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Proceedings
of the

59th Annual Maize Workshop

University of Agricultural Sciences, Bengaluru,
10-12 April 2016

All India Coordinated Research Project on Maize
ICAR- Indian Institute of Maize Research
Pusa Campus, New Delhi 110 012
www.iimr.res.in

Session I: Inaugural Session

Chief Guest	Presiding Officer	Rapporteurs
Dr. J.S. Sandhu, DDG (CS), ICAR	Dr. H. Shivanna, Vice-Chancellor, UAS, Bangalore	Drs. A.K. Singh, J.C. Sekhar, K.P.Singh

The inaugural session was started with invocation by PG students of University of Agricultural Sciences, Bengaluru. Dr T. Sheshadri, Director of Research of UASB briefed on the accomplishments of UASB since its inception 50 years back. He highlighted the contribution of the university in the field of developing hybrids in the case of cotton, sunflower and rice for the first time in the country. He also mentioned on the academic excellence of the university by securing good rank in JRF and ARS examination conducted by ICAR. For the last ten years, the university is maintaining good rank with first rank, second rank or within fifth rank. University also awarded ICAR Sardar Vallabhai Award for two times during the past decade. After briefing about the university accomplishments, the Director of Research welcomed all the guests and participants present.

Then the 59th Annual Workshop was inaugurated by Dr. J.S. Sandhu, Dy. Director General (Crop Science) by lightning the lamp, in the backdrop of ICAR song. While giving inaugural address, Dr J.S. Sandhu appreciated the beautiful arrangements made for the workshop. He mentioned that though for the last two years, the agriculture situation is not favourable for most of the crops, but the maize crop has shown tremendous improvement in the terms of area, production and productivity. In this context, more crop improvement work to enhance further productivity in maize needs to be addressed by the maize group. He wished for the fruitful deliberations of the workshop and advised to draw a good research programme for the forthcoming year.

Dr Vinay Mahajan, Director, IIMR presented the highlights of the Annual Report of AICRP on Maize and he presented the highlights of the last years work made by the different centers in crop improvement, crop production, protection, value addition etc. He also briefed on the results of Front Line Demonstrations. He mentioned the brief details of promising entries which performed very well in the coordinated trials both from private and public sectors. During the inauguration, more than 15 technical publications were released by DDG, Crop Science and other dignitaries present.

Dr H.S. Gupta, DG, BISA while giving his remarks mentioned that though there is climate change and lot of variations for the production and productivity of other crops, the maize has maintained 5% growth rate for the last eight years. Because of its C_4 nature, maize can withstand the vagaries and climate change and it can serve as a future crop of India. The crop can be utilized not only for food but also for feed. In the present scenario of distress agriculture where 40 – 50% farmers want to quit the farming, maize can play a pivotal to make farming more profitable. From the point of production and micro nutrition, maize can be a very good nutritive crop. In the recent past, the maize is becoming more popular through more use of sweet corn, pop corn and baby corn. He highlighted the quality of publications released during the session. He thanked the university for inviting him and to offer his remarks with respect to maize crop situation in the country.

Dr H. Shivanna, Vice-Chancellor, UASB in his presidential remarks thanked the Indian Council of Agriculture Research for choosing UASB as venue for the 59th Annual Maize Workshop. He also mentioned the importance of maize crop in terms of its more adaptability, being grown in more than 155 countries, its C_4 nature, its potentiality and value addition capability. In Karnataka, the area under maize is increasing at a very rapid rate. He wished for the good deliberations and requested the maize scientists to come out with good

recommendations to lay out a sound research programme or maize development in the country.

At the end, Dr Puttaramanaik, Organizing Secretary presented Vote of Thanks thanking all the chief guests, dignitaries, delegates from different parts of the country, the private companies for the good sponsorship and presents, press and print media, officers of the university and PG students.

Session II

Discussion - "Yield performance of new hybrids tested under AICMIP program in last 25 years"

Chairman	Co-Chairman	Speaker	Rapporteurs
Dr. J.S. Sandhu, DDG (CS), ICAR	Dr. I.S. Solanki, ADG (FFC), ICAR	Dr. Vinay Mahajan, Director, ICAR-IIMR	Dr. Ashok Kumar Dr. Chikkappa, G.K. Dr. Bhupender Kumar

Dr. Vinay Mahajan, Director, ICAR-Indian Institute of Maize Research, presented a comprehensive analysis of "Yield performance of new hybrids tested under All India Coordinated Maize Improvement Project (AICMIP) programme in last 25 years (1990 to 2014)". The analysis was carried out across different maturity group and agro-climatic zones. In addition, the details regarding number of cultivars of different kind *viz.,* double cross hybrids, three-way cross hybrids, double top-cross hybrids, open pollinated varieties etc. released, notified under different types *viz.,* quality protein maize (QPM), sweet corn, popcorn, baby corn, non-QPM maize, elite germplasm distributed to different research institutions to strengthen the breeding programme of the centres, strategic initiatives in maize improvement, production and protection, and their impact on cultivar development, breeder seed production undertaken, etc. during 1990 to 2014 were also presented. The salient observations were made by Dr. J.S. Sandhu, DDG (CS), ICAR, on the following aspects and were discussed critically.

1. The hybrids developed by private sector are being released and notified in large number than public sector. In fact there is decline in the number of hybrids notified and released by public sector in recent years, especially from 2010 onwards.

The most probable reason behind such decline is due to lack heterotic grouping of existing inbred lines based on combining ability, recycling of elite inbred lines within heterotic groups through pedigree crosses, and little or no efforts with respect to diversification of existing germplasm through introgression of novel germplasm. Therefore, it is recommended to enhance the efforts towards systematization of breeding efforts across all AICRP centres on maize with respect to heterotic grouping based on combining ability, recycling and diversifying of existing elite inbred lines through introgression of novel germplasm without disturbing the heterotic group, to further increase the potential yield levels of new hybrids developed and also increase the efficiency of hybrid breeding.

In the past, the maize improvement programmes of the country across almost all the AICRP on maize centre have concentrated largely on developing early and extra-early maturity hybrids, with lesser focus on medium and late maturity hybrids. While doing so they had not selected the late maturing temperate germplasm which has reduced the genetic diversity in the existing germplasm of the present. Therefore, the magnitude of genetic improvement is slow due to plateau in the genetic diversity in the absence of recycling. Thus, very less number of entries being promoted and released subsequently.

The hybrids developed by private sector are getting released and notified in more number than public bred hybrids due to increased emphasis of private seed companies on medium and late maturing hybrids. There are an increase number of indigenous seed companies,

which is a healthy sign for the maize programme, hence there is matching contribution of number of entries contributed by private sector.

2. The improvement of yield with respect to compound annual growth rate (CAGR) across different zones and maturity groups varied.
The house responded with different reasons for such variability across zones, like differences in initial yield level in different zones, cropping system, percent of adaptability of new technologies by farmers etc. The growth was highest in NEPZ and lowest in NWPZ, which is a matter of concern.

3. The yield levels across different maturity and zones of the country have declined from NIVT to AVT-1 and AVT-1 to AVT-2.
The effect of plot size is one of the important factors which may be contributing for such decline. But, the magnitude of decline is very high in some cases; crop production or good agronomic management might be another important factor which may be contributing for such decline in higher magnitude. Therefore, it was suggested to manage the coordinated yield trials with highest care and precision to avoid such decline and asked to take necessary initiatives in this regard.

4. The variability of yield levels in front line demonstrations in different states (FLDs) vis-a-vis states average productivity vis-a-vis experimental plot i.e. breeding trials has not considered.
There is need for such analysis to understand the gap and to derive suitable strategies to bridge the gaps. There is a need to increase the number of FLDs so as to effectively demonstrate the latest technology to the farmers.

Session III
Discussion - "Zone wise progress of Agronomy in last 25 years

Chairman	Co-Chairman	Speaker	Rapporteur/s
Dr. J.S. Sandhu, DDG (CS), ICAR	Dr. I.S. Solanki, ADG (FFC), ICAR Dr S. Bhaskar, ADG (AAFCC), ICAR, New Delhi	Dr A. K. Singh, Principal Investigator, AICRP on Maize, Agronomy	Drs. Ashok Kumar and S.L. Jat

The presentation on "Zone wise progress of Agronomy in last 25 years" was made by Dr A. K. Singh, Principal Investigator, AICRP on Maize, Agronomy. Dr A. K. Singh deliberated an exhaustive and comprehensive progress in maize agronomy research covering the different aspects viz., genotype interaction with nutrient management and plant density, production technologies for maize, baby corn, sweet corn, quality protein maize, inter cropping system, conservation agriculture, INM, precision nutrient management, water management and weed management. Dr Singh also discussed the new initiatives of maize agronomy. After the presentation, following observations were made by the Chairman.

1. Chairman appreciated the progress made in the field of maize agronomy. He also suggested that there is need to compare the yield of breeding and agronomy trials and should be presented in next workshop.

2. Dr H. S. Gupta, DG, BISA suggested to include the the trials on micronutrient study in maize and avoid the repetition of AICRP (micronutrient) project and also to work out the nutrient use efficiency in nutrient management trials.

3. Dr S. Bhaskar, ADG (AAF & C) suggested to develop the maize agronomy under congenial and climatic change environment and also suggested to identify the maize cultivars for the niche area of organic farming.

Session IV
Review of work during *Kharif* 2015 and *Rabi* 2014-15

Chairman	Co-chairman	Speakers	Rapporteurs
Dr. I.S.Solanki, ADG (FFC), ICAR	Dr. H.S. Gupta, DG. BISA	Dr. Bhupender Kumar, Dr. A.K. Singh, Dr. J.C. Sekhar, Dr. K.S. Hooda	Dr. P .Lakshmi Soujanya Dr. Meena Shekhar Dr. Ashok Kumar Dr. Chikkappa G.K.

Breeding

Dr. Bhupender Kumar presented the work done during *kharif* 2015 and *rabi* 2014-15.The review of work including number of entries tested under AICRP on maize, success rate of trials conducted across different zones, entries promoted from NIVT to AVT-1 and AVT-1 to AVT-2, varieties notified, germplasm maintained, utilized identified for different traits, distributed to AICRP on maize centres and registered either at NBPGR and/or PPV&FRA, breeder seed produced, along with new initiatives *viz.,* renaming of zones, revised system of promotion, newly formulated a separate rainfed trial, two pre-breeding nurseries comprising elite inbred lines and superior segregating germplasm etc. The house approved the new initiatives and the details of review of work.

The observations made at the end of presentation were as follows.

1. The digitalization of information on maize germplasm with minimum passport information including special traits like drought tolerance, disease resistance etc. need to be developed to facilitate utilization by maize workers of the country in the form of donors for different traits.
2. The additional **NIVT rainfed trial** of different maturity will be formulated from *Kharif* 2016 onwards. The AICRP centres which receive the trials need to be conduct it under rainfed condition only to generate valuable information on performance of test entries under rainfed condition.
3. In order to accelerate and facilitate germplasm utilization, **two pre-breeding nurseries *viz.,* elite inbred lines/ trait specific genetic stocks and superior segregating population**, will be formulated from *kharif* 2016 onwards. The trials will be formulated along with details of contributor to facilitate benefit or credit sharing. AICRP centres which receive pre-breeding nurseries need to submit the utilization report. In addition, AICRP centres can also contribute for pre-breeding nurseries and nurseries will go in their name only through ICAR-IIMR, New Delhi. **The seed quantity required for pre-breeding nurseries will be 1 kgs,** which will be conducted in one replication of two rows with between row and plant spacing of 75 and 25 cm respectively with row length of 3 metres.
4. There is need to explore evaluation of test entries at least in few locations under adverse soil conditions like phosphorous deficient soils etc.
5. The laboratory facility at ICAR-IIMR needs to be strengthened as a nodal centre for biochemical analysis of provitamin A, lysine, tryptophan, sucrose estimation, Fe and Zn estimation etc. to cater the needs of the AICRP maize centres located across the country.

Crop Production

Dr. A.K. Singh, PI (Agronomy) presented the achievements of maize agronomy of *rabi* 2014-15 and *Kharif* 2015. In the presentation, Dr. Singh critically discussed the findings of different zones and also explained the reasons for season-wise variation in the results. He

covered various aspects of maize agronomy viz., evaluation of pre-release genotypes under varying planting density and nutrient management, production technologies for baby corn, sweet corn, quality protein maize, weed, water management in maize etc. Chairman and Co-chairman appreciated the findings of various agronomic interventions. Chairman suggested that in planting density trials, the density may be examined particularly for rainfed conditions. Chairman also agreed and appreciated the new initiatives for the future agronomic research.

Entomology

Dr. J. C. Sekhar presented the results of *kharif* 2015, *rabi* 2014-15 and *spring* 2016. The results of maize genotypes resistant and susceptible to *Chilo partellus*, *Sesamia inferens* and *Atherigona* sp in different co-ordinated trials at different locations were summarized. During Kharif 2015, 71, 41, 39 and 42 entries of different maturity period, speciality corn, QPM and inbreds were evaluated for resistance against *C. partellus* under artificial infestation. Two inbred lines (WNZEXOTICPOOLDC2 , WNZPBTL6) out of thirteen were found to be resistant to *S. inferens* screened during rabi 2014-15. Sixty eight inbred lines were evaluated against shootfly during spring 2015. Incidence of biocontrol agents on *C. partellus* in different zones was presented. No egg parasitization was observed at Karnal, Kolhapur, Ludhiana and Udaipur, while 12.5 percent parasitization by *Trichogramma* was recorded at Delhi. Experiment on monitoring of *H. armigera* by pheromone traps across the locations was also presented. In addition, evaluation of different insecticides in controlling *C. partellus* along with LIR VS grain yield was presented. Chlorantraniliprole 20SC and Flubendiamide 480SC were found to be most effective against *C. partellus* based on leaf injury rating. Chairman appreciated the work done by Entomology team.

Pathology

Dr. K. S. Hooda (P. I. Pathology) presented the overall results of experiments conducted during *Rabi* 2014-15 and *Kharif* 2015 on disease screening of IVT, AVT, specialty corn hybrids of four maturity groups and maize hybrids against cyst nematode (*Heterodera zeae*) and Screening of inbred lines against major diseases of maize. A total of 109 hybrids out of 237 tested in IVT (all maturity groups) trials were resistant to 2 or more diseases. A total of 39 hybrids out of 71 tested in AVT I and AVT II (all maturity groups) trials were resistant to 2 or more diseases. Twenty-three hybrids out of 388 tested were moderately resistant to cyst nematode (*Heterodera zeae*). A total of 41 specialty corn hybrids out of 80 tested were resistant to 2 or more diseases. Experiments on assessment of avoidable yield losses due to major diseases of maize, trap nursery trial for disease incidence, survey and surveillance of maize diseases and efficacy of fungicides and botanicals/bioagents in control of maydis leaf blight, BLSB, downy mildew common rust and PFSR were also presented. Chairman, expressed his satisfaction on presentation and work done by pathology team.

Session V
ICAR-CIMMYT/ International Collaborative Research

Chairman	Co-chairman	Speakers	Rapporteurs
Dr.I.S.Solanki, ADG (FFC), ICAR	Dr. Jasbir Singh Chawla, PAU	Dr. B.S. Vivek, CIMMYT, Dr. M.L. Jat, CIMMYT, Dr. Pranjal Yadava, ICAR-IIMR	Drs. Dharam Paul, C.M. Parihar, Chikkappa G.K

Dr B.S. Vivek presented the ICAR-CIMMYT Collaborative Crop Improvement Research findings. Dr. BS Vivek presented the results of trials conducted during *Rabi* 2014-15 and *Kharif* 2015 under ICAR-CIMMYT collaboration with respect to breeding trials, disease phenotyping trials and breeding nurseries. A clarification was provided that the line should have methionine level of at least 0.4 ppm to consider high methionine line based

on the endosperm. Dr.M.L.Jat, Senior cropping system agronomist, CIMMYT presented the ICAR-CIMMYT Collaborative Agronomic Research *viz*; sustainable intensification of maize systems, monitoring environmental footprints of CA based maize systems, precision water management in CA based maize systems, layering 4 R nutrient stewardship on CA based maize systems, sensor technologies, small farm mechanization trials findings.

Dr. Pranjal Yadava, Scientist (Ag Biotechnology), presented the highlights of the molecular biology and biotechnology research programme of ICAR-IIMR, which has been undertaken under collaborative mode with several institutes, like ICGEB, VPKAS, NRCPB, PAU, TNAU, IARI etc. The programme has three themes, viz (1) Gene mapping, markers and marker assisted selection; (2) Unravelling fundamental mechanisms in maize biology; and (3) Engineering novel germplasm through New Breeding Techniques (NBTs). Presently, IIMR has initiated research on MAS based conversion of elite hybrids for the traits of high lysine/ tryptophan, pro-vitamin A, low phytic acid, and sorghum downy mildew resistance. Genetic mapping using five RIL populations has been undertaken for drought tolerance, heat tolerance and maydis leaf blight resistance. A new programme on DNA fingerprinting for varietal identification is also proposed. Fundamental research for understanding the process of growth regulator mediated adaptation to abiotic stresses has been undertaken, which led to cloning of new maize genes of cellular antioxidant pathway. Deep sequencing of small RNAs in response to nitrogen, and phosphorus stress was undertaken. The house was also informed about the new initiative of CRISPR/Cas9 mediated gene editing for herbicide tolerance trait development.

Session VI
Breeder Seed Production, FLDs and Training Programmes

Chairman	Speakers	Rapporteurs
Director (Seed), UAS, Banglore	Dr. J. Kaul (Seed) Dr. Ashok Kumar (FLDs)	Dr. Chikkappa G.K. Dr. S.B. Singh

Dr. Jyoti Kaul presented a report on BSP1 i.e. indent allocation, BSP2 i.e. compliance report/planting details, BSP3 i.e. monitoring report, BSP4, i.e. *Kharif* 2015 production report and BSP 5 i.e. lifting report. Dr. Ashok Kumar presented outreach programme especially through FLDs, TSPs and Trainings.

The several issues were raised while presenting the reports, the issues were carefully considered and the decisions taken were as follows.

1. Even negligible quantity of seed, once indented needs to be complied along with proper coordination regarding reporting of quantity of breeder seed available against indented lines with the corresponding lifting agencies.
2. The genetic purity of the breeder seed need to maintained with high standard to avoid rejection as well as associated problems in seed multiplication by organizing trainings on maintenance of genetic purity (maintenance breeding). The trainings needs to be organized in such a way that flowering stage should coincides, to impart training in purely a practical way in fields itself.
3. Breeder seed tags should be bar-coded to maintain the identity and proper monitoring.
4. Proper mechanism may be developed for tracking the impact of trainings organized for tribal farmers, FLDs conducted while demonstrating the worth of new hybrids.

PROCEEDINGS OF VIC MEETING HELD DURING 59TH ANNUAL MAIZE WORKSHOP

During the 59th Annual maize workshop held at University of Agricultural Sciences, Bangaluru, the variety identification committee (VIC) meeting was convened under the chairmanship of Dr. J.S. Sandhu, Deputy Director General (Crop Sciences), ICAR, New Delhi in the committee room, UAS, Bangaluru at 6:30PM on April 10, 2016.

Following were present during the meeting:

1. Dr. J S Sandhu , Deputy Director General (CS): Chairman
2. Dr. J S Chauhan, Assistant Director General (Seeds) : Member
3. Dr. S. Rajendra Prasad, Director IISR: Member
4. Dr. T. Seshadari, Director of Research, UAS Bangaluru: Member
5. Dr. S. Murali Krishna, Senior maize breeder, Eldorodo Agri. Tech. Pvt. Ltd., Hyderabad: Member
6. Mr. Mahesh Kuthate, maize breeder, Maharashtra state seed corporation, MS: Member
7. Dr. VS Sangam,DGM & Head, R&D, KSSC, Bangaluru: Member
8. Dr. MC Wali, I/c AICRP Dharwad, UAS : Member
9. Dr. Puttaramanaik, I/c AICRP , Mandya, UAS : Member
10. Dr. V. Mahajan : Member-Secretary

Resource persons:

1. Dr.KS Hooda , PI Pathology , IIMR
2. Dr. JC Sekhar, Principal Scientist (Entomology) , IIMR
3. Dr.AK Singh, PI Agronomy, IIMR
4. Dr.Jyoti Kaul, Principal Scientist(Breeding), IIMR

A total of 30 proposals comprising 10 for Kharif, nine for Rabi, six for Quality protein maize, three for sweet corn, one each for pop corn and baby corn were received from various institutions. The performance of proposed hybrids/OPVs was reviewed vis a vis' best check/s and qualifying hybrids keeping in view their suitability of cultivation in different agro-ecological zones of the country. Based on the deliberations, following recommendations emerged:

Kharif season

Late maturity

1. **X35 D601**: The hybrid X35D601 was proposed for zones NWPZ (Z-2), PZ (Z-4) and CWZ (Z-5) under late maturity group. Based on its yield performance and reaction to diseases it was recommended for **PZ (Z-4)** comprising the states of Andhra Pradesh, Telangana State, Maharashtra, Karnataka and Tamil Nadu.

2. **HTMH5108:** The hybrid HTMH5108 was proposed for CWZ (Z-5) under late maturity group. Based on its high yield, reaction to diseases and agronomic performance, it was recommended for **PZ (Z-4)** comprising the states of Andhra Pradesh, Telangana State, Maharashtra, Karnataka and Tamil Nadu.

3. **HTMH5202:** The hybrid HTMH5202 was proposed for CWZ (Z-5) under late maturity group. The committee found the proposed hybrid low yielding, hence not recommended.

4. **DKC9133:** The hybrid DKC9133 was proposed for CWZ (Z-5) under late maturity group. On the basis of its yield superiority, reaction to diseases and agronomic performance, it was recommended for **CWZ (Z-5)** comprising the states of Rajasthan, Gujarat, Chhattisgarh and Madhya Pradesh.

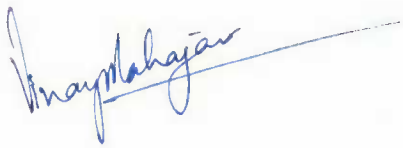
5. **IM8556:** The hybrid IM8556 was proposed for CWZ (Z-5) under late maturity. The committee found it low yielding hence not recommended.

6. **DKC9141:** The hybrid DKC9141 was proposed for CWZ (Z-5) under late maturity. However, the committee found it to be low yielding in comparison with qualifying entries, hence it was not recommended.

Medium maturity

7. **HTMH5402**: The hybrid HTMH5402 was proposed under medium maturity for PZ(Z-4).On the basis of its high yield, reaction to diseases and superior agronomic performance it was recommended for **PZ(Z-4)** comprising the states of Andhra Pradesh, Telangana State, Maharashtra, Karnataka and Tamil Nadu.

8. **DKC9144**: The hybrid DKC9144 was proposed under medium maturity for PZ(Z-4).On the basis of its high yield, reaction to diseases and agronomic performance it was recommended for **PZ(Z-4)** comprising the states of Andhra Pradesh, Telangana State, Maharashtra, Karnataka and Tamil Nadu.



Early maturity

9. **FH3605 (re-testing):** The hybrid FH3605 after re-testing in Kharif 2015 was proposed for NHZ (Z-1) and PZ (Z-4) under early maturity group. Based on its superior performance in these zones, it was identified for Jammu and Kashmir, Himachal Pradesh, Uttarakhand, North east hills, Andhra Pradesh, Telangana State, Maharashtra, Karnataka and Tamil Nadu ie **NHZ (Z-1)** and **PZ (Z-4).**

10. **Bio9720**: The hybrid Bio9720was proposed for NHZ (Z-1) under early maturity. However, it was found to be low yielding, hence not recommended.

Rabi season

Late maturity

11. **PMH2277**: The hybrid PMH2277 was proposed for NWPZ (Z-2), NEPZ (Z-3), PZ (Z-4) and CWZ (Z-5) under late maturity group for Rabi season. However, the committee found it low yielding hence not recommended.

12. **X35C537**:The hybrid X35C537 was proposed for NWPZ(Z-2), NEPZ(Z-3), PZ(Z-4) and CWZ(Z-5).Based on its high yield, reaction to diseases and response to high input conditions, it was recommended for Punjab, Haryana, Delhi NCR, western Uttar Pradesh, eastern Uttar Pradesh, Bihar, Jharkhand, Odisha, West Bengal, Andhra Pradesh, Telangana State, Maharashtra, Karnataka and Tamil Nadu i.e. the states of **NWPZ(Z-2), NEPZ(Z-3)** and **PZ(Z-4).**

13. **P3533**: The hybrid P3533 was proposed for NWPZ (Z-2), NEPZ (Z-3), PZ (Z-4) and CWZ (Z-5) under late maturity group for Rabi season. Based on its high performance, it was recommended for **PZ (Z-4)** comprising the states of Andhra Pradesh, Telangana State, Maharashtra, Karnataka and Tamil Nadu.

14. **GK3150**: the hybrid GK3150 was proposed for NWPZ (Z-2), NEPZ (Z-3), PZ (Z-4) and CWZ (Z-5) under late maturity group for Rabi season. Based on its high yield , reaction to diseases and agronomic performance, it was recommended for **NWPZ (Z-2)** comprising the states of Punjab, Haryana, Delhi NCR, western Uttar Pradesh.

15. **BiscoX6573**: The hybrid Bisco X 6573 was proposed for NWPZ (Z-2), NEPZ (Z-3), PZ (Z-4) and CWZ (Z-5) under late maturity group for Rabi season. Based on its high yield, reaction to diseases and response to input conditions, it was recommended for **NWPZ (Z-2)** comprising the states of Punjab, Haryana, Delhi NCR, western Uttar Pradesh.

16. **KMH2589**: The hybrid KMH2589 was proposed for NWPZ (Z-2), NEPZ (Z-3), PZ (Z-4) and CWZ (Z-5) under late maturity group for Rabi season. Based on its high yield, reaction to diseases and response to high input conditions it was recommended for **NWPZ(Z-2)** and **PZ(Z-4)** comprising the states of Punjab, Haryana, Delhi NCR, western Uttar Pradesh, Andhra Pradesh, Telangana State, Maharashtra, Karnataka and Tamil Nadu.

17. **IL8212**: The hybrid IL8212 was proposed for NWPZ (Z-2), NEPZ (Z-3), PZ (Z-4) and CWZ (Z-5) under late maturity group for Rabi season. However, the committee found it inferior in performance, hence not recommended.

18. **IL8534**: The hybrid IL8534 was proposed for NWPZ (Z-2), NEPZ (Z-3), PZ (Z-4) and CWZ (Z-5) under late maturity group for Rabi season. On the basis of its superior performance in **PZ (Z-4)** it was recommended for the states of Andhra Pradesh, Telangana State, Maharashtra, Karnataka and Tamil Nadu.

19. **DKC9120**: The hybrid DKC9120 was proposed for NWPZ (Z-2), NEPZ (Z-3), PZ (Z-4) and CWZ (Z-5) under late maturity group for Rabi season. Based on its high performance it was recommended for **NEPZ(Z-3)** and **PZ(Z-4)** comprising the states of eastern Uttar Pradesh, Bihar, Jharkhand, Odisha, west Bengal, Andhra Pradesh, Telangana State, Maharashtra, Karnataka and Tamil Nadu.

<u>Quality protein maize</u>

20. **AQH4**: The EDV AQH4 was proposed for NWPZ (Z-2).The committee indicated that the quality data must be generated by growing the hybrid in isolation and grain from the isolation block must be tested for quality viz. tryptophan, lysine and protein at two laboratories (IIMR Ludhiana and VPKAS Almora).

21. **AQH9**: The EDV AQH9 was proposed for NEPZ (Z-3). The committee indicated that the quality data must be generated by growing the hybrid in isolation and grain from the isolation block must be tested for quality viz. tryptophan, lysine and protein at two laboratories (IIMR Ludhiana and VPKAS Almora).

22. **APQH9**: The EDV APQH9 was proposed for NHZ (Z-1) and PZ (Z-4).The committee indicated that the quality data on Provitamin A must be generated after long term storage for at least six months at ambient temperature.

23. **AQH8**: The EDV AQH8 was proposed for PZ(Z-4). The committee indicated that the quality data must be generated by growing the hybrid in isolation and grain from the

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isolation block must be tested for quality viz. tryptophan, lysine and protein at two laboratories (IIMR Ludhiana and VPKAS Almora).

24. **EQH63:** The hybrid EQH63 was proposed for CWZ (Z-5).However, the committee felt that the third year data on yield and other parameters need to be generated.

25. **EQH64:** The hybrid EQH63 was proposed for CWZ (Z-5).However, the committee felt that the third year data on yield and other parameters need to be generated.

Sweet corn

26. **Advsw2:** The hybrid Advsw2 was proposed for all the zones, viz NHZ(Z-1), NWPZ(Z-2), NEPZ(Z-3), PZ(Z-4) and CWZ(Z-5).Based on its high green ear yield, and TSS it was recommended for the states of Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Punjab, Haryana, Delhi NCR, western Uttar Pradesh, Bihar, Odisha, Jharkhand, west Bengal, Tamil Nadu, Andhra Pradesh, Telangana state, Maharashtra and Karnataka ie **NHZ(Z-1), NWPZ(Z-2), NEPZ(Z-3)** and **PZ(Z-4).**

27. **Advsw1:** The hybrid Advsw1 was proposed for all the zones, viz NHZ(Z-1), NWPZ(Z-2), NEPZ(Z-3), PZ(Z-4) and CWZ(Z-5).Based on its high green ear yield, and TSS it was recommended for the states of Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Punjab, Haryana, Delhi NCR, western Uttar Pradesh, Bihar, Odisha, Jharkhand, west Bengal, Tamil Nadu, Andhra Pradesh, Telangana state, Maharashtra and Karnataka ie **NHZ(Z-1), NWPZ(Z-2), NEPZ(Z-3)** and **PZ(Z-4).**

28. **FSCH41:** The hybrid FSCH41 was proposed for all the zones, viz NHZ (Z-1), NWPZ (Z-2), NEPZ (Z-3), PZ(Z-4) and CWZ(Z-5).However, it was found inferior in green ear yield and TSS in comparison with the qualifying entries, hence not recommended.

Pop corn

29. **KDPC2**: The OPV KDPC-2 –a pop corn variety was proposed for all the zones viz NHZ (Z-1), NWPZ (Z-2), NEPZ (Z-3), PZ(Z-4) and CWZ(Z-5).based on its yield and quality parameters it was recommended for the states of Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Punjab, Haryana, Delhi NCR, western Uttar Pradesh, Bihar, Odisha, Jharkhand, west Bengal, Rajasthan Gujarat, Madhya Pradesh and Chhattisgarh **ie NHZ(Z-1), NWPZ(Z-2), NEPZ(Z-3)** and **CWZ(Z-5).**

Baby corn

30. **Vivek Hybrid -27 (re-testing)**: The hybrid Vivek 27 was proposed as baby corn hybrid for all zones viz NHZ (Z-1), NWPZ (Z-2), NEPZ (Z-3), PZ(Z-4) and CWZ(Z-5)

Vinay Mahajan

after re-testing in Kharif 2015. Based on its baby corn quality traits it was recommended for the states of Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Punjab, Haryana, Delhi NCR, western Uttar Pradesh, Tamil Nadu, Andhra Pradesh, Telangana state, Maharashtra, Karnataka, Rajasthan Gujarat, Madhya Pradesh and Chhattisgarh ie **NHZ(Z-1), NWPZ(Z-2), PZ(Z-4)** and **CWZ(Z-5).**

The meeting ended with the vote of thanks to the chair.

V. Mahajan	J.S. Chauhan	J S Sandhu
(Member-secretary VIC)	ADG (Seeds)	DDG (CS) & Chairman

Evaluation of quality traits in maize

- It was decided that a separate replicated trial for grain quality traits would be constituted under the AICRP-Maize. This particular trial would be evaluated only for quality at three locations *viz.,* (i) ICAR-IIMR, Ludhiana, (ii) ICAR-IARI, New Delhi and (iii) ICAR-VPKAS, Almora.
- Samplings would be done as follows:

QPM:

a) In each plot, chain crossing/ bulk sibbing (avoiding any selfing) would be done.
b) Each of the pollinated-cob will be harvested separately, and sent to ICAR-IIMR, Ludhiana.
c) No open-pollinated cobs should be retained.
d) The pollinated-cob should reach ICAR-IIMR, Ludhiana latest by 10th November.
e) Random samples from each of the cobs/entry would be taken, and a bulk sample/entry will be created.
f) This bulk sample/entry will be divided into three parts, and each one of them will be sent to three laboratories *viz.,* (i) ICAR-IIMR, Ludhiana/ New Delhi, (ii) ICAR-IARI, New Delhi and (iii) ICAR-VPKAS, Almora.
g) These three labs would analyze tryptophan and protein, and will submit the quality data to ICAR-IIMR, New Delhi for comparison.

Provitamin A:

a) In each plot, chain crossing/ bulk sibbing (avoiding any selfing) would be done.
b) Each of the pollinated-cobs/entry will be individually harvested with husk.
c) Each of the pollinated-cobs will be dried with husk under shade.
d) The husks will be removed under shade and each of the pollinated-cobs will be send to ICAR-IIMR, Ludhiana.
e) No open-pollinated cobs should be retained.
f) The pollinated-cob should reach ICAR-IIMR, Ludhiana latest by 10th November.
g) Random samples from each of the cobs/entry would be taken, and a bulk sample/entry will be created.
h) This bulk sample/entry will be divided into three parts, and each one of them will be sent to three laboratories *viz.,* (i) ICAR-IIMR, Ludhiana, (ii) ICAR-IARI, New Delhi and (iii) ICAR-VPKAS, Almora.
i) The seeds will be stored under three different conditions viz. (i) ambient temperature (25°C), (ii) vacuum packaged and stored under ambient temperature (25°C), and (iii) -20°C freezer.

j) These three labs would analyze β-carotene at (i) immediately after receiving the samples, (ii) 30 days, (ii) 60 days, (iii) 90 days, (iv) 120 days and (v) 150 days after harvest.
k) The β-carotene data will be submitted to ICAR-IIMR, New Delhi for comparison.

This is with the approval of DDG (CS)

Session VIII

Review of research results of individual AICRP centres for Kharif 2015 and Rabi 2014-15 and formulation of plan of work for Kharif 2016 and Rabi 2016-17 (Concurrent centre-wise presentations of significant results and progress report)

CROP IMPROVEMENT

Chairman	Co-chairman	Rapporteurs
Dr. Shailaja Hittalamani, Head, Genetics and Plant Breeding, GKVK, UAS, Bengaluru	Dr. Vinay Mahajan, Director, ICAR-IIMR, New Delhi	Dr. J. Kaul Dr. Bhupender Kumar Dr. Chikkappa G.K. Dr. Pranjal Yadava

The progress report of *Rabi* 2014-15 and *Kharif* 2015, were presented by In-charge or concerned persons of AICRP on maize centres. The review of the progress report was discussed on aspects like, AICRP coordinated trials conducted, rejected trials (if any), germplasm lines procured along with details of sources, details of utilization of germplasm, progress made with respect to hybrid development *viz.,* number of experimental hybrids evaluated and contributed for coordinated trials, number of hybrids promoted from NIVT to AVT1 to AVT2, and released, notified, protected hybrids along with outreach and new initiatives with problems being faced.
The findings were presented by the breeders from the centres

The following points were emerged after the discussing the progress report presented by the AICRP centres.

1. It is recommended to enhance the efforts towards systematization of breeding efforts with respect to heterotic grouping based on combining ability, recycling and diversifying of existing elite inbred lines through introgression of novel germplasm without disturbing the heterotic group, to further increase the potential yield levels of new hybrids developed and also increase the efficiency of hybrid breeding by all the AICRP centres for systematization of breeding programme.
2. If any centre has collected landraces of maize, one set of such samples should be deposited with NBPGR for future use.
3. The Bajaura centre has initiated use of DH technique in maize breeding. Others centres should also initiate use of DH technique regularly in their breeding programme.
4. The rejection of trials in Barapani, Kanpur, and Kolhapur centres was viewed seriously and given instructions to take care that the same is not repeated in future. All efforts to be taken to ensure success of the trial.
5. The breeding programmes needs to be initiated in centres, like, Kalyani, Gossaingaon, Imphal, Bahraich, Rahuri, Jabua and Sabour.
6. Cold storage facility at centres needs to be established for proper storage of precious seeds of germplasm.
7. The training should be organize at ICAR-IIMR for voluntary centres to expertise them on AICRP trial conductance, data recording and analysis.

CROP PRODUCTION

Chairman	Co-chairman	Convener	Rapporteur
Dr. T. Sheshadri, Director of Research, UAS, GKVK	Dr. A.P. Vishwanath, Prof. & Head, AICRP on Integrated Farming System, UAS, GKVK	Dr. A.K. Singh PI (Agronomy)	Dr. Ashok Kumar & Dr. S.L. Jat

At the outset Chairman welcomed the members present in the review meeting. The session was attended by 34 scientists of different AICRP centres. The following centres presented their project of Kharif-2015 and Rabi 2014-15 under different zones

NHZ	-	Kashmir, Bajaura and Almora
NWPZ	-	Delhi, Ludhiana, Karnal, Pantnagar
NEPZ	-	Ranchi, Odisha, Dholi, Kalyani, Bhubaneshwar, Gossaigaon, Chitrakoot
PZ	-	Hyderabad, Coimbatore, Vagarai, Dharwad, Karimnagar
NWPZ	-	Udaipur, Godhra, Banswara, Chindwara

The following points were emerged during the presentation.

- Higher productivity levels of Bajaura centre due to agronomic intervention were appreciated and Co-Chairman suggested transferring these technologies at farmers levels (Action: Bajaura centre).
- PI pointed out in plant density trials, appropriate plant population as per the treatments should be maintained (Vagarai and Dharwad Centre)
- The plan of experiments for *Kharif* 2016 and Rabi 2016-17 was discussed and finalized and 11 experiments will be part of the programme (Action: PI and all centres).
- The experiment on tillage management in different cropping system should be continued on term basis and soil samples should be sent to IIMR from 0-5, 5-15 and 15-30cms depths (Action: Concerned centres).
- The nutrient doses in nutrient management trials should be worked out each year in SSNM and STCR treatments (Action: PI and all centres).
- The results of trials completed three years should be published (Action: PI and all centres).
- Based on the discussions of the previous year's results two recommendations emerged as follows:
  - Application of RDF or SSNM based fertilization results in yield enhancement of maize by 800 or 1400 kg/ha with increase of net returns by 9300 or 12800 Rs/ha over FFP, respectively. Hence, these practices recommended over FFP in maize.
  - Zero tillage is recommended as alternative crop establishment techniques in sandy, sandy loam and clay loam soils of NWPZ, NEPZ and CWZ in Maize-wheat-mungbean sequence expect high rainfall clay loam areas of NWPZ.
  - Scientists from 34 centers attended this session

PLANT PATHOLOGY & NEMATOLOGY

Chair	Co-Chair	Convener	Rapporteurs
Dr. B.M.R. Reddy University Head, Dept. of Plant Pathology, UAS Bengaluru	Dr. K.T. Rangaswamy Professor and Head, UAS Bangaluru	Dr. K.S. Hooda, Pr. Scientist, IIMR, New Delhi	Drs. Meena Shekhar, S.S. Sharma, Harleen Kaur, P. Renukadevi

The group meeting, comprising of maize pathologists from various parts of the country was held at 9.30 AM at COA, UAS, Bangaluru to review the results of different trials conducted during *kharif 2015*/*rabi* 2014-15, as well as the formulation of technical programme for *kharif 2016*/*rabi* 2016-17. Dr. Hooda, convener, requested the chairman to take up following agenda items, and was attended by scientists from 10 centers and presented their achievements.

i. Review of research results of AICRP centres for *Kharif* 2015 and *Rabi* 2014-15
ii. Actions taken on recommendations of last Workshop 2015
iii. Formulation of Technical Program for *Kharif* 2016 & *Rabi* 2016-17
iv. Revision of rating scale from 1-5 to 1-9 for foliar diseases of maize
v. Disease data of trials under natural condition
vi. Average score vs highest score for disease reaction
vii. Food biosafety issues in maize
viii. Contribution of lines to breeding nurseries
ix. Any other issue with permission of Chair

A total of 23 trials (17 in *Kharif* 2015 and 6 in *Rabi* 2014-15) of Maize Pathology were conducted under sick plot / artificially created epiphytotics at identified hot spot locations namely Bajaura, Almora, Dhaulakuan, Barapani (AVTs only) in Zone I; Ludhiana (*Rabi & Kharif*), Delhi, Karnal, Pantnagar in Zone II; Dholi (*Rabi & Kharif*), Medinapur (*Kharif*) in Zone III; Dharwad (*Rabi & Kharif*), Coimbatore (*Rabi & Kharif*), Mandya (*Rabi & Kharif*), Hyderabad (*Rabi & Kharif*) in Zone IV and Udaipur in Zone V.

A total of 528 hybrids in both seasons and 443 inbred lines (*Kharif* only) were screened against Maydis leaf blight (MLB), Turcicum leaf blight (TLB), Banded leaf and sheath blight (BLSB), Sorghum downy mildew (SDM), Rajasthan downy mildew (RDM), Curvularia leaf spot (CLS), Post-flowering stalk rots (PFSR), Common rust, Polysora rust, Bacterial stalk rot (BSR) and Cyst nematode. Yield loss trials were conducted at Dharwad, Udaipur and Ludhiana centres. Trap nursery trial for disease occurrence was conducted at Almora, Bajaura, Coimbatore, Delhi, Dharwad, Dhaulakuan, Dholi, Hyderabad, Karnal, Ludhiana, Mandya, Pantnagar and Udaipur centres. In addition, disease surveys were conducted at farmers' fields in Himachal Pradesh and Uttarakhand (Zone I), Punjab (Zone II), Karnataka (Zone IV), Rajasthan and Gujarat (Zone V) to assess overall disease scenario during the crop season. Study on management of nematode and its interaction with PFSR and termite in maize was taken up by Udaipur centre. Disease management trials for development of integrated disease management (IDM) strategy in maize were conducted at Bajaura, Ludhiana, Karnal, Delhi, Pantnagar, Godhra, Dharwad, and Udaipur centres.

Fourteen centres presented the results of the trials conducted at their respective locations whereas 4 centres *viz.*; Almora, Barapani, Dhaulakuan, and Medinapur centres remain unrepresented. No new disease was recorded in trap nursery from any location, however, maydis leaf blight and curvularia leaf spot recorded an increasing trend at Mandya centre. The chairman appreciated the achievements made by scientists of representative centres. The chairman expressed that sick plot should be developed for all soil borne diseases. Emphasis should be given in capacity building programme by guiding the freshers at Headquarter and nearby center.

Based on the critical review, the following observations emerged out from the group meeting.

1. **Technical observations**
2. A total of 109 hybrids out of 237 tested in NIVT (all maturity groups) trials were resistant to 2 or more diseases.
3. A total of 39 hybrids out of 71 tested in AVT I and AVT II (all maturity groups) trials were resistant to 2 or more diseases.
4. A total of 41 specialty corn hybrids out of 80 tested were resistant to 2 or more diseases.

5. Out of 140 hybrids tested in *Rabi* 2014-15, 39 were resistant to TLB and one (DMRH 1421) to charcoal rot.
6. Seventy six entries in *Kharif* (24.1%) and 51 entries in *Rabi* (49.5%) were promoted based upon approved yield and disease reaction criteria.
7. Twenty three hybrids out of 388 tested were moderately resistant to cyst nematode (*Heterodera zeae*).
8. A total of 101 inbred lines were identified with multiple disease resistance (MDR) which can be utilized as potential donors in the development of resistant hybrids.
9. Salicylic acid @ 50mg/litre as seed priming and spray @150-200 mg/litre water was effective in inducing the systemic acquired resistance (SAR) in maize against maydis leaf blight, charcoal rot, RDM and turcicum leaf blight.
10. Total phenolic compound, total soluble sugar and total flavonoides were significantly higher in 24 PFSR resistant inbreds at knee high, flowering and grain filling stage when challenged with *Fusarium verticilloides* and *Macrophomonia phaseolina* pathogens. Antifungal activity in bio-extract of challenged maize plant was also observed under *in vitro* condition.
11. *Trichoderma harzianum* (Local)-fortified FYM (1:50) @ 6t/ha; *T. harzianum* (Delhi isolate)-fortified FYM (1:50) @ 6t/ha and Propiconazole @ 0.1% were effective for control of charcoal rot.
12. *Pseudomonas fluorescens @ 0.5%* as seed treatment + bioagent-fortified FYM (1:50) and spray@ 0.5%, *Trichoderma viride* @ 0.5% as seed treatment + bioagent-fortified FYM (1:50) and spray @ 0.5%, Propiconazole @ 0.1% spray at 40 DAS, MOP @ 1 & 2% at 30 & 45 DAS respectively were effective for control of fusarium stalk rot.
13. *Pseudomonas fluorescens as* seed treatment (4g/kg), FYM (100kg/ha) as soil application+ *T. harzianum* (2.5g/kg), Difenoconazole @ 0.1%, Validamycin @ 0.1%, Tebuconazole @ 0.05%, Trifloxystrobin 25% + Tebuconazole 50% @ 0.05% were effective for management of banded leaf and sheath blight.
14. *R. serpentina* leaves (Sarpgandaha) @ 10%, *Trichoderma harzianum (TH-3)* @ 0.5% as seed treatment + bioagent fortified FYM (1:50) and spray @ 0.5%, *Trichoderma viride* (*TV-3*) *@* 0.5% as seed treatment + bioagent fortified FYM (1:50) and spray @ 0.5%, Propiconazole @ 0.1%, Hexaconazole @ 0.1%, Carbendazim @ 0.1%, Mancozeb @ 0.2%, Carbendazim 12 WP + Mancozeb 63 WP @ 0.25% were effective in management of maydis leaf blight.
15. Integrated management of cyst nematode was developed by Udaipur centre:
    - Application of neem / karanj seed kernel at 10% w/w as seed treatment along with soil amendment with neem / karanj cake at 2 q/ha.
    - Intercropping of maize with sesame, soybean or cluster bean (2:2 rows at 30 cm apart).
    - Seed treatment with acephate 75 SP at 2% / methomyl at 1% w/w.
    - Application of lantana leaf powder at 2 q/ha at the time of sowing.
    - Carbofuran 3G / phorate 10 G at 1-2 kg/ha as soil application.
    - *T. viride* 10 g/kg seed along-with soil application of castor cake at 2 q/ha at the time of sowing.
    - Pochonia chlamydosporia @ 2 % w/w as ST + Lantana camara leaves @ 1 q / ha as soil application
    - *Paecilomyces lilacinus* @ 2 % w/w + Lantana leaves at 1 q/ha
    - *Pochonia chlamydosporia* @ 2 % w/w + Aak (*Calotropis procera*) at 1 q/ ha.

1. Data of yield loss assessment trial of MLB and PFSR should be compiled and sent to Dr Robin Gogoi and Dr. Meena Shekhar for publication.

(Action: Ludhiana centre)

2. Centres should put more efforts to increase disease pressure and present data along with disease data of resistant and susceptible checks for comparison.

(Action: All centres)

3. There is urgent need to fill up the post of pathologist at Hyderabad centre.

(Action: PI, Pathology)

4. Survey, surveillance data were not reported by Hyderabad, Dholi, Mandya, Pantnagar centres. Hence, survey, surveillance data and weekly disease status at and around the centres should be presented by each and every centre.

(Action: All centres)

5. Dhaulakuan centre is not doing up to the mark for last three years and data reporting is also not satisfactory and there is a need to follow up this matter.

(Action: PI, Pathology)

6. No fixed area has been allocated for development of sick plot at Pantnagar, Dhaulakuan and Delhi

(Action: PI, Pathology and respective centres)

7. Pantnagar centre is passing through financial problem in conducting trials and there is a need to sort out this financial issue

(Action: PI, Pathology)

8. Revision of guidelines for uniform method of scoring the disease intensity under artificially created epiphytotics and data of NIVT hybrids (*Kharif* 2016 onwards) should be recorded on 1-9 scale uniformly.

(Action: PI & All centres)

9. Susceptible hybrids should be used for conducting yield loss assessment and all disease management trials.

(Action: All centres)

10. There is a need to address food biosafety issues in maize and quantify the mycotoxins in maize growing agro-climatic zones of India.

(Action: IIMR and All centres)

11. Weather data of 1980 onwards should be sent to PI (Pathology) for use in developing weather based disease forewarning models

(**Action: All centres**)

12. Group has decided to record disease data under epiphytotic condtion only and there is no need of recording data under natural condition.
13. Average score instead of highest score (along with range of disease) will be considered for disease reaction.
14. Centres can contribute trait specific lines to breeding nurseries for their evaluation.
15. General disease management tactics to be followed in maize growing areas:
    i. Rotate crops (minimum 3 years with non-host crops for management of BLSB, BSR, PFSR, downy mildews).
    ii. Observe recommended planting dates and plant population.
    iii. Plant resistant/ tolerant hybrids/ composites.
    iv. Strip the basal leaves if infected with BLSB.
    v. Ensure proper drainage for managing bacterial stalk rot and avoid moisture stress at flowering stage for managing PFSR.
    vi. Fertilize crop as per recommendation (higher potash in PFSR infested areas).
    vii. Rogue and destroy infected plants on appearance (downy mildews).
    viii. Control insect pests and cyst nematode with proven technology.
    ix. Use other need based promising IDM practices (Forecasting, Biocontrol, Regulatory, Resistance inducers, Chemical pesticides) for disease management in maize.
    x. Manage the crop residue (plough down or recycling after proper composting).
    xi. Store corn properly (Seed moisture <14%).
    xii. Treat seed before sowing.

The group also discussed and formulated the Technical Programme for *kharif 2016*/*rabi* 2016-17. In all, the group approved 36 trials (27 in *kharif*, 9 in *rabi* season).

B. Trials to be continued during 2016-17:

MPT 1-8. Disease screening of NIVT (4 trials) and AVT (4 trials) of all maturity groups under artificially created epiphyotics (All centres)

MPT 9-12 Disease screening of specialty corn (4 trials) under artificially created epiphyotics (All centres)

MPT 13. Screening of maize hybrids (all maturity groups) against cyst nematode (*Heterodera zeae)* (Udaipur)

MPT 14-17. Disease screening of maize inbred lines (Normal, QPM, association panel & mapping population) under artificially created epiphyotics (Normal, QPM- All centres; association panel & mapping population- 4 centres each for MLB & Ch. rot).

MPT 18. Assessment of avoidable yield losses due to major diseases of maize [Udaipur (RDM), Dharwad (Ch. Rot-Rabi; TLB-Kharif), Dhaulakuan (MLB), Mandya (SDM and TLB), Bajaura (TLB)]

MPT 19. Trap nursery trial for disease incidence (All centres)

MPT 20. Disease (including cyst nematode) survey and surveillance in different maize growing areas (All centres)

MPT 21. Efficacy of newer fungicides on incidence of banded leaf and sheath blight (selected centres)

MPT 22. Efficacy of newer fungicides on incidence of common rust under field condition (selected centres)

MPT 23. Efficacy of bioagents, fungicide and potash in control of post-flowering stalk rots (PFSR) (selected centres)

MPT 24 Efficacy of bioagents and fungicides in control of downy mildews (SDM and RDM) (selected centres)

MPT 25. Efficacy of salicylic acid (SA) on incidence of maize diseases (selected centres)

C. New experiments

MPT 26. Effect of bioextracts/ natural products on the incidence of maize diseases (selected centres)

MPT 27. Efficacy of leaf stripping on severity of BLSB of maize (selected centres)

D. Rabi 2016-17

MPT 1-5. Disease screening of hybrids of *Rabi* maize (NIVT & AVTs) (selected centres)

MPT 6. Disease screening of maize inbred lines under artificially created epiphyotics (selected centres)

MPT 7. Assessment of avoidable yield losses due to Ch. Rot at Dharwad (selected centres)

MPT 8. Efficacy of newer fungicides in control of common rust (Karnal & Dholi centres)

MPT 9. Efficacy of salicylic acid on incidence of common rust (Karnal & Dholi centres)

E. ICAR-CIMMYT trials: Following ICAR-CIMMYT trials would be conducted at centres mentioned against each trial:

Trial name	Management	Material Description	Entries	Reps	Rows	Total Rows	Centre
TLBIT	Turcicum Leaf Blight	Advance generation CIMMYT –Asia lines for TLB resistance	100	2	1	200	UAS, Dharwad
TLBIT	Turcicum Leaf Blight	Advance generation CIMMYT –Asia lines for TLB resistance	100	2	1	200	SKUAST, Kashmir

BLSBIT	BLSB	Advance generation CIMMYT –Asia lines for BLSB resistance	100	2	1	200	GBPUA&T, Pantnagar
BLSBIT	BLSB	Advance generation CIMMYT –Asia lines for BLSB resistance	100	2	1	200	Karnal
FSRIT	Fusarium stalk rot	Advance generation CIMMYT –Asia lines for FSR resistance	100	2	1	200	MPAUT, Udaipur
Ch. rot	Macrophomina stalk rot	Advance generation CIMMYT –Asia lines for MSR resistance	100	2	1	200	UAS, Dharwad
Ch. rot	Macrophomina stalk rot	Advance generation CIMMYT –Asia lines for MSR resistance	100	2	1	200	PAU, Ludhiana

Group meeting ended with vote of thanks to the Chair, Co-chair and all scientists proposed by Dr. Meena Shekhar, Principal Scientist, IIMR.

ENTOMOLOGY

Chairman	Convener	Rapporteur
Dr. V.V.Belwadi Head, Dept of Entomology, UAS, Bengaluru	Dr. J. C. Sekhar, Principal Scientist, Entomology	Dr. Jawala Jindal Dr. P. Laxmi Soujanya

The Entomologists presented the work done at their respective Centers. The work was reviewed and discussed. The Chairman appreciated the uniformity of the experiments conducted at all the centers flawlessly. He emphasized need to initiate work on pheromones on *Chilo partellus* and the monitoring of *Helicoverpa armigera* throughout the all seasons at various locations. Chairman and members were of the opinion that in categorizing of genotypes resistant, moderately resistant and susceptible to be used uniformly. He emphasized need to evaluate selected genotypes under natural conditions and suggested to assess the *Trichogramma* prevalence in farmers fields. The convener briefed the overall results of the different centers. The plan of work for 2016-17 and recommendations were finalized.

Recommendations

1. Chlorantraniliprole 20 SC @ 0.4 ml per lit and Flubendiamide 480 SC @ 0.2 ml per lit were found effective in management of *Chilo partellus.*
2. WNZ Exotic Pool DC 2 (LIR 2.6) and WNZ PBTL 6 (LIR 3.0) were found resistant to pink stem borer based on three years data.
3. For classification of genotypes resistant to shoot fly susceptibility index should be used.

Plan of Work 2016-17

Kharif

ET 1: Evaluation of maize AICRP trials entries against *Chilo partellus* under artificial infestation for AVT I and II

ET 2 : Evaluation of inbred lines against *Chilo partellus* under artificial infestation (2nd year)- All locations

ET 3: Monitoring of *Helicoverpa armigera* by pheromone traps (Kharif, Rabi & Spring)

ET 4: Evaluation of insecticides against *C. partellus (3rd Year)* -6 locations

Insecticide	Dose
Chlorantaniliprole 20 SC	0.3 ml/lit
Chlorantaniliprole 20 SC	0.4 ml/lit
Flubendiamide480 SC	0.1 ml/lit
Flubendiamide480 SC	0.2 ml/lit
Novaluron 10 EC	0.75ml/lit
Novaluron 10 EC	1 ml/lit
Deltamethrin 2.8 EC	0.4 ml/lit
Deltamethrin 2.8 EC	0.8 ml/l
Untreated Control	

ET 5: Evaluation of bio-pesticides against *C. partellus (1st Year)*- All locations

Bio-pesticides	Dose
Bb-5a isolate of *Beauveria bassiana*	1 x 10^8 Spores per ml
Bb-23 isolate of *Beauveria*	1 x 10^8 Spores per ml
Bb-45 isolate of *Beauveria*	1 x 10^8 Spores per ml
Ma-35 isolate of *Metarhizium*	1 x 10^8 Spores per ml
Delfin WG	5 gm per lit.
Neem formulation	5 ml per lit.
State recommended chemical	
Untreated Control	

***Rabi* 2016-17**

ET 6: Evaluation of maize AICRP Trials entries against *Chilo partellus and S. inferens* under artificial infestation for AVT I and II (Kolhapur & Hyderabad)

ET 7:Evaluation of inbred lines against *C. partellus and S. inferens* under artificial infestation (Kolhapur, Karnal & Hyderabad)

ET 8 :Evaluation of insecticides against *S. inferens (Hyderabad)*

Insecticide	Dose
Chlorantaniliprole 20 SC	0.3 ml/lit
Chlorantaniliprole 20 SC	0.4 ml/lit
Flubendiamide480 SC	0.1 ml/lit

Flubendiamide480 SC	0.2 ml/lit
Novaluron 10 EC	0.75ml/lit
Novaluron 10 EC	1 ml/lit
Deltamethrin 2.8 EC	0.4 ml/lit
Deltamethrin 2.8 EC	0.8 ml/lit
State recommended chemical	
Untreated Control	

***Spring* 2017**

ET 09: Evaluation of inbred lines against Sorghum shoot fly under natural infestation (Delhi and Karnal) 2nd year

ET 10: Evaluation of inbred lines against Sorghum shoot fly under natural infestation (Delhi and Ludhiana) 3rd year

Seven scientists from different centres attended the group meeting.

Session IX
Germplasm exchange, registration & seed issues

Chairman	Speakers	Rapporteurs
Dr. S. Rajendra Prasad, Director, ICAR-Indian Institute of Seed Science, Mau-275103, Uttar Pradesh, India	Dr. J.C. Sekhar, DMR Dr. B. S. Vivek, CIMMYT Dr. J Kaul, DMR	Dr. J. Kaul Dr. Chikkappa G.K.

Dr. JC Sekhar presented germplasm supplied to AICRP on maize centres, number of maize germplasm regenerated and returned back to NBPGR, germplasm on which DUS information was generated by Winter Nursery Centre, ICAR-IIMR, Hyderabad. Dr. BS Vivek presented details of germplasm shared by CIMMYT with IIMR and other AICRP on maize centre along with trials conducted under ICAR-CIMMYT collaboration under different categories *viz.,* breeding trials comprising hybrids being evaluated under optimum and abiotic stress like drought and water-logging conditions, disease phenotyping trials for BLSB, DM, TLB, MSR, FSR and breeding nurseries of QPM, high-methionine, drought and agronomic performance. Dr. J Kaul, briefed about procedure need to be followed for varietal and germplasm registration. Based on the discussion following aspects were suggested or decision taken.

1. The process of germplasm and varietal registration process is very slow which needs to be accelerated to complete registration of all the varieties released and notified.
2. Complying with MTA while releasing material is must, therefore timely action may be initiated to meet the compliance requirements.
3. Initiate digitalization of passport data as well as use software for entry of DUS data while characterization of germplasm to accelerate data digitalization.
4. In order to meet-out the genetic purity while registration, proper care should be taken to avoid contamination.

Session X
Preparation of Zonal Trials

The zonal coordinators of the respective zone have met in group separately to coordinate, conduct zonal trials under rainfed condition and formulated the plan of work to be undertaken during kharif 2016 and Rabi 2016-17. **All zonal trials must be conducted in rainfed condition on conserved moisture and NO irrigation to be provided during the kharif crop season** The details of Zonal/Rainfed trials during Kharif 2016 are given below:

ZONAL TRIALS			
Zone	**Coordinator**	**Trial**	**Location**
NHZ	Dr S.K. Gulerial, Sr. Maize Breeder, Bajaura	NHZ: Early, Medium maturity	**Early**: Bajaura+Almora+Sirinagar, **Medium** Kangra+Bajaura+Udhampur
NWPZ	Dr Chawla, Sr. Maize Breeder, PAU, Ludhiana	NWPZ: Late, Medium, Early maturity	**Late**: Karnal, Ludhiana, IARI, New Delhi **Medium:** Pantnagar, Kanpur, **Early**: Pantnagar
NEPZ	Dr J P Shahi, Sr. Maize Breeder, BHU, Varanasi	NEPZ- Medium maturity	**Medium**: Varanasi, Dholi, Bhahraich, Bhubneshwar, Ranchi
PZ *	Dr Neelam/ Dr C. Karjaagi	PZ- Late and Medium	**Late and Medium:** Hyderabad, Karimnagar, Coimbatore, Mandya, and Kolhapur
CWZ	Dr R.B. Dubey, Sr. Maize Breeder, Udaipur	CWZ: Late, Medium, Early + Extra Early	**All Trials (Late, medium, early+extra early):** Udaipur, Banswara, Godhra, Ambikapur, Chindwara, Jhabua
RAINFED TRIALS			
CWZ, PZ	Dr Bhupender Kumar, Scientist, ICAR-IIMR, New Delhi	NIVT-RF: Late, Medium, Early maturity	**CWZ**: Banswara, Godhra, Bhiloda, Chindwara **PZ**: Kohlapur, Karimnagar, Vagarai, Dharwad

The in-charge of AICRP on maize centres from Hyderabad, Karimnagar, Coimbatore, Vagarai, Mandya, Dharawad, Kolhapur and Rahuri together discussed regarding constitution of zonal trials for Peninsular zone. It was decided zonal trial will be conducted in all the centres except Dharawad, Rahuri and Vagarai. **The last date for sending the entries for zonal trial has been fixed 10th May, 2016.** The concerned centres have to send 1 kg seed of each entry which are intended to contribute for zonal trial to **Dr. Sunil Neelam, Sr. Scientist, Winter Nursery Centre, ICAR-IIMR, Hyderabad and seed should reach before 10th May, 2016.**

Session XI
Presentations of work plan 2016-17

Chairman	Speakers	Rapporteurs
Dr. Vinay Mahajan, Director, ICAR-IIMR	Dr. Bhupender Kumar Dr. A.K. Singh Dr. J.C. Sekhar Dr. K.S. Hooda	Drs. Meena Shekhar, Ashok Kumar and Chikkappa G.K

BREEDING

The details of the work plan with respect to number of trials, locations, approximate number of test entries under different stage of testing viz., IVT, AVT-1, AVT-2, and types normal maize, QPM, sweet corn, popcorn, baby corn, Biofortification in different maturity group, revised list of check hybrids, quantity of check hybrid seed required, trial detail like number

of rows, length of row, quantity of seed required for different trial etc. are presented and finalized. The details regarding the same are as follows.

- Out of 315 entries available for promotion from *Kharif* 2015 to *Kharif* 2016, only 76 entries were got promoted in different maturity group.
- The details of AICRP trials during Kharif 2016 are given below:

Trials	**Zone**	**Entry Name**
NIVT		
Late	All zone except-NHZ	New entries are invited
Medium	Across zone	New entries are invited
Early+Extra early	Across zone	New entries are invited
AVT-I		
Late	NHZ	No trial
	NWPZ	PM15104L, SMH-3902, CP.802, BL 103, KMH-2852, PM15103L+ Check
	NEPZ	DKC9163, VNR-31565, CMH12-686, ADV 7022, DKC8161+ Check
	PZ	DAS-MH-111, CMH12-688, ADV 7022, DKC9167+ Check
	CWZ	DKC9164, SYN516753, CMH12-686+ Check
Medium	NHZ	HM15207, KMH 13-5+ Check
	NWPZ	HM15207, HM15206, VaMH 12014, BIO 274, RCRMH2+ Check
	NEPZ	JKMH 4103, JH 13347, BL 106, HM15206, VaMH 12014, IIMRNH 2015-4, BL 107+ Check
	PZ	BL 106, JH 13348+ Check
	CWZ	JH 13348, LMH 615, BL 106, JH 13347, RCRMH2+ Check
Early	NHZ	LMH 1115, DMRH1305, FH 3754, KMH 13-15, JH 31785+ Check
	NWPZ	No trial
	NEPZ	No trial
	PZ	AH7006, JKMH4222+ Check
	CWZ	JKMH 4222+ Check
AVT-II		
Late	NHZ	No trial
	NWPZ	No trial
	NEPZ	No trial
	PZ	HT51412616, ADV 0990296, DMH 192 + Check
	CWZ	ADV 0990296, KH-2192, DKC9151(IN8902) + Check
Medium	NHZ	No trial
	NWPZ	CP.201 + Check
	NEPZ	No trial
	PZ	JKMH 4848, JH 31605+ Check
	CWZ	No trial
Early	PZ	No trial
	CWZ	No trial
Extra Early	NWPZ	No trial
QPM	Across the zone	IIMRQPMH 1502, FQH 106, IIMRQPMH 1503, LQPMH 415, IIMRQPMH 1504, IIMRQPMH 1508, LQPMH 215, IIMRQPMH 1501+New entries +Checks

BC	Across the zone	IMHB 1537, IMHB 1538, GAYMH-1, DMRH 1305, IMHB 1529, IMHB 1539, BVM-2, MBC-11-15, IMHB 1531, IMH 1525, IMHB 1532, AH5021,+New
SC	Across the zone	ASKH1, ASKH4, FSCH 75, BSCH 6, FSCH 55+New
PC	Across the zone	SJPC1, DMRHP 1402, IMHP 1540, IMHP 1535, MPC-1-15+New

Recommendation for Trials: AICRP/RAINFED

National Initial varietal Trials (NIVT-I) (Across the zones): No. of rows – 2 (net) Row length – 4m (net) Spacing- 60cm x 20 cm in Irrigated Replications – 3 Fertilizer – As per the recommendations for zone	**Advance varietal Trials-II (AVT-II) or (AVT I+II) (Zone specific):** No. of rows – 6 (net) Row length – 4m (net) Spacing- 60cm x 20 cm in Irrigated Replications – 3 Fertilizer – As per the recommendations for zone
Advance varietal Trials-I (Zone specific): No. of rows – 4 (net) Row length – 4m (net) Spacing- 60cm x 20 cm in Irrigated Replications – 3 Fertilizer – As per the recommendations for zone	**Specialty corn (QPM/SC/PC/BC-I-II-III (Across the zone) :** No. of rows – 4 (net) Row length – 4m (net) Spacing- 60cm x 20 cm **in Irrigated,** **BC: 60cm x 15cm** Replications – 3 Fertilizer – As per the recommendations for zone *Self plants in two replication (@3 plants/replication) for recording quality parameter in QPM, SC and PC. Baby corn trials must be grown in isolation and de-tasseling should be attempt before anthesis.*
Rainfed Trials: No. of rows – 2 (net) Row length – 4m (net) Spacing- 70 cm x 25 cm Replications – 3 Fertilizer – As per the recommendations for zone **Sowing must be done on residual moisture with no irrigation during crop duration**	

Seed Requirement-kharif-2016:

S.N.	Trial	Year of testing	Seed quantity (Kg)
1	National Initial Varietal Trial (NIVT)	First	3.5Kg/Entry
2	Advance Varietal Trial-I (AVT-I)	Second	4.5Kg/Entry/Zone
3	Advance Varietal Trial-II(AVT-II)	Third	6.5 Kg/Entry/Zone
4	Baby corn	1st, 2nd, 3rd	8Kg/ Entry
5	QPM	1st, 2nd, 3rd	7Kg/Entry
6	Sweet corn	1st, 2nd, 3rd	3.5Kg/ Entry for 1st and 2nd, **4.5Kg/entry for 3rd year**
7	Popcorn	1st, 2nd, 3rd	3.5Kg/ Entry for 1st and 2nd, **4.5 Kg/entry for 3rd year**
8	National Maize Demonstration-Hybrids	1st	0.5Kg/Hybrids

9	National Maize Demonstration-Inbreds	1st	0.2Kg/Hybrids
10	For rainfed trials	1st	1Kg/entry
11	Bifortification Trials (Hybrids)	2nd year	1Kg/entry
12	Check variety seed		List circulated in the workshop

Seed Requirement-rabi-2016-17:

S.N.	Trial	Year of testing	Seed quantity (Kg)
1	National Initial Varietal Trail (NIVT)	First	3.5Kg/Entry
2	Advance Varietal Trial-I (AVT-I)	Second	3 .5Kg/Entry/Zone
3	Advance Varietal Trial-II(AVT-II)	Third	5.5 Kg/Entry/Zone
5	QPM	1st, 2nd, 3rd	6 Kg/ Entry
10	Check variety seed		List circulated among all in the workshop

General requirements:

- Last Date for seed receive at IIMR- Kharif season 2016**: May 10, 2016 and** For Rabi season 2016-17 **: 5th Oct, 2016**
- Testing Fee (Private/Non-ICAR organizations) **– 60,000 + Service tax 14 .5% /entry/trial**
- DD should be in favour **of ICAR Unit, PD- Maize, Pusa Campus New Delhi**
- Seed must be untreated
- Mailing Address: To Director Maize, ICAR-Indian Institute of Maize Research, Pusa Campus, New Delhi, PIN-110012
- No seed will be receive with incomplete information viz. contact no., Name of person, email ID, organization name, trial for which entry is proposed, filled Performa (Distributed in workshop) etc.

Promotion criteria for all trials from NIVT Kharif 2016 and Rabi 2015-16

- Promotion criteria (Yield): Entries must be numerically superior over the best check and should have non-significant differences in yield from the best entry (rank 1st) of the trial at CD (*P*=0.05)
- In extra-early, early and medium trials, the test entry should not exceed the relevant best check by 1.5 days in days to 50% silking
- While promoting entries from NIVT to AVT-1 and AVT-1 to AVT-2, the disease reaction of test entries to the diseases of zonal/regional importance would be considered
- In specialty corn, quality parameters will be considered while promotion e.g. (QPM: % Lys ≥0.6; SC: TSS ≥ 15%; PC: Popping % age ≥ 80%), **Note**: all quality parameters must analyze in self kernels from minimum two replications/location.

CROP PRODUCTION

The approved plan of work for AICRP Maize (Agronomy) is as follows:

Kharif 2016 and *Rabi* 2016-17

MAT 1. Performance of pre release genotypes under varying planting density and nutrient levels

Objective: To study the response of pre-release genotypes to different planting density and NPK levels with their interactions

a) Performance of pre release <u>medium</u> maturity genotypes in kharif under varying planting density and nutrients levels in <u>NWPZ</u>

Main-plot: Density (2) 66,000 & 83,000
Sub-plot: Nutrient Levels (2) 200:65:80, 250:80:100 N: P_2O_5: K_2O kg/ha.
Sub-sub plot: Genotypes (1) +checks
Design: Split-split plot
Replications: 3
Plot size: 15 m^2
Locations: Delhi, Ludhiana, Karnal, Kanpur, Pantnagar

b) Performance of pre release <u>medium</u> maturity genotypes in kharif under varying planting density and nutrients levels in <u>PZ</u>

Main-plot: Density (2) 83,000 & 100,000
Sub-plot: Nutrient Levels (2) 200:65:80, 250:80:100 N: P_2O_5: K_2O kg/ha.
Sub-sub plot: Genotypes (2) +checks
Design: Split-split plot
Replications: 3
Plot size: 15 m^2
Locations: Karimnagar, Hyderabad, Coimbatore, Vagarai, Kolhapur, Dharwad

c) Performance of pre release <u>late</u> maturity genotypes in kharif under varying planting density and nutrients levels in <u>PZ</u>

Main-plot: Density (2) 83,000 & 100,000
Sub-plot: Nutrient Levels (2) 200:65:80, 250:80:100 N: P_2O_5: K_2O kg/ha.
Sub-sub plot: Genotypes (3)+checks
Design: Split-split plot
Replications: 3
Plot size: 10 m^2
Locations: Karimnagar, Hyderabad, Coimbatore, Vagarai, Kolhapur, Dharwad

d) Performance of pre release <u>late</u> maturity genotypes in kharif under varying planting density and nutrients levels in <u>CWZ</u>

Main-plot: Density (2) 66,000 & 83,000
Sub-plot: Nutrient Levels (2) 200:65:80, 250:80:100 N: P_2O_5: K_2O kg/ha.
Sub-sub plot: Genotypes (3)+checks
Design: Split-split plot
Replications: 3
Plot size: 10 m^2
Locations: Ambikapur, Chhindwara, Jhabua, Godhra, Banswara, Udaipur

e) Performance of pre release <u>QPM</u> genotypes in kharif under varying planting density and nutrients levels in <u>all zones</u>

Main-plot: Density (2) 66,000 & 83,000 (NWPZ, NEPZ, CWZ) 83,000 & 100,000 (NHZ and PZ)
Sub-plot: Nutrient Levels (2) 200:65:80, 250:80:100 N: P_2O_5: K_2O kg/ha.
Sub-sub plot: Genotypes +checks
Design: Split-split plot
Replications: 3
Plot size: 10 m^2
Locations:
NHZ: Almora, Bajaura, Gossaingaon, Udhampur, Imphal
NWPZ: Delhi, Kanpur, Ludhiana, Karnal, Pantnagar
NEPZ: Bahraich, Kalyani, Varanasi, Bhubaneswar, Ranchi, Dholi
PZ: Dharwad, Coimbatore, Kolhapur, Karimnagar, Hyderabad, Vagarai
CWZ: Ambikapur, Chhindwara, Jhabua, Godhra, Banswara, Udaipur

f) Performance of pre release <u>QPM</u> or <u>medium</u>/<u>late</u> maturity genotypes in <u>rabi</u> under varying planting density and nutrients levels in <u>NEPZ, NWPZ, PZ & CWZ</u>

Main-plot: Density (2) 83,000 & 100,000
Sub-plot: Nutrient Levels (2) 200:65:80, 250:80:100 N: P_2O_5: K_2O kg/ha.
Sub-sub plot: Genotypes (as per promotion list)+checks
Design: Split-split plot
Replications: 3
Plot size: 10 m^2
Locations:
NWPZ: Delhi, Kanpur, Ludhiana, Karnal, Pantnagar
NEPZ: Bahraich, Kalyani, Varanasi, Bhubaneswar, Ranchi, Dholi
PZ: Dharwad, Coimbatore, Kolhapur, Karimnagar, Hyderabad, Vagarai
CWZ: Ambikapur, Chhindwara, Jhabua, Godhra, Banswara, Udaipur

***Note*: Split N application**

- *Nitrogen to be applied in three equal splits in all MAT 1(a to e) at basal, knee high and tasseling stage in kharif season.*
- *Nitrogen to be applied in four equal splits in all MAT 1(f) at basal, knee high, pre-tasseling and tasseling stage in rabi season.*

Observations to be recorded in MAT 1(a to f):

1. Plant population at 25 DAS & at harvest (thousands/ha)
2. Plant height at harvest (cm)
3. Days to 50% tasseling
4. Days to 50% silking
5. Number of cobs (thousands/ha)
6. 100-seed weight (g)
7. Grain yield at 15% moisture content (kg/ha)
8. Stover yield sun dry basis (kg/ha)
9. Insect-pest and disease incidence, if any
10. Net return and B:C ratio

g) Performance of pre release <u>popcorn</u> genotypes under varying planting density and nutrients levels in <u>all zones</u>

Main-plot: Density (2) 66,000 & 83,000 (NWPZ, NEPZ, CWZ) 83,000 & 100,000 (NHZ and PZ)
Sub-plot: Nutrient Levels (2) 150:50:60, 200:60:80 and N: P_2O_5: K_2O kg/ha.
Sub-sub plot: Genotypes +checks
Design: Split-split plot
Replications: 3
Plot size: 10 m^2
Locations:
NHZ: Almora, Bajaura, Gossaingaon, Udhampur, Imphal
NWPZ: Delhi, Kanpur, Ludhiana, Karnal, Pantnagar
NEPZ: Bahraich, Kalyani, Varanasi, Bhubaneswar, Ranchi, Dholi
PZ: Dharwad, Coimbatore, Kolhapur, Karimnagar, Hyderabad, Vagarai
CWZ: Ambikapur, Chhindwara, Jhabua, Godhra, Banswara, Udaipur
Note: Nitrogen to be applied in three equal splits in all MAT 1(g) at basal, knee high and tasseling stage.

Observations to be recorded in MAT 1 pop corn (g):

1. Plant population at 25 DAS and at harvest (thousands/ha)
2. Plant height at harvest (cm)
3. Number of cobs (thousands/ha)
4. Days to 50% tasseling
5. Days to 50% silking

6. Popping (%)
7. 100-seed weight (g)
8. Grain yield (kg/ha)
9. Stover yield (kg/ha)
10. Insect-pest and disease incidence, if any
11. Net returns and B:C ratio

h) Performance of pre release <u>sweet corn</u> genotypes under varying planting density and nutrients levels in <u>all zones</u>

Main-plot: Density (2) 66,000 & 83,000
Sub-plot: Nutrient Levels (2) 150:50:60, 200:60:80 and N: P_2O_5: K_2O kg/ha.
Sub-sub plot: Genotypes +checks
Design: Split-split plot
Replications: 3
Plot size: 10 m^2

Locations:

NHZ: Almora, Bajaura, Gossaingaon, Udhampur, Imphal
NWPZ: Delhi, Kanpur, Ludhiana, Karnal, Pantnagar
NEPZ: Bahraich, Kalyani, Varanasi, Bhubaneswar, Ranchi, Dholi
PZ: Dharwad, Coimbatore, Kolhapur, Karimnagar, Hyderabad, Vagarai
CWZ: Ambikapur, Chhindwara, Jhabua, Godhra, Banswara, Udaipur

Note: Nitrogen to be applied in three equal splits in all MAT 1(h) at basal, knee high and tasseling stage.

Observations to be recorded in MAT 1 sweet corn (h):

1. Plant population at 25 DAS and at harvest (thousands/ha)
2. Number of cobs (thousands/ha)
3. Plant height at harvest (cm)
4. Days to 50% tasseling
5. Days to 50% silking
6. TSS (Total soluble solids) at harvest (%)
7. Green Cob yield (kg/ha)
8. Green fodder yield (kg/ha)
9. Insect-pest and disease incidence, if any
10. Net returns and B:C ratio

i) Performance of pre release <u>baby corn</u> genotypes under varying planting density and nutrients levels in <u>all zones</u>

Main-plot: Density (2) 100,000 & 1,25,000
Sub-plot: Nutrient Levels (2) 150:50:60, 200:60:80 and N: P_2O_5: K_2O kg/ha.
Sub- sub plot: Genotypes + checks
Design: Split-split plot
Replications: 3
Plot size: 10 m^2

Note: Nitrogen to be applied in three equal splits in all MAT 1(i) at basal, knee high and tasseling stage.

Observations to be recorded in MAT 1 babycorn (i):

1. Plant height at harvest (cm)
2. Plant population at 25 DAS and at harvest (thousands/ha)
3. Days to first picking
4. Number of pickings
5. Baby corn yield with husk in each picking (kg/ha)
6. Baby corn yield without husk in each picking (kg/ha)
7. Green fodder yield (kg/ha)
8. Insect-pest and disease incidence, if any
9. Net returns and B:C ratio

MAT 2: Nutrient management in maize-wheat-green gram cropping system under different tillage practices

Objective: To find out effective SSNM and tillage practices for yield maximization in intensified cropping system

Tillage practices (Main-plots)	Nutrient management (Sub-plots)
1. Zero till 2. Conventional Till 3. Permanent bed	1.RDF 2.SSNM based on nutrient expert 3.Farmer's fertilizer practice

Design: Split Plot Replications: three Main-plot size: 150 m^2

Locations: Udaipur, Pantnagar, Delhi, Dholi, Banswara

Observations to be recorded:

1. Plant population (thousands/ha) in maize and mungbean at harvest
2. Effective tillers of wheat per square meter
3. Plant height (cm) at harvest of all crops
4. Yield attributes and yield of all crops
5. Days to reproductive stage of each crop
6. Days to maturity of each crop
7. System productivity
8. Stover/straw yields of all crops (kg/ha)
9. Net returns and B: C ratio
10. N, P and K uptake by all crops
11. Insect-pest and disease incidence, if any
12. Initial and final (after completion of three year cropping sequence) physical and chemical parameters of soil

MAT 3: Nutrient management in rice-maize cropping system under different tillage practices

Objective: To find out effective SSNM and tillage practices for yield maximization in emerging cropping system

Tillage practices (Main-plots)	Nutrient management (Sub-plots)
1. Zero till 2. Conventional Till 3.Permanent bed	1.RDF 2.SSNM based on nutrient expert 3.Farmer's fertilizer practice

Design: Split Plot Replications: three Main-plot size: 150 m^2

Locations: Dholi, Hyderabad, Kalyani

Observations to be recorded:

1. Plant population (thousands/ha) in maize at harvest
2. Effective tillers of rice per square meter
3. Plant height (cm) at harvest of all crops
4. Yield attributes and yield of all crops
5. Days to reproductive stage of each crop
6. Days to maturity of each crop
7. System productivity
8. Stover/straw yields of all crops (kg/ha)
9. Net returns and B: C ratio
10. N, P and K uptake by all crops
11. Insect-pest and disease incidence, if any
12. Initial and final (after completion of three year cropping sequence) physical and chemical parameters of soil

MAT 4: Nutrient management in maize based rainfed cropping systems under different tillage practices

Objective: To find out effective SSNM and tillage practices for yield maximization in rainfed cropping system

Tillage practices (Main-plots)	Nutrient management (Sub-plots)
1. Zero till 2. Conventional Till 3.Permanent bed	1.RDF 2.SSNM based on nutrient expert 3.Farmer's fertilizer practice

Design: Split Plot Replications: three Main-plot size: 150 m^2

Locations: Maize-chickpea cropping system- Delhi

Maize-mustard cropping system-Srinagar, Chhindwara, Delhi

Observations to be recorded:

1. Plant population in maize, chickpea and mustard at harvest
2. Plant height (cm) of all crops at harvest
3. Yield attributes and yield of all crops
4. Days to reproductive stage of each crop
5. Days to maturity of each crop
6. System productivity
7. Stover/straw yields (kg/ha)
8. Net returns and B: C ratio
9. N, P and K uptake by all crops
10. Insect-pest and disease incidence, if any
11. Initial and final (after completion of three year cropping sequence) physical and chemical parameters of soil

MAT 5: Effect of planting density and nutrient management practices on the performance of hybrids in kharif season

Objective: To study the genotype x planting density x nutrient interactions for achieving higher yield in hybrid maize during kharif season

Locations	**Cropping system**	**Main-plot (Hybrids:2)**	**Sub-plot (Density:2)**	**Sub-sub plot (Nutrient mangement:3)**
Zone I (Bajaura, Srinagar, Imphal, Kangra, Gossaingaon)	Maize – Wheat/ Maize-mustard	Early/ medium maturity	60 x 20 cm 60 x 15 cm	RDF STCR SSNM
Zone II (Delhi, Ludhiana, Karnal, Kanpur, Pantnagar)	Maize – Wheat	Full maturity	67 x 20 cm 67 x 15 cm	RDF STCR SSNM
Zone III (Dholi, Ambikapur, Bahraich, Bhubaneswar, Varanasi, Ranchi, Kalyani)	Maize – Wheat/ Maize-mustard	Medium maturity	60 x 20 cm 50 x 20 cm	RDF STCR SSNM
Zone IV (Dharwad, Coimbatore, Kolhapur, Karimnagar)	Maize alone	Full maturity	60 x 20 cm 50 x 20 cm	RDF STCR SSNM
Zone V(Udaipur, Chhindwara, Banswara, Godhara)	Maize – Wheat/ Maize-Chickpea/ Maize-mustard	Early/ medium maturity	60 x 20 cm 50 x 20 cm	RDF STCR SSNM

Design: Split-split plot Replications: 3 Sub-sub plot size: 15 m^2

***Note*:** Select the hybrids from local market having maximum area at farmers filed and mention their names

Observation to be recorded:

1. Plant population at harvest in maize, mustard and chickpea (thousand/ha)
2. Barrenness in maize (%)
3. Effective tillers of wheat/rice per square meter
4. Plant height (cm) at harvest of all crops
5. Yield attributes and yield of all crops
6. Days to reproductive stage of each crop
7. Days to maturity of each crop
8. System productivity
9. Stover/straw yields of all crops (kg/ha)
10. Net returns and B: C ratio
11. N, P and K uptake by all crops
12. Insect-pest and disease incidence, if any
13. Initial and final (after completion of one year cropping sequence) physical and chemical parameters of soil

MAT 6: Effect of planting density and nutrient management practices on the performance of hybrids in rabi season

Objective: To study the genotype x planting density x nutrient interactions for achieving higher yield in hybrid maize during rabi season

Locations	**Cropping system**	**Main-plot (Hybrids:2)**	**Sub-plot (Density:2)**	**Sub-sub plot (Nutrient mangement:3)**
Zone III (Dholi, Kalyani, Bahraich)	Rice- Maize	Full maturity	60 x 20 cm 50 x 20 cm	RDF STCR SSNM
Zone IV (Karimnagar, Hyderabad, Coimbatore, Vagarai)	Pulse-maize/ Maize alone	Full maturity	60 x 20 cm 50 x 20 cm	RDF STCR SSNM
Zone V (Banswara)	Soybean-maize	Full maturity	60 x 20 cm 50 x 20 cm	RDF STCR SSNM

Design: Split-split plot Replications: 3 Sub-sub plot size: 15 m^2

***Note*:** Select the hybrids from local market having maximum area at farmers filed and mention their names

Observation to be recorded:

1. Plant population at harvest (thousands/ha) in maize, soybean and pulses
2. Barrenness in maize (%)
3. Effective tillers of wheat per square meter
4. Plant height (cm) at harvest of all crops
5. Yield attributes and yield of all crops
6. Days to reproductive stage of each crop
7. Days to maturity of each crop
8. System productivity
9. Stover/straw yields of all crops (kg/ha)
10. Net returns and B: C ratio
11. N, P and K uptake by all crops
12. Insect-pest and disease incidence, if any
13. Initial and final (after completion of one year cropping sequence) physical and chemical parameters of soil

MAT 7: Optimization of nutrient and plant geometry management in zero-till rabi maize
Objective: Optimization of geometry and fertilization practices in ZT maize
Location: Hyderabad
Main-plot: Method of nutrient application
1. Farmer practice
2. Improved practice

Sub-plot: Nutrient management
1. Farmers practice
2. STCR
3. RDF

Sub-sub plot: Planting density
1. 60 x 20 cm
2. 50 x 20 cm
3. 45 x 20 cm

Design: Split-split plot Replications: 3 Sub-sub plot size: 15 m^2
Observations to be recorded:
1. Plant population (thousands/ha) in maize
2. Barrenness in maize (%)
3. Effective tillers of rice per square meter
4. Plant height (cm) at harvest of all crops
5. Yield attributes and yield of all crops
6. Days to reproductive stage of each crop
7. Days to maturity of each crop
8. System productivity
9. Stover/straw yields of all crops (kg/ha)
10. Net returns and B: C ratio
11. N, P and K uptake by all crops
12. Initial and final (after completion of one year cropping sequence) physical and chemical parameters of soil.

MAT 8: Long term trial on integrated nutrient management in maize- wheat cropping system
Objective: To assess the long term effect of integrated nutrient management in maize wheat cropping system
Location: Pantnagar
Treatment details:

T1	Unmanured
T2	100% RDF
T3	75% RDF
T4	50% RDF
T5	FYM 10t/ha + Azatobactor
T6	Maize + Cowpea with FYM 10 t.ha +Azatobactor
T7	100% RDF + 5 t/ha FYM
T8	50% RDF + 5 t/ha FYM
T9	100% RDF + 5 kg Zn/ha
T10	FYM 5 t/ha (state practice)

Design: RBD Replications: 3 Sub-sub plot size: 15 m^2

Observations to be recorded:

1. Soil chemical, physical and biological parameters before start of the experiment
2. Soil chemical, physical and biological parameters after completion of every cropping cycle
3. Disease and insect incidence monitoring
4. Weed dynamics study
5. Plant population (thousands/ha) in maize at harvest
6. Effective tillers of wheat per square meter
7. Plant height (cm) at harvest of all crops
8. Yield attributes and yield of all crops
9. Days to reproductive stage of each crop
10. Days to maturity of each crop
11. System productivity
12. Stover/straw yields of all crops (kg/ha)
13. Net returns and B: C ratio of each crop and cycle
14. N, P, K and micronutrient content and uptake by crops
15. Insect-pest and disease incidence, if any

MAT 9: Weed management in maize systems

Objective: To develop weed management options in maize cropping system

Locations:

Maize-wheat: Pantnagar, Bajaura, Karnal, Ludhiana, Ranchi, Kalyani, Dholi, Udaipur, Banswara Chhindwara, Behraich

Maize-oat: Srinagar

Maize-mustard: Ambikapur, Bhubneshwar, Imphal, Baharaich

Rice-maize: Dholi, Kalyani, Gossaigaon

Maize alone: Vagarai, Jhabua, Karimnagar, Dharwad, Hyderabad, Chitrakoot

Treatment details:

T1	Control (weedy check)
T2	Weed free
T3	Atrazine @ 1.5* kg/ha preemegence
T4	Atrazine (750 g /ha) + Pendemathalin (750 ml/ha) preemegence
T5	Atrazine (750 g/ha) + 2,4-D Amine (75%) at 25 DAS as PoE
T6	Halosulfuron 60 g/ha at 25 DAS
T7	Atrazine @ 1.5 kg/ha preemegence fb Halosulfuron 60 g/ha 25 DAS
T8	Tembotrione (Laudis) 120 g/ha PoE at 25 DAS
T9	Pendemathalin (1000 ml/ha) preemegence fb Atrazine (750 g/ha) + 2,4-D Amine (75%) at 25 DAS as PoE
T10	Atrazine @ 1.5 kg/ha preemegence fb Tembotryn (Laudis) 120 g/ha PoE at 25 DAS

**For light soil Atrazine 1.0 kg/ha*

Design: RBD Replications: 3 Plot size: 15 m^2

Observations to be recorded:

For crop:

i. Plant population at 25 DAS and at harvest (thousands/ha)
ii. No. of cobs (thousands/ha)
iii. Cob yield (kg/ha)
iv. Maize Grain yield (kg/ha)
v. System productivity as Maize equivalent yield
vi. Insect pest and disease incidence, if any
vii. Economics: Net return and B:C ratio

For weeds:

i. No. of grassy, broadleaf weeds and sedges/m^2 at 50 DAS and at harvest

ii. Weed dry matter at harvest/m^2 of grassy, broadleaf weeds and sedges separately

iii. Phototoxic effects on crops, if any

MAT-10: Enhancing water-use efficiency in rainfed maize
Objective: To enhance water productivity in rainfed maize
Locations:
Maize-wheat: Dholi, Udaipur, Hisar
Maize-mustard: Chhindwara, Bhubaneswar, Imphal(pre-kharif)
Maize alone: Karimnagar, Srinagar
Treatment details
Main-plot: Tillage practices

1. Conventional till
2. Conventional till + mulching
3. Zero tillage
4. Zero tillage + residue (4 t/ha)

Sub-plot:

1. Control (no hydrogel)
2. Hydrogel 2.5 kg/ha
3. Hydrogel 5.0 kg/ha

Design: Split -plot Replications: 3 Sub plot size: 50 m^2
Observations to be recorded:

1. Plant population 25 DAS and at harvest (thousands/ha)
2. Plant height (cm) of maize
3. Days to 50% silking
4. Days to maturity
5. Yield attributes and yield of maize
6. Maize equivalents of crop and cropping system (kg/ha)
7. Stover yield of maize (kg/ha)
8. Net returns and B: C ratio
9. Moisture-use efficiency
10. Insect-pest and disease incidence, if any

MAT 11. Evaluation of new biofertilizers in maize
Objective: Identification of potential biofertilizers in maize
Locations:
Maize-wheat: Karnal, Pantnagar, Ludhiana, Dholi, Udaipur, Baharaich,
Maize-mustard: Srinagar, Imphal, Chhindwara, Bhubaneswar, Ranchi, Nadia
Maize-chickpea: Banswara, Jhabua, Kanpur, Ambikapur, Dharwad
Maize alone: Karimnagar, Vagarai, Coimbatore, Kolhapur, Gossaingaon, Chitrakoot

T1	Control (Recommended N and K)
T2	PSB I
T3	PSB II
T4	NPK consortia
T5	60 kg P_2O_5/ha
T6	30 kg P_2O_5/ha + PSB I
T7	60 kg P_2O_5/ha + PSB I

T8	30 kg P_2O_5/ha + PSB II
T9	60 kg P_2O_5/ha + PSB II
T10	30 kg P_2O_5/ha + NPK consortia
T11	60 kg P_2O_5/ha + NPK consortia
T12	90 kg P_2O_5/ha

Design: RBD Replications: 3 Plot size: 15 m^2

Observations to be recorded:

1. Plant population 25 DAS and at harvest (thousands/ha)
2. Plant height (cm) of maize
3. Days to 50% silking
4. Days to maturity
5. Yield attributes and yield of maize
6. Maize equivalents of crop and cropping system (kg/ha)
7. Stover yield of maize (kg/ha)
8. Net returns and B: C ratio
9. Insect-pest and disease incidence, if any

ICAR-CIMMYT collaboration in Agronomy

1. **Estimation of green house gas emission in permanent conservation agriculture experiments at IIMR, Delhi**
2. **Precision-conservation agriculture for maximizing yield and nutrient use efficiency while reducing environmental foot prints in maize wheat cropping system of eastern IGP***

Background: The average productivity of kharif maize in Bihar is very poor (1.5 t/ha) due to poor agronomic management especially due to inadequate nutrient use and improper crop establishment coupled with multiple abiotic stresses. Technological solutions involving precision nutrient management layered with CA based management are needed not only to help adapting maize systems to multiple abiotic stresses in eastern Gangetic plains but also to improve productivity, profitability while reducing environmental foot prints.

***The trial will be conducted at BISA, Pusa, Bihar supported by CIMMYT-CCAFS and with strategic partnership with RAU Pusa, Dholi centre of AICRP on Maize. The results will be presented in annual maize workshop**

Technical program:

Treatments:

S. No	Tillage practices	Nutrient rate	Application method	Application time	
				Maize	Wheat
1	CT (FP)	FFP	FFP	FFP	FFP
2	PB	Ad-hoc state recommendation	Ad-hoc state recommendation (broadcast)	Ad-hoc state recommendation	Ad-hoc state recommendation
3	PB	Ad-hoc state recommendation (NPK)	Drilling	3 splits	3 splits
4	PB	Ad-hoc state rec (NPK)-80% N in 2 splits, 3rd N split based on GreenSeeker	Drilling	3 splits	3 splits
5	PB	Nutrient Expert based NPK rates	Broadcast	3 splits	3 splits

6	PB	Nutrient Expert based NPK rates	Drilling	3 splits	3 splits
7	PB	Nutrient Expert based NPK rates-80% N in 2 splits, 3rd N split based on GreenSeeker	Drilling	3 splits	3 splits

Replication: 03 **Plot size: >150 m^2**

Observations:

1. Growth and yield parameters and yield
2. Input use
3. Production economics
4. Nutrient use efficiency
5. Green House Gases (GHGs)

3. Designing portfolios of precision water* and nutrient management in conservation agriculture based maize-wheat production systems in a sandy loam soils of western IGP[&]

Sub-surface drip irrigation system. The irrigation water will be applied based on SMT

Centers*:* [&]The trial will be conducted at BISA farm, Ladowal, Ludhiana, supported by CIMMYT-CCAFS and with strategic partnership with PAU and IIMR. The results will be presented in annual maize workshop

Objectives

- Optimize water and nutrient rates, time and method of application in CA based maize-wheat system
- Improve system productivity, water and nutrient use efficiency in maize-wheat system in sandy loam soil
- Reduce environmental foot prints of tillage, water and nutrient use.
- Capacity development of stake-holder on precision-conservation agriculture
- Develop science based policy guide for sustainable intensification in western IGP

Treatments

1. No-N control- both residues removed (-R)
2. No-N control- 50% of maize stover and 30% of wheat residue retained (+R)
3. 50% recommended N -R
4. 50% of recommended N +R
5. 75% of recommended N-R
6. 75% of recommended N +R
7. 100% of recommended N-R
8. 100 of recommended N +R
9. 100% of recommended N under CT system (fresh beds for maize & wheat on flat) –R
10. 50% of recommended N –R (supplemented with GreenSeeker guided N at Flowering stage in maize and Feekes 7/8 in wheat)
11. 50% of recommended N +R (supplemented with GreenSeeker guided N at Flowering

Replication: 03

Plot size:

Observations:

1. Growth and yield parameters and yield
2. Input use (water, nutrient, labour, energy etc)
3. Production economics
4. Nutrient use efficiency
5. Water use efficiency
6. Green House Gases (GHGs)

4. **Validation of GreenSeeker optical sensor algorithms for precision N management in maize for India***
5. **Strategic partnerships in SSNM (Nutrient Expert) x Tillage trials**
   - Joint capacity development events
   - Joint publications

Researchers involved from CIMMYT-BISA: ML Jat, RK Jat, HS Sidhu, Tek Sapkota

ENTOMOLOGY

The approved plan of work for AICRP Entomology is as follows:

Kharif

ET 1: Evaluation of maize AICRP trials entries against *Chilo partellus* under artificial infestation for AVT I and II

ET 2 : Evaluation of inbred lines against *Chilo partellus* under artificial infestation (2nd year)- All locations

ET 3: Monitoring of *Helicoverpa armigera* by pheromone traps (Kharif, Rabi & Spring)

ET 4: Evaluation of insecticides against *C. partellus (3rd Year)* -6 locations

Insecticide	Dose
Chlorantaniliprole 20 SC	0.3 ml/lit
Chlorantaniliprole 20 SC	0.4 ml/lit
Flubendiamide480 SC	0.1 ml/lit
Flubendiamide480 SC	0.2 ml/lit
Novaluron 10 EC	0.75ml/lit
Novaluron 10 EC	1 ml/lit
Deltamethrin 2.8 EC	0.4 ml/lit
Deltamethrin 2.8 EC	0.8 ml/l
Untreated Control	

ET 5: Evaluation of bio-pesticides against *C. partellus (1st Year)*- All locations

Bio-pesticides	Dose
Bb-5a isolate of *Beauveria bassiana*	1 x 10^8 Spores per ml
Bb-23 isolate of *Beauveria*	1 x 10^8 Spores per ml
Bb-45 isolate of *Beauveria*	1 x 10^8 Spores per ml
Ma-35 isolate of *Metarhizium*	1 x 10^8 Spores per ml
Delfin WG	5 gm per lit.
Neem formulation	5 ml per lit.
State recommended chemical	
Untreated Control	

***Rabi* 2016-17**

ET 6: Evaluation of maize AICRP Trials entries against *Chilo partellus and S. inferens* under artificial infestation for AVT I and II (Kolhapur & Hyderabad)

ET 7:Evaluation of inbred lines against *C. partellus and S. inferens* under artificial infestation (Kolhapur, Karnal & Hyderabad)

ET 8 :Evaluation of insecticides against *S. inferens (Hyderabad)*

Insecticide	Dose
Chlorantaniliprole 20 SC	0.3 ml/lit
Chlorantaniliprole 20 SC	0.4 ml/lit
Flubendiamide480 SC	0.1 ml/lit
Flubendiamide480 SC	0.2 ml/lit
Novaluron 10 EC	0.75ml/lit
Novaluron 10 EC	1 ml/lit
Deltamethrin 2.8 EC	0.4 ml/lit
Deltamethrin 2.8 EC	0.8 ml/lit
State recommended chemical	
Untreated Control	

***Spring* 2017**

ET 09: Evaluation of inbred lines against Sorghum shoot fly under natural infestation (Delhi and Karnal) 2nd year

ET 10: Evaluation of inbred lines against Sorghum shoot fly under natural infestation (Delhi and Ludhiana) 3rd year

PATHOLOGY/ NEMATOLOGY

Maize pathological trials will be conducted at various coordinating/cooperating centres during *Kharif* 2016 and *Rabi* 2016-17

A. Kharif 2016

MPT 1-8: Disease screening of NIVT (trial No. 61-64) and AVT (trial No. 75-78) of all maturity groups: Evaluation of maize hybrids of the coordinated trials (NIVT, AVT I & AVT II) consisting of four maturity groups against major diseases will be done under artificially/ sick plot created epiphyotics at following hot spot locations.

Hot spot locations:

1. Maydis leaf blight (MLB): Dholi, Karnal, Ludhiana, Delhi
2. Turcicum leaf blight (TLB): Bajaura, Almora, Mandya, Dharwad
3. Banded leaf and sheath blight (BLSB): Medinapore, Pantnagar, Dhaulakuan, Delhi, Karnal.
4. Curvularia Leaf spot (CLS): Udaipur, Dhaulakuan.
5. Bacterial stalk rot (BSR): Pantnagar, Dhaulakuan
6. Fusarium stalk rot (FSR): Udaipur
7. Charcoal rot (CR): Ludhiana, Hyderabad, Coimbatore, Dharwad
8. Common rust: Dharwad
9. Polysora rust: Mandya
10. Sorghum Downy mildew (SDM): Mandya
11. Rajasthan Downy mildew (RDM): Udaipur
12. Cyst nematode: Udaipur

List of susceptible checks

S. no	Check	Diseases
1.	CML 186, CM 600, CM 119, Local Checks	Maydis leaf blight
2.	Dhari, 219J, CM 202, Local Checks	Turcicum leaf blight
3.	CM 600, CM 501, Hishell, Local Checks	Banded leaf and sheath blight
4.	CM 500, Local Checks	Sorghum Downy mildew
5.	Surya	Rajasthan Downy mildew
6.	Surya	Curvularia Leaf spot
7.	CM 600, DAC 7074, Local Checks	Bacterial stalk rot
8.	Surya, CM 500,	Fusarium stalk rot
9.	CM 600, 30V92, CM 501, Hishell	Charcoal rot
10.	CM 202, 219 J, Local Checks	Polysora rust
11.	Local Checks	Common Rust

Observations: Record the disease screening data in following format:

Season	:	Replication	:
Date of Sowing	:	No. of Rows	:
Date of Inoculation	:	Row Length	:
Name of Sus. check	:	Date of Observation	:
Name of Resis. Check	:	Date of Harvesting	:

S. No	Genotype	R1	R2	Mean
1.	....			
2.	....			
3.	Resistant Check			
4.	Susceptible Check			

- Follow uniform method of disease screening under sick plot/ artificial inoculated disease condition. If need be use Mckinney (1923) formula for calculating Percent Disease Index (PDI) [PDI = (Sum of individual ratings)/ (No. of leaves examined) ×100/ (Maximum disease rating)] mentioned in Annexure I.
- Overall mean score of foliar diseases of all plants in row should be recorded by averaging of score of each plant.
- Use susceptible and resistant checks at every 10th/20^{th}row as per availability of land.
- Meteorological data of the centers during crop growth period should be provided along with the disease reaction data.
- Pathogen(s) of every disease should clearly be spelt out.
- In case complex disease like PFSR (FSR, CR and late wilt), score of each individual disease be mentioned.

MPT 9-12 Disease screening of specialty corn (4 trials) under artificially created epiphyotics (All centres): As mentioned in case of MPT 1-8.

MPT 13. Screening of maize hybrids (all maturity groups) against cyst nematode (*Heterodera zeae)* (Udaipur): All the hybrids of NIVT, AVT I, AVT II and Specialty corns will be screened against cyst nematode under sick plot condition.

Hot spot location: Udaipur

Observations: Record the disease screening data in following format.

Season	:	Replication	:
Date of Sowing	:	No. of Rows	:
Date of Inoculation	:	Row Length	:
Name of Sus. check	:	Date of Observation	:
Name of Resis. Check	:	Date of Harvesting	:

S. No	Genotype	R1	R2	Mean
1.	...			
2.	...			
3.	Resistant Check			
4.	Susceptible Check			

MPT 14-17. Disease screening of maize inbred lines (Normal, QPM, association panel & mapping population) under artificially created epiphyotics: The inbred lines will be screened by the following hot spot locations-

Normal & QPM- All centres

Association panel: Dholi, Karnal, Ludhiana, Delhi

Mapping population- Ludhiana, Hyderabad, Coimbatore, Delhi

List of susceptible checks: As mentioned in MPT 1-8.

Observations: As mentioned under disease screening trials of hybrids.

MPT 18: Assessment of avoidable yield losses due to major diseases of maize

Trials on yield losses due to major diseases of maize will be conducted at following locations using paired plot technique with nine replications under sick plot/ artificially created epiphytotics.

Locations: Udaipur (RDM), Dharwad (TLB), Dhaulakuan (MLB), Mandya (SDM and TLB), Bajaura (TLB)

Replication	Treatment	Disease score/ incidence (%)	PDI	Yield (q/ha)	Yield loss (%)
R1	Protected				
	Unprotected				
R2	Protected				
	Unprotected				
.	Protected				
	Unprotected				
.	Protected				
	Unprotected				
R9	Protected				
	Unprotected				
Mean					
Disease control (%)					
Avoidable yield losses (%)					
CD (5%)					
CV (%)					

MPT 19: Trap nursery trial for disease incidence

The trial will be conducted to find out the occurrence of disease and/or any new disease on a set of maize inbred lines (10-12 lines) susceptible to different diseases at various locations. A special care has to be taken in observing the incidence of viral diseases, if any. The weekly disease severity data of natural condition of this trial will also be utilized in development of disease forecasting model by correlating with weekly weather data of each centre.

Locations: Almora, Bajaura, Coimbatore, Delhi, Dharwad, Dhaulakaun, Dholi, Hyderabad, Karnal, Ludhiana, Mandya, Pantnagar, Udaipur, Kalyani (14 centres)

Observations: For development of weather based disease forewarning models in maize crop, the data on following aspects are needed

- Data should be collected on unprotected field.
- Same genotype (inbred line) should be used for collection of data in different years.

- Weekly weather data from the time of sowing to harvesting of crops
- Disease severity should be recorded on weekly basis from time of first appearance of diseases.
- The above information are required for 10-12 years for model development on various character for disease forewarning.

Inbred lines/ diseases	Week	MLB Score (% severity)	TLB Score (% severity)	BLSB Score (% severity)	PFSR Score (% severity)		.
CM 129	1						
	2						
	3						
	4						
	.						
	.						
	.						
CM202	1						
	2						
	3						
	4						
	.						
	.						
	.						

- For soil borne diseases (PFSRs, BLSB, BSDM, SDM, RDM, cyst nematode), exact value of percent incidence should be mentioned.
- For foliar diseases (MLB, TLB, CLS and rusts), scoring should be done using revised standard rating scale of 1-9 and mean disease score of foliar diseases should be reflected in terms of percent disease index (PDI) as mentioned in Annexure I.
- Pathogen(s) of every disease should clearly be spelt out.

MPT 20. Disease survey, surveillance and weekly disease pest status in different maize growing areas

During survey & surveillance of diseases (including cyst nematode), scoring should be done along with the incidence of disease in prescribed proforma. The weekly disease status should be sent in the following proforma:

Weekly Status of Maize Pests/Diseases

Crop Stage	State/District	Pest/ disease	Intensity*

Disease intensity: T - Traces; L - Low; M - Medium; H - High

Locations: Bajaura, Coimbatore, Dharwad, Dhaulakaun, Dholi, Godhra, Hyderabad, Karnal, Ludhiana, Mandya, Pantnagar, Udaipur, Kalyani (13 centres).

Observations:

- Mean disease score and procedure given for calculating PDI should strictly be followed.
- Pathogen of every disease should clearly be spelt out. Name and abbreviated form of diseases as given in Annexure I should uniformly be followed.
- Weather data of locations may be given with disease prevalence.
- Weather data should be recorded in following format and give its correlation

S.No	Station Name	Month	Temperature (°C)		Rainfall of Month (mm)	R.H (%)		Sunshine Hrs.
			Min	Max		Min	Max	

MPT 21. Efficacy of newer fungicides in control of banded leaf and sheath blight
Locations: Karnal, Delhi, Dhaulakuan, Bajaura, Godhra
Observation: Disease data should be recorded in following format:

Season	:	No. of Rows	:
Date of Sowing	:	Row Length	:
Date of Inoculation	:	Date of Observation	:
Test Hybrid	:	Date of Harvesting	:
Replication	:		

Treatment		Location				
		Mean disease score	PDI*	Disease control (%)	Yield (q/ha)	Yield increase (%)
T_1	Difenconazole @ 0.1 %					
T_2	Hexaconazole @ 0.1%					
T_3	Carbendazim @ 0.1%					
T_4	Validamycin @ 0.1%					
T_5	Tebuconazole @ 0.05%					
T_6	Trifloxystrobin 25% + Tebuconazole 50% @ 0.05%					
T_7	Azoxystrobin @ 0.05%					
T_8	Pencycuron @ 0.1%					
T_9	Untreated check (water spray)					
SEM+						
CD (0.05)						
CV (%)						

***Test **Hybrid/ Variety Name**
**** Transformed values in parenthesis**

MPT 22: Efficacy of newer fungicides in control of common rust
Locations: Dharwad
Observation: Disease data should be recorded in following format:

Season	:	No. of Rows	:
Date of Sowing	:	Row Length	:
Date of Inoculation	:	Date of Observation	:
Test Hybrid	:	Date of Harvesting	:
Replication	:		

Treatment		Location				
		Mean disease score	PDI*	Disease control (%)	Yield (q/ha)	Yield increase (%)
T_1	Difenoconazole@ 0.1 %					
T_2	Hexaconazole@ 0.1%					

T_3	Tebuconazole@ 0.05%					
T_4	Propiconazole@ 0.1%					
T_5	Trifloxystrobin 25% + Tebuconazole 50% @ 0.05%					
T_6	Azoxystrobin @ 0.05%					
T_7	Inoculated Control					
T_8	Untreated check (water spray)					
SEM+						
CD (0.05)						
CV (%)						

** Test Variety Name
* Transformed values in parenthesis

MPT 23: Efficacy of bioagents, fungicide and potash in control of post-flowering stalk rots
Locations: Dharwad (charcoal rot), Udaipur (Fusarium stalk rot), Ludhiana* (Charcoal rot) consolidated report will be submitted in 2017.

Observation: Disease data should be recorded in following format:

Season	:	No. of Rows	:
Date of Sowing	:	Row Length	:
Date of Inoculation	:	Date of Observation	:
Test Hybrid	:	Date of Harvesting	:
Replication	:		

Treatments		Mean disease score	PDI	Disease control (%)	Grain yield	
					(q/ha)	Increase (%)
T_1	*TH -3* @ 0.5% as seed treatment, bioagent-fortified FYM (1:50) and spray@ 0.5%					
T_2	*Pseudomonas fluorescens @ 0.5%* as seed treatment, bioagent-fortified FYM (1:50) and spray@ 0.5%					
T_3	Local strains of fungal antagonists @ 0.5% as seed treatment, bioagent-fortified FYM (1:50) and spray@ 0.5%					
T_4	MOP @ 1% at 30 DAS					
T_5	Propiconazole @ 0.1% spray at 40 DAS					
T_6	MOP @ 2% at 45 DAS					
T_7	Untreated check (water spray)					
SEM+						
CD (0.05)						
CV (%)						

Note: Incubate bioagent fortified FYM under moist condition at least for 10 days before sowing of experiment.

MPT 24. Efficacy of bioagents and fungicides in control of downy mildews
Locations: Mandya (SDM), Udaipur (RDM)
Observations: Disease data should be recorded in following format:

Season	:	No. of Rows	:
Date of Sowing	:	Row Length	:
Date of Inoculation	:	Date of Observation	:
Test Hybrid	:	Date of Harvesting	:
Replication	:		

Treatments		Incidence (%)	Disease control (%)	Grain yield	
				(q/ha)	Increase (%)
T_1	*Bacillus amyloliquefaciens*@10g/kg as seed treatment, bioagent-fortified FYM (1:50) and spray @ 1.0%				
T_2	*TH-3* @ 0.5% as seed treatment, bioagent-fortified FYM (1:50) and spray @ 0.5%				
T_3	*TV-3 (Trichoderma viride)* @ 0.5% as seed treatment, bioagent-fortified FYM (1:50) and spray @ 0.5%				
T_4	Fosetyl-al @ 0.2% seed treatment and spray @ 0.2%				
T_5	Azoxystrobin @ 0.2% seed treatment and spray @ 0.15%				
T_6	Metalaxyl+Mancozeb @ 0.25% seed treatment and spray @ 0.25%				
T_7	Metalaxyl @ 0.25% seed treatment and spray @ 0.25%				
T_8	Untreated check (water spray)				
SEM+					
CD (0.05)					
CV (%)					

Note: Incubate bioagent fortified FYM under moist condition at least for 10 days before sowingof experiment.

MPT 25. Efficacy of salicylic acid on incidence of maize diseases
Locations: Bajaura (TLB), Coimbatore (Ch. Rot), Delhi (BLSB), Dharwad (TLB, Common rust & Ch. Rot), Dhaulakaun (BLSB, BSR), Dholi (MLB), Godhra (BLSB), Hyderabad (Ch. Rot), Karnal (BLSB, MLB), Ludhiana (MLB, BLSB, Ch. Rot), Mandya (SDM, TLB, Polysora rust), Pantnagar (BLSB, BSR), Udaipur (RDM, FSR), Kalyani (TLB) (13 centres).
Observation: Disease data should be recorded in following format:

Season	:	No. of Rows	:
Date of Sowing	:	Row Length	:
Date of Inoculation	:	Date of Observation	:
Test Hybrid	:	Date of Harvesting	:
Replication	:		

Treatments		Germination (%)	PDI	Disease control (%)	Grain yield	
					(q/ha)	Increase (%)
T_1	50 ppm SA* as seed priming (SP)					
T_2	100 ppm SA (SP and foliar spray after 24hrs after inoculation)					
T_3	150 ppm SA (foliar spray 24hrs before inoculation).					
T_4	200 ppm SA (foliar spray 24hrs before inoculation).					
T_5	Check (Seed dip in water & spray)					
	SEM+					
	CD (0.05)					
	CV (%)					

***Commercial grade of SA; **Number of réplications =4**

Methodology of treatment:

(i) *Seed priming with Salicyclic Acid (SA) : For priming, soak seeds in solution SA (50 mg/ litre) for 18 h using 1:5 (w/v) ratio. After priming, seeds were rinsed thoroughly and surface dried under shade for 48 h close to original weight.

- (Ref- Journal of Integrative Agriculture Advanced Online Publication 2015 Doi : 10.1016/S2095-3119(14)61000-5 1 Seed priming induced early seedling vigor improves growth and productivity of spring maize Hafeezur Rehman11 , Hassan Iqbal1 , Shahzad M.A. Basra1 Irfan Afzal1 , Muhammad Farooq2 , Abdul Wakeel3 and and NING Wang 4)

(ii) Check (control): Dip seed in distilled water (water control) for same time and spray same volume as in case of chemicals.

MPT 26. Effect of bioextracts/ natural products on the incidence of maize diseases

Locations: Bajaura (TLB), Karnal (MLB), Delhi (MLB), Dholi (MLB), Kalyani (TLB), Mandya (TLB), Udaipur (CLS).

Treatments		Mean disease score	PDI	Disease control (%)	Grain yield	
					(q/ha)	Increase (%)
T_1	*Azadirachta indica* leaves @ 10%					
T_2	*Pongamia pinnata* (Kranj) @ 10% extract					
T_3	*Datura stramonium* (Datura) @ 10%					
T_4	*Calotropis sp.* (AK, Madar) @ 10%					
T_5	*Cymbopogon flexousus* @ 10% (Lemon grass)					
T_6	*Allium sativum* (garlic) bulb @ 10%					
T_7	*Eucalyptus* sp. @ 10%					
T_8	*Polyalthia longifolia* (False Ashoka) @ 10%					
T_9	*Ocimum sanctum* (Tulsi) @ 10%					
T_{10}	*Parthenium hysterophorus* @ 10%					
T_{11}	Cow urine @ 50%					

T_{12}	Lantana camara@ 10%					
T_{13}	Fungicidal check I					
T_{14}	Check II (water spray)					

NOTE: Number of treatments can be taken as per availability of materials

MPT 27. Efficacy of leaf stripping on severity of BLSB of maize

Locations: Ludhiana, Godhra, Karnal, Panthnagar, Delhi

Entries	PDI		Disease control (%)	Grain yield (q/ha)	Increase over control (%)
	Unstripped	Stripped			
1					
2					
3					
4					

***Four rows of each variety.**

***B. Rabi* 2016-17**

MPT 1-5. Disease screening of hybrids of *Rabi* maize (NIVT & AVTs)

Evaluation of maize hybrids of the coordinated trials of *rabi* maize against major diseases will be done under artificially created epiphyotics at following hot spot locations.

Hot spot locations:

1. Turcicum leaf blight (TLB): Mandya, Dharwad, Dholi
2. Fusarium stalk rot (FSR): Udaipur
3. Charcoal rot (CR): Ludhiana, Hyderabad, Dharwad, Coimbatore
4. Common rust: Karnal, Dholi.
5. Sorghum Downy mildew (SDM): Mandya

List of susceptible checks

S. NO	Check	Diseases
1.	Dhari, 219J, CM 202, Local Checks	Turcicum leaf blight
2.	CM 500, Local Checks	Sorghum Downy mildew
3.	CM 600, 30V92, CM 501, Hishell, Local Checks	Charcoal rot
4.	CM 202, 219 J, Local Checks	Polysora rust

Observation: Record the disease screening data in following format:

Season	:	Replication	:
Date of Sowing	:	No. of Rows	:
Date of Inoculation	:	Row Length	:
Name of Sus. check	:	Date of Observation	:
Name of Resis. Check	:	Date of Harvesting	:

S. NO	Genotype	R1	R2	Mean
1.				
2.				
Susceptible Check				
Resistant Check				

MPT 6. Disease screening of maize inbred lines against major diseases of maize

Evaluation of maize inbred lines against major diseases will be done under artificially created epiphyotics at above hot spot locations.

Observation:

Season	:	Replication	:
Date of Sowing	:	No. of Rows	:
Date of Inoculation	:	Row Length	:
Name of Sus. check	:	Date of Observation	:
Name of Resis. Check	:	Date of Harvesting	:

S.No	Genotype	R1	R2	Mean
1.				
2.				
Susceptible Check				
Resistant Check				

•Record the disease screening data in following format :

MPT 7. Assessment of avoidable yield losses due to Ch. Rot at Dharwad

Trial on yield losses due to Ch. Rot of maize will be conducted at Dharwad using paired plot technique with nine replications under sick plot/ artificially created epiphytotics.

MPT 8. Efficacy of newer fungicides in control of common rust

Locations: Karnal, Dholi

Observation: Disease data should be recorded in following format:

Season	:	No. of Rows	:
Date of Sowing	:	Row Length	:
Date of Inoculation	:	Date of Observation	:
Test Hybrid	:	Date of Harvesting	:
Replication	:		

Treatment		Location				
		Mean disease score	PDI*	Disease control (%)	Yield (q/ha)	Yield increase (%)
T_1	Difenoconazole@ 0.1 %					
T_2	Hexaconazole@ 0.1%					
T_3	Tebuconazole@ 0.05%					
T_4	Propiconazole@ 0.1%					
T_5	Trifloxystrobin 25% + Tebuconazole 50% @ 0.05%					
T_6	Azoxystrobin @ 0.05%					
T_7	Inoculated Control					
T_8	Untreated check (water spray)					
SEM+						
CD (0.05)						
CV (%)						

MPT 9. Efficacy of salicylic acid on incidence of common rust

Locations: Karnal, Dholi

Observation: Disease data should be recorded in following format:

Season	:	No. of Rows	:
Date of Sowing	:	Row Length	:
Date of Inoculation	:	Date of Observation	:
Test Hybrid	:	Date of Harvesting	:
Replication	:		

Treatments		Germination (%)	PDI	Disease control (%)	Grain yield	
					(q/ha)	Increase (%)
T_1	50 ppm SA* as seed priming (SP)					
T_2	100 ppm SA (SP and foliar spray after 24hrs after inoculation)					
T_3	150 ppm SA (foliar spray 24hrs before inoculation).					
T_4	200 ppm SA (foliar spray 24hrs before inoculation).					
T_5	Check (Seed dip in water & spray)					
	SEM+					
	CD (0.05)					
	CV (%)					

***Commercial grade of SA; **Number of réplications =4**

The following scientists attended the meeting:

1. Dr. B.M.R. Reddy University Head, Deptt of Plant Pathology, UAS, Bengaluru
2. Dr. K.T. Rangaswamy, Professor and Head, UAS, Bangaluru
3. Dr. Robin Gogoi, Pr. Scientist (Plant Pathology), IARI, N. Delhi
4. Dr. S.I. Harlapur, Principal Scientist, ARS, Arabhavi, KN
5. Dr. Rakesh Mehra, Maize Pathologist, CCS HAU, RRS, Karnal, HRY
6. Dr. Rakesh Devlash, Maize Pathologist, HAREC, HPKVV, Bajaura, HP
7. Dr. S.S. Sharma, Maize Pathologist, MPUAT, Udaipur, Raj.
8. Dr. L.K. Reddy, Pr. Scientist, MRC, ARI, ANGRAU, Hyderabad
9. Dr. Harleen Kaur, Asstt. Plant Pathologist, PAU, Ludhiana, Punjab
10. Dr. N. Mallkarjuna, Maize Pathologist, ZARS, V.C. Farm, Mandya, KN
11. Dr. P. Renukadevi, Asstt. Professor (Pl. Pathology), TNAU, Coimbatore, TN
12. Dr. K.S. Hooda, Pr. Scientist, IIMR, New Delhi
13. Dr. Meena Shekhar, Pr. Scientist, IIMR, New Delhi
14. Dr. Zarka Rashid, CIMMYT, Hyderabad, AP
15. Dr. R.P. Singh, Sr. Maize Pathologist, GBPUAT,Pantnagar, UK
16. Dr. Phool Chand, Maize Pathology Dholi, Muzaffarpur, Bihar
17. Dr. Shrabani Debnath, Scientist, BCKVV, Kalyani, WB
18. Dr. S.K. Singh, Maize Pathologist, AAU, Godhra, Guj.

Session XII:
General session

General Discussion and monitoring reports

Chairman	Co-chairman	Members	Rapporteur
Dr. Vinay Mahajan, Director, ICAR- IIMR	Dr. SK Guleria	All PIs	Drs. J. Kaul, Bhupender Kumar, K.P. Singh

Dr. KP Singh presented the quality of AICRP data and general issues. It has been decided that

1. Data should be sent in MS-Excel and in ascending order of plot no.
2. All centres should provide meteorological data on daily basis for both the seasons.
3. All the volunteer centres should attend the training programme on "AICRP trials conductance and data reporting" which is to be organized by IIMR during June 2016.
4. Properly self seed should be sent by centres to Dr. Dharampal for proper data generation on quality attribute.
5. Dr. AK Singh has presented the monitoring report and discussed the performance of all AICRP centres. Wherever the trials were rejected and graded average, they advised to conduct the trial properly in future.

Session XIII
Lead Lecture

Chairman	Co-Chairman	Rapporteur
Dr. T. Sheshdri, Director-Research UAS, Bangalore	Dr. Vinay Mahajan Director-IIMR	Dr. Ishwar Singh IIMR, New Delhi

In this session one special lecture on "*Maize in Odisha-Status and scope for further improvement"* was delivered by Mr. Sanjay Kumar Pani, Department of Agriculture Government of Odisha, in which he highlighted about the present status of maize cultivation in Odisha with special reference to the tribal belt. He further spoke on various initiatives taken by the state government for popularization of hybrid maize in Odissha in public private partnership in collaboration with OUAT and CIMMYT-Asia. At the end of the session the chairman thanked the speaker for delivering nice presentation and to the organizers for taking initiative for bringing state government agriculture department on the platform of Maize Workshop.

Session XIV
Plenary Session

Chairman	Co-Chairman	Speakers
Dr. H. Shivanna, Vice-Chancellor, UAS, Bangalore	Dr. Vinay Mahajan Director-IIMR	Dr. Vinay Mahajan Dr. Chikkappa G.K. Dr. S.L. Jat Dr. J.C. Sekhar Dr. K.S.Hooda

At the outset, Dr. Vinay Mahajan, Director, IIMR thanked the Vice Chancellor, UAS, Bangalore for all the support provided to conduct the workshop. Director, IIMR presented the recommendations of the Varietal Identification Committee and congratulated the breeders, whose entries were identified for release. He thanked the delegates and members of the organizing committee for making the workshop a success.

Dr. Chikkaappa G. Karjagi presented the following recommendations of the workshop with respect to the **Plant Breeding** programme:

Dr. A.K. Singh presented the following recommendations of the workshop with respect to the **Agronomy** programme:

- The plan of experiments for *Kharif* 2016 and Rabi 2016-17 was discussed and finalized and 11 experiments will be part of the programme.
- The experiment on tillage management in different cropping system should be continued on term basis and soil samples should be sent to IIMR from 0-5, 5-15 and 15-30 cms depths.
- The nutrient doses in nutrient management trials should be worked out each year in SSNM and STCR treatments.
- The results of trials completed three years should be published.
- Application of RDF or SSNM based fertilization results in yield enhancement of maize by 800 or 1400 kg/ha with increase of net returns by 9300 or 12800 Rs/ha over FFP, respectively. Hence, these practices recommended over FFP in maize.
- Zero tillage is recommended as alternative crop establishment techniques in sandy, sandy loam and clay loam soils of NWPZ, NEPZ and CWZ in Maize-wheat-mungbean sequence expect high rainfall clay loam areas of NWPZ.

Dr. J.C. Sekhar presented the following recommendations of the workshop with respect to the **Entomology** programme:

- Chlorantraniliprole 20 SC @ 0.4 ml per lit and Flubendiamide 480 SC @ 0.2 ml per lit was found effective in management of *Chilo partellus.*
- WNZ Exotic Pool DC 2 (LIR 2.6)and WNZ PBTL 6 (LIR 3.0) were found to be resistant to pink stem borer based on three years data.
- For classification of genotypes resistant to shoot fly susceptibility index should be used.

Dr. K.S. Hooda presented the following recommendations of the workshop with respect to the **Pathology/ Nematology** programme:

1. *R. serpentina* leaves (Sarpgandaha) @ 10%, *Trichoderma harzianum (TH-3)* @ 0.5% as seed treatment + bioagent fortified FYM (1:50) and spray @ 0.5%, *Trichoderma viride* (*TV-3*) @ 0.5% as seed treatment + bioagent fortified FYM (1:50) and spray @ 0.5%, Propiconazole @ 0.1%, Hexaconazole @ 0.1%, Carbendazim @ 0.1%, Mancozeb @ 0.2%, Carbendazim 12 WP + Mancozeb 63 WP @ 0.25% are effective in the management of maydis leaf blight.
2. Integrated management of cyst nematode:
    - Application of neem / karanj seed kernel at 10% w/w as seed treatment along with soil amendment with neem / karanj cake at 2 q/ha.
    - Intercropping of maize with sesame, soybean or cluster bean (2:2 rows at 30 cm apart).
    - Seed treatment with acephate 75 SP at 2% / methomyl at 1% w/w.
    - Application of lantana leaf powder at 2 q/ha at the time of sowing.
    - Carbofuran 3G / phorate 10 G at 1-2 kg/ha as soil application.
    - *T. viride* 10 g/kg seed along-with soil application of castor cake at 2 q/ha at the time of sowing.
    - Pochonia chlamydosporia @ 2 % w/w as ST + Lantana camara leaves @ 1 q / ha as soil application
    - *Paecilomyces lilacinus* @ 2 % w/w + Lantana leaves at 1 q/ha
    - *Pochonia chlamydosporia* @ 2 % w/w + Aak (*Calotropis procera*) at 1 q/ ha.
3. General disease management tactics to be followed in maize growing areas:
    i. Rotate crops (minimum 3 years with non-host crops for management of BLSB, BSR, PFSR, downy mildews).
    ii. Observe recommended planting dates and plant population.

iii. Plant resistant/ tolerant hybrids/ composites.
iv. Strip the basal leaves if infected with BLSB.
v. Ensure proper drainage for managing bacterial stalk rot and avoid moisture stress at flowering stage for managing PFSR.
vi. Fertilize crop as per recommendation (higher potash in PFSR infested areas).
vii. Rogue and destroy infected plants on appearance (downy mildews).
viii. Control insect pests and cyst nematode with proven technology.
ix. Use other need based promising IDM practices (Forecasting, Biocontrol, Regulatory, Resistance inducers, Chemical pesticides) for disease management in maize.
x. Manage the crop residue (plough down or recycling after proper composting).
xi. Store corn properly (Seed moisture <14%).
xii. Treat seed before sowing.

4. Revised guidelines for uniform scoring the disease intensity under artificially created epiphytotics should be followed and data of NIVT hybrids (*Kharif* 2016 onwards) should be recorded on 1-9 scale uniformly.
5. Weather data of 1980 onwards should be sent to PI (Pathology) for use in developing weather based disease forewarning models.
6. Data recorded under artificially created epiphytotic/ sick plot condition will only be considered. Pantnagar, Dhaulakuan and Delhi centres have to comply with the previous years' recommendation of sick plot development for screening against soil borne diseases. Progress will be assessed in next workshop of 2017.
7. There is a need to address food biosafety issues in maize and quantify the mycotoxins in maize growing agro-climatic zones of India.
8. Capacity building programme for freshers should be arranged at Headquarter and nearby center.
9. Inocula of both rusts (common and polysora rusts) should be collected in sufficient amounts from infected plants for creation of high disease pressure in next or same season.
10. The screening techniques devised for RDM may be replicated for SDM at Mandya centre on experimental basis and results may be discussed in next workshop of 2017.

In his final remarks, Dr. H. Shivanna, Vice-Chancellor, UAS, Bangalore said that there was very good deliberation in all the four disciplines in which the AICRP is working. The cultivars that have been identified for release would be useful for next one decade and their seed production should be taken care of. He said that more scientific analysis in making genetic pools to isolate inbreds, emphasis on management, especially micronutrients, up scaling of technologies, etc. would be required to target the yield level of 3.5 t/ha in next 3-5 years and further to global average of 5 t/ha.

In the end, Dr. Dr. Mallikarjuna N, Co- organizing Secretary, presented the Vote of Thanks

Annexure I

Guidelines for Uniform Method of Disease Assessment in Maize Under Artificially/ Sick Plot Created Epiphytotics

The screening techniques and rating of the disease intensities for uniform assessment of maize diseases are given below:

1. Turcicum leaf blight (TLB) and maydis leaf blight (MLB)

Sorghum grains soaked in water in a conical flask, autoclaved twice, seeded with fungus under aseptic condition are kept for incubation at 25-27^{0}C. The flasks are shaken once in 2-3 days to facilitate uniform growth on grains. After 10 days the material is ready for inoculation. Prepare a fine powder of impregnated sorghum grains after shade drying. Put a pinch of this powder in the leaf whorl of 30-35 days old plant. Maintain adequate moisture for longer period to permit spore germination with the help of sprayer. Disease can also be created by spraying the spore suspension prepared from the pure culture of fungi or placing a pinch of leaf meal (prepared by grinding dried diseased leaves collected from the previous season) into whorl of each plant at 30-35 centimeter plant height with spray of 10-12 ml of water in whorl in case of dry weather. Second inoculation can be followed if the symptoms do not appear even after a week of first inoculation. Data can be recorded on 30-35 days after inoculation following rating scale of Balint-Kurti *et al.* (2006), Chung *et al.* (2010) and Mitiku *et al.* (2014) mentioned below:

Rating scale	Degree of infection (per cent DLA*)	PDI**	Disease reaction
1.0	Nil to very slight infection (≤10%).	≤11.11	Resistant (R) (Score: ≤ 3.0) (PDI: ≤ 33.33)
2.0	Slight infection, a few lesions scattered on two lower leaves (10.1-20%).	22.22	
3.0	Light infection, moderate number of lesions scattered on four lower leaves (20.1-30%).	33.33	
4.0	Light infection, moderate number of lesions scattered on lower leaves, a few lesions scattered on middle leaves below the cob (30.1-40%).	44.44	Moderately resistant (MR) (Score: 3.1–5.0) (PDI: 33.34-55.55)
5.0	Moderate infection, abundant number of lesions scattered on lower leaves, moderate number of lesions scattered on middle leaves below the cob (40.1-50%).	55.55	
6.0	Heavy infection, abundant number of lesions scattered on lower leaves, moderate infection on middle leaves and a few lesions on two leaves above the cob (50.1-60%).	66.66	Mod. susceptible (MS) (Score: 5.1-7.0) (PDI: 55.56-77.77)
7.0	Heavy infection, abundant number of lesions scattered on lower and middle leaves and moderate number of lesions on two to four leaves above the cob (60.1-70%).	77.77	
8.0	Very heavy infection, lesions abundant scattered on lower and middle leaves and spreading up to the flag leaf (70.1-80%).	88.88	Susceptible (S) (Score: >7.0) (PDI: >77.77)
9.0	Very heavy infection, lesions abundant scattered on almost all the leaves, plant prematurely dried and killed (>80%).	99.99	

***DLA- Diseased leaf area; **Percent disease index (PDI)**

2. Banded leaf and sheath blight (BLSB)

Soak barley grains in water for 24 hours and dispense 40g in 250 ml Erlenmeyer flask after removing excess water; autoclave at a pressure of 1.05 kg/sq. cm for 30 minutes. Homogenize 2-3 days old growth of pathogen taken from potato dextrose agar in sterile water and seed 5 ml in each flask. Incubate at 27°C for 10 days. Inoculations should be made during the rainy season on 30-45 days old plants with grain culture (2-4 grains) inserted between stalk and sheath at second or third level from soil. Grains placed at junction of sheath and leaf can also create optimum disease level and do not fall away with strong wind or heavy rain. Disease is recorded after 30-35 days of inoculations on basis of following modified rating scale of Payak and Sharma (1983), and Muis and Quimio (2006).

Rating scale	Degree of infection (per cent DLA)	PDI	Disease reaction
1.0	Disease on one leaf sheath only; few small, non-coalescent lesions present (≤10%).	≤11.11	Resistant (R) (Score: ≤ 3.0) (PDI: ≤ 33.33)
2.0	Disease on two sheaths; lesions large and coalescent (10.1-20%).	22.22	
3.0	Disease up to four sheaths; lesions many and always coalescent (20.1-30%).	33.33	
4.0	As in disease rating symptoms of 3.0, + rind discolored with small lesions (30.1-40%).	44.44	Moderately resistant (MR) (Score: 3.1–5.0) (PDI: 33.34-55.55)
5.0	Disease on all sheaths except two internodes blow the ear (40.1-50%).	55.55	
6.0	Disease up to one internode below ear shoot; rind discoloration on many internodes with large depressed lesions (50.1-60%).	66.66	Moderately susceptible (MS) (Score: 5.1-7.0) (PDI: 55.56-77.77)
7.0	Disease up to the internodes bearing the ear shoot but shank not affected (60.1-70%).	77.77	
8.0	Disease on the ear; husk leaves show bleaching, bands and cracking among themselves as also silk fibers; abundant fungal growth between and on kernels; kernels formation normal except being lusterless; ear size less than normal; some plants prematurely dead (70.1-80%).	88.88	Susceptible (S) (Score: >7.0) (PDI: >77.77)
9.0	In addition to disease rating symptoms of 8.0, shrinkiage of stalk; reduced ear dimension; wet rot and disorganization of ear; kernel formation absent or rudimentary; prematurely dead plants common; abundant sclerotia production on husk leaves, kernels ear tips and silk fibers (>80%).	99.99	

3. Brown stripe downy mildew (BSDM)

Artificial epiphytotic conditions can be created by placing the powdered infected maize leaves containing spores collected during the last season containing oospores in furrows just before planting. This inoculum could also be prepared by collecting infected leaves supposed to be full of oospores from early plantings of maize of the same season, drying

leaves and making powder out of the debris. Inoculum should be placed in furrows in such a manner that seeds were in proximity of inoculum.

Artificial epiphytotic condition could also be created by putting 2-3 cm pieces of freshly infected leaves containing sporangia of the fungus in the whorls of seedlings. This should be done during cloudy weather in the evening between 5 and 7 P.M. at 17, 24 and 30 days after planting. In experimental plots, where disease occurs year after year, only this method is adequate for creating epidemics. In areas of low disease incidence, both the methods of inoculation can be combined to obtain better results. Disease rating of individual maize varieties can be done by evaluation all plants of the row (s) using modified 1-9 rating scale of Payak and Sharma (1983) as described below:

Rating scale	Degree of infection (per cent DLA)	PDI	Disease reaction
1.0	Nil to very slight infection (≤10%).	≤ 11.11	Resistant (R) (Score: ≤ 3.0) (PDI: ≤ 33.33)
2.0	Slight infection, a few stripes scattered on two lower leaves (10.1-20%).	22.22	
3.0	Light infection, moderate number of stripes scattered on four lower leaves (20.1-30%).	33.33	
4.0	Light infection, moderate number of stripes scattered on lower leaves, a few stripes scattered on middle leaves below the cob (30.1-40%).	44.44	Moderately resistant (MR) (Score: 3.1-5.0) (PDI: 33.34-55.55)
5.0	Moderate infection, abundant number of stripes scattered on lower leaves, moderate number of stripes scattered on middle leaves below the cob (40.1-50%).	55.55	
6.0	Heavy infection, abundant stripes on lower leaves, moderate infection on middle leaves and a few stripes on two leaves above the cob (50.1-60%).	66.66	Mod. susceptible (MS) (Score: 5.1-7.0) (PDI: 55.56-77.77)
7.0	Heavy infection, abundant stripes on lower and middle leaves and moderate number of stripes on two to four leaves above the cob (60.1-70%).	77.77	
8.0	Very heavy infection, stripes abundant on lower and middle leaves and spreading up to the flag leaf (70.1-80%).	88.88	Susceptible (S) (Score: >7.0) (PDI: >77.77)
9.0	Very heavy infection, stripes abundant all leaves. No cob formation. Plants may be killed prematurely (>80%).	99.99	

4. Curvularia leaf spot (CLS)

Mass multiplication of culture is done on half cooked sorghum grains and after evaporating excess moisture from surface, the grains are filled in 500 ml conical flasks and plugged properly. These are autoclaved for two hours at 15 lbs pressure and inoculated when cooled down at room temperature with pure culture of *Curvularia lunata*. After completion of mycelial growth which may take 15-20 days at temperature around 25-27 degree C, these grains are washed in RO water to get conidial suspension of $5X10^4$ conidia per ml. A bucket full of suspension is enough for spray inoculation of two 480 meter strip. The washed grains are spread in a tray to get again mass of conidia. After two days gap, one more spray inoculation is done as per previous method, but this time conidial suspension should be half of the previous one.

At least three observations are made and third observation at 80-85 DAS would be final based on leaf area covered by spots caused by pathogen. Observations are recorded using 1-9 rating scale (Hou *et al.,* 2013**)** as described below:

Rating scale	Degree of infection (percent DLA)	PDI	Disease reaction
1.0	≤10 % area of leaf infected	≤11.11	Resistant (R) (Score: ≤ 3.0) (PDI: ≤ 33.33)
2.0	10.1-20 % area of leaf infected	22.22	
3.0	20.1-30 % area of leaf infected	33.33	
4.0	30.1-40 % area of leaf infected	44.44	Moderately resistant (MR) (Score: 3.1–5.0) (PDI: 33.34-55.55)
5.0	40.1-50 % area of leaf infected	55.55	
6.0	50.1-60 % area of leaf infected	66.66	Mod. susceptible (MS) (Score: 5.1-7.0) (PDI: 55.56-77.77)
7.0	60.1-70 % area of leaf infected	77.77	
8.0	70.1-80 % area of leaf infected	88.88	Susceptible (S) (Score: >7.0) (PDI: >77.77)
9.0	>80% % area of leaf infected	99.99	

5. Common rust (C. rust) and Polysora rust (P. rust)

The rust is an obligate parasite and thus, it is very difficult to grow it on artificial media under laboratory condition. Though, for some specific purposes small amount of inoculum can be grown under laboratory condition on detached leaf culture. But, this meager amount of culture obtained by such method is not sufficient to be utilized for large scale screening trials under field conditions. Therefore, naturally infected leaves showing large number of uredopustules may be collected from different places so that all the prevalent races in the areas may be utilized for screening the materials against the prevalent rust fungus.

The infected leaves thus collected should be macerated thoroughly in between two palms of the hands dipped under a bucket of water until the water gets sufficiently coloured. The uredospores can also be collected on a butter paper by tapping the severely infected leaves with fingers and then stored in glass vial or glass tube which can be sealed easily under a flame. The uredospores, thus obtained may be kept for longer period in the freezer at lower temperature i.e. 5-7°C and can also be easily carried to some distant places for inoculation purposes.

For inoculating the plants in a field use of a knapsack sprayer is very useful. The spore suspension should be sprayed over the plants during the second half of the day when the sun becomes mild. While spraying inoculum, the nozzle of the sprayer should be kept over whorl of the plant and all the leaves may be sprayed thoroughly. The spore suspension must be stirred continuously during spraying as the light spores aggregate together on the upper surface of the water.

Repeating the inoculation two to three times gives a good result. In addition 2-4 lines of susceptible varieties grown as border rows around the screening plots also help to spread the disease. Disease rating is done as per scale devised by Lubberstedt *et al.* (1998) and Paterniani *et al.* (2000).

Rating scale	Degree of infection (per cent DLA)	PDI	Disease reaction
1.0	No uredia or hypersensitive flecks (<1%).	<11.11	Immune/HR (Score: <1.0) (PDI: < 11.11)
2.0	Very slight infection, one or two pustules on lower leaves only (1.0%).	22.22	Resistant (R) (Score: 1.1-2.0) (PDI: 11.12-22.22)

3.0	Very slight to slight infection, few scattered pustules on lower leaves only (1.1-10%).	33.33	Moderately resistant (MR) (Score: 2.1-4.0) (PDI: 22.23-44.44)
4.0	Light infection, few scattered pustules on lower leaves only (10.1-20.0%)	44.44	
5.0	Moderate infection, moderate number of pustules on lower leaves only (20.1-30%)	55.55	Moderately susceptible (MS) (Score: 4.1-6.0) (PDI: 44.45-66.66)
6.0	Moderate infection, abundant pustules on lower leaves; few on middle leaves (30.1-40%)	66.66	
7.0	Severe infection (40.1-60%)	77.77	Susceptible (S) (Score: >6.0) (PDI: >66.66)
8.0	Severe infection, abundant pustules on lower and middle leaves; extending to upper leaves (heavy infection) (60.1-80%)	88.88	
9.0	Severe infection, abundant pustules on all leaves, plant may dry prematurely or killed by the disease (very heavy infection) (>80%)	99.99	

6. Brown spot (BS)

For preparation of inoculum, the infected leaves (fresh or stored for 1-2 years) are taken and crushed into small pieces. These are put in water for thorough moistening and then blended in a blender in tap water. The resultant is filtered through muslin cloth. The filtrate is diluted to bring the concentration of sporangia up to 5000/ml of water. This inoculum is filled in small dropper bottles and the desired plants at susceptible stage (30±10 days) are inoculated by putting 2-3 drops of inoculum into the whorl. The disease appears after 10-20 days. Disease rating is done with modified scale of Payak and Sharma (1983).

Rating scale	Degree of infection (per cent DLA)	PDI	Disease reaction
1.0	Nil to very slight infection (≤10%).	≤ 11.11	Resistant (R) (Score: ≤ 3.0) (PDI: ≤ 33.33)
2.0	Slight infection, a few lesions scattered on two lower leaves (10.1-20%).	22.22	
3.0	Light infection, moderate number of lesions scattered on four lower leaves (20.1-30%).	33.33	
4.0	Light infection, moderate number of lesions scattered on lower leaves, a few lesions scattered on middle leaves below the cob (30.1-40%).	44.44	Moderately resistant (MR) (Score: 3.1–5.0) (PDI: 33.34-55.55)
5.0	Moderate infection, abundant number of lesions scattered on lower leaves, moderate number of lesions scattered on middle leaves below the cob (40.1-50%).	55.55	
6.0	Heavy infection, abundant number of lesions scattered on lower leaves, moderate infection on middle leaves and a few lesions on two leaves above the cob (50.1-60%).	66.66	Moderately susceptible (MS) (Score: 5.1-7.0) (PDI: 55.56-77.77)
7.0	Heavy infection, abundant number of lesions scattered on lower and middle leaves and moderate number of lesions on two to four leaves above the cob (60.1-70%).	77.77	
8.0	Very heavy infection, lesions abundant scattered on lower and middle leaves and spreading up to the flag leaf (70.1-80%).	88.88	Susceptible (S) (Score: >7.0) (PDI: >77.77)

9.0	Very heavy infection, lesions abundant scattered on almost all the leaves, plant prematurely dried and killed (>80%).	99.99	

7. Zonate leaf spot (ZLS)

The fungus is isolated from zonate leaf spot infected maize plants on Potato Dextrose Agar (PDA) and incubated at 28 ± 1°C. The growing mycelium from the margin of distinct colonies is then sub-cultured on fresh petriplates containing (PDA) to obtain pure culture. Plants in the field are artificially inoculated by spraying the spore suspension of *Gloeocercospora sorghi* containing 5×10^4 spores/ml. The inoculum was sprayed between 6-7 pm as night temperature and humidity were conducive for infection. The observations on disease severity are recorded in 1-9 scale 60 DAS as followed in All India Coordinated Sorghum Improvement Project.

Rating scale	Degree of infection (per cent DLA)	PDI	Disease reaction
1.0	0 to ≤1% leaf area covered/ no symptom	≤ 11.11	Resistant (R) (Score: ≤ 3.0) (PDI: ≤ 33.33)
2.0	1.1 to 5% leaf area covered	22.22	
3.0	5.1 to 10% leaf area covered	33.33	
4.0	10.1 to 20% leaf area covered	44.44	Moderately resistant (MR) (Score: 3.1–5.0) (PDI: 33.34-55.55)
5.0	20.1 to 30% leaf area covered	55.55	
6.0	30.1 to 40% leaf area covered	66.66	Moderately susceptible (MS) (Score: 5.1-7.0) (PDI: 55.56-77.77)
7.0	40.1 to 50% leaf area covered	77.77	
8.0	50.1 to 75% leaf area covered	88.88	Susceptible (S) (Score: >7.0) (PDI: >77.77)
9.0	>75% leaf area covered	99.99	

8. Ear and cob rots (ECR)

The ear and cob rots are caused by species of *Fusarium*, *Cephalosporium*, *Aspergillus*, *Diplodia*, *Botryodiplodia theobromae*. The pathogens are isolated and identified from infected kernels. Infected kernels are surface sterilized with in 50 ml of a 1:10 dilution of commercial sodium hypochloride and water (0.3 to 0.6% final concentrations) for 2 minutes, rinsed in sterile water and blot dried on sterile paper. Three seeds are placed at equidistance in a Petri dish containing potato dextrose agar (PDA). After three to four days of incubation, the growth of the fungus would be sufficient for obtaining pure cultures of the pathogens. Pure cultures of the suspected ear rot pathogen are prepared by transferring small sections (0.2 mm^2) of the growing tip of the mycelium that show no mixture of different types of mycelium or bacterial growth. After 2-3 weeks when the fungus has covered the surface of the agar, one of the representative cultures should be observed in the microscope to ensure that the correct fungus was isolated based on morphological structures. The cultures at this time should be stored in a sealed plastic bag in the refrigerator (5-10^0C) to maintain good quality cultures for preparing the inoculum.

For production of *Fusarium verticilloides* and *Aspergillus flavus* inocula for field inoculations, 10 to 20 ml of sterile distilled water is added to a Petri dish containing a pure culture of the fungus using sterile technique and the spores and mycelia are scraped from the agar using a small laboratory spatula and added to a jar containing 1 liter of sterile water. Protective rubber gloves should be used in the preparation of the inoculum since this fungus produces mycotoxins that are water soluble. The contents of the container are mixed and the solution is poured through two layers of gauze placed in a funnel to collect the concentrated spore solution. The spore concentration obtained from a one liter jar is in the order of $2x10^5$ spores/ml and this solution needs to be diluted with water to arrive at the concentration for field inoculations. The stock solution should be stored immediately in the refrigerator and can be used over a period of one week. A spore concentration

of $5x10^5$ spores/ ml is prepared immediately before use (normally 5-10 ml of the stock solution added to one liter of water).
Inoculations for *Fusarium verticilloides* and *Aspergillus flavus* ear rots are done 7-10 days after pollination using a spore suspension with $2x10^5$ spores/ml. The period of 0-14 post-female flowering is the window where the ear is most susceptible to *Fusarium verticilloides* ear rot. For *Fusarium graminearum*, 1 ml of the spore suspension is injected in the silk channel using a repeater syringe used for vaccinating swine at 7-10 days after silking.

Rating scale	Degree of infection (per cent DLA)	PDI	Disease reaction
1.0	0% rot on the cob	0.0	Resistant (R) (Score: ≤ 3.0) (PDI: ≤ 33.33)
2.0	0.1–5% rot on the cob	22.22	
3.0	5.1–10% rot on the cob	33.33	
4.0	10.1–25% rot on the cob	44.44	Moderately resistant (MR) (Score: 3.1-5.0) (PDI: 33.34-55.55)
5.0	25.1–40% rot on the cob	55.55	
6.0	40.1–55% rot on the cob	66.66	Mod. susceptible (MS) (Score: 5.1-7.0) (PDI: 55.56-77.77)
7.0	55.1–70% rot on the cob	77.77	
8.0	70.1–85% rot on the cob	88.88	Susceptible (S) (Score: >7.0) (PDI: >77.77)
9.0	>85.1% rot on the cob	99.99	

9. Sorghum downy mildew (SDM)

A. Screening through direct inoculation with conidia:

i. *Collection and maintenance of inoculum*: Sorghum plants showing systemic infection of downy mildew from the farmer's fields in and are collected during morning hours, preserved in polythene bags and brought to the laboratory. Conidiophores and conidia from the white bloom found on the lower surface of the leaves are washed with a fine jet of distilled water and conidial suspension is collected from the sorghum leaves. The seedlings of susceptible cultivar are spray inoculated at 2 leaf stage (6-7 days old) with the conidial suspension collected from the sorghum leaves. The inoculation of the seedlings is continued till the plants reached 15 days and systemic symptoms are seen. The inoculum from these plants is multiplied by spray inoculating to the fortnightly sowings of maize. The infected plants are maintained in the plot throughout the experimental period. Artificial inoculation technique developed by Lal and Singh (1984) is followed to induce the disease incidence by spraying conidial suspension between 2.30 a.m. and 4.00 a.m.

ii. *Evaluation of maize genotypes under artificial inoculation:* Maize genotypes are evaluated against sorghum downy mildew by artificial inoculation. Artificial inoculation is done when the plants are at two leaves stage as described by Lal and Singh (1984). Diseased plants from which inoculum required to be drawn is sprayed with water at 6.00 PM so that leaves would have a thin film of water for good sporulation. By 2.00 AM, the inoculation crew assembles in the field with cleaned sprayers, torches and buckets. By 2.30 AM the diseased leaves with good sporulation are searched and washed in the water at the rate of 15 leaves per litre of water collected in the buckets. This operation is completed by 3.00 AM. Then the collected spore suspension in different buckets is thoroughly mixed and made upto 25 litres. The 25 litres of conidial inoculum is collected from 375 diseased leaves. The inoculation is completed by 4.00 AM with hand compression sprayer. Between 6.00 AM and at 6.00 PM water spray is given to the inoculated plot to create the

required humidity artificially. With this method 100 percent disease incidence was created.

B. Spreader row technique: Spreader rows are sown 15-20 days prior to the sowing of the entries in 2.5 meter bands with a row spacing of 60 cm and plant to plant spacing of 30 cm. each band consisting of four rows surrounding on all the four directions. For this, highly susceptible variety will be used. Inoculation of these spreader rows is done by following the above artificial inoculation procedure. Test entries were sown as mentioned above.

Per cent disease incidence is recorded 35 days after sowing and the entries are classified according to their disease reaction as described by Lal and Singh (1984).

Disease incidence (%)	Disease reaction
≤ 10	Resistant
10.1 – 25.0	Moderately resistant
25.1 – 50.0	Moderately susceptible
≥ 50.0	Susceptible

10. Rajasthan Downy Mildew (RDM)

Downy mildew nursery is required for artificial inoculation purposes. Susceptible maize cultivar is grown in cage house and the plants are inoculated at seedling stage by placing bits of downy mildew infected grasses *Heteropogon contortus* and *H. melanocarpus.* Humidity around 90% is maintained in the cage house. Chlorotic symptoms along with light green color extends up to upper green portion are typical symptoms. During midnight hours a layer of conidia can be seen. These plants serve as source of inoculum for artificial inoculation.

Since the pathogen is of nocturnal nature and produces conidia during 12:00 to 6 AM, hence the freshly harvested conidia are collected in distilled water or RO water. Before collecting conidia the leaves can be washed before an hour so as to get fresh viable conidia. For screening the test entries, susceptible entries should be planted before 15 days and should be inoculated first. Since this pathogen does not form oospores on maize, hence sick plot technique does not work. The conidial suspension of harvested conidia is filled in dropping bottle to put drops of inoculum at seedling stage (6-7 days old) in the whorl (a cup like structure of upper leaf) during 3-5 AM. This should be done for 4-5 days regularly to avoid any escape. After 15-20 days symptoms become visible.

The observation is recorded as percent infected plants in a row out of total plants. At least three observations are taken at 30, 50 and 80 DAS. The last observation is considered as final, but number of plants is considered as of first observation. This is because some plants die and disappear due to infection. The entries are classified according to their disease reaction as described by Lal and Singh (1984) for SDM.

8. Pre-flowering stalk rot (Bacterial stalk rot)

A virulent isolate of *Erwina chrysanthemi* corn pathotype should be selected for inoculation. To maintain the virulence of the bacterium, it should be inoculated on healthy plants and then reisolated every year before mass inoculation. In order to isolate a virulent strain, the inoculated plants showing characteristic symptoms of the disease are selected. A small piece of rotten internode is immediately dipped into mercuric chloride solution (1:1000) for 5 seconds and passed through three changes of sterile water. The piece is then cut into two halves with sterilized blade, put into little sterile water and then teased apart with sterile needle. The small quantities of resulting suspension are then removed with a flamed wireloop and streaked out on well dried nutrient agar plates, the aim being to separate the cells so that they produce individual colonies. The characteristic colonies are identified after 2 days of incubation at 30°C and used for subculturing. The culture is used for testing the pathogenicity. The cultures which induce the typical symptoms of the disease within 48 hours of inoculation are used for mass inoculation. The inoculum is increased for mass inoculation on nutrient broth for 48 hours

at 30°C. The inoculum was diluted 10 times with sterile water to maintain a concentration of approximate $1X10^{7-9}$ bacteria/ml.

The inoculation may be carried out when the crop is at the pre-silking stage or until flowering has reached 75%. To inoculate the plants a diagonal hole is made in the middle of second internode from the ground to the pith. One milliliter of bacterial suspension is injected into the plant through the hole by a hypodermic syringe. If necessary, a second inoculation may be done one week later in the third internode from the ground**.** Percent disease incidence is recorded 15 days after sowing and the entries are classified according to their disease reaction as described by Lal and Singh (1984) for SDM.

9. Post-flowering stalk rots (Charcoal rot, Fusarium stalk rot and Late wilt)

Screening for resistance against these diseases can is easily be done in sick plots. However, artificial inoculation is necessary where such plots are not available. For this purpose the fungal material should be isolated from the infected stalks, cultured and multiplied in the laboratory as described below.

Small bits cut from the infected stalks should be surface sterilized with 0.1 per cent mercuric chloride solution for one minute followed by washing in sterile distilled water. Finally a single bit is to be aseptically transferred to sterilized potato dextrose agar days at 26±2°C for getting the fungal hyphae to come out from the infected bits. Finally, the fungal hyphae is to be aseptically transferred to culture tubes containing the sterile PDA medium and to be incubated for about 10 days to get the stock culture of the pathogen to be used for increase of the inoculum in the laboratory for field inoculation.

Among various methods of field inoculation, the toothpick inoculation is followed for these diseases under the co-ordinated programmes. Round bamboo toothpicks about 6.5 cm long are boiled three times (about 1 hour each time) in tap water to remove toxic substances. After each boiling these are thoroughly washed in fresh water and dried in the sun. When these are thoroughly dry, they are loosely packed in bundles and put into the glass jars/ bottles and enough potato dextrose broth (one- third length of toothpicks) is added to thoroughly moisten the toothpicks plus some quantity in the bottom of the jars. The jars with the toothpicks are autoclaved immediately after the broth is added. Later the sterilized toothpicks are inoculated with the culture of the pathogen aseptically. The growth of the fungus covers the toothpicks and inoculum is ready for use in about 10 days.

Inoculations should be made just after flowering stage of plants. For inoculating plants, the lower internode (second/third) above soil level is opened with a jabber and the toothpick is inserted into the hole. The jabber is made by driving a nail of the diameter of the toothpick into a wooden handle. The head of the nail is ground off to a point and to the desired length (2cm). The round toothpicks effectively seal the hole in the stalk and prevent drying. The measurement is based on the proportion of disease present in the inoculated internodes and its subsequent spread. For scoring disease severity of PFSR, 1-9 rating scale of Payak and Sharma (1983) is followed:

Rating scale	Disease severity (%)	PDI	Disease reaction
1.0	Healthy or trace/slight discolouration at the site of inoculation.	11.11	Resistant (Score: ≤ 3.0) (PDI: ≤33.33)
2.0	Up to 50% of the inoculated internode is discoloured	22.22	
3.0	51-75% of the inoculated internode is discoloured	33.33	
4.0	76-100% of the inoculated internode is discoloured	44.44	Moderately resistant (Score: 3.1- 5.0) (PDI: 33.34 - 55.55)
5.0	Less than 50% discolouration of the adjacent internode	55.55	

6.0	More than 50% discolouration of the adjacent internode	66.66	Moderately susceptible (Score: 5.1 - 7.0) (PDI: 55.56 - 77.77)
7.0	Discolouration of three internodes	77.77	
8.0	Discolouration of four internodes	88.88	Susceptible (Score: ≥ 7.0) (PDI: ≥ 77.77)
9.0	Discolouration of five or more internodes and premature death of plant	99.99	

10. Maize cyst nematode (*Heterodera zeae)*

Plant parasitic nematodes are responsible to causes 10.2% losses o maize. Though, large number of plant parasitic nematodes attacks on maize but maize cyst nematode (*Heterodera zeae*) is considered as most important and therefore, screening trials are carried out under artificially inoculated conditions in permanent plots to find out source of resistance against maize cyst nematode (*Heterodera zeae*). The observations on nematode infestation are recorded after 45 days of germination. The varieties/hybrids/ lines are categorized on the basis of cyst/plant as mentioned below:

S. No.	Number of cyst/plant	Category
1	0 - 4 cyst/plant	Resistant
2	Above 4 - 9 cyst/plant	Moderately Resistant
3	Above 9 cyst/plant	Susceptible

*** Calculation of Percent Disease Index (PDI) of Foliar Diseases of Maize**

Percent disease index (PDI) is calculated using the following formula of Mckinney (1923).

$$\text{Percent disease index (PDI)} = \frac{\text{Sum of Individual Rating}}{\text{No. of Leaves Examined}} \times \frac{100}{\text{Maximum Disease Rating}}$$

On the basis of PDI, the inbred lines/ varieties/ hybrids can be classified as resistant (R), moderately resistant (MR), moderately susceptible (MS) and susceptible (S). The test inbred lines/ varieties/ hybrids with resistant reaction are considered acceptable for a breeding programme whereas test inbred lines/ varieties/ hybrids with moderately resistant are acceptable when lines with resistant reaction are not available.

REFERNCES

AICRP on Maize. 1983. Techniques of scoring for resistance to diseases of maize. Indian Agriculture Research Institute, New Delhi, 133pp.

Ahuja, S.C. and Payak, M.M. 1983. A rating scale for BLSB. *Indian Phytopath*. 36: 338-40.

Zhou, R., Stanley, B. K. and Gene, E.S. 1983. A study of slow rusting of southern rust of corn: preliminary report. Bull. 925. Crop Science Research Laboratory, ARS, USDA & MAFES, Mississippi State University, MS.

Lal S., Singh, I.S. 1984. Breeding for resistance to downy mildews and stalk rots in maize. *Theor. Appl. Genet.* 69: 111–19

Lübberstedt, Th., Klein, D. and Melchinger, A.E. 1998. Comparative quantitative trait loci mapping of partial resistance to *Puccinia sorghi* across four populations of European flint maize. *Phytopath*. 88:1324-29.

Paterniani, M. E. A. Guidetti Z., Sawazaki, E., Dudienas, C., Duarte, A.P. and Gallo, P.B. 2000. Diallel crosses among maize lines with emphasis on resistance to foliar diseases. *Genet. Mol. Biol.* 23 (2): 381-85.

Balint-Kurti, P. J., Krakowsky, M. D., Jines, M. P., Robertson, L. A., Molnár, T. L., Goodman, M. M. and Holland, J. B. 2006. Identification of quantitative trait loci for resistance to southern leaf blight and days to anthesis in a maize recombinant inbred line population. *Phytopath*. 96:1067-71.

Muisa A. and Quimiob, A.J. 2006. Biological control of banded leaf and sheath blight disease (*Rhizoctonia solani* Kuhn) in corn with formulated *Bacillus subtilis* BR23. *Indonesian J. Agric. Sci.* 7(1): 1-7.

Henry, W.B., Williams, W.P., Windham, G.L. and Hawkins, L.K. 2009. Evaluation of maize inbred lines for resistance to aspergillus and fusarium ear rot and mycotoxin accumulation. *Agron. J.* 101 (5): 1219-26.

Chia-Lin Chung, Longfellow, J.M., Walsh, E.K., Kerdieh, Z., Esbroeck, G.V., Balint-Kurti, Peter and Nelson, R.J. 2010. Resistance loci affecting distinct stages of fungal pathogenesis: use of introgression lines for QTL mapping and characterization in the maize -*Setosphaeria turcica*pathosystem. *BMC Plant Biol.* 10: 103.

Wm. E. Dolezal. 2011. Corn rusts: Common rust, Southern rust & Tropical rust. APS 2011 *Field Crops Rust Symposium*, San Antonio, TX .

Shekhar, Meena and Kumar, Sangit. 2012. Inoculation methods and disease rating scales for maize diseases. Directorate of Maize Research (ICAR), New Delhi, 31pp.

Hou, J., Xing, Y., Zhang, Y., Tao, Y., Tan, G., Xu, M. 2013. Identification of quantitative trait loci for resistance to Curvularia leaf spot of maize. *Maydica* 58: 266-73.

Purohit, J., Singh, Y., Bisht, S. and Srinivasaraghvan, A. 2013. Evaluation of antagonistic potential of *Trichoderma harzianum* and *Pseudomonas fluorescens* isolates against *Gloeocercospora sorghi* causing zonate leaf spot of sorghum. *The Bioscan* 8(4): 1327-30.

Mitiku, M., Eshte, Y., Shiferaw, W. 2014. Evaluation of maize variety for northern leaf blight (*Trichometasphaeria turcica)* in south Omo zone. *World J. Agric. Res. 2 (5): 237-39.*

Vieira, R.A., Mesquini, R.M., Silva, C.N., Hata, F.T., Tessmann, D.J., Scapim, C.A. 2014. A new diagrammatic scale for the assessment of northern corn leaf blight. *Crop Prot.* 56: 55-57.

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