

2020

# वार्षिक प्रतिवेदन

## ANNUAL REPORT



**ICAR-INDIAN INSTITUTE OF MAIZE RESEARCH**

Punjab Agricultural University Campus, Ludhiana - 141004 (INDIA)





**ICAR-Indian Institute of Maize Research**

PAU Campus, Ludhiana-141 004, Punjab

<http://iimr.icar.gov.in>



*Institute Mobile App*

# वार्षिक प्रतिवेदन ANNUAL REPORT 2020



**ICAR - INDIAN INSTITUTE OF MAIZE RESEARCH**  
Punjab Agricultural University Campus,  
Ludhiana - 141004 (INDIA)





**Citation:**

ICAR-IIMR Annual Report 2020, ICAR-Indian Institute of Maize Research  
Punjab Agricultural University campus, Ludhiana – 141004.

**Editorial Team**

: Alla Singh  
Suby S.B.  
B.S. Jat  
Ph. Romen Sharma  
Priyajoy Kar  
Abhijit Das

**Published By**

: Director  
ICAR-Indian Institute of Maize Research  
Punjab Agricultural University Campus  
Ludhiana - 141 004  
Email: pdmaize@gmail.com  
Website: <http://iimr.icar.gov.in>

**Printed at**

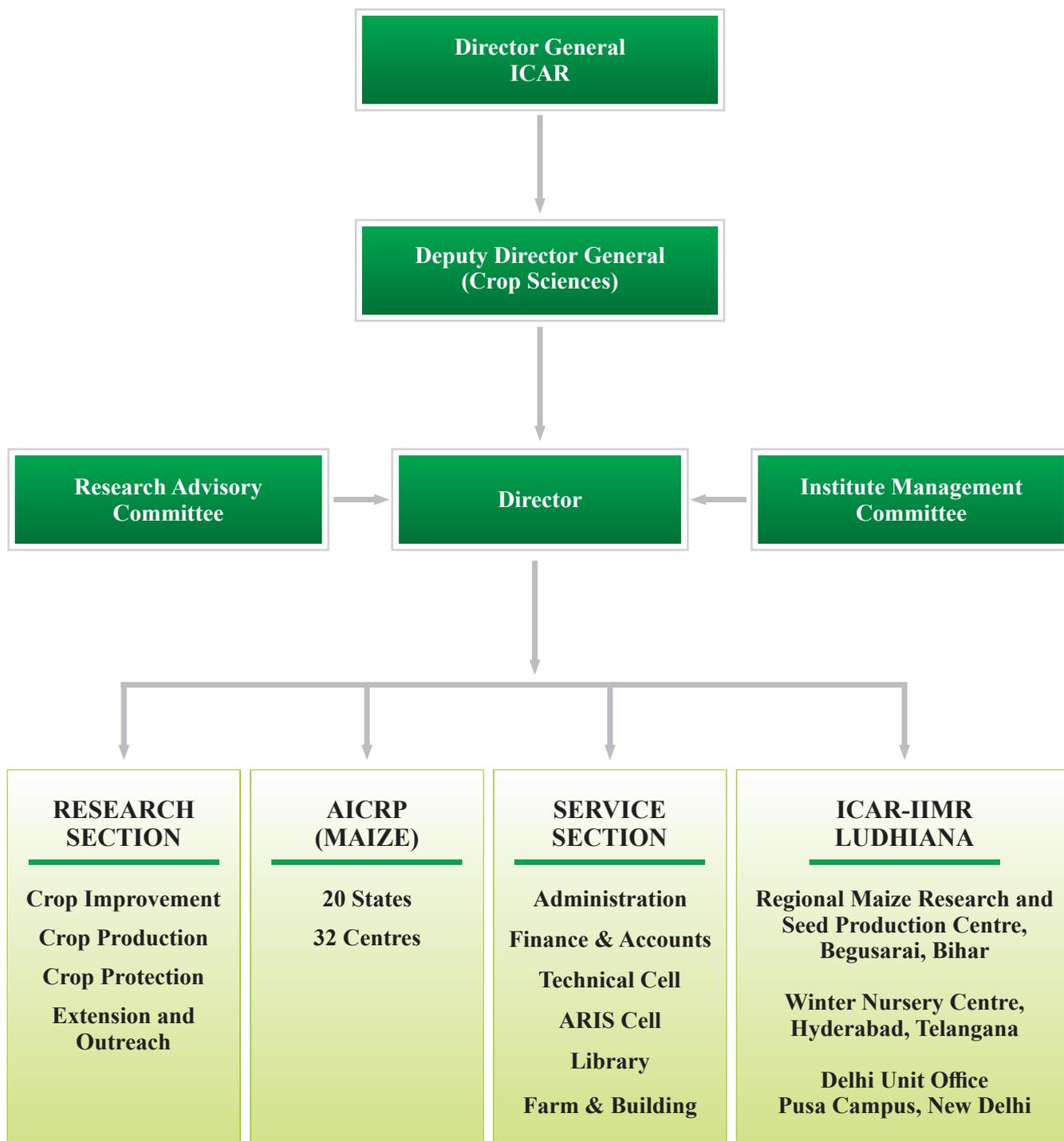
: Azad Offset Printers Ltd.  
# 144, Press Site, Indl. Area-1, Chandigarh  
Tel. : 0172-4611489, 2656144, 2657144

## CONTENTS

प्राक्कथन	i
Preface	iii
विशिष्ट सारांश	v
Executive Summary	xii
1. Crop Improvement	1
2. Basic Sciences	35
3. Crop Production	43
4. Crop Protection	51
5. Extension, outreach and entrepreneurial development	59
6. AICRP on Maize	81
7. Significant Events	91
8. Training and Capacity Building	119
9. Awards and Recognitions	139
<b>Annexures</b>	
Annexure 1: List of Cultivars identified during 63 <sup>rd</sup> Annual Maize workshop	143
Annexure 2: List of Cultivars notified during 2020	146
Annexure 3: DUS Testing and varietal registration	149
Annexure 4: Breeder Seed Production 2019-20	156
Annexure 5: Lectures/T.V./Radio Talks Delivered	158
Annexure 6: Publications	165
Annexure 7: List of On-going projects	170
Annexure 8: Annual Financial Statement	174
Annexure 9: Personnel, transfers, new joining, superannuation, promotions	175



## Organogram of ICAR-IIMR



## प्राक्कथन



भाकृअनुप – भारतीय मक्का अनुसंधान संस्थान (ICAR - IIMR) जिसका उद्भव अखिल भारतीय समन्वित मक्का अनुसंधान परियोजना (AICRP) से हुआ है, भारत में सबसे पुरानी समन्वित फसल सुधार अनुसंधान परियोजना है। यह राष्ट्र का एक अग्रणी संस्थान है जो हैदराबाद और बेगूसराय स्थित अपने दो क्षेत्रीय केन्द्रों और देशभर में फैले अखिल भारतीय समन्वित अनुसंधान परियोजना केन्द्रों के माध्यम से सम्पूर्ण राष्ट्र के लिए मक्का अनुसंधान एवं विकास से जुड़े मुद्दों का समाधान किया जाता है। वर्ष 1950 के दशक के दौरान अपनी प्रारंभिक अवस्था में इस परियोजना के अंतर्गत, मक्का की पारंपरिक अथवा किसानों द्वारा तैयार की गई किस्मों में सुधार करने से लेकर वर्तमान में जैव-संवर्धित किस्मों सहित सामान्य तथा विशिष्ट मक्का एकल क्रॉस संकर किस्मों का विमोचन करने में संस्थान द्वारा 63 वर्षों से भी अधिक समय से राष्ट्र सेवा की जा रही है। यह गर्व का विषय है कि रिपोर्टाधीन वर्ष के दौरान भाकृअनुप – भारतीय मक्का अनुसंधान संस्थान द्वारा चार संकर किस्मों यथा एलक्यूएमएच 1 (आईएमएचक्यूपीएम 1530), एलपीसीएच 2 (आईएमएचपी 1535), एलपीसीएच 3 (आईएमएचपी 1540) तथा एलबीसीएच 3 (डीएमआरएचबी 1305) को खेती के लिए विमोचित एवं अधिसूचित किया गया। इसके अलावा, पूर्व में विमोचित की गई संकर किस्मों यथा डीएमआरएच 1301, डीएमआरएच 1308, डीएमआरएच 1305 एवं आईएमएचबी 1539 के पैतृक वंशकर्मों का कुल 35.46 किंवांटल प्रजनक बीज उत्पादन किया गया और विभिन्न हितधारकों को उनकी मांग के अनुसार बीज की आपूर्ति की गई। इसके अलावा प्रौद्योगिकी के व्यापक अंगीकरण और राजस्व सृजन को बढ़ावा देने के लिए इन संकर किस्मों का लाइसेंस व्यावसायिक बीज उत्पादन एवं विपणन प्रयोजन हेतु विभिन्न बीज कम्पनियों को दिया गया।

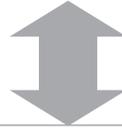
मक्का अनुसंधान का प्रमुख ध्यान उपज के लिए मक्का का आनुवंशिक वृद्धि करने पर निरन्तर बना रहा है। इसका ज्वलंत उदाहरण है कि जहां वर्ष 1950–51 में भारत में मक्का उत्पादन केवल 1.73 मिलियन टन था जो कि वर्ष 2019–20 में बढ़कर 28.64 मिलियन टन तक पहुंच गया है। इसमें मक्का के कृषि रकबे और उन्नत किस्मों विशेषकर एकल क्रॉस संकरों की उत्पादकता दोनों में वृद्धि का योगदान है। हालांकि, भारत की 2.9 टन/हेक्टेयर उत्पादकता का स्तर 5.6 टन/हेक्टेयर के वैश्विक औसत से बहुत कम है। भारत में इस उत्पादकता अन्तराल में मक्का फसल की लघुतर अवधि और बारानी वातावरण जहां मक्का उत्पादन के राष्ट्र रकबे का लगभग चौथाई-पांचवां भाग आता है, की मौसम संबंधी अनियमितताओं का व्यापक योगदान है। इस वास्तविकता से पोषक तत्व उपयोग प्रभावशीलता एवं कम तथा उच्च नमी दबाव के लिए आनुवंशिक बढ़ोतरी जैसी जलवायु स्मार्ट मक्का प्रौद्योगिकियों की शुरुआत करने को बढ़ावा मिलता है जिससे देश के विभिन्न भौगोलिक तथा जलवायु क्षेत्रों की व्यापक अनुकूलनता और फसल सघनीकरण में मदद मिलेगी। इसके अलावा, जैविक तनाव यथा कीट नाशीजीव, रोग और खरपतवार जो कि अजैविक तनावों से अत्यधिक प्रभावित होते हैं मक्का की फसल में पर्याप्त नुकसान पहुंचाते हैं। तनावों को कम करने हेतु, तापमान एवं नमी तनाव, रोग एवं कीट तनाव के लिए आबादी अथवा पापुलेशन सुधार कार्यक्रम के माध्यम से तनाव अनुकूल जननद्रव्य स्रोतों एवं किस्मों का विकास करने में महत्वपूर्ण भूमिका निभाई है। उपज एवं तनाव अनुकूलनता के लिए मक्का फसल के आनुवंशिक आधार में सुधार लाने के प्रयास तेज करने की दिशा में संकरण के माध्यम से नवीन विभिन्नताओं को शामिल करके और उनका सृजन करके जननद्रव्य आधार को व्यापक बनाया गया है। उपज एवं पोषण गुणवत्ता में सुधार लाने के अलावा, हालिया वर्षों में औद्योगिक जरूरतों के अनुसार उच्च एमाइलोज मक्का का विकास जैसे सुधार किए जा रहे हैं। पुनः उपज आधार को गहराई से समझने के लिए उन्नत टूल्स एवं प्रौद्योगिकियों के माध्यम से गुणवत्ता एवं तनाव अनुकूलनता संबंधित किया जा रहा है।

फॉल आर्मीवर्म (FAW) के संक्रमण एवं त्वरित प्रसार ने देशभर में मक्का किसानों के सामने चिन्ताजनक स्थिति उत्पन्न कर दी है। हालांकि, संस्थान द्वारा विभिन्न उपायों से इस समस्या का त्वरित समाधान करने में महत्वपूर्ण भूमिका निभाई जा रही है। संस्थान के नेतृत्व में विकसित परामर्श एवं रीति पैकेज को भारत सरकार द्वारा व्यापक रूप से अंगीकृत किया गया है और इसका प्रसार किया गया है। इससे इस कीट के कारण होने वाले नुकसान को प्रभावी रूप से कम करने में मदद मिली है। संस्थान के वैज्ञानिकों द्वारा भारत में फॉल आर्मीवर्म की रोकथाम पर विभिन्न एजेन्सियों जिनमें संयुक्त राष्ट्र संघ का खाद्य एवं कृषि संगठन भी शामिल है, को जरूरत आधारित परामर्श सेवाएं प्रदान की जा रही हैं।

हासिल की गई आनुवंशिक वृद्धि का दोहन करने हेतु फसल उत्पादन के विभिन्न टूल्स तथा फसल स्वास्थ्य प्रबंधन रीतियों यथा जुताई एवं पोषक तत्व प्रबंधन; संसर निर्देशित नाइट्रोजन प्रबंधन; एकीकृत पोषक तत्व प्रबंधन; तथा पारिस्थितिक गहनता आदि का सृजन किया गया और इनकी क्षेत्रीय उपयुक्तता का पता लगाने के लिए अखिल भारतीय समन्वित अनुसंधान परियोजना केन्द्रों के माध्यम से जांच की गई है। हितधारकों तक प्रमाणित प्रौद्योगिकियों का विस्तार करने के लिए, संस्थान द्वारा अग्रिम पंक्ति प्रदर्शनों एवं विभिन्न प्रायोजित कार्यक्रमों यथा अनुसूचित जनजातीय संघटक, पूर्वोत्तर पर्वतीय संघटक, अनुसूचित जाति उप-योजना तथा मेरा गांव-मेरा गौरव के माध्यम से जीवंत विस्तार एवं आउटरिच कार्यक्रम चलाए जाते हैं जिनसे जमीनी स्तर तक प्रौद्योगिकी को पहुंचाने में मदद मिलती है। वर्ष 2020 के दौरान, कोविड-2019 महामारी की गंभीर चुनौती के बावजूद संस्थान द्वारा मक्का अनुसंधान तथा इसके परिणामों को किसानों तक पहुंचाने के साथ-साथ उनके प्रशिक्षण एवं क्षमता निर्माण की दिशा में उल्लेखनीय प्रयास किया गया है जिसकी प्रगति को इस वार्षिक प्रतिवेदन में प्रस्तुत किया जा रहा है।

सुजय . २०  
(सुजय रक्षित)

# Mission & Vision



ICAR-IIMR



*Enhancing the productivity, profitability and competitiveness of maize and maize-based farming system with economic and environmental sustainability.*



*Rapid growth in the food, feed and industrial application of maize and maize-based products, for generation of wealth and employment in farming and industrial sectors, and for all those who are directly or indirectly associated with maize cultivation and utilization.*

## PREFACE



ICAR-Indian Institute of Maize Research, born out of All India Coordinated Research Project (AICRP) on Maize, the oldest among the co-ordinated crop improvement research projects in India, is the premier institute that addresses maize R&D for the entire nation through its two regional stations at Hyderabad and Begusarai and AICRP centres distributed across the country.

The institute has evolved over 63 years of its service to the nation, from its infancy of improving land races during the 1950s to the level of releasing normal and specialty corn single cross hybrids, including bio-fortified cultivars. It is a matter of pride that four hybrids of the institute, viz., LQMH 1 (IMHQPM 1530), LPCH 2 (IMHP 1535), LPCH 3 (IMHP 1540) and LBCH 3 (DMRHB 1305) have been released and notified during the year. In addition, 35.46 quintals breeder seeds of parental lines of the previously released hybrids, viz., DMRH 1301, DMRH 1308, DMRH 1305 and IMHB 1539 were produced and supplied to various stakeholders, as per their demands. Further, these hybrids were licensed to eight seed companies for commercial seed production and marketing leading greater adoption of the technology and generation of revenue.

Genetic enhancement of maize for yield continued to be the major focus of maize research, such that during 1950-51, India produced only 1.73 million tonnes (mt) of maize, which has reached 28.64 mt in 2019-20. This can be attributed both to an increase of area and productivity of improved cultivars, especially of single cross hybrids. However, the 2.9 tonnes/hectare (t/ha) productivity of India is far behind the global average of 5.6 t/ha. This gap is largely attributed to shorter duration of the crop in India and weather volatilities of the rainfed environment, where four-fifths of maize production area lies. This realization led to inception of climate-smart maize technologies, such as genetic enhancement for nutrient use efficiency and tolerance to low and high moisture stress, which would assist in crop intensification and wider adaptability to different geographic and climatic regimes of the country. In addition, biotic stresses, viz., insect pests, diseases and weeds which are highly influenced by the abiotic stress, cause substantial losses in maize. To mitigate the stresses, population improvement programme for temperature and moisture stress, disease and insect stress has been instrumental in developing stress-resilient germplasm sources and cultivars. To accelerate its stride to improving the genetic base of the crop for yield and stress resilience, the germplasm base has been widened by new introductions and creation of new variations through hybridization. In addition to improving yield and nutritional quality, improvement according to industrial needs is also being addressed in recent years such as the developing high amylose maize. Further, in-depth understanding of the basis of yield, quality and stress resilience are being addressed by basic research through advanced tools and technologies.

The invasion and rapid spread of fall armyworm created panic among maize growers across the country. However, the institute has been instrumental in quickly addressing the issue by various means. The advisories and packages of practices developed under the leadership of the institute have been adopted and disseminated widely by the Government of India. This has led to effective mitigation of the damage caused by the insect. The institute scientists are providing need based expert consultancy to various agencies including the Food and Agriculture Organization of the United Nations on management of FAW in India.

In order to exploit the genetic gains, various tools of crop production and crop health management practices such as tillage and nutrient management, sensor guided nitrogen management, integrated nutrient management, ecological intensification etc. have been generated and tested through AICRP for their regional suitability. To extend the proven technologies to stakeholders, the institute operates a vibrant extension and outreach programme through Frontline Demonstrations and various sponsored programmes such as Scheduled Tribe Component, North Eastern Hill Component, Scheduled Caste Sub Plan and Mera Gaon Mera Gaurav, which helps to penetrate the technology to the grass root level. During 2020, despite the COVID-19 pandemic, the institute made significant strides in maize research and outreach of its outcomes to farmers, as well as training and capacity building, the progress of which has been brought out in this annual report.



(Sujay Rakshit)



## MANDATE

*Basic and strategic research aimed at enhancement of productivity and production of maize, including specialty corn.*

*Coordination of multi-disciplinary and multi-location research to identify appropriate technologies for varied agro-climatic conditions.*

*Dissemination of improved technologies, capacity building and developing linkages.*

*Coordination of the All india Coordinated Research Project (AICRP) on Maize and to carry out extension and outreach programmes.*

## विशिष्ट सारांश

भाकूअनुप – भारतीय मक्का अनुसंधान संस्थान (ICAR-IIMR) द्वारा मक्का फसल के उत्पादन, उत्पादकता और दीर्घकालिकता को बढ़ाने के उद्देश्य से मूलभूत, कार्यनीतिपरक तथा प्रायोगिक अनुसंधान किया जाता है। संस्थान के अनुसंधान कार्यक्रम मुख्यतः तीन क्षेत्रों पर केन्द्रित हैं यथा फसल सुधार, फसल प्रबंधन एवं फसल सुरक्षा। विकसित प्रौद्योगिकियों का प्रमाणन अखिल भारतीय समन्वित मक्का अनुसंधान परियोजना के माध्यम से किया जाता है और प्रसार एवं आउटरिच कार्यक्रमों की मदद से प्रमाणित प्रौद्योगिकियों का विस्तार हितधारकों तक किया जाता है। वर्ष 2020 के दौरान, संस्थान द्वारा अनुसंधान, उत्पाद विकास, प्रौद्योगिकियों का व्यावसायीकरण तथा आउटरिच गतिविधियों के माध्यम से किसानों तक प्रौद्योगिकियों का विस्तार करने में उल्लेखनीय उपलब्धियां अर्जित की गई हैं।

### फसल सुधार

एक फसल सुधार संस्थान होने के कारण भारतीय मक्का अनुसंधान संस्थान का मुख्य अनुसंधान मक्का के आनुवंशिक बढोतरी पर केन्द्रित रहा है। फसल सुधार कार्यक्रम का फोकस संकर किस्मों एवं पैतृक वंशक्रमों की उत्पादकता को सुधारने, जैविक तथा अजैविक तनावों की प्रतिरोधिता एवं गुणवत्ता विशेषताओं हेतु जननद्रव्य वृद्धि पर केन्द्रित है। इसके अलावा, इस संबंध में फोकस का नया आयाम विकसित उत्पादों का व्यावसायीकरण करना है।

### चिन्हित एवं अधिसूचित संकर

वर्ष 2020 के दौरान, दिनांक 10 जुलाई, 2020 को कृषि फसलों के लिए फसल मानक, अधिसूचना एवं किस्म निर्मुक्ति पर केन्द्रीय उप समिति की 84वीं बैठक में चार संकर किस्मों नामतः एलक्यूएमएच 1 (आईएमएचक्यूपीएम 1530), एलपीसीएच 2 (आईएमपीएच 1535), एलपीसीएच 3 (आईएमएचपी 1540) तथा एलबीसीएच 3 (डीएमआरएचबी 1305) को खेती प्रयोजन के लिए जारी एवं अधिसूचित किया गया। एलक्यूएमएच 1 एक क्यूपीएम संकर है जिसमें उच्च ट्रिप्टोफन (0.73%) तथा लाइसीन (3.03%) की मात्रा है। एलपीसीएच 2 एवं एलपीसीएच 3 पॉपकार्न किस्मों हैं जिनमें उच्च पॉपिंग प्रतिशत है जबकि एलबीसीएच 3 एक बेबीकॉर्न संकर है जिसमें उच्च एवं संतुलित पैदावार (एसएसबी 1) पाई जाती है। इसके अलावा, दिनांक 20-22 अप्रैल, 2020 को आयोजित 63वीं वार्षिक मक्का कार्यशाला के दौरान दो क्यूपीएम संकरों की भी की गई। संस्थान द्वारा विकसित की गई तीन जैव-संवर्धित (बायो-फॉर्टीफाइड) संकर किस्मों को दिनांक 16 अक्टूबर, 2020 को विश्व खाद्य दिवस के अवसर पर माननीय प्रधानमंत्री जी द्वारा राष्ट्र को समर्पित किया गया।

### संकर मक्का किस्मों का बीज उत्पादन एवं व्यवसायीकरण

मक्का की संकर किस्मों यथा डीएमआरएच 1301, डीएमआरएच 1308, डीएमआरएच 1305 तथा आईएमएचबी 1539 के पैतृक वंशक्रमों का कुल 35.46 क्विंटल प्रजनक बीज उत्पादन किया गया और विभिन्न राज्यों, राष्ट्रीय एवं अन्य बीज उत्पादक एजेन्सियों को उनकी मांग के अनुसार आपूर्ति की गई। इसके अलावा, व्यवसायीकरण के प्रयोजन से एग्रीनोवेट इंडिया लिमिटेड के माध्यम से विभिन्न बीज कम्पनियों को इन संकर किस्मों का लाइसेंस प्रदान किया गया।

अखिल भारतीय समन्वित अनुसंधान परियोजना परीक्षण के अंतर्गत संकर किस्मों का प्रोन्नयन/योगदान रबी 2019-20 के दौरान, सामान्य मक्का की पांच प्रविष्टियों को एवीटी-1 से एवीटी-2 में प्रोन्नत किया गया और मक्का की

तीन प्रविष्टियों जबकि पॉपकार्न की दो संकर किस्मों को एनआईवीटी से एवीटी-1 में प्रोन्नत किया गया। खरीफ 2020 के दौरान, एक क्यूपीएम संकर किस्म को एवीटी-2 में परीक्षण हेतु प्रोन्नत किया गया जबकि सामान्य मक्का की चार प्रविष्टियों एवं चार क्यूपीएम को एनआईवीटी से एवीटी-1 में प्रोन्नत किया गया। उत्तर पश्चिमी मैदानी क्षेत्र (जोन 2) में एक स्वीट कॉर्न संकर किस्म को एनआईवीटी से एवीटी-1 में प्रोन्नत किया गया। मक्का की पंद्रह संकर किस्मों द्वारा खरीफ 2020 के दौरान और 25 प्रविष्टियों द्वारा रबी 2020-21 के दौरान अखिल भारतीय समन्वित अनुसंधान परियोजना परीक्षण में योगदान दिया गया। पुनः रबी 2020-21 के दौरान एआईसीआरपी चारा परीक्षण में चार प्रविष्टियों और खरीफ 2020 के दौरान मक्का की तीन संकर किस्मों द्वारा अखिल भारतीय समन्वित अनुसंधान परियोजना में योगदान दिया गया।

### परीक्षात्मक संकर किस्मों का मूल्यांकन

तीन स्थानों पर कुल चार चेक किस्मों (जाँच किस्मों) के साथ मक्का की 32 परीक्षात्मक संकर किस्मों का मूल्यांकन किया गया। उच्च माध्य तथा स्थिरता के आधार पर दो परीक्षात्मक संकर किस्मों की पहचान की गई। अगेती परिपक्वता में, खरीफ 2020 के दौरान कुल 38 नवीन क्रास का मूल्यांकन किया गया। दाना उपज के लिए 18 क्रास में चेक डीकेसी 7074 की तुलना में उल्लेखनीय श्रेष्ठता प्रदर्शित हुई। आरएमआर एंड एसपीसी, बेगुसराय में रबी मौसम के लिए सर्वश्रेष्ठ उच्च उपजशील संकर की पहचान करने के लिए 545 परीक्षात्मक संकरों के एक सेट का मूल्यांकन किया गया। मध्य परिपक्वता के अंतर्गत 121 संकर संयोजनों और पछेती परिपक्वता के तहत 10 संकर संयोजनों में संबंधित परिपक्वता समूहों की सर्वश्रेष्ठ चेक के मुकाबले बेहतर उपज प्रदर्शित हुई। खरीफ 2020 के दौरान, उत्पन्न किए गए 275 परीक्षात्मक संकरों के एक सेट का मूल्यांकन बेगुसराय और लुधियाना में किया गया और बेगुसराय तथा लुधियाना में सर्वश्रेष्ठ चेक किस्म की तुलना में क्रमशः 12 एवं 17 परीक्षात्मक संकरों में 10 प्रतिशत से अधिक की उपज प्रदर्शित हुई। लुधियाना में खरीफ 2020 के दौरान कुल चार चेक किस्मों के साथ एक क्यूपीएम परीक्षण के 45 परीक्षात्मक संकरों का मूल्यांकन किया गया। लोकप्रिय सामान्य संकर बायो 9544 की तुलना में दो परीक्षात्मक संकरों ने बेहतर प्रदर्शन किया। लुधियाना में खरीफ 2020 के दौरान 15 परीक्षात्मक बेबी कॉर्न संकरों के एक सेट का मूल्यांकन किया गया जिसमें दोनों चेक किस्मों की तुलना में एक संकर बेहतर पाया गया।

### जननद्रव्य का समावेशन

बेबी कॉर्न कार्यक्रम को मजबूती प्रदान करने के प्रयोजन से रेशा रहित बेबी कॉर्न का विकास करने हेतु मक्का आनुवंशिक स्टॉक केन्द्र, इलिनॉइस विश्वविद्यालय, संयुक्त राज्य अमेरिका से अंतः प्रजात वंशक्रमों की नौ प्राप्तियों का आयात किया गया। पुनः सिम्मत (CIMMYT), भारत से विशिष्ट मक्का स्रोतों के 84 नए स्रोतों की खरीद की गई जिसमें स्वीट कॉर्न (55), पॉपकार्न (19) तथा बेबी कॉर्न (10) शामिल हैं।

### जननद्रव्य का लक्षणवर्णन

अनुक्रमण द्वारा जीनोटाइपिंग करते हुए पहचाने गए कुल 60227 एसएनपी का उपयोग करके 350 विविध मक्का अंतः प्रजात वंशक्रमों के सम्बद्धता मानचित्रण पैनेल (AMP) का लक्षणवर्णन किया गया। आबादी अथवा पापुलेशन संरचना का अध्ययन किया गया और सम्बद्धता मानचित्रण पैनेल में छः संभावित उप

संरचनाओं की पहचान की गई। प्रत्येक उप-वर्ग अन्य से भिन्न था और इस पर जीडब्ल्यूएस के लिए विचार किया जा सकता है। पुनः तीन स्थानों पर 6527 बहुरूपीय एसएनपी के साथ-साथ एचकेआईपीसी 4 B<sub>x</sub> सीएमएल 269 के मध्य कास से उत्पन्न 198 F<sub>8</sub> आरआईएल का लक्षणवर्णन बीज और पॉपिंग विशेषताओं के लिए किया गया। कुल 15 क्यूटीएल (पांच प्रमुख एवं दस गौण) का मानचित्रण पॉपिंग से जुड़ी विभिन्न विशेषताओं के लिए किया गया और गुणसूत्र 10 को छोड़कर सभी गुणसूत्रों में इनका वितरण है। पॉपिंग विशेषताओं के लिए मेटा क्यूटीएल विश्लेषण द्वारा दस मेटा क्यूटीएल तथा विभिन्न क्यूटीएल मानचित्रण प्रयोगों में सूचित किए गए क्यूटीएल से प्रकटन आधार पर (केईजीजी पाथवे का उपयोग करके चयनित 19 जीन) 229 जीन की पहचान की गई। एसएसआर मार्करों के साथ सफेद मक्का की कुल 27 आबादी अथवा पापुलेशन का लक्षणवर्णन उपज में योगदान करने वाले गुणों के लिए किया गया जिसमें प्रति बाली कतार की संख्या (NRPE), प्रति कतार बीज अथवा दानों की संख्या (NKPR) तथा सौ बीजों का भार (HSWT)। प्रति बाली कतार की संख्या (NRPE) के लिए छः, प्रति कतार बीज अथवा दानों की संख्या (NKPR) के लिए तीन तथा सौ बीजों का भार (HSWT) आदि शामिल थे के लिए पांच आबादी अथवा पापुलेशन की पहचान पुनः अध्ययन प्रयोजन हेतु की गई। एसएसआर प्रोफाइल के आधार पर आबादी अथवा पापुलेशन में कुल दो विषमजात समूह मौजूद थे। रबी 2019-20 के दौरान बेगुसराय में कुल 500 अंतः प्रजात वंशकर्मों का मूल्यांकन किया गया जहां सर्वश्रेष्ठ तुलनीय अंतः प्रजात (एचकेआई 193-2) की तुलना में बीस अंतः प्रजात वंशकर्मों में कहीं अधिक उपज पाई गई। पुनः खरीफ 2020 के दौरान लुधियाना में 400 अंतः प्रजात वंशकर्मों की जांच की गई जहां 11 वंशकर्मों में 75 किंगटल/हे. की उच्च दाना उपज दर्ज की गई। इसके अलावा, 776 जीनप्ररूपों का लक्षणवर्णन किया गया और वर्ष 2014-15 से 2018-19 के दौरान उत्पन्न किए गए पासपोर्ट डाटा के आधार पर चुने गए 898 अंतः प्रजात वंशकर्मों का गुणनीकरण सीआरपी-एबी के अंतर्गत परियोजना में किया गया। अटावन संकरों के लिए प्रफुल्लनकाल हेतु बढ़वार डिग्री दिवस (GDD) का मानकीकरण किया गया। अधिकांश अगेती, मध्यम तथा पछेती वंशकर्मों के लिए जीडीडी में कमशः 800 से 900, 900 से 950 तथा 950 से 1000 जीडीडी के बीच भिन्नता थी।

### आनुवंशिक संसाधनों का विकास, रखरखाव एवं विविधीकरण

रबी 2019-20 के दौरान, स्वः परागण के माध्यम से कुल 922 अंतः प्रजात वंशकर्मों का और बल्क परागण के माध्यम से 41 पापुलेशन अथवा संख्या का रखरखाव किया गया। वसंत 2020 के दौरान, लुधियाना में कुल 645 अंतः प्रजात वंशकर्मों का अनुरक्षित और गुणनीकरण किया गया। पुनः कुल 805 परिवारों को S<sub>3</sub> अवस्था में और 289 पृथक्करण परिवारों को S<sub>2</sub> अवस्था में विकसित किया गया। रबी 2018-19 के दौरान आरएमआर एंड एसपीसी, बेगुसराय में खेती के लिए विमोचित मक्का संकरों के 13 पैतृक जीनप्ररूपों एवं 140 अंतः प्रजात वंशकर्मों के एक सेट का मूल्यांकन किया गया और साथ ही तेरह आकारिकी एवं उपज संबंधित गुणों के लिए लक्षणवर्णन किया गया। वं सांख्यिकी से पहचाने गए भिन्न जीनप्ररूपों के बीच 20 कलस्टर एवं कास द्वारा संकर ओज के व्यापक स्तर का सदुपयोग किया जा सकता है। आणविक स्तर पर आनुवंशिक विविधता अध्ययन भी किया गया और इस कार्य में 40 बहुरूपीय एसएसआर मार्करों की मदद ली गई। क्यूपीएम जननद्रव्य में विविधता लाने के लिए दो टेस्टर्स के साथ 24 क्यूपीएम और 24 सामान्य वंशकर्मों का कास कराया गया और आणविक प्रोफाइलिंग की गई। उपज एवं आणविक डाटा दोनों के आधार पर, इन जीनप्ररूपों को विभिन्न कलस्टरों यथा ए तथा बी में वर्गीकृत

किया गया। विषमजात समूह ए तथा बी से जुड़े सामान्य वंशकर्मों का उपयोग श्रृंखला कासिंग के माध्यम से संबंधित समूह के क्यूपीएम जननद्रव्य में विविधता के लिए किया जाएगा।

### विशेष मक्का प्रजनन

संकर ब्रेक-डाउन अथवा संतति कास से हासिल किए गए 126 F<sub>3</sub>-F<sub>5</sub> पृथक्करण स्वीट कॉर्न परिवारों को स्व-परागण के माध्यम से आगे बढ़ाया गया। भुट्टे की लंबाई (EL), भुट्टे की परिधि अथवा घेरा (EG) तथा बीज कतारों की संख्या (NKR) के लिए पाई गई भिन्नता संकर से उत्पन्न अंतः प्रजात वंशकर्मों की तुलना में संतति कास में अपेक्षाकृत कहीं अधिक थी। पुनः विषमजात वर्गीकरण के लिए दो टेस्टर्स यथा एलएम 13 एवं एलएम 14 के साथ स्वीट कॉर्न अंतः प्रजात वंशकर्मों का कास कराया गया और उपज एवं उपज में सहायक लक्षणों के लिए टेस्ट कास (150) का मूल्यांकन किया जा रहा है। बेबी कॉर्न जननद्रव्य को मजबूती प्रदान करने के लिए 82 नए अंतः प्रजात वंशकर्म उत्पन्न किए गए। एक जीनप्ररूप आईबीसीएल 36 में प्रति पौधा 3-4 छल्ली की उर्वरता अथवा उपज प्रदर्शित हुई और एक अन्य वंशकर्म आईबीसीएल 46 सीधी पत्ती के साथ लिग्यूल रहित था। सीएमएस आधारित बेबी कॉर्न संकर का विकास करने के प्रयोजन से प्रगत बैकक्रास पीढ़ियां विकसित की गईं। पुनः जी 5417 तथा अंतः प्रजात वंशकर्मों के बीच कुल 54 नए टेस्ट कास बनाए गए और खेत में नर मंजरी आकारिकी के आधार पर 14 अंतः प्रजात वंशकर्मों को B वंशकर्म के रूप में और 16 वंशकर्मों को R के रूप में वर्गीकृत किया गया जबकि 24 वंशकर्मों में आंशिक उर्वरता प्रदर्शित हुई। दो टेस्टर्स यथा एचकेआई 1105 एवं एचकेआई 323 के साथ कास कराकर 26 अंतः प्रजात वंशकर्मों का विषमजात वर्गीकरण किया गया। कुल 26 वंशकर्मों के बीच, 12 जीनप्ररूपों को वर्ग। (एचकेआई 323) में तथा 14 जीनप्ररूपों को वर्ग B (एचकेआई 1105) में वर्गीकृत किया गया। पूर्व-प्रजनन कार्यक्रम के तहत, उच्च उपजशील एवं जलवायु अनुकूल मक्का का विकास करने हेतु बैकक्रास तथा स्वः परागण के माध्यम से BC<sub>2</sub>F<sub>2</sub> पापुलेशन अथवा आबादी का विकास करने के लिए एलएम 13 एवं एलएम 14 (संकर पीएचएम-1 का पैतृक वंशकर्म) का कास जिया पार्वीग्लूमिस के साथ कराया गया। पुनः दो चेक किस्मों नामतः जे 1006 एवं अफ्रीकन टॉल के साथ कुल 28 पापुलेशन अथवा आबादी का मूल्यांकन चारा विशेषताओं के लिए किया गया और पांच आबादी अथवा पापुलेशन को जे-1006 के समतुल्य पाया गया। एलएम 13 एवं एलएम 14 के साथ कुल 28 चारा अंतः प्रजात वंशकर्मों का कास कराकर चारा अंतः प्रजात वंशकर्मों का विषमजात वर्गीकरण भी किया गया। हरा चारा उपज के विशिष्ट संयोजन क्षमता (SCA) के आधार पर कुल 28 अंतः प्रजात वंशकर्मों को दो विषमजात वर्गों में वर्गीकृत किया गया जिसमें एलएम 13 के वर्ग। के तहत 16 वंशकर्म और एलएम 14 के वर्ग B में 12 वंशकर्म शामिल थे।

### अजैविक तनाव के लिए जननद्रव्य की जाँच

वृद्धि पर बुवाई के समय और शीत तनाव की सम्बद्धता का अध्ययन करने के लिए रबी 2018-19 के दौरान 25 संकर किस्मों और रबी 2019-20 के दौरान 35 संकर किस्मों का मूल्यांकन बेगुसराय, बिहार में किया गया और इसके तहत दोनों वर्षों में बुवाई पांच भिन्न तारीखों यथा 25 अक्टूबर, 5 नवम्बर, 15 नवम्बर तथा 25 दिसम्बर को की गयी। अध्ययन से पता चला कि दिनांक 5 नवम्बर को मक्का की बुवाई करने पर अधिकतम उपज प्राप्त हुई और यह तारीख बिहार राज्य में रबी मक्का के लिए सर्वाधिक उपयुक्त थी। प्रयोग के एक अन्य सेट में, पांच चेक किस्मों के साथ कुल 137 कास को रबी 2019-20 के दौरान लुधियाना में खेत परिस्थितियों के तहत प्रारंभिक बढ़वार अवस्था और फूल आने से पहले वाली अवस्था में शीत तनाव दिया गया जहां मध्यम परिपक्वता अवधि वाले कुल

14 क्रास सर्वश्रेष्ठ चेक किस्म पी-3396 के मुकाबले में बेहतर पाए गए। इनमें से आईएमएलएसबी 274-1 ग सीएमजी 240, आईएमएलएसबी 207-2 ग आईएमएलएसबी 976-2 और आईएमएलएसबी 571-2 ग आईएमएलएसबी 406-2 में चेक किस्म पी-3396 के मुकाबले में क्रमशः 18.2 प्रतिशत, 14.4 प्रतिशत और 14.0 प्रतिशत की अधिक उपज पाई गई। पुनः लुधियाना में रबी 2019-20 के दौरान कुल 500 अंतः प्रजात वंशक्रमों का प्रारंभिक बढ़वार और फूल आने से पहले वाली अवस्था में शीत तनाव के विरुद्ध मूल्यांकन किया गया। अंतः प्रजात नामतः आईएमएलएसबी 250-2 में सबसे अधिक उपज (27.0 क्विंटल/हे.) हासिल की गई। 20.0 से 30.0 क्विंटल/हेक्टेयर के बीच उपज दर्ज करने वाले शीर्ष 11 अंतः प्रजात वंशक्रम नामतः आईएमएलएसबी 250-2, सीएमजी 155, आईएमएलएसबी 2004, आईएमएलएसबी 274-1, आईएमएलएसबी 671-2, आईएमएलएसबी 885-2, आईएमएलएसबी 1296-1, आईएमएलएसबी 509-2, आईएमएलएसबी 733-1, आईएमएलएसबी 428-2 तथा आईएमएलएसबी 268-1 थे। प्रयोग के एक अन्य सेट में लुधियाना में रबी 2019-20 के दौरान कुल 350 अंतः प्रजात वंशक्रमों का मूल्यांकन किया गया जिनमें दाना उपज में 0.18 से 32.31 क्विंटल/हेक्टेयर तक की भिन्नता थी। दाना उपज के आधार पर जीनप्ररूपों को 6 विभिन्न वर्गों में वर्गीकृत किया गया जहां 17, 68, 21, 21 तथा पांच जीनप्ररूपों में क्रमशः 0.18 से 1.00 क्विंटल/हेक्टेयर, 1.01 से 5.0 क्विंटल/हेक्टेयर, 5.01 से 10.0 क्विंटल/हेक्टेयर, 0.01 से 20.0 क्विंटल/हेक्टेयर, 2.001 से 30.0 क्विंटल/हेक्टेयर तथा 30.0 क्विंटल/हेक्टेयर से अधिक की सीमा में दाना उपज दर्ज की गई।

### गुणवत्ता लक्षणों के लिए प्रजनन

नवीन विकसित कुल 115 क्यूपीएम अंतः प्रजात वंशक्रमों के एक सेट का विश्लेषण प्रोटीन और ट्रिप्टोफन मात्रा का पता लगाने के लिए किया गया जहां डीक्यूएल 2760 और डीक्यूएल 2702 उच्च प्रोटीन (क्रमशः 10.7 प्रतिशत एवं 10.0 प्रतिशत) और ट्रिप्टोफन मात्रा (क्रमशः 1.0 प्रतिशत एवं 0.9 प्रतिशत) के साथ सर्वाधिक आशाजनक पाए गए। पुनः खरीफ 2020 के दौरान लुधियाना में दो चेक किस्मों (डीक्यूएल 2192 एवं एचकेआई 163) के साथ 30 अंतः प्रजात वंशक्रमों का मूल्यांकन किया गया ताकि इनके बीच समतुल्य प्रदर्शन का पता लगाया जा सके। इसमें दस अंतः प्रजात वंशक्रमों में सर्वश्रेष्ठ चेक किस्म डीक्यूएल 2192 की तुलना में बेहतर प्रदर्शन पाया गया।

अनुकूलनीय युग्मविकल्पी यथा *opaque2*, *crtRB1* तथा *lpa2* का वहन करने वाले मार्कर सहायतार्थ सेलेक्शन के माध्यम से एलएम 13, एलएम 19, एलएम 14 और एलएम 17 के लिए विकसित किए गए निअर समजीनी वंशक्रमों (छप्पे) का मूल्यांकन सस्यविज्ञान व जैव-रासायनिक प्रदर्शन का पता लगाने के लिए किया गया। मक्का दाने में उच्चतर लाइसीन एवं ट्रिप्टोफन, बढ़े हुए प्रोविटामिन ए और कम फाइटिक अम्ल की पुष्टि के लिए *opaque2*, *crtRB1* तथा *lpa2* के अनुकूलनीय युग्मविकल्पी जिम्मेदार हैं। मूल्यांकन आंकड़ों के आधार पर, तीन-चार सर्वश्रेष्ठ एनआईएल का चयन किया गया और एलएम 13 एवं एलएम 19, तथा एलएम 14 एवं एलएम 17 के एनआईएल का उपयोग करते हुए प्रयोगात्मक कास उत्पन्न किए गए।

### जैव-रासायनिक लक्षणों का मूल्यांकन

रिपोर्टाधीन अवधि के दौरान, अधिकांशतः अंतः प्रजात को शामिल करते हुए कुल 81 जीनप्ररूपों का मूल्यांकन स्टार्च प्रोफाइल यथा स्टार्च, एमाइलोज तथा एमाइलोपेक्टिन के लिए किया गया। अधिकांश जीनप्ररूपों में एमाइलोज की मात्रा 20 से 30 प्रतिशत के बीच पाई गई जिससे प्राकृतिक जननद्रव्य में उच्च

एमाइलोज उत्परिवर्ती की अनुपलब्धता का पता चलता है। क्यूपीएम प्रजनन कार्यक्रम के अंतर्गत, नवीन विकसित कुल 115 वंशक्रमों का मूल्यांकन प्रोटीन गुणवत्ता का पता लगाने के लिए किया गया और 34 सर्वाधिक आशाजनक वंशक्रमों के एक सेट का भी मूल्यांकन किया गया। इसके अलावा, मार्कर सहायतार्थ चयन (MAS) के माध्यम से क्यूपीएम में रूपांतरित 20 वंशक्रमों का विश्लेषण प्रोटीन गुणवत्ता के लिए किया गया तथा उच्च ट्रिप्टोफन मात्रा वाले वंशक्रमों की पहचान की गई। आशाजनक वंशक्रमों की पहचान करने हेतु रंगीन मक्का जननद्रव्य में एथोसाइनिन, फ्लेवोनोंड एवं फिनोलिक मात्रा का मूल्यांकन भी किया गया।

### मक्का में स्वः पात्रे पुनर्जनन एवं रूपांतरण विधि की स्थापना

बायोलिस्टिक एवं एग्रोबैक्टीरियम मध्यस्थ रूपांतरण विधियों का उपयोग करते हुए नोडल कर्तौतक से उत्पन्न कैलाई में एक पुनरुत्पादनीय योग्य स्वः पात्रे पुनर्जनन विधि विकसित की गई। ग्लूकुरोनिडेज (GUS) प्रोटीन का उपयोग करके रूपांतरण प्रोटोकॉल की मानकीकरण प्रक्रिया का कार्य प्रगति पर है। ऊतक-रसायन तथा पीसीआर विश्लेषण से रूपांतरित ऊतकों में जीयूएस गतिविधि की मौजूदगी का पता चला।

### अल्प फाइटेट वाली मक्का के लिए जीन लक्ष्य की इन सिलिको प्राथमिकता

प्लीओट्रॉपिक प्रभावों से बचने के साथ-साथ मक्का में फाइटिक अम्ल मात्रा को कम करने हेतु सर्वाधिक आशाजनक लक्ष्य इनोस्टिल फॉस्फेट काइनेज 1 (IPK 1) पाया गया। इनोस्टिल फॉस्फेट काइनेज 1 (IPK 1) एंजाइम संरचना और पोषाधार के साथ इसकी पारस्परिकता का कम्प्यूटेशनल रूप से निर्धारण किया गया। विशिष्ट अमीनो अम्ल पॉजीशन का खुलासा किया गया जहां प्रोटीन-प्रोटीन पारस्परिकता को प्रभावित किए बिना एंजाइम गतिविधि के अवरोध में उत्परिवर्तन होगा।

### अल्प नाइट्रोजन तनाव में प्रमुख भिन्नात्मक प्रकटित जीनों (DEGs) का प्रमाणन

विषम अंतः प्रजात वंशक्रमों यथा डीएमआई 56 (नाइट्रोजन तनाव का सहिष्णु) एवं डीएमआई 81 (नाइट्रोजन तनाव के प्रति संवेदनशील) से पत्ती एवं जड़ ऊतकों का उपयोग करके ट्रांसक्रिप्टोम विश्लेषण के माध्यम से पहले पहचाने गए प्रमुख भिन्नात्मक प्रकटित जीनों का प्रमाणन qPCR द्वारा किया गया। नाइट्रोजन तनाव की प्रतिक्रिया में भिन्नात्मक प्रकटन के रूप में जीनों यथा *Asn4*, एचएटी 2.3, एनआरपी 1, बेसिक इण्डोकाइटीनेज, एएपी 3, जीटी 31, एमवाईबी 36 ट्रांसक्रिप्शन कारक, AP2-EREBP ट्रांसक्रिप्शन कारक और नाइट्रेट ट्रांसपोर्ट-1 की पहचान की गई।

### फसल प्रबंधन

आनुवंशिकी जहां उच्च गुणवत्ता, उच्च उपजशील तथा तनाव प्रतिरोधी जीनप्ररूपों के विकास में महत्वपूर्ण भूमिका निभाती है वहीं वांछित फार्म उत्पादकता एवं दीर्घकालिकता हासिल करने में फसल प्रबंधन के तरीके महत्वपूर्ण भूमिका निभाते हैं। संस्थान के फसल प्रबंधन कार्यक्रम का मुख्य फोकस जुताई, पोषक तत्व एवं फसलचक्र प्रणाली प्रबंधन पर केन्द्रित है।

### गंगा के मैदानी इलाकों में अनाज आधारित प्रणालियों में प्रेसीजन संरक्षित कृषि रीतियों का विकास

चावल-गेहूं फसलचक्र प्रणाली की तुलना में संरक्षित कृषि (CA) आधारित मक्का-गेहूं फसलचक्र प्रणाली के तहत उल्लेखनीय रूप से उच्चतर प्रणाली उत्पादकता दर्ज की गई। इसी प्रकार, एफएफपी, आरडीएफ तथा एसएसएनएम

के साथ पारम्परिक मक्का-गेहूँ- मूंग तथा चावल-गेहूँ-मूंग फसलचक्र प्रणालियों की तुलना में ग्रीन सीकर (GS) सेंसर आधारित पोषक तत्व प्रबंधन वाली संरक्षित कृषि आधारित मक्का-गेहूँ-मूंग फसलचक्र प्रणाली में अधिकतम शुद्ध लाभ और लाभ : लागत अनुपात पाया गया। विभिन्न फसलचक्र प्रणालियों में खरपतवार बीज बैंक अध्ययन किया गया और यह पाया गया कि पारम्परिक चावल-गेहूँ- मूंग फसलचक्र प्रणाली में कुल बीज बैंक न्यूनतम था जबकि यह पारम्परिक जुताई तथा संरक्षित कृषि आधारित मक्का-गेहूँ-मूंग फसलचक्र प्रणाली में उच्चतर था। इससे यह स्पष्ट तौर पर पता चलता है कि केवल समुचित खरपतवार प्रबंधन के साथ ही संरक्षित कृषि रीति सफल हो सकती है।

### सामान्य मक्का एवं विशेष मक्का में विभिन्न जैविक पोशाक तत्व स्रोतों का अध्ययन

जैविक परिस्थिति के तहत तीन वर्षीय प्रयोग को पूरा करने के उपरान्त चौथे वर्ष में, जैविक उपचारों के अंतर्गत बेबी कॉर्न, स्वीट कॉर्न तथा सामान्य मक्का की उपज उर्वरकों की संस्तुत मात्रा (RDF) का प्रयोग करने के समतुल्य पाई गई। सौ प्रतिशत गोबर की खाद (FYM) का प्रयोग करने पर बेबी कॉर्न की उपज उर्वरकों की संस्तुत मात्रा (RDF) का प्रयोग करने के समतुल्य पाई गई जबकि स्वीट कॉर्न के मामले में उर्वरकों की संस्तुत मात्रा (RDF) का प्रयोग करने पर हासिल की गई उपज के समतुल्य ही 100 प्रतिशत गोबर की खाद तथा 50 प्रतिशत गोबर की खाद + 50 प्रतिशत वर्मी कम्पोस्ट का प्रयोग करने पर उपज हासिल की गई। इसी प्रकार, सभी जैविक उपचारों में सामान्य मक्का की उपज को उर्वरकों की संस्तुत मात्रा (RDF) का प्रयोग करने पर हासिल की गई उपज के समतुल्य पाया गया।

### चावल-गेहूँ एवं मक्का-गेहूँ फसलचक्र प्रणालियों का मृदा जीवाण्विक विविधता विश्लेषण

विभिन्न जुताई रीतियों के तहत चावल-गेहूँ एवं मक्का-गेहूँ फसलचक्र प्रणालियों में मृदा की जीवाण्विक विविधता की जांच क्रोमोजेनिक ऐगार मीडियम पर की गई। यह पाया गया कि स्थान विशिष्ट पोषक तत्व प्रबंधन के तहत मृदाओं में नाइट्रोजन निर्धारण करने वाले जीवाणु का उच्चतर घनत्व था जैसा कि नाइट्रोजन की अल्पता वाली परिस्थितियों के तहत शानदार ढंग से बढ़ने की इनकी क्षमता का आकलन करने से पता चला।

### पारम्परिक एवं संरक्षित कृषि रीतियों के तहत मक्का आधारित फसलचक्र प्रणाली में सेंसर निर्देशित नाइट्रोजन प्रबंधन

पचास प्रतिशत आरडीएन + जीएस आधारित नाइट्रोजन प्रयोग करने पर संरक्षित कृषि के अंतर्गत कृषि अपशिष्ट को बनाये रखते हुए मक्का-गेहूँ-मूंग फसलचक्र प्रणाली को अपनाकर प्रयोग किए गए नाइट्रोजन की आंशिक कारक उत्पादकता, उच्चतर प्रणाली उपज और शुद्ध लाभ को उल्लेखनीय रूप से हासिल किया जा सकता है। मक्का अपशिष्ट का प्रयोग करने पर परिपक्वता अवधि के दौरान गेहूँ की फसल में कमतर कैनोपी तापमान उत्पन्न हुआ जिससे अंतस्थ ताप तनाव को कम करने में इस प्रौद्योगिकी की क्षमता का पता चला। मक्का की फसल में नाइट्रोजन की पहली विभाजित खुराक का उप-सतही बैण्ड प्लेसमेंट करने पर पारम्परिक सतही बैण्डिंग प्रयोग की तुलना में मक्का की उपज में उल्लेखनीय सुधार हुआ।

### फसल सुरक्षा

फसल सुरक्षा कार्यक्रम के अंतर्गत परपोषी पादप प्रतिरोधिता और नाशीजीव व रोग प्रबंधन तकनीकों में एकीकृत युक्तियों पर बल दिया जाता है। वसंत 2020 के दौरान कुल 106 अंतः प्रजात वंशकर्मों की स्क्रीनिंग की गई जिसमें 35 अंतः

प्रजात वंशकर्म चारकोल सड़न रोग के विरुद्ध प्रतिरोधी पाए गए। रबी 2019-20 और खरीफ 2020 के दौरान कृत्रिम संक्रमण के तहत छांटे गए कुल 46 अंतः प्रजात वंशकर्मों में कमशः गुलाबी तना वेधक के विरुद्ध पांच अंतः प्रजात वंशकर्म यथा VH12137F2-1-5-2-3-1-1-1#-2-1-1, ZH111688F2-2-5-3-2-1-1-2#-1-2-1, ZH116002F2-1-3-2-3-1-1-1#-2-1-1, ZH116117F2-1-2-1-1-2-1-1#-1-1-1 तथा ZH112656F2-1-2-2-1-1-1-1#-1-1-1 और धब्बेदार तना वेधक के विरुद्ध एक अंतः प्रजात वंशकर्म यथा 141167-2-PP-25-1-2-1 आशाजनक पाया गया। खरीफ 2020 के दौरान लुधियाना में मेडिस पत्ती अंगमारी (MLB) के विरुद्ध विभिन्न रोग प्रबंधन माड्यूलस यथा जैविक, रासायनिक तथा एकीकृत रोग प्रबंधन (IDM) को जांचा गया। दोनों रोगों की रोकथाम करने में उल्लेखनीय रूप से सबसे अधिक उपज को रासायनिक माड्यूल में एवं तदुपरान्त एकीकृत रोग प्रबंधन माड्यूल में पाया गया। टर्सिकम पत्ती अंगमारी रोगजनक, सिटोस्फीरिया टर्सिका की विविधता का अध्ययन करने के लिए नौ राज्यों नामतः मेघालय, उत्तराखण्ड, हिमाचल प्रदेश, आन्ध्र प्रदेश, ओडिशा, गुजरात, मध्य प्रदेश, जम्मू व कश्मीर तथा महाराष्ट्र से कुल 45 पृथक्कों को संकलित किया गया। पृथक्कों को शुद्धीकृत कर इनका लक्षणवर्णन किया जा रहा है।

मक्का-गुलाबी तना वेधक के बीच पारस्परिकता को समझने की दिशा में विभिन्न प्रकार के उपचारों को आजमाकर उत्पन्न रक्षा प्रतिक्रिया संबंधी अध्ययन किए गए। विभिन्न उपचारों में: कंट्रोल यथा अनुपचारित पौधे, पीएसबी फीडिंग, मैकेनिकल वाउण्डिंग, मैकेनिकल वाउण्डिंग प्लस पीएसबी उर्ध्वनिक्षेप तथा दो अवस्थाओं यथा अंकुरण के 5 एवं 15 दिन बाद (DAG) प्रतिरोधी (डीएमआरई 63, सीएम 500), संतुलित प्रतिरोधी (डब्ल्यूएनजेड विदेशी पूल) तथा संवेदनशील जीनप्ररूप (सीएम 202, बीएमएल 6) में मिथाइल जैस्मोनेट का बहिर्जात प्रयोग करना थे। यह पाया गया कि संवेदनशील जीनप्ररूपों के मुकाबले विशेषकर प्रतिरोधी और संतुलित रूप से प्रतिरोधी जीनप्ररूपों में अधिकांश घटनाओं में अंकुरण के 5 एवं 15 दिन बाद अल्प एवं दीर्घावधि प्रतिक्रियाओं में जब कीट द्वारा आक्रमण किया गया तब p-कॉमैरिक अम्ल (p-CA) तथा फेरुलिक अम्ल (FA) मात्रा स्वाभाविक रूप से ज्यादा थी।

फॉल आर्मीवर्म (FAW) का बेहतर प्रबंधन करने की दिशा में, बीज उपचार कीटनाशकों यथा 6 से 10 मिलि. की मात्रा में थियामिथॉक्सम 30 FS, इमिडाक्लोप्रिड 600 FS तथा फिप्रोनिल 5 SC का मूल्यांकन भाकृअनुप-भारतीय मक्का अनुसंधान संस्थान, डब्ल्यूएनसी, हैदराबाद में खरीफ 2020 के दौरान फॉल आर्मीवर्म के विरुद्ध किया गया। इसमें नुकसान को कम करने और उपज वृद्धि हासिल करने के संबंध में 6-10 मिलि./किग्रा. बीज की दर पर थियामिथॉक्सम 30 FS का प्रयोग करना बेहतर पाया गया। रबी 2019-20 के दौरान दिल्ली में विभिन्न जुताई रीतियों के तहत फॉल आर्मीवर्म के संक्रमण को दर्ज किया गया। सबसे कम संक्रमण को शून्य जुताई (ZT) प्रणाली में और सबसे अधिक संक्रमण को पारम्परिक रूप से जुताई (CT) वाली प्रणाली में पाया गया। खरीफ 2020 में, विभिन्न जुताई रीतियों और फसलचक्र प्रणालियों के तहत V 6-7 अवस्था वाली मक्का फसल में फॉल आर्मीवर्म का संक्रमण दर्ज किया गया जिसमें विशेषकर मक्का-चना-सेस्बेनियाण (MCS), मक्का-सरसों-मूंग (MMuMb) फसलचक्र प्रणालियों में सबसे कम संक्रमण को शून्य जुताई (ZT) में और सबसे अधिक संक्रमण स्तर को पारम्परिक जुताई (CT) में पाया गया।

**अखिल भारतीय समन्वित मक्का अनुसंधान परियोजना**  
अपनी प्रमुख अनुसंधान गतिविधियों के अलावा, संस्थान द्वारा फसल सुधार,

फसल उत्पादन एवं फसल सुरक्षा के अंतर्गत अखिल भारतीय समन्वित मक्का अनुसंधान परियोजना के माध्यम से विभिन्न कृषि विश्वविद्यालयों के मक्का अनुसंधान कार्यक्रमों का समन्वय भी किया जाता है।

### फसल सुधार

रबी 2019-20 के दौरान, सामान्य मक्का, विशिष्ट मक्का के राष्ट्रीय पहल किस्मिय परीक्षण (NIVT), प्रगत किस्मिय परीक्षण-II (AVT-II) तथा प्रगत किस्मिय परीक्षण-II (AVT-II), क्यूपीएम परीक्षणों, कीट विज्ञान एवं रोगविज्ञान परीक्षणों की रूपरेखा तैयार की गई। प्रजनन परीक्षण के तहत एनआईवीटी में दो, एवीटी में तीन, क्यूपीएम में एक और पॉपकार्न में एक परीक्षण को शामिल किया गया। खरीफ 2020 के दौरान, 35 विभिन्न प्रजनन परीक्षणों की रूपरेखा बनाई गई। इनमें एक सेट जहां पूरी तरह से उत्तरी पर्वतीय जोन (NHZ) के लिए था वहीं अन्य सेट शेष जोन के लिए थे। इसके अलावा, विशेषतः वसंत मौसम के लिए भी एक नये परीक्षण की रूपरेखा बनाई गई और उत्तरी भारत के राज्यों के चार केन्द्रों यथा लुधियाना, करनाल, दिल्ली और पंतनगर क्षेत्रों में वसंत मक्का की लोकप्रियता को ध्यान में रखते हुए इन परीक्षणों को आयोजित किया गया। रबी 2019-20 के दौरान, विभिन्न जोन यथा उत्तर पश्चिमी मैदानी क्षेत्र (NWPZ), उत्तर पूर्वी मैदानी क्षेत्र (NEPZ), प्रायद्वीपीय क्षेत्र (PZ), मध्य पश्चिमी क्षेत्र (CWZ) के लिए क्रमशः 91 प्रतिशत, 89 प्रतिशत, 100 प्रतिशत तथा 100 प्रतिशत की सफलता दर पाई गई। उत्तर पश्चिमी मैदानी क्षेत्र (NWPZ) में वसंत परीक्षण आयोजित किए गए जिनमें कुल 11 प्रविष्टियों में से केवल दो प्रविष्टियाँ यथा वीएनआर 37753 तथा एचटी 20185 को परीक्षण प्रयोजन हेतु एवीटी-1 में प्रोन्नत किया गया।

### फसल उत्पादन

रबी 2020-21 के दौरान, विभिन्न कृषि पारिस्थितिकी प्रणालियों में मक्का प्रणालियों की उत्पादकता एवं लाभप्रदता को बढ़ाने के लिए मक्का प्रणालियों में विभिन्न परिपक्वता अवधि वाले पहले विमोचित किए जा चुके जीनप्ररूपों के जुताई एवं पोषक तत्व प्रबंधन, सेंसर निर्देशित नाइट्रोजन प्रबंधन, एकीकृत पोषक तत्व प्रबंधन, पारिस्थितिक गहनता और खरपतवार प्रबंधन पर सस्यविज्ञान प्रयोग किए गए। सघनता एवं पोषक तत्व स्तरों के प्रति पहले विमोचित किए गए जीनप्ररूपों की प्रतिक्रिया की जांच करने के लिए प्रयोग किया गया जिसमें पता चला कि जीनप्ररूपों द्वारा उत्तर पश्चिमी मैदानी क्षेत्र (NWPZ) में एवं सामान्य सघनता (करनाल) में उच्चतर पोषक तत्व की प्रति प्रतिक्रिया दी गई। प्रायद्वीपीय क्षेत्र (PZ) में दीर्घावधि परिपक्वता वाले जीनप्ररूपों द्वारा उच्च पोषक तत्व स्तरों के प्रति प्रतिक्रिया की गई लेकिन ये चेक किस्मों के साथ दाना उपज के लिए आंकड़ों की दृष्टि से समान थे। मध्य पश्चिमी क्षेत्र (CWZ) में भी लंबी परिपक्वता अवधि वाले जीनप्ररूपों में उच्च सघनता के साथ उच्च उर्वरता के प्रति अच्छी प्रतिक्रिया देखी गई और सर्वश्रेष्ठ चेक किस्म के मुकाबले में पीएम 17201 एल में उल्लेखनीय रूप से कहीं उच्चतर उपज पाई गई। इसी प्रकार, मध्यम परिपक्वता अवधि वाले जीनप्ररूपों (4 + 2 तुलनीय) को उत्तर पूर्वी मैदानी क्षेत्र (NEPZ) में चार स्थानों पर जांचा गया और यह पाया गया कि 150 प्रतिशत आरडीएफ के साथ उच्च सघनता में उल्लेखनीय उपज सुधार हुआ। विभिन्न जुताई रीतियों के तहत मक्का-गेहूँ-लोबिया फसलचक्र प्रणाली में पोषक तत्व प्रबंधन के लिए प्रयोग किया गया जिसमें पारम्परिक जुताई (CT) के साथ 100 प्रतिशत आरडीएफ का उपयोग करने पर अधिकतम मक्का समतुल्य उपज दर्ज की गई। पंतनगर (उत्तर पश्चिमी मैदानी क्षेत्र (NWPZ) में भी शून्य जुताई के साथ 100 प्रतिशत आरडीएफ का प्रयोग करने पर इसी प्रकार की समतुल्य उपज दर्ज की गई।

हालांकि, शून्य जुताई के साथ 100 प्रतिशत आरडीएफ का प्रयोग करने पर प्रणाली में अधिकतम शुद्ध लाभ हासिल किया गया। परिणामस्वरूप आरडीएफ-शून्य जुताई के साथ अधिकतम लाभ : लागत अनुपात हासिल किया गया। विभिन्न जुताई रीतियों के अंतर्गत मक्का-गेहूँ-मूंग फसलचक्र प्रणाली में पोषक तत्व प्रबंधन में यह देखने को मिला कि धोली (उत्तर पूर्वी मैदानी क्षेत्र (NEPZ) में अनुवर्ती गेहूँ की उपज और शुद्ध लाभ पर जुताई का कोई विशेष प्रभाव नहीं पाया गया जबकि स्थान विशिष्ट पोषक तत्व प्रबंधन (SSNM) के साथ 60 प्रतिशत आरडीएफ + ग्रीन सीकर (GS) का प्रयोग करने पर समतुल्य परिणाम प्राप्त किए गए जिनमें आरडीएफ की तुलना में कहीं उच्चतर उपज और शुद्ध लाभ हासिल किया गया। पुनः उभरती चावल-मक्का आधारित फसलचक्र प्रणाली में सर्वश्रेष्ठ पोषक तत्व एवं जुताई प्रबंधन रीतियों का पता लगाने के लिए उत्तर पूर्वी मैदानी क्षेत्र (NEPZ) के धोली एवं कल्याणी में एक प्रयोग किया गया। जुताई रीतियों के बीच, स्थायी क्यारी (PB) के तहत मक्का फसल से उल्लेखनीय रूप से उच्चतर उपज और शुद्ध लाभ हासिल किया गया जो कि शून्य जुताई के समतुल्य था। पुनः धोली की रेतीली दुमटी मृदा में पारम्परिक जुताई के मुकाबले में दोनों रीतियाँ उल्लेखनीय रूप से बेहतर पाई गईं। इसके प्रतिकूल कल्याणी की चिकनी दुमटी मृदा में पारम्परिक जुताई और स्थायी क्यारी की तुलना में शून्य जुताई के तहत उल्लेखनीय रूप से कहीं उच्चतर उपज और शुद्ध लाभ मिला। हालांकि दोनों स्थानों पर ग्रीन सीकर निर्देशित नाइट्रोजन का प्रयोग करने पर उल्लेखनीय रूप से कहीं उच्चतर उपज और शुद्ध लाभ हासिल किया गया। मक्का-चना फसलचक्र प्रणाली में बांसवाडा (मध्य पश्चिमी क्षेत्र (CWZ) में विभिन्न जुताई रीतियों के अंतर्गत मक्का आधारित बारानी फसलचक्र प्रणाली में पोषक तत्व प्रबंधन के लिए प्रयोग किया गया। यह देखने में आया कि विभिन्न जुताई रीतियों का मक्का की उपज पर कोई विशेष प्रभाव नहीं था जबकि शून्य जुताई के तहत उल्लेखनीय रूप से उच्चतर चना उपज प्राप्त की गई जो कि स्थायी क्यारी रीति में हासिल की गई उपज के समतुल्य थी तथा ये दोनों रीतियाँ पारम्परिक जुताई (CT) के मुकाबले में बेहतर थीं। पोषक तत्व प्रबंधन के बीच, स्थान विशिष्ट पोषक तत्व प्रबंधन (SSNM) आधारित पोषक तत्वों का प्रयोग करने पर अध्ययन में उपयोग किए गए अन्य विकल्पों की तुलना में दोनों फसलों की उल्लेखनीय रूप से कहीं उच्चतर उपज मिली। मक्का की फसल में जैविक खाद के प्रयोग को एकीकृत करने के प्रयोजन से एकीकृत पोषक तत्व प्रबंधन पर दीर्घावधि परीक्षण किया गया। मक्का-गेहूँ प्रणाली में पंतनगर (उत्तर पश्चिमी मैदानी क्षेत्र (NWPZ) तथा बांसवाडा (मध्य पश्चिमी क्षेत्र (CWZ) में 100 प्रतिशत आरडीएफ + 5 टन/हेक्टेयर की दर पर गोबर की खाद का प्रयोग करने पर उल्लेखनीय रूप से अधिकतम शुद्ध लाभ और लाभ : लागत अनुपात दर्ज किया गया। गोबर की खाद / 10 टन/हे. + एजोटोबैक्टर का प्रयोग करने पर मक्का + फली अंतर फसलचक्र में भी बांसवाडा और पंतनगर में हासिल की गई उपज के समतुल्य उपज दर्ज की गई। सेंसर आधारित नाइट्रोजन प्रबंधन पर आयोजित किए गए प्रयोग में यह देखने में आया कि ग्रीन सीकर सेंसर आधारित नाइट्रोजन का प्रयोग करने वाले उपचारों, 33 प्रतिशत नाइट्रोजन का आधारीय प्रयोग + घुटनों की ऊंचाई तक तथा नर मंजरी निकलने की अवस्था में ग्रीन सीकर आधारित नाइट्रोजन का प्रयोग करने अथवा 30 प्रतिशत नाइट्रोजन का आधारीय प्रयोग + बुवाई के 25 दिनों उपरान्त 30 प्रतिशत + नर मंजरी अवस्था में ग्रीन सीकर नाइट्रोजन का प्रयोग करने पर आंकड़ों की दृष्टि से समान उपज हासिल की गई जबकि उच्चतर शुद्ध लाभ को आरडीएफ का प्रयोग करने पर हासिल किया गया। एसटीसीआर आधारित पोषक तत्वों का प्रयोग करने पर मक्का-गेहूँ फसलचक्र प्रणाली में उल्लेखनीय रूप से कहीं अधिक उपज और लाभ अर्जित

किया गया। विभिन्न मक्का आधारित फसलचक्र प्रणालियों में केवल उत्तर पर्वतीय क्षेत्र (NHZ) को छोड़कर अन्य चार क्षेत्रों में इकोलॉजिकल सघनीकरण (EI) के इष्टतमीकरण के माध्यम से उपज एवं लाभ अधिकता के लिए प्रयोग किया गया। सभी क्षेत्रों अथवा जोन में इकोलॉजिकल सघनीकरण के साथ फसल उपज आंकड़ों की दृष्टि से अधिकतम थी। बांसावाडा, पेड़पुरम, करीमनगर, हैदराबाद तथा धोली में इकोलॉजिकल सघनीकरण माइनस खरपतवार प्रबंधन के लिए; वगारई, कोयम्बटूर तथा पंतनगर में इकोलॉजिकल सघनीकरण माइनस जल प्रबंधन के लिए जबकि कल्याणी, भुवनेश्वर एवं लुधियाना में इकोलॉजिकल सघनीकरण माइनस पोषक तत्व प्रबंधन के लिए कमतर उपज पाई गई। अतः मक्का प्रणाली की उपज को बढ़ाने हेतु इको-क्षेत्र विशिष्ट प्रौद्योगिकी पर ध्यान केन्द्रित करने की जरूरत है। मक्का प्रणालियों में खरपतवार प्रबंधन पर आयोजित किए गए प्रयोग में पता चला कि मक्का की फसल में खरपतवार निकलने के उपरान्त प्रयोग किए गए शाकनाशी जैसे कि टेम्बोट्रियोन अथवा टोपरामिजोन का रोटेशन में बोई गई अनुवर्ती गेहूं फसल पर कोई प्रतिकूल प्रभाव नहीं था। रबी की मक्का फसल में प्रयोग किए गए शाकनाशी उपचारों में खरपतवार निकलने से पूर्व 750 ग्राम/हे. की दर पर एट्राजिन एवं तदुपरान्त बुवाई के 25 दिनों बाद 25.2 ग्राम/हे. की दर पर टोपरामिजोन का प्रयोग करने पर कल्याणी (उत्तर पूर्वी मैदानी क्षेत्र) में उल्लेखनीय रूप से कहीं उच्चतर उपज और शुद्ध लाभ दर्ज किया गया।

### फसल सुरक्षा

रबी 2019-20 एवं वसंत 2020 के दौरान अखिल भारतीय समन्वित मक्का अनुसंधान परियोजना के कीटविज्ञान प्रयोगात्मक परीक्षण आयोजित किए गए जिनका प्रयोजन मुख्यतः गुलाबी तना वेधक (पीएसबी : सिसेमिया इनफेरेन्स), धब्बेदार तना वेधक (एसएसबी : काइलो पार्टलस), फॉल आर्मीवर्म (फॉल आर्मीवर्म : स्प्योडोप्टेरा फ्रुजीपर्डा) तथा प्ररोह मक्खी (एथरीगोना प्रजाति) के विरुद्ध प्रतिरोधिता का पता लगाना था।

हैदराबाद में पीएसबी के विरुद्ध, कोल्हापुर में एसएसबी के विरुद्ध, करनाल एवं लुधियाना में प्ररोह मक्खी के विरुद्ध, कोयम्बटूर, हैदराबाद तथा कोल्हापुर में फॉल आर्मीवर्म के विरुद्ध एवीटी-1 तथा एवीटी-2 पछेती परिपक्वता समूह में कुल 17 प्रविष्टियों की छंटाई की गई। इसमें पता चला कि जहां 16 प्रविष्टियां पीएसबी के प्रति संतुलित प्रतिरोधी थीं वहीं एसएसबी के विरुद्ध सभी प्रविष्टियां संतुलित रूप से प्रतिरोधी थीं। प्ररोह मक्खी के विरुद्ध सबसे कम मृत हृदय को पीएम 17201 एल (16.0) में एवं तदुपरान्त एनएमएच 4313 (17.1) में पाया गया। फॉल आर्मीवर्म के लिए डेविस स्कोर में बुवाई के 14 दिनों उपरान्त 2.4 (केएमएच 25 के 45) से लेकर 2.9 (पीएम 18206 एल) तक; बुवाई के 28 दिनों बाद 3.4 (पीएम 18204 एल) से 4.6 (पीएम 17208 एल) तक; तथा बुवाई के 60 दिनों उपरान्त 4.7 (एनएमएच 713) से 6.0 (पीएमएच 17208 एल) तक की भिन्नता देखने को मिली। पुनः हैदराबाद में पीएसबी के विरुद्ध, कोल्हापुर में एसएसबी के विरुद्ध, करनाल व लुधियाना में प्ररोह मक्खी के विरुद्ध तथा कोयम्बटूर, हैदराबाद और कोल्हापुर में फॉल आर्मीवर्म के विरुद्ध एवीटी-1 एवं एवीटी-2 मध्यम परिपक्वता वर्ग में कुल 15 प्रविष्टियों की छंटाई की गई। इसमें सभी प्रविष्टियां पीएसबी और एसएसबी के विरुद्ध संतुलित प्रतिरोधी पाई गई। प्ररोह मक्खी के विरुद्ध समग्र न्यूनतम मृत हृदय (प्रतिशत) को आईएमएचएसबी 17 आर-16 (12.2) में पाया गया वहीं फॉल आर्मीवर्म के लिए डेविस स्कोर में बुवाई के 14 दिनों उपरान्त 2.7 (आईएमएचएसबी 17 आर-5) से 3.1 (आईएमएचएसबी 17 आर-9, एनएमएच 4140) तक, बुवाई के 28 दिनों उपरान्त 3.5 (आईएमएचएसबी 17 आर-16) से 4.4 (बीएलएच 139) तक तथा

बुवाई के 60 दिनों उपरान्त 3.8 (आईएमएचएसबी 17 आर-8, डीएचएम 117) से 4.2 (एएच 8181, बीएलएच 139) तक की भिन्नता देखने को मिली। पुनः करनाल व लुधियाना में प्ररोह मक्खी के विरुद्ध और कोयम्बटूर में फॉल आर्मीवर्म के विरुद्ध प्राकृतिक संक्रमण के तहत 42 मक्का प्राप्तियों का मूल्यांकन किया गया। प्ररोह मक्खी के विरुद्ध सबसे कम औसत प्रतिशत मृत हृदय को डीएमआर ई 63/सीएमएल 287-4-6 (25.3) में पाया गया। फॉल आर्मीवर्म के मामले में, बुवाई के 28 दिनों उपरान्त सबसे कम औसत डेविस स्कोर को जहां बीएमएल 7 (1.4) में पाया गया वहीं सबसे अधिक मान को डीएमआरई 63/सीएमएल 287-3-61-2बी (4.2) में दर्ज किया गया। खरीफ 2020 के दौरान, इम्फाल, करनाल, लुधियाना, धोली, कोयम्बटूर, हैदराबाद, कोल्हापुर और उदयपुर सहित विभिन्न केन्द्रों पर एसएसबी तथा/अथवा फॉल आर्मीवर्म के विरुद्ध अखिल भारतीय समन्वित अनुसंधान परियोजना प्रविष्टियों का मूल्यांकन किया गया और प्रतिरोधी प्रविष्टियों की पहचान की गई। पुनः अखिल भारतीय समन्वित अनुसंधान परियोजना के विभिन्न केन्द्रों पर विभिन्न परीक्षण किए गए जैसे कि एनबीआईआर मंद गति से जारी करने वाले डिसिपेन्सर के साथ फिरोमॉन ट्रेप का उपयोग करके फॉल आर्मीवर्म की निगरानी; फिरोमॉन ट्रेप द्वारा छल्ली वेधक (हेलिकोवर्पा आर्मीजेरा) की निगरानी; फॉल आर्मीवर्म के विरुद्ध बीज उपचार के रूप में कीटनाशकों का मूल्यांकन; मक्का फसल में तना वेधक और फॉल आर्मीवर्म का प्रबंधन; तथा फॉल आर्मीवर्म के विरुद्ध जैव नाशकजीवनाशियों/जैव एजेन्टों का मूल्यांकन।

रबी 2019-20 के दौरान, देश के विभिन्न जोन में मेडिस पत्ती अंगमारी (MLB), टर्सिकम पत्ती अंगमारी (TLB), चारकोल सड़न (ChR) तथा सोरघम डाउनी मिल्ड्यू (SDM) के विरुद्ध कुल 109 मक्का प्रविष्टियों का मूल्यांकन किया गया। मेडिस पत्ती अंगमारी (MLB), टर्सिकम पत्ती अंगमारी (TLB) तथा सोरघम डाउनी मिल्ड्यू (SDM) के लिए एनआईवीटी पछेती परिपक्वता की कुल 36 संकर किस्मों का मूल्यांकन किया गया। मेडिस पत्ती अंगमारी तथा सोरघम डाउनी मिल्ड्यू के लिए कमशः छः एवं एक प्रविष्टि संतुलित थी जबकि टर्सिकम पत्ती अंगमारी (TLB) तथा चारकोल सड़न (ChR) के विरुद्ध कोई भी प्रविष्टि प्रतिरोधी नहीं पाई गई। एनआईवीटी मध्यम परिपक्वता में कुल 52 प्रविष्टियों में से मेडिस पत्ती अंगमारी के लिए पांच प्रविष्टियां यथा एएच 8047, आईएमएचएसबी 19 आर-17, आईएमएचएसबी 19 आर-4, आईएमएचएसबी 19 आर-9 तथा एमएच 2047 और सोरघम डाउनी मिल्ड्यू के लिए तीन प्रविष्टियां यथा बीएयूएमएचआर 19-2, आईएमएचएसबी 19 आर-12 एवं आईएमएचएसबी 19 आर-14 प्रतिरोधी थीं जबकि टर्सिकम पत्ती अंगमारी (TLB) तथा चारकोल सड़न (ChR) के विरुद्ध कोई भी प्रविष्टि प्रतिरोधी नहीं पाई गई। पुनः मेडिस पत्ती अंगमारी (MLB), टर्सिकम पत्ती अंगमारी (TLB), चारकोल सड़न (ChR) तथा सोरघम डाउनी मिल्ड्यू (SDM) के विरुद्ध एवीटी-1-2 की कुल 22 प्रविष्टियों का मूल्यांकन किया गया। इस कार्य में मेडिस पत्ती अंगमारी के लिए एक प्रतिरोधी प्रविष्टि यथा आरएसआई 4118 तथा सोरघम डाउनी मिल्ड्यू के लिए तीन प्रतिरोधी प्रविष्टियां यथा एडीवी 7043, पीएम 17205 एल और पीएम 18205 एल का पता चला। मेडिस पत्ती अंगमारी (MLB), टर्सिकम पत्ती अंगमारी (TLB), चारकोल सड़न (ChR) तथा सोरघम डाउनी मिल्ड्यू (SDM) के विरुद्ध एवीटी-1-2 मक्का संकरों की रोग स्क्रीनिंग करने पर मेडिस पत्ती अंगमारी के विरुद्ध तीन प्रतिरोधी प्रविष्टियां यथा आईएमएचएसबी 17 आर-16, आईएमएचएसबी 17 आर-8 तथा आईएमएचएसबी 17 आर-9 और सोरघम डाउनी मिल्ड्यू के विरुद्ध एक प्रतिरोधी प्रविष्टि यथा एएच 8181 की पहचान

की गई। पॉपकार्न मक्का संकरों की रोग स्क्रीनिंग करने पर मेडिस पत्ती अंगमारी (MLB), टर्सिकम पत्ती अंगमारी (TLB), चारकोल सडन (ChR) तथा सोरघम डाउनी मिलड्यू (SDM) के लिए किसी प्रतिरोधी स्रोत की पहचान नहीं की जा सकी जबकि क्यूपीएम परीक्षण में दो प्रविष्टियां यथा आईक्यूपीएमएच 19 आर-1 एवं आईक्यूपीएमएच 19 आर-3 मेडिस पत्ती अंगमारी के विरुद्ध प्रतिरोधी थीं। खरीफ 2020 के दौरान, कुल 269 परीक्षण आयोजित किए गए। इनमें से 196 समन्वित परीक्षण थे जबकि ट्रेप नर्सरी के लिए 20 परीक्षण आयोजित किए गए। इसके अलावा, विभिन्न श्रेणियों यथा प्रबंधन परीक्षण; सिम्ट से परीक्षण; टालने योग्य अथवा परिहार्य उपज नुकसान परीक्षण; एवं सर्वे एवं सर्विलांस के तहत क्रमशः 25, 6, 3 तथा 19 परीक्षण भी आयोजित किए गए।

## प्रसार एवं आउटरिच

### प्रसार कार्यक्रम

अनुसंधान जरूरतों का समाधान करने के साथ-साथ संस्थान द्वारा अपने हितधारकों तक पहुंच स्थापित करने के लिए जीवंत प्रसार एवं आउटरिच कार्यक्रम चलाया जाता है। विभिन्न कार्यक्रमों का आयोजन करके संस्थान अपने किसान हितधारकों तक अपनी पहुंच बनाता है। इन कार्यक्रमों में प्रमुख हैं : राष्ट्रीय खाद्य सुरक्षा मिशन (NFSM) के अंतर्गत कृषि, सहकारिता एवं किसान कल्याण विभाग, भारत सरकार द्वारा प्रायोजित अग्रिम पंक्ति प्रदर्शन (FLDs); अनुसूचित जनजाति संघटक (STC); पूर्वोत्तर पर्वतीय संघटक (NEH); अनुसूचित जाति उप-योजना (SCSP); तथा मेरा गांव – मेरा गौरव (MGMG)।

वर्ष 2019-20 के रबी मौसम में, कुल 2 किसानों को लाभ पहुंचाते हुए 100 हेक्टेयर कृषि क्षेत्रफल में अग्रिम पंक्ति प्रदर्शन लगाए गए। इस मौसम में, सात राज्यों में आठ केन्द्रों द्वारा किसानों के खेतों पर सूक्ष्म पोषक तत्व एवं एकीकृत नाशीजीव प्रबंधन जैसी प्रौद्योगिकियों, डीएमआरएच 1301, सीओ 6, जीएवाईएमएच-1 तथा जीएवाईएमएच-3 जैसे सार्वजनिक क्षेत्र के संकरों और मटर एवं आलू के साथ मक्का के अंतर फसलचक्र का प्रदर्शन किया गया। बेगूसराय, बिहार में 8.4 प्रतिशत से लेकर कोल्हापुर, महाराष्ट्र में 46 प्रतिशत तक उपज वृद्धि हासिल की गई। वसंत 2020 में, तीन केन्द्रों द्वारा 30.2 हेक्टेयर से अधिक कृषि रकबे में अग्रिम पंक्ति प्रदर्शन लगाए गए जिनमें सार्वजनिक क्षेत्र के उन्नत संकर (पीएमएच 10) तथा निजी क्षेत्र के संकर (डीकेसी 9108) की प्रौद्योगिकी और संस्तुत बुवाई समय का प्रदर्शन किया गया। इस मौसम में न्यूनतम उपज वृद्धि देखी गई और इस वृद्धि में 2.51 से 5.68 प्रतिशत की भिन्नता थी।

खरीफ 2020 में, तेरह राज्यों में कुल 375 किसानों को लाभ पहुंचाते हुए 151.03 हेक्टेयर से भी अधिक कृषि रकबे में अग्रिम पंक्ति प्रदर्शन आयोजित किए गए। इनमें सार्वजनिक क्षेत्र द्वारा हालिया जारी की गई संकर किस्मों यथा डीएमआरएच-1301, एफक्यूएच 106, वीएमएच 45, पीएमएच 1, CoH(M)-8, एमएच-14-5, जीएवाईएमएच-1, जैव प्रबलित क्यूपीएम संकर शक्तिमान-5 तथा साथ ही निजी क्षेत्र की संकर किस्मों यथा बायो-9544, पीएम-3 तथा पीएम-9 आदि को प्रदर्शित किया गया। इन प्रदर्शनों में मांडया, कर्नाटक में 9.6 प्रतिशत से लेकर इम्फाल, मणिपुर में 103 प्रतिशत तक की उपज वृद्धि हासिल की गई। जलभराव के प्रति संवेदनशील उत्तर पूर्वी मैदानी क्षेत्र (NEPZ) में सपाट बुवाई की तुलना में उठी हुई क्यारियों में रोपण के तहत 73.1 प्रतिशत की

उपज वृद्धि पाई गई। कोल्हापुर केन्द्र में फॉल आर्मीवर्म (FAW) प्रबंधन अग्रिम पंक्ति प्रदर्शन आयोजित किए गए जिनमें 46.1 प्रतिशत की उपज वृद्धि की सूचना मिली। इसी प्रकार, छिंदवाड़ा, मध्य प्रदेश में सर्वश्रेष्ठ खरपतवार प्रबंधन वाले अग्रिम पंक्ति प्रदर्शनों में 44.8 प्रतिशत उपज अग्रता प्रदर्शित हुई।

अनुसूचित जनजाति संघटक (STC) के अंतर्गत, देश के विभिन्न भागों में कुल 33 किसान प्रशिक्षण/प्रक्षेत्र दिवस/जागरूकता कार्यक्रम आयोजित किए गए। मक्का की वैज्ञानिक खेती के विभिन्न पहलुओं पर कुल 1596 जनजाति किसान लाभान्वित हुए। इन कार्यक्रमों में आदान वितरित किए गए जिससे 1459 किसान परिवार लाभान्वित हुए। केन्द्रीय कृषि विश्वविद्यालय, इम्फाल, मणिपुर; केन्द्रीय कृषि विश्वविद्यालय-सीपीजीएस, बारापानी, मेघालय; भाकूअनुप-राष्ट्रीय सूअर अनुसंधान केन्द्र, गुवाहटी, असम; भाकूअनुप-राष्ट्रीय यॉक अनुसंधान केन्द्र, दिरांग, अरुणाचल प्रदेश; भाकूअनुप-राष्ट्रीय मिथुन अनुसंधान केन्द्र, दीमापुर, नागालैण्ड; तथा पूर्वोत्तर पर्वतीय क्षेत्र के लिए भाकूअनुप का अनुसंधान परिसर, उमियाम के साथ सहयोग करते हुए "टिकाऊ पशुधन उत्पादन के लिए मक्का" विषय पर पूर्वोत्तर पर्वतीय कार्यक्रम की परियोजना को लागू किया गया है। इस कार्यक्रम के अंतर्गत सूअरों और यॉक के उत्पादन प्रदर्शन पर क्यूपीएम मक्का चारा और सिलेज के अनुपूर्ति प्रभाव का मूल्यांकन किया गया। इसके अलावा, पूर्वोत्तर भारत में विभिन्न संस्थानों के साथ सहयोग करते हुए पूर्वोत्तर पर्वतीय क्षेत्र के मक्का किसानों के लिए कुल 28 प्रशिक्षण कार्यक्रम आयोजित किए गए और आदानों का वितरण किया गया। इन कार्यक्रमों में कुल 1517 ग्रामीण परिवारों को लाभ पहुंचा।

अनुसूचित जाति उप-योजना (SCSP) के अंतर्गत, विभिन्न अखिल भारतीय समन्वित अनुसंधान परियोजना केन्द्रों द्वारा तीन प्रशिक्षण कार्यक्रम आयोजित किए गए और किसानों को कृषि आदान वितरित किए गए। इन कार्यक्रमों में कुल 117 किसान लाभान्वित हुए। निका-अनुसूचित जाति उप-योजना के अंतर्गत, चौधरी सरवन कुमार हिमाचल प्रदेश कृषि विश्वविद्यालय (CSKHPKV), पालमपुर, हिमाचल प्रदेश के साथ सहयोग करते हुए जिला चम्बा, हिमाचल प्रदेश में लगभग 200 किसान परिवारों को लाभ पहुंचाते हुए चार मक्का श्रेसर वितरित किए गए। इसके अलावा, कोविड-19 महामारी के दौरान समाचार-पत्रों, स्थानीय चैनल, ऑल इंडिया रेडियो, स्थानीय रेडियो स्टेशन, व्हाट्सएप ग्रुप तथा फेसबुक आदि के माध्यम से कुल नौ भाषाओं में किसानों को परामर्श जारी किए गए।

भाकूअनुप-भारतीय मक्का अनुसंधान संस्थान के तीस वैज्ञानिकों की आठ टीमों द्वारा पंजाब, हरियाणा, बिहार और तेलंगाना के पांच ब्लॉक में अंगीकृत किए गए 29 गांवों में मेरा गांव-मेरा गौरव कार्यक्रम को क्रियान्वित किया गया है। गांव में दौरा करके, किसानों को संदेश, ई-मेल, फोन कॉल तथा संदेश आदि भेजकर किसानों को सर्वश्रेष्ठ मक्का उत्पादन रीतियां, फॉल आर्मीवर्म प्रबंधन, स्वच्छता और कोविड-19 के संबंध में सावधानी उपायों पर परामर्श प्रदान किए गए।

## प्रशिक्षण एवं क्षमता निर्माण

अपने स्टाफ सदस्यों को तकनीकी एवं प्रशासनिक प्रशिक्षण के लिए भेजने के अलावा, भारतीय मक्का अनुसंधान संस्थान द्वारा अपने विभिन्न हितधारकों यथा अनुसंधान एवं प्रसार के क्षेत्र में अधिकारियों, प्रशासकों, किसानों और छात्रों के लिए मक्का की वैज्ञानिक खेती एवं नाशीजीव प्रबंधन पर तकनीकी प्रशिक्षण कार्यक्रम आयोजित किए गए।





## Executive Summary

ICAR- Indian Institute of Maize Research (ICAR-IIMR) carries out basic, strategic and applied research aimed at enhancing production, productivity and sustainability of the maize crop. The research programmes of the institute are built around three major theme areas, viz., Crop Improvement, Crop Production and Crop Protection. The technologies developed are validated through All India Coordinated Research Project (AICRP) on Maize and the validated technologies are extended to stakeholders through extension and outreach programmes. During 2020, the institute has made significant achievements in research, product development, commercialization and extending its technologies to farmers through outreach activities.

### CROP IMPROVEMENT

Being a crop improvement institute, the major research focus of ICAR-IIMR has mainly been centered on the genetic enhancement of maize. The crop improvement programme is focused on improving productivity of the hybrids and parental lines, germplasm enhancement for resistance to biotic and abiotic stresses and quality traits. Further, commercialization of developed products is a new dimension of focus in this context.

#### Hybrids identified and notified

During the year 2020, four hybrids, viz., LQMH 1 (IMHQPM 1530), LPCH 2 (IMHP 1535), LPCH 3 (IMHP 1540) and LBCH 3 (DMRHB 1305) have been released and notified in the 84<sup>th</sup> meeting of Central Sub-Committee on Crop Standards, Notification and Release of Varieties for Agricultural Crops held on July 10, 2020. LQMH 1 is a QPM hybrid with high tryptophan (0.73%) and lysine (3.03%) content. LPCH 2 and LPCH 3 are popcorn cultivars with high popping percentage, whereas LBCH 3 is a baby corn hybrid with high prolificacy and moderate. In addition to that two QPM hybrids were also identified during the 63rd annual maize workshop held during April 20-22, 2020. Three biofortified hybrids developed by the institute has been dedicated to the nation by Hon'ble Prime Minister on World Food Day.

#### Seed production and commercialization of maize hybrids

In total, 35.46 quintals of breeder seeds of parental lines of the hybrids in demand, viz., DMRH 1301, DMRH 1308, DMRH 1305 and IMHB 1539 were produced and supplied to various state, national and other seeds producing agencies as per their demands. In addition, these hybrids were licensed to eight seed companies through Agrinnovate India Ltd., for commercialization at their end.

#### Hybrids promoted/contributed under AICRP testing

During *rabi* 2019-20, five entries of normal field corn were promoted from AVT-I to AVT-II and three entries of field corn, while two popcorn hybrids were promoted from NIVT to

AVT-I. During *kharif* 2020, one QPM hybrid was promoted for testing in AVT-II, whereas two entries of normal field corn and four QPM were promoted from NIVT to AVT-I. One sweet corn hybrid was promoted from NIVT to AVT-I in north western plain zone (Zone II).

Fifteen maize hybrids were contributed for AICRP testing during *kharif* 2020 and 25 entries were contributed in *rabi* 2020-21. Further, four entries were contributed in AICRP fodder trials during *rabi* 2020-21, along with three maize hybrids during *kharif* 2020.

#### Evaluation of experimental hybrids

Thirty two maize experimental hybrids with four checks were evaluated at three locations. Based on the high mean and stability two experimental hybrids were identified. In early maturity, 38 fresh crosses were evaluated during *kharif* 2020. Eighteen crosses showed significant superiority over check DKC 7074 for grain yield. A set of 545 experimental hybrids were evaluated to identify the best high yielding hybrid for *rabi* season at RMR&SPC, Begusarai. One hundred and twenty one hybrid combinations under medium maturity and ten under late maturity group out-yielded the best check of the respective maturity groups. During *kharif* 2020, a set of 275 experimental hybrids generated were evaluated at Begusarai and Ludhiana and 12 and 17 experimental hybrids showed >10% yield superiority over the best check hybrid at Begusarai and at Ludhiana, respectively. One QPM trial consisting of 45 experimental hybrids along with four checks were evaluated during *kharif* 2020 at Ludhiana. Two experimental hybrids outperformed the popular normal hybrid Bio 9544. A set of 15 experimental baby corn hybrids were evaluated during *kharif* 2020 at Ludhiana and one hybrid was found superior over both the checks.

#### Introduction of germplasm

To strengthen the baby corn programme, 9 accessions of inbred lines were imported for the development of silkless baby corn from the Maize Genetic Stock Center, University of Illinois, USA. Further, 84 new sources of specialty corn sources were procured from CIMMYT, India which includes sweet corn (55), popcorn (19) and baby corn (10).

#### Characterization of germplasm

An association mapping panel (AMP) of 350 diverse maize inbred lines was characterized using 60227 SNPs identified through Genotype by sequencing (GBS). The population structure was studied and six possible sub-structures in the AMP were identified. Each subgroup was diverse from others and can be considered for GWAS. Further, 198 F<sub>8</sub> RILs derived from the cross between HKIPC 4B × CML 269 were characterized for seed and popping traits over the three locations along with 6527 polymorphic SNPs. Total 15 QTLs (major: 5; minor: 10) were mapped for various popping related traits and were distributed over all the chromosomes except

chromosome 10. Meta-QTL analysis for popping traits identified 10 meta-QTLs and 229 genes on expression basis (19 genes selected using KEGG pathways) from reported QTLs in different QTL mapping experiments. Twenty-seven white maize populations were characterized for yield contributing traits, viz., Number of Row Per Ear (NRPE), Number of Kernel Per Row (NKPR) and Hundred Seed Weight (HSWT) and also with SSR markers. Six populations for NRPE, three for NKPR and five for HSWT were identified for further studies. Overall two heterotic groups existed in the populations based on SSR profile. Five hundred inbred lines were evaluated at Begusarai during *rabi* 2019-20, where 20 inbred lines out-yielded the best check inbred (HKI 193-2). Further, 400 inbred lines were screened at Ludhiana during *kharif* 2020, where 11 lines recorded grain yield as high as 75 q/ha. Besides, 776 genotypes were characterized and 898 inbred lines, which were selected based on passport data generated during 2014-15 to 2018-19, were multiplied during the period under CRP-AB. The Growing Degree Days (GDD) for anthesis was standardized for 58 hybrids. The GDD for the majority of the early, medium and late lines varied between 800-900, 900-950 and 950-1000 GDD, respectively.

#### **Development, maintenance and diversification of genetic resources**

During *rabi* 2019-20, 922 inbred lines were maintained through self-pollination and 41 populations were maintained through bulk pollination. During spring 2020, 645 inbred lines were maintained and multiplied at Ludhiana. Further, 805 families were advanced to S<sub>3</sub> stage and 289 segregating families were advanced to S<sub>2</sub> stage. A set of 140 inbred lines and 13 parental genotypes of released maize hybrids were evaluated at RMR&SPC, Begusarai during *rabi* 2018-19 and characterized for 13 morphological and yield-related traits. D<sup>2</sup> statistics revealed 20 clusters and crosses among identified distant genotypes may harness a greater level of heterosis. The genetic diversity study at the molecular level was also conducted with the help of 40 polymorphic SSR markers. To diversify the QPM germplasm, 24 QPM and 24 normal lines were crossed with two testers, and were also subjected to molecular profiling. Based on both yield and molecular data, the genotypes were grouped in different clusters, viz., A and B. The normal lines belonging to the heterotic group A and B will be used to diversify the QPM germplasm of respective groups through chain crossing.

#### **Specialty corn breeding**

The 126 F<sub>3</sub>-F<sub>5</sub> segregating sweet corn families obtained from hybrid break-down or pedigree crosses are being advanced through self-pollination. The variation observed for ear length (EL), ear girth (EG) and number of kernel rows (NKR) was relatively higher in pedigree crosses than hybrid derived inbred lines. Further, the sweet corn inbred lines were crossed with two testers, viz., LM 13 and LM 14 for heterotic grouping and the test crosses (150) are being evaluated for yield and yield contributing traits. To strengthen the baby corn germplasm, 82 new inbred lines have been derived. One genotype, IBCL 36 showed prolificacy with 3-4 cobs per plant

and another line IBCL 46 was ligule less with erect leaf. To develop the CMS based baby corn hybrid, advanced backcross generations were developed. Further, 54 new test crosses were made between G 5417 and inbred lines, and based on the tassel morphology in the field, 14 inbred lines were classified as B lines and 16 lines as R, whereas 24 lines showed partial fertility. Heterotic grouping of 26 inbred lines was done by crossing them with two testers, viz., HKI 1105 and HKI 323. Among the 26 lines, 12 genotypes were classified in group A (HKI 323) and 14 in group B (HKI 1105). Under the pre-breeding programme, LM 13 and LM 14 (the parental lines of the hybrid PHM 1) were crossed with *Z. parviglumis* for developing BC<sub>2</sub>F<sub>2</sub> population through backcrossing and selfing to develop high yielding and climate-resilient maize. Further, 28 populations were evaluated for fodder traits with two checks, viz., J 1006 and African tall and five populations were found at par with the J 1006. Heterotic grouping of fodder inbred lines was also done by crossing 28 fodder inbred lines with LM 13 and LM 14. Based on the specific combining ability (SCA) data of green fodder yield, the 28 inbred lines were classified into two heterotic groups with 16 lines under group A of LM 13 and 12 lines into group B of LM 14.

#### **Germplasm screening for abiotic stress**

To study the relationship of sowing date and cold stress on growth, 25 hybrids during *rabi* 2018-19 and 35 hybrids during *rabi* 2019-20 were evaluated at Begusarai, Bihar under five different sowing dates, viz., October 25, November 5, November 15, November 25 and December 25 in both the years. The study indicated that planting of maize on November 5 resulted in the highest yield and was the most suitable time for the *rabi* maize in Bihar. In another set of experiment, 137 crosses along with five checks were exposed to cold stress at initial growth and pre-flowering stages under field condition at Ludhiana during *rabi* 2019-20, where 14 crosses of medium maturity were superior to the best check P 3396. Among them IMLSB 274-1 × CMG 240, IMLSB 207-2 × IMLSB 976-2 and IMLSB 571-2 × IMLSB 406-2 out yielded P 3396 by 18.2%, 14.4% and 14.0%, respectively. Further, 500 inbred lines were also evaluated against cold stress at initial growth and pre-flowering stages during *rabi* 2019-20 at Ludhiana. The maximum yield was obtained in inbred IMLSB 250-2 (27.0 q/ha). The top 11 inbred lines which recorded yield between 20.0 to 30.0 q/ha were IMLSB 250-2, CMG 155, IMLSB 2004, IMLSB 274-1, IMLSB 671-2, IMLSB 885-2, IMLSB 1296-1, IMLSB 509-2, IMLSB 733-1, IMLSB 428-2 and IMLSB 268-1.

#### **Breeding for quality traits**

A set of 115 newly developed QPM inbred lines were analyzed for protein and tryptophan content where, DQL 2760 and DQL 2702 were the most promising with high protein (10.7% and 10.0%, respectively) as well as tryptophan content (1.0% and 0.9%, respectively). Further, 30 inbred lines were evaluated along with two checks (DQL 2192 and HKI 163) to assess their *per se* performance at Ludhiana during *kharif* 2020, where ten inbred lines outperformed the best check DQL 2192.

The near isogenic lines (NILs) developed for LM 13, LM 19, LM 14 and LM 17 through marker assisted selection carrying the favourable allele, *viz.*, *opaque2*, *crtRB1* and *lpa2* were evaluated for agronomic and biochemical performance. Favourable alleles of *opaque2*, *crtRB1* and *lpa2* are responsible for conferring higher lysine and tryptophan, increased provitamin A and reduced phytic acid in maize kernel, respectively. Based on the evaluation data, 3–4 best NILs were selected and the experimental crosses using NILs of LM 13 and LM 19, and LM 14 and LM 17 were generated.

#### ***Evaluation of biochemical characteristics***

During the period, 81 genotypes consisting mostly of inbreds were evaluated for starch profile, *viz.*, starch, amylose and amylopectin. Most of the genotypes exhibited amylose content ranging from 20-30%, indicating the non-availability of high amylose mutants in the natural germplasm. Under the QPM breeding program, 115 newly developed lines were evaluated for protein quality and a set of 34 most promising lines were evaluated. In addition, another set of 20 lines converted to QPM through marker-assisted selection were also analyzed for protein quality and high tryptophan lines were identified. The anthocyanin, flavonoid and phenolic content of colored maize germplasm was also evaluated in order to identify promising lines.

#### ***Establishment of in vitro regeneration and transformation method in maize***

A reproducible *in-vitro* regeneration method was developed in nodal explants derived calli using biolistic and *Agrobacterium*-mediated transformation methods. Standardization of the transformation protocol using  $\beta$ -glucuronidase (GUS) protein is under process. Histochemical and PCR analysis revealed the presence of GUS activity in transformed tissues.

#### ***In silico prioritization of gene target for low-phytate maize***

Inositol Phosphate Kinase 1 (IPK1) was found to be most promising target for reducing the phytic acid content of maize, along with avoidance of pleiotropic effects. The IPK1 enzyme structure and its interaction with substrate were determined computationally. Specific amino acid positions where mutations would result in inhibition of enzyme activity, without affecting protein-protein interactions were deciphered.

#### ***Validation of key differentially expressed genes (DEGs) under low nitrogen stress***

Key differentially expressed genes identified previously via transcriptome analysis using leaf and root tissues from contrasting inbred lines, *viz.*, DMI 56 (tolerant to nitrogen stress) and DMI 81 (susceptible to nitrogen stress) were validated by qPCR. The genes, *viz.*, Asn4, HAT 2.3, NRP1, basic endochitinase, AAP3, GT31, MYB 36 transcription factor, AP2-EREBP transcription factor and Nitrate transport1 were identified as being expression differentially in response to nitrogen stress.

## **CROP MANAGEMENT**

While genetics plays a great role in development of high quality, high yielding and stress resistant genotypes, the ways and means to manage the crop plays an important role in achieving desirable farm productivity and sustainability. The crop management programme of the institute is mainly directed at tillage, nutrient and cropping system management.

#### ***Development of precision conservation agriculture practices in cereal-based systems in Indo-Gangetic Plains***

Significantly higher system productivity was recorded under conservation agriculture (CA) based maize-wheat system compared to rice-wheat system. Significantly, highest net returns and Benefit-to-Cost ratio was found with CA-based maize-wheat-mungbean having Green Seeker (GS) sensor based nutrient management as compared to conventional maize-wheat-mungbean and rice-wheat-mungbean systems with FFP, RDF and SSNM. Weed seed bank study was conducted in different cropping systems, and it was found that total seed bank was lowest in conventional rice-wheat-mungbean system, while it was higher under conventional tilled and conservation agriculture based maize-wheat-mungbean system. It clearly indicates that conservation agriculture practice can be successful only with the help of proper weed management.

#### ***Study of different organic nutrient sources in maize and specialty corn***

After completion of three years of experimentation under organic condition, in fourth year, the yield of baby corn, sweet corn and normal maize in organic treatments found at par with Recommended Dose of Fertilizers (RDF). The yield of baby corn with 100% Farm Yard Manure (FYM) was at par with RDF while in sweet corn, the yield with 100% FYM and 50% FYM + 50% vermicompost was found at par with RDF. Similarly, the yield of normal maize in all organic treatments was found at par with RDF.

#### ***Soil bacterial diversity analysis of rice-wheat and maize-wheat cropping systems***

The bacterial diversity of soils under rice-wheat and maize-wheat cropping systems under different tillage practices was investigated on chromogenic agar medium. It was found that soils under site-specific nutrient management contained higher density of nitrogen-fixing bacteria as assessed by their ability to grow luxuriantly under nitrogen-deficient conditions.

#### ***Sensor guided nitrogen management in maize-based cropping system under conventional and conservation agriculture practices***

Significantly higher system yield, net returns and partial factor productivity of applied nitrogen can be achieved by adopting maize-wheat-mungbean system with residue retention under conservation agriculture with 50% RDN+GS based N application. The maize residue application induced lower canopy temperature in wheat during maturity, which indicated potential of this technology in mitigating terminal heat stress. The sub-surface band placement of the first split dose of

nitrogen in maize enhanced the maize yield significantly than conventional surface banding application.

## CROP PROTECTION

The crop protection programme gives emphasis to host plant resistance and other integrated approaches in pest and disease management techniques. Thirty five inbred lines were found resistant against charcoal rot during spring 2020 screening of 106 inbred lines. Five inbred lines viz., VH12137F2-1-5-2-3-1-1-1#-2-1-1, ZH111688F2-2-5-3-2-1-1-2#-1-2-1, ZH116002F2-1-3-2-3-1-1-1#-2-1-1, ZH116117F2-1-2-1-1-2-1-1#-1-1-1 and ZH112656F2-1-2-2-1-1-1-1#-1-1-1 against pink stem borer and one inbred line, 141167-2-PP-25-1-2-1 against spotted stem borer were found promising among 46 inbred lines screened under artificial infestation during rabi 2019-20 and *kharif* 2020 respectively. Different disease management modules, viz., organic, chemical and Integrated Disease Management (IDM) were tested against maydis leaf blight (MLB) at Ludhiana during *kharif* 2020. Significantly higher yield was observed in chemical module followed by IDM module in managing MLB. To study the diversity of turicum leaf blight pathogen *Setosphaeria turcica*, 45 isolates were collected from nine states, viz., Meghalaya, Uttarakhand, Himachal Pradesh, Andhra Pradesh, Odisha, Gujarat, Madhya Pradesh, Jammu & Kashmir and Maharashtra. The isolates were purified and are being characterized.

Towards understanding maize-pink stemborer interactions, induced defense responses were studied by imposing different treatments, including control i.e. untreated plants, PSB feeding, mechanical wounding, mechanical wounding plus PSB regurgitation and exogenous application of methyl jasmonate in resistant (DMRE 63, CM 500), moderately resistant (WNZ Exotic Pool) and susceptible genotypes (CM 202, BML 6) at two stages, viz., 5 and 15 days after germination (DAG) and found *p*-Coumaric acid (*p*-CA) and ferulic acid (FA) content induced were intrinsically higher when challenged by insect attack in short- and long-term responses at 5 and 15 days after germination (DAG) in most of the instances especially in resistant and moderately resistant genotypes than the susceptible ones.

Towards better management of FAW, seed treatment insecticides, viz., Thiamethoxam 30FS, Imidacloprid 600 FS and Fipronil 5 Sc at doses ranging from 6-10 ml were evaluated against fall armyworm during *kharif* 2020 at ICAR-IIMR, WNC, Hyderabad, where Thiamethoxam 30FS @ 6-10 ml/kg seed was superior in terms of damage reduction and yield gain. Fall armyworm infestation was recorded in rabi 2019-20 at Delhi under different tillage practices. Infestation was less in zero-till (ZT) system and highest in conventionally tilled (CT) system. In *kharif* 2020, FAW infestation at V6-7 stage maize under different tillage practices and cropping systems was recorded, where ZT recorded lower infestation and CT recorded the highest, especially in maize-chickpea-sesbania (MCS), maize-mustard-mungbean (MMuMb) cropping systems.

## AICRP ON MAIZE

In addition to its core research activities, the institute also coordinates maize research programmes of various agricultural universities through All India Coordinated Research Project on Maize (AICRP-Maize) under crop improvement, crop production and crop protection.

### Crop Improvement

During *rabi* 2019-20, National Initial Varietal Trials (NIVT), Advance Varietal Trial-I (AVT I) and Advance Varietal Trial-II (AVT-II) breeding trials of normal maize, specialty corn, QPM trials, entomology and pathology trials were constituted. In breeding trial, two were in NIVT, three in AVT, one in QPM and one in popcorn. During *kharif* 2020, 35 different breeding trials were constituted, where one set was exclusively for Northern Hill Zone (NHZ) and the others were for the rest of the zones. Besides, a new trial was constituted specifically for spring season and these trials were conducted at four centres of north Indian states, viz., Ludhiana, Karnal, Delhi and Pantnagar by keeping in mind the popularity of spring maize in these areas. During *rabi* 2019-20, the success rate from different zone was 91%, 89%, 100% and 100% for North Western Plain Zone (NWPZ), North Eastern Plain Zone (NEPZ), Peninsular Zone (PZ), respectively. Spring trials were conducted in NWPZ, where out of 11 entries, only two entries, viz., VNR 37753 and HT 20185 were promoted for testing in AVT-I.

### Crop Production

During *rabi* 2020-21, experiments were conducted on- the agronomy of pre-released genotypes of different maturity, tillage and nutrient management, sensor guided nitrogen management, integrated nutrient management, ecological intensification and weed management in maize systems for enhancing productivity and profitability of maize systems in various agro-ecologies. The experiment for testing the response of pre-released genotypes to density and nutrient levels revealed that genotypes responded to higher nutrient level at NWPZ and at normal density (Karnal). In PZ, long duration genotypes responded to high nutrient levels but were statistically similar for grain yield with checks. In CWZ also long duration genotypes responded well to high fertility along with high density and PM 17201L gave significantly higher yield over best check. Similarly, medium maturity genotypes (4 + 2 checks) were tested in NEPZ at four locations and it was found that yield improved significantly in high density with 150% RDF. The experiment for nutrient management in maize-wheat-cowpea cropping system under different tillage practices revealed highest maize equivalent yield with 100% RDF with conventional tillage (CT) which was closely followed by 100% RDF with zero tillage (ZT) at Pantnagar (NWPZ). However, the net returns of the system were highest under 100% RDF with ZT. As a result, the highest BC ratio was obtained with RDF-ZT. Nutrient management in maize-wheat-green gram cropping system under different tillage practices showed that tillage had non-significant effect on yield and net return of subsequent wheat at Dholi (NEPZ)

while 60% RDF + green seeker (GS) was at par with site specific nutrient management (SSNM) which gave higher yield and net returns over RDF. Further, one experiment was conducted at Dholi and Kalyani of NEPZ to find out best nutrient and tillage management practices of emerging rice-maize based cropping system. Among tillage practices, permanent bed (PB) gave significantly higher yield and net return from maize and was at par with ZT. Further, both practices were significantly superior over CT in sandy loam soil of Dholi. In contrast, in clay loam soil at Kalyani, ZT gave significantly higher yield and net returns over CT and PB. However, at both the locations, green seeker guided nitrogen application gave significantly higher yield and net returns. The experiment for nutrient management in maize based rainfed cropping system under different tillage practices was conducted at Banswara (CWZ) in maize-chickpea system. It was observed that application of different tillage practices had non-significant effect on maize yield while the ZT gave significantly higher chickpea yield, which was at par to PB, and both were superior to CT. Among nutrient management, the SSNM based nutrient application gave significantly higher yield of both the crops over other options used in the study. The long-term trial on integrated nutrient management was conducted to integrate the use of organic manure in maize. Net returns and BC ratio were significantly highest with 100% RDF + 5 t/ha FYM at Pantnagar (NWPZ) and Banswara (CWZ) in the maize-wheat system. Maize + legume intercropping with FYM 10 t/ha + Azotobactor application also gave statistically similar yield to the earlier discussed treatment at Banswara and Pantnagar. The experiment conducted on sensor-based nitrogen management showed that green seeker sensor based N application treatments, 33% basal N + Green Seeker based N at knee high and tasseling stage or 30% Basal N + 30% at 25 DAS + Green Seeker based N at tasseling stage gave statistically similar yield while numerically higher net returns to the RDF. The STCR based nutrient application gave significantly higher yield and returns in maize-wheat system. The experiment for yield and profit maximization through optimization of ecological intensification (EI) was taken up in four zones except NHZ in various maize based cropping systems. The crop yield was statistically highest with EI at all zones. Lower yield was observed for EI minus weed management at Banswara, Peddapuram, Karimnagar, Hyderabad and Dholi; EI minus water management at Vagarai, Coimbatore and Pantnagar while EI minus Nutrient management at Kalyani, Bhubaneswar and Ludhiana. Hence, there is need to focus on the eco-region specific technology for enhancement of the maize systems yield. The experiment on weed management in maize systems revealed that the post-emergence herbicide applied in maize like Tembotrione or Topramezone had no adverse effect on subsequent wheat yield in rotation. The application of atrazine @ 750 g/ha as pre-emergence followed by Topramezone @ 25.2 g/ha at 25 DAS in *rabi* maize gave significantly higher yield and net returns in the herbicide applied treatments at Kalyani (NEPZ).

### Crop Protection

Maize AICRP entomology *rabi* 2019-20 and spring 2020 experimental trials were aimed mainly for screening resistance against pink stem borer (PSB: *Sesamia inferens*), spotted stem borer (SSB: *Chilo partellus*), fall armyworm (FAW: *Spodoptera frugiperda*) and shoot fly (*Atherigona* sp).

Seventeen entries in AVT-I and AVT-II-Late maturity group were screened against PSB at Hyderabad, SSB at Kolhapur, shoot fly at Karnal and Ludhiana, FAW at Coimbatore, Hyderabad and Kolhapur which revealed 16 entries moderately resistant to PSB and all the entries moderately resistant to SSB. Lowest dead heart was observed in PM 17201L (16.0) followed by NMH 4313 (17.1) against shoot fly. For FAW, Davis score varied from 2.4 (KMH 25K45) to 2.9 (PM 18206L) at 14 DAS, 3.4 (PM 18204L) to 4.6 (PM 17208L) at 28 DAS and 4.7 (NMH 713) to 6.0 (PMH 17208L) at 60 DAS. Further, 15 entries in AVT-I and AVT-II-Medium maturity group were screened against PSB at Hyderabad, against SSB at Kolhapur, against shoot fly at Karnal and Ludhiana and against FAW at Coimbatore, Hyderabad and Kolhapur where, all the entries were moderately resistant to PSB and SSB. Overall lowest dead hearts (%) were found in IMHSB 17R-16 (12.2) against shoot fly and the Davis Score varied from 2.7 (IMHSB 17R-5) to 3.1 (IMHSB 17R-9, NMH 4140), 3.5 (IMHSB 17R-17) to 4.4 (BLH 139) and 3.8 (IMHSB 17R-8, DHM 117) to 4.2 (AH 8181, BLH 139) at 14, 28 and 60 DAS, respectively for FAW. Further, 42 maize accessions were evaluated under natural infestation against shoot fly at Karnal and Ludhiana and FAW at Coimbatore. The lowest mean percent dead heart was found in DMR E63/CML 287-4-6 (25.3) against shoot fly. For FAW, the lowest mean Davis score was recorded in BML 7 (1.4) while the highest value was recorded in DMRE 63/CML 287-3-61-2B (4.2) at 28 DAS. During *kharif* 2020, AICRP entries were evaluated against SSB and/or FAW at different centres including Imphal, Karnal, Ludhiana, Dholi, Coimbatore, Hyderabad, Kolhapur and Udaipur and resistant entries were identified. Further, different trials, *viz.*, monitoring of FAW using pheromone traps with NBAIR slow releasing dispenser, monitoring of cob borer (*Helicoverpa armigera*) by pheromone traps, evaluation of insecticides as seed treatment against FAW, management of stem borers and FAW in maize, evaluation of bio-pesticides/bio agents against fall armyworm were also conducted at different AICRP centers.

During *rabi* 2019-20, 109 maize entries were evaluated against Maydis leaf blight (MLB), Turicum leaf blight (TLB), Charcoal rot (ChR) and Sorghum downy mildew (SDM) in different zones across the country. A total of 36 hybrids of NIVT late maturity were evaluated for MLB, SDM and TLB. Six entries for MLB and one entry for SDM were resistant while, none found resistant against TLB and charcoal rot. In NIVT medium maturity, out of 52 entries, five entries, *viz.*, AH 8047, IMHSB 19R-17, IMHSB 19R-4, IMHSB 19R-9 and MH 2047 for MLB and three entries, *viz.*, BAUMHR 19-2, IMHSB 19R-12 and IMHSB 19R-14 for SDM where



resistant, while none of the entries were found resistant against TLB and charcoal rot. Further, 22 entries of AVT-I-II of late maturity were evaluated for MLB, SDM, TLB and charcoal rot, which revealed one resistant entry, viz., RASI 4118 for MLB and three resistant entries, viz., ADV 7043, PM 17205L and PM 18205L for SDM. Disease screening of AVT-I-II maize hybrids of medium maturity against MLB, SDM, TLB and charcoal rot identified three resistant entries, viz., IMHSB 17R-16, IMHSB 17R-8 and IMHSB 17R-9 against MLB, one entry AH 8181 against SDM. Disease screening of popcorn maize hybrids could not identify any resistant sources for MLB, TLB, charcoal rot and SDM, whereas in QPM trial two entries, viz., IQPMH 19-R-1 and IQPMH 19-R-3 were resistant against MLB. During *kharif* 2020, 269 trials were conducted, where, 196 trials were of coordinated trials and 20 trials were for trap nursery. In addition, 25, 6, 3 and 19 trials were also conducted under the categories, viz., management trials, trials from CIMMYT, avoidable yield loss trial and, survey and surveillance, respectively.

## EXTENSION AND OUTREACH

### Extension programmes

Apart from addressing the research requirements, the institute also has a vibrant extension and outreach programme to reach to its stakeholders. The institute reaches out to its farmer stakeholders through conducting programmes, viz., Frontline Demonstrations (FLD) sponsored by Department of Agriculture and Cooperation, Government of India under National Food Security Mission (NFSM), the Scheduled Tribe Component (STC), North Eastern Hill (NEH) component, Scheduled Caste Sub Plan (SCSP) and Mera Gaon Mera Gaurav (MGMG).

In 2019-20 *rabi* season, FLDs were taken up on 100 ha benefitting 294 farmers. In this season technologies like micronutrients and integrated pest management, public sector hybrids like DMRH 1301, CO 6, GAYMH 1 and GAYMH 3, and intercropping of maize with pea and potato were demonstrated at the farmers' fields by 8 centres in 7 states. The yield gains ranged from 8.4% (Begusarai, Bihar) to 46% (Kolhapur, Maharashtra). In spring 2020, three centres conducted FLD over 30.2 ha where technology of improved hybrid of public sector (PMH 10) and private sector (DKC 9108) and recommended sowing time demonstrated. Minimal yield gains was seen in this season and gains varied from -2.51% to 5.68%.

In *kharif* 2020, FLDs were conducted over 151.03 ha benefitting 375 farmers in 13 states. The public sector recently released hybrids like DMRH 1301, FQH 106, VMH 45, PMH 1, CoH(M) 8, MAH 14-5, GAYMH 1, Biofortified QPM

hybrid Shaktiman 5 along with private sector hybrids like Bio-9544, PM 3 and PM 9, etc. were demonstrated. The yield gains ranged from 9.6% (Mandya, Karnataka) to 103% (Imphal, Manipur). Raised bed planting was also demonstrated in water logging prone NEPZ with a yield gain of 73.1% over flat planting. The fall armyworm management FLDs conducted at Kolhapur centre reported 46.1% yield gains. Similarly, the best weed management FLDs showed yield advantage of 44.8% at Chhindwara.

Under STC, 33 farmers' training/ field day/ awareness programmes were conducted in different parts of the country, benefiting 1596 tribal farmers on various aspects of scientific maize cultivation. Inputs distributed during these programmes benefitted 1459 households. The NEH programme a project on "Maize for Sustainable Livestock Production" has been implemented in collaboration with CAU, Imphal (Manipur), CAU-CPGS, Barapani (Meghalaya), ICAR-National Research Centre on Pig, Guwahati (Assam), ICAR-National Research Centre on Yak, Dirang (Arunachal Pradesh), ICAR-National Research Centre on Mithun, Dimapur (Nagaland) and ICAR-Research Complex for North Eastern Hill Region, Umiam. Effect of supplementation of QPM maize fodder and silage on production performance in pigs and yaks were evaluated under this programme. In addition, 28 training programmes were organized and inputs were distributed in collaboration with different institutes for the NEH maize growers in North Eastern India, benefiting 1517 households.

Under SCSP, three trainings and agricultural inputs distributions were conducted and 117 famers benefited by different AICRP centres. Under NICRA-SCSP, in collaboration with CSKHPKV, Palampur has distributed four corn threshers benefiting around 200 farm families at District Chamba, Himachal Pradesh. Apart from this, farmers advisory on maize during COVID-19 pandemic in nine languages were issued among farmers through newspapers, local channel, All India Radio, local Radio Station, WhatsApp groups and Facebook etc.

The MGMG programme in 29 adopted villages in the in the five blocks of Punjab, Haryana, Bihar and Telangana has been implemented by 8 teams of 30 ICAR-IIMR scientists. Advisory on best maize production practices, fall armyworm management, cleanliness, and COVID-19 precautionary measures were provided to the famers through visits, messages, email, phone calls, messages etc.

### Training and capacity building

In addition to deputing its staff for technical and administrative training, ICAR-IIMR has organized technical trainings on scientific maize cultivation and pest management to various stakeholders, viz., officers in fields of research and extension, administrators, farmers, and students.



# Crop Improvement

Food and Agriculture Organization of the United Nations | **FAO 75** Grow, Nourish, Sustain, Together. | my GOV मेरी सरकार

## 17 Biofortified Crop Varieties Dedicated to Nation by Hon'ble Prime Minister on World Food Day

				
Rice: CR Dhan 315	Wheat: HI 1633	Wheat: HD 3298	Wheat: DBW 303	Wheat: DDW 48
				
Wheat: MACS 4058	Maize: LQMH-1	Maize: LQMH-2	Maize: LQMH-3	
				
Finger Millet: CFMV-1	Finger Millet: CFMV-2	Little Millet: CLMV-1	Mustard: PM-32	Ground nut: Girnar-4
				
	Ground nut: Girnar-5	Yam: Da 340 & SreeNeelima		

#SahiPoshanDeshRoshan

*Biofortified varieties, including three maize hybrids dedicated to the nation by the Hon'ble PM*

# CROP IMPROVEMENT



With changing climate and market demands crop improvement is a continuous process with aim to improve the yielding ability of the hybrids and parental lines, germplasm enhancement for resistance to biotic and abiotic stresses and quality traits. Commercialization of developed products is a new dimension of focus in this context.

## Hybrid development, seed production and commercialization

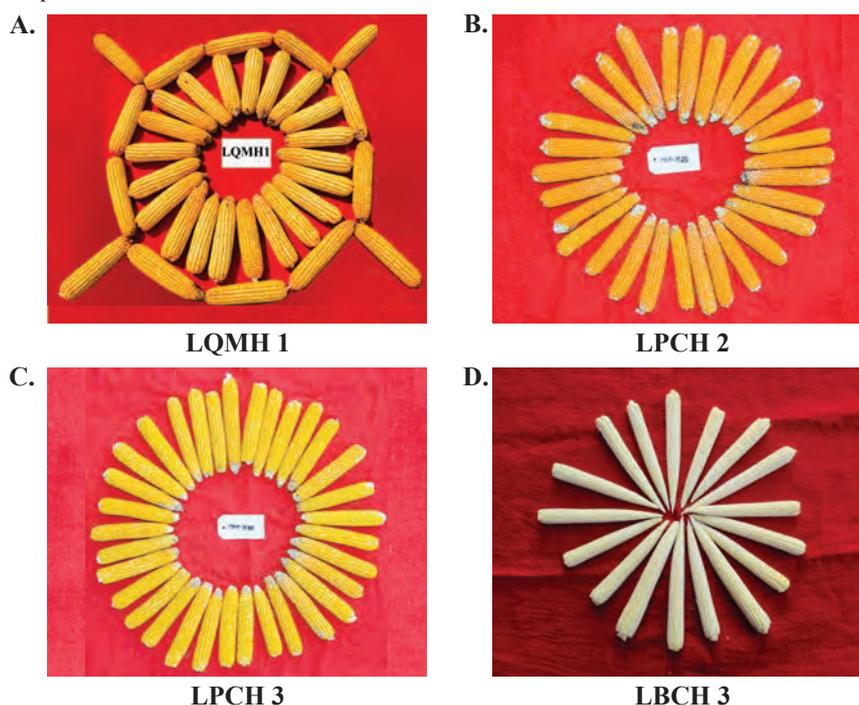
### Hybrids release and notified

During the year 2020, four hybrids (**Figure 1.1**) of ICAR-IIMR have been released and notified in the 84<sup>th</sup> meeting of Central Sub-Committee on Crop Standards, Notification and Release of Varieties for Agricultural Crops held on July 10, 2020. The details of the hybrids are given below in the **Table 1.1**.

**Table 1.1: Details of single cross hybrids developed by the institute and released through CVRC during the year 2020**

Sl. No.	Hybrid Name	Type of corn	Yield (q/ha)	Growing season	Maturity Group	Growing ecologies
1.	LQMH 1 (IMHQPM 1530)	QPM	80.0-85.0	Kharif	Early	Northern Hill Zone (NHZ)
2.	LPCH 2 (IMHP 1535)	Popcorn	25.0-30.0	Kharif	Early	Central western zone (CWZ)
3.	LPCH 3 (IMHP 1540)	Popcorn	30.0-35.0	Kharif	Early	Northern east plain zone (NWZ), Peninsular zone (PZ) and Central western zone (CWZ)
4.	LBCH 3 (DMRHB 1305)	Baby corn	13.0-15.0 <sup>#</sup>	Kharif	Early	Northern Hill Zone (NHZ)

# dehusked baby corn, q/ha: quintal/hectare



**Figure 1.1: Released and notified single cross hybrids from the institute (A. LQMH 1, B. LPCH 2, C. LPCH 3 and D. LBCH 3) of ICAR-IIMR, Ludhiana**

LQMH 1 is a QPM hybrid with moderate resistance to turicum leaf blights (TLB) and banded leaf and sheath blight (BLSB) diseases. It exhibited high tryptophan (0.73%) and lysine (3.03%) content in endospermic protein. LPCH 2 and LPCH 3 are popcorn cultivars had maximum popping percentage of 95.0 to 96.0% with mean value of 86.1 to 89.8%, respectively. Further, LPCH 2 was moderately resistant to curvularia leaf spot (CLS), whereas LPCH 3 showed resistance against maydis leaf blight (MLB), curvularia leaf spot (CLS), charcoal rot (CR) and fusarium

stalk rot (FSR) diseases which are the major diseases of the ecologies for which the hybrids have been recommended. The LBCH 3 is a baby corn hybrid with high prolificacy and moderate resistance to turicum leaf blight (TLB) and MLB diseases.

#### Hybrids identified

Two QPM hybrids were also identified during 63<sup>rd</sup> annual maize workshop held during April 20-22, 2020. The details of the hybrids are given below (Figure 1.2, Table 1.2).



**IQMH 202**



**IQMH 203**

**Figure 1.2: Recently released hybrids of ICAR-IIMR (IQMH 202 and IQMH 203)**

**Table 1.2: Details of QPM hybrids identified during 63<sup>rd</sup> annual maize workshop**

Sl. No.	Hybrid Name	Yield (q/ha)	Recommended areas	Specific traits
1.	IQMH 202	72.0	Punjab, Haryana, Delhi, Western UP and Plains of Uttarakhand	Moderately resistant to MLB and stem borer ( <i>Chilo partellus</i> ), high tryptophan (0.66%) and lysine (3.04%) content
2.	IQMH 203	63.0	Rajasthan, Gujarat, Chatishgarh and Madhya Pradesh	Resistant to FSR, moderately resistant to CLS and stem borer ( <i>Chilo partellus</i> ), high tryptophan (0.77%) and lysine (3.48%) content

#### Seed production and commercialization of maize hybrids

During the year 2020, total of 35.46 quintals (q) breeder seed of parental lines of DMRH 1301, DMRH 1308, DMRH 1305 and IMHB 1539 were produced and supplied to various state, national and others seeds producing agencies as per their demands. Among these four hybrids, the highest demanded was for DMRH 1301 (female: 22.82 q and male:

7.55 q) followed by DMRH 1308 (4.34 q), DMRH 1305 (0.6 q) and IMHB 1539 (0.2q). Further, total four hybrids, viz., DMRH 1301, DMRH 1305, DMRH 1308 and IMHB 1539 of ICAR-IIMR were licensed to various seed companies (Table 1.3). The licensing was carried out through Agrinnovate India Ltd., a wing established by the ICAR for commercialization of its technologies.

**Table 1.3: Details of ICAR-IIMR Maize hybrids licensed to various seeds companies by signing MoUs**

Sl. No.	Name of Organization	Period	Name of Technology	Revenue Generated
1	M/s Sampoorna Seeds 15/465, Gosha Hospital Road, Adoni, Kurnool, Andhra Pradesh - 518 301	March 17, 2020 to March 16, 2025	DMRH 1301	2.0 lakh + 18% GST and 5% royalty on sale value
2	M/s Sampoorna Seeds 15/465, Gosha Hospital Road, Adoni, Kurnool, Andhra Pradesh - 518 301	March 17, 2020 to March 16, 2025	DMRH 1308	2.0 lakh + 18% GST and 5% royalty on sale value
3	M/s Koshi Agro Biotech Pvt. Ltd. Ratanpur, Supaul, Bihar - 852 215	February 3, 2020 to February 2, 2025	DMRH 1301	2.0 lakh + 18% GST and 5% royalty on sale value
4	M/s Chakra Seeds Plot No. 25, Machami Samappa Colony (Near Venkat Raman Colony), Kurnool, Andhra Pradesh - 518 004	March 17, 2020 to March 16, 2025	DMRH 1301	2.0 lakh + 18% GST and 5% royalty on sale value
5	M/s Koshi Agro Biotech Pvt. Ltd. Ratanpur, Supaul, Bihar - 852 215	September 10, 2020 to September 9, 2025	IMHB 1539	2.0 lakh + 18% GST and 5% royalty on sale value
6	M/s Koshi Agro Biotech Pvt. Ltd. Ratanpur, Supaul, Bihar - 852 215	September 10, 2020 to September 9, 2025	DMRH 1305	2.0 lakh + 18% GST and 5% royalty on sale value
7	M/s Beej Sheetal Research Pvt. Ltd. Plot No. BT-5, Phase-II, Additional MIDC area, Jalna District, Maharashtra – 431 203	September 29, 2020 to September 28, 2025	DMRH 1301	2.0 lakh + 18% GST and 5% royalty on sale value
8	M/s Astha Agrigenetics Shikarpur, Colony Chamta, Toofanganj, Cooch Bihar-736159	October 24, 2020 to October 23, 2025	DMRH 1301	2.0 lakh + 18% GST and 5% royalty on sale value
9	M/s Dadabhai Seed Farm Itla, Kalirhat, Kotwali, Nadia-741102	October 24, 2020 to October 23, 2025	DMRH 1301	2.0 lakh + 18% GST and 5% royalty on sale value
<b>Total revenue</b>				<b>18.0 lakh</b>

### Hybrids promoted/contributed under AICRP testing

#### Hybrid promoted in AICRP– Normal

Five entries of field corn namely IMHSB 17R-8, IMHSB 17R-9, IMHSB 17R-16, IMHSB 17R-17 and IMHSB 17R-14 have been promoted from AVT-I to AVT-II (medium) during *rabi* 2019-20. Three entries of field corn, *viz.*, IMHSB 19R-8

(NEPZ), IMHSB19R-2 (NEPZ and PZ) and IMHSB 19R-10 (NEPZ) have also been promoted from NIVT to AVT-I (medium) during *rabi* 2019-20. During *kharif* season two entries, *viz.*, IMHSB 19K-11 (NWPZ and NEPZ) and IMHSB 19K-2 (NEPZ) was promoted from NIVT to AVT-I (medium). The list of promoted entries is given in (Table 1.4).

**Table 1.4: Hybrid promoted in different AICRP trials**

SI. No.	Name of hybrid	Type	Trial	Promoted to	Maturity	Zone	Yield (q/ha)	Superiority (%)
AICRP on maize <i>rabi</i> 2020-21								
1.	IMHSB 19R-8	Normal	NIVT	AVT-I	Medium	NEPZ	115.2	10.6
2.	IMHSB 19R-2	Normal	NIVT	AVT-I	Medium	NEPZ	114.7	10.2
		Normal	NIVT	AVT-I	Medium	PZ	98.3	4.6
3.	IMHSB 19R-10	Normal	NIVT	AVT-I	Medium	NEPZ	114.7	10.1
4.	IMHSB 17R-9	Normal	AVT-I	AVT-II	Medium	NWPZ	100.3	9.6
5.	IMHSB 17R-8	Normal	AVT-I	AVT-II	Medium	NWPZ	100.1	9.5
6.	IMHSB 17R-16	Normal	AVT-I	AVT-II	Medium	NWPZ	97.2	6.3
7.	IMHSB 17R-17	Normal	AVT-I	AVT-II	Medium	NWPZ	92.8	1.4
8.	IMHSB 17R-14	Normal	AVT-I	AVT-II	Medium	CWZ	109.5	4.0
AICRP on maize <i>kharif</i> 2019								
9.	IMHSB-19K-11	Normal	NIVT	AVT-I	Medium	NWPZ	108.1	0.4
		Normal	NIVT	AVT-I	Medium	NEPZ	77.3	1.1
10.	IMHSB-19K-2	Normal	NIVT	AVT-I	Medium	NEPZ	76.5	0.1

**Hybrid promoted in AICRP- QPM**

During the reporting year five QPM hybrids were promoted to advanced trials. Out of these five hybrids, one hybrid namely IQPMH 18-2 was promoted for testing in AVT-II and other

four hybrids were promoted for testing in AVT-I during *kharif* 2020. The detailed performance of these hybrids representing yield, yield superiority and recommended zone has been provided in the **Table 1.5 (Figure 1.3)**.

**Table 1.5: List of QPM hybrids promoted to different advanced trials**

SI. No.	Hybrid	Grain Yield (q/ha)	Sup. Over check (%)	Zone	Promoted to
1.	IQPMH 18-2	65.8	10.7	Zone III	AVT-II
2.	IQPMH 19-1	76.4	5.1	Zone II	AVT-I
		62.1	4.4	Zone III	
		68.1	10.4	Zone V	
3.	IQPMH 19-2	72.8	0.4	Zone II	AVT-I
		62.6	5.2	Zone III	
4.	IQPMH 19-3	62.5	5.2	Zone III	AVT-I
5.	IQPMH 19-4	65.2	10.0	Zone III	AVT-I



**Figure 1.3: QPM hybrids promoted to different advanced trials**

### Hybrid promoted in AICRP– Sweet corn

ISCH 1901, the experimental cross was promoted from NIVT to AVT-I in north western plain zone (NWPZ, Zone II). The average yield (without husk) of the hybrid across four locations, viz., Delhi (10.12q/ha), Karnal (11.57 q/ha), Ludhiana (12.98 q/ha), and Pantnagar (91.39 q/ha) in NWPZ was 10.76 q/ha with 10% superiority over the best sweet corn hybrid check Misthi (97.76 q/ha).

### Hybrids contributed under AICRP testing

Fifteen maize hybrids were contributed for AICRP testing (NIVT early: 2, NIVT medium: 6, NIVT late: 1, AVT-I: 1, QPM: 2 and Baby corn: 3) during *khariif* 2020 and 25 entries (NIVT medium: 16, AVT-I medium: 4 and AVT-II medium: 5) were contributed in *rabi* 2020-21. Further, four entries were contributed in AICRP fodder trials (IVTM: 2 and AVTM-I: 2) during *rabi* 2020-21 along with three maize hybrids during *khariif* 2020.

### Multi-location testing of experimental hybrids

*Study of stability of experimental winter maize hybrids using GGE biplot and AMMI analysis*

Thirty two maize experimental hybrids with four checks (DHM 117, BIO 9544, P 3396 and DKC 9081) were evaluated at three locations, viz., RMR&SPC Begusarai, BAU Sabour and RPCAU Dholi in RBD during *rabi* 2017-18 and 2018-19 and the data was analyzed to study the stability of these hybrids using GGE biplot and AMMI Model (**Table 1.6**). Based on the high mean value and stability two experimental hybrids, viz., IMHSB1 and IMHSB 28 were identified. As per genotype ranking, the hybrids, viz., IMHSB1, IMHSB 28 and IMHSB 30 were closer to the ideal genotype (**Figure1.4**). From both the GGE biplot and AMMI analysis, IMHSB 1 and IMHSB 28 were the best experimental hybrids in terms of all the desirable traits and highly stable across the location.

**Table 1.6: Yield of experimental hybrids in multi-location over years in Bihar**

Sl. No.	Experimental hybrid	Average grain yield (q/ha) over years			
		Begusarai	Sabour	Dholi	Pooled mean
1.	IMHSB 1	118.4	86.2	99.8	101.5
2.	IMHSB 2	92.2	66.9	74.4	77.8
3.	IMHSB 3	97.8	81.8	95.6	91.7
4.	IMHSB 4	85.3	78.0	79.1	80.8
5.	IMHSB 5	85.3	71.0	76.9	77.7
6.	IMHSB 6	57.2	73.9	53.5	61.6
7.	IMHSB 7	65.6	78.3	74.6	72.8
8.	IMHSB 8	100.2	83.5	75.4	86.4
9.	IMHSB 9	93.1	75.3	78.2	82.2
10.	IMHSB 10	98.9	77.1	85.3	87.1
11.	IMHSB 11	63.1	83.3	64.2	70.2
12.	IMHSB 12	86.1	98.6	98.4	94.4
13.	IMHSB 13	92.0	83.8	90.8	88.9
14.	IMHSB 14	79.8	81.0	84.9	81.9
15.	IMHSB 15	88.0	72.0	81.6	80.5
16.	IMHSB 16	97.1	79.6	86.8	87.8
17.	IMHSB 17	109.2	92.7	78.0	93.3
18.	IMHSB 18	86.4	75.3	79.4	80.4

Sl. No.	Experimental hybrid	Average grain yield (q/ha) over years			
		Begusarai	Sabour	Dholi	Pooled mean
19.	IMHSB 19	75.9	75.8	93.8	81.8
20.	IMHSB 20	61.6	89.3	87.5	79.5
21.	IMHSB 21	67.1	64.3	95.2	75.5
22.	IMHSB 22	69.1	76.0	63.2	69.4
23.	IMHSB 23	76.8	80.8	81.7	79.7
24.	IMHSB 24	99.7	86.0	102.9	96.2
25.	IMHSB 25	52.5	82.8	65.5	67.0
26.	IMHSB 26	76.4	73.7	84.0	78.0
27.	IMHSB 27	95.1	75.2	79.7	83.3
28.	IMHSB 28	114.2	91.5	104.5	103.4
29.	IMHSB 29	98.7	86.6	77.7	87.6
30.	IMHSB 30	101.4	71.9	87.6	87.0
31.	IMHSB 31	84.0	88.1	80.0	84.0
32.	IMHSB 32	59.7	73.1	73.9	68.9
33.	DHM 117 (C)	77.9	76.6	79.9	78.1
34.	Bio 9544 (C)	88.8	84.3	94.2	89.1
35.	P 3396 (C)	95.4	87.1	84.3	88.9
36.	DKC 9081 (C)	109.3	77.9	96.1	94.4
	<b>Mean</b>	<b>86.1</b>	<b>80.0</b>	<b>83.0</b>	<b>83.0</b>
	<b>CV (%)</b>	<b>17.7</b>	<b>14.4</b>	<b>19.1</b>	<b>11.8</b>
	<b>LSD (5%)</b>	<b>18.4</b>	<b>15.7</b>	<b>20.1</b>	<b>16.1</b>

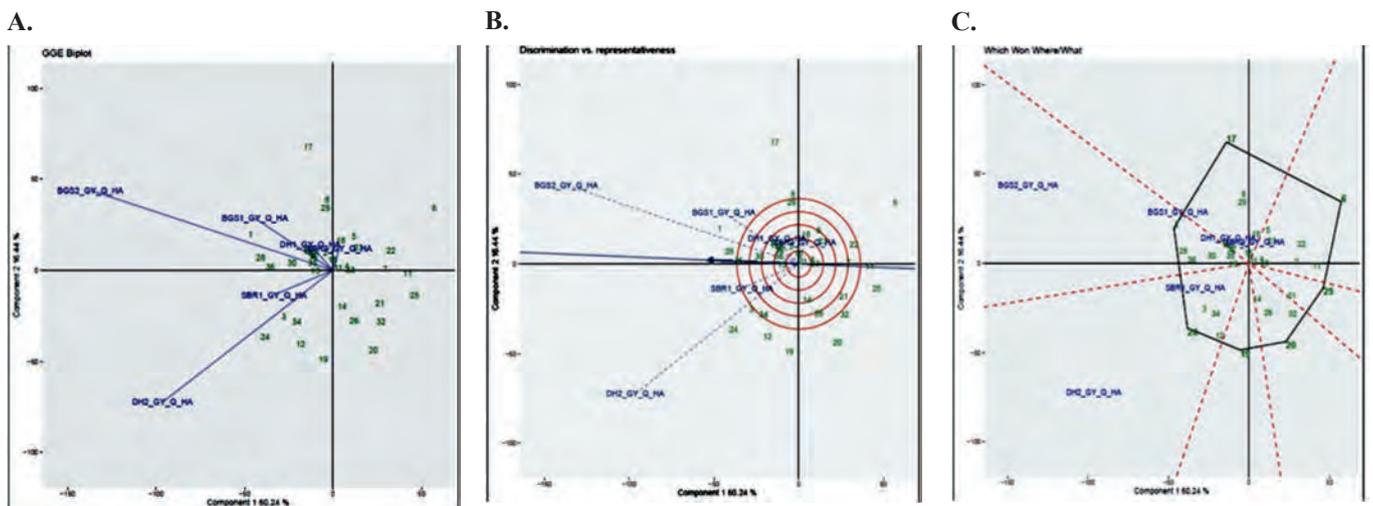


Figure 1.4: GGE biplots of hybrids tested over three locations, viz., Begusarai (BGS1 and BGS2 for 1<sup>st</sup> and 2<sup>nd</sup> year), Dholi (DH1 and DH2 for 1<sup>st</sup> and 2<sup>nd</sup> year) and Sabour (SBR1 and SBR2 for 1<sup>st</sup> and 2<sup>nd</sup> year) in 2019 and 2020. A. GGE biplot for G x E, B. Discriminative vs. representative, C. Which own where (Numerical values denote genotypes in Table 1.6.)

### Experimental hybrids under station trial

Evaluation of fresh crosses for yield and related traits— early maturity normal corn

A hybrid trial comprising of 38 fresh crosses with two checks,

viz., DKC 7074 and PMH 2 was conducted during *kharif* 2020. Eighteen crosses showed significant superiority over check DKC 7074 for grain yield; however none of crosses was superior for grain yield over PMH 2 (Table 1.7).

**Table 1.7: Performance of early maize hybrids for grain yield, crop duration, shelling outturn and grain weight**

Sl. No.	Fresh crosses with parental pedigree	GY (q/ha)	DTM	SP (%)	HGW (gm)
1.	11242 (731-Chain cross 1-3) × LM 16	72.9	81	73	24
2.	11232 (719-Chain cross short cob6-3) × LM 16	63.7	94	63	22
3.	11231 (717-Chain cross short cob5-2) × LM 16	61.6	79	73	23
4.	11358 (382-1) × LM 16	60.6	85	75	22
5.	11289 (818-10309 pool.2-2) × LM 16	57.8	80	69	21
6.	11278 (808-10309 pool.1-2) × LM 16	57.5	82	68	22
7.	11260 (800-10309 pool.1-2) × LM 16*	57.5	87	67	23
8.	11206 (HP 11-1-18-1-12-5--1) × LM 16	57.4	90	67	25
9.	11359 (382-5) × LM 16	57.3	92	54	24
10.	11392 (EC 639397-2-2-1-1) × LM 16	56.9	80	67	22
11.	11265 (802-10309 pool.1-3) × LM 16	56.8	82	67	22
12.	11345 (192-1) × LM-16	56.6	83	69	21
13.	11323 [(E 13118/CML474)PMH 1]-5-2-1-1-1) × LM 16	56.3	89	68	22
14.	11361 (Hey pool 2011-55-3-2-1-2-2) × LM 16	55.5	90	62	22
15.	11357 [(ELPJB10/E121022)BIO9544]-4-2-1-1-1) × LM 16	55.3	86	66	22
16.	11296 (824-10309 pool.1-2) × LM 16	54.4	82	68	22
17.	11283 (811-10309 pool.3-1) × LM 16	54.4	81	67	22
18.	11395 [(E13122/E131210)BIO9544]-2-1-2-1-1) × LM 16	53.3	79	76	20
19.	DKC 7074	40.0	83	65	23
20.	PMH 2	74.6	88	70	22
	<b>CV (%)</b>	<b>15.4</b>	<b>4.1</b>	<b>8.3</b>	<b>8.7</b>
	<b>LSD (5%)</b>	<b>13.3</b>	<b>6</b>	<b>9</b>	<b>3</b>

GY: Grain Yield, DTM: Days to maturity, SP: Shelling %, HGW: 100 grains weight (gm); \*This cross was superior over DKC-7074 in *kharif* 2019 also.

### Evaluation of fresh crosses for yield and related traits—normal corn for rabi season

A set of 545 experimental hybrids comprising crosses generated from line × tester design, diallel fashion and of selected combinations along with five checks were evaluated in an  $\alpha$ -lattice design to identify the best high yielding hybrid under during *rabi* 2019-20 at RMR&SPC, Begusarai. One

hundred and twenty one hybrid combinations under medium maturity and ten under late maturity group out yielded the best check (Bio 9544 and P 3522) of the respective maturity groups. The hybrid combinations which out yielded with >10% superiority over best check under medium maturity duration and late maturity are given in Tables 1.8 and 1.9, respectively.

**Table 1.8: Yield potential and important traits of medium duration experimental hybrid combinations yielding >10% over best check during *rabi* 2019-20**

Sl. No.	Hybrid	Pedigree	DTA	DTM	PH (cm)	GY (q/ha)	SUP (%)
1.	IMHSB 19R-3050	IMLSB 571-2 × IMLSB 406-2	107	155	166	154.5	21.8
2.	IMHSB 19R-1121	IMLSB 2039 × BML 7	109	150	207	149.8	18.2
3.	IMHSB 19R-1153	IMLSB 274-1 × BML 7	112	159	178	149.1	17.6
4.	IMHSB 19R-1197	IMLSB 1045-4-1 × LM 13	109	152	174	149.0	17.5
5.	IMHSB 19R-1016	IMLSB 100 × LM 13	104	154	174	148.0	16.7
6.	IMHSB 19R-3013	IMLSB 114-1 × IMLSB 1062-1-2-1	104	149	161	146.8	15.8
7.	IMHSB 19R-1113	IMLSB 1292-2 × BML 7	113	154	177	146.6	15.6
8.	IMHSB 19R-1163	IMLSB 452-2 × BML 6	105	155	166	145.7	14.9
9.	IMHSB 19R-1108	IMLSB 1043-1-1 × BML 6	107	150	168	144.6	14.1
10.	IMHSB 19R-1117	IMLSB 1298-8 × BML 6	111	152	170	144.6	14.0
11.	IMHSB 19R-3093	IMLSB 100 × IMLSB 207-2	102	152	171	144.1	13.6
12.	IMHSB 19R-1165	IMLSB 467-2 × LM 13	114	149	179	143.9	13.5
13.	IMHSB 19R-3167	IMLSB 406-2 × IMLSB 414-1	109	155	161	143.4	13.1
14.	IMHSB 19R-3011	IMLSB 83-1 × IMLSB 1299-5	110	148	156	141.3	11.4
15.	IMHSB 19R-1252	IMLSB 481-1 × LM 13	103	151	173	141.1	11.3
16.	IMHSB 19R-3054	IMLSB 617-1 × IMLSB 406-2	111	158	174	140.4	10.7
17.	IMHSB 19R-1144	IMLSB 173-1 × BML 6	101	149	166	140.1	10.5
18.	DMRH 1301(C1: medium)		106	152	146	83.4	-
19.	Bio 9544 (C 2: medium)		114	154	169	117.8	-
20.	P 3396 (C 3: medium)		106	154	175	116.9	-
		<b>Mean</b>	<b>104.7</b>	<b>152.6</b>	<b>154.3</b>	<b>97.1</b>	<b>-</b>
		<b>CV (%)</b>	<b>6.7</b>	<b>7.8</b>	<b>13.5</b>	<b>14.8</b>	<b>-</b>
		<b>LSD (5%)</b>	<b>5.6</b>	<b>10.4</b>	<b>10.7</b>	<b>12.8</b>	<b>-</b>

DTA: Days to anthesis, DTM: Days to maturity, PH: Plant height, GY: Grain Yield, SUP (%): Yield superiority over best Check

**Evaluation of fresh crosses for yield and related traits – normal corn for *kharif* season**

A set of 275 experimental hybrids generated through line × tester and diallel design along with some selected hybrid combinations of medium and late maturity duration were evaluated in  $\alpha$ -lattice design during *kharif* 2020 at

RMR&SPC, Begusarai and ICAR-IIMR, Ludhiana to identify high yielding hybrids for the *kharif* season. Twelve experimental hybrids at Begusarai and 17 at Ludhiana showed >10% yield superiority over the best check hybrid as shown in **Table 1.10**. One hybrid, viz., IMLSB 883-1 × IMLSB 388-1 showed superiority over the check at both the location.

**Table 1.9: Yield potential and important traits of late duration experimental hybrid combinations yielding >10% over best check during *rabi* 2019-20**

Sl. No.	Hybrid	Pedigree	DTA	DTM	PH (cm)	GY (q/ha)	SUP (%)
1.	IMHSB 19R-3052	IMLSB 571-2 × IMLSB 1510	110	161	168	152.2	20.0
2.	IMHSB 19R-3075	IMLSB 1298-6 × IMLSB 1062-1-2-1	110	161	184	148.2	16.9
3.	IMHSB 19R-3086	IMLSB 1510 × IMLSB 406-2	111	161	184	146.7	15.7
4.	IMHSB 19R-1128	IMLSB 1299-5 × BML 7	112	159	178	146.4	15.5
5.	IMHSB 19R-1131	IMLSB 1510 × BML 7	110	160	183	144.9	14.3
6.	NK 7720 (C 4: late)		114	159	173	120.3	-
7.	P 3522 (C 5: late)		117	160	206	126.8	-
		<b>Mean</b>	<b>104.7</b>	<b>152.6</b>	<b>154.3</b>	<b>97.1</b>	<b>-</b>
		<b>CV (%)</b>	<b>6.7</b>	<b>7.8</b>	<b>13.5</b>	<b>14.8</b>	<b>-</b>
		<b>LSD (5%)</b>	<b>5.6</b>	<b>10.4</b>	<b>10.7</b>	<b>12.8</b>	<b>-</b>

DTA: Days to anthesis, DTM: Days to maturity, PH: Plant height, GY: Grain Yield, SUP (%): Yield superiority over best Check

**Table 1.10: Yield performance of experimental maize hybrids out yielding best check by >10% during *kharif* 2020 at Begusarai and Ludhiana**

Sl. No.	Name of entry	Pedigree	DTA	PH (cm)	GY (q/ha)	SUP (%)	Rank
Location: Begusarai							
1.	IMHSB 20K-15	IMLSB 119-2 × IMLSB 1062-1-2	52	170	69.0	24.6	1
2.	IMHSB 20K-96	IMLSB 1510 × BML 6	51	205	68.6	23.9	2
3.	IMHSB 20K-66	IMLSB 800-1 × IMLSB 406-1	50	214	68.1	22.8	3
4.	IMHSB 20K-105	IMLSB 2077 × BML 7	51	195	66.7	20.3	4
5.	IMHSB 20K-195	IMLSB 37-2 × LM 14	49	181	66.1	19.3	5
6.	IMHSB 20K-72	IMLSB 883-1 × IMLSB 388-1	54	188	64.2	15.8	6
7.	IMHSB 20K-140	IMLSB 334B-2 × LM 13	54	193	63.4	14.4	7
8.	IMHSB 20K-112	LM 14 × IMLSB 1299-5	52	188	63.8	15.1	8
9.	IMHSB 20K-162	IMLSB 1011-2 × LM 13	54	221	63.2	14.0	9
10.	IMHSB 20K-81	IMLSB 1043-1-1 × BML 6	53	186	62.2	12.3	10
11.	IMHSB 20K-163	IMLSB 1041-4-2 × LM 13	53	213	61.8	11.6	11
12.	IMHSB 20K-262	WNC-40252 × LM 14	51	201	61.2	10.5	12
13.	DKC 7074 (C 1)		50	167	55.4	-	-
14.	CHM 08-287 (C 2)		52	216	47.6	-	-
15.	BIO 9544 (C 3)		55	177	44.7	-	-
16.	DHM 121 (C 4)		56	178	36.0	-	-
17.	NK 6240 (C 5)		54	166	29.2	-	-
		<b>Mean</b>	<b>52.6</b>	<b>200.5</b>	<b>46.2</b>	<b>-</b>	<b>-</b>
		<b>CV (%)</b>	<b>8.6</b>	<b>7.8</b>	<b>14.8</b>	<b>-</b>	<b>-</b>
		<b>LSD (5%)</b>	<b>4.6</b>	<b>14.8</b>	<b>4.6</b>	<b>-</b>	<b>-</b>

Sl. No.	Name of entry	Pedigree	DTA	PH (cm)	GY (q/ha)	SUP (%)	Rank
Location: Ludhiana							
1.	IMHSB 20K-147	IMLSB 406-1 × LM 13	51	226	84.8	28.2	1
2.	IMHSB 20K-145	IMLSB 387-1 × LM 13	51	222	82.7	25.1	2
3.	IMHSB 20K-179	WNC33191 × LM 13	52	240	81.8	23.8	3
4.	IMHSB 20K-60	IMLSB 571-1 × IMLSB 406-1	52	186	80.4	21.7	4
5.	IMHSB 20K-251	IMLSB 2003 × LM 14	50	252	79.7	20.6	5
6.	IMHSB 20K-78	IMLSB 976-2 × BML 7	53	236	79.2	19.8	6
7.	IMHSB 20K-50	IMLSB 406-2 × IMLSB 388-1	50	230	78.6	18.9	7
8.	IMHSB 20K-72	IMLSB 883-1 × IMLSB 388-1	51	209	78.2	18.3	8
9.	IMHSB 20K-30	IMLSB 274-1 × BML 7	52	200	76.8	16.1	9
10.	IMHSB 20K-152	IMLSB 537-2 × LM 13	51	243	76.2	15.3	10
11.	IMHSB 20K-234	IMLSB 837-2 × LM 14	50	177	74.6	12.9	11
12.	IMHSB 20K-246	IMLSB 1292-1 × LM 14	52	238	74.4	12.6	12
13.	IMHSB 20K-75	IMLSB 975-2 × BML 6	52	210	74.3	12.4	13
14.	IMHSB 20K-120	IMLSB3-1 × LM 13	50	231	74.1	12.1	14
15.	IMHSB 20K-22	IMLSB 173-3 × IMLSB 334B-1	54	214	74.1	12.1	15
16.	IMHSB 20K-20	IMLSB 173-2 × BML 7	54	226	73.2	10.8	16
17.	IMHSB 20K-68	IMLSB 814-2 × IMLSB 388-1	52	223	73.2	10.7	17
18.	CMH 08-287 (C)		51	228	66.1	-	-
19.	DKC 7074 (C)		50	175	52.3	-	-
20.	NK 6240 (C)		51	174	51.0	-	-
21.	Bio 9544 (C)		55	185	49.2	-	-
22.	DHM 121 (C)		55	177	27.6	-	-
		<b>Mean</b>	50.9	187.2	36.8	-	-
		<b>CV (%)</b>	10.8	12.8	16.8	-	-
		<b>LSD (5%)</b>	5.9	13.9	3.9	-	-

DTA: Days to anthesis, PH: Plant height, GY: Grain Yield, SUP (%): Yield superiority over best Check, C: Check

### Evaluation of experimental hybrids – QPM

Forty five experimental hybrids along with four checks (QPM: 2 and Normal: 2) were evaluated during *kharif* 2020 at ICAR-IIMR, Ludhiana. Two experimental hybrids, viz., DQL 2064 × DQL 2124 and DQL 2209(P1) × CLQ 40 outperformed

the popular normal hybrid Bio 9544. Though, the normal check hybrid CP 858 was the best performing hybrid in the trial, 6 hybrids outperformed the best QPM check (HQPM 4). The detailed performance of the hybrids is given in the (Table 1.11.)

**Table 1.11: Performance of QPM maize hybrids for grain yield relative to normal check**

Sl. No.	Hybrid	DTA	DTA	GY (q/ha)	Sl. No.	Hybrid	DTA	DTA	GY (q/ha)
1.	DQL2018×DQL2306	48	50	55.1	25.	DQL2290×DQL2192	56	55	27.5
2.	DQL2018×DQL2313	52	52	61.5	26.	DQL2292×DQL2234	51	52	68.4
3.	DQL2018×DQL2330	50	51	59.2	27.	DQL2301×HKI163	56	56	36.1
4.	DQL2064×DQL2303	49	51	42.0	28.	DQL2301×DQL2192	54	55	69.3
5.	DQL2064×DQL2306	50	51	74.1	29.	DQL2304×DQL2170-2	50	51	59.2
6.	DQL2064×DQL2311	52	53	78.0	30.	DQL2311×CML-161 (C.S)	49	50	82.1
7.	DQL2064×DQL2124	53	57	98.2	31.	DQL2317×DQL2330	46	47	40.5
8.	DQL2099×DQL2311	53	53	81.6	32.	CLQ40×DQL2234-5	46	48	42.1
9.	DQL2169-1×DQL2313	52	53	59.1	33.	CLQ40×DQL2099	51	52	81.6
10.	DQL2184×DQL2311	50	51	81.0	34.	DQL2124×DQL2099	56	55	15.7
11.	DQL2184×DQL2313	51	52	78.1	35.	DQL2099×DQL2313	57	59	70.5
12.	DQL2184×DQL2124	50	51	55.1	36.	DQL2234-5×DQL2317	45	46	46.4
13.	DQL2184×DQL2234	48	50	77.3	37.	CLQ-40×DQL2306	50	48	42.2
14.	DQL2184×DQL2238	50	52	42.7	38.	DQL2313×DQL2018-1	54	55	65.5
15.	DQL2184×DQL2192	55	55	43.1	39.	CML161×DQL2311	50	52	39.1
16.	DQL2184×DQL2099	53	54	82.8	40.	HQPM1 (C)	54	55	40.7
17.	DQL2192×DQL2064	50	51	81.2	41.	HQPM4 (C)	52	53	78.9
18.	DQL2209×DQL2234-5	50	51	4.6	42.	HQPM5 (C)	55	56	57.6
19.	DQL2209 (P1)×CLQ40	51	52	87.5	43.	HQPM7 (C)	54	55	63.7
20.	DQL2215-2×HKI193-1	48	50	61.7	44.	CP858 (C)	54	55	115.6
21.	DQL2215-2×DQL2306	47	48	72.3	45.	BIO9544 (C)	53	53	86.6
22.	DQL2234 (C1)×DQL2313	54	57	62.0		<b>CV (%)</b>	-	-	<b>8.8</b>
23.	DQL2234-5×DQL2184	51	52	53.0		<b>LSD (5%)</b>	-	-	<b>11.0</b>
24.	DQL2234-5×DQL2192	50	51	26.1					

DTA: Days to anthesis, DTS: Days to silking, GY: Grain yield, C: Check

### Testing of CMS based hybrids–baby corn

A set of 15 experimental baby hybrids were developed through crossing among the CMS lines which were evaluated during *kharif* 2020 at Ladhawal farm Ludhiana. The experiment was laid out in RCBD design with two replications with three meter row length along with two checks (G 5414 and HM 4). Among the 17 hybrids, one hybrid was found superior over both the checks which need to be confirmed further (**Table 1.12, Figure 1.5**).

**Table 1.12: Superiority of baby corn hybrid over check**

Sl. No.	Hybrid	Yield (q/ha)	Sup. (%) over HM 4	Sup. (%) over G 5417
1.	IBCH 1	16.9	33.4**	21.8*
2.	HM 4 (Check 1)	12.7	-	-
3.	G 5414 (Check 2)	13.9	-	-
	<b>CV (%)</b>	13.7	-	-
	<b>LSD (5%)</b>	2.9	-	-

C: Check, Sup: Superiority



IBCH 1



IBCH 3

Figure 1.5: Experimental superior baby corn hybrid over the check

## Maize Genetic Resource Management

### Introduction of germplasm

To strengthen the baby corn programme, 9 accessions of inbred lines were imported for the development of silkless baby corn from the Maize Genetic Stock Center, University of Illinois, USA. The EC numbers of the imported accessions are EC 1040934 - EC 1040942. Further, 84 new sources of specialty corn sources were procured from CIMMYT, India

which includes sweet corn (55), popcorn (19) and baby corn (10). The sweet corn germplasm includes F<sub>2</sub>s (14), populations (2) and inbred lines (39), carrying the mutant *shrunken 2* allele. The sweet corn germplasm was derived or developed from different sources namely Hawaii sugar, Boli, CHH, DoceOpaco, Dura, Hawaii sugar, Jali, MCH, Sina and Sono. Out of the 84 new source of specialty corn germplasm, 57 (37 sweet corn; 14 popcorn; 6 baby corn) were maintained through self-pollination during spring 2020 at ICAR-IIMR, Ludhiana.

### Characterization of germplasm

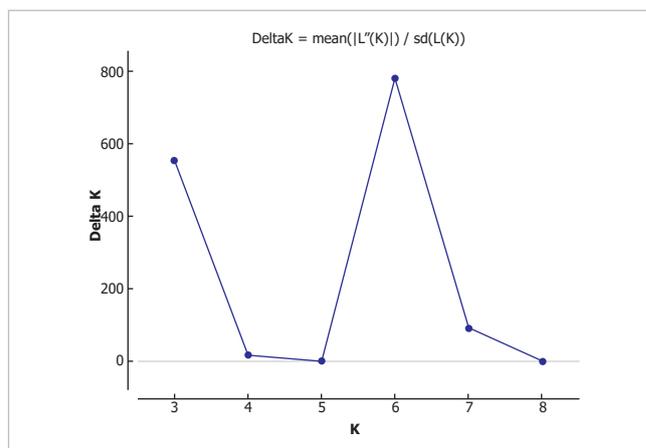
*Study of population structure of tropical maize germplasm using Genotyping by Sequencing (GBS)*

An association mapping panel (AMP) of 350 diverse maize inbred lines was used to study the population structure. The genotypes were subjected to Genotype by sequencing (GBS). The GBS libraries were prepared by restriction digestion of DNA of each of the line with *ApeKI*, followed by ligation with barcoded adapters. The libraries were pooled and sequenced using Illumina TrueSeq Version 3.0 single end sequencing chemistry with read lengths of 151 bp on HiSeq x10 Platform. Reads with minimum Q score of 20 across were considered for further analysis. These reads were sorted and de-multiplexed according to their barcode. The filtered sequence tags were aligned to the already available draft genome sequence of the maize genome using Burrows-Wheeler alignment tool (BWA). Further, pipeline parameters were used for SNP calling and genotyping using GATK and vcftools. Total 60227 SNPs which were found after filtering at minor alleles frequency (MAF)  $\geq 0.05$ , were used to study the population structure and linkage disequilibrium (LD). The chromosomes wise distribution of these SNPs at various MAF have been given in **Table 1.13**, where the highest numbers of SNPs were detected on chromosome 1 and lowest on chromosome 10. Out of 60227, total 20085 SNPs were found unique at MAF  $\geq 0.05$  in the panel. The sufficient numbers of SNPs and allelic variation were observed in the germplasm which can be further utilized genome wide association studies (GWAS) in future.

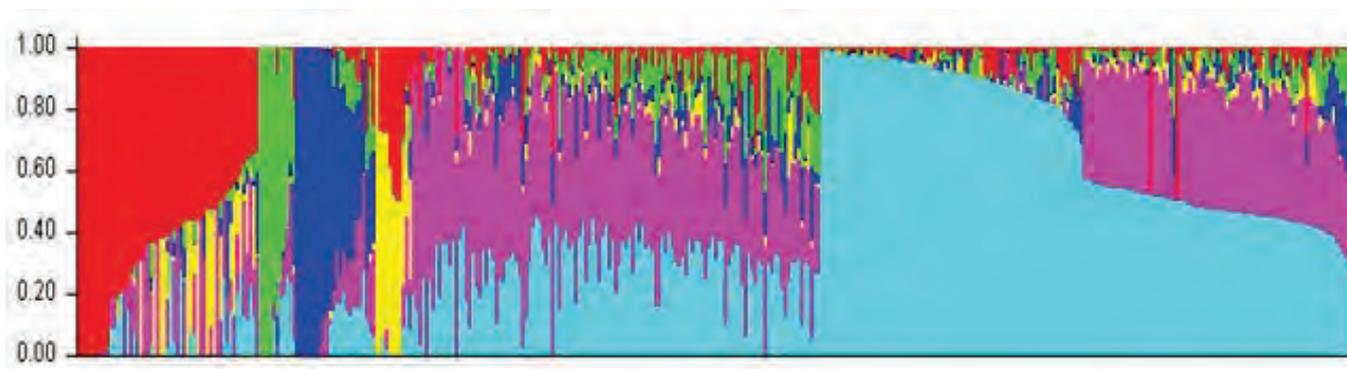
Table 1.13: Chromosome wise details of the SNPs found at various minor alleles frequencies (MAF) in the AMP

Chromosome Nos.	Chromosomes wise number of SNPs at various minor alleles frequency (MAF)					
	MAF $\geq 0.05$	MAF $\geq 0.1$	MAF $\geq 0.2$	MAF $\geq 0.3$	MAF $\geq 0.4$	Unique Loci
Chr. 1	8976	6946	3413	1753	707	2906
Chr. 2	7173	5377	2505	1303	578	2299
Chr. 3	7405	5757	2801	1271	569	2353
Chr. 4	8293	6270	2990	1484	616	2676
Chr. 5	6823	5142	2265	1129	483	2270
Chr. 6	4624	3523	1582	742	324	1511
Chr. 7	6053	4456	2093	1044	374	1983
Chr. 8	5345	4134	1996	1024	464	1733
Chr. 9	3368	2618	1253	671	299	1080
Chr. 10	2167	1325	409	167	56	1274
<b>Total</b>	<b>60227</b>	<b>45548</b>	<b>21307</b>	<b>10588</b>	<b>4470</b>	<b>20085</b>

The data set of 60227 SNPs was used to study the population structure of the selected germplasm using set parameters for population admixture model and correlated frequency of alleles (Pritchard et al. 2000). The hypothetical sub populations were considered as  $K=2-8$  and, the package was run with three independent runs for each  $K$ . Length of burn-in period and number of iterations were set at 1,50,000. A model-based clustering algorithm was applied that identified subgroups with distinctive allele frequencies. Analysis of genetic variation and population structure provided evidence of partial sub-structure in the maize AMP. The highest likelihood value  $[\ln Pr(X|K)]$  for each run was maximum at  $K=6$  (Figure 1.6), therefore there are six possible sub-structures in the association mapping panel (Figure 1.7). It clearly depicts that each subgroup is diverse from others and therefore it can be considered for GWAS.



**Figure 1.6: Population structure estimated in the panel. The average highest likelihood value  $[\ln Pr(X|K)]$  for each run was found maximum at  $K=6$**



**Figure 1.7: Barplots showing diversity in the population structure studied using the 60227 SNPs markers. The optimum sub-populations were obtained at  $K=6$**

### Molecular dissection of popping related traits

Popping traits of popcorn are considered as very important from the commercial point of view. The 198  $F_8$  recombinant inbred lines (RILs) derived from the cross between HKIPC 4B (popping percentage of 80–85%)  $\times$  CML 269 (popping percentage of 35–40%) were characterized along with their parents for seed and popping traits over the three locations viz., Delhi, Ludhiana and Begusarai during *kharif* (2019), spring (2019) and *rabi* (2018-19), respectively. The sufficient

genetic variability was observed in the RILs and the parents for target traits. All the three testing environments were found different and the best performing RILs, viz., RL4 (M15-12), RL51 (M15-107), RL73 (M15-138), RL74 (M15-139), RL85 (M15-152), RL87 (M15-155), RL141 (M15-253), RL163 (M15-279) were identified. The summary of the average values of popping related traits over the three environments have given in (Table 1.14).

**Table 1.14: Descriptive statistics for popping and seed traits over the three environments**

Variable	Min.	Max.	Mean
Popping Percentage (PP)	15.65%	95.36%	67.19 $\pm$ 1.28%
Flake Volume (FV)	14.00 cm <sup>3</sup> /gm	484.44 cm <sup>3</sup> /gm	177.73 $\pm$ 5.98 cm <sup>3</sup> /gm
Popping expansion volume (PEV)	1.57	21.36	7.96 $\pm$ 0.26
100 Seeds weight (TW)	8.99 gm	28.62 gm	17.29 $\pm$ 0.24 gm

The 6527 polymorphic SNPs between the parents were used to characterize the RILs, linkage map construction and mapping studies (Table 1.15). The total map length covered was of 2124.3 cM with an average interval of 0.33 cM. The CIM algorithms implemented in the WinCart 2.5 software and ICI mapping was used for QTL analysis. The QTLs explaining  $\geq 10\%$  of the phenotypic variation at LOD threshold  $\geq 2.5$  was

declared as the major QTLs. Total 15 QTLs (major: 5 ; minor: 10 ) were mapped for various popping related traits and was distributed over all the chromosomes except chromosome 10. The detail of QTLs observed for different traits has been presented in Table 1.16 (Figure 1.8). The QTLs could explain the phenotypic variability in the range of 4.71 to 29.51% for different traits.

**Table 1.15: The chromosomal distribution of SNPs used for filtering and mapping studies**

Chromosomes (Chr.)	Total SNPs detected	No. of effective SNPs (after filtration)	Map length (in cM)	Average marker distance (in cM)
Chr. 1	9532	746	192.74	0.26
Chr. 2	7063	1216	256.57	0.21
Chr. 3	7274	845	323.91	0.38
Chr. 4	7476	315	218.38	0.69
Chr. 5	6988	851	195.30	0.23
Chr. 6	4579	281	211.17	0.75
Chr. 7	5432	575	221.93	0.39
Chr. 8	5471	1074	199.45	0.19
Chr. 9	4520	314	123.01	0.39
Chr. 10	4431	310	181.83	0.59
<b>Total</b>	<b>62766</b>	<b>6527</b>	<b>2124.30</b>	<b>0.33</b>

**Table 1.16: Details of QTLs identified for various popping related traits in different environments**

QTL-trait	Env.	Chr.	Bin	Position (cM)	Left Marker (lower limit CI, cM)	Right Marker (upper limit CI, cM)	LOD	PVE (%)	Additive effect
QTL-K1-TW	E1	3	3.09	29.12	S3_22126143 (27.50)	S3_23175509 (30.50)	3.89	22.60	-0.61
QTL-K2-TW	E1	7	7.01	102.00	S7_9546686 (93.50)	S7_9887965 (106.50)	2.17	7.02	1.10
QTL-R1-TW	E3	3	3.09	29.13	S3_22126143 (27.50)	S3_23175509 (30.50)	3.89	22.60	-1.05
QTL-S1-TW	E2	3	3.09	29.13	S3_22126143 (27.50)	S3_23175509 (30.50)	3.89	22.60	-0.61
QTL-S2-TW	E2	4	4.09	129.00	S4_243881848 (128.50)	S4_211710732 (129.50)	2.83	9.84	-1.22
QTL-K1-PEV	E1	5	5.03	41.09	S5_45815458 (40.50)	S5_47725107 (41.50)	2.56	18.19	-5.88
QTL-K2-PEV	E1	1	1.03	92.00	S1_38214573 (91.50)	S1_38641391 (92.50)	2.84	11.06	-1.72
QTL-R1-PEV	E3	5	5.03	41.12	S5_45815458 (40.50)	S5_47725107 (41.50)	2.56	18.19	-5.88
QTL-S1-PEV	E2	5	5.03	41.12	S5_45815458 (40.50)	S5_47725107 (41.50)	2.56	18.19	-5.88
QTL-S2-PEV	E2	1	1.04	82.00	S1_56168030 (81.50)	S1_56030859 (82.50)	3.06	9.72	-1.02
QTL-K1-PP	E1	6	6.01	61.01	S6_9566475 (52.50)	S6_14741577 (71.50)	2.61	16.60	0.05
QTL-K2-PP	E1	2	2.07	130.00	S2_193005663 (129.50)	S2_194008793 (130.50)	2.13	8.25	-5.83
QTL-R1-PP	E3	6	6.01	62.02	S6_9566475 (52.50)	S6_14741577 (71.50)	2.63	17.54	0.05
QTL-R2-PP	E3	7	7.04	35.00	S7_161599860 (29.50)	S7_160762355 (39.50)	2.20	5.28	4.88
QTL-S1-PP	E2	6	6.01	61.01	S6_9566475 (52.50)	S6_14741577 (71.50)	2.61	16.60	0.05
QTL-K1-FV	E1	9	9.00	24.01	S9_7505733 (22.50)	S9_8647870 (24.50)	3.13	9.15	-0.24
QTL-R1-FV	E3	9	9.00	24.12	S9_7505733 (22.50)	S9_8647870 (24.50)	3.23	9.36	-0.14



QTL-trait	Env.	Chr.	Bin	Position (cM)	Left Marker (lower limit CI)	Right Marker (upper limit CI)	LOD	PVE (%)	Additive effect
QTL-R2-FV	E3	8	8.05	117.00	S8_134641422 (116.50)	S8_134176095 (125.50)	2.06	5.01	20.18
QTL-S1-FV	E2	9	9.00	24.11	S9_7505733 (22.50)	S9_8647870 (24.50)	3.21	9.36	-0.14
QTL-K2-FV	E1	9	9.03	69.34	S9_71030852 (68.50)	S9_72761454 (69.50)	7.57	29.51	-0.42
QTL-R3-FV	E3	9	9.03	69.33	S9_71030852 (68.50)	S9_72761454 (69.50)	7.42	29.19	-0.25
QTL-S2-FV	E2	9	9.03	69.32	S9_71030852 (68.50)	S9_72761454 (69.50)	7.41	29.19	-0.42
QTL-AVG1-PP	AVG	3	3.05	91.00	S3_149051341 (89.50)	S3_149479801 (93.50)	2.09	4.71	-3.73
QTL-AVG2-PP	AVG	1	1.02	105.00	S1_23603571 (104.50)	S1_23359588 (105.50)	2.78	6.68	-4.52
QTL-FV-PEV	AVG	1	1.03	89.00	S1_50728761 (88.50)	S1_50391598 (89.50)	2.47	6.17	-20.49

PP: Popping Percentage; FV: Flake volume; PEV: Popping expansion volume; TW: Test weight; QTLs: Quantitative trait loci; LOD: logarithm of the odds; cM: Centimorgan.

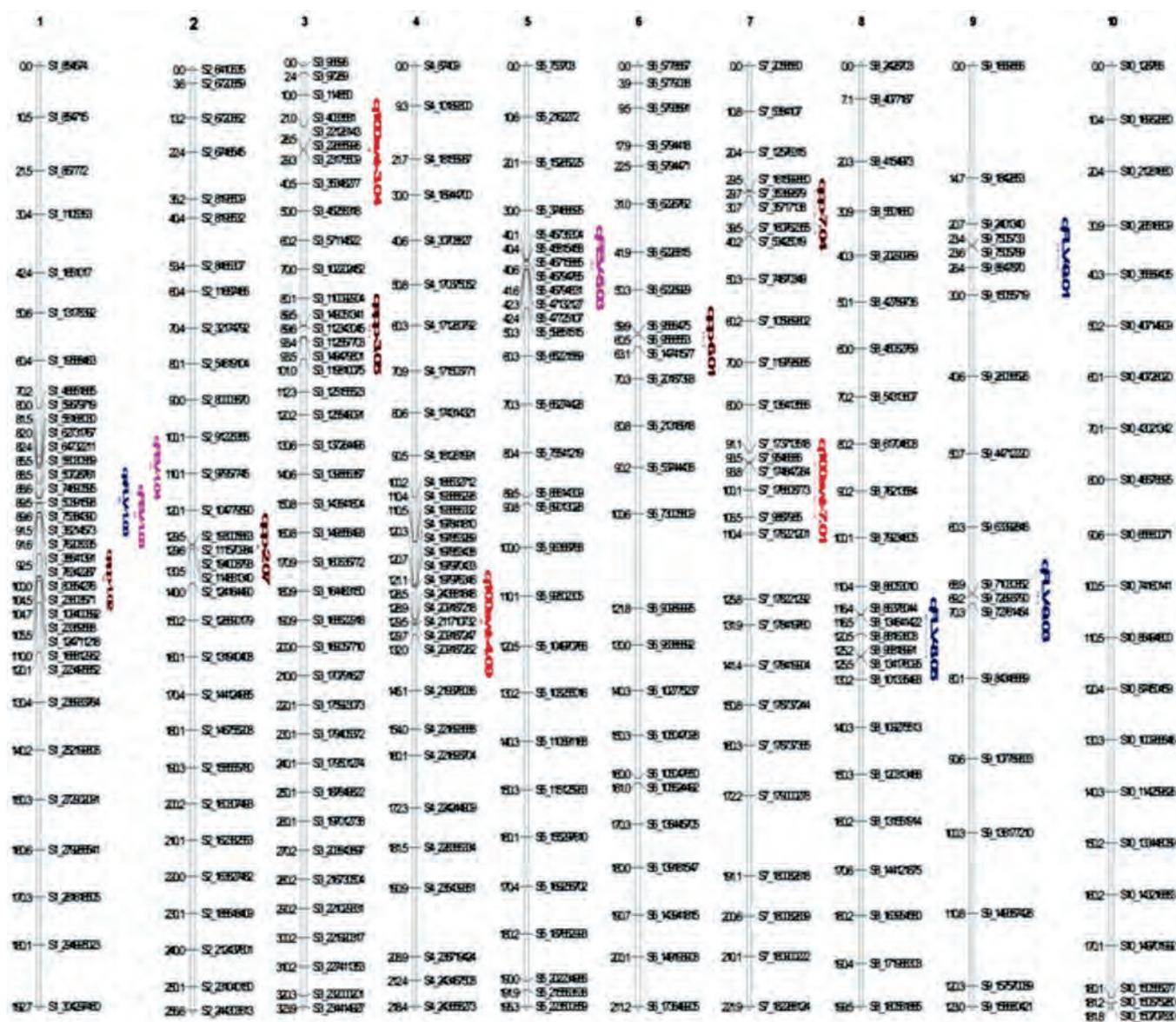
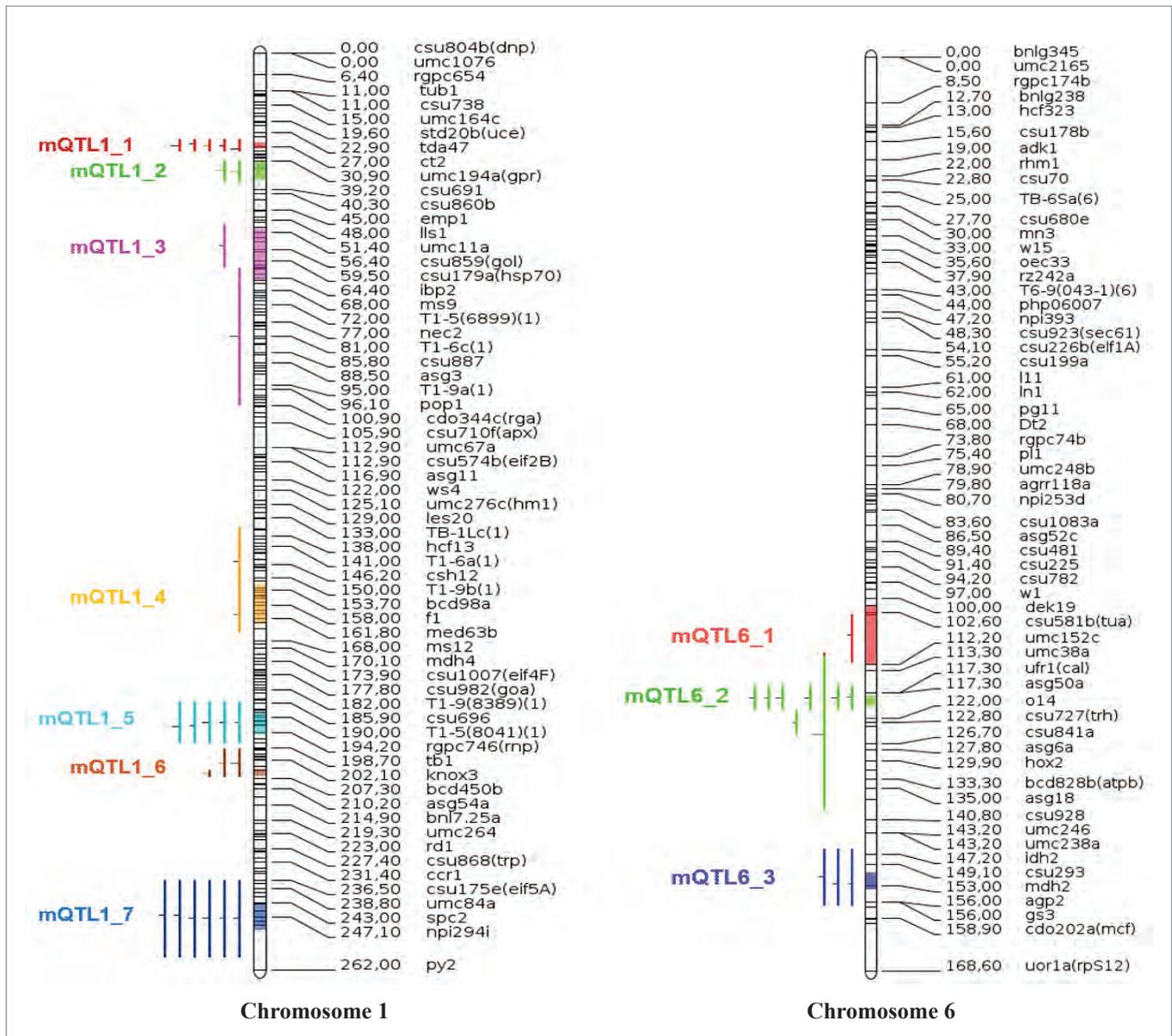


Figure 1.8: Chromosomal wise localization of QTLs identified for various popping related traits

### Identification of meta-QTLs for popping traits

Meta-QTL analysis was done to identify the consistent QTLs reported in different QTL mapping experiments using the software BioMercator v4.2. A total of 10 meta-QTLs were identified and 229 genes were shortlisted in these regions on expression basis (19 genes selected using KEGG pathways). The four meta-QTLs were considered important for popping

traits having 5–8 QTLs clustered in regions (**Figure 1.9**). The QTLs for PEV (two) and seven meta-QTLs for traits PP, TW, PEV, FS were observed at chromosome 1, earlier also QTLs and meta-QTLs were reported on chromosome 1. Therefore the identified regions may be considered as an important region to utilize in enhancement of popping traits in maize.



**Figure 1.9:** Distribution of Ten meta-QTLs for popping traits on chr 1 and 6. (A) Seven meta-QTLs, viz., mQTL1\_1, mQTL1\_2, mQTL1\_3, mQTL1\_4, mQTL1\_5, mQTL1\_6 and mQTL1\_7 identified on chromosome 1 with an average number of markers of 25.75 and average marker interval distance of 13.70 cM. (B) Three meta-QTLs, viz., mQTL6\_1, mQTL6\_2, mQTL6\_3 were identified on chromosome 6 having the corresponding values for marker number and interval were 16.40 and 15.97cM, respectively.

### Characterization of white maize populations for yield contributing traits and population structure:

Twenty-seven white maize populations received from different sources (**Table 1.17**) were grown in two replications

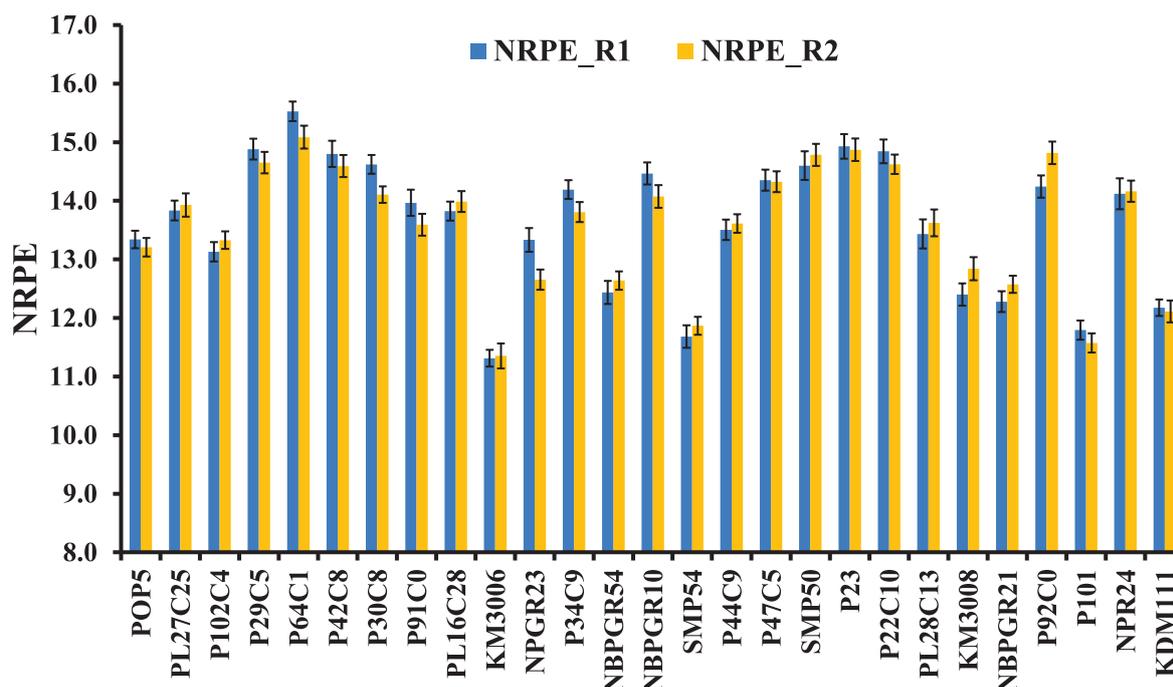
in RCBD design and each individual of the populations were characterized for different yield contributing traits, viz., Number of Row Per Ear (NRPE), Number of Kernel Per Row (NKPR) and Hundred Seed Weight (HSWT).

**Table 1.17: Populations characterized for yield contributing traits**

Sl.No.	Populations	Source	Sl.No.	Populations	Source
1.	POP 5	CIMMYT	15.	SMP 54	Srinagar
2.	PL 27C25	CIMMYT	16.	P 44C9	CIMMYT
3.	P 102C4	CIMMYT	17.	P 47C5	CIMMYT
4.	P 29C5	CIMMYT	18.	SMP 50	Srinagar
5.	P 64C1	CIMMYT	19.	P 23	CIMMYT
6.	P 42C8	CIMMYT	20.	P 22C10	CIMMYT
7.	P 30C8	CIMMYT	21.	PL 28C13	CIMMYT
8.	P 91C0	CIMMYT	22.	KDM 3008	Srinagar
9.	PL 16C28	CIMMYT	23.	NBPGR 21	NBPGR
10.	KDM 3006	Srinagar	24.	P 92C0	CIMMYT
11.	NPGR 23	NBPGR	25.	P 101	CIMMYT
12.	P34 C9	CIMMYT	26.	NBPGR 24	NBPGR
13.	NBPGR 54	NBPGR	27.	KDM 111	Srinagar
14.	NBPGR 10	NBPGR			

Appreciable amount of variation for the yield contributing traits was observed in these populations. Mean (mean of individual population) NRPE varied from 11.3–15.3 with grand mean (mean of all population) 13.6. Six populations, viz., P 29C5, P 64C1, P 42C8, SMP 50, P 23 and P 22C10 were superior with mean 14.8, 15.3, 14.7, 14.7, 14.9 and 14.7, respectively (Figure 1.10). For NKPR, mean values of population ranged from 22.9–34.4 with grand mean 30.8.

Three populations, viz., NBPGR 23, SMP 54 and P 44C9 recorded much higher number of NKPR with mean value 34.4, 33.3 and 34.2, respectively (Figure 1.11). Further, much variation for mean HSWT (24.9–35.2) were also present in these populations with grand mean 30.8. Five populations, viz., P 102C4 (33.5), P 44C9 (35.2), P 47C5 (33.4), P 92C0 (32.9) and KDM 111 (32.7) were superior for HSWT than other populations (Figure 1.12).



**Figure 1.10: Variation in Number of Row Per Ear (NRPE); R1: Replication 1, R2: Replication 2**

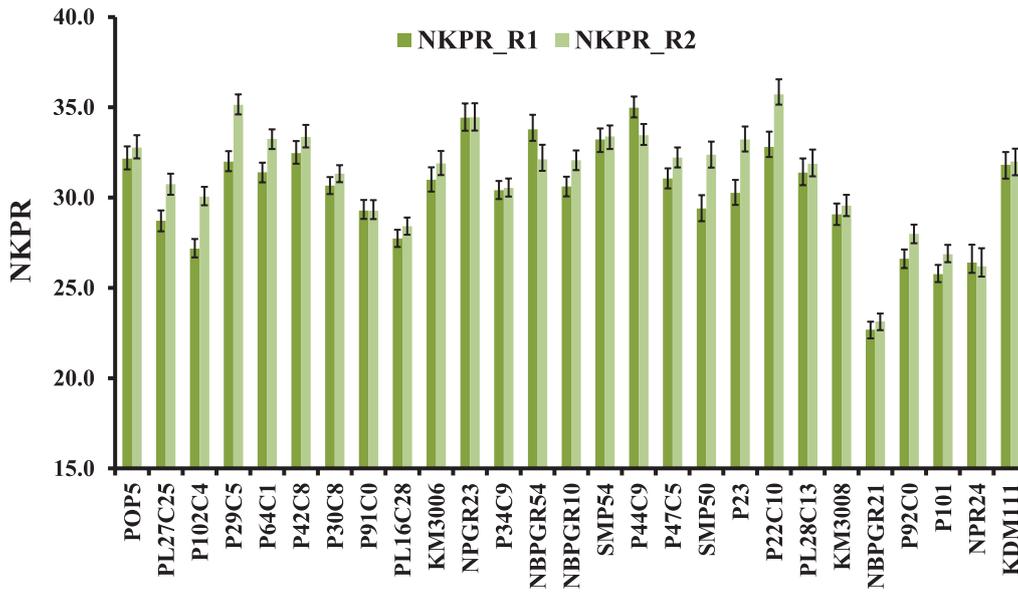


Figure 1.11: Variation in Number of Kernel Per Row (NKPR); R1: Replication 1, R2: Replication 2

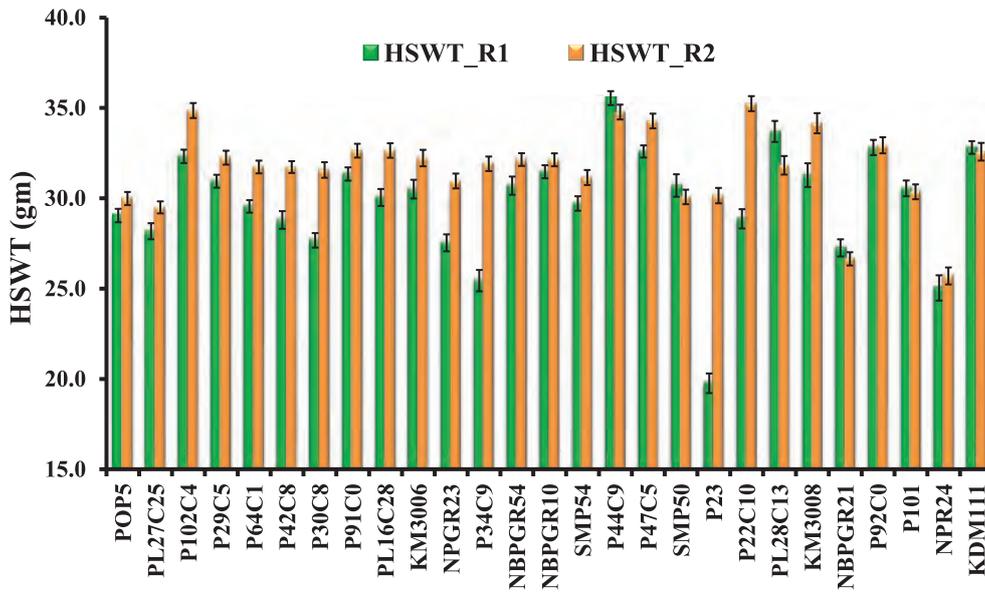


Figure 1.12: Variation in Hundred Seed Weight (HSWT); R1: Replication 1, R2: Replication 2

Further, these populations were also characterized using the 62 SSR markers. From the molecular profile of these populations, the overall structure was determined which revealed two broad groups (A and B) (Figure 1.13). The identified superior populations for NRPE and NKPR also belonged to both these two groups (A and B) except for populations identified for HSWT where all the populations classified as group B (Table 1.18). Inbred lines derived from

the populations belonging to opposite groups with different yield contributing traits (example: populations P 64C1, P 42C8 and P 23 for NRPE belongs to group B whereas populations SMP 54 and NBPGR 23 for NKPR belongs to group A) are expected to produce high yielding hybrids upon crossing. Hence, the inbred lines are being derived from these populations and will be subjected to crossing.

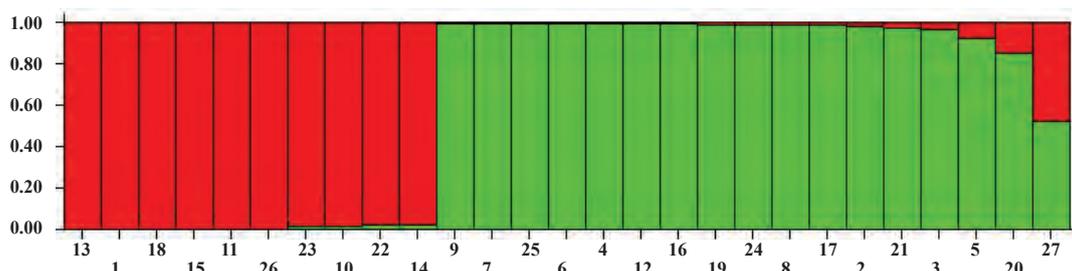


Figure 1.13: Over all structure of 27 populations determined using 62 SSR markers (Red: Group A and Green: Group B)

**Table 1.18: Grouping of populations identified superior for yield contributing traits**

Sl.No.	Populations	Trait	Group	Sl.No.	Populations	Trait	Group
1.	P 29C5	NRPE	A	8.	SMP 54	NKPR	A
2.	P 64C1	NRPE	B	9.	P 44C9	NKPR	B
3.	P 42C8	NRPE	B	10.	P 102C4	HSWT	B
4.	SMP 50	NRPE	A	11.	P 44C9	HSWT	B
5.	P 23	NRPE	B	12.	P 47C5	HSWT	B
6.	P 22C10	NRPE	-	13.	P 92C0	HSWT	B
7.	NBPGR 23	NKPR	A	14.	KDM 111	HSWT	-

**Identification of productive inbred lines of different maturity under the optimum environment**

A trial with 500 inbred lines was constituted by clubbing the inbred lines from different breeding programs of the institute and 20 released inbred lines from different AICRP centres. The trial was conducted at Begusarai during the optimum sowing time of *rabi*. *e.* first fortnight of November. Out of 500 inbred

lines, five lines failed to germinate. Observations on 12 traits including maturity, yield components along with 19 DUS (Distinct, Uniform and Stable) traits were recorded. All the 495 inbred lines were classified based on maturity and productivity, and presented in (Table 1.19). Further, a list of best performing 20 inbred lines that out yielded the best check inbred (HKI 193-2) is given in (Table 1.20).

**Table 1.19: Inbred lines identified for productivity and maturity during rabi2019-20**

Maturity	DTS	DTH	Productivity				Total
			Very High (40–45 q/ha)	High (30–40 q/ha)	Medium (20–30 q/ha)	Low (<20 q/ha)	
Early	<100	<1145	6	14	13	13	46
Medium	100–115	145–155	90	107	98	86	381
Late	>115	>155	12	16	20	20	68
<b>Total</b>			<b>108</b>	<b>137</b>	<b>131</b>	<b>119</b>	<b>495</b>

DTS: Days to silking, DTH: Days to dry husk

**Table 1.20: Best performing (high yielding) inbred lines with desirable traits under optimum environment during rabi 2019-20**

Sl.No.	Inbred line	DTS	DTM	PH	EP	GY	YS	Rank
1.	IMLSB 173-2	112	160	123	1.0	48.9	11.1	1
2.	IMLSB 343-3	120	162	70	1.0	48.7	10.8	2
3.	IMLSB 274-1	115	154	122	1.1	48.2	9.7	3
4.	IMLSB 1299-5	114	164	88	1.2	48.2	9.7	4
5.	IMLSB 1510	116	163	121	1.7	48.0	9.1	5
6.	IMLSB 201-2	115	158	105	0.8	47.9	8.8	6
7.	IMLSB 1292-1	114	158	95	1.2	47.7	8.5	7
8.	BML 6	114	153	107	1.1	47.7	8.5	8
9.	IMLSB 457-2	119	162	71	1.6	47.6	8.3	9
10.	IMLSB 212-2	117	162	73	1.3	47.6	8.2	10
11.	IMLSB 93	109	161	89	1.4	47.5	8.0	11
12.	IMLSB 93-2	106	149	79	0.9	47.2	7.4	12

Sl.No.	Inbred line	DTS	DTM	PH	EP	GY	YS	Rank
13.	IMLSB70-1	105	144	108	1.7	47.2	7.4	13
14.	IMLSB 814-2	114	153	108	1.2	47.2	7.4	14
15.	LM 13	114	160	123	1.5	47.2	7.4	15
16.	IMLSB 79-1	112	162	99	1.1	47.1	7.2	16
17.	IMLSB 164-2	118	158	95	1.9	47.0	6.8	17
18.	IMLSB 406-1	117	158	98	1.2	46.9	6.6	18
19.	EI 670-2	114	155	134	1.1	46.7	6.2	19
20.	IMLSB 839-1	112	158	124	1.5	46.7	6.1	20
21.	HKI 193-2 (C)	113	155	123	1.3	44.0	-	-
22.	HKI 163 (C)	112	157	135	1.2	42.7	-	-
	<b>Mean</b>	<b>109.2</b>	<b>151.0</b>	<b>112</b>	<b>1.0</b>	<b>29.1</b>	-	-
	<b>CV (%)</b>	<b>7.6</b>	<b>6.8</b>	<b>9.8</b>	<b>13.4</b>	<b>14.6</b>	-	-
	<b>LSD (5%)</b>	<b>5.6</b>	<b>8.9</b>	<b>7.4</b>	<b>0.03</b>	<b>3.6</b>	-	-

DTS: Days to silking, DTM: Days to maturity, PH: Plant Height (cm), EP: Ears/ plant, GY: Grain Yield (q/ha), YS: Yield Superiority over best check (%), C: Check

### Screening of inbred lines for yield potential and other agronomic traits

Four hundred inbred lines were screened at Ludhiana in a replicated trial during *kharif* 2020 for yield and other agronomic traits. Total plant stand varied from 20 to 98% with the maturity range of 75 to 102 days. Eleven inbred lines recorded grain yield as high as 75 q/ha. In addition to that 33 inbred lines were also superior in their performance with grain yield 50 to 75 q/ha. Performance of most of the inbred lines was moderate to high (133: 10 q to 25 q/ha; 128: 25 to 50 q/ha) whereas 95 inbred lines recorded grain yield <10 q/ha. The promising genotypes with higher grain yield were 11347 [(V QH9/V QH9)/BIO 9544]-5-1-1-1 (96.7 q), 11582-847-CC-6-1-1 (93.8 q), 11359-382-5 (92.7 q), 11491-141167-2-PP-25-4-3 (91.6 q), 11460-141140-1-PP-3-3-2 (91.42 q), 11053-PFSR(Y)-C0-⊗-2-1-1-2-1-2-1-2-2 (90.7 q), 11219-705-C2-2 (87.8q), 11558-802-10309-P-1-1-1 (87.6q), 11671-86024-05 (79.6q), 11035-CML 342-1-1-1--1-1-2-2 (79.1q), and 11390 [(NS76B/ELCML1)/BIO9544]-3-1-1-1-1 (78.9q). The range for 100 weights varied from 11 to 42gm.

### Germplasm characterization under CRP-AB

The characterization of 776 germplasm accessions was undertaken under CRP-AB in augmented block

design during the year 2019-20. The common check entries comprised of inbred (LM 13), hybrid (PMH 1) and open pollinated variety (Prabhat) were used along with the accessions. In addition, 898 inbred lines which were selected based on passport and characterized data generated during 2014-15 to 2018-19, were also multiplied during the period.

### Germplasm documentation

One hundred and ninety eight inbred lines were grown during *rabi* 2019-20 for characterization. Field characterization of these lines completed and digitization of tassel and cob images of these lines completed has been done. The same is being updated in the database (<https://krishi.icar.gov.in/wnciimr/index.php>).

### Characterization for Growing Degree Days (GDD)

An experiment was conducted to standardize the Growing Degree Days (GDD) for anthesis with 58 hybrids in replicated trial. The trial involved national checks and hybrid entries received in the AICRP *kharif* 2020 trials. There were 11 hybrids in the early category, 29 in the medium maturity and 18 in the late category. The GDD for anthesis in majority of the early lines was between 800-900 GDD and for medium maturity the observed range was 900-950 GDD, whereas in late maturity the GDD was between 950-1000 GDD. These findings

will be further confirmed by similar trial in *rabi* 2020-21.

### Development, maintenance and diversification of genetic resources

#### Maintenance and advancement

During *rabi* 2019-20, 922 inbred lines were maintained through self-pollination and 41 populations were maintained through bulk pollination. During spring 2020, 645 inbred lines were maintained and multiplied at Ludhiana. Further, 805 families were advanced to S<sub>3</sub> stage and 289 segregating families were advanced to S<sub>2</sub> stage.

#### Characterization of germplasm

A set of 140 newly developed inbred lines and 13 parental genotypes of released maize hybrids were evaluated at RMR&SPC, Begusarai during *rabi* 2018-19 to study the genetic diversity. The data was recorded on 13 morphological and yield related traits namely days to 50% anthesis, days to 50% silking, anthesis silking interval, days to maturity, grain filling duration, plant height, ear height, ear length, ear girth, number of kernel rows, kernel per row, 100 kernel weight, grain yield (q/ha). D<sup>2</sup> statistics revealed 20 clusters, among which three clusters comprised 92, 21 and 23 genotypes, while 17 genotypes fall in 17 different clusters individually. The highest inter-cluster distance was found between the cluster 17 and 19 (IMLSB 955-1 and IMLSB 2094) followed by cluster 13 and 17 (IMLSB 423-1 and IMLSB 955-1), and cluster 14

and 17 (IMLSB 81-1 and IMLSB 955-1). Among the first three clusters, the highest inter-cluster distance was found between cluster 2 and 3, and the highest intra-cluster distance was observed within cluster 2. This reveals that the crosses among these distant genotypes may harness a greater level of heterosis.

The genetic diversity study at the molecular level was also conducted with the help of 40 polymorphic SSR markers (Figure 1.14). The molecular diversity study amplified total of 873 alleles with an average polymorphism information content (PIC) value of 0.84. The primer bnlg1614 and bnlg1642 was found as the best marker for the identification of genotypes with highest PIC values (0.98 and 0.97, respectively) (Table 1.21). The Jaccard's dissimilarity index showed the highest value of 1.00 among the genotypes IMLSB 274-1 and LM 16 followed by IMLSB 123-1 and LM16 (0.98), IMLSB 119-2 and LM 14 (0.98), IMLSB 114-1 and HKI 1128 (0.98) and IMLSB 106-2 and HKI 1128 (0.98). The Jaccard's dissimilarity index classified the total genotypes in two major clusters and eight sub-clusters. The high D<sup>2</sup> distance found among the genotypes IMLSB 955-1 and IMLSB 2094, IMLSB 423-1 and IMLSB 955-1, and IMLSB 81-1 and IMLSB 955-1 also recorded high Jaccard's dissimilarity coefficient value of 0.91, 0.80 and 0.84, respectively. These diverse genotypes can be used in breeding program for development of high yielding single cross maize hybrids.

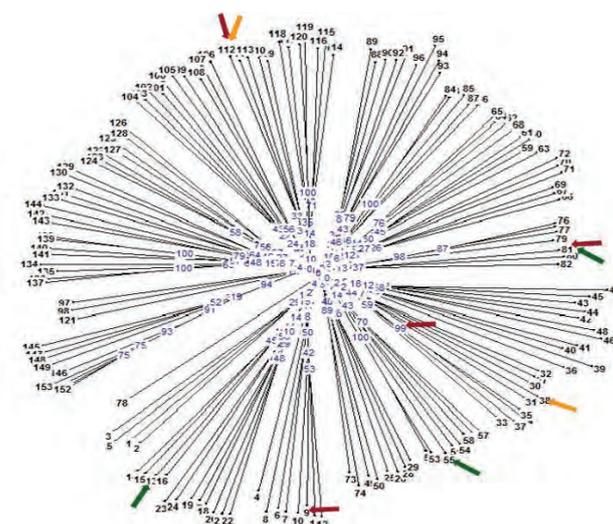


Figure 1.14: Molecular diversity studies of newly developed maize inbred lines using 40 polymorphic SSR markers (Coloured arrows denote genotypes sharing highest inter-cluster distance based of D<sup>2</sup> statistics)

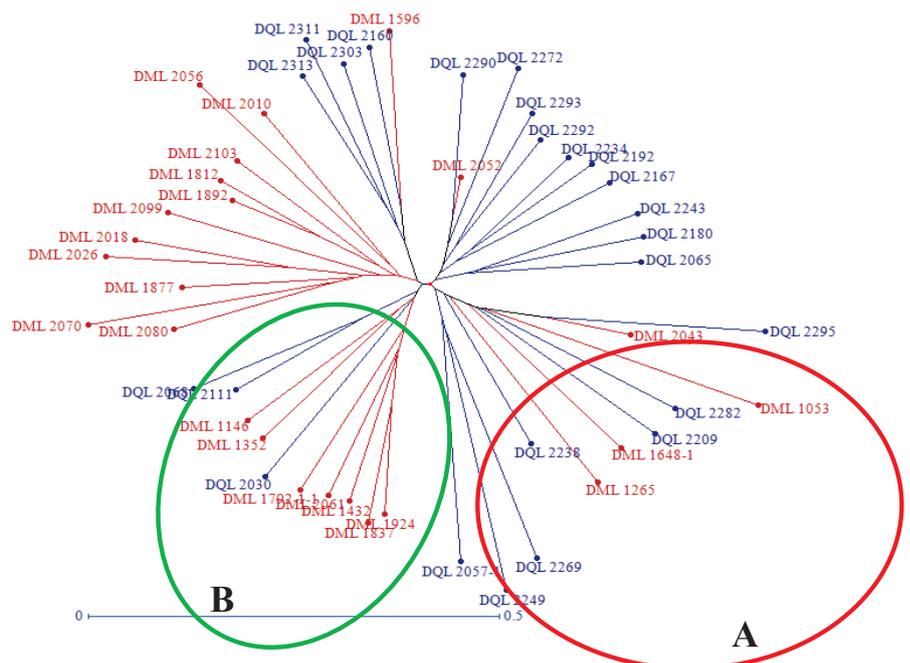
**Table 1.21: Information of SSR markers, PIC value, number of alleles, allele size polymorphic information content**

Sl. No.	Marker	Bin	PIC	NOA	Allele size
1.	umc1353	1.00	0.94	25	105–255
2.	bnlg1614	1.02	0.98	110	125–890
3.	bnlg1811	1.04	0.81	29	55–395
4.	bnlg1057	1.06	0.94	33	195–362
5.	umc2189	1.09	0.86	26	125–745
6.	umc165	2.00	0.87	12	130–185
7.	bnlg1017	2.02	0.91	18	155–574
8.	bnlg1018	2.04	0.88	17	105–200
9.	bnlg1138	2.06	0.91	17	140–220
10.	bnlg1329	2.08	0.95	33	75–115
11.	umc2108	3.00	0.88	13	110–190
12.	phi374118	3.02	0.91	17	180–265
13.	bnlg1904	3.04	0.93	22	125–280
14.	phi046	3.08	0.91	17	56–75
15.	umc2278	4.00	0.80	10	75–120
16.	umc2206	4.03	0.94	27	56–90
17.	bnlg1137	4.06	0.90	27	200–348
18.	bnlg1917	4.10	0.95	31	69–265
19.	phi96160	5.02	0.34	5	290–315
20.	bnlg2323	5.04	0.94	23	80–250
21.	umc1019	5.06	0.89	17	60–150
22.	umc1792	5.08	0.88	14	100–165
23.	bnlg1043	6.00	0.93	27	100–270
24.	bnlg1702	6.05	0.91	34	140–455
25.	umc1424	6.06	0.90	16	85–150
26.	phi089	6.08	0.92	22	75–130
27.	bnlg1642	7.00	0.97	45	110–410
28.	bnlg1094	7.02	0.93	26	110–255
29.	phi116	7.06	0.93	20	125–240
30.	bnlg1194	8.02	0.96	33	110–275
31.	phi014	8.04	0.82	13	135–200
32.	bnlg1056	8.08	0.81	20	75–951
33.	umc1279	9.00	0.73	6	80–105
34.	bnlg1209	9.04	0.81	12	155–220
35.	umc1310	9.06	0.65	5	170–190
36.	umc1129	1.11	0.91	22	120–255
37.	phi041	10.00	0.609	10	145–230
38.	umc1337	10.02	0.37	6	125–150
39.	phi062	10.04	0.03	2	165–170
40.	bnlg1028	10.06	0.86	11	120–190

NOA: No. of alleles

**Diversification of QPM germplasm**

A set of 24 QPM and 24 normal lines were crossed with two testers *i.e.* LM 13 and LM 14 to generate information on heterotic grouping. Further, these inbred lines were also used for molecular diversity analysis. Based on both yield data generated from testcrosses and molecular data using SSR marker, the genotypes were grouped in different clusters, *viz.*, A and B (Figure 1.15). The normal lines belonging to the heterotic group A and B will be used to diversify the QPM germplasm of respective groups through chain crossing and new diverse QPM lines will be developed from this population.



**Figure 1.15: Heterotic grouping of normal and QPM genotypes based on yield and marker data (Blue represents QPM and red represent Normal genotypes)**

## Specialty corn breeding

### Breeding for sweet corn

#### Development of sweet corn inbred lines

The 126 F<sub>3</sub>-F<sub>5</sub> segregating sweet corn families obtained from hybrid break-down or pedigree crosses are being advanced through self-pollination as part of diversification and development of new sweet corn inbred lines. The advanced stage inbred lines were evaluated for three ear related traits, viz., ear length (EL), ear girth (EG) and number of kernel rows (NKR). The variation observed for EL, EG and NKR among inbred lines derived from hybrids was 14–16 cm, 13–15 cm, and 15–19, whereas in pedigree-cross derived lines the variation observed for EL, EG, and NKR was 10–17, 10–14 and 8–17, respectively. In general the variation observed was relatively high in pedigree crosses. Based on advance stage inbred evaluation best 8 inbred lines were selected to be utilized in hybrid development programme and ten families for derivation of new inbred lines.

#### Heterotic grouping of sweet corn inbred lines

The sweet corn inbred lines developed from different sources namely single cross hybrids, open pollinated varieties and pedigree crosses were crossed with two inbred lines testers, viz., LM13 and LM14 for heterotic grouping based on combining ability. The numbers of test crosses attempted were 150 which are being evaluated for yield and yield contributing traits.

### Breeding for popcorn

Two popcorn hybrids namely IPCH 1901 and IPCH1902 were contributed in NIVT conducted during *rabi* 2019-20 under AICRP on Maize. Both IPCH 1901 and IPCH1902 were promoted from NIVT to AVT-I; IPCH1901 was promoted for four (except peninsular zone) out of five zones whereas IPCH 1902 was promoted across all the five zones based on the superiority over the best check entry VL Amber popcorn. The per cent superiority of the entries over the best check varied from 5 to 50% (Table 1.22).

**Table 1.22: The yield (q/ha) performance of popcorn entries in NIVT across zones**

Entry Name	NHZ	Sup. (%)		R	Sup. (%)		R	Sup. (%)		R	Sup. (%)		R	Sup. (%)		R
		R	NWPZ		R	NEPZ		R	PZ		R	CWZ		R		
IPCH 1901	58.8	13	2	54.5	9	3	50.0	22	2	33.1	4	48.8	3	32	2	
IPCH 1902	67.0	29	1	57.2	14	2	52.1	27	1	37.8	19	55.9	1	51	1	
Shalimar Popcorn (C)	50.5	-	5	53.6	-	4	49.3	-	3	34.5	-	48.1	2	-	6	
VL Amber Popcorn (C)	52.0	-	4	49.9	-	5	40.8	-	6	31.7	-	36.9	5	-	3	

R: Rank

### Breeding for baby corn

#### Diversification

For diversification and derivation of new baby corn inbred lines, a total of 82 new inbred lines have been derived through selfing of single and double cross hybrids. Among the newly derived inbred lines, one genotype IBCL 36 showed prolificacy with 3–4 cobs per plant and another line IBCL 46 was legule less with erect leaf, the plant type which is beneficial for high density planting. To develop the CMS

based baby corn hybrid, advanced backcross generations were developed such as three families to BC<sub>4</sub> generation, 10 families to BC<sub>3</sub> stage, 15 families to BC<sub>2</sub> generation and five families to BC<sub>1</sub> generation (Figure 1.16). Further, 54 new test crosses were made between G 5417 and inbred lines to classify them into maintainer line (B) and restorer line (R) which were evaluated during *kharif* 2020. Based on the tassel morphology in the field, 14 inbred lines were classified as B lines and 16 lines as R, whereas 24 lines showed partial fertility (Figure 1.17).



**Figure 1.16: One cross (G 5414 × IMR 284) at BC<sub>4</sub> stage, showing complete sterility**

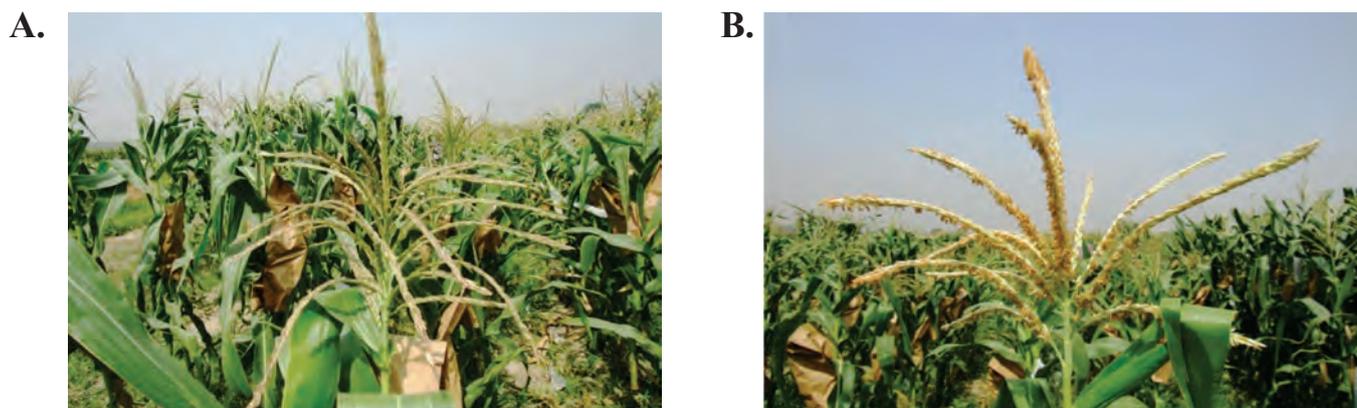


Figure 1.17: Completely sterile (A) and fertile tassel (B) morphology in the field

#### Heterotic grouping of baby corn inbred lines

A set of 26 inbred lines were crossed with two testers, viz., HKI 1105 and HKI 323 to understand the behavior of inbred lines and testers concerning general and specific combining ability. The testcrosses were evaluated in RCBD along with two checks at Ladhawal farm, Ludhiana during *kharif* 2020. Based on the specific combining ability, a total of 26 baby corn inbred lines were classified into two groups, viz., A (HKI 323) and B (HKI 1105). Among the 26 lines, 12 genotypes were classified in group A and 14 in group B. The heterotic grouping information is summarized in (Table 1.23). Further, the 7 common lines among the 26 were also crossed with LM 13 and LM 14. It was observed that five lines which were classified in group B (HKI 1105), appeared in LM 13 group and one line IBCL 20171 which belonged to group A (HKI 323) appeared in LM 14 group. Hence, the lines forming the HKI 1105 group are also appearing to LM 13 group and the line forming the HKI 323 group appearing in LM 14 group with one exception, as one line IBCL 201712 showed the opposite heterotic pattern and grouped as B instead of A group.

#### Fodder maize breeding

##### Pre-breeding for yield enhancement and climate resilience maize using wild species

The different accessions of wild species including *Z. mexicana*, *Z. luxurians*, *Z. diploperennis*, *Z. nicaraguensis* and *Z. parviglumis* have been collected (Figure 1.18). The parental lines of PHM 1 hybrid (LM 13 and LM 14) was

Table 1.23: Heterotic grouping of baby corn lines

Sl.No.	Group A	Group B
1.	IBCL 20171 (LM 14)	IBCL 20172
2.	IBCL 20175	IBCL 20173
3.	IBCL 201710	IBCL 20174 (LM 13)
4.	IBCL 201712	IBCL 20176
5.	IBCL 201714	IBCL 20177 (LM 13)
6.	IBCL 201715	IBCL 20178
7.	IBCL 201718	IBCL 20179
8.	IBCL 201719	IBCL 201711 (LM 13)
9.	IBCL 201720	IBCL 201713 (LM 13)
10.	IBCL 201721	IBCL 201716
11.	IBCL 201723	IBCL 201717
12.	IBCL 201724	IBCL 201722
13.	-	IBCL 201725 (LM 13)
14.	-	IBCL 201726

crossed with *Z. parviglumis* for developing BC<sub>2</sub>F<sub>2</sub> population through backcrossing and selfing (Figure 1.19). Two BC<sub>2</sub>F<sub>1</sub> populations with 156 and 155 individuals, respectively have been derived from the crosses of wild species with LM 13 and LM 14 which are being further advanced.



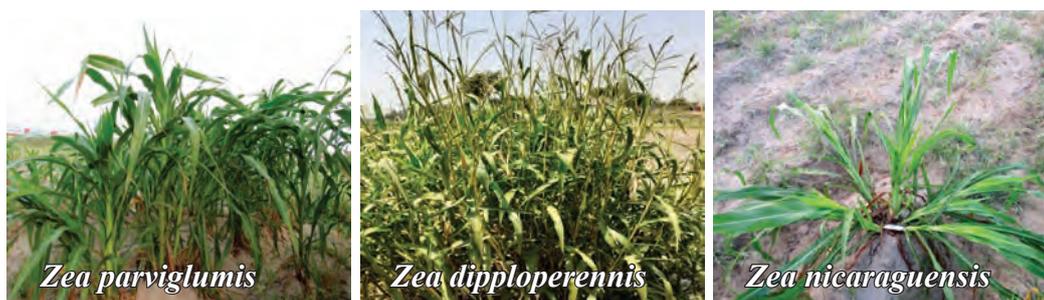


Figure 1.18: Appearance of wild maize accessions in the field

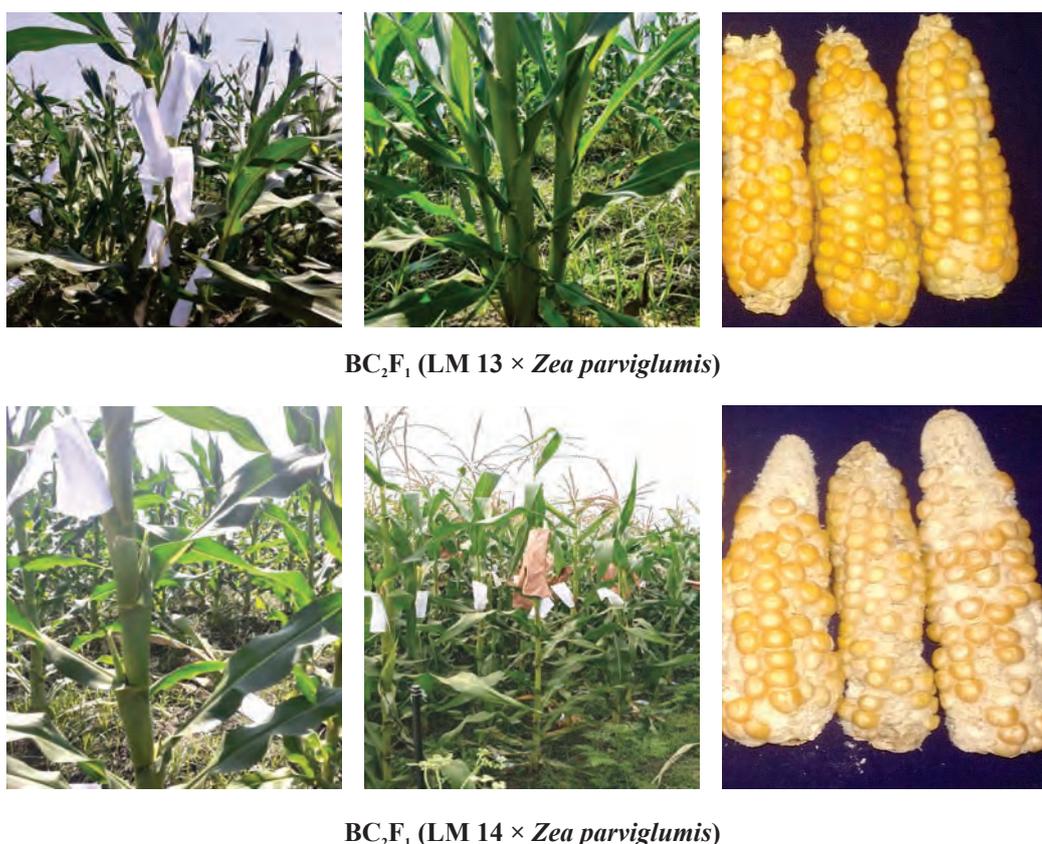


Figure 1.19: BC<sub>2</sub>F<sub>1</sub> populations derived from wild crosses involving LM 13 and LM 14

#### Population evaluation for green fodder yield (GFY)

The 28 populations were evaluated in RCBD design, each of the populations were sown in five rows of four meter length with two checks, viz., J1006 and African tall. Among the 28 populations, none of the populations were statistically superior over the African tall for GFY (Table 1.24). However, five populations were found at par with the J1006, which need to be evaluated for one more year.

#### Heterotic grouping of fodder inbred lines

Total 28 fodder inbred lines were crossed with LM 13 and LM 14 to classify into two heterotic groups based on the specific combing ability for green fodder yield. The F<sub>1</sub> derived from the line × tester between fodder inbred line and two testers were grown in *kharif* 2020 and green fodder yield recorded at

Table 1.24: Comparison of maize populations for GFY with J 1006

Sl. No.	Populations	GFY (q/ha)	Superiority (%) over J1006
1.	IMFP 8	60.07	22.63
2.	IMFP 9	59.93	22.34
3.	IMFP 12	52.67	7.52
4.	IMFP 14	58.80	20.04
5.	J1006 (C)	48.98	-
	CV (%)	18.12	-
	LSD (5%)	16.54	-

50% anthesis. Based on the specific combing ability (SCA) data of green fodder yield, the 28 inbred lines were classified into two heterotic groups (Table 1.25). Hence, 16 lines came under group A of LM 13 and 12 lines into group B of LM 14. This heterotic grouping will help to further to develop the promising silage maize hybrids and fodder composites.

### Germplasm screening for abiotic stress

#### Impact of pre-flowering cold stress on rabi maize sown at different time

Twenty five hybrids including 14 private, one public and ten advance stage experimental hybrids during rabi 2018-19 and 35 hybrids consisting of 13 private, five public and 17 advanced stage experimental hybrids in rabi 2019-20 were evaluated to study the relationship of sowing date and cold stress on growth, reproduction and yield on rabi maize in Bihar. Fifteen hybrids were common in 2018-19 and 2019-20. The trials were conducted in RBD with two replications and sowing was done at five different dates, viz., October 25, November 5, November 15, November 25 and December 25 in both the years. Observations were recorded on 15 morphological and yield traits. Daily minimum and maximum temperatures were also recorded. These hybrids showed variable response for grain yield sown on different dates of planting. Average yield of these hybrids on five dates of planting and average across year and planting dates is given in (Table 1.26). Based on pooled mean yield performance, it was observed that trials sown on the November 5, reported the highest mean yield (104 q/ha), whereas trial laid on November 25 showed the lowest mean yield (70.7 q/ha). The crop sown on October 25 recorded lower yield (89.6 q/ha) than crops sown on November 5 which might be due cold stress at both vegetative and reproductive stages. The crop sown on December 25 managed to recover well after winter and resulted in almost comparable yield with crop sown on October 25. The planting of November 5 took maximum number of days to anthesis and maturity leading to the highest

Table 1.25: Heterotic grouping of fodder inbred lines

Sl. No.	Group A (LM 13)	Sl. No.	Group B (LM 14)
1.	MCFL 400	1.	MCFL385
2.	MCFL 296	2.	MCFL298
3.	MCFL 395	3.	MCFL402
4.	MCFL 280	4.	MCFL403
5.	MCFL 404	5.	MCFL335
6.	MCFL 292	6.	MCFL388
7.	MCFL 398	7.	MCFL322
8.	MCFL 210	8.	MCFL380
9.	MCFL 218	9.	MCFL110
10.	MCFL 379	10.	MCFL221
11.	MCFL 390	11.	MCFL308
12.	MCFL 240	12.	MCFL263
13.	MCFL 396		
14.	MCFL 384		
15.	MCFL 165		
16.	MCFL 119		

yield. The planting of October 25 coincides with the lowest temperature (8.5°C) during anthesis might have affected yield (Figure 1.20). The planting of November 15 and November 25 was affected by cold temperature during growth and developmental stages up to knee high stage although temperature during anthesis was at par for both November 5 and 25 plantings. The study indicated that planting of maize on November 5 resulted in the highest yield and most suitable for the rabi maize plant in Bihar.

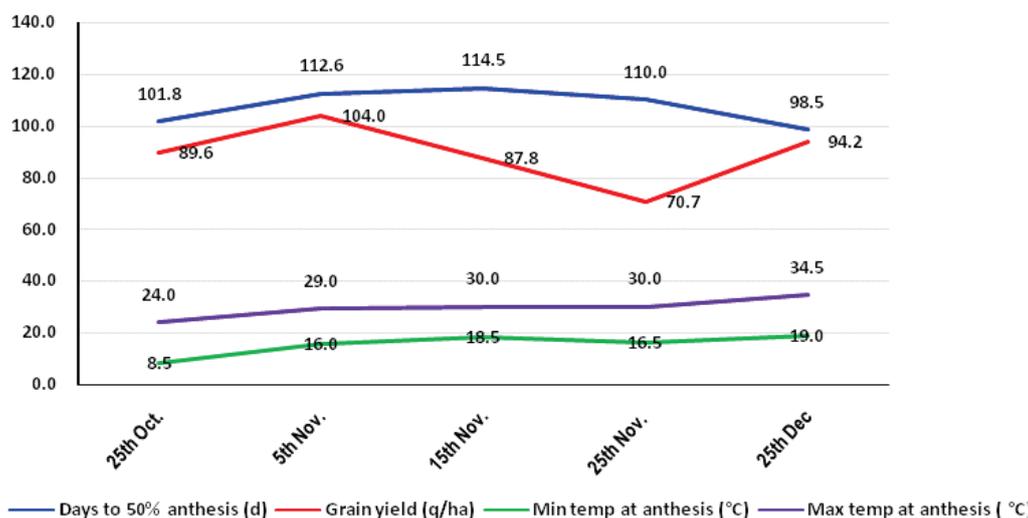


Figure 1.20: Effect of cold temperature at the pre-flowering stage and on grain yield in maize

**Table 1.26: Average yield of hybrids over years as influenced by different planting dates during *rabi* season in Bihar**

Sl. No.	Name of hybrid	Average grain yield (q/ha) over years					Mean
		Oct.25	Nov. 5	Nov. 15	Nov. 25	Dec. 25	
1.	900 MG GOLD	115.0	126.0	119.0	77.0	114.0	110.0
2.	CP 838	99.0	135.0	114.0	80.0	108.0	107.0
3.	P 3522	100.0	106.0	110.0	86.0	133.0	107.0
4.	IMLSB 1299-5 × BML 7	98.0	109.0	110.0	96.0	117.0	106.0
5.	IMLSB 83-1 × IMLSB 388-1	93.0	107.0	104.0	89.0	125.0	103.0
6.	IMLSB 406-2 × BML 6	96.0	96.0	117.0	74.0	124.0	101.0
7.	P 3355	100.0	119.0	96.0	84.0	103.0	100.0
8.	DKC 9081	104.0	119.0	92.0	66.0	108.0	98.0
9.	P 3535	98.0	132.0	88.0	72.0	86.0	95.0
10.	Syngenta 7720	93.0	138.0	74.0	70.0	100.0	95.0
11.	IMLSB 457-2 × IMLSB 1299-5	92.0	97.0	77.0	87.0	96.0	90.0
12.	IMLSB 343-3 × IMLSB 1299-5	86.0	112.0	82.0	68.0	91.0	88.0
13.	Kaveri 50	80.0	104.0	84.0	65.0	87.0	84.0
14.	P 3396	69.0	102.0	79.0	47.0	81.0	76.0
15.	IMLSB 164-1 × BML 7	79.0	96.0	69.0	48.0	78.0	74.0
16.	IMLSB 388-1 × IMLSB 310-1	62.0	66.0	52.0	47.0	67.0	59.0
	<b>Mean</b>	92.0	110.0	92.0	72.0	101.0	93.0
	<b>CV (%)</b>	97.2	147.9	177.8	193.3	184.8	
	<b>LSD (5%)</b>	18.2	33.2	33.3	28.5	36.2	

**Evaluation of experimental hybrids under cold stress during *rabi* 2019-20 at ICAR-IIMR, Ludhiana**

In another set of experiment, a set of 137 experimental crosses developed through diallel fashion (100) and few selected crosses (37) of medium and late maturity along with five checks were expose to cold stress at initial growth and pre-flowering stages under field conditional ICAR-IIMR, Ludhiana during *rabi* 2019-20. The experiment was sown on November 21, 2019. Two crosses could not germinate due to

cold stress. Only 14 crosses of medium maturity were superior to the best medium maturity check (P 3396). Out of these, three cross combinations, viz., IMLSB 274-1 × CMG240, IMLSB 207-2 × IMLSB 976-2 and IMLSB 571-2 × IMLSB 406-2 out yielded the best check (P 3396) by 18.2, 14.4 and 14.0%, respectively (**Table 1.27**). In late maturity duration, none of the crosses were superior to best late maturity check (P3522).

**Table 1.27: Performance of experimental hybrids under cold stress in field conditions during *rabi* 2019-20 at ICAR-IIMR, Ludhiana**

Sl. No.	Entry No.	Pedigree	DTA	DTS	DTM	PH (cm)	GY (q/ha)*	Sup. (%)
1.	D 19R-30	IMLSB 274-1 × CMG 240	144	145	186	157.5	111.7	18.2
2.	D 19R-25	IMLSB 207-2 × IMLSB 976-2	144	144	183	163.8	108.1	14.4
3.	D 19R-50	IMLSB 571-2 × IMLSB 406-2	150	150	190	153.8	107.7	14.0
4.	D 19R-57	IMLSB 801-1 × IMLSB 1299-5	150	150	186	156.3	102.4	8.4
5.	D 19R-87	BML 15 × IMLSB 457-2	149	149	185	168.8	100.1	6.0

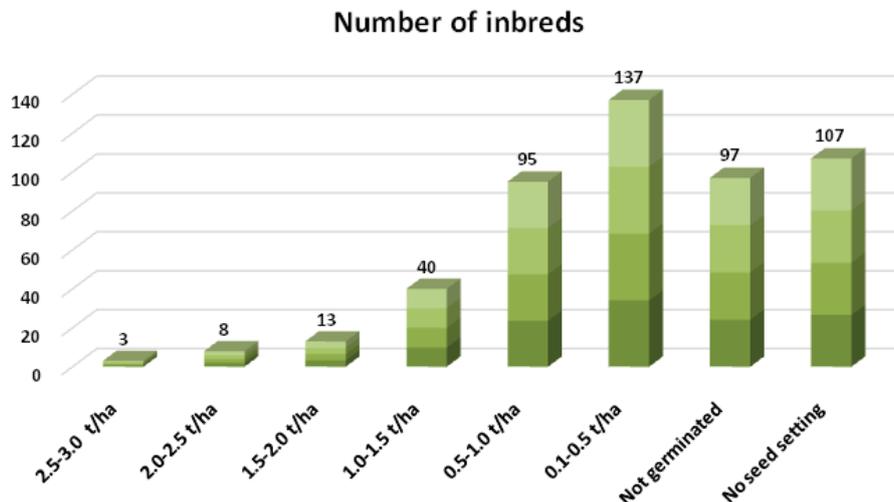
Sl. No.	Entry No.	Pedigree	DTA	DTS	DTM	PH (cm)	GY (q/ha)*	Sup. (%)
6.	D 19R-52	IMLSB 571-2 × WNC 40109	152	152	191	145.0	98.6	4.3
7.	D 19R-54	IMLSB 617-1 × IMLSB 406-2	147	147	187	142.5	98.0	3.7
8.	D 19R-19	IMLSB 196-1 × IMLSB 388-1	145	145	184	146.3	97.4	3.1
9.	D 19R-39	IMLSB 406-1 × IMLSB 883-1	151	151	187	163.8	97.4	3.1
10.	D 19R-9	IMLSB 83-1 × IMLSB 388-1	142	143	183	166.3	97.1	2.7
11.	D 19R-58	IMLSB 801-1 × IMLSB 1298-6	151	151	186	173.8	96.6	2.3
12.	D 19R-32	IMLSB 342-1 × IMLSB976-2	148	148	184	158.3	96.1	1.7
13.	D 19R-139	WNC 32864 × IMLSB 435-2	142	143	182	142.5	95.7	1.3
14.	D 19R-63	IMLSB 883-1 × IMLSB 388-1	146	147	183	162.5	95.2	0.8
15.	D 19R-60	P 3396 (C)	151	151	186	176.3	94.5	0.0
16.	D 19R-40	PAC 751 (C)	151	151	187	171.3	89.4	-
17.	D 19R-120	DMRH 1301 (C)	151	151	182	167.5	86.7	-
<b>Mean</b>			<b>146.1</b>	<b>146.2</b>	<b>184.1</b>	<b>148.1</b>	<b>67.2</b>	<b>-</b>
<b>CV (%)</b>			<b>7.0</b>	<b>7.4</b>	<b>5.8</b>	<b>10.8</b>	<b>14.8</b>	<b>-</b>
<b>LSD (5%)</b>			<b>4.6</b>	<b>6.2</b>	<b>5.4</b>	<b>6.9</b>	<b>4.8</b>	<b>-</b>

\* Yield at 80% shelling, DTA: Days to anthesis, DTS: Days to silking, DTM: Days to maturity, PH: Plant height, GY: Grain yield, Sup (%): Superiority over best check, C= Check

### Evaluation of maize inbred lines under cold stress during rabi 2019-20

A set of 500 inbred lines including 20 parental lines of public bred commercial hybrids were evaluated against cold stress at initial growth and pre-flowering stages during rabi 2019-20 at ICAR-IIMR, Ludhiana. Out of 500 inbred lines, 97 failed to germinate due to cold stress and there was no seed set in 107 genotypes. Based on the initial and final plant stand, survival percentage for each genotype ranged from 5 to 100%. The

maximum yield was obtained by inbred IMLSB 250-2 (27.0 q/ha). The inbred lines were grouped based on their yield performance (**Figure 1.21**). The top 11 inbred lines which recorded yield between 20.0 to 30.0 q/ha were IMLSB 250-2, CMG 155, IMLSB 2004, IMLSB 274-1, IMLSB 671-2, IMLSB 885-2, IMLSB 1296-1, IMLSB 509-2, IMLSB 733-1, IMLSB 428-2 and IMLSB 268-1. The top 20 genotypes were selected for further utilization in the breeding program to improve the cold stress tolerance of maize germplasm.



**Figure 1.21: Grouping of inbred lines based on their performance under cold stress in field condition**

In another set of experiment, a trial comprising of 350 inbred lines was conducted during *rabi* 2019-20 at Ludhiana. However, only 167 genotypes could survive the cold stress and high variation for plant stand was also observed among these inbred lines (4 to 98%). The genotypes were classified into four categories based on plant stand i.e. 125 genotypes with 1 to 25%, 31 genotypes with 26 to 50%, 7 genotypes with 51 to 75% and four genotypes with 76 to 100% plant stand. These four genotypes with highest plant stand were 11148-CM 141-1-2-1-2-1-1-2-1-2-1-2, 11059-CM 500, 11446-200-4 and 11086-Pale yellow grains-2-1-1-2-1-1 with 98%, 86%, 80% and 78% plant stand, respectively (**Table 1.28**). The maturity period among the genotypes varied from 173 to 189 days. Among these 167 inbred lines, seed setting was observed in 143 genotypes. The grain yield varied from 0.18 to 32.31 q/ha. The genotypes were classified into 6 different classes based on grain yield and 17, 68, 21, 21 and five number of genotypes recorded grain yield in the range of 0.18 to 1.00 q/ha, 1.01 to 5.0 q/ha, 5.01 to 10.0 q/ha, 10.01 to 20.0 q/ha, 2.001 to 30.0 q/ha and >30.0 q/ha, respectively. Grain yield per plant varied from 1 to 194 gm with 1 to 25 gm in 49 genotypes, 26 to 50 gm

in 55 genotypes, 51 to 100gm in 32 genotypes and 101 to 200gm in 7 genotypes. The promising inbred lines with higher yield per plant were 11087-Pale yellow grains-2-1-1-2-1-2 (194gm), 11577-825-10309 pool.2-2-1 (128 gm), 11103-(6-Mixture purple)-3-1-1-1-2-2 and 11020-CML 389-1-1-1-1-1-3-1-1 (114 gm), 11160-PFSR (Y)-C1-A-A1-2-3-1 (108 gm), 11098-(6-Mixture purple)-2-2-1-1-1-2 (106 gm), 11032-CML 342-1-1-1-1-1-1-1-2 (101 gm) and 11361-Hey pool 2011-55-3-2-1-2-2 (100 gm). Shelling out turn ranged from 19 to 88%. The genotypes with >80% shelling out turn were 11273-805-10309 pool.1-4, 11081-(6-Mixture purple)-1-1-3-2-1-1, 11187-Indimyt-300-A (B gr. Ycol.)-1-1, 11361-Hey pool 2011-55-3-2-1-2-2, 11529-141167-2-PP-25-3-2-1, 11036-CML 433-2-1-1-3-2-1, 11053-PFSR(Y)-C0-2-1-1-2-1-2-1-2-2, 11310-842-C2 pool-4, 11087- Pale yellow grains-2-1-1-2-1-2, 11090-Yellow (1-Y Cob S3)-3-2-2-1-1-1, 11077-CM 500, 11103-(6-Mixture purple)-3-1-1-1-2-2, and 11213-Hey Pool-2011-5-6-1-1-1, 11032-CML 342-1-1-1-1-1-1-1-2, 11099-(6-Mixture purple)-2-2-1-2-1-2, 11302-837-C2 pool-2 and 11582-847-chain crossing. 6-1-1.

**Table 1.28: Promising genotypes for grain yield under cold stress during *rabi* 2019-20 at Ludhiana**

SI. No.	Entry Code	Pedigree	DTM	Plant stand (%)	SP (%)	GY (q/ha)	Yield/plant (gm)
1.	11059	CM 500	179	86	75	32.3	49
2.	11086	Pale yellow grains -2-1-1-2-1-1	182	78	75	29.9	50
3.	11157	PFSR (Y)-C1-A-B1-3-1-1	186	40	73	27.5	92
4.	11114	PFSR (Y) pink heart-2-1-3-1-1	179	36	75	25.9	94
5.	11357	[(ELPJB10/E121022)BIO9544]-4-2-1-1-1	185	66	70	24.1	65
6.	11275	799-10309 pool.1-3	181	46	66	20.5	62
7.	11148	CM 141-1-2-1-2-1-1-2-1-2-1-2	184	98	71	19.6	26
8.	11199	HP11-1-14-5-2-6--1	181	44	69	19.4	50
9.	11088	Pale yellow grains -2-1-1-2-2-1	180	68	66	18.4	40
10.	11622	[(E13089/V373)VH43]-1-1-2-1-1	180	38	75	17.8	61

#### *Evaluation of experimental maize hybrids under water-logging stress*

A set of 275 experimental hybrids including crosses generated through line × tester design, diallel fashion and selected combinations of medium and late maturity duration along with five checks was evaluated in  $\alpha$ -lattice design under water-logging stress during *khari*f 2020 at RMR&SPC, Begusarai. The water logging treatment was given after 35 days of sowing (DAS) at the pre-flowering stage by stagnant irrigation water up to 30 cm for 7 consecutive days and thereafter the excess

water was drained out. Unfortunately, the occurrence of intermittent rains after water-logging treatment resulted in natural stagnation of water for another 21 days leading to severe excessive moisture stress. As a result in many entries very poor seed setting was observed including 115 test entries without any seed setting. Very few entries survived with low yield productivity. Twenty one experimental hybrids outperformed the best check (Bio 9544) and the highest yield (21.4 q/ha) was reported by hybrid IMHSB 20K 135 (**Table 1.29**).

**Table 1.29: Performance of experimental hybrids under water-logging stress during *rabi* 2019-20 at RMR&SPC, Begusarai**

Sl.No.	Entry Code	Pedigree	DTA	DTS	ASI	PH (cm)	GY (q/ha)	Rank
1.	IMHSB 20K-135	IMHSB 207-1×LM 13	51	56	5	117.8	21.4	1
2.	IMHSB 20K-7	IMLSB58-2 × IMLSB 428-2	50	58	8	120.7	19.4	2
3.	IMHSB 20K-14	IMLSB 114-1 × IMLSB 1062-1-2	44	50	6	113.7	18.9	3
4.	IMHSB 20K-152	IMLSB 537-2 × LM 13	51	56	5	115.8	18.3	4
5.	IMHSB 20K-206	IMLSB 219-2 × LM 14	48	52	4	106.7	16.7	5
6.	IMHSB 20K-84	IMLSB 1210 × BML 7	48	53	5	119.8	16.1	6
7.	IMHSB 20K-144	IMLSB 376-2 × LM 13	51	56	5	98.3	15.8	7
8.	IMHSB 20K-71	IMLSB 883-1 × CMG 240	49	54	5	126.7	15.6	8
9.	IMHSB 20K-67	IMLSB 801-1 × IMLSB 1299-5	53	57	4	97.8	15.0	9
10.	IMHSB 20K-122	IMLSB 30-1 × LM 13	49	53	4	106.0	14.7	10
11.	IMHSB 20K-2	IMLSB 43-2 × HKI 1128	51	57	6	90.5	13.9	11
12.	IMHSB 20K-27	IMLSB 207-2 × IMLSB 457-2	54	60	6	93.3	13.5	12
13.	IMHSB 20K-70	IMLSB 883-1 × IMLSB 207-2	50	55	5	121.2	13.3	13
14.	IMHSB 20K-90	IMLSB 1298-8 × BML 7	53	57	5	107.3	13.1	14
15.	IMHSB 20K-273	EI 670 × LM 14	52	57	5	107.0	12.5	15
16.	IMHSB 20K-246	IMLSB 1292-1 × LM 14	49	55	6	106.3	12.2	16
17.	IMHSB 20K-95	IMLSB 1299-5 × IMLSB 406-1	47	52	5	121.7	11.7	17
18.	IMHSB 20K-165	IMLSB 1062-1-2 × LM 13	52	57	5	127.7	11.4	18
19.	IMHSB 20K-51	IMLSB 406-2 × IMLSB 883-1	49	58	9	119.2	11.1	19
20.	IMHSB 20K-169	IMLSB 1260 × LM 13	49	54	5	136.7	11.1	20
21.	IMHSB 20K-56	IMLSB 428 × IMLSB 1062-1-2	48	52	4	115.5	10.8	21
22.	BIO 9544(C)		57	64	7	67.3	10.8	-
23.	DKC 7074 (C)		53	57	4	96.7	9.4	-
24.	DHM 121 (C)		57	62	5	77.5	8.9	-
25.	NK 6240 (C)		50	54	4	130.0	7.5	-
26.	CHM 08-287 (C)		53	59	6	60.0	6.7	-
		<b>Mean</b>	54.0	59.0	3.4	107.0	5.8	-
		<b>CV (%)</b>	10.8	12.8	14.5	13.4	28.8	-
		<b>LSD (5%)</b>	4.2	5.6	3.8	14.8	10.7	-

C: Check

## Breeding for quality traits

### Lysine and tryptophan

#### Development and identification of lysine rich germplasm

A set of 115 newly developed QPM inbred lines were analyzed for protein and tryptophan content. The most promising lines are given below in the (Table 1.30). DQL 2760 and DQL 2702 were identified as most promising as they have recorded high protein(10.7 and 10.0, respectively) as well as tryptophan content(1.0 and 0.9, respectively).

#### Yield performance of QPM genotypes

During the reporting period 30 inbred lines were evaluated along with two checks (DQL 2192 and HKI 163) to assess their *per se* performance. The experiment was planted in RBD with two replications at Ludhiana during *kharif* 2020. Out of 30 inbred lines, ten inbred lines outperformed the best check inbred lines (DQL 2192). The detailed performance of the genotypes for grain yield, days to anthesis (DTA) and days to silking (DTS) is given in the (Table 1.31).

**Table 1.30: List of QPM genotypes with higher protein and tryptophan content**

Sl. No.	Protein (%)	Trp. (% protein)	Sl. No.	Protein (%)	Trp. (% protein)
1.	8.0	1.1	15.	7.2	1.0
2.	7.2	1.1	16.	7.5	0.9
3.	9.2	1.1	17.	9.5	0.9
4.	5.3	1.0	18.	9.1	0.9
5.	10.7	1.0	19.	7.1	0.9
6.	8.0	1.0	20.	6.9	0.9
7.	7.2	1.0	21.	7.8	0.9
8.	8.3	1.0	22.	10.0	0.9
9.	8.4	1.0	23.	8.3	0.9
10.	7.0	1.0	24.	7.6	0.9
11.	7.2	1.0	25.	5.8	0.8
12.	7.2	1.0	26.	6.5	0.8
13.	8.5	1.0	27.	8.0	1.1
14.	11.0	1.0			

Trp.: Tryptophan

**Table 1.31: Promising QPM lines identified during *kharif* 2020**

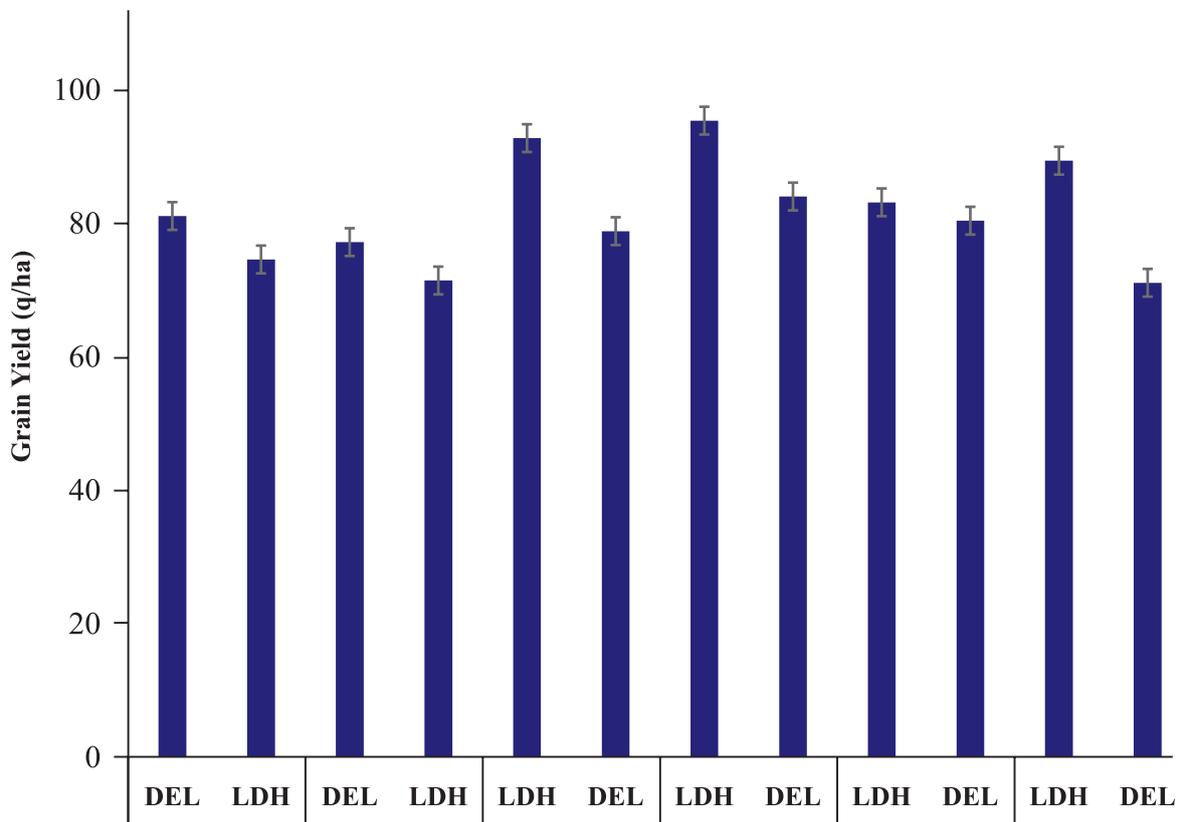
Sl. No.	Name	DTA	DTS	GY (q/ha)	Sl. No.	Name	DTA	DTS	GY (q/ha)
1.	DQL 2327	53.0	54.0	30.8	19.	DQL 2661	52.5	53.5	24.4
2.	DQL 2325	50.5	50.5	31.0	20.	DQL 2572	52.5	54.0	23.1
3.	DQL 2167-2	47.5	48.5	31.0	21.	DQL 2004-1-3-2-1	57.0	56.5	25.5
4.	DQL 2306-1	54.0	53.5	27.5	22.	DQL 2474	52.5	54.5	22.3
5.	DQL 2491	49.5	52.0	25.0	23.	DQL 2334	60.5	62.5	26.5
6.	DQL 2646	52.5	52.5	23.4	24.	DQL 2780	64.0	62.0	26.0
7.	DQL 2604	53.5	53.5	27.0	25.	DQL 2057	50.0	49.5	26.2
8.	DQL 2513	53.0	54.5	28.4	26.	DQL 2293-3	57.0	57.0	25.9
9.	DQL 2650	52.5	53.5	27.1	27.	DQL 2647	55.5	55.5	20.8
10.	DQL 2571	52.5	53.5	24.6	28.	DQL 2192-5	56.5	57.5	25.8
11.	DQL 2471	54.5	56.0	21.1	29.	DQL 2230-2-1	51.5	54.0	25.1
12.	DQL 2491-1	51.0	53.0	25.5	30.	CLQRCY 40 C4	52.0	52.0	25.2
13.	DQL 2230	53.0	54.5	26.1	31.	DQL 2192(C)	58.5	59.5	24.4
14.	DQL 2561	49.0	50.0	20.8	32.	HKI 163(C)	<b>62.0</b>	<b>63.5</b>	<b>22.4</b>
15.	DQL 2487-1	52.0	53.5	26.1		<b>CV (%)</b>	<b>3.2</b>	<b>3.2</b>	<b>13.6</b>
16.	DQL 2358-1	51.5	52.0	24.7		<b>LSD (5%)</b>	<b>3.5</b>	<b>3.6</b>	<b>7.0</b>
17.	DQL 2324	53.5	53.5	24.0					
18.	DQL 2519	52.5	53.5	19.0					

DTA: Days to anthesis, DTS: Days to silking, GY: Grain yield, C: Check

**Enhanced pro-vitamin A and reduced phytic acid in QPM background**

The near isogenic lines (NILs) developed for LM 13, LM 19, LM 14 and LM 17 through marker assisted selection carrying the favourable allele, viz., *opaque2*, *crtRB1* and *lpa2* were evaluated for agronomic and biochemical performance. Favourable allele of *opaque2*, *crtRB1* and *lpa2* are responsible for conferring higher lysine and tryptophan, increased

provitamin A and reduced phytic acid in maize kernel. Based on the evaluation data 3–4 best NILs were selected and the experimental crosses using NILs of LM 13 and LM 19, and LM 14 and LM 17 were also made. The reconstituted hybrids were evaluated at two locations namely New Delhi and Ludhiana. The evaluation of hybrids could identify some cross combinations comparable with the original hybrids (**Figure 1.22**).



**Figure 1.22: Performance of MAS derived hybrids at Delhi (DEL) and Ludhiana (LDH)**





*ICAR-IIMR Maize Hybrid DMRH 1301*

## *Basic Sciences*



*Plants regenerated from tissue culture growing in greenhouse*

## BASIC SCIENCES



### Evaluation of starch profile

During the period, 81 genotypes consisting mostly of inbreds were evaluated for starch profile, viz., content of starch, amylose and amylopectin. Wide variability was observed in the starch content. The average starch content was found to be 59.0%, indicating that inbreds are generally low in the total starch. However, the amylose content ranged from 20.6% (ADBG 0018) to 31.03% (R-19 ADBG 0013), indicating the non-availability of natural variation for amylose in the available maize germplasm.

### Evaluation of protein quality

Under QPM breeding program, 115 newly developed lines were evaluated for protein quality. A total of 50 lines possess more than 0.6% of tryptophan. However, a wide variability has been observed in protein content ranging from 5.25 (DQL 2752) to 12.52% (DQL 2757). Only 34 out of 115 lines possessed more than 9.0% protein. Based on the protein quality index including protein quality, protein quantity and 100 kernel weight, a set of ten most promising lines (Table 2.1) were selected.

Another set of 20 lines converted to QPM through marker-assisted selection (MAS) were also analyzed for protein quality. The data shows that all the lines (except one) possessed the desired protein quality (Table 2.2).

### Evaluation of coloured maize germplasm

The germplasm of coloured maize was imported from various sources globally (Figure 2.1). These were sown in spring 2020 and *kharif* 2020. The seeds were harvested at the maturity stage and analyzed for anthocyanin, phenolic and flavonoid content. Five accessions (NSL 165817, PI 503566, PI 213799, Ames 22778, PI 608649) were identified with high total anthocyanin content. The total phenolic content ranged from 2.6 to 24.4 mg/g and flavonoid content ranged from 0.1 to 6.5 mg/g of selected color maize germplasm (Table 2.3). Selected coloured silk samples of 46 maize lines were analyzed for anthocyanin content, but found to be very less in the range of 30.0 to 330.0 µg/g on fresh weight basis. An experiment trial on the effect of metal ions on the content and stability of anthocyanins was carried out. In comparison to control, samples from metal ion fertigated soil showed better anthocyanin retention at maturity.

**Table 2.1: Promising QPM lines identified for future use in QPM breeding**

Sl. No.	Name of line	Protein (%)	Tryptophan (% of endosperm protein)
1.	DQL 2759	10.4	0.6
2.	DQL 2685	10.0	0.7
3.	DQL 2784	9.8	0.7
4.	DQL 2686	9.9	0.8
5.	DQL 2702	10.0	0.8
6.	DQL 2754	9.1	0.9
7.	DQL 2687	9.5	0.9
8.	DQL 2684	11.0	1.0
9.	DQL 2760	10.7	1.0
10.	DQL 2700	9.2	1.1

**Table 2.2: Quality parameters of MAS-derived QPM lines**

Sl. No.	Name of line	Protein (%)	Tryptophan (% of endosperm protein)
1	K-20LM-17Q-5MB-18	7.5	0.5
2	K-20LM-17Q-4MB-137	9.2	0.6
3	K-20LM-19Q-1MB-1	9.2	0.6
4	K-20DQL2320	11.1	0.7
5	K-20LM-13Q-6MB-67	9.1	0.7
6	K-20LM-13Q-6MB-76	8.5	0.9
7	K-20LM-17Q-1MB-14	9.7	0.9
8	K-20LM-13Q-3MB-122	10.3	1.0
9	K-20LM-17Q-2MB-107	7.4	1.0
10	K-20LM-17Q-1MB-12	6.5	1.0
11	K-20LM-13Q-2MB-46	8.4	1.0
12	K-20LM-19Q-31MB-109	8.5	1.0
13	K-20LM-14Q-3MB-77	8.0	1.0
14	K-20LM-19Q-5MB-35	8.5	1.0
15	K-20LM-19Q-1MB-11	10.2	1.1
16	K-20LM-19Q-32MB-45	7.6	1.1
17	K-20LM-19Q-5MB-171	8.0	1.1
18	K-20LM-17Q-3MB-140	9.7	1.1
19	K-20LM-19Q-4MB-85	8.1	1.1
20	K-20LM-14Q-2MB-14	8.4	1.2



Figure 2.1: Colour diversity of indigenous and exotic maize germplasm

Table 2.3: Anthocyanin, phenolic and flavonoid content of coloured maize germplasm

Sl. No.	Accessions	Anthocyanin content (µg/g)	Total phenolic content (mg/g)	Total flavonoid content (mg/g)
1	Ames22778	9.8	16.8	0.07
2	Ames23683	4.2	11.5	0.3
3	Ames26959	6.4	6.8	0.2
4	NSL26565	3.6	7.0	0.5
5	NSL165817	19.7	24.4	6.5
6	NSL179253	2.4	4.6	1.1
7	PI213768	2.6	4.4	3.0
8	PI213779	6.9	8.8	0.2
9	PI213799	10.9	20.4	0.3
10	PI213811	1.7	3.3	0.3
11	PI278708	4.6	7.7	0.4
12	PI452038	5.2	13.8	0.3
13	PI476868	7.4	8.6	0.2
14	PI476869	5.8	6.7	0.3
15	PI503566	12.4	17.7	0.2
16	PI608523	2.9	6.2	0.2
17	PI608600	6.8	5.8	0.3
18	PI608649	9.4	12.5	1.4
19	IC568293	0.10	4.9	0.2
20	IC596719	0.4	2.9	0.2
21	IC447464	0.5	2.7	0.3
22	IC565889	4.1	6.1	0.2
23	IC327012	0.1	3.7	0.3
24	EC444469	6.5	9.7	0.7
25	IC565888	3.40	8.64	2.24
26	EC444469	6.41	7.82	0.13
27	North East collection 11102	8.80	18.54	0.29
28	North East collection 11099	2.93	6.24	0.26
29	North East collection 11106	2.00	5.39	0.42
30	North East collection 11586	0.80	2.64	0.11

### Establishment of a robust *in vitro* regeneration and transformation method in maize using nodal explants

Twenty eight different tropical maize genotypes were evaluated for *in vitro* callus induction and regeneration using nodal explants (split nodes). Out of these, two genotypes

demonstrated the best *in vitro* regeneration capability (Figure 2.2). The *in vitro* regeneration was repeated five times in both the genotypes with an average regeneration percentage

of 60.4% and 53.6% in DMRH1308 and DMRH1301, respectively. The regenerated plants were able to produce normal plants and cobs bearing normal kernels (Figure 2.2).

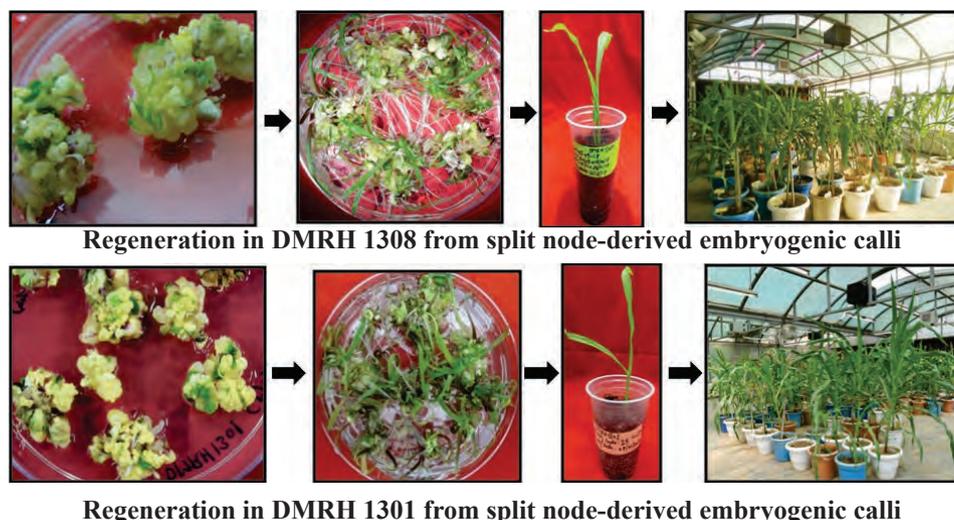


Figure 2.2: *In vitro* regeneration in DMRH 1308 and DMRH 1301 from nodal explants

Activities on optimizing genetic transformation in nodal explants derived calli using biolistic and *Agrobacterium*-mediated transformation methods have been initiated. The pDM803 (plasmid size - 8.95 Kb; containing *bar* gene imparting Basta/phosphinothricin resistance for plant selection and the *gusA* reporter gene) and pCAMBIA1301 (plasmid size - 11.84 Kb; containing hygromycin B resistance gene for plant selection and the *gusA* reporter gene) vectors are being utilized for biolistic and *Agrobacterium*-mediated transformation, respectively. Agro-infected or bombarded calli were kept in antibiotic selection to allow only the transformed cells to grow further. The histochemical assay exhibited the presence of blue spots in calli even ten days after biolistic transformation and hence indicated the expression of GUS protein ( $\beta$ -glucuronidase) within transformed cells

(Figure 2.3A). The shoot initiation was observed from a few calli transformed via biolistic method while no-shoot were initiated from calli transformed via *Agrobacterium*-mediated method. Histochemical analysis showed the presence of GUS activity in the leaf from a few putative transformants while no GUS activity was present in the leaf of the untransformed control plant (Figure 2.3B). Further, PCR analysis of putative transgenic maize plants using  $\beta$ -glucuronidase (*gusA*) specific primers confirmed the presence of expected size band (~0.9 Kb) in the plants allowed to grow throughout in 2 mg/litre Basta selection while the absence of this band in untransformed maize plant and putative transformants allowed to grow by removing selection at regeneration stage (Figure 2.3C). The efforts are underway to improve upon the transformation efficiency of nodal explants derived calli.

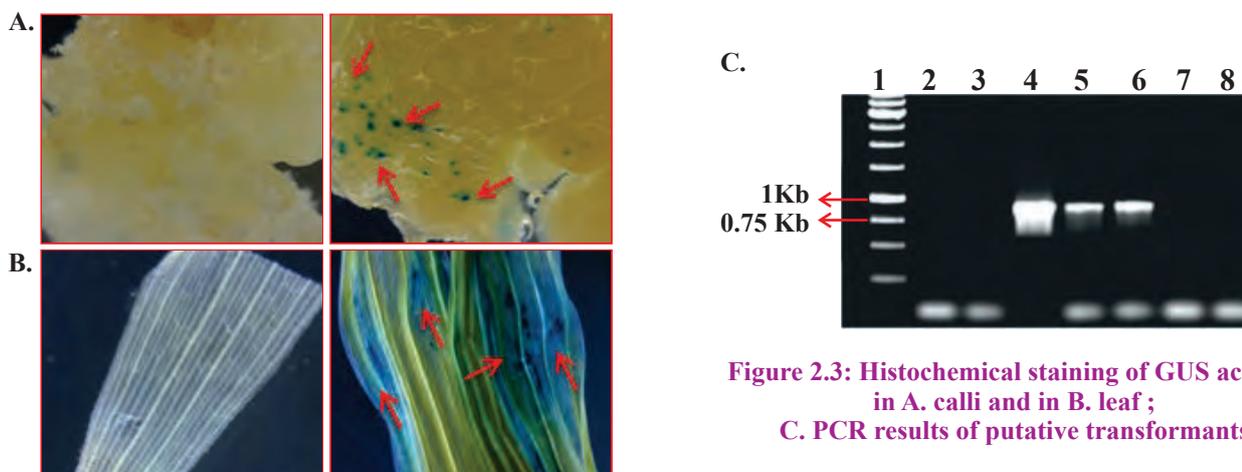


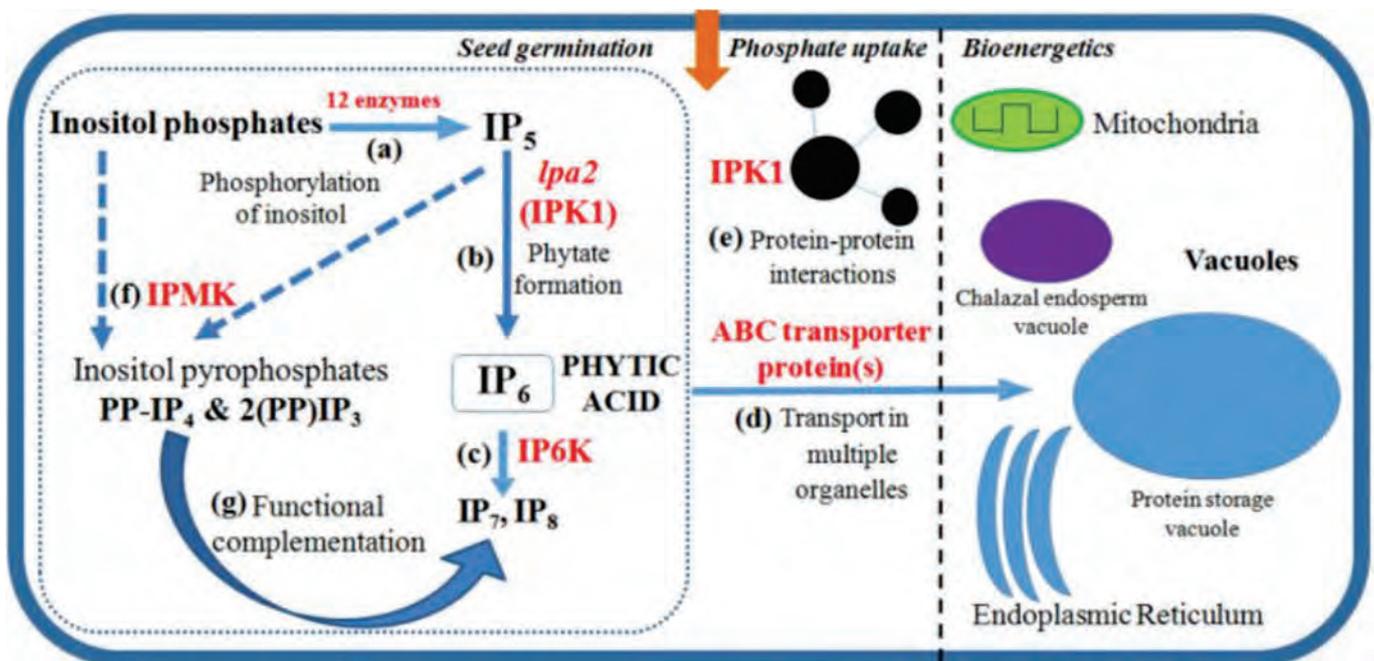
Figure 2.3: Histochemical staining of GUS activity in A. calli and in B. leaf ; C. PCR results of putative transformants

Red arrows represent the blue spots in transformed calli and leaf indicating expression of GUS protein, while no spot observed in control calli and leaf of the untransformed plant. C. PCR analysis of putative transgenic maize plants using  $\beta$ -glucuronidase (*gusA*) specific primers. The numeric number represents different wells and loading pattern in the same is as follows: 1-4 wells correspond to ladder; no template control, negative control (untransformed maize plant), positive control (plasmid), while 5-6 wells correspond to different transgenic plants allowed to grow throughout in 2 mg/litre Basta selection and 7-8 corresponds to putative transformants allowed to grow under selection at the callusing stage while without any selection at regeneration stage.

### In silico prioritization of gene target for low-phytate maize

Phytic acid is considered an anti-nutrient, which sequesters important metal ions, limiting their bioavailability. The *lpa* mutants of maize contain reduced phytate, thus increase its nutritive value. But low phytate is accompanied by negative pleiotropic effects. In many natural mutants, the expression of the encoded protein is switched off. Proteins are usually involved in interactions with many other proteins. Null expression or silencing of a protein results in disruption of protein-protein interactions and signaling or downstream metabolic networks associated with such protein-protein interactions. Disruption of protein-protein interaction networks comprises a potential reason for the diverse negative

pleiotropic effects linked with natural or engineered mutants. One possible strategy to avoid off-target effects is to mutate a protein through gene(s) editing to result in a variant that has reduced or null enzymatic activity. The edited protein would thus block the concerned metabolic reaction. However, the protein would still be fully expressing to fulfill its function of interacting with other proteins. **Figure 2.4** demonstrates the model of key components of inositol phosphate pathway. Based on metabolic routes, the conversion of Inositol-5-phosphate (I5P) to Inositol-6-phosphate (I6P) by Inositol Phosphate Kinase 1 is the best target for reducing phytate content and preventing off-target pleiotropic effects.



**Figure 2.4: A model of key components of inositol phosphate pathway involving IPK1.**

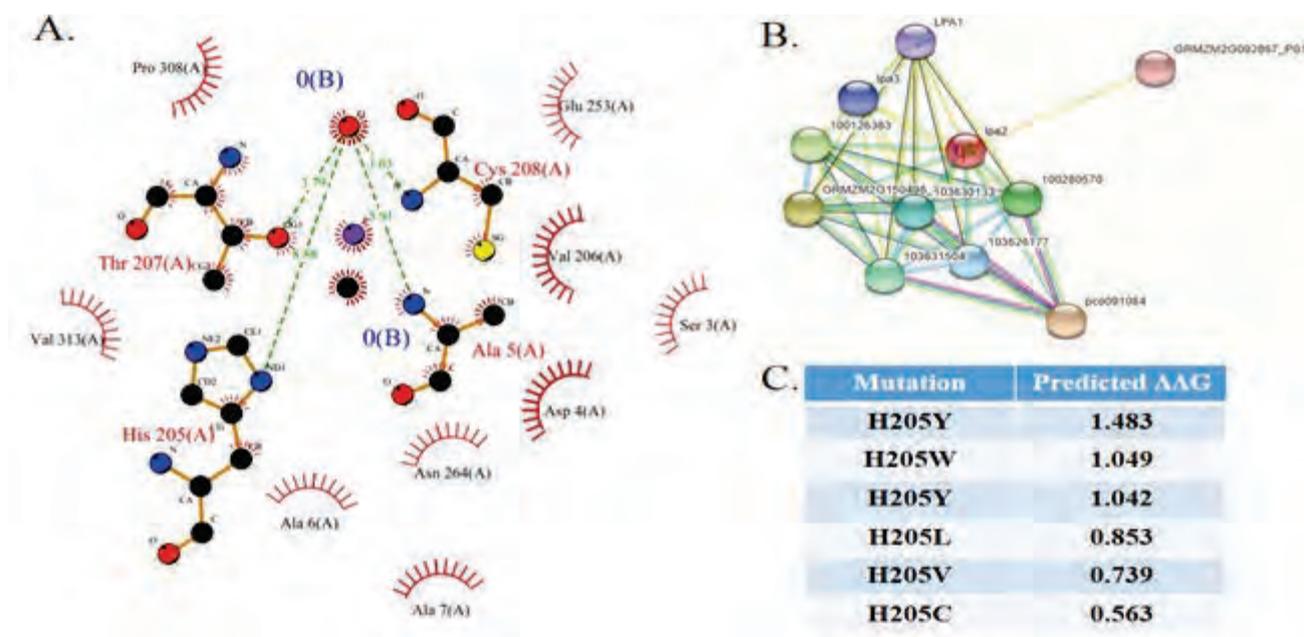
(a) *myo*-Inositol is converted to inositol phosphates, including I5P via 12 enzymes. (b) IPK1 then phosphorylates I5P to I6P or phytic acid. (c) IP6K phosphorylates phytic acid to higher forms like I7P and I8P. (d) Phytic acid is transported to different organelles via ABC transporter proteins into storage vacuole, chalazal endosperm vacuole and Endoplasmic reticulum. (e) IPK1 is involved in protein-protein interactions with other proteins, which are involved in seed germination, phosphate uptake and bioenergetics. (f) Inositol phosphate multi-kinase (IPMK) converts I5P and other inositol phosphates to inositol pyrophosphates PP-IP4 and 2(PP)-IP3. (g) Inositol pyrophosphates PP-IP4 and 2(PP)-IP3 are capable of mediating functions carried by I7P and I8P, which would not be formed in the event of absence of I6P. IPK1 itself, rather than a single transporter protein or upstream enzyme appears to be the most promising target for low-phytate maize.

In order to evaluate the prospects of minimally altering *Zea mays* IPK1, a computational model of the protein was made using PSI-BLAST (Position-Specific Iterative Basic Local Alignment Search Tool) based structure prediction. The structure was refined by side-chain repacking. The refined structure contains 13  $\alpha$ -helices and 15  $\beta$ -sheets, with 92.4% residues in Rama-favoured region and no poor rotamers. The Class (C), Architecture (A), Topology (T), superfamily (H) analysis of the modeled *Zea mays* IPK1 structure showed it to

contain the structure typically found in inositol phosphate kinases. The substrate Inositol-5-phosphate (I5P) was docked to the IPK1 model using a rigid docking algorithm, which was further refined. Both I5P and cofactor Adenosine triphosphate (ATP) bind in a cleft formed by four  $\beta$ -sheets from residues 195-202, 205-212, 278-286, 292-299 and two  $\alpha$ -helices 260-273 & 310-326. Analysis of the docked structure using showed Alanine 5, Histidine 205, Threonine 207 and Cysteine 208 closely interacting with I5P (**Figure 2.5A**). The proteins that

interact with IPK1 via protein-protein interactions include acid phosphatase, inositol-pentakisphosphate 2-kinase, inositol polyphosphate multikinase, succinate-CoA ligase, inositol 3-kinase, ABC MRP4 transporter and a metal ion binding protein (**Figure 2.5B**). Mutation of the IPK1 protein at key amino acids that result in destabilization of the protein in its active site or hinder interactions with substrate or cofactor will result in a protein, functional for protein-protein

interactions but non-functional for phytic acid formation. In the present case, Histidine 205 is implicated to be important for protein stability. Various mutations at His205 position have the potential to destabilize the protein, thereby hindering its function of phosphorylation (**Figure 2.5C**). Similarly, alanine mutants of other interacting residues have the potential to inhibit phosphorylation by IPK1.



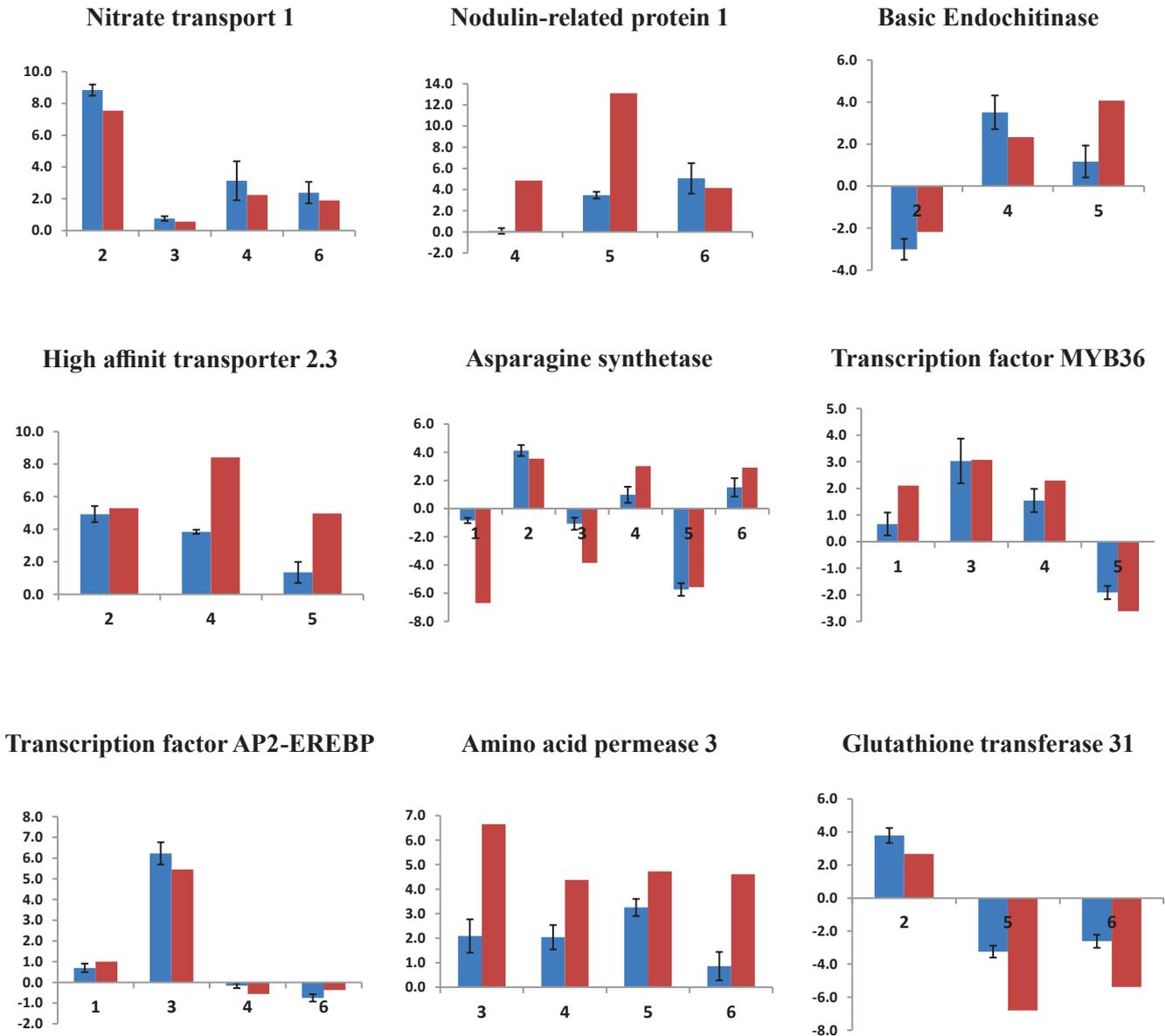
**Figure 2.5: Computational model of IPK1 with its substrate, interaction proteins and identification of key mutations for catalysis inhibition.**

A. Residue of IPK1 that interacts with substrate I5P. B. Protein-protein interactions of IPK1 indicating associated proteins, revealed by database and text mining. C. Mutations that destabilize protein at 205 position and have the potential to hinder catalytic activity.

### Validation of key differentially expressed genes (DEGs) under low nitrogen stress

Key differentially expressed genes (DEGs) identified previously via transcriptome analysis using leaf and root tissues from contrasting inbred lines, viz., DMI 56 (tolerant to nitrogen stress) and DMI 81 (susceptible to nitrogen stress) were validated by qPCR. Total RNA was isolated from frozen leaf and root samples using Spectrum™ Plant Total RNA Kit™ (Sigma). cDNA was synthesized from total RNA using PrimeScript 1st strand cDNA Synthesis Kit (Takara Bio) and stored at -20°C. The coding sequence of selected DEGs was obtained from NCBI and gene-specific qPCR primers were designed using IDT Primer designer and cross-checked by NCBI Primer-BLAST. The qPCR was performed using the real-time PCR (Agilent Technologies, USA) detection system. The PCR program was set for 40 cycles. Melting curves were analyzed and the relative fold change in gene expression was calculated using the  $2^{-\Delta\Delta Ct}$  method (Livak *et al.*, 2001). Nine

DEGs were selected from different combinations to examine the expression pattern. Results showed that the qPCR based expression patterns were similar to Illumina sequencing analysis for all selected DEGs. Mostly, fold changes obtained by sequencing were higher than those obtained by qPCR. Selected DEGs were Asn4 (Asparagine synthetase), HAT 2.3 (High-affinity transporter 2.3), NRP1 (Nodulin-related protein1), basic endochitinase, AAP3 (Amino acid permease 3), GT31 (Glutathione transferase31), MYB 36 transcription factor, AP2-EREBP transcription factor, Nitrate transport1 (**Figure 2.6**). These key DEGs selected for validation encode genes and transcription factors playing a pivotal role in nitrogen metabolism, transport, and signaling mechanism. For example, asparagine synthetase enzyme helps in ammonium assimilation and also plays an important role in nitrogen assimilation, recycling, transport, and storage in plants. HAT 2.3 is high-affinity transporter for nitrogen. In plants, nitrate transporter 2.5 is involved in the constitutive high-affinity transport system under long-term N starvation conditions.



**Figure 2.6: Comparison of gene expression in maize tissues in response to nitrogen stress.**

Comparison of expression analysis of selected nitrogen stress-responsive genes via qPCR (represented by blue colour) and NGS approach (represented by red colour) in maize inbreds, viz., DMI 56 (tolerant to nitrogen stress) and DMI 81 (susceptible to nitrogen stress) in response to nitrogen stress treatment. 1-6 numbers on the X-axis represent comparisons in which a particular gene has significant expression. 1: DMI 81\_leaf\_N sufficient condition v/s DMI 81 leaf\_N starvation condition, 2: DMI 81\_Root\_N sufficient condition v/s DMI 81\_Root\_N starvation condition, 3: DMI 56\_leaf\_N sufficient condition v/s DMI 56\_leaf\_N starvation condition, 4: DMI 56\_Root\_N sufficient condition v/s DMI 56\_Root\_N starvation condition, 5: DMI 56\_leaf\_N starvation condition v/s DMI 81\_leaf\_N starvation condition and 6: DMI 56\_Root\_N starvation condition v/s DMI 81\_Root\_N starvation condition, respectively. Y-axis represents the log<sub>2</sub> fold change in expression level.





*Nitrogen use efficiency experiments in hydroponic culture*

## *Crop Production*



*Maize in zero tillage*



## CROP PRODUCTION

Maize is finding place in new areas replacing other non-remunerative crops in India. However, the enhanced acreage will not be sustainable in the absence of suitable resource-use efficient cropping systems and component technologies. Hence, the development of resource-use efficient cropping systems and production practices is emphasized for enhancing the productivity of traditional areas as well as its expansion.

### Development of precision conservation agriculture practices in cereal-based systems in Indo-Gangetic Plains

Rice-wheat (RW) cropping system in north-west India, although providing food security in the country, has also led to soil degradation and over-exploitation of underground water resources. The diversification of RW systems with maize-

based systems alternate soil and crop management practices help enhance the system productivity, sustain soil health and environment quality, save irrigation water and labour costs, provide palatable fodder and meet the increased demand of maize grains from industries.

Weed seed bank study was conducted in wheat crop and it was found that total seed bank (Table 3.1) was lowest in conventional rice-wheat-mungbean system (207.00); while in conventional maize-wheat-mungbean system, the total weed density was 433.33 in number and highest weeds density were present in conservation maize-wheat-mungbean system (508.33). It clearly shows that conservation agriculture practice can be successful only with the help of proper weed management practice.

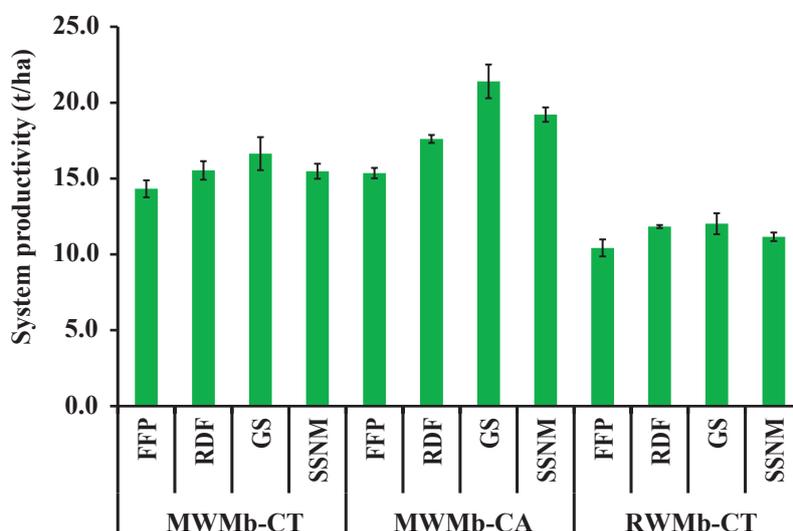
**Table 3.1: Weed Seed Bank Dynamics: Study in wheat season (2019-20)**

Weed seed count at different depths of soil under different cropping systems

S. No.	Cropping System	Tillage System	Soil depth (0-5 cm)	Soil depth (5-15 cm)	Total Weed Density
1.	Rice-Wheat-Mung bean	Conventional	88.67	118.33	207.00
2.	Maize-Wheat-Mung bean	Conventional	140.00	293.33	433.33
3.	Maize-Wheat-Mungbean	Conservation	260.33	248.00	508.33

System productivity was higher under maize-wheat system compared to rice-wheat system. In comparison to rice-wheat system, the system productivity was 30.2% (15.0% in first year, 33.0% second year, 30.0% in third year) and 10.3% (11.0% in first year, 25.0% second year, 20.0% in third year) higher in conservation and conventional maize-wheat system, respectively in the 4<sup>th</sup> year (Figure 3.1). Among different

fertilizer management treatments, significantly higher system yield was obtained under Green Seeker-based (GS), Recommended Dose of Fertilizer (RDF) and Site Specific Nutrient Management (SSNM) over Farmers' Fertilizer Practices (FFP). Maize-wheat system was also water-use efficient, as it reduced water consumption by 84.0% as compared to rice-wheat system. Maize-wheat system can be



**Figure 3.1: System productivity (t/ha) in Maize-wheat-mungbean and rice-wheat-mungbean system**

grown 5-6 times, with the same amount of water that is used to grow one cycle of rice-wheat system. Replacement of rice-wheat system with maize-wheat increased system productivity (up to 30.0%), profitability (up to 50.0%) and also resulted in huge (up to 84.0%) water saving.

Net returns and Benefit to Cost (B:C) ratio was also calculated.

Significantly highest net return and B:C ratio was found with conservation maize-wheat-mungbean with the help of Green Seeker sensor (Figures 3.2 & 3.3) as compared to conventional maize-wheat-mungbean and rice-wheat-mungbean systems with FFP, RDF and SSNM.

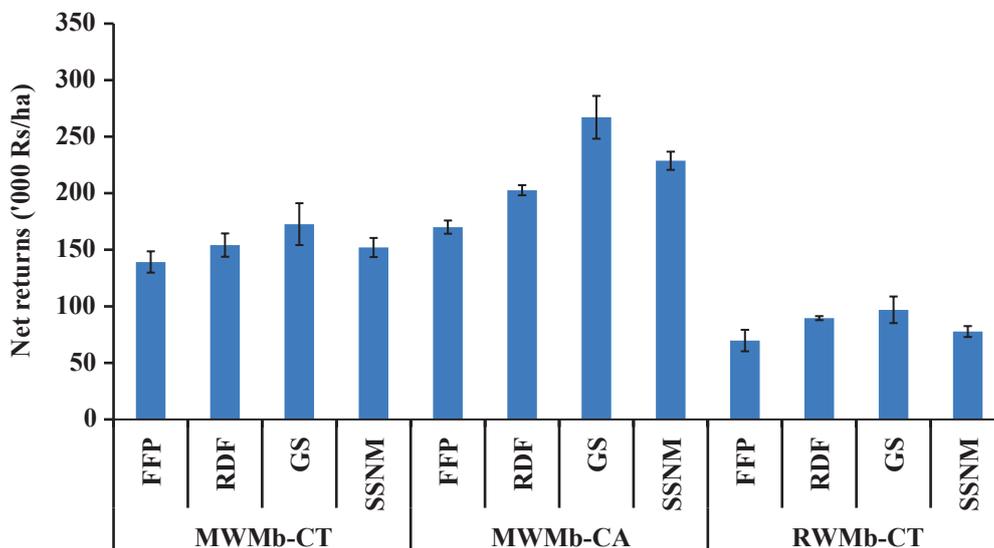


Figure 3.2: Net returns in Maize-wheat-mungbean (MWMB) and rice-wheat-mungbean (RWMb) system under conventional tillage (CT) and conservation agriculture (CA)

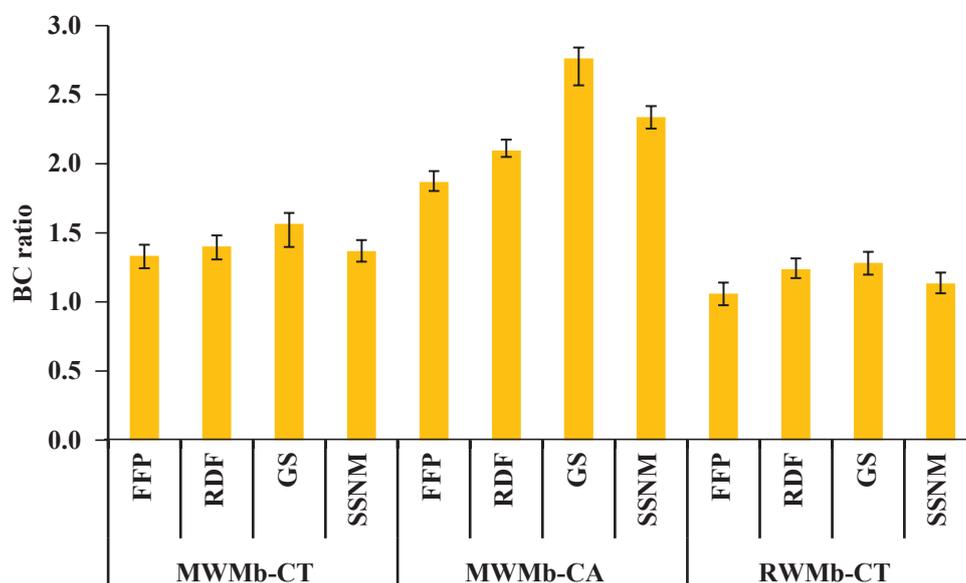


Figure 3.3: B:C ratio in Maize-wheat-mungbean (MWMB) and rice-wheat-mungbean (RWMb) system under conventional tillage (CT) and conservation agriculture (CA)

### Study of different organic nutrient sources in maize and specialty corn

Presently, there is increased demand of organic products due to their better nutrition value and quality. However, no concrete information is available for organic maize production, especially for specialty maize. Hence, on long term basis, one experiment has been conducted on fixed site to measure the effect of fertilizer *vis-a-vis* different organic

sources in maize and specialty corns, *viz.*, baby corn and sweet corn (Table 3.2). After completion of three years, in fourth year, the yield of baby corn, sweet corn and normal maize in organic treatments comes at par with RDF. The yield of baby corn with 100% FYM was at par with RDF. While in sweet corn, the yield with 100% FYM and 50% FYM + 50% VC was found at par with RDF. Similarly, the yield of normal maize in all organic treatments was found at par with RDF.

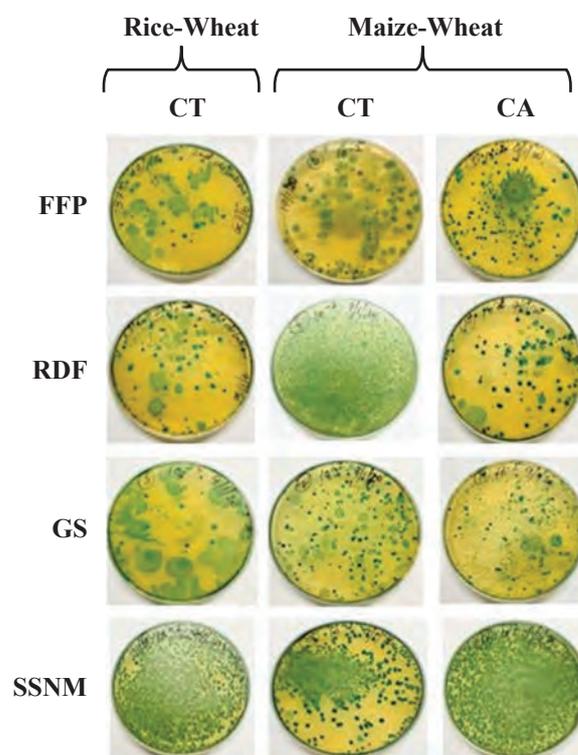
**Table 3.2: Effect of different organic nutrient sources in maize and specialty corn**

Maize type	Treatment	Maize (2017)	Maize (2018)	Maize (2019)	Maize (2020)
Baby corn	RDF	7570.0	8876.0	8750.0	4607.3
	100% FYM	6585.0 (-13)	7721.0 (-13.0)	6995.9	4674.0
	50% FYM+ 50% VC	6268.0 (-17)	7349.0 (-17.0)	6834.5	5173.8
	25% FYM + 25% VC+1/3 Straw	6598.0 (-12)	7736.0 (-12.0)	4095.5	2400.1
	LSD (P = 0.05)	NS	NS	2176.8	1432.2
Sweet corn	RDF	9986.0	12642.0	10464.1	8597.5
	100% FYM	9417.0 (-5.0)	8751.0 (-30.0)	5970.6	6998.7
	50% FYM + 50% VC	9121.0 (-8.0)	8510.0 (-32.0)	5709.6	5966.2
	25% FYM + 25% VC+ 1/3 Straw	8635.0 (-13.0)	7561.0 (-40.0)	2590.9	2634.7
	LSD (P = 0.05)	NS	1272.8	1260.8	1691.6
Normal maize	RDF	6435.0	9706.0	8391.0	5388.7
	100% FYM	4453.0 (-30.0)	6428.0 (-33.0)	6693.0	5098.1
	50% FYM + 50% VC	4487.0 (-30.0)	5621.0 (-42.0)	6136.0	5378.7
	25% FYM + 25% VC+ 1/3 Straw	4518.0 (-29.0)	5514.0 (-43.0)	5286.0	5068.8
	LSD (P = 0.05)	290.1	230.6	240.5	979.4

(Note: Data in parenthesis indicates percent yield reduction as compared to RDF)

### Soil bacterial diversity analysis of rice-wheat and maize-wheat cropping systems

The bacterial diversity of soils under rice-wheat and maize-wheat cropping systems under different tillage was investigated on chromogenic agar medium. The chromogenic agar medium can differentiate different species like *Klebsiella*, *Enterococcus*, *Proteus*, *Pseudomonas* etc. based on different colour indicators. **Figure 3.4** shows the results obtained after spread-plating of different soils at dilution 1:1000. It is found that soils under Site-specific Nutrient Management show higher diversity than other fertilization practices in rice-wheat and maize-wheat under conventional and conservation tillage, respectively. However, under conventional tillage, maximal bacterial diversity is observed in Recommended Dose of Fertilizers in case of maize-wheat, indicating that the soil microbial profile can be used as a biological indicator to estimate soil health. In addition, it was found that soils under Site-specific Nutrient management also contain nitrogen-fixing bacteria (assessed by their ability to grow luxuriantly under nitrogen-deficient conditions). Such microbes can be used to enhance soil fertility and improve crop production.



**Figure 3.4: Soil bacterial diversity analysis of cropping systems under different tillage regimes.**

**Sensor guided nitrogen management in maize-based cropping system under conventional and conservation agriculture practices**

The present scenario of the energy prices makes it essential to devise production systems, which less dependent on external fertilizers and diesel for tillage operations. This will help to pave way for a sustainable production system, while ensuring energy security for other industrial growth. Hence, the tillage minimizing and nitrogen fertilizer optimization practices were evaluated in maize-based systems for higher yield, and maximization of input productivity and economics of crop cultivation.

The productivity of maize-based cropping system was significantly influenced by different cropping system, residue management and nitrogen management practices under conservation agriculture (Figure 3.5). The system yield was 11.5% higher under maize-wheat-mungbean (MWMB) compared to maize-mustard-mungbean (MMuMb) system. Similarly, system productivity enhanced by 7.5% by residue application (With Residue: WR) over no residue application (Without Residue: WoR). The productivity under 50% recommended dose of nitrogen (RDN)+ Green seeker (GS) guided N application was highest, which was at par with 33% RDN+GS.

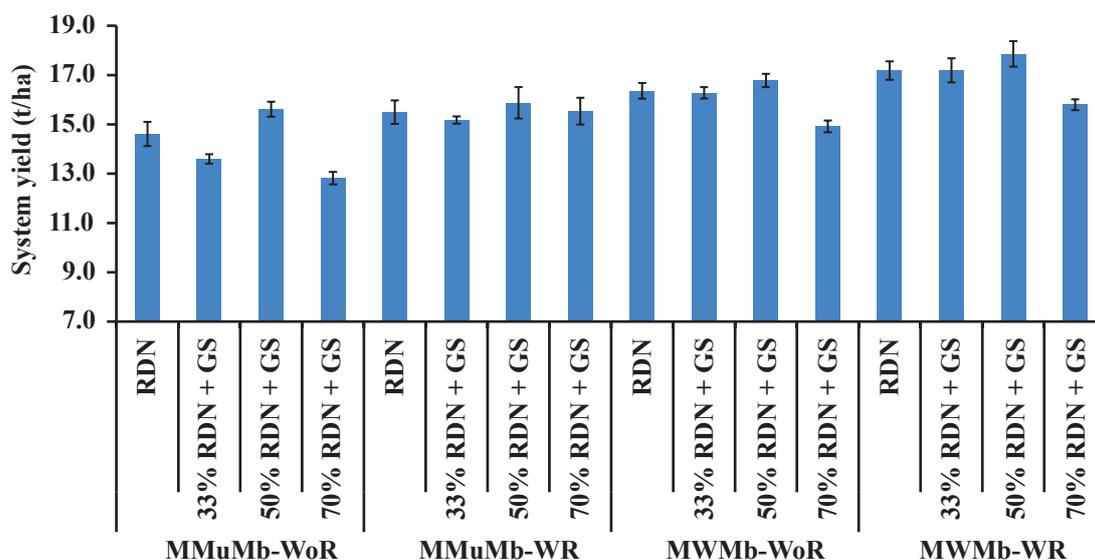


Figure 3.5: System economic yield under different residue and nitrogen management options in the maize-based cropping systems.

(MMuMb: Maize-Mustard-Mungbean; MWMB: Maize-Wheat-Mungbean; WR: With Residue; WoR: Without Residue)

The net returns were significantly influenced with the application of residue and N management options along with different cropping system (Figure 3.6). The net returns of

MWMB system was 21.2% higher compared to MMuMb. Similarly, the residue application increased net returns by 12.5% over no residue application. The nitrogen application in the 50% RDN+GS based module increased net returns of the maize systems by 4.6% over conventional RDN.

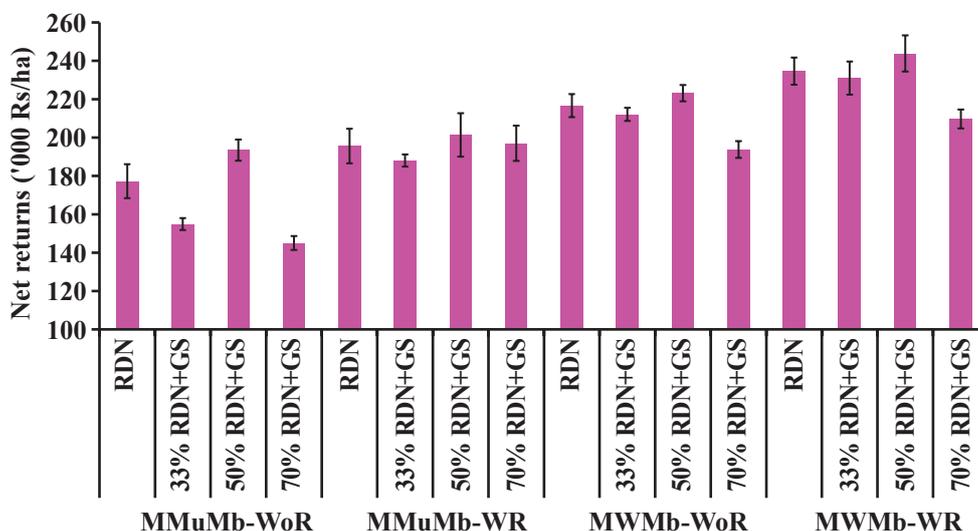


Figure 3.6: Net returns in different maize-based cropping system as influenced by different residue and nitrogen management options during 2019-20.



(MMuMb: Maize-Mustard-Mungbean; MWMb: Maize-Wheat-Mungbean; WR: With Residue; WoR: Without Residue)

The partial factor productivity of the applied nitrogen (PFPN) in maize system was also significantly affected by cropping system, residue and N management options (Figure 3.7). Higher PFPN to the extent of 15.9% was observed under MWMB, compared toMMuMb. The residue application

enhanced PFPN by 5.6% over no residue application, which underlines the importance of residue recycling in the intensive cropping system. The application of the GS guided N improved PFPN, which was highest with 50% RDN+GS and increased by 15.6% over conventional RDN application. Thus, higher returns can be fetched in maize-wheat-mungbean system, opted with residue retention under conservation agriculture by application of 50% RDN+GS based N application.

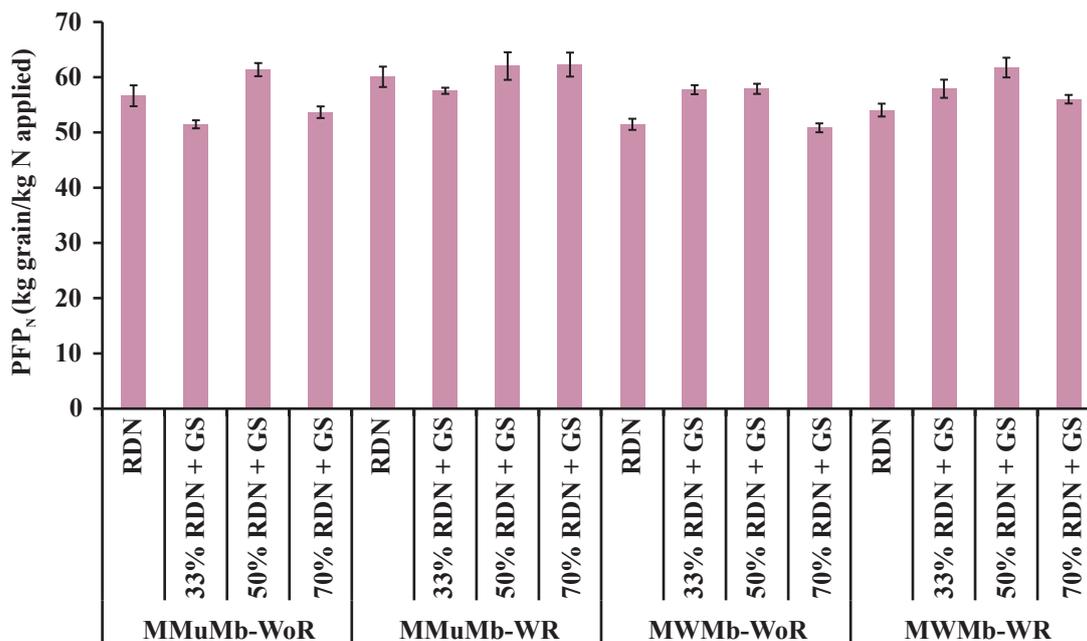
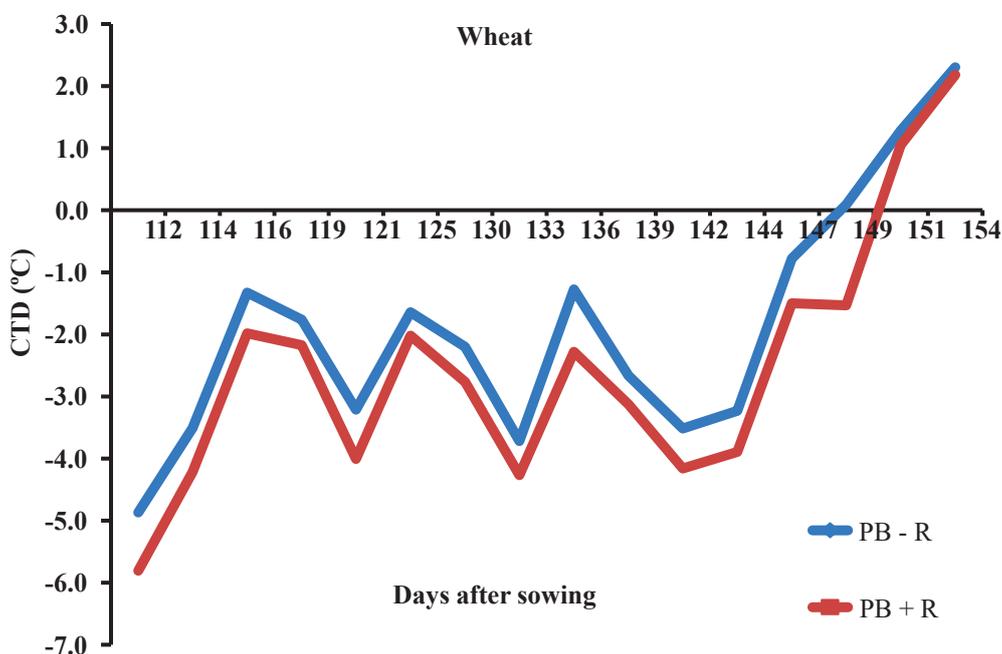
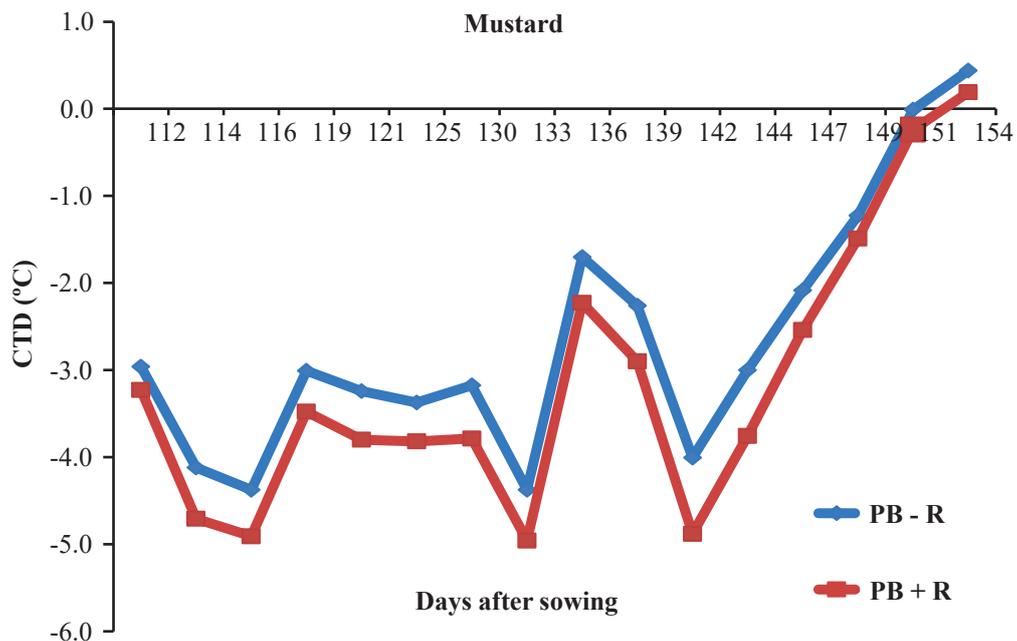


Figure 3.7: The partial factor productivity of maize systems as influenced by different residue and nitrogen management options.

The residue application helped in buffering temperature stress in winter wheat. Thus, it has the potential to reverse the adverse effect of terminal heat stress in wheat productivity (Figure 3.8). However, in mustard, this difference was less

noticeable. The residue and GS guided N application also enhanced the available N, microbial biomass carbon and urease activity in the soil. The residue was also found to have better soil aggregation in this study.

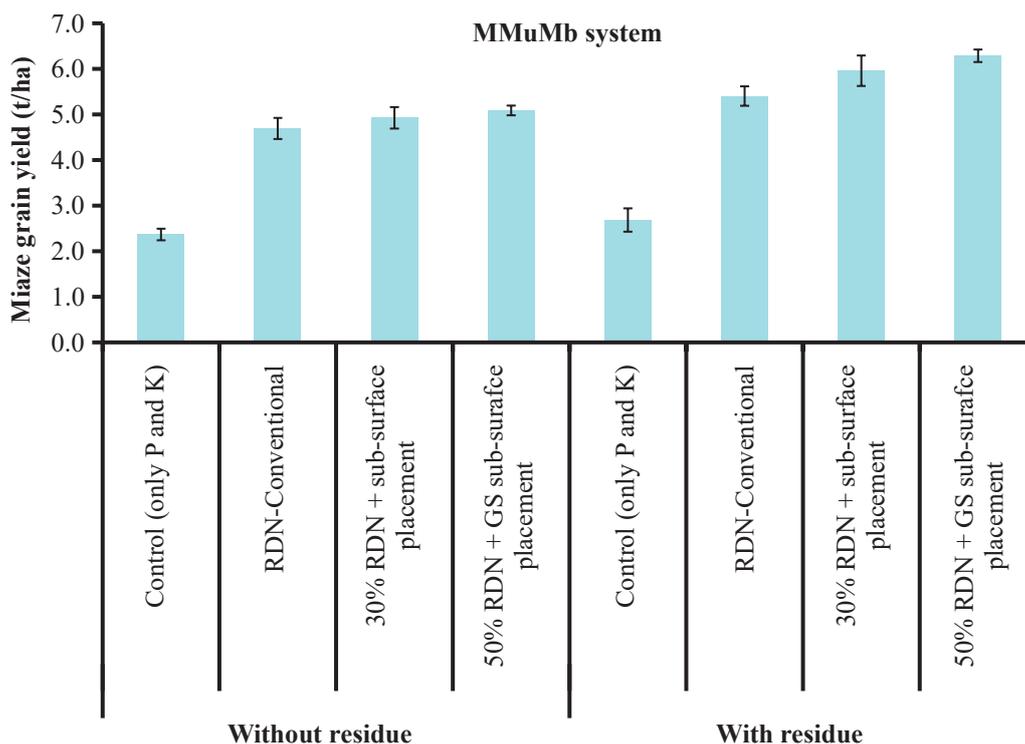


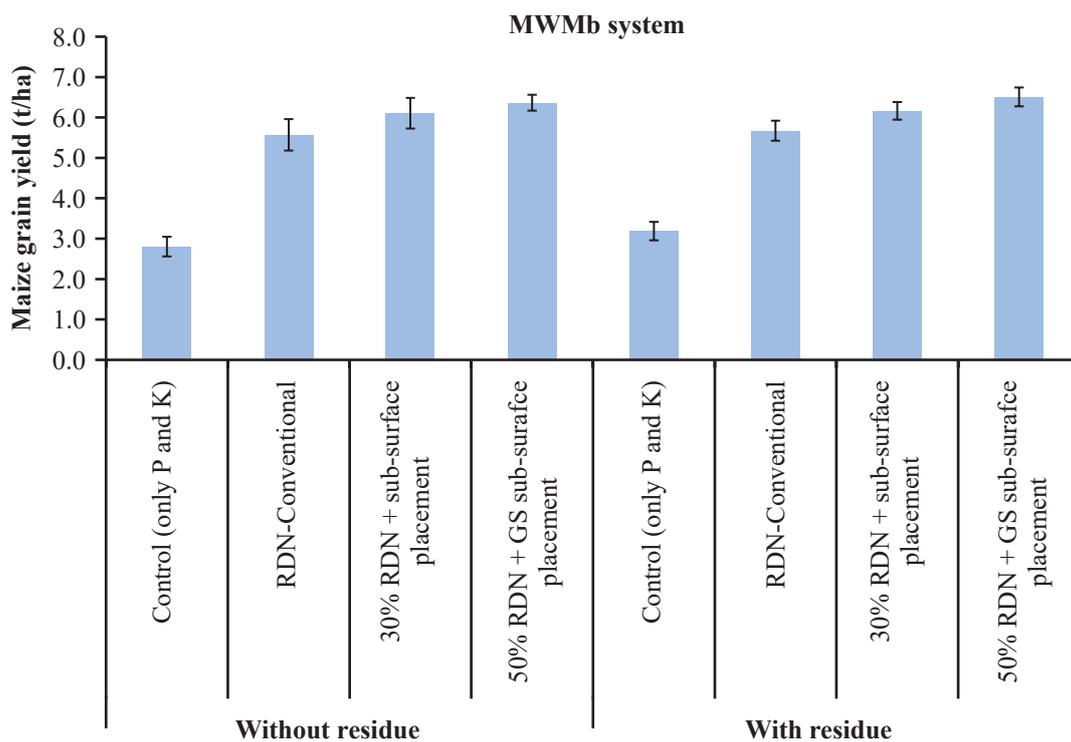


**Figure 3.8: Canopy temperature depression (CTD) in *rabi* season crops, with (PB+R) and without (PB-R) residue application scenario, from the grain filling to harvest stages during 2019-20.**

Apart from optimization of the doses, the placement of the nitrogen played a significant role in enhancing the nitrogen use efficiency and yield of the crops. The application of N by different management options had significant effect on the yield of *kharif* maize during 2020 (Figure 3.9). The sub-surface band placement of the first split N dose at the knee-high stage in the standing maize crop improved the yield of maize under conventional and GS based splitting. This sub-

surface band placement with conventional splitting (30% RDN+ placed) and GS based splitting (50% RDN+GS based placed) resulted in 8.5 and 13.6% higher maize yield over conventional surface band placement. The residue and cropping system also played a significant role in the maize yield and it was higher by 13.3% under MMuMb over MMuMb, while residue application gave 10.4% yield advantage over no-residue application.





**Figure 3.9: The yield of maize during *kharif* 2020 as influenced by different residue and nitrogen management methods.**



## *Crop Protection*



*Fall armyworm damage in maize*



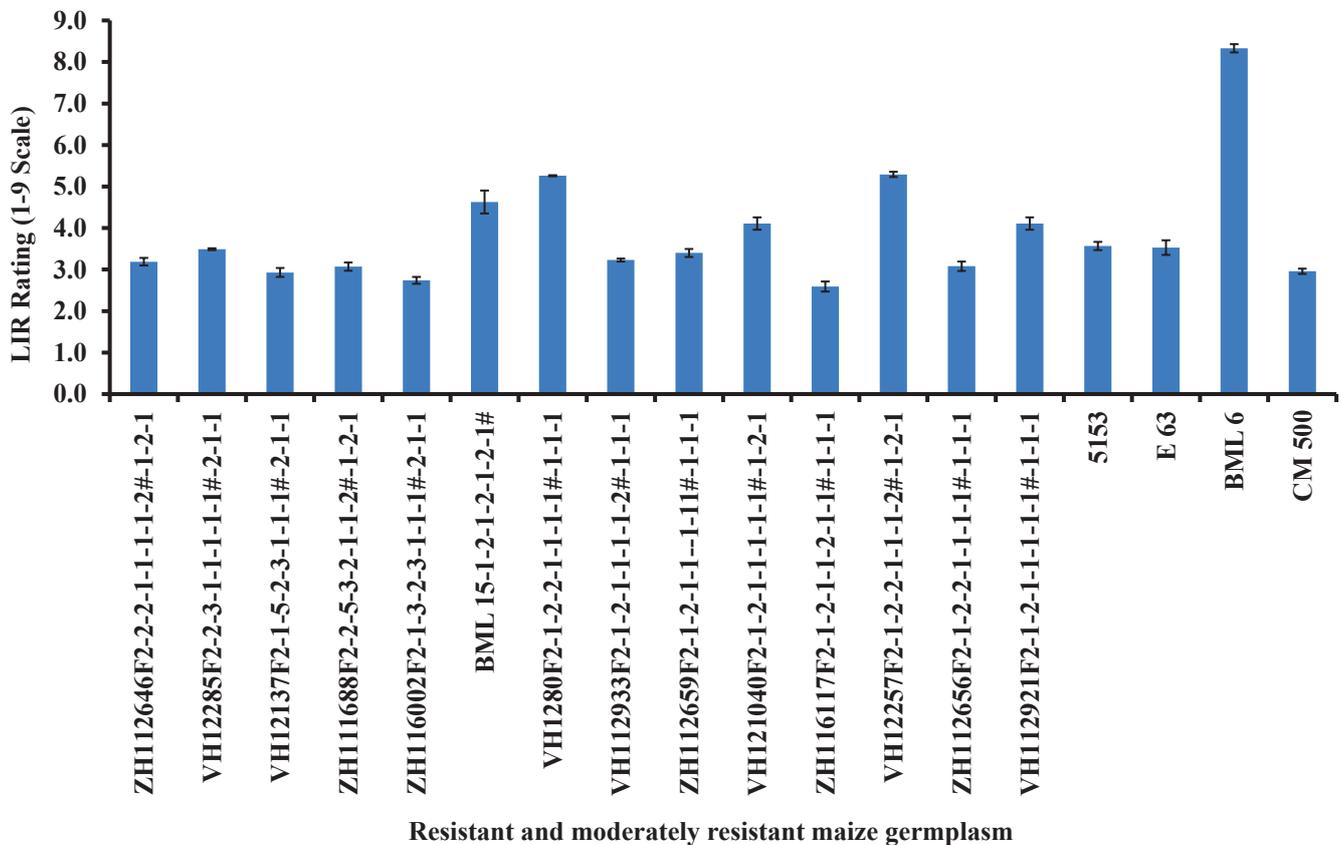


Figure 4.2: Response of maize germplasm against pink stem borer during rabi 2019-20

#### Understanding Induced direct defense responses in maize against pink stem borer, *Sesamia inferens* Walker

Understanding plant-insect interactions is of utmost importance for developing effective pest management approaches. Therefore, the present study was undertaken to study induced defense responses in maize by imposing different treatments, including control i.e. untreated plants (T1), PSB feeding (T2), mechanical wounding (T3), mechanical wounding plus PSB regurgitation (T4) and exogenous application of methyl jasmonate (T5) in resistant (DMRE 63 -G1, CM 500 - G2), moderately resistant (WNZ Exotic Pool - G3) and susceptible genotypes (CM 202 - G4, BML 6 - G5) at two stages, viz., 5 and 15 days after germination (DAG). The pots were kept in a completely randomized design involving a 5 × 5 factorial arrangement with five treatments, five genotypes at two levels of sampling. Induced defenses appearing two days after treatment imposition at each stage (5 and 15 DAG) was considered as short-term response, while 15 days post-treatment was considered as the long-term response. The quantification of *p*-Coumaric acid (*p*-CA) and ferulic acid (FA) at 2 and 15 days after imposition of the above treatments was carried out through ultra-fast liquid chromatography (UFLC). Treatment-specific and genotype-dependent changes were observed in

the accumulation of *p*-CA and FA contents in both short- and long-term responses at 5 and 15 DAG. The results revealed that *p*-CA content induced in leaf tissues of maize genotypes were intrinsically higher when challenged by PSB attack in short- and long-term responses at 5 and 15 days after germination (DAG) (Figure 4.3A, 4.3B). Higher *p*-CA content was observed in stem tissue upon wounding and regurgitation in short- and long-term responses (Figure 4.3C, 4.3D). Significant accumulation of FA content was also observed in leaf tissues in response to PSB feeding at 5 DAG in long-term response (Figure 4.4A), while at 15 DAG, it was observed both in short- and long-term responses (Figure 4.4B). In stem tissues, methyl jasmonate induced higher FA content in short-term response at 5 DAG (Figure 4.4C). However, at 15 DAG, PSB feeding triggered FA content in the short-term while, wounding and regurgitation treatment-induced defense responses in the long-term (Figure 4.4D). Resistant (DMRE 63, CM 500) and moderately resistant genotypes (WNZ Exotic Pool) significantly accumulated higher contents of *p*-CA and FA content than susceptible ones (CM 202, BML 6) in most of the cases. It can be concluded that induced defense responses varied with maize genotypes, stage of crop growth, plant tissue, in terms of both short- and long-term responses.

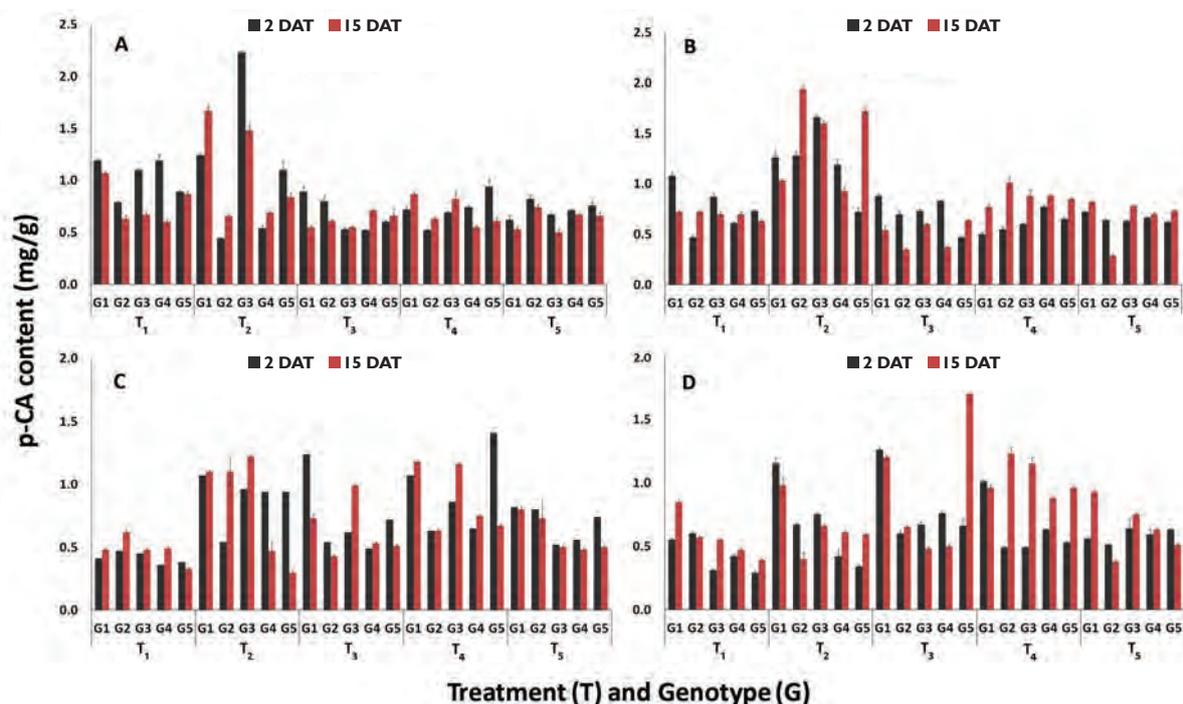


Figure 4.3: p-CA dynamics in host-insect interactions

Changes in p-CA content in leaf (A, B) and stem (C, D) tissues of maize genotypes to induced treatments in short (2 DAT) and long (15 DAT) term responses on the imposition of treatments at 5 DAG (A, C) and 15 DAG (B, D) (G1: DMRE 63; G2: CM 500; G3: WNZ Exotic pool; G4: CM 500; G5: BML 6; T1: Control; T2: PSB feeding; T3: Wounding; T4: Combination of wounding plus regurgitation; T5: Exposure to methyl jasmonate)

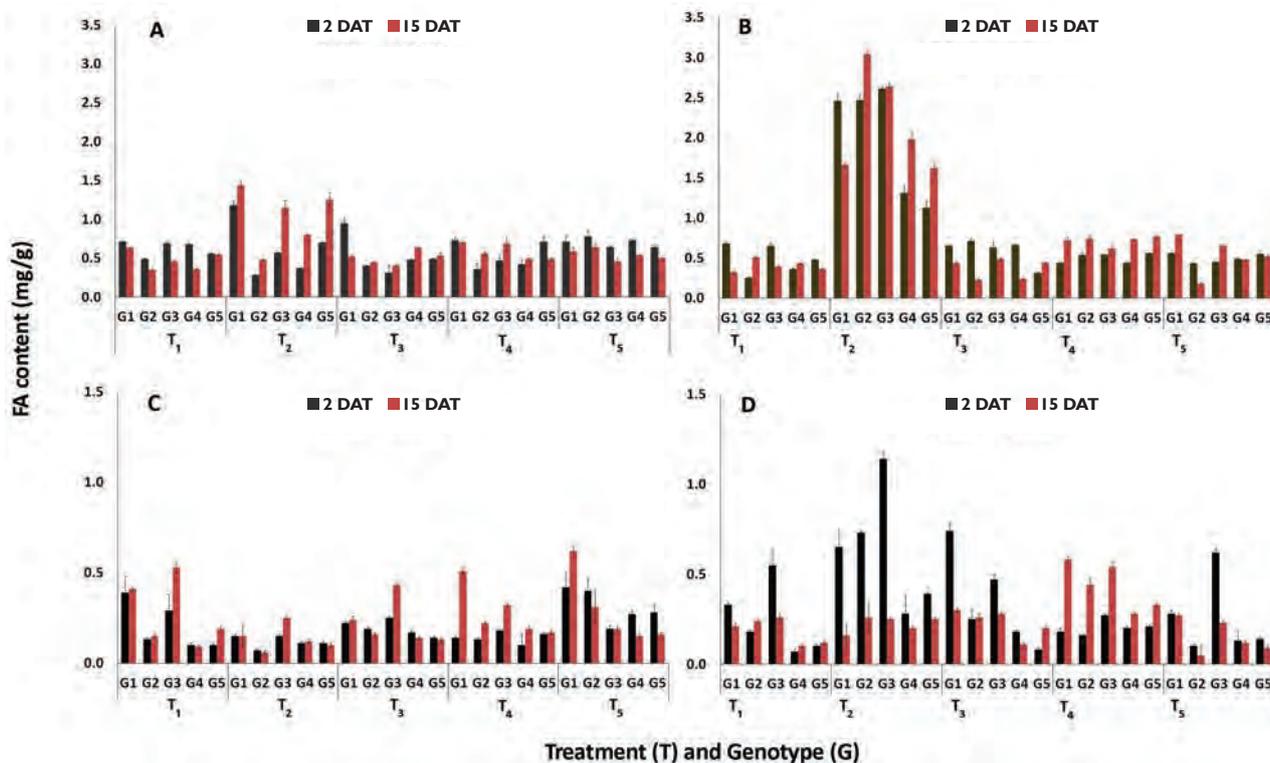


Figure 4.4: FA dynamics in host-insect interactions

Changes in FA content in leaf (A, B) and stem (C, D) tissues of maize genotypes to induced treatments in short (2 DAT) and long (15 DAT) term responses on the imposition of treatments at 5 DAG (A, C) and 15 DAG (B, D) (G1: DMRE 63; G2: CM 500; G3: WNZ Exotic pool; G4: CM 500; G5: BML 6; T1: Control; T2: PSB feeding; T3: Wounding; T4: Combination of wounding plus regurgitation; T5: Exposure to methyl jasmonate)

### Evaluation of insecticides as seed treatment against fall armyworm during kharif 2020

Fall armyworm (FAW) is an invasive insect pest causing serious damage to maize at all stages of its growth. It was first reported in India in May, 2018. Yield losses of about 73.0% have been reported due to fall armyworm infestation. The effect of the seed treatment insecticides at varying doses were evaluated at WNC under natural infestation for the management of fall armyworm (FAW) during *kharif* 2020 (Table 4.1). The experiment was completely randomized with three replicates of 10 treatments including untreated control. Among all the treatments, at 7 DAG, Thiamethoxam 30 FS @ 10 ml/kg seed recorded the lowest per cent plant infestation of 30.2%, followed by Thiamethoxam 30 FS @ 8 ml/kg seed (34.1%) and Thiamethoxam 30 FS @ 6 ml/kg seed (36.4%) (Table 1). Similarly, at 14 DAG, significant lowest per cent

plant infestation was observed in Thiamethoxam 30 FS @ 10 ml/kg seed (18.8%), followed by Thiamethoxam 30 FS @ 8 ml/kg seed (26.4%) and Thiamethoxam 30 FS @ 6 ml/kg seed (29.4%) compared to untreated control (81.8%). Thereafter, the per cent plant infestation increased among all the treatments. At 7 DAG, the minimum Davis score of 1.4, 1.5 and 1.7 was recorded in Thiamethoxam 30 FS @ 10, 8 and 6 ml/kg seed, respectively compared to the remaining treatments. At 14 DAG, the Davis score was 1.2, 1.4 and 1.4 in Thiamethoxam 30 FS @ 10, 8 and 6 ml/kg seed, respectively. However, all the treatments have significantly lower Davis score of 2.0 against untreated control (3.2) at 14 DAG. The maximum yield of 53.0, 54.0 and 55.6 q/ha was recorded in Thiamethoxam 30 FS @ 6, 8 and 10 ml/kg seed followed by imidacloprid 600 FS @ 6, 8 and 10 ml/kg seed (50.3, 51.6 and 51.3 Q/ha) compared to untreated control (31.0 q/ha).

**Table 4.1: Evaluation of insecticides as seed treatment against fall armyworm during *kharif* 2020**

Sl. No.	Treatment	Percent plant infestation			Davis Score			Yield (Q/ha)
		7 DAG	14 DAG	21 DAG	7 DAG	14 DAG	21 DAG	
1.	Thiamethoxam 30FS @ 6ml / kg seed	36.4 <sup>def</sup> (37.12)	29.4 <sup>dc</sup> (32.84)	80.3 <sup>c</sup> (63.73)	1.7 <sup>dc</sup> (1.31)	1.4 <sup>bcd</sup> (1.21)	3.3 (1.82)	53.0 <sup>bc</sup>
2.	Thiamethoxam 30FS @ 8ml /kg seed	34.1 <sup>f</sup> (35.59)	26.4 <sup>dc</sup> (30.95)	70.5 <sup>d</sup> (57.12)	1.5 <sup>ef</sup> (1.25)	1.4 <sup>cd</sup> (1.19)	3.0 (1.75)	54.0 <sup>ab</sup>
3.	Thiamethoxam 30FS @ 10ml/kg seed	30.2 <sup>f</sup> (33.37)	18.8 <sup>c</sup> (27.55)	55.7 <sup>c</sup> (48.32)	1.4 <sup>f</sup> (1.19)	1.2 <sup>d</sup> (1.13)	2.3 (1.51)	55.6 <sup>a</sup>
4.	Imidacloprid 600 FS @ 6ml/ kg seed	54.5 <sup>abc</sup> (47.65)	43.4 <sup>c</sup> (41.25)	87.0 <sup>bc</sup> (69.09)	2.2 <sup>b</sup> (1.48)	1.7 <sup>bcd</sup> (1.30)	3.1 (1.76)	50.3 <sup>dc</sup>
5.	Imidacloprid 600 FS @ 8ml / kg seed	53.5 <sup>bc</sup> (47.07)	41.3 <sup>c</sup> (40.02)	84.2 <sup>c</sup> (66.66)	1.8 <sup>cd</sup> (1.34)	1.8 <sup>bc</sup> (1.36)	3.3 (1.82)	51.6 <sup>cd</sup>
6.	Imidacloprid 600 FS @ 10ml / kg seed	44.7 <sup>cdef</sup> (41.88)	31.8 <sup>d</sup> (34.30)	81.8 <sup>c</sup> (65.20)	1.6 <sup>def</sup> (1.27)	1.2 <sup>d</sup> (1.13)	3.2 (1.80)	51.3 <sup>cd</sup>
7.	Fipronil 5 Sc @6ml / kg seed	65.4 <sup>ab</sup> (54.09)	54.2 <sup>b</sup> (47.45)	91.8 <sup>b</sup> (78.82)	1.9 <sup>bc</sup> (1.41)	1.9 <sup>bc</sup> (1.39)	3.4 (1.85)	46.6 <sup>g</sup>
8.	Fipronil 5 Sc @8ml / kg seed	53.0 <sup>bcd</sup> (46.75)	48.9 <sup>bc</sup> (44.39)	86.9 <sup>bc</sup> (69.03)	1.9 <sup>bc</sup> (1.40)	1.9 <sup>b</sup> (1.41)	3.5 (1.86)	48.3 <sup>fg</sup>
9.	Fipronil 5 Sc @10ml / kg seed	49.6 <sup>bcd</sup> (44.80)	47.2 <sup>bc</sup> (43.44)	84.2 <sup>c</sup> (66.82)	1.7 <sup>cde</sup> (1.32)	2.0 <sup>b</sup> (1.41)	3.3 (1.83)	49.3 <sup>ef</sup>
10.	Control	70.2 <sup>a</sup> (57.04)	81.8 <sup>a</sup> (65.20)	100.0 <sup>a</sup> (89.09)	2.4 <sup>a</sup> (1.57)	3.2 <sup>a</sup> (1.80)	4.2 (2.06)	31.0 <sup>h</sup>
	CD (0.05)	9.84	5.58	5.39	0.09	0.22	NS	1.90
	CV	12.89	7.98	4.70	3.78	9.60	10.05	2.26

Values in parenthesis are transformed

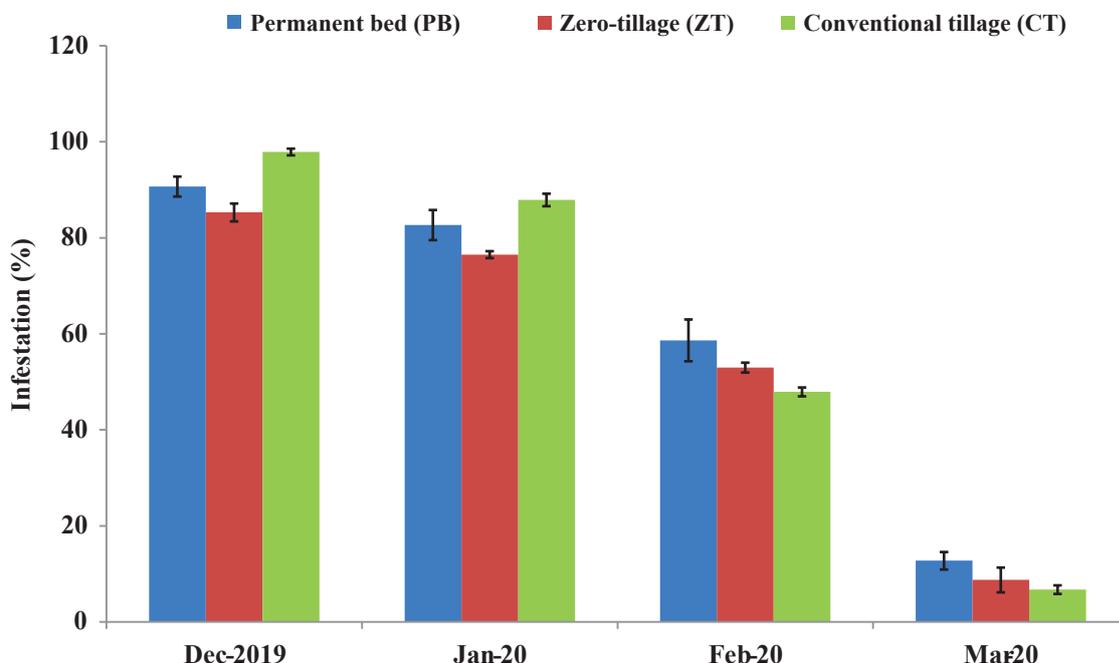
### Infestation of fall armyworm in rabi 2019-20 and kharif 2020 maize under different tillage practices

Fall armyworm infestation was recorded in *rabi* 2019-20 under different tillage practices at ICAR-IIMR Delhi

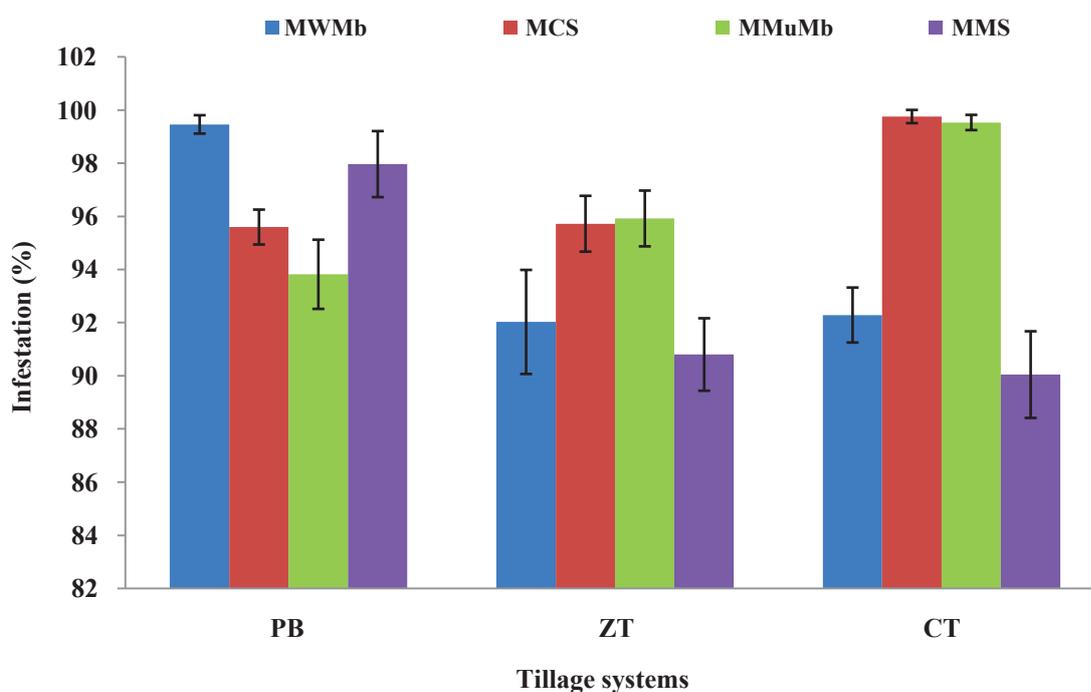
Infestation was less in zero-till (ZT) system and highest in conventionally tilled (CT) system. Infestation was as high as 98% initially and it dropped to as low as 7% by March (Figure 4.5). However, after November, the CT system showed

minimum infestation. In *kharif* 2020, FAW Infestation at V6-7 stage maize under different tillage practices and cropping systems was recorded. ZT recorded lower infestation and CT

recorded the highest, especially in maize-chickpea-sesbania (MCS), maize-mustard-mungbean (MMuMb) cropping systems (**Figure 4.6**).



**Figure 4.5: Dynamics of fall armyworm infestation in maize in rabi 2019-20 in permanent bed (PB), zero-tillage (ZT) and conventional tillage (CT) systems**



**Figure 4.6: Dynamics of fall armyworm infestation in maize in kharif 2020 in permanent bed (PB), zero-tillage (ZT) and conventional tillage (CT) under maize-wheat-mungbean (MWMB), maize-chickpea-sesbania (MCS), maize-mustard-mungbean (MMuMb) and maize-maize-sesbania (MMS) cropping systems**

## PATHOLOGY

### Identification of resistant sources against major diseases

During spring 2020, a total of 106 inbred lines were screened against charcoal rot (CR). Out of these, 35 were found resistant with disease score <3.0, while the susceptible check CM 600 showed a disease score of 5.6. During *kharif* 2020, a total of 52 and 124 inbred lines were screened against CR and maydis leaf blight (MLB). None of the lines showed resistant response, while the susceptible check CM 600 showed a disease score 5.5 and 6.7 against CR and MLB, respectively.

### Efficacy of modules for the management of maydis leaf blight

Three disease management modules, viz., organic, chemical and integrated disease management (IDM) were evaluated against MLB in sweet corn I composite under artificial inoculation at Ludhiana during *kharif* 2020 (Table 4.2). The best disease control was recorded in the chemical module (53.76%), followed by IDM module (48.65%). Chemical module recorded the highest yield (33.1 q/ha), followed by IDM module (27.16 q/ha).

Table 4.2: Efficacy of modules for the management of maydis leaf blight

S. No.	Modules	Treatment	Disease severity* (%)	Disease control (%)	Average yield (q/ha)
1.	Organic	Seed treatment with <i>Trichoderma harzianum</i> formulation (@ 10g/kg seed) + Foliar spray of <i>Pseudomonas fluorescens</i> (@ 10g/l water) at 45 DAS and foliar spray of cow urine (20%) at 60 DAS	51.00	17.30	24.09
2.	Chemical	Seed treatment with Thiram (3g/kg seed) + Foliar spray with Mancozeb 75 WP (@2.5g/l water) at 45 DAS + Foliar spray with Azoxystrobin 18.2% (w/w) + Difenoconazole 11.4% (w/w) SC (@1 ml/l) water at 55 DAS	26.67	53.76	33.15
3.	IDM	Seed treatment with <i>Trichoderma harzianum</i> formulation (@10g/kg seed) + Foliar spray of <i>Pseudomonas fluorescens</i> (@10g/l water) at 45 DAS and foliar spray of Azoxystrobin 18.2% (w/w) + Difenoconazole 11.4% (w/w) SC @1 ml/l water at 50 DAS and foliar spray of cow urine (20%) at 60 DAS	31.67	48.65	27.16
4.	Standard control	Foliar spray with Mancozeb 75 WP (@2.5g/l water) at 45 and 55 DAS	37.67	34.68	25.00
5.	Organic check	Inoculated	61.67	-	16.76
6.	Positive control	Inoculated	57.70	-	18.54
	<b>LSD (P = 0.05)</b>		5.34	-	3.95

### Studies on diversity of *Setosphaeria turcica* isolates

*Setosphaeria turcica* causes turcicum leaf blight, which is a major disease of maize in India. To study the diversity in *S. turcica* 45 isolates were collected from nine states, viz., Meghalaya, Uttarakhand, Himachal Pradesh, Andhra Pradesh, Odisha, Gujarat, Madhya Pradesh, Jammu & Kashmir and

Maharashtra. Out of these, 26 were purified and purification of the other 19 isolates is in process. Morphological characterization of the purified isolates is also in progress. Four isolates and their conidia from Umiam, Meghalaya are represented in Figure 4.7. To preserve these cultures for long time, paper disc method was performed for enhancing the shelf-life of isolates.

**A. Isolates**



**B. Conidia**



Figure 4.7: *Setosphaeria turcica* (A) isolates and (B) conidia from Umiam, Meghalaya



## *Extension, Outreach and Entrepreneurial Development*



*Distribution of inputs to maize farmers*

# EXTENSION, OUTREACH AND ENTREPRENEURIAL DEVELOPMENT



The institute has an effective outreach programme for the transfer of technology and capacity building in maize value chain from input supply to production of the crop and its utilization. The institute uses monetary grants received from ICAR under Scheduled Tribe Component (STC), North Eastern Hill (NEH) component and Scheduled Caste Sub Plan (SCSP) for enhancing adoption of technology amongst farmers and other stakeholders in the maize value chain. The institute also has Mera Gaon Mera Gaurav (MGMG) programmes for capacity building, technology demonstration and regular interactions with maize growers for taking feedback towards the orientation of the farmer-friendly research programme. The Front Line Demonstrations programme sponsored by the Department of Agriculture and Cooperation, Government of India under National Food Security Mission (NFSM) for demonstration of improved maize technologies is also being implemented by ICAR-IIMR as the nodal agency. The aspirational districts identified by the government of India and low maize productivity areas were the focus of all these programmes.

## Front Line Demonstrations

The Front Line Demonstrations (FLDs) under NFSM are being undertaken by ICAR-IIMR in collaboration with various AICRP on Maize centers throughout the country in the three cropping seasons (*kharif*, *rabi* and spring) of maize. In 2019-20 *rabi* season, FLDs were taken up on 100 ha of land benefitting 294 farmers (**Table 5.1**). In this season, technologies like micronutrients application and integrated pest management, public sector hybrids, viz., DMRH 1301, CO 6, GAYMH 1 and GAYMH 3, and intercropping of maize with pea and potato were demonstrated at farmers' field by 8 centres in 7 states. During the *rabi* season, average yield gains of 21.9% was recorded which ranged from 8.4% in Begusarai to 46% in Kolhapur (**Figure 5.1**). In spring 2020, three centres conducted FLDs over 30.2 ha, where the technology of improved hybrid of the public sector (PMH 10) and private sector (DKC 9108), and recommended sowing time were demonstrated. Only minimal yield gains were observed in this season and gains varied from -2.51% to 5.68%. This indicated that intervention of the sowing time could result in bridging yield gaps at the farmers' field, but the costly seed needs to be replaced with suitable public sector hybrids.

**Table 5.1: Centre-wise, season-wise performance report of the FLDs conducted in maize during 2020**

Sl. No.	Name of Centre	FLD area (ha)	Av. yield in FLDs (t/ha)	Av. yield in farmers' practices (t/ha)	Yield gains (%)	No. of beneficiaries
<i>Rabi 2019-20</i>						
1.	UAS, Dharwad	10	5.41	4.98	8.70	27
2.	TNAU, Coimbatore	10	7.77	6.81	14.05	25
3.	Dr RPCAU, Dholi	10	8.27	6.40	29.22	25
4.	RMRSPC, Begusarai	10	6.54	6.03	8.39	29
5.	MPKV, Kohlapur	20	7.20	4.93	46.04	53
6.	AAU, Godhra	10	3.92	2.90	35.29	25
7.	BCKV, Kalyani	20	6.07	5.25	15.56	67
8.	AAU, Gossaingaon	10	4.47	3.44	30.09	43
<b>Total/mean (Rabi season 2019-20)</b>		<b>100</b>	<b>6.21</b>	<b>5.09</b>	<b>21.87</b>	<b>294</b>

Sl. No.	Name of Centre	FLD area (ha)	Av. yield in FLDs (t/ha)	Av. yield in farmers' practices (t/ha)	Yield gains (%)	No. of beneficiaries
<i>Spring 2020</i>						
9.	IIMR, Ludhiana	10	5.77	5.46	5.68	25
10.	PAU, Ludhiana	10.2	5.87	6.02	-2.51	24
11.	GBPUAT, Pantnagar	10	7.83	7.74	1.18	35
<b>Total/mean (Spring season 2020)</b>		<b>30.2</b>	<b>6.49</b>	<b>6.41</b>	<b>1.30</b>	<b>84</b>
<i>Kharif 2020</i>						
12.	CAU, Imphal	10	3.32	1.63	103.00	10
13.	CSKHPKV, Bajaura	10	4.08	2.91	40.36	32
14.	VPKAS, Almora	10	3.53	2.48	42.03	10
15.	SKUAST, Srinagar	10	6.16	4.06	51.48	53
16.	PAU, Ludhiana	10	3.63	3.02	20.20	25
17.	BHU, Varanasi	10.23	1.84	1.06	73.12	22
18.	Dr RPCAU, Dholi	4	5.73	4.08	40.44	10
19.	MPKV, Kolhapur	20	7.20	4.93	46.09	50
20.	TNAU, Coimbatore	10	6.94	6.29	10.35	25
21.	UAS, Mandya	10	2.85	2.60	9.62	25
22.	AAU, Godhara	10	3.57	2.89	23.34	12
23.	JNKVV, Chhindwara	10	4.89	3.38	44.79	25
24.	MPUAT, Banswara	6.8	2.17	1.71	27.27	17
25.	MPUAT, Udaipur	20	2.98	2.11	41.69	59
<b>Total/mean (Kharif season 2020)</b>		<b>151.03</b>	<b>4.21</b>	<b>3.08</b>	<b>36.69</b>	<b>375</b>

In *kharif* 2020, FLDs were conducted in over 151.03 ha, benefiting 375 farmers in 13 states. The recently released public sector hybrids like DMRH 1301, FQH 106, VMH 45, PMH 1, CoH(M) 8, MAH 14-5 and GAYMH 1, along with new hybrid varieties of private sector like Bio 9544, PM 3 and PM 9 were demonstrated. This *kharif* season showed the highest yield gap in technology demonstrated with farmers' practices compared to *rabi* and spring seasons, which varied from 9.6% in Mandya to 103.0% in Imphal (**Figure 5.2**). However, the yield gains in Punjab were negative to the tune of 16.9%, which implied that farmers were adopting very good

practices, and only cost reduction could enhance profitability in maize cultivation. Raised bed planting was also demonstrated in water-logging prone North Eastern Plain Zone, where a yield gain of 73.1% was reported compared to farmers' practice of flat planting. Biofortified QPM hybrid, Shaktiman 5 was also demonstrated in this season. The FLDs demonstrating management of fall armyworm, conducted at Kolhapur centre, reported 46.1% yield gains. Similarly, FLDs demonstrating the best weed management showed yield advantage of 44.8% at Chhindwara.

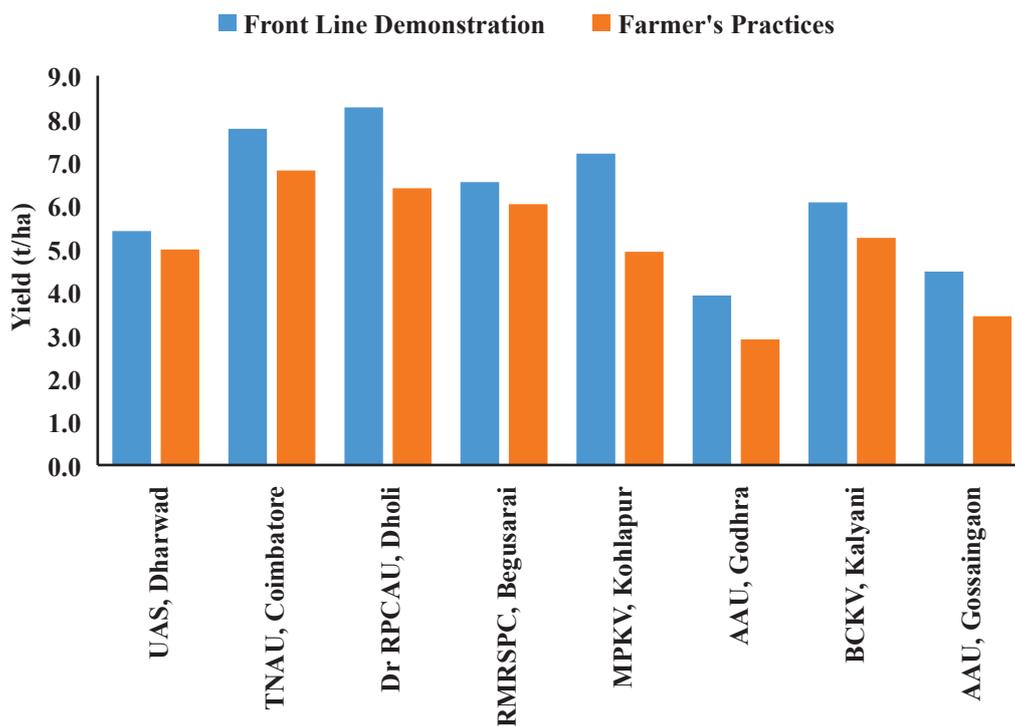


Figure 5.1: Maize yield during *rabi* 2019-2020 in FLDs and farmers' practices

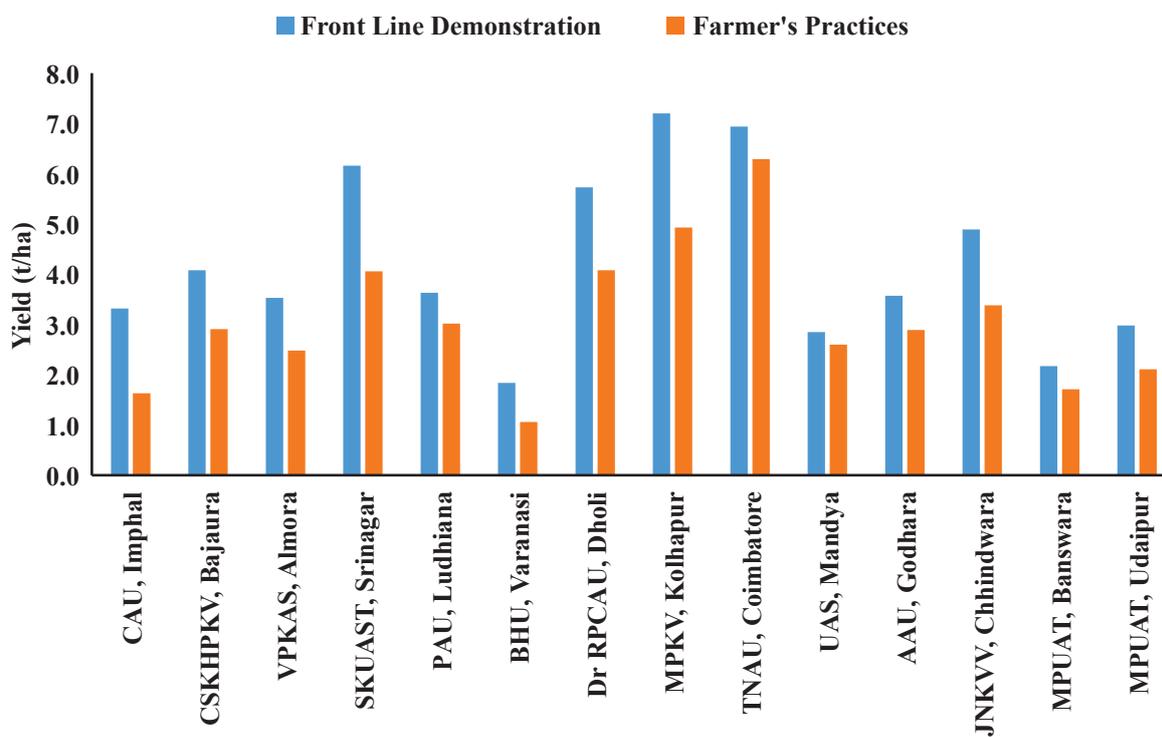


Figure 5.2: Maize yield during *kharif* 2020 in FLDs and farmers' practices



Farmers showing good harvest of the hybrid with herbicide-based weed management in Kashmir

### Scheduled Tribe Component (STC)

Scheduled Tribe Component (STC) funded by ICAR aims to enhance the income and profitability of tribal farmers. The programme was implemented in the tribal-dominated aspirational districts in 16 states, viz., Gujarat, Jharkhand, West Bengal, Uttar Pradesh, Chhattisgarh, Madhya Pradesh, Maharashtra, Rajasthan, Odisha, Telangana, Tamil Nadu, Uttarakhand, Bihar, Himachal Pradesh, Jammu and Kashmir and Manipur. Under the STC, FLDs of *kharif* maize with improved technologies were demonstrated in 238.77 ha in 741 farmers' field. The average yield under FLDs was 4.50 t/ha compared to farmers' practice (3.05 t/ha) with a yield gain of about 47.33 % (Table 5.2). The profitability of hybrid maize cultivation over the upland/midland rice was also demonstrated in 35 ha in two blocks each of Odisha and West Bengal. In Odisha, the monetary gain of the hybrid maize cultivation over the midland rice varied from 24.1 % to 69.2 %, whereas in the upland areas of West Bengal, the gain varied from 36 % to 92 % (Table 5.3).

During 2020, 33 farmers' training/field day/awareness programmes were conducted in different parts of the country, benefiting 1596 tribal farmers on various aspects of scientific



Field day on maize hybrid MAH 14-5 organized by EEU, Nagenahalli Mysore, Mandya

maize cultivation (Table 5.4). Different inputs including seed, biofertilizer/biopesticide/botanical, chemical fertilizer, plant protection chemical, farm implements and farm literature were also distributed to the farmers during these programmes (Table 5.5). Altogether, 1459 households have benefitted from the input distributions.

Table 5.2: FLD performance of *kharif* maize under STC, 2020

Centre	FLD area (ha)	FLD yield (t/ha)	Farmers' practices yield (t/ha)	Yield gains (%)	No. of beneficiaries
BAU, Ranchi	14	6.48	1.81	257.88	70
IGKV, Ambikapur	8	4.48	2.32	92.88	20
MPKV, Kolhapur	40	5.36	4.22	26.93	125
KVK, Chittorgarh, MPUAT	14	4.05	3.50	15.86	35
KVK, Pratapgarh, MPUAT	40	6.88	5.82	18.34	100
KVK, Rajsamand, MPUAT	15.8	1.81	1.45	24.62	79
KVK, Dungarpur, MPUAT	15.6	2.47	1.88	31.46	68
BHU, Varanasi	6.97	4.65	2.08	123.56	29
TNAU, Vagarai	4.4	6.64	5.73	15.88	15
JNKVV, Chhindwara	80	2.15	1.721	25.19	200
<b>Total</b>	<b>238.77</b>	<b>4.50</b>	<b>3.05</b>	<b>47.33</b>	<b>741</b>

**Table 5.3: Profitability of hybrid maize cultivation over upland/ midland rice in eastern India**

Maize	Area (ha)	Upland/ midland paddy	Location	Maize yield (q/ha)	Upland rice yield (q/ha)	Yield gains (%)	Monetary gains (%)
DMH 121	10	MTU 1010	Jeypore, Koraput, Odisha	5.16 ± 1.12	4.09 ± 0.17	25.3 ± 0.41	24.1 ± 0.40
DMH 121	10	MTU 1010	Pottangi, Koraput, Odisha	5.99 ± 0.12	3.52 ± 0.07	70.4 ± 0.50	69.2 ± 0.49
DMH 117	10	MTU 7029	Beldanga – I, Murshidabad, WB	7.09 ± 1.21	5.16 ± 1.54	37.41 ± 3.67	36.09 ± 3.64
P 3378	5	IET-4786	Jalangi, Murshidabad, WB	8.90 ± 1.36	4.59 ± 2.08	94.27 ± 11.89	92.40 ± 10.98

**Table 5.4: Training/field day conducted by AICRP on maize centres under STC programme.**

Centre	Place	Date	Topic	No. of farmers benefitted
IGKV, Chhattisgarh	Ambikapur, RMD CARS, Ambikapur	June 30, 2020	Orientation program on maize production technology	20
OUAT, Odisha	Bhubaneswar, KVK, Gunupur, Rayagada	January 28, 2020	Production technology and Fall armyworm management in maize	40
	KVK, Rayagada, Gunupur, OUAT	March 12, 2020	Kisan mela & farm implement distribution programme	60
BAU, Jharkhand	Ranchi, Kanjagi, Beyasi, Chutiyo and Kullu, Ranchi, Jharkhand	September 25, 2020	Field day on maize	35
BCKV, Bengal	Kalyani, West Bengal, Khoyrasole Birbhum, West Bengal	June 5, 2020	Field day on maize cultivation during <i>kharif</i> season	53
	Panpurya, Binpur 1, Jhargram, West Bengal	June 25, 2020	Training programme on maize cultivation under rainfed, upland condition”	52
BHU, U.P.	Vanarasi, U.P., Kewal, Dudhi, Sonbhadra	September 5, 2020	Training cum field day on maize	30
MPUAT, Rajasthan	Banswara, ARS, Banswara	March 3- 4, 2020	Farmer's awareness training on fall army worm management in maize and production technologies	160
KVK, Rajasthan	Dungarpur, KVK, Faloj, Dungarpur	July 2, 2020	Cultivation technology of maize	28
	Kahari	August 20, 2020	Pest management in maize	44
	Kahari	September 24, 2020	Field day	45
KVK, Rajasthan	Chittorgarh, R.C. Khera and Gundalpur, Barisadri	June 15 -19, 2020	Production technology of maize	35
	Raghunathpura, R.C. Khera, Barisadri	September 29, 2020	Improved production technology of maize	55

Centre	Place	Date	Topic	No. of farmers benefitted
KVK, Pratapgarh, Rajasthan	Hazariguda	September 19, 2020	Integrated nutrient management in <i>rabi</i> maize	35
	Himutapra	December 16, 2020	INM in <i>rabi</i> maize	31
KVK, Rajsamand, Rajasthan	Jegala	June 16, 2020	Improved cultivation of practices of maize	80
	Jivakheda	June 14, 2020	Improved cultivation of practices of maize	35
	Jegala	August 28, 2020	Fertilizer and irrigation management in maize	55
	Jegala	October 3, 2020	Field day on maize	93
Main Maize Research Station, AAU Godhra	Salavada, Lunavada, Mahisagar, Gujarat	December 24, 2020	Scientific maize cultivation practices	50
	Ruyabari, Dahod, Gujarat	December 31, 2020	Scientific maize cultivation practices	60
KVK, Murshidabad, West Bengal	Kishan Mandi, Nowda block, Murshidabad	October 7, 2020	Scientific cultivation of <i>kharif</i> maize under TSP	50
	Asandighi, Nabagram block, Murshidabad	December 9, 2020	Scientific cultivation of <i>rabi</i> maize under TSP	60
Dr. Rajendra Prasad CAU, Dholi, Bihar	बेतिया, पश्चिमी चम्पारण	September 23, 2020	रबी मक्का की उन्नत खेती एवं फसल सुरक्षा	50
	सेमरा, पश्चिमी चम्पारण	December 3, 2020	खाद्य एवं पोषक सुरक्षा हेतु क्वालिटी प्रोटीन युक्त मक्का की उन्नत खेती	50
MPKV, Kolhapur, Maharashtra	Manhere Akole, Ahmednagar	June 14, 2020	Maize cultivation and its importance	45
	Chondwad, Dhadgaon, Nandurbar	June 15, 2020	Importance of maize cultivation and market scope	27
	Umred, Karmala Solapur	June 16, 2020	Maize types and production technology and FAW management	18
	Umred, Karmala, Solapur	August 28, 2020	Maize scope and seed production technology	32
	Chondwad Dhadgaon, Nandurbar	August 29, 2020	FAW symptoms, control measures and maize cultivation	57
	Pimparne, Akole Ahmednagar	August 30, 2020	FAW management, maize cultivation and weather management	48
	Chondwad, Dhadgaon Nandurbar	October 15, 2020	Maize cultivation	32
	Tinkhedi, Pathardi Ahmednagar	October 21, 2020	Maize types and production technology and FAW management	31

**Table 5.5: Distribution of key inputs under Scheduled Tribe Component programme**

Sl. No.	Inputs distributed	Total quantity	Sl. No.	Inputs distributed	Total quantity
1.	Maize seed (kg)	8239	13.	Atrazine (kg)	62
2.	Paddy seed (kg)	250	14.	Phorate (kg)	15
3.	Soya bean (kg)	200	15.	Emamectin Benzoyate (kg)	10
4.	Black gram (kg)	200	16.	Insecticide (l)	10
5.	Cowpea (kg)	30	17.	Regent (kg)	3
6.	Urea (kg)	42510	18.	Plant protection chemical (l)	18
7.	DAP (kg)	27800	19.	Knapsack (no.)	3
8.	MOP (kg)	4121	20.	Pheromone trap (no.)	150
9.	SSP (kg)	16754	21.	Bio-fertilizer culture (Azotobactor+PSB) (kg)	1
10.	Mancozeb (kg)	100	22.	Fertilizer cum seed drill (no.)	3
11.	Chlorantraniliprole (ml)	1200	23.	Neem oil (l)	40
12.	Tombotrin (ml)	1100	24.	Literature (no.)	300



**Field day at Ranchi, Jharkhand**



**Training and Seed distribution under STC at village Simra, West Champaran, Bihar**



**Distribution of farm implement in Kisan Mela at KVK, Gunupur, Rayagada**





Inputs distribution to the tribal farmers of Mahulbhata, Koraput, Odisha



Demonstration at Bariameta, Koraput, Odisha



Distribution of seeds to the tribal farmers group, Vadakarapari, Kodaikanal



Training programme at Panpurya, Binpur 1, Jhargram, West Bengal



Input distribution at Moslia village, Birbhum, West Bengal



Farmer's training at KVK, Chittorgarh



Field Day at Ranchi centre

### Promotion of Maize in North Eastern Hill Region under NEH component

ICAR-IIMR in collaboration with ICAR-Research Complex for North Eastern Hill Region (Umiam), ICAR-National Research Centre on Pig (Guwahati), ICAR-National Research Centre on Yak (Dirang), ICAR-National Research Centre on Mithun (Dimapur) and AICRP on maize centre at CAU (Imphal), CAU-CPGS (Barapani) implemented the NEH programme during 2020. Considering the importance of maize in livestock, a collaborative programme on “Maize production in NEH region for sustainable livestock production” was taken up with National Research Centers working on yak, pig and mithun. The programme has a research component besides demonstration and capacity development of the farmers, state department officials and other stakeholders. This project aimed to assess the effect of supplementation of maize fodder, grain and silage on production performances of pig, yak, and other livestock, with the use of location-specific maize varieties. Promotion of these location-specific maize in the farmers' field was done through technology demonstrations, input distribution and capacity building programmes across all the hill states of North East India.

#### Participatory Technology demonstration under NEH component

Supportive technology demonstrations were conducted in Manipur, Mizoram, Sikkim and Meghalaya covering an area of over 387 ha. The FLDs emphasized on quality protein maize production, crop diversification with sweet corn and cropping intensification with maize *i.e.* intercropping (with groundnut, pea, rice bean, french bean, vegetables etc.) along with scientific management practices (row planting, crop rotation, soil liming and integrated nutrient/water management etc.) against the farmers' practices. In *rabi* season, field pea, vegetable pea, rapeseed and mustard and lentil in maize-based cropping system were demonstrated. The system productivity increased from 20.0 to 95.7% in Manipur under HQPM 5 based cropping system and 133 to 140% in Mizoram under sweet corn based cropping system over farmers' practice. The results indicated the substantial possibility for maize production enhancement with available crop production technologies across the least explored North East Indian hills. Altogether, 1566 farmers benefitted from the technology demonstration.

#### Intensification of maize based cropping system in Manipur

A field experiment was conducted for consecutive three years to assess the impact of intensive cropping system with two levels of tillage practices (conservation tillage and conventional tillage) and cropping systems [(Maize-sweet corn-vegetable pea (CS1), maize-sweet corn-rapeseed and mustard (CS2), maize sweet corn-lentil (CS3), maize-sweet corn-vegetable broadbean (CS4), maize (local)-vegetable pea (local) (CS5) and maize (local) sole cropping)]. After three years of experiment, conservation tillage increased the soil quality (soil carbon dynamics and enzymatic activities),

system productivity, water and energy use efficiency as compared to conventional tillage practices. Among the cropping systems, higher system productivity in terms of maize equivalent yield was recorded in CS4 ( $23.24 \pm 0.73$  t/ha) followed by CS1 ( $23.24 \pm 0.0.53$  t/ha). Consequently, CS4 followed by CS1 and CS3 recorded higher soil quality parameters than CS5 and sole cropping of maize.

#### Potential of maize production in Arunachal Pradesh

Six varieties of maize namely African Tall, QPM (HQPM 1 and Shaktiman 5), sweet corn (NSC-905 P), baby corn (NSC 904 P), and Dirang local were cultivated in two different altitudes, *viz.*, Dirang (5500 ft above mean sea level) and Nyukmadung (9000 ft above mean sea level) with or without using mulch and found out-standing growth of the African Tall variety at mid-altitude (Dirang) than that of high altitude (Nyukmadung). It recorded a total production of 25,000-30,000 kg/ha green fodder per cut @ 2.66kg per m<sup>2</sup>. Amongst the grain varieties, Dirang local variety showed the best results in Dirang campus in comparison to both the varieties of QPM (HQPM 1 and Shaktiman 5) both in farm and field levels. Productivity in other varieties like sweet corn and baby corn also showed satisfactory results. It was also observed that all the varieties performed very poorly in higher altitude, *i.e.*, Nyukmadung situated at 9000 ft above mean sea level, but the use of plastic mulch was found to be effective for the improvement of maize productivity at high altitudes. Moreover, all these varieties were also tried in the farmer's field and satisfactory results were obtained. The maize green fodder cultivated during this period was utilized for feeding farm yaks. Besides, the surplus green maize fodder (almost 12-15 tons) were conserved through ensiling with or without mixing with other forages using concrete silo and polybags and their nutritive values were evaluated in both lactating and growing yaks.

#### Effect of QPM maize fodder supplementation on production performance in Large White Yorkshire grower pigs

Eighteen Large White Yorkshire grower pigs were divided into three groups using randomized block design and they were supplemented with 0, 5 and 10% QPM maize fodder to the basal diet by replacing the maize grains (wt/wt on Dry Matter). The treatments supplementing 0, 5 and 10% QPM were designated as T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub> respectively. The protein content of the experimental diet was  $18.6 \pm 0.3$ ,  $18.5 \pm 0.2$  and  $18.4 \pm 0.1\%$ , while the protein content of QPM maize fodder was  $8.0 \pm 0.04$ . Dry matter intake was found to be similar across the treatment groups. There was no significant difference in nutrient digestibility across the treatment groups. Similarly, there was no significant difference in average daily gain (g/day), feed intake per kg gain (FCR) and feed cost per kg gain. However, FCR and feed cost per kg gain were found better at 5% and 10% supplementation of QPM maize fodder in the diet. Feed cost per kg gain was reduced by Rs. 7.17 and Rs.11.59 at 5% and 10% supplementation of QPM maize fodder by replacing maize grains, in the case of crossbred finisher pigs. (Table 5.6).

**Table 5.6: Effect of supplementation of QPM maize fodder on nutrient utilization in Large White Yorkshire grower pigs**

Sl. No.	Parameters	T1	T2	T3	P-Value
1.	DM intake (g/d)	1319.4 ± 36.4	1313.6 ± 22.6	1316.7 ± 14.3	0.980
2.	Initial weight (kg)	40.9 ± 4.7	41.0 ± 3.4	40.7 ± 4.8	0.996
3.	Final weight (kg)	67.9 ± 2.3	67.9 ± 2.3	67.5 ± 4.4	0.990
4.	Average Daily Gain (g/d)	306.3 ± 29.5	305.7 ± 22.4	304.8 ± 27.6	0.998
5.	FCR	4.4 ± 0.5	4.2 ± 0.3	4.0 ± 0.4	0.661
6.	Feed cost per kg gain (Rs.)	125.9 ± 14.1	118.2 ± 9.1	114.3 ± 11.1	0.661

T<sub>1</sub> = Grower ration containing 0% maize fodder, T<sub>2</sub> = Grower ration containing 5% maize fodder, T<sub>3</sub> = Grower ration containing 10% maize fodder by replacing maize grain; <sup>a,b,c</sup> superscript in a row differ significantly, p<0.05.

**Effect of supplementation of QPM maize grain on production performance of crossbred grower pigs**

Eighteen crossbred (HS × Ghungroo) grower pigs (weight

ranging from 40.4 ± 1.31 to 40.69 ± 3.73 were divided into three groups using randomized block design and they were supplemented with 0, 40% and 60% QPM maize grain by

**Table 5.7: Effect of supplementation of QPM on nutrient utilization in growing crossbred pigs**

Sl. No.	Parameters	T1	T2	T3	P-Value
1.	Feed intake (g/d)	1180.0 ± 37.4	1180.0 ± 20.0	1190.0 ± 10.0	0.949
2.	Initial weight (kg)	40.4 ± 1.3	40.8 ± 2.7	40.7 ± 3.7	0.992
3.	Final weight (kg)	54.8 ± 1.2	55.2 ± 2.7	54.7 ± 3.7	0.992
4.	Growth (d)	319.8 ± 33.5	321.8 ± 9.7	310.4 ± 7.1	0.917
5.	FCR	3.8 ± 0.3	3.7 ± 0.2	3.8 ± 0.1	0.917
6.	Feed cost/kg gain (Rs.)	102.3 ± 7.5	98.0 ± 4.2	100.9 ± 1.9	0.832

T<sub>1</sub> = 0% replacement of normal maize with QPM, T<sub>2</sub> = 40% replacement of normal maize with QPM, T<sub>3</sub> = 60% replacement of normal maize with QPM

replacing the normal maize in the basal diet, and the supplemented treatments were designated as T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub>, respectively. The protein content of the experimental diet was 18.4 ± 0.02, 18.1 ± 0.2 and 18.1 ± 0.3%, respectively in T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub> groups, while the protein content of QPM maize grain was 9.4 ± 0.2. Dry matter intake was found similar across the treatment groups. There was no significant difference in nutrient digestibility across the treatment groups. Similarly, there was no significant difference in average daily gain (g/day), feed intake per kg gain (FCR) and feed cost per kg gain. However, FCR and feed cost per kg gain were found better at 40% and 60% replacement of normal maize with QPM maize in the diet. Feed cost per kg gain was reduced by Rs. 4.30 and Rs. 1.40 at 40 and 60% replacement of normal maize with QPM in crossbred grower pigs (**Table 5.7**).

**Effect of supplementation of QPM maize silage on production performance in crossbred grower pigs**

Eighteen crossbred (HS × Ghungroo) grower pigs were

divided into three groups using randomized block design and they were supplemented with 0, 5 and 10% QPM maize silage in the basal diet by replacing the maize grains (wt/wt on Dry Matter), and the supplemented treatments designated as T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub>, respectively. The protein content of the experimental diet was 18.3 ± 0.1, 18.2 ± 0.2 and 18.3 ± 0.1%, while protein content of QPM maize silage was 17.63 ± 0.13. Dry matter intake was found similar across the treatment groups. There was no significant difference in nutrient digestibility across the treatment groups except crude fiber digestibility which is decreased (P<0.05) significantly in T<sub>3</sub> groups in comparison to T<sub>1</sub> and T<sub>2</sub> groups. Similarly, there was no significant difference in average daily gain (g/day), feed intake per kg gain (FCR) and feed cost per kg gain. However, FCR and feed cost per kg gain were found better at 5% supplementation of maize silage in the diet. Feed cost per kg gain was reduced by Rs. 2.98 at 5% supplementation of QPM maize silage by replacing maize grains in crossbred grower pigs (**Table 5.8**).

**Table 5.8: Effect of supplementation of QPM maize silage on Nutrient utilization in crossbred grower pigs.**

Sl. No.	Parameters	T1	T2	T3	P-Value
1.	DMI (g/d)	1150.0 ± 22.4	1180.0 ± 20.0	1140.0 ± 18.7	0.383
2.	Initial Weight (kg)	54.8 ± 1.2	55.2 ± 2.7	54.7 ± 3.7	0.987
3.	Final Weight (kg)	67.1 ± 1.4	68.2 ± 2.5	66.9 ± 3.8	0.938
4.	Average Daily Gain (g/d)	308.5 ± 11.6	323.0 ± 15.1	305.0 ± 34.8	0.842
5.	FCR	3.8 ± 0.14	3.7 ± 0.12	3.9 ± 0.5	0.805
6.	Feed cost per kg gain (Rs.)	100.7 ± 3.8	97.7 ± 3.3	103.5 ± 12.02	0.867

T<sub>1</sub> = 0% replacement of normal maize with QPM maize silage, T<sub>2</sub> = 5% replacement of normal maize with QPM maize silage, T<sub>3</sub> = 10% replacement of normal maize with QPM maize silage,

**Evaluation of nutritive values of maize fodder and QPMs in lactating and growing yaks**

Four feeding trials (two each in growing and lactating yaks) were conducted to evaluate the nutritive values of maize fodder and QPMs produced in Arunachal Pradesh. The QPM maize grain produced from Shaktiman 5 variety was utilized for the feeding trial to replace normal maize in the concentrate ration of both growing and lactating yaks. The study was conducted at Nyukmadung farm of ICAR-National Research Centre on Yak, West Kameng, Arunachal Pradesh situated at an altitude of 8500 ft above mean sea level. The salient findings of the experimental were as follows:

- Maize silage was beneficial in comparison to green maize fodder in terms of its nutritive value and productivity for both growing and lactating yaks.
- Complete substitution of normal maize with QPM in the concentrate mixture of growing yaks had beneficial effects in growth, feed efficiency, nutrient digestibility, and the plane of nutrition.
- Incorporation of QPM in the concentrate mixture had no significant effect on the performances of lactating yaks in terms of their milk yields, nutrient digestibility and plane of nutrition. However, it improved the average daily gain and feed efficiencies both in growing and lactating yaks.



**Awareness programme of scientific maize cultivation at Dirang, Arunachal Pradesh**



**Harvested Baby corn and HQPM 1 in field at Dirang, Arunachal Pradesh**



Maize field with African tall variety as fodder for Yak at Dirang, Arunachal Pradesh



Training on cultivation practices of sweet corn & baby corn and monitoring and management of fall armyworm by CPGSAS, CAU(I), Umiam, Meghalaya



Capacity building programmes organized by AICRP-Maize, Imphal Centre



**Training programme at Tupul, Tamenglong, Manipur organized by ICAR-RCNEH, Imphal Centre**



**Demonstration of maize (HQPM-5) in Ukhrul district of Manipur by ICAR-RCNEH, Imphal Centre**

### Sweet corn cultivation secured high profit among the tribal farmers of Mizoram: Success Story

Maize is one of the principal cereals grown in the shifting cultivation (*jhum*) lands of Lusai Hills of Mizoram. The majority of the local *jhum* maize cultivars grown by farmers here are of low yield and long duration. The local food preference (taste) of these low yielder sticky maize lines (*mimban*; yield 1.04-2.84 kg/sq.m) limits large-scale adaptation of other high yielding maize hybrids in the *jhum* lands of Mizoram. ICAR-Indian Institute of Maize Research, PAU Campus, Ludhiana in collaboration with ICAR Research Complex for NEH Region, Umiam, Meghalaya introduced a project “Promoting improved technology of maize production in NEH Region” to out-scale improved maize production technologies in the region. Under this programme sweet corn cultivation was introduced among the farmers practicing both *jhum* (rainfed) and settled agriculture (in the low lying areas in *rabi* season). Farmers fetched a steep rise in their annual income from the year round large scale sweet corn cultivation.

At Tuichhuahen village (Kolasib District), the existing cultivation of local *jhum mimban* lines was replaced by the sweet corn under the project compliance. Farmers have cultivated sweet corn replacing local *mimban* under slash and burn agriculture in the steep hill slopes without any fertilizer application or use of plant protection chemicals during the pre-*kharif* season. Farmers in the nearby low lying valley areas of Tuichhuahen village also adapted the standardized package

of practices for growing the *rabi* sweet corn in the rice fallows (September to February). The introduction of sweet corn cultivation during early 2018 resulted in the gradual expansion in the maize area, particularly under the *rabi* sweet corn cultivation in the nearby streambed areas of Tuichhuahen village (29.3% increase over past two years). Many of the regular large scale sweet corn growers (mostly October sown) harvested their produce (green tender cobs) periodically from 4<sup>th</sup> week of January to 2<sup>nd</sup> fortnight of February in Tuichhuahen village. Many farmers have replaced the traditionally grown *rabi* crops such as french bean-rajma and mustard etc. Since 2018, a total of 16.3 ha area was covered under participatory demonstration and 62 beneficiaries were benefited under the collaborative project. Farmers have earned 110.3% more from *jhum* sweet corn cultivation over the traditional cultivation practice of local sticky type *mimban* lines in past years. The average increase in net earning varied between 32.5% (french bean) – 73.2% (vegetable mustard) for sole *rabi* sweet corn cultivation over the traditionally practiced *rabi* vegetable (local) cropping options. Moreover, sweet corn farming at subsistence with multiple sowing windows secured about 20.6% over single sowing window, particularly during COVID 19 lockdown due to rise in market price by about 26% marginal from the sudden disruption of normal supply chain. Thus, it is evident that sweet corn cultivation has considerable potential in increasing the net farming profitability (~68%) for the tribal farmers' in Mizoram.



**Sweet corn cultivation at Tuichhuahen village Kolasib, Mizoram**



### Capacity building activities under NEH component

Under the NEH component, 28 training programmes were organized in collaboration with different institutes for the maize growers in North-Eastern India (Table 5.9). The major theme of the training programmes was concentrated on the scientific maize cultivation technologies, integrated pest management, integrated nutrient, and water management, adaptation of high-yielding varieties (including sweet corn and baby corn cultivation) and post-harvest management under upland conditions. Maize cultivation for improving the livestock production system was also emphasized for improving the livelihood and nutrition security of marginal and small farmers in North East India. Altogether, 1517 beneficiaries participated in the training programmes. Apart from this, the input including maize seed, fertilizer, pulses, and oilseed crop seeds and small farm implements were distributed under the NEH programme, benefitting 504 rural households (Table 5.10).



Maize (HQPM-5) harvest from farmer's fields in Manipur

Table 5.9: List of training programme conducted under NEH component

Institute	Date	Place	Title of the training/ awareness programme	Number of participants
ICAR-NRC on Yak, Dirang (Arunachal Pradesh)	May 2, 2020	Dirang, West Kameng	Maize production potentiality in NER	19
	May 4, 2020	Dirang, West Kameng	Awareness programme on "Maize production potentiality in NER"	39
	July 12, 2020	Dirang, West Kameng	Awareness programme on "Maize production potentiality in NER"	4
	August 24, 2020	Dirang, West Kameng	Awareness programme on "Maize production potentiality in NER"	6
	October 2, 2020	Dirang, West Kameng	Scientific production of maize in Arunachal Pradesh	23
Central Agricultural University, Imphal (Manipur)	January 28, 2020	Siden village, Churachandpur	Promotion of scientific maize cultivation in Manipur	40

Institute	Date	Place	Title of the training/ awareness programme	Number of participants
Central Agricultural University, Imphal (Manipur)	January 30, 2020	Tongou village, Ukhrul	Promotion of scientific maize cultivation in Manipur	80
	February 1, 2020	Sangaitheh Makha Leikai, Imphal West	Scientific cultivation of maize technology in NEH region of India	33
	February 4, 2020	Nongbram, Imphal East	Scientific cultivation of maize technology in NEH region of India	40
	February 3, 2020	Leimaram, Bishnupur	Biological management of insect pest in maize	30
CPGSAS, CAU(I), Umiam, (Meghalaya)	March 5-6, 2020	College of Agriculture, CAU (I), Kyrdemkulai, Meghalaya	Awareness programme on "Scope, importance & cultivation of specialty corn and monitoring & management of maize pest Fall armyworm in Meghalaya in "Farmers Innovation Expo-2020"	289
	March 18, 2020	Umjalasiaw Village, West Jaintia Hill, Meghalaya	Cultivation practices of sweet corn & baby corn and monitoring and management of Fall armyworm	35
	August 5, 2020	Mawkyrwat Block, South West Khasi Hill District, Meghalaya	Cultivation practices of sweet corn & baby corn and monitoring and management of Fall armyworm	18
ICAR RC for NEH, Umiam (Meghalaya)	February 28 – March 1, 2020	Lembucherra, ICAR Tripura Centre, Tripura	Maize as food -feed crop	300
	March 4-5, 2020	Lamphelpat, Imphal, Manipur	Enhancing maize productivity through improved maize-based technologies	40
	March 9-10, 2020	Tupul, Tamenglong, Manipur	Two days Improved maize production technologies for ensuring food, feed and fodder	40
	May 18, 2020	Hee Patal, Peechrek West Sikkim	Input distribution cum training program	20
	June 5, 2020	Hazrapara, Khowai, Tripura	Technological guidance and distribution of high yielding summer vegetable seed as remedial measures for farmer during lockdown period	100

Institute	Date	Place	Title of the training/ awareness programme	Number of participants
ICAR RC for NEH, Umiam (Meghalaya)	June 22, 2020	Mawsiatkhnem Vill., East Khasi Hill District, Meghalaya	Trainings cum awareness programme on maize cultivation	20
	June 23, 2020	Kyrdem village, Ri-Bhoi District, Meghalaya	Trainings cum awareness programme on maize cultivation	20
	June 24, 2020	Mynsain village, Ri-Bhoi District, Meghalaya	Trainings cum awareness programme on maize cultivation	20
	June 25, 2020	Pynthor village, Ri-Bhoi District, Meghalaya	Trainings cum awareness programme on maize cultivation	20
	September 29-30, 2020	Monsangpantha, Chandel, Manipur	Cultivation of sweet/baby corn in maize based cropping system to ensure 300% cropping intensity	30
	October 7, 2020	Lamphelpat, Imphal, Manipur	Cultivation of sweet corn in maize based cropping system	20
	December 8, 2020	Kumbi Bazar, Bishnupur, Manipur	Rabi Crops campaign (maize and pulses)	153
	December 20, 2020	Hmawngkawn village, Serchhip, Meghalaya	Sweet corn cultivation for daily livelihood improvement of <i>jhum</i> farmers in Mizoram	32
	December 23, 2020	Kwakeithel, Imphal Manipur	Awareness cum training programme on <i>rabi</i> maize cultivation	20
	December 21, 2020	Ramther village, Lunglei, Meghalaya	Sweet corn cultivation for daily livelihood improvement of <i>jhum</i> farmers in Mizoram	26

**Table 5.10: Input distribution to farmers under NEH component**

Sl. No.	Inputs distributed	Total quantity	Sl. No.	Inputs distributed	Total quantity
1.	Maize seed (kg)	2308.9	7.	Single Super Phosphate (kg)	16100
2.	Groundnut (kg)	24	8.	Murate of Potash (kg)	5900
3.	Soya bean (kg)	10	9.	Agri tools (no.)	2
4.	Green gram (kg)	7	10.	Nylon pipe (no.)	7
5.	Cowpea (kg)	2.5	11.	Spray machine (no.)	2
6.	Urea (kg)	13200	12.	Sickles (no.)	15

### SCSP programme

The SCSP (Scheduled Caste Sub Plan) has been started by the Government of India to benefit the farmers of scheduled caste (SC) communities of the country. The institute implemented SCSP plan in maize to benefit the maize growing farmers of

SC communities. A total of eight trainings or agricultural inputs distributions programmes were conducted and 417 farmers benefited from different AICRP centres under the SCSP plan during the year 2020 (Table 5.11). Various inputs were provided to farmers under the SCSP plan for strengthening the capacity for maize cultivation (Table 5.12).

**Table 5.11: Training and input distribution programme organized under SCSP**

Sl. No.	Centre/State	Date (s)	Title	Number of beneficiaries
1	TNAU, Coimbatore	February 6, 2020 & February 26, 2020	Maize production and FAW management technologies	50
2	Maize Research Centre, PJTSAU, Rajendranagar	July 6 & 9, 2020	Maize and production technologies, mechanization and Fall armyworm management	50
3	Rani Lakshmi Bai Central Agricultural University, Jhansi	July 22, 2020	Kharif maize production technology	120
4	D h a a n y a G a n g a Krishi Vigyan Kendra, Sargachhi, Murshidabad, West Bengal	August 21, 2020	Frontline demonstration and farmers' training on cultivation of <i>kharif</i> maize under SCSP plan	27
5	Rani Lakshmi Bai Central Agricultural University, Jhansi	August 11, 2020	Insect pest management and production technology of <i>kharif</i> maize in Bundelkhand Region	130
6	Agricultural Research Station, Peddapuram	December 11, 2020	Hybrid seed production in Maize	40

**Table 5.12: Distribution of quality seed and inputs for conduct of demonstrations under SCSP programme**

Sl. No.	Inputs distributed	Total quantity
1.	Maize seed (kg)	2290
2.	Hand operated sprayer (no.)	126
3.	Tarpaulin (no.)	75
4.	Spade (no.)	50
5.	Plastic basket (no.)	50
6.	Pheromone trap + Lure (no.)	289
7.	Storage bin (100 kg capacity)	50

Sl. No.	Inputs distributed	Total quantity
8.	Training display units	10
9.	Urea (kg)	1368.5
10.	SSP (kg)	4872.6
11.	MOP (kg)	483.0
12.	Novaluron 5.25% + Emamectin-benzoate 0.9% SC (250 ml pack)	72



**Two days training cum input distribution program on maize production and FAW management technologies at AICRP TNAU, Coimbatore**



Distribution of assets to the farmers at Maize Research Centre, PJTSAU, Hyderabad



Dr. PV Satyanarayana, Associate Director of Research, Godavari Zone, RARS, Maruteru, Andhra Pradesh addressing the farmers



Sprayers and insecticide distributions under SCSP Plan at Dhaanyaganga KVK, Murshidabad, West Bengal



Frontline demonstrations of kharif maize under SCSP at Dhaanyaganga KVK, Murshidabad, West Bengal



Training on maize production technologies at Pedashapur, RR District for farmers of Kacharam and Bhemaram villages





**Trainings and demonstrations organized under SCSP by Rani Lakshmi Bai Central Agricultural University, Jhansi**

**Extension activities/Technologies demonstration/Inputs distribution**

Under NICRA-SCSP ICAR-IIMR in collaboration with CSKHPKV, Palampur, Himachal Pradesh, distributed four

corn threshers among the farmers of villages having around 200 backward farmer families in District Chamba, Himachal Pradesh on March 20-21, 2020.



**Distribution of corn threshers among the farmers at Chamba district of Himachal Pradesh**

**Gluten-free maize-based chapattis, as an initiative under Agri-business Incubation Centre**

Flat breads (*chapattis*) are usually consumed by most of people particularly in Northern India. The flat breads are traditionally prepared from whole wheat flour. The wheat flour is easily amenable for dough making due to the presence of gluten but it has been reported to be allergic in many individuals. Maize is devoid of gluten and generally requires some binding agents to prepare different products. However, focus was made on the development of flat bread without the addition of any binding agents. Gluten free maize based unleavened flat breads were prepared from different maize genotypes, viz., orange normal maize hybrid (PMH 10, MCFL 15 and MCFL 346), white maize (white hybrid 574), white maize populations (593 landraces) and QPM hybrids (IQPMH 1708 and IQPMH 1705). The analysis of its proximate

composition, amino acids using standard methods was performed using SAS (version 9.0) software. The results showed that significant differences ( $P = 0.05$ ) were present in moisture, fat, protein and carbohydrate mean score values. The moisture, fat, protein, ash, fiber and carbohydrate content (%) in the flour sample are given in (Table 5.13) and for chapattis is given in (Table 5.14). The amino acids such as lysine and tryptophan content also showed a significant difference between flour and *chapattis* (Table 5.15). A higher level of lysine and tryptophan was observed in genotype IQPMH 1705 followed by IQPMH 1708. The amino acid content was found to be lower in *chapatti*, which might have reduced during the baking process. Sensory analysis was also performed using hedonic scales with skilled panelists in triplicates (Table 5.16). The acceptability test revealed that chapattis prepared from IQPMH 1705 and IQPMH 1708 were highly acceptable for all sensory attributes.

**Table 5.13: The proximate composition of flour made from different maize varieties**

Sl. No.	Genotype	Moisture	Fat	Protein	Ash	Fiber	Carbo-hydrates
1.	PMH 10	5.1 ± 0.01 <sup>A</sup>	4.1 ± 0.2 <sup>D</sup>	8.47 ± 0.05 <sup>E</sup>	1.90 ± 0.16 <sup>A</sup>	1.34 ± 0.10 <sup>A</sup>	79.10 ± 0.20 <sup>C</sup>
2.	IQPMH 1708	3.4 ± 0.2 <sup>E</sup>	4.57 ± 0.08 <sup>B</sup>	8.08 ± 0.03 <sup>F</sup>	1.28 ± 0.07 <sup>B</sup>	1.10 ± 0.03 <sup>B</sup>	80.97 ± 0.10 <sup>B</sup>
3.	IQPMH 1705	4.2 ± 0.1 <sup>C</sup>	5.13 ± 0.10 <sup>A</sup>	8.38 ± 0.54 <sup>EF</sup>	1.27 ± 0.10 <sup>B</sup>	1.10 ± 0.00 <sup>B</sup>	78.62 ± 0.23 <sup>C</sup>
4.	MCFL 15	3.0 ± 0.1 <sup>F</sup>	4.47 ± 0.20 <sup>B</sup>	9.58 ± 0.19 <sup>C</sup>	1.19 ± 0.14 <sup>B</sup>	1.36 ± 0.00 <sup>A</sup>	78.94 ± 0.14 <sup>C</sup>
5.	MCFL 346	3.8 ± 0.1 <sup>D</sup>	4.20 ± 0.18 <sup>CD</sup>	8.88 ± 0.03 <sup>D</sup>	1.24 ± 0.04 <sup>B</sup>	1.13 ± 0.01 <sup>B</sup>	80.76 ± 0.25 <sup>B</sup>
6.	White Hybrid 574	4.6 ± 0.1 <sup>B</sup>	4.45 ± 0.13 <sup>BC</sup>	10.18 ± 0.04 <sup>B</sup>	1.08 ± 0.05 <sup>B</sup>	1.17 ± 0.00 <sup>B</sup>	78.56 ± 0.19 <sup>C</sup>
7.	593 Landraces	3.4 ± 0.04 <sup>E</sup>	4.90 ± 0.10 <sup>E</sup>	10.88 ± 0.03 <sup>A</sup>	0.45 ± 0.58 <sup>C</sup>	1.13 ± 0.01 <sup>B</sup>	83.20 ± 0.70 <sup>A</sup>

#Treatments sharing same alphabets are having similar effects and treatments with different alphabets are significantly different from each other

**Table 5.14: The proximate composition of chapattis made from different maize varieties flour**

Sl. No.	Genotype	Moisture	Fat	Protein	Ash	Fiber	Carbo-hydrates
1.	PMH 10	24.82 ± 0.76 <sup>C</sup>	3.93 ± 0.35 <sup>B</sup>	8.18 ± 0.06 <sup>E</sup>	1.48 ± 0.04 <sup>C</sup>	1.06 ± 0.01 <sup>B</sup>	60.53 ± 0.51 <sup>A</sup>
2.	IQPMH 1708	31.15 ± 1.68 <sup>A</sup>	4.57 ± 0.08 <sup>AB</sup>	8.33 ± 0.32 <sup>E</sup>	1.53 ± 0.01 <sup>B</sup>	0.98 ± 0.13 <sup>B</sup>	53.70 ± 1.64 <sup>B</sup>
3.	IQPMH 1705	26.52 ± 3.31 <sup>BC</sup>	4.83 ± 0.56 <sup>A</sup>	9.63 ± 0.26 <sup>C</sup>	1.71 ± 0.01 <sup>A</sup>	0.18 ± 0.00 <sup>D</sup>	58.93 ± 3.32 <sup>A</sup>
4.	MCFL 15	24.67 ± 0.52 <sup>C</sup>	4.37 ± 0.37 <sup>AB</sup>	10.05 ± 0.31 <sup>AB</sup>	1.67 ± 0.00 <sup>A</sup>	1.26 ± 0.06 <sup>A</sup>	59.48 ± 0.93 <sup>A</sup>
5.	MCFL 346	25.95 ± 2.96 <sup>C</sup>	4.00 ± 0.49 <sup>B</sup>	8.73 ± 0.02 <sup>D</sup>	1.41 ± 0.03 <sup>D</sup>	0.99 ± 0.04 <sup>B</sup>	58.92 ± 2.49 <sup>A</sup>
6.	White Hybrid 574	28.27 ± 2.90 <sup>ABC</sup>	4.53 ± 0.12 <sup>AB</sup>	9.95 ± 0.02 <sup>BC</sup>	1.46 ± 0.02 <sup>C</sup>	1.02 ± 0.00 <sup>B</sup>	54.78 ± 2.93 <sup>B</sup>
7.	593 Landraces	29.91 ± 0.09 <sup>AB</sup>	4.53 ± 0.47 <sup>AB</sup>	10.38 ± 0.03 <sup>A</sup>	1.36 ± 0.02 <sup>E</sup>	0.55 ± 0.01 <sup>C</sup>	53.27 ± 0.48 <sup>B</sup>

#Treatments sharing same alphabets are having similar effects and treatments with different alphabets are significantly different from each other

**Table 5.15: Amino acid analysis of maize flour and chapattis**

Sl. No.	Genotype	Flour		Chapatti	
		Lysine	Tryptophan	Lysine	Tryptophan
1.	PMH 10	1.77 ± 0.08	0.44 ± 0.02	1.64 ± 0.11 <sup>B</sup>	0.41 ± 0.02 <sup>B</sup>
2.	IQPMH 1708	4.12 ± 0.14	1.03 ± 0.04	4.28 ± 0.07 <sup>A</sup>	1.07 ± 0.02 <sup>A</sup>
3.	IQPMH 1705	4.76 ± 0.21	1.19 ± 0.05	4.44 ± 0.12 <sup>A</sup>	1.11 ± 0.03 <sup>A</sup>
4.	MCFL 15	1.64 ± 0.11	0.41 ± 0.02	1.4 ± 0.14 <sup>C</sup>	0.35 ± 0.04 <sup>C</sup>
5.	MCFL 346	1.84 ± 0.17	0.46 ± 0.04	1.64 ± 0.08 <sup>B</sup>	0.41 ± 0.02 <sup>B</sup>
6.	White Hybrid 574	1.53 ± 0.12	0.38 ± 0.03	1.8 ± 0.11 <sup>B</sup>	0.45 ± 0.02 <sup>B</sup>
7.	593 Landraces	1.39 ± 0.08	0.35 ± 0.02	1.68 ± 0.11 <sup>B</sup>	0.42 ± 0.02 <sup>B</sup>

#Treatments sharing same alphabets are having similar effects and treatments with different alphabets are significantly different from each other

**Table 5.16: Sensory attributes of maize *chapattis* from different genotypes**

Sl. No.	Genotype	Color	Aroma	Taste	Overall Acceptability
1.	PMH 10	6 ± 0.00 <sup>AB</sup>	6.3 ± 1.15 <sup>A</sup>	6.3 ± 0.58 <sup>AB</sup>	6 ± 0.5 <sup>A</sup>
2.	IQPMH 1708	7.3 ± 0.58 <sup>A</sup>	7 ± 0.00 <sup>A</sup>	7 ± 1.00 <sup>A</sup>	7 ± 0.4 <sup>A</sup>
3.	IQPMH 1705	7.7 ± 1.53 <sup>A</sup>	6 ± 1.73 <sup>AB</sup>	7 ± 1.00 <sup>A</sup>	7 ± 1.4 <sup>A</sup>
4.	MCFL 15	5 ± 1.00 <sup>BC</sup>	4.3 ± 1.15 <sup>BC</sup>	4.7 ± 0.58 <sup>C</sup>	5 ± 0.3 <sup>B</sup>
5.	MCFL 346	6.3 ± 1.53 <sup>AB</sup>	3.3 ± 1.15 <sup>C</sup>	5 ± 1.00 <sup>BC</sup>	5 ± 0.4 <sup>B</sup>
6.	White Hybrid 574	4 ± 1.73 <sup>C</sup>	5.3 ± 0.58 <sup>AB</sup>	5.7 ± 0.58 <sup>ABC</sup>	5 ± 0.3 <sup>B</sup>
7.	593 Landrace	4 ± 0.00 <sup>C</sup>	5.3 ± 0.58 <sup>AB</sup>	5.7 ± 1.53 <sup>ABC</sup>	5 ± 0.6 <sup>B</sup>

#Treatments sharing same alphabets are having similar effects and treatments with different alphabets are significantly different from each other

### **Farmers Advisory during COVID-19 Pandemic**

Farmers across the globe have become victims of the COVID-19. ICAR-IIMR has played its part to minimize the impact of COVID-19 and lockdown among the maize farmers. The institute prepared a document regarding advisory to maize farmers on general precautions and safety measures in farm operations and general guidelines to contain COVID-19 along with agro-advisories on different aspects of maize cultivation. The document was translated into nine regional languages and disseminated among farmers through newspapers, local channels, All India Radio, local Radio Station, WhatsApp groups and Facebook, etc..

### **Mera Gaon Mera Gaurav (MGMG)**

ICAR-IIMR and its regional stations implemented the MGMG programme in 29 villages adopted in the five blocks of Punjab, Haryana, Bihar and Telangana. The eight teams having 30 scientists were in regular touch with the farmers of these villages through visits, messages, email, phone calls, etc. Under MGMG, literature support was provided on best maize production practices and fall armyworm management to the farmers. Due to prevailing COVID-19, experts responded to

lockdown situations farmer's query over the phone by call/SMS or WhatsApp. These queries included FAW management, varietal selection for spring maize and specialty corn, seed rate, tillage methods, weed management in standing maize. The mobile advisory also included meteorology weekly weather forecast of Telangana state to Sarvodaya Vikas Mandalii, crop production, measures to be taken to overcome COVID-19 situation, improved package of practices for higher yields of maize to Sarvodaya Vikas Mandalii, nutrient and weed management, choice of cultivar and sowing methods and zero tillage maize cultivation. The unavailability of hybrid seed at affordable prices, weed menace, poor irrigation facility and lack of awareness on recommended package of practices were found to be the major constraints in maize cultivation. General awareness was also created on package of practices for higher yields of maize, management of fall armyworm in maize through updated strategies, maize seed production, cleanliness, and COVID-19 precautionary measures. Linkages with Maize Research Centre, PJTSAU, Hyderabad, Telangana and Sri Sathya Sai village Integrated programme were developed and the joint collaborated programme benefitted 80 farmers.



# All India Coordinated Research Project On Maize

## ICAR holds Online Workshop of AICRP on Maize

20-22 April, 2020, New Delhi

The Indian Council of Agricultural Research, New Delhi conducted the "63<sup>rd</sup> Online Workshop of the ICAR-All India Coordinated Research Project on Maize" from 20<sup>th</sup> to 22<sup>nd</sup> April, 2020. The online workshop was organized to contain the spread of the deadliest Coronavirus Disease-19 (COVID-19).

In his Plenary Session address through Video Conferencing, Dr. Trilochan Mohapatra, Secretary (DARE) & DG

(ICAR) emphasized on the importance of ICAR-Indian Institute of Maize Research, Ludhiana, Punjab for carrying out the basic, strategic and applied research to enhance the crops' production, productivity and its sustainability. Dr. Mohapatra stressed on the need for the ICAR-AICRP on Maize to play a leadership role for making maize a future crop of the country.



*Information of AICRP on Maize online workshop on ICAR website*

# ALL INDIA COORDINATED RESEARCH PROJECT ON MAIZE



All India Co-ordinated Research Project (AICRP) on Maize was established in 1957. This is the nodal agency to co-ordinate maize research in the country. The objective of AICRP on Maize is to develop and disseminate the high yielding maize cultivars along with protection and production technologies throughout the country. To execute the activities under AICRP the country is divided into five zones, viz., Northern Hilly Zone (NHZ), Northern Western Plain Zone (NWPZ), North Eastern Plain Zone (NEPZ), Peninsular Zone (PZ) and Central Western Zone (CWZ). At present, the AICRP on maize consists of 32 centres and 30 volunteer centres throughout country for testing newly developed technologies.

## AICRP trials conducted during the year

### Rabi trials 2019-20 - Breeding

During *rabi* 2019-20, National Initial Varietal Trials (NIVT), Advance Varietal Trial-I (AVT I) and Advance Varietal Trial-II (AVT-II) breeding trials of normal maize, specialty corn, QPM trials, entomology and pathology trials were constituted. There were 7 trials in breeding, 24 in pathology and two in entomology. In breeding there were two trials in NIVT, three in AVT, one in QPM and one in popcorn. A new trial was constituted specifically for spring season and these trials were conducted at three centres of north Indian states, viz., Ludhiana, Karnal, Delhi and Pantnagar keeping in mind the

popularity of spring maize in these areas. Two trials one each of breeding and pathology were conducted during spring 2020.

During *rabi* 2019-20, a total of 109 entries were received for multi-location testing in late, medium maturity, pop corn and QPM trials (**Table 6.1**). Out of 109 entries, 75 entries were evaluated in NIVT, 12 in AVTI-II-Medium, 8 in AVT-I-Late and 6 in AVT-II-Late, four in QPM and four in pop corn trials. Further in NIVT, out of 75, 30 entries were tested in Late and 45 in medium maturity. In normal maize a total of 32 entries were promoted for testing for next stage. Six entries were promoted from NIVT-Medium, 11 from NIVT-Late, 7 from AVT-I-Medium to AVT-II-Medium and 8 from AVTI-Late to AVT-II-Late and four entries were promoted in popcorn trial. During *rabi* 2019-20, the success rate from different zone was 91%, 89%, 100% and 100% for North Western Plain Zone (NWPZ), North Eastern Plain Zone (NEPZ), Peninsular Zone (PZ), respectively (**Table 6.2**). In addition to the *rabi* trials, spring trials were also conducted in North Western Plain Zone (NWPZ). Eleven entries of medium maturity were tested with six checks in NIVT trial at PAU, Ludhiana, CCSHAU, Karnal, GBPUAT, Pantnagar (**Table 6.3**). Out of 11 entries, only two entries, viz., VNR 37753 and HT 20185 were promoted for testing in AVT-I during spring 2021.

**Table 6.1: Details of the breeding trials constituted in *rabi* 2019-20**

Sl. No.	Trial	Entries + Checks	No. of locations
1.	NIVT-Late	30 + 3	24
2.	NIVT-Medium	45 + 3	24
3.	AVT- I-II-Medium	12 + 3	27
4.	AVT-I-Late	8 + 3	27
5.	AVT-II-Late	6 + 3	27
6.	QPM	4 + 4	24
7.	Popcorn	4 + 4	24

**Table 6.2: Details of success rate (%) in reporting the data in *rabi* 2019-20**

Sl. No.	Zone	No. of Centers	Trials allotted	Trials Reported	Success rate (%)
1.	NWPZ	6	34	31	91
2.	NEPZ	10	54	48	89
3.	PZ	9	59	59	100
4.	CWZ	2	14	14	100

**Table 6.3: Details of the breeding trials constituted in spring 2020**

Trial	Entries + Checks	No. of locations
NIVT-Medium	11 + 6	4

### **Kharif trials 2020 - Breeding**

During *kharif* 2020, total of 35 different breeding trials was constituted. One set of trial was exclusively for Northern Hill Zone (NHZ) and the others were for the rest of the zones. In NHZ, total 9 trials were conducted which included NIVT-Medium, NIVT-Early, AVT-I-Medium, AVT-Early, QPM-I-II-II, Sweet corn-I-II-III and, Baby corn-I-II-III and Popcorn-I-II-III and OPV trials. Total of seven trials viz. NIVT-Late, NIVT-Medium, NIVT-Early, QPM-I-II-II, Sweet corn-I-II-III, Baby corn-I-II-III and Popcorn-I-II-III were constituted across the zones. In zone specific trials 6 trials including AVT-II-Late, AVT-I-Late, AVT-II-Medium, AVT-I-Medium, AVT-I-Early and Quality trial, three trials including AVT-I-Late, AVT-I-Medium and AVT-I-II-Early, five trials including AVT-I-Late, AVT-I-Medium, AVT-II-Medium, AVT-II-Medium (RF/N) and AVT-II-Early (RF/N) and five trials including AVT-I-Late, AVT-II-Medium, AVT-I-II-Early, AVT-II-Medium (RF/N) and AVT-II-Early (RF/N) were conducted at NWPZ, NEPZ, PZ and CWZ, respectively. Total of 274 entries were received for multi-location evaluation in the categories of early, late, medium maturity of normal corn, QPM, sweet corn, baby corn, popcorn and OPV. Out of 274 test entries, total 157 entries were received in NIVT trials which include NIVT early (34), NIVT-Medium (78) and NIVT-Late (45). Total 33 entries were evaluated in AVT-I trials including AVT-I-Early (4), AVT-I-Medium (20) and AVT-I-Late (9) and 12 entries were tested in AVT-II trials including AVT-II-Early (3), AVT-II-Medium (6) and AVT-II-Late (3). Further, 43, 7, 12, 1 and 9 entries were received in QPM, baby corn, sweet corn, popcorn and OPV trials. Two hundred and fifty six entries were promoted from the first and second year of testing. Out of the total 274 entries, 88 entries were contributed by the private sector (25 different firms) and the rest 186 came from 29 centres of AICRP on maize.

### **Rabi 2019-2020 - Entomology**

Maize AICRP entomology *rabi* 2019-20 and spring 2020 experimental trials were aimed mainly for screening resistance against pink stem borer (PSB: *Sesamia inferens*), spotted stem borer (SSB: *Chilo partellus*), fall armyworm (FAW: *Spodoptera frugiperda*) and shoot fly (*Atherigona* spp.). Post-screening, the genotypes were categorized as resistant, moderately resistant and susceptible based on Leaf Injury Rating (LIR) on 1-9 scale (resistant: 1.0-3.0, moderately resistant: 3.1-6.0 and susceptible 6.1-9.0) for stem borers. Seventeen entries in AVT-I and AVT-II-Late maturity group were screened under artificial infestation against PSB at Hyderabad but none of the entries were found resistant. Sixteen entries were moderately resistant to pink PSB and one

entry PM 17208L was susceptible (6.2). Fifteen entries in AVT-I and AVT-II-Medium maturity group were screened against PSB at Hyderabad and all the entries were found moderately resistant. Out of 17 entries in AVT-I and AVT-I-Late maturity group screened under artificial infestation against SSB at Kolhapur all the entries were moderately resistant to SSB. Among the 15 medium maturity entries in AVT-I and AVT-II screened against SSB at Kolhapur, all the entries were moderately resistant. Out of 17 maize entries in AVT-I and AVT-II-Late maturity group screened under natural infestation against shoot fly at Karnal and Ludhiana centres during spring 2020, the lowest mean percent dead hearts were found in PM 17201L (16.0) followed by NMH 4313(17.1). Further, among the 15 medium maturity entries in AVT-I and AVT-II at Karnal and Ludhiana during spring 2020, the overall lowest dead hearts (%) were found in IMHSB 17R-16(12.2) followed by AH 8181 (19.1) and IMHSB 17R-5(19.4). Forty two maize accessions were evaluated under natural infestation against shoot fly *sp.* at Karnal and Ludhiana centres during spring 2020. The lowest mean percent dead hearts were found in DMR E63/CML 287-4-6 (25.3), while highest was observed in IC0549903 (61.6).

The 17 maize entries in AVT-I and AVT-I-Late maturity group were screened under natural infestation against FAW at Coimbatore, Hyderabad and Kolhapur during *rabi* 2019-20. The Davis score varied from 2.4 (KMH 25K45) to 2.9 (PM 18206L) at 14 DAS, 3.4 (PM 18204L) to 4.6 (PM 17208L) at 28 DAS and 4.7 (NMH 713) to 6.0 (PMH 17208L) at 60 DAS. Further, 15 maize entries in AVT-I and AVT-II-Medium maturity group were screened under natural infestation against FAW at Coimbatore, Hyderabad and Kolhapur during *rabi* 2019-20 and the Davis Score varied from 2.7 (IMHSB 17R-5) to 3.1 (IMHSB 17R-9, NMH 4140), 3.5 (IMHSB 17R-17) to 4.4 (BLH 139) and 3.8 (IMHSB 17R-8, DHM 117) to 4.2 (AH8181, BLH 139) at 14, 28 and 60 DAS, respectively. Forty two maize accessions were evaluated under natural infestation against FAW at Coimbatore during *rabi* 2019-20. The lowest mean Davis score was recorded in BML 7 (1.4) while the highest value was recorded in DMRE63/CML 287-3-61-2B (4.2) at 28 DAS. The lowest mean ear damage rating was recorded in CM 400 (1.1), while the highest ear damage rating was observed in DMRE63/CML 287-44A (4.10).

### **Kharif 2020 - Entomology**

Details of the technical programme carried out during *kharif* 2020 is discussed below. The results are awaited.

### **Evaluation of entries against SSB and FAW during kharif 2020**

During *kharif* 2020, AICRP entries were evaluated against SSB and/or FAW at Imphal, Karnal, Ludhiana, Dholi, Coimbatore, Hyderabad, Kolhapur and Udaipur. The reaction of the different entries against SSB and/or FAW is given in the (Table 6.4).

**Table 1.6: Yield of experimental hybrids in multi-location over years in Bihar**

Sl. No.	Centre	Insect	EM & OPV	MM	LM	BC	SC	QPM	Inbred	Total
1.	Imphal	FAW	1	1	1	1	1	1	1	7
2.	Karnal	SSB	1	1	1	1	1	1	1	7
3.	Ludhiana	SSB	1	1	1	1	1	1	1	7
4.	Dholi	SSB	1	1	1	1	1	1	1	7
5.	Coimbatore	FAW	1	1	1		1	1	1	7
6.	Hyderabad	SSB, FAW	2	2	2	2	2	2	2	14
7.	Kolhapur	SSB, FAW	2	2	2	2	2	2	2	14
8.	Udaipur	SSB	1	1	1	1	1	1	1	7
<b>Total</b>			10	10	10	10	10	10	10	70

EM: Early maturity, MM: Medium maturity, LM: Late maturity, BC: Baby corn, SC: Sweet corn

**Monitoring of FAW using pheromone traps with NBAIR slow releasing dispenser**

The experiment to test the effectiveness of pheromone traps against FAW was conducted at the following locations, viz., Coimbatore, Delhi, Dholi, Godhra, Hyderabad, Imphal, Kalyani, Karnal, Kolhapur, Ludhiana, Mandya, Pantnagar, Rahuri, Udaipur and Vagarai. Two locations were selected at each centre and number of traps per location used was 4 per acre. The traps were installed during the time of sowing from June 1, 2020 and data were recorded at weekly interval throughout the season as per Standard Meteorological Week. Data will be analyzed for better understanding of the insect behaviour.

**Monitoring of cob borer (*Helicoverpa armigera*) by pheromone traps**

To monitor cob borer experiment was conducted using pheromone traps at five locations, viz., Ludhiana, Karnal, Delhi, Udaipur and Imphal. Two locations were used at each centre and four traps were used per acre per location. The traps were installed at 6 leaf stage. Observations were recorded once in two weeks and simultaneously lure was changed. Further to know which stage of crop growth attracts the moths, data were recorded for number of moths per trap at weekly interval as per SMW and also the stage of crop at the time of observation, i.e. V8, V9, VT, RI, R2 etc.

**Evaluation of insecticides as seed treatment against fall armyworm (*Spodoptera frugiperda*)**

One experiment was conducted to test the effectiveness of insecticides as seed treatment against FAW at different locations, viz., Hyderabad (WNC), Karnal, Ludhiana, Udaipur, Rahuri and Godhra. The detail of different treatment and dose used in the experiment is given in the (Table 6.5).

**Table 6.5: Evaluation of insecticides as seed treatment against fall armyworm during kharif 2020**

Sl. No.	Insecticide	Dose (ml/kg seed)
1	Thiamethoxam30 FS	6
2	Thiamethoxam30 FS	8
3	Thiamethoxam30 FS	10
4	Imidacloprid600 FS	6
5	Imidacloprid600 FS	8
6	Imidacloprid600 FS	10
7	Fipronil5 SC	6
8	Fipronil5 SC	8
9	Fipronil5 SC	10
10	Cyantraniliprole19.8%+	4
	Thiomethoxam19.8%	10
11	<i>Beauveria bassiana</i> (TNAU strain)	-
12	Untreated Control	

**Management of stem borers and FAW in maize**

In another experiment, the insecticides were tested for their efficacy at different stages as foliar spray for the management of stem borers and FAW at different locations, of the country during kharif 2020. Stages of insecticide application and test locations for spotted stem borer and FAW are given in the (Table 6.6 & 6.7). The lists of different insecticides used against FAW have been mentioned in (Table 6.8).

**Table 6.6: Treatment details and locations for spotted stem borer**

Sl. No.	Treatment	Locations
1.	AT 5% Incidence (Visible leaf feeding damage)	Ludhiana and Karnal
2.	AT 10% Incidence (Visible leaf feeding damage)	
3.	Appearance of Dead Heart (1)	
4.	At 7 DAG	
5.	At 14 DAG	
6.	At 7 and 14 DAG	
7.	At 10 DAG	
8.	At 20 DAG	
9.	At 10 and 20 DAG	
10.	Untreated Control	

DAG: Days after germination

**Table 6.7: Treatment details and locations for FAW**

Sl. No.	Treatment	Locations
1.	At 5% Incidence	Coimbatore, Kolhapur and Udaipur
2.	At 10% Incidence	
3.	Davis score 2	
4.	Davis score 4	
5.	At 7 DAG	
6.	At 14 DAG	
7.	At 7 and 14 DAG	
8.	At 10 DAG	
9.	At 20 DAG	
10.	At 10 and 20 DAG	
11.	As soon as moth found in trap	
12.	Untreated Control	

DAG: Days after germination

**Table 6.8: Insecticide treatment details for FAW**

Sl. No.	Insecticide	Dose	Locations
1.	Chlorantraniliprole 9.3% + Lambdacyhalothrin 4.6% ZC	100 ml per acre (0.5 ml/litre)	Coimbatore, Kolhapur, Hyderabad and Udaipur
2.	Novaluron 5.25% + Emamectin benzoate 0.9% w/w SC	350 ml per acre (2 ml/litre)	
3.	Emamectin benzoate 5% SG	80 g/ha (0.4 g/litre)	
4.	Spinetoram 11.7% w/w SC	100 ml per acre (0.5 ml/litre)	
5.	Chlorantraniliprole 18.5% SC	80 ml per acre (0.4 ml/litre)	
6.	Flubendamide	60 ml per acre (0.3 ml/litre)	
7.	Cypermethrin 25% EC	200 ml per acre (1.0 ml/litre)	
8.	Cartap hydrochloride 75 SG	100 gm per acre (0.5 gm/litre)	
9.	Cyantraniliprole 19.8% + Thiomethoxam 19.8%	6 ml/kg seed treatment	
10.	Untreated Control		

**Evaluation of bio-pesticides/bio agents against fall armyworm (2<sup>nd</sup> Year)**

The experiment for evaluation of bio-pesticides/bio agents against FAW was carried out for the 2<sup>nd</sup> year at Coimbatore, Hyderabad, Imphal, Kolhapur, Udaipur and Ludhiana. The name of insecticide and dose used are mentioned in the (Table 6.9).

To develop pest incidence prediction model for maize growing ecologies, an experiment was conducted to study on

incidence of spotted stem borer and FAW in *kharif* sown maize in relation to plant age and meteorological factors at Coimbatore, Dholi, Hyderabad, Imphal, Karnal, Kolhapur, Ludhiana and Udaipur. Another experiment was conducted to study the pest succession of insect pests in *kharif* sown maize at different locations of country, viz., Dholi, Hyderabad, Imphal, Kolhapur, Karnal, Ludhiana, Udaipur and Coimbatore.

**Table 6.9: Evaluation of bio-pesticides/bio agents against fall armyworm (2<sup>nd</sup> Year)**

Sl. No.	Insecticide	Dose	Locations
1.	EPN <i>H. indica</i> NBAIR H38	10 gm/litre	Coimbatore, Hyderabad, Imphal, Kolhapur, Udaipur and Ludhiana
2.	<i>Pseudomonas fluorescens</i> (Pf DWD 2%)	20 gm/litre	
3.	NBAIR <i>Bt25</i> , 2%	2 ml/litre	
4.	<i>Metarhiziumanisopliae</i> NBAIR-Ma 35, 0.5%	5 gm/litre	
5.	<i>Beauveria bassiana</i> NBAIR -Bb 45, 0.5%	5 gm/litre	
6.	SpfrNPV (NBAIR1)	2 ml/litre	
7.	NSKE 5%	5 ml/litre	
8.	Neem formulation 1500ppm	5 ml/litre	
9.	Chlorantaniliprole 18.5 SC	0.4 ml/litre	
10.	Emamectin benzoate 5% SG	0.4 gm/litre	
11.	Untreated Control	-	

**Rabi 2019-20 - Pathology**

During *rabi* 2019-20, 109 maize entries were evaluated against Maydis leaf blight (MLB), Turicum leaf blight

(TLB), Charcoal rot (ChR) and Sorghum downy mildew (SDM) in different zones across the country. The number of entries and zones for each trial has been mentioned in the (Table 6.10).

**Table 6.10: Entries evaluated for different disease in *rabi* 2019-20**

Trial	NEPZ		NEPZ		NEPZ		NEPZ	
	Late	Medium	Late	Medium	Late	Medium	Late	Medium
NIVT	30	45	30	45	30	45	30	45
AVT I-II	14	12	14	12	14	12	14	12
QPM I-II-III		4		4		4		4
PC I-II-III		4		4		4		4
<b>Total</b>		<b>109</b>		<b>109</b>		<b>109</b>		<b>109</b>

QPM: Quality protein maize; PC: Popcorn, NEPZ: North Eastern Plain Zone, NHZ: Northern Hill Zone, NWPZ: North Western Plain zone, PZ: Peninsular Zone

Total 80 trials were allotted across the five zones, viz., NHZ, NWPZ, NEPZ, PZC and WZ with one, two, three, six and one location, respectively. In all the locations trials were

conducted successfully except Karnal from NWPZ, Sabour from NEPZ and Udaipur from CWZ. The detail of trial success rate has been provided in (Table 6.11).

**Table 6.11: Success rate of trials in different zones in *rabi* 2019-20**

Sl. No.	Zone	Centre	Trials allotted	Trials Reported	Success (%)
1.	NHZ	Gangtok	7	7	100
2.	NWPZ	Ludhiana,	6	6	100
		Karnal	6	0	0
		Dholi,	6	6	100
3.	NEPZ	Kalyani	6	6	100
		Sabour	6	0	0
4.	PZ	Coimbatore,	7	7	100
5.	CWZ	Hyderabad,	6	6	100
		Rahuri,	6	6	100
		Peddapuram,	6	6	100
		Mandya,	6	6	100
		Dharwad	6	6	100
		Udaipur	6	0	0
		<b>Overall</b>	<b>80</b>	<b>62</b>	<b>77.5</b>

### Disease screening of NIVT maize hybrids-late maturity

A total of 36 hybrids including entries and checks of NIVT late maturity were evaluated for MLB. Out of 36 entries, 6 entries, viz., AH 8461, GMH 212, GMH 345, KMH 018, MM-2050 and RASI-5640 were found resistant against MLB. The same entries were also evaluated against SDM and only one entry i.e. JKM 4510 was found resistant to SDM. None of the entries were found resistant against TLB and charcoal rot in this category.

### Disease screening of NIVT maize hybrids-medium maturity

A total 52 hybrids including entries and checks of NIVT medium maturity were evaluated for MLB, out of which five entries, viz., AH 8047, IMHSB 19R-17, IMHSB19R-4, IMHSB19R-9 and MH 2047 were found resistant against MLB. The same entries were evaluated against SDM and three entries, viz., BAUMHR19-2, IMHSB19R-12 and IMHSB 19R-14 were resistant reaction against SDM. None of the entries were found resistant against TLB and charcoal rot.

### Disease screening of AVT-I-II maize hybrids-late maturity

A total of 22 entries hybrids including entries and checks of AVT-I-II of late maturity were evaluated for MLB, only one entry RASI4118 was found to be resistant against MLB. The same entries were screened against SDM, of which three entries, ADV 7043, PM 17205L and PM 18205L showed resistant reaction to SDM. None of the entries were found resistant against TLB and charcoal rot in this category.

### Disease screening of AVT-I-II maize hybrids-medium maturity

A total of 19 hybrids including entries (16) and checks (3) of AVT-I-II of medium maturity were evaluated for MLB, only three entries IMHSB 17R-16, IMHSB 17R-8 and IMHSB 17R-9 were found to be resistant against MLB. The 16 entries were also screened against SDM and only one entry AH8181 was resistant against SDM. None of the entries were resistant against TLB and charcoal rot.

### Disease screening of popcorn maize hybrids

A total of 8 entries including checks were evaluated against

MLB, TLB, charcoal rot and SDM, however none of the entry was resistant to these diseases.

### Disease screening of maize hybrids-QPM trial

A total of 11 entries including checks were evaluated against MLB and two entries, viz., IQPMH 19-R-1 and IQPMH 19-R-3 were resistant against MLB. None of the entries were found resistant against TLB and charcoal rot.

### Screening of CIMMYT maize germplasm

A total of 110 entries were evaluated against TLB at Gangtok, Sikkim. Out of these five entries, viz., CTS013058/(AMATLCOHS167-1-1-1-12F/R)-B\*5/Nei40211)-B\*-11-B-B, CLRCY038-B\*10, (FSRrSynpopC3)-7-8-2-1-1-(CA00310/AMATLCHOS71-1-1-1-2-1-1B\* 14/(CML472)/CML472/CML472/CML472-1-16-B and MSR-Syn-C2-S1-4-4-1-b were found resistant against TLB.

### Efficacy of different components in management of charcoal rot

Field experiment was carried out for the management of charcoal rot at Coimbatore. Foliar application of chitosan @ 5ml/litre at 35DAS and 45DAS recorded significantly the lowest charcoal rot incidence (8.48%), followed by seed treatment with *Trochdermaviride* @ 10 kg/seed (8.90%), foliar application of mancozeb 75WP @ 2.5g/litre at knee high stage (9.54%) and soil application of vermicopmost enriched with *T. Viridae* (2x10<sup>9</sup>cfu/gm) @250 kg/ha(9.80%). The significantly higher cob yield was recorded in seed treatment with *Trochdermaviride* @ 10 kg/seed (9891 kg/ha) and was followed by foliar application of mancozeb 75WP @ 2.5g/litre at knee high stage (9058 kg/ha).

### Kharif 2020 - Pathology

During kharif 2020 total 269 trials were conducted. Out of which 196 trials were of coordinated trials and 20 trials were for Trap nursery. In addition to that, 25, 6, 3 and 19 trials were also conducted under the following categories, viz., management trials, trials from CIMMYT, avoidable yield loss trial and, survey and surveillance, respectively (Table 6.12).

Table 6.12: Trials conducted in kharif 2020

Sl. No.	Centres	Coordinated trials	Trap nursery trial	Management trials	CIMMYT trial	Yield loss trial	Survey & surveillance trial	Total
1.	Almora	7	1	-	-	-	1	9
2.	Larnoo	7	-	-	1	-	-	8
3.	Bajaura	7	1	1	-	-	1	10
4.	Barapani	7	-	-	-	-	-	7
5.	Imphal	7	1	1	-	-	1	10
6.	Dhaulakuan	14	1	-	-	-	1	16

Sl. No.	Centres	Coordinated trials	Trap nursery trial	Management trials	CIMMYT trial	Yield loss trial	Survey & surveillance trial	Total
1.	Delhi	14	1	2	-	-	1	18
2.	Karnal	14	1	1	-	-	1	17
3.	Ludhiana	14	1	2	1	-	1	19
4.	Pantnagar	14	1	1	1	1	1	19
5.	Dholi	7	1	1	-	-	1	10
6.	Sabour	7	1	-	-	-	1	9
7.	Kalyani	-	1	2	-	1	1	5
8.	Dharwad	7	1	1	-	-	1	10
9.	Mandya	14	1	4	2	-	1	22
10.	Rahuri	7	1	-	-	-	1	9
11.	Peddapuram	7	1	1	-	-	1	10
12.	Coimbatore	7	1	-	-	-	1	9
13.	Hyderabad	7	1	1	-	-	1	10
14.	Udaipur	28	1	5	1	1	1	37
15.	Godhra	-	1	2	-	-	1	4
16.	Karimnagar	-	1	-	-	-	-	1
17.	<b>Total</b>	<b>196</b>	<b>20</b>	<b>25</b>	<b>6</b>	<b>3</b>	<b>19</b>	<b>269</b>

### Rabi 2020-21 - Agronomy

In *rabi* 2020-21, experiments were conducted on the agronomy of pre-released genotypes of different maturity, tillage and nutrient management, sensor guided nitrogen management, integrated nutrient management, ecological intensification and weed management in maize systems for enhancing productivity and profitability of maize systems in various agro-ecologies.

### Response of pre-released genotypes to density and nutrient levels

The medium and long duration pre-released maize genotypes in AVT-II were tested at two different fertility and planting density in different trials in all zones except NHZ. Long duration maize genotypes (4 + 2 check) were tested in NWPZ at three different locations. The genotypes responded to higher nutrient level *i.e.* 150% of recommended dose of fertilizer (RDF) at NWPZ and at normal density (Karnal). However, none of the genotypes showed significantly higher yield over best check KMH25K45 at NWPZ. In PZ, long duration genotype (2 + 3 checks) were tested at three locations, the genotypes responded to high nutrient levels but similarly the tested genotypes were statistically similar for grain yield with checks. In CWZ, long duration genotypes (2 + 2 checks) were tested at two locations and genotypes responded well to high fertility along with high density. The genotype PM 17201L gave significantly higher yield over best check *i.e.* P 3522 at CWZ.

Similarly, medium maturity genotypes (4 + 2 checks) were tested in NEPZ at four locations and it was found that yield improved significantly in high density with 150% RDF. The PM17205L genotype gave significantly higher yield over best check NMH713 in NEPZ. In CWZ, medium duration genotypes (2 + 1 check) were tested at two locations. The genotypes responded to high density while none of genotype out performed over best check, *viz.*, Bio 9544.

### Nutrient management in maize-wheat-cowpea cropping system under different tillage practices

The highest maize equivalent yield of the systems was obtained with 100% RDF with conventional tillage (CT) which was closely followed by 100% RDF with zero tillage (ZT) having only 300 kg/ha difference at Pantnagar (NWPZ). However, the net returns of the system were highest under 100% RDF with ZT which was ~Rs 8000/ha higher over CT-RDF. As a result, the highest BC ratio was obtained with RDF-ZT. As a main treatment effect, ZT gave significantly higher net returns, which was on par to CT but superior to permanent bed (PB) while RDF out yielded compared to other nutrient management options.

### Nutrient management in maize-wheat-green gram cropping system under different tillage practices

Tillage had non-significant effect on yield and net return of subsequent wheat at Dholi (NEPZ) while 60% RDF+green seeker (GS) was at par with site specific nutrient management (SSNM) which gave higher yield and net returns over RDF.

### ***Nutrient management in rice-maize cropping system under different tillage practices***

The experiments were conducted at Dholi and Kalyani of NEPZ to find out best nutrient and tillage management practices of emerging cropping system in NEPZ *i.e.* rice-maize based cropping system. Among tillage practices, permanent bed (PB) gave significantly higher yield and net return from maize and was at par with ZT. Further, both practices were significantly superior over CT in sandy loam soil of Dholi. In contrast, in clay loam soil at Kalyani, ZT gave significantly higher yield and net returns over CT and PB. However, at both the locations, green seeker guided nitrogen application gave significantly higher yield and net returns.

### ***Nutrient management in maize based rainfed cropping system under different tillage practices***

The experiment was conducted at Banswara (CWZ) in maize-chickpea system. It was observed that application of different tillage practices had non-significant effect on maize yield while the ZT gave significantly higher chickpea yield, which was at par to PB, and both were superior to CT. Among nutrient management, the SSNM based nutrient application gave significantly higher yield of both the crops over other options used in the study.

### ***Long-term trial on integrated nutrient management***

To integrate the use of organic manure in fast expanding maize crop, experiments were started to sustain and enhance productivity towards meeting emerging need of maize in India. The maize-wheat system yield, net returns and BC ratio were significantly highest with 100% RDF + 5 t/ha FYM at Pantnagar (NWPZ) and Banswara (CWZ). Maize + legume intercropping (for economic produce) with FYM 10 t/ha + Azotobactor application also gave statistically similar yield to the earlier discussed treatment at Banswara and Pantnagar.

### ***Validation of Sensor based nitrogen management in maize***

Among green seeker sensor based N application treatments, 33% basal N + Green Seeker based N at knee high and

tasseling stage or 30% Basal N + 30% at 25 DAS + Green Seeker based N at tasseling stage gave statistically similar yield while numerically higher net returns to the RDF. The STCR based nutrient application gave significantly higher yield and returns in maize-wheat system.

### ***Ecological intensification for climate resilient maize based cropping system***

The experiment for yield and profit maximization through optimization of ecological processes was taken up at 11 locations in four zones except northern hill zone in various maize based cropping systems. The crop yield was statistically highest with Ecological Intensification (EI) at all 11 locations (Karnal, Pantnagar, Ludhiana, Kalyani, Dholi, Bhubaneswar, Vagarai, Peddapuram, Karimnagar, Hyderabad and Banswara). The EI minus weed management (Farmer adopted weed management in all crops) at Banswara, Peddapuram, Karimnagar, Hyderabad and Dholi; EI minus water management (farmer's practice for all crops) at Vagarai, Coimbatore and Pantnagar while EI minus Nutrient management (Farmer adopted nutrients in all crops) at Kalyani, Bhubaneswar and Ludhiana gave significantly lowest yield. Hence, there is need to focus on the eco-region specific technology for enhancement of the maize systems yield by improving certain farmer practices.

### ***Weed management in maize systems***

Maize equivalent yield (kg/ha) of maize-wheat cropping system was significantly higher under unweeded check which was at par to weedicide applied treatment and significantly superior over weedy check at Pantnagar (NWPZ) and Dholi (NEPZ). It shows that the post-emergence herbicide applied in maize like Tembotrione or Topramezone had no adverse effect on subsequent wheat yield in rotation. The application of atrazine @ 750 g/ha as pre-emergence followed by Topramezone @ 25.2 g/ha at 25 DAS in *rabi* maize gave significantly higher yield and net returns in the herbicide applied treatments at Kalyani (NEPZ).





*A farmer with maize harvest*

## *Significant Events*



*National Seminar on "Maize for Crop Diversification under Changing Climatic Scenario"*

## SIGNIFICANT EVENTS



### Institute Events

#### National Maize Seminar

ICAR-IIMR in collaboration with Maize Technologists Association of India (MTAI) and Punjab Agricultural University, Ludhiana organized a National Seminar on “Maize for Crop Diversification under Changing Climatic Scenario” from February 9-10, 2020 on the 6<sup>th</sup> Foundation Day of ICAR-IIMR. The Seminar was inaugurated by Sh. Suresh Kumar, Chief Principal Secretary, Government of Punjab on February 9, 2020. In his speech, he emphasized that *kharif* maize has huge potential to diversify rice cultivation in Punjab and urged

the ICAR-IIMR scientists to develop high yielding maize hybrids for *kharif* season. He lauded the efforts of the Director in establishing the new campus of ICAR-IIMR at Ladhawal. An abstract book of the seminar and Hindi Magazine 'Krishi Chetna' was released on this occasion. Awards were given to distinguished maize scientists in recognition of their significant contribution for maize research and development by the Maize Technologists Association of India (MTAI) on this occasion. Among the major awardees were Dr. B.S. Dhillon, Vice Chancellor, PAU, Ludhiana, Dr. J.C. Shekhar, Dr. Ramesh Kumar, Dr. P.L. Soujanya, Dr. S.L. Jat, Dr. Bhupender Kumar and Dr. Abhijit Kumar Das.



National Maize Seminar



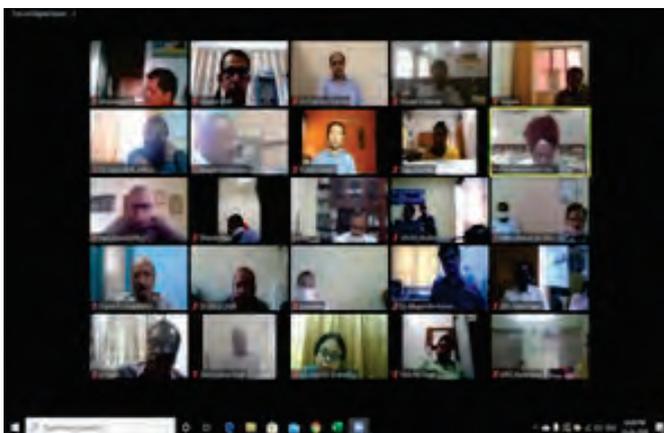
**Awardees during National Maize Seminar**

### Annual Maize Workshop

The 63<sup>rd</sup> Annual Maize Workshop, the first virtual workshop in the history of ICAR-AICRP system, was held online by ICAR-IIMR during April 20-22, 2020. Approximately 200 participants representing both public and private sector across the country attended the meeting which was spread into six sessions over three days. The workshop was inaugurated by Dr. T.R. Sharma, Deputy Director General (Crop Science), ICAR. The various sessions were chaired by eminent technocrats like Dr. T.R. Sharma, Deputy Director General (Crop Science), Dr. S.K. Chaudhari, Deputy Director General (Natural Resource Management) and Dr. P.K. Chakarborty, Member, ASRB. Dr T.R. Sharma, DDG (CS) in his introductory remarks appreciated the role played by the oldest AICRP on Maize and congratulated the Director for organizing the first virtual AICRP workshop during COVID-19 pandemic. Dr. T. Mohapatra, Secretary DARE & DG ICAR, was the Chief Guest of the valedictory session.



**Chief Guest Dr. T. Mahapatra, Secretary DARE & DG ICAR sharing his thoughts**



**Participants of the Annual Maize Workshop**

The Chief Guest congratulated the Director, ICAR-IIMR and maize family for organizing the first online workshop ever in the history of ICAR. In his address, the Chief Guest highlighted the importance of maize in the national agriculture



**Launch of BHARTI MAKKA App**

system and provided his valuable inputs to enhance maize cultivation across India. He stressed upon the use of biotechnological interventions to develop maize hybrids resistant to biotic and abiotic stresses. During the event an

android based mobile app, 'BHARTI MAKKA' was launched by the Chief Guest for the benefit of all stakeholders in maize ecosystem.

### Research Advisory Committee (RAC) Meeting

The meeting of the Research Advisory Committee (RAC) of the institute was held at its Delhi Unit in Pusa Campus, New Delhi on February 25-26, 2020 under the Chairmanship of Dr. H.S. Gupta, Former Director General, BISA & Ex-Director, ICAR-Indian Agricultural Research Institute, New Delhi. Dr. T.R. Sharma, DDG (CS), ICAR also attended the RAC meeting. During the meeting Dr. Sanjay Rakshit, Director ICAR-IIMR presented the overview of the maize scenario and the major accomplishments of the institute during 2018-19. Dr. H.S. Gupta, Chairman, RAC emphasized the importance of maize in food and feed security of the country. He also stressed upon the need to increase the area under maize owing to its higher productivity, profitability and resource conservation. The Chairman called upon the scientists to

evaluate the impact of the replacement of rain-fed upland rice by maize in terms of economics, energy-saving and ecological consequences. He also stressed upon the urgent need to develop a mechanism of seed production of newly developed public maize hybrids so that the public bred hybrids can reach the farmers' field. Dr. T.R. Sharma, DDG (CS), ICAR, special invitee to the RAC meeting, emphasized the need of more collaboration and extramural funding for scientific research so that a larger section of young students in research activities can be attracted. Other members of RAC emphasized the need to popularize zero-till maize in the larger area, a robust seed production chain and farm mechanization, inclusion of QPM in mid-day meal schemes to realize its potential, necessity efforts to declare bio-fortified maize with QPM and  $\beta$ -carotene as 'NUTRI-MAIZE', breeding for host plant resistance, evaluate maize cultivation in non-traditional areas, need for value-chain analysis and business incubation and need for quality seed and demonstration at farmer's field for proper technology adoption.



Director welcoming Dr. T.R. Sharma, DDG (Crop Science)



Discussion during RAC meeting

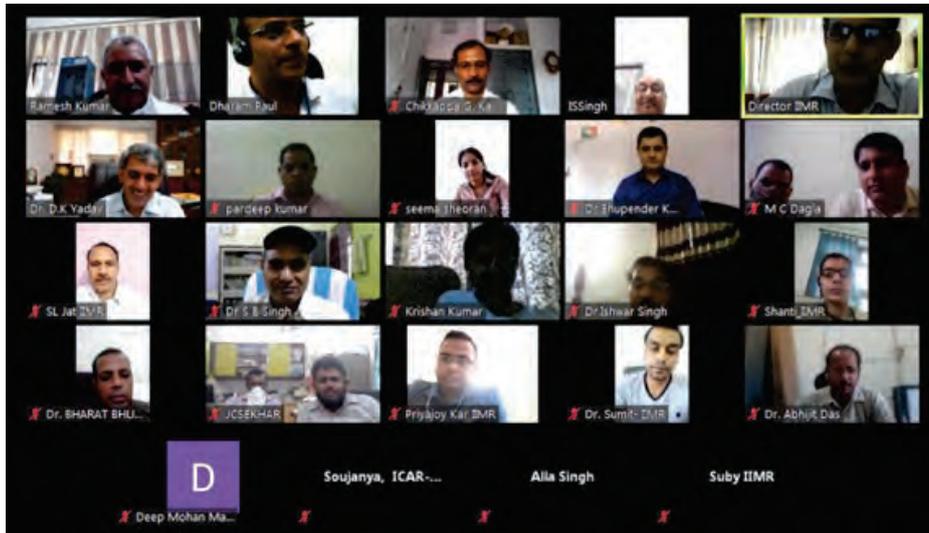
### Institute Research Council (IRC) Meeting

Institute Research Council meeting of ICAR-IIMR was held through Video Conferencing on June 15, 17 & 18, 2020 under the Chairmanship of Dr. Sujay Rakshit, Director, ICAR-IIMR to review the progress of on-going research projects and to consider the new project proposals. Dr. D.K. Yadava, Assistant Director General (Seeds), ICAR; Dr. I.S. Singh, Former Maize Breeder, GBPUAT, Pantnagar; Dr. P.N. Sharma, Senior Pathologist, HPKV, Palampur; Dr. Gururaj Katti, Principal Scientist (Entomology), ICAR-IIRR, Hyderabad; Dr. A.R. Sharma, Director Research, Rani Laxmi Bai Central Agricultural University, Jhansi and Dr. M.L. Lodha, former Principal Scientist and Head (Retd.), Division of Biochemistry, ICAR-IARI, New Delhi were the experts. The Chairman, Dr. Sujay Rakshit, presented the research highlights and other activities going on at the institute and congratulated the scientists for their achievements. Considering the situation arising out of COVID-19 pandemic, he advised the scientists to judiciously plan the field experiments, so that the

experiments can be executed successfully without any failure. He also stressed upon the scientist to utilize the data generated out of the projects in writing high-quality research papers. In his remarks Dr. D.K. Yadava shared his experiences and suggested to club the in house projects into a few mega projects which can further be divided into sub-projects. Achievements of research, teaching, trainings, research papers and other recognition etc. should be presented along with the quantifiable target for the next year. He discussed the need to acquire diverse germplasm and other important traits and to integrate the temperate germ plasm into tropical maize for higher yield. Dr. I.S. Singh suggested to strengthen the linkage between ICAR-IIMR and industries as maize has great importance as an industrial raw material. He highlighted that breeding should be focused on both seed and pollen parent for developing high yielding single cross hybrids. Dr. P.N. Sharma emphasized that the agronomic aspects of plant protection is needed to be strengthened. He also suggested that multiple pests and disease resistant genotypes are needed to be

developed. IPM in maize including all components needs to be worked out, where HPR should be a major component. In his remarks, Dr. Gururaj Katti appreciated the leadership role played by ICAR-IIMR in managing the problem of fall armyworm (FAW). He suggested that pink stem borer specific pheromone available with ICAR-IIRR, Hyderabad needed to be evaluated in maize as well. He also highlighted that real-

time monitoring of FAW by e-pest surveillance is needed to be accomplished. Dr. M. L. Lodha highlighted that extensive literature survey pertaining to status at National and International level should be conducted while formulating a project proposal. The projects should end up into a logical conclusion. The output of one project should be utilized in formulating the subsequent project.



Discussion during Institute Research Council (IRC) Meeting

### Institute Management Committee (IMC) meeting

The 13<sup>th</sup> meeting of Institute Management Committee was held through online on November 10, 2020 under the Chairmanship of Dr. Sujay Rakshit, Director, ICAR-IIMR, Ludhiana. In the meeting utilization of Non-Plan, Plan and AICRP budget for the year, 2019-20 and status of advances were discussed. The other agendas of the meetings were boundary wall construction of Ladhawal farm, construction of Administrative building and empanelment of hospitals for RMR&SPC, Begusarai etc.

### Institutional Biosafety Committee (IBSC) Meeting

The Institutional Biosafety Committee (IBSC) meeting was

held online on December 28, 2020. Dr. Sujay Rakshit (Chairman), Dr. Parveen Chhuneja (Head Biotechnology PAU&DBT Nominee), Dr. Amrita Srivastava (Biosafety Officer IARI), Dr. Monika Dalal (Principal Scientist IIPB, New Delhi & Outside expert), Dr. Chikkappa G. Karjagi (Scientist, IIMR & Member), Dr. Bhupender Kumar (Scientist, IIMR & Member), Dr. Alla Singh (Scientist, IIMR & Member) and Dr. Krishan Kumar (Scientist, IIMR & Member Secretary) and attended the meeting. The committee reviewed the biosafety aspects of ongoing projects involving GMO/LMO and found them to be satisfactory.



Discussion during IMC meeting



Discussion during Institutional Biosafety Committee (IBSC) meeting

## Republic Day Celebration

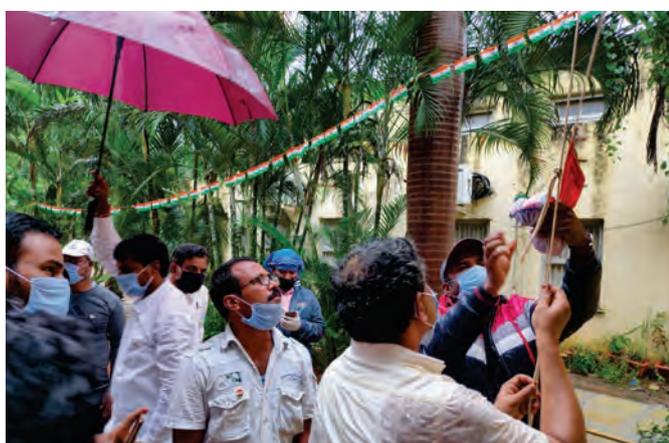
The 71<sup>st</sup> Republic Day was celebrated with much enthusiasm at the Head Quarter and its regional stations. The Director ICAR-IIMR hoisted the National Flag at the upcoming campus of the institute at Ladhawal, Ludhiana. The Director invited the scientists to focus on farmers oriented research for inclusive growth and development of the nation.

## Independence Day celebration

The 74<sup>th</sup> Independence Day was celebrated at ICAR-IIMR, Headquarter and its regional stations with full zeal and patriotism. On this occasion, the flag was hoisted at ICAR-IIMR, Ladhawal farm, Ludhiana. At other centers, respective In-charges did the same. The function was attended by the staff and their family members.



Flag hoisting ceremony on the Republic Day



Flag hoisting ceremony on the Independence Day



## Gandhi Jayanti celebration / Gandhi Ulaas Saptah

ICAR-IIMR, Ludhiana celebrated a weeklong Gandhi Ulaas Saptah to commemorate the 150<sup>th</sup> birth anniversary of the father of the nation, Mahatma Gandhi from 26<sup>th</sup> September - 2<sup>nd</sup> October. During Gandhi Ulaas Saptah a series of activities like book review of Gandhiji's autobiography "My Experiments with Truth", painting competition, debate

competition, quiz competition etc. for staff members were conducted on the theme of Gandhian philosophies and his vision towards new India. Dr. Sujay Rakshit, Director, ICAR-IIMR presented a lecture on the life of Mahatma Gandhiji and his philosophies. On the closing ceremony of Gandhi Ulaas Saptah, a plantation drive at Ladhawal farm were also organised.



Book review of Gandhiji's autobiography  
"My Experiments with Truth"



Plantation by Director ICAR-IIMR  
on the occasion of Gandhi Jayanti



Director ICAR-IIMR presenting special lecture on the concluding day of Gandhi Ulaas Saptah

### Swachhata Pakhwada Campaigns

ICAR-IIMR, Ludhiana organized 'Swachhata Pakhwada' from December 16-31, 2020 at Headquarter and its regional stations. On the inaugural day of the fortnight-long campaign, Dr. Sujay Rakshit, Director, ICAR-IIMR briefed the date wise activities to be undertaken and later administered 'Swachhata Pledge' to the staffs. He highlighted the Gandhian thoughts towards Swachhata and appealed everyone to become a part of Swachh Bharat Abhiyan and contribute towards the Swachh Bharat Mission through one's behavioural changes. During the fortnight-long period, important activities undertaken by the institute and its regional stations, viz., RMR & SPC Begusarai, WNC Hyderabad and Delhi Unit were cleaning of office premises, organizing off-campus cleanliness drive and

awareness campaign to take forward the swachhata message among the villagers and staffs. Key messages highlighted were: the importance of cleanliness and sanitation, plastic waste management, segregation of biodegradable and non-biodegradable waste, management of community waste, farm waste management, kitchen waste management and scope for vermi compost etc. Pamphlets bearing the message of Swachhata and benefits of cleanliness were distributed among the local people in the villages. An online special lecture was also organised on the topic "Swachhata Bharat" in which Shri. Pankaj Mall, CEO, Astitva Foundation delivered a special lecture on December 20, 2020. He shared his experiences of cross-country cycle journey to promote the spirit of Swachh Bharat. During Swachhata Pakhwada campaign different virtual competitions were also conducted. Awareness message



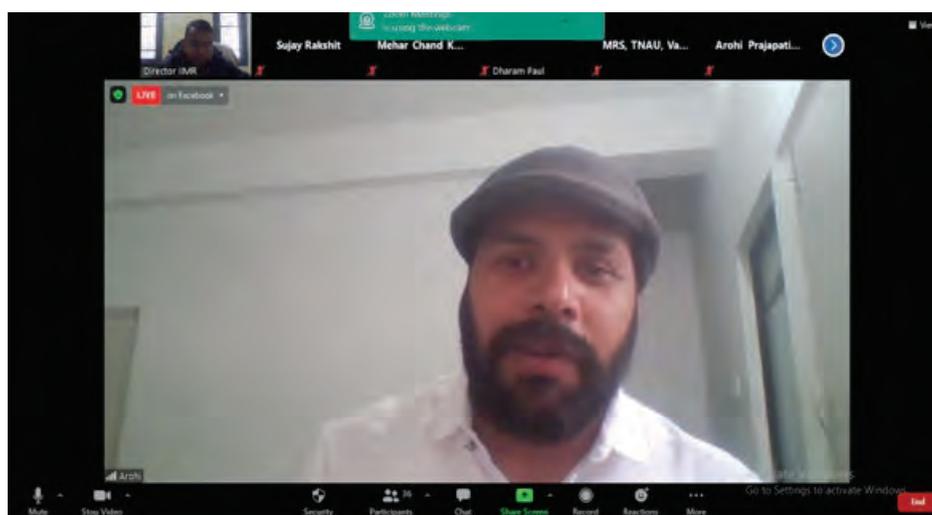
Staff of ICAR-IIMR taking Swachhata Pledge

on Swachh Bharat was also created through various social media handles of the institute like Twitter, Facebook and the institute's website. A major emphasis was given during the campaign on awareness of the general public on maintaining

cleanliness and sanitization to contain the COVID 19 and encouraged to continue the fight against COVID-19 by wearing mask, physical distancing, maintaining hand hygiene, etc.



### Activities during Swachhta Pakhwada



Sh. Pankaj Mall, CEO, Astitva Foundation delivering Special Lecture on Swachh Bharat

### International Women's Day

International Women Day was observed at ICAR-IIMR and its regional stations on March 9, 2020. The multi faceted roles of

women in the society particularly in agriculture were highlighted during the programme.

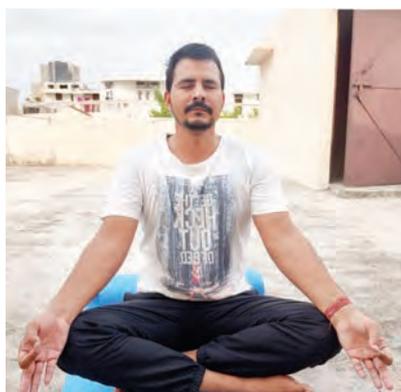


### International Women's Day celebrations

#### International Yoga Day

International Yoga day was observed at ICAR-IIMR, Ludhiana as well as its regional stations on June 21, 2020. All

the staff of the institute celebrated the occasion at their home amid the COVID-19 pandemic situation.

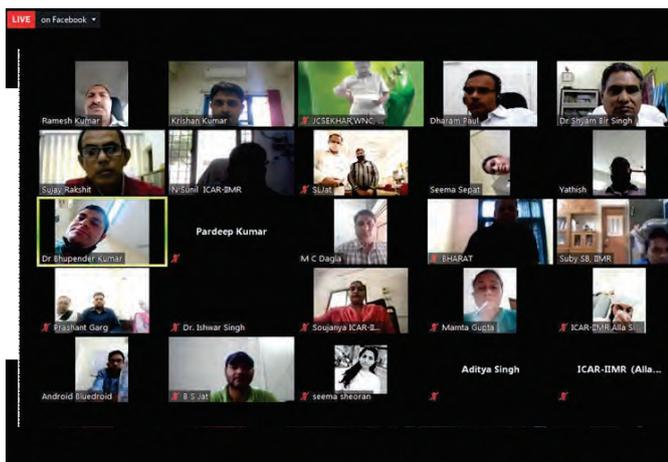


### ICAR-IIMR staff performing yoga exercises at their home

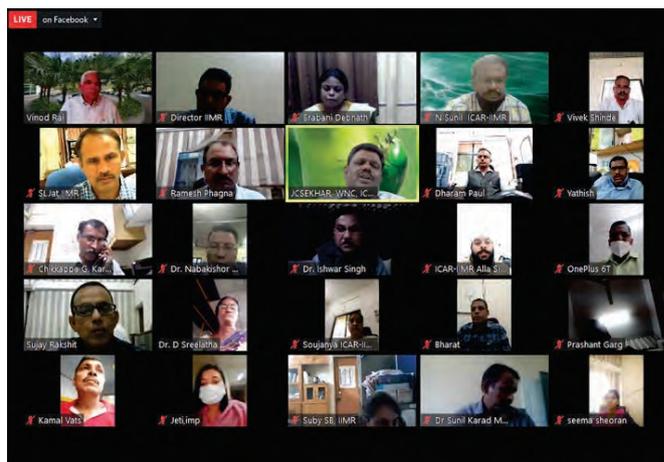
#### Vigilance Awareness Week

ICAR-Indian Institute of Maize Research has observed October 27- November 2, 2020, as Vigilance Awareness Week. Dr. Bhupender Kumar, Vigilance Officer of the institute provided online integrity pledge in Hindi to all the staff of the institute on October 27, 2020. On November 2, 2020, Shri Vinod Rai, former Comptroller and Auditor General (CAG)

Govt. of India delivered a special lecture on the topic "Promoting Integrity and Probity in Public life - with Special Reference to Scientific Institutions" to all ICAR-IIMR, Ludhiana and AICRP on Maize staff. Quiz and debate competition in the line of Vigilance Awareness Week was also organized at the institute level.



ICAR-IIMR and AICRP on maize staff taking pledge on Vigilance Awareness Week



ICAR-IIMR and AICRP on maize staff participating in Vigilance Awareness Week



Shri Vinod Rai, Ex. CAG Govt. of India delivering a special lecture on Vigilance Awareness

### Constitution Day

The year 2020 was marked as 70 years of Indian Constitution. A special lecture series was organized during the year on various topics, viz., “Constitution: The Spirit of India” by Prof. Arun Tiwari, Eminent Scientist, Author and Speaker on October 10, 2020, “Indian Constitution: The Making of a Democracy” by Prof. Gurpreet Mahajan, Centre for Political Studies, JNU, New Delhi on October 30, 2020 and “We the People@70: Constitutional Democracy in Retrospect and

Prospect” by Prof. Ashok Acharya, Delhi University on November 26, 2020. The special lectures were attended by staff of the institute, AICRP centres and other ICAR institutes. All the lectures were live telecasted on the institute's Facebook page. Constitution Day was observed at ICAR-IIMR and its regional stations on November 26, 2020. The staff of the institute read the Preamble of the Constitution along with Hon'ble President of India by seeing live telecast of preamble reading ceremony.



ICAR-IIMR staff taking pledge on Constitution Day

All the regional centers organized various debates on various fundamental duties described in the Constitution of India. Special emphasis was paid on the duty, "To develop the scientific temper, humanism and the spirit of inquiry and reform". Delhi Unit office organized a debate on it on January 25, 2020. Dr. Alla Singh, Scientist, ICAR-IIMR, Ludhiana,

delivered a talk on the significance of NABL for scientific excellence on July 30, 2020 during a programme on 'Constitution Day'. The fundamental duty which requires all to strive for excellence in all spheres of individual and collective action was also discussed. Themes related to fundamental duties were part of various other celebrations.



ICAR-IIMR staff taking pledge on Constitution Day



Staffs of ICAR-IIMR, Delhi Unit discussing Fundamental Duty of Indian Constitution



Prof. Arun Tiwari, Eminent scientist, Author and Speaker delivering lecture on Constitution Day



Prof. Gurpreet Mahajan, Centre for political studies, JNU, New Delhi delivering lecture on Constitution Day



Prof. Ashok Acharya, Delhi University delivering lecture on Constitution Day



ICAR-IIMR and AICRP centres listening to special lectures on Constitution Day

### Rashtriya Ekta Diwas

Rashtriya Ekta Diwas pledge was taken online by the staffs of ICAR-IIMR and its regional centre on October 31, 2020. Dr. Sujay Rakshit, Director, ICAR-IIMR administered the pledge to commemorate the birth anniversary of Sardar Vallabh Bhai Patel, the Architect of national integration of independent India.

### Kisan Diwas

ICAR-IIMR and its regional stations celebrated Farmer's Day on December 23, 2020... On the occasion Scientists of ICAR-IIMR, Ludhiana visited Bhaini Sahib village, Ludhiana in which they highlighted the importance of the farmers and their role in the development of the country and the survival of the human kind. Farmers were motivated and encouraged to

continue farming and continue their role in keeping India growing. Technologies of ICAR-IIMR were highlighted and encouraged farmers to adopt these. Scientific methods of the maize cultivation and control of the insect pests and diseases of maize were also discussed with the farmers on the occasion. Farmers were also encouraged to adopt environmentally friendly technologies. Various issues related to farming, particularly the challenge of rice straw burning were also discussed with the participants. The Kisan Diwas was also celebrated at RMR&SPC, Begusarai in which more than 40 farmers participated. Winter Nursery Centre, ICAR-IIMR, Rajendranagar, Hyderabad distributed seeds, technical bulletins to the farmers on the occasion. Delhi unit organized a virtual meeting to celebrate Kisan Diwas. Participants from all over India discussed the role and importance of farmers, besides the issues raised by the participants.



ICAR-IIMR, Ludhiana staff interacting with farmers on Farmers' Day



RMR&SPC, ICAR-IIMR Begusarai Scientists delivering lectures during Farmers' Day



WNC, ICAR-IIMR, Hyderabad distributing seeds and technical bulletins to the farmers on Farmers' Day



Virtual meeting with farmers by ICAR-IIMR, Delhi Unit staff on Farmers' Day

### World Soil Day

World Soil Day was celebrated at ICAR-IIMR and its regional stations on December 5, 2020. ICAR-IIMR has celebrated World Soil Day among the farmers in Ladhawal. The farmers were educated about the genesis of World Soil Day and its

significant role for the food security of the nation. The theme for 2020 "Keep soil alive, Protect, soil bio diversity" was conveyed to all the participants. The farmers were encouraged to save the soil from degradation due to excessive and unjustified use of fertilizers and insecticides and emphasized the importance of the soil in maintaining healthy ecosystem

sand human well-being by addressing the growing challenges in soil management, fighting soil bio diversity loss, increasing soil awareness, and encouraging governments, organizations, communities, and individuals around the world to commit to proactively improving soil health. On this occasion, soil health

related slogans were also displayed and highlighted the growing problem due to population expansion and soil degradation. Experimental plot under the conservation agriculture were also shown to the participants of ICAR-IIMR, Delhi Unit.



**Celebration of World Soil Day at ICAR-IIMR Headquarter and its Regional stations**

### Mahila Kisan Diwas

ICAR-IIMR has celebrated Mahila Kisan Diwas on October 15, 2020, among the farming community. In this regard, a programme was organized in the IIMR's adopted village, Garhi Mansowal in Hoshiarpur district of Punjab. Nearly 30 women farmers participated in the programme with sincerity and commitment. The women farmers clarified their queries from the scientists of ICAR-IIMR. ICAR-IIMR Scientists informed the women farmers about speciality corn, value addition aspects in crops and milk, hazards of stubble burning, formation of SHG, FPO etc. They have shown immense interest in taking up baby corn cultivation in their area. Scientists from ICAR-IIMR educated them about improved marketing practices, improved varieties of maize and mixed cropping techniques which will enhance their economic condition. Women farmers of the village showed immense zeal in taking up new ventures in farming and strengthening linkages with ICAR-IIMR.



**ICAR-IIMR scientists interacting with women farmers during Mahila Kisan Diwas**

### Live Telecast of MAN KI BAAT Programme

A live telecast of MAN KI BAAT programme of Hon'ble Prime Minister of India Sh. Narendra Modi was screened live at RMR&SPC, Vishnupur, Begusarai on January 28, 2020. This programme was viewed by all the staff along with farmers from nearby villages, who got inspired by the address of the Hon'ble Prime Minister.



### Live Telecast of on Global Potato Conclave

Hon'ble Prime Minister, Shri Narendra Modi and Hon'ble Minister of Agriculture & Farmers Welfare, Shri Narendra Singh Tomar addressed the 3<sup>rd</sup> Global Potato Conclave held at Gandhinagar on January 28, 2020. All scientific, technical and supporting staff of ICAR-IIMR attended the live telecast and listened to the motivational speeches of the dignitaries.



### Live telecast of 3<sup>rd</sup> Global Potato Conclave

### Live Telecast of PM- Kisan Samman Nidhi Programme

The address to the farmers by Hon'ble Prime Minister of India Sh. Narendra Modi on the occasion of the transfer of PM-Kisan Samman Nidhi in the farmer's account was telecasted on December 25, 2020. Farmers and staff viewed the interaction

with the farmers of different part of the country and the address of Hon'ble Prime Minister besides release of instalment of Rs. 18,000 crore to over nine crore farmers under the 'income support' scheme (PM-Kisan) on the birth anniversary of former PM Atal Bihari Vajpayee.



### Live telecast of PM Kisan programme

## हिंदी प्रोत्साहन कार्यक्रम

### हिंदी कार्यशालाएँ

भा. कृ. अनु. प. - भारतीय मक्का अनुसंधान संस्थान, लुधियाना में राजभाषा हिंदी के प्रगामी प्रयोग को बढ़ावा देने तथा राजभाषा संबंधी अधिनियमों, नियमों एवं आदेशों की अनुपालन हेतु वर्ष 2020-21 में राजभाषा की ऑनलाइन कार्यशालाओं का आयोजन दिनांक 30 जून, 2020 तथा 31 दिसम्बर, 2020 को किया गया जिनका शीर्षक: क्रमशः हिंदी के लिए आईटी टूल्स ओर कृषि अनुसंधान एवं तकनीकियों को किसानों एवं अन्य-हितधारकों तक पहुंचाने में हिंदी भाषा की भूमिका

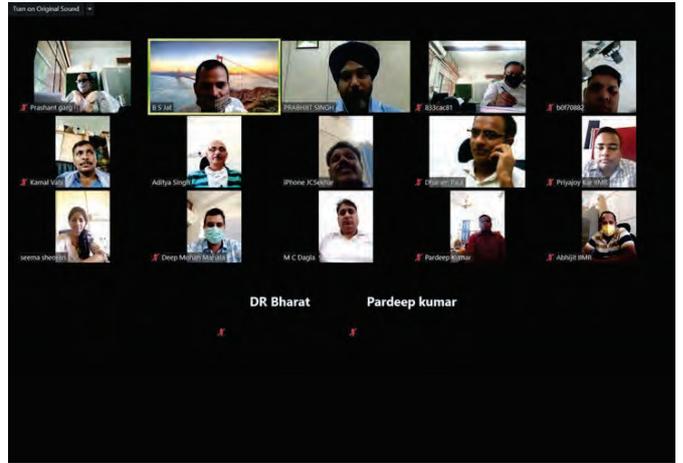


श्री प्रभजीत सिंह (वरिष्ठ प्रबंधक एवं राजभाषा अधिकारी)  
पंजाब नेशनल बैंक हिंदी के लिए आईटी टूल्स विषय पर व्याख्यान

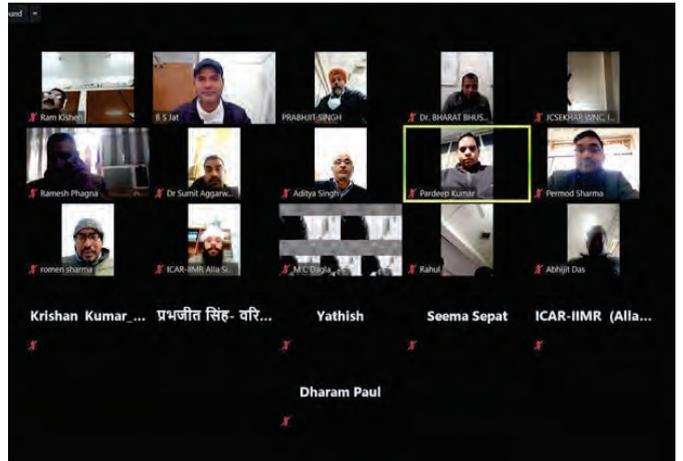
### राजभाषा उत्सव एवं हिन्द पखवाड़ा

प्रति वर्ष की भांति इस वर्ष भी भारतीय मक्का अनुसंधान संस्थान, लुधियाना द्वारा दिनांक 14 से 28 सितम्बर, 2020 के दौरान कार्यालय में ऑन लाइन माध्यम से हिंदी पखवाड़ा मनाया गया। पखवाड़े का शुभारम्भ 14 सितम्बर हिंदी दिवस के दिन संस्थान निदेशक महोदय की उपस्थिति में ऑन लाइन माध्यम से किया गया। इस अवसर पर निदेशक महोदय ने सभी उपस्थित कर्मचारियों/अधिकारियों को हिंदी दिवस की शुभकामनाएं दी एवं हिंदी भाषा के महत्व के बारे में बोलते हुए संस्थान के सभी अधिकारियों/कर्मचारियों को सरकार द्वारा समय-समय पर हिंदी भाषा से सम्बंधित जारी अध्यादेशों की पलना करने के साथ ही कार्यालय में ज्यादा से ज्यादा कार्य हिंदी में करने का आग्रह किया तथा साल भर होने वाले हिंदी भाषा के विभिन्न कार्यक्रमों में भाग लेकर सही मायनों में हमें हिंदी के प्रचार-प्रसार एवं इसकी उपयोगिता के बारे में लोगों को जागरूक बनाना चाहिए। इस वर्ष हिंदी पखवाड़े के दौरान कुल चार प्रतियोगिताएं- हिंदी टिप्पण व प्रारूप लेखन, आशुभाषण प्रतियोगिता, हिंदी निबंध प्रतियोगिता एवं प्रश्नोत्तरी प्रतियोगिता का आयोजन ऑन लाइन माध्यम से किया गया जिसमें संस्थान के सभी अधिकारियों/कर्मचारियों ने भाग लिया।

था। कार्यशालाओं में अतिथि वक्ता के रूप में श्री प्रभजीत सिंह (वरिष्ठ प्रबंधक एवं राजभाषा अधिकारी) पंजाब नेशनल बैंक, को आमंत्रित गया। कार्यशाला में संस्थान के सभी अधिकारियों/कर्मचारियों ने भाग लिया तथा सभी कार्यशालाएं उपयोगी एवं सार्थक रहीं। अतिथि वक्ता ने हिंदी भाषा के विभिन्न आईटी टूल्स के बारे में जानकारी देने के साथ ही उन्होंने बताया कि किस प्रकार इन आईटी टूल्स का प्रयोग करके हम कार्यालय तथा दैनिक जीवन में हिंदी भाषा के प्रयोग को बढ़ावा दे सकते हैं तथा विभिन्न संस्थानों द्वारा किये गए अनुसंधान एवं विकसित तकनीकियों को किसानों एवं हितधारकों तक पहुंचाने में हिंदी भाषा के महत्व के बारे में भी विस्तृत से जानकारी दी।



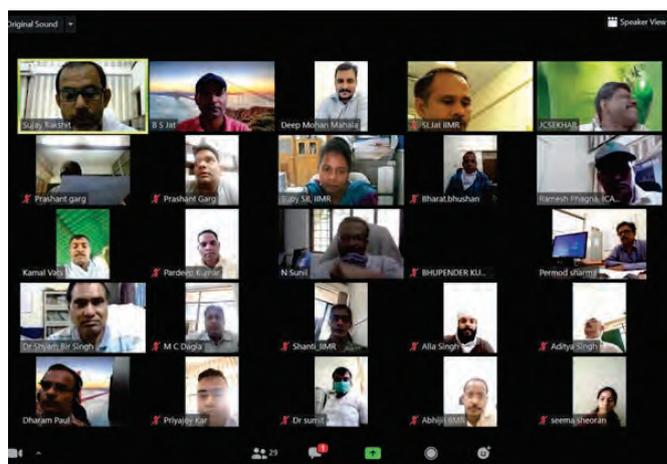
हिंदी के लिए आईटी टूल्स विषय पर हिंदी कार्यशाला



कृषि अनुसंधान एवं तकनीकियों को किसानों एवं अन्य-हितधारकों तक पहुंचाने में हिंदी भाषा की भूमिका विषय पर हिंदी कार्यशाला



राजभाषा पखवाड़े के दौरान संस्थान के स्टाफ सदस्य



संस्थान में राजभाषा पखवाड़ा कार्यक्रम की झलकियां

हिंदी पखवाड़े का समापन समारोह 28 सितम्बर, 2019 को ऑनलाइन माध्यम द्वारा मनाया गया। समारोह की अध्यक्षता निदेशक महोदय ने की कार्यक्रम के दौरान संस्थान के सभी कर्मचारी उपस्थित थे। समारोह का शुभारम्भ निदेशक महोदय की अनुमति से राजभाषा कार्यान्वयन समिति के सदस्य सचिव डॉ. बहादुर सिंह जाट ने समारोह में उपस्थित सभी कर्मचारियों का स्वागत करते हुए किया। समारोह में निदेशक महोदय ने अपने अध्यक्षीय संबोधन में बोलते हुए सर्वप्रथम हिंदी प्रतियोगिताओं के विजेताओं को बधाई दी एवं हिंदी पखवाड़ा आयोजन समिति के सदस्यों को हिंदी पखवाड़े को ऑनलाइन माध्यम से सुचारु ढंग से संचालन के लिए धन्यवाद दिया। संस्थान निदेशक ने जीवन में भाषा के महत्व के बारे बताते हुए कहा कि अपने विचारों की अभिव्यक्ति को व्यक्त करने के लिए प्रत्येक व्यक्ति की अपनी भाषा होती है। भाषा ही एक ऐसा माध्यम है जो हमें एकता के सूत्र में बांधती

है। हिंदी हमारी राजभाषा है और देश में अनेकता में एकता का स्वर हिंदी से ही गूंजता है। अतः हिंदी भाषा का सम्मान और उसकी गरिमा बनाये रखना हमारा कर्तव्य है। भले ही आज अंग्रेजी भाषा का ज्ञान होना जरूरी है लेकिन सफलता पाने के लिये हमें अपनी राष्ट्रभाषा को कभी नहीं भूलना चाहिये। क्योंकि हमारे देश की भाषा और हमारी संस्कृति हमारे लिये बहुत मायने रखती है। समारोह के अंत में प्रधान वैज्ञानिक डॉ. जे. सी. शेखर ने हिंदी पखवाड़ा के समापन समारोह में उपस्थित संस्थान परिवार के सभी सदस्यों, आयोजन समिति के अध्यक्ष एवं संयोजक का धन्यवाद ज्ञापन किया। हिंदी पखवाड़ा से संबंधित समारोह का मंच संचालन तथा सभी प्रतियोगिताओं का समन्वयन डॉ. बहादुर सिंह जाट वैज्ञानिक एवं सदस्य सचिव, राजभाषा द्वारा किया गया।

संस्थान में आयोजित हिंदी पखवाड़ा (14-28 सितम्बर, 2020) कार्यक्रम में आयोजित विभिन्न प्रतियोगिताओं में पुरस्कृत प्रतिभागियों के नाम एवं पुरस्कार का विवरण -

क्र.स.	प्रतियोगिता का नाम	विजेता का नाम	पुरस्कार
1.	हिंदी टिप्पण एवं प्रारूप लेखन प्रतियोगिता (प्रशासनिक, तकनीकी एवं कुशल सहायी स्टाफ वर्ग के लिए)	श्री प्रशांत गर्ग श्री रामकिशन श्री धर्मवीर सिंह	प्रथम द्वितीय तृतीय
2.	आशुभाषण प्रतियोगिता (सभी वर्गों के लिए)	डॉ. शंकर लाल जाट डॉ. आला सिंह डॉ. भारत भूषण	प्रथम द्वितीय तृतीय
3.	हिंदी निबंध प्रतियोगिता शीर्षक : नारी शिक्षा का महत्व (सभी वर्गों के लिए)	सुश्री सीमा श्योराण डॉ. भारत भूषण डॉ. ममता गुप्ता	प्रथम द्वितीय तृतीय
4.	हिंदी प्रश्नोत्तरी प्रतियोगिता (सभी वर्गों के लिए)	डॉ. प्रदीप कुमार श्री दीप मोहन महला डॉ. भारत भूषण	प्रथम द्वितीय तृतीय
5.	वर्ष 2019-20 के दौरान संस्थान में हिंदी में सर्वाधिक कार्य हेतु नकद पुरस्कार (सभी वर्गों के लिए)	श्री धर्मवीर सिंह डॉ. एस.बी. सिंह	प्रथम प्रोत्साहन

### Service to Society during COVID-19 Pandemic

Understanding its roles and responsibilities to the society during the COVID-19 pandemic, all staff members of ICAR-IIMR contributed wholeheartedly and distributed grocery items, vegetables and masks, etc. to field workers and other needy people at Ludhiana, Begusarai, Hyderabad and New Delhi during the lockdown period of COVID-19. More than 135 families were benefited by this noble work. ICAR-IIMR

also prepared advisory to maize farmers on general precautions and safety measures in farm operations and general guidelines to contain COVID-19. The advisory was translated into nine regional languages and disseminated among farmers through newspapers, local channels, All India Radio, local Radio Station, WhatsApp groups, and Facebook, etc.



Distributing of ration during COVID-19 lockdown at various centres of ICAR-IIMR

## Workshops/Meetings

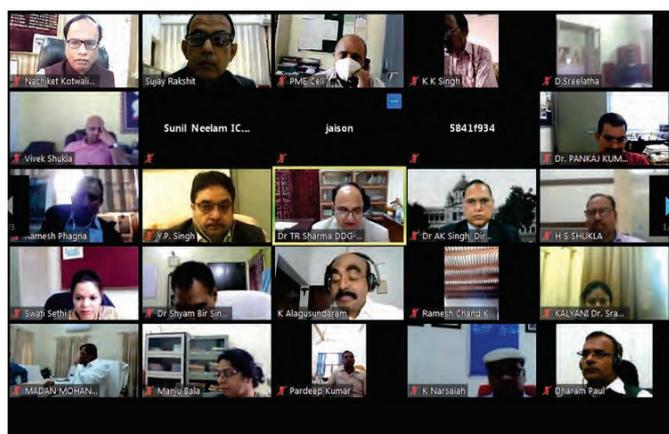
### ICAR – Industry Meet on Maize Value Chain

A virtual meeting between ICAR and different stakeholders of various industries especially maize-based industries was organized by ICAR-Indian Institute of Maize Research, Ludhiana on November 12, 2020. The meeting was co-chaired by Dr. T.R. Sharma, DDG (Crop Science) and Dr. K. Alagusundaram, DDG (Eng.). Dignitaries attended the meeting were Dr. A.K. Singh, Director, ICAR-IARI; Dr. K.K. Singh, ADG (Farm Engineering) and representatives from different ICAR institutes like ICAR-CIPHET, ICAR-CIAE, ICAR-NAARM etc., and various maize-based industries. Dr. Sujay Rakshit, Director, ICAR-IIMR welcomed the dignitaries and all the participants to the ICAR-Industry Meet. The dignitaries emphasized that maize demand and its

production is increasing gradually in India and World. The demand for maize is increasing for food, feed, and as raw material for various food- and non-food based processing and values addition industries. Dr. T.R. Sharma highlighted the increased utilization of maize in value addition and other industries. Dr. K. Alagusundaram focussed on the role of maize in crop diversification in the states of Haryana and Punjab. He also opined that procurement of maize like rice and wheat at MSP would bring natural crop diversification in the above states. Dr. A.K. Singh informed that the significance of maize as a specialized health food is increasing like low GI maize, waxy maize, bio fortified maize, and specialty corn like sweet corn, baby corn, and popcorn. He called upon industry to come forward for up-scaling as such finished products are already available with research institutes.



ICAR – Industry Meet on Maize Value Chain



ICAR – Industry Meet on Maize Value Chain



Virtual meeting of Variety Identification Committee (VIC)

### Variety Identification Committee (VIC) Meeting

First time the Variety Identification Committee (VIC) Meeting of AICRP on Maize was held on May 5, 2020 through Video Conferencing. The meeting was conducted under the Chairmanship of Dr. T.R. Sharma, DDG (Crop Science), ICAR. Ten members of the VIC along with five resource persons from ICAR-IIMR attended the meeting. The Chairman appreciated the initiative of ICAR-IIMR not to hold back such an important meeting under the lockdown due to

Covid19. Timely conduct of VIC meeting is a prelude to release process of developed cultivars for the farmers of the country. Dr. Sujay Rakshit, Director, ICAR-IIMR presented salient features of 26 proposals. Out of these 9 were from the public sector, while 17 were from private seed companies. After thorough discussion 17 proposals were identified for release. Dr. D.K. Yadav, ADG (Seeds) ICAR and Dr. Y.P. Singh ADG (FFC) ICAR appreciated the move and congratulated the ICAR-IIMR family.

### ICAR-IIMR and ISRO-SAC Scientists virtual interaction meeting

Space Applications Centre (SAC) is a major centre of ISRO and a premier research and development institute of the country. Earth observation applications of SAC focuses on numerical and spatial modelling using image processing and GIS tools for applications like crop yield and weather forecasting, dynamics of the atmosphere, oceans, coasts and ecosystem and use of microwave data for various applications.

To formulate collaborative research a virtual interaction meeting between scientists of ICAR-IIMR and ISRO-SAC was organized on May 22, 2020. Dr. Sujay Rakshit, Director, ICAR-IIMR welcomed all the participants and presented the activities carried out by AICRP on Maize. Dr. Bimal K. Bhattacharya, Head, AED, SAC, ISRO elaborated on how the satellite remote sensing works on crops including maize. During meeting all the possible collaboration areas between ICAR-IIMR and ISRO-SAC were discussed and agreed upon a joint work plan.



ICAR-IIMR and ISRO-SAC Scientists virtual interaction meeting

### ICAR-IIMR Agri-Business Incubation (ABI) meeting

Agri-Business Incubation (ABI) meeting of ICAR-IIMR with Komboj Bee Farm, Yamuna Nagar and Dharambir Food Product Pvt. Ltd., Damla was held on November 03, 2020 at

ICAR-IIMR, Ludhiana. Both the firms joined as startup under ABI of ICAR-IIMR. During the meeting, it was discussed that ICAR-IIMR ABI center will provide training and refinement of technologies and will also handhold these startups for the development of their business.



Promotion of ICAR-IIMR Agri Business Incubation (ABI) with Komboj Bee Farm and Dharambir Food Product Pvt. Ltd.

### MoU with Koshi Agro Biotech Pvt. Ltd. Patna

ICAR-IIMR signed MoUs with Koshi Agro. Biotech Pvt. Ltd., Patna for the seed production of ICAR-IIMR developed

normal field corn hybrids DMRH 1305, DMRH 1301 and baby corn hybrid, IMHB 1539. These hybrids have been commercialized through Agrinnovate in a PPP mode.



**ICAR-IIMR signing MoU with Koshi Agro Biotech Pvt. Ltd. Patna for normal field corn hybrids DMRH 1305, DMRH 1301 and baby corn hybrid IMHB 1539**



**MoU with National Dairy Development Board (NDDB), Anand for collaborative research on fodder and silage maize**

Developing Linkages to strengthen and expedite the research and extension activities, the institute developed linkages with reputed National Organizations. In this regard, the institute signed a memorandum of understanding (MoU) with the National Dairy Development Board (NDDB), Anand on January 29, 2020, for five years to conduct collaborative research on fodder and silage maize.

**MoU with Centre for Development of Advance Computing (C-DAC), Mohali**

An MoU was signed with Centre for Development of Advance Computing (C-DAC), Mohali for a period of three years to conduct collaborative research on “Cyber Agro- Physical System for Intelligent Agriculture”. The MoU was exchanged



**Director, ICAR-IIMR signing MoU with National Dairy Development Board**

on February 9, 2020 on the occasion of National Seminar on “Maize for Crop Diversification under Changing Climatic Scenario” held at Ludhiana, Punjab.



**Director, ICAR-IIMR signing MoUs with various Institutes during National Maize Seminar**

### MoU between ICAR-IIMR and Lovely Professional University, Ludhiana

ICAR-IIMR and Lovely Professional University, Jalandhar signed an MoU for five years for collaborative programs on student's Training/Postgraduate/Ph.D. Research. The MoU was exchanged on February 9, 2020 on the occasion of National Seminar on “Maize for Crop Diversification under Changing Climatic Scenario” held at Ludhiana, Punjab.

### Institute Seminars

Looking into the dynamic nature of agricultural science and observance of new concepts in relation to different disciplines, institute seminars programme is a regular feature to share scientific happenings around the world, with special emphasis on maize. These seminars were attended by scientists, research fellows, young professionals, students and technical staffs. A total of three seminars were held during 2020.

#### List of Institute seminar / Discussion conducted at ICAR-IIMR, Ludhiana

Sl. No.	Name of expert	Topic of seminar	Date of seminar
1.	Dr. Ishwar Singh	Speed Breeding in Maize vis-à-vis Other Crops: Status and Prospects	April 25, 2020
2.	Dr. Sujay Rakshit	Common errors in editing	May 26, 2020
3.	Dr. P.N. Sharma	Variability in plant pathogens and implication in resistance breeding	May 30, 2020



Institute seminar being delivered by Scientists

### Trainings

#### Training Programme “Sankar Makka Ki Vaigyanic Kheti, Beej Utpadan Taknikiya Fall Army Worm Keet Ka Parbandhan Ranitiya”

A five-day training program for the tribal farmers was organized by the ICAR-IIMR, RMR&SPC, Begusarai from January 20-24, 2020. In this training programme, 23 tribal farmers participated. They took keen interest to know how the

scientific cultivation of normal maize along with the specialty corns cultivated to improve their income generation and sustain their livelihood by maize cultivation. In the training program, Dr. S.B. Singh, Principal scientist & In-charge RMR&SPC, Begusarai and Mr. Santosh Kumar, Scientist, RMR&SPC delivered lectures on the scientific cultivation of normal maize and specialty corns, and hybrid seed production to raise the farmers' income. Lectures were also delivered by invited expert speakers on various aspects including pests and diseases of maize, and their chemical control.



Training programme of Tribal farmers at RMR&SPC, Begusarai



Trainee farmers visiting protected vegetable cultivation in village Iniyar, Begusarai



**Trainee farmers visiting RMR&SPC Farm Kudhmahaut, Begusarai**



**Distribution of certificates and farm inputs to TSP trainee farmers**

### किसान प्रशिक्षण कार्यक्रम

आतमा परियोजना देहारादून के अंतर्गत, भा.कृ.अनु.प.-भारतीय मक्का अनुसंधान संस्थान, लुधियाना, पंजाब में 7-9 जनवरी, 2020 के दौरान "उत्तराखंड में मक्का की उन्नत खेती द्वारा किसानों की आय दोगुना करना" विषय पर प्रशिक्षण आयोजित किया। इस कार्य क्रम में 45 किसानों ने

भाग लिया। संस्थान के वैज्ञानिकों ने प्रशिक्षण कार्यक्रम के दौरान मक्का से संबन्धित विभिन्न विषयों जैसे- मक्का की उन्नत खेती, QPM, बेबीकॉर्न, स्वीटकॉर्न, पॉपकॉर्न, चारा मक्का, मशीनीकरण, मक्का में कीटों एवं रोगों की रोकथाम पर व्याख्यान प्रस्तुत किए तथा किसानों को संस्थान के लाडोवाल प्रक्षेत्र का भ्रमण भी कराया गया।



आतमा परियोजना देहारादून के अंतर्गत, भा.कृ.अनु.प.-भारतीय मक्का अनुसंधान संस्थान, लुधियाना में किसान प्रशिक्षण कार्यक्रम

### Training Programme on “Single Cross Maize Hybrid Seed Production Technique”

A training programme on the “Single cross maize hybrid seed production technique” was organized under Mega Seed

Project at RMR&SPC, Begusarai, Bihar on November 6, 2020. Staffs of Bihar Rajya Beej Nigam (BRBN) and 12 farmers of the Begusarai and nearby districts participated in the training programme.



Training programme on hybrid maize seed production

### Awareness-cum-Training Programme on Fall army worm and seed production

Two awareness-cum-training programmed of one-day duration were organized on the control and management of Fall armyworm and its hybrid maize seed production at RMR&SPC, Begusarai, Bihar on February 17 and 18, 2020,

respectively. The awareness programme on February 17 was attended by 100 Agricultural extension officers/workers, Block Agriculture Officers, BTMs, ATMs of District Begusarai and nearby Districts. The training programme on February 18 was attended by 131 farmers of the Begusarai district. Dr. S.B. Singh, Principal Scientist and Mr. Santosh Kumar, Scientist delivered lectures to the participants.



Training programmes on hybrid maize seed production and FAW management

### Farmer Awareness-cum-Training Programme under SCSP

An awareness-cum-training programme on the devastating pest, Fall armyworm was conducted for the 216 scheduled cast farmers of the Begusarai at RMR&SPC, Begusarai, on February 19, 2020, in which Dr. S.B. Singh and Mr. Santosh Kumar delivered lectures. The farmers were made aware of the insect and briefed about its integrated management. Farmers were also made aware of the package of practices of

maize cultivation and management of different insects, pests and diseases of maize.

### Farmer – Scientist Interaction Programme

A farmer- Scientist Interaction programme was conducted on March 12, 2020, which was sponsored by District Agriculture Office, Begusarai. Detailed information on scientific cultivation of maize, seed production, and control of FAW in maize was given to farmers. Various queries of farmers related to maize crop were resolved in the programme.



Awareness-cum-Training Programme

### Training programme of AICRP on maize

An online training was organized by co-ordination cell of AICRP on maize during August 5-6, 2020. Altogether, 110 scientists from different AICRP centers across the country attended the online training. Principal Investigators of different disciplines (Plant Breeding, Agronomy, Entomology & plant Pathology) delivered lectures regarding recording of data in AICRP trials. Besides these, lectures on value addition in maize, inoculation techniques for different diseases and importance of conservation agriculture were also delivered by experts.



AICRP training programme

### Awareness-cum-training programme on FAW management in Himachal Pradesh

One day online awareness-cum-training programme on "Management of Fall armyworm (FAW) in Himachal Pradesh" was organized on August 7, 2020 by ICAR-IIMR, Ludhiana in collaboration with Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya (CSK HPKV), Palampur. More than 70 participants comprised of scientists of SAU/ICAR, SMSs, Extension officers and ADOs of the State Department of Agriculture, and students participated the programme.



Awareness-cum-training programme on FAW management in Himachal Pradesh

### Awareness-cum-Training programme on "Management of Fall Armyworm (FAW) in Jammu and Kashmir"

An online awareness-cum-training programme on "Management of Fall armyworm (FAW) in Jammu and Kashmir" was organized on August 18, 2020 by ICAR-IIMR, Ludhiana in collaboration with Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir (SKUAST-K), Srinagar. Around 55 participants from the SAUs, state departments working in Jammu and Kashmir attended this programme.



Awareness-cum-training programme on FAW in Jammu and Kashmir

### One-day online Technical Webinar-cum-Training for Extension Officers

One-day online Webinar-cum-training on 'Integrated Pest Management for Maize Crop with special reference to Fall armyworm in Rajasthan, Gujarat and Haryana States' was organized for the Agricultural Extension Officers of state departments and scientists of ICAR/KVK/SAU/CIPMC of the mentioned states on October 15, 2020, under the FAO project on "Time-critical measures to support early warning and monitoring and sustainable management of the Fall armyworm in India". This training was attended by 120 participants from the states of Rajasthan, Gujarat, Haryana and other places. Various national experts attended the programme online and shared their experiences..



Online Technical Webinar-cum-Training for Extension Officer and Farmers by FAO, India and ICAR-IIMR

### Technical Webinar-cum-Training for Extension Officers and Scientists

One-day online Technical Webinar-cum-training on "Integrated Pest Management for Maize Crop with special reference to Fall armyworm" on September 18, 2020 to the Agricultural Extension Officers of state departments and Scientists of ICAR/KVK/SAU of Maharashtra, Madhya Pradesh, Chhattisgarh and Odisha states organized by FAO, India and ICAR-IIMR. This training emphasized on the need to create awareness on early monitoring of the Fall armyworm incidence on maize and to advice the farmers to initiate the timely management techniques in a sustainable manner using the FAMEWS app. Integrated Management options to manage FAW in sustainable manner in the respective maize agroecological regions was emphasized in the pogramme. The training was attended by 60 participants.



One-day online Technical Webinar-cum-training of Agricultural Extension officers of state departments and Scientists of ICAR/KVK/SAU of Maharashtra, Madhya Pradesh, Chhattisgarh and Odisha states

### Technical Webinar-cum-Training for Extension officers and Scientists

One-day online Technical Webinar-cum-training on "Integrated Pest Management for Maize Crop with special reference to Fall armyworm in North West Hill (NWH) region" to the Agricultural Extension officers of state departments and Scientists of ICAR/KVK/SAU of NWH region was organized by FAO India and ICAR-IIMR on

September 10, 2020, under the FAO project on "Time-critical measures to support early warning and monitoring and sustainable management of the Fall Armyworm in India". The scientists from ICAR- Indian Institute of Maize Research, ICAR- Indian Institute of Millet Research, Hyderabad, Agricultural Extension officers of the state departments and Scientists of ICAR/KVK/SAU of Himachal Pradesh, Jammu & Kashmir and Uttarakhand participated the programme. The training was attended by 55 participants.



**One-day online Technical Webinar-cum-training of Agricultural Extension officers of state departments and Scientists of ICAR/KVK/SAU of Himachal Pradesh, Jammu & Kashmir and Uttarakhand states**

**Field visit of Nehru Yuva Kendra Trainees to learn Hybrid Maize Seed production technology**

A group of 35 trainees of Nehru Yuva Kendra visited the RMR&SPC, Begusarai on March 7, 2020, to learn about the

maize hybrid seed production technology. A lecture on hybrid seed production technology was given to them by Dr. S. B. Singh and then various activities in hybrid seed production and maize research like pollination, selfing, crossing, roging, detasseling were demonstrated to them in the field.



**Field visit of Nehru Yuva Kendra trainees**

## Visits

### Students Visit at ICAR-IIMR, Delhi Unit Office

A batch of 36 B.Sc. (Ag.) final year students from Chhattisgarh Agriculture College, Dhanora, Chhattisgarh visited ICAR-IIMR, New Delhi Unit on February 19, 2020. Dr. Krishan Kumar presented the students with an overview of on going maize Biotechnology research in the institute and taken them

to tissue culture laboratory for on-lab exposure. The students were also acquainted with tissue culture techniques and gene transfer methods being used in maize. The students were exposed to the functioning of various laboratory instruments such as Thermo cyclers, Real-time PCR, Autoclave, Centrifuges, Agro Gel Electrophoresis, Gel documentation system, and UV Spectrophotometer, Nano drop, Biolistic® PDS-1000, Deep freezers.



**B.Sc. (Ag.) final year students from Chhattisgarh Agriculture College, Dhanora, Chhattisgarh visiting ICAR-IIMR New Delhi Unit**





*Participants in the National Seminar held in Ludhiana on February 9-10, 2020*

## *Training & Capacity Building*



*A training program in Begusarai, Bihar*

# TRAINING & CAPACITY BUILDING



## A. Training and Capacity Building of ICAR Employees

### A1. Under approved HRD Annual Training Plan (ATP) 2019

#### A1.1: Scientific

Name of the Scientist	Name of the training program attended	Venue	Date
Dr. Bharat Bhushan	Rapid detection techniques for quality evaluation and safety of foods	Venue Central Institute of Agricultural Engineering (CIAE), Bhopal	January 13-22, 2020
Dr. J.C. Sekhar	MDP on Leadership Development (a pre-RMP programme)	ICAR-NAARM, Hyderabad	December 8-19, 2020

#### A1.2: Technical

Name of the Staff	Name of the training program attended	Venue	Date
Shri Prashant Garg	Capacity Building Programme for CJSC members	ICAR-NAARM, Hyderabad	January 26-February 1, 2020
Shri Permod Sharma	Administrative and Financial Management for Administrative and Finance Officers of ICAR	ICAR-NAARM, Hyderabad (Online)	November 23-27, 2020
Shri Ashwani Kumar	Administrative and Financial Management for Administrative and Finance Officers of ICAR	ICAR-NAARM, Hyderabad (Online)	November 23-27, 2020

#### A2.1: Others

##### A2.1: Scientific

Name of the Scientist	Name of the training program attended	Venue	Date
Dr. Ramesh Kumar	Online training program on IPR	NAHEP (ICAR)	September 9-28, 2020
Dr. S.B. Singh	Training on Integrated Pest Management (IPM) for Maize Crop with special reference to Fall Armyworm	FAO	July 21-22, 2020
Dr. S.B. Singh	Abiotic stress tolerance maize and bio-fortified maize	BAU, Sabour	August 4, 2020
Dr. S.B. Singh	Genomic-assisted maize breeding: Status and Opportunities.	CIMMYT	August 12, 2020



Name of the Scientist	Name of the training program attended	Venue	Date
Dr. S.B. Singh	Improving phenotyping accuracy and throughput in Maize	CIMMYT	August 14, 2020
Dr. S.B. Singh	Online training programme of National facilitators on Farm Bill	Ministry of Agriculture and Farmer Welfare, GOI, New Delhi	October 9, 2020
Dr. Yathish K.R.	Genomics-assisted Maize Breeding: Status and Opportunities	CIMMYT, Kenya	August 12, 2020
Dr. Mamta Gupta	Online Nanotechnology training	ICAR-Central Institute for Research on Cotton Technology (CIRCOT), Mumbai	November 23-27, 2020
Dr. Alla Singh	Online training program on IPR	NAHEP(ICAR)	September 9-28, 2020
Dr. Alla Singh	Online Nanotechnology Training	ICAR-Central Institute for Research on Cotton Technology (CIRCOT), Mumbai	November 23-27, 2020
Dr. Ph Romen Sharma	Market Research & Value Chain Management of Agricultural Commodities	ICAR-NAARM (online)	November, 17-21, 2020
Seema Sheoran	Analysis of Experimental Data Using SAS	NAARM, Hyderabad	November 9-17, 2020
Seema Sheoran	ABC of Scientific Writing	ICAR-NRRI, Cuttack	August 18-2 September, 2020
Seema Sheoran	Analysis of Experimental Data using R	ICAR-NAARM, Hyderabad	August 5-11, 2020

#### B. Trainings conducted

Name of the Scientist	Name of the training program attended	Institutes/Organizations Involved	Date
Drs. J.C. Sekhar and Sujay Rakshit	Management of insect pests of maize with special reference to fall armyworm	FAO, CIMMYT, ICAR-IIMR, ICAR-NBAIR, ICAR-ATARI, DPPQ&S	July 21-22, 2020
Drs. J.C. Sekhar and Sujay Rakshit	Integrated Pest Management for Maize Crop with special reference to fall armyworm in NEH region	FAO, ICAR-IIMR, ICAR-NEH and DPPQ&S	September 4, 2020
Drs. J.C. Sekhar, S.L. Jat and Sujay Rakshit	Integrated Pest Management for Maize Crop with special reference to fall armyworm in NWH region	FAO, ICAR-IIMR, SKUAST and DPPQ&S	September 10, 2020
Drs. J.C. Sekhar, S.L. Jat and Sujay Rakshit	Integrated Pest Management for Maize Crop with special reference to fall armyworm for Maharashtra, Madhya Pradesh, Chhattisgarh and Odisha	FAO, ICAR-IIMR, ICAR-NBAIR, ICAR IIMR (Millets) and DPPQ&S	September 18, 2020



Name of the Scientist	Name of the training program attended	Institutes/Organizations Involved	Date
Drs. J.C. Sekhar, S.L. Jat and Sujay Rakshit	Integrated Pest Management for Maize Crop with special reference to fall armyworm in NEPZ	FAO, ICAR-IIMR, ICAR-NBAIR, ICAR-IIMR (Millets) and DPPQ&S	October 9, 2020
Drs. J.C. Sekhar, S.L. Jat and Sujay Rakshit	Integrated Pest Management for Maize Crop with special reference to fall armyworm in Rajasthan, Gujarat and Haryana states	FAO, ICAR-IIMR, ICAR-NBAIR, ICAR-IIMR (Millets) and DPPQ&S	October 15, 2020
Drs. J.C. Sekhar, P. L.Soujanya, Suby S.B., S.L. Jat and Sujay Rakshit	Fall armyworm (FAW) Awareness Meeting for farmers and officials of Bundi and Kota Districts of Rajasthan”	ICAR-IIMR	September 1, 2020
Drs. J.C. Sekhar, P.L.Soujanya, Suby S.B., S.L. Jat and Sujay Rakshit	Awareness-cum-training programme on "Management of Fall Armyworm (FAW) in Himachal Pradesh”	ICAR-IIMR	August 7, 2020
Drs. J.C. Sekhar, P.L.Soujanya, Suby S.B., S.L. Jat and Sujay Rakshit	Online Awareness training programme on "Management of Fall Armyworm (FAW)"	ICAR-IIMR	August 18, 2020
Dr. Ramesh Kumar	Online training for AICRP on Maize	ICAR-IIMR	August 5-6, 2020
Dr. S.B. Singh and Mr. Santosh Kumar	5-day training pro-gramme under TSP were conducted on “Scientific Cultivation of Hybrid Maize, Seed Production Technology and Fall Army worm Pest Management and Strategy” (संकर मक्का की वैज्ञानिक खेती एवं फॉल आर्मीवर्म कीट का प्रबंधन व रणनीतियां)	Regional Maize Research and Seed Production Centre (RMR&SPC), Begusarai	January 20-24, 2020
Dr. S.B. Singh and Mr. Santosh Kumar	Training-cum-awareness programme under Mega seed project for agricultural officer of Begusarai and nearest district was conducted on “Scientific cultivation of hybrid maize, its seed production technology control and management of Fall Armyworm” ( संकर मक्का व इसके बीज उत्पादन फसल में फॉल आर्मीवर्म कीट की रोकथाम व प्रबंधन)	Regional Maize Research and Seed Production Centre (RMR&SPC), Begusarai	February 17, 2020

Name of the Scientist	Name of the training program attended	Institutes/Organizations Involved	Date
Dr. S.B. Singh and Mr. Santosh Kumar	Training-cum-awareness programme for farmers of Begusarai and nearest district was conducted on “Scientific cultivation of hybrid maize, its seed production technology, control and management of Fall Armyworm” (संकर मक्का की वैज्ञानिक खेती, बीज उत्पादन तकनीकी एवं फसल में फॉल आर्मीवर्म कीट की रोकथाम व प्रबंधन)	Regional Maize Research and Seed Production Centre (RMR&SPC), Begusarai	February 18, 2020
Dr. S.B. Singh and Mr. Santosh Kumar	Training-cum-awareness programme for SC farmers under SCSP programme on “Scientific cultivation of hybrid maize, its seed production technology, control and management of Fall Armyworm” (संकर मक्का की वैज्ञानिक खेती बीज उत्पादन तकनीकी एवं फसल में फॉल आर्मीवर्म कीट की रोकथाम व प्रबंधन)	Regional Maize Research and Seed Production Centre (RMR&SPC), Begusarai	February 19, 2020
Dr. S.B. Singh and Mr. Santosh Kumar	Farmer-Scientist Interaction cum Field Day programme on “Maize hybrid technology, seed production and management of FAW in maize” (संकर मक्का तकनीकी, बीज उत्पादन व फॉल आर्मीवर्म कीट का प्रबंधन)	Regional Maize Research and Seed Production Centre (RMR&SPC), Begusarai	March 12, 2020
Dr. S.B. Singh	Training programme for Officers/staff of Bihar Rajya Beej Nigam (B.R.B.N) and farmers on “Single Cross Maize Hybrid Seed Production Technique” (एकल संकर मक्का बीज उत्पादन तकनीकी)	Regional Maize Research and Seed Production Centre (RMR&SPC), Begusarai	November 6, 2020
Dr. Pardeep Kumar	“उत्तराखंड में मक्का की उन्नत खेती द्वारा किसानों की आय दोगुना करना”	भा. कृ. अनु. प.-भारतीय मक्का अनुसंधान संस्थान, लुधियाना	7 – 9 जनवरी, 2020

### C. Seminar/Symposium/Conferences Organized and attended by employees

#### C1. Seminar/Symposium/Conferences/ Organized:

Scientists of IIMR	Programme	Place	Date
Drs. Sujay Rakshit, Ramesh Kumar and J.S. Chawla	National Seminar on “Maize for Crop Diversification under Changing Climatic Scenario”	ICAR-IIMR	February 9-10, 2020
Dr. Sujay Rakshit	Variety Identification Committee (VIC) Meeting of AICRP on Maize	ICAR-IIMR, Ludhiana (Online)	May 5, 2020
Dr. Sujay Rakshit	ICAR-Industry Meet on Maize Value Chain	ICAR-IIMR Ludhiana (Online)	November 12, 2020
Dr. S.B. Singh	International Web conference on Global Research Initiatives for Sustainable Agriculture & Allied Sciences, (GRISAAS -2020)	Online	December 28-30, 2020

#### C2. Participation in Seminar/Symposium/Conferences/Workshop/Important meeting

Name of the Scientist	Name of the Conference/Seminar/Workshop/Meeting Attended	Venue	Date
Dr. Sujay Rakshit	107 <sup>th</sup> Indian Science Congress	GKVK Bengaluru campus	January 3-7, 2020
Dr. Sujay Rakshit	Annual Review Meeting of CGIAR Institutes	Video Conferencing	May 4, 2020
Dr. Sujay Rakshit	Attended BP Pal Memorial Lecture on “Reforms for Secure and Sustainable Agriculture – a Road Map” delivered by Dr. RS Paroda, Chairman TAAS	Webinar	May 27, 2020.
Dr. Sujay Rakshit	FAO Technical Committee – Global Action on FAW Control meeting	FAO	May 18, 2020
Dr. Sujay Rakshit	Fall Armyworm Research Collaboration Portal - Steering Committee Meeting	CABI	June 10, 2020
Dr. Sujay Rakshit	Second virtual meeting of the Technical Committee on Global Action for Fall Armyworm Control of FAO	FAO	July 27, 2020.
Dr. Sujay Rakshit	ICAR-Federation of Seed Industries of India (FSII) meet chaired by Secretary, DARE & DG, ICAR.	ICAR	July 27, 2020

Name of the Scientist	Name of the Conference/Seminar/Workshop/Meeting Attended	Venue	Date
Dr. Sujay Rakshit	Review meeting of institutes under CS Division under the chairmanship of DDG (CS)	ICAR	July 30, 2020
Dr. Sujay Rakshit	Abiotic stress tolerance maize and bio-fortified maize	BAU, Sabour	August 4, 2020
Dr. Sujay Rakshit	CABI Fall armyworm research collaboration portal - steering committee meeting	CABI	August 11, 2020
Dr. Sujay Rakshit	HTMA Workshop	CIMMYT	September 12, 2020
Dr. Sujay Rakshit	FAW advisory committee meeting	NASF	September 16, 2020
Dr. Sujay Rakshit	3 <sup>rd</sup> Technical Committee meeting of Global Action for Fall Armyworm Control of FAO	FAO	October 1, 2020
Dr. Sujay Rakshit	Zone-II Regional Committee meeting	ICAR	October 8, 2020
Dr. Sujay Rakshit	HTMA meeting	CIMMYT	October 8, 2020
Dr. Sujay Rakshit	National seminar on World Food Day 2020 - "Grow Nourish Sustain Together"	SKUAST-Kashmir	October 17, 2020
Dr. Sujay Rakshit	High Level Committee meeting on "Promotion of Agriculture Mechanization for In-Situ Management of Crop Residue in the States of Punjab, Haryana, Uttar Pradesh and NCT of Delhi"	ICAR	November 12, 2020
Dr. Sujay Rakshit	FAD16 meeting of BIS	BIS	November 18, 2020
Dr. Sujay Rakshit	Zone-IV Regional Committee meeting	ICAR	November 27, 2020
Dr. Sujay Rakshit	FAW Research Collaboration Steering Committee	CABI	December 7, 2020
Dr. Sujay Rakshit	Annual Vice Chancellors and Directors Conference	ICAR	December 5, 2020
Dr. Sujay Rakshit	Zone V Regional Committee meeting	ICAR	December 7, 2020
Dr. Sujay Rakshit	High Level Committee meeting on "Promotion of Agriculture Mechanization for In-Situ Management of Crop Residue in the States of Punjab, Haryana, Uttar Pradesh and NCT of Delhi"	ICAR	December 23, 2020
Dr. Ishwar Singh	National Seminar on "Maize for Crop Diversification under Changing Climate Scenario"	ICAR-IIMR, Ludhiana	February 9-10, 2020
Dr. Ishwar Singh	Workshop on "Training Management Information System for HRD Nodal Officers of ICAR"	HRM Division, ICAR (Online)	May 8, 2020

Name of the Scientist	Name of the Conference/ Seminar/Workshop/Meeting Attended	Venue	Date
Dr. Ishwar Singh	International Webinar on “Translating Physiology into Techniques for Abiotic Stress Tolerance in Crops”	ICAR-NIASM, Baramati & ISPP, New Delhi (Online)	October 9, 2020
Dr. Ishwar Singh	International Plant Physiology Virtual Conference on “Prospects of Plant Physiology for Climate Proofing Agriculture”	SKUAT-Jammu & ISPP, New Delhi (Online)	December 6-7, 2020
Dr. J.C. Sekhar	Workshop on “Drone Use in Agriculture in Telangana State”	PJTSAU, Hyderabad	January 9, 2020
Dr. J.C. Sekhar	National Seminar on “Maize for Crop Diversification under Changing Climatic Scenario”	ICAR-IIMR, Ludhiana	February 9-10, 2020
Dr. J.C. Sekhar	IMIC-Asia Demonstration of germplasm.	CIMMYT	March 12, 2020
Dr. J.C. Sekhar	XXIX Annual Workshop of All India Coordinated Research Project on Biological Control of Crop Pests	ICAR-NBAIR, Bengaluru	May 21-22, 2020
Dr. J.C. Sekhar	Post pandemic (Covid-19) challenges and options in agriculture including horticulture - turning adversity into opportunity	PJTSAU, Hyderabad	May 28, 2020
Dr. J.C. Sekhar	Desert Locust Management: Current status and future strategies, Speaker: Dr. S.N. Sushil, Principal Scientist, IISR & Former Plant Protection Advisor, GOI	Division of Entomology ICAR-Indian Agricultural Research Institute, New Delhi	May 30, 2020
Dr. J.C. Sekhar	Virtual Meet on Desert Locust Speaker: Dr. S.N. Sushil, Principal Scientist, IISR & Former Plant Protection Advisor, GOI	Director & Project Co-ordinator (Biological Control), AICRP on Biological Control, ICAR-NBAIR, Bangalore.	June 5, 2020
Dr. J.C. Sekhar	Regional Steering Group Meeting on Fall Armyworm management	FAO, Bangkok	June 17, 2020
Dr. J.C. Sekhar	Meeting with the Principal Secretaries (Agriculture)/ Director Agriculture of major maize growing States is scheduled under the Chairmanship of Secretary (DAC&FW) to review the current status of Fall Armyworm	DAC&FW, GOI	June 18, 2020
Dr. J.C. Sekhar	Webinar on development of Nutritionally enriched maize, challenges and prospects under changing climatic scenario by Dr. B. M. Prasanna, Director, Global Maize Program CIMMYT	SKUAST, Kashmir	July 3, 2020
Dr. J.C. Sekhar	FAO Technical Network webinar on “Agro-ecological approaches for fall armyworm management: environmentally-friendly, small holder-oriented solutions for controlling an invasive pest”	FAO, Bangkok	July 16, 2020



Name of the Scientist	Name of the Conference/ Seminar/Workshop/Meeting Attended	Venue	Date
Dr. J.C. Sekhar	National webinar on "Challenges and Recent Initiatives on Sustainable Management on Fall Armyworm"	BAU, Sabour	July 16, 2020
Dr. J.C. Sekhar	Webinar on 'Biocontrol of parthenium' by Dr. K. Dhileepan Principal Entomologist, Biosecurity Queensland, Australia	Society for Biocontrol Advancement and ICAR-NBAIR	August 21, 2020
Dr. J.C. Sekhar	Inauguration of Academic and Administrative Building of Rani Lakshmi Bai Central Agricultural University, Jhansi by Hon'ble, Prime Minister of India	ICAR	August 29, 2020
Dr. J.C. Sekhar	Agriculture Technologies-Structured innovations	KISANMITR, Principal Scientific Advisor Office, GOI	August 29, 2020
Dr. J.C. Sekhar	ICAR-NAARM 45 <sup>th</sup> Foundation Day	ICAR-NAARM	September 1, 2020
Dr. J.C. Sekhar	ASEAN Fall armyworm Webinar Series (Part 1) Introduction & Classical Approaches	Grow Asia	September 10, 2020
Dr. J.C. Sekhar	Field experiences with pesticides and biopesticides for fall armyworm management: The case of Kenya and South Sudan	CABI	September 11, 2020
Dr. J.C. Sekhar	HTMA workshop	CIMMYT	September 12, 2020
Dr. J.C. Sekhar	RAP Regional meeting on Global Action for Fall Armyworm Control-EN Chaired by Director, NSP Dr.JingyuanXia, FAO	FAO, Bangkok	September 15, 2020
Dr. J.C. Sekhar	ASEAN FAW Technology Taster: Drones and Digital	Grow Asia	September 17, 2020
Dr. J.C. Sekhar	ASEAN Fall Armyworm Bio-control Webinar Series (Part 2): Biopesticides	Grow Asia	September 24, 2020
Dr. J.C. Sekhar	Webinar on Innovations for sustainable Agriculture by Dr. A. K. Singh Director, IARI	KISANMITR, Principal Scientific Advisor Office, GOI, NSRCEL, IIMB	September 26, 2020
Dr. J.C. Sekhar	XII <sup>th</sup> Dr. Pradhan Memorial lecture by Dr. Kailash Chandra, ZSI, Kolkata on Entomofauna, Ecosystem and Economics	Division of Entomology, ICAR-IARI, New Delhi	September 28, 2020
Dr. J.C. Sekhar	RAISE-2020 virtual global summit on Artificial Intelligence	Ministry of Electronics & IT, Government of India	October 5-9, 2020
Dr. J.C. Sekhar	XXV Meeting of ICAR Regional Committee No. II	ICAR- National Rice Research Institute, Cuttack	October 8, 2020
Dr. J.C. Sekhar	ASEAN Fall Armyworm Bio-control Webinar Series (Part 3): Augmentation & Conservation	Grow Asia	October 8, 2020



Name of the Scientist	Name of the Conference/ Seminar/Workshop/Meeting Attended	Venue	Date
Dr. J.C. Sekhar	World Food Day webinar	NAHEP, SKUAST	October 16, 2020
Dr. J.C. Sekhar	Digital release of commemorative coin on the occasion of 25 years of FAO by Hon'ble Prime Minister of India	ICAR	October 16, 2020
Dr. J.C. Sekhar	Global Burden of Crop Loss Workshop series: Estimating yield loss - Technical discussion of how yield losses can be estimated, using maize as a case study	CABI	October 26, 2020
Dr. J.C. Sekhar	Global Burden of Crop Loss Workshop series Attribution of yield loss biotic and abiotic factors	CABI	October 27, 2020
Dr. J.C. Sekhar	Regional training workshop for farmer field school facilitator sustainable management of fall army worm: IPM, Bio control and farmer field schools- FAO FAW Webinar Session 1	FAO and Thai Education Foundation	October 29, 2020
Dr. J.C. Sekhar	FAO FAW Webinar Session 2	FAO and Thai Education Foundation	November 3, 2020
Dr. J.C. Sekhar	Plantae Presents: Gustavo MacIntosh and Jyothi Vaddasery- Calcium mediated defense against insect herbivores	Plantae ASPB	November 4, 2020
Dr. J.C. Sekhar	FAO FAW Webinar Session 3	FAO and Thai Education Foundation	November 6, 2020
Dr. J.C. Sekhar	Webinar on "Why Post-Pandemic India needs a new social contract" by Dr. Arunabha Ghosh, CEO, Council on Energy, Environment and Water (CEEW)	ICAR - NBAIR	November 17, 2020
Dr. J.C. Sekhar	Regional Coordination meeting on the implementation of the FAO Global action for FAW	FAO, Rome	November 19, 2020
Dr. J.C. Sekhar	Regulatory approaches and registration requirements for Biopesticides in India – Prospects and constraints	NIPHM	November 20, 2020
Dr. J.C. Sekhar	National webinar on Recent trends in vertebrate pest management	NIPHM	November 23, 2020
Dr. J.C. Sekhar	International webinar on Advances in stored grain protection	NIPHM	November 25, 2020
Dr. J.C. Sekhar	International webinar Plant health as a driver of plant biosecurity, food security and sustainable agriculture	NIPHM	November 26, 2020
Dr. J.C. Sekhar	National Webinar on "Bio intensive Management of Plant Parasitic Nematodes	NIPHM	November 27, 2020



Name of the Scientist	Name of the Conference/Seminar/Workshop/Meeting Attended	Venue	Date
Dr. J.C. Sekhar	Webinar on Genomics Strategies for Improvement of Abiotic Stress Tolerance in Crop Plants	ICAR-NIASM, Baramati	November 27, 2020
Dr. J.C. Sekhar	International webinar on Recent trends in plant biosecurity	NIPHM	December 4, 2020
Dr. J.C. Sekhar	XXVI Meeting of ICAR Regional Committee No. V	ICAR-CSSRI, Karnal	December 7, 2020
Dr. J.C. Sekhar	Online Management Development Programme on Leadership Development (Pre-RMP 2020)	NAARM	December 8-19, 2020
Dr. J.C. Sekhar	FAO Follow-up Meeting on the Implementation of Regional Action for Fall Armyworm (FAW) Control	FAO Rome	December 17, 2020
Dr. J.C. Sekhar	Biocontrol WS 1: Field collection and identification of FAW parasitoids and predators"	Grow Asia	December 17, 2020
Dr. J.C. Sekhar	National Webinar Series on "Plant Health Management" Challenges - Interventions – Advances under sub theme "Transboundary pests Threats to Bio security and Bio safety issues"	SV Agrl College ANGRAU	December 21, 2020
Dr. J.C. Sekhar	National Webinar on "Bio intensive Pest Management for Sustainable Agriculture"	NIPHM	December 21, 2020
Dr. J.C. Sekhar	FAO National Coordination meeting on the Implementation of Global Action for Fall Armyworm Control	FAO Rome	December 22, 2020
Dr. J.C. Sekhar	National Webinar on "Alternatives to Plastics for Sustainable Soil and Environmental Health"	ICAR-Indian Institute of Soil Science, Bhopal	December 30, 2020
Dr. J.C. Sekhar	National Workshop on Modern Interventions in Environmental Management	ICAR-IIAB, Ranchi	December 30, 2020
Dr. S.B. Singh	National Seminar on "Maize for Crop Diversification under Changing Climatic Scenario"	ICAR-IIMR, PAU, Ludhiana	February 9-10, 2020
Dr. S.B. Singh	Annual Group Meeting of NSP and ICAR Seed Project on Seed production in Agricultural Crops	ICAR-IISS, Mau	May 15-16, 2020
Dr. S.B. Singh	HTMA-II, Pre-workshop	CIMMYT	September 09-12, 2020
Dr. S.B. Singh	Annual Review & Planning meeting of Heat Tolerant Maize for Asia (HTMA)	CIMMYT	October 08-09, 2020
Dr. S.B. Singh	25 <sup>th</sup> Meeting of ICAR Regional Committee No. IV	ICAR-IVRI and ICAR, New Delhi	November 27, 2020



Name of the Scientist	Name of the Conference/Seminar/Workshop/Meeting Attended	Venue	Date
Dr. S.B. Singh	International Web conference on Global Research Initiatives for Sustainable Agriculture & Allied Sciences, (GRISAAS-2020)	Web conference	December 28-30, 2020
Dr. S.B. Singh	QRT Meeting of ICAR Seed Project "Seed Production in Agricultural Crops"	ICAR-IISS, Mau	December 04 & 08, 2020
Dr. S.B. Singh	Variability in Plant Pathogens and Implications in Resistance Breeding	Online by Dr. P. N. Sharma, Former Head, Deptt. of Plant Pathology. CSKHPKV, Palampur (HP)	May 30, 2020
Dr. S.B. Singh	Opportunity to reinvent Agriculture Policy Reforms	FICCI	July 20, 2020
Dr. S.B. Singh	Varietal Identification Committee (VIC) meeting of Maize	ICAR-IIMR, Ludhiana	May 05, 2020
Dr. S.B. Singh	A virtual meeting with ISRO Scientist regarding Cooperation of IIMR and ISRO on maize research	ICAR-IIMR, Ludhiana	May 22, 2020
Dr. S.B. Singh	A virtual meeting with Agriculture Minister Govt. of Bihar, regarding Cooperation of ICAR Institutes and State Agriculture Departments.	Govt. of Bihar	June 11, 2020
Dr. S.B. Singh	92 <sup>nd</sup> ICAR foundation Day and Award Ceremony	ICAR	July 16, 2020
Dr. S.B. Singh	Project proposal review meeting on finalization of the project proposal on "Popularization of Bio fortified Maize Hybrids in Himalayan States and Central India with Special Reference to North Eastern Region for Sustainable Nutritional Security".	Online by Deptt. of Bio-technology, GOI.	August 06, 2020
Dr. S.B. Singh	EFC presentation ICAR-IIMR to against DDG Crop Science, ICAR	ICAR	August 11, 2020
Dr. S.B. Singh	A meeting with CIMMYT for submission of IIMR-CIMMYT research project proposal for funding by NASF	ICAR-IIMR	August 11, 2020
Dr. S.B. Singh	Germplasm registration meeting of NBPGR.	ICAR-NBPGR, New Delhi	September 29, 2020
Dr. S.B. Singh	A meeting with a team headed by Chief Production Officer, BRBN regarding hybrid maize seed production in Bihar.	BRBN, Bihar and RMR & SPC, Begusarai	October 13, 2020
Dr. S.B. Singh	A meeting of CIMMYT's IMIC Asia project	CIMMYT, Hyderabad	November 04, 2020
Dr. S.B. Singh	State Varietal Trials Meeting for Rabi-2020-21.	RPCAU, Pusa Samastipur	November 10, 2020



Name of the Scientist	Name of the Conference/Seminar/Workshop/Meeting Attended	Venue	Date
Dr. S.B. Singh	Training programme on “Preparation of Strategic Research and Extension Plan (SREP) of Begusarai”	Distt. Agriculture Officer, Govt. of Bihar	November, 25-28, 2020
Dr. S.B. Singh	Scientific Advisory Committee Meeting of KVK, Khagaria	KVK, Khagaria	December 02, 2020
Dr. S.B. Singh	International Web conference on Global Research Initiatives for Sustainable Agriculture & Allied Sciences, (GRISAAS-2020) Conveners Organizing Conveners	Online	December 28-30, 2020
Dr. Dharam Paul	National seminar on ‘Maize for Crop Diversification under Changing Climatic Scenario’	Jointly organized by MTAI, IIMR and PAU at Ludhiana	February 9-10, 2020
Dr. Ramesh Kumar	Webinar on ‘Agriculture, Aquaculture, and Dairying - Key risks and Transfer Mechanisms for the Rural economy’	Webinar	May 15, 2020
Dr. Ramesh Kumar	Online ABI Orientation Workshop	ICAR-NAARM, Hyderabad	August 17-19, 2020
Dr. Bharat Bhushan	एक दिवसीय हिंदी कार्यशाला	नराकास, लुधियाना	जनवरी 29, 2020
Dr. Bharat Bhushan	अर्ध-दिवसीय हिंदी वेबीनर	नराकास, लुधियाना	November 25, 2020
Dr. S. L. Jat	International Seminar on "Challenges and opportunities in Agriculture and Environment in the scenario of COVID-19 Pandemic"	Online	November 23, 2020
Dr. S. L. Jat	Online National Group Meet of the AICRP on Forage Crops	Programme Co-ordinating (PC) unit of AICRP on Forage Crops and its utilization, Jhansi	June 30, 2020
Dr. S. L. Jat	International Webinar on "Translating Physiology into Techniques for Abiotic Stress Tolerance in Crops"	ICAR-NIASM, Baramati	October 9, 2020
Dr. S. L. Jat	International Web-Conference on Food Security Through Sustainable Agriculture, VAKSANA-2020	Shri Vaishnav Vidyapeeth Vishwavidhyalaya, Indore, M.P.	September 21-22, 2020
Dr. S. L. Jat	National Seminar on “Maize for Crop Diversification under Changing Climate Scenario”	PAU Campus, Ludhiana	February 9-10, 2020
Dr. Bhupender Kumar	Translating Physiology into Techniques for Abiotic Stress Tolerance	ICAR-NIASM, SARAS, ISPP	October 9, 2020
Dr. Bhupender Kumar	Genomic-assisted maize breeding: Status and Opportunities	CIMMYT	August 12, 2020
Dr. Bhupender Kumar	National Seminar on “Maize for Crop Diversification under Changing Climate Scenario”	ICAR-IIMR, PAU & MTAI	February 9-10, 2020

Name of the Scientist	Name of the Conference/ Seminar/Workshop/Meeting Attended	Venue	Date
Dr. N. Sunil	Covid and maize value chain-challenges and prospects	Federation of Indian Chambers of Commerce & Industry (FICCI), New Delhi	May 22, 2020
Dr. N. Sunil	Inauguration of Academic and Administrative Building of Rani Lakshmi Bai Central Agricultural University, Jhansi by Hon'ble, Prime minister of India	ICAR	August 29, 2020
Dr. N. Sunil	RAISE 2020 - Responsible AI for Social Empowerment	Govt. of India	October 5-9, 2020
Dr. N. Sunil	AI & Digital applications in Agriculture	FICCI, India	October 8-9 2020
Dr. N. Sunil	Webinar on "Gene Editing for Agriculture, Society and Sustainable Development: Prospects and Perspectives"	Tata Institute for Genetics and Society (TIGS) in partnership with Biotech Consortium India Limited (BCIL)	December 15, 2020
Dr. Yathish K. R.	Integrated Pest Management (IPM) for Maize Crop with special reference to Fall Armyworm	FAO, India and ICAR-IIMR, Ludhiana	July 21-22, 2020
Dr. Yathish K. R.	Integrated Pest Management for Maize Crop with special reference to fall armyworm for Kota and Bundi district of Rajasthan	FAO, India and ICAR-IIMR, Ludhiana	September 1, 2020
Dr. Yathish K. R.	Integrated Pest Management for Maize Crop with special reference to fall armyworm in NEH region	FAO, India and ICAR-IIMR, Ludhiana	September 4, 2020
Dr. Yathish K. R.	Integrated Pest Management for Maize Crop with special reference to fall armyworm in Jammu & Kashmir and Himachal Pradesh states	FAO, India and ICAR-IIMR, Ludhiana	September 10, 2020
Dr. Yathish K. R.	IPM for Maize especially for fall armyworm in Central Plateau Region	FAO, India and ICAR-IIMR, Ludhiana	September 18, 2020
Dr. Yathish K. R.	Innovations for sustainable agriculture	Principal Scientific Advisor's and supported by NSRCEL, IIMB	September 26, 2020
Dr. Yathish K. R.	RAISE 2020 - Responsible AI for Social Empowerment	Govt. of India	October 5-9, 2020
Dr. Yathish K. R.	AI & Digital applications in Agriculture	FICCI, India	October 8-9 2020
Dr. Yathish K. R.	National webinar on a step ahead towards future fuel	National Sugar Institute, Kanpur	October 15, 2020
Dr. Yathish K. R.	International Webinar on Plant Health as a Driver of Plant Biosecurity, Food Security and Sustainable Agriculture	NIPHM, Hyderabad	November 26 2020

Name of the Scientist	Name of the Conference/Seminar/Workshop/Meeting Attended	Venue	Date
Dr. Yathish K. R.	New Education policy and right to education by Dr. Nishtha Jaswal, VC, National law university, HP An insights on fundamental rights by B. Ranganadhan, Advocate Supreme court	ICAR, New Delhi	November 26, 2020
Dr. Yathish K. R.	Genomics Strategies for Improvement of Abiotic Stress Tolerance in Crop Plants	ICAR-NIASM, Baramati	November 27, 2020
Dr. Yathish K. R.	Recent trends in Plant Biosecurity – International and National Perspectives	NIPHM, Hyderabad	December 4, 2020
Dr. Krishna Kumar	National seminar on “Maize for Crop Diversification under Changing Climatic Scenario”	ICAR-IIMR, PAU & MTAI	February 9-10, 2020
Dr. Krishna Kumar	International Webinar on “Translating Physiology into Techniques for Abiotic Stress Tolerance”	ICAR-National Institute of Abiotic Stress Management, Baramati; Society for Agricultural Research on Abiotic Stress (SARAS) & Indian Society for Plant Physiology (ISPP), New Delhi (India)	October 9, 2020
Dr. Krishna Kumar	4 <sup>th</sup> Interactive session for IBSCs registered on IBKP	IBKP Team RCGM Secretariat, Department of Biotechnology	November 5, 2020
Dr. Krishna Kumar	Webinar on “Gene Editing for Agriculture, Society and Sustainable Development: Prospects and Perspectives”	Tata Institute for Genetics and Society (TIGS) in partnership with Biotech Consortium India Limited (BCIL)	December 15, 2020
Dr. Pardeep Kumar	Next Generation Genomics and Integrated Breeding for Crop Improvement (VII-NGGIBCI) on Genomics for food, health and nutrition	International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Hyderabad	May 14, 2020
Dr. Pardeep Kumar	Online webinar on Genomics-assisted Maize Breeding: Status and Opportunities	CIMMYT, Mexico	August 12, 2020
Dr. Pardeep Kumar	Webinar on "साइलेज: चारे की कमी को दूर करने तथा डेरी व्यवसाय में उत्पादन लागत कम करने का व्यावहारिक तरीका"	NDDDB Board	July 23, 2020
Dr. Pardeep Kumar	National seminar on “Maize for Crop Diversification under Changing Climatic Scenario”	ICAR-IIMR, PAU & MTAI	February 9-10, 2020

Name of the Scientist	Name of the Conference/Seminar/Workshop/Meeting Attended	Venue	Date
Dr. Alla Singh	Online webinar on Genomics-assisted Maize Breeding: Status and Opportunities	CIMMYT, Mexico	August 12, 2020
Dr. Alla Singh	National seminar on “Maize for Crop Diversification under Changing Climatic Scenario”	ICAR-IIMR, PAU & MTAI	February 9-10, 2020
Dr. Alla Singh	Webinar on Global Regulations and Analytical Solutions for Mycotoxins	Waters India Pvt ltd.	August 27, 2020
Dr. Alla Singh	International Webinar on “Translating Physiology into Techniques for Abiotic Stress Tolerance in Crops”	ICAR-NIASM (National Institute of Abiotic Stress Management), Baramati	October 9, 2020
Dr. Alla Singh	International Webinar on "Nanotechnology in Agriculture and Biotechnology”	National Higher Education Project, ICAR and Dr. Rajendra Prasad Central Agricultural University, Pusa, Bihar	October 19- 21, 2020
Dr. Alla Singh	Webinar on “Gene Editing for Agriculture, Society and Sustainable Development: Prospects and Perspectives”	Institute for Genetics and Society (TIGS) in partnership with Biotech Consortium India Limited (BCIL-DBT).	December 15, 2020
Dr. B.S. Jat	एक दिवसीय हिंदी कार्यशाला	नराकास, लुधियाना	जनवरी 29, 2020
Dr. B.S. Jat	International webinar on Plant Genomics: Online- Next Generation Sequencing & High-Throughput Genotyping for Climate Resilient & Higher Nutrition Crop Varieties in Legumes	Global Engage	November 5, 2020
Dr. B.S. Jat	International webinar on “Translating Physiology into Techniques for Abiotic Stress Tolerance”	ICAR-National Institute of Abiotic Stress Management, Baramati; Society for Agricultural Research on Abiotic Stress (SARAS) & Indian Society for Plant Physiology (ISPP), New Delhi (India).	October 9, 2020
Dr. B.S. Jat	National seminar on “Maize for Crop Diversification under Changing Climatic Scenario”	ICAR-IIMR, PAU & MTAI	February 9-10, 2020
Dr. B.S. Jat	Professional Attachment Training on “Statistical and Quantitative Genetics Data Analysis”	Department of Plant Breeding and Genetics, PAU, Ludhiana	January 10-March 09, 2020
Dr. B.S. Jat	Integrated Pest Management for Maize Crop with special reference to fall armyworm for Kota and Bundi district of Rajasthan	FAO, India and ICAR-IIMR, Ludhiana	September 1, 2020

Name of the Scientist	Name of the Conference/Seminar/Workshop/Meeting Attended	Venue	Date
Dr. Mamta Gupta	International Webinar on "Translating Physiology into Techniques for Abiotic Stress Tolerance in Crops"	ICAR-NIASM (National Institute of Abiotic Stress Management), Baramati	October 9, 2020
Dr. Mamta Gupta	International Webinar on "Nanotechnology in Agriculture and Biotechnology"	National Higher Education Project, ICAR and Dr. Rajendra Prasad Central Agricultural University, Pusa, Bihar	October 19- 21, 2020
Dr. Mamta Gupta	Webinar on "Gene Editing for Agriculture, Society and Sustainable Development: Prospects and Perspectives"	Institute for Genetics and Society (TIGS) in partnership with Biotech Consortium India Limited (BCIL-DBT).	December 15, 2020
Dr. S.K. Aggarwal	7 <sup>th</sup> International Conference on "Phytopathology in Achieving UN Sustainable Development Goals" at New Delhi, India	ICAR-Indian Agricultural Research Institute, New Delhi	January 16-20, 2020
Dr. S.K. Aggarwal	National seminar on "Maize for Crop Diversification under Changing Climatic Scenario"	ICAR-IIMR, PAU & MTAI	February 9-10, 2020
Dr. S.K. Aggarwal	Webinar on Global Regulations and Analytical Solutions for Mycotoxins	Waters India Pvt Ltd.	August 27, 2020
Dr. S.K. Aggarwal	Webinar on Host-Pathogen Interaction	Online (Plantae community)	September 16, 2020
Dr. S.K. Aggarwal	Webinar on Advancement in plant pathology with reference to diagnosis and management	Dr. Y.S.R. Horticultural University, West Godavari, Andhra Pradesh (Online)	September 16, 2020
Mr. Santosh Kumar	Next Generation Genomics and Integrated Breeding for Crop Improvement (VII-NGGIBCI) on Genomics for food, health and nutrition	International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Hyderabad	May 14, 2020
Mr. Santosh Kumar	National seminar on "Maize for Crop Diversification under Changing Climatic Scenario"	ICAR-IIMR, PAU & MTAI	February 9-10, 2020
Mr. Deep Mohan Mahala	National seminar on "Maize for Crop Diversification under Changing Climatic Scenario"	ICAR-IIMR, PAU & MTAI	February 9-10, 2020
Mr. Deep Mohan Mahala	Role of LaTeX in Scientific Writing	Department of Mathematics, BBDNIIT, Lucknow	June 19-21, 2020
Dr. P. Lakshmi Soujanya	Online webinar on Genomics-assisted Maize Breeding: Status and Opportunities	CIMMYT, Mexico	August 12, 2020
Dr. P. Lakshmi Soujanya	ASEAN Fall armyworm Webinar Series (Part 1) Introduction & Classical Approaches	Grow Asia	September 10, 2020
Dr. P. Lakshmi Soujanya	Online webinar on ASEAN FAW Technology Taster: Drones and Digital	Grow Asia	September 17, 2020

Name of the Scientist	Name of the Conference/Seminar/Workshop/Meeting Attended	Venue	Date
Dr. P. Lakshmi Soujanya	Online webinar on Fall Armyworm Biocontrol Webinar on Biopesticides	Grow Asia	September 24, 2020
Dr. P. Lakshmi Soujanya	Online webinar on Fall armyworm biocontrol webinar series (Part 3): Augmentation & Conservation	Grow Asia	October 8, 2020
Dr. P. Lakshmi Soujanya	Online webinar on Vertebrate Pest Management	NIPHM	November 23, 2020
Seema Sheoran	Genomics-assisted Maize Breeding: Status and Opportunities	CIMMYT	August 12, 2020
Seema Sheoran	Improving phenotyping accuracy and throughput in Maize	CIMMYT	August 14, 2020

#### D. Organization/participation of KisanMela/KisanGosthi/Exhibition/Field Day/Lectures

Name of the Scientist	Programme	Place	Date
Dr. S.B. Singh	Field visit of trainee farmers under TSP Training on “संकर मक्का की वैज्ञानिक खेती, बीज उत्पादन तकनीकी व फॉल आर्मीवर्म कीट का प्रबंधन व रणनीतियां”	Protective vegetable cultivation farm of Mr. Amit Kumar, a progressive farmer at Village Iniyar, Distt. Begusarai	January 22, 2020
Dr. S.B. Singh	Field visit of trainee farmers under TSP Training on “संकर मक्का की वैज्ञानिक खेती, बीज उत्पादन तकनीकी व फॉल आर्मीवर्म कीट का प्रबंधन व रणनीतियां”	Regional Maize Research and Seed Production Centre, Kushmahaut, Begusarai	January 22, 2020
Dr. S.B. Singh	Field visit of 35 trainees of Nehru Yuva Kendra to learn Maize Hybrid Seed Production Technology	Regional Maize Research and Seed Production Centre, Kushmahaut, Begusarai	March 7, 2020
Dr. Yathish K.R.	Drone based application in Agriculture	PJTSAU, Hyderabad	January 9, 2020
Dr. Yathish K.R.	IMIC Asia II Field Day	ICRISAT organized by CIMMYT	March 12, 2020
Dr. Yathish K.R.	Monitoring of BML 45 inbred line seed production	PJTSAU, Hyderabad	August 13, 2020
Dr. Yathish K.R.	Inauguration of Academic and Administrative Building of Rani Lakshmi Bai Central Agricultural University, Jhansi	Virtual	August 29, 2020
Dr. Yathish K.R.	National Launch of “Pradhan Mantri Matsya Sampada Yojana’ & Inauguration/Laying of Foundation Stone of various programs of Agriculture Research & Education, Fisheries and Animal Husbandry Department in Bihar” by Hon'ble Prime Minister	Virtual	September 10, 2020
Dr. Yathish K.R.	Release of Commemorative Coin on Food and Agriculture Organization (FAO) at 75 <sup>th</sup> and World Food Day	Virtual	October 16, 2020



Name of the Scientist	Programme	Place	Date
Dr. P. Lakshmi Soujanya	Drone based application in Agriculture	PJTSAU, Hyderabad	January 9, 2020
Dr. P. Lakshmi Soujanya	Inauguration of Academic and Administrative Building of Rani Lakshmi Bai Central Agricultural University, Jhansi	Virtual	August 29, 2020
Dr. P. Lakshmi Soujanya	Release of Commemorative Coin on the 75 <sup>th</sup> Anniversary of FAO and World Food Day	Virtual	October 16, 2020

#### E. Other Achievements:

Name of the Scientist	Achievements
Dr. J.C. Sekhar	National expert to FAO India from 12th March 2020 under TCP/IND/3709 on Time-critical measures to support early warning and monitoring and sustainable management of the Fall Armyworm in India





*Inauguration of a Farmer's Training programme at ICAR-IIMR*

## Awards And Recognition



*Outstanding AICRP Award 2019 certificate*

## AWARDS AND RECOGNITION



- राजभाषा के प्रचार-प्रसार को बढ़ावा देने के प्रयास स्वरूप भा.कू.अनु.प.-भारतीय मक्का अनुसंधान संस्थान, लुधियाना द्वारा प्रकाशित वार्षिक हिंदी पत्रिका “कृषि चेतना” को नगर राजभाषा कार्यान्वयन समिति, लुधियाना द्वारा सम्मानित किया गया
- ICAR-Indian Institute of Maize Research was awarded by Chaudhary Devi Lal Outstanding All India Co-ordinated Research Project (AICRP) Award for the year 2019 during 92nd Foundation Day of Indian Council of Agricultural Research, New Delhi held on July 16, 2020.
- ICAR-Indian Institute of Maize Research has been rated “Excellent” by ICAR and 4<sup>th</sup> among Crop Science Division Institutes for providing HRD training opportunities to 95.2 % employees during 2014-2020.
- Dr. Sujay Rakshit was nominated as a member of CABI Fall armyworm Research Collaboration Portal Steering Committee.
- Dr. Sujay Rakshit was nominated as a member of FAO Technical Committee-Global Action on Fall armyworm control.
- Dr. J.C. Sekhar was awarded “Dr. Joginder Singh Outstanding Research Award” from Maize Technologists Association of India (MTAI) at the National Seminar on “Maize for Crop Diversification under Changing Climatic Scenario” held during February 9-10, 2020 at Ludhiana, Punjab.
- Dr. J.C. Sekhar received the “Maize Technologists Association of India (MTAI) Fellow Award” during National Seminar on “Maize for Crop Diversification under Changing Climatic Scenario” held during February 9-10, 2020 at Ludhiana, Punjab.
- Dr. Ishwar Singh was elected Vice-President of the Indian Society for Plant Physiology (ISPP), New Delhi for the years 2020-2021.
- Dr. Ramesh Kumar was recognized as “Best Scientist (PS)” of ICAR-IIMR for the year 2020 during National Seminar on “Maize for Crop Diversification under Changing Climatic Scenario” held during February 9-10, 2020.
- Dr. S.B. Singh awarded with “Best Poster Award” on 'Stability' of experimental winter maize hybrids tested across the environment of Bihar using GGE biplot and AMMI analysis' in the National Seminar on “Maize for Crop Diversification under Changing Climatic Scenario” organized by ICAR-IIMR and PAU, at PAU campus Ludhiana on February 9-10, 2020.
- Dr. S.B. Singh, Dr. Ramesh Kumar, Dr. Bhupender Kumar, Dr. S.L. Jat and Mr. Priyajoy Kar received the externally funded project, viz. “Popularization of Biofortified Maize Hybrids in Himalayan States and Central India with Special Reference to North Eastern Region for Sustainable Nutritional Security” from DBT worth Rs. 279 lakh.
- Dr. S.B. Singh was invited as a lead speaker in the International Web Conference on Global Research Initiatives for Sustainable Agriculture & Allied Sciences, (GRISAAS-2020) held from December 28-30, 2020.
- Dr. S.B. Singh awarded with “Fellow Award-2020” of Society for Scientific Development in Agriculture and Technology, in the International Web Conference on Global Research Initiatives for Sustainable Agriculture & Allied Sciences, (GRISAAS-2020) held on December 28-30, 2020.
- Dr. S.B. Singh was awarded with “Best Oral Presentation Award” under Theme 3 Global climate change: Scenario and food security in the International Web Conference on Global Research Initiatives for Sustainable Agriculture & Allied Sciences, (GRISAAS-2020) held on December 28-30, 2020.
- Dr. S.B. Singh was awarded with 2<sup>nd</sup> prize “Protsahan Puruskar” for doing maximum work in Hindi for the year 2019-20 in the ICAR-IIMR.
- Dr. S.B. Singh was nominated as a member of the District Executive Committee for the selection of soil test laboratory beneficiaries under the National Mission on Sustainable Agriculture.
- Dr. S.B. Singh was elected as Vice-President Society for Scientific Development in Agriculture and Technology, Meerut (U.P.) India for the term 2019-20.
- Dr. Chikkappa G. Karjagi received the “Best Poster Award” at the National Seminar on “Maize for Crop Diversification under Changing Climatic Scenario” held during February 9-10, 2020.
- Dr. S.L. Jat received “Dr. N.N. Singh Young Scientist” award for the year 2020 from Maize Technologist Association of India (MTAI) during National Seminar on “Maize for Crop Diversification under Changing Climatic Scenario” for outstanding contribution in maize research & development in India held during February 9-10, 2020.
- Dr. S.L. Jat received the recognition of “Best Scientist (S1)” of ICAR-IIMR for the year 2020 during National

- Seminar on “Maize for Crop Diversification under Changing Climatic Scenario” held during February 9-10, 2020.
- Dr. Bhupender Kumar was awarded with NAAS Associateship from January, 2020 by National Academy of Agricultural Sciences (NAAS), New Delhi.
  - Dr. Bhupender Kumar received “Dr. N.N. Singh Young Scientist” award for the year 2020 from Maize Technologist Association of India (MTAI) during National Seminar on “Maize for Crop Diversification under Changing Climatic Scenario” held during February 9-10, 2020.
  - Dr. Abhijit Kumar Das received the IARI merit medal for outstanding Ph.D. research in the discipline of Genetics during 58<sup>th</sup> Convocation of ICAR-IARI held on February 14, 2020.
  - Dr. Abhijit Kumar Das was recognized as “Best Scientist (S1)” of ICAR-IIMR for the year 2020 during National Seminar on “Maize for Crop Diversification under Changing Climatic Scenario” held during February 9-10, 2020.
  - Dr. Abhijit Kumar Das and Dr. D.P. Chaudhary received the externally funded project, viz., “Development of maize hybrids enriched with resistant starch through marker assisted introgression of ael allele and diversification of high amylose maize germplasm” from DST-SERB worth 39.83 lakh.
  - Dr. P. Lakshmi Soujanya was recognized as “Best Scientist (S1)” of ICAR-IIMR for the year 2020 during National Seminar on “Maize for Crop Diversification under Changing Climatic Scenario” held during February 9-10, 2020.
  - Dr. Alla Singh was awarded the “Best Oral Presentation Award” at the National Conference on Microbial Bio-prospecting 2020 (NCMB-2020) held at Lovely Professional University from March 6-7, 2020.
  - Dr. Alla Singh was invited as a speaker in an international conference on "Present Scenario of Technology and Sciences" (PSTS-2020) held virtually on August 8-9, 2020.
  - Dr. Alla Singh was invited as a Keynote Speaker at the International E-Conference on Nutrition and Food Science during December 9-10, 2020.
  - Mr. Permod Sharma was recognized as “Best Administrative Staff” of ICAR-IIMR for the year 2020 during National Seminar on “Maize for Crop Diversification under Changing Climatic Scenario” held during February 9-10, 2020.
  - Mr. Dharambir Singh was recognized as “Best UDC” of ICAR-IIMR for the year 2020 during National Seminar on “Maize for Crop Diversification under Changing Climatic Scenario” held during February 9-10, 2020.
  - Mr. Dharambir Singh was awarded with 1st prize for doing maximum work in Hindi for the year 2019-20 in the ICAR-IIMR.
  - Mr. Samir Roy was recognized as “Best Technical Assistant” of ICAR-IIMR for the year 2020 during National Seminar on “Maize for Crop Diversification under Changing Climatic Scenario” held during February 9-10, 2020.
  - Mr. Ramkishan was recognized as “Best Supporting Staff” for the year 2020 during National Seminar on “Maize for Crop Diversification under Changing Climatic Scenario” held during February 9-10, 2020.



# National Academy of Agricultural Sciences



*Dr. Bhupender Kumar*

**has been awarded Associateship  
of the  
National Academy of Agricultural Sciences  
New Delhi  
on  
1st January 2020**

  
Secretary

  
President

National Academy of Agricultural Sciences, NASC, DPS Marg, New Delhi-110 012 (INDIA)

*NAAS Associateship Award received by institute scientist*

## *Annexures*



*Institute Maize Hybrid in Bihar*

## ANNEXURE-I

### List of Cultivars identified during 63<sup>rd</sup> Annual Maize Workshop

On the occasion of 63rd Annual Maize Workshop held on May 5, 2020 through Video Conferencing, the Variety Identification Committee (VIC) meeting was convened under the Chairmanship of Dr. T.R. Sharma, Deputy Director General (Crop Science), Indian Council of Agricultural Research, New Delhi. Ten members of the VIC along with five resource persons from ICAR-Indian Institute of Maize Research (ICAR-IIMR) attended the meeting.

Sl. No.	Cultivar	AICRP Centre/ Pvt. Company	Public/ Private	Average Yield (Kg/ha)	Area of adaptation Zones	States	Maturity or Type of Corn	Season
1.	ADV 7037	UPL Limited	Private	9253	PZ	Karnataka, Maharashtra, Telangana, Andhra Pradesh & Tamil Nadu	Late	Rabi
2.	PM 16202L	Pioneer Hi - bred Pvt. Ltd.	Private	9098, 9085	PZ & CWZ	Andhra Pradesh, Telangana, Tamil Nadu, Karnataka and Maharashtra, Rajasthan, Gujarat & Madhya Pradesh	Late	Rabi
3.	PM 16205L	Pioneer Hi - bred Pvt. Ltd.	Private	9216	CWZ	Rajasthan, Gujarat and Madhya Pradesh	Late	Rabi
4.	IM 8013	Bayer Crop Science Ltd.	Private	10518, 9871, 9318, 23948	NWPZ, NEPZ, PZ & CWZ	Punjab, Haryana, Delhi, Uttarakhand (Plain regions), Uttar Pradesh (Western region), Bihar, Jharkhand, Odisha, Eastern Uttar Pradesh (Eastern region), West Bengal, Maharashtra, Andhra Pradesh, Telangana, Tamil Nadu, Karnataka and Maharashtra, Rajasthan, Gujarat & Madhya Pradesh	Medium	Rabi
5.	CP 858	CP Seeds (India) Pvt. Ltd.	Private	9756, 7853	NWPZ & NEPZ	Punjab, Haryana, Delhi, Uttarakhand (Plain regions), Uttar Pradesh (Western region), Bihar, Jharkhand, Odisha, Eastern Uttar Pradesh (Eastern region), West Bengal	Late	Kharif



Sl. No.	Cultivar	AICRP Centre/ Pvt. Company	Public/ Private	Average Yield (Kg/ha)	Area of adaptation		Maturity or Type of Corn	Season
					Zones	States		
6.	HT 17169	Hytech Seed India	Private	9592	NWPZ	Punjab, Haryana, Delhi & Uttar	Late	<i>Kharif</i>
7.	PM 16103L	Pioneer Hi - bred Pvt. Ltd.	Private	8874	NWPZ	Punjab, Haryana, Delhi and Uttar Pradesh	Late	<i>Kharif</i>
8.	ADV 1390164	UPL Limited	Private	10022	NWPZ	Punjab, Haryana, Delhi, Uttarakhand (Plain regions), Uttar Pradesh (Western region)	Late	<i>Kharif</i>
9.	RASI 3499	Rasi Seeds Pvt. Ltd.	Private	7729	NEPZ	Bihar, Jharkhand, Odisha, Eastern Uttar Pradesh (Eastern region), West Bengal	Late	<i>Kharif</i>
10.	ADV 1390064	UPL Limited	Private	9840	PZ	Karnataka, Andhra Pradesh, Telangana, Maharashtra & Tamil Nadu	Late	<i>Kharif</i>
11.	IQPMH 1601	ICAR- IIMR, Ludhiana	Public	7206	NWPZ	Punjab, Haryana, Delhi, Uttarakhand (Plain regions), Uttar Pradesh (Western region)	QPM	<i>Kharif</i>
12.	IQPMH 1705	ICAR- IIMR, Ludhiana	Public	6283	CWZ	Rajasthan, Gujarat, Madhya Pradesh and Chhattisgarh	QPM	<i>Kharif</i>
13.	VEQH 16 -1	BHU, Varanasi	Public	7096	NWPZ	Punjab, Haryana, Delhi, Uttarakhand (Plain regions), Uttar Pradesh (Western region)	QPM	<i>Kharif</i>
14.	AH 7043	RRS, IARI, Dharwad	Public	4089 -- --	NHZ, NEPZ &PZ	Jammu and Kashmir, Himachal Pradesh, Uttarakhand (Hill region), Meghalaya, Sikkim, Assam, Tripura, Nagaland, Manipur, Arunachal Pradesh, Bihar, Jharkhand, Odisha, Uttar Pradesh (Eastern region), West Bengal, Maharashtra, Karnataka, Andhra Pradesh, Telangana, Tamil Nadu	Baby Corn	<i>Kharif</i>

Sl. No.	Cultivar	AICRP Centre/ Pvt. Company	Public/ Private	Average Yield (Kg/ha)	Area of adaptation		Maturity or Type of Corn	Season
					Zones	States		
15.	NUZI 260	Nuziveedu Seeds Pvt. Ltd.	Private	16019, 16142, 18853	NWPZ, NEPZ & PZ	Punjab, Haryana, Delhi, Uttarakhand (Plain regions), Uttar Pradesh (Western region, Bihar, Jharkhand, Odisha, Uttar Pradesh (Eastern region), West Bengal, Maharashtra, Karnataka, Andhra Pradesh, Telangana, Tamil Nadu	Sweet Corn	<i>Kharif</i>
16.	RCM 1 - 61	ICAR-RC- NEHR	Public	5339	NHZ	Jammu and Kashmir, Himachal Pradesh, Uttarakhand (Hill region), Meghalaya, Sikkim, Assam, Tripura, Nagaland, Manipur, Arunachal Pradesh	OPV	<i>Kharif</i>
17.	RCM 1 - 76	ICAR-RC- NEHR	Public	5417	NHZ	Jammu and Kashmir, Himachal Pradesh, Uttarakhand (Hill region), Meghalaya, Sikkim, Assam, Tripura, Nagaland, Manipur, Arunachal Pradesh	OPV	<i>Kharif</i>



## ANNEXURE-II

### List of Cultivars notified during 2020

Sl. No.	Cultivar	AICRP Centre/ Pvt. Company	Public/ Private	Notification Date	Notification No.	Maturity	Area of Adaptation	Zone	Average Yield (kg/ha)	Cropping season	Type
1.	Baby corn GAYMH 1	Anand Agricultural University, Gujrat	Public	07/10/2020	3482	Early	Karnataka, Andhra Pradesh, Tamil Nadu, Telangana, Maharashtra Rajasthan, Guzrat, Chattisgarh and Madhya Pradesh	PZ &C WZ	5766, 6697	<i>Khariif</i>	Baby corn
2.	DMRHB 1305 (Hybrid)	ICAR-IIMR, Ludhiana	Public	07/10/2020	3482	Early	J&K, Himachal Pradesh, Uttarakhand (Hill region), Northern Eastern Hill region (Meghalaya, Sikkim, Assam, Tripura, Nagaland, Manipur, Arunachal Pradesh)	NHZ	4611	<i>Khariif</i>	Baby corn
3.	Hybrid ADV 757 (ADV 7037)	UPL Limited	Private	07/10/2020	3482	Late	Karnataka, Tamil Nadu, Andhra Pradesh, Telangana, & Maharashtra	PZ	9253	<i>Rabi</i>	Normal
4.	Hybrid ADV 759 (ADV 1390064)	UPL Limited	Private	07/10/2020	3482	Late	Irrigated and Rainfed areas in PZ- Karnataka, Tamil Nadu, Andhra Pradesh, Telangana, Maharashtra. Peninsular Zone (PZ) – Karnataka, Andhra Pradesh, Telangana and Tamil Nadu under irrigated and assured rainfall condition	PZ	9840	<i>Khariif</i>	Normal

Sl. No.	Cultivar	AICRP Centre/ Pvt. Company	Public/ Private	Notification Date	Notification No.	Maturity	Area of Adaptation	Zone	Average Yield (kg/ha)	Cropping season	Type
5.	IMHP 1535 (Hybrid)	ICAR-IIMR, Ludhiana	Public	07/10/2020	3482	Medium	Karnataka, Andhra Pradesh, Tamil Nadu, Telangana, Maharashtra, Rajasthan, Guzrat, Chattisgarh and Madhya Pradesh	PZ & CWZ	4110, 2696	<i>Kharif</i>	Popcorn
6.	IMHQP M 1530 (Biofortified hybrid)	ICAR-IIMR, Ludhiana	Public	07/10/2020	3482	Medium	J&K, Himachal Pradesh, Uttarakhand (Hill region), Northern Eastern Hill region (Meghalaya, Sikkim, Assam, Tripura, Nagaland, Manipur, Arunachal Pradesh)	NHZ	8529	<i>Kharif</i>	QPM
7.	Pant Poporn 1 DPCH-306	G.B. Pant University of Agriculture & Technology Pantnagar	Public	06/01/2020	99 (E)	Early	Jammu & Kashmir, Himachal Pradesh, Uttarakhand (Hills) and NE Hill Region (Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura) Tamil Nadu, Karnatka, Andhra Pradesh, Telangana	NHZ & PZ	3884, 4863	<i>Kharif</i>	Popcorn
8.	Pusa HQPM 7 Improved (APQH 7)	ICAR-IA RI, New Delhi	Public	06/01/2020	99 (E)	Medium	Maharashtra, Karnataka, Andhra Pradesh, Telangana, Tamil Nadu.	PZ	7389	<i>Kharif</i>	EDVs



Sl. No.	Cultivar	AICRP Centre/ Pvt. Company	Public/ Private	Notification Date	Notification No.	Maturity	Area of Adaptation	Zone	Average Yield (kg/ha)	Cropping season	Type
9.	Pusa HQPM 5 Improved (APQH 5)	ICAR-IA RI, New Delhi	Public	06/01/2020	99 (E)	Medium	Jammu and Kashmir, Himachal Pradesh, Uttarakhand (Hill region), North Eastern Hill Regions (Meghalaya, Sikkim, Assam, Tripura, Nagaland, Manipur, Arunachal Pradesh) Punjab, Haryana, Delhi, Uttarakhand (Plain regions), Uttar Pradesh (Western region)	NHZ &N WPZ	7377, 7510	<i>Kharif</i>	EDVs
10.	Pusa Super Sweet Corn 2 (ASKH 1)	ICAR-IARI, New Delhi	Public	06/01/2020	99 (E)	Early	States of Himachal Pradesh, Haryana, Uttarakhand, Uttar khand, Tamil Nadu, Karnataka, Chhattisgarh and Rajasthan.	NHZ & PZ	14056, 14045	<i>Kharif</i>	Sweet Corn
11.	Pusa Vivek Hybrid 27 Improved (APH 27)	ICAR-IARI, New Delhi	Public	06/01/2020	99 (E)	Early	Bihar, Jharkhand, Odisha, Uttar Pradesh (Eastern region), West Bengal.	NEP Z	4795	<i>Kharif</i>	EDVs



## ANNEXURE-III

### Application filed for registration at PPVFRA during 2020-21

Sl. No.	Hybrids	Name of centre	Date of filing	Acknowledgement No.
1.	PJMH 1	ICAR-IARI, New	28-10-2020	REG/2020/327
2.	Pratap Hybrid Maize 3	MPUA&T Udaipur	28-10-2020	REG/2020/325
3.	Pant Pop corn 1 (DPCH 306)	GBPUA&T, Pantnagar	28-10-2020	REG/2020/32 6

### DUS Testing undertaken during 2020-21

#### Hybrid Entries

Sl. No.	Name of Entry	Testing Year	Category	SCH/MPH
1.	2880/2552	Second	New	SCH
2.	2881/3488	Second	New	SCH
3.	2880/3748	Second	New	SCH
4.	2882/2958	Second	New	SCH
5.	2880/3229	Second	New	SCH
6.	2883/2543	Second	New	SCH
7.	2883/2691	Second	New	SCH
8.	2883/2646	Second	New	SCH
9.	2884/2084	Second	New	SCH
10.	2884/2083	Second	New	SCH
11.	2884/2082	Second	New	SCH
12.	2884/2085	Second	New	SCH
13.	2884/2086	Second	New	SCH
14.	2884/2087	Second	New	SCH
15.	2884/2099	Second	New	SCH
16.	2881/3663	Second	New	SCH
17.	2881/3838	Second	New	SCH
18.	2883/2641	Second	New	SCH
19.	Talaw Makki	First	Farmer	SCH
20.	NH20-3H	First	New	SCH
21.	NH20-4H	First	New	SCH
22.	NH20-5H	First	New	SCH
23.	NH20-6H	First	New	SCH
24.	NH20-7H	First	New	SCH
25.	NH20-8H	First	New	SCH
26.	NH20-9H	First	New	SCH
27.	NH20-10H	First	New	SCH
28.	NH20-11H	First	New	SCH
29.	NH20-12H	First	New	SCH
30.	NH20-13H	First	New	SCH
31.	NH20-14H	First	New	SCH
32.	NH20-15H	First	New	SCH
33.	NH20-16H	First	New	SCH



Sl. No.	Name of Entry	Testing Year	Category	SCH/MPH
34.	NH20-17H	First	New	SCH
35.	NH20-18H	First	New	SCH
36.	NH20-19H	First	New	SCH
37.	HM 8	Reference Hybrid	Reference	SCH
38.	HM 9	Reference Hybrid	Reference	SCH
39.	HM 10	Reference Hybrid	Reference	SCH
40.	Vivek 39	Reference Hybrid	Reference	SCH
41.	Bio 9544	Reference Hybrid	Reference	SCH
42.	DHM 117	Reference Hybrid	Reference	SCH
43.	KMH 2288	Reference Hybrid	Reference	SCH
44.	COM(M) 5	Reference Hybrid	Reference	SCH
45.	Pratap QPM Hybrid 1	Reference Hybrid	Reference	SCH

### Inbred Entries

Sl. No.	Name of Entry	Testing Year	Category	SCH/MPH
1.	2883/2614	Second	New	Inbred
2.	2883/2642	Second	New	Inbred
3.	2883/2643	Second	New	Inbred
4.	2883/2644	Second	New	Inbred
5.	2883/2645	Second	New	Inbred
6.	2884/2078	Second	New	Inbred
7.	2871/2068	Second	New	Inbred
8.	NH20-1H	First	New	Inbred
9.	NH20-2H	First	New	Inbred
10.	V 345	Reference Inbred	Reference	Inbred
11.	HKI 161	Reference Inbred	Reference	Inbred
12.	HKI 163	Reference Inbred	Reference	Inbred
13.	HKI 193-1	Reference Inbred	Reference	Inbred
14.	HKI 323	Reference Inbred	Reference	Inbred
15.	HKI 1105	Reference Inbred	Reference	Inbred

### Hybrid entries with their Parental Cross

Sl. No.	Name of Entry	Testing Year	Category	SCH/MPH
1.	M20H-1C	2020	New Hybrid	SCH
2.	M20H-1S	2020	Parental cross	SCH
3.	M20H-2C	2020	New Hybrid	SCH
4.	M20H-2S	2020	Parental cross	SCH
5.	M20H-3C	2020	New Hybrid	SCH
6.	M20H-3S	2020	Parental cross	SCH
7.	M20H-4C	2020	New Hybrid	SCH
8.	M20H-4S	2020	Parental cross	SCH
9.	M20H-5C	2020	New Hybrid	SCH
10.	M20H-5S	2020	Parental cross	SCH



Sl. No.	Name of Entry	Testing Year	Category	SCH/MPH
11.	M20H-6C	2020	New Hybrid	SCH
12.	M20H-6S	2020	Parental cross	SCH
13.	M20H-7C	2020	New Hybrid	SCH
14.	M20H-7S	2020	Parental cross	SCH
15.	M20H-8C	2020	New Hybrid	SCH
16.	M20H-8S	2020	Parental cross	SCH
17.	M20H-9C	2020	New Hybrid	SCH
18.	M20H-9S	2020	Parental cross	SCH
19.	M20H-10C	2020	New Hybrid	SCH
20.	M20H-10S	2020	Parental cross	SCH
21.	M20H-11C	2020	New Hybrid	SCH
22.	M20H-11S	2020	Parental cross	SCH
23.	M20H-12C	2020	New Hybrid	SCH
24.	M20H-12S	2020	Parental cross	SCH
25.	M20H-13C	2020	New Hybrid	SCH
26.	M20H-13S	2020	Parental cross	SCH
27.	M20H-14C	2020	New Hybrid	SCH
28.	M20H-14S	2020	Parental cross	SCH
29.	M20H-15C	2020	New Hybrid	SCH
30.	M20H-15S	2020	Parental cross	SCH
31.	M20H-16C	2020	New Hybrid	SCH
32.	M20H-16S	2020	Parental cross	SCH
33.	M20H-17C	2020	New Hybrid	SCH
34.	M20H-17S	2020	Parental cross	SCH
35.	M20H-18C	2020	New Hybrid	SCH
36.	M20H-18S	2020	Parental cross	SCH
37.	M20H-19C	2020	New Hybrid	SCH
38.	M20H-19S	2020	Parental cross	SCH
39.	M20H-20C	2020	New Hybrid	SCH
40.	M20H-20S	2020	Parental cross	SCH
41.	M20H-21C	2020	New Hybrid	SCH
42.	M20H-21S	2020	Parental cross	SCH
43.	M20H-22C	2020	New Hybrid	SCH
44.	M20H-22S	2020	Parental cross	SCH
45.	M20H-23C	2020	New Hybrid	SCH
46.	M20H-23S	2020	Parental cross	SCH
47.	M20H-24C	2020	New Hybrid	SCH
48.	M20H-24S	2020	Parental cross	SCH
49.	M20H-25C	2020	New Hybrid	SCH
50.	M20H-25S	2020	Parental cross	SCH
51.	M20H-26C	2020	New Hybrid	SCH
52.	M20H-26S	2020	Parental cross	SCH
53.	M20H-27C	2020	New Hybrid	SCH
54.	M20H-27S	2020	Parental cross	SCH
55.	M20H-28C	2020	New Hybrid	SCH
56.	M20H-28S	2020	Parental cross	SCH



Sl. No.	Name of Entry	Testing Year	Category	SCH/MPH
57.	M20H-29C	2020	New Hybrid	SCH
58.	M20H-29S	2020	Parental cross	SCH
59.	M20H-30C	2020	New Hybrid	SCH
60.	M20H-30S	2020	Parental cross	SCH
61.	M20H-31C	2020	New Hybrid	SCH
62.	M20H-31S	2020	Parental cross	SCH
63.	M20H-32C	2020	New Hybrid	SCH
64.	M20H-32S	2020	Parental cross	SCH
65.	M20H-33C	2020	New Hybrid	SCH
66.	M20H-33S	2020	Parental cross	SCH
67.	M20H-34C	2020	New Hybrid	SCH
68.	M20H-34S	2020	Parental cross	SCH
69.	M20H-35C	2020	New Hybrid	SCH
70.	M20H-35S	2020	Parental cross	SCH
71.	M20H-36C	2020	New Hybrid	SCH
72.	M20H-36S	2020	Parental cross	SCH
73.	M20H-37C	2020	New Hybrid	SCH
74.	M20H-37S	2020	Parental cross	SCH
75.	M20H-38C	2020	New Hybrid	SCH
76.	M20H-38S	2020	Parental cross	SCH
77.	M20H-39C	2020	New Hybrid	SCH
78.	M20H-39S	2020	Parental cross	SCH
79.	M20H-40C	2020	New Hybrid	SCH
80.	M20H-40S	2020	Parental cross	SCH
81.	M20H-41C	2020	New Hybrid	SCH
82.	M20H-41S	2020	Parental cross	SCH
83.	M20H-42C	2020	New Hybrid	SCH
84.	M20H-42S	2020	Parental cross	SCH
85.	M20H-43C	2020	New Hybrid	SCH
86.	M20H-43S	2020	Parental cross	SCH
87.	M20H-44C	2020	New Hybrid	SCH
88.	M20H-44S	2020	Parental cross	SCH
89.	M20H-45C	2020	New Hybrid	SCH
90.	M20H-45S	2020	Parental cross	SCH
91.	M20H-46C	2020	New Hybrid	SCH
92.	M20H-46S	2020	Parental cross	SCH
93.	M20H-47C	2020	New Hybrid	SCH
94.	M20H-47S	2020	Parental cross	SCH
95.	M20H-48C	2020	New Hybrid	SCH
96.	M20H-48S	2020	Parental cross	SCH
97.	M20H-49C	2020	New Hybrid	SCH
98.	M20H-49S	2020	Parental cross	SCH
99.	M20H-50C	2020	New Hybrid	SCH
100.	M20H-50S	2020	Parental cross	SCH
101.	M20H-51C	2020	New Hybrid	SCH
102.	M20H-51S	2020	Parental cross	SCH

Sl. No.	Name of Entry	Testing Year	Category	SCH/MPH
103.	M20H-52C	2020	New Hybrid	SCH
104.	M20H-52S	2020	Parental cross	SCH
105.	M20H-53C	2020	New Hybrid	SCH
106.	M20H-53S	2020	Parental cross	SCH
107.	M20H-54C	2020	New Hybrid	SCH
108.	M20H-54S	2020	Parental cross	SCH
109.	M20H-55C	2020	New Hybrid	SCH
110.	M20H-55S	2020	Parental cross	SCH
111.	M20H-56C	2020	New Hybrid	SCH
112.	M20H-56S	2020	Parental cross	SCH
113.	M20H-57C	2020	New Hybrid	SCH
114.	M20H-57S	2020	Parental cross	SCH
115.	M20H-58C	2020	New Hybrid	SCH
116.	M20H-58S	2020	Parental cross	SCH
117.	M20H-59C	2020	New Hybrid	SCH
118.	M20H-59S	2020	Parental cross	SCH
119.	M20H-60C	2020	New Hybrid	SCH
120.	M20H-60S	2020	Parental cross	SCH
121.	M20H-61C	2020	New Hybrid	SCH
122.	M20H-61S	2020	Parental cross	SCH
123.	M20H-62C	2020	New Hybrid	SCH
124.	M20H-62S	2020	Parental cross	SCH
125.	M20H-63C	2020	New Hybrid	SCH
126.	M20H-63S	2020	Parental cross	SCH
127.	M20H-64C	2020	New Hybrid	SCH
128.	M20H-64S	2020	Parental cross	SCH
129.	M20H-65C	2020	New Hybrid	SCH
130.	M20H-65S	2020	Parental cross	SCH
131.	M20H-66C	2020	New Hybrid	SCH
132.	M20H-66S	2020	Parental cross	SCH
133.	M20H-67C	2020	New Hybrid	SCH
134.	M20H-67S	2020	Parental cross	SCH
135.	M20H-68C	2020	New Hybrid	SCH
136.	M20H-68S	2020	Parental cross	SCH
137.	M20H-69C	2020	New Hybrid	SCH
138.	M20H-69S	2020	Parental cross	SCH
139.	M20H-70C	2020	New Hybrid	SCH
140.	M20H-70S	2020	Parental cross	SCH
141.	M20H-71C	2020	New Hybrid	SCH
142.	M20H-71S	2020	Parental cross	SCH
143.	M20H-72C	2020	New Hybrid	SCH
144.	M20H-72S	2020	Parental cross	SCH
145.	M20H-73C	2020	New Hybrid	SCH
146.	M20H-73S	2020	Parental cross	SCH
147.	M20H-74C	2020	New Hybrid	SCH



Sl. No.	Name of Entry	Testing Year	Category	SCH/MPH
148.	M20H-74S	2020	Parental cross	SCH
149.	M20H-75C	2020	New Hybrid	SCH
150.	M20H-75S	2020	Parental cross	SCH
151.	M20H-76C	2020	New Hybrid	SCH
152.	M20H-76S	2020	Parental cross	SCH
153.	M20H-77C	2020	New Hybrid	SCH
154.	M20H-77S	2020	Parental cross	SCH
155.	M20H-78C	2020	New Hybrid	SCH
156.	M20H-78S	2020	Parental cross	SCH
157.	M20H-79C	2020	New Hybrid	SCH
158.	M20H-79S	2020	Parental cross	SCH
159.	M20H-80C	2020	New Hybrid	SCH
160.	M20H-80S	2020	Parental cross	SCH
161.	M20H-81C	2020	New Hybrid	SCH
162.	M20H-81S	2020	Parental cross	SCH
163.	M20H-82C	2020	New Hybrid	SCH
164.	M20H-82S	2020	Parental cross	SCH
165.	M20H-83C	2020	New Hybrid	SCH
166.	M20H-83S	2020	Parental cross	SCH
167.	M20H-84C	2020	New Hybrid	SCH
168.	M20H-84S	2020	Parental cross	SCH
169.	M20H-85C	2020	New Hybrid	SCH
170.	M20H-85S	2020	Parental cross	SCH
171.	M20H-86C	2020	New Hybrid	SCH
172.	M20H-86S	2020	Parental cross	SCH
173.	M20H-87C	2020	New Hybrid	SCH
174.	M20H-87S	2020	Parental cross	SCH
175.	M20H-88C	2020	New Hybrid	SCH
176.	M20H-88S	2020	Parental cross	SCH
177.	M20H-89C	2020	New Hybrid	SCH
178.	M20H-89S	2020	Parental cross	SCH
179.	M20H-90C	2020	New Hybrid	SCH
180.	M20H-90S	2020	Parental cross	SCH
181.	M20H-91C	2020	New Hybrid	SCH
182.	M20H-91S	2020	Parental cross	SCH
183.	M20H-92C	2020	New Hybrid	SCH
184.	M20H-92S	2020	Parental cross	SCH
185.	M20H-93C	2020	New Hybrid	SCH
186.	M20H-93S	2020	Parental cross	SCH
187.	M20H-94C	2020	New Hybrid	SCH
188.	M20H-94S	2020	Parental cross	SCH
189.	M20H-95C	2020	New Hybrid	SCH
190.	M20H-95S	2020	Parental cross	SCH
191.	M20H-96C	2020	New Hybrid	SCH
192.	M20H-96S	2020	Parental cross	SCH

Sl. No.	Name of Entry	Testing Year	Category	SCH/MPH
193.	M20H-97C	2020	New Hybrid	SCH
194.	M20H-97S	2020	Parental cross	SCH
195.	M20H-98C	2020	New Hybrid	SCH
196.	M20H-98S	2020	Parental cross	SCH
197.	M20H-99C	2020	New Hybrid	SCH
198.	M20H-99S	2020	Parental cross	SCH
199.	M20H-100C	2020	New Hybrid	SCH
200.	M20H-100S	2020	Parental cross	SCH
201.	M20H-101C	2020	New Hybrid	SCH
202.	M20H-101S	2020	Parental cross	SCH



## ANNEXURE-IV

### Breeder Seed Production 2019-20

Sl. No.	Variety	Year of Notification	Quantity in Quintal			Producing Institute
			Allocation BSP I	Production	Surplus/Deficit over DAC Indent	
1.	CML161 (FP of Shaktiman 4)	2006	0.01	0.95	0.94	RAU, Dholi
2.	CML169 (MP of Shaktiman 4)	2006	0.01	0.3	0.29	
3.	PML 93(FP of PJMH 1)	2018	0.40	0.60	0.20	IARI, New Delhi
4.	PML105 (MP of PJMH 1)	2018	0.20	0.40	0.20	
5.	Pusa Composite 4 (Composite 8551)	2005	0.50	1.50	1.00	
6.	Gujarat Anand Yellow Maize Hybrid 1		0.01	4.00	3.99	Godhra (Gujarat)
7.	HKI 193-1(FP of HQPM 7)	2008	0.05	0.05	0.00	CCS, HAU, Karnal
8.	HKI 161(MP of HQPM 7)	2008	0.02	0.02	0.00	
9.	HKI 193-1 (FP of HQPM1)	2007	1.18	0.58	-0.60	
10.	HKI 163(MP of HQPM 1)	2007	0.15	0.15	0.00	
11.	HKI 163(FP of HQPM 5)	2007	1.28	0.79	-0.49	
12.	HKI 161(MP of HQPM 5)	2007	0.25	0.25	0.00	
13.	HKI 193-2 (FP of HPQM 4)		0.05	0.05	0.00	
14.	HKI 161(MP of HPQM 4)		0.02	0.02	0.00	
15.	Giriza	2016	0.10	2.50	2.40	CSKHPKV, HAREC, Bajaura
16.	Bajaura Makka	2016	0.40	3.11	2.71	
17.	Shalimar Pop Corn 1 (KDPC 2)	2017	5.00	5.00	0.00	SKUA&T, Srinagar
18.	Birsa Vikas Makka 2	2005	1.76	1.95	0.19	BAU, Ranchi
19.	Jawahar Maize 218		8.50	40.00	31.50	JNKVV, Chhindwara or RVSKVV
20.	Jawahar Vikas Maize 421	2007	4.50	-	-	Gwalior or JNKVV, Jabalpur
21.	QMISC 1407 (FP of Phule Madhu)	2017	0.05	-	-	Kolhapur
22.	QMISC 1408 (MP of Phule Madhu)	2017	0.02	-	-	
23.	QMI 1403(FP of Phule Maharshi)	2017	0.05	-	-	
24.	QMI 1401(MP of Phule Maharshi)	2017	0.02	-	-	
25.	BML 6(FP of DMRH 1305)	2018	0.20	3.5	3.30	IIMR, Ludhiana
26.	IML 418-1(MP of DMRH1305)	2018	0.10	0.40	0.30	
27.	BML 6 (FP of DMRH 1301)	2017	1.40	10.00	8.60	



Sl. No.	Variety	Year of Notification	Quantity in Quintal			Producing Institute
			Allocation BSP-I	Production	Surplus/Deficit over DAC Indent	
28.	HKI163 (MP of DMRH1301)	2017	0.80	8.00	7.20	
29.	V373 (FP of DMRH1308)	2018	0.20	10.00	9.80	
30.	HKI1105 (MP of DMRH1308)	2018	0.10	-	-	
31.	Vijay Composite Makka	1969	0.50	0.50	0.00	PAU, Ludhiana
32.	LM13 (FP of PMH-1)		1.00	1.00	0.00	
33.	LM14 (MP of PMH-1)		0.50	0.70	0.20	
34.	LM23 (FP of PMH-10)		2.00	3.50	1.50	
35.	LM24 (MP of PMH-10)		1.00	1.50	0.50	
36.	Praptap Makka-3 (EC3108)	2005	2.00	-	-	MPUAT, Udaipur
37.	Pratap Hybrid-3	2015	9.00	7.50	-1.50	
38.	UMI1201 (FP of CoH (M) 8)	2013	0.40	-	-	TNAU, Coimbatore
39.	UMI1230 (MP of CoH (M) 8)	2013	0.36	-	-	
40.	BML45 (FP of DHM121)	2014	4.16	12.00	7.84	PJTSAU, MRC, Hyderabad
41.	BML6 (MP of DHM121)	2014	2.08	96.50	94.42	
42.	BML45 (FP of DHM121)	2014	0.35	-	-	
43.	BML6 (MP of DHM121)	2014	0.15	-	-	
44.	BML6 (FP of DHM-117)	2010	0.16	-	-	
45.	BML7 (MP of DHM-117)	2010	0.08	-	-	
46.	BML6 (FP of DHM117)	2010	6.00	-	-	
47.	BML7 (MP of DHM117)	2010	3.30	-	-	
48.	BML45 (FP of DHM121)		0.35	-	-	
49.	V407 (FP of Vivek Maize Hybrid-53)	2014	0.40	0.40	0.00	VPKAS, Almora
50.	V409 (MP of Vivek Maize Hybrid-53)	2014	0.20	0.20	0.00	
51.	V433 (FP of Vivek Maize Hybrid-57)	2018	0.65	0.35	-0.30	
52.	V412 (MP of Vivek Maize Hybrid-57)	2018	0.25	1.20	0.95	
53.	V407 (FP of Vivek Maize Hybrid-53)	2014	0.1	0.20	0.10	
54.	V409 (MP of Vivek Maize Hybrid-53)	2014	0.06	0.20	0.14	
55.	V373 (FP of Vivek Maize Hybrid-45)	2013	0.5	4.48	3.98	
56.	V390 (MP of Vivek Maize Hybrid-45)	2013	0.26	0.95	0.69	
57.	Vivek Sankul Makka-31 (VL103)	2005	1.00	-	-	
58.	Vivek Sankul Makka-35		2.00	4.80	2.80	
59.	Azad Kamal (R-9803)	2005	5.00	8.25	3.25	CSAUA&T, Kanpur

Note: FP: Female Parent MP: Male Parent

ANNEXURE-V

## LECTURES /TV/ RADIO TALKS

Scientist	Topic	Programme	Venue	Date
Dr. Sujay Rakshit	भारत में मक्का की वर्तमान स्थिति एवं उपयोगिता	Three days farmers training programme on “उत्तराखंड में मक्का की उन्नत खेती द्वारा किसानों की आय दोगुना करना”	ICAR-IIMR, Ludhiana	January 7-9, 2020
Dr. Sujay Rakshit	Maize breeding in India – current status & future challenges	Special Seminar	College of Agriculture, VisvaBharati, Sriniketan	February 18, 2020
Dr. Sujay Rakshit	Silent Revolution in Maize - Challenges in Hand	National Seminar “Maize Improvement for Stress Tolerance & Bio fortification in Climate Smart Agriculture”	BAU, Sabour	August 4, 2020
Dr. Sujay Rakshit	Maize for Bio ethanol production: Potential and Challenges	National Seminar on step ahead towards Future Fuel	ISMA and NSI	October 15, 2020
Dr. Sujay Rakshit	Maize for Food Nutrition and Economic Security	National Seminar on World Food Day 2020 - “Grow Nourish Sustain Together”	SKUAST, Kashmir	October 17, 2020
Dr. J. C. Sekhar	POP for management of FAW in different types of corn	Online awareness-cum-training programme on "Management of fall armyworm (FAW) in Himachal Pradesh"	ICAR-IIMR, Ludhiana and CSK HPKV, Palampur	August 7, 2020
Dr. J. C. Sekhar	CIBRC Recommendations and FAMEWS APP	Online awareness-cum-training programme on "Management of fall armyworm (FAW) in Jammu and Kashmir”	ICAR-IIMR and SKUAST-K, Srinagar	August 18, 2020
Dr. J. C. Sekhar	CIBRC Recommendations, natural enemies on FAW and FAMEWS APP	One-day online Technical Webinar-cum-training on “Integrated Pest Management for maize crop with special reference to fall armyworm in NEH region”	ICAR-IIMR and FAO India	September 4, 2020
Dr. J. C. Sekhar	CIBRC Recommendations and FAMEWS APP	One-day online Technical Webinar-cum-training on “Integrated Pest Management for maize crop with special reference to fall armyworm in NWH region”	ICAR-IIMR and FAO India	September 10, 2020
Dr. J. C. Sekhar	CIBRC Recommendations and FAMEWS APP	One-day online Technical Webinar-cum-training on “Integrated Pest Management for maize crop with special reference to fall armyworm’ Maharashtra, MP, Chhattisgarh and Odisha	ICAR-IIMR and FAO India	September 18, 2020

Scientist	Topic	Programme	Venue	Date
Dr. J. C. Sekhar	CIBRC Recommendations and FAMEWS APP	Integrated Pest Management for maize crop with special reference to fall armyworm in NEPZ	ICAR-IIMR and FAO India	October 9, 2020
Dr. J. C. Sekhar	CIBRC Recommendations and FAMEWS APP	Integrated Pest Management for maize crop with special reference to fall armyworm in Rajasthan, Gujarat and Haryana states	ICAR-IIMR and FAO India	October 15, 2020
Dr. S.B. Singh	Strategies of agricultural marketing to tackle the Covid-19 situation	Virtual Webinar on "Marketing of Rabi maize and hybrid seed during Covid-19 period"	CCSNIAM, Jaipur	May 14, 2020
Dr. S.B. Singh	Crop management activities in rabi maize and seed production	Institutionalizing COVID Perio Innovations in Agricultural Marketing	CCSNIAM, Jaipur	May 15, 2020
Dr. S.B. Singh	मक्का में उच्च आय व लाभ हेतु विकल्प	Virtual Webinar on Maize for Farmers	Yara Fertilizer India Pvt. Ltd.	September 22, 2020
Dr. S.B. Singh	Lead lecture on Breeding Climate Resilient maize for Bihar	International Web conference on "Global Research Initiatives for Sustainable Agriculture & Allied Sciences"	Online Web conference by Astha Foundation, Meerut (GRISAAS-2020)	December 29, 2020
Dr. S.B. Singh	मक्का: एक परिचय	संकर मक्का की वैज्ञानिक खेती, बीज उत्पादन तकनीकी व फॉल आर्मीवर्म कीट का प्रबंधन व रणनीतियां विषय पर अनुसूचित जनजाति के कृषकों के लिये पांच दिवसीय राष्ट्रीय प्रशिक्षण कार्यक्रम	RMR&SPC, Begusarai, Bihar	January 20, 2020
	मक्के की खेती में अंतरवर्ती फसल प्रणाली द्वारा अधिक आय की प्राप्ति			January 21, 2020
	फॉल आर्मीवर्म विनाशकारी कीट का प्रबंधन व रोकथाम			January 21, 2020
	किसानों की आय दुगुनी करने हेतु संकर मक्का बीज उत्पादन तकनीक			January 23, 2020
	संकर मक्का बीज प्रसंस्करण, संवर्धन, संग्रहण, प्रमाणीकरण एवं विपणन तकनीकी			January 23, 2020
	गुणवत्ता युक्त प्रोटीन मक्का की खेती द्वारा सामाजिक पोषण सुरक्षा			January 23, 2020
Dr. S.B. Singh	मक्का की फसल में फॉल आर्मीवर्म की पहचान व रासायनिक रोकथाम	संकर मक्का व इसके बीज उत्पादन फसल में फॉल आर्मीवर्म कीट की रोकथाम व प्रबंधन विषय पर कृषक प्रशिक्षण कार्यक्रम	RMR&SPC, Begusarai, Bihar	February 17-18, 2020
	मक्का फसल में सूक्ष्म पोषक तत्वों की कमी के लक्षण व प्रबंधन			
	किसानों की आय दुगुनी करने हेतु संकर मक्का बीज उत्पादन तकनीक			

Scientist	Topic	Programme	Venue	Date
Dr. S.B. Singh	मक्का की फसल में फॉल आर्मीवर्म की पहचान व रासायनिक रोकथाम  मक्का फसल में सूक्ष्म पोषक तत्वों की कमी के लक्षण व प्रबंधन  किसानों की आय दुगुनी करने हेतु संकर मक्का बीज उत्पादन तकनीक	“अनुसूचित जाति के कृषकों के लिए मक्का व इसके बीज उत्पादन फसल में फॉल आर्मीवर्म कीट की रोकथाम व प्रबंधन विषय पर प्रशिक्षण कार्यक्रम”	RMR&SPC, Begusarai, Bihar	February 19, 2020
Dr. S.B. Singh	Seed production technology of single cross hybrid DMRH 1301, DMRH 1308 and DHM 117	A Training programme for BRBN officers/staff and farmers on “Single cross maize hybrid seed production technique” (एकल संकर मक्का बीज उत्पादन तकनीकी)	RMR&SPC, Campus Vishnupur, Begusarai	November 6, 2020
Dr. S.B. Singh	स्वच्छता के द्वारा कैसे बचें व बचाएँ अपने परिवार को कोरोना महामारी व अन्य बिमारियों से	“स्वच्छता पखवाड़ा - एक कदम स्वच्छता की ओर”	RMR SPC, Kushma-haut, Begusarai, Bihar	December 29, 2020
Dr. S.B. Singh	नए कृषि कानूनों से किसान कैसे उठायेँ लाभ	राष्ट्रीय किसान दिवस	RMR&SPC, Kushma-haut, Begusarai	December 23, 2020
Dr. S.B. Singh	Oral presentation on Assessing impact of cold temperature at growth and pre-flowering in winter maize	International Web conference on Global Research Initiatives for Sustainable Agriculture & Allied Sciences, (GRISAAS-2020)	Online Web conference by Astha Foundation, Meerut	December 29, 2020
Dr. S.B. Singh	Regional Maize Research and Seed Production Centre Begusarai – A report to Farmers	Stars of Begusarai on KV Studio, A Local TV Channel of Begusarai	Dr. Roshan Kumar, Correspondent KV, Studio	December 5, 2020
Dr. Suby S.B.	Monitoring, Scouting and management of fall armyworm (FAW)	Online awareness-cum-training programme on "Management of fall armyworm (FAW) in Himachal Pradesh"	ICAR-IIMR, Ludhiana and CSK HPKV, Palampur	August 7, 2020
Dr. Suby S.B.	Monitoring, scouting and management of fall armyworm (FAW)	Online awareness-cum-training programme on “Management of fall armyworm (FAW) in Jammu and Kashmir”	ICAR-IIMR and SKUAST-K, Srinagar	August 18, 2020
Dr. Suby S.B.	Monitoring, scouting and management of fall armyworm (FAW)	One-day online Technical Webinar cum training on “Integrated Pest Management for maize crop with special reference to fall armyworm in NWH region”	ICAR-IIMR and FAO India	September 10, 2020

Scientist	Topic	Programme	Venue	Date
Dr. Suby S.B.	Monitoring, scouting and management of fall armyworm (FAW)	One-day online Technical Webinar cum training on “Integrated Pest Management for maize crop with special reference to fall armyworm”	ICAR-IIMR and FAO India	September 18, 2020
Dr. Suby S.B.	Monitoring, Scouting and management of fall armyworm (FAW)	One-day online Technical Webinar cum training on “Integrated Pest Management for maize crop with special reference to fall armyworm in Rajasthan, Gujarat and Haryana states”	ICAR-IIMR and FAO India	October 15, 2020
Dr. P.L. Soujanya	Biology and Identification of fall army worm	Online awareness-cum-training programme on "Management of fall armyworm (FAW) in Himachal Pradesh"	ICAR-IIMR, Ludhiana and CSK HPKV, Palampur	August 7, 2020
Dr. P.L. Soujanya	Biology and Identification of fall army worm	Online awareness-cum-training programme on "Management of fall armyworm (FAW) in Jammu and Kashmir”	ICAR-IIMR and SKUAST-K, Srinagar	August 18, 2020
Dr. P.L. Soujanya	Biology and Identification of fall army worm	One-day online Technical Webinar cum training on “Integrated Pest Management for maize crop with special reference to fall armyworm in NWH region”	ICAR-IIMR, and FAO India	September 10, 2020
Dr. P.L. Soujanya	Biology and Identification of fall army worm	One-day online Technical Webinar cum training on “Integrated Pest Management for maize crop with special reference to fall armyworm”	ICAR-IIMR, and FAO India	September 18, 2020
Dr. P.L. Soujanya	Insect pests of maize, biology and Identification of fall army worm	One-day online Technical Webinar cum training on “Integrated Pest Management for maize crop with special reference to fall armyworm in Rajasthan, Gujarat and Haryana states”	ICAR-IIMR, and FAO India	October 15, 2020
Dr. Aditya Kumar Singh	मक्का उत्पादन की आधुनिक तकनीके एवं संरक्षित खेती	Three days farmer training programme on “उत्तराखंड में मक्का की उन्नत खेती द्वारा किसानों की आय दोगुना करना”	ICAR-IIMR, Ludhiana	January 7-9, 2020

Scientist	Topic	Programme	Venue	Date
Dr. Ramesh Kumar	खाद्य एवं पोषण सुरक्षा हेतु गुणवत्ता युक्त प्रोटीन मक्का (QPM) की खेती	Three days farmer training programme on “उत्तराखंड में मक्का की उन्नत खेती द्वारा किसानों की आय दोगुना करना”	ICAR-IIMR, Ludhiana	January 7-9, 2020
Dr. Dharam Paul	मक्का का हरे चारे एवं साईलेज के रूप में उपयोग	Three days farmer training programme on “उत्तराखंड में मक्का की उन्नत खेती द्वारा किसानों की आय दोगुना करना”	ICAR-IIMR, Ludhiana	January 7-9, 2020
Dr. M.C. Dagla	विभिन्न कृषि परिस्थितिकियों में मक्का की खेती के लिए उपयुक्त किस्मों का चुनाव	Three days farmer training programme on “उत्तराखंड में मक्का की उन्नत खेती द्वारा किसानों की आय दोगुना करना”	ICAR-IIMR, Ludhiana	January 7-9, 2020
	Maize: Crop and Post-harvest management during Covid-19 situations	Strategies of agricultural marketing to tackle the Covid-19 situation	Chaudhary Charan Singh National Institute of Agricultural Marketing (CCS NIAM), Jaipur	May 15, 2020
Dr. S.L. Jat	मक्का की देखभाल	किसान की बात कार्यक्रम	ऍफ़ एम गोल्ड	जनवरी 10, 2020
Dr. S.L. Jat	रबी मक्का की देखभाल	हेल्लो किसान लाइव कार्यक्रम	डीडी किसान	जुलाई 29, 2020
Dr. S.L. Jat	मक्का की उन्नत खेती	किसान की बात कार्यक्रम	ऍफ़ एम गोल्ड	जून 9, 2020
Dr. S.L. Jat	मक्का की खेती	हेल्लो किसान लाइव कार्यक्रम	डीडी किसान	जून 9, 2020
Dr. S.L. Jat	Soil Fertility and Fertilizer Use	Five weeks training programme on "Competitive examination: AIEEA (PG) JRF, AICE-JRF/SRF (Ph.D.) and ICAR-NET/ARS" during 02 July -09 August, 2020 by MPKV, Rahuri	Zoom platform virtual meeting	July 7, 2020
Dr. S.L. Jat	खरीफ मक्का की देखभाल	हेल्लो किसान लाइव कार्यक्रम	डीडी किसान	जुलाई 15, 2020
	खरीफ मक्का की देखभाल	किसान की बात कार्यक्रम	ऍफ़एम गोल्ड	जुलाई 21, 2020
Dr. S.L. Jat	Agro- techniques of FAW management in Himachal Pradesh	Online awareness-cum-training programme on fall armyworm (FAW) for Himachal Pradesh	ICAR-IIMR, Ludhiana and CSK HPKV, Palampur	August 7, 2020
Dr. S.L. Jat	Agro- techniques of FAW Management	Online awareness-cum-training programme on "Management of fall armyworm (FAW) in Jammu and Kashmir”	ICAR-IIMR and SKUAST-K, Srinagar	August 18, 2020
Dr. S.L. Jat	Agro-techniques of FAW management in Rajasthan	Webinar-cum-training for FAW management in Bundi districts of Rajasthan	Zoom platform virtual meeting	September 1, 2020
Dr. S.L. Jat	Agro- techniques of FAW management in NEH region	Technical webinar for FAW IPM NEH	Zoom platform virtual meeting	September 4, 2020

Scientist	Topic	Programme	Venue	Date
Dr. S.L. Jat	Agro- techniques of FAW management in Western Himalayan Region	Technical Webinar for FAW IPM Western Himalayan Zone	Zoom platform virtual meeting	September 10, 2020
Dr. S.L. Jat	Agro- techniques of FAW Management with reference to Indian context	One-day online Technical Webinar cum training on “Integrated Pest Management for maize crop with special reference to fall armyworm”	ICAR-IIMR and FAO India	September 18, 2020
Dr. S.L. Jat	Methodologies for assessment of efficiencies in diversified cropping system	Online training program on “Secondary Agriculture for Doubling Farmers Income: Using Efficient Technologies” 5-11 October, 2020 by Division of Agronomy, Faculty of Agriculture, Wadura, SKUAST-K.	Zoom platform virtual meeting	October 5, 2020
Dr. S.L. Jat	Agro- techniques of FAW Management in Eastern India	Technical Webinar for Eastern India	Zoom platform virtual meeting	October 9, 2020
Dr. S.L. Jat	Agro- techniques of FAW Management in Central Plateau and Hills	Technical Webinar for FAW IPM Central Plateau and Hills	Zoom platform virtual meeting	October 15, 2020
Dr. S.L. Jat	रबी मक्का की बुवाई	किसान की बात कार्यक्रम	ऍफएम गोल्ड	अक्टूबर 26, 2020
	रबी मक्का की देखभाल	किसान की बात कार्यक्रम	ऍफएम गोल्ड	दिसम्बर 18, 2020
Dr. Bharat Bhusan	खाद्य एवं पोषण सुरक्षा में मक्का की उपयोगिता	Three days farmer training programme on “उत्तराखंड में मक्का की उन्नत खेती द्वारा किसानों की आय दोगुना करना”	ICAR-IIMR, Ludhiana	January 7-9, 2020
Dr. Abhijit Kumar Das	पॉप कॉर्न की खेती एवं उपयोगिता	Three days farmer training programme on “उत्तराखंड में मक्का की उन्नत खेती द्वारा किसानों की आय दोगुना करना”	ICAR-IIMR, Ludhiana	January 7-9, 2020
Dr. Pardeep Kumar	बेबी कॉर्न एवं मीठी मक्का की उत्पादन तकनीकें	Three days farmer training programme on “उत्तराखंड में मक्का की उन्नत खेती द्वारा किसानों की आय दोगुना करना”	ICAR-IIMR, Ludhiana	January 7-9, 2020
Dr. Alla Singh	मक्का की औद्योगिक क्षेत्र में उपयोगिता	Three days farmer training programme on “उत्तराखंड में मक्का की उन्नत खेती द्वारा किसानों की आय दोगुना करना”	ICAR-IIMR, Ludhiana	January 7-9, 2020



Scientist	Topic	Programme	Venue	Date
Dr. Alla Singh	Advances in Plant Biotechnology	Vigyan Setu: Bridging Classical Biology and Biotechnology for Pre collegiate students	Doaba College, Jalandhar	May 7-30, 2020
Dr. Alla Singh	Impact of Covid-19 on Agriculture	Vigyan Setu: Bridging Classical Biology and Biotechnology for Pre collegiate students	Doaba College, Jalandhar	May 7-30, 2020
Dr. Alla Singh	Significance of NABL for scientific excellence	Constitution Day	ICAR-IIMR, Ludhiana	July 30, 2020
Dr. Alla Singh	Molecular mechanism of <i>opaque-2</i> mediated protein improvement in maize	2 <sup>nd</sup> International Conference on Plant Science & Research	Plant-2020 (Virtual)	November 2-3, 2020
Dr. B.S. Jat	मक्का में संकर बीज उत्पादन की तकनीकें	Three days farmer training programme on “उत्तराखंड में मक्का की उन्नत खेती द्वारा किसानों की आय दोगुना करना”	ICAR-IIMR, Ludhiana	January 7-9, 2020
Dr. S.K. Aggarwal	मक्का के मुख्य रोग एवं प्रबंधन	Three days farmer training programme on “उत्तराखंड में मक्का की उन्नत खेती द्वारा किसानों की आय दोगुना करना”	ICAR-IIMR, Ludhiana	January 7-9, 2020
Mr. Deep Mohan Mahala	मक्का में पोषक तत्व प्रबंधन एवं खरपतवार नियंत्रण	Three days farmer training programme on “उत्तराखंड में मक्का की उन्नत खेती द्वारा किसानों की आय दोगुना करना”	ICAR-IIMR, Ludhiana	January 7-9, 2020



## ANNEXURE-VI

### Publications

#### Research Papers

1. Banerjee R, Sheoran S, Kumar S, Sanodiya R, Dhanya VG and Samota MK (2020) Participatory Rural Appraisal Techniques for Problem Identification and Formulation of Village Agricultural Development Plan of Chosla Village. *Asian Journal of Agricultural Extension, Economics & Sociology*, 80-99. <https://krishi.icar.gov.in/jspui/handle/123456789/44339>
2. Barman K, Banik S, Pegu SR, Kumar S, Konwar D, Das PJ, Rahman JI, Das AK, Rajkhowa S, Jat SL, Rakshit S (2020) Effect of supplementation of HQPM-1 maize grain on production performances in cross-bred (Hampshire x Ghungroo) Grower Pigs. *Int J. Curr Microbiol Appl Sci*, 9(08):1762-1767. doi: <https://doi.org/10.20546/ijcmas.2020.908.203>. <http://krishi.icar.gov.in/jspui/handle/123456789/43338>
3. Barman K, Banik S, Pegu SR, Kumar S, Rahman JI, Das AK, Rajkhowa S, Jat SL, Rakshit S (2020) Effect of supplementation of QPM maize fodder on production performance in Large White Yorkshire grower pigs. *ECVE*, 5(8):142-146. <http://krishi.icar.gov.in/jspui/handle/123456789/43341>
4. Basavalingaiah K, Ramesha YM, Paramesh V, Rajanna GA, Jat SL, Dhar S, Gaddi AK, Girisha HC, Yogesh GS, Raveesha S, Roopa TK, Shashidhar KS, Kumar B, El-Ansary EO, Elansary H (2020) Energy budgeting, data envelopment analysis and carbon footprint of rice production system: a case study from puddle transplanted rice and direct-seeded rice system of Karnataka, India. *Sustainability*, 12:6439. doi:10.3390/su12166439. <http://krishi.icar.gov.in/jspui/handle/123456789/43518>
5. Das RR, Vinayan MT, Patel MB, Phagna RK, Singh SB, Shahi JP, Sarma A, Barua NS, Babu R, Seetharam K, Burgueño JA, Zaidi PH (2020) Genetic gains with rapid-cycle genomic selection for combined drought and waterlogging tolerance in tropical maize (*Zea mays* L.) *The Plant Genome*, 13(3): 1:10. <https://doi.org/10.1002/tpg2.20035>. <http://krishi.icar.gov.in/jspui/handle/123456789/44326>
6. Garg NK, Dahuja A, Singh A, Sapna, Chaudhary DP (2020) Understanding the starch digestibility characteristics of Indian maize hybrids. *Ind J. Exptl Biol*, 58, 738-744. <http://krishi.icar.gov.in/jspui/handle/123456789/44945>
7. Gupta A, Soujanya PL, Achterberg CV, Sekhar JC (2020) *Coccygidium transcaspicum* (Kokujev) (Hymenoptera: Braconidae) parasitizing larvae of invasive pest *Spodoptera frugiperda* (Lepidoptera: Noctuidae) in India. *Zootaxa*, 4750 (2): 293-297. <http://krishi.icar.gov.in/jspui/handle/123456789/43054>
8. Gupta M, Kaur S, Debbarma A (2020) Frequency distribution of lepidopteran-specific secretory genes in indigenous *Bacillus thuringiensis* isolates recovered from diverse soil habitats of India. *Journal of Entomology and Zoology Studies*, 8(4): 674-681. <http://krishi.icar.gov.in/jspui/handle/123456789/44906>
9. Kaur N, Singh B, Sharma S, Kumar R (2020) Refinement of a protocol for the assessment of antioxidative activities of normal maize (NM) and quality protein maize (QPM). *Journal of Food Processing and Preservation*, 44(9):e14634. <http://krishi.icar.gov.in/jspui/handle/123456789/43516>
10. Kumar B, Kumar K, Jat SL, Srivastava S, Tiwari T, Kumar S, Pradhan HR, Meenakshi, Kumar B, Chaturvedi G, Jha AK, Rakshit S (2020) Rapid method of screening for drought stress tolerance in maize (*Zea mays* L.). *Indian J Genet Plant Breed*, 80(1): 20-25. <http://krishi.icar.gov.in/jspui/handle/123456789/4334>
11. Kumar B, Singh SB, Singh V, Hooda KS, Bagaria PK, Kumar K, et al. 2020. RILs development and its characterization for MLB resistance and flowering in maize (*Zea mays*). *Indian Journal of Agricultural Sciences*. 90 (1): 183-188. <http://krishi.icar.gov.in/jspui/handle/123456789/44618>
12. Kumar P, Kumar S, Choudhary M, Chikappa GK, Kumar B, Singh NK, Sinha SK (2020) GGE biplot based stability analysis of experimental hybrids for baby corn purpose and green fodder. *Range Management & Agroforestry*, 41(1): 60-66. <http://krishi.icar.gov.in/jspui/handle/123456789/43052>
13. Kumar R, Kaul J, Kaur Y, Das AK, Choudhary M, Singode A, Dubey RB, Sravani D, Mukari G, Rakshit S (2020) Response of Quality Protein Maize Hybrids for grain yield in diverse environments. *Ind. J. Agric. Sci*, 90(40): 756-61. <http://krishi.icar.gov.in/jspui/handle/123456789/43517>
14. Pal D, Muthusamy V, Zunjare RU, Jaiswal SK, Chhabra R, Baveja A, Chauhan HS, Bhatt V, Sekhar JC, Hossain F (2020) Genetic variability of popping quality traits and microsatellite-based characterization of popcorn inbreds for utilization in breeding programme. *Indian J. Genet*, 80 (2), 154-162. DOI: 10.31742/IJGPB.80.2.5 <http://krishi.icar.gov.in/jspui/handle/123456789/44901>
15. Pandravada SR, Sunil N, Sekhar JC, Sivaraj N, Kamala V, Babu BS (2020) Identification and characterization of an extra early flowering maize (*Zea mays* L.) accession: A potential germplasm source for developing early maize cultivars. *Maize Journal* 9(1): 23-29. <http://krishi.icar.gov.in/jspui/handle/123456789/44861>
16. Parihar CM, Singh AK, Jat SL, Dey A, Nayak HS, Mandal BN, Saharawat YS, Jat ML, Yadav OP (2020) Soil quality and carbon sequestration under conservation agriculture with balanced nutrition in

- intensive cereal based system. *Soil Tillage Res.*, 202: 104653. <https://doi.org/10.1016/j.still.2020.104653>.  
<http://krishi.icar.gov.in/jspui/handle/123456789/43623>
17. Reddy LM, Sreelatha D, Sekhar JC, Soujanya PL (2020) Techniques for artificial infestation of stem borer *Sesamia inferens* Walker for screening maize germplasm. *Maize Journal*, 9(1):59-63. <http://krishi.icar.gov.in/jspui/handle/123456789/44900>
  18. Sapna, Chauhan SK, Chaudhary DP, Dar ZA, Sayyed RZ, Enshasy HAEI (2020) Correlation Studies among Nutritional Quality Parameters of Baby Corn. *Journal of Scientific & Industrial Research*, 79, 1-6. <http://krishi.icar.gov.in/jspui/handle/123456789/44876>
  19. Sethi M., S. Kumar, A. Singh and D.P. Chaudhary (2019). Temporal profiling of essential amino acids in developing maize kernel of normal, opaque-2 and QPM germplasm. *Physiology and Molecular Biology of Plants* 26(2):341-351 DOI: 10.1007/s12298-019-00724-x. <http://krishi.icar.gov.in/jspui/handle/123456789/35986>
  20. Singh A, Karjagi C, Kumar R, Chaudhary DP, Rakshit S (2020) In-silico characterization of cadmium stress response-associated Abcl-like protein and its homologues in maize (*Zea mays*). *Indian Journal of Agricultural Sciences*, 90(9): 1685-9. <http://krishi.icar.gov.in/jspui/handle/123456789/43322>
  21. Singh A, Karjagi C, Rakshit S (2020) Minimally altering a critical kinase for low-phytate maize. *Scientific Reports*. 10(1): 1-5. <http://krishi.icar.gov.in/jspui/handle/123456789/43325>
  22. Singh AK, Jat SL, Parihar CM, Kumar M, Singh CS, Hallikeri SS, Sreelatha D, Manjulatha G, Mahala DM (2020) Precision nutrient management for enhanced yield and profitability of maize (*Zea mays*). *Indian J. Agri Sci*, 90(5):952-60. (NAAS Rating: 6.23). <http://krishi.icar.gov.in/jspui/handle/123456789/43337>
  23. Singh I, Debnath S, Gautam A, Yadava P (2020) Characterization of contrasting genotypes reveals general physiological and molecular mechanisms of heat-stress adaptation in maize (*Zea mays* L.). *Physiology and Molecular Biology of Plants*, 26(5):921-929. (NAAS rating: 7.54). <http://krishi.icar.gov.in/jspui/handle/123456789/43308>
  24. Singh SB, Kasana RK, Kumar S, Kumar R (2020) Assessing Genetic Diversity of Newly Developed Winter Maize (*Zea mays* L.) Inbred Lines. *Indian J. Plant Genet. Resour*, 33(1): 68-76. <http://krishi.icar.gov.in/jspui/handle/123456789/43333>
  25. Soujanya PL, Sekhar JC, Ratnavathi CV, Shobha E, Karjagi CG, Suby SB, Sunil N, Rakshit S (2020) Role of soluble, cell wall-bound phenolics, tannin and flavonoid contents in maize resistance to pink stem borer *Sesamia inferens* Walker. *Maydica*, 65-M8. <http://krishi.icar.gov.in/jspui/handle/123456789/43055>
  26. Suby SB, Jha SK, Karjagi CG, Kumar P, Sekhar JC, Kaur J, Cholla AK, Soujanya PL, Sharma RK, Rakshit S (2020) Penetration resistance of second above ground internode in V6-10 stage maize plants confer resistance to stalk boring larvae of *Chilo partellus* (Swinhoe) in maize. *PHYTOPARASITICA*. 48:455-469. <http://krishi.icar.gov.in/jspui/handle/123456789/43059>
  27. Yadava P, Aggarwal C, Verma R, Kumar K, Singh I (2020) Effect of nitrogen-starvation on growth pattern and expression of nitrogen assimilation related genes in maize (*Zea mays* L.). *Indian Journal of Agricultural Sciences*, 90(1):195-200. <http://krishi.icar.gov.in/jspui/handle/123456789/43309>
  28. Zaidi PH, Nguyen T, Dang NH, Suriphath T, Salahuddin A, Arshad, M, Koirala KB, Rijal TR, Kuchanur PH, Patil AM, Mandal, SS, Kumar R, Singh SB, Kumar B, Shahi JP, Patel MB, Gumma MK, Pandey K, Chaurasia R, Haque A, Seetharam K, Das RR, Vinayan MT, Rashid Z, Nair SK, Vivek BS (2020) Stress-resilient maize for climate-vulnerable ecologies in the Asian tropics. *Australian Journal of Crop Science*, 14 (8). pp 1264-1274. ISSN 1835-2707. <http://krishi.icar.gov.in/jspui/handle/123456789/44327>

### Review paper

1. Kumar K, Gambhir G, Das A, Tripathi AK, Singh A, Jha AK, Yadav P, Chaudhary M, Rakshit S (2020) Genetically modified crops: current status and future prospects. *Planta*, 251: 91. <http://krishi.icar.gov.in/jspui/handle/123456789/35947>
2. Kumar R, Yadav MR, Arif M, Mahala DM, Kumar D, Ghasal PC, Yadav KC and Verma R K (2020) Multiple agroecosystem services of forage legumes towards agriculture sustainability: An overview. *Indian Journal of Agricultural Sciences*, 90(8), 1367-1377. <http://krishi.icar.gov.in/jspui/handle/123456789/43327>
3. Suby SB, Soujanya PL, Yadava P, Patil J, Subaharan K, Prasad GS, Babu KS, Jat SL, Yathish KR, Vadassery J, Kalia VK, Bakthavatsalam N, Shekhar JC, Rakshit S (2020) Invasion of fall armyworm (*Spodoptera frugiperda*) in India: nature, distribution, management and potential impact. *Current Science*, 119(1): 44-51. (NAAS Rating: 6.76) <http://krishi.icar.gov.in/jspui/handle/123456789/43056>

### Book chapter

1. Bhushan B, Jat BS, Dagla MC, Aggarwal SK, Rakshit S (2020) Anthocyanins and proanthocyanidins as anticancer agents. In: *Exploitation of plant cells for production of compounds of interest*. (Editor Sonia Malik), [https://doi.org/10.1007/978-3-030-58271-5\\_4](https://doi.org/10.1007/978-3-030-58271-5_4). Springer Publication, Brazil. ISBN 978-3-030-58270-8. <http://krishi.icar.gov.in/jspui/handle/123456789/43328>
2. Dagla MC, Kumar P, Bhushan B, Kumar R and Singh SB (2020) Maize: crop and post-harvest management during covid-19 situation. In: *CCS NIAM technical bulletin on Institutionalising COVID period innovations in agricultural marketing*. (Eds. P.C. Shekara, V.K.J. Rao, M.K. Agrawal) pp. 37-46. <http://krishi.icar.gov.in/jspui/handle/123456789/44866>



3. Kumar S, Bhushan B, Wakchure GC, Kumar M, Meena KK, Meena NL, Rane J (2020) Plant phenolics under water deficit conditions: Biosynthesis, accumulation and physiological roles in water stress alleviation. In: Plant Phenolics in Sustainable Agriculture (Springer Publisher) Eds. RafiqLone, RaziaShuab, Azra N Kamili. DOI: 10.1007/978-981-15-4890-1. ISBN: 978-981-15-4889-5. <http://krishi.icar.gov.in/jspui/handle/123456789/43329>
4. Meena HN, Jat SL, Meena MS, Singh SK (2020) Crop Residue Generation, Recycling and its Management for Agricultural Sustainability. *Indian Journal of Fertilisers*, 16 (11): 1152-1161. (NAAS Rating: 2.80). <http://krishi.icar.gov.in/jspui/handle/123456789/43626>
5. Mehta S, Singh B, Patra A, Tripathi A, Easwaran M, Choudhary JR, Choudhary M and Aggarwal SK (2020) Maize microbiome: current insights for the sustainable agriculture. pp 267-296 (Elsevier). <http://krishi.icar.gov.in/jspui/handle/123456789/42998>
6. Parihar CM, Jat HS, Singh Y, Jat SL, Kakraliya SK, Nayak HS (2020) Precision Nutrient Management for Higher Nutrient Use Efficiency and Farm Profitability in Irrigated Cereal-based Cropping Systems. *Indian Journal of Fertilisers*, 16(10): 1000-1014. (NAAS Rating: 2.80). <http://krishi.icar.gov.in/jspui/handle/123456789/43634>
7. Singh A, Sethi M, Verma D, Naliath R, Chaudhary DP. Benefits and Biohazards of Microbial Recombinants. In *Microbial Diversity, Interventions and Scope 2020* (pp. 123-134). Springer, Singapore. <http://krishi.icar.gov.in/jspui/handle/123456789/44875>
8. Singh SB (2020) Crop Management and Hybrid Seed Production Activities in Rabi Maize: Harvest to Marketing during COVID19 Lockdown In *Institutionalizing COVID Period Innovations in Agricultural Marketing*. pp 105-117. <http://krishi.icar.gov.in/jspui/handle/123456789/43331>
9. Singh Y, Jat HS, Jat SL (2020) Wheat productivity enhancement through climate smart practices. in Sareen et al. (eds.) 2020. *Improving Cereal Productivity Through Climate Smart Practices*. Woodhead Publishing, Elsevier. pp 256-268. ISBN: 978-0-12-821316-2. <https://doi.org/10.1016/C2019-0-03165-http://krishi.icar.gov.in/jspui/handle/123456789/43342>

### Extended Summary and Abstracts

1. Aggarwal SK, Hooda KS, Bagaria PK, Sharma SS, Baheti BL, Rathore BS, Mohit, Olakh DS, Rakshit S (2019) Management of important maize diseases of central western zone in India. In: Proceedings, National Seminar on "Maize for Crop Diversification under Changing Climatic Scenario" held on February 9-10, 2020, Ludhiana, Punjab, India. <http://krishi.icar.gov.in/jspui/handle/123456789/42995>
2. Aggarwal SK, Neelam K, Jain J, Kaur R, Pannu PPS, Lenka SK, Lore JS, Singh K (2020) Correlation study for sheath blight of rice with Different disease variables. In: abstract published in 7<sup>th</sup> International Conference on "Phytopathology in Achieving UN Sustainable Development Goals" (January 16-20, 2020) at New Delhi, India. <http://krishi.icar.gov.in/jspui/handle/123456789/42996>
3. Bahar FA, Singh AK, Jat SL, Parihar CM, Mahala DM, Bamboriya SD, Ritesh (2020) Weed seed bank studies under different cropping systems of Indo-Gangetic plains. In: Souvenir and Book of Abstracts of National Seminar on "Maize for Crop Diversification under Changing Climatic Scenario" held on February 9-10, 2020, Ludhiana, Punjab, India. pp 193. <http://krishi.icar.gov.in/jspui/handle/123456789/43633>.
4. Bhushan B, Dagla MC, Dhir A, Chaudhari DP (2020) Maize Anthocyanins: a potential source for nutrition and formulation of novel functional food. In: National seminar on "Maize for Crop Diversification under Changing Climatic Scenario" held on February 9-10, 2020, Ludhiana, Punjab, India. <http://krishi.icar.gov.in/jspui/handle/123456789/35942>
5. Dass S, Jat SL, Chaikkappa GK, Parihar CM, Chaudahry M, Kumar R (2020) Crop diversification – to ensure and promote sustainable natural resources use. In: Souvenir and Book of Abstracts of National Seminar on "Maize for Crop Diversification under Changing Climatic Scenario" held on February 9-10, 2020, Ludhiana, Punjab, India. pp 28-31. <http://krishi.icar.gov.in/jspui/handle/123456789/43627>
6. Jat SL, Gambhir G, Kumar N, Suby SB, Parihar CM, Rakshit S (2020) Seasonal changes in soil health parameters affected by nitrogen and residue management practices under long term conservation agriculture in maize system. In: Souvenir and Book of Abstracts of National Seminar on "Maize for Crop Diversification under Changing Climatic Scenario" held on February 9-10, 2020, Ludhiana, Punjab, India. pp 206-207. <http://krishi.icar.gov.in/jspui/handle/123456789/43622>.
7. Jat SL, Parihar CM, Singh AK (2020) Conservation agriculture for sustainable food security in India. In: Souvenir cum proceedings of International Web-Conference on Food Security through Sustainable Agriculture, VAKSANA-2020 held on September 21-22, 2020, Shri Vaishnav Vidyapeeth Vishwavidhyalaya, Indore, M.P. India. pp 12-23. <http://krishi.icar.gov.in/jspui/handle/123456789/43340>
8. Jat SL, Parihar CM, Singh AK, Sreelatha D, Mahala DM, Bamboriya SD, Radheshyam, Kada PV (2020) Conservation agriculture in maize systems: a way forward for sustainability. In: Souvenir and Book of Abstracts of National Seminar on "Maize for Crop Diversification under Changing Climatic Scenario" held on February 9-10, 2020, Ludhiana, Punjab, India. pp 83-87. <http://krishi.icar.gov.in/jspui/handle/123456789/43336>
9. Kaur S, Gaganjeet, Naliath R, Verma D and Singh A (2020). Analysis of Repeat Markers in highly polymorphic genetic regions of maize genome. In: Souvenir and Book of Abstracts of National Seminar on "Maize for Crop Diversification under

- Changing Climatic Scenario” held on February 9-10, Ludhiana, India. pp 108-9. <http://krishi.icar.gov.in/jspui/handle/123456789/44862>
10. Kumar A, Aggarwal C, Kumar K, Singh I, Yadava P (2020) Profiling of low-nitrogen stress responsive miRNAs in maize using high-throughput sequencing. In: abstract book of *National Seminar* on “Maize for Crop Diversification under Changing Climatic Scenario” jointly organized by MTAI, IIMR and PAU held at Ludhiana, February 9-10, 2020. pp 184. <http://krishi.icar.gov.in/jspui/handle/123456789/44909>. <http://krishi.icar.gov.in/jspui/handle/123456789/43630>
  11. Kumar N, Suby SB, Parihar CM, Jat SL, Gambhir G, Rakshit S (2020). A study on earthworm population and microbial activity in their casts in long-term tillage and residue management practices. In: Souvenir and Book of Abstracts of National Seminar on “Maize for Crop Diversification under Changing Climatic Scenario” held on February 9-10, 2020, Ludhiana, Punjab, India. pp 96.
  12. Moghiya A, Kumar R, Kaur Y, Jat SL, Rakshit S (2020) Evaluation of maize genotypes under irrigated and heat stress ecologies. In: Souvenir and Book of Abstracts of National Seminar on “Maize for Crop Diversification under Changing Climatic Scenario” held on February 9-10, 2020, Ludhiana, Punjab, India. pp 173. <http://krishi.icar.gov.in/jspui/handle/123456789/43631>
  13. Mohit, Hooda KS, Aggarwal SK, Bagaria PK, Aulakh DS, Kaur R, Rakshit S, Sharma SS, Harleen K, Mallikarjuna N, Gogoi R, Malik VK, Devlash RK, Rathee VK, Singh RP, Kumar P, Harlapur SI, Rajashekara H, Chand P, Renuka PD (2020) Prevalence of maize diseases in India. In: abstract published in 7<sup>th</sup> International Conference on “Phytopathology in Achieving UN Sustainable Development Goals” (January 16-20, 2020) at New Delhi, India. <http://krishi.icar.gov.in/jspui/handle/123456789/42997>
  14. Rakshit S, Jat SL, Chikkappa GK (2020) Needs for crop diversification with maize in Punjab. In: Souvenir and Book of Abstracts of National Seminar on “Maize for Crop Diversification under Changing Climatic Scenario” held on February 9-10, 2020, Ludhiana, Punjab, India. pp 25-27. <http://krishi.icar.gov.in/jspui/handle/123456789/43339>
  15. Singh A, Chikkappa G Karjagi, Kaur S, Gaganjeet, Chaudhary DP, Kumar R, Naliath R, Das AK and Rakshit S (2020). Analysis of DNA motifs upstream of opaque2 gene in maize genome. In: Souvenir and Book of Abstracts of National Seminar on “Maize for Crop Diversification under Changing Climatic Scenario” held on February 9-10, Ludhiana, India. pp 149. <http://krishi.icar.gov.in/jspui/handle/123456789/44865>
  16. Singh AK, Jat SL, Parihar CM, Mahala DM, Bamboriya SD, Ritesh (2020) Maize based system with precision conservation agriculture: a suitable alternative to rice-wheat rotation in Indo-Gangetic plains of India. In: Souvenir and Book of Abstracts of National Seminar on “Maize for Crop Diversification under Changing Climatic Scenario” held on February 9-10, 2020, Ludhiana, Punjab, India. pp 191-192. <http://krishi.icar.gov.in/jspui/handle/123456789/43632>
  17. Singh SB, Karjagi CG, Kumar S, Kumar K, Yathish KR, Jat BS, Kasana RK, Kumar A, Rakshit S (2020) Estimation of genetic diversity among newly developed winter maize inbred lines in Souvenir National Seminar on “Maize for Crop Diversification under Changing Climatic Scenario” held on February 9-10, 2020, Ludhiana, Punjab, India. pp 126-127. <http://krishi.icar.gov.in/jspui/handle/123456789/43624>
  18. Singh SB, Kumar S, Kumar A (2020) Assessing impact of cold temperature at growth and pre-flowering in winter maize. In: Souvenir and Abstract Book of the International Web Conference on Global Research Initiatives for Sustainable Agriculture & Allied Sciences, (GRISAAS-2020) held on December 28-30. <http://krishi.icar.gov.in/jspui/handle/123456789/44582>.
  19. Singh SB, Kumar S, Yathish KR, Jat BS, Karjagi CG, Kumar B, Kumar B, Kumar A, Kasana RK, Rakshit S (2020) Poster presentation on Stability of experimental winter maize hybrids tested across the environment of Bihar using GGE biplot and AMMI analysis in Souvenir National Seminar on “Maize for Crop Diversification under Changing Climatic Scenario” held on February 9-10, 2020, Ludhiana, Punjab, India. pp 111-112. <http://krishi.icar.gov.in/jspui/handle/123456789/44325>
  20. Suby SB, Parihar CM, Jat SL, Kumar N, Gambhir G, Rakshit S (2020) Effects of long-term tillage and residue management practices on pest infestation in *rabi* maize in maize-maize-*Sesbania* system. In: Souvenir and Book of Abstracts of National Seminar on “Maize for Crop Diversification under Changing Climatic Scenario” held on February 9-10, 2020, Ludhiana, Punjab, India. pp 206. <http://krishi.icar.gov.in/jspui/handle/123456789/43629>.
  21. Sujatha V, Kumar S, Chandra PB, Singh AK, Jat SL (2020) Validation of sensor based nitrogen management in maize in Godavari zone of Andhra Pradesh. In: Souvenir and Book of Abstracts of National Seminar on “Maize for Crop Diversification under Changing Climatic Scenario” held on February 9-10, 2020, Ludhiana, Punjab, India. pp 94-95. <http://krishi.icar.gov.in/jspui/handle/123456789/43628>
  22. Sunil N, Sivaraj N, Yathish KR, Vinodhana K, Kachhapur RM, Sravani D, Bhadru D, Ramesh P, Dhandapani A, Rakshit S (2020) Understanding Trait and Geographic Diversity Among Maize Hybrids –Through Diversity Indices using Diva-Gis and Maxent in Abstracts, National Seminar on “Maize for Crop Diversification under Changing Climatic Scenario” held on February 9-10, Ludhiana, India. pp 42-43. <http://krishi.icar.gov.in/jspui/handle/123456789/43061>
  23. Verma D, Ahmed Z, Jat BS, Kumar, Singh A and Rakshit S (2020). Effect of thiourea supplementation on in vitro seedling growth in maize landraces. In: Souvenir and Book of Abstracts of National Seminar on “Maize for Crop Diversification under Changing Climatic Scenario” held on February 9-10, Ludhiana, India. pp 109. <http://krishi.icar.gov.in/jspui/handle/123456789/44863>
  24. Verma D, Mahala DM, Bhar FA, Singh AK, Singh A (2020). Bacterial diversity analysis of rice-wheat and maize - wheat cropping systems. In: Souvenir and Book of Abstracts of National Seminar on “Maize for Crop

Diversification under Changing Climatic Scenario” held on February 9-10, Ludhiana, India. pp 149.  
<http://krishi.icar.gov.in/jspui/handle/123456789/44864>

25. Srivastava S, Gangoliya SS, Yathish KR, Kumar A, Preeti, Goshal T, Yadav HK, Kapoor U, Kumar S, Kumar R, Singh SB, Sekhar JC, Das AK, Neelam S, Yadav OP, Mahajan V, Karjagi CG\* and Rakshit S. 2020. Conversion of normal inbred lines into quality protein maize through marker assisted selection. In National Seminar on 'Maize for Crop Diversification under Changing Climatic Scenario', Ludhiana, Feb 09-10, 2020. [http://krishi.icar.gov.in/PDF/ICAR\\_Data\\_Use\\_Licence.pdf](http://krishi.icar.gov.in/PDF/ICAR_Data_Use_Licence.pdf)
26. Yadav HK, Gangoliya SS, Yathish KR, Kumar A, Preeti, Goshal T, Srivastava S, Kapoor U, Kumar S, Kumar R, Singh SB, Sekhar JC, Das AK, Neelam S, Yadav OP, Mahajan V, Karjagi CG\* and Rakshit S. 2020. Introgression of *crtR1* through marker assisted backcross breeding (MABB). In National Seminar on "Maize for Crop Diversification under Changing Climatic Scenario", Ludhiana, Feb 09-10, 2020. [http://krishi.icar.gov.in/PDF/ICAR\\_Data\\_Use\\_Licence.pdf](http://krishi.icar.gov.in/PDF/ICAR_Data_Use_Licence.pdf)
27. Kumar A, Gangoliya SS, Yathish KR, Yadav HK, Preeti, Goshal T, Srivastava S, Kapoor U, Kumar S, Kumar R, Singh SB, Sekhar JC, Das AK, Neelam S, Yadav OP, Mahajan V, Karjagi CG\* and Rakshit S. 2020. Introgression of low phytic acid trait in selected inbred lines of maize. In National Seminar on "Maize for Crop Diversification under Changing Climatic Scenario", Ludhiana, Feb 09-10, 2020. [http://krishi.icar.gov.in/PDF/ICAR\\_Data\\_Use\\_Licence.pdf](http://krishi.icar.gov.in/PDF/ICAR_Data_Use_Licence.pdf)
28. Karjagi CG\*, Singh A, Kumar R, Singh SB, Yathish KR, Das AK, Neelam S, Gangoliya SS, Kumar A, Kapoor U, Yadav HK, Srivastava S and Rakshit S. 2020. Breeding for low phytic acid maize – status and prospects. In National Seminar on "Maize for Crop Diversification under Changing Climatic Scenario", Ludhiana, Feb 09-10, 2020. [http://krishi.icar.gov.in/PDF/ICAR\\_Data\\_Use\\_Licence.pdf](http://krishi.icar.gov.in/PDF/ICAR_Data_Use_Licence.pdf)

### Popular article

1. एस.के. अग्रवाल, के.एस. हुड्डा, मोहित, डी.एस. ओलख, पी.के. बागरिया, आर. कौर और डी.एम. महला (2020) मक्का चारकोल वृंत सडन रोग एवं प्रबंधन, कृषि चेतना, अंक- 3 पृष्ठ सं: 33-35. <http://krishi.icar.gov.in/jspui/handle/123456789/42999>
2. के.एस. हुड्डा, एस.के. अग्रवाल, मोहित, डी.एस. ओलख और पी.के. बागरिया (2020) मक्का का रोगो से बचाव, खेती 72 (9): 72 <http://krishi.icar.gov.in/jspui/handle/123456789/43051>
3. श्यामबीर सिंह, संतोष कुमार एवं अजय कुमार (2020) बिहार में एकल संकर मक्का बीज उत्पादन की सम्भावनाएँ एवं समस्याएँ कृषि चेतना, अंक- 3 पृष्ठ सं: 08-13. <http://krishi.icar.gov.in/jspui/handle/123456789/43335>
4. संतोष कुमार, एस. बी. सिंह, नितीशरंजन प्रकाश, यतीश, के. आर., चिकप्पा जी. के., बी.एस. जाट, प्रदीप कुमार, अभिजीत कुमार दास एवं प्रीती सिंह (2020) मोमी मक्का : एक परिचय. कृषि चेतना अंक- 3 पृष्ठ सं: 25-28 <http://krishi.icar.gov.in/jspui/handle/123456789/433345>.
6. दीप मोहन महला, शंकर लाल जाट, अमित कुमार, सी. एम. परिहार, शांति बंबोरिया, ए. के. सिंह, प्रदीप कुमार एवं सुमित कुमार (2020) मक्का की जैविक खेती. कृषि चेतना, अंक 3 पृष्ठ 43-46. <http://krishi.icar.gov.in/jspui/handle/123456789/43326>
7. पवन कुमार, जीत राम चौधरी, दिनेश कुमार, दिनेश कुमार जींगर, मुकेश चौधरी, प्रदीप कुमार, बी. एस. जाट, मनेश चन्द्र डागला, अनुराग त्रिपाठी एवं भारत भूषण (2020) प्रमाणित बीज सुदृढ खेती का आधार. कृषि चेतना, अंक- 3 पृष्ठ सं: 80-84 <http://krishi.icar.gov.in/jspui/handle/123456789/44946>
8. सी.एम. परिहार, दीप मोहन महला, बी.एस. जाट, मुकेश चौधरी एवं एस.एल. जाट (2020) संरक्षित खेती: टिकाऊ कृषि उत्पादन एवं स्वस्थ मृदा के लिए एक बेहतर विकल्प, कृषि चेतना, अंक- 3 पृष्ठ सं: 59-61 <http://krishi.icar.gov.in/jspui/handle/123456789/44944>

### Technical Bulletin

- Soujanya PL, Suby SB, Sekhar JC, Vasudeva Rao V, Sujay Rakshit (2020) Major insect pests of maize and their management. ICAR-Indian Institute of Maize Research, PAU Campus, Ludhiana, Punjab 141004. pp 62. <http://krishi.icar.gov.in/jspui/handle/123456789/43057>

### Other publications

- Rakshit S, Sunil N, Mahala DM, Jat BS, Bamboriya SD, Karjagi CG, Jat SL, Soujanya PL, Aggarwal SK, Suby SB, Singh SB, Sekhar JC. (2020) Bharti MAKKA. <http://krishi.icar.gov.in/jspui/handle/123456789/44902>



## ANNEXURE-VII

### On-going projects

#### List of on-going institute projects

Project Code	Title of the project	PI	CoPI / CCPI	Project Duration
<b>Agronomy</b>				
AR:IIMR: 17:09	Sensor guided nitrogen management in maize based cropping system under conventional and conservation agriculture practices	Dr. SL.Jat	Dr. AK Singh, CM Parihar, Suby SB, Dilip Singh, D. Sreelatha, CS Singh, Mahesh Kumar, Amit Kumar Bhatnagar, D.R. Thakur, PC Ghashal, Deep Mohan Mahala	July, 2017 to June, 2022
AR:IIMR: 17:10	Development of precision conservation agriculture practices in cereal based system in Indo-Gagatic Plains	Dr.AK Singh	Drs. SL Jat, Deep Mohan Mahla, Shanti Devi Bamboriya, Mahesh Kumar	July, 2017 to June, 2022
<b>Biochemistry</b>				
AR:IIMR: 17:01	Analysis of starch diversity and digestibility in maize	Dr. Dharam Paul	Drs. Alla Singh, AK Das, Yathish KR	April, 2017 to March, 2022
AR:IIMR: 19:02	Extraction, identification and stability analysis of maize anthocyanins	Dr. Bharat Bhushan	Drs. Dharam Paul, MC Dagla	July, 2019 to June, 2022
<b>Biotechnology</b>				
AR:IIMR: 16:02	Development of banded leaf and sheath blight resistant transgenic maize	Dr. Krishan Kumar	Drs. Deepak S Bisht,	July, 2016 to June, 2021
AR:IIMR: 19:05	Evaluation of potential of maize in the emerging Bio-based Industry	Dr. Alla Singh	Drs. GS Kocher, SS Dhaliwal, Dharam Paul, Ramesh Kumar, BS Jat, Shanti Bamboriya, Bharat Bhushan	July, 2019 to June, 2024
<b>Entomology</b>				
AR:DMR: 17:03	Management of maize stem borers through host plant resistance	Dr. P Lakshami Soujanya	Drs. JC Shekhar, Chikkappa GK, Jawala Jindal, Maha Singh, CV Ratnavathi	July, 2017 to June, 2022
<b>Plant Pathology</b>				
AR:IIMR: 19:01	Studies on diversity <i>Setosphaeria turcica</i> isolates of maize in India	Dr. Sumit Kumar Aggarwal	Drs. Harleen Kaur, S.I. Harlapur, Mohammad Ashraf Ahangar, N. Mallikarjuna, R Devlash Srabani Debnath, Shweta Singh, Alla Singh (Co-PI)	July, 2019 to June, 2024
AR:IIMR: 16:01	Development of IDM strategy for major disease of maize with available effective tools	Dr. Sumit Kumar Aggarwal	Drs. Amrender Kumar, Robin Gogoi, RP Singh, Harleen Kaur, Prashant Chauhan	April, 2016 to March, 2021

Project Code	Title of the project	PI	CoPI / CCPI	Project Duration
<b>Plant Breeding</b>				
AR:IIMR: 17:02	Genetic enhancement of QPM germplasm	Dr. Ramesh Kumar	Drs. AK Das, Dharam Paul, SB Singh, Sunil Neelam, SK Aggarwal, Suby SB	July, 2017 to June, 2022
AR:IIMR: 19:03	Genetic enhancement of maize for the development of high yielding and climate resilient hybrids	Dr. S.B. Singh	Drs. Sunil Neelam, Ramesh Kumar, M C D a g l a , Chikkappa GK, Bhupender Kumar, AK Das, Yathish KR, Pardeep Kumar, BS Jat, Santosh Kumar, Shanti Devi Bamboriya, PL Soujanya, Suby SB, Deep Mohan Mahala, SK Aggarwal Ms. Seema Sheoran	October, 2019 to September, 2024
AR:IIMR: 17:04	Genetic enhancement of white maize for food purpose	Dr. A.K. Das	Drs. SB Singh, Suby SB, Narendra Kumawat, SK Guleria, Savita Sharma, Baljit Singh	July, 2017 to June, 2022
AR:IIMR: 17:05	Breeding for high yielding and better quality fodder cultivars in maize	Dr. Pradeep Kumar.	Drs. Yathish KR, MM Dass, JS Lamba, AK Singh (need based), Deep Mohan Mahala, JS Hundal, Yathish KR, Ms. Seema Sheoran	July,, 2017 to June, 2022
AR:IIMR: 17:06	Breeding for development of baby corn hybrids	Dr. Pradeep Kumar	Drs. Sujay Rakshit, Meenakshi Goyal, Bharat Bhusan, BS Jat, Yathish KR, Santosh Kumar, Shanti Devi Bamboriya	July, 2017 to June, 2022
AR:IIMR: 17:07	Development of early maturing maize hybrid with enhanced yield and stress tolerance	Dr. M.C. Dagla	Drs. BS Jat, SK Aggarwal, PL Soujanya	July, 2017 to June, 2022
AR:IIMR: 17:11	Diversification of sweet corn germplasm	Dr. Chikkappa G.K.	Drs. Sujay Rakshit, JC Sekhar, AK Das, Pardeep Kumar, Santosh Kumar, Yathish KR, Ms. Seema Sheoran	June, 2017 to May, 2022
AR:IIMR: 16:03	Decision support system of maize inbred germplasm	Dr. N Sunil	Drs. JC Sekhar, N. Srinivas Rao	April. 2016 to April, 2020
<b>Physiology</b>				
AR:IIMR: 17:08	Physiological and biochemical basis of nitrogen use efficiency in maize	Dr. Ishwar Singh	Drs. SL Jat, Krishan Kumar, Pranjal Yadava	July, 2017 to June, 2020
<b>Agricultural Extension</b>				
AR:IIMR: 17:08	Farmers Led innovation (FLI) in maize and mechanism for their scaling-up	Mr. Priyajoy Kar	Drs. SL Jat, Shanti Devi Bamboriya Sapna Nigam	July 2020 to July 2022

### List of Externally funded projects

Sl. No.	Scheme/project	PI	CoPI / CCPI	Project Duration	Funding agency
1.	Development of sustainable management tools for the invasive pest, Fall Armyworm <i>Spodoptera frugiperda</i> (J.E.Smith) in maize	Dr. JC Sekhar	Drs. Suby SB, P.L. Soujanya, SL Jat, Pranjal Yadav, Yathish, KR, N Baktavatsalam, Vinay K Kalia, Jyothilakshmi V.	2019-2022	NASF FAW project
2.	Pre-breeding of wild crosses for yield enhancement and climate resilience maize using wild species	Dr. Pradeep Kumar	--	2019-2022	DST-SERB
3.	Frontline demonstration in maize under NFSM	Dr. S.L. Jat	Mr Deep Mohan Mahala and Ms S.D. Bamboriya	April, 2014 and continuing	Department of Agriculture and cooperation, Ministry of Agriculture and Farmers ' Welfare, Govt of India
4.	Long-term conservation agriculture impact on micro biome and soil health indicators for resource efficiency and resilience in maize systems	Dr. S.L. Jat	Drs. Bhupender Kumar, Suby SB	2018-2021	Indian Council of Agricultural Research-NASF
5.	Seed Production in Agricultural Crops	Dr. S.B. Singh	--	2017-2020	ICAR-IISS, Mau
6.	Consortia Research Platform on Molecular Breeding (CRPonMB)	Dr. Chikkappa G.K.	--	2015-2020	Indian Council of Agricultural Research
7.	Consortia Research Platform on Agrobiodiversity (CRP AB)	Dr. Chikkappa G.K.	--	2014-2020	Indian Council of Agricultural Research
8.	Strengthening of DUS test centres under central sector scheme for implementation of PVP legislation	Dr. Chikkappa G.K.	--	2007-2021	Protection of Plant Varieties and Farmer's Rights Authority (PPV &FRA), MoA &FW, GoI
9.	CRP on maize bio-fortification	Dr. Bhupender Kumar	Drs. SB Singh, Dharam Paul, Ramesh Kumar, Chikkappa GK, SL Jat, Vishal Singh, Mukesh Choudhary	2017-2020	Indian Council of Agricultural Research
11	Genome-wide association mapping and genetic characterization of turcicum leaf blight ( <i>Setosphaeria turcica</i> ) resistance in tropical maize germplasm	Dr. Bhupender Kumar	--	2018-2021	DST-SERB Early Career Research Award Grant Scheme

Sl. No.	Scheme/project	PI	CoPI / CCPI	Project Duration	Funding agency
12.	Institute Technology Management Unit (ITMU)	Dr. Ramesh Kumar	Drs. Dharm Paul, Suby SB, Alla Singh	Ongoing from 2007	Indian Council of Agricultural Research
13.	Artificial intelligence based mobile app for identification and advisory of maize diseases and insect pests	-	Drs. Soujanya Laxmi P (CCPI), SK Aggarwal (Co-CCPI)	2019 -2021	ICAR-National Agriculture Science Fund (NASF)
14.	Rapid Detection of Quality Protein Maize for Increased Farmer Remuneration	Dr. Alla Singh	Dr. AK Das	2018- 2021	DST





## ANNEXURE-VIII

### Annual Financial Statement (2019-20)

#### A. Expenditure Statement (2019-20)

(Rupees in Lakhs)

Head of Account	RE 2019-20			Actual Expenditure during 2019-20		
	Institute Govt. Grant	Govt. Schemes	AICRP on Maize	Institute Govt. Grant	Govt. Schemes	AICRP on Maize
Grant in Capital	600.00	99.9	0	599.74	14.70	0
Grant in Salary	671.25	0	1643.29	669.57	0	1643.29
Grant in General	560.18	158.99	300.00	551.85	160.57	300.00
TSP	30.00	0	80.46	30.00	0	80.46
NEH	90.00	0	70.00	90.00	0	70.00
SCSP	101.07	0	0	101.03	0	0
<b>Total</b>	<b>2052.50</b>	<b>258.89</b>	<b>2093.75</b>	<b>2042.19</b>	<b>175.27</b>	<b>2093.75</b>

#### Revenue Generation during the year 2019-20

Particulars	Amount (Rupees in Lakhs)
Sale of Farm produce	58.53
Licence fee	2.95
Analytical and testing fee	33.55
Interest earned on Loan & Advances to Employees	1.44
Interest earned on short term deposits	60.04
<b>Total</b>	<b>156.51</b>

#### Funds received for externally funded projects during the year 2019-20

Particulars	Amount (In Rupees)
DUS	23.88
FLD	18.00
SERB – Early Career Research Award Scheme	5.50
SERB – Pre Breeding of Wild Crosses	4.00
SERB – Dr Abhijit Kumar	12.49
HTMA	24.21
<b>Total</b>	<b>88.08</b>

#### B. Financial targets and achievements (All employees)

(Rupees in Lakhs)

RE 2019-20 for HRD	Actual Expenditure up to 31 <sup>st</sup> March, 2020 for HRD	% Utilization of RE 2019-20
3.00	2.98	99.33



## ANNEXURE-IX

### Personnel, transfers, new joining, superannuation, promotions

Name	Designation	Discipline
<b>Indian Institute of Maize Research, PAU Campus Ludhiana</b>		
Dr. Sujay Rakshit	Director	Plant Breeding
Dr. Ishwar Singh	Principal Scientist	Plant Physiology
Dr. Aditya Kumar Singh	Principal Scientist	Agronomy
Dr. Dharam Paul	Principal Scientist	Biochemistry
Dr. Ramesh Kumar	Principal Scientist	Plant Breeding
Dr. Abhijit Kumar Das	Scientist	Plant Breeding
Dr. Pardeep Kumar	Scientist	Plant Breeding
Dr. Mamta Gupta	Scientist	Agricultural Biotechnology
Dr. Alla Singh	Scientist	Agricultural Biotechnology
Dr. Manesh Chander Dagla	Scientist	Plant Breeding
Dr. Bahadur Singh Jat	Scientist	Plant Breeding
Dr. Bharat Bhushanl	Scientist	Biochemistry
Dr. Sumit Kumar Aggarwal	Scientist	Plant Pathology
Sh. Ashwani Kumar	Administrative Officer	
Sh. Permod Sharma	Assistant Finance & Account Officer	
Mrs. Kamlesh Malik	AAO/DDO	
Sh. Dharambir Singh	Assistant	
Sh. Bhagesh Sharma	Assistant	
Sh. Prashant Garg	Assistant	
Sh. Samir Kumar Ray	T3	
Sh. Ram Kishan	SSS	
<b>Indian Institute of Maize Research, Unit Office, Delhi</b>		
Dr. Chikkappa G. Karjagi	Scientist	Plant Breeding
Dr. Shanker Lal Jat	Scientist	Agronomy
Dr. Suby S.B.	Scientist	Entomology
Dr. Bhupender Kumar	Scientist	Plant Breeding
Dr. Krishan Kumar	Scientist	Agricultural Biotechnology
Sh. Anwar Ali	SSS	



Name	Designation	Discipline
<b>Regional Maize Research and Seed production Centre, Begusarai, Bihar</b>		
Dr. Shyam Bir Singh	Principal Scientist	Plant Breeding
Mr. Rahul	T3	
Mr. Kamal Vats	T3	
<b>Winter Nursery Centre, Hyderabad</b>		
Dr. J.C. Sekhar	Principal Scientist	Entomology
Dr. N. Sunil	Principal Scientist	Plant Breeding
Dr. P. Laxmi Soujanya	Scientist	Entomology
Dr. K.R. Yathish	Scientist	Plant Breeding
Sh. Amar Nath	SSS	

### New Joining

Name and Designation	Date of Joining	Discipline
Mr. Priyajoy Kar	4.4.2020	Agricultural Extension
Mrs. Seema Sheoran	4.4.2020	Plant Breeding

### Transfer to

Name and Designation	Date of Transfer	Transferred to
Dr. Santosh Kumar, Scientist	6.6.2020	IARI, Jharkhand

### Transfer From

Name and Designation	Date of Joining	Transferred from
Dr. Seema Sepat, Scientist	19.10.2020	IARI, New Delhi
Dr. Phurailatpam Romen Sharma, Scientist	22.10.2020	ICAR Research Complex For Neh Region

### Scientist on Study Leave

Name	Time period of Study Leave	Institute Name
Ms. Avni	12.6.2018 to 11.6.2021	Guru Jambheshwar University of Science and Technology, Hisar
Mr. Praveen Kumar Bagaria	5.1.2019 to 4.1.2022	Punjab Agricultural University, Ludhiana
Mr. Mukesh Choudhary	28.10.2019 to 27.10.2022	University of Western Australia
Mr. Vishal Singh	18.12.2019 to 17.12.2022	Utah State University Logan, USA
Mr. Deep Mohan Mahala	26.10.2020 to 25.10.2022	IARI, New Delhi
Smt. Shanti Devi Bamboriya	26.10.2020 to 25.10.2022	IARI, New Delhi

### Staff on Deputation

Name and Designation	Time of Deputation	Deputation Institute
Smt. Seema Khatter	3.11.2020 to 2.11.2022	IARI, New Delhi

### Promotion

Name and Designation	Time of Promotion	Promotion Post
Sh. Dharambir Singh	16.07.2020	UDC to Assistant

### Staff positions of ICAR-IIMR

Type of post	Approved by D/O expenditure	In position	Vacant
Scientific	42	27+ 6 (on study leave)	9
Administrative	13	7	6
Technical	5	3	2
Supporting	3	3	0



Home
About Us   Research   Technology   Services   Extension   AICRP on Maize   Publications   Announcement   Contact Us

- About Maize
- Employee Corner
- Online Resources
- Gallery
- Public Grievance Redressal Cell
- Women Grievance Redressal Cell
- RTI
- Vigilance
- Useful Links

### From Director's Desk



Maize or corn is the third most important cereal crop after rice and wheat for India. Globally it is highly valued for its multifarious use as food, feed, fodder and raw material for large number of industrial products. Maize with its wide adaptability it can be grown with elevation ranging from sea level to up to 3000 m above mean sea level. It is grown on 188 million ha area in more than 170 countries across the globe with 1060 million MT of production. Worldwide China has maximum area under maize followed by the USA, both together representing 39% of world maize area. Since 2005, India ranks 4<sup>th</sup> in terms of area with 9.2 million ha land under maize. The USA is the top maize producer followed by China, contributing 34% and 22% of world maize production. However, India remained among the top 10 producers of maize in the World since 1961 and presently ranks 7<sup>th</sup> with annual output of 28 million MT. The productivity of maize in India is litt....

[Read More](#)

#### Search Site

#### Find Us






- Analytical Services
- Gallery
- Get Makka App
- MTAI

### MAIZE JOURNAL



#### Latest News

- » Zoom details for online interview for selection of JRF under DST SERB funded project, 12.03.2021 new
- » Supply of goods and services to ICAR-IIMR and its regional stations require compulsory GEM registration(gem.gov.in) new
- » Draft policy paper on "Crop Diversification in Punjab and Haryana" for comments from stakeholders (Email : director.maize@icar.gov.in) by March 17, 2021 new
- » International Women's Day Lecture, March 8, 2021
- » National Science Day Special Lecture by Dr. Rajeev K Varshney, Research Program Director-Genetic gains, ICRISAT

***Institute Website : [iimr.icar.gov.in](http://iimr.icar.gov.in)***



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

*Agrisearch with a human touch*

**Published by**  
**ICAR-INDIAN INSTITUTE OF MAIZE RESEARCH**  
PAU CAMPUS, LUDHIANA, PUNJAB - 141004  
Phone: +91-161-2440048 Fax: +91-161-2430038  
Mobile: +91-9492430207  
Email: pdmaize@gmail.com  
Website: <https://iimr.icar.gov.in/>