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Early Vigor Parameters Studies Under Water Stress Conditions In Maize (*Zea mays* L.)

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ABSTRACT

Ten inbreds were evaluated to obtain the information on genetic divergence of the inbreds for initial stage water deficit response, planted in the Research Farm of Department of Genetics and Plant Breeding, BHU, Varanasi during the two *Rabi* seasons of 2015 and 2016. The genetic divergence was studied thrugh multi-variate analysis using D^2 statistics for the ten diverse characters. Analysis of variance revealed significant differences among the genotypes for all the traits. D^2 revealed that the genotypes exhibited considerable diversity and and were grouped into two major clusters. Among the two cluster-1 was found with maximum intra cluster difference and more entries. Maximum genetic divergence was obtained for the trait anthesis -silking interval. Based on Tocher's clustering pattern of the genotypes, three inbreds were suggested to include in the further studies of yield attributing traits and developing the hybrid combinations w.r.t. drought tolerance.

INTRODUCTION

Drought, one among the major abiotic stress has adverse effect on the crop growth, vigor, reproduction as well as yield. Maize is a crop which can be grown under medium to low rainfall conditions. However, below the normal water availability during the critical stages cause adverse effect. In maize, early vigor, internodal elongation, root length, root density, Anthesis-silking interval (ASI) are some of the major initial traits indicating drought tolerance/ resistant nature of the crop. However, in maize, a major effect of water stress is a delay in silking, resulting in an increase in the anthesis-silking interval (ASI), (Sari-Gorla et al. 1999, Edmeades, 2013), change in color from green to green-gray, and rolling of the lower leaves followed by those in the upper canopy. At the same time leaf senescence begins at the base of the plant and spreads upwards to the ear. The multi-seasonal trials and comparison between the inbreds helps in selection of the better inbred lines. Apart from yield, studying other characters like fresh shoot character, early plant vigor, plant stand count gives better idea of drought response at various stages of crop development. This is essential because maize is also used for cattle feed (young plant), production of baby-corn etc. However, an estimated 15% to 20% of maize grain yield is lost each year due to drought and such losses may further increase as droughts become more frequent and severe because of climate change [FAO, 2016]. Maize is not a staple cereal in India, so it won't fetch a prime attention of the farmers and crop covers the area where much management conditions are not required in other words, irrigation is not an option for large numbers of farmers.

The breeding programs improve drought tolerance via diverse strategies such as recurrent selection and evaluation of segregating population under managed and multi-location drought-stress environment, use of secondary traits for selection under drought condition, genomic-based approach and transgenic technology. Understanding the nature of drought response in maize and some major strategies for improving drought stress-tolerance will provide opportunities yield the better target lines.

Estimation of genetic divergence allows the breeders to eliminate some parents in restricting the core collections maintained and concentrate their efforts in a limited number of hybrid combinations (Fuzzato et al., 2002). Several methods have been developed to study the extent of genetic divergence in the genotypes among which Mahalanobis' generalized distance (D^2) (Mahalanobis, 1936) is frequently used. D^2 analysis is a useful tool in quantifying the degree of divergence between biological populations at genotypic level and to assess relative contribution of different components to the total divergence both the inter- and intra-cluster levels. In order to utilize the material for further improvement, in the present experiment we focused on the plant initial characters up to the reproductive stage drought response.

MATERIALS AND METHODS

Ten inbred lines of maize (*Zea mays* L.) used in the present investigation were obtained from the All India Co-ordinated Maize Improvement Project, BHU, and planted in the, Research Farm of Department of Genetics and Plant Breeding, BHU, Varanasi during *Rabi*-2015 and *Rabi* -2016. Each genotype was sown in a two row plot of 4 m length spaced at 60 cm with interplant distance of 20 cm. The experiment was laid in Randomized Block Design with three replications. The recommended package and practices were followed to raise a good crop. To impose the water stress only one irrigation to promote the germination was given. The inbreds (1. HKI-193-1, 2. HKI -1105, CML-161, LM-10, CML-163, PBNI-3-1, HUZM-343, HUZM-152, HUZM-242 and HUZM-185) were phenotyped for the ten initial crop traits like Germination % ,Initial vigor (shoot+ root), anthesis-silking interval (ASI), Root weight (gms), Root dry weight (in gms) , Shoot weight (gms), Shoot dry weight (gms), Days to 50 % anthesis , Plant prolificacy and plant height (cm). All the characters recorded from the two seasons were averaged and subjected to appropriate statistical analysis.

Statistical analysis

Pooled analysis of variance (ANOVA) was used to quantify the genetic differences among the genotypes. The multivariate analysis was performed through Indo-stat Software using Mahalanobis' D^2 statistics (Mahalanobis, 1936). Treating D^2 as a generalized statistical distance, the criteria used by Toucher (Rao, 1952) was applied for determining the group constellation and clustering was done accordingly (Fig.1). The character-wise rank totals were used to calculate the per cent contribution of each character to the total divergence. Average inter- and intra- cluster distances were estimated as per the method given by Singh and Chaudhary (1985).

RESULT AND DISCUSSION

In maize a major effect of drought is a delay in silking, which results to increase in the anthesis-silking interval (ASI), which is an important cause of yield failures (Sari-Gorla et al, 1999). From the F-test (Mean error square) the interaction between the two years traits were found to be non-significant. On the basis of that the data is nested (pooled) here. The analysis of variance revealed significant differences among the inbreds for all the traits studied. The inbreds exhibited a wide range of variation for most of the traits. Similar results were reported by Teixeira et al. 2002 and Singh et al. 2009, Moses A.and Menkir, 2014, Shadakshari T. V. and Shanthakumar G, 2015. The estimated phenotypic coefficient of variation (PCV) was greater than the genotypic CV (GCV) which shows a greater influence of the environmental factors (Table 1). However, the value of these measures still needs to be established in reducing the error variance relative to the genetic variance (Masuka et al., 2012). High GCV was found for the trait ASI followed by plant prolificacy and moderate GCV was recorded for plant height and shoot dry weight. Similar results were recorded by Singh et al. 2009. A strong reduction in ASI among drought tolerant plants, to the extent that ASI is generally considered by maize breeders as the secondary trait that is most indicative of drought tolerance (Bolaños and Edmeades, 1996; Ribaut et al., 1996, Ziyomo and Rex Bernardo, 2013). High broad sense heritability was recorded for root dry weight. High broad sense heritability in combination with high genetic advance always yield better character transferability and are considered to be better traits. The wet shoot weight of the plants under water stress proved to have these characters.

The ten inbreds were grouped into two major clusters using Tocher's method with variable number of entries, indicated moderate diversity among the traits, but still adequate scope exist to select the diverse parents to be exploited for any breeding program. Similar results were reported by Kumar and Singh. 2002. The six inbreds HKI 193-1, HKI-1105, CML-161, CML-163, HUZM 152 and HUZM-185 were found in cluster 1 and rest of the four inbreds in cluster 2. In the cluster analysis, cluster 1 revealed maximum intra cluster distance (Table. 2) indicates the existence of considerable genetic divergence among the constituent genotypes. Hence, parents within as well as among the clusters can be chosen for the hybridization program. Among the two clusters, cluster 1 revealed the highest mean value for shoot weight (336.89) followed by the plant height (153.79) and shoot dry weight (130.56) than the cluster 2 (Table 3) whereas cluster 2 registered the greater mean (103.83) for days to 50 % anthesis than cluster 1 (97.11). Further studies on yield and the yield attributing characters and by estimating the correlation coefficient and path analysis it will be useful to select the best lines for moisture deficit conditions. The similar studies were also conducted by Amurrio et al. (1995) and Rabbani et al. (1998) and Mustafa et al. (2015).

Table 1: Estimates of different parameters from germination upto reproductive stage in maize inbreds.

	GM	IV	ASI	RW	RDW	SW	SDW	DA	PP	PH
Mean	**88.96**	**17.37**	**5.9000**	**142.98**	**50.09**	**312.20**	**123.10**	**99.80**	**1.76**	**140.97**
Range Lowest	79.33	11.40	3.6667	118.00	39.00	230.00	102.33	90.33	1.00	98.66
Range Highest	97.33	21.23	8.6667	176.00	56.70	366.00	148.33	107.66	2.00	172.06
GCV	6.64	16.02	28.95	11.14	9.95	13.98	11.63	4.97	20.08	15.42
PCV	6.93	17.72	32.04	11.68	10.19	14.35	12.18	5.28	25.07	15.54
h^2 (Broad Sense)	0.91	0.81	0.81	0.90	0.954	0.94	0.911	0.88	0.64	0.98
Genetic Advancement 5%	11.6	5.18	3.18	31.30	10.03	87.62	28.16	9.64	0.58	44.44
General Mean	88.9	17.37	5.90	142.98	50.09	312.20	123.10	99.80	1.76	140.97
Mean square	100.6**	22.56**	9.08**	174.29**	60.12**	399.8**	151.26**	109.44**	2.35**	185.42**

GM- Per cent germination, IV-Initial vigor, ASI- anthesis silking interval, RW-Root weight,RDW-root dry wight,SW-Shoot weight,SDW-shoot dry weight,DA-days to anthesis, PP-Plant prolificacy and PH-plant height.

Table 2: Cluster distance obtained from D2 analysis. .

	Cluster 1	Cluster 2
Cluster 1	102.6	320
Cluster 2	320.3	94.8

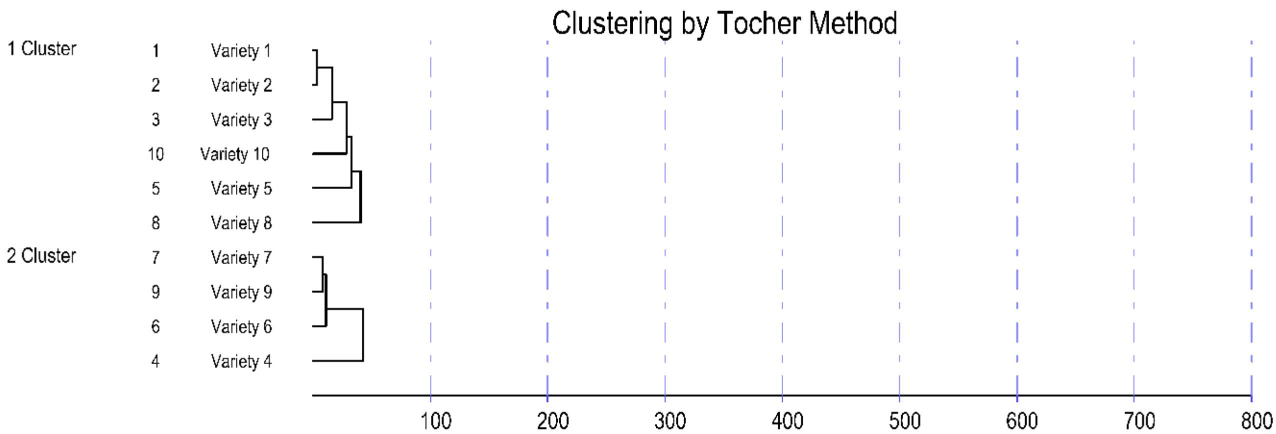

Fig 1: Clustering of the inbred lines by Tocher's method.

*Variety 1. HKI-193-1, 2. HKI 1105, 3. CML-161, 4. LM-10, 5. CML-163, 6. PBNI-3-1, 7. HUZM-343, 8. HUZM-152, 9. HUZM-242 and 10. HUZM-185

Table 3: Cluster distance obtained from D2 analysis. .

	Germination %	Initial vigor (shoot+ root)	ASI	Root weight (gm)	Root dry weight	Shoot weight	Shoot dry wieght	Days to 50 % anthesis	Plant prolificacy	Plant height (cm)
Cluster 1	90.94	18.3	6.33	151	52.7	336.89	130.56	97.11	1.89	153.79
Cluster 2	86	16	5.25	131.6	46.2	275.17	111.92	103.83	1.58	121.75

CONCLUSION

The Mahalanobis' D^2 statistics and Toucher's clustering revealed the moderate amount of diversity among the inbreds through the initial water deficit response studies in maize. Three inbred lines, HKI -193-1, HUZM-242 and HUZM-185 found to be most promising to water deficit conditions during the initial plant growth stages. Based on the genotypic studies, it was found that there is a significant amount of environmental influence on the traits observed, therefore, further studies on reproductive stage and multi-location trials for the effective selection of inbred lines are needed for the future breeding program.

Disclosure statement

No potential conflict of interest was reported by the author.

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