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Multivariate analysis of genetic divergence in blackgram (*Vigna mungo*) (L.) Hepper.)

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Forty five types of blackgram were grouped into ten clusters with the aid of Mahalanobis's D^2 statistic bringing out the presence of wide genetic diversity. The clustering pattern indicated that the geographic diversity was not the only factor for determining the genetic diversity. The intercluster distance between the type No.55 and the types in the cluster VII were found maximum. The clustering pattern of the D^2 more or less confirmed with the clustering pattern of the canonical (Vector) analysis carried out with the same data. Among the characters yield/plant contributed to the maximum towards the genetic divergence.

The success of hybridisation programme in self-pollinated crop for recombining characters is mainly dependent on the genetic diversity of the parents. Crossing between them results in wide spectrum of variability. The utility of multivariate analysis such as Mahalanobis's D^2 and canonical (Vector) statistic to assess the magnitude of such genetic divergence among the base population at genotypic level and also to identify suitable diverse parents for hybridisation programme is well established by Chandrasekariah *et al.* (1969) in Eusorghum, Ram and Panwar (1970) in Rice, Narsinghani *et al.* (1978) in Peas and Mehra and Peter (1980) in Chilli. With this view, the magnitude of genetic divergence among 45 types of blackgram was assessed with the aid of Mahalanobis's D^2 and canonical analysis and the results are presented.

MATERIAL AND METHODS

The experimental material for the present investigation consisted of 45 types of blackgram obtained from different geographical regions. The materrials were sown in the randomised block design with two replications during March, 1980 in Agricultural College and Research Institute, Coimbatore. At the time of harvest, observations were made from ten randomly selected plants in each type for yield and yield components. Mahalanobis's analysis as suggested by Rao, (1952) was used for estimating the genetic divergence among the population. The method suggested by Tocher (Rao, 1952) was followed for determining the group constellations. Intra and inter-cluster divergence and cluster means were worked out. The same data were subjected to canonical analysis as described by Arunachalam and Ram (1967). This method involved the transformation of correlated unstandardised means into uncorrelated standardised variables (Rao, 1952).

RESULTS AND DISCUSSION

The analysis of variance showed the presence of wide variation among

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the selected types for all the ten characters. The presence of variation was again confirmed by the D^2 analysis wherein the 45 varieties formed as many as ten clusters. The varieties within the clusters have smaller D^2 values among themselves than those from groups belonging to two different clusters. The composition of different clusters with their origin was presented in Table 1. Among the ten clusters, cluster I was the largest having sixteen types followed by cluster V and III with 7 and 5 respectively. The cluster IX and X consisted of one type each.

The clustering pattern revealed that the eight clusters out of the ten contained the types from different geographical regions yet indicating their close affinity and similarity irrespective of the origin. In the same way types from same eco-geographic regions had a tendency to fall in different clusters. These indicated that the geographic diversity though important may not be the only factor in determining. the genetic diversity, Factors other than the geographical diversity might be responsible for the differential grouping of the varieties. So, the geographical diversity is not an adequate index of the genetic diversity. This is in consonance with the findings of Gupta aud Singh (1970) and Malhotra *et al.* (1974). Clausen and Hiesey (1958) demonstrated that even a single component of environment such as the temperature could cause difference between and within the race. Murthy and Arunachalam (1966) were of the opinion that the genetic drift and selection in different environments may cause greater diversity than geo-graphic distance. However, in some clusters the effect of geographic origin influenced the clustering pattern also. The clusters VI and VIII contained types from same geographic regrions. This indicated that although the geographic distribution was not the sole criterion of genetic diversity the importance of former could still be traced. Such a parallelism was also reported by Katiyar and Singh (1979) in Chick pea.

The statistical distance (D) (Table 2.) presented the index of genetic diversity among the clusters. The greater is the distance between the clusters wider is the genetic diversity in the genotypes. The inter-cluster D^2 distance was maximum between the clusters VII and x indicating the wide diversity between these two clusters. The inter-cluster divergence was less between II and IV clusters showing the closeness of the types from these two clusters. In addition to the genetic diversity of the clusters, the yield potential of the types of different clusters is also important for the breeding programme. The clusters X had the highest mean value for pod width, number of clusters and yield (Table 3). The types of the cluster VI were late and tall with highest pod length. The cluster III had the highest mean value for the number of branches.

The only one variety that was placed in cluster X had good yield potential and also showed wide genetic divergence with all the clusters. Among them the distance between X and VII was the maximum. So, the solitary type in cluster X on one hand and the types in cluster VII on the other may serve as the potential parents in heterosis breeding. Singh and Gupta (1968) using D^2 statistic found that the progenies derived from diverse crosses gave divergent and useful progenies. Adequate relationship between the extent of heterosis and the genetic divergence was also reported by Harrington (1940) in wheat, Murthy (1965) in Tabacco, Moll *et al.* (1965) and Gomej (1966) in Maize and Rajanna *et al.* (1977) in tomato.

In the canonical analysis, the first canonical root accounted for 79% of the total variability and the first two canonical roots together accounted for 90.9% of the total divergences. Hence the two dimentional representation of the relative position of the types in the λ_1, λ_2 graph was found adequate. The clustering pattern on the basis of λ_1 and λ_2 graph of the canonical analysis more or less confirm with that of D^2 analysis The first two canonical vectors were presented in Table 4. In the present collection yield/plant contributed the primary axis of differentiation followed by the number of clusters. Number of clusters followed by yield/plant were important in the secondary axis of differentiation.

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Table 1. Composition of clusters.

Cluster	Number of types	Types with origin
	16	CO2/107 (C) (43), M2 (C) (8), AC264 (WB) (1), AC207 (AP) (41), AC226 (AP) (5), Cannanore (Ke) (2), BR68 (WB) (35), P293 (D) (29), P49 (D) (9), P225 (D) (21), Nagpur (MP) (17), AC323 (TN) (25), CO2/65 (C) (10), CO4 (C) (45) Bhilsagreem (AP) (44), AB15 (TN) (42).
II	5	US131 (D) (12), AC143 (TN) (20), AC220 (AP) (28), AC220 (AP) (28), AC31 (D) (31), B-12-4-4-(O) (40)
III	5	Mahesan (K) (32), Sardarnagar (N) (18), CO3 (C) (36) Composite 2 (TN) (14), Krishna (R) (39).
IV	4	VZM189/6 (C) (6), UPU2 (UP) (19), P298 (D) (11) Allahabad (UP) (22).
V	7	Sathamangalam (TN) (38), Ettawah Black (S.A) (26) Kargoan (MP) (23), Lu 35/5 (L) (34), P 200/2 (D) (37), CO2 (C) (13), Lalgudi (TN) (16).
VI	2	ADTI (TN) (3), Lalpuram (TN) (7).
VIII	2	CO2/23 (TN) (24), Mathakalai (A) (21).
VIII	2	P133 (D) (4), P45 (D) (33).
IX	1	Si (Ke) (15).
X	1	No. 55 (M) (30).

M=Maharastra, Ke=Kerala, D=Delhi, A=Assam, TN=Tamil Nadu, C=Coimbatore, MP=Madhya Pradesh, L=Ludhiana, S. A. South Africa, UP=Uttar Pradesh, R=Rajasthan, K=Karnataka, O=Orissa AP=Andhra Pradesh WB=West Bengal.

Table 2. Inter and Intra Cluster D^2 and D Value in Black gram.

Clusters	I	II	III	IV	V	VI	VII	VIII	IX	X
I	1184.52 (34.42)	3302.98 (57.47)	8929.89 (94.50)	2653.92 (51.52)	4026.26 (63.45)	11095.53 (105.34)	2243.37 (47.36)	3213.97 (56.29)	15852.46 (125.91)	29618.77 (172.10)
II		1120.44 (33.56)	1946.13 (44.11)	1703.74 (41.28)	17599.09 (102.95)	22840.88 (151.13)	3213.53 (56 69)	9078.23 (95.28)	27098.40 (164.62)	4962.63 (214.39)
III			879.55 (29.51)	1930.70 (43.94)	15632.65 (125.03)	2186.79 (46.76)	13453.58 (115.99)	3923.95 (62.64)	3540.52 (59.50)	7767.89 (88.14)
IV				1310.26 (36.20)	7068.83 (84.08)	19661.11 (140.22)	3806.96 (61.70)	7253.18 (85.17)	20592.38 (143.50)	37658.10 (195.06)
V					1235.23 (35.15)	6470.49 (80.44)	5104.88 (71.45)	2555.34 (50.55)	5213.06 (72.20)	14044.59 (118.51)
VI						1241.49 (35.23)	14062.85 (118.59)	5496.38 (74.41)	8290.68 (91.05)	11688.59 (108.11)
VII							1759.72 (41.95)	5179.56 (71.97)	22416.00 (149.72)	38892.6 (195.20)
VIII								2302.45 (47.98)	888.00 (94.28)	18599 91 (136.38)
IX									— —	3226.46 (56.80)
X										— —

Table 3. Cluster means for ten characters of Black gram.

Clusters	Days to I bloom (days)	Plant Height (cms)	No. of branches	Pod length (cms)	Pod width (cms)	Seed/pod	No. of clusters	Pods/clusters	100 seed weight (gms)	Yield/Plants (gms)
I	36.5	56.8	3.9	5.0	.4	6.8	10.7	4.1	4.8	9.0
II	35.3	45.2	3.7	4.7	.4	6.2	8.7	4.7	4.9	4.2
III	37.8	67.1	4.3	5.3	.5	6.7	20.2	4.0	5.2	16.8
IV	38.1	54.5	4.0	4.8	.4	6.8	14.1	4.4	4.4	5.3
V	39.9	61.0	4.1	5.0	.5	7.2	21.2	4.1	4.9	12.7
VI	43.0	71.0	4.3	5.5	.4	6.4	14.6	3.1	5.1	17.5
VII	40.0	61.0	4.2	4.4	.4	6.5	6.9	4.3	4.6	7.5
VIII	36.3	49.0	3.8	4.6	.5	5.8	15.4	5.5	4.7	13.5
IX	37.0	57.0	3.7	4.7	.5	6.3	32.5	3.9	5.2	18.1
X	38.0	40.2	3.8	5.4	.5	7.0	37.4	5.3	5.3	24.1
Mean	38.2	56.3	3.6	5.0	.4	6.6	18.2	4.3	4.4	12.9
Range	35.3 to 43.0	40.2 to 71.0	3.7 to 4.3	4.4 to 5.5	.4 to .5	5.8 to 7.2	6.9 to 37.4	3.1 to 5.5	4.4 to 5.3	4.2 to 24.1

——— Maximum

— — Minimum

Table 4 The first two canonical vectors and the means of canonical for 45 types.

Characters	Canonical vector Z_1	Z_2
Days to first bloom	.0531	.0452
Plant height	.0041	.0012
No of branches	.0103	.0043
Pod length	.0854	.0275
Pod width	.0426	.1288
Seed/pod	.0463	—.0060
No. of clusters	.4507	—.7793
Pods/clusters	—.2404	.3366
100 Seed weight	.0854	.0186
Yield/plant	.8471	.5094