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Genetic variability, character association and path coefficient analysis in gladiolus for various quantitative traits

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ABSTRACT

Genetic variability, heritability and genetic advance, correlation co-efficient and path co-efficient analysis for different traits were studied in 20 gladiolus genotypes. The results showed significant differences for all the traits studied among the genotypes. The high genotypic co-efficient of variation was recorded for floret diameter (20.38%), flower stalk girth (25.01%), number of corms per plant (41.35%), corm weight (69.19%), number of cormels per plant (41.35%) and cormels weight (47.55%) coupled with narrow difference between the genotypic and phenotypic co-efficient of variation. Genetic advance as percent mean ranged from 0.13 to 141.47% among the traits. High heritability coupled with high genetic advance was observed for plant height (89.40%), leaf length (65.77%), spike length (88.01%), spike weight (97.46%), number of corms per plant (74.75%) and cormels per plant (95.60%) indicating additive gene action, which suggested that improvement of these traits would be effective for further selection of superior genotypes. The estimates that genetic correlations in general were higher than phenotypic correlations. The plant height exhibited positive significant correlation at genotypic and phenotypic levels with number of florets per spike, spike length and spike weight. The path coefficient analysis based on spike weight, as responsible variable showed that the traits, namely, plant height (1.347), number of leaves (0.006), number of florets per spike (0.072) and spike length (0.265) exhibited significantly positive direct effect. Spike weight imparted maximum positive direct effect on the plant height followed by spike length. Hence, traits like spike weight, plant height and spike length may be considered for further improvement.

Key words: Correlation, gladiolus, genetic variability, path co-efficient analysis..

INTRODUCTION

Gladiolus (*Gladiolus grandiflorus* L.), is the leading geophytes grown worldwide for garden displays. The genus *Gladiolus* is mostly heteroploid and comprised of 255 species (Ramzan *et al*., 13). It is very popular for its magnificent inflorescence, wide array of colours and fascinating varieties of different shapes and sizes. In gladiolus, new varieties are evolved through hybridization, which is recognized as the most important source of evolution and crop improvement. Planning and execution of a breeding programme for the improvement of quantitative attributes depends upon the genetic magnitude of the genetic variability (Yadav *et al*., 19). Generally, most of the characteristics of a crop species are inter-related, therefore, selection based on a single trait, may influence the other traits. Inheritance of a quantitative trait is often influenced by variation in other traits. The association among economic traits and their attributes can be known through precise estimation of genotypic and phenotypic correlation studies. The correlation analysis aids in selection of genotypes for a breeding programme determining the interrelationship of quantitative traits and their influence on yield (Kumar *et al*., 8). Further, correlating yield and other traits may not give complete idea, hence these traits have to be analyzed by path co-efficient analysis. The path coefficient analysis deals with the direct and indirect relationship of predicted variable with the responsible variables, which help in assessing the relative influence of significant traits on the ultimate yield (Geeta *et al*., 3). Studies on genetic association are useful to ascertain the important component characters on which suitable genotypes can be selected for further hybridization. Realizing the importance of the aforementioned facts, the present investigation was carried out involving 20 gladiolus genotypes to find out the extent of genetic variability by determining the different genetic components.

MATERIALS AND METHODS

The experiment was conducted in the Department of Floriculture, Medicinal & Aromatic Plants, UBKV, Cooch Behar during 2011-2013. Twenty diverse

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gladiolus genotypes were collected from different centres of India were studied (Table 1). The corms of genotypes having almost 5 cm diameter and about to sprout were planted at 20 cm x 20 cm distance. The standard package of practices was followed for cultivation of the crop. During the two years experiment, the observations on growth and production parameters were recorded from 60 days of planting until harvesting. The corms and cormels were lifted from the ground when the foliage turned yellow. The parameters on corm were recorded thereafter. The data were analyzed as per the procedure given by Panse and Sukhatme (12). Coefficients of variability, heritability, genetic advance and correlation coefficient were estimated according to Johnson *et al.* (6 & 7). The path coefficient analysis was carried out according to Dewey and Lu (2).

RESULTS AND DISCUSSION

Data pertaining to mean, range, variances, genotypic and phenotypic co-efficient of variation, heritability and genetic advance as per cent mean has

Table 1. List of gladiolus germplasm and their spike and floret description.

Acc. No.	Flower colour grouping and RHS (5th Edn.) No.	Spike and floret description
ACC-01	Red group (43-B)	All florets faced one side of the spike having light white coloured throat
ACC-02	Red group (45-B)	Florets are loosely arranged side by side and all florets faced at one side of the spike
ACC-03	Red group (45-B)	All florets faced one side of the spike
ACC-04	Violet group (83-B)	All florets faced one side of the spike and sparsely arranged without any throat
ACC-05	Red-purple group (N57-A	Each floret on the spike face alternatively and loosely having creamy yellow coloured at mid portion
ACC-06	White group (NN155B)	Florets compactly arranged one above the other facing one side of the spike along with red coloured throat
ACC-07	Red group (45-B)	All florets arranged loosely in zig-zag fashion
ACC-08	Red-purple group (N57-A)	Florets arranged compactly one above the other and faced one side of the spike and throat colour is creamy colour
ACC-09	White group (NN155-B)	Each floret on the spike face alternatively one above the other having light greenish throat
ACC-10	Red-purple group (N57-B)	Florets faced in appositive manner one above other and loosely arranged having dark red coloured throat and outside creamy yellow at lower tip portion
ACC-11	Red group (40-C)	Florets faced one side and compactly arranged one above the other without any throat
ACC-12	Violet group (N88-C)	Each floret on the spike face alternatively in loose manner along with white shade at centre
ACC-13	Yellow group (8-C)	Florets are compactly arranged and faced at one side of the spike and fringed
ACC-14	Yellow group (12-C)	Florets are arranged in zig-zag fashion and sparsely having outside orange shade at tip portion
ACC-15	Orange red group (13-B)	Florets are faced side by side and arranged compactly with white shade at centre
ACC-16	Purple group (N20-C)	Arranged in zig-zag fashion and compact manner along with creamy coloured throat at lower two petals
ACC-17	Red-purple group (N57-C)	Florets arranged compactly and faced one above the other and petals become smaller at lower portion
ACC-18	White group (NN155-A)	Florets faced one side and loosely arranged one above the other even petals are big as well as loosely attached
ACC-19	White group (NN155-D)	Florets faced one side and arranged compactly one above the other without ant throat
ACC-20	Red-purple group (N57-C)	Arranged in zig-zag fashion but faced one side having violet coloured throat

been presented in Table 2. The analysis of variances showed highly significant differences for all the traits studied among the genotypes. Number of days taken for spike initiation range from 57.33 to 79.67 days with a mean of 66.59 days. The days taken to opening of first floret ranged from 69.33 to 93.33 days. Number of florets per spike ranged between 9.15 to 17.14. The range of the spike length recorded was from 57.60 to 89.07 cm with a mean value of 73.89 cm. The field life for spike ranged from 5.55 to 7.91 days and the mean value was 6.74 days. The corm numbers ranged from 1.00 to 5.43 with mean of 2.97. The range in the observations recorded reflect the extent of phenotypic variability, which comprised of genotypic variance and interaction between them. However, the inherent genotypic variability could be ascertained considering the range. This can be better known by determining the total genetic variability in the existing genotypes after partitioning the phenotypic variance. Similar variations in spike quality traits of gladiolus were also quoted by Rani *et al.* (15) and Swaroop and Singh (18). The traits like plant height (20.20%), leaves per plant (31.85%), floret length (24.03%), floret diameter (33.52%), florets per spike (21.01%), flower stalk girth (28.06%), corms per plant (47.85%), and cormels per plant (58.37%), showed high phenotypic co-efficient of variation. The high genotypic co-efficient of variation was recorded for diameter of floret (20.38%), flower stalk girth (25.01%), number of corms per plant (41.35%), corm weight (69.19%), and cormel weight (47.55%). Whereas, the phenotypic co-efficient of variations were higher than the genotypic co-efficient of variation for all the traits, which indicated greater genotype and environment interaction. Similar results were also obtained on dahlia (Singh, 16) and chrysanthemum (Misra *et al.*, 10).

The magnitude of heritability in broad sense was high for the characters like plant height (89.40%), leaf

Table 2. Genetic variability, heritability and genetic advance for different traits in gladiolus.

Trait	Mean	Range	G.V.	P.V.	G.C.V. (%)*	P.C.V. (%)	Heritability (%)	GAM (%)
Plant height	70.90	43.98-91.58	183.29	205.03	19.10	20.20	89.40	37.19
Leaves per plant	06.82	4.33-8.67	00.26	04.55	7.66	31.85	5.71	3.80
Leaf length	39.94	32.11-53.07	32.18	48.93	14.20	17.51	65.77	23.72
Days to spike initiation	66.59	57.33-79.67	24.67	39.02	7.46	9.38	63.22	12.22
Days to full emergence of spike	69.56	60.00-82.67	26.29	44.77	7.37	9.62	58.72	11.64
Days to bud separation	72.81	63.33-88.67	33.08	47.10	7.90	9.43	70.23	13.64
Days to show colour	75.59	67.33-92.00	33.45	51.26	7.65	9.47	65.26	12.73
Days to full open 1st floret	77.41	69.33-93.33	46.29	55.83	8.84	9.71	82.91	16.59
Days to flowering (open 3rd floret)	80.02	71.33-97.33	32.35	47.08	7.13	8.60	68.71	12.17
Floret length	09.20	7.54-11.20	00.17	04.77	4.50	24.03	3.56	1.74
Floret diameter	09.09	5.10-15.00	03.42	09.25	20.38	33.52	36.97	25.53
Florets per spike	13.03	9.15-17.14	03.52	07.50	14.40	21.01	46.93	20.34
Flower stalk girth	25.70	18.34-44.34	41.32	52.02	25.01	28.06	79.43	45.93
Rachis length	43.00	34.22-51.30	27.50	37.13	12.20	14.17	74.06	21.62
Spike length	73.89	57.60-89.07	84.30	95.78	12.43	13.24	88.01	24.01
Spike weight	111.80	70.63-138.45	443.60	455.17	18.84	19.08	97.46	38.31
Field life of flower	06.74	5.55-7.91	00.01	01.51	1.07	18.22	0.66	0.13
No. of corms per plant	02.97	1.00-5.43	01.51	02.02	41.35	47.85	74.75	73.61
Corm diameter	04.58	2.72-6.59	00.13	01.88	7.96	29.94	6.91	4.36
Corm weight per plant	42.12	16.70-105.33	849.07	861.84	69.19	69.71	98.52	141.47
No. of cormels per plant	36.45	11.33-78.33	432.86	452.76	57.08	58.37	95.60	114.96
Cormel diameter	04.53	2.72-5.71	0.21	0.97	10.04	21.80	21.65	9.53
Cormel weight per plant	48.10	17.40-99.14	522.96	543.00	47.55	48.45	96.31	96.12

GV = Genotypic variance; PV = Phenotypic variance; GCV = Genotypic coefficient of variation; PCV = Phenotypic coefficient of variation; GAM = Genetic advance as per cent mean (%)

length (65.77%), days to bud separation (70.23%), days to flowering (68.71%), spike length (88.01%), spike weight (97.46%), corms per plant (74.75%), corm weight (98.52%), cormels per plant (95.60%) and cormel weight (96.31%). The high estimates of heritability were coupled with high genetic advance for traits plant height, leaf length, flower stalk girth, rachis length, spike length (24.01%), spike weight (38.31%), number of corms per plant (73.61%), corm weight (141.47%), number of cormels per plant (114.96%) and cormel weight (96.12%).The high heritability for most of the quantitative traits has also been reported by Maurya *et al.* (9) in gladiolus and Kumar *et al.* (8) in gerbera. The high heritability coupled with high genetic advance indicated the possible role of additive gene action and proves more useful for efficient improvement of a trait through selection.

The genotypic (r_g) and phenotypic (r_p) correlation coefficients are presented in Table 3. The plant height had highly significant and positive correlation with number of leaves per plant (r_g: 0.990; r_p: 0.477), number of florets per spike (r_g: 0.480; r_p: 0.346), and weight of spike (r_g: 0.690; r_p: 0.643) both at genotypic and phenotypic levels, respectively. Number of leaves per plant had positive significant correlation with leaf length, spike length and spike weight. This may be due to increased photosynthesis. The leaf length was significant and positively correlated with length of and weight of spike. The results obtained are in agreement with the findings of De and Misra (1) and Ranchana *et al*. (14). The positive and significant correlation was observed for days to spikes initiation with days taken to show colour (r_g: 0.930; r_p: 0.776) and days taken for flowering (r_g: 0.950; r_p: 0.704). The duration required to show colour was significant and positively correlated with days taken for flowering (r_g: 0.970; r_p: 0.742). Number of florets per spike was significant and positively correlated with spike

Table 3. Estimates of genotypic correlation (r_g) and phenotypic correlation (r_p) among different traits in gladiolus.

Trait		Plant height	No. of leaves/ plant	Leaf length	Days to spike initiation	Days to show colour	Days to flowering	Floret length	No. of florets/ spike	Rachis length	Spike length	Spike weight
Plant height	r_g	1.000	0.990**	0.960**	-0.590**	-0.610**	-0.610**	0.340*	0.480**	0.160	0.490**	0.690**
	r_p	1.000	0.477**	0.695**	-0.437**	-0.489**	-0.443**	0.033	0.346*	0.110	0.455**	0.643**
No. of leaves/ plant	r_g		-1.000	0.980**	-0.860**	-0.980**	-0.910**	0.610**	0.930**	0.560**	0.910**	0.910**
	r_p		1.000	0.373**	-0.231	-0.084	-0.119	-0.052	0.139	0.050	0.332*	0.319*
Leaf length	r_g			1.000	-0.470**	-0.420**	-0.420**	-0.220	0.380**	0.250	0.650**	0.630**
	r_p			1.000	-0.191	-0.288*	-0.286*	-0.057	0.223	0.267	0.465**	0.490**
Days to spike initiation	r_g				1.000	0.930**	0.950**	-0.910**	-0.240	-0.280*	-0.370*	-0.500**
	r_p				1.000	0.776**	0.704**	-0.277*	-0.096	-0.106	-0.274*	-0.403**
Days to show colour	r_g					1.000	0.970**	-0.990**	-0.340*	-0.270*	-0.430**	-0.560**
	r_p					1.000	0.742**	-0.161	-0.096	-0.247	-0.269*	-0.460**
Days to flowering	r_g						1.000	-0.900**	-0.250	-0.210	-0.380**	-0.530**
	r_p						1.000	-0.281*	-0.184	-0.206	-0.262	-0.437**
Floret length	r_g							1.000	-0.440**	-0.040	0.760*	0.880**
	r_p							1.000	0.079	0.099	0.099	0.158
No. of florets/ spike	r_g								1.000	0.250	0.190	0.470**
	r_p								1.000	0.241	0.125	0.294*
Rachis length	r_g									1.000	0.370**	0.210
	r_p									1.000	0.255	0.180
Spike length	r_g										1.000	0.660**
	r_p										1.000	0.607**
Spike weight	r_g											1.000
	r_p											1.000

*, **Significant at 5 and 1% levels; Days to show colour = 1st floret; Days to flowering = Opening of 3rd floret

Table 4. Direct (diagonal) and indirect effects of different traits on spike weight.

Trait	Plant height	No. of leaves/ plant	Leaf length	Days to spike initiation	Days to show colour	Days to flowering	Floret length	No. of florets/ spike	Rachis length	Spike weight	Correlation with Y
Plant height	**1.347**	0.006	-0.891	-0.266	0.142	-0.042	0.045	0.072	0.012	0.265	0.643**
No. of leaves/ plant	2.911	**-0.003**	-2.302	-0.386	0.324	-0.083	0.08	0.17	0.04	0.656	0.319*
Leaf length	1.293	0.007	**-0.929**	-0.21	0.099	-0.029	-0.029	0.058	0.018	0.354	0.490**
Days to spike initiation	-0.799	-0.002	0.434	**0.449**	-0.264	0.08	-0.144	-0.036	-0.02	-0.202	-0.403**
Days to show colour	-0.819	-0.004	0.393	0.506	**-0.234**	0.081	-0.176	-0.051	-0.019	-0.233	-0.460**
Days to flowering	-0.817	-0.003	0.393	0.518	-0.273	**0.069**	-0.157	-0.038	-0.015	-0.207	-0.437**
Floret length	0.462	0.002	0.205	-0.497	0.317	-0.083	**0.130**	-0.066	-0.003	0.41	0.158
No. of florets/ spike	0.646	0.003	-0.356	-0.106	0.079	-0.017	-0.057	**0.151**	0.018	0.103	0.294*
Rachis length	0.215	0.002	-0.236	-0.124	0.062	-0.015	-0.005	0.038	**0.072**	0.199	0.180
Spike weight	0.657	0.003	-0.605	-0.167	0.1	-0.026	0.098	0.029	0.026	**0.543**	0.607**

Residual value = 0.48002; Days to show colour = 1st floret; Days to flowering = Opening of 3rd floret

weight (r_g: 0.470; r_p: 0.294) at both genotypic and phenotypic levels, respectively. Higher magnitude of genetic correlation coefficient indicting the presence of inherent association between various traits was also observed in gladiolus (Sirohi *et al.*, 17; Maurya *et al.*, 9).

The correlation coefficients only indicate the relationship of independent variable with the dependent variable without specifying cause and effect shows that relationship. Using path coefficient analysis, it is possible to resolve the correlations, which will provide direct and indirect contribution of different quantitative traits. In Table 4 it is shown that plant height showed positive direct effects (1.347) towards yield of spike, number of leaves per plant (0.006), number of florets per spike (0.072), and spike length (0.265). However, it recorded negative indirect effect with leaf length (-0.891), days taken for spike initiation (-0.266) and days taken for flowering (-0.042). Nonetheless, Hegde (5), reported number of days to first bud to loosen and marketable spikes to have positive direct effect on spike length. Patra and Mohanty (11), reported direct and indirect effects of various traits in gladiolus similar to the present finding. It is suggested that for the improvement of gladiolus both for market value and maintaining quality, plant height, number of florets per spike, rachis length, days for first floret to open, length of spike are of primary importance.

The experimental results conclude that all the traits among the genotypes exhibited significant differences. The traits like floret diameter, flower stalk girth, number of corms per plant, corm and cormel weight showed high genotypic co-efficient of variation. High estimates of heritability coupled with high values of genetic advance were observed for characters plant height, leaves length, flower stalk girth, rachis length, spike length, spike weight, number of corms per plant, corm weight, number of cormels per plant and cormel weight which indicated the scope of improvement is more by following standard selection procedures. All the traits in general exhibited higher estimates of genetic correlations than phenotypic correlations, which indicate the presence of inherent association among the traits. The plant height exhibited positive significant correlation at genotypic and phenotypic level with number of floral characters. The characters having indirect positive effect on spike length could also be considered for evolving new types in this crop.

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