Indian J.Pl. Genet. Resources 6(1): 9-14, 1993

GENETIC DIVERSITY IN GLADIOLUS

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Multivariate analysis of divergence among 25 varieties of gladiolus for 16 developmental characters led to their grouping into five clusters. The first cluster had four varieties while the second had only one. Cluster III was the biggest with 11 varieties whereas cluster V and IV had two and seven varieties (6 varieties and 1 hybrid), respectively. Based on cluster means, characters like days for initial flowering, leaf area, days for last floret opening, number of corms and cormels produced per plant and propagation coefficient were the major factors for differentiation among the 25 genotypes. The intercluster D^2 values ranged from 11.417 to 84.953 suggesting very little domestication in this crop.

Key words : Gladiolus cultivars, genetic diversity, multivariate analysis

Gladiolus, an important cut flower crop with high potential for export, is grown throughout India. Very limited studies have been carried out for its improvement. The present study is aimed to gather information on, (i) genetic divergence among the existing varieties, (ii) the relationship of genetic diversity with their geographic and ecological background, (iii) the factors influencing divergence and (iv) the parental group which are likely to yield superior segregants on hybridization.

MATERIALS AND METHODS

The material for the present investigation consisted of 25 genotypes of gladiolus (11 indigenous hybrids alongwith their 13 exotic and one indigenous parents) which were grown at the Indian Agricultural Research Institute, New Delhi during 1991-92 in RBD replicated thrice, allowing feeding area of 40×15 cm per plant and keeping 10 plants per replication. The main objective was to select divergent forms for the purpose of further improvement through hybridization. Data were recorded on six plants (leaving two bordering plants on each side in each row) per replication, on 16 quantitative characters, viz., days to sprouting and flowering, number of leaves and leaf area per plant, plant height and rachis length, diameter of foremost floret after two days of opening, days for last floret opening, number of florets per spike, number of

capsules per spike and number of seeds per capsule, number and weight of corms and cormels per plant and propagation coefficient.

The data were subjected to multivariate analysis using Mahalanobis' D^2. The 16 × 16 dispersion matrix was used for simultaneous testing of significance of differences in the character means using Wilk's criterion and the varieties were grouped into clusters according to Tocher's method (Rao, 1952).

RESULTS AND DISCUSSION

The analysis of variance for 16 characters (Table 1) showed highly significant mean square for all the characters except for days to last floret opening. A wide range of diversity existed among the 25 genotypes for most of characters. In fact, the past performance of these strains at IARI revealed that distinct genetic forms exist in this crop as they belong to different ecological regions. However, the phenotypic performance of 11 hybrids showed heterotic effects for majority of characters in comparison to respective parents probably due to wide range of genetic diversity among parents.

Table 1 : Analysis of variance for various characters of gladiolus

Characters	Mean sum of squares		
	Replications (d.f. = 2)	Treatments (d.f. = 24)	Error (d.f. = 48)
Days to 50% sprouting	1.25	6.88**	1.17
Days to flowering	14.43	233.76**	2.19
Number of leaves per shoot (excluding flag leaves)	1.88	1.03**	0.14
Leaf area (cm^2)	5.43	1032.61**	15.43
Diameter of foremost floret after two days of opening (cm)	0.67	4.32**	0.19
Number of seeds per capsule	20.23	301.01**	6.33
Plant height (cm)	9.50	462.60**	3.91
Rachis length (cm)	10.89	145.31**	1.69
Days for last floret opening	91.00	274.26*	111.59
Number of corms produced per plant	0.07	0.35**	0.09
Average weight of a daughter corm (g)	25.26	200.96**	5.74
Number of cormels produced per plant	6.55	2901.30**	9.45
Weight of cormels produced per plant (g)	1.81	42.55**	0.87
Propagation coefficient (%)	2939.12	12521.92**	1252.57
Number of florets per spike	1.50	13.65**	0.43

** = $P_{0.01}$, * = $P_{0.05}$

On the basis of D^2 analysis, all the 25 genotypes were grouped in 5 clusters (Table 2). Maximum number of varieties i.e., 11 were included in cluster III. Cluster II had only one variety i.e., High Style and cluster V two (one Gambier Pearl and the other a cross i.e. Green Lilac × Heady Wine). Cluster IV was the second largest group of seven genotypes whereas cluster I had only four genotypes. Cluster I included three exotic varieties (Green Lilac, Heady Wine and Regency), was the earliest in flowering (113.86 days) with less number of leaves (6.12) but highest rachis length (33.77 cm) while propagation coefficient recorded was minimum (169.67%). Cluster II which had only one variety was found to be outstanding with regard to

Table 2 : Cluster formation of 25 genotypes of gladiolus on the basis of genetic divergence

Cluster	Number of genotypes	Varieties
I	4	Gambier Pearl × Regency, Greenlilac, Heady wine, Regency
II	1	High Style
III	11	Christian Jane × Rose Time Steamboat, Eve × Mayur, Mayur × Heady Wine, Miss America × American Beauty, Pfitzer's Sensation × Christian Jane, White Oak × Christian Jane, White Oak × High Style, White Oak × Pfitzer's Sensation, Christian Jane, Miss America, Pfitzer's Sensation
IV	7	American Beauty × Christian Jane, American Beauty, Eve, Mayur, Rose Time Steamboat, Smoky Lady, White Oak
V	2	Green Lilac × Heady Wine, Gambier Pearl

leaf area (115.80 cm^2) and propagation coefficient (338.33%) as number and weight of corms and cormels produced per plant were maximum. However, it was minimum for number of seeds per capsule. Cluster III consisted of eight indigenous and three exotic varieties which gave average performance for many of the characters. However, floral diameter (12.50 cm), rachis length (48.34 cm in Mayur × Heady Wine) and propagation coefficient (209.33% in White Oak × Smoky Lady) were maximum in the indigenous group while among the three exotics, only Miss America produced maximum number of seeds (52.14) per capsule. Cluster IV consisted of seven varieties (5 exotic and 2 indigenous) where one of the indigenous varieties (Mayur) produced minimum number of leaves (6.44) and minimum length of spike (40.79 cm) but maximum number of flowers per spike (15.05), corms per plant (2.15) and maximum propagation coefficient (330.00%). Cluster V consisted of only two varieties (one indigenous and one exotic) which showed that indigenous material was better for flower size (10.58 cm), corm and cormel production and propagation coefficient (22.33%) while its performance was poor for rachis length (30.61 cm) and for number of florets (7.94) per spike.

Cluster means (Table 3) showed that the varieties in cluster I are average varieties for many characters. Cluster II remained good for leaf area, diameter of foremost floret, number of seeds per capsule and for corm and cormel production because the propagation coefficient (338.33%) was maximum in this cluster. Cluster III was average for most of the characters but for propagation coeffcient (145.82%), it was the poorest. The varieties of cluster V showed delayed flowering with maximum plant height and spike length as well as maximum number of flowers per spike (13.35) and seeds per capsule (39.93). Cluster V accessions were earliest in flowering (101.87 days) with minimum leaf area (61.08 cm^2).

Table 3 : Means of clusters for different quantitative characters in gladiolus

Characters	Clusters				
	I	II	III	IV	V
Days to 50% sprouting	10.63	11.60	10.10	10.30	7.30
Days to flowering	120.46	123.29	120.96	128.44	101.87
Number of leaves (excluding flag leaves) per sheet	6.47	8.04	6.54	7.26	6.18
Leaf area (cm^2)	73.61	115.80	66.80	86.83	61.08
Diameter of foremost floret after two days of opening (cm)	9.41	11.17	10.11	10.60	9.93
Number of seeds per capsule	25.78	18.18	37.27	39.93	19.58
Plant height (cm)	69.24	91.84	77.34	97.36	80.57
Rachis length (cm)	30.35	36.23	38.63	45.72	35.69
Days to last floret opening	128.99	132.40	135.74	138.80	115.36
Number of corms produced per plant	1.70	2.51	1.42	1.65	1.69
Average weight of a daughter corm (g)	41.24	54.97	30.70	36.25	38.64
Number of cormels produced per plant	35.80	161.67	16.27	41.09	29.17
Weight of cormels per plant (g)	8.09	17.86	3.43	7.51	4.55
Propagation coefficient (%)	201.25	338.33	145.82	179.90	188.17
Number of capsules per sheet	5.93	8.50	8.17	10.06	6.87
Number of florets per spike	9.61	10.42	12.27	13.35	9.79

Intra and intercluster D^2 values are given in Table 4. Intracluster D^2 values ranged from 0 to 8.596. It was maximum in cluster IV followed by cluster III and cluster I. Cluster II and cluster IV had one and two genotypes, respectively. The intercluster D^2 vlaues ranged from 84.953 to11.854. It was maximum between cluster II and cluster III (84.953) followed by cluster II and cluster V (77.334). The minimum intercluster D^2 values was found between cluster III and cluster IV (11.417), followed by a similar intercluster D^2 values

between cluster I and cluster II (11.854). This reveals that genotypes of these clusters (I, III and IV) are close to each other. It is quite apparent that cluster I and III, and III and IV are close to each other. Cluster I with four genotypes seem to be very close to cluster V which comprised two genotypes. Cluster II which had one genotype appears to be very far from Cluster I, III and V. Cluster II was very far from cluster IV also which consisted of seven genotypes.

Table 4 : Average intra and intercluster D^2 values among 25 genotypes of gladiolus

Cluster	I	II	III	IV	V
I	4.032				
II	56.115	0.000			
III	11.854	84.953	8.082		
IV	25.130	54.125	11.417	8.596	
V	14.737	77.334	19.927	35.772	3.61

Perusal of Table 5 reveals the contribution of different characters. Plant height and number of cormels contributed maximum value (19.33%) followed

Table 5 : Contribution of each character to divergence in gladiolus

Characters	Number of times appearing first to ranking	Per cent contribution
Days to sprouting	0.00	0.00
Days to flowering	50.00	16.66
Number of leaves per sheet	0.00	0.00
Leaf area (cm^2)	19.00	6.33
Diameter of foremost floret after 2 days	3.00	1.00
Number of seeds per capsule	2.00	0.66
Plant height (cm)	58.00	19.33
Rachis length (cm)	38.00	12.66
Days for last floret opening	1.00	0.33
Number of corms produced per plant	0.00	0.00
Average weight of a daughter corm (g)	7.00	2.33
Number of cormels produced per plant	58.00	19.33
Weight of cormels produced per plant (g)	10.00	3.33
Propagation coefficient (%)	32.00	10.66
Number of capsules per sheet	9.00	3.00
Number of florets per spike	13.00	4.33
Total	300.00	100.00

by days for initial flowering (16.66%) and rachis length (12.66%). Lowest contribution was observed for days for 50 per cent sprouting, number of leaves per shoot and number of corms produced per plant whereas contribution of other characters was moderate towards the genetic diversity. Number of seeds per capsule and days for last floret opening contributed less than 1 per cent towards genetic divergence.

The results of present findings are in close agreement with the earlier studies (Suman *et al.*, 1984; Raamsdonk and De Varies, 1989; Misra *et al.*, 1990) which showed that the pattern of distribution of these genotypes in various clusters was having considerable amount of genetic divergence among them for most of the characters studied.

ACKNOWLEDGEMENTS

Senior Author is highly grateful to the Director, IARI, New Delhi for providing financial assistance in the form of Jr. Research Fellowship. Authors are also highly grateful to the Head, Division of Floriculture & Landscaping, IARI, New Delhi for providing facilities, and to Drs. H. C. Saini and C. S. Kalia for their kind help in carrying out the present investigations.

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