

**GENETIC DIVERGENCE ON QUANTITATIVE CHARACTERS OF EXOTIC
MAIZE INBREDS (*Zea mays* L.)**

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ABSTRACT

Forty nine CIMMYT, India Maize inbred lines were characterized based on some morphological traits and grain yield. Genetic divergences of inbred lines of maize were estimated using D^2 and principal component analysis. The genotypes under study fell into five clusters. The inter cluster distance were higher than intra cluster distance suggesting wider genetic diversity among the genotypes of different groups. The maximum intra cluster value was observed in cluster IV and minimum in cluster V. The inter cluster D^2 values revealed that the maximum distance among the cluster. The highest inter cluster distance was observed between cluster II & I and the lowest inter cluster distance was illustrated in cluster III & I. The cluster means were higher for days to 50% tasseling, days to 50% silking, plant height, ear height, cob length, number of rows per cob, number of grains per row in cluster IV; cob diameter and grain yield per plant was found higher in cluster II. It is expected that crossing of inbred lines belonging high to medium D^2 values tend to produce high heterosis for yield.

Keywords: Maize; divergence; cluster analysis; yield; Bangladesh

INTRODUCTION

Maize (*Zea mays* L.) plays a significant role in human and livestock nutrition (food, feed, fodder, fuel and like medical and ornamental plant) in worldwide (Alahdadi *et al.* 2011; Khodarahmpour, 2011). It is the world most widely grown cereal and is the primary staple food in many developing countries (Morris *et al.* 1999). It is a golden crop living the highest capacity to convert the solar energy to grain. Maize in Bangladesh is becoming an important crop in the rice based cropping system. It is the 3rd leading important cereal crop after rice and wheat. Only maize can yield more than rice and wheat (Elias, 1995). Introduction of hybrid varieties and appropriate management practices increased area, production and yield increased by 19.83%, 34.40% and 14.56% respectively for the year 1987 to 2004 (Moniruzzaman *et al.* 2007). According to DAE maize area is 3.12 lac ha in 2012-2013 and total production is 21.78 lac tons and average yield in 6.98 ton/ha (Annous, 2014). The area and production of maize is increasing day by day in Bangladesh and it continues to expand rapidly at an average rate of 20% per year (Annous, 2008).

Hybridization prospective parent (inbred lines) selection is a pre-requisite work for hybrids development. Several studies on maize have shown that an inbred line from diverse stocks tends to be more productive than crosses of inbred lines from the same

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variety (Vasal, 1998). Saxena *et al.* (1998) also reported that manifestation of heterosis usually depends on the genetic divergence of the two parental lines. The qualification of genetic diversity through biometrical procedure made it possible to choose genetically diverse parents. Multivariate analysis is a useful tool in quantifying the degree of divergence between biological population at genotypic level and to assess relative contribution of different components to the total divergence both at the intra-cluster and inter-cluster levels (Murty and Arunachalam, 1966; Ram and Panwar, 1970; Sachan and Sharma, 1971). Genetic diversity is one of the useful tools to select appropriate genotypes for hybridization. Evaluation of genetic diversity is an important to know the sources of genes for particular trait within the available germplasm (Tomooka, 1991). At present, there is no method for increasing atmospheric precipitation during drought periods. Therefore, the experiment was undertaken to find out suitable genotypes that could directly be used as open pollinated variety or parents for hybrid or synthetic variety.

MATERIALS AND METHODS

Forty nine genotypes of maize collected from CIMMYT, India were grown in a completely randomized block design with three replications at Bangladesh Agricultural Research Institute, Gazipur 1701 (AEZ 28 and 24.00°N latitude and 90°.25"E longitude) in the season of 2010-11. The seeds were sown on November 29, 2010 the unit plot size was 25m long and intra row spacing was 75 cm and 25cm with one plant in each hill. Fertilizers were applied @ 120,80,80,20, 5 and 1 kg/ha of N, P₂O₅, K₂O, S, Zn and B respectively. Standard agronomic practices were done and plant protection measures were taken when required. Data on days to 50% tasseling (DT) and silking (DS) were recorded on whole plot basis. Ten randomly selected plants were used for recording observations on grain yield/plant (g), plant height (PLHT) (cm), ear height (ERHT) (cm), Number of rows per cob, (R/COB) Number of grains per row (SEED/ROW), cob length (ERLT) (cm), cob diameter (ERDIA) (cm), 1000 grain weight (TGW) (g). Genetic diversity was estimated using Mahalanabis generalized distance (D^2) extended by Rao (1952). Tocher's method was followed to determine the group constellation. Canonical variate analysis was also performed as per Rao (1964) to confirm the results of cluster D^2 analysis. The data were analyzed using GENSTAT 5.0 and SPSS 11.6 software program.

RESULTS AND DISCUSSION

Principal component analysis revealed that the first axes accounted 36.586% of the total variation among the genotypes, while 10 of these with eigen values accounted for 99.15%. The first three axes of 10 eigen values above the unity accounted 71.962% of the total variation among the ten characters describing 49 maize inbred lines. Range, mean, standard deviation of different characters of the studied inbred lines is presented in Table 1. From, this table we can see that high to medium variation was found in days to 50% silking, grain yield per plant (g), 1000-seed weight, plant height (cm) and ear height (cm). The Lowest variation was observed from Cob diameter (cm), Number of rows per cob and Cob length (cm). Hence, there is enough scope for selection of potential inbred lines for hybridization program.

Forty nine inbred lines were grouped into five different clusters by using clustering techniques. The distribution of the genotypes in different clusters is presented in Table 2. The maximum number of genotypes (17) were grouped into cluster V followed by cluster III (15), whereas minimum number (2) in to cluster IV followed by

cluster II (5). The cluster I consists of ten genotypes. Smith (1990) reported three groups in a divergence study of 48 maize cultivars.

Table 1. Briefly statistics of the quantity characters of exotic maize accessions

Characteristics	Mean	Range		Standard Deviation
		Min	Max	
Days to 50% tasseling	95.714	84	114	6.06
Days to 50% silking	98.878	87	198	78.49
Plant height (cm)	95.282	62.2	150.4	17.96
Ear height (cm)	32.755	14.1	68.6	11.85
Cob length (cm)	10.335	6.1	6.1	2.38
Cob diameter (cm)	11.241	16.8	14.1	1.46
Number of rows per cob	11.676	8	15	1.66
Number of grains per row	15.931	9.3	25.3	4.03
1000-seed weight	256.408	138	382	48.73
Grain yield /plant (g)	180.367	49	372	67.45

Table 2. Pedigree number and different clusters of 49 maize inbred lines

Cluster	No. of cluster	Pedigree number
I	10	P31C4S5B-39-#-B-B-B-B-B-7-B-3-B, CML424-1-B, CML435-2-B, P31C4S5B-23-#-6-BBBB-B-B-B-3-B-2-B, CML474-B-B-B-2-B, P31C4S5B-41-#-B-B-B-B-B-2-B-2-B, P31C4S5B-33-#-8-B-B-B-B-B-B-3-B, CML481-1-B, CA14514-1-B-1-B,
II	5	P31C4S5B-23-#-4-BBB-B-B-B-B-4-B, CML337-1-B, CML121-1-B, CA03130-1-2-B-3-B, CML291-1-B
III	15	CML161-2-B, CML287-1-B, CA03139-6-4-2-B, P31C4S5B-41- #-B-B-B-B-B-1-B-1-B, P31C4S5B-39-#-B-B-B-B-8-2-B, CA03130-B-B-2-B-1-B, CA14514-B-2-B-2-B, CML290-2-B, P31C4S5B-39-#-B-B-B-B-8-7-2-B, BH-21, CML172-2-B, CML112-1-B, CA14514-3-B-1-B, CML41-2-B, CA03130-1-5-B-1-B
IV	2	CML434-2-B, CML 425-B-B-B-4-B
V	17	P31C4S5B-23-#-6-BBBB-B-B-1-2-4-B, CML326-1-B, P31C4S5B-39-#-B-B-B-B-4-B-2-B, CML479-2-B, CA003134-B-B-B-2-B, Pop.31C4S5B-85-#-1-2-B-B-B-B-B2-B-B-4-B, CML469-1-B-B-2-B, CML338-1-B, CML72-1-B, CA14709-4-7-5-1-B, CML299-1-B, P31C4S5B-39-#-B-B-B-B-8-9-2-B, CA14514-2-6-2-B, CML20-2-B, CML293-1-B, SW92145-2EV-7-3-B-B-B-B-5-B-1-B, CML296-1-B

The pattern of clustering revealed that the genotypes originated from same country did not form a single cluster. This indicates that geographic diversity is not always related to genetic diversity. Similar results have been reported by Das and Gupta (1984) in black gram and Mian *et al.* (1991) in Pea. Likewise the genotypes of similar origin were grouped in different clusters.

The intra-and inter-cluster values within and among the clusters are presented in Table 3. Intra-group distances appeared much smaller than the inter-groups, suggesting a lower genetic diversity among the lines of the same group than those from different groups. This is collaborated with the results of Ivy *et al.* (2007) and Hoque *et al.* (2008). Intra-cluster distances varied from 0.634 to 1.611 comparatively, higher intra-cluster

distances were observed in cluster IV and I. Clustering revealed instability due to low divergence and widely diverged clusters remain stable in different environment reported by Raut *et al.* (1985). Inter-cluster distances ranged from 3.328 to 8.731. The maximum inter-cluster distance was observed between clusters II and I (8.731). Medium or intermediate distances were observed between cluster IV and I (6.743), V and IV (5.910) and V and II (4.485). The lowest distance was shown between cluster III and I (3.328). It indicated that the genotypes grouped in these clusters were highly divergent from each other. Selection of parents from the highly divergent clusters is expected to manifest high heterosis in crossing and also wide variability in genetic architecture. Murty and Arunachalam (1966) claimed that there is a positive relationship between the specific combining ability and the degree of genetic diversity.

Table 3. Inter and intra-cluster (bold) distance (D^2) for 49 maize inbred lines obtained by canonical variate analysis

Cluster	I	II	III	IV	V
I	0.9577				
II	8.731	0.6564			
III	3.328	7.211	0.7383		
IV	6.743	8.292	8.565	1.6081	
V	4.545	4.485	3.983	5.910	0.6339

The genetic differences between clusters were reflected in their cluster means. Mean values for different clusters are presented in Table 4. The highest mean values for days to 50% tasseling, days to 50% silking, plant height, ear height, cob length, number of rows per cob, number of grains per row were observed in the same cluster IV. This means lines included in this group are better for these parameters. Cluster V had the lowest value for plant height and ear height. The lowest mean values for days to tasseling and days to silking were found in cluster III.

Table 4. Cluster means for 10 different characters of 49 maize inbred lines

Characters	Clusters				
	I	II	III	IV	V
Days to 50% tasseling	96.90	93.20	92.13	100.50	98.35
Days to 50% silking	100.30	95.80	95.00	104.00	101.76
Ear height (cm)	34.17	32.38	31.89	45.85	31.25
Plant height (cm)	98.70	91.18	97.09	110.65	91.07
Cob length (cm)	9.88	9.88	9.67	12.60	11.05
Cob diameter (cm)	10.40	12.26	11.25	11.30	11.42
Number of rows per cob	11.37	12.24	11.03	12.60	12.15
Number of grains per row	15.15	18.38	13.31	19.10	17.61
1000-seed weight (g)	238.00	260.00	315.67	84.50	234.12
Grain yield /plant (g)	102.00	320.00	151.87	190.00	209.41

Contribution of the characters towards divergence is presented in Table 5. The canonical analysis revealed that, days to 50% tasseling, 1000 seed weight (g), cob diameter and ear height (cm) showed positive values in respect to both the vectors (Vector I and II). Such results indicate that these characters contributed maximum towards divergence of the genotypes. Jagadev and Samal (1991) and Patel *et al.*, (1989) reported that plant height and seed yield were higher contributors towards diversity in niger and safflower, respectively. Thiagarajan *et al.*, (1988) observed that plant height as

higher contributor in cowpea. Maximum contribution of days to tasseling, kernel weight and kernel yield/plant (g) towards diversity of maize was also reported by Ahloowallia (1963).

Table 5. Latent vectors for 10 principal component characters of 49 in maize inbred lines

Characters	Vector I	Vector II
Days to 50% tasseling	0.0707	0.1322
Days to 50% silking	-0.0653	-0.0911
Ear height (cm)	0.0342	0.0027
Plant height (cm)	0.0240	-0.0236
Cob length (cm)	0.0120	-0.0578
Cob diameter (cm)	0.2248	0.4422
Number of rows per cob	0.1371	-0.3892
Number of grains per row	-0.1099	0.0913
1000 seed weight	0.0095	0.0333
Grain yield /plant (g)	-0.0351	0.0054

Considering plant architecture and other traits the inbreds are clustered into 5 diverged groups. It is expected that inbred lines belonging high to medium D^2 values tend to produce high heterosis for yield. On the basis of the findings of the present study, it can be recommended that the genotypes from cluster III, IV and V were selected to be the better parents for future hybridization program to obtain desirable segregates in respect of different yield and yield contributing characters. Hence major emphasis should be given on them for selecting parents for hybridization in maize.

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