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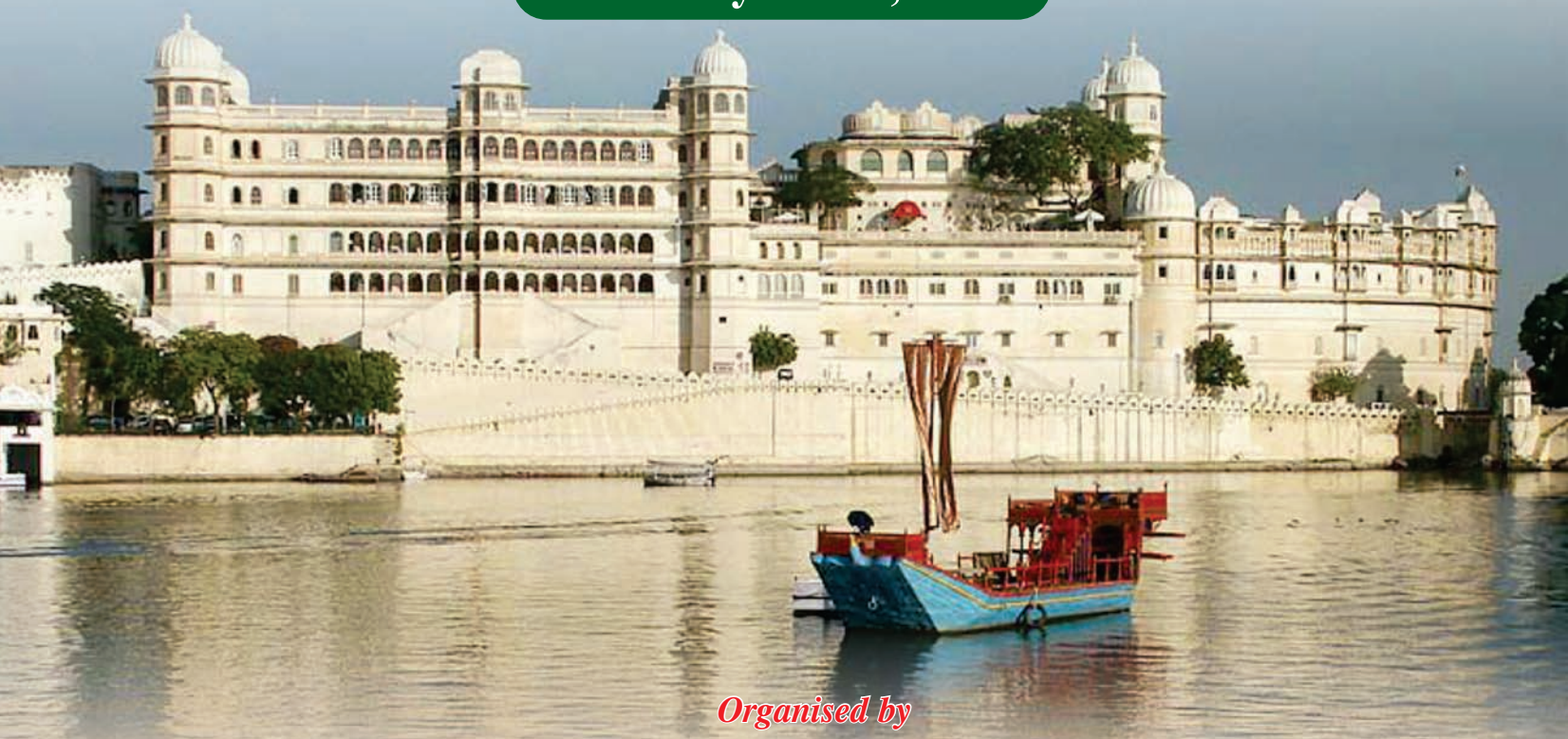
on
Maize for Resource Sustainability, Industrial Growth and Farmers' Prosperity

February 23-25, 2022



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Maize Technologists Association of India (MTAI), New Delhi

In collaboration with

Indian Council of Agricultural Research (ICAR), New Delhi
ICAR-Indian Institute of Maize Research (ICAR-IIMR), Ludhiana
Maharana Pratap University of Agriculture and Technology, Udaipur
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Theme-1
Genetic innovations in maize

T-1/O-1

A novel technique high throughput phenotyping for maize

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Maize (*Zea mays* L.) is one of the important economic, staple food crop and energy plant among cereals which is cultivated globally for fulfilling the requirement of human being and is a vital source of income overwhelming population. Traits like yield and yield related are measured by conventional methods. However, precision phenotyping still remains a bottleneck. Conventional phenotyping techniques are prohibitively expensive, time-consuming, slow, and frequently harmful, and they only allow for the analysis of a few variables at a time. To address the challenges of manual phenotype, a new recent method high throughput phenotyping (HTPPs) is considered a promising tool. The development of high-throughput phenotyping technology began in the preceding decade as advancements in sensor, computer vision, automation, and advanced machine learning technologies. HTPPs platforms are being utilized to undertake non-destructive assessments of the complete plant system in a range of crops. HTPPs provide the precise measurements and suggested the collection of high-quality and accurate data which is necessary for standardizing phenotyping for the collection of genetic dissection and genomic assisted breeding such as genome-wide association studies (GWAS), linkage mapping, marker-assisted selection (MAS), genomic selection (GS). The remainder of this chapter discusses how high-throughput phenotyping technologies can be used in genomic-assisted breeding for maize crop.

T-1/O-2

Predicting genetic progress through correlation and heritability studies in sweet corn and normal corn crosses

R. Ravikesavan, K. Kavya, N. Kumari Vinodhana and A.P. Sivamurugan

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Normal corn and sweet corn were the equally important endosperm types of corn in breeding. In the current study these two diverse endosperm types were crossed with the objective of predicting genetic progress among the heterotic hybrids through correlation and heritability studies. The selection criteria can thus be articulated based on heritability and correlation estimates (Falconer, 1989). Three sweet corn and seven normal corn inbreds were crossed in Line × Tester mating fashion and the heterotic hybrids were evaluated in randomized block design. Anthesis silking interval, kernels per row, cob length, plant height, cob placement height, total sugars, non-reducing sugars and green cob weight were the traits with high heritability and genetic advance as percent of mean. Plant height in direct crosses and kernel rows in reciprocal crosses were strongly and positively correlated to green cob weight. High heritability coupled with high GAM values strengthens the practical applicability of selection (Johnson et al., 1955). Traits with high heritability and high GAM are thus confronted to be responsive to selection. Screening for the traits with strong association to green cob weight ensures the possibility of simultaneous improvement of cob defining traits to effectively improve green cob weight eventually.

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T-1/O-3

Assessing reciprocal cross effect on combining ability and heterosis in heterotic hybrids by crossing diverse endosperm types of corn

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Enhancing the heterotic pool of corn by crossing diverse endosperm types, namely normal corn and sweet corn was one of the potential approaches to tap wider genetic variability (Revilla *et al.*, 2000). Current study was established with the objective of understanding the maternal effect on the establishment of combining ability and heterotic patterns in normal corn and sweet corn crosses. Seven normal corn and three sweet corn inbreds were crossed in Line × Tester mating fashion and the heterotic hybrids were evaluated in randomized block design. Hundred grain weight was the only trait that expressed significantly negative reciprocal cross effects. NCL3 × SCT2; NCL6 × SCT2 and SCL1 × NCT3 were the most promising hybrids predicted based on desirable mean performance, sca effects, standard heterosis and reciprocal cross effects. Differential expression of combining ability and heterosis based on the maternal and paternal parent used addresses the requirement of additional research on kernel endosperm related traits (Jumbo and Careena, 2008). Accuracy in predicting the manifestation of heterosis in hybrids will be thus increased by including reciprocal cross effect estimates.

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T-1/O-4

Inheritance and validation of molecular markers for kernel row number in tropical maize

Sahana Police Patil[1], R.N. Gadag[1], Ganapati Mukri[1*], Jayant S. Bhat[1], Chandu Singh[1], Navin C. Gupta[2], Jyoti Kumari[3], Kumari Shilpa[1] and Chandra Prabha[1]

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Grain yield in maize is a complex trait, determined by many component traits. However, kernel row number (KRN) is a major trait with high heritability among the other parameters contributing to yield. But the genetic information on KRN component in tropical germplasm is meager. This study was conducted to understand the number of genes controlling KRN, its inheritance pattern and also to validate the molecular marker/s associated with KRN trait in tropical maize genotype. Maize lines from two F_2 populations' *viz*., population I derived from AI 505 × AI 542 and population II derived from AI 505 × AI 541 were evaluated for yield and yield contributing parameters during *Kharif*- 2020 at ICAR-IARI, New Delhi. The KRN data of F_2 individuals from both the populations were fit to a gene model as explained by the classical work of East (1916). Bulked segregant analysis approach (BSA) was used to identify putative markers linked to this trait. A set of 69 QTL-based SSR markers linked to the KRN trait was used in assessing the parental polymorphism between high and low KRN parental lines, of which 21 markers were found to be polymorphic. Of these, six were found to be polymorphic between the high and low KRN bulks. These six markers were further used in the analysis for their association with the KRN trait. From the population I having 232 F_2 individuals, one individual exhibited a high KRN parental phenotype which was approximately equal to one in 256 i.e. $1/4^4$. Similarly, population II having 250 F_2 individuals exhibited 17 individuals with a high KRN parental phenotype which was approximately equal to one in 16 i.e. $1/4^2$. The result was again endorsed by Wright and Castle estimator (Wright, 19680), implying that 4 and 2 factors determine the KRN component in populations I and II, respectively. A putative QTL was identified on chromosome 2, having 10.24 and 18.26 as LOD and PVE (%) respectively with flanking markers bnlg 1017 and umc2027. The component determining kernel row number (KRN) exhibits oligogenic inheritance in tropical maize. Among the marker analyzed the SSR marker bnlg1017 appears to be putatively linked to KRN traits. Further fine mapping of the identified QTL may give insight into the linked markers followed by the genes responsible for KRN in tropical maize.

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T-1/O-5

Amino acid substitution causes variation in kernel row number determined by *fea*4 gene in tropical maize

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Kernel row number (KRN) is one of the important domestication traits that have a positive correlation with grain yield. Recently,an allele of the *fea*4 gene that regulates shoot meristem size and number of primordia without reducing ear length or triggering fasciation, both of which would be detrimental to yield, was isolated (Pautler et al., 2015). However, the possibility of additional variation due to the different genetic backgrounds, cannot be ignored. Hence, to understand the cause of KRN variation in tropical field corn, a next-generation sequencing methodology was employed. Two genotypes each for 10, 12, 14, and >14 KRN we sequenced for *fea*4 gene (Gene ID: GRMZM2G133331). The generated gene sequences were aligned through Clustal Omega for multiple sequence alignment and variant calling was performed to identify SNPs and/or INDELs.The SNPs and/or INDELs variations present in the exonic regions were considered to capture transitional changes using FGENESH software. The translated sequences present in the open reading frame were aligned using the Clustal Omega and identified the variation in amino acid sequences. Nucleotide positions 1188,1214 and 2442 showed SNPs among high and low KRN genotypes *viz*.., A>T, G>C, and T>C, respectively (Table1). The transversion at 1188 causes changes in amino acid (Serine: Threonine) and the other two positions contained synonymous changes. Cultivated maize exhibits wide variability for kernel row number (8-24). The available information on the KRN gene in maize suggests its functional variability. In the present investigation, amino acid substitution is evident that causes variation in KRN in tropical maize.

Reference:

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T-1/O-6

Analyzing the genetic variability in maize inbreds across locations for Morphological and Biochemical Traits

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Maize is a major staple crop and has been predominantly used in food and feed sector. It is highly rich in nutrients and is found to have a higher phytic acid. This hinders the absorption of nutrients and minerals in maize based foods and hence its variability in germplasm is being explored (Pramitha *et al.* 2019). A set of forty inbreds were raised across three locations and were evaluated for twenty morphological and four biochemical traits including phytic acid, free inorganic phosphorous, starch and tryptophan. A principal component analysis in the ideal environment was performed. PCA dissected twenty-four components out of which seven were reliable. The maximum variability in the population accounted for 77.71% and PC1 had a major contribution towards the variability contributing for 32.00%. PC1 had a maximum positive contribution from free inorganic phosphorous (0.2677) whereas the traits viz., cob weight (-0.3202) and single plant yield (-0.2976) had the maximum negative influence towards the genetic variability. The positive contribution towards the variability from PC2 were rendered by shank weight (0.3198) and tassel length (0.2726). Among the 24 diverse traits, it was observed that days to 50% tasseling and silking varied together. Similarly, starch, seed thickness and shelling% were positively associated with each other and free inorganic phosphorous alone was negatively related to all the other traits. Hence, selection for lines with a higher free inorganic phosphorous has to be focused in a proper way so that there is minimum reduction in yield related traits of maize (Kumari *et al.* 2021).

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T-1/O-7

Evaluation of late maturity maize hybrids for identification of stable lines using various univariate methods

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A set of 62 late maturing maize single cross maize hybrids including four checks viz. NK 6240, CMH 08-287, CMH 08-282 and BIO 9682 were evaluated for stability. The traits included yield and yield component *viz.* plant height, days to 50% tasseling, days to 50% silking, days to maturity, cob number and cob weight. The experiment was laid out in alpha lattice design in four different environments *viz*., Coimbatore, Dharwad, Hyderabad and Karimnagar. The pooled analysis of variance revealed significant differences among the environments, hybrids and environments x hybrids interactions. The stability was assessed by the linear regression model suggested by Eberhart and Russell (1966) and top ten stable hybrids were identified *viz.*, QMH-1590, JH-16224, JH-15002, BIO-534, STARX-5, AH-1625, AH-8323, BLH-135, HT18007, MAH-14-239 with regression value near to one and non-significant deviation from regression. The stable lines were also identified using other univariate methods also *viz*. Shukla's stability variance (σ^2_i), Coefficient of variance (*CVi*), Huhn's and Nassar and Huhn's non-parametric statistics ($S^{(1)}$) Thennarasu's non-parametric statistics $NP^{(1)}$, *and* Kang's rank-sum (*KR)* and the results discussed.

T-1/O-8

Screening maize genotypes for phosphorus efficiency in calcareous soils

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Phosphorus (P) is an important major nutrient for better crop production but its use efficiency is very low due to various soil constraints such as high pH and calcareousness. It is highly unavailable to plants in calcareous soils due to its precipitation as insoluble Ca-P compounds (Wang *et al*., 2015). Plants have different adaptive mechanisms to stress caused by P deficiency which may vary from crop to crop and among the genotypes of same crop (Bobille *et al*., 2019). Hence a screening experiment was conducted to test the maize genotypes for P efficiency on soils having varying levels of calcareousness. Seven maize genotypes (CO(H)M6,CO7,CO8,CMH-12-686,CMH-11-586,CMH-15-005 and NK6240) were selected and grown for 45 days on calcareous soils having varying intensities of calcareousness (<5,5-10,10-15,15-20 & >20% free $CaCO_3$). All the genotypes were tested with and without P application to select the P efficient maize genotype. RESULTS: Out of the seven maize genotypes tested, CMH-12-686 recorded the highest plant height (61.5 to 91.8 cm), root length (16.6 to 30.8 cm) and SPAD index (24.2 to 38.8) in both P applied and omitted pots which were followed by CO7 and CO (H) M 6 genotypes. The genotypes NK 6240 and CMH-15-005 recorded the lowest growth attributes. Skipping P fertilization significantly reduced the growth attributes of all the maize genotypes in calcareous soils and the magnitude of growth reduction was greater with increasing soil calcareousness. The genotypes CMH-12-686, CO7, CO (H) M 6 can be grouped as P efficient genotypes and NK 6240 and CMH-15-005 can be grouped as P inefficient genotypes based on the growth attributes.

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T-1/P-1

Combining ability, gene action and heterosis in medium maturing maize inbreds under temperate conditions

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The investigation was carried out to generate information on combining ability (general and specific), gene action and heterosis. The experimental material comprised of 28 F_1's derived from crossing 8 maize inbred lines in a half diallel fashion. All the crosses along with parental lines and two checks (DHM-117 and PMH-10) were evaluated in a Randomized Complete Block Design (RCBD) with three replications at FoA, Wadura, SKUAST-K during *Kharif*, 2020. Data recorded for morphological, maturity, yield and yield attributing traits was subjected to analysis of variance (ANOVA) which revealed highly significant differences among the parents and their crosses indicating that the material selected was diverse. Variance analysis for combining ability revealed significant mean squares for GCA for all traits except ASI and significant mean sum of squares for SCA for all the traits indicating the importance of both additive and non-additive gene action in the inheritance of these traits. Estimates of GCA effects for different traits indicated that among the parents, BML-6, and UMI-1200 were having negatively significant GCA effects for maturity and LM-13, UMI1200 showed positive significant GCA effect for grain yield plant^{-1}. Estimates of SCA effects showed cross combinations viz., CML-451 X BML-6 and LM-14 X UMI1200 with highly negative and significant SCA effect for Days to maturity while as CML-451 X LM-13 and BML-10 X V-405 showed highly significant SCA effect for grain yield plant^{-1} in positive desirable direction. Estimates of standard heterosis for grain yield plant^{-1} revealed that cross combinations viz., CML-451 X LM-13,BML-10 X V-405 and BML-10 X UMI1200 showed significant (>30% heterosis over standard checks (DHM-117 and PMH-10). This study concluded that crosses combinations, which reflected substantial heterosis>30% over standard checks shall be further evaluated over locations to have a realistic estimate of the performance these experimental hybrids. Also parental lines with significant GCA effects in negative but desired direction and significant GCA effect for yield attributing traits can be utilized in future crossing programmes as potential parents for development of medium maturing and high yielding hybrids.

T-1/P-2

Genetic variation of Maize (*Zea mays* L.) genotypes for morphological and yield related traits at different growth stages

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Maize (*Zea mays* L.) is the largest crop in the world due to its adaptability and productivity, which is widely used as food, feed and raw material in industry. This study examined the performance of ten genotypes of maize for their morphological and yield traits under rainfed conditions. The field experiment was carried out at Dryland Agriculture Research Station (DARS) Budgam, under natural rainfed conditions, during *Kharif* 2018 season and it was laid out in a randomized block design with three replications. The genotypes were also evaluated for biomass partitioning as well as resource remobilization. A wide variation was recorded in all the traits *viz.*, Days to maturity, Plant height, Shoot biomass, Grain yield plant-1, Cob partitioning, Cob harvest index etc and the genotypes KG-2 (126.33), DT-1 (130.33) and SMC-3 (132.33) mature earlier indicating some escape mechanism in these genotypes under water stress. Thus, genotypes *viz.*, DT-1, DT-2, GM-6 and C-15 showed desirable attributes for most contributing traits at different parametric levels across water stress conditions and also contributed to high yield.

T-1/P-3

Heterotic grouping using combining ability effects among maize (*Zea mays* L.) germplasm lines

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Heterotic grouping of inbred lines is an important step in maize breeding. In the present study 64 hybrids were generated by crossing 32 germplasm lines with two testers (CM-111 and CM-202). These 64 F_1 hybrids along with checks were evaluated for grain yield along with different quantitative traits in alpha lattice design (10x7) at AICRP-Maize, UAS, Dharwad during *kharif*, 2019. Analysis of variance showed significant differences among different quantitative characters, similarly ANOVA for combining ability also revealed that mean sum of squares due to lines, testers and line x tester interaction as significant. Hence, these lines were subjected to heterotic grouping using HSGCA method. The 32 germplasm lines were grouped into heterotic group A (8), B (6) and AB (9), while nine lines were unclassified into any of the group. The lines grouped under AB heterotic group recorded highest *GCA* effects for grain yield GPM-27(25.5), GPM-18(20.3) and GPM-606(17.0). Whereas, GPM-114 (4.3) and GPM-702 (4.2) recorded highest *gca* status for grain yield from heterotic group A and B respectively. The lines belonging to AB heterotic group GPM-27 (96.7 q/ha), GPM-18 (91.6 q/ha), GPM-606 (88.3 q/ha) and GPM-30 (83.3 q/ha) also recorded highest mean grain yield when crossed to the two testers, hence these lines can be intercrossed among themselves to develop as heterotic population to derive high yielding inbred lines. Similarly, the line (GPM-114) with highest mean grain yield and *gca* status from heterotic group A can be crossed with GPM-706 from heterotic group B to get a high yielding heterotic hybrid. Overall two test hybrids recorded significantly highest grain yield GH-1809 (101.93 q/ha) and GH-1829 (101.71 q/ha) as compared to the best check 900M gold (95.74 q/ha). Both these hybrids GH-1809 (GPM-27 X CM-111) and GH-1829 (GPM-606 X CM-111) had their female lines from AB heterotic group with highest *gca* effects for grain yield and CM-111 as their common male parent.

T-1/P-4

Relationship between heterosis, potence ratio and genetic distance for morphological and yield contributing traits in maize

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Maize or corn is the third most important cereal crop after rice and wheat for India. Country is in heavy demand of Maize up to 65 million MT by 2050 (IIMR 2020). This increase in production should preferably come from increase in the productivity levels rather than the area hence; concentrated efforts are of top priority to enhance maize productivity. Genetic diversity plays a major role in the identification of suitable parents for a successful hybrid breeding programme (Moll *et al*. 1965, Hallauer 1972). However, a strong correlation between heterosis and parental genetic distance has been rarely observed (Melchinger 1999). In the present study, relationship between heterosis, potence ratio and parental genetic divergence were studied. Seven newly developed inbreds of maize *viz.*, BML-51, BML-32, BML-14, BML-13, BML-10, BML-7 and BML-6 were crossed in diallel fashion and obtained 21 single, 105 each of three way and double crosses in *kharif* 2014 and *rabi* 2014-15 and were evaluated in balanced lattice design in subsequent *kharif* season at Hyderabad, Karimnagar and Palem representing three different agro ecological zones of the state. Data recorded on inbreds and single crosses for thirteen yield and yield contributing characters was analyzed to estimate genetic distance, heterosis and potence ratio. Two highly heterotic crosses *viz*., BML-51 × BML-14 (8733 kg/ha) and BML-51 × BML-6 (8096 kg/ha) had significantly superior grain yield over the standard check NK-6240 (7151 kg/ha) with 22.1% and 13.2% useful heterosis, respectively and also had negative heterosis for days to 50% pollen shed, days to 50% silking and number of kernel rows ear^{-1}. Correlation between heterobeltiosis and useful heterosis of yield components with heterosis of grain yield revealed that cob components like ear length, number of kernels row^{-1},100 kernel weight are significantly and positively correlated with the grain yield heterosis in single crosses. Five traits *viz*., ear length, ear diameter, number of kernels row^{-1}, fodder yield and grain yield had positive potence ratio values of >1 for all the single crosses emphasizing the major role of over dominance for the inheritance of all these traits. Majority of crosses had inbreds with medium divergence. Similar results were reported by Arunachalam and Bandhopadhyay (1984), Dutta *et al*. (2004) and Ghosh *et al*. (2018). Based on the present investigation medium parental divergence coupled with high *per se* performance of inbreds is more important than merely high genetic diversity to tap the full potential of single cross hybrids.

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T-1/P-5

Influence of mating systems on genetic variability in F_4 populations of maize (*Zea mays* L.)

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Maize productivity is stagnated and the yields of modern cultivars are highly fluctuating with environmental variations. There is an utmost need to adopt diversified strategies for developing vigorous inbreds with broad genetic base so as to obtain highly heterotic and stable hybrids. In the present study, impact of selfing, sib mating and random mating systems on F_4 generations of single, three way and double crosses of maize has been investigated to identify a viable approach for developing superior inbreds. Single cross BML-14 x BML-6, three way cross (BML-10 x BML-6) x BML-14 and double cross (BML-32 x BML-6) x (BML-10 x BML-7) were raised during *kharif* 2016 and subjected to three mating systems *viz*., selfing, sib mating and random mating for three seasons during *rabi* 2016-17, *kharif* 2017 and *rabi* 2017-18 to generate F_2, F_3 and F_4 populations. In all the generations, each cross was raised in three plots for imposing three mating systems in Randomized Block Design with three replications. Nine populations thus developed were evaluated and compared for genetic variability parameters and trait associations in F_4 generation. Data was recorded on twelve phenological and yield traits. Highest mean values along with best recombinants were obtained from random mated populations. High phenotypic variance accompanied by low genotypic variance and heritability indicate the predominant role of non-additive gene action in this system. Highest estimates of genetic variance, heritability and genetic gains for majority of the traits were observed in sib mated progenies implying strong additive gene effects and hence trait selection and improvement in these genotypes will be highly effective (Sesay *et al*., 2016). Further, sib mating contributed to stronger correlations among yield and yield related traits than selfing while random mating exhibited mostly negative or weak positive associations. These differences in correlations indicate the impact of mating systems which could give different genotypic composition of the progenies. Results suggest that vigorous and competent inbred lines can be developed through sib mating as they retain certain levels of heterozygosity within them. Four or five cycles of random mating may be included prior to sib mating for obtaining diverse and promising recombinants. Double cross progenies were superior to other crosses in terms of genetic variability parameters and hence can be utilized in inbred development programmes.

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T-1/P-6

A novel technique high throughput phenotyping for maize

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Maize (*Zea maize* L.) is one of the important economic, staple food crop and energy plant among cereals which is cultivated globally for fulfilling the requirement of human being and is a vital source of income overwhelming population. Traits like yield and yield related are measured by conventional methods. However, precision phenotyping still remains a bottleneck. Conventional phenotyping techniques are prohibitively expensive, time-consuming, slow, and frequently harmful, and they only allow for the analysis of a few variables at a time. To address the challenges of manual phenotype, a new recent method high throughput phenotyping (HTPPs) is considered a promising tool. The development of high-throughput phenotyping technology began in the preceding decade as advancements in sensor, computer vision, automation, and advanced machine learning technologies. HTPPs platforms are being utilized to undertake non-destructive assessments of the complete plant system in a range of crops. HTPPs provide the precise measurements and suggested the collection of high-quality and accurate data which is necessary for standardizing phenotyping for the collection of genetic dissection and genomic assisted breeding such as genome-wide association studies (GWAS), linkage mapping, marker-assisted selection (MAS), genomic selection (GS). The remainder of this chapter discusses how high-throughput phenotyping technologies can be used in genomic-assisted breeding for maize crop.

T-1/P-7

Application of molecular markers analysis for genetic diversity in Maize

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Maize (*Zea maize* L.) is one of the important economic, staple food crop and energy plant among cereals which is cultivated globally for fulfilling the requirement of human being, and is a vital source of income overwhelming population. Several peoples consume maize as a food, an industrial product viz., starch, pharmaceuticals, alcoholic beverages, oil, cosmetics, textiles, etc. In ancient times, landraces were morepopular, due to presence of more genetic variability, resistant to biotic and abiotic factors andhave heterogeneous nature but now, it was replaced by improved and uniform cultivars with ahigher yield. Modern maize has more homogeneity which is vulnerable to any dangerous pathogen strain. We need to study of diversity in maize for the exploitation of good characters. In the current era of molecular markers, DNA markers play an important role to identify diverse germplasm. Several markers such as morphological, biochemical, and DNA based markers/molecular markers are utilized to insight the information of diversity inthe germplasm. The morphological and biochemical markers were being extensively used but these markers were highly sensitive to environment because of which, these markers are being replaced by the molecular markers. Therefore, DNA-based markers are getting popular because of more precision and accuracy.

T-1/P-8

Evaluation of maize genotypes for baby corn characteristics during *kharif* season

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Baby corn is an unfertilized cob of maize preferably harvested within 1-3 days of silk emergence depending upon the growing season and genotypes. It may be consumed directly as salads or after preparation of products. Large number of products may be prepared from the baby corn such as kheer, pickles, chutneys, vegetables, Chinese preparations etc. Baby corn's nutritional quality is at par or even superior to some of the seasonal vegetables. Besides protein, vitamins and iron, it is one of the richest sources of phosphorus. Baby corn is a good source of fibrous protein and hence easy to digest. It is most safe vegetables for consumption as it is almost free from residues of pesticides as wrapped up with husk.Baby corn gives employment to famers, rural women and youth as labour force is required for its cultivation, processing and marketing. Foreign exchange can be earned by exporting baby corn and its products as baby corn has very good demand in the international market. Farmers can earn more money in shortest possible time.Green fodder obtained from baby corn support the cattle industry throughout the year and help to obtain additional income. It helps in crop diversification and provides solutions of many of the problems such as lowering of ground water table and infestation of *Phalaris minor* in rice –wheat cropping system.India has emerged as one of the potential baby corn producing country because of low cost of production as compared to many other countries and now its cultivation is becoming popular in national capital region of Haryana.The genotype which is medium in height and maturity, prolific, sweet in taste, regular row arrangement is preferred in the market and it depends on the genotype, population density and cropping season. Keeping all these points in mind ten hybrids of maize were evaluated during *kharif* 2020 for baby corn traits and fodder yield. HKI 327 T x HKI L287 hybrid took least days (50) for first picking while four hybrids (HKI 1354-7 x HKI 1344, HKI 193-2 x HKI L 287, HKI 288-2 x LM-17 and HKI 288-2 x HKI 659-3) took maximum days (58) for first picking. Least days (64) for last picking were also taken by HKI 327 T x HKI L287 and maximum days (71) for last picking were taken by HKI 193-2 x HKI L 287, HKI 288-2 x LM-17 and HKI 288-2 x HKI 659-3. Maximum baby corn yield (27.6 q/ha) was observed in hybrid HKI 288-2 x HKI 323, followed by HKI 327 T X HKI L287 (27.0 q/ha) and HKI 1354-7 x HKI 1344 (26.6 q/ha) which was 22.6, 20 and 18.2 per cent higher respectively over the check HM 4 (22.5 q/ha). The fodder yield was recorded maximum in HKI 327 T x HKI L287 (245.1 q/ha) followed by HKI 1354-7 x HKI 1344 (239 q/ha) and HKI 288-2 x HKI 323(225 q/ha) having 39.4, 30.3 and 28 per cent superiority over check HM 4 (175.8 q/ha). It is concluded that out of these 10 hybrids tested for baby corn traits, three hybrids viz. HKI 1354-7 x HKI 1344, HKI 288-2 x HKI 323 and HKI 327T x HKI L287 recorded more than 10 per cent superiority over the check HM 4 for baby corn yield as well as fodder yield, simultaneously these are having all desirable traits of baby corn andhence these hybrids may be recommended for cultivation after testing in AICRP trials.

T-1/P-9

Genetic analysis of maize inbreds for yield and its contributing traits over the locations

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Maize (*Zea mays* L.) is one of the most versatile crops having wider adaptability under varied agro-climatic conditions. Maize is known as the queen of cereals because of its highest genetic yield potential among all the cereals. The present investigation was undertaken to determine the combining ability of newly derived maize inbred lines over the locations. The experimental material consisted of eight parental genotypes which were crossed in half diallel mating design during *Kharif*, 2018 to develop twenty-eight crosses. These F_1s along with their parents were evaluated in Randomized Complete Block Design (RBD) at two environments representing different agro-climatic and ecological conditions of North-Western Himalayas (Shivalik Agricultural Research & Extension Centre, Kangra and Hill Agricultural Research & Extension Center, Bajaura) during *Kharif*, 2019. Bartlett's test revealed that error variance was homogeneous only for six traits out of total twelve traits. These traits were days to 50% pollen shed, days to 50% silking, days to 75% brown husk, ear circumference, 1000-grain weight and grain yield. The pooled analysis revealed significant differences between the environments for all the characters except days to 50% silking. The mean squares due to genotypes and genotype × environment interaction was significant for all the traits under study for which pooling was done indicating influence of the environments on the expression of these traits. Combining ability effects over the environments revealed that one parent B-73 had significant GCA effects for five characters *viz.*, days to 50% pollen shed, days to 50% silking, days to 75% brown husk, ear circumference and grain yield. Estimates of σ^2SCA were higher as compared to σ^2GCA in pooled over environment. This indicated higher contribution of non-additive genetic effects than additive genetic effects in expression of various traits in the hybrids. The crosses B-73 × BAJIM-1811, BAJIM-1522 × BAJIM-1811 and B-73 × BAJIM-2010 in pooled over environment identified as the potential hybrids for grain yield and other contributing traits. The inbred lines having good GCA may be utilized as potential parents for further development of high yielding single cross maize hybrids. The crosses identified as potential hybrids may be commercially exploited after critical evaluation for its superiority in performance and with stability across the locations over years.

T-1/P-10

Study of combining ability in newly developed inbred lines of Maize (*Zea mays* L.)

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Maize (*Zea mays* L.) is an important cereal crop in global agriculture after wheat and rice. The present investigation was conducted at Shivalik Agricultural Research and Extension Centre, Kangra during *Kharif* 2020 with an objective to determine combining ability effects of newly developed inbred lines. Experimental material consisted of twenty-five lines, two testers and their fifty crosses were evaluated using Randomized Block Design (RBD) with two replications. Genotype mean square was significant for days to 50% tasseling, days to 50% silking, days to 75% brown husk, ear height (cm), plant height (cm), ear length (cm), ear circumference (cm), kernel rows/cob, kernels/row, 1000-kernel weight (g), shelling (%) and grain yield (q/ha) which indicated the presence of sufficient genetic variability in the material studied. Also the ratio of GCA variance to SCA variance was less than unity for all traits indicated preponderance of non-additive gene action. Among lines, KI-3exhibited higher grain yield followed by KI-7 and CML 140. These lines also exhibited highest significant GCA effect for grain yield and were identified as promising parents. Among testers, LM 13 was good general combiner for ear length, ear circumference, kernel rows/cob, kernels/row, 1000-kernel weight, shelling (%) and grain yield, whereas, LM 14 was good general combiner for ear height and plant height. KI-7 × LM 13, CML 140 × LM 13, CML 139 × LM 13, CML 162 × LM 13 and KI-3 × LM 14 exhibited superior grain yield as compared to the best check *viz.*, Palam Sankar Makka-2. These crosses also exhibited maximum SCA effect. These promising cross combinations need to be evaluated in multi-location trials over the years to assess their suitability in different agro-climatic zones of the State.

T-1/P-11

Stability analysis of medium maturity maize (*Zea mays* L.) hybrids for yield traits under temperate ecology of Kashmir

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G × E interaction is of major importance to the plant breeder in developing an improved stable variety. The importance of G × E interaction was recognized well and these were known to be heritable (Jinks and Mather, 1995). An experiment was conducted to evaluate the hybrids across locations and to assess the magnitude of interaction of maize hybrids with environment. Ten maize hybrids including two checks DHM-117 and PMH-10 were tested in the main cropping season of 2020 across 3 different locations viz; Dryland Agriculture Research Station (DARS) Rangreth, Faculty of Agriculture (FoA) Wadura and Mountain Research Centre for Field Crops (MRCFC) Khudwani. Stability parameters such as mean (X), regression coefficient (b_i) and deviation from regression (s^2di), as suggested by Eberhart and Russell (1966) were evaluated in order to assess the stability of these hybrids for various characters. Analysis of variance revealed that the hybrids possessed highly significant variability for all the traits viz., No. of kernels per row, No. of kernel rows per cob, No. of cobs per plant and Test weight. The mean squares due to environments were also significant for all the traits indicating that the environments selected were random and were different in agro-climatic conditions. Stability analysis for most important trait i.e., grain yield revealed that the mean square deviation from regression was non- significant for all the genotypes, except H10, H11, H18 and H24. Based on the mean performance H05, H32 and H23 were high yielding hybrids across the locations Puttaramanaik *et al*. (2016).

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T-1/P-12

Stability analysis of medium maturity maize (*Zea mays* L.) hybrids for morphological traits under temperate ecology of Kashmir

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G × E interaction is of major importance to the plant breeder in developing an improved stable variety. The importance of G × E interaction was recognized well and these were known to be heritable (Jinks and Mather, 1995). An experiment was conducted to evaluate the hybrids across locations and to assess the magnitude of interaction of maize hybrids with environment. Ten maize hybrids including two checks DHM-117 and PMH-10 were tested in the main cropping season of 2020 across 3 different locations viz; Dryland Agriculture Research Station (DARS) Rangreth, Faculty of Agriculture (FoA) Wadura and Mountain Research Centre for Field Crops (MRCFC) Khudwani. Stability parameters such as mean (X), regression coefficient (b_i) and deviation from regression (s^2di), as suggested by Eberhart and Russell (1966) were evaluated in order to assess the stability of these hybrids for various characters. Analysis of variance revealed that the hybrids possessed highly significant variability for all the traits viz., Plant height, Ear height, Cob diameter and Test weight. The mean squares due to environments were also significant for all the traits indicating that the environments selected were random and were different in agro-climatic conditions. Stability analysis for most important trait i.e., grain yield revealed that the mean square deviation from regression was non- significant for all the genotypes, except H10, H11, H18 and H24. Based on the mean performance H05, H32 and H23 were high yielding hybrids across the locations Puttaramanaik *et al*. (2016). .

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T-1/P-13

Stability of experimental maize hybrids tested across the diverse climatic conditions of Himachal Pradesh

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Maize is an important cereal crop after wheat and rice. Maize is the third most important staple food crop in the world, which accounts for 15-56% of total daily calories of humans in developing countries (FAS/USDA 2019). It is grown on a wide range of environments across the world. Genotype x environment interaction affects the relationship between phenotype and genotype of in breeding programmes, particularly for quantitative traits. So multi environment trials (MET) are used for evaluation and identification of stable genotypes across the environments. So, to assess the differential performance of the 23 genotypes, an experiment was conducted under six different locations. The present study comprising of new hybrids was therefore attempted to understand the G x E interaction and consistency in performance through stability analysis in 23 newly developed single cross maize hybrids along with three checks. These genotypes were evaluated in randomized block design with two replications at varied climatic six locations (*viz.*, Kangra, Bajaura, Palampur, Sundernagar, Dhaulakuan, and Akrot) in Himachal Pradesh during *kharif*, 2021.The mean squares due to genotype and genotype x environment interaction were found significant. The stability analysis conducted through Eberhart and Russell Model recorded non-significant bi values for all the entries under study. Thirteengenotypes recorded non-significant S^2di values. Simultaneous consideration of stability parameters for grain yield indicated that among the test hybrids, viz., DKC 7209and DKC 8209 were stable over the test environments. The hybrid DKC 8209 recorded 83.45 q/ha grain yield and was superior to all the checks under study and has been found suitable for cultivation in Himachal Pradesh.

T-1/P-14

Genotype x management interaction in maize in conservation agriculture in Indo-Gangetic plains of North-West India

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After rice, maize is an important cereal crop for food and nutritional security grown in diverse ecologies and seasons in South Asia. Conservation agriculture (CA) is considered a promising solution for the region for long-term sustainability of cereal-based cropping systems of North-West India. Traditionally, maize genotypes are tailored under conventional tillage (CT) management system. However, genotypes bred under CT system may differ in their performance under upcoming CA system. Recently, drip irrigation system has been designed and successfully evaluated for improving water and nutrient use efficiency in rice-wheat and maize-wheat systems under CA. Therefore, it is imperative to evaluate the performance of advanced breeding lines/genotypes of cereal crops like maize and wheat under different management environments to realize the maximum yield potential. A field experiment was conducted for 2 years to evaluate different maize genotypes with diverse genetic background under three management scenarios: (i) CT with flood irrigation (CT-Flood), (ii) zero tillage with flood irrigation (ZT-Flood) and ZT with subsurface drip irrigation (ZT-SSD) at Borlaug Institute for South Asia (BISA), Ladhowal (Punjab), India. Grain yield of maize was significantly affected by genotypes x management scenarios in both years. The increase in maize yield in ZT-SSD management ranged from 6.3–21.7% compared with the other management scenarios. Maize genotypes CAH 153 and CAH 1414 in CT, PMH 3 and CAH 1511 in ZT-SSD out yielded other genotypes. Genotype CAH 1547 showed poor performance under ZT compared to CT whereas PMH 1 performed similar under all the three management scenarios showing significant G x M interactions. Total amount of irrigation applied under ZT-SSD was about 50% lower compared with CT- and ZT-flood irrigated maize. Results from this study revealed that the performance of maize genotypes is influenced by management systems thus highlighting the need for developing genotypes most suitable for CA system.

T-1/P-15

Evaluation of maize inbred lines for nitrogen use efficiency (NUE) based on physiological traits

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Maize (*Zea mays* L.) is one of the most important staple food in many countries of the world and the third most important crop in India after rice and wheat.The C_4 photosynthesis in maize allows very efficient conversion of CO_2 into carbohydrates and finally green biomass and yield, especially under conditions of optimum nitrogen (N) supply. The genotypic variation exists in all the maize genotypes for nitrogen use efficiency (NUE). High NUE hybrids can be developed if we have high nitrogen use efficient inbred lines for hybrid development. A set of forty inbred lines of maize was received from the ICAR-Indian Institute of Maize Research, Ludhiana, Punjab. The experiment was conducted under nitrogen sufficient (residual N+180 Kg/ha N added by chemical fertilizer) and limiting conditions (residual N only) during Kharif 2016, 2017, and 2018 at Research Farm of ICAR-Indian Agricultural Research Institute, New Delhi. Several morphological (plant height, stem girth, number of leaves, SPAD, leaf area, leaf color chart,), physiological parameters (chlorophyll content, total soluble protein, nitrate reductase, glutamine synthetase, nitrogen content, Nitrogen harvest index), and yield attributes were recorded at various plant growth stages, viz., seedling, vegetative and flowering. In the initial growth stages, there were no visible effects of nitrogen deficit as plants get sufficient nitrogen from the residual soil N but immense effects were visible in later stages i.e. flowering and post-flowering. The reduction was observed with N metabolism enzymes *i.e.* nitrate reductase (NR) activity, glutamine synthetase (GS) activity, and total soluble protein (TSP). The correlation between each enzymatic activity under N sufficient and limiting conditions was assessed with other morphological traits. A significant correlation was observed between leaf nitrate reductase (NR) and TSP (r = 0.59) while negatively correlated to GS (r = -0.28) under N-sufficient conditions. It suggests that during grain filling the capacity of the plant to reduce leaf nitrate is low. The genotypes exhibiting low NR activity yield higher. The Glutamine synthetase (GS) activity is considered a highly significant trait for detecting a correlation between physiological and agronomic traits. Principal Co-ordinate analysis (PCA) based on pedigree formed two major population groups. Group, I included inbred lines DMI 4, DMI 5, DMI 22, DMI 27, and DMI 56 performing well under N-deficit conditions. Group II included inbred lines that performed well under N-sufficient conditions. The contrasting inbred lines, *viz*., DMI 4, DMI 5, DMI 22, DMI 27, and DMI 56 were derived from the drought or thermal tolerant parent with a reduced effect on yield and yield associated traits under nitrogen deficit conditions**.** The role of enzymatic activities *viz*., nitrate reductase (NR), and glutamine synthetase (GS) were found to play a significant role and their assessment at the early growth stages is critical in the screening of maize breeding lines for nitrogen use efficiency at later stages. These lines with improved nitrogen use efficiency characteristics will be used in future breeding programs.

T-1/P-16

Combining ability and heterosis analysis of quality protein maize (QPM) inbreds for grain yield and agronomic traits

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Twenty-eight QPM experimental hybrids generated through 8 x 8 half-diallel mating design of QPM inbred lines were evaluated along with the parental inbred lies and four standard QPM check hybrids in randomized block design with three replications during *Kharif*, 2020 at AICRP on Maize, OUAT, Odisha for analysis of heterosis and combining ability effects (Griffing's Method-II, Model-2) for grain yield and yield contributing traits. ANOVA for combining ability revealed significant mean squares of general combining ability (GCA) and specific combining ability (SCA) for all the 12 traits under study including grain yield/ ha indicating contribution of both additive and non-additive gene action in expression of these traits. However, the ratio of GCA to SCA variances were less than unity for all the traits indicating the preponderance of non-additive gene action in the expression of all the traits under study. Among the eight QPM inbred lines, DQL 2221-1-1 was identified as good general combiner for grain yield followed by DQL 2099. DQL 2099 and DQL 2221-1-1 were also found to be good general combiners for yield component characters like cob length, cob diameter, number of kernel rows per cob, number of grains per kernel row, and shelling percentage. Out of 28 crosses, 15 cross combinations showed positive significant SCA effects for grain yield. The heterobeltiosis for grain yield ranged from -0.38% to 115.7%with27 crosses showing significant positive heterobeltiosis for this trait, while the standard heterosis over best check hybrid, HQPM 7ranged from -47.3% to 14.5% with nine crosses exhibiting standard heterosis of 10% or more. Amongst 28 crosses, five crosses i.e., DQL 2261 x 70160, DQL 2261 x 71266, DQL 2261 x 72155, DQL 2222-1-1 x 70160 and DQL 2221-1-1 x 71266 were found promising on the basis of per se performance, standard heterosis and SCA effects.

T-1/P-17

Standard heterosis for green cob yield and quality traits in sweet corn hybrids

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Increasing urbanization and changing food habits have led to expanding needs for sweet corn. Heterosis breeding has received greater attention to improve its productivity and quality and so, the determination of heterosis in hybrids is necessary for their commercial exploitation. For a hybrid to be promoted, its performance should preferentially exceed the available best commercial check, which is computed based on standard heterosis. Thirty hybrids synthesized from six lines and five testers were used. Standard heterosis was accounted as per cent deviation of mean performance of hybrid from the standard check (Misthi). The extent of economic heterosis for various traits studied ranged from -47.4 to 11.76(green cob yield (t/ha)), -18.34 to 15.84 (green cob weight), -13.16 to 25.63 (cob length), -20.25 to 18.4 (cob girth), -12.5 to 12.5 (the number of kernel rows per cob), -15.53 to 9.30 (number of kernels per row), -11.08 to 20.78 (total sugars), -7.05 to 54.19 (reducing sugars), -11.9 to 22.27 (non-reducing sugar) and -7.52 to 12.03 (total soluble solids). Crosses, SC 11-07 × MRC SC11, SC 11-07 ×WNDMRSCY 19R763, and SC 11-2 × WNDMRSCY 19R763 were heterotic which recorded significant positive standard heterosis for green cob weight, green cob yield (t/ha), number of kernels per row, earliness and at least one of the quality traits. Among them, SC 11-07 × MRC SC11 was found to be with significant positive standard heterosis for cob length, the number of kernel rows per cob, total sugars, non-reducing sugar, total soluble solids and green cob weight**.**On observing the quality attributes, the hybrids, SC 11-07 × DMSC 20and SC 1421-5-2-1 × 951-7 were the best entries that recorded significant positive heterosis for all four quality traits *viz.*, total soluble solids, total sugars, reducing and non-reducing sugar. In the case of flowering traits, most of the hybrids exhibited significant standard heterosis in a favorable negative direction indicating earliness.

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T-1/P-18

Combining ability analysis for grain yield and its contributing characters in maize (*Zea mays* L.)

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Maize (*Zea mays* L.) is one of the most important cereal crops and occupies a prominent position in global agriculture after wheat and rice. The main goal of maize breeding is to obtain new hybrids with high genetic potential for yield and positive features that exceed the existing commercial hybrids. The commercial production of hybrids however, depends upon two factors *viz*., the behavior of the line itself and the behavior of line in hybrid combination. The behavior of a line in hybrid combination is assessed through the estimation of general combining ability (gca) and specific combining ability (sca) effects. Combining ability of the inbred lines is the ultimate factor for determining future usefulness of the lines and helps in classifying inbred lines relative to their cross combinations. Eight diverse maize inbred lines *viz.*,BGS-337, CM-139, BML-6, DML-1432, Bio-688, PFSR-46, Saf91×2#-7 and DMRE-63 were crossed in diallel mating design (without reciprocals) during *Rabi*, 2018-19 at Winter Nursery Centre, ICAR-Indian Institute of Maize Research, Rajendranagar, Hyderabad. Subsequently, the resulted 28 single crosses along with parents and three standard checks (DHM 117, NK 6240 and CMH-8-287) were evaluatedin Randomized block design with three replications during *Kharif*, 2021 at Regional Sugarcane and Rice Research Station, Rudrur, Nizamabad. Data recorded on inbreds, single crosses and checks for twelve yield and yield contributing characters was analyzed to estimate combining ability and gene action. This study indicated the preponderance of non additive gene action in the expression of various traits under study. Similar findings were reported by Varaprasad and Shivani (2015), Suthamathi and Nallathambi (2015) and Patel *et al*. (2019). The parents Bio-688 and BML-6 were found to be good general combiners for grain yield per plant and major yield attributing characters with significant and positive gca effects. The hybrids BML-6 × PFSR-46 (214.03g), BGS-337 × Bio-688 (210.24g) and BML-6 × Bio-688 (202.92g) were found significantly superior over standard checks *viz*., DHM 117 (177.97g) and NK 6240 (175.87g), and onpar with the best check CMH-8-287 (199.15g) for grain yield per plant with high *sca* effects for grain yield and other important yield component characters. Among the inbred lines BML-6 and Bio-688 were found to be good combiners for yield and important yield contributing characters hence, can be considered as potential parents for future breeding programmes. The most promising crosses

BML-6 × PFSR-46, BGS-337 × Bio-688 and BML-6 × Bio-688 with high specific combining ability effects for grain yield and some of its attributes may be tested under multi locations and can be developed as commercial hybrids or advanced for selfing for the isolation of transgressive segregants or homozygous lines for use in breeding programmes.

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T-1/P-19

Genetic Diversity Analysis - a key in Maize Breeding

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Genetic diversity of germplasm plays a key role for future breeding progress especially in cross pollinated crops. Study of genetic diversity is important in maize breeding program for the selection of suitable diverse parents to obtain highly heterotic hybrids as well as for germplasm characterization and conservation. The knowledge of genetic diversity is also important for understanding of the genetic structure and subsequently helps the breeder in choosing desirable parents to conduct breeding program (Badeiry *et al.,* 2014). Multivariate analysis is the most popular approach for genetic variability estimation to study the patterns of variation and their genetic relationships among germplasm collections. The PCA (Principal Component Analysis) and cluster analysis are preferred tools for morphological characterization of genotypes and their grouping on similarity basis. Genotype main effect plus genotype × environment interaction (GGE) biplot method is considered as the best method for reliable assessments in multi-environment experiments. D2 analysis is a useful tool for quantifying the degree of divergence between biological population at genotypic level and in assessing relative contribution of different components to the total divergence both intra and inter-cluster level. The more diverse genotypes can be used to produce superior hybrids/ lines, segregating population with high variability and introgression of desirable traits/genes. Further, the effectiveness of selection is based on the traits that have a high heritability coupled with genetic advance. The levels of heritability and genetic advance for a trait enumerates the nature of gene action involved in each trait and this suggests the breeders to adopt appropriate breeding strategies for systematic improvement (Shukla et al., 2006). The association of traits under selection is necessary to effect the selection and for this correlation and path coefficient analysis are active tools to improve the efficiency of breeding programs (Ghimire and Timsina, 2015). Therefore, there is a need to evaluate the available genotypes for the extent of genetic diversity.

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T-1/P-20

Heterotic grouping of new inbred lines through quantitative genetic methods in maize

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Maize, being a highly cross pollinated crop, heterosis is exploited to a great extent. Development of highly heterotic hybrid is dependent on the choice of parents that combine well and this step is very crucial**.** The selection of parents can be aided by heterotic grouping of germplasm, where in genetically diverse groups are established. Heterotic grouping facilitates exploitation of intra group crosses for development of improved inbred lines and inter-group crosses for hybrid development. Thus, it helps to attempt only the intergroup crosses for generating heterotic hybrids and thereby reducing the number of crosses to be made. In this context, an experiment was conducted at ICAR-IARI Regional Research Centre, Dharwad during *kharif* 2018 and *rabi* 2018 to classify newly developed inbred lines into different heterotic groups and to test the efficiency of different grouping methods. The experimental material included 108 single cross experimental hybrids obtained by crossing 54 lines with two opposite heterotic group testers, *viz*., LM-13 and LM-14 in L × T fashion. Heterotic grouping was done based on two methods; (i) SCA-PY (Specific Combining Ability with Pedigree information), and (ii) HSGCA (heterotic group specific general combining ability). Classification by these methods showed similar but not identical trends. These methods classified inbred lines into three distinct groups (A, B and AB group). The number of genotypes in each group varied between the heterotic grouping methods. HSGCA method classified all the 54 inbred lines studied while SCA-PY method classified 43 inbreds and other were ungrouped and hence, one more tester may be included to classify all the inbred lines. Seventeen lines were common in group A (LM-13 group) and 9 inbreds in B group (LM-14 group) and 13 in AB group between these two methods. The intergroup crosses are expected to produce highly heterotic crosses. Based on the results, it was suggested to go for inter-group crossing to develop heterotic crosses and intra-group crossing to further improve inbred lines, which would also enable to test the efficiency of the grouping methods.

T-1/P-21

Broadening genetic diversity of maize using crop wild relatives

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Maize, a versatile crop besides serving as the staple food for many countries, is also used as feed, fodder, and for industrial applications. It has been continuously exploited for crop breeding in the past century, and significant improvement has been achieved through single cross, double-cross, and three-way cross hybridization. However, it has also led to the narrowing down of genetic diversity in the crop and leading to susceptibility to diseases, pests, abiotic stress, and reduced yield plateaus. Crop wild relatives can be used to broaden the genetic diversity and increase the adaptability of the crop to changing vagaries of the environment (Adhikari et al., 2021). The wild relatives of maize (*Zea mays* L.) include the teosinte, *Zea mays* ssp. *mexicana* (Schrader) Iltis (2n = 20), *Zea luxurians* (Durieu) Bird (2n = 20), *Zea mays* ssp. *parviglumis* Iltis, Doebley (2n = 20), *Zea diploperennis* (2n = 20), and *Zea perennis* (2n = 40) and *Tripsacum* species. Exotic maize germplasm is considered as the storehouse of significant variation for several stress tolerance and quality traits (Karn *et al.*, 2017), many of which remain untapped. The use of wild and distant species will assist in broadening the genetic base, transfer resistance against biotic and abiotic stresses and also help overcome the threat of genetic vulnerability due to a narrow genetic base. The presence of sufficient genetic variability forms the basis of any plant breeding programme and is necessary for selection. Wide hybridization using wild maize germplasm has been widely applied for the past few decades in crop improvement and could have potential variation to bridge the gap in diversity.

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T-1/P-22

Present Use of Haploids in maize Plant Breeding

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Haploids are naturally produced in maize (*Zea mays* L.) at different rates and can also be induced through different methods. Haploids have become one of the most effective tools in corn breeding. This chapter discusses two approaches utilizing maize haploids that have assumed great importance in commercial corn breeding. They are (1) producing and doubling the chromosomes in maternal haploids to generate double haploids (instant inbreds) and (2) utilizing paternal haploids produced utilizing the *indeterminate gametophyte1* mutation to convert male-fertile lines into cytoplasmic male-sterile lines. Both approaches require only two generations, while traditional procedures require about seven to eight generations. These procedures have helped to make the breeding of maize more efficient and economical. The characteristics of maize haploids, methods to produce and select them and double their chromosomes, and the advantages of utilizing maize haploids are discussed.

T-1/P-23

Micronutrient delivery systems through seed for enhancing seed yield and quality of maize

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The experiment was taken up in the Department of Seed Science and Technology, OUAT, Bhubaneswar during *Rabi* season to study the influence of micronutrient delivery to maize crop (hybrid MRM 3777) through seed priming and coating treatments, compared with the conventional approaches like soil and foliar applications. Coating and priming of maize seeds were done with different doses of Borax and zinc sulphate. The performance of the crop raised from the treated seeds was evaluated in the field in RBD with three replications. Different growth and yield attributing characters of the crop, as well as seed yield were recorded. Physiological and biochemical parameters of the harvested seed were studied. In general, the seed priming treatments proved to be more effective than seed coating, basal applications or foliar sprays in increasing the plant growth, yield attributing parameters, as well as seed yield. Priming of maize seeds with Borax (0.05%) + $ZnSO_4$ (3 g/kg seed) resulted in higher plant height, chlorophyll content of leaves at 40 DAS and earlier 50% flowering and maturity. The said treatment combination was also most effective in increasing the cob length, number of seeds per cob, 100-seed weight and seed yield. The seed yield from seeds primed with Borax (0.05%) + $ZnSO_4$ (3 g/kg seed) was 53.32 q/ha, which was 38.6% higher than the Control. The same treatment also recorded highest protein and starch contents of 10.71% and 71.03%, respectively, whereas these two parameters were least in the Control (10.02% and 70.05%, respectively). Germination of the harvest seed was not influenced by any of the priming or coating treatments and all the treatments were at par with each other. However, seed priming with Borax (0.05%) + $ZnSO_4$ (3 g/kg seed) gave maximum seedling length, seedling dry weight and seed vigour indices. Seed priming with Borax (0.05%) + $ZnSO_4$ (3 g/kg seed) was most profitable with B:C ratio of 2.84. Thus, priming seeds with Borax (0.05%) and $ZnSO_4$ (3 g/kg seed) can serve as a very good delivery system of micronutrients to the maize crop.

T-1/P-24

Combining ability and heterosis studies for yield and yield contributing characters in maize Zea mays (L.)

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The present investigation was undertaken with view to study the general and specific combining ability of the parents and crosses respectively for grain yield and its component traits in maize and to study the heterosis for grain yield and its component traits in maize. The experimental material of combining ability analysis consisting of 38 genotypes (8 parents, 28 hybrids and 2 checks) were laid out in randomized block design (RBD) with of three replications. It was observed that, the mean sum of squares due to parents and parent's vs hybrids were highly significant for all characters except cob length for parents and to 50 per cent flowering and ear head height for hybrid. The estimates of GCA and SCA variance found significant for all the characters which indicated the presence of substantial amount of genetic variability among the parents and crosses for respective characters. The parents Hyd.-52337, Hyd.-52623 and Hyd.-52144 were observed good general combiners for grain yield and its contributing traits. Out of 28 hybrids, eight hybrids recorded significant positive SCA effects, among which, cross combinations IC-331144 x Hyd.-52144 (2.20), IC/RNG/SW-7 x Hyd.-52222 (1.40), Hyd.-52349 x Hyd.-52222 (1.20) exhibited high SCA effects for grain yield with high SCA effects for grain yield contributing characters. The cross IC/RNG/SW-7 x Hyd.-52222 showed the highest significant average heterosis (69.76 %) and heterobeltiosis (56.76 %) for grain yield. The extent of standard heterosis observed for grain yield over the check Phule Rajarshi and Phule Maharshi was up to 58.16 and 24.87 per cent respectively. The highest significant standard heterosis recorded over both the checks for the cross IC-331144 x Hyd.-52144 58.16 % and 24.87 % respectively. Based on *per se* performance, GCA effects of parents, SCA effects of hybrids and heterotic performance for yield and its principal components in the F_1 hybrids the cross combinations *viz.*, IC-331144 x Hyd.-52144, IC-331144 x IC/RNG/SW-7and Hyd.-52337 x Hyd.-52623 identified as promising crosses for yield and yield contributing characters and these crosses should be further tested in multilocation hybrid trials for further commercial exploitation.

T-1/P-25

Assessment of genetic variability, character association and path coefficient analysis for yield and its components in maize

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The present investigation was carried out to understand the coefficients of variation, heritability, genetic advance, correlation coefficient and path analysis in F_2 population of maize. The study comprised of 303 F_2 progeny plants, parents and F_1 of the cross, CM 111 × DHKN 509 evaluated under un-replicated trial during *Rabi 2020-21*. The observations were recorded for ten traits *viz.*, days to tasseling, days to silking, anthesis-silking interval, plant height, ear height, ear girth, number of kernels per row, pith weight, shelling per cent and grain yield per plant in all the F_2 progeny plants and ten plants each from parents and F_1, and noticed wide variation among the traits studied in the F_2 population. The extent of phenotypic and coefficient of variation was higher than genotypic coefficient of variation for all the traits studied. High PCV and GCV was recorded for anthesis-silking interval, number of kernels per row, pith weight and grain yield per plant. High heritability coupled with high genetic advance over mean were observed for anthesis-silking interval, number of kernels per row, pith weight and grain yield per plant suggesting that these traits are governed by additive gene action and can be improved through simple selection. Positive and significant association with grain yield was recorded with number of kernels per row, pith weight, cob girth and shelling per cent. Days to tasseling and anthesis-silking interval exhibited highest direct positive effect on grain yield per plant followed by pith weight and shelling per cent indicating the effectiveness of direct selection, whereas direct negative effects were recorded by days to silking and ear height indicating the effectiveness of indirect selection.

T-1/P-26

Heterotic grouping of Indian baby corn lines based on combining ability

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The present study involved estimating the combining ability effects, heterotic grouping and standard heterosis to increase the efficacy of parental selection for successful hybrid development. A total of 52 F_1 hybrids were generated by line × tester mating design by crossing 26 diverse maize inbred lines with two testers (HKI 323 and HKI 1105). The 26 baby corn inbred lines were classified into a different heterotic group based on the SCA effects and HSGCA (heterotic groups's specific and general combining ability). The SCA effects and HSGCA of baby corn yield without husk (BCY) classified the inbred lines into three and five groups respectively. This is the first study of heterotic's grouping for baby corn germplasm considering BCY based on SCA and HSGCA. The standard heterosis data indicated that among the 52 hybrid combinations, L20 × T1 showed significant and positive heterosis over both checks for BCY. Further, eight combinations were superior for BCY over the check (HM 4). The information generated through heterotic grouping may be used for deriving new inbred lines and developing different heterotic combinations for further utilization in breeding programs.

T-1/P-27

HOPE and RIPE: Tools to break genetic ceiling in crop improvement

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Plant Breeding aims at bridging the widening gap between the demand and supply of food. However, it has its own limitations. The replacement of landraces with a few genetically uniform varieties depletes genetic diversity and brings about genetic vulnerability of crop plants to various biotic and abiotic stresses. The ever-expanding human population and the subsequent rise in demands for more food on the one hand, and the success of such efforts like the "Green Revolution" from adoption of genetically uniform varieties in many parts of the world, on the other, are the main driving force towards narrowing of genetic base of crops (Keneni *et al.*, 2012). Although plant breeders recognize that their working germplasm is constricted and this could cause problems in the near future, they are reluctant to use the extensive genetic variability available in national and international genetic resource repositories. The one probable reason for this is that they are afraid that introduction of unadapted germplasms into their breeding programmes may lower the agronomic performance of elite lines. The continuous use of genetically uniform varieties could however, because the gene pool to narrow leading to genetic erosion that in turn puts ceiling on extent of genetic improvement of economically important traits. The restriction imposed on genetic ceiling due to depletion of genetic has caused yield of many crops to be plateaued. So it is imperative to broaden the genetic base to break yield barrier in many extensively exploited crops. Introduction of new germplasm could break the genetic ceiling in crop improvement and reduce vulnerability of crop plants to biotic and abiotic stress while adding new developmental pathways and ecological adaptations. Two breeding systems- HOPE (Hierarchical Open-Ended Population Enrichment) and RIPE (Recurrent Introgressive Population Enrichment)- were developed which could significantly broaden the genetic base of crop plants while still producing lines and cultivars with commercial potential (Kannenberg and Falk, 1993).

T-1/P-28

Plumule colouration as a criterion to improve the efficiency of R1-nj marker based doubled haploid breeding in maize

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The *in vivo* doubled haploid (DH) lines development in maize necessitates accurate haploid seed identification. The goal of this research is to make the *in vivo* maternal haploid induction approach more efficient and reliable in identification of haploid seeds in the progenies derived from crossing source population with the R1-nj visual colour marker based inducer genetic stock. Further, the parameters identified were validated at just after the *in vitro* germination before processing and proceeding for cholchicine treatment, at the seedling and field transplanting stages so that capital investment on skilled labour as well as in handling and growing all the seedlings, plants in the field followed by controlled pollination could be minimized. The investigation in this context was conducted using eight source populations comprised of F1s, F2s, landrace and composite genotype of both field corn and sweet corn. These source populations were crossed as seed parent with CIMMYT bred tropicalized advance haploid inducer line possessing R1-nj colour marker gene. Based on the colour marker of endosperm and endosperm and embryo, the seeds were classified into contaminants, haploids and diploids. The haploid kernels were then categorised based on plumule coloration and no plumule colouration after *in vitro* germination. Plumule coloured seedlings were directly grown in the field by hypothesizing that these seedlings are similar to diploids and the difference of these seedlings with haploids were observed. The remaining seedlings that did not have plumule colour were diploidized using standardised colchicines (0.04%) after cutting shoot and root tips of the *in vitro* germinated seeds. The seedlings having colour on plumule after selfing have differential segregation on kernels due to R1-nj background effect whereas seedlings without plumule colour showed significant haploid behaviour at field screening as low stomata counts, stripe leave trait and less vigor as well as few plants having low pollen viability. The seedlings sorted from haploid seedlings on the basis of plumule colour was highest in PSM-3 (22) followed by landrace DL1 (19) whereas the misclassification percentage was highest of 25% in landrace DL1 followed by PSM-3 (18%) and Sweat corn F1s (13%). Mis-classification of seeds using R1-nj marker arise during the sorting based on visual colour on haploid-diploid seeds. The results shows that second line of sorting using plumule colour in germinated seedlings has significant impact on reducing false positive and thereby increasing resource use efficiency in doubled haploid breeding programme.

T-1/P-29

Generation of Transgene-Free Semidwarf Maize by Gene Editing of Gibberellin-Oxidase 20-3 Using CRISPR

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The "green revolution" gene gibberellin oxidase contributes to the semidwarf phenotype, improving product and lodging resistance. Dissecting the function of GA biosynthetic genes would be helpful for dwarf maize breeding. In this study, we edited the maize GA20ox3 gene and generated semidwarf maize plants using CRISPR/Cas9 technology. Application of exogenous gibberellin can recover the dwarf phenotype, indicating that the mutants are gibberellin deficient. The contents of GA12 and GA53 were elevated in the mutants due to the disruption of GA20 oxidase, whereas the contents of other GA precursors (GA15, GA24, GA9, GA44, and GA20) were decreased in the mutants, and the accumulation of bioactive GA1 and GA4 was also decreased, contributing to the semidwarf phenotype. To generate transgene-free dwarf plants, the T2 generation dwarf plants from the mut1 line were screened by PCR amplification of the OsU3 terminator, TaU3 promoter, Ubiquitin promoter and zcas9 cassettes. The pBUE411-2gR-GA vector was transformed into Agrobacterium tumefaciens strain LBA4401. Immature embryos from the maize inbred line Cal were transformed. Overexpression or suppression of GA biosynthesis-related genes affects plant height and biomass through increasing the accumulation of bioactive GAs. For example, overexpression of GA20ox-1, which is an essential gene in GA biosynthesis, increased the stem biomass yield in poplar and tobacco plants (Eriksson *et al*., 2000; Biemelt *et al*., 2004). The ectopic expression of Arabidopsis GA20ox in transgenic tobacco increased bioactive GA levels and stimulated the growth plants (Sophia *et al*., 2004). Transgene-free dwarf maize was selected from T2-generation plants and might be useful for maize breeding in the future. The CRISPR/Cas9-mediated genome-editing tool was utilized to edit the endogenous maize gene ZmGA20ox3 (GRMZM2G368411). Two target sites were designed in the first exon of ZmGA20ox3 (Figure 1A), and the corresponding sequence was synthesized and ligated into the pBUE411-2gR plasmid (Xing *et al*., 2014) to construct the pBUE411-2gR-GA vector. The vector was transformed into the maize inbred line Cal via the Agrobacterium mediated transformation method, and ten independent T0 transgenic lines were generated. The fragments including the target sites were PCR amplified from the transgenic plants and sequenced directly. The sequencing results showed that three heterozygous transgenic lines exhibited mutations at the target sites of the ZmGA20ox3 gene. Two sgRNA sequences were designed in the first exon of ZmGA20ox3 (GRMZM2G368411) using CRISPR-P web base resource (http://crispr.hzau.edu.cn/CRISPR2/) (Lei *et al*., 2014) Two pairs of primers, designated MT1T2-BsF/-BsR and MT1T2- F0/-R0 (Supplementary Table S1), were designed according to the two sgRNA sequences. The PCR fragments amplified from pCBC-MT1T2 using the two pairs of primers were inserted between the BsaI sites of pBUE411 (Xing *et al*., 2014) to construct the pBUE411-2gR-GA vector.

T-1/P-30

Genetic studies in early maturing maize (*Zea mays* L.) inbred lines

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The Experimental material comprised of thirty F_1's generated by means of crossing ten genetically several strains with three testers as per manner suggested by Kempthrone (1957). The parents alongside with their F_1's (generated at some stage in *Kharif*- 2019) have been evaluated in a randomized whole block design with three replications at Dryland (Karewa) Agriculture Research Station, Srinagar during *kharif*-2019. Observations had been recorded on days to fifty percent tasseling, days to fifity percent silking, days to maturity, plant height (cm), ear height (cm), ear length, ear diameter prolificacy, kernel rows cob^{-1}, kernels row^{-1}, 100-grain weight, grain yield plant. Data used to be as soon as recorded and analysed by the use of Statistical and Biometrical Procedures. Highly tremendous variants have been discovered amongst lines and line × testers for all the features confirming that the material chosen for crossing was very diverse. Variance aspect due to *GCA* and *SCA* impact used to be as soon as great for all the traits. The estimation of genetic aspects of variance indicated larger proportion of dominance variance for days to fifty percent tasseling, plant height, number of kernels per row, number of kernels per cob, ear diameter, grain yield, days to maturity, and higher additive variance for days to fifty percent silking, ear height, ear length, at the same time as dominant aspect used to be greater in magnitude for most of features excluding Days to fifty percent silking, ear height, ear diameter and prolificacy.CML-474 (among lines) was once found to have highest positive and large *GCA* have an effect on for grain yield plant^{-1} for KDM-440. KDM-914 depicted acceptable *GCA* effect amongst testers for grain yield plant $^{-1}$. KDM-347 x V-351, KDM-440 x V-335, CML-470 x KDM-914, KDM-895 x KDM-914, KDM-927 x KDM-914 was discovered as the most appropriate cross combinations for grain yield plant^{-1}. Nature and degree of heterosis used to be recorded to be high in cross combinations viz., CML-470 x KDM-914, CML-474 x V-351, KDM-440 x V-335, KDM-340 x V-335 ,CML-470 x V-351 for grain yield plant^{-1} suggesting the chance of growing essential single cross hybrids.

T-1/P-31

Exploration and evaluation of landraces to strengthen maize quality breeding programme at PAU

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Maize landraces, retaining a distinct identity and subjected to selection by farmers for generations, are not only a reservoir of large allelic diversity but also rich resource for better adaptation, quality and tolerance to biotic and abiotic stresses. Maize from hilly/*kandi* regions of India is known to harbour high quality attributes. Based on certain environmental and cultural reasons, farmers are retaining and cultivating these landraces to some extent. The current social, economic and physical environments are unfavourable for landrace cultivation. In present study, we reported the exploration conducted to collect the land races by visiting different farmers/research stations of different distracts and efforts to harness the untapped native diversity to strengthen maize quality program. Collected 17 traditional varieties/land races from Hills (Bharmor, Chobiya, Tunda valley, Salooni maize from Chamba) and chametli, Khandaghat of Solan district and 20 landraces from Kangra and Una districts of HP and 15 lines from *kandi* belt of Ropar, Hoshiarpur and SBS Nagar districts of Punjab. The lines deciphered extensive variation for grain colour and size. Lines also varied for early vigour, leaf architecture, maturity and grain yield. A selected set of 10 landraces, which exhibited high agronomic potential, were evaluated under organic conditions (in collaboration with School of Organic Farming, PAU, Ludhiana) and at Regional Research Station, Ballowal Saunkiri (representing *kandi* belt of Punjab) and compared with local checks. Three lines were marked for high yield potential, adaptation to organic and rainfed conditions, and earliness. At full maturity, grain samples were analyzed for *chapatti* making quality and total sugars. Two lines collected from Kangra and one each from Solan and Hoshiarpur districts were rated excellent for chapatti quality based on physical and sensory quality attributes *viz*., kneadability of dough, rollability, color, flavor, texture and taste values of *chapatti*. The lines were also recorded with variable beta- carotene and total sugar content.

T-1/P-32

Investigation of molecular diversity among parental lines and identification of elite heterotic combinations in sweet corn

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The popularity of sweet corn varieties with higher yield and sugar content is increasing worldwide due to its higher market value and consumer preference. A study was carried out in fourteen sweet corn inbred lines and their hybrid combinations, to understand the molecular diversity of parental lines and to identify superior heterotic cross combinations. Fourteen inbred lines were screened with 14 SSR markers and cluster analysis was done to group the parents into different clusters based on their diversity status. The parental lines were crossed in line x tester mating design (7 lines and 7 testers) and all the 49 hybrids were evaluated for identification of heterotic patterns along with a check variety, Sugar 75. Parental polymorphism study using 14 SSR markers identified four polymorphic markers and the PIC value obtained from them ranged between 0.142 to 0.497. Cluster analysis grouped the 14 parents into six clusters. Highly significant positive standard heterosis for green cob yield was reported by three hybrids L4 x T6 (19.09%), L5 x T6 (9.27%) and L4 x T5 (8.35%). Besides yield, L4 xT6 showed significant heterosis for cob length, green cob weight, cob placement height, tassel length, days to 50% silking, number of kernel rows per cob, number of kernels per row, dry cob weight, seed weight per cob, 100 seed weight, total chlorophyll content and zinc content. A superior hybrid combination (L4 x T6) has been identified for yield and yield attributing traits. Parents of the hybrids are positioned in diverse clusters emphasizes the importance of diversity among parental lines to harness heterosis.

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T-1/P-33

Genotype x environment interaction and stability analysis in maize across the Southern Aravalli Hilly Ranges of Rajasthan

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Crop production is the function of genotype, environment and their interaction (GEI) and evaluation of genotypes in multi environments helps in identifying their adaptation and stability. The 45 maize hybrids along with their 18 parents and two checks *viz.*, PHM-3 and PM-9 were evaluated in three environments *viz.*, E1 (*Kharif*-2019, Instructional Farm, RCA, Udaipur), E2 (*Kharif*-2019, ARSS Vallabhnagar) and E3 (*Rabi*-2019-2020, Instructional Farm, RCA, Udaipur) in randomized block design with three replications at each environment to assess the phenotypic stability and to select the superior ones in terms of yield and stability by using Eberhart and Russel (1968) model of stability. The mean squares due to genotypes and environments were found significant for all the traits under study indicated inherent genetic differences among the genotypes. The genotype x environment linear component of G x E interaction was found significant for all the traits except for plant height, ear height, ear length, ear girth and grain rows per ear. The MSS due to pooled deviation were found non-significant for all the traits under study indicated major portion of the genotype x environment interaction was formed by predictable portion. The majority of the hybrids depicted non-significant deviations from regression (S^2d_i) for grain yield per plant indicated their predictable response towards possible environment fluctuations. The hybrids EI-2403 x EI-102, EI-2448 x EI-102, EI-2505 x EI-102, EI-2653 x EI-102 and EI-2639 x EI-670 (b_i=1) characterized as well adapted to all environments, similarly hybrids EI-2505 x EI-03, EI-2507 x EI-03, EI-2639 x EI-03, EI-2653 x EI-03 and EI-2159 x EI-102 (b_i<1) were found suitable for poor environment condition, while hybrids EI-2159 x EI-03, EI-2188 x EI-03, EI-2403 x EI-03, EI-2522 x EI-03 and EI-2525-2 x EI-03 (b_i>1) found suitable for favorable environment with good management practices for grain yield per plant in maize. The hybrids EI-2176-3 x EI-03 (b_i<1) EI-2525-2 x EI-03 (b_i>1) and EI-2159 x EI-670 (b_i>1) out yielded the best check cultivar PHM-3. Thus, these hybrids may be used in future breeding programmes of maize after multi location yield testing.

T-1/P-34

Integration of random mating and double haploid tool for rapid development of homozygous lines from maize-teosinte cross

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Maize is one of the most ancient crops of new world with exceptionally highest genetic yield potential. Modern maize is transformed completely from its progenitor during the long spell of domestication and selective breeding leading to loss of many adaptive alleles. Narrow genetic base in cultivated maize is considered to be a bottleneck in sustaining and supporting long term maize improvement programme in changing climate era. Wild relatives and progenitor of maize are supposed to have novel allelic form that may diverse the maize germplasm for not only biotic and abiotic stress parameters but also for modifying plant architecture, yield and various quality parameters. Thus, pre-breeding is seems to be a priority programme for domestication of wild alleles for diversification of maize germplasm. The use of unadpted/wild relatives in crossing with elite genotype of maize may distort the gene constellation of adapted germplasm and also add many undesirable genes and genomic regions as unintentional drag due to close proximity with the desirable wild genes. Such complexities are also expected to delay the pre-breeding process. To accelerate the domestication process, we made crosses of maize with *Zea mays* sub ssp *parviglumis*, followed by one dose of back crossing with maize line. The BC1F1 population was then random mated with intention to break the undesirable linkage. The random mated population was then crossed with tropicalised haploid inducer line obtained from CIMMYT. The crossed seeds were sorted into haploid seeds and diploid seeds using R1-nj seed colour marker. The haploid seeds (D_0) were germinated *in vitro* and exposed to colchicine solution for 12 hours after cut at growing shoot tips and root tips. Thoroughly washed D_0 seedlings were planted in small pots filled with coco-peat, vermicompost and soil and kept under protected condition for 10-12 days. After that the plants were transplanted to field for multiplication using controlled pollination. Thus, in the present investigation, we successfully completed the diplodization of haploid seedling obtained from random mated population derived from maize and teosinte cross. This novel procedure is assumed to have significant implication in inbred line development in pre-breeding programme using wild relatives.

T-1/P-35

Assessment of combining ability in yellow seeded Maize (Zea mays L.)

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Maize (*Zea mays* L.) is a third important crop being grown in diverse ecologies with highest production and productivity among food crops. The present investigation consisted of total 55 genotypes comprised of 36 hybrids, 15 parents and 4 checks and evaluated during Kharif-2016 to elucidate the combining potential of hybrids and parents. The data was recorded on fifteen traits to study of the general and specific combining ability effects. The ratio of sca and gca was greater for all the traits except anthesis-silking interval, number of leaves per plant, harvest index, grain yield per plant, oil content, protein content and starch content. This indicated that the preponderance of non-additive gene effects in the expression of these traits. The inbred line L_{10} was found good general combiners for grain yield per plant, cob girth, number of grain rows per cob, harvest index oil content and starch content, whereas the testers T_3 was good general combines for yield and majority of traits viz., grain yield per plant, harvest index, oil content, protein content and starch content. That general combing ability due to additive and additive x additive gene effects. Which are the fixable components of genetic variation. Twelve hybrids showed significant positive sca effects for grain yield per plant. The maximum significant positive sca effects along with highest *per se* performance and economic heterosis for grain yield per plant was depicted by hybrid L_{12} x T_3, followed by hybrids L_1 x T_2, L_{11} x T_2, L_7 x T_1 and L_4 x T_2. This was cross between average x good gca effects parents for grain yield per plant.

T-1/P-36

Phenotypic evaluation of inbred lines for grain yield and their utilization for developing high yielding maize (*Zea mays* L.) hybrids

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Genetically broad-based inbred lines are pre-requisite for genetic enhancement and development of new hybrids in heterosis breeding. A set of inbred lines were evaluated for their morphological and yield contributing traits. Out of which, 25 best inbred lines were selected after thorough evaluation for two consecutive years at Ludhiana, India. These inbred lines were randomly crossed to obtain high yielding hybrids. A total of 22 outstanding hybrids with three checks were evaluated for two consecutive years at two diverse agroclimatic conditions (Ludhiana and Gurdaspur, India). Analyses of variance for inbred lines and hybrids for both years at both locations were showed significant differences. Both association analysis and principal component analysis revealed that plant height, ear height, ear-plant height ratio and number of cobs per plant were significantly correlated with yield for both years in case of inbred lines evaluation. These promising inbreds were used for accumulation of favorable alleles for developing high yielding maize hybrids. During hybrid evaluation, number of cobs per plant was showing significant and positive correlation with yield for both years at both locations. Although, principal component analysis depicted that days to 50% pollen, days to 50% silking and days to 75% husk brown at Ludhiana and anthesis-silking interval, plant height and ear height at Gurdaspur were major contributors for yield in both years. Thus, a holistic approach across these analyses identified plant height, ear height and number of cobs per plant as the key traits, which could be used for improving yield of maize hybrids. Overall seven Hybrids JH 15002, JH16081, JH 17011, JH 18056, JH 18087, JH 18091 and JH 19085 were identified as high yielding across the years and locations which out-performed the three released hybrids. Further, multi-location evaluation of these new hybrids will provide an opportunity for identifying stable hybrids suitable for large scale commercialization.

T-1/P-37

Genome wide association studies in maize: A review

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Maize is one of the most important food crops worldwide. Population growth and climate change posed great challenges for further maize production. Many technologies have been widely applied in maize genomic study and improvement processes, and contributed greatly to increase the efficiency and accuracy of maize breeding. On the other hand, novel sequencing and genomic technologies also promote the shift of breeding schemes from conventional field selection processes to genomic assisted breeding. Additionally, the advent of high-throughput next-generation sequencing technologies in the last decade, coupled with its substantial decrease in cost in the recent years and development of complementary array-based genotyping platforms, has revolutionized the generation of genome-wide markers and propelled several statistical methods for unearthing marker-phenotype association. Several studies showed how, genome wide association studies are used in maize breeding. These technologies have revolutionized almost every aspect of maize study and breeding.

T-1/P-38

Elucidating molecular diversity and grouping of Indian maize inbred lines using SNP markers

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Knowledge of genetic population structure and genetic diversity of breeding populations is crucial in determining the appropriate breeding tactics to be used in a breeding programme to optimize their potential. The four different complementary approaches namely Bayesian structure analysis model, PCoA, Neighbour-Joining and UPGMA clustering were employed to obtain the information on the population structure of the panel of inbred lines. The groupings obtained by these methods were reasonably reliable. The present study clearly showed that classification of inbred based on regions and center were not effective. Inbreds of the same centers are distributed into different clusters. Instead of grouping based on region, grouping based on genetic variability would help in the classification of maize inbred lines. Additionally, information obtained from the population structure study might be extremely useful for grouping inbred lines into different heterotic groups as well as it reduces cross-pollination between closely related lines.

T-1/P-39

Genetic diversity analysis of inbred lines in maize (*Zea mays* L.)

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The present experiment was carried out at Raj Mohini Devi, College of Agriculture & Research Station Ambikapur during *Rabi* 2019-20 in randomized block design (RBD) with 37 maize genotypes to assess the genetic diversity for various morphological and quantitative traits. The data were recorded for days to 80% maturity, days to 50% tasseling, test weight (100 grain), days to 50% silking, Final plant stand ear height (cm), plant height (cm), ear length (cm), ear diameter (cm), number of cobs per plot, number of kernels per row, grain yield, and number of kernel rows per cob, Shelling %, Grain yield (Q/ha). Based on D^{2-} Statistics, 37 genotypes were grouped into five clusters. The main clusters with 29 genotypes were clusters I and II, followed by clusters III, cluster IV, clusters V. The overall D^2 value for cluster III (D^2=103.35) was followed by Cluster II D^2=100.52) and Cluster I (D^2= 74.26). The inter-cluster D^2 values for the 5 clusters showed that the largest generalized inter-cluster distance (D^2= 414.05) was between cluster V and cluster III, while the lowest (D^2= 0.00) was between cluster V and cluster IV. On the basis of divergence and cluster mean it may be suggested that good recombinants could be obtain in crosses between genotypes of cluster III, II and I in varietal improvement programme thus, crosses between the genetically diverse genotypes of cluster I with genotype IAMI-69, IAMI-45, IAMI-82, IAMI-62, IAMI-44 and cluster II with genotypes like are IAMI-88, IAMI-73, BML-6 and cluster III IAMI-89, IAMI-37 are expected to exhibit high heterosis and are also likely to produce new recombinants with desired traits.

T-1/P-40

Characterization of entire set of maize germplasm conserved at National Genebank (NGB) of India

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Germplasm of any crop refers to basic or fundamental unit of propagation (seed, tissue or any other form of propagule) of all the genetic resources, which comprises of wild relatives, landraces, folk varieties, farmers' varieties, open pollinated varieties, elite breeding lines etc. Plant genetic resources is an important and integral part of crop improvement programme. However, its utilization in the breeding largely determined by the availability of reliable and accurate information on its morphological, vegetative, reproductive, agronomic, and other features of economic importance nutritional value, resistant to biotic and biotic stresses etc. The information on all these aspects can be generated through characterization of available germplasm with respect to all the above-mentioned features. The large-scale maize germplasm characterization was undertaken during rabi (winter) 2020-21. The trial was conducted during winter, generally it provides a neutral kind of climatic conditions and more importantly in order to provide the optimal micro-climate to each of the germplasm accessions for its best expression, the entre germplasm accessions were stratified at three levels into 170 classes based on the information available on each of the accessions conserved at NGB. The first level of stratification was done based on type of germplasm i.e. indigenous and exotic. The entire germplasm was further stratified in level two based on biological status namely landraces, folk cultivars, inbred lines, etc. The third level of stratification was done based on geographical region or collection site from where the germplasm were collected. The number of blocks in which the trial was conducted were 92 and the block size varies from 144 to 132. The plot size followed in conducting the trial was 1.8 m^2, one row of 3 metre with the between row spacing of 0.6 metre. The total number of plants maintained were 15-18 with the plant to plant distance of 0.15 to 0.2 metre. The field experiment was conducted at Regional Maize Research and Seed Production Centre (RMR&SPC), Begusarai, Bihar, India, in augmented design using 12 check entries. The check entries comprises of four each of open pollinated varieties, inbred lines and also hybrids. The total number of germplasm accessions characterized were 11674. The data on 30 morphological traits were collected which includes 17 morphological traits, five each of agronomic and reproductive traits and three vegetative traits. However, the massive exercise is unique of its kind and such kind of exercise will not be repeated in near future, the opportunity was used record observations on 31 additional traits which are of breeders interest and are often considered by the breeders while making selection in the germplasm like stay green, forage production, number of leaves above the ear and number of leaves below the ear, root lodging, stalk lodging, tassel traits, ear aspects (rotting, quality), husk cover, prolificacy, proliferation, cob diameter, kernel length and kernel width, rabbit ear, etc. Further the data on chlorophyll content, plant height was collected using advanced technology, drone. The data captured using drone indicated striking difference in chlorophyll content between landraces, inbred lines and exotic germplasm comprises mainly hybrids.

T-1/P-41

Morphological and molecular characterization of low phytic acid (*lpa1*- and *lpa2*-based) genotypes in maize

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Maize serves one of the most important staples for millions of people worldwide. However, it possesses higher concentration of phytic acid (PA), which is an anti-nutritional factor that drastically reduces the bioavailability of mineral elements (Fe and Zn); thereby causes micronutrient malnutrition. Thus, reduction of PA in maize genotypes through genetic manipulation assumes great importance. The present study was conducted to evaluate a set of 48sub-tropically adapted *lpa1-1* and *lpa2-1*-based maize inbreds derived through molecular breeding at multilocation for their agronomic performance, grain quality and using molecular markers. Significant reduction in PA of 35.75%in *lpa1-1* and 25.8% in *lpa2-1* mutants was observed over wild type inbreds. Mean inorganic phosphorous (iP) content was significantly higher to the extent of 3-fold in both*lpa1-1* and *lpa2-1*inbreds compared to wild type inbreds. Though PA and iP content varied between the *lpa*- and wild type inbreds but the total phosphorous (TP) remained unaffected. Mean PA/TP ratio was found to be higher in the wild type inbreds compared to *lpa* inbreds. Molecular characterization using ~60 genome-wide SSRs generated 172and 181 alleles among the diverse set of *lpa1-1* and *lpa2-1* based inbreds, respectively. Further cluster analysis grouped each set of 24 *lpa1-1* and 24 *lpa2-1* inbreds into three major clusters. No significant difference was observed between *lpa*-genotypes and wild type inbreds for key agronomic traits and grain yield. The study identified, (1) nutritionally superior*lpa1-1* and *lpa2-1* based inbreds as promising donors and (2) potential hybrid combinations for low phytate with good agronomic performance that can be directly utilized in the biofortification programme.

T-1/P-42

Introgression of *waxy1* gene into multi-nutrient rich maize inbreds through genomics-assisted breeding

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Waxy corn possesses 95–100% amylopectin compared to 70–75% in normal maize due to mutation in *waxy1* (*Wx1)* gene encoding *granule-bound starch synthase-I*(GBSS). The presence of recessive *wx1* allele causes enhanced accumulation of amylopectin. These waxy green cobs are popular as breakfast item in South Asia and an important diet in North-Eastern states of India, besides serving as one raw material for series of industrial applications. In the present study, *wx1* allele was introgressed into the parental inbreds of APQH8 (PMI-PV9 × PMI-PV5) having mutant*crtRB1* and *opaque2* genes conditioning higher accumulation of provitamin-A, lysine and tryptophan. Around 100-120 plants of BC_1F_1, BC_2F_1 and BC_2F_2 were genotyped using markers viz. *3'TE-InDel* (for *crtRB1*), *phi057* (for *opaque2*), *phi027* and *wx2507* (for *wx1*).Foreground selection of BC_1F_1 and BC_2F_1 populations led to the selection of progenies with*wx1* gene in heterozygous state, and *crtRB1* and *o2* gene in homozygous state. In BC_2F_2 populations, progenies with all three genes in homozygous conditions were identified. Background selection using 90-100 SSRs covering 10 chromosomes led to the recovery of >90% recurrent parent genome. The progenies possessed high degree of similarity for plant, ear and grain characteristics of their original inbreds. The improved inbreds possess high amylopectin, provitamin-A, lysine and tryptophan and would lead to development of waxy maize hybrids with high amylopectin and nutritional quality.

T-1/P-43

Genetic characterization of a core set of maize germplasm for trait specific variability

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The complexity and low heritability of the grain yield makes it less predictable than any other trait. Thus, the study of yield component traits can reveal the genetic architecture of grain yield for improving maize production. In order to evaluate genetic variability for traits affecting grain yield, a panel of 74 maize inbred lines from different heterotic pools; semi exotic and indigenous lines; lines collected from different institutes *viz.*, CIMMYT Asia Hyderabad, IIMR and NBPGR, New Delhi was selected for the study so as to capture sufficient amount of genetic variability for yield contributing traits viz., cob length, cob girth and kernel rows per cob at research farms of Punjab Agricultural University (PAU), Ludhiana. The synchronising lines harbouring better yield contributing traits were used as parents to generate F_1 combinations using line x tester design during spring 2021 and were evaluated along with the panel of inbred lines during *kharif* 2021. The analysis of variance revealed that highly significant differences exist among the inbred lines for the yield component characters. The highest value for cob girth was exhibited by inbred line PML 365 (5.7cm) and lowest value was recorded in PML 276 (3.5 cm) and PML 501(3.5 cm). Similarly, cob length had a mean value of 10.90 cm with highest value in PML 207 (15.5 cm) followed by PML 24 (14.9 cm) and PML 158 (14.5 cm). Clustering analyses based on Euclidean Distance clearly partitioned all 74 inbred lines of maize into two minor clades (I and II) and one major clade (III). Clade I consist of only two inbred lines viz., PML 161 and PML 77 while as Clade II comprised of 13 lines. Clade III was further partitioned into three sub clusters. Sub clusters III A contained the inbred lines having highest mean values for cob length whereas cluster III C had highest mean values for cob girth. The cross combinations PML 1231 X PML 81, PML 1231 X PML 23, PML 1190 X LM 23 were most desirable for grain yield per hectare coupled with cob length indicated that the parental lines have the potential for utilization as donors for cob length in hybrid breeding programmes. Similarly, the better performance of hybrid combinations PML 1225 X LM 23, PML 1225 X PML 243 and PML 1228 X PML 1224 for grain yield along cob girth suggested that the lines could be used to develop higher yielding maize hybrids. The untapped diversity in the panel of 74 inbred lines could be further exploited for maize improvement through the core and/or minicore subset available to the maize community. This study will provide genetic information and resources for molecular breeding of maize grain yield.

Theme-2
Maize for sustainable and resilient cropping systems

T-2/O-1

Conservation agriculture-based ICMs in cereal-based rotations

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Different integrated crop management (ICM) modules have been developed to enhance the productivity and profitability of the cereal-based rotations. As the available options are used quite often singly or with the few combinations, hence in the present studies, ICM modules have been evaluated; wherein, $ICM_{1\&2}$- conventional maize/rice *fb* wheat, $ICM_{3\&4}$- conventional raised bed maize/direct seedesd rice (DSR) fb furrow irrigated raised bed wheat without residues, $ICM_{5\&6}$- conservation agriculture (CA)-based modules [zero tilled (ZT) maize/DSR and ZT wheat] with the wheat and maize / rice residues, and $ICM_{7\&8}$- CA-based modules (ZT raised bed maize/DSR and ZT wheat) with the wheat, mungbean and rice residues.The CA-based ICM modules ($ICM_{7\&8}$) could be well adopted in the cereal-based rotations, as it not just saves the water, but rather improves the soil carbon dynamics along with the protection of soil, yields and the farm profits.Results of themaize-wheat rotationindicated that the CA-based residue retained $ICM_{5\text{-}8}$ moduleshad given 9.5-14.3% (5 years av.) greater system yields in terms of maize grain equivalents (M_{GEY}) over the residue removed CT-based $ICM_{1\&4}$. Similarly, in the rice-wheat rotation, the five years' mean clearly outlined the superiority of the $ICM_{7\&8}$ in respect of the system yields as rice equivalents, which produced 10-13% greater yields than the $ICM_{1\&2}$.Also, different ICM modules caused significant ($p<0.05$) impacts on the soil properties, such as organic carbon (S_{OC}), microbial biomass carbon (S_{MBC}), dehydrogenase (S_{DH}), alkaline phosphatase (S_{AP}), and urease (U_{RE}) activities. Hence, these studies concludes that the adoption of the CA-based residue retained ICMs in the cereal-based rotations could sustain the crop yields, enhance farm profits, save water and improve soil properties.

T-2/O-2

Performance of single cross maize hybrid (*Zea mays* L.) under varying zinc management practices

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Maize (*Zea mays* L.) is one of the important cereals, next to wheat and rice in the world. It is one of the most versatile crops, which can be grown over diverse environmental conditions for a variety of uses in providing nutrients for humans and animals and serves as a basic raw material for the production of starch, oil and protein, alcoholic beverages, food sweeteners and, more recently, fuel. In Rajasthan, the crop occupies 0.97 m ha area with an annual production of 2.70 m t and average yield of 27.69 q ha^{-1} (Govt. of Rajasthan, 2021). In recent years, maize production has shown a remarkable increase which is mainly associated with significant genetic enhancement from the area of open pollinated varieties to single cross hybrids which is first choice of farmers now a day. Crop nutrition is an important aspect to achieve higher production as well as quality of maize crop. Presently deficiency of zinc has become so widespread that it ranks next to N, P and K in Rajasthan as well as many other states under intensive cropping systems. The objective of experimentation was to standardize economically viable zinc management practices for single cross maize hybrid. The experiment was conducted during *Kharif* 2021 at Instructional Farm, Rajasthan College of Agriculture, MPUAT, Udaipur on clay loam soils having medium fertility status. The treatment consisted combinations of nine zinc management practices (**T_1**: Control, **T_2**:100 % Zn as ZnSo4-25 kg ha^{-1}, **T_3**: 75 % Zn as ZnSo4-18.75 kg ha^{-1}, **T_4:** 50 % Zn as ZnSo4-12.50 kg ha^{-1}, **T_5**: 100 % Zn as ZnSo4-25 kg ha^{-1}, **T_6**: 50 % Zn as ZnSo4-12.5 kg ha^{-1} + 0.5 % ZnSo4 foliar spray, **T_7**: Zinc Solubilising Bacteria, **T_8**: Zinc Solubilising Bacteria + 75 % Zn as ZnSo4-18.75 kg ha^{-1} + 0.5 % ZnSo4 foliar spray at knee high stage and **T_9**: Zinc Solubilising Bacteria + 50 % Zn as ZnSo4-12.50 kg ha^{-1} + 0.5 % ZnSo4 foliar spray at knee high stage) These 9 treatments combinations were evaluated under RBD with three replications. The results of present experiment revealed that soil application of zinc solubilising bacteria + 75 per cent Zn as ZnSo4(18.75 kg ha^{-1}) followed by 0.5 per cent ZnSo4 foliar spray at knee high stage produced highest grain, stover yield and proved economically profitable treatment combination in relation to zinc management practice in medium fertility status of soils.

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T-2/O-3

Evaluation of sensor guided in-season nitrogen management strategies for maize

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Efficient nitrogen (N) fertilization is crucial for economic maize production. Traditionally, farmers apply nitrogen uniformly as a blanket recommendation in maize crop. Mostly farmers apply higher rates of N fertilizer than recommended to ensure high crop yields. But large temporal and field to field variability of soil N supply restrict efficient use of N fertilizer. Hence, the use of some tools for in-season N management like Soil Plant Analysis Development (SPAD)/ chlorophyll meter, Green Seeker, Site-Specific Nutrient Management (SSNM) through Soil-Test Crop Response (STCR) or Nutrient Expert helps in fulfilling the crop nutrient requirement with less environmental footprints apart from higher crop productivity and profitability in maize. A two years (2018 and 2019) field study was conducted at Agricultural Research Station, Peddapuram, East Godavari Dist. during *kharif* season on sandy loam soils to evaluate the influence of precision nutrient management on yield and economics of maize. The experiment was conducted in RBD with three replications. Treatments consisted of T_1- Control, T_2- RDF (1/3+1/3+/1/3 N splitting at basal, knee high and tasseling), T_3- STCR (1/3+1/3+/1/3 N splitting at basal, knee high and tasseling), T_4 -Nutrient expert (1/3+1/3+/1/3 N splitting at basal, knee high and tasseling), T_5 -33% basal N + Green Seeker based N at knee high & tasseling stage , T_6 -60% basal N + Green Seeker based N at knee high stage , T_7 -70% basal N + Green Seeker based N at knee high stage , T_8 -60% basal N + Green Seeker based N at tasseling stage , T_9 -70% basal N + Green Seeker based N at tasseling stage , T_{10}- 30% Basal N + 30% at 25 DAS + Green Seeker based N at tasseling stage, T_{11} - 35% Basal N + 35% at 25 DAS + Green Seeker based N at tasseling stage, T_{12} - N rich strip (300:60:40) (1/3+1/3+/1/3 N splitting at basal, knee high and tasseling). The crop was fertilized based on calculation made using Nutrient Expert (NE), STCR and green seeker. The pooled results of the study indicated that the application of 35% Basal N + 35% at 25 DAS + Green Seeker based N at tasseling stage recorded significantly higher grain yield and B:C ratio (7126.8 kg/ha and 2.35, respectively) which was at par with 30% Basal N + 30% at 25 DAS + Green Seeker based N at tasseling stage (6975.8 kg/ha and 2.32,respectively) and RDF (6745.2 kg/ha and 2.20, respectively) with nitrogen saving of 36 kg/ha. Experimental results disclosed that though yield was at par with RDF green seeker guided nitrogen application could be a best choice in terms of profitability and nitrogen saving than blanket recommendations in maize.

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T-2/O-4

Effect of nitrification inhibitors on productivity and nitrogen use efficiency of maize (*Zea mays* L.)

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Maize (*Zea mays L.*) assumes worldwide significance due to its versatile nature having wider adaptability under varied agro-climatic conditions. Nitrogen is very important nutrient for increasing maize production as it plays important role in plant metabolism such as protein synthesis, thus strongly influencing both protein content and yield. The rapid nitrification of Urea, which is the major source of nitrogen, is one of the key factors of inefficient nitrogen use, particularly in warmer climate such as India. Many nitrification inhibitors have been useful in increasing the growth, development and crop yields. However, most of the nitrification inhibitors such as nitrapyrin, dicyandiamide and ammonium thiosulphate remain still unpopular mainly due to their higher costs and limited availability. In this direction, use of neem-cake or neem oil-coated urea holds immense promise. The present study was laid out in a randomized block design with fourteen combinations of three nitrification inhibitors (Dicynadiamide, neem oil and meliacin) each with two different concentrations (350 and 700 ppm of neem oil and meliacin and 5% and 10% of Dicynadiamide) and two levels of nitrogen (135 and 180 kg/ha). Different growth parameters, grain yield, stover yield and harvest index were significantly influenced by levels of nitrogen and nitrification inhibitors and highest values were observed with MCU350@N180. A critical examination of data indicated that highest agronomic efficiency and physiological efficiency were found with the application of MCU350@N180 and highest Nitrogen harvest index (NHI) was obtained with MCU700@N135. Most durable effect on inhibition of nitrification inhibition, highest net return and net return/rupee invested were also recorded with MCU350@N180. So, identification and evaluation of the new indigenous nitrification inhibitors can be a potential area for further research to increase the yield and nitrogen use efficiency of maize.

T-2/O-5

Sensor guided and placement based nitrogen management in maize under conservation agriculture

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Maize–wheat is the third most important cropping system after rice–wheat and rice–rice in India and occupies about 1.80 m ha areas mainly in Indo Gangetic plains and Central India, which contributes 3% in the national food basket. IGP has been the victim of many problems such as degrading soil, water and air quality, the decline in water productivity and resource use efficiency etc. Among them, residue burning and low nutrient use efficiency are not only worsening the problem of environmental quality but also posing the biggest challenge for the sustainable development of agriculture. The conventional farming practices based on extensive tillage have magnified soil erosion losses and the soil resource base has been degraded steadily, especially when tillage is combined with *in–situ* burning of crop residues. Conservation agriculture and nutrient management are the key to higher productivity with a lower environmental footprint in intensive cropping systems. Nitrogen is the most critical nutrient for enhancing the productivity of the crop while it has serval environmental concerns like groundwater pollution and emission of greenhouse gases like nitrous oxide. Therefore, the higher production of grain with lesser use of nitrogen could be a key for the sustainability of a fast-emerging maize-based cropping system in India. Sensor-based nitrogen management along with better placement methods in maize were evaluated in conservation agriculture plots established at the fixed site in 2012 under split-plot design with tillage practices *viz.* conventional, zero tillage with and without residue retention as the main plot, and control, RDN- conventional, GS-guided improved (SSB) and RDN improved (SSB) as subplots. Results revealed that the retention of crop residue leads to enhancement in maize yield significantly by 7.1% over residual removal. The yield of maize due to improved placement was 8.1 and 9.5% higher with green seeker–subsurface banding (GS-SSB) and RDN-improved (SSB), respectively irrespective of the residue management scenarios and was significantly superior over RDN-conventional. However, the yield gains in placement were differed due to the residue management scenario and the gains were 11.1 and 7.8 without residue while 5.2 and 11.1% with residue retention by GS-SSB and RDN-improved (SSB), respectively over RDN-conventional. The Agronomy efficiency (AE_N) in maize was significantly higher with sub-surface banding of nitrogen. The SSB increased AE_N by 42.8 and 17.8% without residue while 39.6 and 31.3% in with residue over RDN-conventional respectively under GS-SSB and RDN-improved treatments.

T-2/O-6

Estimation of photo synthetically active radiation distribution and absorption in corn based intercropping system

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Corn productivity and biomass accumulation is a function of light absorption and its conversion through photosynthetic rate. In intercropping systems sunlight absorption and utilization is better than respective monoculture. Quantification of extent of photosynthetically active radiation (PAR) absorption across crop canopy will indicate light available for component crops in the different crop combinations. Field experiment was conducted at Main Agriculture Research Station, Raichur (16.2N 77.37E), Karnataka, India to know productivity and radiation use efficiency of corn-legume intercropping system under protective irrigation. Pigeonpea, dolichos lablab, blackgram and cowpea are selected as intercrops. Experiment was carried out in randomized complete block design with three replications. Corn was planted at 60 cm apart and intercrops sown each row (1:1) and two rows (2:1) of corn. Intercrops were compared to respective sole crops. Incident light and transmitted light at different plant height was recorded simultaneously using SunScan canopy analyzer. Light interception, Leaf Area Index and light absorption were worked out by light differences in top and bottom of crop canopy. Crop yields of intercrops were converted into crop equivalent yields based on prevailed market price. Significantly higher corn grain yield, corn equivalent yield was obtained from maize + pigeonpea intercropping over rest of intercropping systems. The system also recorded better utilization of PAR across crop canopy. The results indicated that light distribution and absorption estimation was real indicator of growth and yield potential of corn as well as intercropping systems.

T-2/O-7

Effect of foliar application of zinc based nanofertilizer and varying fertility levels on growth attributes, yield attributes, yield and economics of maize

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A field experiment was conducted during two consecutive *Kharif*, seasons of 2020 and 2021 at Instructional Farm, Rajasthan College of Agriculture, Udaipur to evaluate the effect of foliar application of zinc based nanofertilizer and different fertility levels on growth attributes, yield attributes, yield and economics of maize. The experiment was laid out in a factorial randomized design with three replications comprising four foliar application of nanofertilizer (Control, at knee high stage, at 50% tasseling stage and both at knee high stage and at 50% tasseling stage) and four fertility levels (100% RDF, 90% RDF, 80% RDF and control). Significantly highest grain, stover and biological yield (51.90, 82.32 and 134.21q ha^{-1}) were recorded with the dual foliar application of nanofertilizer at knee high stage and at 50 per cent tasseling stage over single stage foliar application. Among different levels of fertility, application of 90 per cent RDF significantly increased grain, stover and biological yield. Yield attributing characters viz., cob length (cm), girth of cob (cm), grains cob^{-1}, cob height (cm), grain weight cob^{-1} (g), 1000 grain weight (g) and Shelling (%) were significantly higher with the dual foliar application of nanofertilizer at knee high stage and at 50 per cent tasseling stage and application of 90 per cent RDF in maize. Similarly, the significantly highest protein content of maize (11.13 % and 10.97 %) was found in with dual foliar application of nanofertilizer and 90 per cent RDF, respectively. The significantly highest net return and B-C ratio were found under dual foliar application of nanofertilizer 82956 and 3.04) and soil application of 90 per cent RDF (`86112 and 3.15) in maize.

T-2/P-1

Assessing the effect of seedling age and sources of nutrients on performance of sweet corn under temperate climatic conditions

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An experiment was conducted to evaluate the effect of age of seedling and sources of nutrients on growth and yield of sweet corn at SKUAST-K during *Kharif*-2020. It was laid out in randomized complete block design with factorial arrangement replicated thrice. The age of seedling consisted of 12, 22 and 32 days old seedlings and sources of nutrients consisted of control, 100 % RDF, 50 % RDF + FYM @ 12 t ha^{-1}, 50 % RDF + vermi-compost @ 4 t ha^{-1} and 50 % RDF + poultry manure @ 2 t ha^{-1}. The variety used was Sugar-75 transplanted at a spacing of 75 cm x 20 cm. The findings of this study indicated that age of seedling and sources of nutrients extended a significant influence on growth parameters, yield attributes and yield of sweet corn. Transplanting of 22 days old seedlings recorded significantly highest values for various growth parameters of sweet corn *viz.* plant height, number of functional leaves, leaf area index and dry matter accumulation from 30 DAT up to the harvest. Significantly higher yield attributes and yield was obtained by transplanting 22 days old seedlings. Application of 50 per cent RDF + poultry manure @ 2 t ha^{-1} registered significantly higher plant height, leaf area index, dry matter accumulation and number of functional leaves which resulted in significantly higher green cob yield and green fodder yield. Overall, the study indicated that transplanting 22 days old seedlings and application of 50 per cent RDF + poultry manure @ 2 t ha^{-1} proved superior in realizing higher yield and profitability with BCR of 6.57 under temperate climatic conditions.

T-2/P-2

Crop-weather relationship of maize hybrids sown under different dates at varied row spacings

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A field experiment was conducted in *Kharif* season of 2020 at Agronomy Research Farm, Wadura Sopore, Sher-e Kashmir University of Agricultural Sciences and Technology Kashmir with three dates of sowing as main plot treatments *viz*. (17th SMW(23-29 April) (D_1), 19th SMW (7-13 May) (D_2) and 21st SMW (21-27 May) (D_3), three spacings as sub-plot treatments *viz*. 50 cm× 20 cm (S_1), 60 cm× 20 cm(S_2), 70 cm× 20 cm (S_3) and two hybrids as sub-sub-plot treatments *viz.* Hytech- 5801 (H_1), YSH- 1(H_2) laid out in Split- split plot design and replicated thrice to identify the suitable time of sowing, best plant spacing and suitable maize hybrid under temperate conditions. Results of the experiment revealed that among the different dates of sowing, the maize crop sown on 17th SMW (D_1) registered significantly highest values of growth parameters, yield attributes and yield. Wider spaced (70 cm×20 cm) maize hybrid (Hytech- 5801) recorded highest values of growth parameters, yield and yield attributes as compared to narrow spaced crop. Among the two hybrids Hytech-5801 recorded significantly highest values of growth parameters, yield attributes and yield. This study conclusively showed that for getting higher yield the maize hybrid Hytech- 5801 should be sown in 17th SMW (29th April) with a plant spacing of 70×20 cm.

T-2/P-3

Performance of maize (*Zea mays* L.) genotypes for fodder and quality attributes as influenced by sowing dates under Kashmir conditions

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An experiment comprising of two factors with four dates of sowing viz. 30th April, 10th May, 20th May and 30th May as main plot treatments and three genotypes viz. SFM-1, PMC-6 and J-1006 as sub- plot treatments replicated thrice was conducted during *Kharif* 2019. The results of the experiment revealed that 30th April sowing of maize recorded statistically significantly higher plant height at 45 DAS up to harvest whereas, lowest plant height was registered in 30th May sowing date. Among, genotypes SFM-1 recorded highest plant height at 15 DAS to harvest. Statistically significantly higher leaf area index was noticed with 30th April sowing at 45 DAS to harvest. Among, genotypes SFM-1 recorded higher leaf area index from 15 DAS to harvest followed by PMC-6 and J-1006 respectively. Plant population was more in early sowing date of 30th April followed by 30th May but statistically non-significant. Among genotypes PMC-6 registered more plant population but statistically non-significant with rest of genotypes. Dry matter accumulation (DMA) was statistically significantly higher in 30th April sowed crop at 30, 60 DAS and at harvest. Among genotypes SFM-1 recorded higher DMA at 30, 60 DAS and harvest. Crop growth rate (CGR) was registered significantly higher in sowing on 30th April from 30-60 DAS and 60-90 DAS, whereas lowest on 30th May sowing. Among genotypes, SFM-1 registered significantly superior CGR at 30-60 DAS and 60-90 DAS. Relative growth rate (RGR) and net assimilation rate (NAR) showed the same trend. Green fodder yield was statistically significantly higher in 30th April sowing, however, lowest in 30th May sowing. Genotype SFM-1 registered higher green fodder yield among genotypes, which was lowest with J-1006 but statistically par with PMC-6.

Quality parameters viz. Protein content, ash content, neutral detergent fiber and acid detergent fiber were statistically significantly higher in 30th April sowing, while as they were lowest with 30th May sowing except protein content which showed non-significant effect with sowing dates. Among genotypes SFM-1 recorded higher protein content, ash content, acid detergent fiber, and lowest neutral detergent fiber respectively and genotype J-1006 had poor quality parameters except higher neutral detergent fiber but statistically at par with PMC-6.

T-2/P-4

Performance of sweet corn hybrids (*Zea mays saccharata*) as influenced by soil and foliar application of zinc

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A field experiment entitled "Performance of sweet corn hybrids (*Zea mays saccharata*) as influenced by soil and foliar application of zinc" was conducted during *kharif* 2018 at the Experimental Farm of the Division of Agronomy, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir at Wadura, Sopore. The experiment comprised of two factors with three sweet corn hybrids, *viz.*, Sugar 75, FSCH 75 and CMVL SC and four zinc levels, viz., $ZnSO_4$ @ 20 kg ha^{-1}, $ZnSO_4$ @ 15 kg ha^{-1} + $ZnSO_4$ (0.5%) foliar spray at knee high stage, $ZnSO_4$ @ 15 kg ha^{-1} + $ZnSO_4$ (0.5%) foliar spray at tasseling stage and $ZnSO_4$ @ 15 kg ha^{-1} + ZnSB @ 200 ml/kg of seed laid out in randomized complete block design (RCBD) with three replications. It was also observed that hybrids had a significant effect on the yield parameters and on the yield of sweet corn and among different hybrids, Sugar 75 recorded significantly higher number of grains per cob, average cob weight with and without husk, average cob length with and without husk and average cob girth with and without husk, green cob yield and green fodder yield. However, hybrids had no effect on number of cobs per plant. FSCH 75 recorded significantly lowest values for yield and yield attributes. Among zinc levels, $ZnSO_4$ @ 15 kg ha^{-1} + $ZnSO_4$ (0.5%) foliar spray at knee high stage produced significantly higher yield attributes and yield whereas zinc level, $ZnSO_4$ @ 15 kg ha^{-1} + ZnSB @ 200 ml/kg of seed recorded significantly lowest values of all the yield attributes and yield. However, zinc levels had no effect on number of cobs per plant.

T-2/P-5

Economic analysis of sweet corn hybrids (*Zea mays saccharata*) in response to soil and foliar application of zinc

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A field experiment entitled "Economic analysis of sweet corn hybrids (*Zea mays saccharata*) in response to soil and foliar application of zinc" was conducted during kharif 2018 The results of the experiment revealed that among different sweet corn hybrids, Sugar 75 produced significantly higher growth parameters, *viz.*, plant height, leaf area index, dry matter accumulation and mean crop growth rate compared to other sweet corn hybrids whereas FSCH 75 recorded significantly lowest growth parameters. Among different zinc levels, $ZnSO_4$ @ 15 kg ha^{-1} + $ZnSO_4$ (0.5%) foliar spray at knee high stage recorded significantly higher growth parameters whereas $ZnSO_4$ @ 15 kg ha^{-1} + ZnSB @ 200 ml/kg of seed recorded lowest plant height, leaf area index, dry matter accumulation and mean crop growth rate. Among different hybrids, sugar 75 recorded significantly higher zinc uptake by the crop, zinc content in grain and total soluble solids whereas FSCH 75 recorded significantly lowest zinc uptake by the crop and zinc content in grain. Zinc level, $ZnSO_4$ @ 15 kg ha^{-1} + $ZnSO_4$ (0.5%) foliar spray at knee high stage also recorded significantly higher zinc uptake by the crop, zinc content in grain and total soluble solids. However $ZnSO_4$ @ 15 kg ha^{-1} + ZnSB @ 200 ml/kg recorded significantly lowest zinc uptake by the crop, zinc content in grain and total soluble solids also. The economic analysis showed that highest net profit and benefit cost ratio of ₹466230.5 and 4.37 respectively was recorded by hybrid sugar 75 applied with zinc level of $ZnSO_4$ @ 15 kg ha^{-1} + $ZnSO_4$ (0.5%) foliar spray at knee high stage whereas lowest net profit and benefit cost ratio of ₹294742.5 and 2.76 respectively by hybrid FSCH 75 applied with zinc level, $ZnSO_4$ @ 15 kg ha^{-1} + ZnSB @ 200 ml/kg of seed.

T-2/P-6

Maize production technology for future, challenges and opportunities: A review

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Maize (*Zea mays* L.) is the prime crop for food security and income generation for millions of smallholder farmers in sub-Saharan Africa (SSA), Asia and Latin America. The importance of maize among cereal crops has been rising in the world. It is perhaps nature's most important gift to mankind as its reproductive system is unique and indeed a great asset permitting genetic recombination on a grand scale, resulting in enormous genetic diversity which exists today. It has now become the leading cereal crop contributing about two billion tons to the total world food basket. In India it is a commodity of high economic significance and its demand and production is increasing more rapidly as compared to other major commodities. Certain constraints including over-dependence on rainfall, frequent droughts, yield losses due to pre and post-harvest pathogens and insect-pests, weeds, poor agronomic management, lack of access to quality seed are associated with its production. But despite these constraints several Asian countries have registered impressive growth rate in terms of maize area, production and productivity over the past decade. In India maize cropping can provide insights on intensive agriculture and other strategies for meeting future food production challenges and will be one of the important cereals in food security. In next 10 years, strong interventions will be required to double the nation's maize production. To achieve the targeted productivity level for doubling the maize production, both technological and policy interventions will be essential. While policy interventions are required to remove the bottlenecks in the Indian maize sector in the short-run, strategic maize research is vital to significantly enhance genetic gains and for sustainable intensification of maize-based cropping systems in the country.

T-2/P-7

Conservation agriculture for higher resource use efficiency in maize-based production system

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Maize is considered one of the most imperative cereal crops in South Asia possessing wider adaptability in view of soil and diverse agro-climatic conditions. Due to the growing concern of food insecurity caused by natural resource degradation, diminishing water tables, and projected climate change consequences around the world, there has been a significant shift in traditional monoculture of diverse crops toward cropping sequences. In sight of changing resource base and diminishing water table under the existing farming scenario, intensive efforts are need of the hour to maximize food production per unit of water, minimize land and environmental degradation and to accomplish socio-economic progress through reorientation of agricultural research such as adoption of system based research and employment of recent advances with regard to soil, water and crop management practices viz. conservation tillage practices**.** Conservation agriculture-based management practices regarding maize systems aid in attaining the higher profitability in hand with reduced environmental as well as natural resource degradation, sustained soil health and quality and enhanced organic matter addition. In the face of shrinking arable land and rising population, these crop management approaches offer options for agricultural intensification and diversity. Furthermore, these management approaches aid in lowering the principal input cost of farming, which is incurred during tillage operations. Thus, conservation agriculture stays an approach forward in direction of improved food production and farm profitability in hand with environmental remunerations from agriculture.

T-2/P-8

Planting density and nutrient management effects on yield of maize hybrids in temperate ecology of Kashmir

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A field experiment entitled "Planting Density and Nutrient Management Effects on Yield of Maize Hybrids in Temperate Ecology of Kashmir" was carried out at Dryland (Karewa) Agriculture Research Station, SKUAST-K, Budgam during the *Kharif*season 2019. The experiment comprised of three factors with two maize hybrids viz. Kanchan-101 and Bio-605 as main-plot treatments and two plant geometries viz. 60×20 cm (83,000 plants ha^{-1}) , 60×15 cm (1,11,111 plants ha^{-1}) and three nutrient management practices viz. RDF (Recommended Dose of Fertilizers), SSNM (Site Specific Nutrient Management) and FP (Farmers Practice) as sub-plot treatments replicated thrice.

The results of the experiment revealed that among maize hybrids Bio-605 recorded significantly higher values of yield parameters like grain rows cob^{-1}, grains row^{-1} thus leading to higher grain yield (83.57q ha^{-1}). The results also showed that highest plant height, leaf area index, barrenness and dry matter accumulation (at harvest) was found with a plant population of 1, 11,111 plants ha^{-1} However, highest functional leaves $plant^{-1}$, cobs $plant^{-1}$, grain rows cob^{-1}, grains row^{-1}, grains cob^{-1}, grain yield (81.63q ha^{-1}) and harvest index (29.32) was found higher with plant population of 83,000 plants ha^{-1}. The results showed that balanced fertilization of maize crop involving nutrient combinations of N, P and K applied as per Site Specific Nutrient Management (SSNM) recommendation most effectively enhanced growth parameters viz., plant height, functional leaves, chlorophyll content, leaf area index, cobs $plant^{-1}$ and dry matter accumulation of maize. Application of SSNM also improved yield attributes (Cob length, grain rows cob^{-1}, grains row^{-1}) and consequently grain yield (87.03 q ha^{-1}), Stover yield (192.36) and harvest index (31.87).

T-2/P-9

Growth of baby corn as intluenced by sowing dates and fertility levels under temperate conditions

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A field experiment was conducted at Crop Research Farm of Division of Agronomy, Faculty of Agriculture, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Wadura during *Kharif* 2018 to study the "Growth of baby corn as influenced by sowing dates and fertility levels under temperate conditions". The experiment comprised of two factors with four sowing dates viz., 18th SMW (30th April - 6th May), 21st SMW (21st May – 27th May), 24th SMW (11th June – 17th June) and 27th SMW (2nd July – 8th July) as main plot treatments and four fertility levels viz., unfertilized control (F_0), 100:50:25 N:P_2O_5:K_2O kg ha^{-1} (F_1), 120:60:30 N:P_2O_5:K_2O kg ha^{-1} (F_2) and 140:70:35 N:P_2O_5:K_2O kg ha^{-1} (F_3) as sub-plot treatments laid out in split plot design with three replications. The results of the experiment revealed that growth parameters of baby corn viz., plant height, leaf area index and dry matter accumulation were significantly influenced by sowing dates and fertility levels. The results indicated that among the different sowing dates, 18th SMW (30th April - 6th May) sowing date recorded significantly higher plant height, leaf area index and dry matter accumulation, whereas 27th SMW (2nd July – 8th July) sowing date recorded significantly lower growth parameters. Fertility level 140:70:35 N:P_2O_5:K_2O kg ha^{-1} (F_3) recorded significantly higher plant height, leaf area index and dry matter accumulation among all the fertility levels whereas unfertilized control (F_0) recorded significantly lower growth parameters.

T-2/P-10

Effect of different integrated nutrient management on productivity of maize (*Zea mays* L.) in maize-mustard cropping system

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To achieve higher productivity in crops, use of chemical fertilizer was popularized during the era of green revolution, which was the need of hour. Over the time indiscriminate and continuous use of chemical fertilizers has resulted in the degradation of inherent soil fertility parameters. The excessive buildup of certain plant nutrients in has lead to the contamination of soil. The use of chemical fertilizers cannot be ruled out under commercial agriculture where use of high yielding varieties is done. There is need for integrated application from alternate source of nutrients as it will have a positive impact on the soil health and sustaining crop productivity for a longer time. Organic manures are bulky in nature and contain less quantity of plant nutrients when compared to chemical fertilizers. But, presence of various growth hormones and enzyme make them essential for soil fertility and plant growth. In an exhaustive crop like maize, where the nutrient requirement cannot be met only through native nutrient reserves integrated nutrient management becomes important. Keeping these facts in consideration, the present investigation was carried out to find out Effect of different integrated nutrient management on productivity of maize (*Zea mays* L.) in maize-mustard cropping system. The study was conducted during *Kharif* season of 2019, 2020 & 2021 consecutively at a fixed site at JNKVV, Zonal Agriculture Research Station, Chandangaon, Chhindwara, M.P-*.. It is situated at a height of 682m above mean sea level with a latitude range of 21° 28’ N and longitude range of 78° 10' E. It receives an average rainfall of 1087 mm during the crop period the rains were normal. The experiment was laid out in randomized block design keeping with eleven treatments viz: T_1=Unmanured; T_2=100% RDF; T_3=75% RDF; T_4=50% RDF; T_5=FYM 10 t/ha + Azatobactor; T_6=Maize + legume intercropping (for economic produce) with FYM 10 t/ha + *Azatobactor*; T_7=100% RDF + 5 t/ha FYM; T_8=75% RDF + 5 t/ha FYM; T_9=50% RDF + 5 t/ha FYM; T_{10}=100% RDF + 5 kg Zn/ha and T_{11}=FYM 5 t/ha (state practice) where the RDF was 120:60:40; N:P_2O_5:K_2O kg/ha. The experiment was laid out with three replications. The results from the present experiment clearly indicate that under the climatic conditions of Chhindwara, Integrated application of the 100% RDF + 5 t/ha FYM resulted in the significantly higher maize yield. Whereas, the growing maize +legume intercropping (for economic produce) with FYM 10 t/ha + *Azatobactor* resulted in higher system productivity in terms of Higher maize equivalent yield, net return and B:C.

T-2/P-11

Effect of organic weed and nutrient management practices on yield attributes and yields of maize in western Rajasthan

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A field experiment was conducted during *kharif* 2019-20 and 2020-21 at instructional farm of College of Agriculture Sumerpur, Agriculture University Jodhpur (Rajasthan-India). The experiment was executed in split plot design with three replications in a fixed layout during study period. The main plot treatments consisted of six weed management techniques and five sub plot treatment comprised organic nutrient management practices. Organic farming is now being practiced in 187 countries on 72.3 million hectare area and it was of 1.6 percent increase over 2018(FIBL and IFOAM, 2021).Stale seedbed flushing out germinating weed seeds before planting of crop and keep the field weed free up to critical period especially in*kharif* season provided adequate weed control, as well as optimal yield. The spreading of organic or plastic mulch over soil surface reduces weed problems by preventing weed seed germination or by suppressing the growth of emerging weed seedlings and increases competition in favour of crop. The experiment was conducted to evaluate the efficiency of organic weed management practices on weed dynamics and productivity of maize and to study the effect of different nutrient management practices on growth and yield of maize in organic farming. Further, assessment of the residual effect of weed and nutrient management practices on succeeding mustard. At harvest, the maximum weed control efficiency of broadleaf weeds (83.42%) and total weeds (87.27 %) was achieved in straw mulched treatment fb weed free check while 95.49 percent of grasses and sedges recorded in weed free check fb straw mulched treatment. Yield attributing characters viz., number of cobs plant^{-1}, grain rows cob^{-1}, number of grains cob^{-1}, average cob weight (g), weight of grains per cobs (g), shelling percentage and 1000- grain weight (g)of maize at harvest were influenced significantly by various weed management treatment compared to weedy check. On pooled basis, weed free check recorded the highest yield attributes except 1000 seed weight in stale seedbed+ hoeing once at 20 DAS+ straw mulch at 30 DAS and these treatments were found statistically at par to each other in respect of yield attributes in pooled analysis. All the weed management treatments significantly increased the grain yield of maize over weedy check both during 2019 and 2020 as well as in pooled analysis. The mean data indicated that the weed free treatment gave maximum grain yield of maize (3,358 kg ha^{-1}) which was statistically similar to stale seedbed + hoeing once at 20 DAS + straw mulch at 5.0 t ha^{-1} at 30 DAS (3,245 kg ha^{-1}) over weedy check (1,959 kg ha^{-1}). Among the nutrient management treatments under study significantly increased various yield attributes viz., number of cobs plant^{-1}, grain rows cob^{-1}, number of grains cob^{-1}, average cob weight (g), weight of grains per cobs (g), shelling percentage and 1000- grain weight (g)of maize during individual as well as pooled basis. The treatment 75% RDN through vermicompost in two splits + seed treatment with *beejamurt* + spray of *jeevamurt* twice *fb*75% RDN through vermicompost as basal + seed treatment with *beejamurt* + spray of *jeevamurt* twice as against 100% RDN through FYM.The mean data indicated that the treatment 75% RDN through vermicompost in two splits + seed treatment with *beejamurt* + spray of *jeevamurt* twice recorded maximum grain yield of maize (3,169 kg ha^{-1}) over 100% RDN through FYM (2,747 kg ha^{-1}).

T-2/P-12

Influence of site-specific nitrogen management on yield and nitrogen use efficiency of fodder maize

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An experiment on "Influence of site specific nitrogen management on yield and NUE of fodder maize" was laid down during *kharif* 2020 at the farm of Dry land Agricultural Research Station, Rangreth, Srinagar SKUAST-K. Experiment was conducted in completely randomized block design with twelve treatments viz; T1 (Control), T2 50 kg N/ha (40% basal) + remaining based on SPAD meter critical value of 40, T3 50 kg N /ha (40 % basal) + remaining based on SPAD meter critical value of 50, T4 50 kg N/ha (40% N basal) + remaining based on LCC 4 , T5 50 kg N/ha (40% N basal) + remaining based on LCC 5, T6 100 kg N/ha (40% N basal) + remaining based on SPAD meter critical value of 40 , T7 100 kg N/ha (40% N basal) + remaining based on SPAD meter critical value of 50, T8 100 kg N/ha (40% N basal) + remaining based on LCC 4, T9 100 kg N/ha (40% N basal) + remaining based on LCC 5, T10 150 kg N/ha (40% N basal) + remaining based on SPAD meter critical value of 40, T11 150 kg N/ha (40% N basal) + remaining based on SPAD meter critical value of 50, T12 150 kg N/ha (40% N basal) + remaining based on LCC 4, T13 150 kg N/ha (40% N basal) + remaining based on LCC 5, T14 As per recommended package of practices (50 % N as basal, remaining 50 % at 30 days after sowing. The treatments were replicated thrice. The results recorded revealed that the production of fodder maize was better with the treatment T13 150 kg N/ha (40% N basal) + remaining based on LCC 5. It recorded 470.01 q green and 135.02 q dry matter yield per hectare. The growth parameters viz; plant height, number of leaves per plant and NUE were also enhanced with this treatment as compared to other treatments.

T-2/P-13

Response of varied levels of phosphorus on growth and yield performance of sweet corn, *Zea mays* L.

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A field experiment was conducted during Kharif season 2019 at Zonal Agricultural Research Station, GKVK, University of Agricultural Sciences, Bangalore. The soil of the experimental site was red loamy sandy in nature having medium nitrogen, low phosphorus and high potassium content with slightly acidic in nature. The treatment consisted of 5 levels of Phosphorus viz. T_1 (50 % RDF P_2O_5), T2 (75% RDF P_2O_5), T_3 (100% RDF P_2O_5) T_4 (125% RDF P_2O_5) and T_5 (150% RDF P_2O_5) in the presence of static dose of Nitrogen and Potassium. There were 5 treatments each replicated four times. The experiment was laid out in Randomized Complete Block Design. The result showed that application of 150 % RDF of P_2O_5 recorded significantly higher growth attributes viz., plant height (T_5 - 128.125 cm) and the number of leaves per plant (T_5 -11.1 at 60 DAS). However, the application of 100 % RDF of P_2O_5 treatment recorded a significantly higher seed yield (T_3 - 296.25g).

T-2/P-14

Effect of organic manure, Bio NPK Consortium and Chemical Fertilizer on yield of hybrid maize (*Zea mays*, L) in *Kharif* season

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A field experiment was conducted at Main Maize Rsearch Station, AAU, Godhra during kharif 2018 to kharif 2020 to study the yield of maize hybrid GAYMH-1 (Gujarat Anand Yellow Maize hybid-1) by keeping spacing 60 x 20 cm under RDF (160 kg N/ha, 20 kg P_2O_5/ha) FYM @ 10 t/ha + 100 % RDF, FYM @ 5 t/ha + 100 % RDF, FYM @ 10 t/ha + BioNPK consortium 5 ml/kg+50 % RDF, vermicompost@ 2.5 t/ha + Bio NPK consortium 5 ml/kg + 50 % RDF, castor cake @ 1.0 t/ha+Bio NPK consortium 5 ml/kg+ 50 % RDF, Neem cake @ 1.5 t/ha + Biuo NPK consortium 5 ml/kg + 50 % RDF with four replications.Experimental findings showed that FYM@ 5 t/ha + 100% RDF(160 kgN/ha + 20 kg P_2O_5/ha) gave 3924 kg/ha grain yield and 9638 kg/ha stover yield. This treatment also gavehigher ear length (17.2 cm), higher test weight (264 gm) , higher ear girth (13.5 cm) as well as total soil microbial count (7.6 X 10^7 cfu/g soil). Soil properties afte harvesting is aslo increasing by adding organic manure. Among all the treatmetns, this treatment gave higher net profit (Rs. 55478/ha) with high BCR (3.02) than other treatments. So, the farmers of middle Gujarat Agro-climatic zone growing maize hybrid GAYMH-1 are recommended to fertilize the crop with 5t FYM/ha with 100 % RDF (160 kgN/ha +20 kg P_2O_5/ha) to achieve higher grain yield. The nitorgen should be applied in 4 equal splits at basal, 4 leaf, 8 leaf and at tasseling stage, while phosphorus as basal.

T-2/P-15

On-farm crop response to plant nutrients in maize-toria cropping system

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The experiment entitled "On-farm crop response to plant nutrients in maize- toria cropping system was conducted at three villages of Sadar block of Keonjhar district, Odisha during *Kharif-Rabi* season of 2018-19 under On-farm research project. The three villages where the experiments were conducted were Ambadahara, Talapada and Kanthadas. The experiment was laid out in a Randomized Block Design with seven treatments combinations and three replications. The seven treatment combinations studied in *kharif* were as follows: F_1: Control(No fertilizer was applied), F_2: N @120kg/ha , F_3: N @120kg/ha, P_2O_5 @ 60kg/ha , F_4: N @120kg/ha, K_2O @ 60kg/ha, N_5: N @120kg/ha, P_2O_5 @ 60kg/ha, K_2O @ 60kg/ha, N_6: N @120kg/ha, P_2O_5 @ 60kg/ha, K_2O @ 60kg/ha, $ZnSo_4$ @ 25 kg/ha and N_7: Farmers practice (N @56kg/ha, P_2O_5 @ 45kg/ha, K_2O @ 24 kg/ha. The seven treatment combinations studied in *rabi* were as follows: F_1: Control(No fertilizer was applied), F_2: N @30kg/ha , F_3: N @30kg/ha, P_2O_5 @ 15kg/ha , F_4: N @30kg/ha, K_2O @ 15kg/ha, N_5: N @30kg/ha, P_2O_5 @ 15kg/ha, K_2O @ 15kg/ha, N_6: N @30kg/ha, P_2O_5 @ 15kg/ha, K_2O @ 15kg/ha, Sulphur @ 40 kg/ha and N_7: Farmers practice (N @ 12kg/ha, P_2O_5 @ 10 kg/ha, K_2O @ 3 kg/ha). Hybrid maize variety Kalinga Raj was taken in *kharif* and toria variety Anuradha was taken in *rabi* as test crops. Results revealed that response of NPK was highest in terms of economic yield per unit of nutrient application. Both zinc to maize and sulphur to toria increased the economic yields of the respective crops to the tune of 317 and 84 kg/ha, respectively. Application of full dose of nutrients along-with micronutrients increased the system net return by Rs. 7472 over farmers practice.

T-2/P-16

Performance of AGROTAIN incorporated urea for yield and nitrogen use efficiency in winter maize

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Nitrogen management is among the most widely and intensively studied topics in contemporary agronomy because of its crucial importance in food production and environment. In comparison to other crops, the major cereals (maize, rice, and wheat) that provide the bulk of food calories and protein consumed by humans either directly as grain or indirectly through livestock products, are produced using about 50% of synthetic fertilizer-N produced today. However, a larger part of this applied N is lost due to volatilization and leaching and resultant nitrogen use efficiency (NUE) in cereal systems in India is very low. Under surface broadcast application, reducing ammonia volatilization losses using AGROTAIN incorporated urea, can potentially help in improving NUE in cereal-based systems. Urea coated with N stabilizers to delay N release, may increase N use efficiency and reduce the potential for N losses. To improve the NUE, a study was conducted during 2020-21 to evaluate the performance of neem coated urea (NCU) (nitrification inhibitor) and Agrotain incorporated urea (AIU) (urease inhibitor) in winter maize in rotation with rice in eastern IGP. The experiment comprised of five N management including control (No nitrogen), 100% NCU, 100% AIU, 80% AIU and 60% AIU in a randomized complete block design with four replications. Results showed, significant increase in SPAD and NDVI values recorded at different growth stages with 100% Neem coated AIU followed by 100% NCU, 80% Neem coated AIU and 60% Neem coated AIU. Grain yield of maize increased by 16.7% and 8.3% with 100% AIU and 80% AIU, respectively as compared to 100% NCU. Agronomic efficiency of N (AE_N) was improved by 39.3, 35.4 and 33.1 % in 60, 80 and 100% Neem coated AIU compared to 100% NCU, respectively. The 60 and 80% Neem coated AIU improved partial factor productivity of N (PFP_N) by 53 and 35%, respectively compared to 100% NCU. Our study revealed that new urea molecule (AIU) can potentially save significant amount nitrogen/urea and minimizing environmental footprints through improved efficiency in winter maize in eastern Indo-Gangetic plains of India. However, further studies being undertaken for more robust results.

T-2/P-17

Effect of phospho enriched compost and fertility levels on productivity of maize

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A field experiment was conducted during *kharif* season of 2018 and 2019 at Instructional Farm (Agronomy), Rajasthan College of Agriculture, Udaipur (Rajasthan) to study the Effect of Phospho Enriched Compost and Fertility Levels on productivity of maize. The increasing levels of phospho enriched compost application increased significantly the plant height at harvest, cob per plant, cob length, weight of cob, number of grains per cob, test weight, grain yield, stover yield and biological yield as well as content and uptake of nitrogen, phosphorus, potassium, zinc, iron, manganese and copper in grain and stover, protein content in grain and net returns as compared to control. The grain yield of maize was found significantly and positively correlated with stover yield, biological yield, total uptake of P (grain and stover) and different chemical pools of phosphorus in soil and coefficient of multiple determinations was found highly significant.

T-2/P-18

Comparison of yield and economics in normal maize and sweet corn in kharif season under conditions of Haryana

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Maize (Zea mays L.) commonly known as corn is mainly grown for food, feed and industrial purpose across the world and all of its parts are being used to develop thousands of products. Maize is a versatile crop in respect of development of economic product and no other cereal crop can match. In the past corn was grown mainly for grain purposes but after realizing its diverse economic importance farmers started growing it for different purposes. The corn which has some specific properties that make it suitable for particular end uses and fetches good return in specific markets are called specialty corm. Quality protein maize (QPM), baby corn, sweet corn, popcorn, high oil corn, high starch corn, waxy corn are different types of specialty corn and among this sweet corn is most important corn that fetches more returns in the market. In the past India was importing it from other countries to meet the growing demand of the country. But now realizing its importance farmers has started its cultivation in India. Now it is becoming popular in national capital region of Haryana state. The sweet corn can be cultivated in Haryana successfully in all the three seasons i.e. rabi, kharif and spring season. It is very sweet and tasty and a person who eats once never leave it hence its demand is increasing day by day particularly in the urban areas. The sweet corn is used in different countries in different ways. The sweet corn cob is boiled, steamed, or grilled whole; the kernels are then eaten directly off the cob or cut off. Creamed corn is sweet corn served in a milk or cream sauce. It is also used as a pizza topping, mix vegetables, sweet corn soup or in salads.

Despite of many efforts done by Govt. of Haryana there is no increase in the area under normal maize while the sweet corn is gaining popularity in the national capital region of the state. Keeping this point in mind a study was conducted on fifty progressive farmers of Haryana state comprising twenty-five farmers of normal maize and twenty-five farmers of sweet corn during kharif season, 2021. The observation was recorded on yield and related parameters, cost of cultivation, gross return of main product and its byproduct, return over variable cost and B: C ratio and finally mean value was calculated for each parameter. The mean value of grain yield of normal maize was found 51 quintals/ha with gross return and total variable cost as Rs. 103480 and Rs. 43750 respectively while in case of sweet corn mean green cob yield/ ha was found 148 q/ha with gross return and variable cost Rs. 194600 and Rs. 66200 respectively. The B:C ratio in sweet corn was found very high (2.93) as compared to normal maize (2.36). So sweet corn is not only economical but provides green fodder to the farmer which is helpful in promoting the cattle industry. In addition, the sweet corn harvesting take 16 days less than the normal maize which allow farmers to grow vegetable early and help in providing more returns. Hence cultivation of sweet corn may be helpful for economic growth, employment generation, flourish cattle industry, social upliftment and simultaneously in crop diversification if processing industries are established in the Haryana state.

T-2/P-19

Influence of black gram genotypes and nitrogen levels on performance of maize equivalent yield and available status of soil under maize + black gram intercropping system

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A field experiment was conducted to study the effect of black gram genotypes and nitrogen levels on performance of maize + black gram intercropping system at the Research Farm, Department of Agronomy, CSKHPKV, Palampur . The experiment was laid out in randomized block design comprised of five genotypes (Him mash-1, DKU-118, DKU-82, DKU-98 and DKU-99), two nitrogen levels (50 % and 100% recommended dose of nitrogen) and two sole crops (maize and black gram). Experimental site was silty clay loam in texture and acidic in reaction. Results of the study revealed that Maize + Him mash-1+100 % recommended dose of nitrogen recorded significantly higher maize equivalent yield (5040.2 kg/ha) and organic carbon (0.72 %) whereas available nitrogen (208.17 kg/ha) and potassium (233.9 kg/ha) were significantly higher in Maize + DKU 118 + 100% recommended dose of nitrogen. Available phosphorus was significantly higher in Maize + DKU 82 +100% recommended dose of nitrogen. Available nitrogen (r = 0.822**) and organic carbon (r = 0.575**) were significantly and positively correlated with maize equivalent yield whereas in available phosphorus and potassium, no significant relationship was found with maize equivalent yield.

T-2/P-20

Studies on optimization of row ratios for maize-bean intercropping in Kashmir

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The study was conducted at Dryland Agriculture Research Station (DARS), Srinagar during *Kharif*, 2019 to enhance the production and productivity of the intercropping system. As the availability of land for agriculture is shrinking every day and is increasingly utilized for non-agricultural purposes. Under this situation, one of the most important strategies to increase the agriculture output is the development of high intensity cropping system. Among different treatments, Maize (60 cm) and common bean grown under 1:1 ratio showed better results compared to maize plus bean in a paired row arrangement. The intercropping system was evaluated interms of crop yields and growth. The Land equivalent ratio (LER) for yield and growth was 1.12 and 1.25 respectively showing yield and growth advantage of intercropping system. Maize equivalent yield (MEY) was also highest for most of the intercropping treatments relative to sole-crop maize with yield advantage of 14% from single row IPA (inter-planting arrangement). Also financial returns showed increase by 16% relative to sole crop maize.

T-2/P-21

Weed management in maize with new generation herbicides

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Maize (*Zea mays* L.) is one of the important cereal crops of the world. The productivity of maize in India is relatively very low compared to developed countries of world mainly due to lack of timely weed control. The major yield reducing factors for maize cultivation in India are weeds and about 100 weed species in 66 genera and 24 plant families known to be problematic for maize in the country. Most of the presently available herbicides provide only a narrow spectrum weed control. Thus, weed management with new generation broad spectrum herbicides are needed. Therefore, this study was conducted to evaluate the weed control efficiency of new generation herbicides in *kharif* maize under vertisols of Rajasthan.

A field experiment was conducted on weed management in maize with new generation herbicides during *Kharif* 2017 & 2018 at Agricultural Research Station, Ummedganj, Kota, Rajasthan with the objective to find out effective post emergence new generation herbicide for controlling weeds as season long and increasing the productivity of maize. The experiment comprised ten treatments viz; T_1: Weedy check, T_2: Hand weeding twice (20 & 40 DAS), T_3: Atrazine 50% WP @ 0.5 kg ai/ha (PE), T_4: Bentazone 48% SL @ 1.2 kg ai/ha (15-20 DAS), T_5: Tembotrione 42 % SC @ 120.75 g ai/ha (15-20 DAS), T_6: Tembotrione 42 % SC @ 150.95 g ai/ha (15-20 DAS), T_7: Topramezone 33.6 % SC@ 25.2 g ai/ha (15-20 DAS), T_8: Topramezone 33.6 % SC@ 31.5 g ai/ha (15-20 DAS), T_9: Tembotrione 42 % SC @ 120.75 g ai/ha +Atrazine 50 WP @ 0.5 kg a.i./ha (15-20 DAS) and T_{10}: Topramezone 33.6 % SC @ 25.2 g ai/ha + Atrazine 50 WP @ 0.5 kg a.i./ha (15-20 DAS) and was laid out in randomized block design with three replications. The crop was grown and managed with their recommended package of practices for the zone. Results revealed that application of topramezone 31.5 g ai/ha at 15-20 DAS recorded significantly minimum weed density, weed dry weight and maximum weed control efficiency at 30 & 60 DAS, being at par with tembotrione 150.95 g ai/ha followed by topramezone 25.2 g ai/ha and tembotrione 120.75 g ai/ha, which were par at par with hand weeding twice at 20 & 40 DAS over rest of the treatments. Maximum yield attributes viz; no. of cobs/ plant, no. of grains/cob, 100-grain weight and grain yield was recorded with the topramezone 31.5 g ai/ha at 15-20 DAS and being on par with tembotrione 150.95 g ai/ha, topramezone 25.2 g ai/ha, tembotrione 120.75 g ai/ha and hand weeding twice at 20 & 40 DAS over rest of the weed management practices. Post emergence application of topramezone 31.5 g ai/ha at 15-20 DAS fetched significantly higher net returns (Rs. 66503/ha) and B: C ratio to the tune of 207.39 & 158.33 per cent, respectively over weedy check and while being at par with tembotrione 150.95 g ai/ha, topramezone 25.2 g ai/ha, tembotrione 120.75 g ai/ha, tembotrione 120.75 g ai/ha + atrazine 0.5 kg a.i./ha, topramezone 25.2 g ai/ha + atrazine 0.5 kg a.i./ha and hand weeding twice at 20 & 40 DAS. The results are in close conformity with the findings of Kantwa *et al*. (2020).

Post-emergence application of new generation herbicides viz; topramezone 25.2 g ai/ha or tembotrione 120.75 g ai/ha at 15-20 DAS found effective for controlling season long weeds and increasing productivity of maize under vertisols of south-eastern Rajasthan.

T-2/P-22

Soil biology and climate smart agriculture (CSA) practices under major agri-food systems of IGP

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Rice-wheat (RW) is the dominant cropping system in Indo-Gangetic plains (IGP) of India since '*Green Revolution'* but the sustainability of this system is on the cost of over exploitation of natural resources (ground water, energy, soil). Climate smart agriculture (CSA) practices with efficient rotations like maize-wheat system are considered as alternative of conventional RW systems and their management practices for the systems sustainability and resources stability in the domain. Maize is the remunerative option instead of rice during *Kharif* season as it provides equivalent yields, use very less water (20% of rice requirement) and also helps in conservation of other natural resources. These agriculture management practices alter soil biological properties and can reflected by differences in microbial biomasses and enzyme activities in soils. A study was conducted to evaluate the effects of CSA practices in comparison to conventional management on microbial diversity, microbial biomass carbon (MBC), nitrogen (MBN), dehydrogenase activity (DHA), and alkaline phosphatase activity (APA). Samples were collected from CSA based cereal management scenarios (Sc) at CSSRI-CIMMYT strategic experimental platform during 2014-18. In these four scenarios *viz*., conventional RW (ScI); partial CSA based rice-wheat-mungbean (ScII); full CSA based rice-wheat-mungbean (ScIII), and full CSA based maize-wheat-mungbean (ScIV) were studied. Results were taken after harvest of wheat crop and bacterial diversity was found highest with conventional till (CT/FP) compared to CA based management in rice/maize systems. At phylum level, *Proteobacteria, Acidobacteria, Actinobacteria*, and *Bacteroidetes* accounted for more than 70% of the identified phyla. Rice based systems were dominated by phylum *Proteobacteria;* however, maize based system was dominated by *Acidobacteria*. At class level, *Proteobacteria* was dominated by *Alphaproteobacteria*, and it was closely followed by *Deltaproteobacteria, Betaproteobacteria*, and *Gammaproteobacteria*. Maize based CSA scenarios recorded higher diversity indices than rice-based CSA scenarios. A higher relative abundance of copiotrophs (*Proteobacteria*) was found in CSA based systems while oligotrophs (*Acidobacteria and Actinobacteria*) were associated with CT based RW system. Fungal diversity increased with CA- based management practices, maximum sequences of phylum were in order of *Ascomycota>Basidiomycota>Glomeromycota*. However, *Alternaria*, *Cercophora* and *Epicoccum* were most abundant fungal genera. At phylum level, relative abundance of *Ascomycota* ranged from 55 to 74%, with the highest dominance recorded in CA based maize systems (74%) followed by rice systems (71%) and lowest with CT (55%), however at class level *Sordariomycetes* had the highest abundance followed by *Dothideomycetes* and *Eurotiomycetes.* CA-based MW system registered 208, 263, 210 and 48% improvement in soil microbial biomass C (MBC) and N (MBN), dehydrogenase activity (DHA) and alkaline phosphatase activity (APA), whereas CA-based RW system registered 83, 81, 44 and 13%, respectively compared with farmers practice (intensive-till) of RW system. MBC,

bulk density, APA and microarthropod population were identified as key soil quality indicators under cereal based systems. CA-based MW system recorded the highest SQI of 1.45, whereas 0.58 with CA-based RW system and the lowest score (0.29) being in conventional RW system. Microbial population of bacteria, fungi, and actinomycetes increased by 25-30%, 65-70% and 95-100% respectively, under CA-based MW system than RW system. Results shows that CSA based maize systems improved the soil biological activities compared to RW system. CSA based maize systems are good for soil sustainability as it improves all the biological practices compared to RW system and it should be promoted in IGP for improving the soil health and quality for system sustainability.

T-2/P-23

Study on nutrient management of hybrid maize (*Zea mays*. L) through decision support tools

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A field study was conducted during *Kharif* 2019-20 at Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Telangana, India to study the nutrient management in hybrid maize (*Zea mays* L.) using simple hand held decision support tools *viz.*, LCC,SPAD and Greenseeker. Treatments consisted of state recommended nitrogen @ 200 kg ha^{-1} in three splits, Leaf Colour Chart (LCC) based N application at threshold 3 and 4, SPAD chlorophyll meter based N application at threshold 35 and 40 and Green Seeker based N application at NDVI value 0.6 and 0.8 compared with absolute control and RDN. The field experiment was conducted in Randomized complete block design with three replications. The results of the field study revealed that application of nitrogen-based on Green Seeker NDVI at threshold 0.8 recorded significantly higher maize grain (8408 kg ha^{-1}), and stover (9923 kg ha^{-1})yields with higher N uptake of 225.5 kg ha^{-1} .Further, among different precision nitrogen management practices, significantly higher Partial Factor Productivity (57.8 kg kg^{-1}), Recovery Efficiency (99.7 %), Agronomic Efficiency (25.7 kg kg^{-1}) were obtained in nitrogen management through SPAD based N at threshold 40 as compared to recommended dose of nitrogen and absolute control.

T-2/P-24

Trends in area, production and productivity of maize crop in Hyderabad-Karnataka region: an economic analysis

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Owing to their several drought tolerant characteristics, cultivation of coarse cereals in drought prone areas for providing food for human consumption, feed and fodder for livestock and to provide fuel for industries and automobiles are common. Trends in area, production and productivity of maize in Hyderabad-Karnataka region was estimated using the compound growth function (CAGR). The necessary secondary data was collected for a period of 27 years from 1991-92 to 2017-18. Maize was selected purposively because the crop occupied highest area under coarse cereals group. The results of compound growth rate in area, production and productivity of Hyderabad Karnataka region revealed that there is increasing trend in area and production. This may be due to rapid expansion in area under this crop and it was mainly due to its important features like short duration, adaption to a wide range of soils and climatic conditions and high yield per hectare as compared to other cereal crops and also poultry industry is dependent on this crop, which is on increasing trend. Decreasing trend in productivity of maize crop was noticed among the studied districts. This may be attributed to lack of technological breakthrough in maize production and fluctuations in prices. Hence, there is a need for gearing up the research and extension activities so as to improve the productivity of maize and provide remunerative price to farmers.

T-2/P-25

Effect of suitable weed management practices to enhance the yield of rainfed maize in Odisha

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A Field experiment was carried out during *Kharif* season at OUAT, Bhubaneswar with ten weed management practices i.e., Control, Weed free, Atrazine (1.0 kg/ ha) as pre-emergence (PE), Atrazine (750 g/ ha) + Pendemathalin (750 ml/ha) as PE, Atrazine (750 g/ ha) + 2,4-D Amine (500 g/ ha) at 25 days after sowing (DAS) as post-emergence (PoE), Halosulfuron (60 g/ ha) at 25 DAS as PoE, Atrazine (1.0 kg/ ha) as PE followed by Halosulfuron 60 g/ ha 25 DAS as PoE, Tembotrione (Laudis) 34.4 SC @ 120 g/ ha as PoE at 25 DAS, Pendemathalin (1000 ml/ ha) as PE followed by Atrazine (750 g/ ha) + 2,4-D Amine (500 g/ ha) at 25 DAS as PoE, Atrazine (1.5 kg/ ha) as PE followed by Tembotrione (Laudis) 34.4 SC (120 g/ha) as PoE at 25 DAS in randomized block design with three replications to find out the best possible weed management practices to enhance the maize crop yield during the *kharif*. The results of the study revealed that PE application of Atrazine @ 1.5 kg/ ha followed by Tembotrione (Laudis) 34.4 SC @ 120 g/ ha as PoE at 25 DAS produced significantly maximum grain yield (7023 kg/ha) and B:C (2.47) which was 54.5% and 6.4% B:C respectively as compared to control (i.e. weedy check grain yield 4547 kg/ha and B:C 1.51). The yield was also 39.8% higher over the existing recommended practice of application of Atrazine @ 1.5 kg/ ha as pre-emergence.

T-2/P-26

Productivity and monetary return of sweet corn (*Zea mays* L. var. saccharata) under different planting geometry and nutrient levels

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Sweet corn (*Zea mays* L. var. *saccharata*) is gaining popularity among the farmers because it fetches higher market price than normal maize. Added advantage of sweet corn is that after the harvest of green cobs, the plants remains green and can be used as green fodder. Optimum population and balanced nutrition are of prime importance for higher productivity of sweet corn. Therefore, field experiment was conducted at G. B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand during *kharif* season, 2018 to assess the response of sweet corn to varied nutrient doses and planting geometry. The experiment was laid out in split plot design with four planting geometry (60 cm × 25 cm, 60 cm × 30 cm, 75 cm × 25 cm and 75 cm × 30 cm) in main plots and three doses of nutrients (120: 60: 40, 150: 75: 50 and 180: 90: 60 kg N: P_2O_5: K_2O/ha) in sub plots with three replications. The narrowest planting geometry *i.e.* 60 cm × 25 cm recorded significantly higher husked cob yield (13325 kg/ha) than 75 cm × 30 cm but remained at par with rest of geometries. Compared to 60 cm × 25 cm reduction in cob yield under 60 cm × 30 cm, 75 cm × 25 cm and 75 cm × 30 cm was 7.8, 9.2 and 16.6 per cent, respectively. Net return (Rs. 150176/ha) was also maximum in 60 cm × 25 cm geometry but differences were non-significant. An increase in nutrient level from 120: 60: 40 to 150: 75: 50 and 180: 90: 60kg N: P_2O_5: K_2O/ha resulted into 4.3 and 8.3 per cent increase in cob yield but differences did not vary statistically with maximum yield (12687 kg/ha) in 180: 90: 60 kg N: P_2O_5: K_2O/ha. The economics of sweet corn cultivation in terms of net return was non-significant among nutrient levels with maximum net return in 180: 90: 60 kg N: P_2O_5: K_2O/ha. The results indicated that for higher monetary return sweet corn should be sown at wider planting geometry and fertilized with 120: 60: 40 kg N: P_2O_5: K_2O/ha.

T-2/P-27

Weed dynamics of baby corn (*Zea mays* L.) as influenced by different weed management practices under organic farming

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A field experiment was conducted to determine the effect of different organic weed management practices on weed population and productivity in baby corn. The experiment was done at the Agronomy Farm, Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan with twelve treatments in randomized block design replicated thrice. Season long weed control could be achieved by using three tier weed management practices before sowing, after sowing and in standing crop *viz* combination of summer ploughing, soil solarisation, stale seed bed with plastic mulch, straw mulch, mechanical weeding, inter culture and hand weeding. The major broadleaf weeds in the experimental fields were *Digera arvenris*, *Trianthema portulacstrum*, *Amaranthus viridis* and *Commelina bengalensis*. The grassy weeds were *Echinochloa colona* and *Dinebra retroflexa*. The maximum total weed control efficiency (100 per cent) was recorded by soil solarization *fb* plastic mulch at sowing and stale seedbed preparation *fb* plastic mulch (25 micron) at sowing. A significant increase in plant height and dry matter accumulation, baby corn cob yield with and without husk, green fodder yield and biological yield was observed with the soil solarization *fb* plastic mulch at sowing. Maximum baby corn cob yield (19.33 q ha^{-1}) was acquired by controlling weeds by soil solarization *fb* plastic mulch at sowing which was at par with that obtained by stale seedbed preparation *fb* plastic mulch at sowing (18.94 q ha^{-1}). Research has shown that use of plastic mulch is an effective method for reducing weed problem in organic baby corn in India.

T-2/P-28

Effect of dose, application time and herbicide combination on weed growth and maize (*Zea mays* L.) in North Western India

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In India maize is mainly grown in *kharif* season which is accompanied by rainfall and higher relative humidity, favours suitable conditions for weed growth. In *kharif* season weeds pose a major problem by competing with crop and reduce the productivity. Although manual weeding renders better results but involve cost and labour simultaneously, makes it economically non-viable. Being a cost effective and saving labour and time, use of herbicides become necessary, thus to maintain a balance just integrate one or more efficient herbicides in excellent weed management strategy. Therefore, a experiment was conducted in *kharif* season 2021 at G.B. Pant University of Agriculture & Technology, Pantnagar to find out herbicide combination, thier dose and application time. Nine treatments viz., weedy, weed free, Atrazine 1kg a.i./ha (PE) *fb* hand weeding at 25 DAS, Atrazine 0.75 kg a.i./ha (PE) *fb* Topramezone 25.2 g/ha at 25 DAS, Atrazine 0.75 kg a.i./ha (PE) *fb* Tembotrione 120 g a.i./ha at 25 DAS, Atrazine 1kg a.i./ha (PE) *fb* Topramezone 25.2 g/ha at 25 DAS, Atrazine 1kg a.i./ha (PE) *fb* Tembotrione 120 g/ha at 25 DAS, Topramezone 25.2 g a.i./ha + Atrazine 750 g/ha at 15 DAS and Tembotrione 120 g a.i./ha + Atrazine 0.75 kg a.i./ha at 15 DAS were tested in RBD with three replications. The results indicated that all herbicide combinations were effective in reducing weed dry matter and were at par with weed free treatment. The highest grain yield (7202 kg/ha) was obtained in weed free treatment which was statistically at par with all herbicide treatments. Results indicated that single application of atrazine @ 0.75 kg a.i. along with either Tembotrione 120 g a.i. or Topramezone 25.2 g a.i./ha at 15 DAS is helpful in reducing weed growth and reduction in herbicide dose.

T-2/P-29

Growth and yield parameters of maize under integrated nutrient management

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Maize (*Zea mays* L.) is an important cereal crop of India and plays a pivotal role in agricultural economy as staple food for larger section of population, feed for animals and raw material for industries. As maize being an exhaustive crop, has very high nutrient demand and its productivity mainly depend upon nutrient management system. Therefore, it needs highly fertile soil to express its yield potential. However, long term use of chemical fertilizers also led to a decline in crop yields and soil fertility in the intensive cropping systems (Dadhich *et al*., 2011). Therefore, maximizing the usage of organic waste and combining it with chemical fertilizers and biofertilizer in the form of integrated manure appear to the best alternative (Guldur *et al*., 2015). A field study was carried out for two consecutive years (2019-2020) at the Research Farm of Rajasthan College of Agriculture, Udaipur (Rajasthan), India. The soil of the study site was Vertisols (montmorillonitic and Typic Haplusterts), clay loam in texture, moderate in organic carbon (0.63%) and alkaline in reaction (pH 8.32). In the experiment 11 nutrient treatments were evaluated to determine the best nutrient management option for growing maize for the region. Application of 75% NPK+5t ha^{-1} phosphorous enriched compost+biofertilizer+Zn foliar spray (0.5%) produced taller plants (249 cm) with larger leaf area (2.35) and dry weight/plant (144 g) than control and 100% NPK+Zn. Moreover, cob length (19.5 cm) and cob girth (16.8 cm), grain rows per cob (14.8), grains per cob row (17.5) and test weight (238 g) were also highest in integrated nutrient management over 100% NPK+Zn. Therefore, for getting more yields and biomass, maize should be grown following integrated nutrient management approach. Integrated use of organic, inorganic and biofertilizers based nutrient sources were found better than sole chemical fertilizer application as it recorded higher growth and yield parameters.

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T-2/P-30

Effect of nitrogen levels and weed management practices on weed dry matter accumulation, yield and economics of hybrid maize (*Zea mays* L.)

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Maize, the queen of cereals, is the third important cereal crop after rice and wheat, grown in India mostly as *kharif* crop in rainfed uplands. Among the different constraints of production, weeds and imbalance application of nitrogen are two major factors affecting the yield of *kharif* maize. The field experiment was carried out during *kharif* seasons of 2019 and 2020 at Regional Research and Technology Transfer Station, Bhawanipatna, Kalahandi, Odisha with the objectives to evaluate the effect of different levels of nitrogen and weed management practices on hybrid maize. The experiment was laid out in split plot design with three replications taking four nitrogenlevels*i.e.*N_1:100, N_2:120N_3:140 and N_4:160 kg/ha in main plots and three weed management practices viz. W_1: atrazine 1 kg a.i./ha at 1 day after sowing (DAS) + one hand hand weeding (HW)at 40 DAS, W_2: pendimethalin 1 kg a.i./ha at 1 DAS + one HWat 40 DAS and W_3: two HW at 20 and 40 DAS in sub-plots. The dose of P_2O_5, and K_2O were 60kg/ha each for all the treatments. All standard procedures were followed to raise the maize hybrid DKC-9126and in recording the observations. The weed dry matter increased significantly with increase in the dose of nitrogen at 20, 40 and 60DAS. Maize grain yield, gross return, net return and return/rupee invested increased with increase in dose of nitrogen. However, application of 140 and 160 kg/ha nitrogen were at par with each other with respect to grain yield (6188 and 6537 kg/ha), net return (Rs. 63735 and 69629/ha) and return/rupee invested (2.43 and 2.56). Among weed management practices, application of pendimethalin + HW at 40 DAS was found to be effective (1.4, 3.8, 2.3 g/m^2) than atrazine + HW at 40 DAS (1.5, 4.1, 24 g/m^2) in controlling weeds at 20, 40, and 60DAS and recoded maximum net monetary return (Rs.61901/ha) as against Rs.59283/ha with atrazine + HW at 40 DAS and Rs.59833/ha with HW at 20 and 40 DAS. The return/rupee invested was significantly higher with pendimethalin (2.44) and atrazine (2.40) than HW at 20 and 40 DAS (2.23).Thus, growing hybrid maize with fertilizer dose of 160:60:60 kg/ha N-P_2O_5-K_2O and application of pendimethalin 1 kg a.i./ha at 1 DAS followed by one hand weeding at 40DAS recorded higher net return and return/rupee invested than all other treatment combinations.

T-2/P-31

Maize – a crop of opportunities and challenges to grow

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Maize grown in more than 166 countries of temperate, tropical and sub-tropical regions and contributes 9% to the Indian food basket. Raw material of maize used for hundreds of industrial products that includes starch, oil, protein, alcoholic beverages, food sweeteners, pharmaceutical, cosmetics etc. Modern maize is susceptible to various pathogens including fungus, bacteria and viruses and other microorganisms. More than 115 diseases of maize have so far been reported from all over the world whereas about 60 are known to occur in India leading to about 10% yield losses in maize due to diseases. Due to regular use of chemicals to control diseases, fungicide-resistant phytopathogenic strains may develop and adverse effect of chemicals on soil, plant health and crop products have compelled plant pathologist to look for eco-friendly strategies for plant disease management. Various disease management methods have been implemented to combat and eradicate pathogen. These include cultural, regulatory, physical, chemical and biological methods. All the methods are effective only when employed in advance as precautionary measures.

T-2/P-32

Effect of organic and inorganic sources of nitrogen on yield attributes and yield of maize in maize-mustard cropping system under sandy loam soil conditions in Northern Telangana Zone of Telangana State

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Maize (*Zea mays L.*) is the world's third leading cereal crop after wheat and rice. It accounts to 8% and 25% of the world's total area and production, respectively under cereal crops. Nutrient management in maize is one of the significant yield influencing character. The combined use of chemical fertilizers along with various organic sources is capable of improving soil quality and crop productivity on long term basis. As cropping system serves as a component of integrated nutrient management (INM) for sustaining the productivity of the system through efficient nutrient cycling, balanced fertilization must be based on the concept of the cropping system to sustain productivity of a system as a whole rather than a single crop. Intensified and multiple cropping systems require judicious application of chemical, organic and bio-fertilizers for yield sustainability and improved soil health. Such integrated application is not only complementary but also has synergistic effects. Therefore, the nutrient needs of crop production systems can be met through integrated nutrient management and sustainable crop productivity, nutrient uptake and soil nutrient status in maize based cropping systems (Kemal and Abera, 2015). Hence, the present study was carried out to study the direct effect of integrated nutrient management on yield attributes and yield of maize. This experiment was conducted at Regional Agricultural Research Station, Polasa, Jagtial during *Kharif*, 2018 and 2019. The soil of experimental site was sandy loam in texture. The soil reaction was alkaline with 7.6 pH. The electrical conductivity was 0.23 dS m^{-1}. Its nutrient status was low with 0.28% organic carbon. The available nitrogen was low with 180 kg N ha^{-1}. The available phosphorus was medium with 53 kg P_2O_5 ha^{-1}andpotassiumwith 315 kg K_2O ha^{-1}. The experiment was laid out in a randomized block design for maize during *kharif* 2018 and 2019. There were nine treatments. They comprised the application of the virtual practice to apply 200 kg N ha^{-1}, substitution of 25% of this inorganic nutrient level with farmyard manure, vermicompost, poultry manure, sheep manure, neem cake, the addition of *Azotobacter* and *Azospirillum* @ 5 kg ha^{-1} each and their combined application @ 2.5 kg ha^{-1} each. There were three replications. The plot size was 12.0 m long and 6.0 m wide. The crop was spaced 60 cm between the rows and 20 cm between the plants. The results showed that the yield attributes *viz.*, cob length, cob girth, number of rows cob^{-1}, number of kernels row^{-1}, number of kernels cob^{-1} and test weight also did not alter significantly by the expedient of 25% part substitution of inorganic nitrogenous fertilizer with vermicompost, FYM or sheep manure. The other

sources – poultry manure, neem cake, bacterial cultures and their consortium were not as effective as the sole application of inorganic nitrogenous fertilizer. These responses were consistent both in 2018 and 2019. The existing practice of nurturing maize with inorganic supplement of 200:60:50 kg ha^{-1} NPK produced 6262 kg ha^{-1} grain yield in 2018 and 6342 kg ha^{-1} in 2019. The results showed that it is possible to substitute 25% level of nitrogenous fertilizer with vermicompost, FYM or sheep manure with equivalent production levels. The grain yield was 6349 kg ha^{-1} in 2018 and 6514 kg ha^{-1} in 2019 owing to the substitution of 25% nitrogenous fertilizer with vermicompost. Maize produced 6007 and 6211 kg ha^{-1} grain yield by the substitution of 25% nitrogenous fertilizer with FYM, while the production level realized was 5424 and 5630 kg ha^{-1} with sheep manure. This trend was consistent in both the years. Since the yield of the crop is a function of several yield components which are dependent on the complementary interaction between the vegetative and reproductive growth of the crop. Increased nutrient availability and uptake with organic nitrogen had increased photosynthetic rate and net assimilation rate, which has resulted in more cob yield. Similar observations were reported by Thavaprakash *et al.* (2005) and Kar *et al.* (2006). The supply of nitrogen through organic sources *viz.*, vermicompost, FYM, sheep manure by replacing 50 kg N ha^{-1} out of the 200 kg recommended dose ha^{-1} to maize produced similar yield attributes and yield as with the application of entire nitrogen through inorganic fertilizer.

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T-2/P-33

Effects of different crop established methods with different herbicide in Maize

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The field experiment was conducted in IARI farm station new entitled "Effects of different crop established methods with different herbicide in Maize". The experiment was laid out in split plot design with three main plots and five subplots. The main plots consist of three crop establishment methods like M_1: raised bed, M_2: Zero tillage and M_3: Conventional tillage having covered with straw mulch equally in all at the rate of 3 tonns per hectare. And the subplots consist of 5 treatments like T_1 Pyroxasulfone @ 0.15 kg/ha, T_2 Pyroxasulfone @ 0.15 kg/ha followed by Tembotrione @ 0.10 kg/ha, T_3 Atrazine @ 1 kg/ha followed by Tembotrione @ 0.10 kg/ha, T_4 weedy check and T_5 weed free check. The results revealed that in different crop establishment methods, in raised bed recorded higher growth attributes and yield attributes compared to other two methods. In different herbicides, significantly higher growth, yield attributes and yield recorded in treatment T_5, followed by T_2. The yields in treatment T_3 and T_1 recorded statistically on par and higher compared to control T_4.

T-2/P-34

Maize, a remunerative crop CA- based sustainable intensification of rice-wheat system in Indo-Gangetic plains

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The rice-wheat (RW) cropping systems of western Indo-Gangetic plains (IGP) supports the bovine as well as human population for past several decades by producing major food grains. But in the past few decades, conventional monotonous RW system coupled with ever increasing population pressure led to serious water scarcities diminishing profitability and deteriorating natural resources are some of the major threats to agricultural sustainability in Indian IGP. The improvement in crop yield and water productivity may be achieved by pursuing alternative crops, which are more friendly and efficient in utilizing natural resources. Adoption of cereals/oilseeds/pulses crop in cropping system may help in the efficient use of natural resources and higher economic returns even for the marginal farmers. Participatory strategic research was conducted during *kharif* 2020 and 2021 at CSSRI-CIMMYT research platform of Karnal, Haryana, India with the objective of sustainable use of natural resources and enhances crop productivity. The experiment comprised of seven (tillage and crop management practices) scenarios- S1; Puddled transplanted rice (PTR), S2; Conventional tillage direct seeded rice (CTDSR), S3; Zero tillage direct seeded rice (ZTDSR), S4; Maize on permanent beds(PB), S5; Maize on PB, S6; Soybean on PB, S7; Pigeon pea on PB. CA-based scenarios (S2 to S7) significantly improved crop productivity and profitability while enhancing resource use efficiency. Based on 2-years mean, crop yield (maize equivalent) and net returns of individual scenarios were increased by -5.0, -2.7, 48.9, 56.8, -15.3 and -63.5%, and -9.4, -0.8, 107.3, 120.4, 9.4 and -62.7% under S2, S3, S4, S5, S6 and S7, respectively compared to S1 (6.79 Mg ha^{-1} and 72915 INR ha^{-1}). Overall, CA-based scenarios (mean of S2-S7) increased the crop yield by ~3% and net return by 27%, with 66% less irrigation water compared to PTR (S1). CA-based maize scenarios (mean of Sc4 and Sc5) recorded higher grain yield by 52.8% and net return by 113.8% and save 91.4% irrigation water compared to S1, respectively. Findings of this study support differential opportunity of tillage, crop diversification and suggest that a combination of full CA-based maize crop with CA-package could increase crop productivity, resource-use efficiency, and farm profitability while sustaining the natural resources in IGP and other similar agro-ecologies.

T-2/P-35

Integrated nutrient management in maize (*Zea mays* L)-wheat (*Triticum aestivum* L.) cropping system

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Maize-wheat cropping system is one of the major cropping systems in India. Maize and wheat are main source of the world's food energy and also contains significant amounts of proteins, vitamins and minerals, which are essential nutrients for human health. Both the cereal crops are heavy feeder of nutrients. The continuous use of chemical fertilizers in intensive cropping system is leading to imbalance of nutrients in soil which has an adverse effect on soil health and also on crop yields. But use of organics alone does not result in spectacular increase in crop yields due to their low nutrient status. Sustainable yield could be achieved only by applying of organic manures, bio-fertilizers in cereal+legume intercropping. Keeping the view, an experiment was conducted at Agriculture Research Station, Banswara during 2018-19 and 2019-20 to evaluate the effect of integrated nutrient management on growth and yield attributes and yield and economic of maize-wheat cropping system. The experiment was laid out in randomized block design with three replications. 11 treatments were compared in maize crop during rainy season and successive wheat crop grown during winter season. The results revealed that maize+blackgram intercropping under FYM 10t/ha+seed treated with azotobactor resulted in significantly higher maize equivalent yield of maize-wheat cropping system was 12.28t/ha. It was significantly higher than control (4.61t/ha) and 50% RDF (7.93 t/ha). However, benefit: cost (B:C) ratio were recorded significantly higher under 100% RDF followed by maize+ blackgrame intercropping with FYM 10t/ha+azotobactor. Based on this study it can be concluded that maize+ blackgram intercropping with FYM @10t/ha +azotobactor could be recommended for maize-wheat cropping system for sustaining crop production under organic nutrient management practices.

T-2/P-36

Maize for diversification and sustainable intensification option for rice-wheat system

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Maize is the third most important crop after wheat and rice in the world. It is providing food for human, feed and fodder for livestock mostly poultry and consume as second cycle product for human nutrition. It has great inherent potential to produce food under adverse and diverse climatic condition and diversifying rice-wheat system to ensuring food as well as nutritional security and sustaining crop production. The field experiment is undertaking at participatory evidence based research during 2019-20 and 2020-21 at farmer's field collaboration with CIMMYT at Karnal district of Haryana with four locations and six cropping system scenarios are evaluated viz., Scenario-1: Rice-wheat as farmers practices with conventional tillage, Scenario-2: Rice-wheat-mungbean (rice as conventional, wheat and mungbean as zero-tll) with precision inputs management, Scenario-3: Dry direct seeded Rice-wheat-mungbean all with zero-till and precision inputs management, Scenario-4:Maize-wheat-mungbean, Scenario-5:Maize-mustard-mungbean and Scenario-6:Soybean-wheat-mungbean on permanent raised beds under zero-till and nutrients management with precision tools (nutrient expert and green seeker). The crop residues incorporated/retained on soil surface as per treatment scenarios. The results outputs of one year study (2019-20), The different cropping system and tillage practices with precision nutrients and water management were found superior with respect to system crop yield (rice equivalent yield), water productivity and net return of the maize/soybean based diversified systems by 18.47-26.61%, 63.91-164.70 % and 17.50-37.57 % respectively, over farmer practice. The shifting from conventional agriculture to conservation agriculture (CA)-based diversification with kharif maize/soybean and integration with summer mungbean based management optimization, like: residues management, precision nutrients and irrigation management, legume intensification through system based approach of sustainable intensification help in triple win; increased yield, reduced cost and efficient water use in term of water productivity, it has potential to ensures sustainable crop production.

T-2/P-37

Raised bed planting in maize: An effective agronomic intervention for sustainable maize production under changing climatic condition

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Maize (*Zea mays* L.) is considered to be the third most significant cereal crop in the world after rice and wheat in terms of area, production and productivity. Since the crop requires a well-drained soil with a fair water holding capacity, the ongoing climate change and climate variability (drought, flood, heat etc.) has largely been detrimental for the crop growth and production. Therefore, in order to enhance the global production with the upsurging population, large scale trials have been conducted and raised bed planting (RBP) method has been found to be a suitable approach for augmenting the production of this important crop under the regime of changing climate. On-field trials under Climate Resilient Agriculture Program in 770 acres have been conducted in 11 districts during the *Rabi* season of 2020-21 and *Kharif* season of 2021. *Kharif* maize with raised bed planting have produced grain yield to the tune of 64q/ha with a benefit cost ratio of 2.5. In case of *rabi* maize, an yield of up to 85q/ha with a benefit cost ratio of 2.75 has been achieved. The planting method also helped increase the overall harvest index to approximately 40%. Apart from yield enhancement, the planting method led to an improvement in the soil health; leading to an enhancement in soil microbial population, soil nutrient content and decrease in bulk density. At the physiological level, RBP maize has been observed to enhance the root vigour, root dry weight, net photosynthetic rate, dry matter accumulation and quantum yields. Thus, maneuvering the planting method could be an encouraging intervention to combat the adverse impacts of climate change and consequently, enhance the production as well as economic returns of the farmers for an eco-friendly and sustainable agricultural development.

T-2/P-38

Ecological intensification: A step towards climate resiliency in maize based cropping systems

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In India, maize is the third most important cereal crop after rice and wheat. The diversified use of this crop is gaining demand as grain, fodder and other industrial uses. Policy makers, scientists and farmers have to focus on increasing the yield of maize crop for food security of the nation. Thus, there is need of technological advancement to increase the production in a sustainable, affordable manner to address future global food security in the country. Furthermore, need based advancement will reduce dependence on non-renewable resources which ultimately will overcome the harmful effect of intensive agriculture on environment. Ecological intensification (EI), the smart use of biodiversity-mediated ecosystem functions to support agricultural production, is portrayed as the most promising avenue to achieve these goals. EI means to sustain productivity with efficient use of inputs for better human life and sustainable use of ecological process for better management of agricultural inputs for getting higher returns. It requires scientific adaptation of maize based cropping system to local context. Keeping this in view, an experiment on ecological intensification in maize based cropping systems was conducted during *kharif* season from 2017-18 to 2020-21 at CCS Haryana Agricultural University, Regional Research Station, Karnal. The experiment was laid out in randomized block design with three replication and eight treatments *viz.*, T1-Farmer practice, T2-Ecological Intensification (EI), T3- EI minus tillage practice (Conventional tillage without residue retention in all crops), T4 - EI minus Nutrient management (Absolute control for nutrients in all crops), T5 - EI minus Planting density (Farmer adopted genotype and density in all crops), T6 - EI minus Water management (Complete rainfed for maize and farmers practice for rest of the crops), T7 - EI minus Weed management (No weed management in all crops) and T8 - EI minus Disease and insect management (No management in all crops) in clay loam soil. Ecological intensification included all the recommended practices for sustainable productivity. Among all the treatments, ecological intensification was found best treatment which gave significantly higher grain yield (8036 kg/ha), minimum weed density, increase in soil productivity and nutrient use efficiency followed by EI minus tillage practice (7750 kg/ha) as compared to all other treatments. However, grain yield was observed to be minimum in EI minus weed management (1465 kg/ha) due maximum weed density and EI minus nutrient management (3975 kg/ha) due to low availability of nutrients from fertilizers but successively yield increased due to availability of nutrient from previous crop residues. In treatment T6-EI minus water management, the crop yields was variable depending upon availability of water though rain fall in different year. In all the crops, EI performed best and gave maximum of potential yield. Residue retention supplemented the yield of crops in subsequent years, thus helping in climate resilience for sustainable maize based production systems.

T-2/P-39

Exploring the efficiency of calcium and potassium thiosulphate on yield, nutrient uptake and quality of winter maize

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This field experiment was conducted during *rabi* season of 2019-20 at the Crop Research Centre of Dr. Rajendra Prasad Central Agricultural University, Pusa (Samastipur) Bihar. The experiment was conducted in RBD with twelve treatments and replicated four times, variety was DKC-9081. The treatment comprised of twelve treatments *viz.* fertigation of RDF:150:75:60 N-P_2O_5-K_2O kg/ha- Drip (T_1), 150:75:54.5 N-P_2O_5-K_2O kg/ha + 15 L KTS/ha- Drip (T_2), 150:75:49 N-P_2O_5-K_2O kg/ha + 30 L KTS/ha- Drip (T_3), 150:75:38 N-P_2O_5-K_2O kg/ha + 60 L KTS/ha- Drip (T_4), 150:75:60 N-P_2O_5-K_2O kg/ha + 15 L CaTS/ha- Drip (T_5), 150:75:60 N-P_2O_5-K_2O kg/ha + 30 L CaTS/ha- Drip (T_6), 150:75:38 N-P_2O_5-K_2O kg/ha + 30 L CaTS/ha + 30 L KTS/ha- Drip (T_7), conventional recommended dose N-P-K 150:75:60 N-P_2O_5-K_2O kg/ha- band application (T_8), 150:75:38 N-P_2O_5-K_2O kg/ha + 30 L KTS/ha- band application (T_9), 150:75:60 N-P_2O_5-K_2O kg/ha + 30 L CaTS/ha- band application (T_{10}), 150:75:49 N-P_2O_5-K_2O kg/ha + 60 L KTS/ha- band application (T_{11}) and 150:75:38 N-P_2O_5-K_2O kg/ha + 30 L CaTS/ha+ 30 L KTS/ha- band application (T_{12}). The weight of cobs plant^{-1} (150.1 g), weight of grains cob^{-1}(121.6 g), weight of stones cob^{-1} ((21.3 g) and 100-grain weight (32 g), were found significantly higher with treatment T_7 (150:75:38 N-P_2O_5-K_2O kg/ha + 30 L CaTS/ha + 30 L KTS/ha- Drip). The grain, stover and stone yield were significantly influenced by different treatments. The maximum grain yield (9063.0 kg ha^{-1}), stover yield (7951.3 kg ha^{-1}) and stone yield (1591.7 kg ha^{-1}) were recorded under treatment T_7 (150:75:38 N-P_2O_5-K_2O kg/ha + 30 L CaTS/ha + 30 L KTS/ha- Drip). Significantly higher K, Ca and S content of grain and stover were recorded with treatment T_7 (150:75:38 N-P_2O_5-K_2O kg/ha + 30 L CaTS/ha + 30 L KTS/ha- Drip). Significantly higher N, P, K, Ca and S uptake of grain and stover were recorded under T_7 (150:75:38 N-P_2O_5-K_2O kg/ha + 30 L CaTS/ha + 30 L KTS/ha- Drip) as compared to other treatments. Economics of different treatments clearly indicated that by virtue of higher grain yield, treatment T_7 (150:75:38 N-P_2O_5-K_2O kg/ha + 30 L CaTS/ha + 30 L KTS/ha- Drip) exhibited a higher gross return, net return and B:C ratio of ₹ 184163ha^{-1}, ₹ 124905ha^{-1} and 2.11, respectively.

T-2/P-40

Organic weed management in maize

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Sweet corn (*Zea mays* L.) is generally grown for fresh green cobs for human consumption and it is also used as raw and processed material for the food industry. It is an important source of dietary fiber, minerals and certain vitamins like A and C. Its taste and nutritional value have made it a valued crop all over world and the scope of sweet corn production is constantly increasing (Olabode and Sangodele 2015). As part of the 1990 Farm Bill, the U.S. Department of Agriculture's National Organic Program (NOP) was created to establish national standards and mandatory certification for organically grown products. These regulations are the framework for the production, handling, and processing of all organic agricultural products. The Organic Foods Production Act also established the National Organic Standards Board (NOSB), which advises the Secretary of Agriculture in setting the standards upon which the NOP is based. Producers, who meet NOP standards and are certified through annual onsite inspections by licensed certified inspectors, may label their products as "USDA Certified Organic." Production systems that are certified organic integrate cultural, biological, and mechanical practices that foster cycling of resources; promote ecological balance; and conserve biodiversity without the use of synthetic pesticides, GMO, or other specified products. Certified organic foods generally receive higher selling prices than nonorganic foods. Changing from "conventional management" to organic production requires a transition period free from synthetic chemicals for several years prior to certification. A two years field experiment was conducted during *kharif* 2018–19 at the Instructional Farm, Department of Agronomy, Rajasthan College of Agriculture, MPUAT, Udaipur. The experiment was laid out in randomized block design (RBD) with 12 treatment combinations (Summer ploughing + 1 hand weeding at 20 DAS (T1), Summer ploughing + straw mulch (5 t/ha) at 20 DAS+1 hand weeding at 40 DAS (T2), Summer ploughing + plastic mulch at sowing (T3), Stale seed bed preparation + 1 hand weeding at 20DAS (T4), Stale seed bed preparation + straw mulch (5 t/ha) at 20 DAS+1 hand weeding at 40 DAS (T5), Stale seed bed preparation + plastic mulch at sowing (T6), Soil solarization + 1 hand weeding (T7), Soil solarization + straw mulch (5 t/ha) at 20 DAS+1 hand weeding at 40 DAS (T8), Soil solarization + plastic mulch at sowing (T9), *Sesbania* as smothering crop in between rows and used same Sesbaina as mulch after 30 days + 1 hand weeding at 40 DAS (T10), Pendimethalin 1000 ml /atrazine 500g fb straw mulching (5 t/ha) at 20 DAS (T11) and Weedy check (T12)) in three replications. For plastic mulch, polythene sheet of black colour with 25-micron size was used. In one ha, 11 kg polyethene sheet was used. The final validity of any new agro-technology in weed management system is validated by its relative economics over the conventional practices, both in terms of net profit and benefit cost ratio (B:C) ratio. Among organic weed management practices, highest net return (₹ 62746/ha) and BC ratio (1.62) were recorded with stale seed bed and plastic mulch, whereas in 2019 highest net return (₹ 108825/ha) was obtained with soil solarization and plastic mulch, whereas maximum B:C ratio (2.35) was recorded with stale seed bed technique and plastic mulch (Table 2). This opposite in B:C ratio was due to higher cost of plastic sheet used

at the time of sowing and plastic mulching which increased the cost of cultivation in soil solarization + plastic mulch at sowing ultimately led to low BC ratio. On the basis of two-year field experimentation, it may be concluded that highest green cob yield, net return and BC ratio were recorded under stale seed bed and plastic mulch. On the basis of experiment stale seed bed with plastic mulch is most efficient in terms weed density, weed dry matter and increased weed control efficiency, productivity and economic viable in the sweet corn- fennel cropping system.

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T-2/P-41

Evaluation of effect of fortified Jeevamrit on growth & yield of maize under organic production system

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The field experiment was conducted during *kharif* seasons of 2017 at the Organic Farming Unit, MPUAT, Udaipur, Rajasthan, to evaluate the effect of fortified Jeevamrit on growth & yield of maize. The experiment comprises seven treatments *viz.*, Jeevamrut + Rock Phosphate, Jeevamrut + Gypsum, Jeevamrut + Silica, Jeevamrut + Rock Phosphate + Gypsum + Silica, Jeevamrut + Trichoderma + Rhizobium + PSB, Jeevamrut only and Control. The significantly higher yield of maize was obtained with the application of Jeevamrut fortified with Rock Phosphate + Gypsum + Silica (5900 kg/ha) as compared to other treatments. Similarly, maximum net return was obtained by application of Jeevamrut fortified with Rock Phosphate + Gypsum + Silica (Rs. 101732/ha).

T-2/P-42

Mechanized maize production

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Maize (*Zea mays* L.) is the third most important food grain crop in India next to rice and wheat. It is the main source of cereal for food, forage and processed industrial products and it has the highest yield potential among the cereals hence it is called "Queen of Cereals". In India, nearly 80 percent of maize is grown in rain fed region where all the agriculture operations are rain depended and labours intensive. The scarcity of agricultural labours at peak period causes delay in key operations like sowing, weeding, harvesting etc. Further, higher demand for labourers in peak cropping periods and high the labour wages leading to additional cost of cultivation. Mechanization increases the speed of agricultural practices and saves time and labour in farming operations. It lowers production cost and improves farm income. Mechanization is defined as application of machine power instead of draught animals or human labour to complete agricultural tasks. Mechanization of farm operations can shift agriculture from 'subsistence farming' to 'commercial agriculture. Maize cultivation is completely mechanized in the major producing countries like USA and China but in India, mechanization in maize cultivation is penetrating at slower pace. It is primarily due to less awareness about applicability of mechanization of maize cultivation and availability of these machines at farmers' doorsteps. The improved tools and machines play a very important role in the development of agriculture. Seed-bed preparation with power tiller rotary has enhanced the crop yields by 25-30% in comparison to bullock ploughing. Mechanical maize sowing by multicrop planter/manual planter ensured proper crop stand and gave 10-15% increased yield compared to kera and broadcasting. Similarly, weeding, earthing up and shelling operations by wheel hand hoe, hand ridger/power ridger and different type of shellers produced better results as well as saved labour and time, respectively. Ridge furrow system of planting of maize crop offers wider scope and tractor drawn raised bed planter showed 5-10% increase in maize yield over conventional practice. Increase in the yield of crops, due to mechanization of farms, has been traced from 40 to 50 per cent in the case of maize. So adoption of mechanization can ensure higher productivity and profitability in crops like maize.

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T-2/P-43

Soil health in agricultural systems

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Soil health is presented as an integrative property that reflects the capacity of soil to respond to agricultural intervention, so that it continues to support both the agricultural production and the provision of other ecosystem services. The major challenge within sustainable soil management is to conserve ecosystem service delivery while optimizing agricultural yields. It is proposed that soil health is dependent on the maintenance of four major functions: carbon transformations; nutrient cycles; soil structure maintenance; and the regulation of pests and diseases. Each of these functions is manifested as an aggregate of a variety of biological processes provided by a diversity of interacting soil organisms under the influence of the abiotic soil environment. Analysis of current models of the soil community under the impact of agricultural interventions (particularly those entailing substitution of biological processes with fossil fuel-derived energy or inputs) confirms the highly integrative pattern of interactions within each of these functions and leads to the conclusion that measurement of individual groups of organisms, processes or soil properties does not suffice to indicate the state of the soil health. A further conclusion is that quantifying the flow of energy and carbon between functions is an essential but non-trivial task for the assessment and management of soil health

T-2/P-44

Crop diversification options for income and nutritional security

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India is a country of about one billion people. More than 70 percent of India's population lives in rural areas where the main occupation is agriculture. Indian agriculture is characterized by small farm holdings. Presently, with the rapid growth of population, the pressure on land has increased and the size of holdings has considerably decreased while the food demand is rising. Hence, crop diversification through technologically feasible and economically viable enterprise seems to be the only option to achieve the income and nutritional security. Crop diversification needed for the employment generation, sustainable income, ecological balance and to reduce the risk due to crop failure. Horizontal and vertical crop diversification are the two approaches of diversification. Introduction of new crops is a most important diversification option. Praharaj et al. (2016) reported that the highest system productivity and net returns were recorded with soybean + pigeonpea - lentil cropping system followed by soybean + urdbean – lentil system. The intercropping of maize + groundnut at 1:5 rows showed significantly higher B:C ratio and the soil moisture content (SMC) in intercropping system significantly differed with solitary and maize-legume intercrops and their respective row proportions. Solitary planting of soybean registered 24% higher SMC than that of solitary maize. (Choudhary and Kumar, 2015).

T-2/P-45

Performance of Sweet corn under varying fertilizer levels

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Maize is a versatile product with uses ranging from industrial products to food preparations, as well as direct human consumption at the vegetative stage. The immature ears are used after roasting, boiling or canning. (Meena et al., 2005). Out of the various specialty corns, sweet corn (*Zea mays L.* var. saccharata Sturt) has a big market potential. It is one of the most popular vegetables in countries like USA and Canada and is becoming increasingly popular in India and other Asian countries also. It is consumed in the immature stage of the cob. The kernels of sweet corn taste much sweeter than normal corn especially at 18 to 21 days after pollination. The total sugar content in sweet corn ranges from 25-30 per cent. In addition, fodders derived after harvest may be sold, which bring additional income to the farmers. Thus, they promise higher income to maize growers. The experiment was conducted in Technopark of Vidya Bhawan Krishi Vigyan Kendra, Udaipur (Rajasthan) during *kharif* season 2020. The sweet corn variety Sugar-75 was used for this study. It is sturdy and vigorous plants having height of 180-200 cm and maturity period of 90-100 days. It is high yields of grade "A" ears with a good cylindrical shaped ear, with light yellow kernel color. Experiment was laid out in RBD with factorial concept with total sixteen treatment combinations consisting four levels of nitrogen and four levels of phosphorus fertilizers replicated thrice was employed in this study. The area of experiment was 38.0 m x 31.95 m, while gross and net plot sizes were 5.0 m X 3.6 m and 4.0 m X 2.7 m, respectively. Application of nitrogen brought about significant variation in green cob, green fodder and biological yield (Table 1). Fertilizing the crop with 180 kg N ha^{-1}(N3) produced remarkably higher green cob, green fodder and biological yield to the extent of 8.61 and Discussion 112 16.80 per cent of green cob, 7.03 and 15.56 per cent of green fodder and 7.24 and 15.72 per cent of biological yield over 60 kg ha^{-1}(N2) and no application of nitrogen (N0) respectively. However, it was remain statistically at par with 120 kg ha^{-1}. A close perusal of data on green cob yield, green fodder yield and biological yield (Table 1) indicates that application of P @ 90 kg P2O5 ha^{-1} (P3) produced significantly higher green cob yield, green fodder yield and biological yield, to the extent of 7.70 and 15.76 per cent of green cob, 6.97 and 15.08 per cent of green fodder yield and 7.07 and 15.17 per cent biological yield over 30 kg P2O5 ha^{-1} (P1) and control (P0) respectively. Which was found statistically at par with 60 kg P2O5 ha^{-1}(P2) . Besides or higher green cob, green fodder yield and biological yield (Table 1) the net returns (Table 1) clearly indicated that the highest net returns of ` 52647 Rs $ha^{-1}$ was accrued with application of 120 kg N $ha^{-1}$(N2). With regard to phosphorus levels, application of P @ 60 kg P2O5 $ha^{-1}$ (P2) gave highest net returns of ` 50571 ha^{-1}. Significant increase in green cob, green fodder and biological yield under these nitrogen levels appears to be on account of their influence on dry matter production and indirectly via increase in plant height, number of leaves, leaf area index, stem thickness and possibly a result of higher uptake of nutrients. The present findings are in close agreement with the results obtained by Shapira and Wortmam (2006) and El-Yazied et al., (2007) in sweet corn. In nut shell, it could be concluded from the present investigation that for getting higher production and economic return from sweet corn crop under Southern Rajasthan conditions, the crop should be fertilized with 120 kg N ha^{-1} and 60 kg P_2O_5 ha^{-1}.

T-2/P-46

Influence of stages and heights of detopping on productivity of *kharif maize* (*Zea Mays* L.)

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Maize is the third most important cereal crop after wheat and rice in India. Besides as food crop, it is consumed more as feed, fodder and large scale importance as an industrial crop. Detopping in maize is practiced to avoid lodging problem in fertile soils and especially in coastal districts and areas prone for wind damage. In some other places detopping is practiced for getting green fodder for livestock. Proper time of detopping is very important for controlling lodging and obtaining enough forage without sacrificing grain yield. Field studies were conducted at Agricultural Research Station, Peddapuram, East Godavari Dist, Andhra Pradesh, India during *kharif*, 2018 and 2019 to study the influence of different stages and heights of detopping on grain yield of rainfed maize (*Zea mays* L.). The experiments were laid out in a factorial randomized block design with three replications comprising ten treatments *viz.*, three stages of detopping *(*D_1-20 days after silking, D_2 -30 days after silking, D_3-40 days after silking) and three heights of detopping *(*L_1 - Detopping up to two leaves, L_2 - Detopping up to three leaves, L_3 -Detopping up to four leaves) and control (no detopping). Detopping was done as per the treatments. At every detopping, the green fodder yield was recorded. Significantly higher grain yield was observed with control (no detopping) and it was on par with detopping at 40 days after silking up to two leaves in addition green fodder yield of 2.1 t/ha was obtained. Significantly higher reduction in yield was noticed in detopping at 20 days after silking. Different heights of detopping did not influence the grain yield of maize. Based on the present study, It was inferred that without considerable reduction in yield and also production of green fodder the stage of detopping at 40 days after silking up to two leaves was found to be optimum in maize.

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T-2/P-47

Effect of integrated weed management on weeds, growth and yield attributes of maize (*Zea mays* L.)

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A field experiment was carried out at RMD college of Agriculture and Research station, Ambikapur, during *Kharif* season of 2020 to study the "Effect of different weed control methods on growth and yield of maize" (Zea mays L.). The Soil in the experiment field was sandy loam acidic with pH of 6.2 low in available N, P and medium in K. Experiment comprises with 8 treatments, Viz ; T_1 **:** Atrazine @ 1.00 kg ha^{-1} (PE), T_2 : Tembotrione 110g ha^{-1} as (PoE), T_3 : Topramezone 25g ha^{-1} as (PoE), T_4: Atrazine 1000g ha^{-1} as(PE) fb Tembotrione 110g ha^{-1} as (PoE), T_5 : Atrazine 1000g ha^{-1} as (PE) fb Topramezone 25g ha^{-1} as (PoE), T_6 : Pendimethaline 750g ha^{-1} as (PE) fb Holosulfuron methyl 90 g ha^{-1} as (PoE), T_7 : Two hand weeding at 20 and 40 DAS and T_8 : weedy check in Randomize block design with three replications. The highest weed control efficiency was at 30 DAS, 60 DAS and at harvest (77.31, 85.68 and 72.67 %) and found effective against complex weed flora in maize followed by atrazine @1000 g ha^{-1} as a (PE) fb Tembotrione @110 ha^{-1} as a (PoE), atrazine @ 1000g ha^{-1} as a PE fb Topramezone @25g ha^{-1} as a PoE and Pendimethaline @ 750 g ha^{-1} as a PE fb Holosulfuron methyl @ 90g ha^{-1} as a PoE compared to weedy check. The highest growth and yield attributing characters and kernel yield (5.98 t ha^{-1}) and net return (Rs. 108085 ha^{-1}) were recorded under 2 HW at 20 and 40 DAS followed by Atrazine @1000 g ha^{-1} as a PE fb Tembotrione @110 g ha^{-1} as a PoE (Rs. 105487 ha^{-1}) but B:C ratio was highest under Atrazine @1000g ha^{-1} as a PE fb Tembotrion @ 110g ha^{-1} as a PoE (2.58) than Atrazine 1000g ha-1 as fb Topramezone 25 g ha^{-1} as PoE (2.52) due to higher cost of cultivation. Therefore it was concluded that, 2 HW at 20 and 40 DAS followed by Atrazine @1000 g ha^{-1} as a PE fb Tembotrione @110 g ha^{-1} as a PoE and Atrazine 1000g ha^{-1} as fb Topramezone 25 g ha^{-1} as PoE found more effective and economic as compared with other treatments.

T-2/P-48

System productivity of diversified baby corn based cropping system under various nutrient managements

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The continuous monocropping of cereals and faulty nutrient management practices becomes challenging issue for sustainable production (Jat *et al.*, 2019. Therefore, there is a need to opt for possible replacement of rice and wheat crops with other remunerative crops like baby corn, sweet corn, fenugreek and cowpea along with suitable nutrient managements to overcome the ill effect of cereals based mono cropping. The field experiment entitled "Nutrient management in baby corn based cropping system" was carried out with three baby corn based cropping systems and five nutrient management practices at the research farm of ICAR-IARI, New Delhi during *kharif*, *rabi* and *summer* season of 2016-17 and 2017-18. The results manifested that total BCEY of system (*kharif, rabi and summer*) (t/ha) was significantly differ under different cropping systems and nutrient levels. Among different cropping systems, significantly highest total BCEY (7.4 t/ha) was recorded with CS_3 (baby corn- baby corn + fenugreek* – sweet corn) followed by CS_1 (5.8 t/ha) and CS_2 (4.80 t/ha) cropping system. Among all nutrient levels significantly highest total BCEY (7.15 t/ha) of system was recorded with N_2 (FYM) followed by N_3(VC) and N_4 (LC).

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T-2/P-49

Integrated nutrient management - maize based cropping systems

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Maize is grown widely in India as a cereal crop. Despite the use of inorganic fertilizers maize yield is declining due to the removal of essential plant nutrients from the soils. The deficiencies of essential plant nutrients, organic matter, and beneficial soil microbes in soils has negative impact on soil fertility, maize productivity, and farmer's income, Therefore, sustainable maize productivity can be attained through the judicious use of both organic and inorganic fertilizers. The substitution of parts of inorganic fertilizers with organic fertilizer could maintain and sustain soil productivity and improve maize productivity. Integrated nutrient management enhances maize yield, nutrient uptake, and economic return compared with the sole application of organic and inorganic fertilizers. Integrated use of chemical and organic fertilizer on yield and yield attributes component of maize is very crucial for assurance of food security & food self-sufficiency. Integrated Nutrient Management (INM) aims at adjustment of soil fertility and plant nutrient supply to an optimum level for sustaining the desired crop productivity through optimization of benefit from all possible sources of plant nutrients. The integrated use of major plant nutrients (nitrogen, phosphorus, and potash) along with different organic carbon sources (animal manures and plant residues) plus biofertilizers (beneficial microbes) significantly improves maize growth, yield and yield components, and grower's income.

T-2/P-50

Correlation analysis of yield and its component traits in maize

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Maize (Zea mays L.) is the third most important cereal food crop in the world and it is called as queen of cereals. An experimaental study was conducted to study the study the relationship between yield and its components. Yield is dependent on many contributing charecters and it is essential to study the contribution of the component characters. Hence, correlation study was performed among nine biometrical traits in forty genotypes of maize to see if there is any interdependence among the traits *viz*., plant height, ear height, days to 50 % tasselling, days to 50 % silking, cob length, number of rows per cob, number of kernels per row, Shelling percentage and yield. Plant height, ear height, cob length, number of rows per cob, number of kernels per row and shelling percentage exhibited positive association with yield at 5% significance level. Days to 50 % tasselling and days to 50 % Silking showed negative association with yield at 1% significance level. Cob length had positive association with number of rows per cob, number of kernels per row and shelling percentage. Number of rows per cob showed positive association with number of kernels per row and shelling percentage.

Knowledge of the relationships among yield components is of the great importance in breeding, because it is likely to facilitate breeders to choose the most efficient selection criteria. Hence the cob characters *viz*., cob length, number of rows per cob, number of kernels per row, shelling percentage can be given more importance in selection criteria as they are contributing to yield.

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T-2/P-51

Maize production under organic farming in Indian context

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Green revolution technologies have helped to alleviate hunger, but they have also had some negative consequences for our natural resources. As a result of these negative consequences, other forms of agriculture that are more sustainable are being emphasised. Organic farming, which is a holistic approach to farming, is one of these alternative methods for achieving long-term agricultural productivity. Maize Crop production under organic cultivation is based on crop rotations, green manures, organic manures, biofertilizers, composts, and biological pest management, with synthetic fertilisers, chemical pesticides, plant growth enhancers, and livestock feed additives being avoided or tightly limited. Without a doubt, the benefits of organic farming exceed the drawbacks, but it is constrained by a number of factors, including the threat to national food security, limited availability of organic manures, farmer profitability, and consumer affordability of organic goods. As a result, a total switch to organic farming is neither desirable nor feasible in high-input areas, which are the primary sources of food grains for the central pool. In these locations, a systematic phase-out of agrochemicals and synthetic fertilisers could be a positive start. "For national food security, higher household income, and climate resilience, an organic (integrated crop management) approach for input-intensive areas (food hubs) and a certified organic approach by integrating tradition, innovation, and science in de-facto organic areas (hill and rainfed/dryland regions) will be a better option."

T-2/P-52

Re-designing nitrogen management protocol in maize through precision agronomic innovations: A paradigm shift towards agricultural sustainability in Indo Gangetic Plains of India

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The agricultural sustainability of intensively cultivated–conventionally managed Indo-Gangetic Plains (IGP) of India has become a major challenge due to depletion of groundwater table at faster rates, stagnating or declining productivity growth, degrading soil health and environmental quality, and diminishing farm profitability. To alleviate these issues many developmental practitioners and policy makers have suggested several resource conservation technologies (RCTSs). During recent past it has been reported that adoption of conservation agriculture (CA) based innovative agronomic management practices like zero-tillage (ZT)/ no-tillage (NT), permanent bed (PB) along with surface residue retention had not only ensured higher productivity, but also proved beneficial in multiple aspects including greater soil water storage (Parihar et al., 2016), improved soil quality (Jat et al., 2019), decreased erosion (Montgomery, 2007), and in some instances, greater yield and net farm income (Thierfelder et al., 2015; Pradhan et al., 2018). However, without proper nitrogen management, realization of full potential of CA is limited (Vanlauwe et al., 2014) as large amount of broadcasted nitrogen remains over the surface of crop residues which not only reduce direct contact of fertilizer material with soil but also increase losses like volatilization and leaching. Therefore, proper placement of fertilizer material under CA is crucial to increase availability of nutrients to crops. In recent years nutrient and water management through sub-surface drip fertigation (SSDF) in cereals have provided excellent opportunities for improving resource use efficiencies as well as crop performance. Keeping all these in mind, a field experiment was conducted in maize under medium-term CA-based maize-wheat system at BISA-CIMMYT, Ladhowal, Punjab in *Kharif* 2019 to investigate the potential complementarity of bundling CA with SSDF (CA+) on nutrient use efficiency, water economy and productivity. The experiment involved two CA+ (CA coupled with SSDF) viz. residue retained (WR) permanent beds in combination with sub-surface drip fertigation (PBWR-SSD) at N rates of 120 and 150 kg N/ha, were compared with CA (PB using furrow irrigation with crop residue-120 kg N/ha) and conventional practices (residue removed-WOR, furrow irrigated-conventional tillage-CT with 120 kg N/ha) resulting in 4-treatments. Result showed that highest grain yield (7.97 t/ha) was recorded in CA+ treatment PBWR-SSD-N150 followed by PBWR-SSD-N120 (7.38 t/ha). The GY of PBWR-SSD-N120 was 20 and 23% higher than CA and CT, respectively. The highest ANUE (47.6 kg grain/kg N) was obtained from PBWR-SSD-N120 which was about 30% higher than both CA and CT. Switching over to the CA+ practices from the CA and CT resulted 14 and 21% increase in cumulative root water uptake (CRWU) respectively (result obtained from simulation studies). Therefore, adoption of SSDF in CA (CA+ technology) can be a sustainable option to address the emerging issues related to declining input use efficiency, water economy and productivity under changing climate scenario.

T-2/P-53

Impact of precision nutrient management on productivity, economics, and water and energy use efficiency of long-term conservation agriculture-based maize-wheat system

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Adoption of conservation agriculture (CA)-based maize-wheat (MW) system has been promoted in north Western Indo-Gangetic Plains-NW-IGP as an alternative to the rice-wheat system (RW) to attain higher crop productivity, farm profitability, water and energy-use efficiency and better soil quality. The contrasting tillage practices and crop residue as mulch in CA have implications on soil moisture regime and nutrient dynamics that in turn could influence nutrient response, nutrient availability and use efficiency. We aimed to investigate the effect of different precision nutrient management and CA practices on the productivity, economic profitability and input (water and energy) use efficiency, C emission, C sequestration and C footprint of maize in a maize–wheat (MW) crop rotation under different precision nutrient management and CA practices. To do so, a 2-year field experiment was carried out during 2017 and 2018-19 at the research farm of ICAR-Indian Agricultural Research Institute, New Delhi, India, on the site of an ongoing experiment since *kharif*, 2012. We compared the effect of CA-based permanent bed (PB+R) and zero tillage (ZT) with residue retention, with conventional till (CT) with residue incorporation. Under each tillage treatment, three nutrient management options, *i.e.*, recommended dose of fertilizers (RDF), GS-guided N and site-specific nutrient management (SSNM) were compared with farmers' fertilizers practices (FFP). The experiment was laid out in a split-plot design with three replications. The CA practices enhanced the growth, total dry matter and yield attributes, grain yield, economic profitability of maize and wheat in CA-based PB and ZT plots compared to CT plots. The improved nutrient management options enhanced the growth, total dry matter and yield attributes, grain yield of maize and wheat, thus attained MW system's productivity with SSNM treatment having the highest increment (2-seasons mean basis), compared to FFP. CA-based PB plots recorded lower MW system's water use, thus, the highest and lowest WUE of MW system was recorded in CA-based PB and CT plots, respectively. Due to the higher MEY and lower cultivation cost, a significantly higher system's net return and net BC ratio were recorded in CA-based PB plots compared to CT plots. CA-based PB and ZT plots recorded a significantly higher MW system's net energy output thereby, a higher MW system's EUE was recorded, meanwhile GS-guided N application and SSNM treatments recorded a significantly higher MW system's net energy output compared to FFP, respectively. GS-guided N treatment recorded a significantly higher MW system's EUE compared to FFP. The adoption of long-term CA-based PB+R & SSNM and GS-guided N could be a viable option to attain higher crop productivity, farm profitability, water, nutrient and energy-use efficiency and decreased C-footprint in the MW system to meet the increasing future food and energy demand under changing current and future extreme climatic conditions in north-western India and other similar agro-ecologies.

T-2/P-54

Grain cum fodder production in maize based intercropping system under irrigated condition

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After rice and wheat, maize (*Zea mays* L.) is India's most significant crop. Maize is utilized not only for human food and animal feed, but also for starch and oil production. An experimental study was conducted to study grain cum fodder production in maize based intercropping system (additive series) under irrigated condition. Field experiments with seven treatments *viz*., T1 - Maize alone (for grain) (100 % RDF), T2 - Maize (for grain) + Maize (for fodder) with 100 % RDF, T3 - Maize (for grain) + Maize (for fodder) with 125 % RDF, T4 - Maize (for grain) + Maize (for fodder) with 150 % RDF, T5 - Maize (for grain) + Fodder cowpea with 100 % RDF, T6 - Maize (for grain) + Fodder cowpea with 125 % RDF and T7 - Maize (for grain) + Fodder cowpea with 150 % RDF which replicated thrice and laid out in randomized block design.

The experimental results reveals that, maize for fodder recorded higher fodder yield than fodder cowpea. Regarding maize fodder, maize + maize for fodder with 150 % RDF (T4) recorded higher fodder yield (16.9 t/ha) followed by maize + fodder maize with 125 % RDF (16.4 t/ha). With regard to fodder cowpea, maize + fodder cowpea with 150 % RDF recorded higher fodder yield (12.2 t/ha) followed by maize + fodder cowpea with 125 % RDF.

Regarding grain yield, sole maize with 100% RDF (T_1) recorded the highest mean yield (7013 kg / ha) followed by maize + maize fodder with 125% RDF and maize + maize fodder with 150% RDF and these treatments were comparable among themselves. Lesser grain yield was recorded under maize + fodder maize with 100% RDF and maize + fodder cowpea with 100% RDF. Regarding straw yield, sole maize with 100% RDF (T_1) recorded the highest mean yield (8869 kg / ha) followed by maize + maize fodder with 150% RDF followed by maize + fodder maize with 125% RDF and these treatments were comparable among themselves. The least straw yield was recorded under maize + fodder cowpea with 125% RDF. Regarding economics, maize + maize fodder with 125% RDF (T_3) recorded higher net return (Rs. 91,571) and BC ratio (2.87) followed by maize + cowpea fodder with 125% RDF (T_6) with a net income of Rs. 85,640 and BC ratio of 2.78.

T-2/P-55

Effect of foliar application of zinc based nanofertilizer and different fertility levels on growth attributes and yield of maize in Southern Rajasthan

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A field experiment was conducted during two consecutive *Kharif*, seasons of 2020 and 2021 at Instructional Farm, Rajasthan College of Agriculture, Udaipur to evaluate the effect of foliar application of zinc based nanofertilizer and different fertility levels on growth attributes and yield of maize in Southern Rajasthan. The experiment was laid out in a factorial randomized design with three replications comprising four foliar application of nanofertilizer (Control, at knee high stage, at 50% tasseling stage and both at knee high stage and at 50% tasseling stage) and four fertility levels (100% RDF, 90% RDF, 80% RDF and control). Growth attributing characters viz., Plant height (cm), Plant dry matter (g plant^{-1}), Days to 50 per cent tasseling, Days to 50 per cent silking, LAI, CGR (g m^{-2} day^{-1}) and RGR (g g^{-1} day^{-1}) were significantly higher at all the stages of growth periods with the dual foliar application of nanofertilizer at knee high stage and at 50 per cent tasseling stage and application of 90 per cent RDF in maize. Similarly, the significantly highest Chlorophyll content (2.180 mg g^{-1} and 2.181 mg g^{-1}) was found in with dual foliar application of nanofertilizer and 90 per cent RDF, respectively. Significantly highest grain, stover and biological yield (51.90, 82.32 and 134.21q ha^{-1}) were recorded with the dual foliar application of nanofertilizer at knee high stage and at 50 per cent tasseling stage over single stage foliar application. Similarly, different levels of fertility, application of 90 per cent RDF significantly increased grain, stover and biological yield.

T-2/P-56

Yield performance of maize (*Zea mays* L.) genotypes under different nutrient levels

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Maize (*Zea mays* L.) being a C_4 plant is very efficient in converting solar energy in to dry matter. As it is heavy feeder of nutrients, its productivity is largely dependent on nutrient management. Yield potential of crop not only dependent on its genetic makeup but also on the environment in which it's grown. The maximum genetic potential can be exploited by raising the crop in favourable environment. Balanced and optimum use of fertilizers plays an important role in increasing the maize yield. Currently, the yield potential of available varieties is high enough, but it has not been exploited fully due to some production constraints. Among these, proper level and ratio of nitrogen, phosphorus and potassium is one of prime importance. The nutritional requirements of approved varieties also must be investigated. As the newly developed high yielding single cross hybrids requires more nutrients to exploit their full yield potential. Therefore, present study was conducted a field experiment was conducted at Punjab Agricultural University, Ludhiana during spring, 2020 to study the influence of different nutrient levels on yield of maize genotypes. Three nutrient levels (125:60:30, 156:75:38, 188:90:45 $N:P_2O_5:K_2O$ kg/ha) as main plots and seven genotypes (PM 17201L, PM 17205L, DKC 9197, PM 17208L, RASI 4118, P 3522 and KMH 25K45) in sub plots were evaluated in this experiment. Application of nutrients @ 188:90:45 kg/ha resulted in significantly higher stover and grain yield (126.6 and 93.2 q/ha) as compared to the nutrients @ 125:60:30 q/ha (101.0 and 79.2 q/ha), however, it was statistically at par with nutrients @ 156:75:38 kg/ha (122.9 and 90.3 q/ha). Among different genotypes, RASI 4118 recorded significantly higher stover and grain yield as compared to all genotypes except KMH 25K45 and DKC 9197.

T-2/P-57

Low input sustainable agriculture with ecological management practices

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The majority of farmers in India are small scale entrepreneurs whose farm operations are performed with low input agricultural technologies. Majority of the technologies comprised the refined indigenous knowledge system. Farm size, labour inputs, capital inputs, planting materials and organic manure are the main determinants of the gross income of LEISA farmers. Farmers preferences for low input system vary considerably depending upon the phase of crop production which include technologies for land preparation use of draught animals, natural/organic substitute for inorganic pesticides and fertilizers, seed multiplication technologies, simple irrigation and drainage method, low input processing. The ultimate goal of sustainable agriculture is to develop farming systems that are productive and profitable, conserve the natural resource base, protect the environment, and enhance health and safety, and to do so over the long-term. The means of achieving this is low input methods and skilled management, which seek to optimize the management and use of internal production inputs (i.e., on-farm resources) in ways that provide acceptable levels of sustainable crop yields and livestock production and result in economically profitable returns. This approach emphasizes such cultural and management practices as crop rotations, recycling of animal manures, and conservation tillage to control soil erosion and nutrient losses and to maintain or enhance soil productivity. Low-input farming systems seek to minimize the use of external production inputs (i.e., off-farm resources), such as purchased fertilizers and pesticides, wherever and whenever feasible and practicable: to lower production costs: to avoid pollution of surface and groundwater: to reduce pesticide residues in food: to reduce a farmer's overall risk and to increase both short-term and long-term farm profitability. The use of chemicals for high crop productivity and compensation for soil, water and biological resource degradation contribute to the high production costs. This has prompted strong interest by small scale farmers in low-input sustainable agriculture. The principles that underlie a low-input sustainable agricultural system are: (1) adapting the agricultural system to the environment of the region, including soil, water, climate and biota present at the site; (2) optimizing the use of biological and chemical/physical resources in the agro ecosystem.

T-2/P-58

Conservation agriculture and its impact on hydrothermal properties of soil–plant continuum

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Maintenance of soil physical health at its optimum level is essential for sustainable crop production and rational use of natural resources without jeopardizing their quality. The ongoing conventional tillage practices for crop production using intensive ploughing and removal of crop residue from the field have resulted in an increase in surface crusting, soil compaction, soil erosion, decrease in water infiltration and ultimately aggravation of the overall soil physical health deterioration. In recent years, many agricultural scientists across the world have recommended conservation agriculture as a solution to overcome the adverse effects of conventional tillage practices on soil physical health.

Conservation Agriculture (CA) approach was introduced to manage agro-ecosystems for improved and sustained productivity, and increased farmers' profits while maintaining the natural resources. This comprises the management of natural resources at the farm, village, and landscape scales to increase synergies between food production and ecosystem conservation. CA-based rice-wheat (RW) system integrated with mungbean improved the system productivity by 10%, profitability by 20–30% using 15–30% less irrigation water, and 20–25% less energy input compared to conventional RW system in the IGP. (Choudhary *et.al*., 2018). However, the replacement of rice with maize improved the productivity by 10-15% and profitability by 40–50% using 70% less irrigation water. CA layered with subsurface drip irrigation (SDI) in CA-based rice/maize systems recorded 5% higher system productivity and saved 50% of irrigation water compared to flood irrigation in CT-based systems.

CA-based systems are found more adapted to extreme climatic conditions and can mitigate the negative effects of climatic stresses like terminal heat, water stress and thereby helps in increasing crop yields to the tune of 0.4–0.8 t ha^{-1} per season over the conventional system. The effect of CA on crop yield component and its application in various farming perspective, is under debate across the world. The present data indicates that conservation agriculture can improve soil physical properties and associated processes especially, soil water infiltration and storage, soil aeration, soil structure and soil porosity. (Indoria, *et.al*., 2017). The existing crop production systems involving repeated tillage and straw removal practices result in surface crusting and soil compaction, which reduce water infiltration and enhance soil erosion, ultimately causing an overall deterioration in soil physical health. However, it is inevitable to maintain soil physical health at its optimum level for sustainable crop production, efficient use of natural resources and improved response to added inputs.

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T-2/P-59

Winter maize-based cropping system: strategies to improve productivity and profitability of farming community of Bihar

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Agriculture production system in Bihar needs to sustain productivity and improve profitability under changing climatic scenario. Bihar state is called capital of marginal farmers (~91%), all such farmers are vulnerable to climate change impacts and crop losses due to climatic changes affect livelihood and farmers income. In India Bihar state is the second largest growers of winter maize (*Zea mays* L.) after Andhra Pradesh state. This is an important cereal crop in world after wheat and rice. Climate resilient production technologies have potential to sustain productivity to meet the growing demands of rapidly growing world population and improve profitability of farming community. Winter maize could also be a sustainable option to improve system productivity. We hypothesized that winter maize-based cropping system would promote sustainable intensification, productivity, and profitability. We also predicted that winter maize would maintain total system productivity. Farming community of Bihar may expect higher revenues but also higher income volatilities in the future. Seven project sites (Purnea, Katihar, Nalanda, Nawada, Munger, Samastipur and Vaishali) were consider for this study. Winter maize was planted after harvest of Kharif rice. Results showed that rice grain and maize yield varied from 42.20 to 63.76 q/ha and 67.0 to 106.38 q/ha, respectively. However, in case of rice and maize profitability registered in range of 43300 to 94600 INR/ha and 74624 to 99000 INR/ha, respectively in different project sites. We conclude that winter maize-based cropping system has the potential to increase system productivity and profitability of Bihar farmers.

T-2/P-60

Long-term effect of organic and inorganic fertilization on maize yield in maize- wheat cropping sequence in typic *haplustepts* soil of southern Rajasthan

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A field experiment was conducted at the Agronomy farm, Rajasthan College of Agriculture, Udaipur during 2016-17 and 2017-18 with the objectives to study the effect of organic and inorganic fertilization on microbial population and microbial biomass of soil. The soil of the experimental field was sandy clay loam in texture, non-saline and slightly alkaline in reaction. The experiment consisted of 12 treatment combinations *viz.*, T_1-Control, T_2-100% N, T_3-100% NP, T_4-100% NPK, T_5-100% NPK + Zn, T_6-100% NPK + S, T_7-100% NPK + Zn + S, T_8-100% NPK+ *Azotobacter*, T_9-100% NPK+FYM 10 t ha^{-1}, T_{10}- FYM 10 t ha^{-1} +100% NPK (-NPK of FYM), T_{11}-150% NPK and T_{12}-FYM 20 t ha^{-1} with four replications in a randomized block design. The results of the present investigation revealed that 100% NPK + FYM 10 t ha^{-1} (T_9) gave the highest grain yield and increase yield by 209.45 and 24.45 per cent as compare to control (1322 kg ha^{-1}) and recommended dose of fertilizer (3287 kg ha^{-1}). The highest stover yield 5365 and 5394 kg ha^{-1} was recorded under 100% NPK + FYM 10 t ha^{-1} treatment (T_9) during 2016-17 and 2017-18, respectively and at par with 150% NPK (T_{11}). The pooled analysis reveals 100% NPK + FYM 10 t ha^{-1} (T_9) gave 145.77 and 14.41 per cent higher stover yield as compare to control (2189 kg ha^{-1}) and recommended dose of fertilizer (4702 kg ha^{-1}). The highest biological yield 9448 and 9492 kg ha^{-1} was recorded under 100% NPK + FYM 10 t ha^{-1} treatment (T_9) during 2016-17 and 2017-18, respectively. It was followed by 150% NPK (T_{11}), 100% NPK + Seed treatment with *Azotobacter* (T_8) and 100% NPK + Zn + S (T_7) during both the year. The pooled analysis reveals 100% NPK + FYM 10 t ha^{-1} (T_9) gave 169.72 and 18.55 per cent higher yield as compare to control (3511 kg ha^{-1}) and recommended dose of fertilizer (7988 kg ha^{-1}).

T-2/P-61

Maize production in India: future, challenges and opportunities

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Maize is the second most important cereal crop in the world in terms of acreage and is called the 'Queen of Cereals'. Global maize production touched approx. 1040 million MT in 2016-17, wherein, US has been the leading producer, followed by China, accounting for about 38% and 23% respectively. India contributes around 2% of this production chart with a quantum of 26 million MT in 2016-17. In the Indian context, not less than 15 Million farmers are engaged in maize cultivation and it generates employment for more than 650 million person-days at farming and its related business ecosystem levels. Importantly, maize contributes more than 2 per cent to the total value of output from all agricultural crops.

The crop is less water demanding than other similar cereals and being a 'C4' as well as 'dayneutral plant', it gives higher yield per hectare in a shorter period and can be grown in any season. The multiple utilities of maize as a 'food', 'fodder' and 'feed' makes it further more demand friendly and insulates it against low demand situations. These unique characteristics of maize make the crop a suitable crop candidate for enhancing farmer's income and livelihoods in India. The current maize production scenario highlights presence of hybrid maize at about 65-70 percent acreages and most of it accounts for feed and industrial grade Maize, while food grade Maize is produced using traditional cultivars (OPVs). In the recent years, although the rate of adoption of hybrids has slowed down, but farmers continue to replace traditional cultivars/old hybrids with the newer higher-yielding hybrid varieties.

States such as Karnataka, Rajasthan, Andhra Pradesh and Madhya Pradesh, contribute towards half of the total maize acreage in the country. The aforementioned states including Bihar account for almost 2/3rd of the national maize production. However, it is very pertinent to observe that the national productivity of maize is considerably lower than the global standards. India stands almost half the global yield standards and therefore there lies immense scope for improvement in the strategically important crop in the country. To achieve the targeted productivity level for doubling the maize production, both technological and policy interventions will be essential. While policy interventions are required to remove the bottlenecks in the Indian maize sector in the short-run, strategic maize research is vital to significantly enhance genetic gains and for sustainable intensification of maize-based cropping systems in the country.

T-2/P-62

Assessment of QPM hybrids (*Zea mays* L.) production technology for Southern Rajasthan

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Maize (*Zea mays* L.) is an important food crop cultivated in diverse agro-climatic conditions of the world. Normal maize is poor in protein quality due to the deficiency of essential amino acids, viz. lysine and tryptophan.Opaque-2 mutation in quality protein maize (QPM) doubles the lysine and tryptophan content in the maize kernel. These two amino acids allow the body to digest complete proteins; thereby eliminating wet-malnutrition (Kumar *et al.* 2020). QPM assumes a great significance in overcoming problem of malnutrition in tribal dominated population of southern Rajasthan as well as in many parts of country where maize is raised as staple food crop.

A field experiment entitled "Assessment of QPM hybrids production technology for Southern Rajasthan (*Zea mays* L.)" was conducted for two consecutive Kharif season of year 2014 and 2015 at Instructional Farm of Rajasthan Collage of Agriculture, Udaipur. An experiment was laid out in split plot design with sixteen treatment combinations consisting two plant densities and two QPM hybrids in main plot and four levels of nutrient management approaches in sub plot four replications used in this experiment. The area of gross plot size was 5.0 m × 3.0 m = 15.0 m^2.The QPM hybrids "HQPM-1" resulted in the highest grain yield and exhibited a significant superiority over "Pratap QPM hybrid-1" on pooled basis. On pooled basis the extent of increase in grain yield was to the tune of 4.44 q ha^{-1} and stover yield 6.98 q ha^{-1} over "Pratap QPM hybrid-1" (Table 1).

The yield recorded under high density (50 cm x 20 cm) was significantly higher over normal density (60 cm x 20 cm). The extent of increase grain and stover yield was 9.98 and 7.59 per cent on pooled basis, respectively (Table 1). Similarly, the highest yield under higher plant density may be reasoned due to direct effect of higher plant at harvest is in close conformity with findings of Sharma (2017). Application of nutrients in different proportions resulted in significant variation in the yield of the QPM hybrids. The maximum grain and stover yield was recorded under STCR approach which significantly enhanced it over SSNM, RDF and Green seeker on pooled basis with the enhancement of grain yield by 5.12, 10.08 and 12.04 q ha^{-1} and 11.36, 25.19 and 31.56 per cent, respectively on pooled basis (Table 1). The results of present investigation indicated higher production under influence of N, P and K fertilization are in close conformity with findings of Vikram *et al.*, (2015).

Based upon results it is recommended that for profitable QPM hybrid production, "HQPM-1" may be grown by fertilizing STCR based recommendation (133 kg N + 43 kg P_2O_5 + 62 kg K_2O ha^{-1}) keeping a density of 1,00,000 plants ha^{-1}.

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Table 1 Effect of treatments on grain, stover, yields (q ha^{-1}) and economics of quality protein maize

Treatments	**Grain yield (q ha^{-1})**	**Stover yield (q ha^{-1})**
	Pooled data	**Pooled data**
QPM hybrids		
Pratap QPM hybrid-1	41.72	62.64
HQPM-1	46.16	69.62
S. Em. ±	0.61	0.78
C.D. (P=0.05%)	1.81	2.31
Plant densities		
Normal	41.85	63.71
High	46.03	68.55
S. Em. ±	0.61	0.78
C.D. (P=0.05%)	1.81	2.31
Nutrient management approaches		
RDF	40.67	61.12
SSNM	45.63	68.71
STCR	50.75	76.52
Green Seeker	38.71	58.16
S. Em. ±	0.49	0.75
C.D. (P=0.05%)	1.39	2.11

T-2/P-63

Productivity & economics of single cross hybrid maize (*Zea mays* L.) under varying level of hydrogel polymer and fertility levels under rain fed conditions

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The experiment was conducted under field condition at Instructional Farm, RCA, MPUAT, Udaipur during rainy season of 2019 and 2020 *Kharif* season to ascertain suitable 4 hydrogel level (Control, 2.0, 5.0 and 7.5 kilogram per hactare) & 4 fertility levels (75 kilogram Nitrogen + 40 kilogram Poshporus +30 kilogram Potassium, 90 kilogram Nitrogen + 45 kilogram Phosphorus +35 kilogram Potassium, 105 kilogram Nitrogen + 50 kilogram Posphorus + 40 kilogram Potassium & 120 kilogram Nitrogen + 55 kilogram Posphorus + 45 kilogram Potassium per hactare). Results indicated that highest grain yield and economics was realized under application of 7.5-kilogram hydrogel polymer ha^{-1}, however in terms of Benefit Cost ratio 5.0 kg hydrogel polymer ha^{-1} application proved economically beneficial and best to meet out water stress under rain fed conditions. Providing 105 kg N + 50 kg P_2O_5 + 40 kg K_2O ha^{-1} affirmed potential role in increasing the productivity of single cross hybrid maize under rain fed conditions.

Theme-3

Maize value chain for industrial growth and farmers' prosperity

T-3/O-1

Exploring the role of maize in ensuring food and nutritional security: A bibliometric perspective

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Maize is the third most important food crop in the world, providing at least 30% calories to more than 4.5 billion people. Increasing demand and hovering inter-year production levels have altered the market sustainability of maize resulting in increasing the global price levels. The trade potential of the crop is being utilized by a few developed countries adding revenue to their state's exchequer. Post setting the Sustainable Development Goals (especially 1 and 2), this commodity has gained much significance across the globe due to its nutritional significance. In the context, the present paper aims to decipher the production as well as research status for setting future priorities. The bibliometric analysis indicated that the USA, China, India, and Mexico are leading the research with transdisciplinary approach. Countries like China and the USA are concentrating more on nutrition facets especially QPM and biofortified maize. Quality Protein Maize (QPM) comprise a significant dietary upgrade and the USA centrals the QPM research front alongside India and China. Nonetheless, reorienting the research priorities and policy advisories in the coming decade will significantly contribute in achieving the food and nutritional security. Increased investment in policy support towards technology generation, value addition accounting for its industrial usage, enabling the extension support, adopting remunerative maize-based farming systems, along with implementing efficient coping mechanisms to climate change will uplift the farmers' livelihood significantly and facilitate in meeting the global demand of maize across different sectors.

T-3/O-2

Maize production in Northeast India: Trend and decomposition analysis

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Maize is the second most important cereal crop after rice in North-Eastern region (NER). This study aimed to analyse the Compound Annual Growth Rate (CAGR), instability using Cuddy-Della Valle Index, estimated maize requirement with the projected population during 2022, 2025, 2030 and 2035. The contribution of yield and area to the total production of maize in NER of India was also examined using decomposition analysis. The study was conducted based on time series data for 54 years (1966-67 to 2019-20) on state-wise area, production and yield of maize in the region. The whole time period was divided into four phase *viz*., phase I (1966-67 to 1983-84), phase II (1984-85 to 2001-2002), phase III (2002-03 to 2019-20) and phase IV (1966-67 to 2019-20). The requirement of maize production was estimated to be 7549 thousand tonne and 8347 thousand tonne (increased by 10.57%) during 2022 and 2035, respectively. Among the NER states, the requirement of maize production was estimated to be highest in Assam (5717 thousand tonne) followed by Tripura (663 thousand tonne) and Meghalaya (536 thousand tonne) during 2035. During phase I, there was medium instability in production and yield, and low instability in area under maize. However, during phase II and phase III, low instability was observed in area, production and yield of maize. Further, during phase IV, the result indicated medium instability in production and low instability in both yield and area under maize. The study also showed 32 per cent annual growth in production of maize due to 3.62 per cent growth in area and 1.63 per cent growth in yield of maize in NER during the study period (1966-67 to 2019-20).

T-3/P-1

Maize based complementary food (Weaning Food): A review

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Today more than 795 million people suffer from chronic undernourishment. According to the Global Hunger Index 2020, India ranks 101out of 116 countries. The prevalence of malnourished children in India is nearly double than in Sub-Saharan Africa and negatively affects the productivity and economic growth. India continues to face the challenges of poverty, malnutritionand inadequate public healthcare. Micronutrient deficiencies affect large segments of India's population, making efforts to curtail this issue is a major focus. Maize contains adequate quantity of protein, dietary fiber and bioactive compounds (like, carotenoids, tocopherols, polyphenols, antioxidants etc). Maize-based products are an excellent source of micro as well as macronutrients. Also, there have been several studies that have considered the role of low fibre diets in the etiology of childhood constipation especially in infants. Thus, a diet rich in dietary fibre can act as a potential cure to this condition for which maize based weaning product could be helpful. A variety of complementary foods are commercially available with high nutritive value (e.gcerelacetc), which are directly used for instant preparation of gruels. However, in many developing countries, these products are beyond the economic means of most families (cerelac cost 700 to 1000 per week). So, mothers use traditional gruels, as complementary foods for infants. These gruels usually have low energy density and poor protein, vitamin and mineral content. Thus, protein-energy malnutrition is a common problem among infant and children in the poor socio-economic groups of developing countries. The traditional complementary food could be improved by combining locally available foods that complement each other and the combination would be that recommended for infants. So, there is an immediate need to develop affordable and nutritious product utilizing natural products without harmful chemicals. The maize based weaning product thus developed will be valuable to the fast - growing infants who require food of low viscosity and high nutrient density.

T-3/P-2

Enhancement of attributes of maize by germination and fermentation

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Maize (*Zea mays* L.) is third leading global cereal (after rice and wheat) that feed the world. Currently this coarse grain is cultivated in about 10.2 million hectares in India. Maize can provide a more nutritious diet to make sustainable nutrition shifts among the poorest and most malnourished who continue to rely mostly on plant-based diets and thus will pave way of nutritional enhancement of maize (with micro and macro-nutrients) through fortification, by combining maize-products with nutrient-dense crops (e.g., legumes), probiotics, calcium, specific vitamins etc. This key intervention will map the nutritional requirement of specific groups like lactating mothers, infants, mal-nourished children, diabetics, gluten allergic cohorts etc. However, the nutritional quality of maize and the sensorial properties of their products are sometimes inferior as compared to other sources of food which is due to the lower protein content and starch availability, the presence of determined antinutrients (phytic acid, tannins etc.) and the coarse nature of the grains. To ameliorate the nutritional qualities of maize, they are processed in a number of ways to enhance nutritional value as well as the functional characteristics by the processes of germination and fermentation. The protein concentration increases and the amino acid profile is balanced by germination and fermentation. The antinutritional factors are reduced increasing the mineral availability from the cereals. Germination enhances the quality of nutrients and bioactive compounds of cereals thereby increasing the content in proteins, amino acids, sugars, and vitamins. The functional properties of maize are enhanced due to generation of bio-functional substances, increase in protein solubility, in vitro protein digestibility and lowering of glycaemic index.

T-3/P-3

Pulse-maize mix: a viable livelihood venture in himalayan foothills of Kashmir

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Inclusion of legumes in any cropping systems makes thecrop production system, more remunerative, climate-change resilient, due totheir ability to reveal itwell under changing climatic conditions. Thisalso helps in mitigating the impact of climate vulnerability.Moreover, pulses help in enhancing soil and humanhealth whether taken as sole crop or mixed with any crop. In temperate foothills of Kashmir maize since ages has proved to be the optimal companion crop for pulses particularly Rajmash and soybean. More than 80 per cent acreage of maize is under mixed cropping with pole type Rajmash and soybeans. Maize being the third most important agricultural crop of Kashmir is being mostly grown in rainfed karewa lands across whole valley. In most of the farms it is grown with mostly pole type pulses. The combination is inevitable as in foothills maize flour is consumed for roti making and pole type Rajmash ensures protein availability during harsh lean months of long winters. Formal experiments have revealed that intercropping of maize with local bean (Rajmash) in paired row at 60 cm in 1:2 row ratio is biologically and economically sustainable intercropping system for rainfed soils of Kashmir. Treatment comprising of maize + Bean in single row arrangement showed significantly higher grain yield (43.8 q ha-1) compared to other intercrop ratios. The corresponding figures of maize + Bean in single row arrangement for maize equivalent yield (MEY) and land equivalent ratio (LER) reveals significant yield advantage compared to the sole crop planting as well as other treatments. Since last few years the erratic distribution of rains and related weather attributes have challenged maize cultivation in particular but the companion pulses ensures sustainable returns besides mean water usage and ensuring soil fertility levels. This cropping system has flourished under native compulsive adjustments for enabling sustainable livelihood systems of farming masses living in challenging topographies over the generations.

T-3/P-4

An insight on nutritionally superior sweet corn

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Sweet corn has now emerged as a preferred food worldwide, and the demand for it has increased steadily in the last decade. Sweetness in sweet corn is due to recessive gene mutations in genes regulating carbohydrate mechanisms. Sweetness is conferred by *sugary1* (*su1*); *sugary enhanced* (*se*) and *shrunken2* (*sh2*); *brittle2* (*bt2*). The *sh2*-based sweet corn is more popular in South-East Asian countries, while American and European countries prefer *sugary1* (*su1*)-based sweet corn. Among the sweet corn mutants, *sh2* based sweet corn retains the higher sugar and has extended shelf life compared to *su1*-based sweet corn. However, *sh2*-based traditional sweet corn is poor in nutritional quality due to low levels of proA carotenoids as well as lysine and tryptophan.

Recently, several attempts have been made to stack *shrunken2 (sh2)* and *β-carotene hydroxylase (crtRB1)* genes into an elite genetic background. Mehta *et al.*, (2020) reported that there was about 7.7-fold increase in mean provitamin-A in the reconstituted sweet corn hybrids after targeted introgression of *crtRB1* genes into parental lines of ASKH-1 and ASKH-2. Similarly, bio-fortified sweet corn hybrids having high kernel sweetness (Brix 18.96%) and a 4-fold increase in proA were obtained by Baveja *et al.*, (2021) after targeted introgression of *sh2* allele into parental lines of QPM hybrids *viz*., APQH1, APHQ4, APHQ5 and APHQ7.

Unlike field corn varieties, sweet corn does not involve much thermal and photo-degradation of proA in the harvested kernels as the grains are consumed fresh or stored at freezing temperature. Thus, developing nutritionally superior sweet corn hybrids either by direct introgression of *crtRB1* genes into *sh2* based sweet corn background or by converting nutritionally superior maize inbred into sweet corn types by introgressing *sh2* allele could address malnutrition sustainably and cost-effectively.

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T-3/P-5

Comparative evaluation of diverse and contrasting color maize germplasm for their functional food applicability

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The collection of indigenous grown landraces and exotic color maize germplasm from USDA, CIMMYT has been assessed for various functional parameters. These genotypes vary in color i.e. purple, blue and red. These genotypes were grouped according to their colors and preliminary evaluated for color profile and polymeric density. The measurement of Tristimulus patterns (L, a, b) and polymeric color percentage of different color maize samples was also observed. The freshness and lightness of seed was better represented by the lower value of polymeric color density. The anthocyanin in the pericarp part (purple) was more as compared to the aleurone layers (blue) of these genotypes. The antioxidant activity of color maize also has been determined through various methods viz. ORAC and DPPH. The antioxidant capacity of anthocyanin rich extract correlated well with the phenolic profile in these genotypes. The antioxidant activity of purple maize was also more as compared to the blue and red maize germplasm. The phenolic and flavonoid content of maize germplasm also have been evaluated in order to speculate the untapped potential for the pharmaceutical and nutritional/anti-nutritional properties.

T-3/P-6

Analysis of nutritional quality attributes and their inter-relationship in maize inbred lines for sustainable livelihood

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The present investigation was planned to understand the variability and inter-relationship among various nutritional quality attributes of maize kernel to identify potential donors of the respective trait for future hybridization programs. Sixty-three maize inbred lines were processed for the estimation of protein, starch, fat, sugar, 100 kernel weight, specific gravity, and moisture level of the grain. The results revealed a wide variability among protein, starch, 100 kernel weight, specific gravity, and fat were seen with special emphasis on protein concentration that varied from 8.83 to 15.54%, starch (67.43-75.31%), and 100 kernel weight (9.14-36.11gm). Factor analysis revealed that Protein concentration, starch, and 100 kernel weight, the three major components alone, comprises 68.58% of the kernel variability. Protein exhibited a significant negative correlation with starch and 100 kernel weight indicating that an increase in protein concentration will down-regulate the starch and 100 kernel weight. Contrary to this, fat content showed a significant positive relationship with specific gravity indicated that the specific gravity of maize may be increased with an increase in fat content. Genetic distance analysis revealed that DMR WNC NY 397 and DMR WNC NY 404 are the farthest apart inbred lines having major differences in their protein, fat starch, and sugar content followed by DMR WNC NY 2436 and DMR WNC NY 2394. Moreover, study proposes these possible combinations of lines that crosses (in a breeding program) would result in genetic variability with simultaneous high values for respective characteristics.

T-3/P-7

Electrostatic field seed treatment in Maize – A promising tool for seed quality enhancement.

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Due to ageing of seed over the time, seed losses its vigour and viability, which makes it unfit for sowing. Amongst the various seed quality enhancement techniques, with the implementation of cost effective, non-chemical and eco-friendly electrostatic field seed treatment, seems to be encouraging in modern agriculture. The objective of the study is to understand the effect of electrostatic field on physiological and biochemical attributes of seed quality of aged maize seeds. The aged seeds of genotype KDMI-1 were subjected to electrostatic field seed treatments of different intensities and time periods i.e. 3kV cm^{-1} for 60 sec, 3kV cm^{-1} for 90 sec, 4kV cm^{-1} for 60 sec, 4kV cm^{-1} for 90 sec, 5kV cm^{-1} for 60 sec and 5kV cm^{-1} for 90 sec and were compared with untreated control and seeds primed with $CaCl_2$ (2 % for 8 hours).

Treatment	Germination (%)	Root length (cm)	Shoot length (cm)	Seedling vigour index	Seedling dry weight (g)	α-amylase (µmol/ml.)	Superoxide dismutase (Units)
3kV cm^{-1} for 60 sec	91	20.5	18.6	3558.1	0.153	0.0024	1.389
3kV cm^{-1} for 90 sec	93	21.5	20.1	3868.8	0.162	0.0027	1.422
4kV cm^{-1} for 60 sec	92	21.2	19.6	3753.6	0.168	0.0025	1.420
4kV cm^{-1} for 90 sec	90	20.2	18.6	3492	0.157	0.0023	1.345
5kV cm^{-1} for 60 sec	90	19.8	17.7	3375	0.156	0.0022	1.219
5kV cm^{-1} for 90 sec	89	19.1	17.2	3230.7	0.149	0.0021	1.215
Control	81	17.9	16.1	2754	0.133	0.0018	1.172
$CaCl_2$ (2 %)	85	18.8	16	2958	0.146	0.0019	1.196
CD	1.295	0.823	0.492		0.0043	0.00012	0.0339
SE	0.2057	0.0831	0.0297		2.27E-06	2.1E-09	0.000172

Irrespective of the intensity and time periods, all of the treatments showed significant influence on all parameters over the untreated control as well as $CaCl_2$ primed seeds. Exposing the seeds to 3kV cm^{-1} for 90 sec recorded the highest germinability (93 %), seedling vigour index (3868.8) and seedling dry weight (0.162g) supported by highest biochemical traits i.e. α-amylase (0.0027 µ mol/ml) and superoxide dismutase activity (1.422 units), than the control.

T-3/P-8

Molecular breeding to improve nutritional quality of maize

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Maize is a staple food along with rice and wheat and provides food security to millions of people especially in sub-Saharan Africa, Latin America, and the Caribbean. In India, maize comes after rice and wheat in terms of production and area, but has higher productivity per unit area as compared to rice and wheat, so the increased production can help in food security especially in lower income families. Maize is deficient in certain essential amino acids (lysine and tryptophan) vitamins, and minerals, which are essential for proper growth and development. The nutritional quality of maize can be increased using biofortification of quality protein, essential minerals and vitamins and it will help in fight against hidden hunger and malnutrition. A lot work has been done to improve the quality of maize protein using mutants like opaque-2, but less work is focussed on to increase the vitamines and mineral content. Maize display large genetic diversity for all the quality parameters and several mutants are available each of the quality traits. With the advancement in molecular techniques, like QTL mapping, sequencing and use of molecular markers (marker assisted selection) have reduced the time and efforts required for biofortification.

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T-3/P-9

Development of a single row self-propelled maize cob picker cum stalk cutting machine

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Maize is one of the important crops after rice and wheat in India and is widely produced cereal. Maize contributes only 2.4 % of total world production. Maize occupied 9.21 Mha, with a production of 25.82 MT in India. The average yield per hectare during 2018-19 was 2804 kg per hectare. Maize is being utilized in different sectors and activities in India. The demand for maize in the developing world would double and to meet the demand, the production must be increased. The small-scale harvesters which can be affordable by Indian farmers are to be developed to make harvesting operation easier. The proposed machine can accomplish three operations at a time such as cutting the maize stalk, removal of cobs from stalk and collection of removed cobs from plant. The maize plant is cut using the horizontal rotating serrated blade made up of carbon steel with 2.5 mm thickness and 250 mm diameter and the cut plant is conveyed into the snapping rollers with the help of guiding unit. The spiral ribbed rollers are used to remove the cobs from stalk which revolve in inward direction. It will have tapered and spiral ribbed points to facilitate stalk entry and pull the maize stalks downward between the two rolls. The cobs are snapped off from stalk when the cobs contact the closely space rollers and are conveyed into the collection box. A 5 Hp Diesel engine is used to operate the mechanism. The machine can perform stalk cutting and cob picking simultaneously.

T-3/P-10

Meta QTLs Analysis in maıze (*Zea mays* L.) associated with popping traits

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The increased demand for popcorn involves enhancing the popping quality of popcorn cultivars with higher yield. Several Quantitative Traits Loci (QTLs) for popping traits have been identified in this direction. However, precise and consistent QTL identification across different genetic backgrounds and conditions is required to properly use the found QTLs in marker-assisted breeding.

To identify meta QTLs with consistent QTLs, 99 QTLs associated to popping traits reported in 8 independent studies were assembled and projected on the reference map "Genetic 2005" using Bio Mercator v4.2. A total of ten meta QTLs were found on chromosomes 1 (7 meta QTLs) and 6 (3 meta QTLs), with physical distances ranging from 0.43 to 12.75 Mb. The four identified meta QTLs, mQTL1 1, mQTL1 5, mQTL1 7, and mQTL6 2, each had 5–8 QTL clusters with a reasonably high R2 value.

The QTLs that were clustered were from two or more experiments. A total of 229 genes were chosen based on their expression patterns in endosperm and pericarp tissues. Nineteen of these genes are involved in the metabolism of carbohydrates. 11 of the 19 genes directly implicated in glucose metabolism were found in these locations, indicating the significance of these clustered QTLs. MetaQTL11 at bin location 1.01 corresponded to previously published QTLs for a variety of agronomic parameters such as stalk diameter, tassel length, leaf area, and plant height. The identified meta QTLs can be further investigated for fine mapping and candidate gene identification, which can be confirmed by function loss or gain. Identified meta QTLs can be exploited to enhance popping ability by introgression of popping traits.

T-3/P-11

Biochemical and molecular characterization of locally adapted maize inbreds for kernel provitamin-A and α-tocopherol

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Malnutrition afflicts two-billion people worldwide. Deficiency of vitamin-A causes serious vision related problems, while vitamin-E affects neurological and cardio-vascular functions in humans. Maize emerged as one of the important staple crops possesses lower concentration of vitamin-A and vitamin-E. Thus, identification of maize inbreds rich in vitamin-A and vitamin-E assumes great significance in biofortification programme. Here, a panel of 24 diverse maize inbreds were raised at four locations viz., Bajaura, Palampur, Kangra and New Delhi. Three inbreds possessed the favorable allele for *crtRB1* gene, while seven inbreds had the favourable allele of *vte4* gene. Inbreds revealed wide variation for provitamin-A (0.93-9.46 ppm) and α-tocopherol (6.50-17.81 ppm). The mean provitamin-A in the *crtRB1* and *vte4* favourable genotypes were 9.35 ppm and 15.27 ppm compared to 1.43 ppm and 8.63 ppm among the wide type inbreds, respectively. The lines possessing favourable allele for *crtRB1* and *vte4* would serve as the suitable donors in the breeding programme. Molecular characterization of inbreds using 75 SSRs classified the 24 inbreds into three major groups consistent with the pedigree. Based on the genetic distance and higher nutritional values, two cross combinations for higher provitamin-A and three crosses for α-tocopherol were identified for future usage in the hybrid breeding programme. These newly identified maize genotypes with higher accumulation of provitamin-A and vitamin-E would help to alleviate malnutrition through sustainable and cost-effective manner.

T-3/P-12

Protein and NPK content of maize grain as influenced by soil and foliar application of active silica

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Maize is the third most important cereal crop in the world after rice and wheat. In India, maize occupies third place after rice and wheat, contributing 8.46% of total food grain production. Health and food security are critical issues now a days. Chemical fertilization creates the ill effects on soil health and environment. Communicable and non-communicable diseases are speeding now a day's due to low quality food. To mitigate such effects, the adoption of organic farming might be an ecologically viable option. Production of crop without use of any synthetic fertilizers and chemicals are the main theme of organic farming. Organic farming is a production system that sustains the health of soil, ecosystem and people. Active silica which is considered as organic nutrient source aids in sustaining the crop production including enhance quality and resistance biotic and abiotic stress. Considering above facts, the present experiment was therefore, carried out during Kharif season of 2018 and 2019 at Organic Unit of Instructional Farm, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur (Rajasthan) with aims to study the effects of active silica on grain quality and nutrients content of maize. The experiment was laid out in split-plot design with three replications consisting of 36 treatment combinations of six soil applications in main plots (0, 50, 75, 100, 125, and 150 kg/ha) and six foliar applications of active silica in subplots (No spray, water spray, 0.25, 0.50, 0.75 and 1.0%). Results showed that application of 150 kg/ha active silica to soil recorded significantly higher protein content in grain which was at par with 100 and 125 kg/ha. Similar results were also reported for N, P and K content of grains. In case of foliar application, significantly higher protein content was noticed with 1.0% spray of active silica. Though, it remained at par with 0.50 and 0.75% spray. Similarly, N and K content were also recorded higher with 1.0% foliar spray which were at par with 0.50 and 0.75% spray. However, P content in grain was recorded highest in 1.0% active silica spray and it found at par with 0.25, 0.50 and 0.75% spray. Overall, it can be concluded that soil application of 150 kg/ha or/ and 1.0% foliar spray of active silica significantly improves the protein, N, P and K content in grain of maize.

T-3/P-13

Studies on yield traits and β-Carotene content in single cross hybrids of Maize (*Zea mays* L.)

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Maize (*Zea mays* L. 2n=20) is the third most important cereal crop in the world after wheat and rice. Maize belongs to family Poaceae and genus *Zea.* Maize is a carotenogenic plant and a staple food for more than one billion and 200 million consumers in Africa and Latin America regions where more than 50 million people present are vitamin A deficient. About 50 carotenoids have pro-vitamin A activity and the β-carotene has the highest activity and for this reason it has been considered as a compound of interest in breeding programmes. Improving the micronutrient balance of staple crops such as maize through biofortification is therefore an economically and socially sound way to address micronutrient malnutrition, including vitamin A deficiency on a global scale. Breeding to increase β-carotene levels in cereal grains, termed pro-vitamin A biofortification is an economical approach to address dietary vitamin A deficiency in the developing world. Changan *et al.* (2017) analysed a set of 100 inbred lines comprising of 50 normal and 50 quality protein maize (QPM) for β-carotene content. The present study was carried out during *Rabi*, 2016 at Seed Research and Technology Centre, Rajendranagar, Hyderabad and top ten high yielding F_1 hybrids were analysed for β-carotene content according to Zakaria (1979) methodology at Quality Control Laboratory, Rajendranagar, Hyderabad. The hybrid BML 6 x EC 30, reported highest β-carotene content with a concentration of 122.21 µg/g. Whereas, the Line BML 6 showed β-carotene content of 62.26 µg/g and tester EC 30 showed β-carotene content of 25.50 µg/g. These results are comparable with the findings of Snezana *et al.* (2015), Pitambara *et al.* (2016) and Pitambara *et al.* (2017) who reported improvement of β-carotene content in hybrids.Thus the study of the evaluated populations indicated that it is possible to develop high β-carotene hybrids than that of the parents. The crosses, BML 6 x EC 30, CM 211 x EC 30, BML 11 x EC 15, BML 6 x EC 15 and CM 118 x EC 30 can be considered as worthy crosses with good amount of β-carotene content. Hence, these high yielding hybrids with good β-carotene content can be tested under different field trials and can be developed as commercial hybrids.

T-3/P-14

QPM-A man made maize

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Lysine and tryptophan are two essential amino acids and these are deficit in maize grain thus posing the problem of nutritional deficiencies in the consumers. A wide range of deficiency symptoms like cognitive disorder, kwashiorkor disease, reduced appetite, impaired skeleton development, delayed growth and aberrant behaviour are associated with lysine and tryptophan deficiency. These amino acids are also important to cure the Pellagra disease. Researchers identified several mutants in maize especially opaque-2 which are responsible for higher lysine and tryptophan contents. Few years later, it was observed that opaque-2 mutant has several pleiotropic effects on maize grain and plant. Efforts of researchers are spanning over the period of four decades to develop quality protein maize (QPM). QPM is described as nutritionally superior maize with high lysine and tryptophan contents and desired kernel characteristics as compared to its normal maize counterparts. Biological value of QPM was almost equivalent to egg protein. Breeding of maize for quality protein is based on three genetic systems like opaque-2 genetic system, endosperm modifier genetic system and associated gene systems. Keeping in view the importance of QPM, current review article is compiled to discuss the genetic basis, genetic systems and breeding strategies. Timeline for various events is also drafted like discovery of various mutants, several conventional and modern approaches for development and deployment of QPM varieties across the world. Despite its nutritional benefits, the rate of adoption of QPM is generally at low pace in the developing world and this review article discuss the challenges and potential opportunities for QPM adoption.

T-3/P-15

Maize biology

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Maize (*Zea mays* L.) is the world's leading crop that was domesticated in Central America. Globally, maize is known as queen of cereals because of its highest genetic yield potential. Beside this maize have many types like normal yellow/ white grain, sweet corn, baby corn, popcorn, waxy corn, high amylase corn, high oil corn, quality protein maize, etc. Maize belongs to the tribe Maydeae of the grass family *Poaceae*. "*Zea*" was derived from an old Greek name for a food grass. The genus *Zea* consists of four species of which *Zea mays* L. is economically important. The other *Zea sp.*, referred to as teosinte, is largely wild grass native to Mexico and Central America. The number of chromosomes in *Zea mays* is 2 n = 20. Tribe Maydeae comprises seven genera which are recognized, namely Old and New World groups. Old World comprises *Coix* (2n = 10/20), *Chionachne* (2n = 20), *Sclerachne* (2n = 20), *Trilobachne* (2n = 20) and *Polytoca* (2n = 20), and New World group has *Zea* and *Tripsacum*. It is generally agreed that maize phylogeny was largely determined by the American genera *Zea* and *Tripsacum*, however it is accepted that the genus *Coix* contributed to the phylogenetic development of the species *Zea mays*.

T-3/P-16

Maize-Source of Human Nutrition and Health

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Corn, (*Zea mays L*), also called **Indian corn** or **maize**, cereal plant of the grass family (Poaceae) and its edible grain. Maize is an important cereal crop of the world. The domesticated crop originated in the Americas and is one of the most widely distributed of the world's food crops. Corn is used as livestock feed, human food, biofuel, and raw material in the industry. In India maize is the third most important food crop after rice and wheat, according to advance estimates it is cultivated in 8.7 m ha mainly during "Kharif Season" which course 80% of the area, maize in India contributes nearly 9% in the national food basket and more than Rs 100 Billion to the agricultural GDP at current prices apart from the generating employment to over 100 million man-days at the form and downstream agricultural and industrial sectors. A tablespoon of maize oil satisfies the requirements for essential fatty acids for a healthy child or adult. Decoction of maize silk, roots, leaves, and cob are used for bladder problems, nausea, vomiting, and stomach complaints. Maize germ contains about 45–50% of the oil that is used in cooking, salads and is obtained from the wet milling process. The oil contains 14% saturated fatty acids, 30% monounsaturated fatty acids, and 56% polyunsaturated fatty acids. There is a scope of manipulating production technologies in respect of crop diversification, resource conservation, and insect-pest control for improving crop yields on a sustainable basis. To make farming sustainable and economically viable, there is a need for rethinking, planning, and management in order to face the emerging challenges. Research on maize production systems has therefore provided exciting opportunities for improving input use efficiency, productivity, and sustainability. Innovative practices are being attempted to improve productivity, resource-use efficiency, and livelihood security. Maize is a healthy food due to the presence of nutrients and phytochemicals. Based on the health benefits of maize discussed in this article, it can be recommended and made a part of our daily diet.

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Theme-4

Biotic and abiotic stresses in maize under changing climatic scenario

T-4/O-1

Synthesis and validation of IPM strategy in maize for fall army worm management in farmer participatory mode

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Recently invasion of Fall army (FAW), *Spodoptera frugiperda* (J.E. Smith), in maize created havoc among farmers in various maize growing states. Since the pest introduced in the country in 2018 and we had no validated IPM technology to tackle this pest in maize. Therefore, IPM strategy was formulated and validation trial in winter maize was carried out in farmer participatory mode at village Damera in Warangal district of Telangana during 2019-2020. The FAW infestation was recorded 15-22% in IPM field whereas, 33 percent in FP. Natural enemies population were dominant in IPM field (1.28 to 2.0 predators/50 plants)in comparision to FP (<0.30/50 plants). The data on yield and economics indicated that the yield in IPM and FP was not significantly different, as both recorded yield of 28q/Acre. IPM fields recorded Benefit:Cost ratio of 1:2.27 where as in FP the ratio was 1:2.21. From this study it appears that FAW infestation upto 30% do not cause significant crop loss if managed by IPM intervention at early stage and IPM also helped in reducing pesticides application.

T-4/O-2

Artificial Intelligence based identification of important pests of Maize crop and their management

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Maize is one of the most important crops grown in India, having 9.2 m. ha area of cultivation and 27.8 m. MT of production. Maize is not only sumptuous source of nutrients and minerals but also have an important place in the food basket of the consumers. However, its productivity remains very low i.e. almost half of the world. Maize production is severely hampered by several pests (insects and diseases) causing significant yield losses. Many times these pests cause about 30-35 % yield loss to these crops. In the absence of knowledge and expertise, farmers are over-dependent on pesticide dealers for support on pest identification and their management, which results in excessive and injudicious use of pesticides for controlling the pests. The major concern of farmers for decision making in pest management is "pest identification and timely availability of correct pest management information". Timely availability of support for pest identification and their management to the farmers can either result in saving crop worth crores of rupees or in non-application of intervention saving the cost of intervention involved and thus saving the environment. The core of pest management framework is the decision-making process. Decision-making in pest management is a dynamic and complex process (Figure 1) which requires much more knowledge and support than the conventional agriculture. Pest identification and availability of correct management information are the vital aspects of process of decision-making in pest management. Early pest identification is of paramount importance in terms of productivity and reduction of the usage of pesticides. Eye/physical observation methods have been used in recent years, but they are not efficient. Application of Artificial Intelligence (AI) approach such as deep learning can help in automating this repetitive task of inspection. Once pest is identified, farmers have to have the correct information about pest management option that is safer, economical and applicable at field level. Deep learning modeling approach that trains on huge data sets and then learns on its own, can overcome the problem of pest identification faced by the farmers. Application of deep learning model in mobile based Decision Support System (DSS) of pest management can speed up and automate the process of pest identification and timely delivery of correct pest management information to the farmers/stakeholders. Application of AI in agriculture has taken place in the country and world over, but not much has been done in the field of pest management, particularly in maize crop. Therefore, ICAR-NCIPM, New Delhi envisage to develop an AI based mobile app for identification of important pests of Maize crop and their management.

T-4/O-3

Total phenol and tannins contain in selected maize genotypes and resistance to *Sesamia inferens*

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To fulfil the expanding population's food need, cereal production and productivity must be increased in a sustainable manner. Maize is one of major cereal crop having high productivity potential and pink stem borer, *Sesamia inferens* Walker is a major pest of maize causing significant yield loss. Plant phenols constitute one of the most common and widespread group of defensive compounds against herbivores. The *S. inferens* feeding strongly induced defense responses resulted in the accumulation of higher content of phenolic acids in resistant genotypes (Soujanya *et al*., 2021). Tannins have a strong deleterious effect and affect insect growth and decrease the nutritive value of plants to herbivores. Present study was carried out to estimate the phenol and tannins contain in selected maize genotypes *viz.*, CPM 2, CPM 8, CPM 9, CPM 18, CPM 15, CPM 19, CPM 4 and CPM 13 along with resistant (CML 345) and susceptible (Basi Local) checks in control and infested condition to identify the maize genotypes having resistance to *S. inferens.* The insect culture was maintained on maize stalk cuttings at 27 ± 2^0C, 80 ± 5% RH and 12L:12D conditions. The maize seedlings of test genotypes were grown in the plastic pots and 2 third instar larvae of *S. inferens* inoculated in 20 days old plants. Tannins (Amorim *et al.*, 2008) and phenol (Singleton and Rossi, 1965) determined in both infested and healthy plant. RESULTS: it was revealed that the infestation response in maize is characterized by higher tannins and phenols as anti-nutritive and toxic compounds that reduce insect viability in resistance genotype of maize. The tannins content varied from 0.81 to 2.38 mg/g in the *S. inferens* damaged and 0.24 to 1.02 mg/g in healthy seedlings and it was significantly higher in CPM 13, CPM 2, CPM 9, CPM 15, CPM 8, CML 345 than Basi Local under *S. inferens* damaged conditions. The total phenol content varied from 1.72 to 3.49 mg/g in the *S. inferens* damaged and 0.78 to 1.46 mg/g in healthy seedlings. CONCLUSION: Findings suggest that CPM 2, CPM 9, CPM 13, CPM 15 and CML 345 and can be utilised in breeding to develop *S. inferens* resistant varieties of maize.

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T-4/O-4

Screening of maize (*Zea mays* L.) germplasms against turcicum leaf blight disease

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Maize the third most important cereal crops in the world's agricultural economy had highest genetic yield potential and is commonly called as queen of cereals. It is the third most important cereal crop next to rice and wheat in India. It is one of the potential crop of Telangana State. At global level, maize is cultivated over an area of 197.20 million hectares with an annual production of about 1148.49 million tons with an average productivity of 5.8 tons per hectare (Anonymous-A, 2019).In Telangana, it is being cultivated on16.06 lakh acres area with an annual production of 40.78 lakh million tons and productivity of 2,539 kg per acre (Anonymous B, 2019-2020). Among all the foliar diseases which are affecting the maize, Turcicum leaf blight caused by *Exserohilum turcicum* (syn. *Heliminthosporium turcicum* Pass.), is considered a serious disease.Maize grain yield loss varies from 25% to 90 % in different parts of India and world depending upon the severity of turcicum leaf blight epiphytotics (Chenulu and Hora, 1962; Jha,1993; Meghashri *et al*.,2020;Baffour *et al*., 2021). The objective of this study was to assess the maize inbred lines and their hybrids for resistance to turcicum leaf blight disease under field conditions. The diseased leaf samples of affected maize plants showing typical symptoms of turcicum leaf blight having necrotic lesions were collected in paper poly bags from different maize growing areas of research station, Karimnagar district in *rabi*-2019-2020 and *kharif* season-2020. For the identification of source of resistance to turcicum leaf blight disease, a set of three hundred and two maize entries were evaluated in a randomized block design (RBD) along with a check CM-202 at Agricultural Research Station, Karimnagar field conditions using 1 to 9 disease rating scale (Mitiku *et al.*, 2014) . The test genotypes were planted in 2 rows of 3m length each with a plant spacing of 60cm×20 cm. Disease reaction was recorded by using 1 to 9 scale (Mituku *et al.*, 2014 and Indian Institute of Maize Research, Ludhiana (Anonymous A, 2014) and assessed per cent disease index of TLB disease. The genotypes showing disease score /scale from 1.0 to 3.0 were considered as resistant (R), 4-5 as moderately resistant (MR), 6-7 as moderately susceptible (MS) and 8-9 as susceptible (S).

Disease score of maize entries to turcicum leaf blight disease and artificially inoculated under field conditions during *rabi*-2019-2020 and *kharif*-2020 was observed. The performance of three hundred two germplasms along with susceptible check on the basis of disease reaction and 1-9 disease scale was classified into four groups. Out of the two hundred five entries, five lines viz.,IB-140, DHM-121,17X605-1-2,107xBML-7 and 186xBML-32 were identified with disease score1,one hundred and nine lines with a score 2 and sixty one lines with a score 3 .Entries with disease scores 1,2 and 3 were categorized as resistant.Twenty eight with disease score 4 are moderately resistant. CM-202(check) recorded 88.88 per cent disease index and severely affected by turcicum leaf blight and rated as susceptible. Ninety eight genotypes were screened against turcicum leaf blight disease. Out of them, forty one genotypesviz.,70531xCML156, 70530xBML45, 70530x11-2-1, 70425xBML6, 72554x50-2-

1, 72555xBML7, 72343x50-2-1, 2336X11-2-1, 72336XCML156, 72343XBML45, 72603x66-1-1, 72513xCML156, 72343x66-1-1,70531xBML45, 722603xCML-156, 72555x66-1-1, 72336xBML6, 70439xCML156, 70576x50-2-1, 72555x605-1-1, 72555xBML6, 72336x50-2-1, 72374xBML7, 72555xCML156, 72555x33-1-4, 70425xBML45, 72520xCML156, 72504xCML156, 70474x50-2-1, 72568xBML-14, 72686xPFSR3, 72260xCML156, 66-1-1, 524-3-2, 31-2-4, 207-1-3, 244-1-2, 540-2-3, 388-2-1, KML225 and 186-4-3 were identified as disease score 1, fifty lines with a disease score 2 and three lines with a score 3 ,which were categorized as resistant. In CM-202(check), the per cent disease index was 88.88%,which was also severely affected by turcicum leaf blight and rated as susceptible..

In *rabi* 2019-2020,out of two hundred five lines,5 entries viz.,IB-140,DHM-121,17x605-1-2, 107xBML-7 and 186xBML-32 were identified with a disease score 1 and CM -202 (check) recorded disease score 8 and in *Kharif* -2020, out of ninety eight entries, forty one entries were noticed with a disease score 1,remaining were recorded with disease score from 2- 7and one line CM-202 (check) was observed with high diseased score 8, severely affected by turcicum leaf blight disease and rated as susceptible. Breeders use these identified resistant lines in crossing program to develop high yield turcicum leaf blight disease resistant hybrid varieties.

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T-4/O-5

Loss assessment and management of charcoal stalk rot of maize

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Charcoal stalk rot is a post flowering stalk rot disease caused by *Macrophomina phaseolina*. The disease is likely to be severe with climate change effect like drought and high soil temperature. (Khokhar *et al.* 2014). Field trials comprised of yield loss assessment and management of the disease have been carried out. The susceptible hybrid 900 M super was planted in paired row plot technique. The protected treatment comprised of local strain of fungal bio agent, *Trichoderma harzianum* (UASD-1) @ 0.5% as seed treatment, bio-agent fortified FYM (1: 50) furrow placement and spray @ 0.5% and Murate of potash @ 80 kg / ha additional dose at 45 days after sowing. Disease severity was recorded 10 days before maturity using 1-9 scale (Anon, 2016). Field efficacy of bio agent, fungicide and potash in control of charcoal stalk rot disease was carried at with seven treatments. The protected plots scored mean disease rating of 3.42 and in unprotected plots it was 7.66. The mean avoidable yield loss was 21.0 per cent. *Pseudomonas fluorescens* @ 0.5% as seed treatment, bio agent fortified FYM (1:50) and spray @ 0.5% found effective in managing the charcoal stalk rot. This treatment recorded significantly lower disease severity (36.22%) and maximum grain yield (60.25 q/ha). This treatment recorded 47.66% disease control efficacy and resulted in 21.2% increase in grain yield over untreated check. Seed treatment with local strains of fungal bio agent, *Trichoderma harzianum* (UASD-1) @ 0.5%, bio-agent fortified FYM (1: 50) furrow placement and spray @ 0.5% and Murate of potash @ 80 kg / ha additional dose at 45 day after sowing or bacterial bio agent, Pseudomonas *fluorescens* @ 0.5% as seed treatment, bio agent fortified FYM (1: 50) and spray @ 0.5% can be recommended for effective management of charcoal stalk rot.

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T-4/O-6

Confirmation of stable resistance sources to northern corn leaf blight [*Exserohilum turcicum* (pass.) Leonard and Suggs] in Maize

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Maize (*Zea mays* L.) is the third most important cereal crop after rice and wheat. It can be grown under varied agro-climatic conditions as it has wider adaptability. It is globally recognized as the "Queen of cereals" and "Miracle crop" because of its higher genetic yield potential compared to other cereals. It is prone to many diseases caused by fungi, bacteria, viruses and nematodes due to monoculturing and commercial production on a large area. Among them, diseases caused by fungi are more important as they are known to cause extensive damage and seedling blights, stalk rots, downy mildews, ear rots and Northern Corn Leaf Blight are more serious. Among the different management techniques, Host plant resistance is considered as most practical, feasible and economical method of plant disease management. Hence, it is important to carry out screening of parental inbred lines under artificial epiphytotic conditions to identify stable sources of resistance. A total of 33 inbred lines were screened against two virulent isolates of Hassan and Mandya was conducted during *Rabi* 2020-21. These inbred lines were sown in RCBD (Randomized complete block design) in one-row plot of 3m length in three replications. These inbred lines were sown in two sets separately with a distance of 100 m, one set for Mandya isolate and another for Hassan isolate, which was covered with a polythene sheet to avoid the spores from Mandya isolate. These inbred lines were artificially inoculated twice on the 30th and 40th days after sowing through the leaf whorl inoculation technique. Disease severity was recorded by using 1-9 scale given by Chung (2010). Among the 33 inbred lines, 17 inbred lines showed similar reaction to both the Mandya and Hassan isolates out of which eight inbred lines *viz*., CAL-1443, MAI-2, NAH-1137, MAI-214, MAI-264, CML-451, SKV-50 and KUI-1411A were resistant to both the isolates and eight inbred lines *viz*., NAI-117, NAI-175, NAI-204, MAI-3, MAI-13, MAI-191, MAI-218 and MAI-227 were moderately resistant and CM-202(SC) was susceptible to both the isolates. Sixteen inbred lines *viz.*, NAI-137, MAI-277, MAI-726, MAI-759, CML-300, QMSC-36, KUI-1411, NAI-179, MAI-7, MAI-8, MAI-12, MAI-21, MAI-105, NAI-217, MAI-16 and NAI-252 showed differential reaction to Mandya and Hassan isolaes.

T-4/P-1

Monitoring of target site mutations in acetylcholinesterase (ace) and voltage-gated sodium channel (VGSC) genes in *Spodoptera frugiperda* (J.E. Smith) in Indian context

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Maize (Zea mays) is the 3rd most preferred cereal crop in India after wheat and rice. Maize production drastically decreased from 2018 due to the accidentally introduction of fall armyworm *Spodoptera frugiperda* (J.E.smith) in India. The incidence of FAW first time recorded in may month 2018 at Karnataka state (Sharanabasappa, 2018). The present study is carried out for monitoring of target site mutations in acetylcholinesterase (*ace*)) and voltage-gated sodium channel (*vgsc*) genes which are responsible for carbamates, organophosphate and pyrethroid resistance. Samples of FAW were collected from five states i.e Bihar, Punjab, Delhi, Tamil Nadu and Karnataka. DNA of all the test populations were isolated and amplified with gene specific primers. The results of sequenced data revealed that in *ace* two mutations were found that is A201S and F290V, of which A201S was noticed only in heterozygous state in 40% of the samples tested from Karnataka and Punjab. F290V was detected in homozygous resistant state in Tamil Nadu (16.6%) and Punjab (16.6%) populations. Heterozygous form of it in rest of the samples tested. There are no any mutations were found in the *vgsc* segment. This pattern of insecticide mutations and the phylogeny if *ace* target segment suggest the founder population at Karnataka is being evolving into geographically adapted populations. So present study will useful in monitoring of resistance at molecular level.

T-4/P-2

Studies on Common Rust of Maize (*Puccinia sorghi* Schw.) under Temperate Agro-ecologies of Kashmir

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Common rust is one of the most destructive diseases of maize causing significant loss to maize production under temperate agro-climatic conditions of Kashmir. An extensive survey conducted during *Kharif*, 2020-21 in major maize growing areas of Kashmir valley revealed the prevalence of disease in all the surveyed areas with varied levels of incidence and intensity. The fungus inciting the rust disease of maize disease was identified as *Puccinia sorghi* Schw. on the basis of its morphological and pathological characters of the pathogen. Two hundred and twenty early maturing, cold tolerant maize genotypes were screened for resistance against *Puccinia sorghi* under artificially inoculated field conditions during *Kharif* season 2020 and 2021 using 1-9 disease evaluation scale. Differential disease response was observed among the maize inbred lines to *Puccinia sorghi*. There was sufficient disease pressure to differentiate the inbred lines for their disease response to common rust. The genotypes showed varied response from resistant to highly susceptible reaction. 4 inbreds lines (SMI-135, SMI-360, SMI-74, SMI-48) were found highly resistant with disease grade-1, 20 genotypes were categorized as resistant with disease score of 2 and 31 as moderately resistant. The remaining genotypes showed moderately susceptible to susceptible reaction. The resistant genotypes were put forth for breeding programme to develop the rust resistant maize varieties for temperate ecologies of Kashmir.

T-4/P-3

Identification of drought tolerance maize hybrids using selection indices under managed field conditions

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Maize is traditionally a kharif season crop in India and nearly 85% maize grown under rain fed area. Drought is one of the major causes of yield reduction in maize among abiotic stresses and often unpredictable occurrence worldwide. For enhancing productivity under drought prone areas, and mitigating yield loss, the development of drought tolerant maize hybrids are essentially required. Screening under managed drought stress field conditions is an efficient way to identify stress tolerant maize hybrids. One hundred ninety-two experimental maize hybrids with four commercial check hybrids were evaluated under non stress and drought stress environment at Regional Maize and Seed Production Centre (ICAR-IIMR), Begusarai during rabi-2020-21. The drought stress was imposed by withholding irrigation for three weeks starting before flowering and continues to grain filling stage. Fifteen selection indices including mean productivity (MP); geometric mean productivity (GMP); harmonic mean (HM); tolerance index (TOL); stress susceptibility index (SSI); stress tolerance index (STI); yield index (YI); yield stability index (YSI); stress susceptibility percent index(SSPI); drought resistance index (DRI);drought tolerance efficiency (DTE);sensitivity drought index (SDI);relative decrease in yield (RDY)and modified tolerance index under non-stress and stress condition (KiSTI) were calculated using yield in non-stress (Yp) and stress condition (Ys). Indices MP, GMP, HM and STI were positively correlated with grain yield under non-stress and stress environment suggesting more applicability and efficient selection indices for drought tolerance. On the basis of STI, GMP, HM YI and Kist experimental hybrid MIL 2-406-2×MIL 2-3470, MIL 2-1062-1-2× BML 7, BML-6×MIL 2-3470, MIL 2-1510× BML 6, BML-6×MIL 2-406-1 and MIL 2-406-2×MIL 2-2039 were most drought tolerant hybrids and produced good yield under drought stress and non-stress conditions.

T-4/P-4

Solo and Integrated Approacnes ıor Management of Banded Leaf and Sheath Blight (BLSB) of Maize

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Banded leaf and sheath blight (BLSB) is one of the most devastating disease of *kharif* maize and can cause significant economic losses. The magnitude of grain loss may reach to 100 per cent when ear rot phase of disease predominates. Adoption of solo management approach is not effective to manage this disease. Therefore, the experiment on comparison of solo and integrated management practices against BLSB was conducted at CCS HAU Regional Research Station, Karnal which is one of the main hot spot for BLSB. The experiment included nine treatments*viz.*foliar spray of *Allium sativum* (garlic) bulb @ 10%,*Azadirachtaindica* (neem) leaves @ 10% at 35 and 50 days after sowing (DAS), leaf stripping at 35 days after sowing, foliar spray of azoxystrobin 18.2%+ difenoconazole 11.4% w/w SC @ 1ml/L of water at 35 and 50 DAS, leaf stripping + foliar spray of *Allium sativum* (garlic) bulb @ 10% at 50 DAS, Leaf stripping + foliar spray of *Azadirachtaindica* (neem) leaves @ 10% at 50 DAS, leaf stripping + foliar spray of azoxystrobin 18.2%+ difenoconazole 11.4% w/w SC @ 1ml/L of water at 50 DAS along with recommended chemical check Dithane M-45 @ 3g/L water and inoculated untreated check. The plants were inoculated at 30 DAS and conducive environment was maintained for disease development. Among the treatments,leaf stripping + foliar spray of azoxystrobin 18.2%+ difenoconazole 11.4% w/w SC @ 1ml/L of water at 50 DAS resulted in highest 68.5% disease control and 34.9 per cent increase in yield, followed by foliar spray of azoxystrobin 18.2%+ difenoconazole 11.4% w/w SC @ 1ml/L of water at 35 and 50 DAS with 62.8 per cent disease control and 31.2 per cent increase in yield. The results indicated that combination of leaf stripping and fungicide spray can significantly reduce the disease incidence and progress in comparison to other management approaches. An integrated approach exhibited more effective tool to manage banded leaf and sheath blight of maize.

T-4/P-5

Detection of biotic stresses in maize crop under changing climatic scenario using hyperspectral remote sensing

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Varying climatic conditions and different ecological settings in temperate and tropical regions encompass different level of attacks and incidences by the associated pests in maize crop. Timely detection of the pests in this crop with precision using noninvasive ways are essentially required to combat the menace of its pests which otherwise cause a great loss to the produce of the crop. Remote sensing techniques provide the pathways to answer the problem in timely detection and monitoring of pests. Field observations for the Maize crop and the associated candidate pests for measuring biophysical measurements, LAI, recording of severity of the candidate pests based on the specific adopted scale are adopted for analytical task to understand the spread and the associated intensity of the infestation caused by the pests of Maize crop. Chlorophyll measurements with SPAD. Hyperspectral radiometric data collection using Field radio spectrometer having 350nm-2500nm and 350nm-1100nm spectrum. Plant and soil sample collection for biochemical analysis are also the integral components for arriving at the expected scale of severity of incidence and occurrence. Hyperspectral data sets collected are subjected to processing of raw data, perturbation, continuum removed reflectance, specific band depth and observing the reflectance using normalized band depth. Continuum removed spectral signatures are developed using ENVI software for different- segments comprising of visible (blue, green and red), red-edge, NIR, SWIR-1 and SWIR-2 bands. Difference in band depth of healthy and different levels of insect pest/disease infested crop. Difference in normalized band depth of healthy and different levels of insect pest/disease infested maize crop including band significant analysis are found to understand the infestation level with hyperspectral instruments for noninvasive investigation and monitoring using remote sensing techniques.

T-4/P-6

Profiling of core set of Maize (*Zea Mays* L.) Germplasm for Root Traits in Hydroponic system

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Maize (Zea mays L) is one of the most versatile emerging crops having wider adaptability under varied agro-climatic conditions but in contemporary climatic volatility, serious water deficits and deteriorating environmental quality are threatening its sustainability especially in Asia and Africa. In India erratic behaviour of rains during wet season is affecting the rain fed crops and approximately 80% maize areas are rain-fed. The crop faces water stress (WS) from the pre-flowering to late grain-filling stages leading to significant yield losses. Maize is highly sensitive to water stress especially at reproductive phase. Maize is grown in spring and *kharif* seasons in Northern region. In spring, though maize crop exhibits higher grain yields due to long crop duration, less weed pressure and comparatively low biotic and abiotic stresses but is accompanied by higher water requirements as compared to main season (*Kharif*). Therefore it is prompt to increase water productivity by improving biological, economic and environmental output of water used in agricultural systems. Genetic enhancement in maize for water use efficiency (WUE) has emerged as a prime breeding goal. The present proposal is aimed to decipher the variability for WUE in diverse array of indigenous, semi exotic and CIMMYT maize inbred lines, being maintained at Punjab Agricultural University, Ludhiana. The evaluation was conducted (in 2020-21) under controlled conditions using hydroponic system and water stress was created using an osmolyte, (Polyethyleneglycol) PEG. The treatment was given in two concentrations *viz:* 1% and 5% at 21 days interval and grown till the flowering stage. Profiling was done for root and shoot traits. Root architectural analysis was done using root scanner (Biovis). The study led to identification of diverse maize inbreds which were water use efficient *viz*: LM22, LM17, LM26, LM25, LM11, PML 98, PMLf76, LM5, CML539, CML545, PML51 were best in both root and shoot traits with better shoot dry weight, vigour and root architecture (volume, total length, projection area and maximum root length). Therefore after further validation they can serve as potential donors to breed for water use efficiency in maize.

T-4/P-7

Evaluation and identification of sources of resistance against *Turcicum* Leaf Blight of maize under temperate areas of Kashmir valley

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Turcicum Leaf Blight is also known as Northern Corn Leaf blight in maize is caused by fungus Exserohilum turcicum (Pass.). It is economically the most important disease affecting maize in the world and frequently occurs in high altitude ecologies of Kashmir.

A set of 100 germplasm lines of maize belonging to CIMMYT SKUASTK an IIMR Ludhiana were screened under artificial inoculation conditions during Kharif 2018-2019. Test lines were planted in plots of 2 rows of 3 m length and a spacing of 60X 20 cm. Four isolates of mixed inoculation of 20 days old culture of *Exserohilum turcicum* were utilised.

The genotypes viz. VL- 1018641, VL-108665, VL-05614 and Vl-102 showed resistance reaction with disease grade1 against *Exserholium turcicum* whereas remaining genotypes showed moderate resistance to susceptible reaction. The genotypes Pahalgam Local and SMI 154 were found highly susceptible.

To validate the resistance reaction,the genotypes need further evaluation under controlled conditions against all the available isolates of *Exserohilum turcicum*

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T-4/P-8

Impact of straw mulching on leaf physiological response and yield of winter maize (*Zea mays* L.) irrigated under available soil moisture depletion conditions in Mollisols

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Maize is sensitive to soil moisture in arid and semi arid regions especially in winter and spring seasons. In northern India, during winter season maize is grown in the dry month of October and November and crop depends on the irrigation water for survival. Since the response of maize to applied water and physiological characteristics are very important in winter season for better outcomes. Hence, a two year field experiment was conducted during winter season to evaluate the effect of different residue mulch and irrigation on the physiological response and yield of maize. The experiment consisted three levels of irrigation viz., irrigation at available soil moisture depletion percentage of 20 (I_1), 30 (I_2) and 40 (I_3) from field capacity and four levels of straw mulch viz., no mulch (M_0), green gram (M_G), maize (M_M) and lantana (M_L) applied at 5 t ha^{-1} was conducted in split plot design keeping irrigation in main plots and mulch in sub plots. The results revealed that mulch enhanced soil temperature at 15 cm by 0.6-9.8 ^{0}C compared with no mulch. Irrigation applied at 20 per cent depletion raised the soil temperature at 15 cm by 0.3-1.2 ^{0}C. Mulch and increase in irrigation frequency tended to increase in relative water content and transpiration rate while decreased leaf diffusive resistance. There was significant variation in relative water content among irrigation levels at knee high stage but remained on par between I_2 and I_3 at tasseling stage. Green gram mulch maintained significantly higher leaf water status at knee high but was at par with maize and lantana mulch at tasseling. With the advancement of growth to tassel emergence transpiration rate decreased from 0.71-1.09 µg/cm^2/s and leaf diffusive resistance increased 4-6 fold during both years. Irrespective of irrigation applied based on depletion of available soil moisture no noticeable differences in leaf temperature were observed. Green gram straw mulch and irrigation given at 20% depletion produced 2.6-14.2 % and 1.3-9.2% higher grain yield, respectively.

T-4/P-9

Evaluation of indigenous materials against Fall Armyworm, *Spodoptera frugiperda* (J.E. Smith) in Maize

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The present investigation was carried out to evaluate the indigenous materials against fall armyworm, *Spodoptera frugiperda* (J.E. Smith) in maize. The experiment was conducted at Main Maize Research Station, AAU, Godhara, during *kharif* 2019 and 2020 in Randomized Block Design with seven treatments including control and three replications to evaluate indigenous materials on *S. frugiperda* infesting maize. Effect of different indigenous materials was evaluated by recording observations on number of FAW larvae/10 plants, plant damage (%), cob damage (%), grain yield (kg/ha) and dry fodder yield (kg/ha). The significantly lowest (2.09 larvae /10 plants) *S. frugiperda* incidence and highest grain and dry fodder yield was recorded in the treatment of whorl application of soil @ 5 g/ plant and it was found equally effective with whorl application of sand @ 5 g/plant. Among all the indigenous materials evaluated, the whorl application of saw dust @ 4 g/plant recorded the highest FAW incidence and lowest grain and dry fodder yield of maize and proved as most inferior indigenous material in their efficacy. Whorl application of soil @ 5 g/plant or whorl application of sand @ 5 g/plant at 30 and 45 days after sowing was emerged as effective in controlling fall armyworm, *S. frugiperda* infesting maize. The eco-friendly, no cost input indigenous materials that showed high efficacy against FAW can be used as components of Integrated Pest Management (IPM) for FAW management by small and marginal farmers to obtain the rich harvest and to keep the environment safe forever.

T-4/P-10

Effects of seasonal variation on the ovipositional behavior of fall armyworm, *Spodoptera frugiperda* (J. E. Smith) in maize

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Fall armyworm (FAW), *Spodoptera frugiperda* (J. E. Smith) an invasive insect pest was first reported in Africa in 2016 and moved rapidly to many regions including West and sub-Saharan Africa, India, China, Japan, South Korea, Taiwan, and Australia. Climatic conditions in India are highly favorable and its temporal spread has been documented (Rakshit *et al*. 2019). In the absence of any control measures, FAW is predicted to cause 21-53% loss in annual maize production (Day *et al*. 2017). Due its potential damage in maize, it has become imperative to understand the ovipositional behavior of FAW with respect to seasonal variation at different dates of sowing.

To study the effect of seasonal variation on the ovipositional behavior of FAW in relation to different dates of sowing and to find out suitable sowing time to escape its severity of incidence. The present study was conducted to observe the ovipositional behavior of FAW in maize (DHM 117) during 2020-21 by sowing at fortnight intervals from January to December.

The maximum mean number of egg masses were observed in the crop sown during the 3rd standard meteorological week (SMW) (2.57) (Second fortnight of January, 2020) followed by 31st SMW (2.28) (First fortnight of August, 2020); whereas minimum mean number of egg masses were observed in the crop sown during the 24th SMW (0.57) (Second Fortnight of June, 2020) followed by the 22nd SMW (0.71) (First Fortnight of June, 2020) and 44th SMW (0.85) (First fortnight of November, 2020). The ovipositional behavior of FAW showed a positive correlation with maximum temperature (r=0.0276) and bright sunshine (r=0.3687) whereas negative correlation with minimum temperature (r=-0.3187), rainfall (r=-0.0472), rainy days (r=-0.0956), morning (r=-0.1895) and evening (r=-0.3395) relative humidity and wind speed (r=-0.3480).

It is concluded that ovipositional behavior of FAW is very much dependent on seasonal variations of the cropping season. Early planting of maize in the month of June (*kharif*) and first fortnight of November (*rabi*) could escape the peak incidence of FAW.

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T-4/P-11

Physiological changes upon hydropriming in maize hybrids

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Germination and seedling establishment are critical stages in the plant life cycle. The three early phases of germination are: (i) imbibition, (ii) lag phase and (iii) protrusion of the radicle through the testa. While seed germination is impaired by certain conditions (soil contamination, extreme temperatures, pathogens), several types of simple procedures known as priming can be used to enhance it. Seed priming is defined as the process of regulating seed germination by managing parameters like temperature or seed moisture content during the initial stages of germination. A study was undertaken in the laboratory of National Seed Project Shalimar and in the laboratory of Department of Genetics and Plant Breeding, Faculty of Agriculture, Wadura during 2019-2021. The objective of the present study was to standardize the hydro-priming technique in two maize hybrids SMH-3 and SMH-5 and to know the physiological changes associated with the priming in maize seeds. Different combinations of temperature and duration of soaking were tested and the most efficient priming temperature was 25±1°C and the ideal duration of soaking was 24 h. All the physiological attributes like first count, final count of germination, T_{50}, BRI, MSL, MSDW, SVI-I, SVI-II were significantly higher in both hybrids and their parental lines than the non-primed maize seeds.

T-4/P-12

Comparative study of three different isolates of *Rhizoctonia solani* collected from banded leaf and sheath blight disease of maize

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The present study was carried out in Maize (*Zea mays* L.). It is the most important cereal crops in the world agricultural economy with high yield potential. The disease banded leaf and sheath blight of maize caused by *Rhizoctonia solani* f.sp. *sasakii* is considered as the main limiting factor for reduced production. Keeping in view the economic importance and regular occurrence of BLSB disease in West Bengal in severe form, the present studies were carried out in the laboratory of AICRP on Maize, Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia, West Bengal. The characteristic symptoms of disease appear on leaves and sheaths on 40-45 days old plants. Symptoms on leaf sheath were water-soaked, round in shape and straw coloured whereas on leaves irregular, water soaked, round to stretched lesions were observed. In case of severe infection, sclerotia were found on the leaf sheaths and tassel. In these investigations, the causal fungus of BLSB – *Rhizoctonia solani* was collected from three different locations, symptomatology of three isolates of the pathogen was studied, growth of the fungus on different types of media was observed under *in-vitro* condition and attempt has been made for management of disease through plant extracts & screening of different varieties against the disease. It was observed that the growth of pathogen was white to creamy whitish on PDA after 24 hours of inoculation. The sclerotia were round, semi spherical to irregular in shape and were scattered in the Petri plates in case of Singha isolates and in ring form in Gayeshpur isolate. Among six solid media ½ PDA medium is showed best for the growth of all three isolates of *Rhizoctonia solani.* To evaluate the efficacy of plant extract five plant extracts were taken. Among them in Isolate I showed 46.52% growth inhibition and Isolate II 55.97 % growth inhibition in Basak applied media. In Isolate III lowest mycelial growth (2.63cm) was obtained in Neem applied media. Experiment showed that only ADV 9293 showed MR reaction among 12 hybrids of Maize.

T-4/P-13

Genome-wide association mapping for turcicum leaf blight resistance in tropical maize

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Turcicum leaf blight (TLB) also called as northern corn leaf blight (NCLB) caused by the *Setosphaeria turcica* is an important disease of maize. It is prevalent in almost all maize growing areas where there is high humidity coupled with moderate temperatures (17–28 ^{0}C). Yield losses due to TLB can be large, but vary depending upon environmental conditions and geographic location. The losses due to this are found to be directly proportional to disease intensity. However, yield losses under experimental conditions of artificially created disease epiphytotics were estimated to the extent of 66% in susceptible variety Basi and 56.0% in CM 202. Considering it, the association mapping panel of 350 diverse lines was constituted and phenotyped for TLB disease under artificial inoculated conditions at hot-spots sites *viz.*, Bajaura, Srinagar, Dharwad and Mandaya during 2018-2020. The disease reaction on each genotype was recorded after grain filling stage using 1.0-9.0 disease scale which was used to calculate the percent disease incidence for genome wide association studies. The IML12-10, IML15-65, IML319, UMI1200, DML170, CML413 and CML540W were found as sources of resistant to moderately resistant (with disease score ≤ 5.0) across the locations. The panel was genotyped by 60277 polymorphic SNPs using genotyping-by-sequencing (GBS) technique. The mean values of pair wise LD (r^2) throughout the genome decreases rapidly with increasing of physical distance. The significant declining in mean LD values across the genome has been observed at physical distance interval of 10.0 -100.0 kb. There were six-subpopulations observed in the structure study of the panel. Genome wide association studies were performed using both general linear model (GLM) and mixed linear model (MLM). Total 22 Significant SNPs were found associated with TLB resistance using GLM as well as MLM. Of total 22 SNPs, 8 were found on Chromosome (Chr.). 4, 5 on Chr. 8, 3 on Chr. 5, 2 each on Chr. 2 & 7 and one each on Chr 3 & 6.There were no SNPs found associated on Chr. 9 & 10. Identified SNPs can be considered for further studies and utilization in TLB resistance breeding programme.

T-4/P-14

Character association and path analysis of grain yield and its attributes in maize under heat stress

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Maize (Zea mays L.) is one of the most diversified and versatile crops grown worldwide under varied agro-climatic condition. However, a significant amount of reduction in grain yield has been reported because of heat stress. Being a complicated character that depends on multiple component traits, direct selection is in effective for grain yield. Considering these aspects, a study was conducted to determine the magnitude and extent of trait interdependency among yield and yield attributing characters under heat stress condition using forty-five maize hybrids. The hybrids were evaluated by following randomized block design with two replications at EB-II section of the Department of Plant Breeding and Genetics, College of Agriculture, OUAT, Bhubaneswar during Summer 2018. Association studies revealed that, six characters *viz.*, plant height, ear height, cob diameter, number of grain rows per cob, number of grains per row and 100 seed weight exhibited significantly positive correlation at both genotypic and phenotypic level, while anthesis to silking interval was the only trait that attained negative significant correlation at genotypic level with grain yield per plant. Path analysis indicated that plant height, ear height, number of rows per cob and 100 grain weight have positive direct effect while, anthesis to silking interval has negative direct effect on grain yield per plant. Hence, these traits in desirable direction could be relied upon for selection of genotypes in order to improve genetic yield potential of maize under heat stress condition.

T-4/P-15

Field efficacy of fungicides against *Drechslera maydis* causing maydis leaf blight of maize (*Zea mays* L.)

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Maydis leaf blight (MLB), caused by *Drechslera maydis*, is a disease that significantly affects maize productivity and also deteriorates the value and quality of the grains across the globe. This disease has strong influence on early hybrids, speciality corn (sweet corn, baby corn, pop corn and QPM) and the losses vary with the genotype and environment conditions. Warm and wet temperate and tropical areas are more conducive for this disease. It may cause up to 40 percent grain yield loss under favourable conditions. Symptoms and severity of MLB depends on the pathogen race and host germplasm. The present study was undertaken to work out the efficacy of seven different fungicides for the management of MLB under artificial epiphytotic conditions in the field for two *Kharif* seasons. Whorl inoculations were done with the inoculum prepared on sorghum seed. Standard disease rating scale (1-9) was followed for recording the severity of maydis leaf blight after 30 and 45 days of inoculations. Among all the fungicides, Opera BASF (Pyraclostrobin 133g/lt+epoxyconazole 50g/lt) @0.15 % closely followed by Amistar Xtra 280 SC (azoxystrobin 18,2%+Cyproconazole 7.3%SC) @0.2 % sprayed at 3 days and 18 days after inoculation were found highly effective giving 58.30 and 55.76 percent mean disease control respectively. Mancozeb 75WP served as a protected check. In the plots sprayed with Opera BASF (Pyraclostrobin 133g/lt+epoxyconazole 50g/lt) and Amistar Xtra 280 SC (azoxystrobin 18,2%+Cyproconazole 7.3%SC), the grain yields were recorded to be at par which was significantly more than control and protected check. The identified sources of management can be used further in strengthening the plant protection in maize against Maydis leaf blight.

T-4/P-16

Elucidating the initial vigor under drought in Maize genotypes with Polyethylene glycol (PEG, 6000)

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Owing to the unprecedented climate changes, the crop growth and establishment has been facing numerous sterns. Maize being a C_4 crop has been endowed to cope up with water stress and yet the crop has to be explored for initial vigor germination under drought (Alvarez-Iglesias *et al*., 2017). This study was carried out with eighteen genotypes of maize with two replications and four treatments of PEG (0, -1, -2 and -4 bars). All the genotypes recorded a significant change in its germination under four treatments (0, -1, -2 and -4 bars) and the sensitive lines namely, UMI 1201 and UMI 1223 had the maximum reductions in its germination percentage at -4 bars. The lines S8-1-48-6208-7-3-1 and VIM 213 had a higher seedling vigor index at -4 bars. Hence, these two lines could be forwarded for field testing under rainfed conditions (Majid *et al*., 2011). It was also observed that the drastic reductions in seed germination were found to be in effect from -2 bars to -4 bars in all the lines. Thereby, it could be understood that a water potential greater than -2 bars is found to alter the plant establishment in maize (Mohammedkhani and Heideri, 2008). Few accessions managed to absorb optimum water under stress and among all the inbreds, VIM 455 had the highest root length at -4 bars (Zahra *et al*.,2012). This line could be further studied for its higher root penetration under advanced phenomics approaches and these findings could further accelerate the breeding activities for arid regions.

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T-4/P-17

Investigations on the incidence of bacterial stalk rot *(Erwinia chrysanthemi* pv zeae) of maize in Telangana state during *kharif* – 2020

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Maize (*Zea mays* L.) is one of the important cereal crops of the world and world's third leading cereal crop, after wheat and rice. Maize is affected by various biotic and abiotic stresses. Among the different diseases bacterial stalk rot of corn is one of the important diseases coausing considerable yield losses in maize. Due to climatic changes disease prevelnce is changing from year to year and occossionally if weather favours causing crop losses at significant level. An intensive roving survey was carried in order to study the incidence of bacterial stalk rots in major maize growing districts of Telangana state, *viz.* Karimnagar, Khammam, Nizamabad and Rangareddy during *Kharif 2020*. At each location, the disease incidence recorded by counting the number of wilted plants/plants showing typical disease symptoms out of total number of plants in a 4 X 4m area at all the four corners as well as centre of the field. Per cent disease incidence was calculated by using the formula

$$\text{Per cent disease incidence} = \frac{\text{Number of plants affected}}{\text{Total number of plants observed}} \times 100$$

Maize plants showing typical symptoms like tan or browncoloured lesions on stalk, intermodal decay, foul odour and complete drying and lodging at 2nd or 3rd internode were collected from different locations and isolated the bacterial pathogen on nutrient agar media. The survey results reveal that incidence of bacterial stalk rot in different areas surveyed was ranged from 5.0 to 30.8 per cent. The maximum wilt incidence of 30.8 per cent was recorded inNizamabad followed Khammam ditrict with incidence of 25.4 per cent. Jatoth *et al* (2022) also reported the distribution of bacterial stalk disease of maize from 13.3 to 37.93 during their survey from 2019 to 2021 in India. Further it was noticed that the main reason for high disease incidence is heavy rains for long periods during August and September months coincided with vegetative growth of the crop (45 to 50 DAS) during the year 2020. Timely identification of disease incidence and proper control measures are essential to prevent the crop losses in maize.

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T-4/P-18

Compatibility of new generation insecticides and fungicides against major pests and diseases of Maize

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Maize (*Zea mays* L.) is one of the most important crop in tropical countries. Maize is cultivated throughout the world and the area is increasing year by year. India produces 28 metric tonnes of maize per year and stands seventh in position in maize production and maize is the second major cultivated crop in the state of Telangana in 14 lakh acres producing annually 16 lakh tonnes. From 2018 onwards Fall army worm, *Spodoptera frugiperda* (Smith, 1797) is considered as the key pest in the maize growing tracts of Telangana recording severe yield losses and leaf spots also causes considerable yield losses in maize. As insect pests and diseases occur simultaneously in a crop season demand for combination spray of insecticides and fungicides is ever increasing to reduce the labour cost. Improper use of pesticides in combinations without proper knowledge may reduce the efficacy of the combinations in managing the pests and diseases (Kubendran *et al.,* 2009). Laboratory experiment (Physical, Chemical compatibility) was conducted at Department of Entomology, field experiment (Phytotoxicity, Efficacy of pesticide combinations) was conducted at College Farm, College of Agriculture, PJTSAU, Rajendranagar during *rabi* 2020-2021. The physical compatibility of insecticides *viz*., (lambda cyhalothrin 4.6% + chlorantraniliprole 9.3% ZC), chlorantraniliprole 18.5% SC, flubendiamide 39.35% SC, azadirachtin 1500 ppm and fungicides (azoxystrobin 18.2% + difenoconazole 11.4% SC), (carbendazim 12% + mancozeb 63% WP) was evaluated by using jar compatibility test. Chemical compatibility of spray solutions of insecticides and fungicides alone and in combination was tested by pH analysis. Phytotoxicity of insecticides and fungicides alone and in combination was evaluated in field by spraying the pesticidal solution on ten selected plants in each treatment. Observations of phytotoxicity symptoms like chlorotic leaf margins and laminas, reddish or purplish veins, wrinkled leaves, stunted growth, death of leaf tissue(necrosis), wilting, whiplashing were recorded 1 day before spraying and also on 3rd, 7th, 14th day after spraying. The extent of phytotoxicity was recorded based on the scale described by Central Insecticide Board and Registration Committee (C.I.B and R.C). The per cent injury will be calculated by using the formula (Pullam Raju, 2018).

$$\text{Per cent injury} = \frac{\text{Total grade points}}{\text{Maximum grade x number of leaves observed}} \text{x } 100$$

A total of eight combinations of insecticides and fungicides were examined for foaming and sedimentation.

Physical compatibility of insecticides and fungicides

S. No	Pesticide Combination	Sedimentation ml l^{-1}	Foaming ml l^{-1}

1	(Lambda cyhalothrin 4.6% + Chlorantraniliprole 9.3% ZC) + (Azoxystrobin 18.2% + Difenoconazole 11.4% SC)	**0**	**0**
2	Chlorantraniliprole 18.5% SC + (Azoxystrobin 18.2% + Difenoconazole 11.4% SC)	**0**	**0**
3	Flubendiamide 39.35% SC + (Azoxystrobin 18.2% + Difenoconazole 11.4% SC)	**0**	**0**
4	Azadirachtin 1500 ppm + (Azoxystrobin 18.2% + Difenoconazole 11.4% SC)	**0**	**0**
5	(Lambda cyhalothrin 4.6%+ Chlorantraniliprole 9.3% ZC) + (Carbendazim 12% + Mancozeb 63% WP)	**15**	**0**
6	Chlorantraniliprole 18.5% SC + (Carbendazim 12% + Mancozeb 63% WP)	**0**	**0**
7	Flubendiamide 39.35% SC + (Carbendazim 12% + Mancozeb 63% WP)	**5**	**0**
8	Azadirachtin 1500 ppm + (Carbendazim 12% + Mancozeb 63% WP)	**0**	**0**

Therefore, it is evident that all the combinations of insecticides and fungicides are physically compatible and are readily used for spraying.

The pH of test pesticides alone and in combinations was tested by using digital pH meter. The pH of all the test solutions was in the range of 5.47 to 6.78.

pH of insecticides, fungicides alone and in combination

S. No	Pesticide	pH	Nature
1	Lambda cyhalothrin 4.6% + Chlorantraniliprole 9.3% ZC	6.4	Slightly acidic
2	Chlorantraniliprole 18.5% SC	6.18	Slightly acidic
3	Flubendiamide 39.35% SC	6.17	Slightly acidic
4	Azadirachtin 1500 ppm	6.06	Slightly acidic
5	Azoxystrobin 18.2% + Difenoconazole 11.4% SC	6.06	Slightly acidic
6	Carbendazim 12% + Mancozeb 63% WP	5.59	Strongly acidic
7	(Lambda cyhalothrin 4.6% + Chlorantraniliprole 9.3% ZC) + (Azoxystrobin 18.2% + Difenoconazole 11.4% SC)	6.50	Slightly acidic
8	Chlorantraniliprole 18.5% SC + (Azoxystrobin 18.2% + Difenoconazole 11.4% SC)	6.78	Neutral
9	Flubendiamide 39.35% SC + (Azoxystrobin 18.2% + Difenoconazole 11.4% SC)	6.54	Slightly acidic
10	Azadirachtin 1500 ppm + (Azoxystrobin 18.2% + Difenoconazole 11.4% SC)	6.77	Neutral
11	Lambda cyhalothrin 4.6%+ Chlorantraniliprole 9.3% ZC + Carbendazim 12% + Mancozeb 63% WP	5.47	Strongly acidic
12	Chlorantraniliprole 18.5% SC + (Carbendazim 12% + Mancozeb 63% WP)	5.78	Moderately acidic
13	Flubendiamide 39.35% SC + (Carbendazim 12% + Mancozeb 63% WP)	6.14	Slightly acidic
14	Azadirachtin 1500 ppm + (Carbendazim 12% + Mancozeb 63% WP)	6.21	Slightly acidic

Phytotoxicity symptoms were observed only at 3 days after 1st spraying. The per cent injury calculated was below 1.0 per cent at 3 DAS which reveals that the combinations did not

produced phytotoxicity symptoms based on the phytotoxicity visual rating scale. Therefore, from the above results it is evident that all the combinations are compatible at their recommended doses.

Phytotoxic effects of pesticide combinations on maize plants at 3 DAS after 1st spraying

S.No.	Pesticide combination	C	R	WL	S	N	W	WP
1	(Lambda cyhalothrin 4.6% + Chlorantraniliprole 9.3% ZC) + (Azoxystrobin 18.2% + Difenoconazole 11.4% SC)	0	0	0	0	0	0	0
2	Chlorantraniliprole 18.5% SC + (Azoxystrobin 18.2% + Difenoconazole 11.4% SC)	0	0	0	0	0	0	0
3	Flubendiamide 39.35% SC + (Azoxystrobin 18.2% + Difenoconazole 11.4% SC)	0	0	0	0	0.23	0	0
4	Azadirachtin 1500 ppm + (Azoxystrobin 18.2% + Difenoconazole 11.4% SC)	0	0	0	0	0	0	0
5	(Lambda cyhalothrin 4.6%+ Chlorantraniliprole 9.3% ZC) + (Carbendazim 12% + Mancozeb 63% WP)	0	0	0	0	0.10	0	0
6	Chlorantraniliprole 18.5% SC + (Carbendazim 12% + Mancozeb 63% WP)	0	0	0	0	0	0	0
7	Flubendiamide 39.35% SC + (Carbendazim 12% + Mancozeb 63% WP)	0	0	0	0	0.35	0	0
8	Azadirachtin 1500 ppm + (Carbendazim 12% + Mancozeb 63% WP)	0	0	0	0	0	0	0

Conclusion:

At 60 minutes after the jar test out of 8 combinations (lambda cyhalothrin 4.6%+ chlorantraniliprole 9.3% ZC) + (carbendazim 12% + mancozeb 63% WP), flubendiamide 39.35% SC + (carbendazim 12% + mancozeb 63% WP) registered 15 ml l^{-1} and 5 ml l^{-1} respectively which was less than the limits of 2ml/ 100 ml as specified by ISI. Hence, all the combinations were treated as physically compatible. Out of all the pesticidal solutions (carbendazim 12% + mancozeb 63% WP), (lambda cyhalothrin 4.6%+ chlorantraniliprole 9.3% ZC) + (carbendazim 12% + mancozeb 63% WP) were strongly acidic and remaining are near to neutral. The per cent injury calculated was below 1.0 percent which shows that the combinations did not produced any phytotoxicity symptoms on the basis of phytotoxicity scale revealing that all the combinations are biologically compatible.

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T-4/P-19

Confirmation of stable resistance sources to Northern corn leaf blight [*Exserohilum turcicum* (pass.) Leonard and Suggs] in maize

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Maize (*Zea mays* L.) is the third most important cereal crop after rice and wheat. It can be grown under varied agro-climatic conditions as it has wider adaptability. It is globally recognized as the "Queen of cereals" and "Miracle crop" because of its higher genetic yield potential compared to other cereals. It is prone to many diseases caused by fungi, bacteria, viruses and nematodes due to monoculturing and commercial production on a large area. Among them, diseases caused by fungi are more important as they are known to cause extensive damage and seedling blights, stalk rots, downy mildews, ear rots and Northern Corn Leaf Blight are more serious. Among the different management techniques, Host plant resistance is considered as most practical, feasible and economical method of plant disease management. Hence, it is important to carry out screening of parental inbred lines under artificial epiphytotic conditions to identify stable sources of resistance. A total of 33 inbred lines were screened against two virulent isolates of Hassan and Mandya was conducted during *Rabi* 2020-21. These inbred lines were sown in RCBD (Randomized complete block design) in one-row plot of 3m length in three replications. These inbred lines were sown in two sets separately with a distance of 100 m, one set for Mandya isolate and another for Hassan isolate, which was covered with a polythene sheet to avoid the spores from Mandya isolate. These inbred lines were artificially inoculated twice on the 30th and 40th days after sowing through the leaf whorl inoculation technique. Disease severity was recorded by using 1-9 scale given by Chung (2010). Among the 33 inbred lines, 17 inbred lines showed similar reaction to both the Mandya and Hassan isolates out of which eight inbred lines *viz*., CAL-1443, MAI-2, NAH-1137, MAI-214, MAI-264, CML-451, SKV-50 and KUI-1411A were resistant to both the isolates and eight inbred lines *viz*., NAI-117, NAI-175, NAI-204, MAI-3, MAI-13, MAI-191, MAI-218 and MAI-227 were moderately resistant and CM-202(SC) was susceptible to both the isolates. Sixteen inbred lines *viz.*, NAI-137, MAI-277, MAI-726, MAI-759, CML-300, QMSC-36, KUI-1411, NAI-179, MAI-7, MAI-8, MAI-12, MAI-21, MAI-105, NAI-217, MAI-16 and NAI-252 showed differential reaction to Mandya and Hassan isolaes.

T-4/P-20

Evaluation of maize hybrids for yield and yield attributes under rainfed conditions

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Drought is one of the major abiotic stress factors that severely limit grain yield production, often causing extreme economic crop losses. Maize (*Zea mays* L.) is an enviable prime crop in global agriculture and ranks third next to wheat and rice in terms of production. Maize is particularly sensitive to water stress during the period of one week before flowering and two weeks after flowering causing severe losses when exposed to drought conditions during flowering due to increased anthesis silking interval. As such, improving drought tolerance in maize has become one of the top priorities in maize breeding programs. Hybridization of elite inbred lines and evaluation of new single cross hybrids to mid season drought conditions has been the primary objective. Pertaining to this context, the present study was conceptualized to identify potential drought tolerant hybrids under rainfed conditions at Agricultural Research Station, Karimnagar during *kharif* 2020. During *kharif* 2021 season, 54 Entries + 6 checks in two sets were evaluated in 2 replications in Randomized Block Design at 60 x 20 cm spacing in two rows of 3 m length. Data pertaining to Plant stand (Initial and final), Plant height (cm), Ear height (cm), Total no. of ears harvested per plot, Total grain yield per plot (g), Ear length (cm), Ear diameter (cm), No. of kernel rows/ear, No. of kernels / row, Grain yield (kg/ha), Shelling (%), Test weight (g) were recorded. In set I, 54 entries were evaluated against 6 checks and the hybrids KNMH-420543 (6681kg/ha), KNMH-420565 (5493 kg/ha), KNMH-420556 (5393 kg/ha), have out-yielded the best check DHM-121 (5268 kg/ha). In set II, 54 entries were evaluated against 6 checks and the hybrids KNMH-420610 (5230 kg/ha), KNMH-420575 (4627 kg/ha), KNMH 420594 (4566 kg/ha), have out-yielded the best check Karimnagar Makka-1 (4120 kg/ha). Drought tolerant inbred lines of the promising hybrids identified in this study could be utilized for future breeding programme for the development of climate resilient maize hybrids. These lines can be utilized as a future perspective in the development of maize hybrids to tolerate the extremes of climate change which is posing a serious effect on the growth and development of the crop.

T-4/P-21

Agro - ecological options for fall armyworm management

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Current maize productivity is below its potential, although still higher than that of other major cereal crops which is attributed to a combination of several production constraints mainly lack of improved production technologies such as pest management practices, moisture stress, low fertility and poor cultural practices (Tufa & Ketema, 2016). Arthropod pests are among the key factors contributing to low yields facing maize production today. In corn, they defoliate and kill young plants, result in huge loss of yield, and feeding of ears may cause depletion in grain quality and yield (Capinera et al., 2017). Hence, this experiment has planned to study the effect different cropping system on FAW management. This experiment was conducted at Agricultural Research Station, Karimnagar during *Kharif*, 2020-21 in red sandy loam soils. The initial soil status indicated of medium available N, P, K. This experiment was carried out in two sub experiments. Experiment I: Intercropping based strategies Factorial RBD Design has been conducted in 3 Replications during *Kharif* with Treatments: Factor A: Row arrangement *i.e* Regular (1:1) Paired (2:2) Factor B: Intercrop *i.e.* Maize + Mungbean, Maize + Cowpea, Maize + Groundnut, Maize + Soybean, Sole maize. Experiment II: includes Push-pull strategy for FAW management in RCBD in 4 replications during *Kharif* with treatments 1. Maize + Tephrosia, 2. Maize + Fenugreek, 3. Maize + Coriander, 4. Maize + Marigold (*A border row of hybrid napier to be planted for pulling FAW). Data has been collected on % plant infestation of FAW at 10 days interval starting from date of first infestation till harvest on maize. Severity of infestation recorded based on Davis Scale starting from date of first infestation till harvest, Grain yield (kg/ha) and yield attributes are also recorded.

Intercropping based strategies: Among the row arrangement, significantly highest maize grain yield was observed with regular row arrangement. But among the intercropping systems significantly highest maize grain yield was recorded with maize + greangram and sole maize system. In-terms of FAW infestation and severity there was no difference was observed among the row arrangement. But significantly lesser FAW infestation and severity observed from 50 DAS to harvest with maize + greengram intercropping and it is on par with maize + cowpea intercropping.

Push-pull strategy for FAW management: Among the treatments there was no significant difference was observed in-terms of maize grain yield and recorded lesser grain yield when compared to normal grain yield. High FAW infestation and severity was observed in all the treatments.

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T-4/P-22

Efficacy of biological agents and botanicals against *Exseorhilum turcicum* causing Turcicum leaf blight in Maize

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Maize is an important cereal crop after rice and wheat and it is grown in a wide range of environments, extending from extreme semi-arid to sub-humid and humid regions. Among the foliar diseases affecting maize, the Turcicum leaf blight (TLB) also called Northern corn leaf blight caused by *Exserohilum turcicum* (Pass.) Leonard and Suggs. (syn. *Heliminthosporium turcicum* Pass.) is of worldwide importance which causes losses upto 25-90 per cent. Use of fungicides for the control of plant diseases is a common practice. As *Exserohilum turcicum* is an air borne pathogen and developed resistant to many of the fungicides and also having residue effects. In present studies, the biological agents and botanicals were used to study their efficacy against TLB under *in vitro* conditions at AICRP on Maize, MPKV, Rahuri. The results revealed that *Trichoderma harzianum* was most effective antagonist exhibiting 77.07 per cent mycelial inhibition of fungus followed by *Trichoderma hamatum* (73.51 %). Among eight treatments of botanicals maximum mycelial growth inhibition (56.92 %) was in *Parthenium hysterophorus* extract with least colony diameter of 38.77 mm and this treatment was followed by *Allium cepa*, *Azadiracta indica* and *Senna auriculata* extracts with 55.11, 51.85 and 49.22 per cent inhibition of mycelial growth respectively. Thus it was concluded that, biological and botanicals measures may be exploited for eco-friendly management of TLB.

T-4/P-23

Habitat management for control of Maize Fall Army Worm in Telangana State

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Maize is a preferred host of fall armyworm (FAW), *Spodoptera frugiperda*, an invasive pest which is highly migratory and economically destructive and its sudden outbreak is threatening maize production across the country during *Kharif*, 2018. In Telangana it was reported in 17 out of 31 districts with a crop damage of 17,400 ha during *Kharif* and 21,718 ha during *Rabi*, 2018-2019 respectively,(Source: State Dept. of Agriculture).

FAW incidence is influenced by habitat management with culturally appropriate low-cost pest control strategies that can be readily integrated into existing efforts to improve smallholder incomes and resilience through sustainable intensification (Prasanna BM *et al.*, 2018). Among them, planting leguminous inter-crops or cover crops improves soil fertility management through nitrogen fixation, diversifies the field environment for beneficial insects, including insect predators and parasitoidswith considerable system yield advantage and income. Hence a two year field study has under taken during rainy season of 2020 and 2021respectively.

1. Comparative study of different leguminous inter crops for control of FAW in maize
2. Evaluation of yield advantage and income of the maize based intercropping system

A field trial was conducted at Maize Research Centre, Agricultural Research Institute, Rajendranagar, Hyderabad during rainy season of2020 and 2021in sandy clay loam soil with low available N, medium available P, K. This experiment was carried out in Factorial RBD design with two row arrangements (Regular 1:1 and paired 2:2) and four legume intercrops (Soybean, Groundnut, Greengram and Cowpea) in comparison with sole maize as factor I and II respectively and replicated thrice. The sole maize and intercrops were raised as per the recommended package. The data on percent plant infestation of FAW at 10 days interval starting from date of first infestation to till harvest on maize and intercrops and severity of infestation based on Davis scale starting from date of first infestation till harvest has been recorded along with the yield advantage with maize based intercropping system. Use of chemical pesticides could undermine pest control through natural enemies and hence, agro-ecological approaches should therefore be promoted as integrated pest management (RehettD.Harrison *et al*.,2019).

The research interventions revealed that the two row ratios (1:1 and 2:2) did not show significant impact on maize and maize equivalent yield of maize based inter crops and system yield. However, among the maize based intercropping system, Maize + Green gram (3636 kg/ha) and Maize + Groundnut (3344 kg/ha) realized higher Maize Equivalent yield and also system yield(10452 kg/ha and 9898 kg/ha) compared to Soybean and Cow pea. The FAW incidence based on percent infestation on maize was less recorded with Maize + Green gram

and Maize + Cowpea intercropping as compared to Soybean and Groundnut. The Davis scale rating (1-9) indicated that the incidence was moderate on maize with all intercrops.

Further, the Maize+ Cowpea intercropping system has suppressed weeds considerably and recorded less weed density(4.74/m^2).In terms of economics Maize+ Green gram has realized higher system net returns(Rs.2,00,239/-) and benefit cost ratio (3.23) due to high prevailing market price for green gram.

Inclusion of short duration leguminous crops in maize as a low cost agro-ecological approach should therefore be promoted as a core component of integrated pest management (IPM) programmes.

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T-4/P-24

Discriminating maize inbreds for drought tolerance using physiological parameters

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Drought has become the prime cause of agricultural disaster which causes immense crop loss. Defining the physiological and metabolic strategies used by maize to tolerate drought events are important for ensuring yield stability in the future, but studies addressing this is quite limited. This study quantifies the effect of physiological adjustment in maize under drought. A field experiment was laid out with 50 inbreds with two treatments, one is an irrigated control and other is water stress condition and stress was imposed at reproductive stage. After 20 days of water stress, the leaf samples were collected and subjected to the analysis of relative leaf water content (RWC), chlorophyll content, chlorophyll stability index (CSI) and free proline content. Significant differences were found between the control and water stress for relative water content, chlorophyll content, chlorophyll stability index and proline content. In comparision to control, the proline concentration and rate of reduction of leaf water content and CSI has increased during stress. Among the inbreds, N09-162 was found to have high proline content (1.30 mg/g) and chlorophyll stability index (51.53) followed by N10-51, 52485, 52099 and the lowest was recorded in UMI1223. The relative water content was high in 52485 (62.79) and chlorophyll content was ranged from 18 to 55. The results suggested that the inbreds N09-162, 52485, N10-51 and 52099 can tolerate drought. The tolerant mechanism exhibited by this inbreds are primarily due to their high-water holding capacity, osmatic adjustment and chlorophyll stability which in turn results in great photosynthetic ability and increased grain yield.

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T-4/P-25

Cob borer on Maize (*Helicoverpa armigera*)

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Helicoverpa armigera is an emerging pest of maize, especially in sweet corn. *Helicoverpa armigera* is major, widespread, regular pest. Female moths lay eggs on the stem, leaves, tassels, silk and husks on the upper two-thirds of plants. Eggs -are Spherical in shape and creamy white in color, laid singly on silk, Larva - Shows color variation from greenish to brown. It has dark brown grey lines on the body with lateral white lines, there are five or six larval stages. Pupa - Brown in color, occurs in soil, leaf, pod and crop debris, Adult-Light pale brownish yellow stout moth. Forewings are olive green to pale brown with a dark brown circular spot in the center. Hind wings are pale smoky white with a broad blackish outer margin. Females were also identified by the presence of tuft of hairs on the tip of abdomen. Larva feeds on silk and developing grains. Silk damage reduces pollination and grain set. Feeding damage also occurs on the top 1-3 cm of the cob, and may result in the presence of mycotoxins. leaf damage can indicate pest presence. According to Ali and Choudhary,2009 the pre pupa phase is comprised between the stage when the caterpillar stops feeding until the pupa phase. **Management-**Set up of light traps, Set up sex pheromone traps at 12/ha, Two applications of NPV at 10 days interval at 1.5 $X10^{12}$ POB along with, Crude sugar 2.5 kg + cotton seed kernel powder 250 g on the ear heads

T-4/P-26

Performance of Maize (Zea mays L.) hybrids to adapt to rainfall changes and climatic aberrations

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Maize is one of the most important agricultural crop in India and world wide It is seen in last two decades that changing climate effects the crop plant in changing variety of ways. Mid-season or terminal drought is the major limiting factor in achieving the higher productivity levels across the rainfed growing areas. (Prasad *et al*., 2017). The productivity of maize crop can be increased further by adjustment of sowing window with suitable single cross hybrids of different maturity durations, which are best suited to different climatic conditions & soil types. Hence it was realized to evaluate the performance of different maturity maize hybrids under different dates of sowings in red sandy loam soils of Telangana to increase maize production under kharif season. A field experiment was conducted under AICRP on Maize Improvement Project Scheme at Agricultural Research Station, Karimnagar, Telangana state during Kharif, 2012-13. The experiment was conducted in factorial RBD with factor A as four dates of sowings, 1) 20th June (15 Days advance from normal date of sowing). 2) 5th July (normal date of sowing). 3) 20th July (15 days delayed from normal date of sowing) 4) 5th August (30 days delayed from normal date of sowing) and factor B as four maize hybrids of different maturity H1- QPM 9 (extra early maturity), H2-DHM 115 (early maturity), H3- DH-117 (medium maturity), H4- 30V92 (Full season) replicated three time. All the cultural practices are followed as per the state recommended package of practices. The plant height at harvest with 15 days advance sowing i.e., June 20th recorded lower plant height (190 cm) on par with normal date of sowing, July 5th (199.9cm), which in turn was on par with 15 days delayed sowing i.e July 20th (211.1cm) and significantly lowest plant height was resulted at 30 days delayed sowing, Aug 5th (215.3 cm) which was onpar with 15 days delay sowing July 20th. Among hybrids, significantly higher plant height (215.6 cm) was recorded with DHM 117 and was on par with 30v92 (full season) (206.4cm) and extra early maturity hybrid QPM 9 (205.3cm). Beiragi et al., 2011 also reported difference in plant height of different hybrids.

The yield attributes, the cob girth resulted significantly higher with 15 days advance sowing June 20th (15.3cm) and is on par with normal date of sowing July 5th 915.3cm) and 15 days delayed sowing July 20th (15.3cm). Similarly kernel number also resulted significantly higher with July 20th sowing (35.3cm) on par with July 5th normal date of sowing (34.8cm) and 15 days advance sowing i.e., June 20th. Among the hybrids, DHM 117, recorded significantly higher cob girth (16.1cm) followed by QPM 9 (15.4 cm). The significantly more no. of kernels was also observed with DHM 117 (35.4) on par with QPM 9, extra early (34.5).

The grain yield resulted significantly higher with normal date of sowing i.e., July 5th (8195 Kg/ha) and is on par with 15 days advance sowing June 20th (8077Kg/ha). The grain yield in this is inturn on par with 15 days delayed sowing, July 20th (7067 Kg/ha). Among the hybrids,

the full season maize hybrid 30V92 observed significantly higher yield (8150 Kg/ha), followed by medium maturity maize hybrid DHM 117 (7394 kg/ha) and significantly lower grain yield was recorded with early maturity, DHM 115 (6411 Kg/ha) and extra early maturity maize hybrid, QPM 9 (6091 Kg/ha). In interaction, full season maize hybrid 30V92, with 15 days advance sowing i.e., June 20th (10083 Kg/ha or with the normal date of sowing i.e., July 5th sowing (9713 Kg/ha) recorded similar yields. The cob yield also followed the similar trend.
The optimum dates of sowing of maize in Telangana are June 20 to July 5th. If there is any deviation from normal onset of monsoon, sowing by 15 days advance and 15 days delay from normal date had no adverse effect on grain yield. Among hybrids 30V92 (full season) and DHM 117 (Medium maturity) can he grown from June 20 to July 5th with significantly higher grain and cob yield.

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T-4/P-27

Effect of Different Temperature and Time Intervals on Germination of Uredospores of *Puccinia Polysora Underw*

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Southern rust, caused by *Puccinia polysora* Underw., is a troublesome foliar disease of maize (*Zea mays* L.). The disease develops mainly in tropical and subtropical areas of the world and is restricted by the temperature sensitivity of the pathogen. In disease development, temperature is a critical factor. To determine how specific environmental variables affect southern corn rust, we determined effects of different temperature on different time intervals on uredospore germination. For evaluating the effect of different temperature levels and time intervals on germination of uredospores, four different temperatures (5, 15, 25, 35^{0}C) were taken and at each different level of temperature, germination percentage of uredospores was evaluated under microscope. In every temperature level uredospore germination percentage was being checked at different time intervals i.e., 2hrs, 4hrs, 8hrs, 16hrs and 24hrs. Maximum mean spore germination was recorded in 25^{0}C (74.23%) and minimum was on 5^{0}C (48.12%) after 24 hours of incubation. The germination percentage declined gradually at temperatures above and below 25°C. Thus, the optimum temperature for polysora rust germination was 24^0-27^{0}C as recorded.

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T-4/P-28

Bio-efficacy of combined and sequential application of herbicide in kharif maize

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A field experiment was conducted in a randomized block design with ten treatments replicated thrice in maize hybrid P 3441 during *kharif*, 2020 at OUAT, Bhubaneswar under AICRP on Maize with an objective to study the bio-efficacy of combined and sequential application of herbicides in maize. The treatments were T_1-Weedy check (Control),T_2-Weed free, T_3-Atrazine (PE) 50WP @1000g/ ha (farmer's practice), T_4- Atrazine (PE) 50WP @1000g/ ha fb one hand weeding at 30 DAS, T_5- Atrazine (PE) 50WP @ 500g/ ha fb topramezone 33.6 SC @ 25.2g/ ha at 25 DAS, T_6-Atrazine (PE) 50WP @ 500g/ ha fb tembotrione 34.4 SC @ 120g/ha at 25 DAS, T_7 -Atrazine (PE) 50 WP @1000 g/ ha fb topramezone 33.6 SC @ 25.2g/ha at 25 DAS, T_8-Atrazine (PE) 50WP @1000g/ha fb tembotrione 34.4 SC @ 120g/ha at 25 DAS, T_9-Tank mix of atrazine @ 500g/ha + topramezone 33.6 SC @ 25g/ ha at 15 DAS, T_{10}-Tank mix of atrazine @ 500g/ha + tembotrione 34.4 SC @120g/ ha at 15 DAS. The weed flora of the experimental site was comprised of 18 species of weeds including 7 grasses (*Cynodon dactylon, Panicum maximum, Echinochloa colonum, Dactyloctenium aegyptium, Digitaria sanguinalis, Eleusine indica, Digitaria ciliaris)*, 2 sedges (*Cyperus rotundus, Cyperus iria)*, and 9 broadleaf weeds (*Mimosa pudica, Alternanthera sessilis, Cassia tora, Portulaca oleraceae, Commelina benghalensis, Sida acuta, Phyllanthus niruri, Eclipta alba, Celosia argentea).* The results revealed that weed free treatment recorded highest grain yield (6956 kgha^{-1}) and stover yield (9076 kgha^{-1}). Among the ten treatments, application of atrazine 50WP as PE @1000g/ ha fb tembotrione 34.4SC @ 120g/ ha at 25 DAS recorded maximum grain yield (6667 kg ha^{-1}) and stover yield **(**9038 kg ha^{-1}) with maximum weed control efficiency (77.5%) and minimum weed index (4.20%), weed population and weed dry weight (5.29 g m^{-2}) at harvest. This treatment also recorded maximum plant growth parameters like plant height (202.7cm), number of leaves per plant (11.67), leaf area index (2.15), dry matter accumulation (104.81g m^{-2}) at harvest, length of cob (15.07), kernel rows per cob (13.33), number of grains per row (20.75) ,100 seed weight (27.67g), harvest index (42.46%) and maximum net return (Rs. 48,781/- ha^{-1}) and B:C ratio (1.71) with maximum nutrient uptake by crop (N-98.27, P-31.67, K-88.32 kg ha^{-1}) and minimum uptake of nutrients by weeds (N-4.98, P-2.24, K-3.55 kg ha^{-1}). Therefore, the application of atrazine 50WP as PE @1000g/ ha fb tembotrione 34.4SC @ 120g/ha at 25 DAS was found to be effective weed management practices in controlling the complex weed flora in *kharif* maize during critical period of crop weed competition.

T-4/P-29

Current Scenario of Rajasthan Downy Mildew of Maize Incited by *Pernosclerospora heteropogoni in Southern Rajasthan*

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Maize (*Zea mays* L.) is a most important cereal crop of Rajasthan, which are cultivated in considerable area. Numerous species of downy mildews are known to occur on maize across the world. The downy mildew pathogens are prevailing in Europe, Asia, North and South America and Australia, while some species such as *P. miscanthi*, *P. spontanea*, and *P. heteropogoni* have limited distribution, yet these species have potential to causes damage in maize crops. Downy mildews cause losses in maize crop ranges from 20 to 35.8%. The incidence of Downey mildew (*Pernosclerospora heteropogoni)* is observed in major maize growing areas in southern Rajasthan during 1973 to 1980. Recent surveys indicate that its natural incidence extent up to 60% on local land races of Udaipur region. At seedling stage, a complete chlorosis or chlorotic strips with typical prominent shoulders are seen. Secondary expression of this disease appears at three- or four-leaf stages. Infected plants turn chlorotic; leaves tend to narrower and more perpendicular than uninfected plants. Initially, symptoms on the leaves appears as straitened, chlorotic stripes, 3 to 7 mm wide with adequately defined margins and delineated by the veins. Later, the strips turn reddish to purple. Wooly and downy cottony whitish growth observed during dawn hours on both surfaces. Tassels imaginably malformed, generating less pollen and ears are terminated, resulting sectional or complete sterility.

T-4/P-30

Cowpea+baby corn intensification and stress mitigation for higher productivity during summer season

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Cowpea (*Vigna unguiculata* L.) is a quick growing and high yielding crop belongs to the family *leguminosae*. It is a valuable multipurpose grain legume widely cultivated in arid and semiarid tropics. Cowpea is grown as intercrop, mixed crop, catch crop, mulch crop and green manure crop. The cowpea cultivation is gaining popularity among growers due to soil enriching habit, quick growing nature, short duration, higher yield and higher profitability per unit area that gradually replacing the other traditional summer legume crops. Baby corn is dehusked maize ear, harvested within 2-3 days of silk emergence but prior to fertilization and it is consumed as vegetable due to its sweet flavour. Great nutritional value, eco-friendly and crispy nature of baby corn has made it special choice for many traditional and continental dishes apart from canning in the elite society (Singh *et al*., 2006). During summer season night temperature at the time of reproductive phase of crops in North-West India remains > 20°C which may adversely affect the flowering and seed setting in summer crops.

Field experiments were conducted to study yield of summer cowpea + baby corn intercropping system as influenced by fertility levels and stress mitigating chemicals during summer seasons of 2019 and 2020 in Kota, Rajasthan, India at agriculture research station, Ummedganj, Kota. The mean daily maximum and minimum temperature during the growing season fluctuated between 32.1 to 47.3°C and 17.1 to 33.6°C, respectively in the year 2019. The corresponding values for the year 2020 were between 37.0 to 44.5°C and 17.4 to 24.4°C, respectively. The experiment was taken in Split split plot design with five intercropping systems [sole cowpea, sole baby corn, cowpea + baby corn (2:1), cowpea + baby corn (3:1) and cowpea+ baby corn (4:1)] in main plot, three fertility levels (100, 125 and 150% RDF) in sub plot and two stress mitigating chemicals (0.5% $CaCl_2$ and 1% KNO_3 at flowering and pod development stage of cowpea) in sub sub plot and replicated four time.

Results from pooled data of two year revealed that 2:1 row ratio of cowpea and baby corn significantly increased the cowpea equivalent yield (963 kg/ha) and economics [Gross return (58667 Rs/ha), net return (31025 Rs/ha), B:C ratio (2.12)] of cowpea and baby corn intercropping system. The highest relative water content of cowpea (74.08 %) and baby corn at 50 DAS (77.32 %) and lowest canopy temperature of both crops at 50 DAS (27.90 ^{0}C in cowpea and 33.01 ^{0}C in baby corn) was also observed in 2:1 row ratio of cowpea and baby corn intercropping system.

In the sub plot cowpea equivalent yield (942 kg/ha), gross return (54358 Rs/ha), net return (28050 Rs/ha) and B: C (2.07) ratio were higher with the fertility level of 150% over lower levels (100% & 125%).

Our results further suggest that foliar application of 0.5% of $CaCl_2$ at flowering and pod development stage were significantly increased the cowpea equivalent yield (872 kg/ha), economics [Gross return (52491 Rs/ha), net return (26819 Rs/ha) and B: C ratio (2.05)], relative

water content in cowpea (72.35 %) and baby corn (78.28) and lowest canopy temperature of both crops (28.97^{0}C in cowpea and 34.10 in baby corn ^{0}C) over 1% KNO_3.

Based on results of two-year experimentation, it may be concluded that cowpea+baby corn should be intercropped in 2:1 row ratio to achieve significantly higher equivalent yield, economics of intercropping system, relative water content and lowest canopy temperature of cowpea and baby corn. Fertilizing the crop with 150% RDF also record the significantly higher productivity and profitability. Further the application of $CaCl_2$ at the rate of 0.5% at flowering at flowering and pod development stage of cowpea fetched significantly highest the above parameters.

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T-4/P-31

Management of stem borer (*Chilo partellus* Swinhoe) in maize using conventional pesticides

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Maize (*Zea mays* L.) occupies an important place in world agriculture. It is estimated that demand for maize in developing countries will surpass demand for both wheat and rice. Maize in India ranks fifth in total area and third in total production and productivity. This level of production has to be substantially raised to meet growing demand of maize for human food, animal and poultry feed, as well as industrial processing by the wet and dry millers to produce value added products. The stem borer (*Chilo partellus* Swinhoe) is one of the most destructive pests of maize crop. The experiments were laid in RCB design with three replications. Granular insecticides were applied at knee high stage in plant whorl where as liquid form of insecticides applied as foliar first at 15 days after emergence and second before tasseling stage. Insect data was recorded on the basis of 1-9 scoring scale as described by CIMMYT, Mexico. All used pesticides had significant effect ($P \leq 0.05$) on percent damage and crop yield over control. All used conventional pesticides had significant effect ($P \leq 0.05$) on percent damage and crop yield over control. The lower percent damage (5.30%) with higher crop yield (4.52 t/ha) and lowest insect score (1.00) was observed in plot sprayed with spinosad 45% EC at 0.5 ml L-1 of water followed by plot treated with chloropyriphos 50% EC+cypermethrin 5%EC @1.5 ml L-1 of water with percent damage of 6.60%, crop yield (4.23 t ha-1) and insect score of 1.60 (Table 1). A linear positive correlation between insect damage control yield increase percentages was observed during 2015. The maize yield was found significantly highly positive correlation (r = 0.89) with the insect damage control percentage in maize stem borer management experiment through the application of conventional pesticides. The equation Y= 0.412X + 19.59 and R2 = 0.80 gave the best fit. The estimated regression line indicated that the unit rise in the insect damage control percentage during experimentation period of first year (within 1-9 scale), there existed possibilities of yield increase by 0.41%.

Table 1. Effect of pesticides on damage percentage of stem borer and grain yield increase in maize

Treatments	IS (0-9 scale)	%DAS	%DC	GY (t ha-1)	YI (%)
1. Fipronil 0.3Gr @ 3-4 g/whorl	2.00	11.00	36.05	4.01	35.02
2. Spinosad 45% EC @ 0.5ml/ l of water	1.00	5.30	69.19	4.52	52.19
3. Furadon 3 Gr @ 3-4g/whorl	1.60	10.80	37.21	4.11	38.38
4. Margosom @ 3 ml L^{-1} of water	2.33	11.30	34.30	3.93	32.32
5.Chlorophyriphos 20%EC (Darshan) @ 1.5 ml L^{-1} of water	1.60	8.80	48.84	4.13	39.06
6. Chloropyriphos 50% EC+cypermethrin 5%EC (Super-D) @ 1.5 ml L^{-1} of water	1.60	6.60	61.63	4.23	42.42

7. Imidachloprid 17.8% (Confidor 200SL) @ 0.5 ml L^{-1} of water	2.00	7.60	55.81	4.14	39.39
8. Control (water spray)	3.50	17.20		2.97	
Grand mean	**1.90**	**9.80**		**4.01**	
F test	**	*		**	
LSD 0.05	**0.67**	**5.22**		**0.31**	
CV%	**19.50**	**30.20**		**4.42**	

Note: Means of 3 replications. IS- Insect Score, %DAS- Percent Damage After Spray, %DC- Percent Damage Control, GY- Grain Yield, YI- Yield Increase, t/ha- ton per hectare, L- liter, EC- Emulsifiable concentration, ml- mililitre, g- gram, Gr- granule

T-4/P-32

Molecular identification and scanning electron microscopy (SEM) study of *Aspergillus Flavus* isolated from maize and colony morphology study of aspergillus flavus on different media

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Aspergillus flavus is an opportunistic pathogen causing ear rot disease in maize (*Zea mays*). It infects maize kernels and produces aflatoxin (a highly toxic secondary metabolite) in maize grains both before and after harvest. Plant stress due to drought, heat, or insect damage during fungal growth usually increases aflatoxin levels. Due to this fungal attack in the pre-harvested as well as in stored maize crops, there is a huge economic loss of the crops. Even aflatoxin contamination can cause life-threatening effects in both humans and livestock. Research is being carried out regarding the molecular identification of *Aspergillus flavus* isolated from maize, scanning electron microscopy (SEM) study of *Aspergillus flavus*, and study of colony morphology of *Aspergillus flavus* on different media. Nine different media have been chosen for this study. Media of PDA (Potato Dextrose Agar), SDA (Sabouraud Dextrose Agar), Oat Meal Agar, Corn Meal Agar, Potato Dextrose Sucrose Agar, Richards Synthetic Agar, Nutrient Agar, V8 Juice Agar, and Czapek Dox Agar have been used for this purpose, and among these the culture has grown best on SDA (Sabouraud Dextrose Agar) (3.6cm) followed by V8 Juice Agar (2.8cm).

T-4/P-33

An overview of pollution, climate change, and maize production strategies

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Maize (*Zea mays*) is the most widely planted crop on the planet. Its reaction to numerous environmental stressors is complicated and dynamic, and it can be either elastic (reversible) or plastic (irreversible). The intensity and frequency of both abiotic and biotic stress factors are projected to increase as a result of climate change. Climate characteristics, particularly temperature and rainfall, have witnessed fluctuations in the past. The global temperature has risen dramatically, affecting economically vital crops as well as humans directly or indirectly. There has been a decrease in overall rainfall and an increase in the variability of rainfall. The weather in different sections of the country is variable. Pollutants harm economically significant plants severely and have resulted in biotic and abiotic stress in all crops. Burning of crop wastes in the area. It is a big worry, particularly in the metro areas. Agriculture and manufacturing in the peri-urban area are rapidly expanding. Pollution has been linked to a hazard to urban food production and quality. The crop's harvest wastes with the most up-to-date farm gear, which transforms them into transportable bales to a storage facility or a distant market. In peri-urban agriculture and animal husbandry, sewage water and industrial wastes have been a major source of worry. In crops, a multi-pronged approach is required. To ensure maize's optimal resilience and production, a greater understanding of the underlying response mechanisms regulated in the face of climate change-related abiotic stress is required. The creation of novel climate resilient cultivars/crops that are useful to humans, as well as the employment of environmentally friendly technology, could aid in the fight against pollution and climate change.

T-4/P-34

Influence of flooding on chlorophyll pigment, enzyme activity and carbohydrate content of maize

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Maize is sensitive for waterlogging throughout growth period. Its growth and productivity gets severely reduced due to excess soil moisture as a result of unfavorable physiological and biochemical changes. Therefore experiment was conducted at G.B. Pant University of Agriculture & Technology, Pantnagar during *kharif* 2019 to analyse the biochemical changes in maize plants due to excess soil moisture stress. Maize was grown on flat bed with recommended cultivation practices under non ponded and ponded conditions. Water ponding was created artificially at knee height stage i.e. 30 days after sowing. Depth of standing water was maintained 5 cm in the field continuously for 7 days. After 7 days water was surface drained from the field. 'Student t' test was used to know the significance level between ponded and non-ponded plants. The observations were recorded at 14 days after draining of water. Plants grown under non ponded conditions showed significantly higher total chlorophyll (3.06 mg/g fresh weight) as compared to ponded condition (1.65 mg/g fresh weight). Super oxide dismutase (SOD) which is first line defense enzyme in stressed plants was 31.8 per cent higher compared to non-ponded plants. Malonidialdehyde (MDA) enzyme, responsible for lipid peroxidation significantly increased in ponded plants. Its content (20.5 n mol/mg protein) in flood treated plants was 122.8 per cent more over normal grown plants. A significant reduction in total soluble carbohydrates content of plants was observed due to excess soil moisture and was 20.3 per cent lower compared to non ponded plants. These unfavorable changes in MDA enzyme and soluble carbohydrate content may be responsible for poor productivity of maize under excess soil moisture stress condition.

T-4/P-35

Change in biochemical and physio-morphological characteristics due to heat and drought stress in maize

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Maize is one of the main staple food in world along with wheat and rice, as it is grown for various purposes like animal food, forage production other than human consumption. Mainly it is grown in the regions having semi-arid environment, where low water availability and high daytime temperature prevails. The Maize crop is extremely sensitive to heat and drought stress due to which 15-20% of yield is reduced.

In maize, the contribution of heat and drought reduces the photosynthetic rate, stomatal conditions, leaf area and WUE of which photosynthesis rate is extremely sensitive leads to stomatal closure, reduced leaf expansion, low content of photosynthetic pigments, increased transpiration rate.

Stress condition in the reproductive stages results in the decrease of pollen and stigma viability, pollen tube growth tassel blasting, delay of silking. In the maturity phase, yield parameters such as kernels per ear, 100-kernel weight, kernel yield per plant, harvest index due to which 20-50% reduction in yield are observed.

Plants have developed different strategies like escape, tolerance, avoidance to survive and will help the plant to grow under hot and dry environmental conditions. Early maturation, changes in stomatal regulation, the establishment of a deep root system, constitute the responses related to escape and avoidance. Tolerance is related to the production of compatible osmolyte compounds like proline which helps to sustain these conditions.

T-4/P-36

Climate change's impact on the changing patterns of maize diseases in the India: A review

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Plant pathogens' occurrence, prevalence, and severity are all influenced by climate change. Due to human activities, global temperatures are expected to rise by 2–4°C, and greater market globalisation, along with temperature may cause temporary excess soil moisture, water logging, or drought, resulting in changes in biotic stress factors. Sorghum downy mildew (SDM) and Turcicum leaf blight (TLB), two maize diseases, thrive in the Indian subcontinent's changing environment along the west coast, central, interior peninsula, and rising temperatures, creates an environment that is conducive to pest movement and establishment. After wheat and rice, maize is the third most significant crop. In some maize-growing locations, changes in rainfall distribution and northeast areas examines the impact of climate change on maize diseases and their management. The declining trend in monsoon and seasonal rainfall in North India, Central India, sections of Gujarat, and Kerala is conducive to post flowering stalk rot (PFSR), which is becoming more prevalent in maize. Under changing climate conditions, the outcome of any host-pathogen interaction is difficult to anticipate. This review examines the impact of climate change on maize pathogens and, as a result, plant health. Climate change has already enlarged the host range and geographical distribution of diseases, increasing the danger of pathogen introduction into new places, according to the research reviewed.

T-4/P-37

In-vitro management of banded leaf and sheath blight of maize by using fungicides

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Maize (*Zea mays* L.; 2n=20) is an important staple food crop that has responded to a variety of biotic and abiotic challenges around the world..In certain places, the banded leaf and sheath blight (BLSB), first discovered by Berthus in 1927, is a severe barrier to maize production. *Rhizoctonia solani* is the fungus that causes the sickness. The pathogen that can infect plants has brown tints in the mycelium, dolipore septa, right angle branching of hyphae, and constriction. Grain yield losses of 11 to 40% have been documented under favourable conditions due to banded leaf and sheath blight. In some maize-growing districts, this disease has manifested itself in a severe form, resulting in significant yield losses. The rising severity of this illness could be related to hybridization and a more favourable climate for pathogen growth and adaptability. *In vitro* studies were carried out by studying seven different fungicides with different concentrations against control of *R. solani.* Fungicides used were Azoxystrobin+Difenoconazole, Propiconazole, Tebuconazole, Kresoxim methyl, Zineb, Dithane M-45, Azoxystrobin+Tebuconazole. Among all these Propiconazole and Tebuconazole showed positive impact by reducing the growth of pathogen *R. solani.* Inhibition percentage was Highest inhibition percentage was shown by Propiconazole and Tebuconazole with 100% followed by Azoxystrobin+Difenoconazole with 90.3%. All the fungicides used under the study were found to be effective in controlling the growth of the test fungus.

T-4/P-38

Influence of sowing method, nitrogen and growth regulator on maize yield under excess soil moisture stress

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Excess soil moisture stress is one of the constraints for maize production. Proper crop management practices need to be developed to reduce yield loss due to flooding. Therefore, a field experiment was conducted during the *kharif* season 2019 at G.B. Pant University of Agriculture and Technology, Pantnagar, to find out suitable sowing method and to analyze amount of nitrogen and foliar application of gamma amino butyric acid (GABA) on excess soil moisture stressed maize. Six treatment combinations of nitrogen and GABA {recommended dose of N (RDN), RDN + 30 kg N/ha, RDN +1 mM GABA, RDN +2 mM GABA, RDN + 30 kg N/ha + 1 mM GABA and RDN + 30 kg N/ha + 2 mM GABA} were tested under two sowing methods viz., flat and ridge. Thus 12 treatments were analyzed in factorial RBD with three replications. The recommended dose of nutrients was120:60:40 kg N:P_2O_5:K_2O/ha. Artificial ponding was created at knee height stage continuously for 7 days. The depth of standing water was maintained 5 cm in the field. Extra 30 kg N was top dressed and foliar application of GABA was made 4 days after draining of ponded water. Maize grown on ridge exhibited significantly 7.2 % more grain yield (3501 kg/ha) than flat sowing under excess soil moisture condition. Among N and GABA treatments, significantly lowest grain yield was recorded with RDN. Top dressing of extra 30 kg N and foliar application of GABA proved helpful in increasing grain yield significantly over RDN. Maximum grain yield was obtained with 30 kg extra N + 2 mM GABA application which was at par with 30 kg extra N + 1 mM GABA and extra 30 kg N. Results revealed that effect of excess soil moisture stress on maize grain yield can be overcome by growing it on ridge and applying extra 30 kg N/ha.

T-4/P-39

Screening of maize genotypes against turcicum leaf blight of maize disease under artificial epiphytotic conditions in field.

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The present study were carried out at Main agricultural research station (MARS), Dharwad during K*harif* 2019 and 2020 to identify the resistant genotypes against turcicum leaf blight (TLB) of maize. The results revealed that a significant differences in disease reaction were observed among different genotypes for TLB. Out of 160 genotypes, CM-119, D-2282-2-1, DDM-207, DMI-1200, LM-13, LM-14, PDM-194-2-1, PML-26 and PML-70 were showed highly resistant reaction to TLB. Whereas, 37 genotypes showed moderately resistant reaction and 59 genotypes were showed moderately susceptible reaction. 54 genotypes showed susceptible reactions. The CI-4 and CM-202 genotypes were used as resistant and susceptible checks, respectively. Screening of maize genotypes identified as resistant sources against TLB disease that holds a great promise in resistance breeding and genotypes can also be used for identification of genomic regions determining turcicum leaf blight resistance through QTL mapping.

T-4/P-40

Transcriptional profiling for turcicum leaf blight disease resistance in Indian maize germplasm

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Biotic and abiotic stresses are the important constraints to maize production and productivity in the era of climate change. In this scenario, sustaining of maize yield stability over the year and locations is the big challenge. Turcicum leaf blight **(**TLB) disease is caused by fungus *Setosphaeria turcica* and is one of the most devastating diseases causing up to 50% yield losses in maize. Therefore, there is a need to identify key candidate genes playing vital role in TLB resistance. In this direction, a comparative transcriptome analysis using contrasting maize inbred lines was performed to delineate the differentially expressed genes (DEGs). The contrasting lines were selected from artificially inoculated conditions and transcriptome profiling was performed in two biological replicates. A total of 16 sequencing libraries were prepared and 80%-94% of the sequenced raw reads were mapped to the reference B73 maize genome which indicates the good quality of sequencing data. Genes with a p-value ≤ 0.05 and fold change of ≥ 2.0 or ≤ -2 were considered as DEGs in various combinations performed between contrasting genotypes. In total 2533 and 1395 DEGs were identified in the resistant line and susceptible line, respectively, which were further classified into different functional categories and pathways according to their putative functions. Gene Ontology-based annotation of these DEGs identified three different functional categories: biological processes, molecular function, and cellular component. The KEGG and Mapman-based analysis revealed that most of the DEGs fall into various metabolic pathways, biosynthesis of secondary metabolites, hormone signal transduction, carbon metabolism, glutathione metabolism, and photosynthesis. Many transcripts belonging to bHLH, MYB-related, NAC, WRKY and ERF transcription factors were found to be differentially expressed in current study. Some of the key genes involved in defence response, response to biotic stimulus, redox homeostasis was observed to be highly dys-regulated in the tolerant genotype compared to susceptible one. The candidate genes which are highly differentially expressed in present study might be playing a pivotal role in adaptation to TLB in maize and hence could be useful in augmenting further research to develop tolerant maize cultivars.

T-4/P-41

Effect of different temperature levels and incubation time on germination of urediniospores of *Puccinia polysora* Underw.

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The Southern corn rust, caused by the fungus *Puccinia polysora*, has been one of the major foliar diseases of Maize. In plant disease development, temperature and incubation time is the critical factor. *In vitro* experiments were conducted to assess the effects of temperature and time of exposure on *P. polysora* uredospore germination. The development of the germ tube was assessed for 12 hours. The 0.6g of fresh urediniospores were added to 10ml sterilized distilled water and plated in a 0.1 ml aliquot in water – agar (1.5%), placed in BOD, and regulated at temperatures of 5°c, 10°c, 15°c, 20°c, 25°c, 30°c, 35°c and 40°c. Readings were performed after 1, 3, 6, 12, 18 and 24 hours. The studies on the effect of temperature and incubation time on germination of urediniospores revealed that maximum percent spore germination was found at 25°c (25%, 33%, 57.67%, 67.67% and 78% at 2hrs, 3hrs, 6 hrs, 9hrs and 12hrs respectively). The minimum and maximum temperatures where germination percentage were found to be nil at different incubation times are 5°c and 40°c respectively.

T-4/P-42

Screening for maydis leaf blight under artificial epiphytotic conditions in maize (*Zea. Mays* L.).

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Maydis Leaf Blight (MLB), caused by *Bipolaris maydis*, has been reported from most maize growing regions in the world including India. Under severe conditions depending upon the susceptibility of the variety, MLB causes significant grain yield losses upto to the tune of 70%. The present study involving 27 inbred lines, 2 testers, 54 crosses and 3 checks was conducted in HAREC, Bajaura, Himachal Pradesh in *Kharif*, 2015 with the objective of identifying new valuable sources of resistance to MLB. The experimental material was artificially inoculated at four to six leaf stages by manually dropping the inoculum in powdered form in the whorls of each seedling. For MLB scoring, a scale recommended by Shekhar and Kumar (2012) was used. The present study revealed 53 resistant and 1 moderately resistant cross against MLB. Among lines and testers 21 lines and 1 tester T_1 were found resistant whereas 6 lines exhibited moderately resistant reaction. None of the crosses, lines and testers was found susceptible/highly susceptible. The new sources of resistance identified in this study will be a valuable addition to breeding programmes.

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T-4/P-43

Subsurface drip irrigation in cereal systems for addressing water and crop productivity in north-west India

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In the present climate change scenario the biggest challenge is to produce more food for the teeming population within the boundaries of limited land and water resources. Serious water deficits, diminishing profitability and deteriorating natural resources are some of the major threats to the agricultural sustainability in many regions of South Asia. Food security and water sustainability may be achieved by bringing improvement in the crop water productivity and the amount produced per unit of water consumed. The increase in the crop water productivity may be achieved by pursuing alternative crops, varieities and agronomics approaches, which are more friendly and efficient in utilizing natural resources. A study on conservation agriculture (CA) conducted during *kharif* 2020 and 2021 at CSSRI-CIMMYT research platform of Karnal, Haryana, India. The experiment comprised of six (tillage, crop management practices and irrigation method) scenarios: Sc1- conventional-till (CT) rice (farmers' practice), Sc2- CT rice with flood irrigation (partial CA), Sc3- Zero tillage (ZT) rice with flood irrigation (Full CA), Sc4- ZT maize with flood irrigation (Full CA), Sc5- ZT rice with sub surface drip (SDI) (CA^+ R) and Sc6- ZT maize with SDI (CA^+ M). Based on 2-years mean, crop yield (maize equivalent) of individual scenarios were increased by 3.6, -6.9, 26.1, -3.8 and 35.6% and save irrigation water by 1.5, 17.8, 92.5, 50.1 and 95.9% under Sc2, Sc3, Sc4, Sc5 and Sc6, respectively compared to Sc1 (6.84 Mg ha^{-1} and 1577 mm ha^{-1}). The SDI system saved 40-50% (2-yr mean) of irrigation water in maize based system. SDI based maize system produced 35.6% higher productivity with 50% less water and 20% nitrogen compared to flood irrigation. Substitution of rice with maize in Sc4 recorded 26.13% higher productivity.

T-4/P-44

Field efficacy of insecicides for management of invasive fall armyworm, *Spodoptera frugiperda* (J.E. Smith) on maize in India

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The fall armyworm (FAW), *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae) is an invasive pest species and has become a threat to farmers and Indian Agriculture. It was first detected in the Indian subcontinent in May 2018 on maize crop at the College of Agriculture, Shivamogga, Karnataka. Thereafter, the pest has spread to most states of India and then spread to other Asian countries, including Thailand, Sri Lanka, Bangladesh, Myanmar, Vietnam, Laos, and China. The ICAR-National Bureau of Agricultural Insect Resources (NBAIR), Bengaluru has reported the damage intensity of FAW as 9 - 62% with the yield loss of 34% in Karnataka. It spread in India via Karnataka state. The pest is rapidly spreading in India due to little characteristic behaviour like voraciousness, fast and rapid flying capacity and more number of alternate hosts etc. Development of IPM package to manage the pest is in infancy in India for want of basic information about this pest. The infestation of this pest has been reported during Kharif 2019 in Karnataka, Andhra Pradesh, Tamil Nadu, Maharashtra, Rajasthan, Madhya Pradesh, Uttar Pradesh and Bihar. Being a new invasive pest, there is no information on its susceptibility to insecticides. Hence, insecticides having different modes of action were evaluated for control of second instar larvae by the leaf-dip bioassay method, as well as under field conditions both in June and September. The results obtained that Emamectin benzoate 5 SG showed highest acute toxicity, followed by chlorantraniliprole18.5 SC, and spinetoram 11.7 SC, whereas toxicities of flubendiamide 480 SC, indoxacarb 14.5 SC, lambda-cyhalothrin 5 EC, and novaluron10 EC were at par by the leaf-dip bioassay. The results of field efficacy for 2 planting dates (June sown crop, and September sown crop 2018) revealed that the effective insecticides were chlorantraniliprole 18.5 SC, followed by emamectin benzoate 5 SG, spinetoram 11.7 SC, flubendiamide 480 SC, indoxacarb 14.5 SC, lambda cyhalothrin 5 EC, and novaluron 10 EC. Higher efficacy also was correlated with higher grain yield in comparison with the control. Chlorantraniliprole, emamectin benzoate, and spinetoram are suitable as one of the components of Integrated Pest Management of fall armyworm in India.

T-4/P-45

Occurrence of natural enemies of maize stem borer *Chilo partellus* (Swinhoe) in *Kharif* maize ecosystem

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Maize (*Zea mays* L.) is the most important cereal crop after wheat and rice, grown virtually in every suitable agricultural region of the world. It has been referred as the "Queen of cereals" due its highest yield potential among all the cereals (Ali *et al*., 2014). Maize is attacked by over 250 species of insect and pests. Of those four species of tissue borers *viz*., maize stem borer or spotted stem borer (*Chilo partellus* Swinhoe), pink stem borer (*Sesamia inference*), shoot fly (*Atherigona soccata*) and Asiatic corn borer (*Ostrinia furnacalis* Guenee) are regular and serious pests of maize. Among these, maize stem borer, *C. partellus,* is the principal pest in all maize growing countries. Natural enemies plays important role in suppression of this target insects and also an important component of integrated pest management practices. Field experiments were carried out at Maize field of AICRP on Maize, Central farm, OUAT, Bhubaneswar, Odisha during *Kharif* 2019 and *Kharif* 2020 to document the "Occurrence of natural enemies of maize stem borer *Chilo partellus* (Swinhoe) in *Kharif* maize ecosystem". The average seasonal coccinellid population in *Kharif* 2019 *and Kharif* 2020 was in between 1.10 to 1.20 per plant respectively from 30th SMW (19 DAS) to 40th SMW(89DAS) .Number of eggs/ plant laid by the green lacewings, *Chrysoperla carnea* recorded 0.07 to 0.43/ plant and 0.04 to 0.47/ plant in the same time period. Mixed population of two predominant spider population over two growing seasons reached maximum (1.56/ plant) and (1.55/ plant) at 39th SMW in maize ecosystem in both the seasons. Syrphid maggots reached the peak (1.26. and 0.80) / plant in maize at 40th SMW in these years ranged from 0.68 to 1.75/ plant. Pentatomid bug ,*Eocanthecona. furcellata* was very negligible on maize crop. Reduviid bugs appeared from 31st to40th SMW however in growing seasons the population varied from 0.03 to 0.26/ plant.

T-4/P-46

Detection and monitoring of cob borer, *Helicovera armigera* (Hubner) using pheromone traps in maize

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Maize (*Zea mays* L.) is the most versatile crop with wider adaptability in varied agro-ecologies and has highest genetic yield potential among the food grain crops. One of the major causes of the low productivity is the damage by different insect pests. Maize crop is attacked by nearly 130 species of insect-pests in India (Atwal and Dhaliwal, 2002). Among these, *Helicoverpa armigera* (Hubner) has recently emerged as a major cob borer in maize. Cob borer, *H. armigera* infests cob and causes qualitative and quantitate losses. Massive application of pesticides not only leaves harmful residues in the food chain but also decimates non-target organisms besides problem of environment pollution, pest resurgence and development of resistance in insects to insecticides. With this background, experiment was conducted to monitor the adult male of *H. armigera* population through pheromone traps so that timely management strategies can be adopted.

The present studies were carried out at the research farm of the CCSHAU, Regional Research Station, Karnal during 2018-19 and 2019-20 (*Kharif*, *Rabi* and *Spring* seasons). Four traps were installed in one acre area at two locations commencing from 30 days after germination and were monitored for the adult moth emergence at weekly intervals till harvest of the crop. Lures were changed after 4 weeks and the numbers of trapped adults at weekly intervals were counted.

First *H. armigera* adult moth trapping was recorded during the first week of September (36 SMW) with a frequency of 0.25 moths/trap that continued up to third week of October (42 SMW) during *Kharif*, 2018. Maximum trapping (1.37 moths/trap) was recorded during third week of September (38 SMW). During *Kharif*, 2019 however, adult moths were trapped during the month of September only. The first trapping was recorded during the 1st week of September (36 SMW) with a frequency of 0.63 moths/trap that declined during the second week (0.38 moths/trap) that peaked during the third week (38 SMW) at 3.13 moths/trap. Moth catches declined marginally in the 39 SMW (0.88/trap) and were not recorded later on. During *Rabi* 2018-19, first *H. armigera* moth trapping was reported during second week of March (11 SMW), continued up to fourth week of April (18 SMW) to peak (15.75/trap) during second week of April (16 SMW). During *Rabi*, 2019-20, first moth trapping was recorded during third week of January 2020 that continued gradually up to second week of March (10 SMW) to maximize (0.75/trap) during second week of March (10 SMW). In *spring*, 2019, first moth trapping was observed during fourth week of April (18 SMW), continued till third week of May (21 SMW) to peak (17.25/trap) during second week of May (20 SMW). During *Spring*, 2020 high intensity moth catches (14.5 moth/trap) were recorded from 12 SMW (17th March, 2020) that peaked (154.75/trap) during 15 SMW (15th April, 2020) and declined substantially later on continuously till 24 SMW (10th June, 2020).

Present studies confirmed *H. armigera* moth catches employing pheromone traps as an important indicator to initiate management strategies against this noxious pest of maize. The moth catches during *Kharif* and *Rabi* seasons were nominal. However, during *Spring* season higher intensity of moth capturing was recorded during both years of study. Therefore, management strategies for *H. armigera* should be planned for spring maize to avoid economic losses.

T-4/P-47

Screening of maize germplasm for resistance against maize stem borer, *Chilo partellus* (Swinhoe) under artificial infestation

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Maize (*Zea mays* L.) is third important cereal crop in India after rice and wheat and occupies an area of 9.86 million hectares having production of 31.51 million tones. Average productivity of maize is very low in comparison to its potential. Maize crop is attacked by nearly 130 species of insect-pests in India (Atwal and Dhaliwal, 2002). Among these, maize stem borer, *Chilo partellus* (Swinhoe) is widely distributed pest of maize. The use of resistant variety is the most valuable and practical tool for minimizing pest attack, as it is compatible with other methods of control. Therefore, studies on screening of maize germplasm for resistance against *C. partellus* under artificial infestation were conducted to find out the sources of resistance for effective pest management strategy which will lead to achieve sustainable maize production.

Thirty-two single cross hybrids and 73 inbred lines of maize developed at the station were screened against *C. partellus* under artificial infestation during *Kharif*, 2019. Black headed eggs (10-12) per plant were released after 14-16 days after germination in the central whorl. After 25 days of release of eggs, plants were observed for level of infestation by recording the leaf injury rating (LIR) on 1-9 scale as per Sarup *et el*., 1978.

Results revealed that seven hybrids viz. HKI 327T x HKI 428T, HM 11, HKI 193-2 x L 287, HKI 169 x L 287, HKI 288-2 x LM 17, HKI 1040-7 x L 287 and HKI 1040-7 X HKI 659-3 were resistant against *C. partellus* with LIR score of 1-3. Similarly, fourteen inbred lines viz. HKI 139, HKI 193-1, HKI 295, HKI 194-6, HKI 1011, HKI 1105, HKI 1128, HKI-288-2, HKI L-287, HKI-1651, HKI-288-2, HKI LM-17, HKI-1126 and HKI-659-3) also exhibited resistant reaction to this pest. Bulk of the hybrids (22) and inbred lines (56) were moderately resistant with LIR of 3.1-6.0. Proportion of susceptible entries (LIR 6.1-9.0) was relatively lower as only three hybrids (T-Bio 47 ER-3-2 x 1128, HKI 132 x HKI 193-2 and HKI 295 X HKI 1126) and three inbred lines (HKI 14-1 (1+2+3), HKI 1352-58-9-29-2 and HKI 1352-58-9 (1+2)-2) exhibited this trait.

These genotypes could be used in breeding programme for the development of *C. partellus* resistant maize hybrids which will lead to achieve sustainable maize production.

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T-4/P-48

Maize hybrids tolerant to excessive soil moisture stress based on morphological and biochemical attributes

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The rising incidences of erratic rainfall due to changing climatic pattern has led to extensive yield loss due to waterlogging, flooding or high water table. A set of 32 maize hybrids in two replications were critically evaluated during Kharif 2019-20 for screening of hybrids tolerant to excessive soil moisture stress (ESM). The study was carried out at EB-II section of Plant Breeding and Genetics, College of Agriculture, OUAT, Bhubaneswar. The hybrids were exposed to 12 days of water logging at flowering stage through flooding irrigation. A water level of 3-5cm was continuously maintained during this period and fourteen agro-economic traits along with five biochemical traits were studied to screen tolerant hybrids. Correlation and path coefficient studies were conducted to extrapolate the relationships between various traits and yield under ESM stress. Among morphological traits, plant height, ear height, number of plants with adventitious roots (after stress) and number of kernels per row depicted highly significant positive genotypic and phenotypic correlation with yield while leaf senescence percentage (after stress) depicted highly significant negative relationship. Kernels per row and plant height manifested highest positive direct effect on plant yield at phenotypic and genotypic levels respectively. The total chlorophyll content along with chlorophyll a and b declined after stress and the decrease was significantly higher in case of susceptible hybrids. The total carbohydrate content showed a declining trend after stress but the tolerant hybrids maintained higher carbohydrate concentration. The hybrids exhibited increased proline accumulation with tolerant hybrids maintaining higher proline levels after stress. Plant yield under water logging depicted positive correlation with total chlorophyll content, chlorophyll a content, carbohydrate content, proline content and increase in proline content (after stress), while percentage decline in chlorophyll and decrease in carbohydrate exhibited negative correlation. Further, the chlorophyll 'a' content exerted highest positive direct effect on yield followed by increase in proline content after stress, indicating that these traits can be considered for plant selection under ESM stress. The hybrids ZH17368, VH19487, ZH17446, ZH17815 and VH133157 were identified to withstand water logging stress.

T-4/P-49

Management of stem borer (*Chilo partellus* Swinhoe) in maize using conventional pesticides

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Maize or corn (*Zea mays* Linn.) is one of the important cereal crops of the world, cultivated for food, fodder and for raw material in many industries. In many parts of the world, it is an important food crop providing daily bread for the rural population. Stem borer, *Chilo partellus* (Swinhoe) is one of the major pests of maize and causes considerable yield loss. Heavy infestation may result in total loss of the crop leading to resowing during *Kharif* season. To evaluate the efficacy of insecticides to control maize stem borer, an experiment was laid out there were six insecticidal treatments, one botanical and a biopesticide along with control, each of which replicated thrice in 6 x 3 meter plots. The insecticides were applied 40 days after sowing to strike the activity of insect pest on the crop. Efficacy of the treatments was judged based on per cent mortality of the stem borer. Pre treatment count of stem borer per ten plants ranged from 11.66 to 21.30. The stem borer population reduced among all the treatments on different days of observation (Table 1). A day after imposition of treatment, indoxacarb 14.5 SC showed the highest mortality (91.30) per cent followed by lambda- cyhalothrin 5EC which showed 60.70 per cent mortality. However, cypermethrin 10EC, endosulfan 35 EC and Bt-toxin (Dipel 8L) were at par with each other showing the mortality of 55.15, 52.77and 54.87 per cent, respectively. Whereas the lowest per cent mortality was noticed in imdacloprid 17.80 SL and Azadiractin(1%) showing 34.95 and 44.96 per cent mortality (Table 1). Indoxacarb 0.0145, lambda cyhalothrin 0.005 and cypermethrin 0.01 per cent spray showed higher efficacy in suppressing the stem borer. All other chemicals showed moderate to least effectiveness but they were significantly superior to untreated control.

Table 1. Efficacy of insecticides against maize stem borer *chilo partellus*

Sr. No.	Treatments	Concentrations (%)	Pre count (mean no.of stem borer/10 plant)	Per cent mortality of maize stem borer		
				1DAA	3DAA	5DAA
1	Bt-toxin (Dipel 8L)	0.008	19	54.87(47.78)	67.57 (55.65)	63.28 (52.78)
2	Imidacloprid (17.8SL)	0.0056	17.33	34.95 (36.20)	31.81 (34.27)	25.29 (30.05)

3	Cypermethrin 10EC	0.01	13.33	55.15 (47.95)	50.16 (45.08)	45.38 (42.33)
4	Lambda-cyhalothrin5 EC	0.005	18.50	60.70 (51.21)	69.86 (56.91)	73.58 (60.23)
5	Indoxacarb 14.5 SC	0.0.145	19.00	91.31 (73.45)	82.54 (66.14)	77.45 (61.79)
6	Azadirachtin (1%)	0.20	11.66	44.96 (42.01)	54.77 (47.77)	44.96 (42.01)
7	Untreated control		16.48	16.48 (23.10)	8.76 (16.99)	14.12 (21.53)
	S.E. ±		NS	2.73	3.33	3.55
	C.D.(P=0.05)		-	8.27	10.09	10.77
	CV%		-	10.25	12.50	13.42

DAA- Days after application. NS-Non significant
Figures in parentheses are arc sin transformed values.

T-4/P-50

Fall armyworm management strategies through integrated approach in maize

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Bihar state have diversified yield potential across the agro-climatic zone of rabi, kharif and summer maize. In last two cropping season a significant incidences of Fall armyworm (FAW) were observed. FAW is a polyphagous and voracious pest, devastating maize crop. Pests also co-evolve and adapt very quickly to single control tactics through natural selection, and no single method was able to completely control the pest. So that "integrated" approach, is the most efficient and sustainable approach. We have used different approach for management to identify the best integrated pest management (IPM) modules. Three IPM modules with the various combination of cultural, mechanical, botanical, biological and chemical methods were used. Results showed that seed treatment with Cyantraniliprole 19.8% + Thiamethoxam 19.8% FS @ 6 mL/kg, Spraying of azadirachtin 1500 PPM @5 mL/liters of water (10 DAG), Whorl application of *Emamectin benzoate* 5 SG @ 0.4 g/litre (80 g/acre) (20 DAG), *Metarhizium anispoliae* @ 05 mL/litre water (30 DAG)and whorl application of Spinetoram (0.5 mL/litre) (40 DAG) is need to be spray if incidence is high, this module shows effective and promising role in the management of FAW in terms of farmer's adoptability, productivity (37.64%), cost effective (31.29%) over control and environment eco-friendly approach.

T-4/P-51

Adjustment in sowing date to prevent heat stress in spring maize

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Heat stress has became one of the primal abiotic stresses in crop production for tropics. Maize is sensitive to heat stress and a combination of high temperature (>33° C) and low RH (<40%) may causes huge loss in grain yield particularly when it occurs during flowering period (Zaidi *et al.*, 2016). Each degree day spent above 30◦C can reduce the maize yield by 1-1.7% (Lobell *et al.*, 2011). Spring maize-an attractive crop alternative to the summer rice in the state of Punjab is likely to face heat stress (Zaidi *et al.*, 2016). Hence, the present experiment was carried out to identify the sowing date having minimum risk of heat stress-based yield loss in maize. The experiment was conducted in split plot design with three replications at Research farm of ICAR-Indian Institute of Maize Research, Ludhiana during February to July of 2020 and 2021. Four planting dates-15th February; 25 February; 5 March and 15 March and four maize genotypes viz. PMH 1, PMH 10 CoH(M) 6 and CoH(M) 8 were tested in the experiment. All the recommended package of practices were tested to raise the crop. Staggered planting of maize significantly affected the grain yield. Maize sown on 15th February produced the greatest yield (8.5 t/ha) while 15th March planted maize had the least yield (6.2 t/ha). The yield penalty with delaying in planting beyond 15th February was 1.3-2.3 t/ha. Across the planting dates, PMH 10 outperformed than rest cultivars with respect to grain yield (7.8 t/ha). This cultivar recorded 0.5, 0.9 and 0.5 t/ha greater yield over PMH 1, CoH(M) 6 and CoH(M) 8, respectively. Therefore, it is advised to plant spring maize by 15th of February to obtain better yield. If sowing cannot be done timely than use heat resistant cultivar to minimize the yield penalty caused by heat stress.

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T-4/P-52

Meta-QTL analysis for mining of candidate genes and constitutive gene network modulating fungal disease resistance in maize (*Zea mays L.*)

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The most efficient and sustainable approach for combating fungal diseases is to develop resistant maize varieties. Many QTL mapping studies for fungal disease resistance (FDR) in maize have been published in the past three decades. However, the applicability of identified QTLs for comparative research is limited due to the diverse genetic backgrounds of experimental materials across studies in different environments and different QTL analysis algorithms. The meta-QTL analysis (MQTL) helps in the combined analysis of diverse QTL mapping studies revealing common genomic regions for target traits. An extensive literature search was conducted for QTLs linked to resistance against 19 maize fungal diseases. MQTL analysis was carried out using BioMercator V4.2.3 (Arcade *et al*. 2004). The candidate gene identification, annotation, and ontology analysis-related information were extracted using 'qTeller' and inhouse Perl Script. In the present study, 128 out of 381 reported QTLs from 82 mapping studies for FDR could be projected on the maize genome through MQTL analysis. The analysis revealed 38 MQTLs for resistance against 12 fungal diseases on chromosome 1 to chromosome 9 across the maize genome. Five MQTLs were linked with multiple FDR. A total of 1910 candidate genes were identified for all the MQTL regions associated with FDR. The MQTL regions were verified from previous GWAS studies. The putative candidate genes underlying identified MQTLs can help in the functional validation of MQTLs for FDR. The study also attempted to identify the constitutive gene network, which will be important in understanding the molecular mechanism of defense-response and multiple FDR in maize.

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T-4/P-53

Development and screening of maize hybrids under water log conditions using selection indices

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Waterlogging is one of the major key constraints for maize production during *kharif* especially in Northwestern plain zone of India. The early vegetative stage is highly sensitive to waterlogged conditions for maize. To identify, tolerant maize hybrids to waterlog stress, ten maize hybrids were screened for waterlog condition *vis a vis* normal condition as the control in three replication during *kharif* 2021. The inbreds used for hybrids development had high agronomic potential along with tolerance to stresses. Continuous flooding for a week was used to create waterlogs tension at the V_4 stage with a ponding depth of 10 ± 0.5 cm. Need-based irrigation was supplemented to keep the water table at a constant depth. The stagnant water from the field was drained after the seventh day and recommended irrigation was provided as per crop need. Various yields and their contributing characters were recorded. The analysis of variance revealed that the hybrids showed statistically significant differences for 50% pollen shed, 50% silk emergence, plant height, 75% husk browning, cob length, and cob yield under normal conditions whereas, the hybrids showed statistically significant differences for anthesis silking interval, cob length, cob girth, and cob yield under waterlogged stress. The grain yield in normal and waterlogging stress conditions was subjected to seven selection indices, including tolerance index, mean productivity, stress susceptibility index, stress tolerance index, yield index, yield stability index, and relative stress index, and the waterlogged tolerant hybrids in waterlogged conditions were identified as JH 21028, JH 21078, and JH 21038.

T-4/P-54

The efficacy of fungicides against post flowering stalk rot (PFSR) of specialty corn caused by *Fusarium verticillioides* (sheldon).

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Three Systemic fungicides were evaluated against four isolates (Fv SC-01 to Fv SC-04) of *Fusarium verticillioides in vitro* condition to develop effective management strategies for post flowering stalk rot (PFSR) of specialty corn caused by *F. verticillioides*. Bavistin and saaf were found most effective inhibited 100% mycelial growth of pathogen *in vitro* at different concentrations@ 200, 400 and 600 ppm. Tebuconazole also showed complete inhibition of the mycelial growth at 400 and 600 ppm concentration, while at 200 ppm concentration it caused 97.80, 98.0, 98.33 and 98.55 per cent inhibition (Fv SC-01, 02, 03 and 04) of all isolates respectively.

T-4/P-55

Evaluation of insecticides as spray based on incidence for the management of fall armyworm *Spodoptera frugiperda* (J.E. Smith)

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The experiment to evaluate the efficacy of one recommended insecticide (Chlorantraniliprole 18.5% SC @ 0.4 ml/litre of water) against fall armyworm infesting maize under natural infestation conditions was conducted during *Kharif*, 2020 and 2021 at Agronomy Farm, Rajasthan College of Agriculture, MPUAT, Udaipur. The observations were recorded at 10 days after spray and ear damage rating scale at harvest. The results revealed that the whorl feeding injury rating ranged from 2.10-5.15 and 2.12 to 5.45 Davis score and ear damage rating ranged from 1.88 to 5.92 and 1.92 to 6.12 Davis score in different treatments during *Kharif*, 2020 and 2021 respectively. The lowest whorl feeding injury rating 2.10 and 2.12 was recorded in recommended insecticide treatment application of Chlorantraniliprole 18.5% SC @ 0.4 ml/litre at 7 & 14 DAG followed by (2.17 & 2.28 during 2020) and (2.22 & 2.33 during 2021) whorl feeding injury rating in treatment Davis core-2 and at 10 & 20 DAG, respectively. The maximum infestation was recorded in treatment application at as soon as moth found in trap, with mean whorl feeding injury rating 4.33 and 4.10. Untreated control was recorded highest mean whorl feeding injury rating 5.15 and 5.45 during *Kharif*, 2020 and 2021 respectively.

T-4/P-56

Inhabitant's fluctuation of fall armyworm, *Spodoptera Frugiperda* (J.E. Smith), infesting in maize (*Zea Mays* L.)

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Experimental distribution and abundance of the fall armyworm, *Spodoptera frugiperda*, and infesting maize were investigated at the Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan, from July to October 2020 and 2021. *S. frugiperda* was revealed to become a serious maize pest throughout both years, as per the observations during 2020 and 2021, the optimum larval counts of *S. frugiperda* were found during the first week of August (2.10 larvae/plant) and the second week of August (2.45 larvae/plant). Plant damage percentages increased over the years, approaching 49.45 and 54.33 percent in the last week of September in 2020 and 2021, respectively. *S. frugiperda* caused cob damage beginning in the first week of September and peaked last week (34.62 & 44.25 percent). The larval abundance of *S. frugiperda* had such a positive correlation with average temperatures during both years, however a negative correlation with rainfall.

T-4/P-57

Evaluation of organic management practices for control of fall army worm (*Spodoptera frugiperda*) and yield in sweet corn

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The field experiment was conducted during *kharif* seasons of 2020 at the Organic Farming Unit, MPUAT, Udaipur, Rajasthan, to evaluate the effect of organic management practices for control of fall army worm (*Spodoptera frugiperda*) and yield in sweet corn. The experiment comprises 12 treatments and 3 replications with RBD design. Results revealed that application of 5% neem leaf extract + use of pheromone mass trap + Dusting of silica powder on foliage of sweet corn plant @ 25kg/ha + Application of silicon granules in whorls of sweet corn plants @ 125kg/ha recorded minimum mean per cent infestation 21.67% and leaf injury rating 1.25 and this treatment recorded significantly higher green cob yield 35.60 q/ha and net return Rs 111555/ha as compared to other treatments.

T-4/P-58

Abiotic stress management in maize under changing climatic condition

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Abiotic stress is a negative impact of non living factor on the living organisms in a specific environment. Plant growth and development are affected by various abiotic stresses like drought, submergence, salinity and high and low temperature. These abiotic stresses cause average yield losses of greater than 50 per cent in a majority of crop plants. Maize is the widely grown crop throughout the world. Its response against several environmental stress element is quite complex and dynamic, and can be either adjustable or non adjustable in nature. Climatic change on other hand is expected to stretch the intensity and frequency of both the abiotic and biotic stress factors or elements. In this context, the literature on climate change consortium with abiotic stress highlighting the scenario of this nutritionally valuable crop plant and its elicited responses at morphological, physiological, biochemical and phytochemical levels. Architecture of the plant toward multiple stress factors is also discussed as a report of its first kind. Inspite of remarkable knowledge gaps still exist, it is evident that climate change is going to influence the abiotic stress tolerance mechanisms in plants in common and in maize plant particularly. While broad generalizations are not yet possible, because the specific plant responses towards one type of stress at one time or multiple stresses differ considerably. However, a better understanding of underlying response mechanisms regulated in the face of climate change-associated abiotic stress is needed to safeguard the optimal resilience and productivity of the maize.. A holistic approach taking into account the different management options to deal with heat and drought stress simultaneously could be a win-win approach in future. Understanding plant responses and molecular and physiological changes occurring during these stresses is necessary to improve current cultivars and release new cultivars with enhanced resistance to such stresses. An overview of the impacts of high and low-temperature stress, drought and submergence in plant growth and development and the physiological and molecular responses of plants. Strategies adopted by plants to overcome these stresses through avoidance and tolerance mechanisms such as early maturity, maintain water balance, higher yield even under low water potential.

T-4/P-59

Unravelling genetic variability and inheritance for Fall army worm tolerance in PAU maize germplasm stock

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Spodoptera frugiperda (J. E. Smith) commonly known as Fall army worm (FAW), isa devastating insect pest of maize (*Zea mays* L.) resulting in significant yield and economic losses. FAW is one of the most difficult insect pests to control in maize. Late planted fields and later maturing hybrids are more likely to become infested. FAW causes serious leaf feeding damage as well as direct injury to the developing ear. While fall armyworms can damage corn plants in nearly all stages of development, it will concentrate on later plantings that have not yet reached silk emergence stage.

It is a native to tropical and subtropical regions of the America reported infesting maize from Nigeria in 2016. Till now it has been confirmed in more than 40 African countries. In India, since its first report from Karnataka on maize in May, 2018, it has spread to almost all the states and to many Pan-Asia countries posing a major threat to maize production in the region. Implications of these new threats are alarming, calling for urgent action to halt the spread of these pests. PAU has a rich reservoir of maize genetic stock from diverse origin; introgression fixed lines from wild relatives and biotic stress tolerant lines from CIMMYT. Moreover, insect rearing and artificial infestation techniques have also been standardized at PAU so that uniform selection pressure can be applied. Good insect rearing facilities are necessary to maximize selection efficiency. Preliminary screening for FAW in PAU genetic stock of 100 lines indicated differential response to FAW resistance under natural infestation. In *kharif* 2021, amongst these 100 lines, a set of 45 inbred lines were screened under artificial conditions. The Data was recorded at four stages viz., 14, 28, 50 days after infestation and at cob formation stage. F_1 s generated using FAW infestation tolerant inbred PML 1253, as either of the parent, using different susceptible inbreds, generated tolerant single cross hybridss as revealed by artificial screening of generated hybrids. PML 1253, hence, can be effectively used to breed for commercial hybrids inferring tolerance against FAW.

T-4/P-60

Abiotic stress resistance in maize (*Zea mays*)

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Maize (*Zea mays* L.) is an important staple cereal crop grown for food, feed and biofuel production all around the world. Maize production is threatened by increase in moderate to severe droughts, high air temperature and erratic rainfalls. Maize is a drought sensitive crop, mainly in critical stage of growth such as seedling stage and is grown in wide range of climatic conditions from semi-arid to temperate regions including drought prone areas. Plants undergo morphological and physiological changes under drought stress condition. This process can be covered under three major categories. Drought resistance is ability of plant to maintain favorable water balance and turgidity under water stress condition. Drought escape is a strategy in which plant complete its life cycle before the onset of drought. They show the seasonal response. Drought avoidance strategy integrates increase water uptake and decrease water loss by plants.

Maize plants showed decrease in net photosynthesis at leaf temperature increased above 38 degree centigrade and the reduction was severe when the temperature increased abruptly rather than gradually. Transpiration rate increased with increase in temperature which implied that decrease in photosynthesis was not because of stomata closure. Salinity stress is mostly caused by the high concentration of NaCl which induces abiotic stress in plants in both irrigate and non-irrigated condition. Salinity stress retards plant growth and productivity, mainly due to ion toxicity and osmotic stress. Thus induced osmotic stress decrease stomata opening which reduces photosynthetic ability.

The effects of abiotic stress on maize are prevalent from seed germination to maturity. The combined managerial and biological strategies are the way forward for the development of abiotic stress resistance. Managerial strategies include wise use of water and other resources and development of water saving agronomic practices.

T-4/P-61

Spatial distribution of invasive fall armyworm, *Spodoptera frugiperda* in maize at Udaipur

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In India, fall armyworm was reported for the first time on maize from Shivamogga district (Karnataka) during May-June 2018. The present investigation aimed to study the distribution pattern of larvae of invasive fall armyworm in maize crop at Udaipur district of Rajasthan.

The larval population of *S. frugiperda* was recorded on 60 randomly selected plants at weekly interval. The data from original counts were arranged in frequency tables for fitting the different statistical parameters. Variance to mean ratio (Southwood, 1978), exponent – K (Lloyd, 1967), patchiness index (Lloyd, 1967), clumping index (David and Moore, 1954), mean colony size (Tanigoshi *et al.*, 1975), mean clump size (Arbous and Kerrich, 1951), Iwao's patchiness regression (Iwao's, 1968) and Taylor's power law (Taylor, 1961) were analyzed to test the dispersion behaviour of *S. frugiperda.*

The result revealed that clumped, uniform and random type of distribution of *S. frugiperda* larvae in maize field. The value of dispersion index exceeded unity in most of the weekly observations indicating a contagious type of distribution. The Lloyd's index was close to one that also indicated clumped type of distribution.

The larvae of *S. frugiperda* showed clumped type of distribution in most of sampling date during both the year. This showed that timely management practices should be required for this pest.

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T-4/P-62

Drought stress response in maize (*Zea mays* L.): Impacts, resistance strategies and management for sustainable food production

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Maize (*Zea mays* L.) has become the key crop with a global food supply of 1×109 t (1012 kg) since 2013 (FAOSTAT, 2017) and is the third most important crop grown after rice and wheat. It supports the ever-increasing human population by fulfilling dietary demands directly as a consumptive foodstuff or indirectly as feed for the livestock and for biofuel production as well. To meet the increasing demand for animal and human consumption, studies have suggested that the maize production must double especially in developing nations. Plants, being sessile suffer from significant yield losses and changing climatic conditions are intensifying the variability in maize yield. Maize is a drought sensitive crop, mainly in critical stage of growth such as seedling stage, drought stress during vegetative growth especially during V1 to V5 reduces plant growth, increases the vegetative growth period and reduces growth period of reproductive stage. Plants develop strategies such as osmotic adjustment, facilitation of antioxidant defensive machinery, and development of desiccation tolerance in order to develop drought tolerance. Altogether, crosstalk between morphological, physiological, biochemical, phytochemical and molecular responses plays an important role in developing drought tolerance in maize.

Plant pigment concentration under drought stress varies in different inbred line of maize, under water-stressed conditions, total chlorophyll, chlorophyll-a, chlorophyll-b, carotenoids and anthocyanin concentration gets decreased in the two inbred lines of maize, B73 and MO17. Apart from pigments, more general changes found in maize genotypes under drought stress include reduction in RWC and membrane stability index (MSI), enhanced rate of superoxide radical and hydroxyl radicals, production of hydrogen peroxide, thiobarbituric acid reactive substances (TBARS) as a measure of lipid peroxidation in the membrane, increased content of different osmoprotectants like proline, total soluble sugars, glycine-betaine. Increase in defense related enzymes such as Catalase (CAT), peroxidase (POX), super oxide dismutase (SOD), Glutathione reductase (GR) and ascorbate peroxidase (APX) etc also contribute towards drought stress tolerance. The plants are found to develop stress tolerance upon external application of plant growth regulators thus, exogenous application of proline, glycine betaine and secondary metabolites such as terpenes and phenolics may be considered as an indispensable strategy to mitigate the harmful effects of drought stress and an auspicious tool for maintaining and enhancement of both growth and productivity in maize. Study suggested

that 2-(3, 4-Dicholorophenoxy) Triethylamine (DCPTA) application on maize seedlings enhanced growth and photosynthetic activity of plant under drought stress condition.

NAC protein responses to drought and other abiotic stresses along with regulation of multiple biological processes in plants. The natural variation in maize drought tolerance was significantly associated with insertion of miniature inverted repeat transposable element (MITE) in promoter of NAC gene (ZmNAC111). Heat shock proteins (HSP45, HSP70) expression along with the proteins such as ZmMPK3, ZmMPK7 and ZmAN13 and epigenetic alterations (DNA methylation and histone modifications such as H3K9 acetylation) can be exploited further to characterize and validate the drought responsive genes in maize. Genome wide association study (GWAS) showed that Indel-572, located 572-base pair upstream of start codon of ZmNAC111, was found to be significantly associated with seedling survival rate during drought stress in maize.

Despite having significant knowledge of various drought tolerant mechanisms in maize, yet there are many gaps that still exist, it is evident that climate change is going to influence the drought stress tolerance mechanisms in maize. Therefore, better understanding of underlying response mechanisms regulated in the face of climate change-associated drought stress is needed to safeguard the optimal resilience and productivity of the maize for sustainable production in the years to come. To generate a climate-smart maize cultivar combination of conventional breeding methods and molecular approaches, explicitly transgenic strategies need to be implemented and also effective measures at global level to increase the per hectare yield of maize crop is need of the hour.

T-4/P-63

Involvement of maize chitinases in disease resistance against maydis leaf blight

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Maydis leaf blight (MLB) also known as Southern corn leaf blight (SCLB) caused by *Bipolaris maydis* (Y. Nisik. & C. Miyake) Shoemaker. In response to pathogens, plant produces different Pathogenesis-related (PR) proteins. Among the PR-proteins, chitinases produced by plants play a very active role in defending the host plants against phytopathogens. It enzymatically degrade chitin, an insoluble linear alpha-1,4 linked polymer of N-acetyl-glucosamine. Chitin is a component of the cell walls of fungi and is absent in plants. We spectrophotometrically measured the chitinase in pre-inoculated maize plants for five different stages at 7 days interval. Chitinase specific activity (CHI) activity was expressed as µmoles NAG min^{-1} mg^{-1} protein. Results showed highest chitinase activity in the leaves of LM 13 during various growth stages examined as compared to control and LM 15 plants. The higher chitinase activity of LM 13 plants might help in resisting infection. Soluble chitin fragments released from *B. maydis* cell wall, through the action of increased chitinase level in maize might have elicited the PAMP-triggered immunity (PTI) and defense-related responses like phytoalexin synthesis. LM 13 was found to be resistant genotype which showed the significant increase of chitinase activity. Thus in maize, induction of chitinase enzymes is one of the multifaceted defense mechanism triggered in response to *B. maydis*.

T-4/P-64

Status of fall armyworm (*Spodoptera frugiperda* Smith) in Bihar

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Owing to the geographical location and agro-ecological conditions, Bihar is well known for the cultivation of maize round the year. It is grown in almost all the districts either as a sole crop or as an intercrop with potato. Though, lots of factors are responsible, insect pests play an important role for getting optimum production and productivity. Recently an invasive pest identified as Fall Armyworm (*Spodoptera frugiperda*) which made its first intercontinental migration from America to Africa has also been reported from almost all the states of India. The pest was first reported in some isolated place of Bihar during August, 2019 and spread to almost all districts with in a short span of time. A survey was conducted in the four major maize growing district of Bihar to know the present status of fall army worm infestation. In each district, ten progressive farmers were selected and monitored through both physically and telephonically. The infestation of fall army worm was recorded from 100 selected plants at a fortnight interval from seedling emergence to harvesting. Based on the survey, it was found that, maximum infestation was recorded in Begusarai district followed by Muzaffarpur, Samastipur and West Champaran. Further, it was noticed that infestation was initiated during the seeding stage, attained peak during knee height stages. Infestation was rarely observed in reproductive stages under Bihar scenario. The egg period is about 5-7 days, larval period is lasts for 20-28 days, pupation occurs inside the soil and pupal period varied from 8-12 days, under Bihar scenario. Based on the survey, farmers were advised to take two sprays of either Chlorantriniliprole 18.5 SC or Emmamectin Benzoate 5 % SG @0.4 ml/L at fortnight interval during initial growth stages.

T-4/P-65

Effects of waterlogging on the growth parameters of maize hybrids under field water logging condition

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The screening for water stress of fifty-five CIMMYT maize genotypes was carried out to estimate the genetic variability and correlation at Agriculture Research Farm, Institute of Agriculture Science, BHU, Varanasi. The experiment was conducted in an alpha lattice design with two replication and phenotypic data were analyzed using seven traits. Analysis of variance revealed significant differences among the genotypes for all the parameters studied. The maize hybrids (ZH15506, ZH17506, ZH17229 and ZH17496) showed highest value for grain yield per plant. Yield per plant was increased with germination percentage, plant height at seedling and chlorophyll content. If the selection for a water logging tolerant genotype is made for any of these component traits, the improvement in yield per plant could be achieved.

T-4/P-66

Recent advances in effective biorationals management of serious biotic threat of maize

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Globally, maize (*Zea mays* L.) is known as 'Queen of the Cereals' or 'Miracle C4 crop' because of its genetic makeup conserve highest yield potentiality among the other cereals and gaining popularity as evidenced by its large-scale consumption as food (61%), feed (17%), fodder for animals and as source of industrial raw materials (22%) *viz.*, starch, syrup, dextrose, gelatin, protein, alcoholic beverages, oil, pharmacy, cosmetics, bio-fuel (ethanol), food sweeteners. Despite its high yield potential, maize is affected by several biotic stresses that constrain the tropical and subtropical maize yield production. Banded leaf and sheath blight disease of maize caused by fungus, *Rhizoctonia solani* f.sp. *sasakii* Exner, belonging to anastomosis group (AG-1-IA) is considered as the major constrain for declined production. The magnitude of grain yield losses recorded up to 11-40 per cent with 71 percent disease index in India, up to 100 per cent at the ear rot phase in Indonesia, and 44-66 per cent in Myanmar depends upon varied agro-climatic conditions. Recently several "bio-rationales" such as phytoextracts and biocontrol agents have been adopted by agricultural ecosystem to minimize this serious threat of maize. Phytoextracts and biocontrol have great potent to control the banded leaf and sheath blight of maize below the threshold level of economic losses. Several phytoextracts, including garlic, cloves, and neem, as well as antagonists such as *Trichoderma viride, T. harzianum, Pseudomans fluorescence,* and *Baclillus subtilis*, have been reported to inhibit *R. solani* mycelium growth in vitro and to be effective in field conditions with a positive correlation with a significant increase in yield. Integration of cultural practices with biorationals as a seed dresser as well as foliar spray has high potential to combating soil borne pathogens.

T-4/P-67

Development of Fall armyworm (*Spodoptera frugiperda* L.) at different temperatures

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Fall armyworm (*Spodoptera frugiperda* L.) (Noctuidae: Lepidoptera) is an intercontinental, devastating, polyphagous farm pest causing economic losses worldwide. FAW larvae voraciously feed on foliage on maize crop causing extensive damage resulting in total crop loss. FAW invaded in Karnataka (India) at Shivamogga in maize fields during July 2018 (Sharanabasappa *et al* 2018) and afterwards in other Asian countries (FAO 2018). FAW invaded Punjab during end season of *kharif* 2019. The present study was conducted to understand the survival rate of different growth stages and population dynamics of the invading insect at prevailing temperature conditions of northern India. The eggs, larvae at 1st, 3rd, 5th instar and pupae survival and duration was recorded at 10°C, 15°C, 20°C and 25°C at 70-72 % RH. The maximum duration was recorded at 15°C while minimum at 25°C for all the larval stages. A significant difference in larval period at all growth stages was observed. The development duration of 1st instar to pupa was maximum at 15°C i.e., 67.10 days compared to 20°C (32.20 days) and 25°C (21.84 days).The 3rdinstar showed the minimum developmental duration at 25°C.The larvae 1st and 3rd instar stages did not survive at 10°C but only 5th instar larvae survived at 10°C with 15% survival rate, which is of concern. The survival percentage for the larvae at 1st, 3rd, 5th instar and pupae was recorded to be 20%, 48%, 65% and 90% at 15°C, respectively. At 20°C, it was, 35% for 1st instar, 56% for 3rd instar, 90% for 5th instar and 100% for pupae. The survival %age for larvae at 1st, 3rd, 5th instar and pupae at 25°C was recorded to be54%, 86.74%, 95% and 100%, respectively. The survival percentage of larvae hatched from eggs was 61.36% at 20°C and 89.13% at 25°C. Based on these parameters temperature threshold will help in prediction of their potential survival at o low temperature and non availability of maize crop in Northern India during winter months. Practically as observed the survival of FAW is negligible, but if the alternative host is available, the FAW may persist.

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T-4/P-68

Integrated management of banded leaf and sheath blight of maize caused by *Rhizoctonia solani* f. sp. *Sasakii*

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Banded leaf and sheath blight of maize is caused by a destructive and versatile pathogen *Rhizoctonia solani* f. sp. *sasakii*. Integrated management of Banded leaf and sheath blight of maize is done by using the bioagents, botanicals and fungicides under both in vitro and in vivo conditions. Under in vitro conditions among the organic enriched compost, vermicompost showed the maximum mycelial inhibition (83.8%) at 50 % concentration and in case of bioagents, *Trichoderma* spp. MDA-1 showed the maximum mycelial inhibition up to 87.1% followed by *Trichoderma koningii*-DMA-8 (85.7%). Aqueous extracts of *Eucalyptus globules* yielded maximum mycelial inhibition of about 92.1% at 50% concentration. Crude extract of *Eupatorium adenophorum* showed 100% mycelial inhibition at 2.5% concentration. Among test fungicides, bavistin at 5 ppm was found most effective to inhibit the pathogen up to 77.1%. Tilt and companion also resulted in the 100% mycelial inhibition at 100 ppm. Integrated practices *i.e.* soil amendment with vermicompost and seed treatment with bavistin @ 2.0 g/kg seed followed by two foliar sprays of bavistin @ 0.1 % at 15 days interval was found to be the best treatment with maximum disease reduction of 73.1% as compared to that of control. Soil amendment with vermicompost and seed treatment with *Trichoderma* sp. (MDA-1) + *Eupatorium adenophorum* (50:50) and two foliar sprays of bavistin @ 0.1% at 15 days interval recorded 53.8% disease reduction over control.

Theme-5
Last mile delivery of maize technologies

T-5/O-1

Success story of Farmers' participatory seed production of Maize hybrid –Karimnagar Makka-1 in the state of Telangana

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Karimnagar Makka-1 (KNMH4010131) is a medium duration, high yielding single cross hybrid tolerant to late wilt and maydis leaf blight released in 2016 through SVRC from PJTSAU and is recommended for wilt prone areas of Telangana. With the increase in seed demand of Karimnagar Makka-1, it is very difficult to carryout hybrid seed production at research station due to problem arose in maintaining isolation distance. Hybrid seed production was carried out at Antakpet village of Siddipet district, Telangana state during *rabi, 2018-19* & 2019-20 in red sandy loam soils. *Rabi* is the most suitable season for taking up hybrid seed production where temperature during the growth periods does not go below 10^0 C in that area during winter season in last decade i.e., 2010-19, average minimum temperature during November, December and January were 23.3^{o}c, 19.9 ^{o}c and 20.2 ^{o}c, respectively in Karimnagar). Moderate humidity (65-70%) prevailed in the areas are much more suited to seed production. Recommended dose of fertilizers @ 200: 60: 50 NPK kg/ha are applied, entire P & K was applied at basal and N was applied at 30, 45, 60 DAS and need based weed control, irrigations and plant protection measures were followed. Detasseling was done in case of female parent to have pure hybrid seed. The farmers of Antakpet village normally cultivate maize during *rabi* season every year, the average yield ranges from 32-35 q/ acre and the farmers have expertise in maize cultivation. Farmers have shown keen interest in maize seed production, so we distributed female and male seed @ 15 kg and 5 kg/ha, respectively during *rabi*, 2018-19 & *rabi*, 2019-20. The advantage of this hybrid seed production is both female and male parents can be sown at a time. The seeds were sown with active guideline and participation of Scientists. In seed production fields, average cob yield ranged from 10-12 q /acre. Farmers got a gross income of Rs. 60,000- Rs. 66,000/ acre in maize seed production whereas a gross income of Rs. 45,600- Rs. 49,875 was realized through normal maize cultivation with average grain yield of 32-35 q/acre. It clearly emphasized an ample scope for the seed production of public bred maize hybrids to spread area of the hybrid in wilt prone areas so that farmer's income levels are raised through participatory seed production *via* seed cooperatives.

T-5/P-1

Impact assessment of Quality Protein Maize Hybrid (SQPMH-1) in frontier District Kupwara of Kashmir

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District Kupwara has the maximum area under maize among all districts of Kashmir valley. Most of the tribal areas of district Kupwara cultivate maize and have maize chapattis as their staple food; such areas have higher demand for maize. However, farmers cultivate local varieties of maize with low yield potential. One of the major constraints in the maize production in such areas is non-availability of high yielding varieties of maize. To overcome this constraint Krishi Vigyan Kendra Kupwara in collaboration with DARS Rangreth conducted front line demonstrations at farmers' field on hybrid maize hybrid SQPMH -1 with recommended package of practices, whereas the local variety in the adjoining areas was taken as check/ control. During the period under study it was observed that the hybrid maize hybrid SQPMH-1 with recommended package of practices recorded yield of 6.5 t/ha as compared to local check with farmers practices with the yield of 2.5t/ha. The percentage increase in the yield over check was 61.5%. The increase in yield could be attributed to the high yield potential, quality and suitability of the hybrid in the area.

T-5/P-2

A preliminary study of the evaluation of maize hybrids for grain yield under Temperate areas of Kashmir for inclusion in the farmers fields.

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Maize is the third most important cereal crop after wheat and rice.. Improving maize production is considered to be one of the most important strategies for food security in the developing countries.. The farmers in Kandi areas usually grow their own saved seed which comprises of composites and landraces due to which maize production suffers due to low productivity. So a number of hybrids were developed in order to improve yield and productivity in order to enhance their income. The experiment was carried out in RCBD with three replications in two main cropping seasons 2018 and 2019. The standard package of practices were followed. The hybrids were evaluated over two years for yield and the ranking done on the basis of yield for inclusion in the breeding programme. The highest and lowest grain yield were recorded for KDMH-118 (83.47 q/ha) and VH-3815 (81.49 q/ha) respectively. All the hybrids were early maturing hybrids. These results are in line with those of Tripathi and Shrestha and Javed *et al.* (2015) who reported significant differences among maize cultivars for grain yield. As such these hybrids can be used for distribution to farmers to improve their livelihood security.

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T-5/P-3

IHPC-1203, Pop corn hybrid for cultivation in NWPZ, NEPZ and PZ in *Kharif* season

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Popcorn consumption may have boomed over the past decade, especially in multiplex cinemas, malls and food courts across metros and Tier-II cities as well as people conscious regarding health. Pop corn hybrid is not available in Gujarat till date. In India, most of the hybrids available from private sector and some from public sector as well. Therefore, there is a need to develop popcorn hybrids for Gujarat and some part of country. Therefore, the research was started with the objective to develop single cross popcorn hybrid and release for cultivation in kharif season and to improve livelihood of the farmers.A Popcorn hybrid IHPC-1203 was developed at Main Maize Research Station, AAU, Godhraby crossing of IGPF-21 and IGPM-23. This hybrid was tested in AICRP and in trials were conducted in AICRP across all the four zones. The trials were conducted in RBD with 3 replications by keeping 60 x 20 cm sowing distance.Themultilocation evaluation of hybrid carried out during *Kharif*-2016 to 2018. The experiments laid down by taking 60 x 20 cm plot size. Popping tests were performed by using a hot air popping machine (Arçelik, ARK77 MP, 230 V, 1200W). It yielded on an average 38.76 Q/ha popcorn yield and found 24.8 % superior in yield over the check VL Amber popcorn in the North West Peninsular Zone (NWPZ). It yielded on an average 32.94 Q/ha popcorn yield and it is found 30.6 % superior in yield over the check VL Amber popcorn in North East Peninsular Zone (NEPZ) and it yielded on an average 49.22 Q/ha popcorn yield and found 26.1 % superior in yield over the check VL Amber popcorn in the Peninsular Zone (PZ). The quality point of view, this hybrid having high popping (92 %) and popping volume (213 ml/ cm3). It exhibited moderate resistant against MLB and charcoal rot in NWPZ. Moderate resistance against C. Rot, P. rust and TLB diseases in PZ. It exhibited moderate resistance against *Chillopartellus* in all three zone. Based on the overall performance and superiority over national check VL Amber Pop corn , it is identified and recommended to release for *Kharif* cultivation in the NEPZ, NWPZ and PZ in India.

T-5/P-4

GAYMH-1, high yielding baby corn hybrid for cultivation in PZ and CWZ in *Kharif* season

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In Maize, now a days tender and immature cobs of corn are being used as vegetable (Galinat, 1985). This novel use, known as baby corn (candle corn in Thai cook books), is becoming popular in domestic and foreign markets and has enormous processing and export potential. For baby corn a seed variety is chosen and planted to produce only baby corn. Many varieties are suitable, but those developed specifically for baby corn tend to produce more ears per plant. But the available varieties/ hybrids don't provide the better-quality baby cobs. In *kharif*, some of the farmers are growing yellow varieties resulted in low productivity. Hence, there is a need to release medium maturing and high yielding bay corn hybrid to replace the composite varieties to enhance yield of baby corn. Therefore, the study was started with objective to develop and release single cross hybrid for baby corn. Then after new Baby corn hybrid, GAYMH-1 was developed involving two inbred lines IGI-1101 and IGI-1103 in 2016-17. This hybrid was tested in AICRP system and trials were conducted in AICRP across all the five zones. The trials were conducted in RBD with 3 replications by keeping 60 x 20 cm distance. The multilocation evaluation of hybrid carried out during *kharif* -2015 to 2017. On the basis of overall mean of all the three years of testing across all the five zones, GAYMH-1 in Peninsular Zone (PZ), it yielded on an average 14.3 Q/ha Baby corn yield which is 12.6 % superior in yield over the best check HM-4. Same way, it yielded on an average 22.9 Q/ha baby corn yield which is found 18.6 % superior in yield over the HM-4 in Central West Zone (CWZ). In PZ, it showed moderate resistant against CLS and moderate susceptible to moderate resistant against C. rust and TLB. In CWZ, it showed moderate resistant against C. Rot, RDM and CLS diseases. In both the zones, it showed moderate resistant against stem borer (*Chillo partellus*). Being a high yielder, it will be more suited to farmers as a cash crop. The produce will be preferred by farmers, consumers, hotels and canning industries as well.

T-5/P-5

Popularization of maize in tribal belt of Pali through frontline demonstrations

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Maize (Zea mays L.) is the most versatile crop with wider adaptability and highest genetic yield potential among the food grain crops. Maize is an important staple food of the tribal belt of Pali, Rajasthan. Lack of suitable high yielding variety as well as poor knowledge about production practices are described as main reasons for low productivity of maize in the district. The productivity of maize per unit area could be increased by carried out front line demonstrations on new varieties with recommended production technologies to convincing farmers to adopt improved production management practices for enhancing productivity of maize.

PRA techniques were applied in these to know the priorities and constraints which were adversely affecting the yield levels. Based on problems identified, front line demonstrations were planned and conducted in different villages of Desuri and Bali at the farmers' field. Under FLD during this period 40 demonstrations were organized of 0.2-0.4 ha/each using short duration improved variety i.e., HQPM-5. The purpose of these Front Line Demonstration's (FLD) was to know the yield gaps, technology gap, extension gap and the technology index by collecting of front line demonstration's and farmers field yields data and to find out the reasons for low yield and specific constraints with the small farmers.

Based on the study it was observed that in FLDs, improved maize cultivar i.e. HQPM-5 recorded average grain yield (40.7 q/ha) and the per cent increase in yield was 36.7 higher over local variety. Yield of the FLD trials and potential yield of the crop was compared to estimate the yield gaps. High technology gap (37.3) and extension gap (42.5) was observed as compared to farmers practices. The technology index was low. The observed technology gap may be attributed to dissimilarities in soil fertility, salinity and erratic rainfall and other vagaries of weather conditions in the area (Dhaka et al., 2010). The need to educate the farmers through various means for the adoption of improved high yielding varieties and improved agro technologies to reverse this trend of wide extension gap. More and more use of new HYV's by the farmers will subsequently change this alarming trend of galloping extension gap.

From the present study it can be concluded that improved maize variety and technology in frontline demonstrations gave promising results in terms of yield, gap and technology index. Therefore, it is suggested that more number of front line demonstration are to be organized to demonstrated newly released crop production/protection technologies and its management practices in farmers field.

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T-5/P-6

Redundancy assessment for management of genebank collections- A case study in maize

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The National Genebank at ICAR-National Bureau of Plant Genetic Resources conserves one of the largest collections of maize germplasm, which comprises of indigenous maize diversity collected from throughout the country. A major collection is from the north eastern hill region, from where recent exploration missions have added large number of populations with unknown identity. The large collection size of such populations hamper their effective utilization since in maize, concerted efforts are required to address the genetic bottlenecks of trait introgression. Hence, the present study was undertaken to assess the extent of redundancy, through use of passport data, morphological data and molecular characterization data, in a selected set of 24 maize populations collected from four northern districts of Mizoram. The experiments involved 30 morphological descriptors and 93 microsatellite markers for an extensive analysis of multiple parameters. The analysis could identify redundant sets within genetic clusters, through integration of geographic, morphological and molecular data and from within 24 accessions, 16 accessions were marked for bulking, which would bring down the conservation size from 24 accessions to 14 accessions. The study also proposed an exploration strategy for mimban maize populations, which would enable their cost-effective conservation and utilization *i.e.* within a district, samples collected from comparable altitude, having synchronized flowering behaviour and similar cob characteristics, should be pooled and submitted as single accession with recommended seed quantity. Further application of this information in maize populations from other regions and also in other crop groups that are conserved in NGB, is envisaged.

T-5/P-7

Performance of different maize varieties under Front Line Demonstrations in District Kupwara.

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Maize is one of the important cereals next to wheat and rice in the world and in India as well and is grown with equal success in temperate, tropical and subtropical regions of the world. In Kashmir valley maize is cultivated on area of 1.0 lac hactares which comprises of 26% of total maize area in the UT of J&K. Maize is grown in all the districts of Kashmir Valley with second highest area of 19.50 thousand hactares in Kupwara after Baramulla district, however the productivity of maize in Kupwara is very low as compared to the national average because of the poor seed replacement rate. To improve seed replacement rate and adoption rate of maize technologies front line demonstration on different high yielding area specific varieties were carried out in Kupwara. In the present investigation 120 Front line Demonstrations on maize varieties were conducted by KVK–Kupwara at farmers field in District Kupwara to demonstrate the impact of high yielding varieties of maize viz , Shalimar Maize Composite-,3 Shalimar omposite-4 , Shalimar KG-2, Shalimar QPMH-1 and LQMH-1 with recommended Package of Practices and compared with local check during the kharif seasons of 2020 and 2021 The improved high yielding varieties Shalimar Maize Composite-,3 Shalimar omposite-4 , Shalimar KG-2, Shalimar QPMH-1 and LQMH-1 recorded yield of 48, 58 45 68 and 85 qs/ha respectively .as compared to local variety with yield of 12 q /ha. The technology gap of SMC-3, SMC-4, Kg-2 Shalimar QPMH-1 and LQMH-1 was recorded as 3,2,5,2 and 5 respectively and extension gap was recorded as 36,46,33,56 and 73.

T-5/P-8

Yield performance of maize through front line demonstration in Malwa Region of Madhya Pradesh

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Frontline demonstrations have been proven one of the most effective tools for showcasing the technological benefits among the farming community. Frontline Demonstrations (FLD), a further advanced methodology has been used to enhance the yield and income of the maize growers. During 2018 to 2021, under FLD, demonstrations were conducted by KVK Ratlam in 6 block of district in maize crop using variety DKC-9133. Besides, scientists recommended seed rate, line sowing for proper spacing & placing, timely sowing, use of balanced fertilizer, integrated pest management, *etc*. under demonstration. The result reveals the increases yield of demonstrated plots that was 28.85 percent as compared to existing farming practices for maize, respectively due to adoption of improved package of practices.

T-5/P-9

Assessment of hybrid maize cultivation using participatory approaches in Mayurbhanj district of Odisha

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Maize (Zea mays L.) is one of the important cereal crops in Odisha. The crop occupies a crucial place than other cereal crops since it is used as food, feed, fodder and other industrial raw materials. Maize cultivation is increasing day by day in Mayurbhanj district of Odisha by approaching crop diversification in upland during kharif season. KVK, Mayurbhanj-II, Jashipur in collaboration with AICRP on maize, OUAT demonstrated hybrid maize variety Kaling Raj (OMH 14-27) with full package of practices at farmer's field in participatory mode to popularize the variety along with to increase the yield and income of maize farmers. The demonstration was conducted in 15 ha of land at four villages of 3 blocks in Mayurbhanj district of Odisha where 40 nos. of beneficiaries were involved. Farmers cultivated other hybrid maize varieties available in the local market with traditional practices, which was taken as control. Improved package of practices are application of pre and post emergence herbicides, need based insecticides, STBF, farm mechanization for sowing of seeds by tractor drawn seed cum fertilizer drill and intercultural operation by power weeder. The results suggested that the demonstrated hybrid with full package of practices, (OMH 14-27) produced significantly higher yield (5.2 tons ha−1) than traditional variety with traditional practices (3.0 tons ha−1). Comparing results, OMH 14-27 with full package of practices consistently outperform the farmer's practice in terms of grain yield, which is an important trait for the farmers. Average number of grains /cob (nos.), average nos. of cobs/kg (nos.) and average weight of cob (g) were found to be 618, 3 and 376 respectively in demonstrated plots in comparison to farmer's practice i.e. 387, 4 and 252 respectively. Average net return and BC ratio in demonstration practices and farmer's practices were Rs. 44,200/ha, 1.85 and Rs. 25,550/ha, 1.4 respectively. Therefore, Kalinga raj (OMH 14-27) may be suggested as promising hybrid for the maize growers in the Mayurbhanj district of Odisha.

T-5/P-10

Evaluation of Front-Line Demonstration on QPM at Farmer's Field

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A front line demonstration programme of quality protein maize was conducted in order to evaluate the scientific method of QPM cultivation and farmer practices for a period of three years in the important maize growing districts i.e Samastipur, Muzaffarpur, Vaishali, Begusarai and Darbhanga of Bihar. The scientific method of QPM cultivation for QPM includes sowing of seeds at a distance of 60 X 20 cm, application of fertiliser at the rate of N: P_2O_5:K_2O:: 150:70:60 kg/ha, irrigation at knee height, pre-flowering and grain filling stages and application of Chlorantriniliprole 18.5 SC @0.4 ml/L at fortnight interval during initial growth stages. The framer practices include broad casting method of sowing, application of higher doses of fertiliser at the time of sowing and irrigation depending upon the soil moisture content irrespective of critical stages. In each districts, 10 progressive farmers were selected for recording the observation regarding grain yield. Based on the results of three year data, it was found that FLD practices gave 23 % higher yield in Samastipur district, 21 % higher yield in Begusarai district, 18 % higher yield in Vaishali district, 17 % higher yield in Muzaffarpur district and 14 % higher yield in Darbhanga district. The FLD practices also showed lesser damage by the Fall Armyworm (*Spodoptera frugiperda*) as compared to farmer practices. The QPM also aids in nutritional benefits to the children by providing the essential nutrients.

T-5/P-11

Sustainability of Maize-Based Production Practices among Small-scale Maize Farmers

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The study assessed sustainability of maize-based production practices among small-scale maize farmers. Purposive and random sampling techniques were used to select 180 respondents used for the study while data were generated using questionnaires. Descriptive and inferential statistics were used to analyze the data generated. The study indicated that the existing sustainable maize-based production practices that can enhance maize production in the area were adequate fertilizer use (mean =4.13), pest and disease control (mean =3.84), planting of hybrid maize (mean =3.66), use of animal manure (mean =3.57), planting cover crop (mean =3.51) and early planting (mean =3.20). Also, the result shows that maize production in the study area is somewhat sustainable since the sustainability index of 51.0% was recorded which is little above average score. Finally, on the constraints militating against sustainability of maize production, the farmers observed that economic problems such as high labour cost (0.802), high cost of fertilizer (0.796), high price of quality seed (0.710), inadequate capital (0.645) and low cost of cob (0.582) posed the greatest threat to sustainability of maize production followed by natural factors such as erosion menace (0.643), incidence of pest and diseases (0.629), destruction of cobs by flood, drought and storms (0.625) and destruction of cobs by other animals (0.588); while social factors such as lack or no access to land (0.892) and poor infrastructure (0.642) were not left out. Based on the findings of the study, there is need for the Government, relevant non-governmental bodies and stakeholders to invest in the sustainability of maize production among small-scale farmers, in order to ensure steady supply of maize and it products at a cheaper price, by providing necessary and dependable assistants such as provision of subsidized inputs and low interest loans.

Table-1: Mean scores on existing practices that could lead to sustainability of maize production

Existing practices	Mean scores	Decision
Adequate use of organic fertilizer	4.13	Accept
Pest and disease control	3.84	Accept
Planting hybrid maize	3.66	Accept
Use of animal manure	3.57	Accept
Planting cover crop	3.51	Accept
Early planting	3.20	Accept
Practice crop rotation	2.83	Reject
Engage in mixed farming	2.16	Reject
Use of irrigation	1.32	Reject

Good storage system	1.65	Reject
Others	2.95	Accept

Source: field survey 2014 (Decision rule: <2.95= reject and ≥ 2.95 accept)

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T-5/P-12

The role of agricultural extension in the corn intensification program

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The role of extension can be realized through the performance of extension and the effectiveness of extension in increasing production in the corn intensification program. Performance and effectiveness are the roles of extension in changing the behavior of farmers as the main actors in agricultural cultivation. The performance will produce work effectiveness that will have a good impact on increasing agricultural output. The research was conducted in Gorontalo Utara Regency, Gorontalo Province, from October 2018 to January 2019. The research sample was 91 agricultural extension workers taken by simple random sampling technique. Research data were analyzed using the semantic differential method. The results showed that the extension performance a good and very effective role in the corn intensification program. The agricultural intensification program is an effort to increase agricultural output by optimizing existing agricultural land using various agricultural production facilities through the agribusiness system. The intensification program is very needed in agricultural development, especially the use of technology that is useful for increasing agricultural output. The corn intensification program aims to increase corn production achieved through the use of quality and certified seeds, fertilization, irrigation, pest and disease control as well as harvest and post-harvest handling

Sr.No.	Variables / Sub Variables	Score	Category	Percentage of Answers	
				Frequency	%
1	The performance of agricultural extension workers as a motivator				
A	Motivating the ease of accessing information on corn intensification	4.35	Very good	89	97.8
B	Motivating to direct farming according to the com intensification programs	4.23	Very good	83	91.2
C	Motivate increasing corn production in intensification programs	4.27	Very good	85	93.4
2	The performance of agriculture extension as facilitators				
A	Facilitating the availability of agricultural production facilities in the corn intensification programs	4.38	Very good	70	76.9
B	Facilitating policies and rules on the com intensification programs	3.42	Good	82	90.1
C	Facilitating budget availability in the corn intensification programs.	3.48	Good	75	82.4

3	The performance of agricultural extension workers as educators				
A	The Increase farmers knowledge of new ideas on corn intensification programs	4.31	Very good	91	100
B	The arrange material, media, and extension methods according to the con intensification programs	3.45	Good	80	87.9
C	Provide training in using new technologies in the corn intensification programs	2.67	Less well	87	95.6
4	The performance of agricultural extension as communicators				
A	Looking for access information on agricultural technology to develop a corn intensification programs	3.38	Good	91	100
B	They assist farmers in the process of making decisions on the corn intensification programs	2.62	Less well	75	82.4
C	The assist communication between farmers and stakeholders in the corn intensification programs	4.21	Very good	70	76.9

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Theme-6

Social inclusion and policy in maize research and development

T-6/O-1

Access to Maize Genetic Resources- the policy perspective

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The global maize germplasm collection, as depicted in PGR-genesys database platform, consists of 1, 06, 502 accessions which are held as *Ex situ* collections mainly by CIMMYT, Mexico (91,439); USDA, USA (26,915) and VIR, Russia (14,233). Ukraine, Serbia and Nigeria are the other prominent sources. Amongst these collections, ~ 30,000 accessions are designated as traditional cultivars/landraces and 310 accessions are of Indian origin (held by VIR, Russia). International germplasm exchange data reveals that maize genetic resources have one of the highest amounts of global transaction and hence has a significant role in issues pertaining to access and benefit sharing. The Plant Genetic Resources are globally accessed and used within the frame work of two major international treaties *viz.*, Convention on Biological Diversity (CBD) and International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA). The Access and Benefit Sharing (ABS) mechanism for CBD has been implemented through the Nagoya Protocol, whereas the ITPGRFA has developed a complementary multi-lateral system of ABS. India, being a signatory to all these legal instruments, has complied to its requirements by enacting corresponding national legislations, *viz.*, Biological Diversity Act (BDA) and Protection of Plant varieties and Farmers' Rights Act (PPV&FRA). Currently, maize accessions have not been designated under MLS in India; therefore the access to maize germplasm is still governed by the National Biodiversity Authority (NBA), though it is an Annex 1 crop under the Treaty. Thus, the researchers need to have a thorough understanding of ABS, while accessing elite maize germplasm.

T-6/O-2

Optimization of resource use in cereal-based cropping system using big data: A deductive approach using econometric tool

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Across the farmers field there are large disparity between resource use, energy use, and c-foot print. Evaluation of the carbon foot print and energy foot print of food products are necessary to find the sustainable crop production practices. The main sources of energy input and c-foot should be selected based on the management practices used by farmers to prepare the inventory. This may include inputs such as mineral fertilizers, electricity for irrigation, diesel for tillage operations, agrochemicals, manual labour, and seeds. Farmers used electricity mainly for pumping groundwater used in irrigation and diesel in field operations involving machinery. After establishing the resource use inventory, the two-stage boot strapped meta frontier analysis can be used for delineating district specific and overall efficiency scores to the farms. Based on the efficiency scores famers can be classified as efficient vs less efficient. Further the truncated regression can be used to establish the cause-and-effect relationship between the management variables and input use to energy use efficiency and C-foot print. Such type of analysis can provide extent of resource and energy savings. The estimates can be somehow more accurate if bio-physical conditions are accounted in the study. Inclusion of precise soil data and more resources conservation technologies in the farmer's field has still greater potential of energy use efficiency improvement.

T-6/O-3

Need for assessing soil potassium supply capacity in conservation agriculture-based maize-wheat system

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Potassium (K) is essential for crop growth and also crucial for soil health. The negligence towards K fertilizer in Indian agriculture reflects from the N-P_2O_5-K_2O consumption ratio (6.1:2.5.1 in 2018-19) (FAI, 2019) as against the desirable ratio of 4:2:1. Furthermore, this ratio has reached an alarming stage under rice-wheat sequence (205:47:1), followed by maize-wheat (34:4.9:1) and sugarcane (21:4.2:1) (Ramamurthy *et al*. 2017). As a result, at the national level, K depletion is about 10.2 m t/year with a mining index of 8.0. In India, around 683 million tonnes (Mt) of crop residues are produced, out of which, around 87 Mt of crop residue is burnt in different croplands. In the past three decades, conservation agriculture (CA) has emerged as a major way forward to achieve the twin targets of food security and sustainability. Cereal straws generally have a much higher K content ranging from 1.2 to 1.7% as approximately 75% of K taken up by cereal crops remain in crop residues, making them valuable nutrient sources. Whitbread *et al*. (2000) reported an apparent positive K balance in the soil of 8 kg ha^{-1} when wheat straw was retained, and a negative balance of 102 kg ha^{-1} was recorded on the removal of straw. Crop residue retention can be an effective means to improve soil K content. Maize (*Zea mays* L.)-wheat (*Triticum aestivum* L.) is the 3rd most important cropping system covering 1.8 m ha area, contributing about 3% in the food grain basket of India. Setiyono *et al*. (2010) estimated that 16.4 kg N, 2.3 kg P and 15.9 kg K would be required to produce 1 tonne of maize grain. Maize is a nutrient exhaustive crop, hence, maintaining adequate K supplying capacity of soil under CA or conventional agriculture is even more important as compared to other major cereals like rice and wheat. Quantity-intensity (Q/I) relationship is an important indicator of K supplying capacity of soil cropping as assessing available potassium is inadequate for soils that contain significant amounts of clay minerals that fix K, like illite or vermiculite, or for soils under intensive cropping.

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T-6/P-1

Sensor-based nitrogen management in maize-wheat cropping system under conservation agriculture in North-West Indo-Gangetic plains

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Conservation agriculture (CA), an alternative practice that involves minimum soil disturbance, crop residue retention and crop rotation, is postulated to conserve soil organic matter (SOM), energy, irrigation water and biodiversity. On the other hand, conventional tillage practices (CT) characterized by excessive tillage, residue removal and monoculture are often associated with the degradation of soil mainly in terms of depletion of SOC, sub-soil compaction and loss of biodiversity. As fertilizer nitrogen (N) is one of the key inputs in food production, it is typically required in larger quantities than any other nutrients by the crop for its growth and development. Therefore, proper management of N is essential to reap high yield, profit and ultimately with a safe environment. Given the scarcity of information on N management protocols under CA, a field experiment was initiated in *kharif* 2013 at IARI farm, to evaluate different N management options i.e. basal application of 80, 50 and 33% of total fertilizer requirement followed by need-based top dressing as suggested by GreenSeeker, and N sources and methods of application on crop yield, N uptake, N use efficiencies (NUE), and temporal changes in soil organic C and mineral-N in maize (*Zea mays* L.)-wheat (*Triticum aestivum* L.) cropping system under CA and CT practices. Results revealed that maize grain yield was statistically similar under both cultivation practices *i.e.* CA (7.47 t ha^{-1}) and CT (7.48 t ha^{-1}), whereas grain yield of wheat was significantly higher under CA (5.0 t ha^{-1}) than that under CT (4.71 t ha^{-1}). The N top-dressing requirement as assessed by using GreenSeeker was relatively less under CA in both the crops, which ultimately curtailed fertilizer N application in this practice. Averaged across N management options, it was possible to curtail 62 kg fertilizer N ha^{-1} without any grain yield penalty in the maize-wheat system. Such advantages of CA were apparently due to higher N use efficiency and better mineralization of N during the cropping period. On average, N use efficiencies in wheat computed as agronomic efficiency (AE_N), partial factor productivity (PFP_N) and recovery efficiency (RE_N) were 23.2 kg grain kg^{-1} N, 38.4 kg grain kg^{-1} N and 52.5%, respectively under CA; the corresponding values under CT were 15.1 kg grain kg^{-1} N, 26.1 kg grain kg^{-1} N and 37.5%. Among N sources and methods of application band placement of slow-release modified urea materials (*i.e.* USG and IFDC-product) resulted in higher yields and NUE compared with urea broadcasting. In CA, Walkley-Black C (WBC) and mineral-N (NH_4^+-N + NO_3^--N) contents were significantly higher compared with CT in the surface layer (0–15 cm depth). Results thus indicated the superiority of CA over CT particularly for the increase in SOC and mineral-N content and enhancement in the NUE. The benefits associated with CA present a greater potential for its adoption to sustain soil health and crop productivity of maize–wheat cropping system.

T-6/P-2

Estimation of yield gap and decomposition to efficiency and resource yield gap methodology

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Yield gap indicates the difference between attained and attainable yield, whose estimation and decomposition are important for sustainable intensification perspectives. Yield gaps can be decomposed into efficiency, resource, and technology yield gaps. The efficiency yield gap refers to the difference between technical efficient yields and actual yields, and can be explained by sub-optimal crop management in relation to time, space and form of the inputs applied. Technical efficient yields and efficiency yield gaps can be estimated for each of the farm using stochastic frontier analysis in combination with concepts of production ecology. The resource yield gap refers to the difference between highest-farmers' yields and most efficient yield, and can be attributed to sub-optimal amounts of inputs applied. Lastly, the technology yield gap refers to the difference between potential yield and highest farmers yield, hence reflecting resource yield gaps of individual inputs and/or technologies used by farmers not being able to reach. The area for crop production is fixed with limited horizontal expansion. To meet the future food demand, need the food production must be increased, which can be achieved either by breakthrough technologies or improving the resource use efficiency. If also there is no scope to improve the crop yield, resource use efficiency must be increased, as inefficient resource use leads to many environmental problems.

T-6/P-3

Social and Government Gaze on Maize

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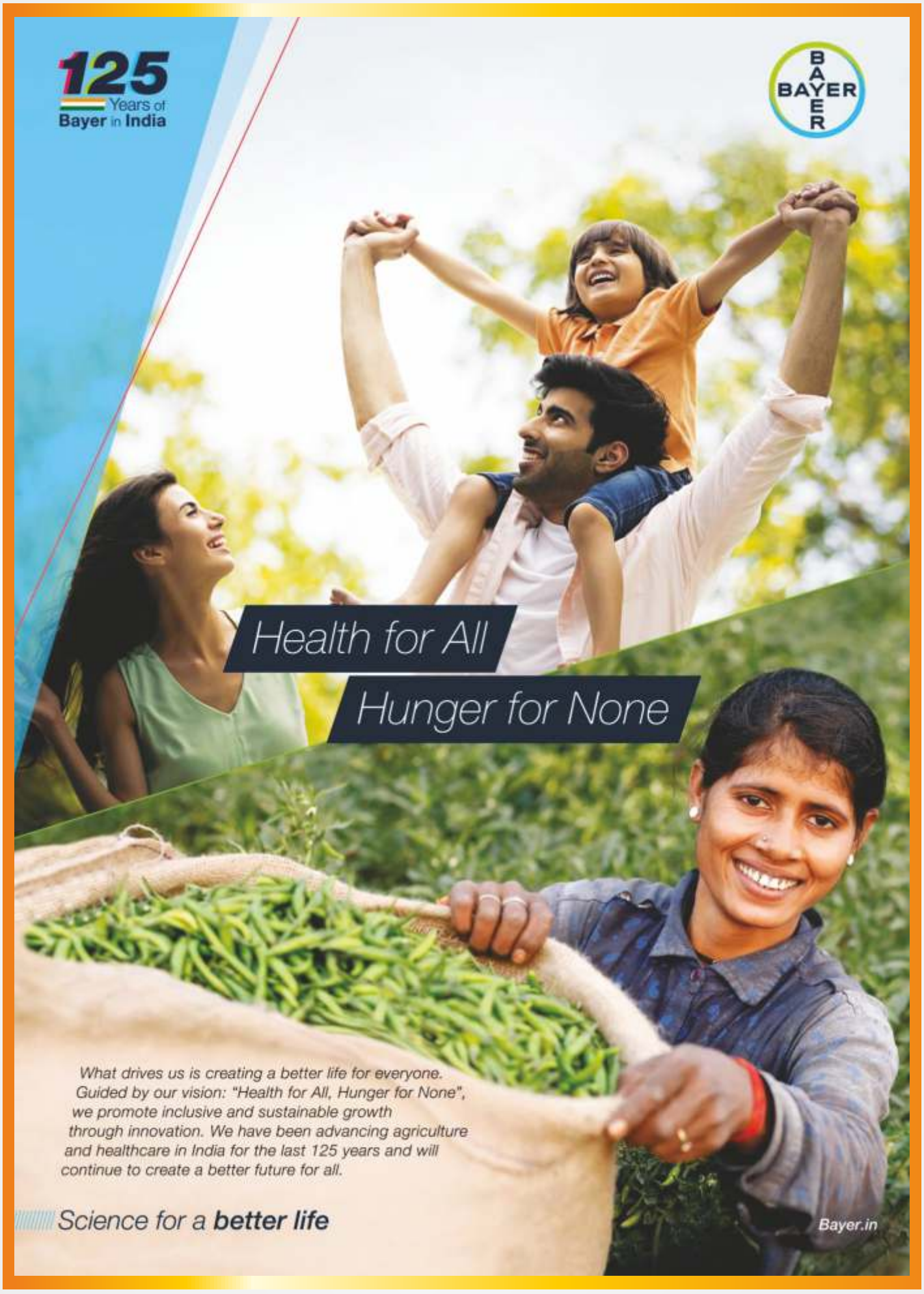
Over the last decade, global maize consumption has increased from ~808 mMT (2009) to ~1,134 mMT (2019) growing at a CAGR of 3.4%. By 2029, the global maize consumption and share of maize used in animal feed is expected to increase by ~16% and ~60.3%, respectively. Also, maize consumption in India grew at a CAGR of 5.6% while production grew at just about 2.9%. With domestic demand for maize growing faster than production and the fact that maize provides the right opportunity for crop diversification and increasing farmer income, there is an imminent need to identify and address key barriers hindering growth of the Indian maize ecosystem.

In the Indian context, 15 million Indian farmers are engaged in maize cultivation and it generates employment for more than 650 million person-days at farming and its related business ecosystem levels. Despite, the dependency of such a significant population in terms of employment generation and diversity in the usage of maize, Indian maize is performing comparatively low in terms of yield (-130%) as compared to world average, which is alarming. Innovation in R&D could bridge the existing average yield gaps between global and Indian maize crop bringing incremental gains to cultivators.

With a strong focus on doubling farmers' income while conserving natural resources by promoting sustainable agriculture. The GoI has taken numerous proactive initiatives to safeguard the interests of farmers as well as promote private sector investment across the agriculture sector. While most of these initiatives have positively impacted the maize ecosystem, there appears to be a need for a focused, public-private co-created strategy to address the multifaceted demands of the maize sector – such that diverse stakeholders across the value chain actualize the true socio-economic potential of this crop.

Improved policy framework to unleash the potential Need based adoption of Price Deficiency Payment system, scaling up of PMKSY and PMFBY and quality-based customization of maize derivative contract post e- NAM integration would be possible avenues for industry and government to intervene and would provide lateral push to the sector. Seventy-six important policy decisions like RKVY, National Food Security Mission and National Food Security Act, taken up by the GoI have significant impact on maize production. Smooth implementation and grounding of such ambitious scheme will not only benefit the ecosystem at large, but will also bring in desired benefits to the maize value chain. Improved policy towards bio-fuels, investment promotion in maize industries, better regulatory framework, IPR protection methods and ways to tackle the grey markets in seed supply chain have tremendous potential to support the maize sector. Devising practical ways to implement PDP and enhanced MSP (Minimum Support Prices) in maize will further corroborate the crop uptake amongst farmers. In order to meet the desired demand levels and enhance farmer's income, encompassing of backward and forward linkage strategies is needed to bring paradigm shift in crop economy. While constraints can be found at every stage of the chain, from research to consumption, an amalgamation of strategies and interventions around technological innovations and all stakeholders will have to act together with scale and speed to create a "Brand India for Maize" which demonstrates India's advantages and capabilities to become a world leader.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Live Safely	We embrace safety and the environment in all we do

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Crop Protection Solutions: herbicides, fungicides, insecticides, pasture and land management, seed applied technologies, urban pest management, turf and ornamental pest management

Digital Services: software for growers to build and sustain stronger businesses by maximizing yield with data-driven crop models, improving teamwork efficiency and communication, measuring profit down to the field-level and simplifying farmland research and transactions

Climate Resilient Agriculture (CRA) Programme

The *"Climate Resilient Agriculture (CRA) Programme"* was a combined approach of Bihar Agricultural University (BAU), Sabour, Dr. Rajendra Prasad Central Agricultural University (RPCAU), Pusa-Samastipur, ICAR-Research Complex for Eastern Region (ICAR-RCER), Patna along with nodal organization at Borlaug Institute for South Asia (BISA) as a follow-up of the instructions of the **Hon'ble chief minister of Bihar, Shree Nitish Kumar ji**, for preparing a workable plan to cope up with current future climatic risks and demonstrate climate resilient technologies in all districts of Bihar, to provide climate resilient science based solutions to the hard working farmers of Bihar.

Project Goal

To develop and introduce evidence-based response strategies for addressing the principal climate-based threats to the productivity and resilience of staple crop production systems in Bihar.

Project Objectives

To achieve the project goal, climate resilient agriculture (CRA) programme, new futuristic cropping system (crop cycle) relevant to needs of resource poor farmers that can address climatic risks is to develop, validated and deployed through a community-led approach to make farming relevant, remunerative, and stable. The engagement model is being working around principles of convergence with multi-stakeholder, multi-disciplinary, and multi-institute teams contributing to innovation and knowledge generation.

- Laser land leveling
- Direct seeded rice
- Climate resilient varieties
- Zero tillage seeding
- System optimization and intensification
- Raised bed planting
- Water management
- Precision nutrient management
- Potato based farming system
- Crop diversification by deploying appropriate crop cycle
- Residue management
- Biochar production
- Long-term cropping system experiment
- Precision nutrient management

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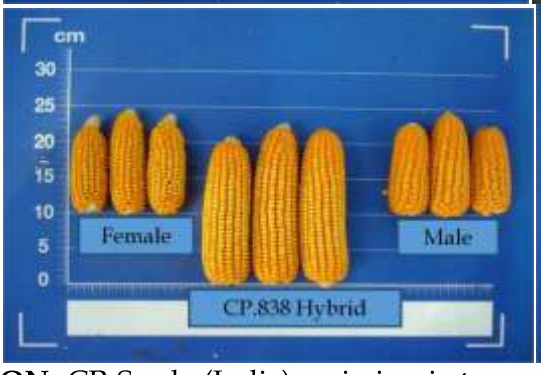
NOTIFICATION HYBRIDS OF CP SEE

Hybrid Name	Zone Details	Location details
CP 333	Zone V	Rajasthan, Gujarat, Chhattisgarh and Madhya Pradesh.
CP 999	Zone V	Madhya Pradesh , Rajasthan and Gujarat
CP 838	Zone II Zone III Zone IV Zone V	**Zone-II** - Punjab, Haryana, Delhi, Uttarakhand (Plain), Uttar Pradesh (Western region) **Zone-III** - Bihar, Jharkhand, Odisha, West Bengal, Uttar Pradesh (Eastern region) **Zone-IV**- Maharashtra, Telangana, Andhra Pradesh, Karnataka, Tamil Nadu **Zone-V** - Rajasthan , Gujarat, Madhya Pradesh
CP 858	Zone II , Zone III,	**Zone-II** - Punjab, Haryana, Delhi, Uttarakhand (Plain), Uttar Pradesh (Western region) **Zone-III** - Bihar, Jharkhand, Odisha, West Bengal, Uttar Pradesh (Eastern region)



MISSION: CP Seeds (India)s mission is to provide farmers with a comprehensive service through detailed analysis of crops, custom solutions and precision application by embracing science, innovation and technology. CP Seeds (India) will assist them to improve the sustainability and profitability of their business while increasing the value of the seed they are producing. We view ourselves as partners with our customers, our employees, our community and our environment.

Mahyco Maize Product Portfolio

mahyco grow

MAIZE 4060

- Big Cob- Thin Shank- More Grain
- Shiny Orange Grain- High Market Price
- Wider Adaptability Product

MAIZE 4064

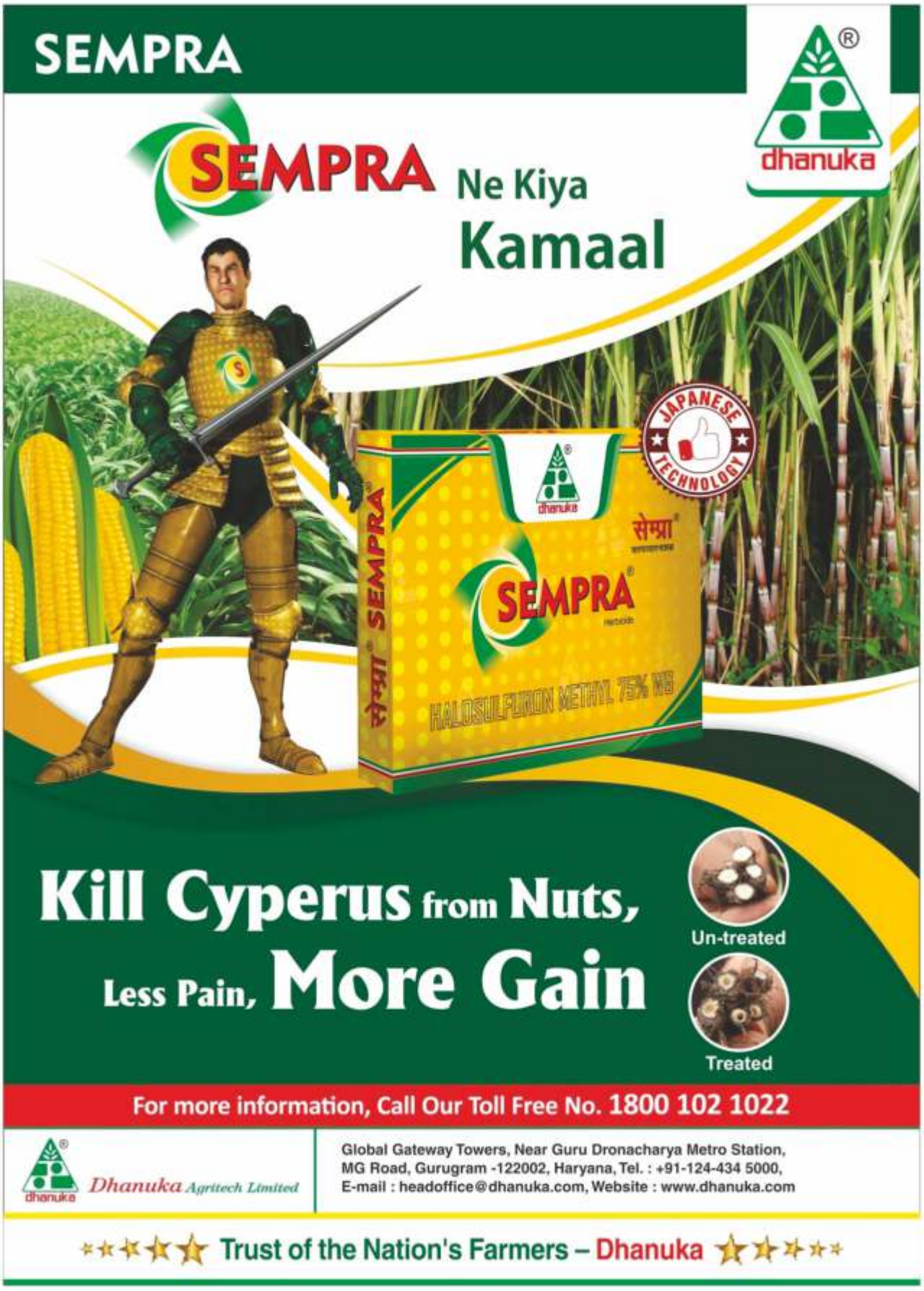
- Large Uniform Cobs
- Shiny Grain- Good Market Price
- Higher Yield Potential

MAIZE 4062

- Large Cobs and High Volume Weight Grain
- High Shelling Percentage
- Tolerant to Foliar diseases

MAIZE 4065

- Big Uniform Cobs
- Orange Shiny Grain – Good Market Price
- Higher Yield Potential



Sempra English Pestology Ad 18x25 cm

Syngenta Babycorn

Syngenta New Generation Sweetcorn

BIOSEED

HYBRID CORN-9544

- National notified hybrid
- High yield potential up to 11MT/ ha.
- Uniform ears and excellent tip filling.
- Maturity-95-100 days
- **Suitability :**
  Kharif & Rabi except early Rabi planting in Bihar

HYBRID CORN-9546

- High yield potential up to 11MT/ ha
- Uniform ears and excellent tip filling
- Maturity-95-105 days
- **Suitability :**
  Kharif & Rabi except MH

HYBRID WHITE CORN-9730

- Medium maturity white corn hybrid
- Yield potential 25-30 Qu/ Ac
- Maturity-85-90 Days
- Long conico- cylindrical ears

HYBRID CORN-9220 SUPER

- Early maturing hybrid with long cylindrical ear
- Good grain yield with >80% grain recovery
- Yield-20-25 Qu/Ac
- Maturity-80-82 Days

Shriram Bioseed Genetics
An ISO 9001:2015 CERTIFIED ORGANISATION Plot No. 234, B Block, opp. Phase 2, Kavuri Hills, Madhapur, Telangana 500033
Email: customer.care@bioseed.com
Customer Care Cell No.:+91 40 67066695

Genetics for Improved Agriculture

1978

RASI

3499

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Sx 38

सिंगल क्रॉस
सफेद हाइब्रिड मक्का

RASI

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हाइब्रिड मक्का

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Committed High Quality Corn Seeds to Farmers Land

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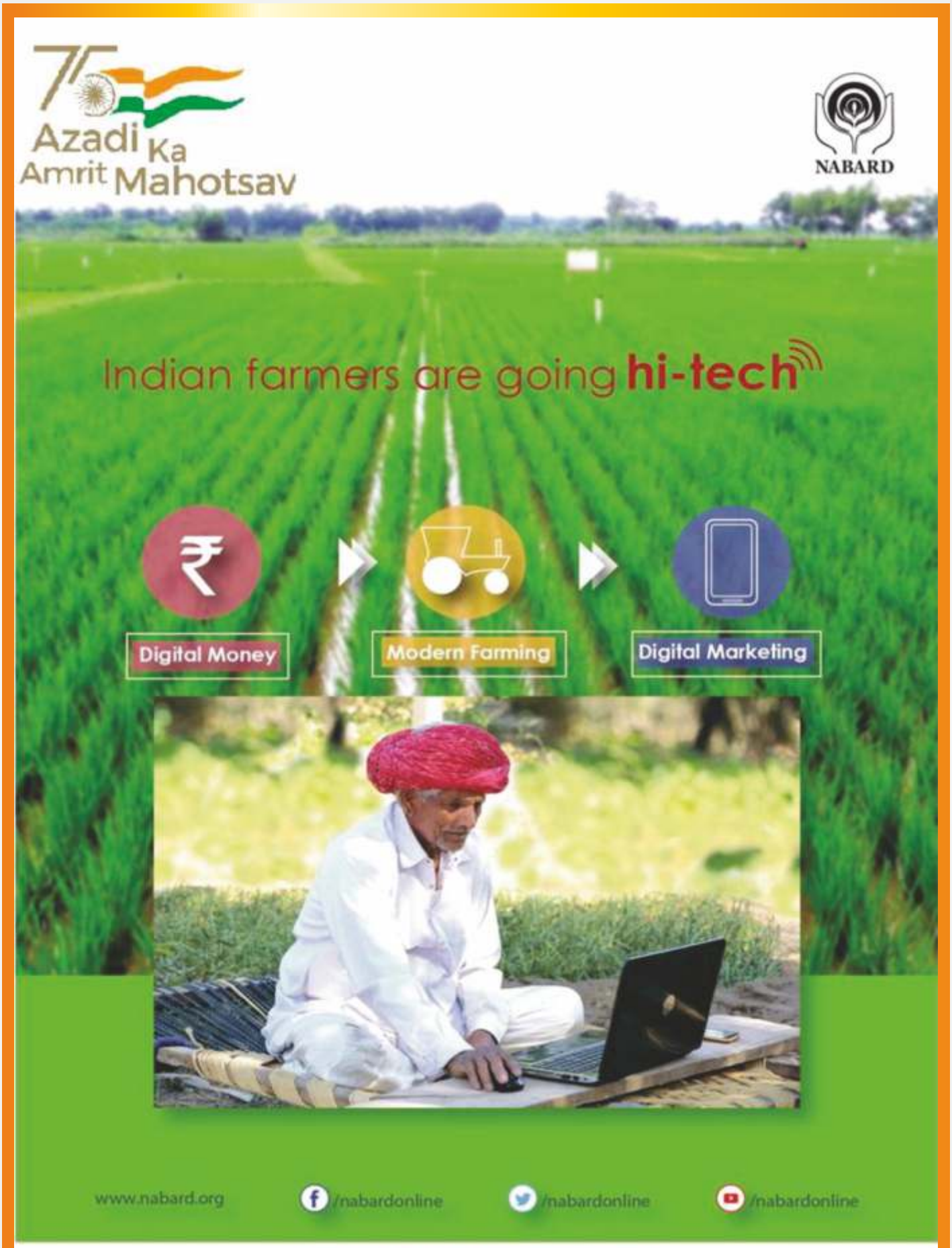
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