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GENETIC DIVERSITY IN MAIZE INBREDS UNDER EXCESS SOIL MOISTURE CONDITION

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Abstract

Genetic diversity study was done in 64 maize inbreds grown under excess soil moisture condition.The genotypes were grouped into eight clusters. It was observed that all intercluster distances were larger than all intracluster distances. Such results indicated that genotypes included within a cluster had less diversity among themselves but wider genetic diversity among the inbreds of different clusters. The highest inter cluster distance was observed between cluster IV & VII followed by IV & V , IV & VIII, II & VII and I & IV. The highest intra cluster distance was noticed in cluster V and the lowest was in cluster VII. The highest yield/plant, cob girth, number of rows/ear, number of grains/plant, SPAD value and number of nodes with brace roots were observed in cluster IV. The lowest mean value for yield/plant yield components and dwarf statured plant were observed in cluster VII. The plant height, ear height,days to 50% tasseling and silking, cob length, cob girth, 100 grain weight and SPAD value contributed considerably to total divergence. The genetically diverged genotypes in these distinct clusters could be used as parents in hybridization program for getting desirable hybrid(s).

Introduction

Maize (*Zea mays* L.) is one of the most important cereal crop in the world as well as developing countries like Bangladesh. It is the highest producing grain crop having multiple uses. Hybrid maize has higher yield potentiality than synthetics and composites. Knowledge of germplasm diversity and of relationship among elite breeding materials has a significant impact on the improvement of crop plants (Hallauer *et al.*, 1988). Maize breeders are consistently emphasizing the importance of diversity among parental genotypes as a significant factor for developing heterotic hybrids (Ahloowalia and Dhawan, 1963; Hallauer, 1972). Customarily D^2 analysis is an useful tool for quantifying the degree of divergence between biological population at genotypic level and also in assessing relative contribution of different components to the total divergence both intra and inter cluster level (Murthy and Arunachalan, 1966; Sachan and Sharma, 1971).

Maize area in Bangladesh is increasing day by day for its versatile use. In the year 2014-15, *rabi* and *kharif* maize production was 19.28 and 4.33 lakh metric ton from 2.84 and 0.71 lakh hactre of land, respectively in Bangladesh (Krishi

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diary, 2016). Area of *kharif-1* maize would be increased dramatically for profitable cropping pattern i.e. maize followed by potato cultivation utilizing residual effects of fertilizers used in potato field. Maize crop considered as queen of the cereals grown during the summer-rainy season in Bangladesh critically face waterlogging caused by contingent flooding, continuous rainfall coupled with inadequate drainage or high water table. In south and south east asia alone,over 18% of of the total maize growing areas are frequently affected by floods and waterlogging problems (Zaidi *et al.*, 2008).

In general, most of our modern high yielding varieties are developed under favorable environments and optimal input conditions. Selection and improvement under optimal conditions may not be suitable for the target areas prone to abiotic constraints (Simmonds, 1991). Therefore, in order to achieve improved and stable yields in stress prone environments it is desirable to improve tolerance to major abiotic constraints prevalent in target environment. This is why the present study was undertaken to analyze the genetic divergence of maize inbreds under excess soil moisture condition and to develop high yielding and excess moisture tolerant maize hybrids

Materials and Method

The experiment was undertaken at Regional Agricultural Research station, Jamalpur during *rabi* season 2009-10 to estimate genetic diversity among 64 genotypes of maize inbred lines. Seeds of each entry were sown on 08 December 2009 in single sow 2 m long. Spacing was maintained 75 X 20 cm from entry to entry and plant to plant respectively. One plant was kept per hill after thinning. Fertilizers were applied @ 120, 80, 20, 5 and 1 Kg/ ha of N, P_20_5, K_2O, Zn and B respectively. Other intercultural operations were done according to the necessity to raise the crop uniformly. Irrigations were applied continuously for 7 days maintaining with a ponding depth of 9-11cm induced at knee high stage of maize plants. Genetic divergence was estimated following Mahalanobis (1936) generalized distance (D^2) extended by Rao (1952). Tocher's method (Rao,1952) was followed for determining the group constellations. Canonical analysis was also done according to Rao (1964) to confirm the results of cluster and D^2 analysis. Based on D^2 values, sixty four inbreds were grouped into clusters using the GENSTAT 5.0 computer software.

Results and Discussions

Results pertaining to various genetical analysis tools are presented below. Genetic diversity was estimated by Mahalanobis D^2 statistics and the sixty four inbreds were grouped into eight clusters (Table 1).The number of inbreds in the clusters varied from 3 to 12. Maximum 12 inbreds were present in cluster VI and minimum number of inbreds (3) were found in cluster IV. Hemathavy *et al.* (2006) studied with 42 maize inbreds and the lines were fell into 7 cluters and Kadir (2010) worked with 20 maize inbreds and grouped into 4 clusters. From the Table 2, the highest inter cluster distance was observed between cluster IV & VII followed by IV & V , IV & VIII, II & VII and I & IV. So, selection of parents from those maximum divergent clusters may manifest maximum herterosis . Murthy and Anand (1966) observed a positive corelation between specific combining ability and the degree of genetic diversity. Similar conclusion was also drawn by Ghaderi *et al.* (1979) and Amiruzzaman *et al.* (2008). It was also observed that all intercluster distances were larger than all intra cluster distances. It suggests that genotypes included within a cluster had less diversity among themselves. This is corroborated with the findings of Ivy *et al.* (2007) and Kadir (2010). The highest intra cluster distance was observed in cluster V and the lowest was in cluster VII .

The highest mean value of cluster IV for grain yield/plant along with cob girth, number of grain rows/ear, number of grain/plant, low mean value for plant height, ear height , days to 50% tasseling and days to 50% silking indicated that plants of this clusters were high yielder and low in statured. Ahmed (2007) also observed similar results in maize. The highest SPAD value and 2nd highest number of nodes with brace roots (2.06) along with lowest ASI indicated plants of this clusters are tolerant to excess soil moisture condition. These results showed conformity with those of Zaidi *et al.* (2003) who reported that lower ASI value (<5 days) and higher number of nodes with brace roots along with SPAD value were the important characters for tolerance to excess soil moisture condition in maize . The lowest mean value for yield/plant, cob length, cob girth, number of grain rows/ear, plant height, ear height and low mean value for days to 50% tasseling and silking were observed in cluster VII which indicated that plants of cluster VII were low yielder but were dwarf statured and early maturing.The highest plant height, ear height, days to 50% tasseling and silking were observed in Cluster III. Endang *et al.* (1971) stated that the clustering pattern could be utilized in choosing parents for cross combinations which likely to generate the highest possible variability for effective selection of various economic traits. Under such condition Chaudhury *et al*. (1975) suggested that selection for one type from each cluster and testing them by a series of diallel analysis may prove to be highly fruitful.

The characters cob length, cob girth, 100 grain weight, plant height, ear height, days to tasseling, days to silking and SPAD value showed major contribution towards divergence of the genotypes as shown by positive value of these characters for both the vectors (vector I and vector II).The characters number of grains/plant, ASI and number of nodes with brace roots also showed contribution towards divergence. The results of the present study showed partial agreement with that of Utkhede *et al.* (1975), Hoque *et al.* (2008), Amiruzzaman (2010) and Amiruzzaman and Amin (2010). Utkhede *et al.* (1975) reported the higher contribution of days to tasseling towards total divergence in maize. In contrast, Datta and Mukharjee (2004) reported that very little role was found for days to tasseling and days to silking in the discrimination of inbred lines in maize. They observed that important yield contributing characters like ear weight, ear length and kernel weight had considerable contribution towards divergence. Hoque *et al.* (2008) observed days to tasseling, cob girth, 100 grain weight and grain yield/plant contributed considerably towards divergence. Amiruzzaman and Amin (2010) found that days to silking, cob length, number of grain/row, 1000 grain weight and grain yield/plant showed major contribution in maize. So, considerable emphasis should be given on those parameters responsible for genetic divergence.

Considering the highest/high inter cluster distance, crosses between genotypes of cluster IV with those of cluster V, VII and VIII are expected to improve yield & short statured plant. But mean values of cluster V (low SPAD value) and VII(>5 days ASI) were not suitable for excess soil moisture condition. Considering cluster mean and medium inter cluster distance crosses between genotypes of cluster III & IV are expected to exploit heterosis for grain yield in maize.

Table 1. Distribution of 64 maize inbreds in different clusters under excess soil moisture condition induced at knee high stage

Cluster	No. of inbreds	Inbred lines included in different clusters
I	11	BML36, BIL30, BIL76, BIL77, BIL104, BIL113, BIL128, BIL175, BIL198, BIL206, BIL208
II	5	BIL19, BIL102, BIL108, BIL110, BIL173
III	8	BIL26, BIL65, BIL79, BIL107, BIL114, BIL127, BIL176, BIL207
IV	3	BIL182, BIL184, BIL199
V	9	BML3, BIL101, BIL109, BIL111, BIL172, BIL183, BIL186, BIL201, BIL205
VI	12	BIL97, BIL168, BIL169, BIL170, BIL171, BIL174, BIL177, BIL178, BIL179, BIL181, BIL193, BIL200
VII	9	BIL180, BIL185, BIL187, BIL188, BIL194, BIL197, BIL202, BIL203, BIL204
VIII	7	BIL43, BIL189, BIL190, BIL191, BIL192, BIL195, BIL196

Table 2. Inter and intra-cluster (bold) distance (D^2) for 64 maize inbred lines obtained by canonical vector analysis under excess soil moisture condition induced at knee high stage

Cluster	I	II	III	IV	V	VI	VII	VIII
I	**0.703**							
II	6.425	**0.911**						
III	3.507	3.732	**0.896**					
IV	13.109	6.780	9.922	**0.916**				
V	3.596	8.727	6.806	15.475	**0.962**			
VI	3.923	4.484	4.373	11.044	4.577	**0.644**		
VII	8.986	13.231	12.046	19.644	5.390	8.747	**0.642**	
VIII	6.020	8.035	7.880	14.181	3.879	3.720	5.529	**0.780**

Table 3. Cluster means for 13 different characters of 64 maize inbred lines under excess oil moisture condition induced at knee high stage

SI. No.	Characteristics	cluster							
		I	II	III	IV	V	VI	VII	VIII
1.	Yield/Plant (g)	42.24	47.73	57.44	62.95	34.21	36.29	30.43	49.64
2.	Cob length (cm)	11.69	11.81	13.33	11.73	10.75	11.00	9.80	10.17
3.	Cob girth (cm)	11.68	11.32	12.24	12.76	11.00	10.44	10.07	11.61
4.	Grain rows/ear (no.)	11.34	13.36	12.47	15.58	11.37	12.06	10.85	11.03
5.	Grains/plant(no.)	200.72	266.49	240.20	337.50	169.74	217.28	136.26	197.75
6.	100 Grain wt (g)	23.58	20.13	24.41	19.51	22.42	20.55	20.45	25.52
7.	Plant height(cm)	119.87	101.10	128.04	89.02	108.26	90.64	76.80	69.34
8	Ear height (cm)	59.14	49.91	59.74	45.63	44.67	39.10	26.22	28.24
9.	Days to 50% tasseling	96.12	91.24	96.34	90.98	94.04	90.32	91.24	91.78
10.	Days to 50% silking	101.35	96.15	102.13	94.40	98.75	94.42	96.52	95.90
11.	ASI (days)	5.23	4.91	4.67	3.42	4.71	4.13	5.27	4.13
12.	SPAD value	11.72	11.40	11.77	13.25	9.89	12.65	10.83	11.18
13.	Nodes with brace roots (no.)	1..3	1.74	1.62	2.06	1.52	1.61	1.79	2.44

Table 4. Relative contributions of the 13 characters to the total divergence in maize under excess soil moisture condition induced at knee high stage

SI. No.	Characteristics	Vector I	Vector II
1.	Yield/Plant (g)	-0.10.37	-0.0265
2.	Cob length (cm)	0.1873	0.1782
3.	Cob girth (cm)	0.1092	0.1000
4.	Grain rows/ear (no.)	-0.0121	0.1312
5.	Grains/plant (no.)	0.1083	-0.0227
6.	100 Grain wt (g)	0.2596	0.1174
7.	Plant height (cm)	0.0151	0.0414
8	Ear height (cm)	0.0038	0.0728
9.	Days to 50% tasseling	0.0251	0.0247
10.	Days to 50% silking	0.0649	0.0179
11.	ASI (days)	-0.2022	0.0874
12.	SPAD value	0.0008	0.1178
13.	Nodes with brace roots (no.)	0.4444	-0.5560

Conclusion

The crosses between inbred lines of cluster IV with those of cluster VIII are expected to exploit heterosis for yield & short statured plant but crosses between the inbred lines of clusters III & IV are expected to high yielding hybrid maize. Cob length, cob girth, 100 grain weight, plant height, ear height, days to tasseling, days to silking and SPAD value contributed maximum towards divergence. Hence major emphasis should be given on them for selecting parents for hybrids in maize. From this study it can also be concluded that promising results concurring diversed gene pool of desired plant traits could be obtained in this piece of research work.

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