule per plant was maximum in AN-20 (50) while number of seeds per capsule was maximum in PK-2 (95.22). The highest yield was recorded in NDBC-20 (8.12 q $ha^{-1}$) followed by AN-112 (7.43q $ha^{-1}$) and IN-1(7.15 q $ha^{-1}$)

Seven Nigella genotypes were evaluated in a Coordinated Varietal trial at Kalyani. The genotype HKL-T recorded maximum plant height (52.22 cm), number of primary branches per plant (7.56), number of secondary branches per plant (9.00), days to 50 % flowering (67.33 days), number of capsules per plant (22.56), number of seeds per capsule (69.78), test weight (2.65 g), yield per hectare (5.28 q) (Table 20).

**Table 20: Growth, yield and yield parameters of Nigella genotypes for coordinated trial at Kalyani**

| Nigella genotypes | 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 | 64.00 | 47.78 | 6.33 | 6.78 | 16.00 | 64.67 | 2.52 | 4.61 |
| AN-20 | 64.67 | 48.78 | 7.00 | 7.56 | 16.67 | 65.33 | 2.58 | 4.72 |
| AN-23 | 62.33 | 47.00 | 7.22 | 8.33 | 15.56 | 58.44 | 2.42 | 4.25 |
| HKL-T | 67.33 | 52.22 | 7.56 | 9.00 | 22.56 | 69.78 | 2.65 | 5.28 |
| Pant Krishna | 63.00 | 48.67 | 6.22 | 7.33 | 18.89 | 60.11 | 2.44 | 4.31 |
| PK-1 | 63.67 | 43.22 | 7.33 | 8.67 | 19.67 | 62.44 | 2.48 | 4.38 |
| PK-2 | 65.67 | 45.11 | 6.33 | 7.00 | 20.67 | 66.33 | 2.61 | 4.90 |
| SE | 0.457 | 0.275 | 0.168 | 0.217 | 0.238 | 0.590 | 0.020 | 0.010 |
| C.D. | 1.409 | 0.849 | 0.519 | 0.670 | 0.733 | 1.819 | 0.061 | 0.032 |

**Fig. 37: Performance of Nigella in CVT at Kalyani**

# XIII. Monitoring

The research programmes undertaken by the centres were monitored by Project Coordinator and the Scientists from PC unit's through visits to various centres and the experimental plots. 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 suggestions were given for improvement. A seed spices monitoring team involving Dr. Dhirendra Singh from SKNAU, Jobner and Dr.Y.K. Sharma from NRCSS, Ajmer have visited the seed spices centres for reviewing progress of the experiments.

**Visit to the centres during the period from 1st April 2016 to 31st March 2017**

| Sl.No. | Dates of visit | Centre visited |
|---|---|---|
| 1 | 01.06.2016 | AICRPS Centre, Ambalavayal |
| 2 | 01.08.2016 | AICRPS Project mode center Thrissur |
| 3 | 19.09.2016-20.09.2016 | AICRPS Centre at Coimbatore |
| 4 | 28-09-16 | AICRPS Centre, Ambalavayal, KAU |
| 5 | 06.11.2016-08.11.2016 | AICRPS Centres at Sakleshpur and Mudigere |
| 6 | 10.11.2016-13.11.2016 | AICRPS Centre at Coimbatore |
| 7 | 14.11.2016-27.11.2016 | AICRPS Centre at Nagaland |
| 8 | 07.12.2016-08.12.2016 | AICRPS Centre at Panniyur |
| 9 | 10.02.2017 | AICRPS Centre at Ambalavayal |
| 10 | 27.02.2017-02.03.2017 | AICRPS Centre at Mudigere |
| 11 | 20.03.2017-24-03-2017 | Seed spices monitoring team-Jobner, Hisar, Ajmer and Jagudan |
| 12 | 22.03.2017-25.03.2017 | AICRPS Centre at Yercaud |


**Visit of Project Coordinator and Seed Spices monitoring team to centres**

# XIV. Annual Group Meeting

The 27th Workshop of ICAR-All India Coordinated Research Project on Spices was conducted during 24-26 October 2016 at ICAR-National Research Centre on Seed Spices (NRCSS), Ajmer, Rajasthan. Dr. T. Janakiram, Asst. Director General (Hort. Sciences- II), ICAR, New Delhi inaugurated the workshop and emphasized the importance of co-ordinated programme in the varietal evaluation and technology development. He urged the researchers to work on water saving techniques for getting more crop per drop to save the precious natural resources for the future generation. Dr. Gopal Lal, Director NRCSS, Ajmer delivered presidential address. Dr. Homey Cheriyan, Director, Directorate of Arecanut and Spices Development (DASD), Kozhikode, Dr. P. N. Jagadev, Director of Research, OUAT, Bhubaneshwar and Dr. S. R. Maloo, Former Director Research, MPUAT, Udaipur were the Guest of Honour and expressed their views towards coordinated research in evolving new technologies and varieties for farmers. During the inaugural session the "Best AICRPS Centre Award 2015-16" was presented to SKNAU, Jobner, Rajasthan and 21 booklets / pamphlets on AICRP technologies in English and local languages from different AICRPS centres were released during the occasion.

Dignitaries like Dr. H. P. Maheswarappa, Project Coordinator, AICRP on Palms, Dr. Ravindra Singh, Dr. R.K. Kakani, Dr. Y. K. Sharma, Dr. R. K. Solanki, Dr. R.S. Mehta, Dr. N.K. Meena, Principal Scientists from NRC for Seed Spices, Ajmer, Dr. S. J. Ankegowda, Head, IISR Regional Station Appangala, Dr. Santhosh J. Eapen Head, Division of Crop Protection, Dr. T. John Zachariah, Dr. S. Devasahayam, Dr. K. Kandiannan Dr. K. S. Krishnamurthy and Dr. D. Prasath, Principal scientists from ICAR-Indian Institute of Spices Research 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 in which Project Coordinator presented the Action Taken Report of 26th workshop and the research highlights and it was approved by the workshop.


**Inaguration of the workshop by Dr. T. Janakiram, ADG, Horticulture Sciences, ICAR, New Delhi**


**Dignitaries on the dias during inagural session**

**Some important decisions taken in the workshop are**

1. Varieties recommended by AICRPS should be submitted immediately to Central Varietal Release committee.

2. Technologies under AICRPS need to be commercialized and AICRPS centers have to share the credit with ICAR-AICRPS.

3. Technologies recommended from AICRPS should be incorporated in Package of Practices of respective states

4. Funds for conservation of genetic resources need to be increased. A proposal for this may be submitted.

5. Funding from Bioversity international may be explored for conservation of genetic resources

6. SOP (Standard operation protocol) for all AICRPS may be developed for uniformity in the trial layout, data recording, compilation and presentation

7. In experiments on field screening of accessions to various pathogens and pests, the results may be supplemented by laboratory/ greenhouse studies with identified strains. In experiments on field screening of accessions to various pathogens and pests, the results may be supplemented by laboratory/greenhouse studies with identified strains.

8. Expertise available at ICAR-IISR may be availed for confirming the identity of pathogens isolated by coordinating centres. Expertise available at ICAR-IISR may be availed for confirming the identity of pathogens isolated by coordinating centres.

9. The quality analysis has to be done for all the seed spices varieties. For this NRCSS, Ajmer will give the quality score card and centres which have facility can do the quality analysis or else they can submit the major varieties seed samples to NRCSS, Ajmer for quality analysis.

**Some important New Projects initiated from this year are**

Two new crops *viz.*, Nigella and Ajowain were included in the AICRPS. Multi-location evaluation trials in these crops were finalized during the workshop. A project mode centre was approved for "Evaluation of nutmeg genotypes" for Three years at KAU, Vellanikkara with a funding of Rs. 2 lakh/year. New trials on multi-location evaluation of thrips tolerant small cardamom lines, organic production, evaluation of micronutrients, and biocapsules in ginger and turmeric were also initiated.

This year the SKNAU, Jobner, Rajasthan was adjusted the best AICRPS center for their contribution, new initiatives, prompt reporting, utilization of funds, transfer of technology and submission of AUCs.

**Scientists of AICRPS, SKNAU, Jobner, receiving "Best AICRPS Centre" Award from the Chief Guest**

**Technologies developed**

Five location specific technologies for various states were recommended

1. **New insecticides in cardamom against**

**shoot and capsule borer** - application of Ponneem (2 ml/lit. of water) was recommended for controlling shoot and capsule borer in Kerala.

**2. Management of foliar disease of turmeric** - pre-planting treatment of seed rhizome and foliar spray of standing crop at 90, 105, 120 days after planting with Propiconazole (0.1%) is recommended for Bihar

**3. Management of *Colletotrichum* and *Taphrina* leaf blotch of turmeric** - Seed rhizome treatment with Carbendazim + Mancozeb (1:1) (0.1%) + Foliar spray of Carbendazim + Mancozeb (0.1%) on 45 and 90 days. or Seed rhizome treatment with Azystrobin (0.1%) + Spray on 45, 75 and 105 DAP is recommend for Chhattisgarh

**4. Application of Sulphur and bio regulators for yield and quality enhancement in cumin** - application of sulphur @ 45 kg/ha and foliar application of TGA, Ascorbic acid and Salicylic acid @ 100 ppm at vegetative and flowering stage is recommended in Rajasthan.

**5. Management of *Phyllosticta* leaf spot in ginger using new molecules**

- Spray with Hexaconazole two times at 20 DI (0.1%) is recommended for Himachal Pradesh
- Carbendazim (0.1%) + Mancozeb (0.1%) first at disease appearance and subsequently 2 sprays at 20 DI after 1st spray or Foliar spray with Propiconazole (0.1%) first at disease appearance and then 2 times at 20 DI or Foliar spray with Tricyclazole (0.1%) first at disease appearance and then 2 times at 20 DI is recommended for Bihar
- Foliar spray with Carbendazim: Mancozeb (1:1) (0.1%) first at a disease appearance with two times at 20 days of interval is recommended for Chhattisgarh
- Spray with Hexaconazole (0.1%) or with Propiconazole (0.1%) first at disease appearance and then 2 times at 20 days interval is recommended for West Bengal

## Publications released

Twenty one publications in local languages and English on package of practices of spices and technologies / varieties developed by the centres were released during the workshop.


**Release of publications**

## Release of varieties

Seven high yielding varieties of spices were recommended for release in the workshop. One black pepper variety, Panniyur- 9 from Pepper Research Station (KAU), Panniyur, Kerala with high yield potential was recommended for release in Black pepper growing areas of Kerala, Karnataka and Andhra Pradesh. Two high yielding ginger varieties *viz;* GCP-49 (UBKV AADA 1) developed by Uttar Banga Krishi Viswavidyalaya, Pundibari, West Bengal at national level and V1S1-2 (Sourabh) developed by High altitude Research Station (OUAT), Pottangi for Odisha were recommended for release. In turmeric NDH-98 from Narendra Dev University of Agriculture & Technology, Kumarganj, Faizabad, Uttar Pradesh with high yield potential for release at national level and a

high yielding, short duration variety, moderately tolerant to root knot nematode (IISR Pragati) developed by ICAR-Indian Institute of Spices Research, Kozhikode, Kerala, for release in turmeric growing areas of Kerala, Karnataka, Andhra Pradesh, Tamil Nadu, Chhattisgarh and Telangana were recommended for release. In seed spices, RD 385 (Dr. RPCAU Dhania-1) a high yielding coriander variety from Dr. Rajendra Prasad Central Agricultural University, Dholi, Bihar for release at national level and HM 444 (Hisar Manohar), a fenugreek variety with high yield and unique green seed colour developed by Chowdhary Charan Singh Haryana Agricultural University, Hisar, Haryana for release at Haryana were recommended.

The workshop came to an end on 26th October 2016. The plenary session was chaired by Dr. T. Janakiram, ADG (HS-II) and Co-chaired by Dr. Gopal Lal, Director, ICAR-NRCSS.

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. He also suggested that there should be 10 action points for each workshop and action has to taken for those points by the next workshop. The action points are

1. Unique germplasm has to be registered with NBPGR, New Delhi.

2. Proposals of varieties recommended for release during the workshop has to be submitted to the Central Varietal Release Committee within next 6 months.

3. AICRPS in consultation with all concerned will prepare Standard Operating Procedure (SOP) and this will be made available in the AICRPS website for uniformity.

4. Status report on AICRPS centres in different states and spices cultivation in respective state may be prepared. One publication on this may be brought out.

5. Fact sheets on spices may be prepared for publishing in the Indian Horticulture Journal.

6. Human Resource Development is very important and in this regard Project Coordinator may facilitate for special trainings to the staff working in AICRPS.

7. For the recommendation on transfer of technology follow up action to be taken up.

8. Seed standards may be prepared for spices for which it is not available.

9. Publications – Popular articles can be prepared and published in Indian Horticulture Journal, Phal Phool, ICAR newsletter etc. Success stories may also be prepared and sent for publishing.

10. Technologies which have created impact may be compiled and report may be submitted to the Director General, ICAR.

# 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.

❖ FLD on 11 high yielding varieties of turmeric (Guntur)

❖ Demonstration of technique of removing bark of cinnamon, Pro tray 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, Preparation of preserve and chutney from nutmeg rind (Dapoli)

❖ Eight demonstrations on high yielding varieties of fenugreek, cumin and fennel (Jobner).

❖ Demonstration on seed treatment of two budded turmeric seed rhizomes, four rows of raised bed method, and tractor mounted harvesting of turmeric (Kammarapally)

❖ Demonstrations of high yielding varieties of turmeric, coriander, fennel and fenugreek (Kumarganj).

❖ Demonstration of technologies for small cardamom production at farm level under MIDH (Pampadumpara)

❖ FLD on performance of turmeric transplants in an area of 1.00 ha (Coimbatore)

❖ Training on "Hi- tech production technology for turmeric, ginger, coriander and curry leaf" in collaboration with DASD (Coimbatore)

❖ One day training programme on "Recent trends in black pepper production techniques" in collaboration with DASD(Yercaud)

❖ Demonstration of single bud portray propagation of ginger and turmeric(Pottangi)

❖ Farmers' Training on " Organic ginger and turmeric cultivation", "Coriander, chilli and black pepper cultivation" and awareness training on "Improved Spices Cultivation" (Pottangi)

Apart from the above, the scientists were 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.

**Demonstration plot for the performance of single bud propagated turmeric to the tribal farmers of Koraput**

**Demonstration of softwood grafting in nutmeg at Dapoli.**

# XVI. Success Stories

## Income enhancement through crop diversification and seed production in Gujarat

Mr. Devrajbhai Amthabhai Patel, resident of village Varsada, Taluka Kankrej, Dist. Banaskantha, Gujarat is holding 25 acres of land. Kankrej is one of the backward Talukas of Banaskantha district. The traditional cropping pattern of Mr. Patel was mustard, cotton, castor and cumin before 2004. In spite of very high potential land he was earning only about Rs. 3.0 lakhs from cultivation of these crops annually due to traditional method of cultivation and use of either local or very old varieties. In order to introduced fennel as a new cash crop and demonstrate the technologies of cumin the field demonstrations of recently released variety Gujarat Fennel – 11 with Gujarat Fennel – 2 and Gujarat Cumin – 4 with Gujarat Cumin-2 was conducted in this area under All India Coordinated Research Project on Spices by CRSS, Jagudan in 2004. Very encouraging results obtained in these demonstrations. This has motivated Mr. Patel to replace mustard crop by fennel and also extended the area of cumin. The others farmers of this village and neighbouring village also started sowing fennel and now fennel has become major source of income as well as profit of the farmers. Inspiring from the trainings organized by CRSS, Jagudan Mr. Patel started seed productions Gujarat Fennel – 11 and Gujarat Cumin – 4. Last year he produced about 5000 kg of Certified / TF seeds of GC-4 and 2000 kg of GF-11 and distributed among farmers of this area and surrounding belts also. His farm income is increased from Rs. 3.0 to 15.0 lakhs by diversification of the crops and seed production programme. Mr. Patel was awarded as best farmer for crop diversification and seed production by S. D. Agricultural University, Sardarkrushinagar in the year 2011.

**Farmers vist to the seed production plot of Mr. Devrajbhai Amthabhai Patel**

**Mr. Devrajbhai Amthabhai Patel, with fennel seed**

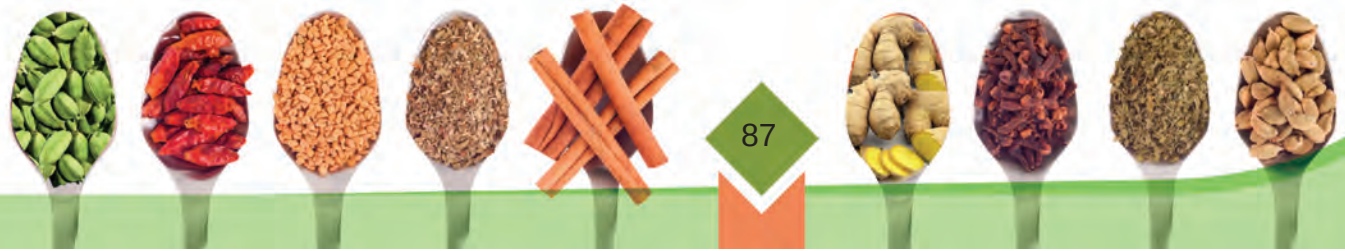
## Success story of coriander cultivation under adverse weather conditions in Andhra Pradesh

The rabi season in the State of Andhra Pradesh was very stressful for the farmers due to severe deficit in rain fall and the resultant drought situation. The rainfall in Andhra Pradesh due to North-East monsoon was only 78 % of the normal, which had severely constrained the growing of rabi crops. The cultivation of Pulses chilli, coriander and ajowan coincide with rabi and the rainfall on account of the North-East monsoon is critical for their establishment, growth and productivity. The pulses and spices are largely grown as rainfed crops under residual soil moisture regime. The success story of farmers in coriander cultivation from the adverse agro-climatic regions of Andhra Pradesh (Southern Zone, Scarce Rainfall Zone and western part of Krishna-Godavari zone) gives confidence that the climate change can be mitigated by use of appropriate technologies.

Some farmers approached All India Coordinated Research Project on Spices, Guntur for advice on raising some rabi crops from Pedacherlopalle mandal of the Prakasam district (Southern Zone), A perennially drought prone, arid region. The farmers were provided with two elite varieties Suguna and APHU Dhania-1. The crop grew well even though the rainfall was meager. Two farmers harvested the crop during the third week of March when the fodder crop jowar was failed due to insufficient soil moisture. The variety APHU Dhania-1 recorded 125 kg acre-1, whereas the other variety Suguna recorded a yield of 115 kg acre-1. The net income from four acres of Suguna was Rs. 41,472/- and 7,296/- from one acre of APHU Dhania-1 (@ Rs. 9000/- per quintal). The Benefit Cost Ratio was 2.46 for the variety Suguna and 2.76 for the variety APHU Dhania-1 even under such drought situation.

Another progressive farmer, Sri Viswanadha Reddy, farmer from Vempalle mandal, the traditional coriander growing area of the State, comes under the Scarce Rainfall Zone has approached the AICRPS centre. He realized that choosing the appropriate variety can make a huge difference and procured seed of APHU Dhania-1 for raising crop in eight acres. He was advised to go for sprinkler irrigation at least for three hours daily, approximately delivering 30 mm of water at the critical stage of flower initiation. The crop grew exuberantly without any pest or disease problem. He harvested 750 kg $acre^{-1}$ coriander grain, which comes to 1875 kg $ha^{-1}$ and 1.44 times higher than the national average (835 kg $ha^{-1}$) The net income per acre was Rs. 57,500/-, which was earned in three months period. The high Benefit Cost Ratio of 5.8 was achieved by providing the micro-irrigation at critical growth stage of the crop.

Another success story is from the western part of Krishna-Godavari zone. The rainfall in the mandal in rabi was only 44 mm. The kharif rainfall was 897 mm, with 468 mm during September to November months. Monoculture in rabi and high pest load resulted in reduced yield of chikpea crop and increased the cost of cultivation. Hence, farmers were looking for an alternative to chickpea. A marginal farmer from Nadikudi village, Sri Edukondalu, of Dachepalle mandal has approached AICRPS centre in this regard and suggested him to consider coriander. He had sown coriander variety Suguna In the last week of November. The farmer took the advantage of mobile and Whatsapp technology to ensure proper care to the crop. He was very happy when he harvested 450 kg $acre^{-1}$, in 85 days. The net income was Rs. 34000/- with a Benefit Cost Ratio of 5.2. The story highlights that the right choice of crop at appropriate time is the key for success.



## Success story of young brothers in Karnataka in black pepper cultivation

Mr. Vishwanath and Mr. Gurupad Hegde brothers of Ullal-Koppa, Uttara Kannada dist. of Karnataka are having about 6 acres of areca plantation intercropped with black pepper. They had harvested about 70 kg dry pepper before 2012-13 from the 50-60 older vines. In 2012-13, they have taken up planting of 3000 plants of black pepper in the areca nut plantation and followed scientific cultivation practices. The vines were provided with 20 kg farm yard manure and 350 g of NPK in two split doses per plant and the irrigation is given through drip system during summer. The areca plantation has underground drainage system with an open drain (6 inches) for black pepper. Two sprays of Bordeaux mixture were invariably given before and after the monsoon and the garden is free from foot rot disease. Regular crop monitoring and scientific cultivation practices have given 3.6 quintals of black pepper during 2014-15 and 13 quintals during 2015-16. During the current year (2016-17) they have harvested 46.5 quintals with an average yield of 7.75 quintals per acre under areca inter crop. The pepper garden has become a popular tourist spot for the young farmers in this region.

**Luxuriant growth of pepper vines on areca nut**

**Mr. Gurupad Hegde in his black pepper plantation**

# XVII. UNIQUE GERMPLASM COLLECTION


Zanzibar clove – with more anthocyanin pigmentation on petioles and flower buds


Double seeded nutmeg


Seedless nutmeg

"Bukit tinggi"- A Malaysian ginger cultivar

# XVIII. PUBLICATIONS

## Research publications

### Coimbatore

Chitra, R. , Shoba, N., Devapriya, P., Lokesh, B., Priyanka, R. and Ramar. A. 2016. Off season production of leafy corriander under shade net condition. *Indian Journal of Arecanut, Spices and Medicinal Plants.* 18(2) : 37-38

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Kalidasu, G., Sarada, C., Kumari, S.S. and Naidu, L. 2016. Comparative study on the performance of coriander genotypes under receding soil moisture regimes in rainfed vertisols. International *Journal of Bio-Resource & Stress Management.* 7(2).

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Rajasthan state. *International Journal of Seed Spices* 6(1): 93 – 95.

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Ajay, D., John Jo Varghese, Rajkumar, R., and Dhanapal, K. 2016. Effect of raw coir pith with bioconsortium ion the incidence of diseases and rhizosphere microbial activity of small cardamom (*Elettaria cardomomum* Maton.) at East Sikkim in *PLACROSYM 22 Leveraging Innovation System in Plantation Sector Through Value Addition* held during 15-17 December, 2016 at ICAR-Central Plantation Research Institute, Kasaragod, Kerala, pp. 123.

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Gudade, B.A., Dhanapal, K., Deka, T.N., Bora, S.S. and Rema Shree, A. B. 2017. Indigenous Medicinal Practices of Lepcha Tribe at Dzongu, Sikkim (Northeast India) Presented in *National seminar on Understanding Himalayan Phytodiversity in a changing a Climate* from 9.3.17 to 10.3.17 at Gangtok, Sikkim. Organized The Botanical Survey of India, Sikkim Himalayan Regional Centre, Gangtok. Pp.60-61.

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Mishra, R.S., Sandeep Kumar and Pandey, V.P. 2016. Effect of stem gall disease caused by *Protomyces macrosporus* on biochemical changes of coriander. Oral presentation in *International Seminar on Agriculture and Food for Inclusive Growth and Development* and publication in souvenir. Samagra Vikas Welfare Society at Lucknow.

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## Raigarh

Ajit Kumar Singh, Shrikant Swargaonkar, Sarita Sahu & NK Choubey. 2017. Evaluation of bio -agents and fungicides against stem gall (*Protomyces macrosporous* Unger) of Coriander (*Coriandrum sativum* L.) in *National Seminar on Seed Spices for enhancing farmers prosperity and livelihood security.* January 21-22, 2017. Organized by ICAR-NRC Seed Spices, Ajmer and Directorate of Arecanut and Spices Development Calicut.

## Jobner

Mittal, G. K., Shivran, A. C., Singh, D. and Gothwal, D. K. 2017. Chemo-profiling of volatile oil in cumin (*Cuminum cyminum* L.) varieties orally in two days *National seminar on Seed Spices for enhancing farmer's prosperity and livelihood security* jointly organized by ICAR-NRC on seed spices, Ajmer and Directorate of Arecanut and Spices Development, Calicut on January 21 & 22, 2017 held at NRCSS, Ajmer (Rajasthan). This paper got first price in V session.

Mittal, G. K. 2017. Variation In Volatile Oil Constituents of Coriander (*Coriandrum Sativum*) Varieties in *National seminar on Research and Developmental Advances in Spices, Medicinal & Aromatic Crops Cultivition, Processing and Trade for Prosperity of Indian Farmers* jointly organized by Society for Integrated Development of Agriculture (SIDA) Agriculture University, Jodhpur and Directorate of Arecanut and Spices Development, Kozhikode, Calicut Kerala February 1 & 2, 2017 held at Agriculture University, Jodhpur (Rajasthan).

Shivran, A. C., Jat, N. L. and Singh. D. 2016. Effect of integrated nitrogen management on cumin productivity. In: Extended Summaries Vol. 2nd of 4th *International Agronomy Congress on Agronomy for Sustainable Management of Natural Resources, Environment, Energy and Livelihood Security to Achieve Zero Hunger Challenge,* 22–26 November, New Delhi, India, pp. 661-662.

## Jagudan

Amin, A.M., Patel, N.R., and Amin, A.U. 2017. Chemical Management Scheduling for Cumin Blight at *National seminar on Seed Spices for Enhancing Farmers Prosperity and livelihood Security* jointly organized by the ICAR-NRC on Seed Spices, Ajmer and Directorate of Arecanut and Spices Development, Calicut during January 21-22,2017 at NRCSS, Ajmer.

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*Spices for enhancing farmers prosperity and livelihood security* held during January 21-22, 2017 at NRCSS, Ajmer.

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### Yercaud

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### Solan

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**Panniyur**

Neema, V. P., Heera, G. and Ajith, P. M. 2017. Karutha ponninu manjalippu (Malayalam). Kerala Karshakan, 8 March 2017, 69p.

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**Coimbatore**

Chitra, R. 2016. Modern propagation technique in turmeric cultivation. Spice India, 29(6) : 22

**Guntur**

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Chitra, R., Ushamalini, C. and Balakrishnan, S. 2016. Manjalil ootachathu kuraipadum avatrin nivarthi muraigalum. (Tamil)

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**Jagudan**

Prajapati, D. B., Gupta, S. A. and Amin, A. M. 2017. Newly develop multicut fenugreek variety. Pusa Early Branching: 30-32. (Gujarati)

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**Pottangi**

Organic turmeric cultivation (In Odiya)

Organic ginger cultivation (In Odiya)

Packages and practices of Black pepper (In Odiya)

Packages and practices of Black pepper (In English)

**Yercaud**

Nageswari, K., Durairaj, C., Jayalakshmi, V. and Kavitha, P. S. 2016-17. Recent trends in Black pepper cultivation. Horticultural Research Station, Yercaud, p 100.

# XIX. Awards and Recognitions

### Best AICRPS Centre Award

AICRP on Spices centre at Sri Karan Narendra Agriculture University, Jobner, Rajasthan.

### Oral/ Poster Presentation Awards

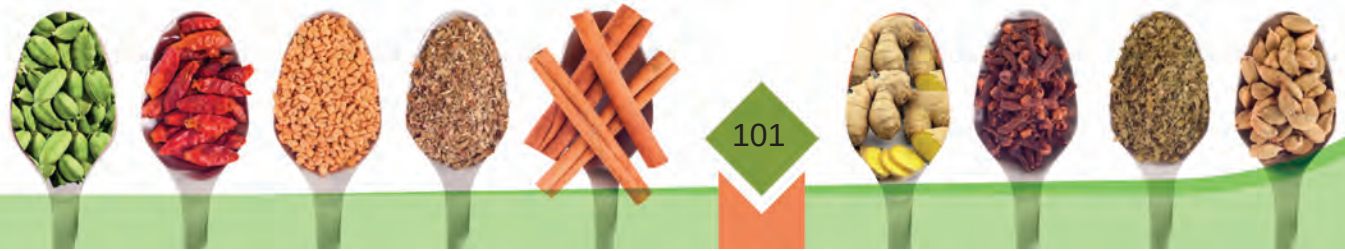
**Dr. G. K. Mittal,** 2017. National seminar on "Seed Spices for enhancing farmer's prosperity and livelihood security". ICAR-National Research Centre on Seed Spices, Ajmer, 21st to 22nd Jan 2017. (Best Oral presentation Award).

**Dr. R.S. Mishra,** 2017. "Evaluation of fenugreek genotypes for seed yield and downy mildew disease resistance" In: National Seminar on seed spices, "Seed Spices for Enhancing Farmers Prosperity and Livelihood Security". ICAR-National Research Centre on Seed Spices, Ajmer, 21st to 22nd Jan 2017. (Best Oral presentation Award).

**Dr. R.S. Mishra,** 2017. "Effect of organic treatments for minimization of stem gall disease caused by Protomyces macrosporus, growth and yield of coriander" in National Seminar on seed spices, "Seed Spices for Enhancing Farmers Prosperity and Livelihood Security". ICAR-National Research Centre on Seed Spices, Ajmer, 21st to 22nd Jan 2017. (Second in Poster Presentation).

**K. Dhanapal,** B.A. Gudade, S.S. Bora and A. B. Rema Shree 2017"Hailstorm damage in large cardamom (*Amomum subulatum* Roxb.) at Sikkim, North East India" in National Seminar on "Understanding Himalayan Phytodiversity in a changing a Climate". ICAR-Indian Cardamom Research Institute Gangtok, Sikkim, 9th to 10th March 2017. (Best Paper Presentation Award).

**Ajit Kumar Singh, Shrikant Swargaonkar**, Sarita Sahu & NK Choubey (2017). Evaluation of bio -agents and fungicides against stem gall (*Protomyces macrosporous* Unger) of Coriander (*Coriandrum sativum* L.) in National Seminar on Seed spices for enhancing farmers prosperity and livelihood security. January 21-22, 2017. Organized by ICAR- NRC seed spices, Ajmer and Directorate of Arecanut and spices Development Calicut. (First prize in Oral presentation).



# XX. STAFF POSITION

## PROJECT COORDINATOR'S OFFICE

| | | | |
|---|---|---|---|
| 1. | Project Coordinator | : | Dr. K. Nirmal Babu<br>Dr K Kandiannan<br>(In-Charge from 5th September 2016 ) |
| 2. | Scientist (SPMAP) | : | Mr. Muhammed Nissar V. A |
| 3. | Scientist (SPMAP) | : | Mrs. Akshitha H. J. (till 04-03-2017) |
| | | : | Dr. Sharon Aravind<br>(Joined on 20-03-2017) |
| 4. | Technical Officer | : | Vacant |
| 5. | Personal Assistant | : | Mrs. Shyna Deepesh (Joined on 02-01-2017) |
| 6. | Skilled Supporting Staff | : | Vacant |

## COORDINATING CENTRES

### 1. Cardamom Research Station, KAU, Pampadumpara

| | | | |
|---|---|---|---|
| 2. | Assistant Professor (Ag. Entomology) | : | Vacant |
| 3. | Associate Professor (Agron/Hort.) | : | Vacant |
| 4. | Assistant Professor (Pl. Breeding) | : | Vacant |
| 5. | Farm Manager Gr. I | : | Mr. C.T. Jacob |
| 6. | Laboratory Assistant Gr. II | : | Mr. Anil Kumar |
| 7. | 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. | Asst. Professor (Pl. Pathology) | : | Vacant |
| 5. | Farm Manager Gr I | : | Vacant |
| 6. | Farm Manager Gr II | : | Mr. P. Krishnan |
| 7. | Farm Manager Gr II | : | Vacant |
| 8. | Lab Asst. Gr.III | : | Mr. K. Rajeev |
| 9. | Peon Gr II | : | Mr. MohananValayangatan |

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

| | | | |
|---|---|---|---|
| 1. | Associate Professor (Agronomy) | : | Dr. K. M. Devaraju |
| 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) : Dr. M. J. Manju
3. Technical Assistant : Sh. B. B. Doddamani

## 5. Horticultural Research Station(TNAU), Yercaud

1. Agronomist (Hort.) : Dr. K. Nageswari
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 R Chitra
2. Jr. Pathologist (Pathology) : Dr. C. Ushamalini
3. Agricultural Assistant : Th. R. Swaminathan

## 7. Turmeric Research Station(SKLTSHU), Kammarapally

1. Jr. Pathologist : Dr. B. Mahender
2. Jr. Horticulturist : Vacant
3. Technical Assistant : Engaged on contract basis

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

1. Senior Scientist (Horticulture) : Dr V. Siva Kumar
2. Scientist (Plant Pathology) : Dr. Pradeep Manyam
3. Technical Assistant : Vacant from 25.01.2012 onwards (Engaged outsourcing)

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

1. Jr. Breeder (Horticulture) : Dr. K. Giridhar
2. Horticulturist : Dr. S. Suryakumari
3. Technical Assistant : Sh. Shaik Jilani Bhasha

## 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. ChunniLal Sharma

## 11. High Altitude Research Station(OUAT), Pottangi

1. Sr. Breeder & Officer-in-charge : Dr. ParshuramSial
2. Breeder : Vacant
3. Technical Assistant : Mr. Laxmikanta Mishra
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 | : | Dr. 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. Vinod 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. U.S. Chavan Joined on 09.03.2017<br>Sh. G. D. Bandre Retired on 31.01.2017 |

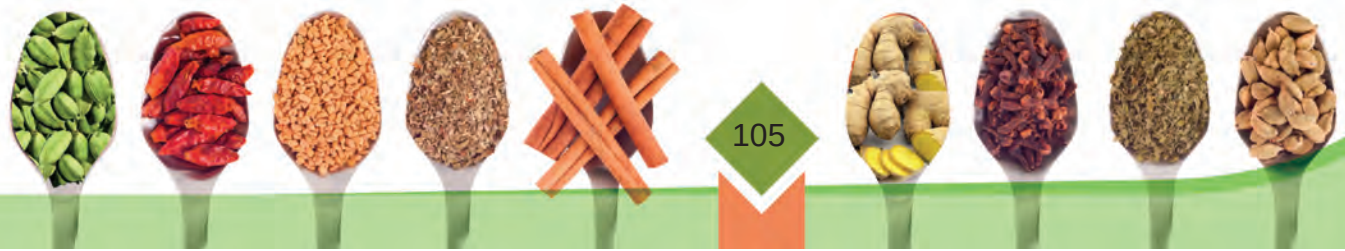
## 19. College of Agriculture and Research Station, IGKV, Raigarh

| | | | |
|---|---|---|---|
| 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. K. Nirmal Babu Project Coordinator (AICRPS) | EDP on Leadership Development Programme | ICAR-NAARM, Hyderabad | 27.08.2016 to 31.08.2016 |
| 2 | Dr. C. Ushamalini Asst. Prof. (Plant Pathology),TNAU, Coimbatore | Training on "Question paper authoring and evaluation" | TNAU, Coimbatore | 23.11.16 to 25.11.16 |
| 3 | Dr. D. K. Gothwal, Breeder SKNAU, Jobner | Training on SAS Programme | SKNCOA, Jobner | 04.02. 2017 to 10.02.2017 |
| 4 | G. K. Mittal Assistant Biochemist SKNAU, Jobner | Short course on Climate change | Department of Horticulture, SKN COA, Jobner | 10 days, 2017 |
| 5 | G. K. Mittal Assistant Biochemist SKNAU, Jobner | ICAR sponsored 34$^{th}$ training course on "Adoption of suitable conventional and Biotechnological Approaches for Biotic and Abiotic Stress Management in Crops" | Centre of Advanced Faculty Training in Plant Pathology, G. B. Pant University of Agriculture & Technology Pantnagar-263145 (Uttarakhand). | 13. 02. 2017 to 05.03. 2017 |
| 6 | Dr Preeti Verma Assistant Professor (Plant Breeding), Agricultural Research Station, Kota | Pre breeding using wild species | IIRR, Hyderabad (TS) | 16.01.2017 to 26.01.2017 |
| 7 | Dr. Heera, G Asst Professor (Plant Pathology), PRS Panniyur, KAU | Training programme on Hands on training course on microbiological identification – Biochenmical, genotypic and mass spectrometric methods | National Coir Research and Management Institute, Kudappanakkunnu, Thiruvananthapuram | 15.02.2017 to 7$^{th}$ March, 2017 |



# XXII. AICRPS CENTREWISE BUDGET 2016-17

| *Regular Centres* | | | | | | | | | | | | | *(Rs. in lakhs)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Name of the centres** | **Pay and Allowances** | | **TA** | | **RC** | | **Tech-A** | **Total RC** | **Works** | | **Total** | | **Grand Total** |
| | **Total** | **ICAR** | **Total** | **ICAR** | **Total** | **ICAR** | **ICAR** | **ICAR** | **Total** | **ICAR** | **ICAR share** | **State share** | |
| | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** | **(8)** | **(9)** | **(10)** | **(11)** | **(12)** | **(13)** |
| Pampadumpara (KAU) | 13.20 | 9.90 | 1.50 | 1.125 | 4.50 | 3.37 | 0.10 | 4.595 | - | - | 14.495 | 4.795 | 19.29 |
| Panniyur (KAU) | 49.33 | 37.00 | 1 | 0.75 | 3.00 | 2.25 | 0.10 | 2.35 | - | - | 40.10 | 13.33 | 53.43 |
| Mudigere (UAHS) | 7.87 | 5.90 | 2.00 | 1.50 | 6.00 | 4.50 | 0.10 | 4.60 | - | - | 12.00 | 3.96 | 15.96 |
| Sirsi (UHS) | 27.27 | 20.45 | 1 | 0.75 | 3.00 | 2.25 | 0.10 | 2.35 | - | - | 23.55 | 7.82 | 31.37 |
| Yercaud (TNAU) | 24.87 | 18.65 | 1 | 0.75 | 3.00 | 2.25 | 0.10 | 2.35 | - | - | 21.75 | 7.22 | 28.97 |
| Coimbatore (TNAU) | 32.67 | 24.5 | 1 | 0.75 | 3.00 | 2.25 | 0.10 | 2.35 | - | - | 27.60 | 9.20 | 36.77 |
| Chintapalle (Dr YSRHU) | 7.53 | 5.65 | 1 | 0.75 | 5.33 | 4.00 | 0.10 | 4.10 | - | - | 10.50 | 3.47 | 13.97 |
| Kamarpally (SKLTSHU) | 7.87 | 5.9 | 0.5 | 0.375 | 1.50 | 1.125 | 0.10 | 1.225 | - | - | 7.50 | 2.47 | 9.97 |
| Guntur (Dr YSRHU) | 28.71 | 21.53 | 1 | 0.75 | 3.00 | 2.25 | 0.20 | 2.45 | - | - | 24.7295 | 8.21 | 32.94 |
| Solan (YSPUHF) | 20.70 | 15.525 | 1.5 | 1.125 | 4.50 | 3.375 | 0.10 | 3.475 | - | - | 20.125 | 6.68 | 26.80 |
| Pottangi (OUAT) | 4.70 | 3.525 | 0.5 | 0.375 | 5.33 | 4.00 | 0.10 | 4.10 | - | - | 8.00 | 2.63 | 10.63 |
| Jobner (SKNAU) | 39.20 | 29.40 | 2.00 | 1.50 | 6.00 | 4.50 | 0.10 | 4.60 | - | - | 35.50 | 11.80 | 47.30 |
| Jagudan (SDAU) | 22.00 | 16.5 | 1 | 0.75 | 3.00 | 2.25 | 0.10 | 2.35 | - | - | 19.60 | 6.50 | 26.10 |
| Hisar (HAU) | 28.00 | 21.00 | 1 | 0.75 | 3.00 | 2.25 | 0.10 | 2.35 | - | - | 24.10 | 8.00 | 32.10 |
| Dholi (RAU) | 26.20 | 19.65 | 1 | 0.75 | 3.00 | 2.25 | 0.10 | 2.35 | - | - | 22.75 | 7.55 | 30.30 |
| Kumarganj (NDUAT) | 42.67 | 32.00 | 1 | 0.75 | 3.00 | 2.25 | 0.10 | 2.35 | - | - | 35.10 | 11.67 | 46.77 |
| Pundibari (UBKV) | 14.20 | 10.65 | 1 | 0.75 | 3.00 | 2.25 | 0.10 | 2.35 | - | - | 13.75 | 4.55 | 18.30 |
| Dapoli (BSKKV) | 35.34 | 26.505 | 1.5 | 1.125 | 4.50 | 3.375 | 0.10 | 3.475 | - | - | 31.105 | 10.34 | 41.44 |
| Raigarh (IGKV) | 12.37 | 9.275 | 1 | 0.75 | 5.33 | 4.00 | 0.10 | 4.10 | - | - | 14.125 | 4.68 | 18.80 |
| AICRPS Workshop | | | | | | 1.8205 | | 1.8205 | | | 1.8205 | - | 1.8205 |
| **Total (A)** | **444.7** | **333.51** | **21.5** | **16.125** | **72.99** | **56.5655** | **2.00** | **59.6905** | **-** | **-** | **408.20** | **134.875** | **543.0305** |








(Rs. in lakhs)

| Name of the centres | Pay and Allowances | | TA | | RC | | Tech-A | Total RC | Works | | Total | | Grand Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Co-opting Centres*** | **Total** | **ICAR** | **Total** | **ICAR** | **Total** | **ICAR** | **Total** | **ICAR** | **Total** | **ICAR** | **ICAR share** | **State share** | |
| Ambalavayal (KAU) | - | - | 0.67 | 0.50 | 4.00 | 3.00 | - | 3.00 | - | - | 3.50 | 1.17 | **4.67** |
| Peechiparai (TNAU) | - | - | 0.67 | 0.50 | - | - | - | 0.0 | - | - | 0.50 | 0.17 | **0.67** |
| Gangtok (ICRI) | - | - | 0.5 | 0.50 | 2.65 | 2.65 | - | 2.65 | - | - | 3.15 | 0.00 | **3.15** |
| Sakleshpur (ICRI) | - | - | 0.5 | 0.50 | 2.00 | 2.00 | - | 2.00 | - | - | 2.50 | 0.00 | **2.50** |
| Myladumpara (ICRI) | - | - | 0.5 | 0.50 | 2.00 | 2.00 | - | 2.00 | - | - | 2.50 | 0.00 | **2.50** |
| ICAR RC NEHR, Barapani | - | - | 0.5 | 0.50 | 3.5 | 3.50 | - | 3.5 | - | - | 4.00 | 0.00 | **4.00** |
| ICAR RC NEHR, Mizoram | - | - | 0.5 | 0.50 | 1.50 | 1.50 | - | 1.50 | - | - | 2.00 | 0.00 | **2.00** |
| ICAR RC NEHR, Gangtok | - | - | 0.5 | 0.50 | 3.00 | 3.00 | - | 3.00 | - | - | 3.50 | 0.00 | **3.50** |
| Nagaland (NAU) | - | - | 0.67 | 0.50 | 4.67 | 3.50 | - | 3.5 | - | - | 4.00 | 1.33 | **5.33** |
| Kahikuchi (AAU) | - | - | 0.67 | 0.50 | 5.07 | 3.80 | - | 3.8 | - | - | 4.30 | 1.43 | **5.73** |
| ***Voluntary centres*** | | | | | | | | | | | | | |
| Pantnagar (GBPUAT) | - | - | 0.67 | 0.50 | 1.33 | 1.00 | - | 1.00 | - | - | 1.50 | 0.50 | **2.00** |
| Pasighat (CAU) | - | - | 0.50 | 0.50 | 1.05 | 1.05 | - | 1.05 | - | - | 1.55 | 0.00 | **1.55** |
| Kanke (BIRSAAU) | - | - | 0.67 | 0.50 | 0.4 | 0.30 | - | 0.30 | - | - | 0.80 | 0.27 | **1.07** |
| Kalyani (BCKVV) | - | - | 0.67 | 0.50 | 1.33 | 1.00 | - | 1.00 | - | - | 1.50 | 0.50 | **2.00** |
| Kota (AUK) | - | - | 0.67 | 0.50 | 2.00 | 1.50 | - | 1.50 | - | - | 2.00 | 0.67 | **2.67** |
| Navasari (NAU) | - | - | 0.67 | 0.50 | 0.67 | 0.5 | - | 0.5 | - | - | 1.00 | 0.33 | **1.33** |
| Jabalpur (JNKV) | - | - | 0.67 | 0.50 | 0.67 | 0.5 | - | 0.5 | - | - | 1.00 | 0.33 | **1.33** |
| Mandor (AUJ) | - | - | 0.67 | 0.50 | 2.00 | 1.5 | - | 1.5 | - | - | 2.00 | 0.67 | **2.67** |
| Sanand (AAU) | - | - | 0.67 | 0.50 | 0.67 | 0.5 | - | 0.5 | - | - | 1.00 | 0.33 | **1.33** |
| ***Project mode funding*** | | | | | | | | | | | | | |
| Trichur (KAU) | - | - | - | - | 2.66 | 2.00 | - | 2.00 | - | - | 2.00 | 0.66 | 2.66 |
| Periyakulam (TNAU) | - | - | - | - | - | - | - | - | - | - | - | - | - |
| COH, Bengaluru (UHS) | - | - | - | - | - | - | - | - | - | - | - | - | - |
| HC&RL, Coimbatore (TNAU) | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **Total (B)** | - | - | **11.54** | **9.5** | **41.17** | **34.8** | - | **34.8** | - | - | **44.3** | **8.36** | **52.66** |
| **Grand Total (A+B)** | **444.7** | **333.51** | **33.04** | **25.625** | **114.16** | **91.3655** | **2.00** | **94.4905** | - | - | **452.50** | **143.235** | **595.70** |

# XXIII. Weather Data

## Panniyur

| Month / Year | Rainfall (mm) | No. of Rainy Days | Temperature (ºC) Max. | Temperature (ºC) Min. | RH (%) |
|---|---|---|---|---|---|
| April'16 | 1 | 1 | 39.53 | 28.03 | 86.53 |
| May | 176.4 | 18 | 36.94 | 26.3 | 91.96 |
| June | 768.6 | 28 | 30.52 | 25.09 | 95.53 |
| July | 859.7 | 26 | 32.74 | 25.13 | 94.80 |
| Aug. | 560.5 | 26 | 32.91 | 24.94 | 94.58 |
| Sept. | 172 | 24 | 33.59 | 24.29 | 93.76 |
| Oct. | 109.6 | 10 | 35.08 | 24.01 | 94.03 |
| Nov. | 45.5 | 7 | 35.45 | 24.25 | 94.13 |
| Dec. | 17.6 | 2 | 37.52 | 21.66 | 93.74 |
| Jan.'17 | 4.5 | 2 | 38.57 | 21.21 | 92.03 |
| Feb | - | - | 39.72 | 23.02 | 91.07 |
| March | 14 | 2 | 40.79 | 24.23 | 91.25 |

## Pampadumpara

| Rainfall (mm) | No. of Rainy Days | Temperature (ºC) Max. | Temperature (ºC) Min. |
|---|---|---|---|
| 29.4 | 5 | 26.66 | 23.13 |
| 117.8 | 8 | 25.01 | 21.25 |
| 321.8 | 23 | 21.31 | 17.03 |
| 241.4 | 27 | 20.91 | 16.98 |
| 139.6 | 21 | 21.12 | 17.54 |
| 61 | 15 | 21.75 | 17.15 |
| 131.4 | 7 | 22.83 | 19.24 |
| 82.8 | 3 | 22.2 | 19.15 |
| 26.2 | 6 | 21.48 | 18.83 |
| 56.4 | 5 | 20.74 | 18.25 |
| 1 | 1 | 21.55 | 19.35 |
| 87.4 | 5 | 23.91 | 21.43 |

## Coimbatore

| Month / Year | Rainfall (mm) | No. of Rainy Days | Temperature (°C) Max. | Temperature (°C) Min. | RH (%) I | RH (%) II |
|---|---|---|---|---|---|---|
| April'16 | 4.2 | 2 | 37.3 | 25.5 | 81 | 38 |
| May | 64.4 | 6 | 34.8 | 24.6 | 83 | 50 |
| June | 34.2 | 5 | 31.8 | 23.9 | 81 | 60 |
| July | 23.9 | 3 | 31.3 | 23.7 | 83 | 59 |
| Aug. | 4.0 | 1 | 32.5 | 23.7 | 83 | 55 |
| Sept. | 6.3 | 1 | 32.3 | 22.4 | 86 | 55 |
| Oct. | 70.7 | 2 | 32.5 | 22.5 | 88 | 54 |
| Nov. | 18.9 | 1 | 32.3 | 21.6 | 86 | 50 |
| Dec. | 45.0 | 5 | 29.9 | 20.3 | 88 | 55 |
| Jan.' 17 | 26.4 | 2 | 30.5 | 20.1 | 84 | 48 |
| Feb. | 6.0 | - | 32.4 | 19.6 | 80 | 38 |
| March | 63.0 | 3 | 34.4 | 22.8 | 86 | 46 |

## Yercaud

| Rainfall (mm) | No. of Rainy Days | Temperature (°C) Max. | RH (%) |
|---|---|---|---|
| 20.1 | 3 | 22.03 | 77.0 |
| 259.8 | 14 | 24.69 | 69.19 |
| 184 | 11 | 21.86 | 87.36 |
| 277.5 | 7 | 21.50 | 93.39 |
| 241.5 | 10 | 22.42 | 89.42 |
| 19 | 3 | 22.16 | 83.20 |
| 29.1 | 3 | 21.0 | 52.68 |
| 328 | 8 | 23.1 | 67.11 |
| 173.4 | 5 | 22.04 | 86.7 |
| 4.5 | 2 | 40.0 | 75.19 |
| 0 | 0 | 40.0 | 79.5 |
| 0 | 0 | 41.0 | 83.25 |

## Mudigere

| Month / Year | Rainfall (mm) | No. of Rainy Days | Temperature (°C) Max. | Temperature (°C) Min. | RH (%) I | RH (%) II |
|---|---|---|---|---|---|---|
| April'16 | 20.8 | 5 | 33.76 | 23.23 | 83.23 | 75.1 |
| May | 148.4 | 7 | 31.54 | 19.9 | 84.58 | 76.2 |
| June | 363.6 | 22 | 25.36 | 20.66 | 85.43 | 79.63 |
| July | 557.75 | 29 | 25.35 | 20.32 | 85.87 | 79.93 |
| Aug. | 201.3 | 28 | 25.5 | 20.4 | 85.2 | 80.3 |
| Sept. | 75.7 | 15 | 24.56 | 20.13. | 85.16 | 79.6 |
| Oct. | 38.4 | 4 | 29.03 | 20.06 | 85.19 | 78.03 |
| Nov. | 49.1 | 3 | 29.7 | 20.06 | 84.4 | 73 |
| Dec. | 10.6 | 4 | 28.7 | 20.03 | 80 | 71.19 |

## Sirsi

| Rainfall (mm) | No. of Rainy Days | Temperature (°C) Max. | Temperature (°C) Min. | RH (%) |
|---|---|---|---|---|
| 00 | 00 | 40 | 18 | 81.0 |
| 29 | 05 | 40 | 21 | 83.5 |
| 398 | 19 | 36 | 20 | 88.5 |
| 495.2 | 24 | 26.2 | 21.1 | 89 |
| 418.4 | 25 | 26.3 | 20.8 | 91 |
| 94.4 | 17 | 26.8 | 20.1 | 85 |
| 37.4 | 2 | 29.9 | 17.7 | 75 |
| 19.4 | 2 | 31.7 | 13.8 | 70 |
| 00 | 0 | 30.9 | 11.8 | 69 |

## Chintapalle

| Month / Year | Rainfall (mm) | No. of Rainy Days | Temperature (°C) Max. | Temperature (°C) Min. | RH (%) I | RH (%) II |
|---|---|---|---|---|---|---|
| April'16 | 68.0 | 7.0 | 30.33 | 18.50 | 90.13 | 90.20 |
| May | 124.4 | 5.0 | 33.10 | 21.19 | 86.29 | 80.67 |
| June | 295.8 | 9.4 | 27.23 | 27.73 | 89.66 | 89.93 |
| July | 212.0 | 9.0 | 28.09 | 22.00 | 88.16 | 87.64 |
| Aug. | 159.2 | 13.0 | 27.32 | 21.93 | 90.48 | 88.09 |
| Sept. | 261.6 | 10.0 | 27.53 | 20.96 | 90.83 | 88.06 |
| Oct. | 109.6 | 8.0 | 27.38 | 18.32 | 90.38 | 81.87 |
| Nov. | 44.6 | 5.0 | 26.1 | 15.18 | 87.63 | 81.50 |
| Dec. | 0.0 | 0.0 | 25.97 | 13.10 | 86.58 | 80.65 |
| Jan.' 17 | 1.0 | 1.0 | 25.85 | 10.47 | 85.77 | 66.48 |
| Feb. | 21.0 | 2.0 | 29.20 | 13.06 | 29.20 | 88.07 |
| March | 98.4 | 7.0 | 29.38 | 15.61 | 81.00 | 66.34 |

## Guntur

| Rainfall (mm) | No. of Rainy Days | Temperature (°C) Max. | Temperature (°C) Min. | RH (%) I | RH (%) II |
|---|---|---|---|---|---|
| 0.0 | 0.0 | 39.7 | 26.1 | 86 | 44 |
| 90.0 | 4.0 | 40.2 | 27.9 | 82.5 | 50.4 |
| 234.9 | 14 | 36.3 | 25.6 | 89.4 | 61 |
| 126.0 | 6.0 | 35.3 | 25.1 | 83.5 | 65.0 |
| 60.5 | 5 | 36.0 | 25.2 | 79.4 | 58.1 |
| 131.1 | 11.0 | 32.61 | 24.02 | 82.40 | 70.20 |
| 154.5 | 6.0 | 33.9 | 21.1 | 80.5 | 65.8 |
| 0 | 0 | 33.6 | 17.5 | 79.2 | 58.8 |
| 9 | 1 | 31.8 | 15.8 | 79.1 | 56.9 |
| 0.0 | 0.0 | 31.9 | 16.0 | 77.3 | 54.0 |
| 0.0 | 0.0 | 34.7 | 17.5 | 75.2 | 40.8 |
| 8.3 | 1.0 | 36.5 | 21.8 | 79.1 | 57.7 |

## Dapoli

| Month / Year | Rainfall (mm) | No. of Rainy Days | Temperature (°C) | | RH (%) | | Rainfall (mm) | No. of Rainy Days | Temperature (°C) | | RH (%) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Max. | Min. | I | II | | | Max. | Min. | I | II |
| April' 16 | 0.00 | 0.00 | 32.15 | 12.57 | 91.16 | 36.77 | 96.0 | 4 | 43 | 30 | 75 | 57 |
| May | 0.00 | 0.00 | 31.25 | 14.57 | 92.28 | 53.52 | 256.0 | 11 | 43.6 | 31 | 72 | 56 |
| June | 0.00 | 0.00 | 33.88 | 17.58 | 89.77 | 55.23 | 236.0 | 11 | 41.2 | 29 | 69 | 59 |
| July | 0.00 | 0.00 | 33.50 | 20.41 | 88.23 | 68.53 | 288.0 | 19 | 39.7 | 26 | 65 | 60 |
| Aug. | 0.27 | 0.03 | 34.02 | 24.14 | 87.77 | 65.35 | 213.0 | 11 | 35.7 | 24 | 77 | 69 |
| Sept. | 35.86 | 0.63 | 31.08 | 24.06 | 93.07 | 81.17 | 340.0 | 15 | 32.7 | 19.5 | 88 | 68 |
| Oct. | 54.53 | 0.97 | 28.21 | 22.87 | 97.00 | 90.74 | 147.0 | 3 | 30.7 | 18 | 73 | 67 |
| Nov. | 24.09 | 0.87 | 28.40 | 23.47 | 94.13 | 89.32 | Nil | - | 25.7 | 16 | 69 | 64 |
| Dec. | 26.12 | 0.57 | 28.89 | 22.23 | 95.23 | 82.00 | Nil | - | 24.7 | 8.5 | 69 | 59 |
| Jan. ' 17 | 6.43 | 0.26 | 31.39 | 20.35 | 94.81 | 78.39 | Nil | - | 26.2 | 10 | 73 | 58 |
| Feb. | 0.00 | 0.00 | 33.36 | 14.42 | 92.30 | 67.43 | Nil | - | 29.2 | 17 | 69 | 56 |
| March | 0.00 | 0.00 | 32.28 | 13.97 | 92.87 | 46.06 | Nil | - | 33 | 23 | 64 | 52 |

## Pottangi

## Jagudan

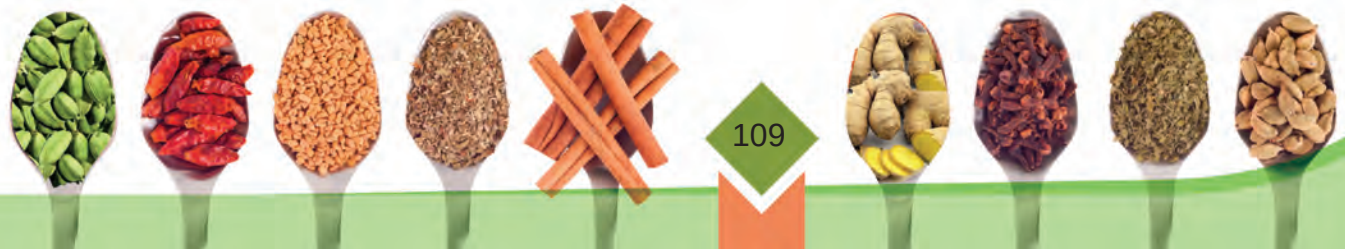
| Month / Year | Rainfall (mm) | No. of Rainy Days | Temperature (°C) | | RH (%) | Rainfall (mm) | No. of Rainy Days | Temperature (°C) | | RH (%) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Max. | Min. | | | | Max. | Min. | I | II |
| April'16 | 0 | 0 | 39.3 | 23.24 | 78.57 | 0.0 | 0 | 35.4 | 22.5 | 83.1 | 41.9 |
| May | 0 | 0 | 44.03 | 25.59 | 86.67 | 0.0 | 0 | 34.5 | 86.4 | 81.8 | 59.1 |
| June | 0 | 0 | 43.34 | 27.36 | 87.18 | 22.8 | 3 | 33.7 | 27.3 | 85.2 | 72.1 |
| July | 199.9 | 14 | 34.3 | 24.9 | 83.74 | 98.3 | 20 | 29.9 | 25.0 | 93.2 | 82.7 |
| Aug. | 139.23 | 12 | 33.11 | 24.86 | 83.25 | 73.2 | 15 | 29.6 | 24.9 | 92.4 | 80.9 |
| Sept. | 19.04 | 3 | 36.8 | 25 | 84.03 | 117.0 | 13 | 30.0 | 23.6 | 96.7 | 78.3 |
| Oct. | 25.08 | 4 | 35.61 | 23.4 | 83.8 | 25.7 | 5 | 32.3 | 20.3 | 91.3 | 52.3 |
| Nov. | 0 | 0 | 33.36 | 13.64 | 55 | 0.0 | 0 | 33.1 | 14.8 | 74.7 | 32.4 |
| Dec. | 0 | 0 | 31.61 | 10.68 | 56 | 0.0 | 0 | 32.1 | 13.8 | 71.4 | 28.5 |
| Jan.'17 | 0 | 0 | 30.29 | 7.99 | 87.4 | | | | | | |
| Feb. | 0 | 0 | 34.91 | 9.19 | 82.14 | | | | | | |
| March | 0 | 0 | 40.4 | 13.79 | 84.25 | | | | | | |

## Navsari

## Jobner

| Month / Year | Rainfall (mm) | No. of Rainy Days | Temperature (°C) | | RH (%) | | Rainfall (mm) | No. of Rainy Days | Temperature (°C) | | RH (%) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Max. | Min. | I | II | | | Max. | Min. | I | II |
| April'16 | 015.2 | 1 | 39.0 | 20.1 | 50 | 24 | - | - | - | - | - | - |
| May | 005.2 | 1 | 42.1 | 26.8 | 51 | 21 | - | - | - | - | - | - |
| June | 075.0 | 3 | 41.6 | 28.3 | 56 | 30 | 119.00 | 8 | 38.67 | 26.13 | 68.75 | 40.25 |
| July | 220.0 | 16 | 33.9 | 25.6 | 83 | 63 | 1978.70 | 23 | 30.74 | 23.78 | 92.00 | 74.60 |
| Aug. | 078.8 | 8 | 31.8 | 24.5 | 91 | 70 | 1214.10 | 21 | 29.15 | 23.10 | 91.50 | 79.75 |
| Sept. | 000.0 | 0 | 35.6 | 22.8 | 74 | 45 | 691.80 | 6 | 31.30 | 23.50 | 90.50 | 68.75 |
| Oct. | 013.2 | 2 | 34.4 | 17.0 | 75 | 39 | 24.20 | 2 | 31.26 | 17.70 | 88.20 | 42.00 |
| Nov. | 000.0 | 0 | 30.0 | 8.1 | 71 | 31 | 0.00 | 0.00 | 28.90 | 8.95 | 88.75 | 24.25 |
| Dec. | 000.0 | 0 | 28..0 | 6.2 | 79 | 38 | 0.00 | 0.00 | 25.40 | 6.58 | 90.75 | 32.50 |
| Jan.'17 | 021.8 | 2 | 22.6 | 7.1 | 88 | 46 | 3.40 | 1 | 24.16 | 8.50 | 90.80 | 44.00 |
| Feb. | 000.4 | 0 | 28.3 | 9.2 | 69 | 30 | 0.00 | 0.00 | 28.63 | 10.38 | 85.50 | 34.00 |
| March | 002.6 | 1 | 31.2 | 13.2 | 66 | 27 | 2.80 | 1.00 | 33.03 | 13.15 | 72.50 | 18.50 |

## Jabalpur



## Solan

| Month / Year | Rainfall (mm) | Temperature (° C) | | RH (%) |
|---|---|---|---|---|
| | | Max. | Min. | |
| April'16 | 71.8 | 25.4 | 11.9 | 58 |
| May | 16.1 | 31.3 | 15.7 | 45 |
| June | 93.6 | 30.5 | 17.3 | 58 |
| July | 258.3 | 27.9 | 19.3 | 80 |
| Aug. | 102.2 | 28.4 | 19.4 | 74 |
| Sept. | 19.0 | 26.9 | 17.2 | 72 |
| Oct. | 34.6 | 25.6 | 11.3 | 59 |
| Nov. | 0.0 | 23.5 | 06.4 | 50 |
| Dec. | 0.0 | 19.7 | 03.2 | 54 |
| Jan.'17 | 49.4 | 16.6 | 02.6 | 64 |
| Feb. | 80.4 | 21.5 | 05.8 | 68 |
| March | 15.3 | 23.6 | 08.1 | 63 |

## Hisar

| Rainfall (mm) | Temperature (°C) | | RH (%) | |
|---|---|---|---|---|
| | Max. | Min. | I | II |
| 4.1 | 19.6 | 7.1 | 94.9 | 64.5 |
| 7.2 | 23.8 | 7.2 | 92.0 | 48.9 |
| 8.1 | 29.9 | 13.7 | 88.5 | 46.4 |
| 8.6 | 37.9 | 18.4 | 60.7 | 25.4 |
| 8.1 | 41.0 | 24.8 | 62.8 | 35.3 |
| 7.8 | 39.6 | 27.6 | 71.0 | 44.2 |
| 5.9 | 35.1 | 26.1 | 90.4 | 71.9 |
| 6.0 | 34.0 | 25.6 | 89.6 | 69.2 |
| 8.8 | 35.2 | 24.2 | 86.4 | 54.2 |
| 7.8 | 34.6 | 18.4 | 84.4 | 41.8 |
| 5.8 | 29.3 | 10.6 | 91.4 | 46.8 |
| 6.7 | 25.0 | 7.5 | 97.1 | 52.7 |

## Dholi

| Month / Year | Rainfall (mm) | Temperature (°C) | | RH (%) | |
|---|---|---|---|---|---|
| | | Max. | Min. | I | II |
| April'16 | 3.2 | 38.3 | 21.7 | 70 | 29 |
| May | 132.8 | 34.6 | 23.1 | 83.4 | 53.1 |
| June | 105.1 | 35.2 | 26.3 | 81 | 61 |
| July | 304.1 | 32.0 | 26.0 | 91 | 79 |
| Aug. | 110.8 | 33.7 | 26.2 | 86 | 67 |
| Sept. | 319.2 | 31.4 | 25.0 | 93 | 79 |
| Oct. | 34.6 | 32.8 | 23.0 | 88 | 58 |
| Nov. | 0.0 | 29.0 | 15.9 | 86 | 44 |
| Dec. | 0.0 | 22.3 | 11.3 | 90 | 65 |
| Jan.'17 | 0.0 | 22.4 | 8.7 | 93 | 62 |
| Feb. | 0.0 | 26.0 | 10.9 | 90 | 58 |
| March | 10.6 | 29.7 | 15.5 | 86 | 54 |

## Kanke

| Rainfall (mm) | No. of Rainy days | Temperature (°C) | | RH (%) | |
|---|---|---|---|---|---|
| | | Max. | Min. | I | II |
| 0.0 | 0 | 41.3 | 17.2 | 80.2 | 35.7 |
| 128.1 | 6 | 41.2 | 19.4 | 80.8 | 40.5 |
| 215.4 | 9 | 41.3 | 20.5 | 79.6 | 60.5 |
| 445.6 | 12 | 34.3 | 15.2 | 82.5 | 67.9 |
| 357.4 | 14 | 34.4 | 18.4 | 83.0 | 65.4 |
| 247.5 | 10 | 34.3 | 19.4 | 83.2 | 66.4 |
| 19.3 | 2 | 31.4 | 13.3 | 84.7 | 60.9 |
| 0.0 | 0 | 30.1 | 5.1 | 87.0 | 55.9 |
| 0.0 | 0 | 28.3 | 2.2 | 86.4 | 55.0 |
| | | | | | |
| | | | | | |
| | | | | | |

## Pundibari

| Month / Year | Rainfall (mm) | Temperature (°C) | | RH (%) | |
|---|---|---|---|---|---|
| | | Max. | Min. | I | II |
| April'16 | 137.60 | 31.52 | 21.78 | 80.57 | 73.80 |
| May | 364.80 | 31.02 | 21.72 | 83.61 | 76.42 |
| June | 886.20 | 32.77 | 23.61 | 88.97 | 79.43 |
| July | 846.20 | 31.48 | 25.35 | 93.26 | 85.65 |
| Aug. | 412.85 | 34.16 | 25.99 | 85.90 | 78.42 |
| Sept. | 498.20 | 32.16 | 24.79 | 91.07 | 86.10 |
| Oct. | 147.70 | 32.85 | 21.81 | 82.00 | 74.32 |
| Nov. | 0.00 | 31.13 | 16.52 | 74.83 | 69.10 |
| Dec. | 0.00 | 28.32 | 12.32 | 80.32 | 69.97 |
| Jan.'17 | 0.00 | 26.28 | 9.66 | 97.00 | 46.84 |
| Feb. | 0.00 | 27.71 | 12.11 | 96.86 | 49.25 |
| March | 67.70 | 28.41 | 15.30 | 92.74 | 53.06 |

## Kalyani

| Rainfall (mm) | Temperature (°C) | | RH (%) | |
|---|---|---|---|---|
| | Max. | Min. | I | II |
| 0.11 | 38.21 | 23.74 | 89.90 | 48.33 |
| 5.45 | 35.36 | 22.61 | 91.35 | 65.23 |
| 5.36 | 34.55 | 23.91 | 93.57 | 74.20 |
| 12.86 | 32.37 | 24.16 | 96.42 | 87.06 |
| 13.94 | 32.63 | 24.14 | 96.39 | 82.23 |
| 4.04 | 33.53 | 24.16 | 93.70 | 78.47 |
| 5.39 | 32.30 | 21.64 | 94.42 | 68.55 |
| 0.57 | 36.83 | 15.33 | 92.90 | 58.17 |
| 0.00 | 26.25 | 10.90 | 96.77 | 57.71 |
| 0.00 | 25.40 | 8.55 | 96.32 | 46.52 |
| 0.00 | 29.48 | 12.61 | 92.25 | 42.61 |
| 0.61 | 32.29 | 17.64 | 92.10 | 48.81 |

## Mizoram

| Month / Year | Rainfall (mm) | No. of Rainy Days | Temperature (ºC) | | RH (%) | |
|---|---|---|---|---|---|---|
| | | | Max. | Min. | I | II |
| April'16 | 337.1 | 14 | 29.3 | 19.5 | 87 | 67 |
| May | 525.4 | 18 | 28.2 | 20.4 | 86 | 74 |
| June | 443.5 | 21 | 28.9 | 22.5 | 94 | 78 |
| July | 353.4 | 23 | 28.9 | 22.6 | 93 | 80 |
| Aug. | 513.5 | 19 | 29.4 | 22.6 | 96 | 82 |
| Sept. | 778.3 | 21 | 28.7 | 22.6 | 96 | 81 |
| Oct. | 133.2 | 11 | 28.4 | 21.6 | 93 | 77 |
| Nov. | 70.3 | 4 | 25.5 | 16.6 | 94 | 69 |
| Dec. | 2.7 | 1 | 24.5 | 14.8 | 88 | 63 |
| Jan.'17 | 0 | 0 | 23.6 | 12.8 | 79 | 53 |
| Feb. | 5.8 | 1 | 25.7 | 14.9 | 73 | 42 |

## Barapani

| Rainfall (mm) | Temperature (ºC) | | RH (%) | |
|---|---|---|---|---|
| | Max. | Min. | I | II |
| 6.00 | 28.53 | 16.65 | 74.86 | 57.18 |
| 9.51 | 27.28 | 16.02 | 85.71 | 74.32 |
| 13.59 | 28.15 | 18.00 | 85.96 | 77.79 |
| 14.54 | 27.86 | 19.38 | 88.63 | 77.69 |
| 5.70 | 30.13 | 19.06 | 85.29 | 70.68 |
| 13.91 | 28.26 | 18.20 | 87.63 | 77.86 |
| 4.74 | 28.05 | 15.57 | 81.75 | 69.00 |
| 0.65 | 25.95 | 11.56 | 85.86 | 56.96 |
| 0.23 | 23.54 | 7.35 | 85.40 | 51.11 |
| 0.76 | 22.22 | 5.69 | 85.78 | 45.30 |
| 6.00 | 28.53 | 16.65 | 74.86 | 57.18 |

## Gangtok

| Month / Year | ICRI, Kabi farm | | | |
|---|---|---|---|---|
| | Temperature (˚C) | | Rainfall (mm) | No. of rainy days |
| | Max | Min | | |
| April'16 | 25.1 | 8.1 | 217.6 | 12 |
| May | 25.2 | 10.2 | 494.1 | 18 |
| June | 24.6 | 9.7 | 651.3 | 20 |
| July | 25.5 | 9.6 | 712.4 | 29 |
| Aug. | 25.3 | 8.4 | 801.9 | 31 |
| Sept. | 24.9 | 8.2 | 307.6 | 28 |
| Oct. | 24.4 | 10.6 | 187.7 | 11 |
| Nov. | 23.4 | 12.4 | Nil | Nil |
| Dec. | 19.6 | 10.3 | 40.3 | 02 |
| Jan.'17 | 22.8 | 11.1 | 74.9 | 04 |
| Feb. | 20.2 | 9.2 | 60.1 | 03 |
| March | 24.3 | 9.8 | 175.2 | 13 |

## Pasighat

| Month / Year | Rain fall (mm) | No. of rainy days | Temperature (ºC) | | Relative Humidity (%) | |
|---|---|---|---|---|---|---|
| | | | Max. | Min. | I | II |
| April'16 | 501.2 | 16 | 24.40 | - | 89.4 | 81.0 |
| May | 281.0 | 10 | 29.30 | - | 79.7 | 71.9 |
| June | 482.9 | 13 | 35.80 | - | 83.6 | 74.6 |
| July | 1108.0 | 17 | 23.10 | - | 69.7 | 66.75 |
| Aug. | 144.0 | 06 | 33.95 | - | 73.1 | 63.3 |
| Sept. | 642.0 | 14 | 29.60 | - | 86.4 | 74.4 |
| Oct. | 56.6 | 03 | 30.75 | - | 71.5 | 65.9 |
| Nov. | 00.0 | 00 | 28.07 | - | 71.4 | 64.4 |
| Dec. | 10.6 | 02 | 26.50 | - | 63.1 | 61.0 |

# XXIV. AICRPS Centers

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| **Andhra Pradesh** | | | |
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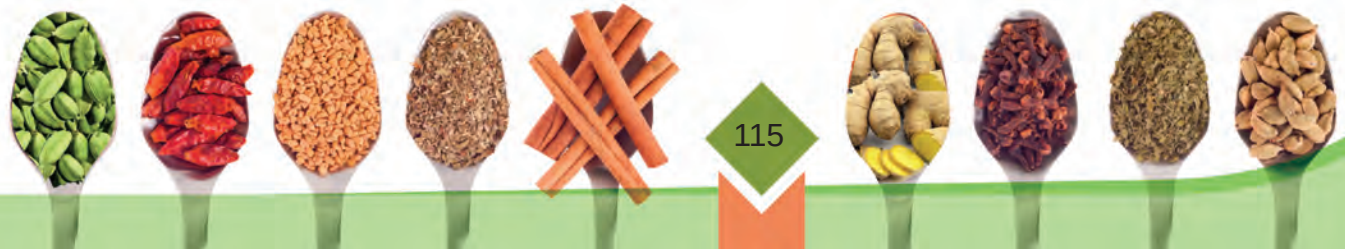

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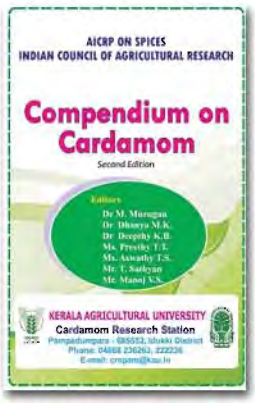
# PUBLICATIONS RELEASED DURING 27TH AICRPS WORKSHOP




Compendium on cardamom


Cardamom pest management


Caradamom-pest management (Malayalam)


Cardamom- disease management


Cardamom- disease management (Malayalam)


Black Pepper - pest magagement


Black Pepper - pest management (Malayalam)


Black pepper-disease management


Black pepper-disease management (Malayalam)


Brochure on biocontrol agents (Malayalam)


AICRPS Dapoli at a glance (Marathi)


Spices Cultivation in Konkan Region (Marathi)

Turmeric Diseases & Pest Management (Tamil)

Turmeric -Nutrient Decifciency & Management (Tamil)

Off season production of leafy coriander under shade net condition (Tamil)


Black Pepper cultivation

Black pepper cultivation (Odiya)


Seed spices cultivation (Gujarati)

Calender of operations in seed spices (Gujarati)

Vanilla-Package of Practices (Kannada)

Allspice-Package of Practices (Kannada)

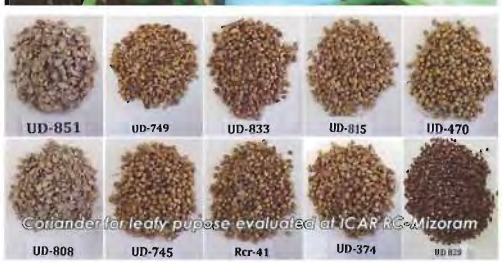
Black pepper cultivation in teak plantation at Bandiwade Tal. Malvan,Maharashtra

Field view of blackpepper at Kahikuchi, Assam

Nadia Ginger from Karbi Anglong, Assam

Demonstration plot for the single bud propagated ginger for the tribal farmers of Koraput, Odisha

A well maintained large cardamom plot in Sikkim




Coriander for leafy purpose evaluated at ICAR RC-Mizoram

Cumin seed production plot at Jagudan, Gujarat

भाकृअनुप
ICAR

हर कदम, हर डगर
किसानों का हमसफर
भारतीय कृषि अनुसंधान परिषद

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