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PERFORMANCE OF DIFFERENT EXOTIC MAIZE HYBRIDS

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ABSTRACT

A field experiment was conducted in the Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh during the Kharif season 2008 to study the performance of different maize hybrids. A larger variation in plant characters and yield performance among the hybrids was noticed. The hybrids MH_7 and MH_{26} produced maximum grain yield per plant (187.2 g) which were identical with MH_5 and MH_{26} (186.7 and 186.2 g, respectively) while MH_{23} produced minimum grain yield per plant (129.2 g) and was also identical with the Check (MH_{39} and MH_{40}). Phenotypic variance against yield per plant (371.79) was higher than the genotypic variance (172.94). This indicated the existence of much influence of environment on the expressivity of the character. This character showed moderate genotypic (8.43) as well as phenotypic (12.35) co-efficient of variation associated with low heritability (46.52 %).

Key words: *Maize hybrids, genotypic and phenotypic variance*

INTRODUCTION

Maize (*Zea mays* L) is one of the important cereals of the world. It belongs to the family Gramineae and is a photo-insensitive, cross pollinated C_4 crop. It is one of the promising cereal crops and ranks 3^{rd} both in acreage and production in Bangladesh. Maize grains have high nutritive values and used as food, fodder, feed and fuel. Its demand is increasing day by day. Maize is being cultivated all over the world but the yield of maize is low in Bangladesh as compared to other maize growing countries. The area of maize cultivation increased to 0.14 million hectare in 2006 from 0.09 million hectare in 2005. In the FY2004-2005, maize production estimated by DAE was about 0.47 million metric tons, that particularly compensated the short fall in wheat production (Bangladesh Food Situation Report, 2005).

Natural calamities such as drought, flood, cyclone etc. and above all, the high rate of population explosion is the burning question, which cause food crisis around the world. This alarming situation indicates the urgency of making a wide range effort to produce more food globally and particularly in third world country like Bangladesh.

Loamy soil with nearly neutral pH is most suitable for production of maize. It can be grown all the year round in Bangladesh, and fitted in the gap between the main cropping seasons without affecting the major crops. It can also be grown in flood prone areas under no tillage, and with minimum inputs (Efferson, 1982).

Maize being the highest yielding crop among cereals has high potential for growing in Bangladesh. Development of maize varieties having high yield within the shortest time may go a long way to supplement food and fodder shortage in Bangladesh and establish industries.

Revolution in maize yield and production was brought about by the hybrid maize over the use of inbreed lines. The initial commercial hybrids in U.S.A. included mostly double crosses and three way crosses suggested by Jones (1918, 1922). The recent trend is towards use of single crosses. Single cross hybrids are uniform and may be higher yielders than other commercial hybrids. Nevertheless, through extensive field testing and by participatory variety selection strategy single-cross hybrids with high yields and adaptability can be identified. For the reasons of significantly

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higher yields and/or uniformity in expression of desired traits are feasible in maize hybrids. Single-cross hybrids are more commonly used today despite low seed yields (F_1 seed yields, commercial hybrid seed) compared to other types of commercial hybrids (Agarwal, 2002).

The goal of every plant breeder is to operate selection among the germplasm at his disposal and to utilize them to obtain new cultivars superior to the existing ones. The breeders thus need clear understanding of the nature and extent of different types of genetic variation in the population. The quantitative genetic techniques provide a more systematic approach to study the inheritance of continuously varying characters and thus supply basic information for designing appropriate plant breeding programme.

Information on genetics of yield and other associated characters as influenced by the local environment is limited in Bangladesh. Such information is prerequisite to plan any breeding programme for development of high yielding synthetics and hybrids of maize (Agarwal, 2002). Yield is complex entity and is the cumulative end product of many factors called yield components. For effective selection information on nature and magnitude of variation in populations, association of characters with yield and among themselves and the extent of environmental influence on the expression of these characters are necessary. The investigation was therefore, conducted with forty hybrids with the objectives of- to study the performance of hybrid maize based on yield and yield attributes.

MATERIALS AND METHODS

The investigation was conducted with forty maize hybrids. The hybrids have been developed by CIMMYT and were collected from the maize breeding project of Lal Teer Seed Company Limited, Bangladesh. The investigation was conducted at Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh, at the experimental plot of the department of Genetics and Plant Breeding during the Kharif season of 2008. Geographically, Dinajpur is situated at 24^0 north latitude and 90.25^0 east latitude with an elevation of 34 m from sea level.

The experimental land was medium high. The soil belongs to the old Himalayan Piedmont Plain agro-ecological region (AEZ-1), textured by sandy loam with pH of around 6.2. During the growing period of the crop, total rainfall and mean monthly temperature for the month of February, March, April, May and June were recorded.

The experiment was conducted with 40 maize hybrids along with the check variety BARI hybrid maize-5 (BHM-5). The hybrids were collected from International Maize and Wheat Improvement Centre (CIMMYT), Mexico and the check varieties were collected from the Bangladesh Agricultural Research Institute (BARI). MH_1, MH_2, MH_3, MH_4, MH_5, MH_6, MH_7, MH_8, MH_9, MH_{10}, MH_{11}, MH_{12}, MH_{13}, MH_{14}, MH_{15}, MH_{16},MH_{17}, MH_{18}, MH_{19}, MH_{20}, MH_{21}, MH_{22}, MH_{23}, MH_{24}, MH_{25}, MH_{26}, MH_{27}, MH_{28}, MH_{29}, MH_{30}, MH_{31}, MH_{32}, MH_{33}, MH_{34}, MH_{35}, MH_{36}, MH_{37}, MH_{38}, MH_{39} and MH_{40}. The experimental area was thoroughly prepared by ploughing and cross ploughing followed by laddering. All the stubbles and weeds were removed from the experimental area and were leveled properly. During final land preparation the experimental area was fertilized with basal dose of fertilizers.

The experiment was set up in randomized complete block design with three replications. The plot size was 6m X 8m (48 m^2). Each plot comprised with 8 rows 8 meter long with row-to- row spacing of 70 cm and plant-to-plant spacing of 25 cm. the seeds were sown by hand on the 13th February, 2008. Seeds of the check variety BHM-5 were also sown along with the hybrid seeds. One plant was kept per hill. Chemical fertilizers such as urea, triple super phosphate (TSP), muriate of potash (MP), gypsum, zinc sulphate, magnesium sulphate and boric acid were applied at the rate of 167 kg ha^{-1}, 195 kg ha^{-1}, 70 kg ha^{-1}, 98 kg ha^{-1}, 10 kg ha^{-1}, 10 kg ha^{-1} and 10 kg ha^{-1}.During land preparation, half of the urea and the whole quantity of TSP, MP, gypsum, zinc sulphate and magnesium sulphate were applied. The remaining urea was applied in two equal splits as top dressing, one after 30 days of sowing and another at the presilking-pretasseling stage of plant growth. During the growth period intercultural operations such as thinning, weeding, earthing up, etc. were done from time to time as required in order to provide right conditions for regular growth and development of the plants. Flood irrigation was given four times, an irrigation preceding each top dressing. Insecticides such as, Furadan and Ripcord were applied uniformly as a preventive measure to keep plants free from insect attack. Crops were harvested when the husk cover was completely dried and black layer was formed in the grain. The ears of five randomly selected plants of each line were separately harvested.

Data were collected from five plants of each line on the following characters:
Days to flowering of male, Days to flowering of female, Days to maturity, Plant height, Ear height, Cob length, Cob diameter, 100-grain weight, Grain yield per plant, No. of grains /cob, Distance between tassel and cob, Shelling percent.

Estimation of genetic parameters:
(I) **Estimation of genotypic and phenotypic variances:**
Genotypic and phenotypic variances were estimated following Jhonson *et al*. (1955).
(II) **Estimation of genotypic and phenotypic co-efficient of variation**:
According to formula given by Burton (1952) the genotypic and phenotypic co-efficient of variation were calculated.
(III) **Estimation of Heritability:**
Broad sense heritability of all characters was estimated by the formula used by Johnson *et al.* (1955) and Hanson *et al.* (1956):

RESULTS AND DISCUSSION

The results of the present study are discussed under the following sub-headings:
Analysis of variance, mean performance and genetic parameters
The analysis of variance (Table 1) showed significant differences among the maize hybrids for plant height, ear height, cob length, cob diameter, 100-grain weight, grain yield per plant, no. of grain per cob, distance between tassel and cob and non-significant for days to flowering of male, female and days to maturity, cob diameter and shelling percentage. The mean performances of the hybrids are presented in the Table 2. The range, mean, standard error and phenotypic, genotypic and environmental variances for different characters are presented in table 3. The estimates of genotypic and phenotypic co-efficient of variation, heritability are presented in Table 4.
Days to flowering of male
Days to flowering of males were not significant. However the higher days to flowering of male was obtained in the hybrid MH_{11} followed by MH_{30}, and MH_{20}. The lowest days to flowering of male was recorded from the genotype MH_9 (Table 2). The phenotypic variance for the lowest days to flowering of male was much higher than the genotypic and environmental variances indicating considerable influence of environment on the trait. The genotypic and phenotypic co-efficients of variations (11.48 and 12.33, respectively) were obtained for this trait (Table 4). More or less similar results were also reported in maize by Debnath (1991). Heritability estimate (86.75%) was high as was also reported by Debnath (1991). The heritability estimates provide the basis for selection on the phenotypic performance; Johnson *et al.* (1955) suggested that the estimates of heritability and genetic advance should always be considered simultaneously. These results were in agreement with those obtained by Debnath (1988). The ± SE was only 2.61 indicated that there was good precision in distribution of the hybrids on overall blocks and sample means recorded for the characters were precise in statistical sense (Table 3).
Days to flowering of female
Days to flowering of females were not significant. However the higher days to flowering of female was recorded from the hybrid MH_{11} followed by MH_{26}, MH_{20} and MH_{18}. The lowest days to flowering of female was obtained from the hybrid MH_4 (Table 2). The phenotypic variance (18.39) was comparatively higher than the genotypic variances (25.75) showing comparatively much environmental influence on this trait. The phenotypic and genotypic co-efficients of

variation were very low (6.74 and 5.69, respectively). Medium heritability (71.42 %) was obtained for this trait (Table 4). Low genotypic co-efficient of variation, moderate heritability for days to flowering of female was reported in maize by Debnath (1988) which partially confirmed the present findings. The ± SE was only 2.22(Table 3) which showed that data collected from the sample plants did not differ from the population mean for the character concerned (Table 3).

Days to maturity

There was no significant difference for the days to maturity among the hybrids. The late matured genotype was MH_{26} was followed by MH_{37} and MH_{40}. The earliest variety was MH_{16} and the second earliest variety was MH_2 (Table 2). The phenotypic variance (31.32) was higher than genotypic variance (23.39) indicating comparatively much environmental influence on the trait. Genotypic co-efficient of variation (4.56) and phenotypic co-efficient of variation (5.28) along with low heritability (74.68 %) were observed for this trait there was scope to isolate good genotype for this character in the present materials (Table 4). Here ± SE 2.30 indicated that the sample means recorded for the character was precise in statistical sense and the distribution of the hybrids in the overall blocks was good (Table 3).

Plant height

The highest value for plant height was observed in MH_{29} (200.4 cm) which was statistically identical with MH_{37}, MH_{36}, MH_{30}, MH_{28}, MH_{25}, MH_{22}, MH_{19}, MH_{18}, MH_{17}, MH_{16}, MH_{11}, MH_{10}, MH_9, MH_4 and MH_3. The shortest plant height was exhibited by MH_{24} (143.3 cm). It was observed that maximum genotypes were significantly longer than the two checks MH_{39} and MH_{40} (Table 2). The phenotypic variance (310.79) was higher than the genotypic variance (125.13) showing appreciable environmental influence on this trait. Low genotypic coefficient of variation (6.52) with low heritability (40.26) indicated that selection for this trait would not be so much effective (Table 4). Similar results were also reported Parh *et a1.* (1992) in maize which were in agreement with the present results. The ± SE was 11.13 provided a good precision about the sample means for different hybrids on this character and the distribution of the hybrids in blocks is good (Table 3). The value of ± SE increases when the mean difference for various characters increases.

Ear height

The highest ear height was exhibited by the hybrids MH_3 and MH_{29} followed by statistically similar genotypes MH_{37}, MH_{28}, MH_{18} and MH_{17}. The hybrid MH_{24} had the lowest ear height and it was statistically identical with most of the genotypes. Most of the genotypes showed significantly less ear height compared to the check MH_{39} and MH_{40} (Table 2). The phenotypic variance (178.73) was higher than genotypic variance (104.94). The highest genotypic and phenotypic co-efficient of variation (14.77 and 19.28 respectively) and low heritability value (58.71 %) for ear height indicated that selection for this trait would not be so much effective (Table 4). The present findings showed confirmity with those of Debnath and Debnath (1988) and Parh *et al*. (1992). The ± SE 7.02 showed that data collected from the sample plants were not differed from the population mean for the character concerned (Table 3).

Cob length

The longest cob length (16.89 cm) was produced by the hybrid MH_{16} which was statistically identical with most of the hybrids. The smallest cob length was recorded in hybrid MH_{36} and it was also identical with most of the hybrids (Table 2). The phenotypic variance (8.91) did not approach genotypic variance (7.08) indicating the presence of much environmental effect on this trait. The character showed low genotypic (17.99) and phenotypic (20.18) co-efficient of variation and heritability in broad sense was (79.46 %). This indicated limited scope of selection for ear length. These findings were in agreement with the results obtained by Debnath (1989). Here ± SE 1.10 indicated uniform distribution of the hybrids in the overall blocks and the sample means recorded for the character was precise in statistical sense (Table 3).

Table 1. Analysis of variance for various characteristics

Source of variation	Degrees of freedom	MEAN SQUARE											
		Days to flowering of male	Days to flowering of female	Days to maturity	Plant height	Ear height	Cob length	Cob Diameter	100-grain Weight	Grain yield /plant	No. of grain /cob	Distance between tassel and cob	Shell %
Replica-tions	2	52.83	70.61	104.5	4950	322.3	6.99	8.35	3.53	45.23	2316	1945	56.31
Genotypes	39	211.075	62.53	118.102	561.0	388.6	23.07	97.15	93.14	717.7	5449	560.0	18.30
Error	78	10.22	7.36	7.935	185.7	73.79	1.83	4.01	7.49	198.9	915	67.42	3.02

Table 2. Mean performance for various characters in maize hybrids by DMRT Test

Genotypes	Days to flowering of male	Days to flowering of female	Days to maturity	Plant height (cm)	Ear height (cm)	Cob length (cm)
MH_1	72.00 a	77.00 a	104.0 a	154.7 f-j	60.23 i-n	13.81 b-f
MH_2	71.00 a	74.33 a	103.7 a	169.2 b-j	66.27 d-n	15.01 a-f
MH_3	69.00 a	73.00 a	105.7 a	190.1 a-c	97.87 a	15.20 a-f
MH_4	68.33 a	72.00 a	108.3 a	179.5 a-i	78.63 b-g	15.02 a-f
MH_5	71.00 a	73.33 a	103.3 a	189.0 a-c	76.48 b-i	15.56 a-d
MH_6	73.33 a	77.67 a	107.7 a	169.2 b-j	66.10 e-n	16.26 ab
MH_7	70.67 a	74.33 a	106.0 a	185.1 a-d	65.10 f-n	15.58 a-d
MH_8	71.67 a	75.67 a	107.0 a	156.8 e-j	56.03 k-n	14.31 a-f
MH_9	68.00 a	72.33 a	105.7 a	180.6 a-g	59.86 i-n	14.45 a-f
MH_{10}	69.67 a	74.67 a	107.3 a	179.9 a-g	67.22 d-n	16.06 ab
MH_{11}	75.00 a	80.00 a	106.7 a	187.1 a-c	87.41 a-c	14.64 a-f
MH_{12}	72.00 a	76.67 a	105.3 a	178.6 a-i	67.37 d-n	15.55 a-d
MH_{13}	72.33 a	77.33 a	107.7 a	163.8 c-j	61.35 h-n	14.18 a-f
MH_{14}	73.00 a	76.00 a	104.0 a	157.9 d-j	73.20 c-k	16.14 ab
MH_{15}	71.67 a	75.33 a	107.0 a	152.2 h-j	53.63 mn	14.05 b-f
MH_{16}	70.67 a	73.67 a	103.0 a	183.5 a-e	68.41 d-m	16.89 a
MH_{17}	70.33 a	74.33 a	105.0 a	179.7 a-h	72.60 c-l	15.91 a-c
MH_{18}	73.33 a	78.33 a	106.0 a	179.2 a-i	82.44 a-e	15.07 a-f
MH_{19}	69.33 a	75.67 a	105.3 a	181.3 a-f	62.13 g-n	15.56 a-d
MH_{20}	74.00 a	78.33 a	105.7 a	170.4 b-j	61.17 h-n	14.08 b-f
MH_{21}	71.67 a	77.00 a	105.7 a	165.1 c-j	61.75 g-n	15.96 a-c
MH_{22}	71.67 a	74.33 a	105.7 a	178.5 a-i	64.73 f-n	15.57 a-d
MH_{23}	70.00 a	74.00 a	107.7 a	162.8 c-j	59.10 j-n	14.48 a-f
MH_{24}	70.00 a	74.00 a	106.3 a	143.3 j	51.05 n	15.01 a-f
MH_{25}	73.67 a	78.00 a	106.3 a	174.4 a-i	66.61 d-n	14.39 a-f
MH_{26}	73.00 a	78.67 a	109.7 a	154.5 f-j	65.20 f-n	14.10 b-f
MH_{27}	70.00 a	72.67 a	104.7 a	152.0 ij	56.90 j-n	13.02 d-f
MH_{28}	70.33 a	74.00 a	104.0 a	195.0 ab	90.11 ab	15.73 a-d
MH_{29}	73.33 a	77.33 a	104.7 a	200.4 a	96.10 a	15.28 a-e
MH_{30}	74.33 a	78.00 a	106.7 a	182.8 a-e	80.01 b-f	15.55 a-d
MH_{31}	68.33 a	72.67 a	104.0 a	162.7 c-j	58.37 j-n	12.72 ef
MH_{32}	70.33 a	74.67 a	108.0 a	170.4 b-j	76.53 b-i	13.86 b-f
MH_{33}	69.00 a	73.00 a	105.3 a	164.6 c-j	73.42 c-j	13.65 b-f
MH_{34}	71.33 a	74.67 a	104.3 a	169.5 b-j	73.50 c-j	14.72 a-f
MH_{35}	71.00 a	74.67 a	106.0 a	157.0 e-j	55.70 l-n	13.65 b-f
MH_{36}	73.00 a	76.33 a	107.0 a	177.7 a-i	78.01 b-h	12.50 f
MH_{37}	71.67 a	75.33 a	109.3 a	185.5 a-c	83.30 a-d	14.78 a-f
MH_{38}	70.00 a	73.00 a	106.7 a	168.1 b-j	58.20 j-n	14.50 a-f
MH_{39}	70.00 a	73.33 a	104.3 a	152.2 h-j	71.60 c-l	13.22 c-f
MH_{40}	72.00 a	77.00 a	108.7 a	153.2 g-j	69.90 d-m	14.54 a-f
CV (%)	7.0	6.81	8.85	7.95	12.39	9.15
S.E (±)	NS	NS	NS	7.87	4.96	0.78

NS = Not significant

Table 2. Contd.

Genotypes	Cob Diameter (cm)	100-grain Weight (gm)	Grain yield/plant (gm)	No. of grain /cob	Distance between tassel and cob (cm)	Shelling %
MH_1	4.87 a	33.88 a-d	156.3 c-h	491.3 a-c	94.48 fgh	74.88 a
MH_2	4.56 a	34.59 a-d	157.1 b-h	463.0 bc	102.9 b-h	76.58 a
MH_3	4.68 a	35.39 a-c	159.2 b-g	502.7 a-c	92.18 gh	75.59 a
MH_4	4.54 a	35.81 ab	147.7 d-h	458.7 bc	100.9 b-h	78.20 a
MH_5	4.71 a	32.71 a-d	186.5 a	489.3 a-c	112.5 a-d	76.84 a
MH_6	4.63 a	32.21 a-d	160.6 a-f	531.3 a-c	103.1 b-h	80.00 a
MH_7	4.73 a	36.54 a	187.2 a	583.3 a	109.0 a-f	76.21 a
MH_8	4.46 a	30.05 cd	135.0 f-h	436.3 cd	100.7 b-h	72.40 a
MH_9	4.61 a	30.72 b-d	136.2 f-h	508.7 a-c	120.8 a	78.40 a
MH_{10}	4.58 a	33.22 a-d	161.7 a-f	553.0 ab	112.7 a-d	80.99 a
MH_{11}	4.78 a	31.24 a-d	141.0 f-h	491.3 a-c	99.68 b-h	76.07 a
MH_{12}	4.65 a	33.53 a-d	157.2 b-h	530.7 a-c	111.2 a-e	78.77 a
MH_{13}	4.53 a	29.85 cd	135.8 f-h	432.7 cd	102.5 b-h	71.11 a
MH_{14}	4.64 a	34.96 a-d	174.1 a-e	508.0 a-c	102.4 b-h	75.36 a
MH_{15}	4.53 a	31.86 a-d	143.9 f-h	529.3 a-c	98.53 b-h	80.30 a
MH_{16}	4.69 a	31.71 a-d	175.6 a-d	522.3 a-c	115.1 ab	75.45 a
MH_{17}	4.78 a	33.80 a-d	183.9 ab	553.3 ab	107.1 a-g	75.04 a
MH_{18}	4.35 a	29.86 cd	153.0 d-h	552.0 ab	96.79 d-h	74.40 a
MH_{19}	4.63 a	30.67 b-d	183.2 a-c	557.3 ab	109.2 a-f	75.22 a
MH_{20}	4.71 a	32.32 a-d	149.7 d-h	511.0 a-c	109.3 a-f	72.93 a
MH_{21}	4.83 a	33.92 a-d	154.1 d-h	516.3 a-c	103.3 b-h	75.44 a
MH_{22}	4.74 a	31.43 a-d	146.4 e-h	539.0 a-c	113.8 a-c	75.86 a
MH_{23}	4.60 a	29.85 cd	129.2 h	464.7 c	103.7 b-h	75.25 a
MH_{24}	4.40 a	33.70 a-d	149.5 d-h	557.0 ab	92.28 gh	79.16 a
MH_{25}	4.88 a	33.10 a-d	157.2 b-h	510.0 a-c	107.8 a-g	75.51 a
MH_{26}	4.71 a	35.98 ab	186.2 a	512.3 a-c	89.27 h	73.40 a
MH_{27}	4.69 a	33.67 a-d	156.1 c-h	511.7 a-c	95.13 e-h	73.66 a
MH_{28}	4.57 a	33.98 a-d	150.0 d-h	468.0 bc	104.9 a-h	73.33 a
MH_{29}	4.55 a	33.58 a-d	156.1 b-h	476.0 a-c	104.3 b-h	77.23 a
MH_{30}	4.61 a	36.66 a	182.0 a-c	484.3 a-c	100.1 b-h	79.86 a
MH_{31}	4.73 a	30.64 b-d	152.1 d-h	482.3 a-c	104.3 b-h	75.92 a
MH_{32}	4.59 a	35.31 a-c	152.7 d-h	452.0 b-d	93.83 f-h	78.61 a
MH_{33}	4.82 a	35.02 a-d	146.1 e-h	451.7 b-d	91.18 gh	75.60 a
MH_{34}	5.07 a	32.41 a-d	155.6 c-h	534.3 a-c	96.00 d-h	74.18 a
MH_{35}	4.60 a	34.85 a-d	156.6 b-h	490.3 a-c	101.3 b-h	72.88 a
MH_{36}	4.88 a	35.28 a-c	148.1 d-h	358.0 d	99.65 b-h	72.22 a
MH_{37}	4.92 a	29.66 d	152.9 d-h	469.0 bc	102.2 b-h	76.89 a
MH_{38}	4.85 a	33.17 a-d	131.8 gh	509.7 a-c	109.9 a-f	76.37 a
MH_{39}	4.42 a	29.97 cd	149.3 d-h	518.0 a-c	98.30 c-h	73.00 a
MH_{40}	4.44 a	30.14 cd	146.6 e-h	522.7 a-c	93.27 f-h	76.24 a
CV (%)	4.29	7.66	14.30	14.69	7.93	2.28
S.E (±)	1.16	1.58	8.14	31.17	4.74	NS

Cob diameter

Cob diameter was found not significant. However the highest cob diameter was obtained in the genotype MH_{34} followed by MH_{37}, MH_{36} and MH_{25}. The lowest Cob diameter was recorded from the genotype MH_{18} (Table 2). The phenotypic variance was higher (35.06) than genotypic variance (31.05) and the environmental variance (4.01) indicating the existence of considerable influence of environment for the expression of this character. Low genotypic (11.95) and phenotypic (12.69) co-efficient of variation, high heritability (88.57 %) suggested a great scope for the improvement of this character through selection (Table 4). Debnath (1991) reported low genotypic and phenotypic co-efficients of variation. These results confirmed the present findings. There was only ± SE 1.62 confirmed that data collected from the sample plants were not differed from the population mean for the character concerned. So, sampling for recording the trait was reliable (Table 3).

100-grain weight

The highest 100-grain weight (36.66 g) was obtained in MH_{30} and MH_{7}. The lowest 100-grain weight (29.66 g) was obtained in MH_{37}. All the genotypes except MH_{31}, MH_{13} and MH_{8} were statistically superior to both of the check varieties for this trait (Table 2). The difference between genotypic (28.35) phenotypic (36.04) and environmental (7.49) variances was very high indicating very much influence of environment for this character. High genotypic (16.23) and phenotypic (18.23) co-efficients of variation were observed in this trait. Debnath and Debnath (1988) and Parh *et al.* (1992) also observed high genotypic co-efficientt of variation for 1000-kernel weight. Moderate heritability (79.22 %) was observed for this trait (Table 4). And the value of ± SE 2.23 denoted that there was good precision in distribution of hybrids overall the blocks and the sample means recorded for this character was precise in statistical sense (Table 3).

Grain yield per plant

The hybrids MH_{7} and MH_{26} produced maximum grain yield per plant (187.2 gm) which was identical with MH_{5} and MH_{26} (186.7 and 186.2 gm respectively) while MH_{23} was the minimum in this respect having minimum grain yield per plant (129.2 gm) and was also identical with the check MH_{39} and MH_{40} (Table 2). Phenotypic variance (371.79) was higher than the genotypic variance (172.94). This indicated the existence of much influence of environment on the expressivity of the character. This character showed moderate genotypic (8.43) as well as phenotypic (12.35) co-efficient of variation associated with low heritability (46.52 %). This denoted limited scope of selection for grain yield per plant. Debnath (1991) reported low for this character which supported the present findings. The minimal ± SE 11.52 projected that data collected from the selected plants were not differed from the population mean for the character concerned. So, the collected data was meaningful (Table 3).

No. of grains /cob

The highest number of grain per cob exhibited by the hybrid MH_{7} which was statistically similar with most of the hybrids including the check (MH_{39} and MH_{40}). The hybrid MH_{36} had the lowest number of grain per cob and it was statistically identical with the hybrids MH_{8}, MH_{13}, MH_{32} and MH_{33} (Table 2). The difference between genotypic (1511.33) and phenotypic (2426.33) variances for this character environmental variance was 915, which was considerably higher, which revealed much involvement of environment for the expression of this character. Low values of genotypic and phenotypic coefficients of variation (7.76 and 9.83, respectively) along with heritability (62.29 %) were observed which suggested that selection for this trait would not be effective (Table 4). These results were in agreement with those obtained by Debnath and Debnath (1988). Here ± SE 24.69 denoted that the data generated from different hybrids seems to be well for further interpretation and the sample means recorded for this character was good due to the uniform distribution of the hybrids overall the blocks (Table 3).

Table 3. Range, means, standard error and estimates of components of variance for various characters in maize hybrids

Characters	Range	Mean ± S.E	Variances		
			Genotypic	Phenotypic	Environmental
Days to flowering of male	68.0-75.0	71.27±2.61	66.95	77.17	10.215
Days to flowering of female	72.0-80.0	75.32±2.22	18.39	25.75	7.36
Days to maturity	103-109.7	105.99±2.30	23.39	31.32	7.93
Plant height	143.3-200.4	171.44±11.13	125.13	310.79	185.66
Ear height	51.05-97.87	69.34±7.02	104.94	178.73	73.79
Cob length	12.5-16.89	14.79±1.10	7.08	8.91	1.83
Cob Diameter	4.35-5.07	46.64±1.62	31.05	35.06	4.01
100-grain Weight	29.66-36.66	32.93±2.23	28.55	36.04	7.49
Grain yield/plant	129.17-187.22	156.09±11.52	172.94	371.79	198.85
No. of grain /cob	358-583.3	500.99±24.69	1511.33	2426.33	915
Distance between tassel and cob	89.26-120.8	102.64±6.70	164.19	231.61	67.42
Shell percentage	71.11-80.99	75.88±1.42	5.09	8.11	3.02

Table 4. Estimates of Co-efficient of variation and heritability in broad sense for various characters in maize hybrids

Characters	Co-efficient of variation		Heritability in broad Sense (%)
	Genotypic	Phenotypic	
Days to flowering of male	11.48	12.33	86.75
Days to flowering of female	5.69	6.74	71.42
Days to maturity	4.56	5.28	74.68
Plant height	6.52	10.28	40.26
Ear height	14.77	19.28	58.71
Cob length	17.99	20.18	79.46
Cob Diameter	11.95	12.69	88.57
100-grain Weight	16.23	18.23	79.22
Grain yield/plant	8.43	12.35	46.52
No. of grain /cob	7.76	9.83	62.29
Distance between tassel and cob	12.48	14.82	70.89
Shelling percentage	2.97	3.75	62.76

Distance between tassel and cob

The highest value for distance between tassel and cob was observed in MH_9 (120.8 cm) which was statistically identical with MH_{38}, MH_{28}, MH_{22}, MH_{17}, MH_{16}, MH_{12} MH_7, and MH_5 (Table 2). Minimum distance between tassel and cob was exhibited by MH_{26} (89.27 cm). The phenotypic variance (231.61) was higher than the genotypic variance (164.19) showing appreciable environmental influence on this trait. The low genotypic coefficient of variation (12.48) and phenotypic coefficients of variation (14.82) along with medium heritability (70.89 %) indicated that there was limited scope to isolate good genotype for this character in the present materials (Table 4). The ± SE 6.70 showed that data recorded from the selected plants was meaningful and were not differed from the population mean for the character concerned (Table 3).

Shelling percentage

There was no significant difference for the shelling percentage among the hybrids. The shelling percentage was high for the genotype MH_{10} (80.99). The lowest shelling percentage was recoded from the genotype MH_{13} (71.11). The phenotypic variance (8.11) was higher than genotypic variance (5.09) indicating comparatively much environmental influence on the trait. Low genotypic co-efficient of variation (2.97) along with high heritability (62.76 %) were observed for this trait which suggested that selection for this trait would not be so much effective (Table 4). The

± SE 1.42 suggested that the distribution of hybrids and their randomization in different blocks were authentic to generate the mean against each of the hybrids and the data recorded from the selected plants were not differed from the population mean for the character concerned (Table 3).

CONCLUSIONS

The hybrids MH_7 and MH_{26} produced maximum grain yield per plant. The maximum number of grains per cob exhibited by the hybrid $MH_{7.}$ The highest 100-grain weight was obtained in MH_{30} and $MH_{7.}$ All the hybrids except $MH_{31,}$ MH_{13} and MH_8 were statistically superior to both of the check varieties for this trait. The late matured genotype was MH_{26} which was followed by MH_{37} and MH_{40}. The earliest variety was MH_{16}. Out of the 40 hybrids, MH_{37} had the lowest 100-kernel weight and MH_7 had the highest. Among the hybrids, MH_7 had the highest no. of grain per cob and MH_8 had the lowest.

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