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Short Communication

GENETIC DIVERGENCE IN INDIGENOUS MAIZE (*ZEA MAYS* L.) GERMPLASM OF U.P. HILLS

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Classification of indigeneous maize based on genetic divergence may provide a basis for selection of parents with heterotic combination (Ahloowalia and Dhavan, 1963; Key, 1987 and Ordas et al. 1994). An attempt was therefore, made to study the genetic diversity, using multivariate statistical technique based on measurement of yield and thirteen yield attributes, among indigenous maize germplasm from hills of Uttar Pradesh (U.P.).

One hundred indigenous accessions of maize belonging to hilly areas of U.P. alongwith five check varieties, VL 16, VL 42, Hunius, Vijay and MCU 508 were sown in augmented block design with 13 blocks at VPKAS (ICAR), Almora. Plot size was 3.0 m × 1.2 m. with inter and intra-row spacings of 60 cm and 25 cm, respectively. The data were recorded on five randomly selected plants in each genotype for different characters *viz.* plant height (cm), ear height (cm), ear/plant, ear length (cm), ear girth (cm), grain rows/ear, grains/row, ear weight/plant (g), grain yield/plant (g) and shelling index (%). However, days to pollenshed, silking and dry husk, and 200 grain weight were recorded on plot basis. Recommended agronomic practices were adopted through various stages of crop growth.

Analysis of the data was done in augmented block design (Petersen, 1985). Principal component analysis was used to transform all the variables into new set of independent variables. The first several principal components that accounted for more than 90% of the total variation were used for non-hierarchical euclidean cluster analysis (Beale, 1969).

Correlation matrix of the adjusted values was used for principal component analysis which yielded into 14 eigen vectors and eigen roots. First principal component had highest eigen root (7.89) and also accounted highest proportion

(56.4%) of the total variation present in the original data. The magnitude of eigen root and proportion of total variation decreased for subsequent principal components and ended with minimum eigen root (.003) and proportion of variation (.02%) for fourteenth principal component. Cumulative percentage of total variation indicated the first seven principal components accounted for more than 95% of the variation present in the data. Therefore, first seven principal components, in reduced dimension, were used for non-hierarchical euclidean cluster analysis.

Cluster analysis was initiated with 7 principal component scores by arbitrarily assigning 12 clusters and by reducing one cluster each at every subsequent stage, thus, four cluster solutions with 12, 11, 10 and 9 clusters were obtained. Sequential F ratio test showed that merging of 11 clusters into 10 clusters make F ratio significant at 5% level of probability and, therefore, solutions converged with 11 clusters which aptly described the data. The grouping of 100 accessions into 11 non-overlapping clusters, obviously, showed the diversity among indigeneous maize of U.P. hills.

The distribution pattern of 100 germplasm accessions varied from a minimum 2 in cluster X to a maximum of 16 in cluster VI (Table 1). Intracluster

Table 1. Composition of clusters based on genetic divergence in maize.

Cluster	No. of accession	Germplasm accessions included in clusters
I	10	P 442, P 584, P 446, P 263, P 99, P 94, P 1, P 525, P 14, P 15
II	10	P 35, P 88, P 37, P 54, P 78, P 74, P 39, P 76, P 66, ML 21
III	07	ML 46, P 440, P 579, ML 12, ML 48, P 7, P 581
IV	10	P 637, P 34, P 17, P 97, P 51, P 81, P 73, P 53, P 13, P 42
V	11	P 244, P 86, P 115, P 116, P 105, P 123, P 432, P 114, P 12, P 414, P 430
VI	16	ML 44, P 98, P 56, ML 22, P 264, P 18, P 71, ML 36, P 16, P 40, P 47, P 75, P 44, P 79, P 45, P 55
VII	10	ML 2, ML 3, ML 13, P48, ML 40, P 50, P 49, ML 4, ML 5, ML 7
VIII	07	P 80, P 19, P 20, P 38, P 72, P 82, P 69
IX	08	ML 45, P 343, P 63, P 445, ML 42, P 70, P 96, P 636
X	02	P 77, P 46
XI	09	P 439, P 583, P 43, P 447, P 580, P 87, P 437, P 83, P 443

distance was maximum in cluster VIII (2.39) while minimum (1.16) in cluster X (Table 2). Thus, seven accessions grouped in cluster VIII seem to be more heterogeneous owing to highest intracluster distance. The estimates of inter cluster distance revealed that members grouped in cluster III were more distantly (9.66) related to cluster VIII. CLuster VII was also distantly related to cluster V, cluster VII, cluster I and cluster IX. Inter-cluster distances were also appreciably higher between cluster III and X, cluster V and X, cluster VII and X, cluster III and IV, and cluster II and III.

The cluster means indicated that accessions grouped in cluster VIII had medium maturity, highest plant and ear height, largest ear size with maximum number of grains/row, ear weight/plant and 200- grain weight. Cluster III possessed early maturing accessions with medium stature, lower ear placement and highest shelling index, whereas late maturing accessions having lowest shelling index were grouped in cluster X. The accessions that possessed maximum number of rows/ear were grouped in cluster IV.

Table 2. Average inter and intra-cluster (in bold) distances (D) in maize

Cluster	I	II	III	IV	V	VI	VII	VIII	IX	X	XI
I	**1.73**										
II	4.79	**1.96**									
III	2.68	7.15	**1.92**								
IV	4.83	2.93	7.32	**1.54**							
V	2.55	5.45	2.62	6.47	**1.37**						
VI	3.07	2.33	5.34	2.67	4.14	**1.71**					
VII	3.21	5.99	3.21	6.40	2.79	4.60	**2.04**				
VIII	7.16	4.72	9.66	3.00	8.84	5.22	8.42	**2.39**			
IX	3.32	3.54	4.73	5.01	2.72	2.50	4.14	7.20	**1.81**		
X	6.29	2.58	8.67	2.93	7.40	3.74	7.39	3.17	5.35	**1.16**	
XI	2.68	4.40	4.19	4.57	4.00	2.82	4.07	6.48	3.39	5.01	**2.07**

The final goal of most of the breeding programmes in maize is to develop hybrid/composite outyielding the existing ones in yield coupled with adaptability. It has been observed that, in general, indigenous maize germplasm possess high adaptability as these are build up on same agroecological niches. To harness better recombinants for yield attributes, the breeder would like to choose genetically diverse parents. Inter-mating of such lines may result in providing desirable recombinants, which may subsequently be utilized in the development of superior open-pollinated populations on hybrids. Significance of diversity in the selection of parents has also been stressed by Ahloowalia and Dhavan (1963), Dhillon and Singh (1983), Prasad and Singh (1986), Key (1987) and Saxena and Sandhu (1989).

The validity and reliability of divergence, therefore, lies in the selection of parents showing heterotic relationship with degree of divergence upon resume of inter-mating. Many workers including Prasad and Singh (1986), Key (1987) and Ordas *et al.* (1994) have reported that degree of heterosis is related to the divergence of the parents in spite of some irregularities. Statistical distance represents the index of genetic diversity. Members grouped in a cluster are presumably least diversly which may be utilised to develop a population. Consequently a crossing programme could be formulated with the potential parents belonging to different clusters which exhibit high divergence. Mean of all the inter-cluster distances may be considered as guide line for the selection of diverse parents from different clusters. Considering the inter cluster distance and cluster means, inter-mating of parental lines from cluster VIII with parental lines either from cluster I, III or VII, and also between cluster III and IV is likely to produce desirable recombinants.

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