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GENETIC DIVERGENCE IN GLADIOLUS

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The genetic divergence analysis of 60 varieties of gladiolus for 20 developmental characters showed grouping of varieties into 12 clusters. Based on cluster means, characters such as spike length, no. of florets per spike, no. of florets opening at first, no. of florets remaining open at a time, no. of capsules forming per spike and the seeds set per capsule, no. of daughter corms & cormels produced per plant, and diameter of foremost floret were major factors of differentiation among these 60 varieties. The varieties producing more no. of corms and cormels, spike length and no. of florets per spike can thus be utilized for hybridization for making improvement in these characters in this crop.

Key words : Gladiolus, divergence, genotype, variability

Gladiolus occupies fourth place in the international cut flower trade hence is grown in each country on the globe for cut flower and garden display. The improvement in this crop was very much limited due to limited germplasm but with the introduction of exotic and indigenous varieties the avenues have opened in our country. Therefore, the present study was undertaken to gather the information on genetic divergence among existing varieties, and the factors influencing genetic divergence.

MATERIALS AND METHODS

The material for the present investigation consisted of 60 varieties of gladioli, 57 exotic belonging to America, Europe, Australia and USSR, and 3 indigenous. These were subjected to multivariate analysis using D^2 statistics. They were grown at Naggar Farm of IARI Regional Station, Katrain, Kullu Valley (H.P.) during 1988 and 1989 seasons (April to November), in randomised block design with three replications, maintaining a distance of 40 cm from row to row and 20 cm from plant to plant. Each entry consisted of two rows and data were recorded on 12 plants per replication for the characters as mentioned in Table 3.

The data were subjected to multivariate analysis using Mahalanobis' generalized distance D^2. The 20×20 dispersion matrix was used for simultaneous use for testing significance of difference in the character means using Wilk's criterion (1952) and the varieties were grouped into clusters according to the Tocher's method adopted from Rao, (1952)

RESULTS AND DISCUSSION

The analysis of plant means revealed significant differences at 1% level between 60 varieties of gladioli for all the 20 characters. Maximum variation was observed for spike length, no. of florets per spike, no. of florets remain open at a time, no. of capsules per shoot, no. of seeds per capsule, no. of cormels produced per plant and 10-cormel weight. The multivariate analysis revealed that the 60 varieties could be grouped in 12 clusters (Table 1). The varieties included were 29 in cluster I, 10 in cluster II and five in cluster III.

Table 1. Name of varieties included in twelve clusters of gladioli

Cluster	No. of genotypes falling in each cluster	Name of genotypes
I	29	American Beauty, Smoky Lady, Vladimir Vasiliev, Ruby pattern, Cameltone, Rose Royal, Redeem, Rose Time Steamboat, Barlew, Heady Wine, Ratna's Butterfly, Setting sun, Salmon Queen, Gambier Pearl, Vicki Lin, High Style, Spring Song, Howard, Ivy Agnes, Coppertone, Bush Ballad, High Hopes, Tall Timber, Wind Song, Red Softglow, Tiger Flame, Rose Memento, Legend, Green Willow
II	10	Himprabha, Cardinal, Miss America, Ecstasy, Sylvia, Cygnet, Ultima, Coral Beauty, Katrain Local, Green Lilac
III	5	Blue Lilac, Spectacular True Love, Beauty Crest, Peter Pears, Ripples
IV	4	Littlest Angle, Garnet, Sugar Babe, Little Mo
V	4	Gillian, Green Finch, Gambier Dainty, Ave
VI	2	Nugget, Melody
VII	1	Lady Fayre
VIII	1	White Oak
IX	1	Royal Jubilee
X	1	Psittacinus Hybrid
XI	1	Australian Fair
XII	1	Kawaliar

Clusters IV and V comprised four varieties in each while the cluster VI had two varieties. Rest of the clusters i.e. VII, VIII, IX, X, XI and XII were having one variety in each. Most varieties in cluster I were of exotic origin but they seem to be highly adopted to Indian conditions because the characters expressed by them like number of cormels per plant, number of seeds per capsule, days to flowering, spike length and number of leaves per shoot were equally good (as also in the Indian var. Ratna's Butterfly). In this regard, varieties like *Berlew*, *Heady Wine* and *Salmon Queen* from Australia, USA and Holland, respectively were good for their phenotypic performance for some of the important characters. From the exotic sources *Redeem* from Australia, *Blue Lilac* from USA, and *Red Softglow* from Australia flowered earlier than the Indian var. *Ratna's Butterfly*. The remaining exotics were generally late in first flowering and poor in the production of cormels per plant. For some of the other important characters like number of florets per spike the exotic vars like *Rose Memento* (USA), *Red Softglow* (Australia), *Vicki Lin* (USA) and *Salmon Queen* (Holland) produced more number of spikes than the indigenous ones.

Varieties included in cluster II were found promising for plant height and spike length by the exotic varieties like *Cardinal* and *Ultima* (both USA) over the indigenous var. *Himprabha*. Other var. *Miss America* produced maximum number of cormels per plant (127.13) which falls in the same cluster. Out of the five varieties included in cluster III, exotic var. *Blue Lilac* (USA) expressed earlier flowering and more number of cormels per plant than the indigenous var. *Ratna's Butterfly*. Clusters IV and V which comprised four varieties, mostly tall, early flowering with more number of shoots per plant and larger diameter of the flowers. In most of the six clusters having one variety in each, were mostly of exotic origin, these were tall and late in flowering, with less number of cormels per plant although the cormels were of considerably bigger size.

The inter and intra-cluster distances D^2 among 12 clusters presented in Table 2 revealed that lowest intra-cluster distance was observed for cluster III

Table 2. Intra- and inter-cluster in gladioli

Cluster	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
I	**79.50**	98.12	94.30	116.57	180.59	125.83	137.63	172.91	295.65	160.41	201.70	256.57
II		**86.42**	88.28	141.48	248.54	95.25	155.47	213.41	308.64	164.55	182.17	188.43
III			**70.52**	96.78	187.85	83.93	88.36	232.64	349.18	209.79	206.30	202.07
IV				**84.71**	241.73	87.05	132.07	315.80	405.70	245.68	204.39	186.93
V					**144.47**	238.08	188.75	252.65	454.12	320.23	365.71	449.89
VI						**107.11**	172.36	253.30	330.22	189.99	183.04	176.19
VII							**0.00**	255.92	385.33	25.81	254.09	262.93
VIII								**0.00**	289.24	217.11	323.05	488.72
IX									**0.00**	121.41	227.72	508.24
X										**0.00**	47.73	269.95
XI											**0.00**	257.20
XII												**0.00**

(D^2 = 70.52) and maximum (D^2 = 144.47) for cluster V. clusters I, II and IV had relatively moderate to high D^2 values (79.50, 86.42 and 84.71, respectively), indicating that the varieties were relatively more diverse genetically. Similar expectations also emerged from the inter-cluster distances which were maximum among clusters XII and IX (D^2 = 508.24) and minimum between clusters XI and X (D^2 = 47.73).

The character mean of varieties in 12 clusters are given in Table 3. The mean values of these clusters expressed a wide range among the varieties of different clusters. Cluster I was distinguished by members having less durability of spike while with average number of days taken by the florets open at first. Cluster III having five members was characterised with more number of days taken by the florets to open at first. However, the varieties included in cluster V were having more durability of the first flower, more number of florets remaining open for longer days, more spike durability and larger polar and equatorial diameter of daughter corms. The clusters with only one entry had distinct characteristics, e.g. cluster X had tallest height of the plant and less number of shoots per planted corm, cluster IX had more number of leaves per shoot, more number of days for first flower, more durability of first floret and of the whole spike with more number of side spikes formed per shoot, cluster VIII was characterized for largest flower diameter, more number of florets remaining open at a time with more number of florets per spike, more number of capsules per shoot, more number of seeds per capsule and maximum weight of one daughter corm.

Earlier studies with 39 varieties conducted by Negi *et al.* (1982) had also indicated that the selection of varieties based on the characters namely weight of cormels produced per plant, number of cormels produced per plant and the weight of daughter corms produced will be very effective for the improvement of this crop. Though the exotic genotypes responded poorly for some of the characters but these are good sources for increasing flower diameter, durability of foremost floret and the number of florets opening at a time. These can help directly to achieve the goal of increasing the number of cormels per corm, etc. Some of the characters which change with the change of environment like height of the plant, capsule and seed setting and corm formation can also help to improve the economy of this crop. In this way more number of florets with good quality and size appear when the total height of the plant is increased and thus it becomes more remunerative.

In the past gladiolus remained neglected and improvement through breeding in this crop was not very much effective for improving the characters like number of corms and cormels per plant, number of florets per spike and the number of florets remaining open at a time due to limited genetic stock. The recent introductions have opened the way for improvement through hybridization. The cluster comprising only one variety with specific trait could

Table 3. Cluster mean values for twelve clusters in gladiolus

	Characters*																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
I	107.81	88.26	6.75	1.53	94.85	11.77	3.46	1.76	5.50	15.35	13.21	4.97	10.18	0.51	2.44	4.59	1.59	39.19	50.74	4.50
II	102.56	79.57	6.46	1.77	91.26	10.66	3.35	1.69	4.64	15.51	13.64	6.99	17.51	0.45	1.98	3.84	1.60	23.60	43.54	4.70
III	104.23	80.08	6.27	1.99	83.79	10.63	3.53	2.05	5.39	15.27	13.36	6.80	13.58	1.02	2.48	4.40	1.89	34.87	37.11	3.72
IV	98.64	75.81	6.39	1.60	87.80	8.06	3.27	1.98	5.85	17.17	13.02	9.50	17.95	0.96	2.74	4.44	1.59	35.45	30.40	5.18
V	112.82	90.15	7.17	1.48	386.57	12.19	3.67	1.70	5.97	15.30	13.55	5.57	9.67	0.62	4.12	5.17	1.84	49.53	37.44	4.23
VI	100.52	70.25	6.50	1.83	85.70	9.23	3.50	1.53	5.40	17.03	14.66	12.40	18.75	0.53	2.25	4.25	1.84	31.36	31.03	4.65
VII	114.67	82.00	7.13	1.60	83.07	11.20	3.00	2.80	5.80	14.27	13.27	1.07	8.87	1.13	2.93	4.43	1.53	21.23	20.27	3.50
VIII	137.27	94.27	8.67	1.07	107.53	13.67	3.33	2.07	7.53	20.27	15.53	12.87	36.83	0.00	2.70	5.17	1.07	52.20	80.57	4.37
IX	128.53	91.70	8.93	1.07	128.60	12.07	4.00	2.00	4.00	16.73	18.13	11.53	9.40	2.00	2.30	3.63	1.00	24.37	7.40	17.20
X	146.67	106.00	8.00	1.13	116.93	10.20	3.00	1.40	4.67	16.60	17.67	6.80	2.47	1.00	2.33	4.33	1.20	35.57	30.83	15.17
XI	144.73	107.27	7.53	1.47	112.20	8.10	2.93	1.80	3.93	17.13	18.00	6.07	1.00	0.40	2.33	4.70	1.40	44.20	9.27	19.03
XII	82.12	58.87	5.93	2.60	81.73	7.07	2.00	1.00	2.00	8.80	13.33	3.93	16.73	1.07	2.07	4.10	2.07	25.93	111.83	4.93

*1. Height of the pant, 2. Spike length, 3. Number of leaves per plant, 4. Number of shoots per plant, 5. Days to flowering, 6. Diameter of foremost floret, 7. Durability of foremost floret, 8. Number of florets open at first, 9. Number of florets remain open, 10. Number of florets per spike, 11. Durability of whole spike, 12. Number of capsules per shoot, 13. Number of seeds per capsule, 14. Number of side spikes per shoot, 15. Polar diameter of daughter corms, 16. Equatorial diameter of daughter corms, 17. Number of daughter corms per plant, 18. Weight of one daughter corm, 19. Number of cormels produced per plant, and 20. 10-cormel weight.

be used in hybridization programme for exploiting hybrid vigour. The highly divergent groups are likely to produce new genotypes with desired characters on crossing.

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