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GENETIC VARIABILITY AND CORRELATION STUDIES IN *GLADIOLUS HYBRIDUS* HORT. UNDER BUNDELKHAND CONDITIONS

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Abstract

A field experiment was conducted to estimate genetic variability, heritability and correlation among the economically important characters in gladiolus varieties at the Instructional Farm, College of Horticulture, BUAT, Banda. The healthy and uniform sized corms (4 to 5 cm) were planted at a spacing of 30 × 20 cm in each row at a depth of 5-6 cm. Before planting, corms were dipped in captan (0.2%) solution for 25-30 min as a preventive measure against *Fusarium* wilt disease. The varieties showed significant variability ($p < 0.05$) for days taken to spike emergence (66.67-86.69 days), days taken to opening of first floret (86.21-101.80 days), plant height (74.93 to 105.47 cm), spike length (67.07 to 89.93 cm), rachis length (33.89 to 55.64 cm), water uptake (17.33-46.67 ml), corm weight (39.97 to 100 g) and number of cormels per plant (4.47-41.97). Phenotypic coefficient of variation and genotypic coefficient of variation were high for the traits studied, except days taken to spike emergence, days taken to opening of first floret and corm diameter. High broad-sense heritability value was found for number of corms per plant (90.64 %), corm weight (76.09 %) and days taken to opening of first floret, indicating the presence of additive gene effects. Positive correlation was found between days taken to spike emergence and days taken to opening of first floret ($r = 0.880^{**}$); number of leaves per plant ($r = 0.543^{*}$), plant height ($r = 0.560^{*}$) and corm weight ($r = 0.515^{*}$).

Introduction

Gladiolus (*Gladiolus hybridus* Hort.) is one of the economically important bulbous cut flower crops grown worldwide. In India, gladiolus is grown in all over the country and is mostly used as cut flower, floral arrangements, bouquets, garden display, bedding plant and decoration purpose (Lepcha *et al.* 2007). The yield potential of gladiolus is high depending on the genotype and growing conditions, though actual yields are low. In the context of yield enhancement, in order to have a good choice of character for selection of desirable genotypes under planned breeding programme, information on the nature and magnitude of variation present in existing material and association of component characters with yield is of utmost importance for crop improvement programme (Kadam *et al*. 2014). Generation of information on genetic variability, genotypic coefficient of variation, heritability and genetic advance is very valuable for genetic improvement of gladiolus by the breeding program. As the existing variability can be used to enhance the yield level of the cultivars, the evaluation of existing genetic variability in any crop species is a pre-requisite for formulating effective breeding strategies (Belaj *et al.* 2002). Genotypic and phenotypic components of variance, heritability and genetic advance have been calculated for different yield characters by several workers (Ubi *et al*. 2001, Omoigui *et al.* 2006 and Manggoel *et al.* 2012) which revealed that selection was effective for a population with broad genetic variability and character with high heritability. Correlation study provides information about the inter-relationship of desired traits among each other and influence of studied traits on yield, thereby provide an effective basis of selection. The objective of this study was to understand the

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magnitude of genotypic as well as phenotypic variation, heritability and genetic advance along with correlation coefficients of yield contributing traits among the varieties of gladiolus in Bundelkhand region of India.

Materials and Methods

The present investigation was carried out at Instructional Farm, College of Horticulture, Banda University of Agriculture and Technology, Banda during 2019-20. It is located 123 m above mean level at the latitude of $24^0$53' and $25^0$55'N, and $80^0$07'and $81^0$34' E. The maximum temperature of this region may reach as high as 49 ºC during summer and minimum may fall to 7ºC during winter. This region receives average annual rainfall of 800-910 mm of which more than 80% is received from third week of June to first week of September and very little is received between October and February. The experiment was laid out in a Randomized Block Design (RBD)in three replications. The experiment comprised of 15 varieties of gladiolus procured from ICAR-Indian Agricultural Research Institute, New Delhi and CSIR-National Botanical Research Institute, Lucknow. The field was properly ploughed and brought to a fine tilth by ploughing and harrowing. Thereafter, field was leveled properly and then plots were prepared according to the layout plan. During harrowing, well rotten FYM was incorporated in soil at the rate of 5 Kg/m^2. Corms were treated with carbendazim 0.2% to avoid any incidence of disease. Thereafter, planting was done at a spacing of 30 x 20 cm in raised beds. A spacing of 70 cm between replications and 50 cm between plots was provided for laying out irrigation channel and to facilitate intercultural operations. All the recommended cultural operations i.e., irrigation, hoeing, weeding, spraying and fertilizer application, etc. were carried during the entire crop period. Observations were recorded on five randomly selected plants from each genotype in each replication for 19 characters *viz.* days taken to sprouting of corms, number of leaves per plant, plant height, days taken to spike emergence, days taken to opening of first floret, floret size, number of florets opened at one time, duration of flowering, number of florets per spike, number of spikes per plant, spike length, rachis length, vase life, water uptake, number of corms per plant, corm diameter, corm weight, number of cormels per plant and weight of cormels per plant. Data for all the variables measured were subjected to Analysis of Variance (ANOVA), to estimate the level of variability among the gladiolus varieties, using Genstat Discovery Edition 3 software. To compare the variations among traits, phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) were computed according to the method suggested by Allard (1960) and Burton (1952):

$$PCV = (\sqrt{Vp}/X)\ 100$$

$$GCV = (\sqrt{Vg}/X)\ 100$$

where X is the grand mean for each of the studied traits. The genetic parameters were calculated according to Burton and De Vane (1953). Broad sense heritability (h2B) was calculated according to Burton and DeVane (1953) and Allard (1960) as the ratio of the genotypic variance (Vg) to the phenotypic variance (Vp). The correlation coefficients (r) were computed among all the measured traits using SPSS for Windows Version 16 (SPSS, Inc., Chicago, IL).

Results and Discussion

The analysis of variance (ANOVA) showed significant variation for all the traits (Table 1). The extent of variation concerning 19 characters of 15 genotypes of gladiolus was measured in terms of range, general mean, phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability, genetic advance and genetic advance as percent of mean. The perusal of data appended in Table 2 revealed widest range in corm weight (39.97-100.00 g), followed by number of cormels per plant (4.47-41.97) and plant height (74.93-105.47 cm).

However, the narrowest range was recorded for the number of spikes per plant (1-1.67), followed by corm diameter (5.60-6.77) and number of corms per plant (1.00-2.27). General mean was found maximum for days taken to opening of first floret (93.48), followed by plant height (89.59) and days taken to spike emergence (76.71).

Table 1. **Analysis of variance of 19 traits of gladiolus.**

Traits	Mean sum of square		
Source of variation	Replication	Genotypes	Error
Degree of freedom	2	14	28
DTS	1.83	6.80*	2.55
DTE	107.44	78.10**	26.94
DTO	16.44	72.80**	8.53
FS	1.78	2.96**	0.50
NFO	2.41	1.41	1.07
DF	5.53	5.90*	2.47
NFS	39.07	9.47**	2.71
NSP	0.49	0.13	0.07
NLP	6.36	1.83**	0.34
PH	214.58	271.59**	68.24
SP	343.14	242.49**	81.37
RL	37.19	99.01*	44.31
VL	4.83	8.64**	1.54
WU	8.87	168.39**	48.98
NCP	0.067	0.40**	0.01
CD	0.87	0.35**	0.10
CW	5.58	706.06**	66.92
NPP	1.42	340.88**	68.07
WCP	15.21	32.16**	9.06

*Significant at 0.1, **significant at 0.05, DTS-Days taken to sprouting of corms, DTE-Days taken to spike emergence, DTO-Days taken to opening of first floret, FS - Floret size, NFO- Number of florets opened at one time, DF- Duration of flowering, NFS- Number of florets per spike, NSP- Number of spikes per plant, NLP- Number of leaves per plant, PH- Plant height, SP-Spike length, RL- Rachis length, VL- Vase life, WU-Water uptake, NCP- Number of corms per plant, CD- Corm diameter, CW- Corm weight, NPP-Number of cormels per plant and WCP- Weight of cormels per plant.

Estimates of phenotypic coefficient of variation (PCV) were slightly higher than genotypic coefficient of variation(GCV) for all the characters under study, indicating the apparent variation is not only due to genotypes but also due to influence of the environment in the expression of the genotypes. As stated by Deshmukh *et al.* (1986), PCV and GCV values greater than 20% are regarded as high and values between 10 and 20% to be medium, whereas values less than 10% are considered low. Estimates of PCV and GCV were high for characters *viz.* days taken to sprouting of corms, number of spikes per plant, water uptake, number of cormels per plant, corm weight, number of cormels per plant and weight of cormels per plant. Moderate value of PCV and GCV

were recorded for floret size, number of florets opened at one time, duration of flowering, number of florets per spike, number of leaves per plant, plant height, spike length, rachis length and vase life. However, low estimates of PCV and GCV were observed in days taken to opening of first floret (5.85 and 4.95), corm diameter (6.93 and 4.58) and days taken to spike emergence (8.65 and 5.38), respectively.

Table 2. Estimates of genetic parameters of gladiolus varieties for morphological traits.

Traits	Range	General mean ± SE	PCV	GCV	Heritability (h^2) %	Genetic advance	Genetic advance as % of mean
DTS	5.17-10.40	7.95±0.92	25.04	14.97	35.72	1.46	18.36
DTE	66.67-86.69	76.71±3.00	8.65	5.38	38.75	5.29	6.90
DTO	86.21-101.80	93.48±1.69	5.85	4.95	71.50	8.06	8.62
FS	7.05-9.82	8.45±0.41	13.60	10.72	62.19	1.47	17.40
NFO	5.95-8.47	7.15±0.60	15.23	4.74	9.69	0.22	3.08
DF	13.40-17.98	15.41±0.91	12.34	6.94	31.64	1.24	8.05
NFS	8.13-14.22	11.64±0.95	19.14	12.90	45.39	2.08	17.87
NSP	1-1.67	1.27±0.15	23.71	10.53	19.73	0.12	9.45
NLP	7.42-9.84	8.57±0.34	10.68	8.24	59.47	1.12	13.07
PH	74.93-105.47	89.59±4.77	13.02	9.19	49.83	11.97	13.36
SP	67.07-89.93	74.49±5.21	15.60	9.84	39.76	9.52	12.78
RL	33.89-55.64	44.60±3.84	17.73	9.57	29.15	4.75	10.65
VL	11.48-17.33	15.48±0.72	12.77	9.94	60.57	2.47	15.96
WU	17.33-46.67	36.27±4.04	25.98	17.39	44.83	8.70	23.99
NCP	1.00-2.27	1.33±0.07	28.34	26.98	90.64	0.70	52.63
CD	5.60-6.77	6.23±0.19	6.93	4.58	43.81	0.39	6.26
CW	39.97-100.00	66.66±4.72	25.10	21.90	76.09	26.23	39.35
NPP	4.47-41.97	15.82±4.76	79.52	60.04	57.01	14.77	93.36
WCP	2.01-13.42	5.83±1.74	70.27	47.62	45.92	3.87	66.38

PCV-Phenotypic coefficient of variation, GCV- Genotypic coefficient of variation

Low values for PCV and GCV indicate that genotypes do not exhibit much variation among themselves for these characters. Moderate values for PCV and GCV indicate that genotypes exhibit only some amount of variation among themselves with respect to these characters. High values for PCV and GCV indicate that genotypes exhibit much variation among themselves with respect to these characters. Similar results were reported by Kumar and Singh (2020), Kispotta *et al.* (2017) in gladiolus, Kumar *et al.* (2012) in snapdragon and Chauhan *et al.* (2017) in carnation. The narrow genetic difference among GCV and PCV for all the traits studied implies that the traits are mostly governed by genetic factors with little role of environment in the phenotypic expression of these characters. Thus, selection of these traits on the basis of the phenotypic value may be effective (Chauhan *et al.* 2017).

Table 3.**Correlation coefficient among different traits in 15 varieties of gladiolu**s.

Trait	DTS	DTE	DTO	FS	NFO	DF	NFS	NSP	NLP
DTS	1.000**								
DTE	-0.005	1.000**							
DTO	0.185	0.880**	1.000**						
FS	-0.202	0.007	0.091	1.000**					
NFO	0.321	0.034	0.223	0.357	1.000**				
DF	0.469*	-0.433	-0.328	-0.147	-0.012	1.000**			
NFS	0.328	0.269	0.380	-0.138	-0.009	0.494*	1.000**		
NSP	-0.700	-0.181	-0.374	0.060	-0.420	-0.472	-0.536	1.000**	
NLP	-0.199	0.543*	0.652**	0.539*	0.220	-0.515	0.123	-0.013	1.000**
PH	0.070	0.560*	0.528*	0.354	-0.031	-0.019	0.466*	-0.229	0.338
SP	-0.088	0.391	0.425	0.374	-0.097	-0.036	0.477*	-0.056	0.317
RL	0.106	0.375	0.407	0.565*	0.158	0.039	0.485*	-0.298	0.311
VL	0.289	0.276	0.373	0.203	0.341	0.328	0.610**	-0.804	0.186
WU	-0.117	0.192	0.265	-0.030	0.181	-0.306	-0.130	-0.163	0.048
NCP	-0.139	0.009	0.020	0.242	0.070	0.084	-0.069	0.144	-0.005
CD	-0.417	0.326	0.327	-0.114	-0.237	-0.438	0.159	0.104	0.448
CW	-0.329	0.515*	0.521*	-0.009	-0.147	-0.497	0.233	0.118	0.546*
NPP	-0.254	0.187	0.277	0.676**	0.302	-0.569	-0.350	0.258	0.424
WCP	-0.267	0.053	0.103	0.505*	0.207	-0.652	-0.526	0.339	0.251

Right side of the table.

PH	SP	RL	VL	WU	NCP	CD	CW	NPP	WCP
1.000**									
0.918**	1.000**								
0.861**	0.864**	1.000**							
0.498*	0.367	0.578**	1.000**						
0.170	0.073	0.008	0.319	1.000**					
0.105	0.088	0.071	0.115	0.376	1.000**				
-0.228	-0.131	-0.132	0.037	0.075	-0.097	1.000**			
0.137	0.126	0.050	0.076	0.434	0.227	0.741**	1.000**		
0.138	0.260	0.398	-0.073	0.150	0.233	0.194	0.188	1.000**	
-0.054	0.053	0.201	-0.250	0.159	-0.026	0.205	0.126	0.914**	1.000**

*significant, **highly significant.

Heritability estimates in the present study were generally high for number of corms per plant (90.64), followed by corm weight (76.09) and days taken to opening of first floret (71.50). The minimum value for heritability was found in number of florets opened at one time (9.69) followed by number of spikes per plant (19.73) and rachis length (29.15). Similar work was also reported by Kispotta *et al.* (2017) in gladiolus. High heritability estimates for these characters indicate that these characters are highly heritable and the environment has less influence on their expression. So, there is a good scope for the improvement of these characters through direct selection.

The characters exhibiting maximum heritability and high genetic advance as a percentage of mean could be used as a powerful tool in the selection process, such attitudes are controlled by the genes and influenced less by the environment (Panes and Sukhatme 1995). According to Johnson *et al*. (1955), the value of genetic advance as per cent of the mean is categorized as low (< 10%), moderate (10 - 20%) and high (> 20%). In this study, high heritability along with high genetic advance was recorded for corm weight whereas high heritability along with low genetic advance was exhibited by number of corms per plant. The characters having high heritability along with high genetic advance appeared to be controlled by additive gene action and selection for such parameters will be very useful. However, characters having high heritability along with low genetic advance may be controlled by non-additive gene action and selection for such parameters may not be effective. Similar results were reported by Kumar *et al*. (2012) and Chauhan *et al.* (2017) in gladiolus.

Correlation coefficients were computed in all possible combinations for 19 characters and interpretations are made on the basis of results (Table 3). Days taken to spike emergence exhibited highly significant and positive correlation with days taken to opening of first floret; significant and positive correlation with number of leaves per plant, plant height and corm weight. Days taken to opening of first floret showed highly significant and positive correlation with number of leaves per plant. Vetrivel *et al*. (2018) also reported significant and positive correlation of number of days taken for first floret opening with number of daughter corms per plant. Similar results were also reported by Vetrivel *et al*. (2018) in gladiolus. So, more number of leaves means more plant height and length of spike, because of the increased photosynthesis leading to the availability of more photosynthates.

Plant height exhibited highly significant and positive correlation with spike length and rachis length; significant and positive association with vase life. The results obtained are in agreement with the findings of Kumar and Kumar (2010), Pattanaik *et al*. (2015) and Vetrivel *et al*. (2018) in gladiolus. Spike length exhibited highly significant and positive correlation with rachis length. Results are in line with the findings of Vetrivel *et al.* (2018) in gladiolus. Rachis length exhibited highly significant and positive correlation with vase life. Floret size showed highly significant and positive correlation with number of cormels per plant. Naresh *et al.* (2019) also reported significant and positive correlation of floret diameter with corm diameter and number of cormels per plant.

Duration of flowering showed significant and positive association with number of florets per spike. Number of florets per spike exhibited highly significant and positive correlation with vase life; significant and positive correlation with plant height, spike length and rachis length. Kumar *et al.* (2015), Pattanaik *et al.* (2015) and Vetrivel *et al.* (2018) also reported similar results. Vase life showed positive correlation with water uptake and number of corms per plant, corm diameter and weight. Number of corms per plant showed positive correlation with corm weight and number of cormels per plant; negative association with corm diameter and weight of cormels per plant. Corm weight showed positive correlation with number of cormels per plant and weight of cormels per plant. Corm diameter showed highly significant and positive correlation with corm weight.

Vetrivel *et al*. (2018) also reported significant and positive correlation between diameter of mother corm with weight of mother corm, number of cormels per plant and diameter of daughter corm.

Based on the findings in the present study, number of cormels per plant, weight of cormels per plant, corm weight, days taken to opening of first floret, floret size could be useful criteria for selection in the gladiolus improvement because these characters had a high genotypic coefficient of variation, heritability estimate and genetic advance. Besides, positive correlation was found between days taken to spike emergence and days taken to opening of first floret, number of leaves per plant, plant height and corm weight. Therefore, it is recommended that these characters should be used for the development of high yielding varieties through selection.

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