



# वार्षिक रिपोर्ट ANNUAL REPORT 2018 - 2019



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

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



TCP 129



Solan Giriganga



Konkan Sanyukta



Rajendra Dhania 3



Ajmer Coriander 3



Chhattisgarh Sri Chandrasini Dhania - 2



Ajmer fennel 3



Gujarat cumin 5



Narendra Richa (NDM 79)



HM 425

**ICAR-ALL INDIA COORDINATED RESEARCH  
PROJECT ON SPICES**

**ANNUAL REPORT 2018 - 19**



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

**Indian Institute of Spices Research**

**Kozhikode – 673 012, Kerala, India**

### ***Published by***

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Kozhikode – 673 012, Kerala, India  
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### ***Cover Design***

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### ***Correct Citation***

Aarthi S, Krishnamurthy K S, Radha E, Nirmal Babu K (Eds.) (2018) Annual Report 2018-19, ICAR-All India Coordinated Research Project on Spices, ICAR-IISR, Kozhikode, Kerala, India 124p.

### ***June 2019***

### ***Printed at***

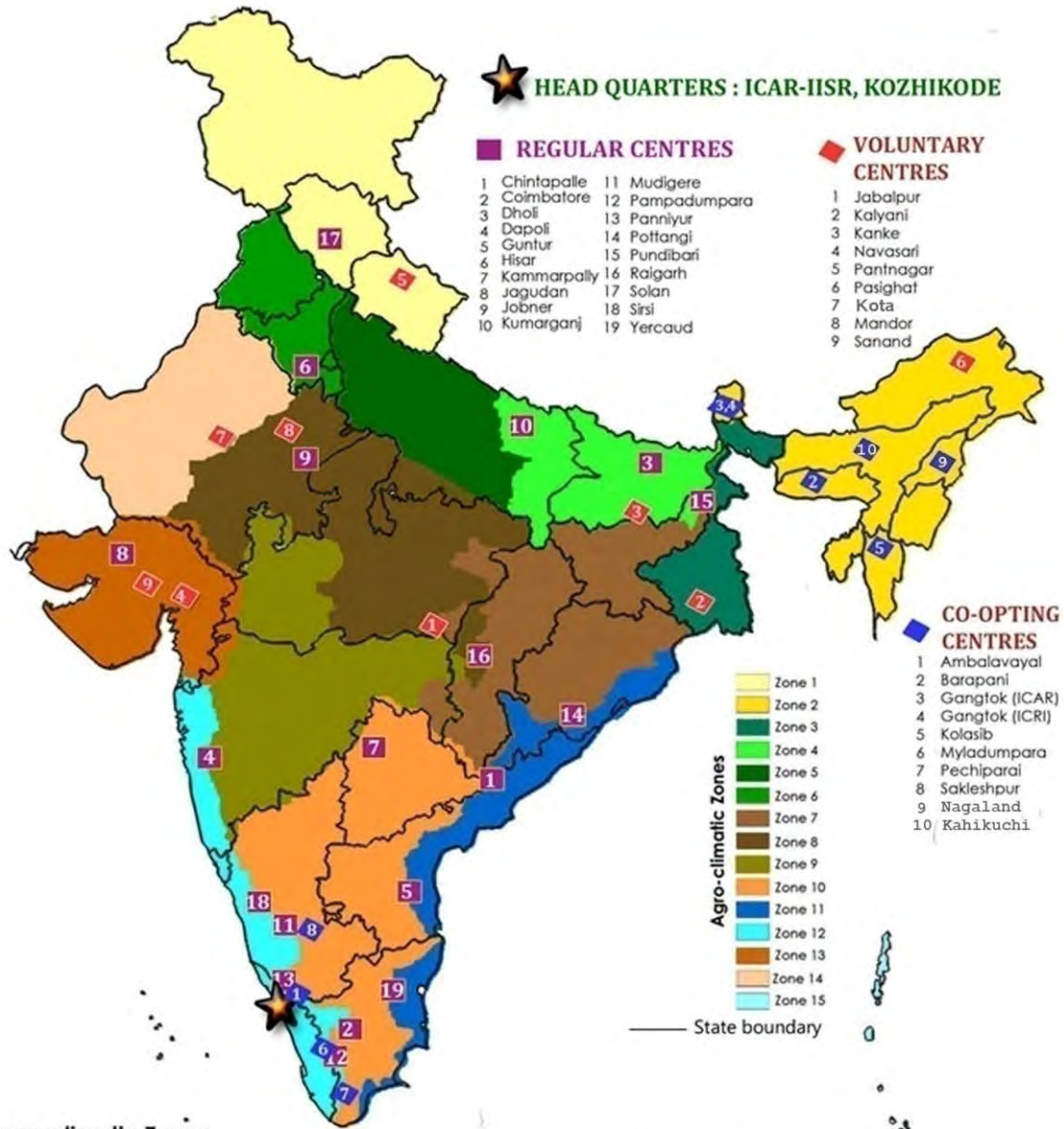
Papyrus Printers, Kozhikode

## CONTENTS

	<b>कार्यकारी सारांश</b>	<b>1</b>
	<i>Executive summary</i>	<b>11</b>
	<i>Profile of AICRP on Spices</i>	<b>22</b>
	<i>Technical programme 2018-19</i>	<b>25</b>
<b>I</b>	<i>Black pepper</i>	<b>32</b>
<b>II</b>	<i>Small cardamom</i>	<b>37</b>
<b>III</b>	<i>Large cardamom</i>	<b>43</b>
<b>IV</b>	<i>Ginger</i>	<b>45</b>
<b>V</b>	<i>Turmeric</i>	<b>56</b>
<b>VI</b>	<i>Tree spices</i>	<b>64</b>
<b>VII</b>	<i>Coriander</i>	<b>68</b>
<b>VIII</b>	<i>Cumin</i>	<b>76</b>
<b>IX</b>	<i>Fennel</i>	<b>79</b>
<b>X</b>	<i>Fenugreek</i>	<b>81</b>
<b>XI</b>	<i>Ajwain</i>	<b>85</b>
<b>XII</b>	<i>Nigella</i>	<b>86</b>
<b>XIII</b>	<i>Mango ginger</i>	<b>87</b>
<b>XIV</b>	<i>Saffron</i>	<b>88</b>
<b>XV</b>	<i>Kalazeera</i>	<b>89</b>
<b>XVI</b>	<i>Monitoring</i>	<b>91</b>
<b>XVII</b>	<i>Annual Group Meeting</i>	<b>92</b>
<b>XVIII</b>	<i>Popularization of Technology</i>	<b>96</b>
<b>XIX</b>	<i>Success stories</i>	<b>97</b>
<b>XX</b>	<i>Krishi Melas and Farmers Trainings</i>	<b>99</b>
<b>XXI</b>	<i>Publications</i>	<b>103</b>
<b>XXII</b>	<i>Awards and Recognitions</i>	<b>112</b>
<b>XXIII</b>	<i>Staff position</i>	<b>113</b>
<b>XXIV</b>	<i>Training and Capacity Building</i>	<b>115</b>
<b>XXV</b>	<i>Centre wise budget 2018-19</i>	<b>116</b>
<b>XXVI</b>	<i>Weather data</i>	<b>117</b>
<b>XXVII</b>	<i>AICRPS centres</i>	<b>120</b>

# 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  
 Zone 7-E.plateau and hills region  
 Zone 8- C. Plateau and hills region  
 Zone 9- 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  
 Zone 14- Western dry region  
 Zone 15- Island region

## कार्यकारी सारांश

भाकृअनुप- अखिल भारतीय समन्वित मसाला अनुसंधान परियोजना देश के 25 राज्यों में 14 कृषि जलवायु क्षेत्रों में फैले हुए 38 केन्द्रों (19 नियमित, 11 सहयोगी तथा 8 अवैतनिक केन्द्रों) में प्रमुख मसाला फसलें जैसे काली मिर्च, बडी इलायची, छोटी इलायची, अदरक, हल्दी, आम आदरक, दालचीनी, जायफल, लौंग, धनिया, जीरा, सौंफ, मेथी, अजवाइन, निगेल्ला, केसर तथा काला जीरा पर अनुसंधान कार्यों का समन्वय करता है। वर्ष 2018-19 की वार्षिक बजट में भारतीय कृषि अनुसंधान परिषद का आबंटन 607.76 लाख रुपए थे।

अखिल भारतीय समन्वित मसाला अनुसंधान परियोजना ने वर्ष 2017-18 में सर्व श्रेष्ठ एआईसीआरपीएस के लिए प्रतिष्ठित **चौधरी देवी लाल उत्कृष्ट एआईसीआरपीएस पुरस्कार** प्राप्त किया है। केरल कृषि विश्वविद्यालय के अन्तर्गत काली मिर्च अनुसंधान स्टेशन., पन्नियूर को एआईसीआरपीएस के तहत सर्वश्रेष्ठ केन्द्र के लिए सम्मानित किया गया है। डॉ. के. नर्मल बाबू, परियोजना समन्वयक एवं डॉ. पी. एम. अजित, प्रजनक, काली मिर्च अनुसंधान स्टेशन, पन्नियूर ने आईसीएआर स्थापना दिवस के अवसर पर एनएएससी कॉम्प्लेक्स, नई दिल्ली में आयोजित पुरस्कार वितरण समारोह में माननीय केन्द्रीय कृषि एवं किसान कल्याण मंत्री श्री. राधा मोहन सिंह से पुरस्कार ग्रहण किया।

### नई पहल

आम अदरक, केसर और कालाजीरा जैसी नई फसलों को जोड़ा जाता है तथा नई फसलों के जर्मप्लासम का संग्रह और संरक्षण कार्य शुरू किया।

एआईसीआरपीएस के विभिन्न बीज मसाला केन्द्रों में जीरा और धनिया के लिए खाद्य सुरक्षा आश्वासन और मसालों में कीटनाशक अवशेषों को कम करने के साथ साथ, एकीकृत कीट और रोग प्रबन्धन पर अच्छी कृषि प्रथाओं की परियोजना शुरू की गई थी।

विशिष्ट लक्षणों के लिए, जीनप्रकारों के मूल्यांकन के लिए, विभिन्न एआईसीआरपीएस केन्द्रों ने काली मिर्च, आम अदरक, अदरक, इलायची, धनिया, जीरा, सौंफ तथा मेथी जैसी मसाला फसलों में समन्वित प्रजाति परीक्षण किया है।

### उनतीसवीं एआईसीआरपीएस कार्यशाला में विमोचित करने के लिए संस्तुत प्रजातियां

मसालों की ग्यारह उच्च उपज वाली प्रजातियों (अदरक 1, हल्दी 1, जायफल 1, धनियां 1, सौंफ 1, मेथी 2 तथा जीरा 1) को बागवानी अनुसंधान स्टेशन, डॉ. वाई. एस. परमार बागवानी एवं वानिकी विश्वविद्यालय, सोलन, हिमाचल प्रदेश में आयोजित की जाने वाली उनतीसवीं कार्यशाला में विमोचित करने के लिए संस्तुत किया गया।

### प्रजातियां

- 1. सोलन गिरिगंगा:** - यह डॉ. वाई. एस. परमार बागवानी एवं वानिकी विश्वविद्यालय, सोलन की अदरक प्रजाति है। इसमें शुष्क उपज के साथ मोटे और बोल्ड प्रकन्द 21.01%, एसनशियल तेल 1.45%, ओलिओरसिन - 4.69%, कच्चे फाइबर 4.47% और प्रकन्द गलन का आपतन <10% है।
- 2. टीसीपी 129:** युबीकेवी, पुंडिबारी, पश्चिम बंगाल की हल्दी प्रजाति। पर्ण चित्ती एवं पर्ण ब्लॉच के सह्य प्रजाति और उसमें कुरकुमिन की मात्रा 5.1% तथा शुष्क उपज की प्राप्ति 26.51% है।
- 3. कोंकण संयुक्ता :** डॉ. बीएसकेकेवी, दापोली से जायफल की किस्म। इस द्विलिंगी जायफल से मोटे नट (9.20 ग्राम) , जावित्री वजन (1.07 ग्रा.), उच्च नट तेल (27%) और जावित्री तेल (17.75%) के साथ प्रतिवर्ष 500 फल मिलता है।
- 4. राजेन्द्र सोनिया 3 :** डॉ. आरपीसीएयू, धोली से विमोचित धनिया प्रजाति। उच्च उपजता (14.09 कुन्तल /हेक्टेयर) तथा उच्च तेल (0.52%) के साथ जलवायु लचीला धनिया प्रजाति को राष्ट्रीय विमोचन के लिए संस्तुत है।
- 5. जेडी (एसआई) 1:** जेएनकेवीवी, जबलपुर से विमोचित धनिया प्रजाति, उच्च तेल ( 0.67%) तथा उच्च उपज क्षमता (14.14 कु. / हेक्टे.) वाली यह प्रजाति मध्यप्रदेश के लिए उचित है।

6. **अजमेर धनिया 3** : धनिया की इस प्रजाति को आईसीएआर-एनआरसीएसएस, अजमेर से विमोचित किया गया। उच्च बाष्पशील तेल (0.55%), उच्च लिनालूल (75.42%) उच्च एवं स्थिर उपज (13.09 कुन्तल / हेक्टे.) के साथ धनिया की प्रजाति।
7. **छत्तीसगढ़ श्री चन्द्रहासिनी धनिया 2** : आईजीकेवी, राईगढ़ की धनिया प्रजाति। जलवायु लचीला धनिया प्रजाति पत्ते और बीज दोनों के लिए उपयुक्त है, पाउडरी मिल्ड्यू तथा एफिड के लिए मध्यम प्रतिरोधी है।
8. **अजमेर सौंफ 3** : आईसीएआर -एनआरसीएसएस, अजमेर की सौंफ प्रजाति। उच्च उपज (21.43 कुन्तल / हेक्टे.) तथा उच्च तेल (1.9%) की सौंफ प्रजाति *रामुलारिया* ब्लाइट के प्रतिरोधी तथा देश के सौंफ उगाने वाले क्षेत्रों के लिए उचित।
9. **एचएम 425** : सीसीएसएचएयु, हिसार की मेथी प्रजाति। उच्च उपजता (20-22 कुन्तल/ हेक्टे.) पाउडरी मिल्ड्यू तथा डाउनी मिल्ड्यू के प्रतिरोधक मेथी देश के मेथी उगाने वाले क्षेत्रों के लिए उचित।
10. **नरेन्द्र रिचा (एनडीएम 79)** : एनडीयुए तथा टी, कुमारगंज से विमोचित मेथी प्रजाति। उत्तर प्रदेश और आंध्रप्रदेश के लिए उपयुक्त पाउडरी मिल्ड्यू के लिए मध्यम प्रतिरोध के साथ दोहरे उद्देश्य वाले क्षारीय सहिष्णु मेथी है।
11. **गुजरात जीरा 5** : एसडीएयु, जगुदान से विमोचित जीरा प्रजाति। उच्च उपजवाले म्लानी प्रतिरोधक जीरा अल्प अवधि एवं उच्च उपज वाले (जी सी 4 की अपेक्षा 38% उच्चतर उपज) देश के जीरा उगाने वाले क्षेत्रों के लिए उचित।

### उनतीसवीं एआईसीआरपीएस कार्यशाला में विकसित तकनीकियां

एआईसीआरपीएस के उनतीसवीं वार्षिक कार्यशाला में विभिन्न राज्यों के लिए विभिन्न मसाला फसलों में छः स्थान विशिष्ट तकनीकियों को विकसित किया गया।

#### जल उपयोग दक्षता (प्रति बूंद अधिक फसल)

**धनिया में ड्रिप सिंचाई एवं प्रजनन** : भारत की हल्की बनावट वाली मिट्टी में धनिया और डब्ल्यूयुई में सुधार के लिए 2-3 दिनों के अन्तराल में वास्तविक बाष्पीकरण (0.8 आईडब्ल्यू/सीपीई अनुपात) के 80% के बराबर पानी के साथ उर्वरकता और संस्तुत मात्रा के उर्वरक विकास के विभिन्न चरणों (बुआई के 20,40, 60 तथा 80 दिनों के बाद) में घुलनशील उर्वरकों के माध्यम से देने की सिफारिश की जाती है।

**सौंफ में ड्रिप फर्टिगेशन** : भारत की हल्की बनावट वाली मिट्टी में सौंफ और डब्ल्यूयुई में सुधार के लिए 2-3 दिनों के अन्तराल में वास्तविक बाष्पीकरण (0.8 आईडब्ल्यू/सीपीई अनुपात) के 80% के बराबर पानी के साथ उर्वरकता और 75%) संस्तुत मात्रा के उर्वरक विकास के विभिन्न चरणों (बुआई के 20,40, 60 तथा 80 दिनों के बाद) में घुलनशील उर्वरकों के माध्यम से देने की सिफारिश की जाती है।

#### स्थायी मसाला उत्पादन के लिए जैविक पोषण प्रबन्धन

**इलायची की जैविक खेती** : जैव उर्वरक (अज़ोस्फिरिल्लम और पीएसबी) तथा जैव नियन्त्रण कारक (ट्राइकोडेरमा विरिडे) दोनों 10 ग्राम तथा 30 टन खाद के साथ जीवामृत (20 लिटर / पौधे) मासिक अन्तराल में इलायची पहाड़ी रिज़र्व, केरल में एक जैविक उत्पादन पद्धति के रूप में प्रयोग करने के लिए संस्तुत किया जाता है।

**धनिया की उत्पादकता बढ़ाने के लिए जैव उर्वरक** : धनिया की उत्पादकता बढ़ाने के लिए फॉस्फेट सोलुबिलाइसिंग बैक्टीरिया (पीएसबी) 15 कि. ग्राम प्रति हेक्टेयर या अज़ोस्फिरिल्लम 15 कि. ग्राम प्रति हेक्टेयर की दर के साथ एनपीके 60 : 40 : 30 कि. ग्राम प्रति हेक्टेयर मृदा अनुप्रयोग करने को संस्तुत किया जाता है।



## रोग प्रबन्धन

**जीरा ब्लाइट के लिए रासायनिक प्रबन्धन :** गुजरात के जीरा उत्पादन क्षेत्रों में ब्लाइट के प्रभावी प्रबन्धन के लिए क्रेसोक्सिम मीथाइल 44.3 एससी (1 मि. लि./लि.), मॅकोज़ेब 75 डब्ल्यूपी(3.7 ग्रा. /लि.) तथा डिफनाकोनाज़ोल 25 ईसी (0.5 मि. लि./लि.) अंकुरण के 40, 50 तथा 60 दिनों के बाद छिड़काव करने के लिए संस्तुत किया जाता है।

**जीरा एफिड के प्रति कीटनाशकों के नए अणुओं की जैव-प्रभावकारिता :** जीरा एफिड के प्रभावी और किफायती प्रबंधन के लिए 10 दिनों के बाद 10% एफिड का आक्रमण होने वाले खेतों में थियोमैथोक्साम 25 डब्ल्यूजी का पहली बार पत्तों पर छिड़काव (25 ग्रा. ए.आई/ हेक्टे.; 2.5 ग्रा. /10 लि. जल) करना तत्पश्चात् थियाक्लोप्रिड 21.7 एससी (25 ग्रा.ए.आई/हेक्टे.; 2.88 ग्रा./10 लि. जल) का छिड़काव गुजरात के जीरा उत्पादक क्षेत्रों के लिए संस्तुत किया जाता है।

## काली मिर्च

वर्ष 2018-19 में पेप्पर रिसर्च स्टेशन, पन्नियूर काली मिर्च के 15 नये अक्सेशनों को तथा एचआरएस, सिरसी काली मिर्च के 15 अक्सेशनों को तथा पुंडिबारी केन्द्र 12 अक्सेशनों को संचित करके कुल जर्मप्लासम में 840 अक्सेशनें हो गये। वर्ष 2018-19 में पन्नियूर में जीनप्रकार पीआरएस 64, पीआरएस 136 तथा पीआरएस 154 उच्चतम उपजदायक थे। पीआरएस 64 4.98 कि. ग्रा. हरी बरियों एवं 1260 स्पाइक/बेल के साथ प्रथम आ गये। स्पाइक की अधिकतम लंबाई पीआरएस 155 (15.1 से. मी.) और पीआरएस 137 (75.0) में विकसित बरियों / स्पाइकों की संख्या, पीआरएस 154 में 100 बरियों की वज़न (12.4ग्रा.) तथा पीआरएस 136 में शुष्क बरियां (38%) है। सीवीटी में कुम्बक्कल ने उच्चतम हरी बरियों की उपज 2.20 कि. ग्रा. अंकित किया तथा पन्नियूर 1 उसके निकट है। पन्नियूर 1 में औसत स्पाइक लंबाई उच्चतम ( 17.03 से. मी.) थी जो पन्नियूर 5 की 166.6से. मी. के निकट है। पन्नियूर 1 में बरियों / स्पाइकों की संख्या अधिक ( 8466) थी। उच्चतम शुष्क उपज प्राप्ति का प्रतिशत ज़ियोन मुंडी, पन्नियूर 5 तथा पन्नियूर 1 (35%) में अंकित किया।

चिन्तपल्ली में संरक्षित जर्मप्लासम प्रकारों में पन्नियूर-1 ने प्रति बेल की अधिकतम स्पाइक (639), प्रति बेल ताज़ा बरियों की उपज (4.04 कि. ग्रा.), सूखी उपज (1.29 कि. ग्राम), प्रति हेक्टेयर ताज़ा उपज (4.13 टन/हेक्टे.) अंकित की जबकि प्रति स्पाइक की उच्चतम बरियों की संख्या नीलमुंडी में अंकित की तथा उच्चतम सूखी उपज (32.65%) पेराम्बामुंडी में अंकित की।

दापोली में एचबी 20052 में उच्चतम हरी बरियों की उपज 5.20 कि. ग्रा. अंकित की तत्पश्चात् अक्सेशन सं. 53 (4.97 कि. ग्रा./ बेल)। पौधों की उच्चतम ऊंचाई पन्नियूर 1 (5.17 मी.) में अंकित की। सभी प्रजातियों के पौधों की ऊंचाई में 2.20 से 5.02 मी. का अंतर है। अक्सेशन सं. 106 ने अधिकतम पादप ऊंचाई (5.02 मी) अंकित की जबकि निम्नतम पादप ऊंचाई एचपी-39 ने अंकित की।

येरकाड में वर्ष 2018-19 के दौरान प्रति मीटर वर्ग (48.0) स्पाइक की अधिकतम संख्या आईआईएसआर शक्ति में अंकित की गई और सबसे निम्नतम अक्सेशन सं. 106 (15.0) में थी। प्रति स्पाइक के बरियों की संख्या (68) तथा हरे बरी एवं सूखे बरी की उपज (क्रमशः 0.580 कि. ग्रा. तथा 0.169 कि. ग्रा.) भी उसी जीन प्रकार में उच्चतम थी।

## छोटी इलायची

सकलेशपुर में, सूखा सहिष्णुता पर सी वी टी परीक्षण से पता चला है कि नमी के तनाव में जीनप्रकार आईसी 349537 (46.30) ने फलोंयुक्त टिल्लर की अधिक संख्या (10.83), पनिकिल्स की संख्या (5.39) तथा लंबी पनिकिल्स की संख्या (35.65 से. मी.) एवं प्रति रेसीम्स में कैप्सूल की संख्या (4.30) के लिए पंजीकृत किया। नियन्त्रण के अन्तर्गत भी समान जीन प्रकारों ने फलोंयुक्त टिल्लर्स की संख्या (17.10) पनिकिल्स की संख्या (7.55) तथा लंबी पनिकिल्स (50.41 से. मी.) एवं प्रति रसिम्स से कैप्सूल की संख्या (5.10) को भी पंजीकृत किया। मुडिगरे में, पौधे की अधिकतम ऊंचाई आईसी-584078 (248.30 से. मी.) में अंकित किया तथा प्रति पौधे में अधिक सकेर्स आईसी 349537 (46.30) में दर्शाया तत्पश्चात् एचएस-1 (41.60)।

मैलाडुमपारा के किसानों के प्रजाति परीक्षण से पता चला कि टिल्लर्स की संख्या वन्डर कारडमोम (68) में अधिक थी तत्पश्चात् तिरुताली (54.33)। पादप ऊंचाई तिरुताली ( 285.67) में अधिक थी तत्पश्चात्

पनिकुलंगरा 1 (250.67)। अर्जुन (4) में वनस्पति कलियों की संख्या अधिकतम थी तत्पश्चात् पीएनएस वैगई (3.67)। रोपण के 9 महीने बाद पनिकिल प्रारंभ होते हैं। अपेक्षितता तिरुताली (43) में अधिक पनिकिल्स को देखा गया तत्पश्चात् पनिकुलंगरा (16.33)।

मुडिगरे तथा पाम्पाजुमपारा में फिप्रोनिल 5 एससी @0.005% लगाए गए पौधों में थ्रिप्स बाधा की अधिकतम कमी अंकित की। सकलेशपुर में, थ्रिप्स क्षतिग्रस्त कैप्स्यूल (%) छिड़काई के 15 दिन बाद स्पिनोसाद, इमिडाक्लोप्रिड और फिप्रोनिल में सबसे कम थे और एक दूसरे के बराबर थे।

### बडी इलायची

बडी इलायची के प्रमुख मृदा जनित रोगों के प्रति जैविक उपचारों के मूल्यांकन पर अध्ययन करने पर, सीओसी 2 ग्रा. / लिटर ट्राइकोडेरमा (4 मि.लि./लि.) (रोपण के 10 दिनों के बाद) बुआई के समय मृदा में लगाने तथा सीओसी 2 ग्रा. / लिटर क्लम्प के पास तत्पश्चात् ट्राइकोडेरमा (4 मि.लि./लि.) (सीओसी लगाने के 10 दिनों के बाद) प्रत्येक महीने लगाने पर रोग आपतन कम (9.52%) अंकित किया।

### अदरक

बारापानी में, अदरक के तिरालीस (43) जीनप्रकारों का संरक्षण करके मूल्यांकन किया गया। उनमें से आईसी - 584354 ने 20.95 टन/हेक्टे. के साथ उच्चतम उपज अंकित की। आईसी 584335 तथा आईसी 584347 (6.15%) में कूड फाइबर अधिकतम थी। उच्चतम सूखे उपज की मात्रा 25.09% आईसी -584353 में अंकित की तथा ओलिओरसिन की उच्चतम मात्रा (7.07%) आईसी-584343 में अंकित की।

ट्राइकोडेरमा और जीआरबी 35 टाल्क संयोजन के संयुक्त उपचार को पौधे के विकास के मापदंडों को बढ़ाने और अन्य उपचारों में प्रकन्द गलन को कम करने में बेहतर पाया गया। जीआरबी 35 टाल्क संयोजन के साथ ट्राइकोडेरमा के टाल्क संयोजन ने सोलन और राइगढ़ में बेहतर प्रदर्शन किया।

### हल्दी

वर्ष 2018-19 में, कोयंबतोर केन्द्र ने 275 हल्दी जीनप्रकारों का मूल्यांकन किया, जिसमें वृद्धि, उपज एवं गुणवत्ता मानकों के लिए व्यापक विविधताएं प्रकट हुईं। इस जीनप्रकारों को उच्च उपजवाले जीनप्रकार तथा उच्च कुरकुमिन उपजवाले जीन प्रकार के रूप में वर्गीकृत किया गया। कम्मरपल्ली केन्द्र में 280 हल्दी जर्मप्लासम अक्सेशनों का संरक्षण किया जा रहा है। इन अक्सेशनों में, निज़ामाबाद लोकल (62.34 टन/हेक्टे.), चेनूर लोकल (62 टन/हेक्टे.), एनडीएच - 4 (61.69 टन/हेक्टे.), एनडीएच - 9 (62.13 टन/हेक्टे.) तथा जेटीएस - 332 (60.69 टन/हेक्टे.) ने लोकल चैक दुग्गिराला रेड (43.25 टन/हेक्टे.) तथा आईआईएसआर प्रतिभा- नेशनल चैक (59.92 टन/हेक्टे.) की अपेक्षा बेहतर प्रदर्शन किया। धोली में संरक्षण किये 67 अक्सेशनों में से चैक प्रजाति राजेन्द्र सोनिया (49.83 टन/हेक्टे.) की अपेक्षा केवल चौदह अक्सेशनों में 50.25 से 54.17 टन/हेक्टे. अन्तर के उच्च उपज अंकित की। चौदह आशाजनक अक्सेशनों में, आरएच-421 ने अधिकतम उपज (54.17 टन/हेक्टे.) अंकित की तत्पश्चात् आरएच-2 (53.33 टन/हेक्टे.)।

कुमारगंज में, कुल 180 अक्सेशनों का संरक्षण किया जाता है। सभी 180 अक्सेशनों का मूल्यांकन किया गया तथा उनमें से एनडीएच-74 (275 ग्रा./पौधा) तथा एनडीएच -86 (265 ग्रा./पौधा) पहले, एनडीएच - 98 (290 ग्रा./पौधा) तथा एनडीएच-78 (270 ग्रा./पौधा) तथा एनडीएच-2 (265 ग्रा./पौधा) देर से परिपक्व होने वाले प्रकारों में उच्च उपजवाले थे। गुंटूर केन्द्र ने 280 हल्दी जर्मप्लासम अक्सेशनों का संरक्षण किया है जिनमें 48 का मूल्यांकन किया गया। पासिघाट में, संपूर्ण उत्तर पूर्व क्षेत्रों से 52 विविध जीनप्रकारों को संचित करके मूल्यांकन किया गया। एचएआरएस, पोटांगी में, वर्ष 2018-19 में 179 अक्सेशनों का मूल्यांकन किया गया और सीएआरएस, राइगढ़ में 86 जर्मप्लासम अक्सेशनों का संरक्षण किया जाता है। वर्तमान में एआईसीआरपीएस के जर्मप्लासम में कुल 1621 हल्दी अक्सेशनें है।

हल्दी के समन्वित प्रजाति परीक्षण में, विभिन्न केन्द्रों पर दो जॉचों (आईआईएसआर प्रतिभा तथा बीएसआर 2) के साथ बारह जीनप्रकारों का मूल्यांकन किया गया। जीनप्रकार एलटीएस - 2 ने कोयंबतोर (40.92 टन/हेक्टे.) तथा गुंटूर (48.9 टन/हेक्टे.) बेहतर प्रदर्शन किया। कम्मरपल्ली में एनडीएच - 11 (37.50 टन/हेक्टे.) उच्चतम ताज़ा प्रकन्द अंकित किया। चिन्तपल्ली में, पीटीएस -2 (27.87) ने उच्चतम उपज अंकित किया। पुंडिबारी में, सबसे अधिक अनुमानित उपज टीसीपी -191 (39.78 टन/हेक्टे.) में अंकित की गयी और पोटांगी में पीटीएस-18 (15.2 टन/हेक्टे.) उच्चतम उत्पादक थे। कुमारगंज में अधिकतम प्रकन्द उत्पादक

एलटीएस-1 (261.11 कुन्टल/हेक्टे.) तथा राइगढ में आईटी 36 ने अधिकतम प्रकन्द उपज (36.7 टन/हेक्टे.) अंकित की। धोली में आरएच-9/90 तथा आरएच -80 ( क्रमशः 57.98 टन/हेक्टे. तथा 53.13 टन /हेक्टे.) उच्चतम उत्पादक थे।

माताबंगा क्षेत्र में पुंडिबारी केन्द्र द्वारा आयोजित सर्वेक्षण में हल्दी की दो प्रमुख रोगों जैसे, पर्ण ब्लोच (टफरीना स्पीसीस) तथा कोलेटोड्राइकम पर्ण चित्ती (कोलेटोड्राइकम स्पीसीस) को प्रचलित मानी गई। अधिकांश क्षेत्रों में स्थानीय प्रजातियां फैले हुए हैं जो इन रोगों के लिए अति संवेदनशील हैं। सर्वेक्षण में यह पाया गया कि माताबंगा में औसत पर्ण ब्लोच रोग की गंभीरता 18.35 पीडीआई तथा पर्ण चित्ती के लिए 20.53 थी।

कोयंबतोर में, ईरोड जिले के पेरुन्तुराई क्षेत्र में पर्ण चित्ती (14.3 पीडीआई) का अधिकतम आपतन दर्शाया और अधिकतम पर्ण ब्लोच गोबी ( 24.6 पीडीआई) में तत्पश्चात् ईरोड जिले के पेरुन्तुराई (22.9 पीडीआई) में दर्शाया। कोयंबतोर जिले में, अधिकतम पर्ण ब्लोच (25.7 पीडीआई) आपतन तोन्डमुतुर में दर्शाया तथा पर्ण चित्ती का आपतन कारामडई में 8.9 पीडीआई थे। राइगढ विकास खण्ड के भिखारी माल गाँव में कोलेटोड्राइकम पर्ण चित्ती रोग आपतन 43.78% तथा टफरीना पर्ण ब्लोच का आपतन 38.78% है तथा अमलिडिह गाँव में, कोलेटोड्राइकम पर्ण चित्ती रोग आपतन 34.78% और टफरीना पर्ण चित्ती की तीव्रता 22.57% है।

### वृक्ष मसाले

पीचीपराई में संरक्षित जायफल अक्सेशनों में, एमएफ-1 ने अधिकतम वृक्ष ऊंचाई (9.14 मी.) तथा तना व्यास (58.55 से. मी.) अंकित किया। एम एफ -4 ने अधिकतम पर्ण लंबाई (20.14 से. मी.), पर्ण चौड़ाई (9.15 से. मी.) फलों की संख्या (667), एकल फल की वजन (53.0 ग्रा.) तथा जावित्री उपज (286 ग्रा./वृक्ष) अंकित की। दापोली में, जीनप्रकार DBSKKVMF 29 (972), DBSKKVMF 9772 (507), DBSKKVMF 22 (498) ने क्रमशः अधिकतम औसत फलों की संख्या अंकित की। जीनप्रकार DBSKKV 29 ने अधिकतम सूखे नट उपज (9817.20 ग्रा.) तथा सूखी जावित्री उपज (2721.60 ग्रा.) अंकित की।

दापोली में वर्ष 1996-97 में रोपण किये लौंग जर्णप्लासम में चार आशाजनक जीनप्रकारों का चयन किया गया। पौधों की ऊंचाई में 5.89 से 7.15 मी. का अन्तर है, व्यास में 35-40 से. मी. और 2.50 मी. से 3.05 मी. व्याप्ति में अन्तर है। पीचीपराई के 24 अक्सेशनों में, स्थानीय चैक वृक्ष की ऊंचाई (9.31 मी.) की अपेक्षा एसए-1 ने उच्चतम वृक्ष ऊंचाई 11.78 मी., तत्पश्चात् एसए-3 (11.63 मी.) अंकित किया। अक्सेशन एसए -13 अन्य अक्सेशनों की अपेक्षा काफी बेहतर था और स्थानीय चैक (40.57 से. मी.) की तुलना में उच्चतम तना व्यास (49.59 से. मी.) अंकित किया। अक्सेशन एसए -3 ने उच्चतम पर्ण लंबाई (12.47 से. मी.), पर्ण चौड़ाई (7.46 से. मी.), शाखाओं की संख्या (16) तथा शुष्क मुकुल उपज (1.52 कि. ग्रा. / वृक्ष/वर्ष) अंकित किया। पीचीपराई में मूल्यांकन किये बारह दालचीनी अक्सेशनों में सीवी-5 में अधिकतम पेड की ऊंचाई (2.81 मीटर), प्ररोहों की संख्या (10) तथा तना व्यास (16.84 से. मी.) अंकित किया।

### धनिया

रबी 2018-19 में, जोबनर से धनिया की 21 (सीवीटी) प्रविष्टियों को पाउडरी मिलड्यू रोग के प्रति जाँच की गयी। परीक्षण किये गये प्लॉट में दो प्रविष्टियों जैसे, सीओआर-190 तथा सीओआर-192 ने मध्यम प्रतिरोध दर्शाया तथा दस प्रविष्टियां जैसे COR-176 से COR-180, COR-185 से COR-187, COR-191 तथा RCr-728 संवेदनशील थी और बाकी प्रविष्टियों ने रोग के प्रति अतिसंवेदनशील प्रतिक्रिया दिखाई।

सामान्य परिस्थितियों में UD-35, UD-76, RCr- 436, UD-27, UD-39 आदि तथा तनाव की स्थिति में UD-27, UD-86, UD-77, UD-73 और UD-87 उच्च उत्पादक थे। तनाव सूचकांकों के आधार पर UD-87, RCr-20, UD-86, UD-77 और UD-30 को सूखे हालत में वांछनीय प्रविष्टि के रूप में पाया गया।

कटाई प्रबंधन, प्रजातियों और उर्वरकता के स्तर ने धनिया के बीज को जगुदान में बराबर उपज को प्रभावित किया। पैंतालीस दिनों के बाद एक बार कटे हुए पौधे ने दो बार कटे हुए पौधे या बिना कटे हुए पौधे से अधिक धनिया बीज के बराबर उपज अंकित की। जीडीएलसी 1 प्रजाति ने जीसीओ2 से काफी अधिक धनिया बीज के बराबर उपज का उत्पादन किया। अन्य उपचारों की अपेक्षा 60:30:00 कि. ग्रा. एनपीके/हेक्टे. लगाने से सबसे अधिक बीज के बराबर उपज अंकित की। विभिन्न उर्वरक स्तर के तहत जीसीओ2 की अपेक्षा प्रजाति जीडीएलसी 1 अधिक प्रभावी थे।

## जीरा

जगुदान में जीरा की तेरह प्रजातियों को पाउडरी मिल्ड्यू रोग के प्रति छानबीन की गयी। न्यूनतम रोग आपतन जेसी-16-07 (5.0%) में दर्शाया जबकि अधिकतम रोग आपतन प्रविष्टि जेसी-18-02में तथा सीवीटी-42 (15.0%) में दर्शाया। पाउडरी मिल्ड्यू आपतन का अन्तर 5.0 से 15.0 प्रतिशत है।

मनडोर में जीरा में तीन वर्ष के ड्रिप सिंचाई एवं फरटिगेशन परीक्षण के फलस्वरूप यह सूचित किया कि उच्चतम कुल प्राप्ति (रु. 1,80,9000 /हेक्टे.), नेट प्राप्ति (रु. 1,21,700 /हेक्टे.) तथा लाभ मूल्य के अनुपात (3:1) की डेटा फरटिगेशन द्वारा 80% आरडीएफ के साथ 0.6 आईडब्ल्यू /सीपीई अनुपात में ड्रिप सिंचाई के अन्तर्गत अंकित की गयी।

## सौंफ

जगुदान में रामुलारिया ब्लाइट रोग प्रतिरोधकता की छानबीन की गयी। उनमें किसी भी प्रविष्टि को रामुलारिया ब्लाइट से मुक्त नहीं देखा गया। रामुलारिया ब्लाइट का न्यूनतम आपतन एफएनएल-118 तथा एफएनएल - 126 (25.00%) में दर्शाया जबकि अधिकतम आपतन एफएनएल -129 (32.25%) प्रविष्टि में अंकित किया। रोग आपतन का अन्तर 25.00 से 32.25 प्रतिशत है।

जोबनर में सीवीटी परीक्षण से पता चला कि बीज की उपज में 13.20 से 25.22 कुन्तल / हेक्टे. अन्तर थे। मूल्यांकन किये दस प्रविष्टियों में से, प्रविष्टि युएफ-231 ने अधिकतम बीज उपज 25.62 कुन्तल / हेक्टे. अंकित की तत्पश्चात् युएफ-232 (24.69 कुन्तल / हेक्टे.), युएफ-230 (23.22 कुन्तल / हेक्टे.), आरएफ-125 (22.95 कुन्तल / हेक्टे.) , तथा आरएफ-205 (22.84 कुन्तल / हेक्टे.) जबकि निम्नतम बीज उपज 13.21 कुन्तल / हेक्टे. युएफ-234 में अंकित की। वर्ष 2017-18 तथा 2018-19 में आईईटी मूल्यांकन किये गये सौंफ प्रविष्टियों के औसत प्रदर्शन से युएफ-231 की उपज 26.71 कुन्तल / हेक्टे.का बेहतर प्रदर्शन सामने आया तत्पश्चात् युएफ-230 (24.84 कुन्तल / हेक्टे.) तथा आरएफ-205 चैक (23.64 कुन्तल / हेक्टे.), जबकि निम्नतम औसत बीज उपलब्धि 14.20 कुन्तल / हेक्टे. युएफ-234 में अंकित किया।

## मेथी

जोबनर में, जीनप्रकार युएम 88, युएम 87, युएम 73, युएम 71 तथा युएम 69 सामान्य स्थिति में तथा युएम 80, युएम 92, युएम 89, युएम 75 तथा युएम 93 तनाव की स्थिति में उच्च उत्पादक थे। तनाव सूचकांकों के आधार पर युएम 80, युएम 75, युएम 89, युएम 92 तथा युएम 93 को सूखे हालत के लिए वांछनीय प्रविष्टि पाया गया।

धोली में सत्रह प्रविष्टियों एवं एक चैक प्रजातियों में सीवीटी परीक्षण मूल्यांकन करने पर चैक राजेन्द्र कान्ती की तुलना में किसी भी प्रविष्टि को प्रति प्लॉट की उपज या प्रति हेक्टेयर की उपज में बेहतर नहीं पाया गया। फिर भी, चैक राजेन्द्र कान्ती की तुलना में एफजीके - 137 तथा एफजीके -132 ने प्रति हेक्टेयर उच्चतम उपज ( क्रमशः 26.27 तथा 25.53 कुन्तल /हेक्टेयर) अंकित की। गुंटूर में, चैक लाम मेथी -3 (14.80 कुन्तल /हेक्टे.) की अपेक्षा एफजीके-136 (21.68कुन्तल/हेक्टे.), एफजीके-135 (19.50 कुन्तल/हेक्टे.), एफजीके-132 (18.77कुन्तल/हेक्टे.), एफजीके-137 (18.57 कुन्तल/हेक्टे.) तथा एफजीके-127 (18.29कुन्तल/हेक्टे.) में अधिक उपज अंकित की।

## अजवाइन

अजवाइन के लिए किये गये सी वी टी परीक्षण में बीज उपज में 6.54 से 12. 88 कुन्तल / हेक्टेयर का अन्तर है। परीक्षण किये चौदह प्रविष्टियों में से प्रविष्टि एल एस -14-3 ने अधिकतम बीज उपज 1288.43 कि. ग्रा./हेक्टे. अंकित की तत्पश्चात् स्थानीय (12.31कुन्तल /हेक्टे.), एनडीएजे- 10 (9.25 कुन्तल / हेक्टेयर), एए-73 (8.94 कुन्तल / हेक्टेयर) तथा एए-6 (8.93 कुन्तल / हेक्टेयर) अंकित की, जबकि निम्नतम उपज एनडीएजे-11 में 654.17 कि. ग्रा. /हेक्टे. थे। प्रविष्टियों के मध्यम प्रदर्शन से पता चला कि स्थानीय उत्पादक का श्रेष्ठ प्रदर्शन 10.21 कुन्तल / हेक्टेयर तत्पश्चात् एलएस-14-4 (9.94 कुन्तल / हेक्टेयर) तथा आईए-1 ( 9.24 कुन्तल / हेक्टेयर) है जबकि, निम्नतम बीज उपज 6.99 कुन्तल / हेक्टेयर) जोबनर के एचएजे-7 में अंकित किया।

## आम आदरक

राइगड केन्द्र में आम आदरक के छः जर्मप्लासम को संचित करके मूल्यांकन किया। इंदिरा आम आदरक 1 (आईएमजी1) ने उच्चतम प्रकन्द उपज (28.6 टन/हेक्टेयर) अंकित किया तत्पश्चात् चैक (24.8 टन/हेक्टे.) से अधिक आईएमजी 2 (27.5) तथा आईएमजी 4 (25.4टन/हेक्टे.) थे।

## केसर

केसर अनुसंधान केन्द्र में मूल्यांकन और लक्षण वर्णन के लिए जैव विविधता और सैंपिल कॉर्म संचयन (160 ) को मापने के लिए कश्मीर और चिनाब घाटी के क्षेत्रों में संभावित केसर उगाने वाले गाँवों का सर्वेक्षण किया गया। पांपोर केसर उगाने वाले क्षेत्रों के 18 नमूनों से राइसोस्फियर में मृदा कवक का पृथक्करण, पहचान एवं उसकी जनगणना अध्ययन से ज्ञात हुआ कि नौ कवकों (फ्युसेरियम स्पी., अस्परगिल्लस स्पी. पेनिसिलियम स्पी. ट्राइकोडेरमा स्पी. मुकोर स्पी. तथा कुछ अनजाने कवक) की पहचान की गयी। कई मृदा नमूनों में कम कवक थे। फ्युसेरियम स्पी. प्रबल है जो केसर कॉर्म गलन के लिए कारण होता है।

## काला जीरा

पुलवामा, डोडा तथा बडीपोरा जैसे तीन जिलों में सर्वेक्षण करके 12 नमूनों (कन्द एवं बीज) को संचित करके पाम्पोर में संरक्षण किया गया।

## गुणवत्ता रोपण सामग्रियों का उत्पादन एवं वितरण

एआईसीआरपीएस केन्द्रों ने काली मिर्च के 4.16 लाख जड़ लगाए कतरन, इलायची के 2374 सकेर्स, 16.98 टन हल्दी, 13.71टन अदरक, 194 जायफल की कलमी पौधे, 1048 जायफल के बीज पौधे, 150 दालचीनी के कलमी पौधे और 250 दालचीनी के बीज पौधे का उत्पादन करके वितरण किया। बीज मसालों में 31.19 कुन्तल धनिया, 30.5 कुन्तल सौंफ, 61.71 कुन्तल मेथी और 10 कि. ग्रा. अजवाइन बीज सामग्रियों का उत्पादन करके वितरण किया।

- 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)।

## तकनीकी अन्तरण

विभिन्न केन्द्रों के वैज्ञानिकों ने नवीनतम तकनीकों को लोकप्रिय बनाने के लिए ज़ोरदार प्रयास किया है क्योंकि अनुसंधान तभी सार्थक होता है जब वह किसानों तक पहुंचता है और उससे लाभान्वित होता है। वर्ष के दौरान प्रदर्शित कुछ प्रौद्योगिकियाँ निम्नलिखित हैं।

## उच्च उपजवाली प्रजातियाँ- किसानों को वरदान

- ◆ कोरापुट में दम्बरुद्धार पुजारी (पोट्टांगी) में 1 हेक्टेयर में जैविक अदरक खेती की लोकप्रियता।
- ◆ पन्नियूर काली मिर्च प्रजातियों की छः प्रदर्शनियाँ।
- ◆ हल्दी की सीवी राजेन्द्र सोनिया प्रजाती (गुंटूर) के रोपण प्रदर्शनी।
- ◆ उच्च उपजवाली हल्दी प्रजाति सीओ2 (कोयंबतोर) की तीन प्रदर्शनी।

किसानों के खेत (कुमारगंज) में नरेन्द्र सरयू (एनडीएच-8) की तकनीकी प्रदर्शनी।

- ◆ रिडोमिल एमजेड 0.2% की दर + मोनोक्रोटोफोस 0.2% की दर में 45 मिनट (कामरपल्ली) बीज उपचार की तकनीकी प्रदर्शनी।

- ◆ असम्बुर गाँव (येरकाड) में जैव उर्वरक एवं जैव नियन्त्रण कारक के साथ समृद्ध खाद निर्माण की प्रदर्शनी।
- ◆ विभिन्न स्थानों (जोबनर) के लिए अनुशंसित कृषि पद्धतियों को अपनाकर मेथी की सूक्ष्म खेती।

### रोपण सामग्रियों का द्रुत गुणन- न्यूनतम व्यय के लिए

- ◆ शेड नेट के तहत प्रो-ट्रे तकनीक के साथ हल्दी की नर्सरी को लोकप्रिय बनाया गया (कम्मरपल्ली)।
- ◆ केवीके, कोन्डेम्पुडी, विशाखपट्टनम के सहयोग से पडेरु, दुम्ब्रिगुडा और अरकु में प्रो-ट्रे तकनीक।
- ◆ 1.5 एकड़ क्षेत्र (कोयंबतोर) में हल्दी प्रत्यारोपण के प्रदर्शन पर खेती गत प्रदर्शनी।
- ◆ अदरक और हल्दी के लिए प्रो-ट्रे प्रवर्धन तकनीक की प्रदर्शनी, जायफल और कोकुम में मुलायम लकड़ी ग्राफ़िटिंग तकनीक, झाड़ी काली मिर्च उत्पादन तकनीक (दापोली)।

### जैविक खेती

- ◆ ओडीशा के पूर्वी घाट उच्च भूमि क्षेत्र में जैविक अदरक खेती की लोकप्रियता। उपरोक्त खेती गत प्रदर्शनों के अलावा, वैज्ञानिकों ने प्रशिक्षण कार्यक्रम आयोजित करके, प्रशिक्षण और संगोष्ठियों में रिसोर्स व्यक्ति के रूप में भाग लेकर और विभिन्न मीडिया (समाचार पत्र, रेडियो वार्ता और टीवी कार्यक्रम) के माध्यम से प्रोद्योगिकी को और अधिक लोकप्रिय बनाया।

### सफलता की कहानियां

#### आमदनी के लिए काली मिर्च

काली मिर्च, केरल के महत्वपूर्ण मसाला फसलों में से एक है। श्री. राघवन नम्बियार, कल्याडनकंडी वीड, पट्टनूर ने ड्रिप सिंचाई के द्वारा उच्च उत्पादन क्षमतावाले पन्नियूर प्रजातियों का सफलतापूर्वक उत्पादन किया है। श्री. रमेशन पी. ई., वायक्करा, श्रीकण्डपुरम ने कई मूल्यवान जीनप्रकारों का संरक्षण किया है और काली मिर्च के कलमी पौधे की सफलतापूर्वक खेती की है। श्री. जॉर्ज मंकुलत्तु, कुन्नितला, नलपाडी, पेरावूर (पी.ओ.) ने ड्रिप सिंचाई के तहत एक हेक्टेयर में पाइपर कोलुब्रिनम के कलमी पौधे एवं सभी विमोचित पन्नियूर प्रजातियों का रोपण किया है। अली पारक्कडवत्तु, ब्लातूर ने आईपीडीएम के तहत पन्नियूर प्रजातियों की उत्पादन क्षमता का सफल प्रदर्शन किया है।

#### समृद्धि के लिए हल्दी की खेती

श्री बक्की गोवर्धन यादव, अदिलाबाद जिले के एक हल्दी किसान है, उन्होंने कामरपल्ली अनुसंधान स्टेशन के मार्गदर्शन से हल्दी की छः किस्मों (राजेन्द्र सोनिया, राजेन्द्र सोनाली. अक्सेशन 48, अक्सेशन 79, सेलम और दुगिराला लाल) की खेती करने पर प्रति एकड़ 30 टन से अधिक उपज प्राप्त किया है। उन्हें पीजेटीएसएयु, हैदराबाद में आरएसी सदस्य के रूप में नामित किया है और राज्य स्तरीय पुरस्कार भी प्राप्त हुए हैं। अरमूर के मग्गिडी गाँव के श्री. चिन्ता तिरुपति रेड्डी ने भी इसी प्रजाती की खेती की और उन्हें 29 टन / प्रति एकड़ प्रकन्द उपज प्राप्त हुए। वारंगल के रामकृष्ण रेड्डी, एक अन्य प्रगतिशील किसान हैं जिन्होंने कामरपल्ली अनुसंधान स्टेशन की कृषि पद्धतियों का पालन करके प्रति एकड़ 180 कुन्तल दुगिराला लाल हल्दी का उत्पादन किया।

#### किसानों की आय को दोगुना करने वाली मिश्रित फसल

मिश्रित फसल प्रणाली किसानों को अतिरिक्त आय सुनिश्चित करता है। मिश्रित फसल पर किये गये परीक्षण में वर्ष 2018-19 में विभिन्न अन्तर फसलों में प्राप्त उपज क्रमशः कोलेकैशिया 4.02 टन, एरोरूट 4.11 टन, रतालू (एलिफन्ट फूट यार्म) 11.17 टन, टपियोका 9.31 टन / हेक्टे. थे। अनन्नास के लिए विभिन्न मिश्रित फसल ब्लॉकों में प्राप्त उपज क्रमशः कोलोकैशिया 3.39 टन, एरोरूट 3.35 टन, रतालू (एलिफन्ट फूट यार्म) 3.39 टन तथा टपियोका 3.14 टन थे। यह देखा गया कि काली मिर्च + रतालू (एलिफन्ट फूट यार्म) और अनन्नास और काली मिर्च + ग्रेटर यार्म ने औसत बी: सी अनुपात 2.35 के प्रयोग के सभी चार वर्षों में सबसे किफायती उपचार साबित किया जो यह बताता है कि इन संयोजनों से किसानों की आय दोगुनी हो सकती है।

## आय बढ़ाने के लिए उच्च उपजवाली अदरक एवं हल्दी प्रजातियां

पोटांगी के युवा उद्यमी बेहतर अभ्यास के पैकेज के साथ अदरक और हल्दी की खेती के लिए आगे आए। उन्हें अदरक और हल्दी की उच्च उपज वाली प्रजातियों के साथ आपूर्ति की गई और एआईसीआरपीएस, एचएआरएस, पोटांगी के वैज्ञानिकों द्वारा सभी बेहतर तकनीक प्रदान की गई। बहुत उच्च प्रतिफल पाने में सफल होने के बाद, कई बेरोज़गार युवा और प्रगतिशील किसान अदरक और हल्दी की खेती की ओर आकर्षित हुए।

## आदिवासी कल्याण उपाय- अप्राप्य तक पहुंचना

भाकृअनुप-अखिल भारतीय समन्वित मसाला अनुसंधान परियोजना को आदिवासी उपयोजना के अन्तर्गत तीन केन्द्र है जैसे, ओडीशा में पोटांगी, आन्ध्रप्रदेश में चिन्तपल्ली तथा छत्तीसगढ़ में राइगढ़। ये केन्द्र 2008 आदिवासी किसानों को लाभान्वित करने के लिए निम्न लिखित पहलुओं पर किसान प्रशिक्षण कार्यक्रम आयोजित करके आदिवासियों का उत्थान करते हैं। इसके अलावा, एससीएसपी आबादी की बेहतरी के लिए अनुसूचित जाति उप योजना भी शुरू की है।

- वर्ष 2018-19 में एससीएसपी परियोजना शुरू की गई थी।
- बीज लागत को कम करने के लिए एआईसीआरपीएस के कोयंबतोर, तमिलनाडु केन्द्र द्वारा विकसित हल्दी और अदरक की एक ही मुकुल से प्रवर्धन करने की प्रणाली को लोकप्रिय बनाना।
- इस केन्द्र द्वारा अदरक की सुप्रभा, सुरवि तथा सुरुचि; हल्दी की रोमा, सुरमा, रंगा और रश्मी तथा आम अदरक के अम्बा प्रजातियों को विमोचित किया गया।
- अदरक प्रजातियां सुप्रभा, सुरवि तथा सुरुचि; हल्दी प्रजातियां रोमा, सुरमा और रंगा को इस केन्द्र द्वारा 5.11.2018 को अधिसूचित किया गया।
- कृषि विज्ञान केन्द्र, कन्डमपुडी, बीसीटी-केवीके, येलमंचिवी तथा एनजीओ के सहयोग से हल्दी की उच्च उपज वाली हल्दी प्रजाति रोमा को परिचित करके एक ही नोडवाले कतरनों का उपयोग करके बीजपौधों का उत्पादन बढ़ाकर आन्ध्रप्रदेश के आदिवासी किसानों की आजीविका को परिवर्तित करना।
- कृषि विज्ञान केन्द्र, कोन्डेम्पुडी, विशाखपट्टनम के सहयोग से पडेरु, दुम्ब्रिगुडा और अरकु में प्रो-ट्रे तकनीक।
- एआईसीआरपीएस, पोटांगी केन्द्र द्वारा अपनाये टीएसपी क्षेत्र : कोरापुट (पोटांगी, सेमिलिगुडा, नन्दापुर, लमटापुट, दशमंतपुर), कंधमाल (दरिगिबडी, फुलबानी, बलिगुडा, जी. उदटगिरि), गजपति (ई. उदयगिरि, रामगिरि, नाउगडा, लोबसिंग, रेयिसिंग, जिरांग आदि) जैसी जिलों में टीएसपी गतिविधियां। कोरापुट की प्रमुख जनजातियां : 3 (गडाबा, झडिया परजा, परंगा)।
- हल्दी, काली मिर्च एवं लॉग पेप्पर में मसाला प्रजातियों एवं फसलोत्तर प्रक्रिया में सुधार।
- बागवानी फसलों में आईपीएम प्रौद्योगिकियां।
- जैविक अदरक एवं हल्दी खेती।
- मौसम के बाद या पहले धनिया खेती।
- झंगरगुडा, पोटांगी में जैविक अदरक खेती तथा गजपति में काली मिर्च खेती की प्रदर्शनी।
- काली मिर्च की 60,000 कतरनें, 5 टन हल्दी, 5.3 टन अदरक तथा 1.5 कुन्तल धनिया, 800 इलायची सकेर्स का उत्पादन करके उस क्षेत्र के आदिवासी किसानों को वितरण करने के लिए उत्पादन किया।

## उत्तर पूर्व - अस्पष्टीकृत की खोज

नागालैंड में अदरक के जीवाणु म्लानी के प्रबन्धन के लिए जैव कारक के साथ मृदा सौरीकरण परीक्षण से पता चला कि टी 1 (CaCl<sub>2</sub> @3%) और टी 2 (जैवनियन्त्रण कारक) सौरीकरण के साथ उपचार करने पर नदिया कल्टिवार के लिए अन्य उपचारों की अपेक्षा जीवाणु म्लानी का प्रभाव नहीं थे।

बारापानी में, अदरक की वृद्धि और उपज पर बायोकैप्सूल के प्रभाव से पता चला कि टी 4 (पीओपी + जीआरबी 35 केप्सूल) ने अधिकतम उपज 29.92 टन/हेक्टे. अंकित की। ओलिओरसिन की मात्रा टी5 (पीओपी) में नदिया (3.53%) तथा हिचिंग (5.04%) में अधिकतम थी। अदरक के जैविक उत्पादन परीक्षण में अधिकतम उपज 25.51 टन/हेक्टे. (हिचिंग), 14.87 टन/हेक्टे. (सुप्रभा) तथा 13.58 टन/हेक्टे. (जोरहट) टी2 में (एसएयु

द्वारा संस्तुत मात्रा) अंकित किया। टी1 आईआईएसआर द्वारा विकसित जैविक पैकेज ने सभी तीन प्रजातियों में ओलिओरसिन की अधिक मात्रा अंकित की।

मिज़ोरम में अदरक के जैविक उत्पादन पर किए गए प्रयोग से पता चला कि अधिकतम उपज टी7 (एसएयु द्वारा अनुशंसित पैकेज; अदरक-एन पी के 100: 90: 90 कि. ग्रा. /हेक्टे.) को 152.88 कुन्तल/हेक्टे. की उपज अंकित की, इसके बाद टी 3 (100% जैविक खाद +(सूक्ष्मपोषण) की 142.39 कुन्तल /हेक्टे. की उपज है, जबकि किसानों के अभ्यास से 140.90 कुन्तल /हेक्टे. प्रकन्द उपज प्राप्त हुई। हल्दी की प्रजाति एनडीएच-4 ने पिछले 4 वर्षों से पासीघाट केन्द्र में उच्चतम उपज अंकित की। किसानों के बीच इस बेहतर प्रजाति को लोकप्रिय करने के लिए एनडीएच-98 प्रजाति की 30 कि. ग्रा. प्रकन्द तीन किसानों को वितरित किया था। इस प्रजाति ने किसानों के खेत में उपज और कीटों और रोगों के प्रतिरोध के मामले में बेहतर प्रदर्शन किया। हल्दी प्रजाति एनडीएच -98 की औसत उपज 30 टन/हेक्टे. या 10 कि. ग्रा. रोपण सामग्रियों से 120 कि. ग्रा. थी।

## सहयोग

अखिल भारतीय समन्वित मसाला अनुसंधान परियोजना निम्न केन्द्रों के सहयोग से काम करता है।

- आईसीएआर-आईआईएसआर, कोषिककोड तथा एनआरसीएसएस, अजमेर (प्रौद्योगिकियों के लिए)
- स्पाइसेस बोर्ड प्रौद्योगिकियों को आदिवासी क्षेत्रों में लोकप्रिय बनाने के लिए।
- गुणवत्ता रोपण सामग्रियों का उत्पादन एवं वितरण करने के लिए एमआईडीएच (बागवानी के लिए एकीकृत विकास मिशन)।
- आदिवासी क्षेत्रों में उच्च उत्पादन तकनीकों को लोकप्रिय बनाने के लिए एनजीओ।
- उत्पादन, उत्पादकता एवं किसानों की आय बढ़ाने के लिए राज्य कृषि विभाग।
- जहाँ कॉफी उगाया जाता है वहाँ कॉफी आधारित काली मिर्च फसल प्रणाली की स्थापना के लिए कॉफी बोर्ड।

## प्रबोधन

केन्द्र द्वारा किए गए अनुसंधान परियोजनाओं और कार्यक्रमों का प्रबोधन परियोजना समन्वयक और पीसी यूनिट के वैज्ञानिकों ने विभिन्न केन्द्रों और प्रायोगिक खेतों में भ्रमण करके किया गया। प्रस्तुत वर्ष, 12 केन्द्रों का दौरा किया गया जिसमें नियमित, सह-चयन, स्वैच्छिक और परियोजना मोड केन्द्र शामिल थे। केन्द्र द्वारा भेजे गये मासिक, त्रैमासिक, छमाही और वार्षिक रिपोर्टों के आधार पर केन्द्रों की गतिविधियों का प्रबोधन किया गया। आईसीएआर-एआईसीआरपीएस की XXIX वीं कार्यशाला दिनांक 4-6 अक्टूबर 2018 को डॉ. वाई. एस. आर परमार बागवानी एवं वानिकी विश्वविद्यालय, सोलन, हिमाचल प्रदेश में आयोजित की गयी। डॉ. हरी सी. शर्मा, माननीय कुलपति, डा. वाईएसपीयुएच एवं एफ, सोलन ने कार्यशाला का उद्घाटन किया। डॉ. के. निर्मल बाबू, निदेशक आईआईएसआर, एवं परियोजना समन्वयक, (एआईसीआरपीएस), कोषिककोड ने भारतीय अर्थ व्यवस्था में मसालों के महत्व और मसालों में की गयी अनुसंधान उपलब्धियों पर प्रकाश डाला। उद्घाटन सत्र में **बेस्ट एआईसीआरपीएस सेंटर अवार्ड 2017-18** केरल के पन्नियूर (केएयु) के पेप्पर रिसर्च स्टेशन को प्रदान किया गया। इस अवसर पर विभिन्न एआईसीआरपीएस केन्द्रों से मसाला उत्पादन प्रौद्योगिकियों पर तेरह पुस्तिकाएं/पैम्फलेट जारी की गईं।



## EXECUTIVE SUMMARY

ICAR-All India Coordinated Research Project on Spices with 38 centres (19 regular, 11 co-opting and 8 voluntary centres) spread over 14 agro climatic zones in 25 states of the country coordinates the research activities on spice crops like black pepper, large cardamom, small cardamom, ginger, turmeric, mango ginger, cinnamon, nutmeg, clove, coriander, cumin, fennel, fenugreek, ajwain, nigella, saffron and kalazeera. Annual budget for the year 2018/19 was Rs. 607.76 lakhs as ICAR share.

AICRP on spices has won the prestigious **Chaudhary Devi Lal outstanding AICRP award** for the best AICRP for the year 2017-18. Pepper Research Station, Panniyur under Kerala Agricultural University has been awarded for the Best Centre under AICRPS. Dr. K. Nirmal Babu, the Project Coordinator and Dr. P. M. Ajith, Breeder, Pepper Research Station, Panniyur received the award from Hon'ble Union Minister of Agriculture and Farmers welfare, Shri. Radha Mohan Singh in the Award Ceremony held during ICAR Foundation Day at NASC Complex, New Delhi.

### *New initiatives*

- New crops like mango ginger, saffron and kalazeera are added and initiated collection and conservation of germplasm of new crops.
- In line with food safety assurance and minimization of the pesticide residue in spices, good agricultural practices project on integrated pest & disease management was initiated in cumin and coriander at various seed spices centres of AICRPS.
- For the evaluation of genotypes for specific traits, various AICRPS centres have undertaken co-ordinated varietal trials in spice crops like black pepper, mango ginger, ginger cardamom, coriander, cumin, fennel and fenugreek.

### *Varieties recommended for release in XXIX AICRPS workshop*

Eleven varieties of spices for specific traits (1 in ginger, 1 in turmeric, 1 in nutmeg, 4 in coriander, 1 in fennel, 2 in fenugreek and 1 in cumin) were recommended for release in XXIX AICRP on Spices workshop held at Horticultural Research Station, Dr. Y. S. Parmar University of Horticulture & Forestry, Solan, Himachal Pradesh.

### **Varieties**

1. **Solan Giriganga:** Ginger variety from Dr. Y S Parmar University of Horticulture & Forestry, Solan. Plumpy and bold rhizomes with high dry matter recovery of 21.01%, 1.45% essential oil, 4.69% oleoresin, 4.47% crude fibre and < 10% incidence of rhizome rot.
2. **TCP 129:** Turmeric variety from UBKV, Pundibari, West Bengal. Tolerant to leaf spot and leaf blotch and with curcumin content of 5.1% and high dry recovery of 26.51%.
3. **Konkan Sanyukta:** Nutmeg variety from Dr BSKKV, Dapoli. Monoecious nutmeg bearing 500 fruits per plant per year with bold nuts (9.20 g), mace wt (1.07 g), high nut oil (27%) and mace oil (17.75%).



4. **Rajendra Dhania 3:** Coriander variety released from Dr RPCAU, Dholi. Climatic resilient coriander variety with high yield (14.09 q ha<sup>-1</sup>) and high oil (0.52%), recommended for national release.
5. **JD (SI) 1:** Coriander variety released from JNKVV, Jabalpur, High oil type coriander (0.67%) with high yield potential (14.14 q ha<sup>-1</sup>) suitable for Madhya Pradesh.
6. **Ajmer Coriander 3:** Coriander variety released from ICAR-NRCSS, Ajmer. Coriander variety with high volatile oil (0.55%), high linalool (75.42%), high (13.09 q ha<sup>-1</sup>) and stable yield.
7. **Chhattisgarh Sri Chandrasahini Dhania-2:** Coriander variety from IGKV, Raigarh. climate resilient coriander variety suitable for both leafy and seed purpose, moderately resistant to powdery mildew and aphids.
8. **Ajmer fennel 3: Fennel variety from ICAR-NRCSS, Ajmer.** High yielding (21.43 q ha<sup>-1</sup>) and high oil (1.9%) fennel resistant to *Ramularia* blight, suitable for fennel growing regions of the country.
9. **HM 425:** Fenugreek variety released from CCSHAU, Hisar. High yielding (20-22 q ha<sup>-1</sup>) powdery mildew and downey mildew resistant fenugreek suitable for fenugreek growing regions of the country.
10. **Narendra Richa (NDM 79):** Fenugreek variety released from NDUAT, Kumarganj. Dual purpose alkaline tolerant fenugreek with moderate resistance to powdery mildew suitable for Uttar Pradesh and Andhra Pradesh.
11. **Gujarat cumin 5:** Cumin variety released from SDAU, Jagudan. High yielding wilt resistant cumin with short duration and high yield (38% higher yield than GC 4) suitable for cumin growing regions of the country.

### **Technologies recommended during XXIX AICRPS workshop**

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

### **Water use efficiency (more crop per drop)**

**Drip irrigation and fertigation in coriander:** Fertigation with water equal to 80% of actual evaporation (0.8 IW/CPE ratio) at an interval of 2-3 days and recommended dose of fertilizers through soluble fertilizers at different growth stages (20, 40, 60 & 80 DAS) is recommended for improving the yield and WUE in coriander in light textured soils of India.

**Drip fertigation in fennel:** Fertigation with water equal to 80% of actual evaporation (0.8 IW/CPE ratio) at an interval of 2-3 days and 75% recommended dose of fertilizers through soluble fertilizers at different growth stages (20, 40, 60, 80 & 100 DAS) is recommended for improving the yield and WUE in fennel in light textured soils of India.

### **Organic nutrient management- for sustainable spice production**

**Organic farming in cardamom:** Monthly application of *Jeevamrutha* (20 l/plant) along with 10 g each of biofertilizers (*Azospirillum* and PSB) and bio-control agent (*Trichoderma viride*) and 30 tonnes of compost are recommended as an organic production practice for the Cardamom Hill Reserves, Kerala.

**Bio-fertilizers for yield enhancement of coriander:** Soil application of Phosphate Solubilizing Bacteria (PSB) @15 kg ha<sup>-1</sup> or *Azospirillum* @15 kg ha<sup>-1</sup> along with NPK @ 60:40:30 kg ha<sup>-1</sup> is recommended for improving the productivity of coriander.

### Management of diseases

**Chemical management schedule for cumin blight:** Spraying of kresoxym methyl 44.3 SC (1 ml/lit), mancozeb 75% WP (3.7 g/lit) and difenaconazole 25 EC (0.5 ml/lit) at 40, 50 and 60 days after germination is recommended for effective management of blight in cumin growing regions of Gujrat.

**Bio-efficacy of newer molecules of insecticides against cumin aphid:** For effective and economical management of cumin aphid, first foliar spray of thiamethoxam 25WG (25g a.i./ha; 2.5 g/10 lit.water) at 10% umbels infestation of aphids followed by thiacloprid 21.7SC (25g a.i./ha ; 2.88 g/10 lit. water) spray after 10 days is recommended for cumin growing regions of Gujarat.

### *Black pepper*

During 2018-19, Pepper Research Station, Panniyur collected 15 new accessions of black pepper and HRS, Sirsi collected 15 accessions of black pepper and Pundibari centre collected 12 accessions, bringing the total germplasm holding of black pepper to 840 accessions. During the year 2018-19 at Panniyur, the genotypes PRS 64, PRS 136 and PRS 154 were the top yielders. PRS 64 ranked first with 4.98 kg green berry yield and 1260 spikes/vine. Spike length was maximum in PRS 155 (15.1 cm), the number of developed berries/spike in PRS 137 (75.0), 100 berry weights in PRS 154 (12.4 g) and the dry recovery in PRS 136 (38%). In CVT Kumpukkal recorded the highest green berry yield of 2.20 kg and was on par with Panniyur 1. Average spike length was highest in Panniyur 1 (17.03 cm) which was on par with Panniyur 5 (16.6 cm). Number of berries/ spike was more in Panniyur 1 (84.66). Highest dry recovery % was recorded in Zion Mundi, Panniyur 5 and Panniyur 1 (35%).

Among the germplasm lines maintained at Chintapalle, Panniyur -1 recorded the highest number of spikes per vine (639), fresh berry yield/ vine (4.04 kg), dry yield (1.29 kg), fresh yield/ha (4.13 t/ha) whereas the highest no. of berries per spike was recorded in Neelamundi and highest dry recovery was recorded in Perambramundi (32.65%).

At Dapoli HB 20052 recorded the highest green berry yield of 5.20 kg/vine followed by Acc. No. 53 (4.97 kg/ vine). The highest plant height was recorded for Panniyur 1 (5.17 m). Plant height of all the varieties ranged between 2.20 to 5.02 m. The ACC. No. 106 recorded maximum plant height (5.02 m) while lowest plant height was recorded by HP- 39.

At Yercaud, during 2018-19, the maximum number of spikes per meter square (48.0) was recorded in IISR Shakthi and the lowest in the Acc. No.106 (15.0). The number of berries per spike (68) and green berry and dry berry yield (0.580 kg and 0.169 kg respectively) were also highest in the same genotype.

### *Small cardamom*

CVT trial on drought tolerance at Sakleshpur revealed that under moisture stress the genotype, IC 349537 registered more number of bearing tillers (10.83), number of panicles (5.39) and long panicles (35.65 cm) and number of capsules per racemes (4.30). Same genotype registered more number of bearing tillers (17.10), number of panicles (7.55) and long panicles (50.41 cm) and number of capsules per racemes (5.10) under control also. At Mudegere, maximum plant height

was found in IC-584078 (248.30cm) and more number of suckers / per plant was observed in IC-349537 (46.30) followed by HS-1 (41.60).

Farmers varieties trial at Myladumpara revealed that, number of tillers were significantly more in Wonder cardamom (68) followed by Thiruthali (54.33). Plant height was significantly more in Thiruthali (285.67) followed by Panikulangara I (250.67). Number of leaves of the tallest tiller was highest in Panikulangara I (13.67) followed by Thiruthali (13.33). Numbers of vegetative buds were highest in Arjun (4) followed by PNS Vaigai (3.67). Panicle initiation started after 9 months of planting. Significantly more panicles were found in Thiruthali (43) followed by Panikulangara I (16.33).

Fipronil 5 SC @ 0.005% applied plants showed highest per cent reduction of thrips infestation at Mudigere and Pampadumpara. At Sakleshpur, the thrips damaged capsules (%) were least in spinosad, imidacloprid and fipronil 15 days after spray and were on par with each other.

### **Large cardamom**

Studies on evaluation of organic treatments against major soil borne diseases of large cardamom revealed that, COC 2 g/litre + soil application of *Trichoderma* (4 ml/l) (10 days after planting) during sowing & COC 2 g/litre near clump followed by *Trichoderma* (4 ml/l) (10 days after COC application) each month) showed less incidence of disease (9.52%).

### **Ginger**

At Barapani, forty three genotypes of ginger were maintained and evaluated. Among them, IC-584354 recorded the highest yield with 20.95 t/ha. Crude fibre was highest in IC 584335 and IC 584347 (6.15%). Highest dry matter content of 25.09% was recorded in IC-584353 and highest oleoresin content (7.07%) was recorded in IC-584343.

Combined treatments of *Trichoderma* and GRB 35 talc formulation was found superior in increasing the plant growth parameters and reducing the incidence of rhizome rot over other treatments. The talc formulation of *Trichoderma* in combination with talc formulation of GRB-35 performed better at Solan and Raigarh.

### **Turmeric**

During 2018-19, Coimbatore centre evaluated 275 turmeric genotypes which revealed wide variations for growth, yield and quality parameters. The genotypes were further grouped into (i) high yielding genotypes and (ii) high curcumin yielding genotypes. 280 turmeric germplasm accessions are maintained at Kammarpally centre. Among the accessions, Nizamabd Local (62.34 t ha<sup>-1</sup>), Chennur Local (62 t ha<sup>-1</sup>), NDH-4 (61.69 t ha<sup>-1</sup>), NDH-9 (62.13 t ha<sup>-1</sup>) and JTS-332 (60.69 t ha<sup>-1</sup>) performed better compared to Local check Duggirala Red (43.25 t/ha) and IISR Prathibha- National check (59.92 t ha<sup>-1</sup>). Out of 67 accessions maintained at Dholi, only fourteen accessions recorded higher yield ranging from 50.25 to 54.17 t ha<sup>-1</sup> compared to check variety Rajendra Sonia (49.83 t ha<sup>-1</sup>) Among the fourteen promising accessions, RH-421 recorded highest yield (54.17 t ha<sup>-1</sup>) followed by RH-2 (53.33 t ha<sup>-1</sup>).

At Kumarganj, a total 180 germplasm accessions are maintained. All the 180 accessions were evaluated and among them NDH-74 (275 g/plant) & NDH-86 (265 g/plant) in early, NDH-98 (290 g/plant) & NDH-78 (268 g/plant) in medium and NDH-8 (270 g/plant) & NDH-2 (265 g/plant) in late maturing types were the top yielders. The Guntur centre has maintained 280 turmeric germplasm accessions out of which 48 were evaluated. At Pasighat, 52 diverse genotypes of turmeric collected from entire NE region and were evaluated. At HARS, Pottangi, 179

accessions were evaluated in 2018-19 and 86 germplasm accessions are maintained at CARS, Raigarh. At present, total germplasm holding of turmeric with AICRPS is 1621.

In the Coordinated Varietal Trial of turmeric, twelve genotypes along with two checks (IISR Prathibha and BSR 2) were evaluated at different centres. The genotype LTS- 2 performed better at Coimbatore (40.92 t ha<sup>-1</sup>) and Guntur (48.9 t ha<sup>-1</sup>). At Kammarapally NDH-11 (37.50 t ha<sup>-1</sup>) recorded highest fresh rhizome yield. At Chintapalle, PTS-2 (27.87) recorded highest yield. At Pundibari, the highest projected yield was recorded in TCP-191 (39.78 t ha<sup>-1</sup>) and at Pottangi, PTS-18 (15.2 t ha<sup>-1</sup>) was the top yielder. At Kumarganj, maximum rhizome yield was recorded in LTS-1 (26.11 t ha<sup>-1</sup>) and at Raigarh IT 36 recorded maximum rhizome yield (36.7 t ha<sup>-1</sup>). At Dholi, RH-9/90 and RH-80 (57.98 t ha<sup>-1</sup> and 53.13 t ha<sup>-1</sup> respectively) were the highest yielders.

In surveys conducted by Pundibari centre in Mathabanga area, two major diseases of turmeric were found to be prevalent viz., leaf blotch (*Taphrina* spp.) and *Colletotrichum* leaf spot (*Colletotrichum* spp.) Most of the area is covered with local varieties which are highly susceptible to these diseases In the survey it was found that average leaf blotch disease severity in Mathabanga was 18.35 PDI and for leaf spot it was 20.53.

At Coimbatore, the maximum incidence of leaf spot (14.3 PDI) was noticed in Perunthurai area of Erode district and maximum leaf blotch was noticed in Gobi (24.6 PDI) followed by Perunthurai (22.9 PDI) area of Erode district. In Coimbatore district, maximum leaf blotch (25.7 PDI) incidence was noticed in Thondamuthur and the leaf spot incidence was 8.9 PDI in Karamadai. In the Bhikhari Mal village of Raigarh developmental block, 43.78 % disease intensity of *Colletotrichum* leaf spot and 38.78 % *Taphrina* leaf blotch and in Amalidih village, 34.78 % intensity for *Colletotrichum* leaf spot and 22.57% for *Taphrina* leaf blotch were noticed.

### **Tree spices**

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

Among the germplasm of clove planted during the year 1996-97 at Dapoli, four promising genotypes were selected. The plant height varied from 5.89 to 7.15 m, girth ranged from 35-40 cm and spread varied from 2.50 m to 3.05 m. Among the 24 accessions at Pechiparai, SA-1 recorded the highest tree height of 11.78 m, followed by SA-3 (11.63 m) compared with local check tree height (9.31 m). The accession SA-13 was significantly superior than other accessions and recorded highest stem girth (49.59 cm) compared with local check (40.57cm). The accession SA-3 recorded the highest leaf length (12.47cm), leaf breadth (7.46 cm), number of branches (16 nos) and dry bud yield (1.52 kg/tree/year).

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

### **Coriander**

In rabi, 2018-19, twenty one (CVT) entries of coriander from Jobner were screened against powdery mildew disease. Among the tested lot, two entries viz., COR-190 and COR-192 showed moderate resistance and ten entries viz., COR-176 to COR-180, COR-185 to COR-187, COR-191

and RCr-728 entries were susceptible and rest of the entries showed highly susceptible reaction against the disease.

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

Cutting management, varieties and fertility levels affected significantly the coriander seed equivalent yield at Jagudan. One cut at 45 DAS recorded significantly higher coriander seed equivalent yield over two cut and no cut. Variety GDLC 1 produced significantly higher coriander seed equivalent yield over GCo2. Application of 60:30:00 kg NPK/ha recorded significantly the highest coriander seed equivalent yield over rest of the treatments. GDLC 1 was more responsive than G Co2 under different fertility levels.

### **Cumin**

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

The results of the three year experimentation on drip irrigation and fertigation in cumin at Mandor showed that, the data that highest gross return (Rs. 1,80,9000 /ha), net return (Rs. 1, 21,700/ha) and benefit cost ratio (3.1) were recorded under drip irrigation at 0.6 IW/CPE ratio with 80% RDF through fertigation.

### **Fennel**

Screening for resistance against *Ramularia* blight disease was conducted at Jagudan. None of the entries were found free from the *Ramularia* blight. The minimum intensity of *Ramularia* blight was noticed in FNL-118 and FNL-126 (25.00%) while the maximum intensity was recorded in entry FNL-129 (32.25%). The disease intensity ranged between 25.00 to 32.25 per cent.

The CVT trial at Jobner revealed that the seed yield ranged from 13.20 to 25.22 q ha<sup>-1</sup>. Of the ten entries evaluated, entry UF-231 recorded maximum seed yield of 25.62 q ha<sup>-1</sup> followed by UF-232 (24.69 q ha<sup>-1</sup>), UF-230 (23.22 q ha<sup>-1</sup>), RF-125 (22.95 q ha<sup>-1</sup>), and RF-205 (22.84 q ha<sup>-1</sup>) while lowest seed yield of 13.21 q ha<sup>-1</sup> was recorded in UF-234. Mean performance of the entries evaluated in IET of fennel over 2017-18 and 2018-19 revealed superior performance of UF-231 yielding 26.71 q ha<sup>-1</sup> followed by UF-230 (24.84 q ha<sup>-1</sup>) and RF-205 check (23.64 q ha<sup>-1</sup>), while lowest mean seed yield of 14.20 q ha<sup>-1</sup> was recorded in UF-234.

### **Fenugreek**

At Jobner, the genotypes UM 88, UM 87, UM 73, UM 71 and UM 69 in normal conditions and UM 80, UM 92, UM 89, UM 75 and UM 93 in stress conditions were top yielders. Based on stress indices UM 80, UM 75, UM 89, UM 92 and UM 93 were found to be the desirable entries for drought conditions.

Among seventeen entries and one check varieties in CVT trial evaluated at Dholi, none of the entries were found significantly superior regarding yield per plot and yield per ha compared to check Rajendra Kanti. However, FGK-137 and FGK-132 recorded the highest yield per hectare (26.27 & 25.53 q ha<sup>-1</sup> respectively) compared to check variety Rajendra Kanti (23.51 q ha<sup>-1</sup>) At Guntur, FGK-136 (21.68 q ha<sup>-1</sup>), FGK-135 (19.50 q ha<sup>-1</sup>), FGK-132 (18.77 q ha<sup>-1</sup>), FGK-137 (18.57

q ha<sup>-1</sup>) and FGK-127 (18.29 q ha<sup>-1</sup>) recorded significantly higher yield over the check Lam Methi-3 (14.80 q ha<sup>-1</sup>).

### **Ajwain**

In CVT trial on ajwain, seed yield ranged from 6.54 to 12.88 q ha<sup>-1</sup>. Of the fourteen entries evaluated, entry LS-14-3 recorded maximum seed yield of 12.88 q ha<sup>-1</sup> followed by local (12.31 q ha<sup>-1</sup>), NDAJ-10 (9.25 q ha<sup>-1</sup>), AA-73 (8.94 q ha<sup>-1</sup>) and AA-6 (8.39 q ha<sup>-1</sup>) while lowest yield of 6.54 q ha<sup>-1</sup> was recorded in NDAJ-11. Mean performance of the entries revealed that superior performance of Local yielding 10.21 q ha<sup>-1</sup> followed by LS-14-4 (9.94 q ha<sup>-1</sup>) and IA-1 (9.24 q ha<sup>-1</sup>), while lowest seed yield of 6.99 q ha<sup>-1</sup> was recorded in HAJ-7 at Jobner.

### **Nigella**

The CVT trial conducted on nigella at Kota revealed that, the seed yield ranged from 456-990 kg/ha. During its third and final year of evaluation, AN-1 was found to be the best performing entry in terms of seed yield (9.90 q ha<sup>-1</sup>) followed by AN-23 (9.00 q ha<sup>-1</sup>) and showing 8.14 per cent higher yield over the check AN-20. The mean days to flowering ranged from 96 days (AN-23) to 100 days (AN-20, NDBC-21, PK-2 and Pant Krishna); days to maturity from 139 days (Pant Krishna) to 151 days (AN-1); and test weight from 7.17 g (Pant Krishna) to 8.12g (HKL-7).

### **Mango ginger**

Six germplasm of mango ginger was collected and evaluated at Raigarh centre. Indira Mango ginger 1 (IMG 1) recorded highest rhizome yield (28.6 t ha<sup>-1</sup>) followed by IMG 2 (27.5) and IMG 4 (25.4 t ha<sup>-1</sup>) over check (24.8 t ha<sup>-1</sup>).

### **Saffron**

Potential Saffron growing villages were surveyed in Kashmir and Chenab Valley region to tap biodiversity and sampled corm collections (160 nos.) were planted for evaluation and characterization at Saffron Research Station.

Isolation, identification and population studies of soil fungi in rhizosphere from 18 samples at Pampore saffron growing areas revealed nine fungal populations (*Fusarium* spp., *Aspergillus* spp., *Penicillium* spp., *Trichoderma* spp., *Mucor* spp. & few unidentified fungi). Many soil samples had very fewer fungi. *Fusarium* spp. was predominant which is mainly responsible for saffron corm rot.

### **Kalazeera**

Three districts Pulwama, Doda and Badipora were surveyed and 12 samples (tubers and seeds) were collected and conserved at Pampore.

### **Production and distribution of quality planting material**

The AICRPS centres have multiplied and distributed 4.16 lakh rooted cuttings of black pepper, 2374 suckers of cardamom, 16.98 tons of turmeric, 13.71 tons of ginger, 194 grafts of nutmeg, 1048 seedlings of nutmeg, 150 grafts of cinnamon and 250 seedlings of cinnamon. In seed spices 31.19 q of coriander, 30.5 q of fennel, 61.71 q of fenugreek and 10 kg of ajwain seed material were produced and distributed.

### **Transfer of technology**

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

#### **High yielding varieties- boon to farmers**

- ❖ Popularisation of organic ginger cultivation at Koraput in 1ha at Dambarudhar Pujari (Pottangi)
- ❖ Six demonstration of Panniyur black pepper varieties (Panniyur)
- ❖ Demonstrated transplanting of turmeric cv. Rajendra sonia varieties of turmeric (Guntur)
- ❖ Three demonstration of high yielding turmeric variety CO 2 (Coimbatore)
- ❖ Technology demonstration of Narendra Saryu (NDH-8) at farmers field (Kumarganj)
- ❖ Technology demonstration of seed treatment with Ridomyl MZ @ 0.2% + monocrotophos @ 0.2% for 45 minutes ( Kammarpally)
- ❖ Demonstration on preparation of enriched compost along with bio fertilizers and bio control agents in the Asambur village (Yercaud)
- ❖ Micro farming situation of fenugreek by adopting the recommended package of practices at different locations (Jobner)

#### **Rapid multiplication of planting materials- for minimal expenditure**

- ❖ Turmeric nursery with pro-tray technology under shade net was popularized (Kammarapally)
- ❖ Pro-tray technology in Paderu, Dumbriguda and Araku in collaboration with KVK, Kondempudi, Visakhapatnam (Chintapalle)
- ❖ FLD on performance of turmeric transplants in an area of 1.5 acres (Coimbatore)
- ❖ Demonstration of pro-tray propagation technique for ginger and turmeric, soft wood grafting technique in nutmeg and kokum, bush pepper production technology (Dapoli)

#### **Organic farming- for nurturing Mother Nature**

- ❖ Popularisation of organic ginger cultivation in the Eastern Ghat High Land Zone of Odisha.

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

### **Success stories**

#### **Black pepper for income generation**

Black pepper is one of the important spice crops of Kerala. Sri.Raghavan Nambiar, Kalyadankandi veedu, Pattanur has successfully cultivated and demonstrated the high yield potential of Panniyur varieties under drip irrigation system Mr. Ramesan P.E., Vayakkara, Sreekandapuram has conserved many valuable genotypes and successfully cultivated grafts of black pepper. Sri. George, Mankulathu, Kunnithala, Nalpady, Peravoor (P.O.) has planted one hectare of *Piper colubrinum* grafts and all the released Panniyur varieties under drip irrigation. Ali Parakkadavathu, Blathur has successfully demonstrated the yield potential of Panniyur varieties under IPDM.



### **Turmeric cultivation for prosperity**

Sri Bakki Govardhan yadav, a turmeric farmer of Adilabad district, obtained more than 30 tonnes per acre rhizome yield and is cultivating six varieties (Rajendra Sonia, Rajendra sonali, Acc No. 48, Acc. No. 79, Salem and Duggirala Red) under the guidance of Kamarpally Research Station. He is nominated as RAC member in the PJTSAU, Hyderabad and has won state level award also. Sri Chinta Thirupathi Reddy of Maggidi village of Armoor also cultivated the same varieties and obtained 29 t/acre rhizome yield. Ramakrishna Reddy from Warangal, is another progressive farmer who produced 180 quintals of turmeric per acre cultivating Duggirala Red following the package of practice of Kamarpally Research Station.

### **Mixed cropping for doubling farmers income**

The mixed cropping system ensures additional income to the farmers. In an experiment on mixed cropping, the yield obtained in different inter crops during 2018-19 were colocasia 4.02 tons, arrow root 4.11 tons, elephant foot yam 11.17 tons, tapioca 9.31 tons and greater yam 10.0 tons, per/ha respectively. The yield obtained in different mixed crop blocks for pineapple were 3.39 tons in colocasia 3.35 tons in arrow root 3.39 tons in elephant foot yam and 3.14 tons in tapioca blocks respectively. Monocrop black pepper did not produce additional yield as it is in pre bearing stage. It was observed that black pepper + elephant foot yam and pineapple and black pepper + greater yam proved most economical treatment in all four years of experiment with average B:C ratio 2.35 which indicates that the farmers income can be double with these combinations.

### **High yielding ginger and turmeric varieties- for income maximization**

Young enterprising youths of Pottangi came forward for cultivation of ginger and turmeric with improved package of practices. They were supplied with high yielding varieties of ginger and turmeric and provided with all improved technology by the scientists of AICRPS, HARS, Pottangi. After they became successful in getting a very high return, many unemployed youth and progressive farmers were attracted towards the cultivation of ginger and turmeric.

### ***Tribal welfare measures – Reaching the unreached***

ICAR-AICRP on spices under Tribal Sub Plan has 3 centres viz., Pottangi in Odisha, Chintapalle in Andhra Pradesh and Raigarh in Chhattisgarh. These centres uplift the tribals through conducting Farmers training programmes on the following aspects benefitting 2008 tribal farmers. In addition to this, scheduled caste sub plan was also launched for the betterment of the SCSP population.

- The SCSP project was started since 2018-19
- Popularizing single bud propagation of turmeric and ginger developed by AICRPS, Coimbatore, Tamilnadu and Kondempudi, Visakhapatnam to reduce the seed cost.
- Ginger varieties Suprabha, Suravi and Suruchi, turmeric varieties Roma, Surama and Rasmi were released and notified and mango ginger variety Amba was released by Pottangi centre.
- Transforming livelihood of tribal farmers of Andhra Pradesh through introducing high yielding turmeric cultivar Roma and extending production of the seedling by using single node cuttings in turmeric in collaboration with KVK, Kondempudi, BCT-KVK, Yelamanchili and NGOs.
- Adopted TSP area by AICRP on Spices, Pottangi: TSP activities in the districts like Koraput (Pottangi, Semiliguda, Nandapur, Lamataput, Dasamantapur), Kandhamal (Daringibadi,



Phulbani, Baliguda, G. Udayagiri), Gajapati (R. Udayagiri, Ramagiri, Nuagada, Lobasing, Raising, Jirang etc.). Major tribes in Koraput: 3(Gadaba, Jhadia Paraja, Parenga)

- Demonstrations of IPM technologies in horticultural crops
- Training on organic ginger and turmeric cultivation
- Off season coriander cultivation
- Demonstration of the performance of organic ginger cultivation in Jhankarguda, Pottangi and black pepper cultivation in Gajapati
- Produced 60,000 black pepper cuttings, 5 t of turmeric, 5.3 t of ginger and 1.5 q of coriander, cardamom suckers – 800 nos. for distributing to tribal farmers of the region.

### ***North East- exploring the unexplored***

At Nagaland, soil solarization trial combined with bioagents for the management of bacterial wilt of ginger revealed that plants under treatment T<sub>1</sub> (CaCl<sub>2</sub> @3%) and T<sub>2</sub> (bio control agent) with solarization were not affected by bacterial wilt in comparison to other treatments in Nadia.

At Barapani, effect of biocapsule on growth and yield of ginger revealed that T<sub>4</sub> (POP + GRB 35 capsule) recorded maximum yield of 29.92 t/ha. Oleoresin content was highest in T<sub>5</sub> (POP) in Nadia (3.53%) and Hitching (5.04%). Organic production trial on ginger produced maximum yield of 25.51 t ha<sup>-1</sup> (Hiching), 14.87 t ha<sup>-1</sup> (Suprabha) and 13.58 t ha<sup>-1</sup> (Jorhat) in T<sub>2</sub> (recommended package by SAU). T<sub>1</sub> (organic package developed by IISR) recorded higher oleoresin content in all the three varieties.

The experiment on organic production of ginger at Mizoram revealed that the maximum yield was recorded for T<sub>7</sub> (recommended package by SAU; ginger-NPK100:90:90 kg ha<sup>-1</sup>), with an yield of 15.29 t ha<sup>-1</sup>. The turmeric variety NDH-98 performed well and recorded highest yield in Pasighat centre for the past 4 years. To popularize this improved variety among the farmers, 30 kg rhizome of turmeric variety NDH-98 was distributed to three farmers. This variety performed better than local cultivars in terms of yield and resistance to pest and diseases in farmers' field. The average yield of turmeric variety NDH-98 was 30t/ha or 120 kg from 10 kg planting material.

### ***Collaboration***

AICRP on Spices centres works in collaboration with

- ICAR- IISR, Kozhikode and NRCSS, Ajmer (for technologies)
- Spices Board for popularization of technologies in tribal areas
- MIDH (Mission for Integrated Development for Horticulture) for providing and supplying quality planting material production
- NGOs for popularizing high production technologies in tribal areas
- State Department of Agriculture for increasing production, productivity and income for farmers
- Coffee Board for establishing coffee based black pepper cropping system wherever coffee is grown

### ***Monitoring***

The research projects and programs undertaken by the centres were monitored by Project Coordinator and Scientists from PC unit's visit to various centres and the experimental plots. During this year, 12 centres were visited which included regular, co-opting, voluntary and project mode centres. The activities of the centres were also monitored through monthly reports, quarterly,

half yearly and annual report sent by the centres. The XXIX Workshop of ICAR-All India Coordinated Research Project on Spices was conducted during 4-6 October 2018 at Dr. Y.S. Parmar University of Horticulture and Forestry, Solan, Himachal Pradesh. The workshop was inaugurated by Dr. Hari C. Sharma, Hon'ble Vice Chancellor, Dr. YSPUH & F, Solan on 4 October 2018 Dr. J.N. Sharma, Director of Research, Dr. YSPUH & F, Solan presided over the function and Dr. A. K. Sharma, Professor and Head, Department of Vegetable Science, Dr YSPUH&F, Solan welcomed the gathering. Dr. K. Nirmal Babu, Director, IISR & Project Coordinator (AICRP on spices), Kozhikode highlighted the importance of spices in Indian economy and research accomplishments made in spices. Dr Gopal Lal, Director, NRC for Seed Spices, Ajmer and Dr. Rakesh Gupta, Dean, College of Horticulture, Dr. YSPUH & F, Solan were the Guest of Honour and offered felicitations. Luminaries like Dr. K.K Jindal, Former ADG (Hort.) and Former DoR, Dr. YSPUHF, Solan & CAU, Pasighat and Dr. Homey Cheriyan, Director, DASD, Kozhikode also participated in the workshop. During the inaugural session the “Best AICRPS Centre Award 2017-18” was presented to Pepper Research Station, Panniyur (KAU), Kerala.

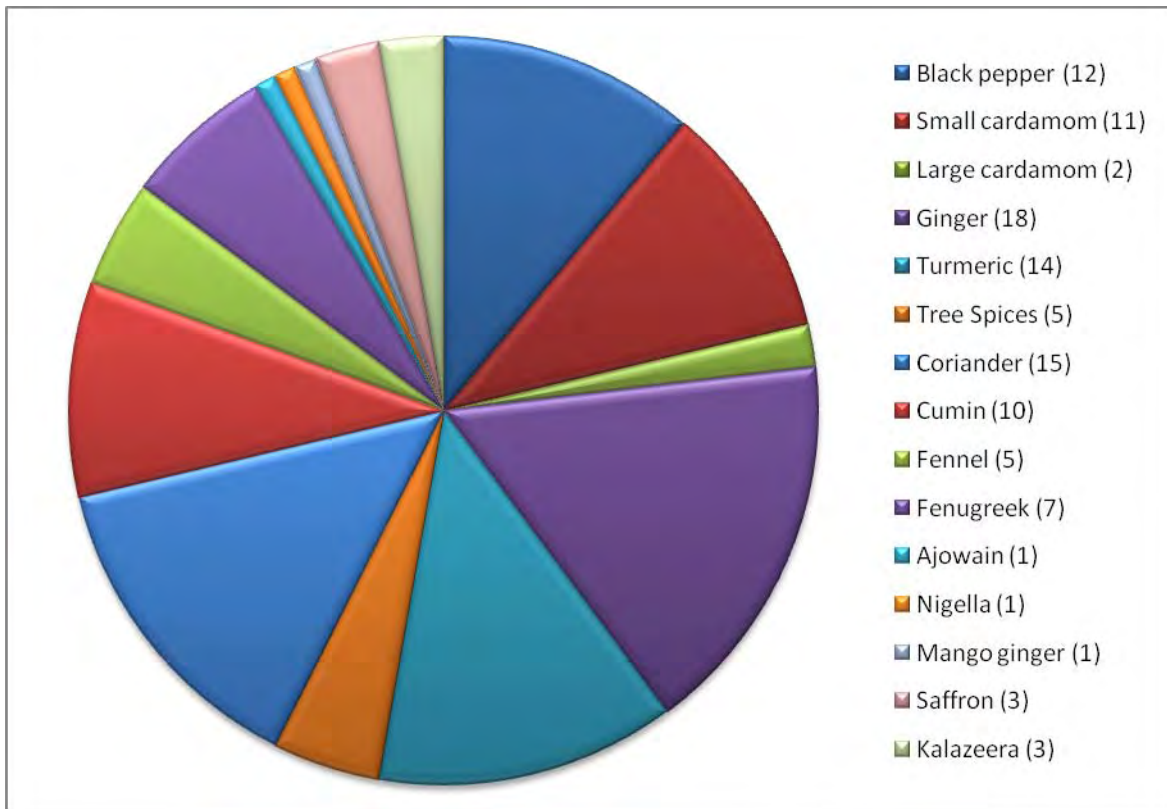
## Profile of AICRP on Spices

ICAR-All India Coordinated Research Project on Spices (ICAR-AICRPS) is the largest spices research network in the country through which a nationwide collaborative and interdisciplinary research is being carried out, linking ICAR system with the State Agricultural Universities and central institutions. AICRPS was initiated in 1971 as All India Spices and Cashew nut Improvement Project (AISCIP). In 1986 it has become a full-fledged coordinating unit for spices (major spices and seed spices) with its headquarters at Indian Institute of Spices Research, Kozhikode, Kerala. In VII plan (1986) it was having 12 centres and subsequently grew into 19 regular centres by the end of VIII Plan. AICRPS is working on 14 mandate crops *viz.*, black pepper, small cardamom, large cardamom, ginger, turmeric, nutmeg, cinnamon, clove, coriander, cumin, fennel fenugreek, ajowan, nigella, mango ginger, saffron and kalazeera. Presently the network has 38 centres including 10 co-opting centres and 9 voluntary centres focusing the major agro climatic regions of the country. These centres are mostly located in State Agricultural Universities and some centres in ICAR Institutes and also Spices Board. In addition to this, there are two centres functioning under project mode funding.

### AICRPS mandate

- Evolving high yielding, high quality varieties suitable for various agro-ecological situations and that are tolerant/ resistant to biotic and abiotic stresses to mitigate climate change
- Development of location specific green agro technologies for improved production with water and nutrient management, organic farming, ecologically sound control measures against pests and through mechanisation for production of quality clean spices and spice products.
- Facilitate faster adoption of proven technologies/varieties developed through technology dissemination, Field Level Demonstrations and attract youth to agriculture and agro enterprise.
- Working as an interface between State Agricultural Universities (SAUs) and Indian Council of Agricultural Research (ICAR).
- Spread the cultivation of spices to non traditional areas, North East and tribal areas for increased production. Tribal empowerment and identification of most suitable areas (crop mapping) for each of the crop.

### Number of Ongoing research programs-Crop wise



### Back ground and mandate crops of centres

Sl. No.	State	University/ Institution	Centre	Year of start	Crops handled
<b>Regular centres</b>					
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

<b>Co-opting centres</b>					
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
<b>Voluntary centres</b>					
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

## Technical programme 2018-2019

Project code	Title	Centres
<b>Black pepper</b>		
PEP/CI/1	<b>Genetic Resources</b>	
PEP/CI/1.1	Germplasm collection, characterization, evaluation and conservation	Ambalavayal, Chintapalle, Dapoli, Panniyur, Pundibari, Sirsi, Yercaud
PEP/CI/2	<b>Hybridization trial</b>	
PEP/CI/2.1	Inter-varietal hybridization to evolve high yielding varieties	Panniyur
PEP/CI/2.2	Hybridization to evolve varieties tolerant to biotic and abiotic stresses	Panniyur
PEP/CI/3	<b>Coordinated Varietal Trial (CVT)</b>	
PEP/CI/3.3	CVT 2006 Series VI	Chintapalle, Dapoli, Panniyur, Pampadumpara, Sirsi, Yercaud, Pechiparai
PEP/CI/3.5	CVT 2015 on Farmers varieties of black pepper – Series VII	Chintapalle, Sirsi, Panniyur, Dapoli, Yercaud
PEP/CI/3.6	CVT on black pepper 2015-Series VIII	Chintapalle, Sirsi, Panniyur, Dapoli, Yercaud, Kahikuchi
PEP/CI/3.7	CVT 2018 on black pepper Series IX	Ambalavayal, Chintapalle, Sirsi, Panniyur, IISR, Dapoli, Yercaud
PEP/CM/4	<b>Nutrient Management Trial</b>	
PEP/CM/4.7	Black pepper based mixed cropping system for sustainable productivity and food security	Ambalavayal, Sirsi, Panniyur, Dapoli
PEP/CM/4.8	Management of <i>Phytophthora</i> foot rot by mulching	Sirsi
PEP/CP/5	<b>Disease Management Trial</b>	
PEP/CP/5.3	Trial on management of <i>Phytophthora</i> foot rot of black pepper in new plantation	Chintapalle, Mudigere, Dapoli
PEP/CP/5.6	Biological management of slow decline in black pepper	Panniyur, Sirsi, Dapoli
PEP/CP/5.7	Studies on management of <i>Phytophthora</i> causing foot rot in black pepper	Panniyur, Sirsi, Dapoli, Mudigere
<b>Small cardamom</b>		
<b>CAR/CI/1</b>	<b>Genetic Resources</b>	
CAR/CI/1.1	Germplasm collection, characterization, evaluation and conservation	Mudigere, Pampadumpara
CAR/CI/2	<b>Hybridization</b>	
CAR/CI/2.1	Hybridization and selection in cardamom	Mudigere
CAR/CI/2.2	Evaluation of promising small cardamom ( <i>Elettaria cardamomum</i> L. Maton) cultivars/varieties for organic cultivation in the high ranges of Idukki district	Pampadumpara
<b>CAR/CI/3</b>	<b>Coordinated Varietal Trial</b>	
CAR/CI/3.7	CVT of drought tolerance in cardamom – Series VII	Appangala, Mudigere, Sakaleshapur, Myladumpara Pampadumpara

CAR/CI/3.8	CVT 2015 on Farmers varieties of cardamom-Series VIII	Appangala, Mudigere, Pampadumpara, Sakleshpur, Myladumpara,
CAR/CI/3.9	CVT on hybrids of small cardamom-2018 – Series IX	Appangala, Mudigere, Sakaleshapura, Myladumpara, Pampadumpara
<b>CAR/CI/4</b>	<b>Varietal Evaluation Trial (VET)</b>	
CAR/CI/4.3	Initial Evaluation Trial – 2012	Pampadumpara
CAR/CI/4.4	Multi location evaluation of thrips tolerant cardamom lines	Appangala, Mudigere, Pampadumpara, Myladumpara, Sakleshpura
CAR/CP/6	<b>Pest and Disease Management Trial</b>	
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, Myladumpara, Pampadumpara, Sakleshpura
CAR/CP/6.10	MLT on leaf blight tolerant lines of small cardamom 2018	Appangala, Mudigere, Pampadumpara, Myladumpara, Sakaleshapura
<b>Large cardamom</b>		
LCA/CI/1.1	Germplasm collection and evaluation of large cardamom	ICAR Regional Station, Gangtok, ICRI Regional Research Station, Gangtok
LCA/CP/1.2	Integrated pest and disease management in large cardamom	ICRI Regional Station, Gangtok, ICAR Regional Station, Gangtok
<b>Ginger</b>		
GIN/CI/1	<b>Genetic Resources</b>	
GIN/CI/1.1	Germplasm collection, characterization, evaluation and conservation	Barapani, Dholi, Kammarpally, Kumarganj, Pundibari, Pottangi, Raigarh, Solan
GIN/CI/2	<b>Coordinated Varietal Trial (CVT)</b>	
GIN/CI/2.4	CVT 2015-Series IX	IISR, Dholi, Pottangi, Pundibari, Kalyani, Solan, Nagaland
GIN/CI/3	<b>Varietal Evaluation Trial</b>	
GIN/CI/3.4	Initial Evaluation Trial of bold / vegetable ginger	Pottangi
GIN/CI/3.5	Initial Evaluation Trial – 2015	Kumarganj
GIN/CI/3.6	Initial Evaluation Trial – 2016	Pundibari, Pottangi, Solan
GIN/CI/4	<b>Quality Evaluation Trial</b>	
GIN/CI/4.1	Evaluation of germplasm for quality	Solan
GIN/CI/4.2	Evaluation of germplasm from other centres	Solan
GIN/CI/4.3	Evaluation of genotypes of ginger for vegetable purpose (observational trial)	Kozhikode, Mizoram, Gangtok Chintapalle, Pottangi, Pundibari, Nagaland
GIN/CM/5	<b>Nutrient Management Trial</b>	
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, Dholi, Pottangi, Chinthapalle, Barapani, Solan, Kammarpally, Kumarganj, Pundibari, Raigarh, 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	<b>Disease Management Trial</b>	
GIN/CP/6.11	Eco-friendly management of rhizome rot of ginger	Kumarganj
GIN/CP/6.12	Field screening of different varieties of ginger against leaf spot and rhizome rot	Dapoli
GIN/CP/6.13	Effect of PGPR biocapsule on growth and yield of ginger	Pottangi, Chintapalle, Dholi, Barapani, Kammarpally, Kumarganj, Pundibari, Raigarh, Solan, Kalyani, Ambalavayal
GIN/CP/6.14	Management of bacterial wilt of ginger through chemicals and bio agents	Kozhikode, Pottangi, Dholi, Pundibari, Solan, Kalyani, Nagaland, Pasighat, Gangtok
<b>Turmeric</b>		
TUR/CI/1	<b>Genetic Resources</b>	
TUR/CI/1.1	Germplasm collection, characterization, evaluation and conservation	Barapani, Coimbatore, Dholi, Guntur, Kammarpally, Kumarganj, Solan, Pasighat, Pottangi, Pundibari, Raigarh
TUR/CI/2	<b>Coordinated Varietal Trial</b>	
TUR/CI/2.6	CVT on Turmeric – 2016	Chintapalle, Coimbatore, Dholi, Guntur, Kammarpally, Pundibari, Kumarganj, Pottangi, Raigarh, Navsari
TUR/CI/3	<b>Varietal Evaluation Trial</b>	
TUR/CI/3.7	Initial Evaluation Trial 2015	Kumarganj
TUR/CI/3.8	Initial Evaluation Trial 2016	Pundibari, Pottangi, Solan
TUR/CM/5	<b>Nutrient Management Trial</b>	
TUR/CM/5.9	Source sink relationship in turmeric	Coimbatore, IISR, Guntur, Kammarpally, Dholi, Barapani
TUR/CM/5.10	Organic production of turmeric	Barapani, Mizoram
TUR/CM/5.14	Organic production of turmeric	Barapani, Solan, Dholi, Chinthapalle, Coimbatore, Guntur, Kammarpally, Kumarganj, Mizoram, Pantnagar, Raigarh, Pasighat, Pottangi, Pundibari
TUR/CM/5.15	Effect of micronutrients on growth and yield of turmeric	Chinthapalle, Solan, Dholi, Coimbatore, Kammarpally, Kumarganj, Pantnagar, Pasighat, Pottangi, Pundibari, Raigarh

TUR/CP/7	<b>Disease Management Trial</b>	
TUR/CP/7.1	Survey and identification of disease causing organisms in turmeric and screening of turmeric germplasm against diseases	Coimbatore, Pundibari, Dholi, Raigarh
TUR/CP/7.3	Assessment of fungicide and biological control agents against foliar disease of turmeric	Raigarh, Coimbatore
TUR/CP/7.4	Management of foliar diseases in turmeric using tolerant lines	Dholi, Kumarganj, Pundibari, Raigarh, Kammarapally, Solan, Guntur
TUR/CP/7.5	Eco-friendly management of foliar diseases of turmeric	Kumarganj
TUR/CP/7.6	Field screening of different varieties of turmeric against leaf spot and rhizome rot	Dapoli
TUR/CP/7.7	Effect of PGPR biocapsule on growth and yield of turmeric	Chinthapalle, Coimbatore, Dholi, Kumarganj, Pantnagar, Pasighat, Pottangi, Pundibari, Raigarh, Solan, Kammarpally
<b>Tree spices</b>		
TSP/CI/1	<b>Genetic Resources</b>	
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	<b>Coordinated Varietal Trial</b>	
TSP/CI/2.2	CVT 2001-Nutmeg	Dapoli, Pechiparai
TSP/CI/2.4	Coordinated Varietal Trial on farmer's varieties of nutmeg	Dapoli, Pechiparai, Thrissur
Project Mode	Evaluation of nutmeg genotypes	KAU
<b>Coriander</b>		
COR/CI/1	<b>Genetic Resources</b>	
COR/CI/1.1	Germplasm collection, description, characterization, evaluation, conservation and screening against diseases	Coimbatore, Dholi, Guntur, Hisar, Jagudan, Jobner, Kumarganj, Raigarh
COR/CI/1.3	Identification of drought/ alkalinity tolerant source in coriander	Jobner
COR/CI/1.4	Multilocation evaluation of coriander germplasm – 2015	Ajmer, Guntur, Coimbatore, Dholi, Kota, Hisar, Jobner, Jagudan, Kumarganj, Raigarh
COR/CI/2	<b>Coordinated Varietal Trial</b>	
COR/CI/2.7	Coordinated Varietal Trial on coriander 2018-Series X	Ajmer, Coimbatore, Dholi, Guntur, Hisar, Jabalpur, Kota, Jagudan, Jobner, Kumarganj, Navsari, Pantnagar, Raigarh
COR/CI/3	<b>Varietal Evaluation Trial</b>	
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	<b>Quality Evaluation Trial</b>	
COR/CI/4.1	Quality Evaluation in coriander	Jobner
COR/CM/5	<b>Nutrient management trial</b>	
COR/CM/5.5	Response of coriander varieties to various levels of fertility under multi cut 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	Ajmer, Jobner, Guntur, Kumarganj
COR/CP/6	<b>Disease Management Trial</b>	
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	Coimbatore, Raigarh, Jobner, Jagudan, Kumarganj
COR/CP/6.5	Eco-friendly management of stem gall of coriander (Observational trial)	Kumarganj
COR/CP/6.6	Integrated management of stem gall disease of coriander	Dholi
COR/CP/6.7	Integrated pest and disease management in coriander	Ajmer, Coimbatore, Dholi, Hisar, Jabalpur, Raigarh, Jobner, Jagudan, Kumarganj, Navsari, Pantnagar, Kota
<b>Cumin</b>		
CUM/CI/1	<b>Genetic Resources</b>	
CUM/CI/1.1	Germplasm collection, characterization, evaluation, conservation and screening against diseases	Jagudan, Jobner, Mandor, Sanand
CUM/CI/1.3	Identification of drought tolerance	Jobner
CUM/CI/2	<b>Coordinated Varietal Trial</b>	
CUM/CI/2.4	Coordinated Varietal Trial – 2017	Ajmer, Jagudan, Jobner, Mandor
CUM/CI/3	<b>Varietal Evaluation Trial</b>	
CUM/CI/3.5	IET on cumin 2013	Jagudan
CUM/CI/4	<b>Quality Evaluation Trial</b>	
CUM/CI/4.1	Quality evaluation in cumin	Jobner
CUM/CM/5	<b>Nutrient Management Trial</b>	
CUM/CM/5.2	Organic nutrient and disease management in cumin	Jobner
CUM/CM/5.4	Standardization of drip irrigation and fertigation in cumin	Jobner, Jagudan, Mandor
CUM/CP/6	<b>Disease Management Trial</b>	
CUM/CP/6.6	Bio-efficacy of newer molecules of insecticides against cumin aphid	Jagudan, Jobner, Ajmer
CUM/CP/6.7	Management of powdery mildew in cumin through new chemicals	Jobner
CUM/CP/6.8	Integrated pest and disease management in cumin	Ajmer, Jobner, Jagudan, Mandor

<b>Fennel</b>		
FNL/CI/1	<b>Genetic Resources</b>	
FNL/CI/1.1	Germplasm collection, characterization, evaluation, conservation and screening against diseases	Dholi, Hisar, Jagudan, Jobner, Kumarganj
FNL/CI/2	<b>Coordinated Varietal Trial</b>	
FNL/CI/2.6	Coordinated Varietal Trial on fennel 2015 – Series IX	Ajmer, Dholi, Hisar, Jabalpur, Jagudan, Jobner, Kumarganj, Pantnagar
FNL/CI/3	<b>Varietal Evaluation Trial</b>	
FNL/CI/3.5	Initial Evaluation Trial 2015	Jagudan, Kumarganj, Dholi
FNL/CI/4	<b>Quality Evaluation Trial</b>	
FNL/CI/4.1	Quality evaluation in fennel	Jobner
FNL/CM/5	<b>Nutrient Management Trial</b>	
FNL/CM/5.5	Standardization of drip fertigation in fennel	Jobner
<b>Fenugreek</b>		
FGK/CI/1	<b>Genetic Resources</b>	
FGK/CI/1.1	Germplasm collection, characterization, evaluation, conservation and screening against diseases	Dholi, Guntur, Hisar, Jagudan, Jobner, Kumarganj, Raigarh
FGK/CI/1.3	Identification of drought tolerance source in fenugreek	Jobner
FGK/CI/2	<b>Coordinated Varietal Trial</b>	
FGK/CI/2.5	Coordinated Varietal Trial of fenugreek 2018 – Series X	Ajmer, Coimbatore, Dholi, Guntur, Hisar, Jagudan, Jabalpur, Jobner, Kumarganj, Pantnagar, Navsari, Raigarh, Kota
FGK/CI/3	<b>Varietal Evaluation Trial</b>	
FGK/CI/3.6	Initial Evaluation Trial 2014	Dholi, Hisar
FGK/CI/3.7	Chemo-profiling for identification of industrial types among the released varieties of fenugreek	Ajmer, Coimbatore, Guntur, Dholi, Hisar, Jobner, Kumarganj
FGK/CI/3.8	Initial Evaluation Trial 2015	Kumarganj, Jagudan, Jobner
Project Mode	Evaluation of coriander, fenugreek and fennel for growth, yield and quality parameters under Bengaluru conditions.	COH, Bengaluru
<b>Ajowain</b>		
AJN/CI/2	<b>Coordinated Varietal Trial</b>	
AJN/CI/2.1	Coordinated Varietal Trial-2016	Ajmer, Guntur, Hisar, Jobner, Jagudan, Kumarganj, Raigarh
<b>Nigella</b>		
NGL/CI/2	<b>Coordinated Varietal Trial</b>	
NGL/CI/2.1	Coordinated Varietal Trial-2016	Ajmer, Hisar, Kota, Kalyani, Kumarganj, Raigarh, Pantnagar
<b>Mango ginger</b>		
MG/CI/1	<b>Genetic Resources</b>	



MG/CI/1.1	Germplasm collection, characterization, evaluation and conservation	Barapani, Pottangi, Raigarh
<b>Project mode</b>		
<b>Saffron</b>		
	Conservation, evaluation and utilization of exotic and indigenous saffron germplasm lines	Pampore
	To study the impact of organic sources on saffron yield and quality	
	Population dynamics of rhizosphere mycoflora and their efficacy on corm rot pathogens of saffron	
<b>Kalazeera</b>		
	Exploration, collection and conservation of kalazeera from high altitudes of northern Himalayas	Pampore
	Evaluation of saffron-kalazeera intercropping system module for improving profitability and livelihood of farmers	
	Status of major prevalent diseases of kalazeera ( <i>Bunium prsicum</i> Bioss) under Kashmir conditions	

## 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 is presented in Table 1. At present 318 cultivated types, 54 wild types and 3 exotic types of black pepper are being maintained at PRS, Panniyur. The survey work was carried out and 15 new genotypes were collected during the year. During the year 2018-19, the genotypes PRS 64, PRS 136 and PRS 154 were the top yielders. PRS 64 ranked first with 4.98 kg green berry yield and 1260 spikes/vine. Spike length was highest for PRS 155 (15.1 cm). The number of developed berries/spike was more for PRS 137 (75.0). The 100 berry weight was high for PRS 154 (12.4 g). The dry recovery % was more for PRS 136 (38 %).

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

Centres	Indigenous				Exotic	Total
	Cultivated		Wild and related species			
	Existing	Addition (April 2018 to March 2019)	Existing	Addition (April 2018 to March 2019)		
Ambalavayal	10	-	-	-	-	10
Chintapalle	26	-	-	-	-	26
Dapoli	52	2	-	-	-	54
Panniyur	318	15	54	-	3	390
Pundibari	31	-	-	-	-	31
Sirsi	186	15	45	7	-	253
Yercaud	34	-	3	-	-	37
<b>Total</b>	<b>657</b>	<b>32</b>	<b>102</b>	<b>7</b>	<b>3</b>	<b>801</b>

At Pundibari, 31 accessions of black pepper are being maintained. Among the germplasm accessions only 28 accessions set berries. Due to the uneven distribution of rainfall the yield was low in all the accessions. Spike shedding might be due to poor rainfall distribution, excess moisture, dense shade, absence of pollination and inadequate pollination. The significant difference was observed among the germplasm accessions for the characters viz., spike length, 100 green berry weight, 100 dry berry weight, green berry yield and dry berry yield.

A total of 10 genotypes are maintained in the germplasm at Ambalavayal. They are HP 780 (IISR), HP 1411 (IISR), OPKM (IISR), HP 117 X Thommankodi (IISR), IISR Thevam (IISR), Kumbakkal (IISR), Ponmani (IISR), PRS 137 (Panniyur), SV 7 (Sirsi), Kurimalai (Sirsi) & Panniyur 1 (Check).

At Sirsi centre, 15 collections were added during the year 2018-19 (from Yellapur, Sirsi, and Siddapur taluk) (Table 2). A Total of 253 accessions including 7 related species: (*P. colubriunum*, *P. arborium*, *P. chaba*, *P. longum*, *P. attenuatum*, *P. hymenophyllum*, *P. hookeri*) are maintained at Sirsi.

**Table 2. Quality analysis of collections studied at Sirsi**

Sample name	Volatile Oil (%)	Oleoresin (%)	Piperine (%)	BD (g/l)	1000 seed wt (g)
Uddakare	1.75	12.64	7.31	634	76.8
Jeerakamunda	1.43	7.14	3.90	610	91.2
Kanmurta	1.60	9.61	5.72	600	77.5
Panchami	1.50	7.97	4.29	580	38.00
Pinjarumundi	1.15	8.31	3.86	670	50.40
Tirupukare	1.38	6.39	3.41	600	70.00
Okkalu	1.96	8.81	4.57	650	78.70
Karimunda	1.25	7.00	4.28	559	44.30
Sapthami	0.78	5.22	4.56	530	57.50
Thevam	1.50	5.40	2.79	604	55.20
Karimallisara	0.71	5.35	3.25	656	54.80
SV-2 (okkalu)	1.00	4.24	3.01	570	65.60
Bilimallisara	1.68	6.99	3.61	677	72.40

Panniyur -1 recorded the highest number of spikes per vine (639), fresh berry yield/ vine (4.04 kg), dry yield (1.29 kg), fresh yield/ha (4.13 t/ha) whereas the highest no. of berries per spike was recorded in Neelamundi and highest dry recovery was recorded in Perambramundi (32.65%).

At present 54 germplasm accessions are being maintained at Dapoli. Two elite types of black pepper were collected.

## Crop Improvement

### PEP/CI/2 Hybridization trial

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

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

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



**Fig. 1. Spikes of promising hybrid PRS 161**

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

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

Seedlings of all the crosses are being maintained. Crossing Panniyur 1 with PRS 4 was carried out this year also and the seeds obtained were sown in nursery.

## **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)***

This experiment was initiated during the 2009-10 at Horticultural Research station Chintapalle. Ten varieties of black pepper planted, namely PRS-88, HB-20052 (Panniyur-8), Acc-33, Acc-53, Acc-57, Acc-106, C-1090, HP-39, Panniyur-1 and Karimunda. The maximum plant height was recorded in C-1090 (590.53 cm) followed by Panniyur -8 (HB20052) (560 cm) and the minimum plant height was noticed in ACC 33 (304.30 cm). ACC-33 recorded maximum number of branches per plant (28.75) followed by C-1090 (19.94) and Panniyur-1 (19.77) and these two were on par with each other. Fresh berry yield was the highest in Panniyur-1 (63.776) followed by P-8 (507.44) and C-1090 (472.02).

Plant growth parameters of different black pepper varieties were non significant. Plant height of all the varieties varied and ranged between 2.20 to 5.02 m. The Acc. 106 recorded maximum plant height (5.02 m) while lowest plant height was recorded by HP- 39 at Dapoli. HB 20052 recorded the highest green berry yield of 5.20 kg/vine followed by Acc.no.53 (4.97 kg/vine). Both the varieties were statistically on par. The highest plant height was recorded for Panniyur 1 (5.17 m). At Sirsi, PRS-88 recorded maximum number of spikes followed by Panniyur-1.

Among the characters studied, the highest fresh weight (0.98 kg/vine) of berries per vine was registered for HB 20052 which was on par with Karimunda (0.93 kg/vine) followed by Acc 53 (0.76 kg/vine). For dry weight of berries Karimunda recorded the highest (0.53 kg/vine) which were on par with HB 20052 (0.53 kg/vine).

In this trial totally nine entries are being maintained at Yercaud. Maximum number of spikes per meter square (48.0) was recorded in IISR Shakthi and the lowest in the Acc. 106 (15.0). The number of spikes berries per spike was highest in the variety (68) IISR Shakthi. The green berry and dry berry yield were also the highest in the variety IISR Shakthi with 0.580 kg and 0.169 kg respectively.

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

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

The trial was started at Panniyur centre during 2015. During 2018, Kumbakkal recorded the highest green berry yield of 2.20 kg and is on par with Panniyur 1. Average spike length was highest for Panniyur 1 (17.03 cm) which was on par with Panniyur 5 (16.6 cm). Number of berries/ spike was more for Panniyur 1 (84.66). Higher dry recovery % was recorded for Zion Mundi, Panniyur 5 and Panniyur 1 (35%) (Table 3).



**Table 3. Yield data of CVT 2015 on Farmers' varieties, Panniyur**

Treatment	Pl. height (m)	No of branches/vine	Spike length (cm)	No. of berries/spike	Fresh berry yield (kg)	Dry berry yield (kg)	Dry Recovery %
Zion Mundi (T1)	3.50	6.67	15.03 <sup>b</sup>	50.00 <sup>c</sup>	0.60 <sup>d</sup>	0.23 <sup>d</sup>	35 <sup>a</sup>
Kumbakkal (T2)	3.50	7.67	14.63 <sup>b</sup>	52.43 <sup>c</sup>	2.20 <sup>a</sup>	0.70 <sup>a</sup>	33 <sup>b</sup>
Panniyur 5 (T3)	2.83	11.33	16.6 <sup>a</sup>	69.33 <sup>b</sup>	1.46 <sup>b</sup>	0.52 <sup>b</sup>	35 <sup>a</sup>
Panniyur 1 (T4)	3.50	8.33	17.03 <sup>a</sup>	84.66 <sup>a</sup>	1.93 <sup>a</sup>	0.69 <sup>a</sup>	35 <sup>a</sup>
Karimunda (T5)	3.83	8.00	9.33 <sup>c</sup>	51.66 <sup>c</sup>	1.07 <sup>c</sup>	0.35 <sup>c</sup>	32 <sup>b</sup>
CD (0.05)	NS	NS	1.14	8.87	0.29	0.11	2.0

At Dapoli, the genotype Pepper Thekken recorded maximum plant height (97.0 cm) whereas genotype Kumbakkal recorded minimum plant height (56.27 cm). At Chintapalle, Kumbakkal recorded maximum plant height (165.78 cm) followed by Zion Mundi (164.97 cm). Panniyur-1 recorded the highest number of branches/vine (7.42) followed by Kumbakkal (6.14).

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

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

The trial was started during 2015. During 2018, PRS 161 recorded the highest green berry yield of 1.93 kg (dry berry yield 0.73 kg) and was on par with check Panniyur 1. Average spike length was the highest for PRS 161 (21.93 cm). Number of berries/ spike was also the highest for PRS 161 (118) and was on par with PRS 160 (112). The highest dry recovery % was recorded for PRS 161 (38%) (Table 4).

**Table 4. Growth and yield data of CVT 2015, Panniyur during**

Treatment	Pl. height (m)	No of branches/vine	Average spike length (cm)	No. of berries/spike	Fresh berry yield (kg)	Dry berry yield (kg)	Dry Recovery %
PRS 161 (T1)	3.33	5.33	21.93 <sup>a</sup>	118.00 <sup>a</sup>	1.93 <sup>a</sup>	0.73 <sup>a</sup>	38a
PRS 160 (T2)	2.83	8.67	16.23 <sup>b</sup>	112.33 <sup>a</sup>	0.97 <sup>c</sup>	0.33 <sup>c</sup>	34c
SV 17 (T3)	2.60	8.33	13.66 <sup>c</sup>	72.00 <sup>c</sup>	0.57 <sup>d</sup>	0.18 <sup>d</sup>	32d
SV 11(T4)	3.50	8.00	-	-	-	-	-
Panniyur 1 (T5)	2.50	8.00	17.03 <sup>b</sup>	84.66 <sup>b</sup>	1.93 <sup>a</sup>	0.69 <sup>a</sup>	35b
Panniyur 5 (T6)	2.83	11.33	16.6 <sup>b</sup>	69.33 <sup>c</sup>	1.46 <sup>b</sup>	0.52 <sup>b</sup>	35b
Karimunda (T7)	3.83	8.00	9.33 <sup>d</sup>	51.66 <sup>d</sup>	1.07 <sup>c</sup>	0.35 <sup>c</sup>	32d
CD (0.05)	NS	NS	1.356	11.13	0.32	0.108	4.0

The trial was planted in 2016 at Dapoli. Panniyur -1 recorded maximum plant height. At Sirsi, Two entries from Panniyur (PRS-160, 161) and 2 entries from HRES, Sirsi (SV-11, 17) are planted under replicated trial along with Panniyur -1 as check. All have established well.

## Crop Management

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

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

Good yield was obtained from the intercrops in black pepper garden except arrow root and tapioca at Panniyur. Among the intercrops T<sub>3</sub>- elephant foot yam recorded maximum yield of 7.55 kg followed by T<sub>5</sub> -greater yam (6.46 kg ) from an inter space of 4m x 2 m between black pepper vines. Colocasia (T<sub>1</sub>) yielded 2.28 kg and arrowroot (T<sub>2</sub>) – 1.82 kg per plot. At Ambalavayal, mean yield per plot was highest in tapioca (7.8 kg) and lowest in greater yam (2.475 kg) and colocasia (1.875 kg). Green pepper yield of 1.575 kg was recorded when black pepper was grown as main crop. At Sirsi, mean yield per plot was highest in elephant foot yam (6.4 kg) and lowest in mango ginger (0.74 kg). At Dapoli, yield of intercrops (per/ha) varied as colocasia 4.02 tons, arrow root 4.11 tons, elephant foot yam 11.17 tons, tapioca 9.31 tons and greater yam 10.0 tons, respectively. The yield obtained in different mixed crop blocks for pineapple varied as 3.39 tons in colocasia 3.35 tons in arrow root 3.39 tons in elephant foot yam and 3.14 tons in tapioca block respectively. Black pepper is still in pre-bearing stage.

## Crop Protection

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

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

At Mudigere, the treatment T<sub>3</sub> i.e., spraying and drenching of 0.2% kocide 10 days after application of *T. harzianum* @ 50g + 1 kg neem cake / vine was found more effective in reducing the disease incidence (10.39 %) with higher yield of 783.5 g / vine which was on par with T<sub>2</sub> i.e., spraying and drenching of 0.1% sectin + *T. harzianum* (50 g) + neem cake (1 kg / vine). All the treatments were found effective in reducing the incidence of the disease compared to control.

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

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

Soil application of *Trichoderma viride* + neem cake @ 2 kg/vine (T1), soil application of *Trichoderma viride* followed by soil drenching with *P. fluorescens* @ 2% (T2), soil application of *Pochonia chlamydosporia* (multiplied in partially decomposed FYM @ 2 kg/vine) followed by soil drenching with *P. fluorescens* @ 2% (T3) were significantly superior in reducing yellowing due to slow decline disease in black pepper. Soil application of *Trichoderma viride* followed by soil drenching with *P. fluorescens* @ 2% (T2) recorded minimum disease incidence (2.77%) and maximum yield (2.19 kg/vine).

Soil application of *Pochonia chlamydosporia* @ 2 kg/vine followed by soil drenching with *Pseudomonas fluorescens* IISR-6 @ 2% (10<sup>6</sup>cfu) (drench 3 l/vine) recorded the lowest per cent disease at Dapoli (6.78) which was significantly superior to rest of the treatments. The treatment soil application of *Trichoderma harzianum* (10<sup>8</sup>cfu @ 50g/vine) followed by soil drenching with *Pseudomonas fluorescens* and another treatment, soil application of *Pochonia chlamydosporia* @ 50g/vine followed by soil drenching with *P. fluorescens* @ 2% were at par. Maximum per cent reduction (68.33) in the disease was observed in vines treated during onset of monsoon (June) and

again during third week of August with soil application of *Pochonia chlamydosporia* @ 2 kg/vine followed by soil drenching with *Pseudomonas fluorescens* @ 2%.



**Fig. 2. Field view of biological management of slow decline in black pepper at Panniyur**

**PEP/CP/5.7 Studies on management of *Phytophthora* causing foot rot in black pepper (Centres: Western plateau and hills region – Dapoli; West coast plains and ghat region – Panniyur, Sirsi, Mudigere)**

At Panniyur, the percentage disease incidence was minimum in application of fosetyl aluminium amended fertilizer brickets at the onset of rain and post monsoon (T3) and RIL070/F1 -72% WP 100ppm soil drenching (T5). There was no significant variation among treatments for plant height and no of leaves both at Panniyur and Dapoli.

## II. Small cardamom

### Genetic Resources

**CAR/CI/1.1 Germplasm collection, characterization, evaluation and conservation (Centres: West Coast Plains and Ghat Region - Mudigere, Pampadumpara)**

Among the 188 cardamom accessions conserved in the gene bank of Pampadumpara, IC number was obtained for 73 accessions (CRSP 1-73) IC numbers (547920 to 547992) from the ICAR-National Bureau of Plant Genetic Resources, New Delhi. All the characters including yield and biotic stress characters, except *Azhukal* incidence showed significant difference among the accessions at 5% confidence levels. HY 13 recorded the highest fresh yield (1.82 kg/plant) followed by HY 16 (1.81 kg/plant) and they were significantly different from each other. The same trend was also observed for dry yield of capsules per plant. The percentage thrips incidence was least in HY 12, HY 2, PV 2, HY 16 and HY 15 compared to other accessions.

At Mudigere 132 cardamom germplasm accessions are conserved which consists of 67 local collections, 35 collections from other institutions and 30 breeding materials (Table 5).

**Table 5. Best performing clones/lines for important yield attributing traits of germplasm at Mudigere**

Character	Genotypes	
Tillers / clump	AGP-293	42.52
	SKP-170	40.52
	26-16-D-11	38.27
	CCS-800	35.9
	M-1	33.21
Tiller height (cm)	M-2	315.3
	MCC-309	300.5
	D-163	292.3
	M-3	290.8
	M-1	287.24
Bearing tillers/clump	SKP-170	29.17
	26-16-D-11	24.45
	M-1	21.2
	SEL-98	19.23
	D-168	18.12
Panicles/clump	NCL-1	25.24
	26-16-D-11	24.3
	MHC-26	22.27
	D-168	20.18
	SEL-98	18.54
Yield/plant (g/plant)	SKP-170	498.21
	M-1	385.10
	26-16-D-11	346.27
	PS-44	321.45
	MHC-26	308.47



**Fig. 3. Variability in green cardamom capsules**

## Crop Improvement

### CAR/CI/2 Hybridization

### CAR/CI/2.1 Hybridization and selection in cardamom

*(Centres: West Coast Plains and Ghat Region – Mudigere)*

Different F1 combinations were produced by crossing seven improved elite genotypes in all possible combinations and the seedlings will be raised and evaluated in the next seasons. Promising genotypes: CL-726 and CL-691, these lines are in CVT for testing.

### **CAR/CI/2.2 Evaluation of promising small cardamom (*Elettaria cardamom* Maton) cultivars/varieties for organic cultivation in the high ranges of Idukki district (Centre: West Coast Plains and Ghat Region - Pampadumpara)**

In this experiment, PV2 showed the highest plant height (307.6 cm), closely followed by PL NO 14 (293.0 cm). No of productive tillers GG registered maximum no of tillers (41.0) followed by PS 27 (32.6) and PV2 (30.3).

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

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

Eight varieties viz., IC 349537, IC 584058, GG X NKE- 12, IC 584078, CL 668, HS 1, Appangala 1 and IC 584090 were planted at Appangala, Mudigere, Myladumpara, Pampadumpara and Sakleshpur. Morphological observation revealed that in general plants in the control (without moisture stress, T<sub>1</sub>) recorded vigorous growth as compared to the moisture stress plots (T<sub>2</sub>). At Mudigere, maximum plant height was found in IC-584078 (248.30cm) and more total number of suckers / per plant was observed in IC-349537 46.30) followed by HS-1 (41.60).

At Sakleshpur, under moisture stress the genotype, IC 349537 registered more number of bearing tillers (10.83), number of panicles (5.39) and long panicles (35.65 cm) and number of capsules per raceme (4.30). Same genotype registered more number of of bearing tillers (17.10), number of panicles (7.55) and long panicles (50.41 cm) and number of capsules per raceme (5.10) under control also.

At Appangala, accession IC 584058 recorded 400.34 kg/ha yield in control and 278.78 kg/ha under stress. followed by that accession IC 584090 which recorded 307.32 kg/ha in control and 166.33kg/ha under stress. Accession IC 584058 recorded 80 per bold capsule (>7 mm) and synchrony in flowering and harvesting can be completed in four harvest. Essential oil and oleoresin was also recorded. Essential oil percent ranged from 6.81 to 8.18 and oleoresin per cent ranged from 3.61 to 5.55 per cent.

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

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

At Pampadumpara, superiority in plant height was observed in Njallani and Thiruthali (166.30 and 160.63 respectively) followed by Wonder Cardamom and Patchaikkai (153.83 and 151.50 respectively). Maximum number of tillers were produced by Thiruthali (16.53) followed by Patchaikkai (14.97).

At Myladumpara, During 2019, data on growth characters such as tillers/clump, tiller height (cm), number of leaves, length of a leaf (cm), breadth of a leaf (cm), number of vegetative buds and number of emerging panicles were recorded and analyzed. No. of tillers were significantly more in Wonder cardamom (68) followed by Thiruthali (54.33). Plant height was significantly more in Thiruthali (285.67) followed by Panikulangara I (250.67). Number of leaves of the tallest tiller were highest in Panikulangara I (13.67) followed by Thiruthali (13.33). Numbers of vegetative buds were highest in Arjun (4) followed by PNS Vaigai (3.67). Panicle initiation started after 9 months of planting. Significantly more panicles were found in Thiruthali (43) followed by Panikulangara I (16.33) compared to other varieties. (Table 6).

**Table 6. Variation in growth parameters of farmers varieties at Myladumpara**

Genotype	No. of Tillers / clump	Tiller height (cm)	No. of leaves of the tallest tiller	No. of veg. buds	No. of emerging panicles
Wonder cardamom	68.00	219.67	10.67	2.67	9.67
Patchaikikai	37.33	249.33	12.00	2.00	13.00
Thiruthali	54.33	285.67	13.33	2.33	43.00
Arjun	41.00	243.67	10.33	4.00	15.67
Panikulangara I	42.67	250.67	13.67	1.00	16.33
Elarajan	22.67	225.33	12.00	1.00	6.33
Pappalu	36.33	244.00	12.00	2.33	9.33
PNS Vaigai	41.00	217.00	11.67	3.67	15.00
Njallani Green Gold (National check)	45.00	274.67	14.67	5.00	37.00
ICRI 5 (Local check)	25.00	231.00	11.00	2.33	9.33
CV	21.28	11.07	15.44	40.10	35.52
CD @ 5%	15.09	46.35	3.21	1.81	10.64



**Fig. 4. Field view of farmer's varieties trial cardamom at Mudigere**

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

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

The trial is initiated in all centres. Planting materials are multiplied and planting will be taken up.

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

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

*(Centres: West Coast Plains and Ghats Region –Pampadumpara)*

Maximum number of tillers was produced in PPK 2 (55.6) which on par with Pl. No. 14 and HY 6 (49.3 and 48.3 respectively). Maximum leaf width (12.1 cm) was observed in PV 2 which was on par with PPK 2 and HY 6 (11.5 and 11.5 respectively). Length of panicle was maximum in PPK 2 (73.7 cm) followed by GG (69.0 cm).

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

(Centres: West coast plains and ghats region –Mudigere, Myladumpara, Pampadumpara; Southern Plateau and Hills Region - Sakleshpur)

Thrips tolerant lines viz., IC 349362, IC 349364, IC 349370, IC 349606 along with Njallani Green Gold and local check was planted at Mudegere, Myladumpara, Pampadumpara and Sakleshpur. The plants were established in the field and 6-7 new tillers were formed. At Myladumpara, observations on thrips population was recorded at monthly intervals on different cardamom accessions. Among the accessions, IC 349606 showed lower thrips population than other accessions and Njallani Green Gold had the highest population.

### Crop Protection

#### CAR/CP/6 Pest and disease management trial

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

(Centres: West Coast Plains and Ghat Region – Mudigere)

At Mudigere, all the treatments were found effective when compared to control is presented in table 10. The minimum tiller infection of (4.63%) with higher yield (711.25 g/plant) was recorded in T<sub>1</sub>, which was followed by T<sub>5</sub> (5.16% incidence).

**Table 7. Effect of chemical treatments as well as bio-control agents against Pseudostem rot of cardamom at Mudigere**

Treatment	% Tiller infection	Yield (g/plant)
T <sub>1</sub> = Carbendazim (0.2%)	4.63	711.25
T <sub>2</sub> = <i>Pseudomonas fluorescens</i> (2% solution)	8.00	615.00
T <sub>3</sub> = Consortium of bacteria (2% solution)	10.27	577.63
T <sub>4</sub> = <i>T. harzianum</i> (50 g with 1 kg neem cake ) + consortium of bacteria	9.68	547.69
T <sub>5</sub> = <i>T. harzianum</i> (50g with 1kg neem cake) + <i>Pseudomonas fluorescens</i> (2%)	5.16	672.50
T <sub>6</sub> = Control	12.63	380.25
CD @ 5%	2.00	44.26
CV %	18.21	5.03

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

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

At Mudigere, the data on thrips infestation after seven sprays revealed that, fipronil 5 SC @ 0.005% applied plants showed highest per cent reduction of infestation (89.30%). Spinosad 45 SC @ 0.0135% and quinalphos 25 EC @ 0.05% were also found effective in reducing the infestations (76.30% and 70.21% respectively) and were on par with each other (Table 8).

**Table 8. Effect of new molecules on *S. cardamomi* of cardamom at Mudigere**

Treatment	*Pre-treatment observations	**Per cent thrips infestations (Pooled data)	Per cent reduction over control
Spinosad 45 SC @ 0.0135%	11.00 (3.20)	5.65 (13.30) <sup>b</sup>	76.30
Imidacloprid 17.8 SL @ 0.0089%	11.55 (3.23)	4.70 (11.96) <sup>bc</sup>	78.70
Fipronil 5 SC @ 0.005%	9.30 (2.84)	2.59 (8.80) <sup>c</sup>	89.30
Quinalphos 25 EC @ 0.05%	11.07 (3.15)	7.55 (14.48) <sup>b</sup>	70.21
Control	9.70 (3.00)	22.06 (27.09) <sup>a</sup>	-
CD ( P=0.5 )	NS	13.86	-
S. Em ±	1.11	4.11	-

At Pampadumpara, The pooled data on thrips infestation after seven sprays revealed that fipronil 5 SC treated plots registered the least damage (0.72%) while control registered 50.42% damage. The highest per cent reduction of thrips population over control was noticed in fipronil 5 SC (98.57%) closely followed by spinosad 45 SC (96.90%) and imidacloprid 17.8 SL (96.69%).

At Sakleshpur, the thrips damaged capsules (%) were least in spinosad, imidacloprid and fipronil 15 days after spray and were on par with each other. Imidacloprid, fipronil and quinalphos showed least thrips damage which were on par with each other. Imidacloprid recorded maximum reduction in damaged capsule (46%) at 7 DAS. Imidacloprid and fipronil recorded maximum reduction in damaged capsule (32.4%) at 15 DAS. However, at 30 DAS all the four insecticides were found effective in reducing the damaged capsule and were on par with each other (Table 9). The residue of quinalphos was analysed and found that there is a gradual reduction in the residue level from the seventh day (0.43 mg/kg) to 30<sup>th</sup> day (0.23 mg/kg) after harvest. At Myladumpara, among insecticide sprayed treatments, quinalphos recorded lower thrips damaged capsules (26.91%) followed by imidacloprid (29.99%), fipronil (30.46%) and spinosad (36.51%).

**Table 9. Capsule damage due to thrips infestation at Sakleshpur**

Treatment	Thrips damaged capsule (%)				Reduction in damaged capsule (%)			
	Days after spray				Days after spray			
	0	7	15	30	0	7	15	30
T <sub>1</sub> Spinosad 45% SC @ 0.0135%	30 (33.12) <sup>b</sup>	31 (33.79) <sup>b</sup>	26 (30.55) <sup>b</sup>	23 (28.65) <sup>ab</sup>	-	13.8 (20.82) <sup>b</sup>	29.7 (32.37) <sup>ab</sup>	8 (16.12) <sup>a</sup>
T <sub>2</sub> Imidacloprid 17.8SL @ 0.0089%	35 (36.23) <sup>ab</sup>	21 (27.25) <sup>c</sup>	25 (29.96) <sup>b</sup>	19.5 (26.13) <sup>b</sup>	-	41.6 (40.01) <sup>a</sup>	32.4 (34.54) <sup>a</sup>	22 (25.17) <sup>a</sup>
T <sub>3</sub> Fipronil 5% SC @ 0.005%	27 (31.30) <sup>b</sup>	29 (32.53) <sup>b</sup>	25 (29.99) <sup>b</sup>	20 (26.55) <sup>b</sup>	-	19.4 (25.45) <sup>b</sup>	32.4 (32.69) <sup>ab</sup>	20 (26.43) <sup>a</sup>
T <sub>4</sub> Quinalphos 25EC @ 0.05%	41 (39.79) <sup>a</sup>	39 (38.64) <sup>a</sup>	32 (34.41) <sup>a</sup>	22 (26.13) <sup>b</sup>	-	0 (0.0)	13.5 (20.33) <sup>b</sup>	12 (26.67) <sup>a</sup>
T <sub>5</sub> Water spray (control)	29 (32.53) <sup>b</sup>	36 (36.86) <sup>a</sup>	37 (37.45) <sup>a</sup>	25 (29.98) <sup>a</sup>	-	-	-	-
CD (P<0.05)	4.60	2.18	3.80	2.54	-	9.57	13.10	12.47



### 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 10 genotypes of large cardamom viz., Ramsey, Sawney, Dzongu Golsey, Varlangey, Seramney, Madhusai and Dudhe Golsai of large cardamom are being maintained at ICAR RS, Gangtok (Table 10).

**Table 10. Passport data of germplasm collected and conserved at ICRI, Gangtok**

Sl. No.	Cultivar	Location	Productive tiller/Clump	Spike/Clump	Capsule /Spike	Seeds/ Capsule	Dry yields/ Plant (g)	Remarks
1	Varlangey	South Regu Busty East Sikkim	35	29-68	15.13	28-40	409.39	--
2	Seramna	Nompanang, Pasidang Lingthem North Sikkim	26	19-37	12.62	24-42	311.64	Waxy appearance of leaves
3	Ramsey	Moolpala Siddim, Samalbang Khasmal, Kalimpong, West Bengal	24	28-49	14.78	26-38	381.84	Bolder capsule

#### Crop Protection

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

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

Evaluation of organic treatments against major soil borne diseases of large cardamom was carried out to evaluate different organic treatments against major soil borne diseases of large cardamom in field. Among all, treatment number six (Sapling treatment with COC 2gm/litre + Soil application of *Trichoderma* (4 ml/l) (10 days after planting) during sowing & COC 2gm/litre near clump followed by trichoderma (4 ml/l) (10 days after COC application) each month) showed less incidence of disease (9.52 %) (Table 11).

- T1 Application of neem cake 100 gm/pit during sowing + application of neem cake (100 gm/clump) each month
- T2 Sapling treatment with *Trichoderma* 4 ml/l during sowing + application of trichoderma (4 ml/l) each month
- T3 Sapling treatment with COC 2gm/litre during sowing + application of COC 2 gm/litre near clump each month

- T4 Application of neem cake 100 gm/pit + Sapling treatment with Trichoderma 4 ml/l during sowing & application of neem cake (100 gm/clump) and trichoderma (4 ml/l) each month
- T5 Application of neem cake 100 gm/pit + Sapling treatment with COC 2 gm/litre & application of neem cake (100 gm/clump) and COC 2gm/litre near clump each month
- T6 Sapling treatment with COC 2 gm/litre + Soil application of Trichoderma (4 ml/l) (10 days after planting) during sowing & COC 2gm/litre near clump followed by trichoderma (4 ml/l) (10 days after COC application) each month
- T7 Application of neem cake 100 gm/pit + Sapling treatment with COC 2 gm/litre + Soil application of Trichoderma (4 ml/l) (10 days after planting) during sowing & application of neem cake (100 gm/clump), COC 2 gm/litre near clump followed by trichoderma (4 ml/l) (10 days after COC application) each month
- T8 Drenching of clump area with Copper Oxy Chloride (2 gm/litre) after each 30 days
- T9 No application- control

**Table 11: Evaluation of organic treatments against soil borne diseases of large cardamom**

Treatments	Plant height	No. of tillers	Disease Incidence (%)
T1	81.67	3.07	28.57
T2	85.10	3.74	14.29
T3	76.33	3.24	14.29
T4	75.10	2.69	23.81
T5	77.36	2.83	33.33
T6	66.26	2.21	9.52
T7	70.67	2.48	23.81
T8	82.71	2.00	38.10
T9	95.08	2.17	42.86

**Evaluation of some new biopesticides and organically permitted insecticides against insect pests of large cardamom**

The experiment was conducted to evaluate the efficacy of biopesticides viz., neem oil (1500 ppm) @ 4 ml/l, *Beauveria bassiana* 7 g/l, *Metarhizium anisopliae* 5 ml/l, petroleum oil based agrospray @ 10 ml/l, petroleum oil based horticultural spray @ 10 ml/l, *Bacillus thuringiensis* @ 2 g/l, and spinosad 45 SC @ 0.3 ml/l against insect pests of large cardamom viz., stem borer, shoot fly, leaf eating caterpillar and tea mosquito bug. All the treatments showed effective results to control insect pests over the control. However, spinosad 45 SC @ 0.3 ml/l was found to be the most effective to control all the pests (62.35 to 75.12 % reduction of infestation over control) followed by neem oil (1500 ppm) @ 4 ml/l (54.63 to 57.82% reduction of infestation over control) and petroleum agrospray @ 10 ml/l (47.42 to 52.47% reduction of infestation over control).

## 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 - Kamarpally; Eastern Plateau and Hills Region – Barapani, Pottangi, Raigarh; Western Himalayan Region - Solan)*

Among 75 accessions maintained at Dholi, sixteen accessions recorded higher yield ranging from 8.51 to 18.42 t ha<sup>-1</sup> compared to check variety Nadia (8.23 t ha<sup>-1</sup>). RG-39 recorded highest yield (18.42 t ha<sup>-1</sup>) followed by RG-56 (18.00 t ha<sup>-1</sup>) and RG-9 (17.87 t ha<sup>-1</sup>) under shade condition. At Kumarganj, among 63 germplasm accessions evaluated, NDG-55 (440 g/plant) was promising followed by NDG-6 (143 g/plant) and NDG-23 (140 g/plant). At Pundibari, among 35 accessions evaluated, highest rhizome yield was recorded in GCP 10 followed by GCP-49 (13.81 t ha<sup>-1</sup> and 13.41 t ha<sup>-1</sup> respectively) GCP 9 and GCP 43 (13.08 t ha<sup>-1</sup>). Lowest rhizome rot and wilt disease incidence was recorded in GCP- 49, GCP 23 and GCP 25 (10%) followed by GCP-10 (12.50%). At Pottangi, out of 140 ginger germplasm studied, 34 entries yielded more than 5 kg/3m<sup>2</sup> fresh rhizome. The range of plot yield being 0.10 kg (PGS-119) to 9.5 kg/3 m<sup>2</sup> (PGS-163) with the mean yield of 3.1 kg /3 m<sup>2</sup> in tested germplasms during Kharif 2018-19. The highest fresh rhizome yield was recorded by PGS-163 (21.1 t ha<sup>-1</sup>) followed by Zo-9 (20.0 t ha<sup>-1</sup>), PGS-151 & PGS-158 (18.4 t ha<sup>-1</sup>). At Raigarh, eleven new accessions were collected and tested for their yield performance and disease tolerance during *Kharif* 2018. Indira Ginger -1 (9.9 t ha<sup>-1</sup>) recorded maximum yield over two national checks Suprabha (7.5 t ha<sup>-1</sup>) and Suruchi (8.3 t ha<sup>-1</sup>) followed by IN-4 (7.2 t ha<sup>-1</sup>) and IN-3 (6.4 t ha<sup>-1</sup>).

At Barapani, 43 genotypes of ginger (Accessions IC-584322 to IC-584364) were maintained and evaluated. It was found that, IC-584354 recorded the highest yield with 20.95 t/ha. Crude fibre was found to be highest in IC 584335 and IC 584347 (6.15%). Highest dry matter content of 25.09% was recorded in IC-584353 and highest oleoresin content of 7.07% was recorded in IC-584343.

### Crop Improvement

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

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

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

An experiment was conducted at ICAR-AICRP on Spices field during 2014-15 to 2018-19 to study the performance of nine ginger genotypes. The experiment was concluded in 2018. At Pundibari, SG-2604 showed the highest projected yield (10.61 t ha<sup>-1</sup>), followed by ACC-247 (9.96 t ha<sup>-1</sup>). Lowest yield was found in SEHP-9 (7.88 t ha<sup>-1</sup>). Highest disease incidence was recorded in IISR Varada (23.07 PDI) and lowest in ACC 247 (11.47 PDI). The analyzed pooled data at Pottangi revealed that, among 11 entries, the entry SE-86-40 (13.8 t ha<sup>-1</sup>) was the top yielder with the yield advantages of 36.4% over IISR Varada (10.1 t ha<sup>-1</sup>) followed by PGS-121 (13.0 t ha<sup>-1</sup>), SEHP-9 (12.7 t ha<sup>-1</sup>) and SE86-131(10.9 t ha<sup>-1</sup>). At Nagaland, consistently good performance of SG-2604 for three consecutive years was recorded (20.75 t ha<sup>-1</sup> of fresh rhizomes) which was statistically at par with the local check variety Nadia (24.17 t

ha<sup>-1</sup>) which may be recommended for cultivation as one of the potential alternative variety for commercial cultivation in Nagaland.

The average fresh rhizome yield at Solan centre varied from 5.15 t ha<sup>-1</sup> to 18.25 t ha<sup>-1</sup>. The local genotype Solan Giriganga (IC-593889/ SG-26-04) recorded maximum yield 18.25 t ha<sup>-1</sup> by statistically excelling all other entries and minimum disease incidence. The high yielding promising genotype was superior/ comparable for quality attributes viz., dry matter recovery (21.01%), essential oil (1.45%), oleoresin (4.69%) and crude fibre content (4.47%) to the check variety Himgiri. Therefore, Solan Giriganga (IC-593889/ SG-26-04) has been identified for cultivation under Western Himalayan Regions of the country.

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

*(Centres: Middle Gangetic Plain Region – Dholi; Eastern Plateau and Hills Region – Pottangi)*

At Pottangi, the analyzed data revealed that the entry PGS-121(20.3 t ha<sup>-1</sup>) was the top yielder followed by PGS-95 (17.6 t ha<sup>-1</sup>) and PGS102 (15.7 t ha<sup>-1</sup>).

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

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

In IET for ginger consisting of seven entries, maximum yield was recorded in NDG-24 (15.33 t ha<sup>-1</sup>) followed by NDG-13 (15.0 t ha<sup>-1</sup>) and NDG-23 (13.22 t ha<sup>-1</sup>).

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

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

At Pundibari a wide range of variability was found among the genotypes for different with respect to growth and yield characters of different ginger genotypes (Table 12). Among the different genotypes, the highest yield was recorded in GCP-39 (11.76 t ha<sup>-1</sup>) and lowest in GCP-56 (7.94 t ha<sup>-1</sup>). The lowest rhizome root rot and fungal wilt disease severity was found in GCP-46 (11.72 PDI) followed by GCP-14 (13.75 PDI) and GCP-39 (14.17 PDI).

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

Genotype	Plant height (cm)	Tiller number	Rhizome yield/plot (kg/3m <sup>2</sup> )	Projected yield (t/ha)	Rhizome rot and wilt incidence (PDI)
GCP-51	74.44	9.53	4.67	9.41	20.37
GCP-56	61.45	8.27	3.94	7.94	24.56
GCP-5	64.04	8.73	4.95	9.99	15.55
GCP-46	71.09	9.87	4.30	8.67	11.72
GCP-30	76.74	10.20	4.57	9.22	17.54
GCP-36	77.70	11.40	4.11	8.28	14.87
GCP-39	68.37	10.33	5.83	11.76	14.17
GCP-14	60.86	9.60	4.91	9.89	13.75
SE(m)±	<b>1.87</b>	<b>0.41</b>	<b>0.16</b>	<b>0.32</b>	<b>0.58</b>
C.D. (P< 0.05)	<b>5.74</b>	<b>1.27</b>	<b>0.48</b>	<b>0.96</b>	<b>1.76</b>
CV%	<b>4.69</b>	<b>7.37</b>	<b>5.79</b>	<b>5.80</b>	<b>6.02</b>

The analyzed pooled data at Pottangi revealed that out of 25 entries, PGS-8 (11.8 t/ha) was the top yielder yield advantages of 11% over IISR Varada (10.6t/ha) followed by V<sub>1</sub>E<sub>4</sub>-5 (11.0 t/ha).

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

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

The trial was initiated with 7 genotypes (Gorubathane, Bold Nadia, Bhaise, Johns Ginger, PGS 121, PGS 95 & PGS102), At Nagaland, results revealed that PGS 121 produced maximum plant height (44.1 cm) and no of tillers (20.4) followed by Nadia and Gurubathane. Highest yield (22.05 t ha<sup>-1</sup>) was recorded with Nadia followed by Gurubathane and PGS 121. Highest fibre content, oleoresin and oil content were recorded in PGS 95 (10.6%, 10.20% and 3.6% respectively). At Gangtok, among all the varieties, PGS 121 performed better with 17.0 t ha<sup>-1</sup> followed by local cultivar Bhaise with 12.5 t ha<sup>-1</sup> (Table 13).

**Table 13. Performance of different varieties of bold and vegetable ginger at ICAR RC NEHR Sikkim Center**

Treatment	Sprouting percentage	Plant population at 50 DAS	Plant height (cm) at 50 DAS	Plant height (cm) at 120 DAS	Number of tillers per clump	Bacterial wilt	Fresh rhizome yield/plot (t/ha)	Dry rhizome yield/plot (t/ha)
Gorubathane	96.88	15.50	44.00	72.80	1.30	0.00	10.20	1.84
Bold Nadia	90.63	14.50	55.30	71.60	1.97	2.38	6.50	1.33
Bhaise	100.00	15.67	53.20	85.33	1.79	0.00	12.50	2.15
Johns Ginger	100.00	16.00	37.80	75.80	2.05	0.00	9.60	1.81
Pottangi PGS 121	96.88	15.67	56.20	82.87	2.28	0.00	17.00	2.97
Pottangi PGS 95	90.63	13.33	43.60	60.67	2.07	10.24	4.80	0.96
Pottangi PGS 102	100.00	15.33	52.60	70.73	2.55	12.64	9.00	1.63

## Crop Management

### GIN/CM/5 Nutrient Management Trial

#### GIN/CM/5.5 Source sink relationship

*(Centres: West Coast Plains and Ghat Region – Kozhikode; Middle Gangetic Plain Region – Kanke; Eastern Himalayan Region – Mizoram, Barapani; Middle Gangetic Plain Region – Pundibari; Western Himalayan Region - Solan)*

At Mizoram, all the growth parameters were recorded at 60 and 120 days after planting. Maximum no. of tillers/plant was found highest in IISR Mahima (3.33) at 60 DAP and in IISR Mahima (4.67) and Mizoram Local (4.67) in 120 DAP. Leaf area/plant (cm<sup>2</sup>) was found to be highest in Mizoram Local (147.67) at 60 days after planting, whereas IISR Mahima (266.67 cm<sup>2</sup>) recorded highest at 120DAP. Total dry weight/plant (g) was maximum in Gorubathane (12.33 and 29.73 g) both at 60 and 120 DAP. Rhizome fresh weight was maximum in IISR Mahima (31.30 g) at 60 DAP and Gorubathan (76.00 g) at 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.

From the data at Kanke centre, it was inferred that Mahima recorded maximum tiller per plant (5.8). IISR Mahima stood at first position with rhizome fresh weight (120.60 g) and dry weight (17.86 g) of rhizome at harvest, followed by rhizome fresh and dry weight of (105.0 g and 16.6 g), (91.80 and 16.84 g) and (79.54 g and 15.2 g), respectively in Ranchi Local, GCP-5 and Mizoram Local, respectively.

At Pundibari, the genotype Mahima produced the highest fresh yield (13.35 t ha<sup>-1</sup>) and highest dry yield of 1.48 kg plot<sup>-1</sup> followed by Nadia (fresh yield of 12.52 t/ha) and it was lowest in Himgiri (fresh yield of 9.60 t ha<sup>-1</sup>). At Barapani, the observations were recorded at 60, 120, 180 DAP and at harvest stage. Highest fresh rhizome weight at 60 days (14.28 g plant<sup>-1</sup>), 120 DAP (93.57 g plant<sup>-1</sup>), 180 DAP (147.59 g plant<sup>-1</sup>) and at harvest (271.61 g plant<sup>-1</sup>) were recorded in Nadia. Biochemical parameters viz, oil, oleoresin and starch were analysed at 120, 180 DAP and at harvest. In general, oil and oleoresin were more in Gorubathane at all stages while IISR Mahima had more starch compared to other varieties at different centres. But the pattern varied in different centres.

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

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

At Barapani, maximum yield of 22.99 t ha<sup>-1</sup> was recorded in T<sub>5</sub> (75% N requirement of ginger from FYM + micronutrients) followed by 20.94 t ha<sup>-1</sup> in T<sub>1</sub> (100% organic manures equivalent to 100% N requirement of ginger). Highest dry recovery of 20.03% was recorded in T<sub>5</sub> (75% N requirement of ginger from FYM + micronutrients). T<sub>6</sub> (75% N requirement of ginger + vermiwash 10%) had the highest fibre content of 3.91%. Highest oleoresin content (4.31%) was recorded in T<sub>7</sub> (Recommended Package by SAU).

At Mizoram, The maximum yield was recorded in T<sub>7</sub> (recommended package by SAU; ginger-NPK100:90:90 kg ha<sup>-1</sup>), with a yield of 152.88 q/ha, followed by T<sub>3</sub> (100% organic manure + (micronutrients) with a yield of 14.24 t ha<sup>-1</sup>, T<sub>8</sub> (farmers practice) with a yield of 14.09 t ha<sup>-1</sup>. Moreover, dry matter content was found to be highest in T<sub>6</sub> (75% N requirement of ginger + Vermiwash 10%); dry recovery 20.40% followed by T<sub>5</sub> (75% N requirement of ginger + micronutrients); dry recovery 20.30%, and T<sub>8</sub> (dry recovery 20.20%). The maximum fresh weight of clump was recorded in T<sub>7</sub> (111.90 g plant<sup>-1</sup>), followed by T<sub>6</sub> (106.13 g plant<sup>-1</sup>) and T<sub>2</sub> (105.50 g plant<sup>-1</sup>) (Table 14).

**Table 14. Growth and quality parameter recorded in organic trial on ginger at Barapani and Mizoram**

Treatment	Fresh weight of clump (g)		Yield (t/ ha)		Dry Recovery (%)	
	Barapani	Mizoram	Barapani	Mizoram	Barapani	Mizoram
T <sub>1</sub>	245.00	103.03	20.94	13.73	19.64	18.30
T <sub>2</sub>	187.33	105.50	13.30	11.64	19.47	19.43
T <sub>3</sub>	272.33	101.80	20.59	14.24	19.83	20.03
T <sub>4</sub>	230.67	95.40	19.23	12.00	19.96	18.90
T <sub>5</sub>	283.67	96.10	22.99	11.10	20.03	20.30
T <sub>6</sub>	257.33	106.13	20.87	11.71	19.85	20.40
T <sub>7</sub>	224.33	111.90	19.82	15.29	19.78	19.80
T <sub>8</sub>	208.33	96.33	14.79	14.09	19.45	20.20
CD	12.39	3.69	1.67	19.33	0.07	2.31

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

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

At Chintapalle, foliar application of IISR micro nutrient mixture showed marked increase in rhizomes yield per hectare as compared to control. Among the treatments T2 (Nadia + IISR micro nutrients application) recorded maximum plant height (64.91 cm), fresh weight of rhizome (320.40 g), yield/ha (24.54 t ha<sup>-1</sup>) followed by T1 (Nadia). The highest dry recovery was observed in T6 (Surabhi+ IISR micro nutrients application) (21.11%) followed by T5 (20.66%). Highest fresh rhizome yield of 20.5 t ha<sup>-1</sup>, 21.3t/ha and 21.1 t ha<sup>-1</sup> in Suprabha, Suravi and IISR Varada, respectively with the yield advantages of 10.4% , 10.1% and 9.8% of T1 over T2 were recorded at Pottangi.

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

(Centres: Middle Gangetic Plain Region - Dholi)

The three years pooled data revealed that among sixteen treatments and one control, ten treatments recorded significantly higher yield as compared to control (4.93 t ha<sup>-1</sup>) except in T<sub>1</sub>- NPK (80:50:80 kg ha<sup>-1</sup>), T<sub>2</sub>- NPK (80:50:80 kg ha<sup>-1</sup>) + *Azotobacter* @10 kg ha<sup>-1</sup>, T<sub>3</sub>- NPK (80:50:80kg ha<sup>-1</sup>) + *Trichoderma* @10 kg ha<sup>-1</sup>, T<sub>4</sub>- NPK (80:50:80 kg ha<sup>-1</sup>) + PSB @10 kg ha<sup>-1</sup>, T<sub>5</sub>- Vermicompost @10 t ha<sup>-1</sup> and T<sub>14</sub> - Sewage sludge @25 t ha<sup>-1</sup>) + *Azotobacter* @10 kg ha<sup>-1</sup>. However, among the treatments, T<sub>12</sub> - FYM @ 30 tha<sup>-1</sup> + PSB @10 kg ha<sup>-1</sup> recorded the highest yield (11.85 t ha<sup>-1</sup>) followed by T<sub>11</sub> - FYM @30 t ha<sup>-1</sup> + *Trichoderma* @10 kg ha<sup>-1</sup> (11.16 t ha<sup>-1</sup>) and T<sub>7</sub>- Vermicompost @10 t ha<sup>-1</sup> + *Trichoderma* @10 kg ha<sup>-1</sup> (10.70 t ha<sup>-1</sup>) (Table 15).

**Table 15. Effect of organic manures and bio-fertilizers on pertaining of dry matter of ginger for the year 2016-17 to 2018-19 (Three years pooled)**

Treatments	Plant neight (cm)	No. of tillers per plant	No. of leaves per tiller	Yield (t ha <sup>-1</sup> )
T <sub>1</sub> - N.P.K (80:50:80kg ha <sup>-1</sup> )	61.38	43.53	22.68	7.33
T <sub>2</sub> - T <sub>1</sub> + <i>Azotobacter</i>	65.23	45.97	22.27	7.50
T <sub>3</sub> - T <sub>1</sub> + <i>Trichoderma</i>	67.41	48.27	22.09	6.37
T <sub>4</sub> - T <sub>1</sub> + PSB	65.86	47.22	21.86	7.01
T <sub>5</sub> - Vermicompost (10t ha <sup>-1</sup> )	66.96	47.33	23.58	7.09
T <sub>6</sub> - T <sub>5</sub> + <i>Azotobacter</i>	70.27	47.94	25.04	8.68
T <sub>7</sub> - T <sub>5</sub> + <i>Trichoderma</i>	74.21	49.42	27.87	10.70
T <sub>8</sub> - T <sub>5</sub> + PSB	73.53	48.73	26.93	9.54
T <sub>9</sub> - FYM (30t ha <sup>-1</sup> )	71.67	55.30	28.39	9.39
T <sub>10</sub> - T <sub>9</sub> + <i>Azotobacter</i>	77.73	57.14	29.08	10.15
T <sub>11</sub> - T <sub>9</sub> + <i>Trichoderma</i>	89.43	65.95	32.28	11.16
T <sub>12</sub> - T <sub>9</sub> + PSB	81.00	61.98	30.03	11.85
T <sub>13</sub> - Sewage sludge (25t ha <sup>-1</sup> )	64.89	48.07	25.17	8.30
T <sub>14</sub> - T <sub>13</sub> + <i>Azotobacter</i>	70.88	51.18	26.58	7.60
T <sub>15</sub> - T <sub>13</sub> + <i>Trichoderma</i>	74.27	50.87	27.51	8.24
T <sub>16</sub> - T <sub>13</sub> + PSB	70.41	53.23	27.28	8.08

T <sub>17</sub> - Control	47.24	32.70	18.50	4.93
SEm (±)	2.90	3.71	1.72	1.06
CD (P=0.05)	8.13	10.68	4.97	3.04
CV (%)	<b>7.14</b>	<b>9.07</b>	<b>8.30</b>	21.61

### GIN/CM/5.9 Organic production of ginger

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

At Ambalavayal, variety Maran recorded the maximum yield of 24.00 t/ha and 25.50 t/ha in IISR organic package and KAU organic package respectively. Between two organic package (IISR organic package and RPCAU, Bihar organic package), both organic package were on par. Among the three varieties evaluated at Dholi, (Nadia, Surabhi and Suprabha), all the varieties were par for yield. Between two organic packages (IISR organic package and RPCAU, Bihar organic package), both organic packages were also on par. At Kumarganj, organic production trial, the maximum yield was observed in V1T3 treatment (14.75 t ha<sup>-1</sup>) followed by V2T3 (13.00 t ha<sup>-1</sup>) and V3T3 (12.67 t ha<sup>-1</sup>).

In organic production of ginger trial at Pundibari, The highest fresh yield of ginger was recorded in Nadia (11.58 t ha<sup>-1</sup>) followed by GCP-5 (10.95 t ha<sup>-1</sup>). Organic package developed by IISR recorded the highest yield (11.30 t/ha). Considering the interaction effect, it was found that Nadia cultivar along with organic package developed by IISR recorded the highest fresh yield (11.73 t ha<sup>-1</sup>). Dry recovery percentage, varied significantly among the varieties but organic package of practices had no influence. Among the cultivar the lowest wilt incidence was recorded in GCP-5 (21.22%) and organic package developed by IISR recorded the lowest wilt incidence (20.23%). At Kalyani, O<sub>1</sub>V<sub>2</sub> (organic package developed by IISR + Nadia) recorded highest plant population (38.5). Number of tillers per clump was recorded highest (18.75) in O<sub>2</sub>V<sub>3</sub> (recommended package by SAU + Suprabha) treatment. O<sub>2</sub>V<sub>1</sub> (recommended package by SAU + Gorubathane) recorded maximum plant height (58.96 cm). O<sub>2</sub>V<sub>2</sub> (recommended package by SAU + Nadia) recorded highest fresh yield per clump (248.54 g) and highest estimated yield per hectare (18.55).

At Chintapalle, among the treatments, T2 (Nadia + Inorganic) recorded the maximum plant height (62.05 cm), fresh weight of rhizome (230.38 g), yield/ha (23.16 t/ha) and dry recovery percentage (22.25) followed by T1 (Nadia + IISR OPP). The lowest yield was recorded in Treatment T5 (CTPL Local + IISR OPP) (13.18 t ha<sup>-1</sup>).

At Raigarh, among the varieties, V1 (Local) recorded maximum plant population (87.44%), plant height (35.02 cm), number of leafs per plant (3.54), rhizome weight per plant (39.26 g), number of primary and secondary rhizome (3.48 and 5.34, respectively) and yield (7.82 t/ha). T1 (organic package developed by IISR) recorded maximum number of tillers per plant (2.82), number of leafs per plant (3.83), rhizome weight per plant (40.82 g), number of primary and secondary rhizome (3.45 and 5.61, respectively) and yield (6. 6.8 t ha<sup>-1</sup>). Both the treatments are statistically at par with each other.



In Mizoram, maximum yield was recorded in T<sub>2</sub> (100% organic manure equivalent to 75% N requirement of turmeric), with and yield of 352.43 q/ha, followed by T<sub>1</sub> with an yield of 34.06 t ha<sup>-1</sup> and T<sub>5</sub> with an yield of 33.54 t ha<sup>-1</sup>. Dry recovery was found to be highest in T<sub>4</sub> (17.51%) followed by T<sub>1</sub> (17.25%) and T<sub>3</sub> (16.65%). At Barapani, three genotypes of ginger viz. Jorhat, Suprabha and Hiching were evaluated for study (Table 16). Maximum yield of 25.51 t ha<sup>-1</sup> (Hiching), 14.87 t ha<sup>-1</sup> (Suprabha) and 13.58 t ha<sup>-1</sup> (Jorhat) were recorded in T<sub>2</sub> (recommended package by SAU). T<sub>1</sub> (organic package developed by IISR) recorded higher oleoresin content in all the three varieties.

**Table 16. Observations recorded for Organic production of ginger at Barapani**

Variety	Treatment	No. of Tillers	Fresh weight of clump (g)	Yeild (t/ha)	Dry Recovery (%)	Fiber Content (%)	Oleoresin Content (%)
Hiching	T <sub>1</sub>	3.00	204.33	18.18	18.45	4.65	3.95
	T <sub>2</sub>	3.33	241.67	25.51	18.27	4.96	3.92
	CD (5%)	<b>0.01</b>	<b>31.23</b>	<b>7.11</b>	<b>0.10</b>	<b>0.03</b>	<b>0.02</b>
Suprabha	T <sub>1</sub>	3.00	181.00	12.66	21.84	6.07	3.67
	T <sub>2</sub>	3.33	191.00	14.87	21.70	6.17	3.59
	CD (5%)	<b>0.01</b>	<b>0.12</b>	<b>0.19</b>	<b>0.08</b>	<b>0.04</b>	<b>0.03</b>
Jorhat	T <sub>1</sub>	3.00	132.33	9.38	17.67	6.32	3.71
	T <sub>2</sub>	2.67	160.67	13.58	17.21	6.43	3.69
	CD (5%)	<b>0.16</b>	<b>27.84</b>	<b>1.86</b>	<b>0.05</b>	<b>0.08</b>	<b>0.01</b>

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

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

At Dholi, among three varieties viz., Nadia, IISR Varada & Surabhi, Nadia produced significantly higher yield (12.66 t ha<sup>-1</sup>) as compared to Surabhi and IISR Varada (10.48 & 7.20 t ha<sup>-1</sup> respectively). Between two packages of micro-nutrients (IISR & RPCAU), micro-nutrient package of IISR showed significantly higher yield (10.94 t ha<sup>-1</sup>) compared to micro-nutrients package of RPCAU (9.28 t ha<sup>-1</sup>). At Ambalavayal, two micro-nutrients package in above three varieties were at par. At Kumarganj, maximum yield was observed in V1T3 treatment (13.83 t ha<sup>-1</sup>) followed by V2T3 (12.25 t ha<sup>-1</sup>) and V3T3 (12.08 t ha<sup>-1</sup>). At Pundibari, highest fresh yield of ginger was recorded in Nadia (13.10 t ha<sup>-1</sup>) followed by GCP-5 (11.36 t ha<sup>-1</sup>). Micronutrient package developed by IISR recorded the significantly highest yield (12.38 t ha<sup>-1</sup>). In Kalyani, M<sub>2</sub>V<sub>2</sub> (recommended package of practice + IISR ginger micronutrient two sprays 60 and 90 days after planting @ 5g/litre + Nadia) recorded highest plant population (38.75), number of tillers per clump (18.25), fresh yield per clump (252.24 g) and estimated yield per hectare (19.77 t ha<sup>-1</sup>). In Pottangi, highest fresh rhizome yield of 20.5 t ha<sup>-1</sup>, 21.3 t ha<sup>-1</sup> and 21.1 t ha<sup>-1</sup> in Suprabha, Suravi and IISR Varada, was recorded respectively with the yield advantages of 10.4%, 10.1% and 9.8% of T1 over

T2. In Raigarh, both the treatments were statistically at par with each other for all the observations except plant height, number of tillers per plant and number of primary rhizome. At Barapani, recommended package of practice along with IISR micronutrients (T<sub>2</sub>) produced higher yield of 24.66 t/ha, 20.76 t ha<sup>-1</sup> and 21.55 t ha<sup>-1</sup> in Hiching, Himgiri and Nadia, respectively. Also the oleoresin content was higher in T<sub>2</sub> (recommended package of practice+IISR micronutrients) in all the varieties. Foliar application of IISR micro nutrient mixture showed marked increase in rhizomes yield per hectare at Chintapalle as compared to control. Among the treatments T2 (Nadia + IISR micro nutrients application) recorded maximum plant height (64.91 cm), fresh weight of rhizome (320.40 g), yield/ha (24.54 t/ha) followed by T1 (Nadia). The highest dry recovery was observed in T6 (Surabhi+ IISR micro nutrients application) (21.11%) followed by T5 (20.66%). Foliar application of IISR micro nutrient mixture showed marked increase in rhizome yield per hectare as compared to control at Ambalavayal.

## Crop Protection

### GIN/CP/6 Disease management trial

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

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

Eight treatments were tested. T-7 (Soil solarization+plastic mulching+ neem oil) recorded highest yield (32.8 t ha<sup>-1</sup>) followed by T-5 (Soil solarization+ neem oil) (28.2 t ha<sup>-1</sup>) and T-6 (Plastic mulching+ neem oil) (25.7 t ha<sup>-1</sup>).

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

*(Centre: Western Plateau and Hills Region – Dapoli)*

Ten varieties of ginger were screened against leaf spot and rhizome rot separately and recorded their yield accordingly during 2015-16 to 2017-18. All nine varieties were observed resistant except Athira which was found moderately resistant against leaf spot disease. Whereas, against rhizome rot two varieties were moderately resistant and remaining were found tolerant. All the varieties performed well for yield but on the basis of percent disease intensity, the varieties IISR Rejatha and IISR Mahima were found superior over other varieties.

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

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

Experiment was conducted with three genotypes viz. Himgiri, Nadia and Hiching at Barapani. For Himgiri and Hiching the highest yield was recorded in T<sub>5</sub> (POP) while for Nadia highest yield (30.79 t ha<sup>-1</sup>) is recorded in T<sub>4</sub> (POP + GRB 35 capsule) with 22.18 t ha<sup>-1</sup> and 29.92 t ha<sup>-1</sup> respectively. Oleoresin content was highest in T<sub>5</sub> (POP) in Nadia (3.53%) and Hiching (5.04%) (Table 17).

**Table 17. Effect of biocapsules on growth and yield of ginger at Barapani**

Variety	Treatment	Fresh weight of clump (g)	Yield (t ha <sup>-1</sup> )	Dry Recovery (%)	Fiber Content (%)	Oleoresin Content (%)
Himgiri	T <sub>1</sub>	214.00	14.50	16.21	4.81	4.09
	T <sub>2</sub>	232.67	13.18	16.47	4.74	4.17
	T <sub>3</sub>	212.00	17.67	16.36	4.87	4.05
	T <sub>4</sub>	204.00	8.83	16.24	4.95	4.03
	T <sub>5</sub>	262.67	22.18	16.38	4.84	4.15
	<b>CD (5%)</b>	<b>5.31</b>	<b>2.25</b>	<b>0.04</b>	<b>0.02</b>	<b>0.01</b>
Nadia	T <sub>1</sub>	208.33	17.11	19.95	3.50	4.33
	T <sub>2</sub>	240.00	27.99	20.17	3.43	4.38
	T <sub>3</sub>	237.67	29.84	20.26	3.52	4.35
	T <sub>4</sub>	254.33	30.79	19.90	3.45	4.36
	T <sub>5</sub>	260.67	23.69	19.81	3.53	4.37
	<b>CD (5%)</b>	<b>10.59</b>	<b>2.10</b>	<b>0.02</b>	<b>0.02</b>	<b>-</b>
Hitching	T <sub>1</sub>	204.33	16.80	18.73	5.02	4.05
	T <sub>2</sub>	216.00	21.37	18.89	4.92	4.13
	T <sub>3</sub>	224.33	21.19	18.56	4.95	4.10
	T <sub>4</sub>	233.33	18.14	18.49	4.93	4.06
	T <sub>5</sub>	239.00	29.92	18.33	5.04	4.01
<b>CD (5%)</b>	<b>7.79</b>	<b>2.13</b>	<b>0.03</b>	<b>0.02</b>	<b>0.01</b>	

At Raigarh, POP+ *Trichoderma* (talk formulation) + GRB 35 (talk formulation) recorded highest yield and lowest disease incidence (13.14 t ha<sup>-1</sup> and 13.04%) respectively. In interaction, local variety with treatment was best and rest of the treatments had non-significant effect. At Solan, in all the three genotypes, combined treatments of *Trichoderma* and GRB 35 talc formulation were found superior in increasing the plant growth parameters and reducing the incidence of rhizome rot over other treatments. The talc formulation of *Trichoderma* in combination with talc formulation of GRB-35 resulted in highest germination (86.32%) in LC-1 followed by Himgiri (85.67%) and LC-2 (85.36%). Similarly, combined talc formulations resulted in highest number of tiller per plant, height, yield and other biochemical parameters in all three genotypes and reduced incidence of rhizome rot. At Ambalavayal, 1 and T2 were found to be best and suitable cultivation practice of ginger. In Nadia T2 ((POP + *Trichoderma* capsule + GRB 35 capsule) recorded the highest yield (20.13 t ha<sup>-1</sup>), in Suprabha T1 (POP + *Trichoderma* talc + GRB 35 talc) recorded the highest yield (14.73 t ha<sup>-1</sup>) where as in Suravi T5 (POP) recorded the highest yield (13.32 t ha<sup>-1</sup>) at Chintapalle. In Kalyani, P<sub>2</sub>V<sub>2</sub> (*Trichoderma* capsule + GRB 35 capsule + Nadia) recorded highest plant population (38.75), fresh yield per clump (241.79 g) and estimated yield per hectare (20.58t). P<sub>2</sub>V<sub>3</sub> (*Trichoderma* capsule + GRB 35 + Suprabha) recorded maximum number of tillers (15). At Kumarganj, the evaluation of PGPR bio-capsule the maximum yield was observed in V1T2 treatment (13.58 t ha<sup>-1</sup>) followed by V3T2 (13.25 t ha<sup>-1</sup>) and V2T2 (12.5 t ha<sup>-1</sup>). At Pundibari, lowest rhizome rot and wilt % were recorded with the capsule formulation of *Trichoderma* and GRB 35 for all the varieties (0, 0, and 0.83%) for Gorubathane, Nadia and Pundibari local respectively). Highest yield was recorded with capsule formulation of *Trichoderma* and GRB 35 in case of Nadia and TCP2 (13.17 t ha<sup>-1</sup>). In case of Gorubathane and Pundibari Local highest yield was recorded with talc formulation of *Trichoderma* and GRB 35 (11.52 t ha<sup>-1</sup> and 11.94 t ha<sup>-1</sup>

respectively). At Pottangi, percent disease intensity significantly reduced from 27.41 (control) to 6.21 and highest rhizome yield was observed (17.8 t ha<sup>-1</sup>) in treatment T5 (Tricho power liquid @ 5 ml/l).

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

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

At Solan, in solarised treatments, calcium chloride treatment recorded the highest sprouting percentage and plant population after 50 days of planting followed by copper oxychloride. Calcium chloride treatment also resulted in highest plant height, number of tillers per clump, fresh rhizome yield and dry rhizome yield. This treatment also recorded highest dry recovery, fibre content, oleoresin, essential oil and minimum incidence of rhizome rot. However, in non solarised treatments, biocontrol agent recorded the highest sprouting percentage and other growth and yield parameters and minimum incidence of rhizome rot. At Sikkim, treatment (*Bacillus* + solarization) showed higher yield (5.48 t ha<sup>-1</sup>) than others despite higher infection of bacterial wilt 4.08% (Table 18). It was followed by treatment (CaCl<sub>2</sub> + non-solarization). This result suggests the complimentary role of soil solarization with *Bacillus* spp. in enhancement of yield through better plant growth.

**Table 18. Evaluation of organic treatment against Bacterial wilt of ginger at Sikkim**

Treatment	Sprouting percentage	Number of tillers clump <sup>-1</sup>	Bacterial wilt (%)	Fresh yield (t ha <sup>-1</sup> )	Dry yield (t ha <sup>-1</sup> )
CaCl <sub>2</sub> + Solarization	83.50	2.76	2.86	4.76	0.82
CaCl <sub>2</sub> + Non-solarization	80.50	2.92	1.54	4.44	0.74
Bacillus + Solarization	75.50	2.64	4.08	5.48	1.05
Bacillus + Non-solarization	78.00	2.68	0.00	3.88	0.70
CoC + Solarization	82.50	2.72	1.72	5.10	0.98
CoC + Non-solarization	81.00	2.72	2.22	4.20	0.74

CoC-Copper oxy chloride (recommended dose), CaCl<sub>2</sub> (Calcium chloride 3%)

At Nagaland, the plants under treatment T1 (CaCl<sub>2</sub> @3%) and T<sub>2</sub> (Bio control agent) under Solarization plots did not infested with bacterial wilt in comparison to other treatments for the cultivar Nadia.



**Fig 5. Field view of management of bacterial wilt of ginger at Nagaland**

At Pasighat centre, solarisation treatment (M1) recorded significantly higher number of tillers per plant (5.08), dry rhizome yield per hectare (2.84 t ha<sup>-1</sup>) and dry recovery (22.95%) as compared to non-solarisation (M2). The fresh weight of clump, fresh and dry rhizome yield of ginger recorded maximum in T1 which remained at par to T2 but significantly superior to T3. However, dry recovery (%) of ginger did not differ significantly among the three treatments. The incidence of disease was significantly higher in non-solarisation (M2) compared to solarisation (M1) (Table 19) However, the shoot borer incidence did not differ significantly between the two treatments. The minimum disease incidence was observed in T1 which remained at par to T2. The maximum disease incidence was recorded in T3. Maximum shoot borer incidence was found in T3 and the minimum in T1.

**Table 19. Variation in growth and yield characters in different treatments at Pasighat**

Treatment	No. of tillers/ plant	Fresh wt. of clump (g)	Fresh rhizome yield (t ha <sup>-1</sup> )	Dry rhizome yield (t ha <sup>-1</sup> )	Dry recovery (%)
M1 (Solarization)	5.08	117.20	12.88	2.84	22.95
M2 (Non-Solarization)	4.32	111.22	11.91	2.37	20.27
SEm±	0.165	4.279	0.391	0.11	0.546
CD <sub>0.05</sub>	<b>0.501</b>	<b>NS</b>	<b>NS</b>	<b>0.335</b>	<b>1.66</b>
T1 (Chemical)	5.21	128.92	14.30	3.11	21.85
T2 (Biocontrol agent)	5.85	126.88	13.92	3.06	21.98
T3 (Control)	3.04	86.83	8.98	1.65	21.00
SEm±	0.202	5.24	0.479	0.135	0.668
CD <sub>0.05</sub>	<b>0.613</b>	<b>15.94</b>	<b>1.458</b>	<b>0.41</b>	<b>NS</b>
SEm± (TxV)	0.285	7.411	0.678	0.191	0.945
CD <sub>0.05</sub> (TxV)	<b>NS</b>	<b>NS</b>	<b>NS</b>	<b>NS</b>	<b>NS</b>
CV %	12.13	12.98	10.93	14.65	10.24

The low wilting (8.4%) and high fresh rhizome yield (17.2 t ha<sup>-1</sup>) was highest in treatment T<sub>3</sub> (rhizome treatment with mancozeb @ 3g/l along with carbendazim @ 1g/l and streptomycin @ 1g/l and foliar spray at 45 DAS and 90 DAS) followed by T<sub>1</sub> (bacterial consortia).

In Dholi, bacterial wilt incidence was found significantly low in all the soil solarization treatments compared to non-soil solarization. However, significantly lowest incidence of bacterial wilt (14.34%) was recorded in treatment, soil solarization treatment of RPCAU POP. All the treatments were found to enhance yield significantly over control. However, significantly highest yield of 87.99 q/ha was recorded in the same treatment which registered lowest disease incidence (soil solarization treatment of RPCAU POP).

## IV. Turmeric

### Genetic resources

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

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

A total of 275 genotypes are conserved at Coimbatore and all the genotypes were evaluated and characterized. Statistical analysis of data revealed wide variations for growth, yield and quality parameters. At Kammarpally, 280 turmeric germplasm accessions are conserved. All the DUS characters were recorded in germplasm accessions. During 2018-19, Nizamabad Local (62.34 t/ha), Chennur Local (62 t/ha), NDH-4 (61.69 t/ha), NDH-9 (62.13 t/ha) and JTS-332 (60.69 t/ha) were superior compared to local check Duggirala Red (43.25 t/ha) and IISR Prathibha- national check (59.92 t/ha). These accessions were also screened against major foliar diseases.

Out of 67 accessions maintained at Dholi, only fourteen accessions recorded higher yield ranging from 50.25 to 54.17 t ha<sup>-1</sup> compared to check variety Rajendra Sonia (49.83 t ha<sup>-1</sup>) and eight accession compared to Rajendra Sonali (52.33 t ha<sup>-1</sup>). RH-421 recorded highest yield (54.17 t ha<sup>-1</sup>) followed by RH-2 (53.33 t ha<sup>-1</sup>).

At Kumarganj, 180 accessions are maintained and were evaluated. Maximum yield was recorded in NDH-74 (275 g/plant) followed by NDH-86 (265 g/plant) among early maturing, NDH-98 (290 g/plant) followed by NDH-78 (268 g/plant) among medium and NDH-8 (270 g/plant) followed by NDH-2 (265 g/plant) among late maturing types. At Pundibari, 176 germplasm accessions are maintained. Five genotypes showed above 40 t/ha yield, 16 genotypes showed 31 t/ha to 40 t/ha and 22 genotypes showed 25 t/ha to 30 t/ha. With respect to disease resistance, 28 accessions showed low leaf blotch (PDI 0.00 to 15) and 27 showed low leaf spot (PDI 0.00 to 15) disease incidence.

The Guntur centre has maintained 280 turmeric germplasm accessions out of which, forty eight were evaluated during 2018-19. Among them, only seven accessions i.e. Kasturi (665.4 g), KTS-18 (561.4 g), KTS-5 (537.4 g), CLI-328 (53.6.4 g), CL-5 (533.4 g), SLM-1 (531.4 g) and IC-211641 (527.4 g) recorded significantly higher clump weight compared to the best check Tekurpet (480.5 g). At Pasighat, Fifty two diverse genotypes were collected from entire north east region and among them, the maximum fresh rhizome yield per plant was recorded in genotype CHFT-8 (351.50 g), which was statistically at par with CHFT-4 (341.60 g), CHFT-40 (336.30 g), and CHFT-103 (345.70g) but significantly higher to the other genotypes. The maximum rhizome yield per plot was found in CHFT-8 (11.95kg) which was at par with genotypes CHFT-4, CHFT -16, CHFT-24, CHFT-36, CHFT-40, CHFT- 52, CHFT-102 and CHFT-103.

Among 179 turmeric accessions evaluated in 2018-19 at HARS, Pottangi, 152 were *Curcuma longa*, 23 were *Curcuma aromatic* and 4 were *Curcuma amada*. Out of 152 *Curcuma longa* accessions 77 accessions recorded more than 5 kg/3m<sup>2</sup> fresh rhizome yield. Fresh rhizome yield per plot in *C. longa* varied from 1.5 kg/3 m<sup>2</sup> to 8.6 kg/3m<sup>2</sup> with the mean of 5.2 kg/3m<sup>2</sup> among and CLS-20 (8.6 kg/3m<sup>2</sup>), VK-5 (8.5 kg/3m<sup>2</sup>), PTS-60 (8.3 kg/3m<sup>2</sup>) and Tu-3 (8.2 kg/3m<sup>2</sup>) were the best yielders. In *Curcuma aromatica*, fresh rhizome yield varied from 1.4 kg/3 m<sup>2</sup> to 8.0 kg/3 m<sup>2</sup>. Among 23 accessions, 12 accessions recorded more than 5 kg/3m<sup>2</sup> fresh rhizome yield.

A total of 86 genotypes were evaluated at Raigarh. IT 34 recorded maximum rhizome yield (28.2 ton/ha) followed by IT 35 (25.7 ton/ha) and IT 20 (24.8 ton/ha) over all the national checks

BSR 2 (19.2 ton/ha), Narendra Haldi (12.2 ton/ha), Roma (12 ton/ha), IISR Prathibha (12 ton/ha) and Suranjana (10 ton/ha). Thirty two genotypes (IC-586749 to IC-586780) are maintained and all were evaluated at Barapani. IC-586773 recorded the maximum yield with 63.33 t ha<sup>-1</sup> and IC-586762 had highest curcumin content of 6.48%. Highest oleoresin content was recorded in IC-586771 (19.46%).



**Fig. 6. a) Field view of turmeric germplasm conservation at Kamarapally; b) Experimental Plot at Barapani**

**Table 20. Turmeric germplasm collections maintained at various AICRPS centres**

Centre	Indigenous			Exotic Existing	Total
	Cultivated		Wild and related species Existing		
	Existing	Addition (2018-19)			
Coimbatore	275	-	-	-	275
Dholi	67	-	-	-	67
Kammarpally	280	-	-	-	280
Kumarganj	180	-	-	-	180
Pantnagar	52	-	-	-	52
Pasighat	50	-	2	-	52
Pottangi	155	-	24	-	179
Pundibari	170	-	-	-	170
Raigarh	86	-	-	-	86
Guntur	280	-	-	-	280
<b>Total</b>	<b>1595</b>	<b>-</b>	<b>26</b>	<b>-</b>	<b>1621</b>

## Crop Improvement

### TUR/CI/2 Coordinated Varietal Trial

#### TUR/CI/2.6 CVT on Turmeric 2016

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

At Chintapalle, it was observed that among the genotypes the maximum plant height was recorded in IT 10 (149.15 cm) followed by Roma (134.58 cm) and the highest number of tillers per plant was

recorded in TCP-191 (2.80). IT-36 recorded the highest fresh weight per plant (508.13 g), yield per plot (12.66 kg) and yield (37.97 t ha<sup>-1</sup>). Dry recovery % was highest in PTS-2 (27.87) followed by LTS-2 (27.40%) and Roma (26.20%). At Coimbatore, among twelve genotypes, PTS 38 recorded maximum plant height (56.48 cm) whereas the lowest plant height was recorded IISR Prathiba (38.40 cm). The fresh rhizome yield per plot (3 m<sup>2</sup>) ranged from 8.32 kg in RH 80 to 12.37 kg in NDH 11. The accession LTS- 2 recorded the highest dry recovery (27.20 %) with an estimated yield of 40.92 t ha<sup>-1</sup>. Among 16 genotypes, NDH-11 (37.50 t ha<sup>-1</sup>) and recorded highest fresh rhizome yield followed by IT-36 ( 34. t ha<sup>-1</sup>) in comparison to Duggirala Red- state check (25.9 t ha<sup>-1</sup>) and IISR Prathibha- national check (32.6 t ha<sup>-1</sup>) at Kammarpally.

During the year among the entries evaluated at Guntur, LTS-20 (48.9 t ha<sup>-1</sup>), GLP-2 (41.9 t ha<sup>-1</sup>), PTS-4 (37.7 t ha<sup>-1</sup>), CL-15 (36.8 t ha<sup>-1</sup>) and AC-94 (34.8 t ha<sup>-1</sup>) recorded significantly higher yield over the check Mydukur (29.6 t ha<sup>-1</sup>). At Dholi, the three years pooled data revealed that RH-9/90 and RH-80 (57.98 t ha<sup>-1</sup> and 53.13 t ha<sup>-1</sup> respectively) were significantly superior compared to national check IISR Prathibha (34.32 t ha<sup>-1</sup>) and statistically at par with local check Rajendra Sonali (49.05 t ha<sup>-1</sup>). At Kumarganj, three years pooled data revealed that maximum rhizome yield was recorded in LTS-1 (26.11 t ha<sup>-1</sup>) followed by NDH-128 (25.22 t/ha) and NDH-11 (24.33 t ha<sup>-1</sup>). Maximum leaf spot disease severity was found in IT-36 (12%) followed by LTS-2 (11%) and TCP-191 (08%). Whereas maximum leaf blotch was recorded in IT-36 (13%) followed by LTS-1 (12%) and IT-23 (10%). At Pundibari, highest projected yield was recorded in TCP-191 (39.78 t ha<sup>-1</sup>) followed by IT-10 (25.07 t ha<sup>-1</sup>). TCP-191 and LTS-1 showed no leaf blotch followed by LTS-2 (7.84 PDI). The lowest leaf spot disease severity was found in TCP-191 (0.00 PDI) followed by LTS-1 (5.93 PDI) and it was highest in RH-9/90 (15.92). At Navsari, IT-36 (26.17 t ha<sup>-1</sup>) and IT-23 (26.67 t ha<sup>-1</sup>) were superior with respect to fresh rhizome yield over national check IISR Prathibha (Table 21).

**Table 21. Performance of rhizome characters in turmeric, Navasari**

Entry	Rhizome yield (t/ha)	Rhizome weight (g)	Rhizome length (cm)	Rhizome width (cm)	No. of mother rhizomes	No. of finger rhizomes
IT-36	8.99	280.00	13.00*	15.07	3.60	16.93
IT-23	12.78	290.00	13.00*	15.27	4.20	21.40
IT-10	10.89	298.33	13.13*	13.60	4.13	23.47
LTS-1	15.05	292.33	13.80*	14.33	4.40	22.80
LTS-2	19.63*	358.33*	14.80*	16.00*	5.07*	25.73
TCP-191	7.00	190.00	9.80	13.00	3.53	17.07
NDH-11	11.31	280.00	12.40	14.53	4.53	16.00
NDH-128	9.77	320.00*	12.27	14.07	5.33*	20.00
Pratibha	15.93	205.00	10.40	13.40	4.07	20.33
GNT-1	17.65	401.67	15.00	16.20	5.07	25.80
GNT-2	21.17	326.67	14.60	15.00	5.87	22.13
SEm (±)	1.13	32.56	0.76	0.64	0.32	1.93
CD	3.35	96.06	2.24	1.89	0.94	5.71
CV %	14.39	19.13	10.17	7.62	12.24	15.91

At Pottangi, PTS-18 (15.2 t ha<sup>-1</sup>) was the top yielder with the yield advantages of 23.6% than the national check IISR Prathibha (12.3 t ha<sup>-1</sup>) followed by RH-9/90 (14.8 t ha<sup>-1</sup>) and CLS-38 (15.1 t ha<sup>-1</sup>).



At Raigarh, IT 36 recorded maximum rhizome yield (36.7 t ha<sup>-1</sup>) followed by IT 10 (36.2 t ha<sup>-1</sup>) over national check IISR Prathibha (30.3 t ha<sup>-1</sup>), Suranjana (25.3 t ha<sup>-1</sup>), Narendra Haldi (32.2 t ha<sup>-1</sup>), Roma (26.6 v) and BSR 2 (31 t ha<sup>-1</sup>) as well as superior over local check Chhattisgarh Haldi-1 (31.6 t ha<sup>-1</sup>).

### TUR/CI/3 Varietal Evaluation Trial

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

(Centres: Middle Gangetic Plain Region - Kumarganj)

Under IET, Turmeric, 10 entries were tested and found maximum rhizome yield in NDH-53 (31.22 t ha<sup>-1</sup>) followed by NDH-126 (30.55 t ha<sup>-1</sup>) and NDH-88 (30.33 t ha<sup>-1</sup>).

#### TUR/CI/3.8 Initial Evaluation Trial 2016

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

It was observed that for rhizome yield IT 55 recorded maximum rhizome yield (35.9 t ha<sup>-1</sup>) followed by germplasm entry IT 54 (34.8 t ha<sup>-1</sup>) and IT 29 (32.2 t ha<sup>-1</sup>) over all the checks Suranjana (22.2 t ha<sup>-1</sup>) and BSR 2 (26.7 to t ha<sup>-1</sup>n/ha) at Raigarh.

It was revealed from the analyzed pooled data that the entry PTS-22 (18.7 t ha<sup>-1</sup>) was the top yielder with the yield advantages of 14.2% than the Local check variety Roma (16.4 t ha<sup>-1</sup>) followed by PTS-56(16.8 t ha<sup>-1</sup>) and PTS-57(16.7 t ha<sup>-1</sup> t/ha).



Fig. 7. Field view: a. CVT Kammarpally; b. IET at Pottangi

### Crop Management

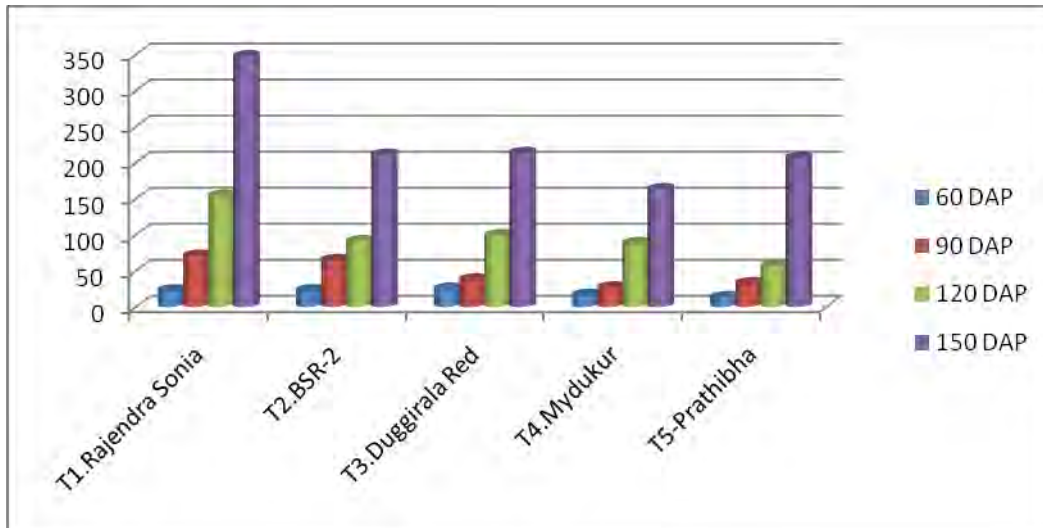
#### TUR/CM/5 Nutrient Management Trial

##### TUR/CM/5.9 Source sink relationship in turmeric

(Centres: Southern Plateau and Hills Region – Coimbatore, Kammarpally; West Coast Plains and Ghat Region – Kozhikode; East Coast Plains and Hill Region – Guntur; Middle Gangetic Plain Region – Dholi; Eastern Himalayan Region - Barapani)

At Dholi, Rajendra Sonia was better regarding most of the yield and yield contributing characters compared to IISR Prathibha, Mydukar, Dugirala Red and BSR-2 and dry recovery was also maximum in Rajendra Sonia. At Kammarpally, Rajendra Sonia recorded maximum rhizome fresh weight at all days in general (90, 120 and 150 DAP) and at harvest Duggirala Red recorded maximum fresh rhizome weight (15.93. kg plot<sup>-1</sup>) followed by Mydukar (15.33 kg plot<sup>-1</sup>). At Guntur, Mydukar recorded maximum fresh rhizome yield (381.2 g/clump) followed by BSR-2 (375 g clump<sup>-1</sup>) and Duggirala Red (370.8 g clump<sup>-1</sup>) which were on par with each other and

significantly superior to other varieties. At Barapani, Mydkur recorded highest fresh rhizome weight at 60 DAP (18.12 g plant<sup>-1</sup>), while IISR Pratibha recorded highest fresh rhizome weight at 120 DAP (193.43 g plant<sup>-1</sup>) while at 180 DAP and harvest the fresh rhizome weight was highest in Duggirala Red (354.12 g plant<sup>-1</sup> and 371.84 g plant<sup>-1</sup> respectively).

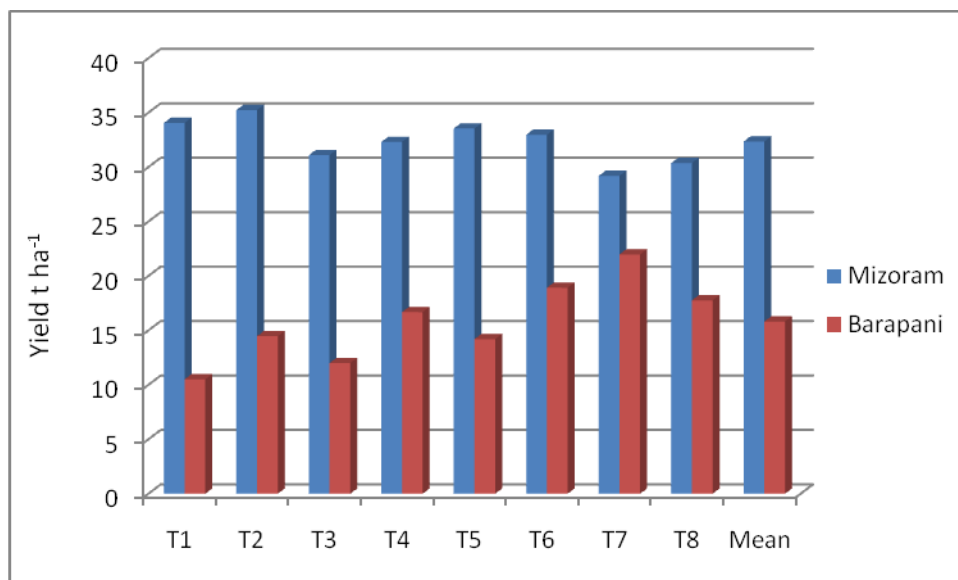


**Fig. 8. Variation in rhizome fresh weight at different days after planting recorded at Kammarpally**

### TUR/CM/5.10 Organic production of turmeric

(Centres: Eastern Himalayan Region – Mizoram, Barapani)

At Mizoram, The maximum yield was recorded in T<sub>2</sub> (100% organic manure equivalent to 75% N requirement of turmeric), with a yield of 35.24 t ha<sup>-1</sup>, followed by T<sub>1</sub> (100% organic manure



**Fig. 9. Organic production of turmeric at Mizoram and Barapani**

T <sub>1</sub> : 100% organic manures equivalent to 100% N requirement of turmeric	T <sub>2</sub> : 100% organic manures equivalent to 75% N requirement of turmeric
T <sub>3</sub> : 100% organic manures + (micronutrients)	T <sub>4</sub> : 100% organic manures + (vermiwash 10%)
T <sub>5</sub> : 75% N requirement of turmeric + (micronutrients)	T <sub>6</sub> : 75% N requirement of turmeric + (vermiwash 10%)
T <sub>7</sub> : Recommended Package by SAU (Turmeric – NPK 120:90:90 NPK kg/ha)	T <sub>8</sub> : Farmers practice

equivalent to 100% N requirement of turmeric) with a yield of 34.06 t ha<sup>-1</sup>, T<sub>5</sub> (75% N requirement of turmeric + micronutrients) with a yield of 33.54 t ha<sup>-1</sup>. Dry recovery was highest in T<sub>4</sub> (100% organic manure + Vermiwash 10%) - 17.51% followed by T<sub>1</sub> (100% organic manure equivalent to

100% N requirement of turmeric); - 17.25%, and T<sub>3</sub> (100% organic manure + micronutrients); - 16.65%. At Barapani, maximum yield of 21.98 t ha<sup>-1</sup> was recorded in T<sub>7</sub> (recommended package by SAU). Highest Dry recovery (21.95%) was recorded in T<sub>7</sub> (recommended package by SAU) and lowest (21.36%) in T<sub>5</sub> (75% N requirement of turmeric from FYM + micronutrients). Treatment T<sub>4</sub> (100% organic manures + 10% vermin wash) had highest curcumin content of 6.53% and highest oleoresin (14.35%) was recorded in T<sub>1</sub> (100% organic manure + 100% N requirement).

### **TUR/CM/5.14 Organic production of turmeric**

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

At Coimbatore, the highest fresh rhizome yield per plant (469.00 g) was recorded in the Variety IISR Pragati treated with organic package developed by IISR, Kozhikode. The highest fresh rhizome yield per plot of 3m<sup>2</sup> was however recorded in CO2 (8.33 kg/plot) treated with organic package developed by IISR, Kozhikode. The dry recovery percentage was higher in IISR Pragati (22.73) with an yield of 7.8 kg/plot of 3 m<sup>2</sup>. Among three varieties (V1- Duggirala Red, V2 - IISR Pragati and V3 -IISR Pratibha) at Kammarpally, IISR Pragati (48.40 t ha<sup>-1</sup>) and IISR Pratibha (47.20 t ha<sup>-1</sup>) responded to organic package (T<sub>1</sub>) with maximum yield, where as Duggirala Red (38.90 t ha<sup>-1</sup>) responded to SAU package (T<sub>2</sub>).

At Dholi, Rajendra Sonia & Rajendra Sonali recorded significantly higher yield (67.13 & 66.36 t ha<sup>-1</sup>, respectively) as compared to IISR Pratibha (57.52 t ha<sup>-1</sup>). Between two organic packages, (IISR-Calicut & RPCAU) organic package of RPCAU recorded significantly higher yield (64.68 t ha<sup>-1</sup>) compared to organic package of IISR (62.65 t ha<sup>-1</sup>). Interaction effect on yield was found non-significant. At Kumarganj, maximum yield was observed in V3T3 treatment (31.33 t ha<sup>-1</sup>) followed by V3T1 (31.00 t ha<sup>-1</sup>) and V3T2 (30.92 t ha<sup>-1</sup>). At Pundibari, the highest fresh yield of turmeric was recorded in ACC-48 (34.57 t ha<sup>-1</sup>) and it was lowest in TCP-2 (30.75 t ha<sup>-1</sup>). Organic package developed by IISR recorded the highest yield 33.48 t/ha). Considering the interaction effect, it was found that ACC-48 genotype along with organic package developed by IISR recorded the highest yield of 35.95 t ha<sup>-1</sup>. At Guntur, IISR-organic production system recorded significantly higher yield (44.2 t ha<sup>-1</sup>) over the chemical production system (38.0 t ha<sup>-1</sup>). Among the the varieties evaluated, Mydukur (43.5 t ha<sup>-1</sup>), was on par with BSR-2 (41.7 t ha<sup>-1</sup>), but superior to IISR Prathibha (38.8 t ha<sup>-1</sup>). Among the interaction between production system, maximum yield was recorded in Mydukur with IISR-organic production system (47.3 t ha<sup>-1</sup>), which was significantly superior to all other combinations except with BSR-2 (44.1 t ha<sup>-1</sup>) with IISR-organic production system. At Chintapalle, among the treatments, T4 (NDH-98 + Inorganic) recorded the maximum plant height (148.43 cm), fresh weight of rhizome (507.93 g), yield ha<sup>-1</sup> (40.52 t ha<sup>-1</sup>) and dry recover percentage (25.04) followed by T3 (NDH-98 + IISR OPP). Organic package developed by IISR (T1) showed significantly taller plants (100.60 cm), higher fresh weight of clump (343.33g/clump), yield/plot and yield per hectare (34.47 t ha<sup>-1</sup> respectively) compared to recommended package of SAU (T2).

At Raigarh, variety V1 (Chhattisgarh Haldi-1) recorded maximum yield (23.75 t ha<sup>-1</sup>) while, in treatment effect, T1 (organic package developed by IISR) recorded maximum number of primary (4.88) and secondary rhizomes (9.10) while, T2 (recommended package by SAU) recorded

maximum fresh rhizome weight (186.52 g) and yield (21.22 t ha<sup>-1</sup>). Both the treatments were statistically at par. The maximum fresh rhizome weight (206.65 g) was recorded in V3T1 (Narendra Haldi X organic package developed by IISR) and maximum yield (21.19 t ha<sup>-1</sup>) was recorded in V1T1 (Chhattisgarh Haldi -1 X organic package developed by IISR). In Barapani, Megha Turmeric-1, Rajendra Sonia and IISR Prathiba were evaluated. T<sub>2</sub> (recommended package by SAU) produced higher yield of 31.87 t ha<sup>-1</sup> and 26.94 t ha<sup>-1</sup> in Megha Turmeric-1 and IISR Prathiba, respectively. The dry recovery percentage were higher in T<sub>1</sub> (organic package developed by IISR) in all the three varieties.

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

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

At Coimbatore, the experiment was conducted with BSR 2, CO 2 and IISR Pragati. CO 2 with recommended package of practices and IISR turmeric micronutrient spray at 60 and 90 DAP @ 5 g/litre recorded the highest fresh weight of the clump (416.67 g) and fresh rhizome yield per plot of 3 m<sup>2</sup> (16.20 g). Recommended package of practices + IISR turmeric micronutrient @ 5g per litre (T<sub>2</sub>) recorded significantly higher number of tillers per plant (2.72), fresh weight of clump (300.09 g) and rhizome yield per plot (9.49kg) and per hectare (31.86 t ha<sup>-1</sup>) compared to recommended package of practices (T<sub>1</sub>-control) at Pasighat. At Kammarpally, The maximum yield was recorded in T<sub>2</sub> (recommended package of practice + IISR turmeric micronutrients) compared to T<sub>1</sub> (Recommended package of practice) for all the three varieties, Duggirala red 34.8 t ha<sup>-1</sup>, IISR Pragati -46.93 t ha<sup>-1</sup> and IISR Prathiba - 46.05 t ha<sup>-1</sup> which responded to T<sub>2</sub>. At Raigarh, maximum yield (24.87 t ha<sup>-1</sup>) was recorded in V1 (Chhattisgarh Haldi-1). T<sub>2</sub> (recommended package of practice + IISR ginger micronutrient two spray at 60 and 90 days after planting @ 5g/litre) recorded maximum fresh rhizome weight (244.27 g) and number of secondary rhizomes (9.10). The maximum fresh rhizome weight (268.25 g) was recorded in V1T2 (Chhattisgarh Haldi 1 x recommended package of practice + IISR ginger micronutrient two spray at 60 and 90 days after planting @ 5g/litre).

## **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 turmeric growing areas of Erode and Coimbatore districts by Coimbatore centre. The maximum incidence of leaf spot (14.3 PDI) was noticed in Perunthurai area of Erode district and maximum leaf blotch was noticed in Gobi (24.6 PDI) followed by Perunthurai (22.9 PDI) area of Erode district. In Coimbatore district, maximum leaf blotch (25.7 PDI) incidence was noticed in Thondamuthur and the leaf spot incidence was 8.9 PDI in Karamadai. Raigarh centre during the survey, found that village Bhikhari Mal at Raigarh developmental block had 43.78 per cent *Colletotrichum* leaf spot and 38.78 per cent *Taphrina* leaf blotch disease intensity

followed by Amalidih village with 34.78% *Colletotrichum* leaf spot and 22.57% *Taphrina* leaf blotch disease intensity.

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

*(Centres: Southern Plateau and Hills Region - Coimbatore)*

Among the various fungicides tested, rhizome treatment with propiconazole (0.1%) + foliar spray with propiconazole (0.1%) at 90, 105 & 120 DAP was found to be effective in reducing the incidence of both leaf spot and leaf blotch. This treatment recorded minimum leaf spot (6.16 PDI) and leaf blotch (12.43 PDI) followed by rhizome treatment with dithane Z-78 (0.1%) + foliar spray with dithane Z-78 (0.1%) that recorded 6.93 PDI leaf spot and 13.96 PDI leaf blotch, while in control the incidence was 20.10 and 24.56 PDI respectively.

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

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

In disease evaluation trail at Kammarpally, nine germplasm accessions were tested and found that all were susceptible to foliar diseases. For the leaf spot disease, all the accessions were in the severity range of 5 grading scale (11-25%) whereas most of the accessions are in 20-30 % for leaf blotch disease severity. At Raigarh, none of the accessions were found to be in the highly resistant category. At Solan, minimum leaf spot disease severity (8.75%) was observed in CL-54 genotype followed by TCP161 with 11.67 per cent disease severity. Leaf blotch severity in disease tolerant lines ranged from 7.25 to 11.20 per cent and was minimum in TCP 129 (7.25%) followed by CL-52 (7.50%). Yield was maximum in CL-54 (21.52 t h<sup>-1</sup>) among disease tolerant genotypes (Table 22).

**Table 22. Management of foliar diseases in turmeric using tolerant lines at Solan**

Genotype	Germination (%)	Leaf spot PDI (%)	Leaf blotch PDI (%)	Yield (q/ha)
CL-3	87.50	15.75	11.20	201.25
CL-34	89.00	12.50	8.50	210.50
CL-52	91.50	12.00	7.50	207.75
CL-54	88.30	8.75	9.25	215.25
TCP 14	89.67	10.67	8.50	204.50
TCP 129	90.87	12.33	7.25	207.00
TCP 161	87.61	11.67	7.60	208.50
Local check	85.50	17.67	18.50	195.00
CD <sub>0.05</sub>	NS	0.78	0.68	2.21

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

*(Centre: Western Plateau and Hills Region – Dapoli)*

Among the thirty varieties of turmeric screened against leaf spot (*Colletotrichum capsici*) and rhizome rot disease and yield, twenty nine varieties were observed moderately resistant except 'Kanti' which was found susceptible against leaf spot disease. Against rhizome rot twenty nine varieties were tolerant and Krishna variety was found moderately resistant.

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

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

At Coimbatore, combined application of capsule formulation of *Trichoderma* and GRB 35 in BSR-2 recorded highest highest yield of 5.0 kg plot<sup>-1</sup>. This treatment also recorded minimum incidence of leaf spot (5.5 PDI) and leaf blotch (14.0 PDI) compared to control that recorded 19.9 and 26.2 PDI of leaf spot and leaf blotch respectively. At Kumarganj, maximum yield was observed in V2T2 treatment (32.00 t ha<sup>-1</sup>) followed by V2T1 (30.92 t ha<sup>-1</sup>) and V2T3 (30.67 t ha<sup>-1</sup>). At Raigarh, minimum disease intensity of *Colletotrichum* leaf spot was 24.13% and *Taphrina* leaf spot was 24.85%. The treatment POP+ *Trichoderma* (talk formulation) + GRB 35 (talk formulation) recorded maximum yield (24.59 t ha<sup>-1</sup>).

Combined treatments of *Trichoderma* and GRB 35 talc formulation were found superior in increasing the plant growth parameters and reducing the incidence of leaf blotch over other treatments at Solan. The talc formulation of *Trichoderma* in combination with talc formulation of GRB-35 resulted in highest germination (92.67%) in Palam Lalima followed by Palam Pitamber. At Kammarpally, Duggirala Red recorded maximum yield (36.9 t ha<sup>-1</sup>) in the treatment POP + GRB 35 capsule (T4), IISR Pragati responded for -POP + *Trichoderma* (talc formulation) + GRB 35 (talc formulations ( T1) and recorded 85.7 t ha<sup>-1</sup> yield (T1), where as IISR Pratibha recorded higher yield (48.9 t ha<sup>-1</sup>) for POP + *Trichoderma* capsules + GRB 35 capsule (T2). At Pasighat, the maximum fresh weight of clump was recorded in T2 (POP + *Trichoderma* capsule + GRB 35 capsule) but remained at par with T1. Significantly higher per plot yield (12.05 kg) and per hectare yield (40.12 t ha<sup>-1</sup>) was recorded with T2. The lowest yield was recorded in T5 (28.84 t ha<sup>-1</sup>) which remained at par to T4.

## **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)*

##### **a. Nutmeg**

Among the accessions conserved at Pechiparai, MF- 1 recorded maximum tree height (9.14 m) and stem girth (58.55 cm) and MF 4 recorded maximum leaf length (20.14 cm), leaf breadth (9.15 cm), no. of fruits (667), single fruit weight (53.0 g) and mace yield (286g/ tree).

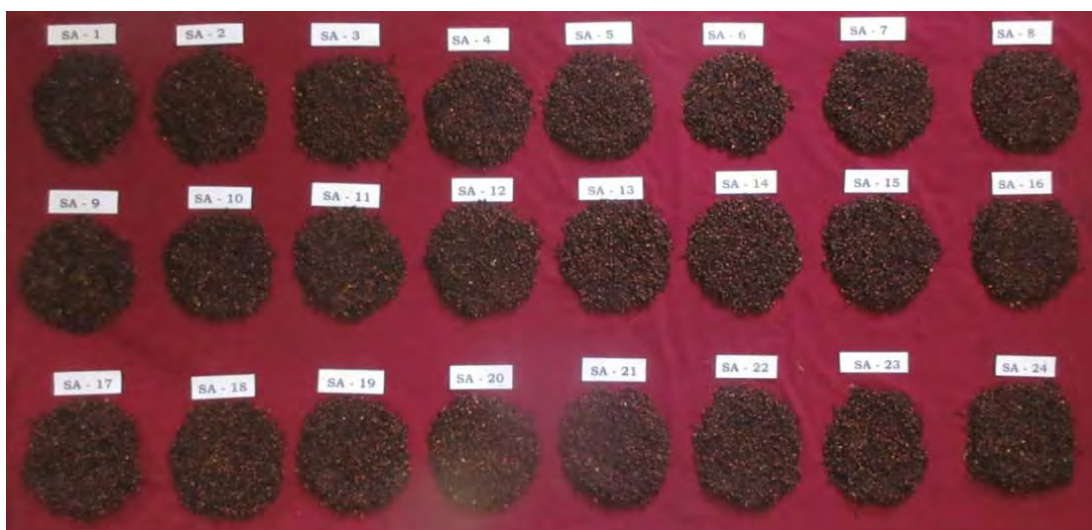
At Dapoli, average number of fruit recorded in 2018-19 ranged from 160-972. Genotypes DBSKKVMF 29 (972), DBSKKVMF 9772 (507), DBSKKVMF 22 (498) recorded maximum average number of fruits respectively. The genotype DBSKKV 29 recorded maximum dry nut yield (9817.20g) and dry mace yield (2721.60 g). From overall performance, the genotype DBSKKVMF 29 was found to be promising considering its fruit yield parameters.

### b. Clove

Among the germplasm of clove planted during the year 1996-97 at Dapoli, four promising genotypes were selected. The plant height varied from 5.89 to 7.15 m., girth ranged from 35 - 40 cm and spread varied from 2.50 m to 3.05 m. From tree number 01, 310 g dried cloves were harvested. Among the 24 accessions at Pechiparai, SA-1 recorded the highest tree height of 11.78 m, followed by SA-3 (11.63 m) compared with local check (9.31 m). The accession SA-13 was significantly superior to other accessions and recorded highest stem girth (49.59 cm) compared with local check (40.57cm). The accession SA-3 recorded the highest leaf length (12.47cm), leaf breadth (7.46 cm), number of branches (16 nos) and dry bud yield (1.52 kg/tree/year) (Table 23).

**Table 23. Performance of clove accessions at Pechiparai**

Accession	Tree height (m)	Stem girth (cm)	Leaf length (cm)	Leaf breadth (cm)	No of branches	Dry bud yield kg tree <sup>-1</sup>
SA- 1	11.78	39.58	12.47	6.12	11	0.45
SA -2	10.84	48.57	11.46	7.15	12	0.41
SA -3	11.63	49.54	12.47	7.46	16	1.52
SA -4	8.88	39.59	11.13	6.44	14	0.46
SA -5	9.57	39.15	10.48	6.12	12	0.54
SA -6	10.29	48.58	11.12	6.47	14	0.46
SA -7	9.35	45.15	09.46	7.12	13	0.68
SA -8	8.98	45.57	08.44	6.23	12	0.55
SA -9	9.88	44.12	07.47	4.74	11	0.41
SA -10	9.35	47.14	08.12	6.11	13	0.46
SA -11	9.48	33.56	06.10	6.48	13	0.42
SA -12	8.62	43.09	09.54	6.44	13	0.58
SA -13	8.98	49.59	15.56	6.11	14	1.44
SA -14	8.61	41.12	08.12	4.45	11	0.55
SA- 15	7.82	34.15	09.48	4.62	12	0.81
SA-16	8.88	35.11	08.12	4.44	13	0.46
SA -17	8.15	31.10	11.46	5.45	11	0.51
SA -18	7.21	30.14	10.16	3.63	9	0.57
SA -19	6.46	29.75	09.10	3.46	10	0.49
SA -20	5.88	24.28	11.06	4.54	12	0.52
SA -21	6.18	25.19	07.14	5.52	13	0.56
SA -22	4.88	15.14	10.11	5.47	10	0.62
SA -23	4.62	16.64	11.50	3.51	10	0.57
SA -24	4.31	12.68	11.46	4.52	9	0.48
Local check	9.31	40.57	11.17	4.47	9	0.42
SEd	0.17	1.82	0.53	0.54	0.34	0.35
CD (P = 0.05)	0.48	2.14	0.58	0.44	0.46	0.42



**Fig. 19. Dry buds of clove germplasm**

### c. Cinnamon

Among the twelve accessions evaluated at Pechiparai, CV-5 recorded maximum tree height (2.81 m), number of shoots (10) and stem girth (16.84 cm) and local check recorded 2.47 m tree height, 6 shoots and 16.25 cm stem girth. The germplasm conserve at AICRPS centre is presented in table 24.

**Table 24. Tree spices germplasm collection at AICRPS centres**

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

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

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

The different genotypes have been planted in germplasm block of nutmeg at Dapoli. The growth of plants is satisfactory. The addition new genotypes in unique nutmeg block are in progress.

Among the various unique type of nutmegs planted at Pechiparai, the maximum plant height (4.84 m), numbers of branches (8), number of fruits (17), single fruit weight (39.55 g) and mace yield/ tree (11.50 g) were recorded in IISR Viswashree.



**Table 25. Morphological and yield performance of unique nutmeg**

Sl. No	Name of the variety	Plant height (m)	No of branches	No. of fruits	Single fruit weight (g)	Mace yield tree g <sup>-1</sup>
1	Konkan Swad	3.55	6	14	35.50	6.0
2	Yellow nutmeg	3.64	7	11	31.51	5.0
3	IISR Viswasree	4.84	8	17	39.55	11.50
4	Konkan Suganda	3.15	6	15	27.50	6.5
5	Konkan Shrimathi	3.34	7	13	26.25	6.0
6	ACC-3	3.39	9	15	34.60	7.5
7	ACC-5	3.14	8	15	38.15	7.0
8	ACC-7	3.24	7	12	34.28	5.5
9	ACC-13	3.99	7	14	37.21	6.0
10	ACC-17	2.64	5	14	33.50	9.0
	SEd	0.24	0.24	0.31	0.47	0.18
	CD	0.18	0.18	0.24	0.31	0.14

## Crop Improvement

### TSP/CI/2 Coordinated Varietal Trial

#### TSP/CI/2.2 CVT 2001-Nutmeg

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

At Dapoli, the plant height ranged from 1.28 to 2.63 m., girth from 11.17 to 33.50 cm, branches from 26.75 to 43.50 and spread from 0.94 to 3.14 m. A-9/150 produced maximum number of fruits per plant (166.67) and was significantly superior over rest of the accessions and check except the accession A-9/71 (152.67) which was at par.

Among the different accessions of nutmeg evaluated at Pechiparai, A9/150 recorded the highest plant height (5.89 m), stem girth (26.57 cm), maximum number of branches (14) and number of fruits (264) and mace yield tree<sup>-1</sup> (174.5 g) compared with local check, plant height (4.88 m), stem girth (18.55 cm), maximum number of branches (13), number of fruits (216) and mace yield/ tree (145.5 g<sup>-1</sup>) (Table 26).

**Table 26. Morphological and yield performance of nutmeg accessions at Pechiparai**

Sl.No.	Accession	Plant height (m)	Stem girth (cm)	No. of branches	No of fruits tree <sup>-1</sup>	Mace yield tree g <sup>-1</sup>
1.	A9/4	5.90	25.58	12	225	165.5
2.	A9/20	5.80	22.15	13	232	170.0
3.	A9/25	5.90	21.57	11	242	165.0
4.	A9/71	5.85	23.59	11	253	166.0
5.	A9/150	5.89	26.57	14	264	174.5
6.	M.L.	5.67	22.58	14	252	165.5
7.	Local check	4.88	18.55	13	216	145.5
	SEd	0.31	0.81	2.85	3.91	1.28
	CD (P=0.05)	0.22	1.22	5.78	8.90	1.19

## **TSP/CI/2.4 CVT on farmers varieties of nutmeg**

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

The trial was planted in August- 2016 at Dapoli. The data indicates non-significant differences for all the growth parameters. The genotype Kochukudy recorded highest plant height (2.27 m) followed by Punnathanam Jathy (1.92 m). Punnathanam Jathy produced maximum branches (25.33) followed by Kochukudy while maximum spread was recorded by Kochukudy (1.90 m) followed by local check (1.73 m) and Cheripuram (1.68 m). The improved nutmeg variety recorded the maximum plant height (1.98 m) and numbers of branches (11) at Pechiparai. The trial is initiated 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)***

At Coimbatore, 276 genotypes are maintained in the germplasm collection, which were evaluated during 2018-19 based on genetic divergence, yield and quality assessment. The plant height at harvest varied significantly from 31.63 cm to 69.87 cm with a mean value of 51.05 cm. The genotype CS 135 recorded the highest plant height of 69.87 cm whereas the lowest was recorded in CS 12 (31.63cm). The number of umbels per plant varied from 11.00 to 45.00 with an overall mean of 22.83. The highest number of umbels per plant was recorded in CS 2 (45.00) and the lowest in CS1 (11.00). Similarly, the number of fruits per umbel ranged between 17.67 and 34.67 with an overall mean of 25.04 among the genotypes evaluated. The highest number of fruits per umbel was observed in CS 275 (34.67) and the lowest number of fruits per umbel was recorded in CS 156 (17.67).

Seventy four accessions along with three check (Rajendra Swati, Hisar Anand and Pant Haritima) were collected and evaluated at Hisar, Out of seventy four accessions, only seventeen accessions namely- RD-415, RD-422, RD-414, RD-418, RD-439, RD-400, RD-395, RD-398, RD-441, RD-407, RD-417, RD-382, RD-435, RD-399, RD-401, RD-387 and RD-393 recorded the highest yield ranging from 81.51g to 98.58g per five plants & 1.43 kg to 1.59 kg yield per plot (7.2 m<sup>2</sup>) as compared to best check variety Rajendra Swati (80.94g per five plants) and yield per plot (1.42 kg).

Two hundred thirty germplasm accessions were evaluated at Jobner along with eight checks namely RCr-20, RCr-41, RCr-435, RCr-436, RCr-475, RCr-480, RCr-684 & RCr-728 in augmented design in 4 blocks in one row plot of 3 x 0.3 sq.m. size. The trial was sown on 03.11.2018. One meter uniform section of each row of a plot was maintained by bagging with muslin cloth and on maturity seeds were harvested separately to obtain the self seed to raise the crop for next season.

Seventy four accessions of coriander along with three check (Rajendra Swati, Hisar Anand and Pant 200 germplasm of coriander were evaluated at kumarganj .The highest yield was recorded in NDCor-11 (30g/plant) followed by NDCor-22 (28.30 g plant<sup>-1</sup>), ND Cor-32

(27.50g/plant). During 2018-19, out of 350 collections, thirty five accessions were evaluated at Guntur in Augmented Block Design. Among the entries evaluated, LCC-316 (5.49 g plant<sup>-1</sup>), LCC-319 (5.09 g plant<sup>-1</sup>), LCC-336 (5.09 g plant<sup>-1</sup>), LCC-343 (5.09 g plant<sup>-1</sup>) and LCC-344 (4.89 g plant<sup>-1</sup>) were found significantly superior in yield over the best check Suguna (2.92 g plant<sup>-1</sup>).

At Jagudan, 151 germplasm accessions (132 indigenous and 19 exotic) are maintained, among them 91 entries were evaluated with GCori-3 as check for yield performance. The seed yield ranged from 39 to 1194 kg/ha. Among them eight genotypes recorded higher seed yield than check GCori-3.

**Table 27. Coriander germplasm collections at various AICRPS centres**

Centre	Indigenous			Total
	Cultivated		Wild and related species	
	Existing	Addition (2018 -19)	Existing	
Coimbatore	276	-	-	276
Dholi	74	-	-	74
Guntur	350	-	-	350
Hisar	314	8	-	322
Jagudan	132	-	19 (Exotic)	151
Jobner	230	-	-	230
Kumarganj	200	-	-	200
Pantnagar	85	-	-	85
Raigarh	37	-	-	37
Total	1698	8	19	1725

At Jobner, Two hundred thirty (230) germplasm accessions were evaluated along with eight checks namely RCr-20, RCr-41, RCr-435, RCr-436, RCr-475, RCr-480, RCr-684 & RCr-72. A wide range of variability was found for all the characters studied. Out of 230 accessions, 45 accessions were better than best check variety RCr-475 (33.14 g) on the basis of seed yield per 5 plants. Promising accessions identified on the basis of seed yield per 5 plants were UD-70 (70.61 g), UD-169 (52.32 g), UD-855 (49.96 g), UD-412 (49.34 g), UD-211 (47.23 g), UD-429 ( 46.23 g), UD-96 (44.63 g), UD-803 (43.49 g), UD-406 (42.51 g), UD-831 (41.54 g), UD-436 (41.04 g) and UD-823 (41.03 g)



**Fig. 20. Visit of accreditation team of ICAR to Coriander germplasm at Raigarh**

At Raigarh a total of 37 germplasm of coriander are maintained. Among 33 accessions evaluated, ICS 54 and 15 recorded maximum seed yield ( $15 \text{ q ha}^{-1}$ ) followed by ICS 9 ( $14.9 \text{ q ha}^{-1}$ ) over checks Hisar Anand ( $14.9 \text{ q ha}^{-1}$ ) and Rcr 728 ( $9.8 \text{ q ha}^{-1}$ ), Gujarat 2 ( $9.3 \text{ q ha}^{-1}$ ) and Rajendra Swati ( $5.4 \text{ q ha}^{-1}$ ).

### Screening of coriander germplasm against powdery mildew

Total thirty five (34+1) accessions were screened under natural condition at seed Spices Research Station, Jagudan during 2018-19. The minimum disease intensity was noticed in JCr-17-13, J Cr – 2013-24, COR 175, COR 177 and COR 178 (5.0%). The maximum disease intensity was recorded in JCr – 18-03 (40.0 %). The disease intensity was ranged between 5.0 and 40.0 per cent. In *Rabi* 2018-19, twenty one (CVT) accessions from Jobner were screened against powdery mildew disease. Among the tested, two accessions viz., COR-190 and COR-192 showed moderately resistant and ten accessions viz., COR-176 to COR-180, COR-185 to COR-187, COR-191 and RCr-728 showed susceptible and rest of the entries showed highly susceptible reaction against the disease.

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

*(Centres: Central Plateau and Hills Region – Jobner)*

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

## Crop Improvement

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

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

Twenty one genotypes of coriander including two checks were evaluated at Navsari. COR-186 ( $16.85 \text{ q ha}^{-1}$ ) was found significantly superior over a both the national checks for seed yield. COR-176 ( $16.03 \text{ q ha}^{-1}$ ), COR-189 ( $15.92 \text{ q ha}^{-1}$ ), COR-187 ( $15.70 \text{ q ha}^{-1}$ ) and COR-175 ( $15.15 \text{ q ha}^{-1}$ ) was found significantly superior over RCr-728 for seed yield. At Raigarh, evaluation of coriander entries for seed yield revealed that none of the entries performed well over national check Rcr 728 ( $18.2 \text{ q ha}^{-1}$ ) while COR 184 ( $18 \text{ q ha}^{-1}$ ) is at par with Rcr 728. The maximum seed yield recorded by entry COR 185 ( $17.2 \text{ q ha}^{-1}$ ) followed by ICS 4 ( $15.6 \text{ q ha}^{-1}$ ), COR 182 ( $15 \text{ q ha}^{-1}$ ) and COR 190 ( $14.6 \text{ q ha}^{-1}$ ) over national checks R. Swati ( $14.1 \text{ q ha}^{-1}$ ), Hisar Anand ( $12.8 \text{ q ha}^{-1}$ ) and over local check Chhattisgarh Dhaniya-1 ( $11.5 \text{ q ha}^{-1}$ ).

At Jabalpur, COR-185 was the highest yielder with  $23.98 \text{ q ha}^{-1}$  whereas; lowest yield was reported in COR-189 with  $14.26 \text{ q ha}^{-1}$ . At Jobner, the seed yield ranged from  $1564.81$  (COR-181) to  $26.67 \text{ ha}^{-1}$  (COR-190). Of the nineteen entries evaluated, COR-190 recorded maximum seed yield of  $26.67 \text{ q ha}^{-1}$  while lowest seed yield of  $15.65 \text{ q ha}^{-1}$  was recorded in COR-181. The yield levels were very high due to prolonged winter season for 20-25 days. The seed yield was highest in COR 185 ( $131.67 \text{ g/ plot of } 1 \text{ m}^2$ ) at Coimbatore. At Kumarganj, the promising accessions were Cor-188 ( $16.25 \text{ q ha}^{-1}$ ) followed by Cor-192 ( $16.04 \text{ q ha}^{-1}$ ) and Cor-189 ( $14.16 \text{ q ha}^{-1}$ ). Maximum

seed yield was observed in Cor-188 (20.37 q ha<sup>-1</sup>) followed by local check Pant Haritima (20 q ha<sup>-1</sup>) at Pantnagar.

**Table 28. First year yield data of CVT X centre wise**

S. No.	Entry	Yield q ha <sup>-1</sup>					
		Jagudan	Dholi	Hisar	Pantnagar	Kota	Guntur
1	COR 174	11.11	12.39	20.87	17.92	14.04	23.51
2	COR 175	7.65	15.33	21.94	14.49	14.81	15.05
3	COR 176	12.25	28.17	18.90	17.41	17.65	6.68
4	COR 177	10.34	14.50	19.29	18.29	15.76	15.91
5	COR 178	9.07	15.94	16.45	21.48	14.69	15.36
6	COR 179	7.59	17.67	17.43	16.57	13.83	20.01
7	COR 180	1.02	9.83	13.02	15.79	17.00	11.57
8	COR 181	0.96	11.22	14.44	15.05	17.63	10.72
9	COR 182	5.40	10.06	13.70	17.04	0.77	3.49
10	COR 183	7.50	21.39	18.34	15.88	11.61	7.44
11	COR 184	2.72	11.50	13.15	17.36	18.24	18.36
12	COR 185	2.25	11.50	16.33	16.34	18.60	23.62
13	COR 186	8.30	21.17	16.10	17.87	15.45	15.24
14	COR 187	9.69	12.17	15.25	19.77	20.05	18.98
15	COR 188	5.46	10.22	14.13	20.37	14.67	18.65
16	COR 189	10.86	18.94	15.34	19.49	12.18	18.07
17	COR 190	10.83	9.50	15.76	12.96	13.80	24.69
18	COR 191	9.63	12.72	17.06	-	8.78	17.19
19	COR 192	6.64	8.17	17.98	-	6.20	15.91
20	L.Check	10.22	25.72	-	20.00	-	15.36
	C.D. at 5%	2.40	5.25	0.70	1.89	2.80	3.77
	C.V. %	0.19	0.21	-	0.07	0.13	0.11

A new trial was initiated with seventeen coded entries along with check Susthira were evaluated at Guntur. Among the entries evaluated, COR-190 (24.69 q ha<sup>-1</sup>), COR-185 (23.61 q ha<sup>-1</sup>) and COR-174 (23.51 q ha<sup>-1</sup>) were significantly superior to the check Susthira (17.19 q ha<sup>-1</sup>). At Kota, COR-187 was found to be the best performing entry in terms of seed yield, yielding 2005 kg/ha followed by COR-185 (18.60 q ha<sup>-1</sup>). COR-182 was the lowest yielder. COR-180, COR-184 and COR-185 were the earliest in days to 50 % flowering (61 days) and maturity (121 days). COR - 185 and COR- 190 had the highest test weight of 18.86 and 18.38 g while COR-174 had the lowest test weight of 12.13 g. At Hisar, the significant differences were recorded for all the parameters. Maximum seed yield (21.94 q ha<sup>-1</sup>) was recorded in COR- 175 followed by COR-174 (20.86 q ha<sup>-1</sup>) and COR-177 (19.29 q ha<sup>-1</sup>).



**Fig. 21. CVT Coriander entries at Guntur (COR 174 to COR 182)**

### **COR/CI/3 Varietal Evaluation Trial**

#### **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)*

At Jagudan JCr 16-02 (9.10 q ha<sup>-1</sup>) and JCr 17-13 (8.61 q ha<sup>-1</sup>) found numerically superior over local check variety G. Cor-3 (8.02 q ha<sup>-1</sup>) by 13.5% and 7.4 %, respectively. This experiment was affected by adverse environmental condition at harvesting stage and hence the low yield. At Kumarganj, highest yield was recorded in NDCor-22 (19.44 q ha<sup>-1</sup>) followed by NDCo-32 (18.75 q ha<sup>-1</sup>) and NDCor-64 (17.98 q ha<sup>-1</sup>)

At Dholi, Hisar Anand gave higher yield per plot (0.92 kg 4.8m<sup>-2</sup>) and yield per hectare (19.10 q ha<sup>-1</sup>) as compared to check variety Rajendra Dhania-1 yield per hectare (18.68 q ha<sup>-1</sup>). Among nine promising entries and two check varieties, four entries, RD-392, RD-434, RD- 412 and RD-414 gave significantly higher yield as compared to the best check varieties Hisar Anand. Among these four entries, RD-392 gave the maximum yield 27.77 q ha<sup>-1</sup> followed by RD-434

(27.56 q ha<sup>-1</sup>), RD- 412 (26.38 q ha<sup>-1</sup>) and RD-414 (24.24 q ha<sup>-1</sup>) as compared to best check Hisar Anand yield per hectare (19.09 q ha<sup>-1</sup>).

The initial evaluation trial of coriander at Raigarh revealed that for seed yield entry ICS 5-2 (22 q/ha) recorded maximum seed yield followed by entry ICS 5-11 (21 q ha<sup>-1</sup>) over checks Hisar Anand (10 q ha<sup>-1</sup>) and Rajendra Swati (10 q ha<sup>-1</sup>).

### **COR/CI/3.9 Initial Evaluation Trial - 2016**

*(Centres: Middle Gangetic Plain region – Dholi)*

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

## **Crop Management**

### **COR/CM/5 Nutrient management trial**

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

*(Centre: Gujarat Plains and Hills Region - Jagudan)*

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

Interaction effect between cuttings management and variety was significant. Cultivation of GDLC 1 with two cuttings of leaves recorded the maximum seed equivalent yield and was at par with one cut of GDLC 1, but significantly superior over rest of the treatment combinations. Under no cut system, G Co 2 recorded significantly higher coriander seed equivalent yield than GDLC 1. Interaction effect between cuttings management and fertility levels was significant. The application of 60+30 kg NPK/ha under one cut practices recorded the maximum equivalent seed yield over rest of the treatment combinations.

Variety GDLC 1 was more responsive than GCo2 under different fertility levels. Application of higher level i.e 60+30 kg NPK/ha recorded the maximum coriander seed equivalent yield when coriander cultivar GDLC 1 was grown over rest of the fertility levels combined with two cultivars.

## **Crop Protection**

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

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

At Coimbatore, among the six fungicides tested, propiconazole effectively controlled the powdery mildew incidence. The disease incidence in propiconazole sprayed plants was (5.30 PDI) followed by tebuconazole (6.83 PDI), while in control the incidence was 87.83 PDI. This treatment recorded the highest seed yield of 954.17 kg/ha compared to control (69.25 q ha<sup>-1</sup>). At Jagudan, minimum

percent disease intensity was observed in T<sub>6</sub> i.e spraying of propiconazole 0.1% (4 ml/l) and was at par with treatments T<sub>5</sub> i.e spraying of hexaconazole 0.1% (20 ml/lit and T<sub>4</sub> i.e. spraying of Wettable sulphur 0.2% (2.5 g/l), the plots sprayed with propiconazole 0.1% (4 ml/l) at the initiation of the disease and second spray at 15 days after first spray (T<sub>6</sub>) had recorded the highest seed yield which was at par with treatment T<sub>5</sub> but, significantly superior over rest of the treatments in pooled data. During 2015-16 and 2018-19, T<sub>6</sub> showed higher yield and was at par with treatments T<sub>5</sub>, T<sub>4</sub>, T<sub>3</sub> and T<sub>1</sub> but significantly superior over treatments T<sub>2</sub> and T<sub>7</sub>. Higher yield under treatment T<sub>6</sub> might be due to better management of powdery mildew disease. At Kumarganj, four years of pooled data revealed that foliar spray of Wettable sulphur (0.2%) showed minimum disease intensity (4.25%) and maximum yield (14.25 q ha<sup>-1</sup>) followed by hexaconazole 7.23% and tebuconazole 7.61% disease intensity and yield (12.00 and 11.98 q ha<sup>-1</sup> in hexaconazole and tebuconazole treatments respectively).

At Jobner, pooled analysis of three years data revealed that out of seven treatments minimum (15.27%) disease intensity and maximum (15.88 q/ha) seed yield was recorded with foliar spray of hexaconazole 5% SC @ 0.1% with highest B:C ratio 4.75. It was statistically significant from foliar spray of propiconazole 25% EC @ 0.1% which resulted in 20.57 per cent disease intensity and 15.09 q ha<sup>-1</sup> seed yield and 4.41 B:C ratio. Maximum (72.06%) disease intensity and minimum seed yield (11.37 q/ha) and B:C ratio (3.44) were recorded under the untreated control.

**Table 29: Effect of different fungicides on disease intensity of powdery mildew & seed yield in coriander at Jagudan and Raigarh**

S.No	Treatment	P.M ( PDI )		Yield (q ha <sup>-1</sup> )	
		Jagudan	Raigarh	Jagudan	Raigarh
T <sub>1</sub>	Foliar spray of Tebuconazole 0.1%	22.98*	7.61	19.92	11.98
T <sub>2</sub>	Foliar spray of Propineb 0.2%	23.78	17.88	19.17	7.40
T <sub>3</sub>	Foliar spray of Azoxystrobin 0.1 %	22.13	13.96	20.55	9.70
T <sub>4</sub>	Foliar spray of wettable sulphur 0.2%	20.22	4.25	19.90	14.25
T <sub>5</sub>	Foliar spray of Hexaconazole 0.1%	20.68	7.23	21.90	12.00
T <sub>6</sub>	Foliar spray of Propiconazole 0.1%	18.94	15.69	23.87	8.65
T <sub>7</sub>	Control	34.33	23.45	15.49	5.64
	C.D.at 5 %	2.60	3.10	3.98	0.73

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

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

Foliar spray of 0.2% propiconazole (9.11%) followed by foliar spray of 1% Mahuwa oil (16.33%) and foliar spray of 1% Argimone oil (16.5%) at 45, 60 75 and 90 days were better in controlling leaf blotch. In case of leaf spot the minimum incidence was observed in foliar spray of 0.2% propiconazole at 45, 60 75 and 90 days (13.33%) followed by foliar spray of 1% neem oil at 45, 60 75 and 90 days (16.7%) and foliar spray of 1% marigold oil at 45, 60 75 and 90 days (18.5%). The highest fresh rhizome yield was recorded in foliar spray of 0.2% propiconazole (175.2 q ha<sup>-1</sup>) followed by foliar spray of 1% Argimone oil (172.66 q ha<sup>-1</sup>) and foliar spray of 1% neem oil (172.33 q ha<sup>-1</sup>).



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

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

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

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

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

At Raigarh, spray of carbendazim 50 WP @ 0.1% (20 g /10 l water) (first & second spray) + two foliar sprays of acetamiprid 20SP (0.004 %) showed minimum disease intensity (7.12 %), minimum population of aphid (4.2) and maximum yield (13.49 q ha<sup>-1</sup>).

In Rabi 2018-19, twenty one (CVT) entries of coriander were screened against powdery mildew disease at Jobner. Among the tested lot, COR-190 and COR-192 showed moderately resistant and ten entries viz., COR-176 to COR-180, COR-185 to COR-187, COR-191 and RCr-728 entries showed susceptible and rest of the entries showed highly susceptible reaction against the disease.

At Dholi, all the treatments significantly reduced the stem gall disease incidence and average population of aphid per 5 twigs of coriander plant over control. However, lowest stem gall disease incidence (25.58%) and average population of aphid per 5 twigs (6.40) was recorded seed treatment & foliar spray with hexaconazole @ 0.1% at 45, 60 & 75 DAS (package developed by RPCAU) and two foliar sprays of acetamiprid 20 SP (0.004%) + spray of carbendazim 50 WP @ 0.1% (20 g/10 l water) (first spray) + spray of propiconazole 25 EC @ 0.05% (10 ml/10 l) (second spray) respectively over control.

At Jabalpur, T5 (two foliar sprays of *Lecanicillium lecanii* + spray of propiconazole (first spray) + spray of carbendazim (second spray) was found to be superior after first as well as second spray. However T8, T7 and T5 were on par after the first spray. W. r. t disease, T6 (two foliar sprays of *Lecanicillium lecanii* + spray of carbendazim (first spray) + spray of propiconazole (second spray) was found to be superior over all the other treatment with lowest per cent disease incidence (12.27%) after first spray. Whereas, after second spray T6 (7.95%) was found to be superior followed by T7 (9.21%) which were at par.

At Jagudan, the plots sprayed with flonicamid 50WG @ 0.015% followed by flonicamid 50WG @ 0.015% registered significantly the lowest aphid infestation (2.85 aphid index) at 3days after first spray. Flonicamid 50WG @ 0.015% followed by flonicamid 50WG @ 0.015% recorded significantly the lowest aphid infestation (2.29 aphid index) at 7days after first spray. Same treatment exhibited significantly the lowest aphid infestation (1.35 aphid index) at 3 and 7 days after second spray. Flonicamid 50WG @ 0.015% followed by *L. lecanii* 1.15WP (1x10<sup>9</sup>cfu/gm) @ 40g/10 l (1.40 aphid index) and thiamethoxam 25WG @ 0.0084% followed by *L. lecanii* 1.15WP (1x10<sup>9</sup> cfu/gm) @ 40g/10 l(1.46 aphid index) ranked second at 7days after second spray. Unprotected plots of coriander had registered the highest (3.46) aphid index at 7 days after second spray.

## 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)

Ninety three (93) germplasm accessions were evaluated along with four checks namely RZ-19, RZ-209, RZ-223 and RZ-341 at Jobner. A wide range of variability was found for all the characters studied. Out of 93 accessions, 16 accessions were better than best check variety RZ-19 (10 g) on the basis of seed yield per 5 plants. Promising accessions identified on the basis of seed yield per 5 plants were UC-300 (18 g), UC-266 (15 g), UC-270 (15 g), UC-271 (15g), UC-282 (14 g), UC-335 (14 g), UC-265 (13 g), UC-276 (13 g), UC-268 (12 g) and UC-298 (12 g).

**Table 30. Germplasm collection of cumin in various AICRPS centres**

Centre	Indigenous		Exotic	Total
	Cultivated			
	Existing	Addition (2018-19)	Existing	
Jagudan	327	7	-	334
Jobner	93	-	-	93
Sanand	84	-	-	84
Total	504	7	-	511

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

During 2018-19, 330 germplasm accessions were evaluated with GC-4 as check for yield performance at Jagudan. The seed yield ranged from 20.83-416.67 kg/ha. Among them fifty five genotypes showed higher seed yield than check GC-4. Germplasm was affected by adverse environmental condition, which leads to severe yield loss.

#### Screening for resistance against powdery mildew disease

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

#### Screening of cumin entries for resistance against blight disease

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

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

Sixty six entries of cumin were screened for the resistance against wilt disease under wilt sick plot conditions at Jagudan. Overall wilt incidence was high. The minimum disease intensity was noticed in JC-95-103 GC-5)-1 (10%) followed by JC-95-103 (GC-5)-2, GC-3 and JC-18-11 (12.0%), while

the maximum disease intensity was recorded in the CVT-38, CVT-42, GP-57, 58, 60, 62,65, 66, 71, 72, 74, 75,76 and JC 16-07 (100%). The wilt disease incidence ranged from 10.0 to 100%.

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

**(Centre: Central Plateau and Hills Region - Jobner)**

An experiment was started during Rabi 2017-18 to identify moisture stress/ drought tolerance in cumin at Jobner. Thirty genotypes were randomly selected from the germplasm being maintained at Jobner. The genotypes; UC-436, UC-319, UC-332, UC-333 and UC-342 in normal conditions while UC-323, UC-330, UC-270, UC-229 and UC-346 in stress conditions were top yielders. Based on stress indices, UC-270 was found to be the desirable genotype for drought conditions, followed by UC-323, UC-330, UC-280 and UC-282.

## **Crop Improvement**

### **CUM/CI/2 Coordinated Varietal Trial**

#### **CUM/CI/2.4 Coordinated Varietal Trial-2017**

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

In CVT trial at Jagudan, none of the genotypes showed neither significantly nor numerically superiority over national check GC-4 (4.68 q ha<sup>-1</sup>). This experiment was affected by adverse environmental condition at harvesting stage. At Jobner, seed yield ranged from 1.52 ha<sup>-1</sup> (CUM-42) to 3.02 ha<sup>-1</sup> (CUM-40). Of the ten entries evaluated, CUM-40 recorded maximum seed yield of 302.31 kg/ha followed by RZ-19 (2.70 q ha<sup>-1</sup>), CUM-41 (2.63 q ha<sup>-1</sup>), GC-4 (2.62 q ha<sup>-1</sup>) and CUM-39 (2.46 q ha<sup>-1</sup>), while lowest seed yield of 1.51 ha<sup>-1</sup> was recorded in CUM-42. At Mandor, general mean of the trial was 3.19 q ha<sup>-1</sup>. Only one test entry CUM-41 (5.29 q ha<sup>-1</sup>) was found significantly superior over check variety GC-4 (4.07 q ha<sup>-1</sup>).

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

**(Centres: Gujarat Plains and Hills Region – Jagudan)**

In IET trial, JC-18-10 (3.10 q ha<sup>-1</sup>) was significantly superior over national check GC-4 (2.0 q ha<sup>-1</sup>) by 17.5% whereas, JC-18-09 (3.03 q ha<sup>-1</sup>) and JC-18-01(2.82 q ha<sup>-1</sup>) were numerically superior over national check variety GC-4 (2.64 q ha<sup>-1</sup>) by 14.9% and 7.0% respectively.

## **Crop Management**

### **CUM/CM/5 Nutrient Management Trial**

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

**(Centre: Central Plateau and Hills Region - Jobner)**

Pooled analysis of three years data of Jobner, revealed that out of thirteen treatments, minimum (11.08%) disease intensity and maximum (2.68 q ha<sup>-1</sup>) seed yield were recorded with soil application of vermicompost @ 2 t/ha + seed treatment with *Trichoderma* @ 6 g/kg + spray of NSKE @ 5% (T<sub>4</sub>) with B:C ratio 2.29. It was statistically at par with of soil application of FYM @ 6 t/ha + seed treatment with *Trichoderma* @ 6 g/kg + spray of NSKE @ 5% (T<sub>1</sub>) which resulted in 13.34 per cent disease intensity and 2.37 q ha<sup>-1</sup> seed yield and B:C ratio 2.51. Maximum (33.26%) disease intensity and minimum seed yield (1.41 q ha<sup>-1</sup>) and B: C ratio (1.58) was recorded under the untreated control.

### UM/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)

Fertigation significantly increased the plant height, umbels plant<sup>-1</sup>, umbellets umbel<sup>-1</sup>, seeds umbel<sup>-1</sup>, test weight, seed yield, volatile oil, water use efficiency and water saving of cumin as compared to surface irrigation with conventional fertilization at Jobner. The drip fertigation at 0.6 IW/CPE ratio with 80% RDF recorded significantly higher plant height (31.04 cm), umbels/plant (20.70), umbellets/umbel (5.53), seeds/umbel (27.78), test weight (4.90 g), seed yield (5.08 q ha<sup>-1</sup>), volatile oil (3.20%), volatile oil yield (16.61 kg ha<sup>-1</sup>), net returns (Rs 47140 ha<sup>-1</sup>), B:C ratio (2.20), water use efficiency (2.57 kg/ha-mm) and water saving (23.3%). This treatment increased seed yield by 44.7%, net return by 57.99% and 23.3% saving of irrigation water compared to surface irrigation with conventional fertilization. However it remained at par with drip fertigation at 0.6 IW/CPE ratio with 100% RDF. The results of the three year pooled data at Mandor showed that highest gross return (Rs. 1,80,9000 ha<sup>-1</sup>), net return (Rs. 1, 21,700 ha<sup>-1</sup>) and benefit cost ratio (3.1) were recorded under drip irrigation at 0.6 IW/CPE ratio with 80 % RDF through fertigation (Table 31).

**Table 31. Effect of drip fertigation on economics, water use, water use efficiency and water saving of cumin at Mandor**

Treatment	B:C ratio	Water used (mm)	Water use efficiency (kg/ha-mm)	Water saving (%)
1. Standard check (Surface irrigation at 0.8 IW/CPE ratio with 100% RDF)	2.0	270.0	2.0	0.0
2. Drip fertigation at 0.4 IW/CPE ratio with 60% RDF	1.8	165.8	3.8	38.6
3. Drip fertigation at 0.4 IW/CPE ratio with 80% RDF	2.0	165.8	4.3	38.6
4. Drip fertigation at 0.4 IW/CPE ratio with 100% RDF	2.1	165.8	4.4	38.6
5. Drip fertigation at 0.6 IW/CPE ratio with 60% RDF	2.0	223.6	3.1	17.2
6. Drip fertigation at 0.6 IW/CPE ratio with 80% RDF	2.3	223.6	3.7	17.2
7. Drip fertigation at 0.6 IW/CPE ratio with 100% RDF	2.3	223.6	3.7	17.2
8. Drip fertigation at 0.8 IW/CPE ratio with 60% RDF	2.3	270.0	3.0	0.0
9. Drip fertigation at 0.8 IW/CPE ratio with 80% RDF	2.2	270.0	2.9	0.0
10. Drip fertigation at 0.8 IW/CPE ratio with 100% RDF	2.1	270.0	2.9	0.0
S.Em.±	-	-	0.1	-
C.D. (P=0.05)	-	-	0.4	-

## Crop Protection

### CUM/CP/6 Disease Management Trial

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

(Centre: Central Plateau and Hills Region – Jobner)

Pooled analysis of two years data from Jobner revealed that, out of seven treatments minimum (11.25%) disease intensity and maximum (2.81 q ha<sup>-1</sup>) seed yield were recorded with foliar spray of hexaconazole 5% SC @ 0.1% with highest B:C ratio 2.21. It was statistically significant compared to foliar spray of dinocap @ 0.1% which resulted in 15.42 per cent disease intensity and 234.96

kg/ha seed yield and 1.67 B:C ratio. Maximum (54.58%) disease intensity and minimum seed yield (1.49 q ha<sup>-1</sup>) and B:C ratio (1.20) were recorded under the untreated control.

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

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

Significantly higher yield was recorded in treatment T<sub>4</sub> (three sprays of kresoxym methyl 44.3 SC @ 0.044% (10 ml/ 10 l) + two foliar sprays of thiamethoxam 25WG (0.0084%) and was at par with T<sub>13</sub>, T<sub>10</sub>, T<sub>1</sub> and T<sub>8</sub> at Jagudan. The work is in progress at Jobner centre.

## 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)

Among 43 germplasm accessions maintained at Dholi, only 23 accessions out yielded check variety, Rajendra Saurabh. Highest yield was recorded in RF-10 (24.53 q ha<sup>-1</sup>) followed by RF -65 (23.75 q ha<sup>-1</sup>).

At Kumarganj, Total 168 germplasm accessions were evaluated. NDF-46 (52 g/plant) recorded maximum yield followed by NDF-52 (51.9 g/plant) and NDF -49 (50.4 g/plant). During the year 80 entries were evaluated with GF-12 as check for yield performance at Jagudan. The seed yield ranged from 333 to 2444 kg/ha. Among them thirty three genotypes recorded higher seed yield than check GF-12. One hundred thirty three (133) inbred lines were raised at Jobner in single row plot of 3 × 0.5 sq.m. size. Sowing was done on 25.10.2018. In each row of a plot inbreeding was achieved by bagging individual umbel with muslin cloth and on maturity seeds were harvested separately to raise the lines for next season.

**Table 32. Germplasm collection of fennel in various AICRPS centres**

Centre	Indigenous		Exotic	Total
	Cultivated			
	Existing	Addition (2018-19)	Existing	
Dholi	43	-	-	43
Hisar	174	6	-	180
Jagudan	80	-	-	80
Jobner	133	-	-	133
Kumarganj	168	-	-	168
Total	598	6	-	604

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

During *Kharif* season, thirteen (11+2) entries of fennel were screened under natural conditions at Jagudan. None of the entry was found free from the *Ramularia* blight. The minimum intensity of *Ramularia* blight was noticed in JF-2012-8 (10.0%) while the maximum intensity was recorded in JF-2016-05 (30.0%). The disease intensity ranged from 10.0 to 30.0 per cent. Again during *rabi*

season, fifteen (14+1) entries of fennel were screened under natural conditions. None of the entry was found free from the Ramularia blight. The minimum intensity of Ramularia blight was noticed in FNL-118 and FNL-126 (25.00%) while the maximum intensity was recorded in FNL-129 (32.25%). The disease intensity ranged between 25.00 and 32.25 per cent.

## 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)*

Fourteen promising entries with check Rajendra Saurabh were tested under coordinated varietal trial at Dholi. FNL-124 and FNL-117 recorded maximum yield per plot (1.38 and 1.35 kg 7.2 m<sup>-2</sup> respectively) compared to check variety Rajendra Saurabh (1.19 kg 7.2 m<sup>-2</sup>). Three entries FNL-124, FNL-117 and FNL-116 recorded significantly higher yield per ha (19.02, 18.70 and 18.29 q ha<sup>-1</sup> respectively) compared to check variety Rajendra Saurabh (14.83 q ha<sup>-1</sup>). Among 14 entries tested in CVT at Kumarganj, FNL-125 recorded maximum yield (15.06 q ha<sup>-1</sup>) followed by FNL-123 (14.37 q ha<sup>-1</sup>) and FNL-121 (14.02q/ha). At Hisar maximum seed yield was recorded in FNL-116 (21.51 q ha<sup>-1</sup>) followed by FNL-117 (20.10 q ha<sup>-1</sup>) and FNL-123 (19.30 q ha<sup>-1</sup>) respectively. The CVT at Jagudan revealed that FNL-124, 127 and FNL-119 ranked in top three positions. At Jobner, The seed yield ranged from 13.17 q ha<sup>-1</sup> to 25.65 q ha<sup>-1</sup>. FNL-118 recorded maximum seed yield of 25.97 q ha<sup>-1</sup> followed by FNL-127 (25.65 q ha<sup>-1</sup>), FNL-126 (25.08 q ha<sup>-1</sup>), FNL-122 (24.46 q ha<sup>-1</sup>), and FNL-129 (22.87 q ha<sup>-1</sup>), while lowest seed yield of 13.17 q ha<sup>-1</sup> was recorded in FNL-121. Fifteen genotypes of fennel were evaluated at Pantnagar centre. Highest seed yield was observed in FNL-128 (19.91q ha<sup>-1</sup>) followed by FNL-121 (19.49 q ha<sup>-1</sup>).

**Table 33: Performance of fennel promising entries under coordinated varietal trial**

Genotype	Yield (q ha <sup>-1</sup> )		
	Dholi	Hisar	Pantnagar
FNL-116	18.29	21.51	17.45
FNL-118	16.95	18.37	16.62
FNL-120	17.32	19.71	15.05
FNL-128	13.96	16.82	19.91
FNL-124	19.02	18.19	18.43
FNL-121	14.60	18.26	19.49
FNL-126	9.58	17.82	17.59
FNL-117	18.70	20.10	17.04
FNL-123	18.01	19.30	16.85
FNL-119	14.33	16.08	15.51
FNL-125	14.97	13.32	15.37
FNL-122	13.68	16.83	16.25
FNL-127	13.04	17.65	19.17
FNL-129	18.20	16.36	17.22
Local check	14.83	16.46	18.06
CD (P=0.05)	3.41	0.87	2.10

## **FNL/CI/3 Varietal Evaluation Trial**

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

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

Among nine promising entries and two check varieties tested at Dholi, none of the entries showed significantly higher yield per plot and yield per ha as compared to the check varieties GF-11 and Rajendra Saurabh. However, RF-29 recorded maximum yield per hectare (21.20 q ha<sup>-1</sup>) as compared to best check variety GF-11 (20.80 q ha<sup>-1</sup>). At Jobner, the seed yield ranged from 13.20 to 25.22 q ha<sup>-1</sup>. Of the ten entries evaluated, entry UF-231 recorded maximum seed yield of 25.62 q ha<sup>-1</sup> followed by UF-232 (24.69 q ha<sup>-1</sup>) UF-230 (23.22 q ha<sup>-1</sup>), RF-125 (22.95 q ha<sup>-1</sup>), and RF-205 (22.84 q ha<sup>-1</sup>) while lowest seed yield of 13.21 q ha<sup>-1</sup> was recorded in UF-234. Mean performance of the entries evaluated in IET of fennel over 2017-18 and 2018-19 revealed superior performance of UF-231 yielding 26.71 q ha<sup>-1</sup> followed by UF-230 (24.84 q ha<sup>-1</sup>) and RF-205 check (23.64 q ha<sup>-1</sup>), while lowest mean seed yield of 14.20 q ha<sup>-1</sup> was recorded in UF-234. The IET was conducted with thirteen entries and check variety GF-12 at Jagudan. JF 18-13 (16.05 q ha<sup>-1</sup>) was significantly superior than check GF-12 (13.89 q ha<sup>-1</sup>) with 15.5 per cent increase yield over check and JF 18-14 (14.04 q ha<sup>-1</sup>) ranked second, which recorded numerically superior yield than check GF-12. At Kumarganj, 11 entries were tested and maximum yield was recorded in NDF-59 (15.48 q ha<sup>-1</sup>) followed NDF-46 (14.23 q ha<sup>-1</sup>) and NDF-44 (13.61 q ha<sup>-1</sup>).

## **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)***

One hundred and eleven (111) germplasm accessions were evaluated along with nine checks namely RMt-1, RMt-305, RMt-354 and RMt-361 at Jobner. Out of 347 accessions, 44 accessions were better than best check variety RMt-354 (51.01 g). Some of the promising accessions identified on the basis of seed yield per 5 plants were UM-72 (93.30 g), UM-208 (87.38 g), UM-297 (78.62 g), UM-28 (74.85 g), UM-11 (73.75 g), UM-376 (71.12 g), UM-157 (70.38 g), UM-246 (70.17 g), UM-379 (67.20 g) and UM-377 (65.66 g). Among 58 germplasm accessions, only 11 accessions out yielded check variety Rajendra Kanti at Dholi. Highest yield was recorded in RM-170 (23.15 q ha<sup>-1</sup>) followed by RM -198 (22.66 q ha<sup>-1</sup>). Two hundred and four germplasm accessions are maintained and were evaluated at Kumarganj. The highest yield was found in NDM-49 (6 g/plant) followed by NDM-97 (5.8 g/plant), NDM-80 (5.7 g/plant) and NDM-143 (5.7 g/plant). Seventy six germplasm accessions are maintained at Jagudan centre among which 26 were evaluated and IC number was obtained for 30 accessions. At Guntur 124 accessions were evaluated. Among them, eleven accessions recorded significantly higher yield than the best check LM-2 (4.87 g plant<sup>-1</sup>). The top five performing accessions were LFC-82 (6.27 g plant<sup>-1</sup>), LFC-115 (6.19 g plant<sup>-1</sup>), LFC-122 (6.11 g plant<sup>-1</sup>), LFC-6 (5.95 g plant<sup>-1</sup>) and LFC-14 (5.95 g plant<sup>-1</sup>).

**Table 34. Germplasm collection of fenugreek in various AICRPS centres**

Centre	Indigenous		Total
	Existing	Addition (2018-19)	
Dholi	58	-	58
Guntur	124	-	124
Hisar	401	5	406
Jagudan	76	-	76
Jobner	111	-	111
Kumarganj	204	-	204
Pantnagar	139	-	139
Total	1358	5	1363

At Raigarh, IFGS-11 (18.2 q ha<sup>-1</sup>) recorded higher seed yield over National checks RMT 305 (15.6 q ha<sup>-1</sup>) and Hisar Sonali (14.1 q ha<sup>-1</sup>). While IFGS -9 (16.5 q ha<sup>-1</sup>) and IFGS-6 (15.3 q ha<sup>-1</sup>) recorded higher seed yield over Hisar Sonali (13.8 q ha<sup>-1</sup>). During Rabi 2017-18 total 15 crosses were attempted using six parents (IFGS-12, IFGS-4, IFGS-9, IFGS-11, IFGS-07 and Gujarat-2) as per Griffings half diallele design. The newly developed crosses were evaluated for yield and yield attributing traits during 2018-19 in randomized block design (RBD) with six parents and two checks (RMT 305 and Hisar Sonali) at experimental farm of CARS, Raigarh. The F<sub>1</sub> population advanced to F<sub>2</sub> generation. IFHyb-11 (21.6 q ha<sup>-1</sup>) recorded higher seed yield over National checks RMT 305 (14.6 q ha<sup>-1</sup>) and Hisar Sonali (13.2 q ha<sup>-1</sup>) followed by IF Hyb 9 (19.9 q ha<sup>-1</sup>) and IFHyb 15 (19.5 q ha<sup>-1</sup>). F<sub>2</sub> plants selected for wilt and powdery mildew resistance were back crossed with resistant parents and produced BC<sub>1</sub>F<sub>1</sub> crosses. During Rabi 2019-20 parents, F<sub>1</sub>, F<sub>2</sub> and BC<sub>1</sub>F<sub>1</sub> will be evaluated for wilt, powdery mildew and yield and yield attributing traits.

### Screening of germplasm

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

In Rabi 2018-19, three hundred and fifty entries of fenugreek were screened under this trial against powdery mildew disease at Jobner. Among the tested lot, twenty one entries viz., UM-15, UM-33, UM-80, UM-118, UM-129, UM-141, UM-144, UM-145, UM-146, UM-148, UM-150, UM-161, UM-164, UM-199, UM-210, UM-217, UM-297, UM-298, UM-363, UM-364 and UM-382 showed resistant and seventy one entries viz., UM-4, UM-5, UM-6, UM-8, UM-12, UM-13, UM-16, UM-17, UM-18, UM-20, UM-25, UM-27, UM-28, UM-29, UM-32, UM-35, UM-38, UM-46, UM-50, UM-51, UM-60, UM-62, UM-65, UM-67, UM-68, UM-71, UM-72, UM-73, UM-81, UM-86, UM-98, UM-107, UM-112, UM-114, UM-116, UM-140, UM-142, UM-153, UM-165, UM-167, UM-168, UM-169, UM-184, UM-198, UM-209, UM-220, UM-221, UM-225, UM-227, UM-239, UM-242, UM-250, UM-254, UM-281, UM-287, UM-292, UM-303, UM-304, UM-322, UM-323, UM-324, UM-329, UM-330, UM-334, UM-368, UM-369, UM-370, UM-377, UM-380, UM-385 and RMT-305 showed moderately resistant and rest of the entries showed susceptible and highly susceptible reaction against the powdery mildew disease.

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

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

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



indices UM 80, UM 75, UM 89, UM 92 and UM 93 were found to be the desirable entries for drought conditions.

## Crop Improvement

### FGK/CI/2 Coordinated Varietal Trial

#### FGK/CI/2.5 Coordinated Varietal Trial 2018 Series X

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

Coordinated varietal trial of fenugreek was carried out with 17 test entries and three checks in RBD during 2018-19. Highest yield was recorded in FGK-125 (21.54 q ha<sup>-1</sup>) followed by FGK-133 (18.21 q ha<sup>-1</sup>) as compared to checks Hisar Sonali (17.38 q ha<sup>-1</sup>).

At Jobner, the seed yield ranged from 12.82 to 21.23 q ha<sup>-1</sup>. Of the eighteen entries evaluated, FGK-123 recorded maximum seed yield of 21.23 kg/ha followed by FGK-124 (21.13 q ha<sup>-1</sup>), FGK-129 (20.25 q ha<sup>-1</sup>) and FGK-131 (20.09 q ha<sup>-1</sup>), FGK-133 (19.89 q ha<sup>-1</sup>) and FGK-122 (19.19 q ha<sup>-1</sup>), while lowest yield of 12.82 q ha<sup>-1</sup> was recorded in FGK-126. Seventeen entries were tested at Kumarganj. FGK-123 recorded maximum yield (16.25 q ha<sup>-1</sup>) followed by FGK-128 (15.97 q ha<sup>-1</sup>) and FGK-122 (15.48 q ha<sup>-1</sup>).

**Table 35. Performance of promising entries on fenugreek under coordinated varietal trial**

Genotype	Yield (q ha <sup>-1</sup> )						
	Dholi	Hisar	Raigarh	Pantnagar	Jabalpur	Navasari	Kota
FGK-123	21.44	23.283	13.7	16.85	19.07	15.93	15.7
FGK-130	23.49	22.42	9.5	17.92	16.44	14.67	23.93
FGK-128	24.75	22.86	9.5	16.30	25	14.13	17.82
FGK-133	17.77	22.18	11.4	11.90	17.59	14.11	20.68
FGK-127	16.62	23.73	10.3	17.55	22.92	13.73	20.27
FGK-132	25.54	24.54	10.8	18.01	16.2	15.97	18.41
FGK-124	17.78	26.24	13.1	19.31	20.97	15.79	19.83
FGK-129	16.79	21.85	9.2	16.48	16.9	13.09	19.85
FGK-138	23.56	23.39	10.6	15.51	16.44	13.08	23.3
FGK-134	19.54	21.41	9.5	17.04	17.59	16.21	20.74
FGK-137	26.27	25.39	11.3	18.70	11.53	15.11	16.62
FGK-125	23.87	27.91	12.0	15.69	23.03	15.45	18.59
FGK-122	23.97	22.22	16.1	16.57	18.52	17.99	19.08
FGK-136	20.28	21.04	11.1	18.75	20.14	18.26	13.27
FGK-135	20.07	22.61	9.6	15.32	16.67	8.49	10.88
FGK-131	20.49	22.83	10.1	13.29	21.76	17.33	21.54
FGK-126	20.23	24.397	10.6	16.34	22.45	14.91	18.56
Local check	23.51	-	14.5	18.84	-	15.68	-
CD (P=0.05)	6.26	2.29	1.41	2.46	4.54	3.55	3.95
CV (%)	0.18	0.06	10.83	0.09	14.49	0.14	0.13

At Coimbatore fourteen genotypes along with two checks were evaluated for the second time during 2018-19. The plant height of the genotypes ranged from 37.33 cm (FGK 131) to 46.03 cm (FGK 130). The genotype FGK 124 (22.66) recorded maximum number of pods per plant and the genotype FGK 134 (11.60) recorded the lowest. Seed yield per plot (2 m<sup>2</sup>) varied from 98.07 g to 174.67 g with a mean of 124.06 g. Among seventeen entries and one check variety evaluated at Dholi, none of the entries were found significantly superior regarding yield per plot and yield per ha as compared to check Rajendra Kanti. However, FGK-137 and FGK-132 recorded the highest yield per hectare (26.27 & 25.53 q ha<sup>-1</sup> respectively) as compared to check variety Rajendra Kanti (23.51 q ha<sup>-1</sup>).

Among the entries evaluated, FGK-136 (21.68 q ha<sup>-1</sup>), FGK-135 (19.50 q ha<sup>-1</sup>), FGK-132 (18.77 q ha<sup>-1</sup>), FGK-137 (18.57 q ha<sup>-1</sup>) and FGK-127 (18.29 q ha<sup>-1</sup>) recorded significantly higher yield over the check Lam Methi-3 (14.80 q ha<sup>-1</sup>). Maximum seed yield (27.91 q ha<sup>-1</sup>) was recorded in FGK-125 followed by FGK-124 (26.24 q ha<sup>-1</sup>) and FGK-137 (25.39 q ha<sup>-1</sup>) at Hisar. At Jagudan, FGK -131 (15.57 q ha<sup>-1</sup>), FGK -130 (14.75 q ha<sup>-1</sup>), FGK -135 (13.91 q ha<sup>-1</sup>), FGK -134 (13.50 q ha<sup>-1</sup>) and FGK -133 (13.33 q ha<sup>-1</sup>) found numerically superior over national check variety GM-2 (11.85 q ha<sup>-1</sup>) by 31.4%, 24.5%, 17.4%, 14.0% and 12.5% respectively. Entries FGK -132, FGK -125, FGK -137, FGK -136, FGK -127, FGK -126 and FGK -128 also found numerically superiority over check. FGK-136 (18.26 q ha<sup>-1</sup>) and FGK-122 (17.99 q ha<sup>-1</sup>) recorded significantly highest seed yield over national check Hisar Sonali. None of the entry was found to out yield RMT-361 at Navsari. At Raigarh, FGK-122 (16.1 q ha<sup>-1</sup>) recorded highest seed yield over national check Hisar Sonali (14.5 q ha<sup>-1</sup>) and RMT 305 (14.2 q ha<sup>-1</sup>) followed by FGK 123 (13.7 q ha<sup>-1</sup>) and FGK 124 (13 q ha<sup>-1</sup>). The seed yield ranged from 7.81-18.05 q ha<sup>-1</sup>. During the first year of evaluation, FGK 130 was found to be the best performing entry in terms of seed yield (23.93 q ha<sup>-1</sup>).

Maximum yield was observed in FGK-124 (19.31 q ha<sup>-1</sup>) followed by FGK-136 (18.75 q ha<sup>-1</sup>) at Pantnagar. Data on seed yield at Jabalpur revealed that FGK-128 was the highest yielder with an average yield of 25.01 q ha<sup>-1</sup> while, FGK-137 was the lowest yielder with 11.53 q ha<sup>-1</sup>.

### **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)*

The nine promising entries and two checks *i.e.*, Hisar Sonali and Rajendra kanti were tested at Dholi. Between two checks, Rajendra Kanti recorded the highest yield (24.01 q ha<sup>-1</sup>) as compared to Hisar Sonali (22.81 q ha<sup>-1</sup>).

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

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

In the trial on chemo-profiling, two varieties *viz.*, CO 1 and CO 2 were evaluated for the second time during 2018-19. The seed shape of both varieties is angular. The seed colour of the variety CO 1 is light brownish yellow and CO 2 is dark brownish yellow. The variety CO 2 recorded highest thousand seed weight (12.38 g) compared to CO 1 (11.61 g). The samples were sent to Jobner

centre for quality analysis. Quality analysis is in progress at Coimbatore centre also. The chemo-profiling in other centres is in progress.

### 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)*

Seven entries were evaluated along with local check GM-2 at Jagudan. J Fg – 17-04 (1779 q ha<sup>-1</sup>), J Fg – 17-06 (17.22 q ha<sup>-1</sup>), J Fg – 17-03 (16.20 q ha<sup>-1</sup>) and J Fg – 17-01 (15.69 q ha<sup>-1</sup>) found numerically superior over national check variety GM-2 (15.08 q ha<sup>-1</sup>) by 18.0%, 14.2%, 7.5% and 4.1% respectively. At Jobner, the seed yield ranged from 16.48 to 23.43 q ha<sup>-1</sup>. Of the ten entries evaluated, entry UM-233 recorded maximum seed yield of 23.43 q ha<sup>-1</sup> followed by UM-259 (22.04 q ha<sup>-1</sup>), RMt-1 (20.589 q ha<sup>-1</sup>) and UM-251 (19.74 q ha<sup>-1</sup>), while lowest yield of 16.49 q ha<sup>-1</sup> was recorded in UM-333.

### Project mode: Evaluation of seed spices under Bengaluru condition

**Coriander:** Some of the desirable varieties identified by this study were CO (CR)-4, ACr-1 and RCr-446 for higher seed yield, CO (CR)-4, CO-3, CO-2 for higher essential oil content and varieties RCr-728 and RCr-480 for higher linalool content.

**Fenugreek:** 15 varieties were evaluated and significant correlation with plant height, days to 50 % flowering, pod length, days to maturity, number of seeds per pod, test weight and harvest index.

**Fennel:** The experiment was laid out in RCBD with 3 replications for evaluating 12 varieties at Bengaluru. Some of the desirable varieties viz., RF 145, GF 12, RF 143 and RF 205 recorded higher seed yield but GF 2 and RF 145 recorded higher oil yield and they may be recommended for commercial cultivation in Eastern Dry Zone of Karnataka.

**Ajwain:** Maximum growth parameters like plant height (134.26), number of primary (18.26) and secondary branches (29.36) and yield parameters like number of umbels plant<sup>-1</sup> (161.66), number of umbellets/ umbel (24.84), number of seeds per umbellet (24.32) and seed yield per hectare (12.56 q), was recorded in Ajmer Ajwain-6 which was on par with Ajmeer Ajwain-73 and differed significantly with rest of the varieties.

**Nigella:** Maximum growth parameters like plant height (61.02 cm), number of primary (7.12) and secondary branches (10.30) and yield parameters like weight of capsule per plant (12.12 g), number of capsules per plant (55.76), number of seeds per capsule (70.84), seed yield per hectare (5.98 q ha<sup>-1</sup>), was recorded in Ajmer Nigella-23 which differed significantly compared to rest of the varieties.

## XI. Ajwain

### Crop Improvement

#### AJN/CI/2 Coordinated Varietal Trial

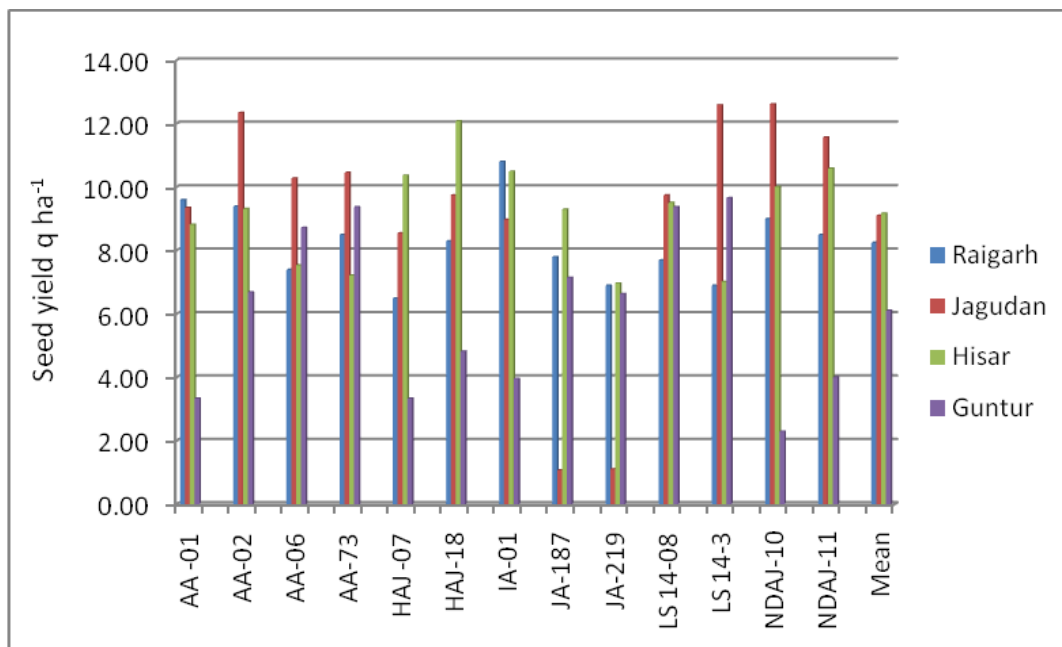
##### AJN/CI/2.1 Coordinated Varietal Trial 2016

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

Out of 13 entries of Ajwain evaluated at Kumarganj, maximum yield was recorded in IA-1 (8.53 q ha<sup>-1</sup>) followed by NDAJ-10 (8.26 q ha<sup>-1</sup>) and HAJ-7-187 (8.19 q ha<sup>-1</sup>) and three years pooled data

showed maximum yield in NDAJ-10 (8.21 q ha<sup>-1</sup>) followed by JA-187 (7.64 q ha<sup>-1</sup>) and AA-73 (7.61 q ha<sup>-1</sup>)

Eleven genotypes from different coordinating centers were evaluated at Guntur. Among the entries evaluated, highest yield was recorded in LS-14-3 (9.66 q ha<sup>-1</sup>) followed by LS-14-8 (9.38 q ha<sup>-1</sup>), AA-73 (9.38 q ha<sup>-1</sup>) and AA-6 (8.73 q ha<sup>-1</sup>) which were on par with each other and significantly superior to the best check Lam Selection-1 (7.93 q ha<sup>-1</sup>). At Raigarh, IA-1 (10.8 q ha<sup>-1</sup>) recorded maximum seed yield followed by AA-1 (9.60 q ha<sup>-1</sup>) and AA-2 (9.4 q ha<sup>-1</sup>).



**Fig. 22. Yield performance of genotypes at different centres**

At Hisar, maximum seed yield (12.08 q ha<sup>-1</sup>) was recorded in HAJ-18 followed by NDA-11 (10.59 q ha<sup>-1</sup>) and IA-1 (10.50 q ha<sup>-1</sup>). None of the genotypes recorded significantly higher yield than local check variety GA-2 (11.57 q ha<sup>-1</sup>) at Jagudan. Of the fourteen entries evaluated at Jobner, entry LS-14-3 recorded maximum seed yield of 1288.43 kg/ha followed by local variety (12.31 q ha<sup>-1</sup>), NDAJ-10 (9.25 q ha<sup>-1</sup>), AA-73 (8.94 q ha<sup>-1</sup>) and AA-6 (8.39 q ha<sup>-1</sup>) while lowest yield of 654.17 kg/ha was recorded in NDAJ-11. Mean performance of the entries revealed that superior performance of local yielding 10.21 q ha<sup>-1</sup> followed by LS-14-4 (9.94 q ha<sup>-1</sup>) and IA-1 (9.24 q ha<sup>-1</sup>), while lowest seed yield of 6.99 q ha<sup>-1</sup> was recorded in HAJ-7.

## 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)*

At Kumarganj, Total 10 entries of nigella were tested in CVT and recorded maximum yield in NDBC-20 (8.88 q/ha) followed by AN-1 (7.77 q ha<sup>-1</sup>) and IN-1 (7.29 q ha<sup>-1</sup>) and three years pooled

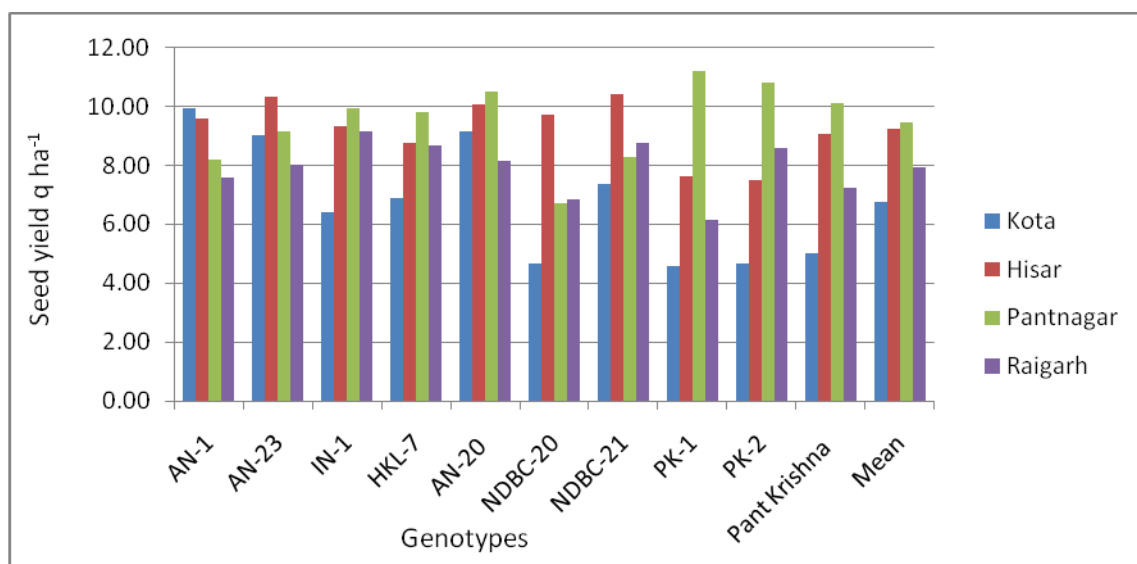
data showed maximum yield in NDBC-20 (8.40 q ha<sup>-1</sup>) followed by AN-1 (7.61 q ha<sup>-1</sup>) and IN-1 (7.24 q ha<sup>-1</sup>)

At Kalyani, highest number of capsules per plant in HKL-T (24.37), seeds per capsule HKL-T (68.82), the highest test weight AN-1(C) (2.86 g) Highest yield per hectare was recorded by IN1 (7.00 q ha<sup>-1</sup>).

At Kota, the seed yield ranged from 456-990 kg/ha. During its third and final year of evaluation, AN-1 was found to be the best performing entries in terms of seed yield, yielding 9.90 q ha<sup>-1</sup> followed by AN-23 (9.00 q ha<sup>-1</sup>) and showing 8.14 per cent higher yield over the check AN-20.

The significant differences were obtained for all the parameters at Hisar. Plant height ranged from 83.4 to 93.4 cm, pods per plant 49.8 to 65.0 and seeds per umbel 83.0 to 98.0. Maximum seed yield (1038.0 kg ha<sup>-1</sup>) was recorded in NDBC-21 followed by AN-23 (10.30 q ha<sup>-1</sup>) and AN-20 (10.04 q ha<sup>-1</sup>).

Ten genotypes of Nigella were evaluated along with 2 checks at Pantnagar centre. Maximum yield was observed in PK-1 (11.16 q ha<sup>-1</sup>) followed by PK-2 (10.79 q ha<sup>-1</sup>). At Raigarh, Total seven germplasm of nigella maintained. For seed yield Indira Nigella -1 (IN-1) recorded (9.1 q ha<sup>-1</sup>) followed by entry NDAZ-21 (8.7 q ha<sup>-1</sup>) over checks AN-1 (7.58 q ha<sup>-1</sup>) and Pant Krishna (7.23 q ha<sup>-1</sup>).



**Fig. 23: Yield performance of genotypes at different centres**

### XIII. Mango ginger

#### Genetic Resources

#### MG/CI/1.1 Germplasm collection, characterization, evaluation and conservation

(Centres: Eastern Plateau and Hills Region – Barapani, Pottangi, Raigarh)

A new trial on mango ginger was initiated in 2018. Six germplasm accessions of mango ginger were collected and evaluated at Raigarh centre. Indira Mango Ginger 1 (IMG 1) recorded highest rhizome yield (28.6 t ha<sup>-1</sup>) followed by IMG 2 (27.5 t ha<sup>-1</sup>) and IMG 4 (25.4 t ha<sup>-1</sup>) over mean rhizome yield (24.8 t ha<sup>-1</sup>).

**Table 36. Evaluation of germplasm of mango ginger for yield and yield attributing traits at CARS, Raigarh during 2018-19**

Sl. No	Entry	Pedigree	Maturity (days)	Plant ht (cm)	Leaf no./ plant	Tillers/plant	Yield t ha <sup>-1</sup>	Disease reaction
1	IMG1	IMGS 2015-1	215	129.2	7.8	3.7	28.6	MR
2	IMG2	IMGS2015-2	232	132.0	11.2	2.3	27.5	MR
3	IMG3	IMGS 2015-3	214	122.5	10.7	3.2	22.6	MR
4	IMG4	IMGS 2015-4	216	127.8	16.5	2.8	25.4	MR
5	IMG5	IMGS 205-5	215	131.2	18.2	2.5	20.2	MR
6	IMG6	IMGS 2015-6	218	117.7	17.2	2.5	24.3	MR
	Mean						24.77	
	SE <sub>t</sub>						0.16	
	CD at 5%						0.68	
	CV at 5%						12.32	

## XIV. Saffron

### Genetic Resources

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

(Centres: Pampore)

Potential Saffron growing villages were surveyed in Kashmir and Chenab Valley region to tap biodiversity and 160 corm collections were made and planted for evaluation and characterization at Saffron Research Station.



**Fig. 24. Saffron cultivation at Pampore**



**Fig. 25. Survey and collection of Saffron**

### Crop Management

#### Nutrient management trial

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

(Centre: Pampore)

The trial is initiated with 13 treatments using *Azotobacter sp.*, *P. fluorescens*, *Trichoderma* and vermicompost. The plants are in vegetative phase.

## Crop Protection

### Disease management trial

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

The isolation, identification and population studies of soil fungi in rhizosphere from 18 samples at pampore saffron growing areas showed nine fungal populations (*Fusarium* spp. *Aspergillus* spp., *Penicillium* spp. *Trichoderma* spp., *Mucor* spp. and a few unidentified fungi were also recorded. Many soil samples were found with very fewer fungi, it is because of continuous crop cultivation and non-application of organic manures to the crop. Maximum number of fungal genera belonged to *Fusarium* spp. which is mainly responsible for saffron corm rot. The isolation and identification of fungal genera is under progress.

## XV. Kalazeera

### KAZ/CI/1 Genetic Resources

#### SAF/CI/1.1 Exploration, collection and conservation of Kalazeera from high altitudes of northern Himalayas

(Centres: Pampore)

Three districts Pulwama, Doda and Badipora were surveyed and samples (tubers and seeds) were collected (12 accessions) and are currently planted for characterization and identification of promising lines. The collected germplasm is under evaluation.

## Crop Management

### KAZ/CM/2 Cropping system trial

#### KAZ/CM/2.1 Evaluation of Saffron-Kalazeera intercropping system module for improving profitability and livelihood of farmers

(Centre: Pampore)

Trial is laid out with different spacings with three replications



Fig. 26. Kalazeera cultivation at Pampore



Fig. 27. Intercropping of saffron with kalazeera

## Crop Protection

### KAZ/CP/3 Disease management trial

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

During the report period, 12 locations in the districts Pulwama, Badgam and Srinagar were surveyed. In all the areas surveyed, the fields were found infested and five pathogens were found associated with kalazeera namely *Pythium* spp., *F. solani*, *F. oxysporium* and unknown fungal and bacterial pathogens were recorded and their identification is in progress.



**Fig. 28. Major prevalent diseases of Kalazeera under Kashmir condition**



## XVI. Monitoring

The Project coordinator and the scientists from PC unit monitored the working of various AICRPS centres and experimental plots by personal visits. Frequent monitoring was done through e-mail and phone calls also. Monthly progress report and budget utilization certificates sent from the centres were reviewed critically and proper guidance was given for improvement. A seed spices monitoring team involving Dr. Gapal Lal from NRCSS, Ajmer, Dr. Dharendra Singh from SKNAU, Jobner, Dr. N. R. Patel from Jagudan and Dr. S. K. Tehlan, Hisar visited the seed spices centres for reviewing the progress of the experiments.

S. No.	Date of visit	Centre visited
1	17.04.2019	AICRPS Centre at TNAU, Coimbatore
2	29.05.2018 - 30.05.2018	AICRPS Centre at RAU, Dholi
3	07.06.2018 - 08.06.2018	AICRPS Centre at Chintapalle
4	12.06.2018 – 14.06.2018	AICRPS Centre at BSKKV Dapoli
5	20.06.2018 – 21.06.2018	AICRPS Centre at IGKV Raigarh
6	08.07.2018 – 09.07.2018	AICRPS Centre at Yercaud
7	22.07.2018	AICRPS Centre at UHS, Sirsi
8	24.07.2018 – 25.07.2018	AICRPS Centre at BSKKV Dapoli
9	04.09.2018 – 06.-9.2018	AICRPS Centre at KAU, Panniyur
10	04.09.2018-06.09.2018	AICRPS Centre at KAU ,Thrissur
11	17.09.2018	AICRPS Centre at ICRI, RS, Sikkim
12	17.09.2018	AICRPS Centre at ICAR NEHR, RS, Gangtok
13	04.10.2018 – 06.10.2018	AICRPS Centre at YSPUHF, Solan
14	18.01.2019 – 19.01.2019	AICRPS Centre at IGKV Raigarh
15	27.02.2019 – 01.03.2019	AICRPS Centre at Chintapalle, OUAT, Pottangi



**ICAR IISR team addressing the tribal people of Chintapalle**

## XVII. Annual Group Meeting

The XXIX Workshop of ICAR-All India Coordinated Research Project on Spices jointly organized by Dr. Y.S. Parmar University of Horticulture and Forestry, Solan, Himachal Pradesh and ICAR-AICRP on Spices, Kozhikode, Kerala was inaugurated by Dr. Hari C. Sharma, Hon'ble Vice Chancellor, Dr. YSPUH & F, Solan on 4 October 2018. During his inaugural address he suggested that modern molecular tools such as transgenics, MAS, CRISPER, metabolomics *etc.*, may be utilized for crop improvement and also to enhance secondary metabolite content. He remarked that AICRPS is the strongest spices research and development network in the country, hence staff position should be enhanced to meet the requirements. He emphasized that rhizome rot is the major threat for ginger cultivation in Himachal Pradesh and measures/ technologies need to be developed to eradicate the same. Also, GI tag should be utilized for quality spice production in different geographical regions.

Dr. J.N. Sharma, Director of Research, Dr. YSPUH & F, Solan presided over the function and Dr. A. K. Sharma, Professor and Head, Department of Vegetable Science, Dr YSPUH&F, Solan welcomed the gathering. In his presidential address, Dr. J.N. Sharma, emphasised the vast potential of spice cultivation in Himachal Pradesh and the necessity of the youth to enter into the field of agriculture. Dr. K. Nirmal Babu, Director, ICAR-IISR & Project Coordinator (Spices), Kozhikode highlighted that spices are the fourth largest commodity in terms of export and high value compounds in spices should be characterized and utilized for developing products. The major concern is to produce pesticide free safe to consume spices for which organic farming needs to be encouraged. Also, he remarked that research institutions and industries should interact and work in collaboration to meet industry and consumer demands.

Dr. Gopal Lal, Director, ICAR-NRC for Seed Spices, Ajmer and Dr. Rakesh Gupta, Dean, College of Horticulture, Dr. YSPUH & F, Solan was the Guest of Honour and offered felicitations. Dr. Gopal Lal suggested that there should be road map for future and also emphasized on maximisation of farmers income through IFS model, maximum utilization of cultivable space and value chain development. Luminaries like Dr. K.K Jindal, Former ADG (Hort.), ICAR, New Delhi and Former DOR, Dr. YSPUHF, Solan & CAU, Pasighat, Dr. Homey Cheriyan, Director, DASD, Kozhikode also participated in the workshop.

During the inaugural session the “Best AICRPS Centre Award 2017-18” was presented to Pepper Research Station, Panniyur (KAU), Kerala for its contribution towards black pepper production and development. Thirteen booklets/pamphlets on spices production technologies in English and local languages from different AICRPS centres were released during the occasion. Vote of thanks was proposed by Dr. Meenu Gupta, Asst. Professor, Dr YSPUH&F, Solan. The representatives of State and Central Research Institutes, industry and farming fraternity participated in the event.

The workshop was organized in six technical sessions – Genetic Resources and Crop Improvement, Crop Management, Crop Protection, Variety Release, Technology Transfer and Plenary.



**Inauguration of the workshop**



**Release of Publications**



**Presentation of 'Best AICRPS Centre Award'**



**Felicitation to Dr. T. John Zaccharia**

### Some important decisions taken in the workshop are

1. Importance has to be given for quality and biotic resistance while evaluating germplasm
2. The best performing entries in the CVT can be recommended for the respective states even though it has not performed across the locations
3. Quality profile has to be included in all the varietal release proposals
4. Evaluation trials on mango ginger (*Curcuma amada*), saffron (*Crocus sativus*) and kalazeera (*Bunium persicum*) may be taken up
5. Research on precision farming, vertical farming and nano-technology may be explored in spice crops in future programmes.
6. Develop value chain in all spice crops.
7. The experimental treatments/methodology/applications should be given in detail in proceedings for newly proposing experiments to execute the experiment uniformly in all centres.
8. Soil nutrient status and quality parameters may be recorded in all the organic and micro-nutrients experiments.
9. Residue analysis data need to be used for fixing MRL values and label expansion.
10. Standard operating procedures need to be developed for *Phytophthora* and nematode management
11. A training programme may be organized at ICAR-IISR, Calicut for the plant protection scientists working in AICRPS centres

## New projects initiated in 2018-2019

- In line with food safety assurance and minimization of the pesticide residue in spices, efficacy trials in coriander and cumin were initiated in various seed spice centres of AICRPS.
- For sustainable production of spices, new programme on the management of bacterial wilt of ginger through chemicals and bioagents have been undertaken in various AICRPS centres of different agro climatic regions.
- Research on new crops like mango ginger, saffron and kalazeera were initiated.
- For the evaluation of genotypes for specific traits, various AICRPS centres have undertaken coordinated varietal trials in spice crops like black pepper, cardamom, mango ginger, ginger, coriander, cumin, fennel and fenugreek.

## Technologies developed

Six location specific technologies for various states were developed

### 1. Bio-fertilizers for yield enhancement of coriander – Dholi

Soil application of Phosphate Solubilizing Bacteria (PSB) @ 15 kg ha<sup>-1</sup> or *Azospirillum* @ 15 kg ha<sup>-1</sup> along with NPK @ 60:40:30kg/ha-1 is recommended for improving the productivity of coriander.

### 2. Drip irrigation and fertigation in coriander – Jobner

Fertigation with water equal to 80% of actual evaporation (0.8 IW/CPE ratio) at an interval of 2-3 days and recommended dose of fertilizers through soluble fertilizers at different growth stages (20, 40, 60 & 80 DAS) is recommended for improving the yield and WUE in coriander in light textured soils of India.

### 3. Bio-efficacy of newer molecules of insecticides against cumin aphid – Jagudan

For effective and economical management of cumin aphid, first foliar spray of thiamethoxam 25WG (25 g a.i./ha; 2.5 g/10 l) at 10% umbels infestation of aphids followed by thiacloprid 21.7SC (25g a.i./ha; 2.88 g/10 l) spray after 10days is recommended for effective control of aphids in cumin growing regions of Gujarat.

### 4. Chemical management schedule for cumin blight – Jagudan

Spraying of kresoxym methyl 44.3 SC (1 ml/l), mancozeb 75% WP (3.7 g/lit) and difenaconazole 25 EC (0.5 ml/lit) at 40, 50 and 60 days after germination is recommended for effective management of blight in cumin growing regions of Gujrat.

### 5. Drip fertigation in fennel – Jobner

Fertigation with water equal to 80% of actual evaporation (0.8 IW/CPE ratio) at an interval of 2-3 days and 75% recommended dose of fertilizers through soluble fertilizers at different growth stages (20, 40, 60, 80 & 100 DAS) is recommended for improving the yield and WUE in fennel in light textured soils of India.

### 6. Organic farming in cardamom – Pampadumpara

Monthly application of *Jeevamrutha* (20 l/plant) along with 10 g each of biofertilizers (*Azospirillum* and PSB) and bio-control agent (*Trichoderma viride*) along with 30 tonnes of compost is recommended as an organic production practice for the Cardamom Hill Reserves, Kerala.

## Release of varieties

Eleven high yielding varieties of spices were recommended for release in XXIX AICRPS workshop.

S.No.	Crop	Name of the variety	Organization	Desirable chafracters
1.	Ginger	Solan Giriganga	Dr YSPUH&F, Solan	Plumpy and bold rhizomes with high dry matter recovery of 21.01%, essential oil -1.45%, oleoresin – 4.69%, crude fibre 4.47% and < 10% incidence of rhizome rot.
2.	Turmeric	TCP 129	UBKV, Pundibari	Tolerant to leaf spot and leaf blotch and with curcumin content of 5.1% and high dry recovery of 26.51%.
3.	Nutmeg	Konkan Sanyukta	Dr BSKKV, Dapoli	Monoecious nutmeg bearing 500 fruits per plant per year with bold nuts (9.20 g), mace wt (1.07 g), high nut oil (27%) and mace oil (17.75%).
4.	Coriander	Rajendra Dhania 3	Dr RPCAU, Dholi	Climatic resilient coriander variety with high yield (14.09 q ha <sup>-1</sup> ) and high oil (0.52%), recommended for national release.
5.	Coriander	JD(SI)1	JNKVV, Jabalpur	High oil type coriander (0.67%) with high yield potential (14.14 q ha <sup>-1</sup> ) suitable for Madhya Pradesh.
6.	Coriander	Ajmer Coriander 3	ICAR-NRCSS, Ajmer	High volatile oil (0.55%), high linalool (75.42%), high (13.09 q ha <sup>-1</sup> ) and stable yield.
7.	Coriander	Chhattisgarh Sri Chandrahasini Dhania - 2	IGKV, Raigarh	Climate resilient coriander variety suitable for both leafy and seed purpose, moderately resistant to powdery mildew and aphids.
8.	Fennel	Ajmer Fennel 3	ICAR-NRCSS, Ajmer	High yielding (21.43 q ha <sup>-1</sup> ) and high oil (1.9%) fennel resistant to <i>Ramularia</i> blight suitable for fennel growing regions of the country.
9.	Fenugreek	HM 425	CCSHAU, Hisar	High yielding (20-22 q ha <sup>-1</sup> ) powdery mildew and downey mildew resistant fenugreek suitable for fenugreek growing regions of the country.
10.	Fenugreek	Narendra Richa (NDM 79)	NDUA&T, Kumarganj	Dual purpose alkaline tolerant fenugreek with moderate resistance to powdery mildew suitable for Uttar Pradesh and Andhra Pradesh.
11.	Cumin	Gujarat Cumin 5	SDAU, Jagudan	High yielding wilt resistant cumin with short duration and high yield (38% higher yield than GC 4) suitable for cumin growing regions of the country.

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

- Certificate from pathologist/entomologist for pest and disease resistance has to be included in the release proposal.



- Stability analysis data need to be included in the release proposal.
- All the technologies identified may be demonstrated through KVKs of the respective regions of adoption.
- The approved technologies are to be incorporated in the package of practices of the state.
- The recommended technologies must be prepared in a brochure form covering application methodology, preparation of materials/chemicals, ingredients and sources of availability in detail and submitted to Project Co-ordinator cell.

## XVIII. POPULARIZATION OF TECHNOLOGY

Popularization of the latest technologies to make aware the farming community about scientific cultivation practices and sustainable spice production is a mandate of AICRPS. Scientist from AICRPS centres have actively involved in popularizing some of the technologies demonstrated during the year as follows.

### Popularization of technologies

- Demonstration of the foliar mixture 1, viz., potassium nitrate 0.5%, boric acid 0.3%, zinc sulphate 0.25%, ferrous sulphate 0.25% and magnesium sulphate 0.25% was conducted at different location at Yercaud, demonstration of bio control agents for pepper wilt at Karadiyur village was conducted to educate 34 farmers and demonstration on preparation of enriched compost along with bio fertilizers and bio control agents was demonstrated in the Asambur village (Yercaud).
- The grafted pepper cultivation was demonstrated on a large scale at Sri. Raghav Hegde, Somanalli Ta. Sirsi (Uttara Kannada dist.) About 650 grafted vines were planted four years ago. The farmer has harvested a minimum of 1.7 kg dry pepper per vine during 2018-19. No foot rot symptom is seen in any of the vines while about 80 per cent mortality is seen in vines which are not grafted (Sirsi).
- Fish meal trap was found effective against shoot fly in cardamom and popularized among the farming community. The traps were installed in all the experimental plots for the control of shoot fly (Sakleshpur).
- Front line demonstration was done to evaluate the performance of TCP-129 (turmeric germplasm) for yield and tolerance to foliar diseases. Technology assessment trials were conducted in the farmers field of Mahishbathan, village of Cooch Behar and found successful (Pundibari).
- Single bud propagation in ginger from other AICRPS was transferred to farmers' field in Odisha (Pottangi)
- Nutmeg grafts was introduced as intercrop in coconut, arecanut and in multitier cropping system, cinnamon was recommended as intercrop and hardy crop (which is resistant to drought condition and less management practices and provides more income). More seedlings are raised by farmers with less management practices (Pechiparai)
- In black pepper, standards like *Glyricidia* and *Simauruba glauca* are most popular and useful standards used in this station and the farmers have adopted this technique and proved successful in their gardens and popularization of bush pepper plants as homestead gardening, terrace gardening and kitchen garden is done ((Pechiparai)

- To popularize the improved variety of turmeric NDH-98 and also for higher income, 30 kg rhizome of the variety was distributed to three farmers. This variety performed better than local cultivars in terms of yield and resistance to pest and diseases in farmers' field. The average yield of turmeric variety NDH-98 was 30t/ha or 120 kg from 10 kg planting material (Pasighat)
- Sri. Shinoj Immanuel, Kappimala has demonstrated superiority of Panniyur black pepper varieties on thornless *Erythrina* standards, Sri. Joseph, Puthuparambil, Kudiyanmala has demonstrated yield potential of Panniyur varieties under high altitude cultivation, Sri. Jacob Thannimoottil, Mathamangalam has successfully conserved more than fifteen local genotypes of black pepper and is following IPDM practices on Panniyur varieties successfully. Sri. George Kaliyanil, Chandanakkampara has demonstrated the performance of all Panniyur varieties and grafts (Panniyur)
- Popularization of technologies like turmeric nursery with pro-tray technology for seed material production to reduce the seed cost and seed treatment with Ridomyl MZ @ 0.2% + monocrotophos @ 0.2% for 45 minutes and four rows of raised bed method for higher yields (Kammarapalli)
- The budget (Rs.10000/-) for demonstrations at farmers field was sanctioned by the PC Unit and 08 demonstrations of fenugreek and fennel were laid out during *Rabi*, 2018-19 to popularize the HYV and advance technology developed for the state. It is clear from the results that by adopting the recommended package of practices such as quality seed, seed treatment, and application of proper dose of fertilizers at appropriate time and plant protection measures increased the seed yield of fenugreek by 14.74% to 28.97% over checks (farmers practices) and fennel by 22.28to 34.09% over check (farmers' practices) at different locations (Jobner)
- Demonstrated transplanting of turmeric cv. Rajendra Sonia in association with Mangaladri Farmers Cooperative Pvt.Ltd. which is farmers cooperative of five hundred turmeric farmers (Guntur)
- Demonstration of harvesting and processing of black pepper was conducted. The demonstration was conducted on how to processing black pepper and also white pepper production. Pro-tray production techniques of raising seedlings of turmeric and ginger were demonstrated to the farmers (Dapoli)

## XIX. SUCCESS STORIES

### Black pepper for income generation

Black pepper is one of the important spice crops of Kerala. Sri.Raghavan Nambiar, Kalyadankandi veedu, Pattanur has successfully cultivated and demonstrated the high yield potential of Panniyur varieties under drip irrigation system Mr. Ramesan P.E., Vayakkara, Sreekandapuram has conserved many valuable genotypes and successfully cultivated grafts of black pepper. Sri. George, Mankulathu, Kunnithala, Nalpady, Peravoor (P.O.) has planted one hectare of *Piper colubrinum* grafts and all the released Panniyur varieties under drip irrigation. Ali Parakkadavathu, Blathur has successfully demonstrated the yield potential of Panniyur varieties under IPDM.

### **Turmeric cultivation for prosperity**

Sri Bakki Govardhan yadav, a turmeric farmer of Adilabad district, obtained more than 30 tonnes per acre rhizome yield and is cultivating six varieties (Rajendra Sonia, Rajendra sonali, Acc No. 48, Acc. No. 79, Salem and Duggirala Red) under the guidance of Kamarpally Research Station. He is nominated as RAC member in the PJTSAU, Hyderabad and has won state level award also. Sri Chinta Thirupathi Reddy of Maggidi village of Armoor also cultivated the same varieties and obtained 29 t/acre rhizome yield. Ramakrishna Reddy from Warangal, is another progressive farmer who produced 180 quintals of turmeric per acre cultivating Duggirala Red following the package of practice of Kamarpally Research Station.

### **Mixed cropping for doubling farmers income**

The mixed cropping system ensures additional income to the farmers. In an experiment on mixed cropping, the yield obtained in different inter crops during 2018-19 were colocasia 4.02 tons, arrow root 4.11 tons, elephant foot yam 11.17 tons, tapioca 9.31 tons and greater yam 10.0 tons, per/ha respectively. The yield obtained in different mixed crop blocks for pineapple were 3.39 tons in colocasia 3.35 tons in arrow root 3.39 tons in elephant foot yam and 3.14 tons in tapioca blocks respectively. Monocrop black pepper did not produce additional yield as it is in pre bearing stage. It was observed that black pepper + elephant foot yam and pineapple and black pepper + greater yam proved most economical treatment in all four years of experiment with average B:C ratio 2.35 which indicates that the farmers income can be double with these combinations.

### **High yielding ginger and turmeric varieties- for income maximization**

Young enterprising youths of Pottangi came forward for cultivation of ginger and turmeric with improved package of practices. They were supplied with high yielding varieties of ginger and turmeric and provided with all improved technology by the scientists of AICRPS, HARS, Pottangi. After they became successful in getting a very high return, many unemployed youth and progressive farmers were attracted towards the cultivation of ginger and turmeric.

### **Mixed cropping- bonus to farmers**

The mixed cropping system ensures additional income to the farmers. The yield obtained in different inter crops in year 2018-19 are per/ha varied as colocasia 4.02 tons, arrow root 4.11 tons, elephant foot yam 11.17 tons, tapioca 9.31 tons and greater yam 10.0 tons, respectively. The yield obtained in different mixed crop blocks for pineapple varied as 3.39 tons in colocasia 3.35 tons in arrow root 3.39 tons in elephant foot yam and 3.14 tons in tapioca block respectively. Monocrop black pepper did not produce additional yield as it is in pre bearing stage.

### **High yielding ginger and turmeric varieties- for reaping profit**

Young enterprising youths of Pottangi came forward for cultivation of ginger and turmeric with improved package of practices. They were supplied with high yielding varieties of ginger and turmeric and provided with all improved technology by the scientists of AICRPS, HARS, Pottangi. After they became successful in getting a very high return, many unemployed youth and progressive farmers were attracted towards the cultivation of ginger and turmeric. The success story of 7 progressive ginger growers during 2018-19 cultivated ginger (sourabh) in 16.6 ha of land harvested a total of 18.44 tonnes fresh ginger rhizome @ 8000/quintal.



Transforming livelihood of tribal farmers of Chintapalle, Andhra Pradesh through introducing high yielding turmeric cultivar Roma and extending production of the seedling by using single node cuttings in turmeric in collaboration with KVK, Kondempudi, BCT-KVK, Yelamanchili and NGOs.

### **Intercropping spices for additional benefit**

Mr. Drush Kr. Sangma is a farmer of village Santipur under Boko Agricultural Sub Division in Kamrup district of Assam. He had 3 ha of land with arecanut plantation intercropped with black pepper. Although the black pepper attained the productive age of growth, he did not get satisfactory return. Due to the intervention of AICRPS at Kahikuchi, he was able to convert his black pepper garden to a beautiful and productive one and finally earned Rs 2,17,000 from 500 plants during 2018-19. Mr. Sangma is now self sufficient income and has been running his four members family happily.

At Dapoli a farmer has trained black pepper on mango tree as inter crop in established mango orchard. It was planted in year 2012. Both mango and black pepper are at bearing stage. There are 600 mango trees and 250 pepper vines were trained on mango trees. The farmer earned a profit of 7 lakhs after deducting the production cost (Rs. 4.5 lakhs) and thereby farmer's income has been doubled by cultivating spices on mango orchard.

## **XX. KRISHI MELAS & FARMER'S TRAININGS**

### **Krishi Melas/exhibition organized**

- Farmers day cum training programme for farmers on procurement of quality seed, seed treatment and sowing methods was conducted on 18.04.2018 at High Altitude Research Station, (OUAT), Pottangi
- Farmers training on Black pepper cultivation on 29.01.2019 at Merchant Association Hall, Kudiyannala, Kannur was conducted by PRS, Panniyur centre. About 100 farmers participated and benefitted
- About 200 farmeres participated in "Turmeric – Improved varieties and production of turmeric transplants through portrays" conducted by Tamil Nadu Agricultural University, Coimbatore on 19.05.2018..
- On field training programme for the farmers of Dzongu, North Sikkim and Rogli, East Sikkim was conducted on 05.09.2018 and 13.09.2018 by ICRI, RS, Gangtok, around 130 farmers participated and got benefitted.
- "Scientific production technology of ginger and turmeric" under CSS-MIDH at Ziro, Lower Subansiri district, Arunachal Pradesh was conducted by CAU, Pasighat on 15.02.2019. 103 farmers participated in the programme.



SCSP Training programme conducted at Ambalavayal

### Trainings organized by various AICRPS centres

Sl. No.	Date	AICRPS centre	Details of training	No. of farmers
1.	26.05.2018	NDUAT, Kumarganj	Nursery management in spice crops	75
2.	30.05.2018	PPS, Panniyur	ATMA training on black pepper cultivation	22
3.	02.06.2018	IGKV, Raigarh	Scope of organic farming in Spices at Patel Dharmashala Raigarh	30
4.	04.06.2018 09.06.2018	ICRI, Sakleshpur	Hands on training on Bio-Agents production to Farmers	20
5.	11.06.2018	PPS, Panniyur & KVK Kannur	'Skill development training programme for youth'	20
6.	11.06.2018, 14.06.2018 & 29.06.2018	KAU, Ambalavayal	Pepper cultivation	220
7.	10.07.2018	PPS, Panniyur	Pepper cultivation at Kunnummel Block, Kozhikode	20
8.	16.07.2018	IGKV, Raigarh	Training of Self help group in collaboration with KVK, Raigarh.	25
9.	24.07.2018	SKLTSHU, Kammarpally	Turmeric cultivation at Domakonda fort, Kamredy district	55
10.	10.07.2018	PPS, Panniyur	Pepper cultivation at Kunnummel Block, Kozhikode	20
11.	10.08.2018	PPS, Panniyur	Pepper cultivation at KVK Farmers club, Eruvessi Panchayath, Kannur	130
12.	17.09.2018	RARS, IGKV, Raigarh	Spices production and disease management	50
13.	18.09.2018	RARS, KAU, Ambalavayal	Crop management in black pepper	80
14.	27.09.2018 & 28.09.2018	HRS, TNAU, Yercaud	Training programme on Coffee, pepper and silver oak cultivation in collaboration with Integrated Development Scheme for Hill Tribes	120

15.	13.11.2018	PRS, Panniyur	Training programme on black pepper cultivation	38
16.	23.11.2018	HRS, TNAU, Yercaud	Cultivation practices of Black Pepper to the farmers from Kollihills	50
17.	7.12.2018 & 8.12.2018	NDUAT, Kumarganj	Kisan Mela	75
18.	11.12.2018	PRS, Panniyur	Farmers training on Black pepper cultivation in collaboration with ATMA	70
19.	27.12.2018	ICRI Gangtok	Exposure tour cum training on cultivation aspects of large cardamom for the officials of Dept. of Hort. & Dept. of Agri., Govt of Arunachal Pradesh	26
20.	28.12.2018	ICRI Gangtok	Master Training Programme on Scientific post harvest technology of large cardamom and ginger	49
21.	10.01.2019	HRS, Yercaud	Cultivation practices of Black Pepper farmers from Kolli hills.	50
22.	15.01.2019	PRS, Panniyur	Green protocol for staff and labourers of PRS, Panniyur under Harithakeralam programme of Govt. of Kerala	26
23.	16.01.2019	ICRI Gangtok	Production Technologies of Large Cardamom at ICRI, RRS, Research Farm, Pangthang	12
24.	23.01.2019	ICRI Gangtok	Quality Improvement Training Programme on Large Cardamom at Buriakhop, Jorethang, West Sikkim	52
25.	29.01.2019	ICRI Gangtok	Scientific Production Technologies and Post Harvest Management of Large Cardamom at Gairigaon, Assam Lingzey, East Sikkim.	28
26.	05.02.2019	ICRI Gangtok	Production Technologies of Large Cardamom', at Research Farm, Pangthang Pithoragarh District, Uttarakhand.	16
27.	06-02-2019	PRS, Panniyur	Black pepper cultivation at Taliparamba block Panchayath, Kannur	25
28.	12.02.2019	ICRI Gangtok	"Doubling the Income of Tribal Farmers in Darjeeling Hills: Strategies & Policies" at Tindhury village, Kalimpong, West Bengal	50
29.	13.02.2019	ICRI Gangtok	Quality Improvement in Large cardamom at Lower Mirik, Darjeeling district of West Bengal.	40

30.	14.02.2019 & 26.02.2019	TNAU, Yercaud	“Watershed level user group members under capacity building” under TAWDEVA, Chennai were conducted in 4 batches to the farmer group of 40 members of Trichy district	160
31.	15.02.2019	PRS, Panniyur	Black pepper cultivation to farmers of Padiyur Grama Panchayath , Kannur.	120
32.	15.02.2019 to 28.02.19	UBKV, Pundibari	“Vermicompost Producers” under MIDH Scheme participants	25
33.	20.2.2019	PRS, Panniyur	Black pepper cultivation to farmers from Kooveri, Chapparappadavu Panchayath , Panniyur, Kannur	30
34.	27.02.2019	CCHSAU, Hisar	“Production technology of spice crops” for farmer of Haryana state	75
35.	06.03.2019	CCSHAU, Hisar	“ <i>Production technology of spice crops</i> ” for farmers of Haryana	80
36.	15.02.2019 to 15.03.2019	UBKV, Pundibari	Skill Development Training on “Vermicompost Producers” under MIDH Scheme	25
37.	22.03.2019	Dr.YSRHU, Chintapalle	“Production, Processing and Post Harvest Management in Spice crops” in collaboration with ICAR-Indian Institute of Spices Research, Kozhikode, Kerala.	45
38.	23.3.2019	ICRI, Sakaleshpur	Fifty farmers visited the Institute as part of exposure programme on spices cultivation organized by the NGO “ <i>Shri Kshetra Dharmasthala Rural Development Project (SKDRDP)</i> ”,	50
39.	23.03.19	OUAT, Pottangi	Spices cultivation with practical demonstration to farmers of Pottangi	108
40.	26.03.2019	UBKV, Pundibari	Scope for spices cultivation in multistoried cropping Under MIDH Scheme	80
41.	28.03.2019	DR.YSRHU, Chintapalle	“Seed storage and post harvest management in turmeric and ginger”	30

## XXI. PUBLICATIONS

### Research Publications

#### Chinthapalle

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- Sawargaonkar S L Singh A K & Sahu S 2018 Stability analysis for seed yield and yield attributing traits in fennel. Journal of Spices and Aromatic Crops, 27(1):80-86.





### Sirsi

Divya Bhat, Hegde N K, Hegde L, Manju M J, Shivakumar KM & Mahantesh P S 2018 Effect of Fortified Nursery Media with Bioagents in Nursery Production of Black Pepper (*Piper nigrum* L.) varieties. Int.J.Curr.Microbiol. App.Sci., 7(8): 390-395.

Divya Bhat, Hegde, N.K., Hegde, L., Manju M J & Shivakumar K M 2018 Effect of Foliar Nutrition with Zinc and Boron on the Performance of Black Pepper (*Piper nigrum* L.) under Hill Zone (Zone-9) of Karnataka, India Int.J.Curr.Microbiol.App.Sci., 7(7): 517-522.

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

### Solan

Leharwan, Munish, Gupta, Meenu & Shukla, Arti 2018 Effect of temperature and moisture levels on disease development of stem gall of coriander. Agri. Sci. Digest 38(4):307-309.

### AICRPS Head Quarters, Kozhikode

Thomas V P, Sabu M & Muhammed Nissar V A 2019 A new species of *Amomum* Roxb. (Zingiberaceae) from Nagaland, India. Taiwania 64(1): 9-12.

## Book Chapters

### Chintapalle

Sivakumar V 2018 Black pepper cultivation (Telugu) in Udyana Panchangam, Dr. YSRHU, A.P.

Sivakumar V 2018 Cardamom cultivation (Telugu) in Udyana Panchangam, Dr. YSRHU, A.P.

Sivakumar V 2018 Coffee cultivation (Telugu) in Udyana Panchangam, Dr. YSRHU, A.P.

Sivakumar V 2018 Ginger cultivation (Telugu) in Udyana Panchangam, Dr. YSRHU, A.P.

Sivakumar V 2018 Turmeric cultivation (Telugu) in Udyana Panchangam, Dr. YSRHU, A.P.

### Hisar

Kumar V, Tehlan, S K and Kumar A 2018 *Quality seed production of seed spices*. In: Advances in Agriculture Sciences (Singh, A.K., Alam, M.D. S., Harish,M.S., Seema, Kumar,V.,Kumar,A. and Loyavar, R.C.) Akinik Publications.

Kumar V, Tehlan, S K and Kumar, S 2018 *Post harvest technology and value addition in spices*. In: Advances in Horticultural Crops (Singh, J.; Nigam, R.; Kumar, A. and Singh, H.) Weser Books, Zittau, Germany.

### Jobner

Dudwal BL & Shivran AC 2018 Crop Diversification and Strategies for Adaptation to Climate change in Rainfed areas. In: Sustainable Development for Agriculture and Environment. J. Singh et al. (eds.) Published by Anu Books, New Delhi, India 2018. pp. 10-11.

### Solan

Gupta S K & Gupta Meenu 2018 Diseases of commercial vegetables and their management. In: About Diseases of Horticultural Crops, eds, HR Gautam and SK Gupta, Neoti Book Agency Private Limited, New Delhi, India, 265-274.

Gupta S K & Gupta Meenu 2018 Diseases of Vegetables under Protected Cultivation Conditions. *Plant Disease Research* 33(1): 1-14.

Gupta, Meenu & Vikram, A. 2018 Botanical based formulations for management of diseases of vegetable crops. In: Alternative Approaches in Plant Disease Management. Eds. Satish K. Sharma and HR Gautam, Neoti Book Agency Private Limited, New Delhi, pp. 474-496.



## Leaflet/Folder /Booklet /Bulletins

### Coimbatore

Balakrishnan S, Shoba N, Ramar A, Mohanalakshmi M, Ushamalini C, Jegadeeswari V, Senthamizh Selvi B & Pugalendhi L 2019 Curry leaf – Production technology. Pg: 1-17.

Balakrishnan S, Shoba N, Ramar A, Mohanalakshmi M, Ushamalini C, Jegadeeswari V, Senthamizh Selvi B & Pugalendhi L 2019 Turmeric – Production Technology. Pg:1-31.

### Mudigere

Shivaprasad M, Ravi C S, Swamy A V, Pavithra N R, Rashmi C, Ramya T S & Shilpa Malaghan 2018 Rubbernalli Anthara beleyagi elakki.

Shivaprasad M, Ravi C S, Swamy A V, Rashmi C, Pavithra N R, Ramya T S & Shilpa Malaghan 2018 Four Decades of Cardamom Research at AICRP (S).

Shivaprasad M, Ravi C S, Swamy A V, Shilpa Malaghan, Ramya T S, Pavithra N R & Rashmi C 2018 Dashakagala Elakki Sadane.

### Solan

Gupta Meenu & Sharma AK 2018 Diagnosis and Management of Diseases of Spice Crops in Himachal Pradesh. Published by AICRP on Spices, ICAR, New Delhi and Dept. of Vegetable Science, UHF, Nauni, Pg: 1-33.

## Popular Article

### Chintapalli

Sivakumar V & Mallikarjuna Rao 2018 Adhunik Paddatulalo Allam Saagu. Annadaatha, April, Pg: 18-20.

### Dapoli

Khandekar R G and Kulkarni Krishi Jagran Masik M M 2018 Kokamachi Lagwad ani Jati 2018 in marathi- Pg:1-5.

Khandekar R G and Kulkarni Krishi Jagran Masik M M 2018 Kharip Hangamat Kanda Pikanchi Lagwad Pg: 6-7.

### Sanand

T T Patel, J P Bhatt, D R Patidar & G. A. Patel 2019 Beej-masala pakoni vaigyanik kheti padhati (Gujarati Language).

### Solan

Meenu Gupta 2018 Bacterial wilt – an emerging disease in ginger. Technology Notes- Himalayan Phytopathological Society, Dr YS Parmar university of Horticulture & Forestry, Nauni, 1(1): 7.

Gupta, Meenu. 2018. Pink root of garlic in Himachal Pradesh. Indian Phytopathological Newsletter 1(4): 4.

Meenu Gupta and Shalini Verma. 2018. Jalvaayu Parivartan ka Krishi tatha rogon par prabhav. Zigyasa Vigyan Patrika (submitted).

### Guntur

Sarada, C., Giridhar, K., Hariprasad Rao, N., Naram Naidu, L., Venkata Ramana, C., Rajani, Ambati., Vijayalakshmi, T. and K. Sireesha. Lam udyana parishodhana stahanam nundi vidudalaina nutana vangadalu. Rytunestam, December, 2018.

### Kumarganj

Kumar S, Pandey V P, Singh D & Kumar P 2018 Adarak ki Vaigyanik kheti. Krishi Bharti, Pg: 8-10.

Kumar S, Singh D & Pandey V P 2019 Guno Se ParipurnAdrak, KrishakAradhana, Pg: 11.

Kumar S, Singh D & Pandey V P 2019 ApnePuraneBagicheko de NayaJivan, Madhya Bharat Krishak Bharti. Pg: 27.

Kumar S, Singh D & Pandey V P 2019 Patta Gobhi ki Jaivik Kheti, KrishakAradhana, pp. 2.

Pandey V P, Singh D, Kumar S & Kumar P 2018 Haldi ki Vaigyanik kheti. Purvanchal kheti, Pg: 16-17.

Singh D, Kumar S & Pandey V P 2019 Swasth Sabjiya, Swasth Jivan, Madhya Bharat Krishak Bharti. Pg: 16.

## Publications in Seminar/Conference/Abstract/Symposium

### Ambalavayal

- Ajith Kumar K, Renjan B Shajeesh Jan 2019 Organised AICRP on Spices SCSP Training programme for SC farmers, RARS, Ambalavayal.
- Ajith Kumar K, Shajeesh Jan, Renjan B 2019 Facilitated organizing MIDH-“Sugandhi 2019”, RARS, Ambalavayal.
- Renjan B 2018 Attended one day workshop “Child development through horticultural therapy”, Govt. guest house, Vazhuthakkad, Thiruvananthapuram.
- Renjan B 2019 Presented paper “History of meteorological alterations and peasant life since 1990”, NMSM, Govt. college, Kalpetta, Wayanad).

### Jabalpur

- National Seminar on “Advances and Challenges in Horticulture” was organized by Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur in collaboration with Department of Horticulture and Food Processing, Govt. of Madhya Pradesh during February 26-27, 2019 at College of Agriculture, Jabalpur.

### Jobner

- Dhirendra Singh, D K Gothwal, A C Shivran & Girdhari Lal Kumawat 2019. Plant Genetic Resources in Seed Spices. Presented in State Level Seminar on Clean and Safe Production of Seed Spices for Enhancing Farmers Income. Organized by NRCSS, Tabiji-Ajmer during 27-28 March, 2019.
- Gothwal D K, Shivran A C & Sh Kumawat G L 2018 Annual Workshop of AICRP on Spices at Nauni (Himachal Pradesh). Organized by AICRP on Spices at Nauni, H.P during Four Days/ 03-06 Oct 2018.
- Shivran A C 2018 XXI Biennial National Symposium on “Doubling Farmers’ Income Through Agronomic Interventions Under Changing Scenario”. Organized by MPUA&T, Udaipur, Rajasthan during Three Days/24<sup>th</sup> - 26<sup>th</sup> Oct 2018.
- Kumawat G L 2018. Election Duty as Executive magistrate, Flying Squared, State Legislation Election-2018. Organized by R.O, Bassi, Jaipur during 59 days/11.10.2018-08.12.2018.
- Dhirendra Singh & Shivran A C 2019. State level seminar on “Clean and safe production of seed spices for enhancing farmers’ income”. Organized by ICAR-NRCSS, Ajmer during 27<sup>th</sup>-28<sup>th</sup> March, 2019.

### Pampadumpara

- Sathyan T, Dhanya M K, Aswathy T S, Murugan M and Ambika Menon R 2018 Evaluation of biocontrol agents and chemical nematicides on the management of nematode pest of small cardamom’. Abstract of symposium on Zoology congress 2018, Palayamkotti, Tamil Nadu.pp 67.
- Sathyan T, Dhanya M K, Manoj V S, Aswathy T S and Murugan M 2018 Influence of meteorological parameters on the population dynamics of mealy bugs (*Ferrisia virgata*) in black pepper. Extended Abstract of International conference on biocontrol and sustainable insect pest management.500-502.
- Murugan M 2018 Impact of climate change in cardamom cultivation In: Krishnamurthy K S, Biju C N, Prasad D, Senthil Kumar C M, Kandiannan K, Maiti C S, Pauline Alila, Akali Sema, Aviboli Zhimomi & Nirmal Babu K (Eds) .2018. Souvenir and Abstracts, National Symposium on Spices and Aromatic Crops (SYMSAC IX): Spices for doubling farmer’s income. Indian Society for Spices, Kozhikode, Kerala, India.pp 130-135.
- Murugan M, Dhanya M K, Sathyan T, & Aswathy T S 2018 Empirical evidences on the ecological nexus of the tropical cardamom production system In: Krishnamurthy K S, Biju C N, Prasad D, Senthil Kumar C M, Kandiannan K, Maiti C S, Pauline Alila, Akali Sema, Aviboli Zhimomi & Nirmal Babu K (Eds) .2018. Souvenir and Abstracts, National Symposium on Spices and Aromatic Crops (SYMSAC IX): Spices for doubling farmer’s income. Indian Society for Spices, Kozhikode

### Panniyur

- Laya P K, Yamini Varma C K, Nusrath Beegum C H, Anita Cherian K, Beena S, Mohamed Anees, Rashmi C R and Rajeshkumar P P 2018 Physiological characterisation and standardization of culture medium for *Ophiocordyceps neovolkiana* (Kobayasi) from Kerala, India *International Conference*

- on “Role of Soil and Plant Health in Achieving Sustainable Development Goals” at Bangkok, Thailand, November 21-25, 2018. organized by Indian Phytopathological Society Asia- Pacific Association of Agricultural Research Institutions and Dept. of Agriculture, Bangkok, Thailand
- Yamini Varma C K, Mohamed Anees M, Rashmi C R 2018 Muhammad Suhaib Ismayil M 2018 Bio safety in the mass multiplication of the fungal biocontrol agent, *Trichoderma* National Symposium on “Cutting edge approaches for sustainable plant disease management and ensuring farmers’ profit by Indian Phytopathological Society (South zone) at ICAR-National Research Centre for Banana, Tiruchirapalli, Tamil Nadu. December 21 to 23rd, 2018.
- Laya P K, Yamini Varma C K, Anita Cherian K, Beena S, Mohammed Anees M and Rashmi C R 2018 Isolation and molecular characterization of the mysterious caterpillar fungus *Ophiocordyceps neovolkiana* from Kasargod district of Kerala. National Symposium on “Cutting edge approaches for sustainable plant disease management and ensuring farmers’ profit” by Indian Phytopathological Society (South zone) at ICAR-National Research Centre for Banana, Tiruchirapalli, Tamil Nadu. December 21 to 23rd, 2018.

### **Solan**

- Meenu Gupta 2018 XXIX Workshop of ICAR- All India Coordinated Research Project on Spices organized by ICAR- IISR and Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan HP, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan HP 03-6 October, 2018

### **Pasighat**

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

### **Raigarh**

- Singh A K, Shrikant Sawargaonkar, Sandipa Paikara & Paraye P M 2019 Survey for identification of disease causing organism, screening of local germplasm and management of *Colletotrichum* leaf spot of turmeric by new generation fungicides. Poster Presented in 8th Indian Horticulture Congress 2019 “Shaping future of Indian Horticulture” at IGKV, Raipur, Chhattisgarh.
- Sawargaonkar S L, Singh A K, Sandipa Paikara & Paraye P M 2019 Performance of turmeric genotype in Chhattisgarh for yield and attributing traits. Poster Presented in 8th Indian Horticulture Congress 2019 “Shaping future of Indian Horticulture” at IGKV, Raipur, Chhattisgarh.
- Swargaonkar S L, Singh A K & Sahu S 2018 Identification of Water-logging Tolerant Genotypes in Turmeric for Chhattisgarh for National Symposium on Spices and Aromatic crops (SYMSAC - IX) will be held at School of Agricultural Science & Rural Development (SASRD) at Nagaland University, Medziphema Campus Nagaland during 15-17 March 2018.
- Singh A K attended and oral presentation on 71st Annual meeting of Indian Phytopathological Society and National Symposium “Recent Challenges and opportunities in Sustainable Plant Health Management February 26-28, 2019 “Effect of Plant growth promoting Rhizobacteria (PGPR) bio-capsule on growth yield, and foliage disease suppression in turmeric (*Curcuma longa* L.) Under field condition at Banaras Hindu University, Varanasi.

### **ICRI Gangtok**

- Swargaonkar S L, Singh A K & Sahu S 2018 Identification of Water-logging Tolerant Genotypes in Turmeric for Chhattisgarh for National Symposium on Spices and Aromatic crops (SYMSAC - IX) will be held at School of Agricultural Science & Rural Development (SASRD) at Nagaland University, Medziphema Campus Nagaland during 15-17 March 2018.
- Gudade B A, Ashutosh Gautam, Bora S S, Dhanapal K & Rema Shree A B 2018. Effects of Soil Application of Mg, Zn and Mn on Growth and Yield of Large Cardamom (*Amomum subulatum* Roxburgh). Publication in the International Symposium on “Advancement in Soil, Water and Plant Nutrition Research (ISSWPNR-2018)” from 02 to 03 November, 2018 at College of Agriculture Nagpur, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Maharashtra, India.

Gudade B A, Ashutosh Gautam, Bora S S & Rema Shree A B 2018. Effects of Soil Application of Mg, Zn and Mn on Growth and Yield of Large Cardamom (*Amomum subulatum* Roxburgh) published in the International Symposium on “Advancement in Soil, Water and Plant Nutrition Research (ISSWPNR-2018)” organized by International Plant Nutrition Institute, South Asia Program, USA and Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Maharashtra, India at Nagpur, M.S. during 02-03 November, 2018 pp. 89-90.

### **Dapoli**

Rathod R R, Khandekar R G, Suryawanshi A P, Bhagwat R G, Pethe U P, Sawant U K, Joshi M S, Kadam J J & Shirke G D 2018 Reactions of Turmeric Varieties against Diseases of collectotrichum leaf spot and pythium Rhizome Rot. Abstracts published in 12<sup>th</sup> National symposium on costal agriculture, Boosting production potential under stressed Environment 18<sup>th</sup> September- 1<sup>st</sup> October 2018 Pg: 46.

Rathod R R, Khandekar R G, Suryawanshi A P, Bhagwat R G, Pethe U P, Sawant U K, Joshi M S, Kadam J J & Shirke G D 2018 Study on field screening of Ginger varieties against phyllosticta leaf spot and pythium Rhizome Rot Diseases abstracts published in 12<sup>th</sup> National symposium on Costal Agriculture, Boosting production potential under stressed Environment 28<sup>th</sup> September - 1<sup>st</sup> October 2018, Pg:46.

### **Jagudan**

Prajapati B G & Amin A U 2018 Eco-friendly management of sucking insect pests infesting cumin. Proceedings of SYMSAC-IX on spices for doubling farmer's income held at SASRD, Medziphema, Nagaland during March 15-17, 2018. Pg: 185-186.

## XXII. Awards and Recognitions

### ICAR- Chaudhary Devi Lal Outstanding AICRP

ICAR-Chaudhary Devi Lal Outstanding AICRP Award (2017-18) was awarded to AICRP on Spices, Kozhikode. Pepper Research Station, Panniyur (KAU), Kerala was awarded the best AICRP centre under spices.



**Dr. K. Nirmal Babu, Project Coordinator (Spices) and Director, ICAR-IISR, Kozhikode receiving ICAR-Chaudhary Devi Lal Outstanding AICRP centre award**

### Recognition

Dr. Ajith P. M received a certificate of appreciation for being the Principal Breeder of the new black pepper variety Panniyur 9 from Hon. Minister for Industries, Sports and Youth Affairs, Govt. of Kerala on 26/5/18

Mr. Ashutosh Gautam, Scientist-B (Crop Improvement) has been awarded the certificate for Intellectual property (IP) by World Intellectual Property Organization Academy (WIPO Academy), Geneva, Switzerland.

Mr. Ashutosh Gautam has been nominated as member of editorial boards of following journals,

- Acta Scientific Agriculture published by AS International Open Library.
- International Journal of Agricultural Research, Sustainability and Food Security published by Academia Scholarly Journals.

### Oral / Poster Presentation Awards

Ajit Kumar Singh, Shrikant Sawargaonkar, Sandip Paikara & P M Paraye 2018 Survey, etiology, screening of local germplasm, management of Taphrina leaf blotch ( Taphrina maculans Butler) of turmeric by new generation fungicides and validation under farmers fields. Special national symposium on extension Plant Pathology: sept.25-26, September 2018 pp.91-92 (Best oral presentataion).

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

## XXIII. STAFF POSITION

### Project Coordinator's Office

- |                                   |                      |
|-----------------------------------|----------------------|
| 1. Project Coordinator            | : Dr. K. Nirmal Babu |
| 2. Principal Scientist (Agronomy) | : Dr. K. Kandiannan  |
| 3. Scientist (SPMAP)              | : Dr. Sharon Aravind |
| 4. Technical Officer              | : Dr. E. Radha       |
| 5. Personal Assistant             | : Vacant             |
| 6. Skilled Supporting Staff       | : Vacant             |

### Coordinating Centres

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

- |  |                       |
|--|-----------------------|
| 1. Asst.Professor (Soil Scientist)             | : Dr.M.Murugan        |
| 2. Associate Professor (Agronomy/Horticulture) | : Dr. Nimisha Mathews |
| 3. Laboratory Assistant Gr. II                 | : Mr. R.Anil Kumar    |
| 4. Peon  | : Mr. Shinoj Antony   |

#### 2. Pepper Research Station, KAU, Panniyur

- |  |                         |
|--|-------------------------|
| 1. Asst. Professor/ Jr. Breeder (Pl. Breeding) | : Dr. P. M. Ajith       |
| 2. Associate Professor (Plant Pathology)       | : Dr. C K, Yamini Varma |
| 3. Asst. Professor (Agronomy/Horticulture)     | : Dr. C.K. Airina       |
| 4. Farm Manager Gr II                          | : On daily wages        |
| 5. Lab Asst. Gr.III                            | : Mr. K. Rajeev         |

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

- |                                   |                      |
|-----------------------------------|----------------------|
| 1. Associate Professor (Agronomy) | : Dr. M. Shivaprasad |
| 2. Technical Assistant            | : Vacant             |

#### 4. Horticultural Research Station (UHS), Sirsi

- |  |                                |
|--|--------------------------------|
| 1. Professor (Horticulture)              | : Dr. Laxminarayan Hegde       |
| 2. Associate Professor (Plant Pathology) | : Mr. A. Prashantha            |
| 3. Technical Assistant                   | : Sri. Santosh Kumar Bommanagi |

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

- |                               |                     |
|-------------------------------|---------------------|
| 1. Jr.Breeder (Horticulture)  | : Dr. M. Anand      |
| 2. Jr. Breeder (Horticulture) | : Dr. P. Arul Arasu |
| 3. Jr. Breeder (Horticulture) | : Dr. P. Arul Arasu |
| 4. Lab Assistant              | : Mrs. K. Leela     |

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

- |                                |                           |
|--------------------------------|---------------------------|
| 1. Breeder (Horticulture)      | : Dr. B. Senthamizh Selvi |
| 2. Jr. Pathologist (Pathology) | : Dr. S.Sundravadana      |
| 3. Agricultural Assistant      | : Th. R. Swaminathan      |

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

- |                                |                   |
|--------------------------------|-------------------|
| 1. Scientist (Plant Pathology) | : Dr. B. Mahender |
| 2. Jr. Horticulturist          | : Dr.P.Srinivas   |
| 3. Technical Assistant         | : K Vijaya Kumar  |
| 4. AEO                         | : Vacant          |

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

- |                                    |                           |
|------------------------------------|---------------------------|
| 1. Senior Scientist (Horticulture) | : Dr V. Siva Kumar        |
| 2. Technical Assistant             | : Vacant (Contract basis) |

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

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

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

1. Jr. Pathologist : Dr. Meenu Gupta
2. Jr. Biochemist : Dr. Vipin Sharma
3. Field Assistant : Mr. Jogindhar Bansal

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

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

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

1. Sr. Breeder : Dr. Dharendra Singh
2. Junior Pathologist : Sh. G. L. Kumawat
3. Agronomist : Dr. A. C. Shivran
4. Junior Technical Assistant : Sh. S. R. Kumawat

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

1. Assoc. Research Scientist (Plant Pathology) : Dr. N.R. Patel
2. Asst. Research Scientist (Plant Breeding) : Dr. Surabhi S. Chauahn
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. C. Mukhin
2. Jr. Pathologist : Dr. A. K. Mishra
3. Technical Assistant : Sh. A. N. Mishra

**16. Department of Vegetable Science (NDUAT), Kumarganj**

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

**17. Department of Horticulture (UBKV), Pundibari**

1. Horticulturist : Dr. Suchan Dutta
2. Jr. Pathologist : Dr. Anamika Debnath
3. Technical Assistant : Sh. Murari Krishna Roy

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

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

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

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



## XXIV. TRAINING AND CAPACITY BUILDING

### Trainings attended by the Staff of AICRPS

S. No	Name and Designation	Details of training	Venue	Duration
1.	Dr. B. Renjan	Soil, plant and field health management in spice garden	RARS, Ambalavayal	07.03.2019
2.	Dr. M. Murugan	Quality of spices and pesticides	District Industrial Centre, Kattapana	02.11.2018
3.	Dr. M. Palanikumar	The demo on web science and reference management training	ADAC&RI, Trichy	11.12.2018
4.	Dr. Laxminarayan Hegde	ICAR-CAFT training programme	College of Horticulture, Sirsi	03.12.2018 to 23. 12. 2018
5.	Dr. Dr. J.P. Devmore	Mutation breeding for crop improvement	BARC, Mumbai & Regional Agricultural Research Station, Karjat, Dr. B. S. Konkan Krishi Vidyapeeth	26.11.2018 to 01.12.2018
6.	Dr. V. Sivakumar	National training programme on entrepreneurship management & development	Ahmedabad	3.12.2018 to 14.12.2018
7.	Dr. B. Senthamizh Selvi	One day training on automated agro advisory - web cum mobile app	TNAU, Coimbatore	15.02.2019

## XXV. AICRPS CENTRE WISE BUDGET 2018-2019

Regular centre	Salary		TA		RC		Tech. A	Total RC	Works		Total		Grand
	ICAR	State	ICAR	State	ICAR	State	ICAR	ICAR	ICAR	State	ICAR	State	Total
Pampadumpara (KAU)	17.13	5.17	0.5	0.17	1.50	0.50	0.1	1.6	-	-	19.23	6.41	25.64
Panniyur (KAU)	26.39	8.79	1.5	0.5	3.50	1.17	0.1	3.6	-	-	31.49	10.5	41.99
Mudigere (UAHS)	17.53	5.84	0.5	0.17	1.50	0.50	0.1	1.6	-	-	19.63	6.54	26.17
Sirsi (UHS)	29.02	9.67	1.0	0.34	4.00	0.84	0.1	4.1	-	-	34.12	11.37	45.49
Yercaud (TNAU)	19.29	6.43	0.5	0.17	1.50	0.50	0.1	1.6	-	-	21.39	7.13	28.52
Coimbatore (TNAU)	22.72	7.57	1.0	0.34	3.79	1.00	0.1	3.89	-	-	27.61	9.20	36.81
Chintapalli (Dr. YSRHU)-TSP	10.12	3.37	0.5	0.17	7.47	0.50	0.1	7.57	-	-	18.19	6.06	24.25
Kamarpally (SKLTSHU)	24.72	8.24	0.5	0.17	4.50	0.84	0.1	4.6	-	-	29.82	9.94	39.76
Guntur (Dr. YSRHU)	24.15	8.05	1.0	0.34	2.50	0.84	0.2	2.7	-	-	27.85	9.28	37.13
Solan (YSPUHF)	13.16	4.38	0.5	0.17	1.81	0.50	0.1	1.91	-	-	15.57	5.19	20.76
Pottangi (OUAT) -TSP	9.93	3.31	0.5	0.17	10.17	0.50	0.1	10.27	-	-	20.7	6.9	27.6
Jobner (SKNAU)	77.33	25.78	1.5	0.5	4.00	1.34	0.1	4.1	-	-	82.93	27.64	110.57
Jagudan (SDAU)	30.05	10.02	1.0	0.34	3.00	1.00	0.1	3.1	-	-	34.15	11.38	45.53
Hisar (HAU)	32.82	10.94	1.0	0.34	3.00	1.00	0.1	3.1	-	-	36.92	12.31	49.23
Dholi (RAU)			1.0	0.34	3.43	1.00	0.1	3.53	-	-	4.53	1.51	6.04
Kumarganj (NDUAT)	12.92	4.3	1.0	0.34	6.00	0.84	0.1	6.1	-	-	20.02	6.67	26.69
Pundibari (UBKVV)	23.16	7.72	1.0	0.34	3.50	0.84	0.1	3.6	-	-	27.76	9.25	37.01
Dapoli (KKV)	26.87	8.96	1.0	0.34	2.50	0.84	0.1	2.6	-	-	30.47	10.16	40.63
Raigarh (IGKV)-TSP	28.69	9.56	1.0	0.34	7.86	0.84	0.1	7.96	-	-	37.65	12.55	50.2
<b>Total</b>	<b>446.00</b>	<b>148.67</b>	<b>16.5</b>	<b>5.59</b>	<b>75.53</b>	<b>15.39</b>	<b>2.00</b>	<b>77.53</b>	<b>-</b>	<b>-</b>	<b>540.03</b>	<b>199.22</b>	<b>720.02</b>
<i>Coopting Centers</i>													
Ambalavayal (KAU)	-	-	0.5	0.17	1.44	0.65	0	1.44	-	-	1.94	0.65	2.59
Pechiparai (TNAU)	-	-	0.5	0.17	0.63	0.38	0	0.63	-	-	1.13	0.38	1.51
Gangtok (ICRI)-NEH	-	-	0.5	0.17	5.00	1.84	0	5.0	-	-	5.5	1.83	7.33
Sakleshpur (ICRI)	-	-	0.5	0.17	2.00	0.84	0	2.0	-	-	2.5	0.83	3.33
Myladumpara (ICRI)	-	-	0.5	0.17	2.00	0.84	0	2.0	-	-	2.5	0.83	3.33
ICAR RC NEHR, Barapani-NEH	-	-	0.5	0.17	2.76	1.08	0	2.76	-	-	3.26	1.09	4.35
ICAR RC NEHR, Mizoram-NEH	-	-	0.5	0.17	1.29	0.60	0	1.29	-	-	1.79	0.6	2.39
ICAR RC NEHR, Gangtok-NEH	-	-	0.5	0.17	6.0	2.17	0	6.0	-	-	6.5	2.17	8.67
Nagaland (AU)	-	-	0.5	0.17	3.99	1.49	0	3.99	-	-	4.49	1.49	5.98
Kahikuchi (AAU)	-	-	0.5	0.17	4.00	1.5	0	4.0	-	-	4.5	1.5	6.0
Pasighat (KAU)-NEH	-	-	0.5	0.17	13.72	4.57	0	13.72	-	-	14.22	4.74	18.96
<b>Total</b>	<b>-</b>	<b>-</b>	<b>5.5</b>	<b>1.87</b>	<b>42.83</b>	<b>15.96</b>	<b>0</b>	<b>42.83</b>	<b>-</b>	<b>-</b>	<b>48.33</b>	<b>16.11</b>	<b>64.44</b>
<i>Voluntary Center</i>													
Pantnagar (GBPUAT)	-	-	0.5	0.17	1.03	0.5	0	1.03	-	-	1.53	0.51	2.04
Kanke (BIRSAU)	-	-	0.5	0.17	0.15	0.22	0	0.15	-	-	0.65	0.22	0.87
Kalyani (BCKVV)	-	-	0.5	0.17	2.01	0.84	0	2.01	-	-	2.51	0.84	3.35
Kota	-	-	0.5	0.17	1.48	0.68	0	1.48	-	-	1.98	0.66	2.64
Navasari (NAU)	-	-	0.5	0.17	0.65	0.37	0	0.65	-	-	1.15	0.39	1.54
Jabalpur (JNKV)	-	-	0.5	0.17	1.42	0.68	0	1.42	-	-	1.92	0.64	2.56
Mandor	-	-	0.5	0.17	0.89	0.47	0	0.89	-	-	1.39	0.47	1.86
Sanand	-	-	0.5	0.17	1.50	0.68	0	1.5	-	-	2.0	0.67	2.67
<b>Total</b>	<b>-</b>	<b>-</b>	<b>4.0</b>	<b>1.36</b>	<b>9.13</b>	<b>4.44</b>	<b>0</b>	<b>9.13</b>	<b>-</b>	<b>-</b>	<b>13.13</b>	<b>4.4</b>	<b>17.53</b>
<i>Project Mode</i>													
Thrissur	-	-					0	2.0	-	-	2.0	0.67	2.67
SRS Pampore	-	-					0	2.0	-	-	2.0	0.67	2.67
<b>Total</b>	<b>-</b>	<b>-</b>					<b>0</b>	<b>4.0</b>	<b>-</b>	<b>-</b>	<b>4.0</b>	<b>1.33</b>	<b>5.33</b>
Workshop release	-	-					0	0.77	-	-	0.77	0	0.77
Seed spices monitoring-NRCSS	-	-					0	1.5	-	-	1.5	0	1.5
<b>Total</b>	<b>446.00</b>	<b>148.67</b>	<b>26.00</b>	<b>8.82</b>	<b>127.49</b>	<b>35.79</b>	<b>2.00</b>	<b>135.76</b>	<b>-</b>	<b>-</b>	<b>607.76</b>	<b>221.06</b>	<b>809.59</b>

## XXVI. WEATHER DATA

### PANNIYUR

### PAMPADUMPARA

Month	Rain Fall (mm)	No. of Rainy days	Temperature (°C)		RH (%)	Rain Fall (mm)	No. of Rainy days	Temperature (°C)	
			Max.	Min.				Max.	Min.
Apr-18	33.40	3	37.35	26.43	90.03	23.15	8	24.88	23.15
May-18	264.70	13	35.36	25.96	90.22	21.85	17	23.61	21.85
Jun-18	956.90	27	30.87	26.01	90.40	19.48	24	21.16	19.48
Jul-18	1772.80	31	30.21	25.23	91.77	18.69	27	20.27	18.69
Aug-18	824.60	29	30.44	24.97	99.52	19.01	23	20.74	19.01
Sep-18	34.00	4	33.45	23.95	90.63	21.40	9	22.78	21.4
Oct-18	311.02	17	33.85	24.44	90.35	20.64	20	22.16	20.64
Nov-18	43.60	5	34.55	23.90	91.77	20.30	13	21.58	20.3
Dec-18	21.00	2	34.24	23.36	91.87	20.08	1	21.37	20.08
Jan-19	-	-	35.32	20.80	91.09	15.58	0	20.01	15.58
Feb-19	-	-	37.29	22.68	92.29	13.21	2	22.58	13.21
Mar-19	-	-	37.95	24.76	92.83	15.01	3	24.32	15.01

### COIMBATORE

### YERCAUD

Month	Rain Fall (mm)	No. of Rainy days	Temperature(°C)		RH (%)		Rain Fall (mm)	No. of Rainy days	RH (%)	Temperature (°C)	
			Max.	Min.	I	II				Max.	Min
Apr-18	45.40	5	24.80	35.50	84	58	7.76	3	75.6	22.5	21.3
May-18	259.00	12	23.50	32.80	88	61	8.18	14	78.9	23.0	21.5
Jun-18	54.00	7	23.70	30.30	84	67	10.86	11	90.5	22.7	21.2
Jul-18	73.40	9	23.30	30.30	84	64	13.71	9	95.6	22.7	21.1
Aug-18	60.40	6	22.90	30.20	85	64	15.60	9	97.10	21.1	19.4
Sep-18	115.70	7	22.40	32.80	87	53	13.60	13	93.06	22.5	20.9
Oct-18	151.60	9	21.90	30.40	89	61	11.55	13	89.30	23.2	21.3
Nov-18	59.10	9	21.50	29.10	89	62	10.30	10	90.60	18.7	17.3
Dec-18	8.00	2	20.80	30.30	89	53	6.87	4	82.80	18.1	17.1
Jan-19	0.0	-	17.90	29.90	88	42	20.00	1	73.10	16.3	15.9
Feb-19	0.0	-	21.40	33.10	85	44	3.00	1	78.10	18.2	17.8
Mar-19	0.0	-	23.5	35.70	82	41	0	0	58.00	22.7	21.6

### MUDIGERE

### SIRSI

Month	Rain Fall (mm)	No. of Rainy days	Temperature (°C)		RH (%)		RainFall (mm)	No. of Rainy days	Temperature (°C)		RH (%)
			Max.	Min.	I	II			Max.	Min.	
Apr-18	2.0	1	31.19	20.32	80.48	71.19	24.20	3	34.6	20.5	86.3
May-18	0.0	-	31.15	20.35	81.89	68.71	132.80	8	32.8	21.1	88.6
Jun-18	34.5	3	32.41	20.58	87.80	69.80	458.80	19	28.5	21.4	87.9
Jul-18	40.8	4	29.43	20.40	69.76	62.70	714.40	26	26.3	21.0	92.5
Aug-18	158.1	9	27.41	19.96	84.80	58.09	542.00	27	25.7	20.7	92.9
Sep-18	303.4	22	24.16	20.76	82.06	72.96	89.00	6	29.0	20.2	91.8
Oct-18	410.2	25	22.83	19.51	84.67	72.03	141.60	7	31.3	19.3	86.4
Nov-18	393.9	19	23.16	18.38	84.70	61.70	4.60	1	31.1	18.3	82.9
Dec-18	200	15	25.73	18.60	84.33	45.16	15.00	1	30.4	15.2	84.6
Jan-19	66.3	8	27.06	18.54	84.54	44.93	-	0	30.9	12.8	82.9
Feb-19	12	1	29.46	24.03	84.50	38.90	-	0	32.7	13.5	81.7
Mar-19	10.6	1	27.80	18.35	81.74	24.80	-	3	34.9	16.6	84.0

### CHINTAPALLE

### GUNTUR

Month	Rain Fall (mm)	No. of Rainy days	Temperature (°C)		RH (%)		RainF all (mm)	No. of Rainy days	Temperature (°C)		RH (%)	
			Max.	Min.	I	II			Max.	Min.	I	II
Apr-18	242.40	13.00	35.97	13.88	91.80	68.53	12.20	1	38.5	26.8	80.7	46.6
May-18	57.40	8.00	35.30	15.80	89.80	71.50	46.50	1	40.1	28.8	75.4	43.7
Jun-18	229.40	18.00	30.87	15.42	91.50	79.47	139.40	10	37.9	27.5	82.4	59.7
Jul-18	333.50	25.00	26.50	14.40	93.50	87.50	125.50	11	34.5	25.7	85.0	67.0
Aug-18	222.30	24.00	26.10	15.20	89.70	88.20	210.40	11	33.6	25.1	85.2	62.6
Sep-18	89.20	14.00	29.00	12.90	92.80	81.30	60.80	4	34.8	25.4	83.7	59.7
Oct-18	31.20	2.00	29.40	12.30	94.40	72.40	26.60	2	34.2	23.1	87.4	55.5
Nov-18	16.50	2.00	28.40	10.80	94.20	68.80	2.30	0	33.4	21.4	88.9	56.8
Dec-18	111.10	3.00	25.90	11.00	99.00	72.90	71.20	2	29.7	18.4	86.7	66.0
Jan-19	0.00	0.00	26.90	8.10	99.20	64.90	6.00	1	29.8	16.2	92.5	57.6
Feb-19	0.00	0.00	29.30	11.60	93.40	59.50	0.00	0	33.1	24.5	89.3	39.3
Mar-19	26.00	1.00	31.08	14.70	94.60	59.20	0.00	0	36.6	26.6	85.3	34.0



DAPOLI						POTTANGI				
Month	Rain Fall (mm)	No. of Rainy days	Temperature (°C)		RH (%)		RainFall (mm)	No. of Rainy days	Temperature (°C)	
			Max.	Min.	I	II			Max.	Min.
Apr-18	0.00	0.0	33.7	20.1	91.1	73.7	84.00	8.0	36.0	22.2
May-18	0.20	0.0	33.7	23.6	90.3	72.4	86.30	9.0	35.8	26.3
Jun-18	35.40	0.7	30.5	23.5	95.4	90.1	93.10	9.0	32.6	23.3
Jul-18	36.50	0.9	27.9	23.6	96.6	94.8	263.30	25.0	28.2	22.8
Aug-18	22.10	1.0	27.5	23.2	95.2	91.6	84.00	8.0	36.0	22.2
Sep-18	5.00	0.4	29.6	21.9	90.3	81.4	246.40	11.0	29.7	21.8
Oct-18	1.20	0.1	33.7	20.6	90.1	66.3	26.50	2.0	29.3	18.8
Nov-18	0.00	0.0	34.0	17.2	87.5	64.7	0.50	1.0	27.3	14.8
Dec-18	0.00	0.0	31.9	13.2	87.6	65.3	95.40	3.0	26.0	11.2
Jan-19	0.00	0.0	31.8	11.5	88.6	59.2	0.00	0.0	27.9	10.7
Feb-19	0.00	0.0	32.6	13.9	89.0	60.9	0.00	0.0	31.7	14.4
Mar-19	0.00	0.0	32.4	15.5	88.5	59.8	4.20	1.0	35.0	20.2

JAGUDAN					NAVSARI					
Month	Rain Fall (mm)	Temperature (°C)		RH (%)	RainFall (mm)	No. of Rainy days	Temperature (°C)		RH (%)	
		Max.	Min.				Max.	Min.	I	II
Apr-18	-	23.49	40.06	61.42	-	-	-	-	-	-
May-18	-	21.32	42.54	71.55	0	0	35.05	25.42	84.97	56.3
Jun-18	15.00	19.90	39.08	71.11	24.00	1.2	33.8	26.4	91.3	73.04
Jul-18	16.00	22.53	34.21	82.40	320.50	5.5	28.67	23.82	96.47	93.7
Aug-18	34.4	25.85	34.59	83.74	44.40	3.4	29.78	23.96	91.2	81.84
Sep-18	6.00	24.71	33.46	80.58	12.75	0.75	31.75	21.82	90.37	63.27
Oct-18	-	23.20	36.29	65.94	0	0	36.48	19.70	81.36	51.76
Nov-18	-	19.50	32.79	63.60	0	0	34.85	14.625	87.2	55.525
Dec-18	-	12.77	27.18	67.38	0	0	29.2	11.375	81.675	51.75
Jan-19	-	11.30	26.86	83.16	0	0	30.14	10.12	86.44	49.94
Feb-19	24.20	13.7	27.9	82.35	0	0	25.33	9.26	71.9	38.76
Mar-19	-	18.60	33.68	82.36	-	-	-	-	-	-

JOBNER					RAIGARH					
Month	Rain Fall (mm)	Temperature (°C)		RH (%)		RainFall (mm)	Temperature (°C)		RH (%)	
		Max.	Min.	I	II		Max.	Min.	I	II
Apr-18	0.00	39.2	19.4	51.0	15.8	3.20	39.2	26.7	60.5	26
May-18	0.00	42.4	24.2	42.5	13.8	82.40	40.6	28.6	66.6	31.5
Jun-18	102.40	40.2	26.5	61.2	34.8	151.00	36.5	28.1	77	50.7
Jul-18	142.80	34.3	25.1	83.3	63.0	450.60	31.2	26.5	89	71
Aug-18	110.60	32.8	24.3	83.2	64.2	447.90	30.9	26	90.3	76.5
Sep-18	54.40	31.9	20.8	84.8	56.3	241.00	31.8	25.8	88	70.9
Oct-18	0.00	35.4	15.4	68.5	23.3	0.00	33.1	22.1	82.8	65.2
Nov-18	0.00	30.6	9.2	72.2	30.4	0.00	31.5	17.2	82.1	59.6
Dec-18	0.00	24.5	2.7	81.0	29.0	45.80	26.1	12.7	84.1	71.2
Jan-19	6.00	23.0	3.1	81.0	36.3	12.80	26.7	10.4	82.2	64.8
Feb-19	0.00	24.1	6.4	81.0	33.5	24.60	29.7	14.9	82.3	43.6
Mar-19	0.00	29.6	10.7	67.4	26.4	14.20	34	19.9	81.6	52.8

KUMARGANJ						KANKE				
Month	Rain Fall (mm)	Temperature (°C)		RH (%)		Rain Fall (mm)	Temperature (°C)		RH (%)	
		Max.	Min.	I	II		Max.	Min.	I	II
Apr-18	8.80	36.7	19.3	70.8	30.3	3.00	32.8	17.7	85.4	37.0
May-18	11.00	38.3	24.7	72.8	40.5	7.00	37.3	2.0	85.0	41.3
Jun-18	12.40	39.1	27.4	80.7	56.8	7.00	35.3	22.0	86.1	53.2
Jul-18	340.60	33.5	26.5	93.5	83.4	13.00	29.3	20.4	86.8	67.4
Aug-18	349.50	31.6	25.6	93.4	78.7	11.00	28.3	20.5	85.2	68.5
Sep-18	113.40	32.0	25.1	90.0	65.5	12.00	28.7	19.3	85.3	68.3
Oct-18	0.00	33.4	21	83.0	48.1	0.00	26.5	16.3	85.7	68.6
Nov-18	0.00	30.3	14.1	92.7	59.8	0.00	26.8	13.6	84.9	68.5
Dec-18	0.00	26.0	9.5	92.8	45.2	2.00	22.5	5.1	85.1	68.9
Jan-19	0.00	23.5	6.3	94.3	47.3	-	-	-	-	-
Feb-19	41.00	21.8	6.7	93.0	52.0	-	-	-	-	-
Mar-19	0.00	22.8	9.8	91.8	56.3	-	-	-	-	-

PUNDIBARI						KALYANI					
Month	Rain Fall (mm)	Temperature (°C)		RH (%)		Rain Fall (mm)	Temperature (°C)		RH (%)		
		Max.	Min.	I	II		Max.	Min.	I	II	
Apr-18	213.60	30.33	19.61	77	65	0.11	37.81	21.54	89.90	48.33	
May-18	237.11	30.92	21.04	84	70	5.45	35.36	22.61	91.35	65.23	
Jun-18	334.50	32.64	23.89	86	74	5.36	34.55	23.91	93.57	74.20	
Jul-18	621.40	32.5	25.5	89	79	12.86	32.37	24.16	96.42	87.06	
Aug-18	369.30	33.51	25.39	87.90	75.13	13.94	32.63	24.14	96.39	82.23	



Sep-18	419.10	32.32	24.94	89.00	76.20	4.04	33.53	24.16	93.70	78.47
Oct-18	3.90	30.85	20.54	76.0	63.9	5.39	32.30	21.64	94.42	68.55
Nov-18	0.00	29.0	15.1	75.2	51.7	0.57	36.83	15.33	92.90	58.17
Dec-18	5.80	25.9	10.8	76.3	48.5	0.00	26.25	10.90	96.77	57.71
Jan-19	0.50	26.0	9.0	79.0	43.0	0.00	25.40	8.55	96.32	46.52
Feb-19	13.60	26.1	12.04	81.0	54.0	0.00	29.48	12.61	92.25	42.61
Mar-19	81.10	29.5	15.5	70.0	45.0	0.61	32.29	17.64	92.10	48.81

**MIZORAM**

**BARAPANI**

Month	Rain Fall (mm)	No. of Rainy days	Temperature (°C)		RH (%)		RainFall (mm)	Temperature (°C)		RH (%)	
			Max.	Min.	I	II		Max	Min	I	II
Apr-18	214.20	14	28.8	18.6	81	62	208.20	26.7	14.9	85.8	58.7
May-18	465.90	22	27.7	20.0	89	75.35	281.30	26.1	17.0	87.4	75.7
Jun-18	597.10	14	28.7	22.3	95	82.06	424.30	27.9	20.0	88.5	79.5
Jul-18	406.30	25	28.9	22.7	94	84.12	354.70	28.3	21.0	87.5	77.4
Aug-18	579.50	19	28.9	22.2	96	81.90	435.70	29	20.8	86.7	72.7
Sep-18	137.40	8	29.1	22.2	94	77.76	435.70	28.4	19.1	88.3	74.4
Oct-18	184.80	7	26.7	19.5	94	75.16	258.60	25.5	15.1	86.5	68.5
Nov-18	9.40	2	24.9	15.8	90	69.43	214.90	24.2	10.8	83.9	56.3
Dec-18	7.60	2	22.4	13.5	90	65	7.30	21.3	8.1	84.3	55.5
Jan-19	0.0	0	23.3	12.4	85	56	28.60	21.2	6.6	83.4	45.6
Feb-19	31.60	3	24.7	14.5	82	64	13.60	22.6	8.9	84.6	50.7
Mar-19	56.60	4.0	27.0	16.3	74	61	-	-	-	-	-

**GANGTOK**

**PASIGHAT**

Month	RainFall (mm)	No. of Rainy days	Temperature (°C)		RainFall (mm)	No. of Rainy days	Temperature (°C)		RH (%)	
			Max.	Min.			Max.	Min.	I	II
Apr-18	1294.40	21	17.1	5.0	182.50	10	29.1	29.1	83.8	71.6
May-18	969.30	24	21.0	5.0	391.50	13	29.1	29.1	87.4	82.6
Jun-18	671.90	22	23.0	4.0	560.00	18	31.8	31.8	88.3	86.3
Jul-18	913.40	29	29.0	5.0	734.00	16	31.1	31.1	84.5	82.1
Aug-18	1029.90	29	29.0	5.0	147.00	10	30.2	30.2	89.2	79.6
Sep-18	554.30	17	27.0	5.0	794.50	15	30.2	30.2	90.5	85.5
Oct-18	171.00	06	23.0	5.0	95.00	07	29.1	29.1	82.9	76.2
Nov-18	132.10	04	18.0	5.0	169.00	07	25.3	25.3	78.8	78.8
Dec-18	22.00	03	13.0	4.0	17.00	02	24.6	24.6	85.9	73.2
Jan-19	7.60	01	13.0	4.0	17.00	1	25.1	25.1	80.6	61.8
Feb-19	60.10	07	16.0	5.0	136.00	9	24.6	24.6	81.2	70.6
Mar-19	272.00	16	22.0	4.0	129.00	12	25.6	25.6	82.8	71.1

**AMBALAVAYAL**

**KAHIKUCHI**

Month	RainFall (mm)	No. of Rainy days	Temperature (°C)		RH (%)		Rain Fall (mm)	Temperature (°C)		RH (%)
			Max	Min	I	II		Max	Min	
Apr-18	93.48	119.6	30.3	20.1	93.48	59.48	181.00	30.7	19.9	68
May-18	92.28	51.6	28.9	19.5	92.28	67.30	226.00	31.0	22.4	75
Jun-18	100.00	68.5	30.4	19.2	100	87	309.00	31.9	24.8	81
Jul-18	97.67	37.8	23.8	19.0	97.67	88.46	377.00	31.7	25.3	83
Aug-18	96.16	41.3	23.5	18.8	96.16	83.64	227.00	32.1	25.4	82
Sep-18	93.80	120.3	27.6	18.4	93.8	64.6	199.00	31.4	24.4	83
Oct-18	88.19	118	27.2	18.5	88.19	63.54	92.00	30.2	21.9	82
Nov-18	90.36	105.7	27.2	18.0	90.36	59.73	25.00	27.5	16.8	82
Dec-18	93.64	96.2	27.3	17.5	93.64	57.80	10.00	24.4	11.8	82
Jan-19	91.00	128.9	27.6	14.1	91.0	48.83	12.00	22.7	10.6	74
Feb-19	84.60	140.7	30.1	18.2	84.60	51.85	trace	24.3	11.6	67
Mar-19	95.00	153.1	30.7	19.9	95	58	34.00	27.5	14.3	72

**PEECHIPARAI**

**SAKLESHPUR**

Month	Rain Fall (mm)	No. of Rainy days	Temperature (°C)		RH (%)	Rain Fall (mm)	No. of Rainy days
			Max	Min			
Apr-18	152.00	14	33.5	25.50	76.2	61.00	2
May-18	355.50	12	34.2	25.20	82.50	48.00	7
Jun-18	325.00	21	31.5	25.15	81.50	235.00	11
Jul-18	82.50	14	33.7	22.53	77.14	483.00	13
Aug-18	178.00	18	33.5	22.14	76.75	688.00	27
Sep-18	524.00	21	32.1	22.54	77.52	664.00	22
Oct-18	425.00	18	32.0	22.16	72.42	297.00	10
Nov-18	357.00	17	32.5	22.35	71.45	173.00	6
Dec-18	265.00	6	34.5	-	68.78	15.00	1
Jan-19	43.50	1	35.2	22.50	72.87	-	-
Feb-19	25.50	2	34.5	25.50	75.48	-	-
Mar-19	22.50	2	33.4	25.15	75.25	-	-

**XXVII. AICRPS CENTRES****HEAD QUARTERS**

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 Website: www.aicrps.res.in

**COORDINATING CENTRES**

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PUBLICATIONS RELEASED DURING XXIX AICRPS WORKSHOP

'मसालों की खेती से आय बढ़ेगा ज्यादा यह है जीवन में कामयाबी का वादा'



**पशु और विज्ञान कर्मी**

**'इंडियन जर्नल ऑफ अरीकनट, स्पाइसेस एण्ड मेडिसिनल प्लान्ट्स'**

सुपारी और मसाला विकास निदेशालय द्वारा अंग्रेजी में प्रकाशित इस तिमाही पत्रिका में कृषि विज्ञान, पौध संरक्षण, संस्करण एवं विपणन संबंधी सर्वसाध्य एवं अर्ध-वैज्ञानिक लेखों का प्रकाशन विपुल चित्र- निरूपण, बाजार समीक्षा, मूल्य सांख्यिकी, कृषि क्रियाएँ आदि के साथ किया जाता है।

चन्दे की दर	विज्ञान तारीक दर	प्रति अंक	वार अंक
अंग्रेजी (4 अंक)	150.00 ₹	3000	10000
रुप पाठ	40.00 ₹	इसकाइस चक्र/वर्ष/वर्ग	1250 4000
चित्र (4 अंक)	20 ₹ चक्र और	एक	2000 7000
रुप पाठ	5 ₹ चक्र और	सामान्य रूप (रचना/वर्ग)	1000 3000
		एक	1500 4000

पत्रिका के लिए चन्दे की छटाही का रंग व जो इस निदेशालय को जने और दुबका व डेरा तय होकर आतीकरी, कृषि और सहकारी विभाग के ज्ञान प्रिकार ग्य भारतीय स्टेट बैंक, इटावा शहा, एन/उदा को देर डिपॉजिट इनर सीट इन निदेशालय को भेजकर करे।

**भारत सरकार**  
**सुपारी और मसाला विकास निदेशालय**  
 कृषि एवं किसान कल्याण मंत्रालय  
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**अदरक एवं हल्दी की खेती एवं उनका प्रसंस्करण**



**भारत सरकार**  
**सुपारी और मसाला विकास निदेशालय**  
 कृषि एवं किसान कल्याण मंत्रालय  
 (कृषि, सहकारिता एवं किसान कल्याण विभाग)  
 कालिक्ट-673005, केरल



पत्तियों व जड़ों पर बने छोटे छोटे के रूप में प्रकट होते हैं। प्रारंभ में अदरक पौधा में रोग लगे होने के बाद ही। रोगी पौधों की पत्तियों के अंदर खेती से बचाव उपचार में भारी भूमिका होती है। इस रोग के रोकथाम के लिए, पौधों, पौधों की जड़ों व पत्तियों पर उपचारण कर पौधों को सुरक्षित रखना है। इस रोग के रोकथाम के लिए, पौधों की जड़ों व पत्तियों पर उपचारण कर पौधों को सुरक्षित रखना है।

प्रकाशन संख्या 2018/1

### मेथी के प्रमुख रोग एवं प्रबंधन

**कृषि अनुसंधान केंद्र, उममेदगंज, कोटा**  
**कृषि विश्वविद्यालय-कोटा (राज.)**  
 बाबू रोड, सिरसेड़ा, कोटा (राज.)

**मेथी के प्रमुख रोग एवं प्रबंधन**

मेथी एक प्रमुख वीजीय मसाला फसल है और यह खेती में प्रचलित है। इस की खेती भारत में मुख्य रूप से राजस्थान, मध्य प्रदेश, गुजरात, पंजाब, और उत्तर प्रदेश में की जाती है। यह पौधा 3 महीने में पक्का होता है। इसमें प्रमुख रोगों में फंगल रोग, बैक्टीरियल रोग, वायरल रोग, और वायुमय रोग शामिल हैं।

**वायरल रोग:** यह रोग इरीटोब्रियस पालीकॉमि के कारण होता है। यह रोग पौधों में पीलेपन, फंगल रोगों के साथ-साथ, जलवायु-संबंधी माह में पौधों पर दिखाई देता है। इस रोग की प्रतिक्रिया अत्यंत में पौधों की पत्तियों पर फंगल रूप में प्रकट होकर प्रकट होती है जो पौधे के जड़ों को नुकसान पहुंचा देता है।

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**सुरक्षा विभाग**

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**जलवायु-संबंधी रोग:** यह रोग पत्तियों पर छोटे-छोटे काले के दाग फैलाता है। यह रोग सामान्यतः वसंत ऋतु में पौधों पर दिखाई देता है। इसमें पत्तियों की उपरी सतह पर पीलेपन के दाग दिखाई देते हैं जो पौधों की सतह पर फंगल रूप में प्रकट होकर प्रकट होती है। इस रोग की प्रतिक्रिया अत्यंत में पौधों की पत्तियों पर फंगल रूप में प्रकट होकर प्रकट होती है जो पौधे के जड़ों को नुकसान पहुंचा देता है।

रोग के लक्षण दिखाई देने पर कार्य-विधि 50 उच्च/मी. 2.0 ग्र./मी. मिथोलेक्स 3 ग्राम प्रति लीटर पानी का इन्फेक्शनोस 5 इंसी 2 एएल/मी. दवा का उपचार करें। उपचारण के बाद 15 दिनों के अंतराल पर दोहराएं।

**कोलेक्टोड्रॉम सुलसा रोग**

यह रोग कोलेक्टोड्रॉम के कारण होता है। रोग प्रथम पौधों की जड़ों में प्रकट होता है। रोग के बाद ही पौधों की पत्तियों पर प्रकट होता है। रोगी पौधों की पत्तियों के अंदर खेती से बचाव उपचार में भारी भूमिका होती है। इस रोग के रोकथाम के लिए, पौधों की जड़ों व पत्तियों पर उपचारण कर पौधों को सुरक्षित रखना है।

प्रकाशन संख्या : 2018/2

### धनियाँ के प्रमुख रोग एवं प्रबंधन

**कृषि अनुसंधान केंद्र, उममेदगंज, कोटा**  
**कृषि विश्वविद्यालय-कोटा (राज.)**  
 बाबू रोड, सिरसेड़ा, कोटा (राज.)

**धनियाँ के प्रमुख रोग एवं प्रबंधन**

धनिया फसल से ही रोगों में बाबर रोग को रोकना ही प्रथम प्राथमिकता है। रोगों के रोकथाम के लिए, पौधों की जड़ों व पत्तियों पर उपचारण कर पौधों को सुरक्षित रखना है।

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