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Research Article

EVALUATING INTERACTIVE EFFECT OF INITIAL SCREENING HYBRIDS IN DIFFERENT ENVIRONMENTAL CONDITION

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Abstract- Thirty hybrids were produced after the cross formation from 5 QPM (Quality Protein Maize) and 6 non QPM inbreds in two environments *viz.*1) Irrigated Agricultural Farm BHU Varanasi and, 2) Rain-fed RGSC, Barkachha, Mirzapur during *Rabi* (Winter) season 2015-16 and *Kharif* (Rainy) season 2016. These inbreds were selected from the normal irrigated environments. Total thirty hybrids were grown under different irrigated and rain-fed environments in randomized block design, in which rain-fed environment irrigation was controlled. Data were collected after the single and double cross formation in Rabi (Winter) season 2015-16 and Kharif (Rainy) season 2016. From the initial screening observations were recorded on important yield and quality traits of 30 hybrids such as, plant height (cm), days to tasseling, days to silking (days/plot), days to maturity (days/plot), grain yield per plot (GYP). Such types evaluate suitability of hybrids and select for the next generation, on the basis of best performance. There were only five hybrids selected from the both environment which better survived at high temperature. The selected hybrids could be grown in normal (Irrigated), poor environment (Rain-fed) and new environment (*Rabi*), which will bring high level of food and nutritional security in India.

Keywords- Hybrid selection, Initial screening, QPM, non QPM, Yield and Quality traits

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Introduction

Maize (*Zeya mays* L.) is a short-day plant, influenced by temperature and photoperiod. Its population comprises of freely inter breeding individuals and is heterogeneous. Maize breeding programs established in unique environments for germplasm adaptation to climate changes will also be essential for the development of the next generation of cultivars [1]. Maize has shown to be a model and flexible crop by nature through produce elite products under a wide range of environments [1]. Therefore, even through productivity yield has increased over the years, maize production across the same period has been very unstable and dependent on climate changes [2]. From the breeding program have even successfully adapted genetic materials across latitudes by utilizing stratified mass selection programs in early flowering at minimum cost [2], one of the oldest breeding methods that has maximum efficiency in simply inherited traits that are easy to manipulate like flowering time.

Maize is a summer growing crop requires warm temperature about 25- 30°C and cool nigh, usually causes of growth and development [3]. In tropical and subtropical regions, maize crop is grow mainly on marginal lands and faces various extreme climatic conditions at different biotic and abiotic stress [4]. It is suitable for mechanical cultivation during entire development and grown between 30 - 34°C latitudes in North and South. Maize is improving the moisture ability to increase yield and global productivity [5], Therefore maize is called C4 plant. C4 plants resist environmental stress condition [6], and grow a number of environments such as dry-land and irrigated environment [7].

QPM hybrids produced along with numerous modifiers gene (Opaque-02), therefore, QPM has high nutritive value of endosperm protein, with substantially higher content of two essential amino acids. The development of high lysine and tryptophan level in the grain by manipulation of opaque 2 gene (o2o2), modifiers of 2O2O containing endosperm and gene that modify opaque-2 induced soft endosperm to hard endosperm [8]. The o*2* mutation in maize is increased level of free amino acid in the mature endosperm. Maize is preferred as open-pollinated populations subject to higher level of resistance and more grain yield [9]. It is preferable for higher yield potential and enhanced stress tolerance. Under the breeding programs are identification of high yield maize crop in drought-prone environments using multi location testing, it is inherently complicated by year to year variability in the available soil water and nutrients of that environments [10]. Blum [11] has argued that breeding for high WUE (water use efficiency) under drought conditions will ultimately low-yielding genotypes with reduced drought tolerance. Therefore, biomass production under most drought conditions can only be enhanced by maximizing soil moisture capture after transpiration, where involves minimized water loss by soil evaporation [11]. There some strong evidences were support for adaptation to abiotic stresses which comes from retrospective comparisons from temperate hybrids maize produced over the last 70 years in the USA [12]. A high level of association between yield stability and general stress tolerance is observed in new maize hybrids, where yield stability does not appear to have declined with increasing yield potential [13]. Keeping in view of above information my objective is "Evaluating interactive effect of initial screening maize hybrids in different environmental condition" was planned to characterize and standardize different hybrids for a new environment.

Materials and Methods

The present experiment was undertaken at Agricultural Research Farm, Institute of Agricultural Sciences, BHU Varanasi and RGSC (Rajeev Gandhi South Campus) Barkachha Mirzapur, during 2015-2016. The experiment was laid out in a randomized block design (RBD) with three replications. Each plot consisted of 3x4.5m-long having six rows, with 0.70m space in line to line and spacing 20 cm between plant to plant respectively. 15 seeds were planted per lines. The number of plants row-1 was 17 (seventeen). Plant spacing was 75cm and 30cm between row and plant, respectively. The fertilizer rates were 150 kg/ha DAP at planting and application of 200 kg/ha of Urea in 3 splits that is 1/3 after 21 days of germination, 1/3 at knee height and last doses during flowering and irrigation time to time but second environment was control for irrigation.

Plant Materials

Initially 12 QPM lines (CML141, CML175, CML-193, DMR QPM 58, HKI 164-7-6, CML165, HKI162, CML 169, CML176, CML 186, CML 161 and CML 163) and 23 non QPM maize inbreds (HUZM185, HUZM121, HUZM60, HUZM47, HUZM97-1-2, HUZM509, HKI287, HUZM 478, HUZM-80-1, HUZM 88, CM212, V361, V338, V336, V341, V25,V388, V348,V351, V358, CM141, V386 and V335) were subjected to adaptability test in local environment along with check (Malviya Makka-2). The adaptability test aimed at testing the particular genotype to phenotypically express physio-morphological traits and its disease reaction in a known environment [14]. This led to selection of 5 testers (QPM donor inbred) and 6 non QPM inbred lines. Each tropical and subtropical QPM donor inbreds were obtained from DMR New Delhi but originally introduced from CIMMYT, Mexico and Karnal, India were used as testers (males).The normal inbred lines obtained from BHU, Varanasi; VPKAS, Almora were used as lines. Many of these lines were early and medium maturity. This study led to screening 11 maize inbreds involving 5 QPM inbred lines and 6 non QPM inbred lines which used for cross formation by initial screening [Table-1].

Table-1 *Characteristic features of selected QPM and non QPM inbreds in Kharif (Rainy) season 2015.*

Sr. No.	QPM Inbreds	Pedigree and Sources	Characteristic Features
1	CML-141	Pop, CIMMYT	White flint Kernel, dwarf height, medium to late duration
2	CML-176	P-63-12-2-1/P67-5-1-1)-1-2-B-B,CIMMYT	White kernel medium to late duration
3	CML-193	CY0162-B-1-1-B (S-Afrika), CIMMYT	medium height, medium to Late duration
4	DMR-QPM-58	Shakti 1 DMR	Orange yellow flint kernel, Early duration Tall height
5	HKI-164-7-6	CML 164, Kernel	Yellow, semi dent, medium to late height and duration
	Non QPM Inbreds	**Pedigree and Sources**	**Characteristic Features**
6	HUZM-185	Seed tec-1250-1-2-2-1-##, BHU, Varanasi	White flint kernel, medium duration, tall height and good grain yield
7	V-336	CML-145,P-63CDHC 181-3-2-1-4#2-BBBB#,VPKAS Almora	Yellow, Flint Kernel, medium duration, leaf and tassel angle is small, straight leaf attitude.
8	V-351	Shakti(So) He 25, VPKAS, Almora	Orange yellow, flint kernel, early duration ,better yield
9	CM-141	Pool33(Alm),VPKAS, Almora	Yellow kernel medium to late duration, curved tassel
10	V-335	TZI-25, VPKAS,Almora	Orange, flint kernel, short to medium duration
11	HUZM-478	BH3427, BHU, Varanasi	Yellow flint kernel, late duration, small wide leaf angle, anthocynin present

Raising of the Hybrids

Materials of these experiments consist of 30 hybrids from the parents F1 crosses and 1 check, and border rows were maintaining at the end of each replication to minimize border effect. The single cross formation was performing in *Rabi* (winter) season 2015-16 and double cross formation were in *Kharif* (Rainy) 2016. The QPM and non QPM are self-cross formation in both environment such as 1) Irrigated as well as Agricultural Farm BHU, Varanasi and, 2) Rain-fed as well as RGSC, Barkachha, Mirzapur during *Rabi* (winter) season 2015-16 and *Kharif* (Rainy) season 2016.

Maize is protandrous crop therefore male spikelets were mature earlier than the female spikelets. Prior to the initiation of flowering, plants to be hand pollinated were checked daily for signs of ear shoot emergence and pollen shedding. According to Poehlman [15], a single tassel was produce over 25,000 pollen grains in each kernel. These shed pollen grains were viable for 10 to 30 minutes [16] and there after they may be killed in few hrs either by heat or desiccation but mostly remain viable for longer durations under favorable conditions [17]. The pollen shedding normally begins 1-3 days before the emergence of silk and continues 3-4 days after the silks were receptive and ready for pollination.

Cross Formation in Selected Maize Inbreds

Crossing was performed in morning after sun-shine, when pollens emerge from the pollen grain. In the crossing, top of an ear was cut by a sharp razor before emergence of the silk and covered with butter paper bag. Simultaneously, the tassel of the desired male parent was covered with tassel bag. The anthesis (dehiscence of anthers) was starts from the central shoot of the tassel. It was start from the top and proceeds downwards.

The covering of tassel was done on those male parents in which one-fourth of the tassel has dehisced. Now, plants prevent dislodging by wind and rain. Therefore, uniform growth of silk was visible on the cobs that covered with a bag of butter paper. The tassel bag containing freshly shed pollen was transferred over the cobs after removing the butter paper bags from the cobs and again covered with pollen bag. This will be avoiding undesirable probable pollen and undesirable environmental conditions in breeding program [18]. It avoids to contamination and received fresh pollen grains, therefore tassels are covered with tassel bags before pollination as one day earlier, that means date of pollination should be one day later date of tasseling. The tassel bags are held in position with the support of U clips, and a sign make on tassel bag for identification cross.

Evaluation of New Hybrids

The thirty Hybrids were evaluated into two environments *viz.,* rainfed as well as irrigated during *Rabi* (winter) season 2015-16 as well as *Kharif* (Rainy) season-2016. These hybrids were evaluated in four environments. Five hybrids (HKI-164-7-6x HUZM-185, HKI-164-7-6x HUZM-478, HKI-164-7-6 x CM-141, DMR-QPM-58x HUZM-478, DMR-QPM-58 x HUZM-185) were selected based on their performance. These hybrids were applicable for different environments as applicable in climate changing. Environmental parameters in relations to performance of the QPM hybrids were also studied. Based on the present study the suitable recommendations will be made to cultivate particular QPM hybrids in diverse environment.

Data Collection and Analysis

Hybrids were evaluated in both environments after 50% of flowering on the basis of 12 traits, such as, days to 50% tasseling, days to 50% silking, plant height (cm), ear height (cm), days to 75% brown husk, ear length (cm), ear diameter (cm), number of kernel rows per ear, number of kernels per row as 100-grain weight (g), shelling percentage, grain yield per plant (g). From the 5 QPM and 6 non QPM obtained 30 QPM Hybrids by crossing formation in inbreds lines during *Rabi* (Winter) season 2015-16 as well as *Kharif* (Rainy) season-2016 for initial screening.

After double crossing, initial screening was observations and recorded on the basis of important yield and quality traits as above. The collected data for each character were first computed using analysis of variance (ANOVA) separately and statistically analysis of variance using SAS [19]. Significant means will be separated using the least significant differences at 5% probability levels (LSD 0.05).

Results and Discussion

Thirty hybrids were observation and evaluation data of yield, yields component and other morphological traits, such as [Days to 50% tasseling, Days to 50 percent silking, Plant height (cm), Ear height (cm), Days to 75 percent brown husk, Ear Length (cm), Ear diameter (cm), Number of kernel rows per ear, Number of kernels per row, 100-grain weight (g), Shelling percentage, Grain yield per plant (g), Grain yield (q/ha)] during *Rabi* (Winter) season 2015-16 and *Kharif* (Rainy) season-2016.

Table-2 *Number of 30 crosses which formed by combination of 5 QPM and 6 Non QPM Inbreds during Rabi 2015-16 and Kharif 2016.*

Sr. No.	Crosses in Rabi 2015- 16 (F1)	Crosses in Kharif-2016 (F2)
1	CML-141X HUZM 185	CML-141X HUZM 185 X CML-141
2	CML-141X V336	CML-141X V336X CML-141
3	CML-141X V351	CML-141X V351X CML-141
4	CML-141X CM-141	CML-141X CM-141X CML-141
5	CML-141X V335	CML-141X V335X CML-141
6	CML-141X HUZM 478	CML-141X HUZM 478X CML-141
7	CML-176 X HUZM 185	CML-176 X HUZM 185 X CML-176
8	CML-176 X V336	CML-176 X V336X CML-176
9	CML-176 X V351	CML-176 X V351X CML-176
10	CML-176 X CM-141	CML-176 X CM-141X CML-176
11	CML-176 X V335	CML-176 X V335X CML-176
12	CML-176 X HUZM 478	CML-176 X HUZM 478X CML-176
13	CML-193X HUZM 185	CML-193X HUZM 185 X CML-193
14	CML-193X V336	CML-193X V336X CML-193
15	CML-193X V351	CML-193X V351X CML-193
16	CML-193X CM-141	CML-193X CM-141X CML-193
17	CML-193X V335	CML-193X V335X CML-193
18	CML-193X HUZM 478	CML-193X HUZM 478X CML-193
19	DMR-QPMX HUZM 185	DMR-QPM-58X HUZM 185X DMR-QPM-58
20	DMR-QPMX V336	DMR-QPMX-58 V336X DMR-QPM-58
21	DMR-QPMX V351	DMR-QPM-58X V351X DMR-QPM-58
22	DMR-QPMX CM-141	DMR-QPM-58X CM-141X DMR-QPM-58
23	DMR-QPMX V335	DMR-QPM-58X V335X DMR-QPM-58
24	DMR-QPMX HUZM 478	DMR-QPM-58X HUZM 478X DMR-QPM-58
25	HKI-164-7-6X HUZM 185	HKI-164-7-6X HUZM 185 X HKI-164-7-6
26	HKI-164-7-6X V336	HKI-164-7-6X V336X HKI-164-7-6
27	HKI-164-7-6X V351	HKI-164-7-6X V351X HKI-164-7-6
28	HKI-164-7-6X CM-141	HKI-164-7-6X CM-141X HKI-164-7-6
29	HKI-164-7-6X V335	HKI-164-7-6X V335X HKI-164-7-6
30	HKI-164-7-6X HUZM 478	HKI-164-7-6X HUZM 478X HKI-164-7-6

Table-3 *Evaluating different traits of 5 QPM and 6 Non QPM maize hybrids in Rabi (winter) season 2015-16 for cross formation.*

Selected Hybrids*	1	2	3	4	5	6	7	8	9	10	11
CML-141	176.3	72.4	55.9	57.5	10.7	3.9	11	25	319	272	55.31
CML-176	179.2	72.3	55.2	57.3	9.9	3.7	10	18	216	224	34.71
CML-193	181.4	82.1	55.0	56.2	11.9	3.3	12	20	297	217	38.10
DMR-QPM-58	194.8	84.3	55.3	57.6	11.7	4.0	14	26	321	292	58.62
HKI-164-7-6	192.3	83.2	56.3	58.4	11.6	3.7	12	24	319	287	58.49
HUZM-185	182.7	81.4	56.6	58.3	11.8	3.6	12	24	297	259	48.36
V-336	169.6	82.5	54.8	57.4	10.4	3.3	10	19	217	249	33.22
V-351	167.2	81.4	53.7	55.0	9.4	3.4	10	19	243	243	40.74
CM-141	153.2	79.3	55.0	57.2	8.6	3.2	11	18	256	276	38.26
V-335	156.9	86.4	53.2	56.6	9.3	3.8	10	23	278	248	44.56
HUZM-478	172.4	87.2	52.8	55.8	11.9	4.2	13	26	322	273	34.46
Mean	168.3	83.2	54.3	55.4	10.2	3.2	10	20	248	221	36.2
CV (%)	12.41	9.1	1.32	13.2	1.3	1.5	4.3	7.9	3.12	1.62	6.3
LSD 0.05	0.01*	0.01*	0.13*	0.14*	0.91	0.61	0.71	4.03	16.2	8.51	9.75

Selected Genotypes* CV= Coefficient of Variation

1. Plant height (cm), 2. Ear height (cm),3. Days to 50% tesseling, 4. Days to 50% silking, 5. Ear length (cm), 6. Ear diameter (cm),7. Number of kernel row/ear, 8. Number of kernel/row, 9. Number of kernel/ear, 10. 100 kernel wt. (g), 11. Grain Yield/Plant (g)

Table-4 *Identification of 5 hybrids (crosses) in out of 30 after the initial screening on the basis of grain yield per plant (GYP) during Kharif* (Rainy) *season - 2016.*

Sr. No.	Hybrids in F2 (Environment-I)	Plant Maturity	GYP(g)
1	HKI-164-7-6xHUZM-185x HKI-164-7-6	88-95	55.48
2	HKI-164-7-6xHUZM-478x HKI-164-7-6	85-91	52.73
3	HKI-164-7-6xCM141xHKI-164-7-6	87-98	48.16
4	DMR-QPM-58xHUZM-478x DMR-QPM-58	86-96	41.0
5	DMR-QPM-58xHUZM185x DMR-QPM-58	85-93	33.73
	Hybrids IN F2 [Environment II]	**Plant Maturity**	**GYP(g)**
1	HKI-164-7-6xHUZM-185x HKI-164-7-6	83-93	53.46
2	HKI-164-7-6xHUZM-478x HKI-164-7-6	80-95	40.81
3	HKI-164-7-6xCM141xHKI-164-7-6	82-108	36.73
4	DMR-QPM-58xHUZM-478x DMR-QPM-58	85-103	32.42
5	DMR-QPM-58xHUZM185x DMR-QPM-58	95-103	27.32

Out of 30 crosses only 17 crosses were better surviving in *Kharif* (Rainy) season 2016 from the environment-I and 14 crosses from the environment-II. These crosses were dissimilar in both environments, when crosses (hybrids) evaluating on the basis of GYP in environment-I and environment –II. All the maize hybrids of F2 were mature in 85-98 days, after days of sowing in environment-I while 83-103 days in environment-II. Therefore, only 5 crosses were selected from the initial screening in the both environments.

Table-5 *Amount of NPK determination in different stage of soil during hybrids maize production.*

Environment-I	N (Kg/ha)		P(Kg/ha)		K (Kg/ha)	
	Rabi	*Kharif*	*Rabi*	*Kharif*	*Rabi*	*Kharif*
Before sowing	213	209	22.2	24.6	232	238
After Harvesting	217	211	24.8	24.4	226	224
Environment-II						
Before sowing	132	121	17.5	17.5	176	181
After Harvesting	149	138	19.6	14.2	184	183

Performance of Hybrids and their Yields

Mean square values of selected 5 hybrids were highly significant due to effect of the traits such as plant height, ear height, days to 50% tasseling, days to 50% silking, ears length, ear diameter, number of kernel row/ear, number of kernel/row, number of kernel/ear, 100 grain weight and grain yield per plot [Table-3]. The yield related parameters were significantly ($P<0.05$) differ for grain yield and differences among hybrids were highly significant.

The significant impacts of agronomic parameters were expressed in maize breeding program. These are possible by a significant effect of environmental factors as like a cropping year exhibited in different rainfall which normally affected the performance of maize hybrids. There were grain yield differences in between the two environment and other characters could be due to differences in environmental conditions which vary from environment to environment. Crop variety also affects of the plant height, ear height, days to silking and grain yield, it was highly significant (P<0.01) in different year. Grains yields were indicated their potential differences with considerable characteristics and morphological differences among maize hybrids. The wide variability was determination of yield parameters and it have ample opportunity for improvement of important characters of economic value through selection of maize genotypes.

Table-6 *Estimated soil moisture of both environments in three levels during Rabi 2015-16 and Kharif 2016*

Environment-I	0-15cm		15-30cm		30-60cm	
	Rabi	Kharif	Rabi	Kharif	Rabi	Kharif
Before sowing	1.159	1.176	1.622	1.145	1.222	1.142
After Harvesting	1.141	1.121	1.123	1.202	1.124	1.123
Environment-II						
Before sowing	1.162	1.249	1.142	1.125	1.132	1.115
After Harvesting	1.24	1.722	1.112	1.621	1.121	1.583

Table-7 *Evaluation interactive effects of maize hybrids for agronomic grain yield in different environments*

Sources of Variation	DF	1	2	3	4	5	6	7	8
Year	2	9.34	5.68	0.25	0.47	1.56	4.64	7.73	3.34
Rep (Year)	3	0.51	3.45	0.34	0.23	0.04	0.070	0.04	0.09
Hybrids	5	14.45	7.39	0.45	2.39	0.36	0.004	0.17	4.78
Year x Hybrids	10	0.023	0.112	0.04	10.03	0.005	0.045	0.003	0.05
Error	138	0.006	0.005	0.009	0.008	0.003	0.01	0.006	0.001

Significant at P<0.05 and P<0.01 respectively.

Evaluating Interactive Effects of Hybrids

The chemical properties were revealed that soil properties, it had a pH of 6.4 in first environment and 6.8 in second environments which is moderately acidic. Such types chemical properties of soil were differing in different environment. The soil nitrogen was low, in the second environment [Table-6] than K during *Rabi* (Winter) season 2015-16 and *Kharif* (Rainy) season 2016. Soil phosphates were also low of the second environment in comparison to first environment. Amount of rainfall and irrigation distribution played a significant role for utilization of macronutrients and expression of flowering and grain filling period in hybrid maize. There was soil temperature may be more environment-II, therefore potassium and phosphorus were immobile condition in depth of soil and plant could not use in absence of adequate moisture and optimum temperature. Therefore, yield of environment-II is less than environment-I in *Kharif* 2016, because that environment was totally rain-fed. According to Olaoye [20] weather pattern (temperature and soil moisture) of reproductive phase crop was vital in stimulating plants to speed up the process of maturation.

The selected 5 hybrids were interactive effect showed by eight traits [Table-7], such as plant height (cm), ear height (cm), seedling emergence, days to 50% tasseling, days to 50% silking, days number of plant harvest, number of ear harvest and grain yield (t/ha) earlier attained maturity but more problems were creating in grain feeling of maize hybrids, because after February month environmental temperature was increase that more variation create of seed maturity during *Rabi* (Winter) season environment-II. The favorable condition of environment was maintained by irrigation during growing period (silking and tasseling) in maize hybrids. The differences of hybrids were indicated variability which could be heritable and can be exploited in the overall process of breeding program. The Yusuf [21], reported that CIMMYT inbred lines is superior to local varieties, and produce higher grain yield compared with the currently released normal maize varieties regarding most grain yield [22].

Conclusion

The QPM development is a challenging work for plant breeders, enhancement of grain qualities is ensuring to seed functionality, processing, grain yield and agronomic performance. In screening germplasm for quality proteins maize hybrids require wider sources. Such types more opportunities are developed for maize improvement. The focus is varietal evaluation of maize that could replace existing cultivars as sources of genes for the extraction of inbred lines in breeding superior. Most of the QPM inbred lines and hybrid yields were evaluated for grain yields and other yield performance, especially inbred lines. These inbreds were development of productive maize varieties for future maize breeding. The hybrids could be assessed in different environment for yield characteristics in the field. These will be revealing the comparative advantages of the different environments and quality parameters of the yield and yield component in different abiotic parameters.

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Abbreviation

QPM: Quality Protein Maize
CV: Coefficient of Variation
G: Gram
RGSC: Rajeev Gandhi South Campus
M: Meters
CM: Centimeter
Mg: Milligram
ANOVA: Analysis of Variation
WUE: Water Use Efficiency
GYP: Grain Yield Per Plant
Q/Ha: Quintal Per Hectare
Kg: Kilogram
RBD: Randomized Block Design

Conflict of Interest: None declared

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