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Assessment of Variability, Heritability and Genetic Advance in 31 Genotypes of Gladiolus (*Gladiolus grandifloras* L.)

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ABSTRACT

In this study, 31 genotypes of gladiolus were examined to provide estimates of genetic variability, analysis of variance, genetic parameters (GCV, PCV, heritability and genetic progress) for thirteen different characters. The research trial was conducted at the crop research Center, Department of Genetics and Plant Breeding, School of Agriculture, ITM University, Gwalior, Madhya Pradesh using RBD design. According to the analysis of variance, 31 genotypes had notable variations for each character. Heritability estimates ranged from 22% to 99%. While the highest heritability 99% was predicted for the spike initiation, the character number of shoots per corm was expected to have the lowest heritability 22.76% . The percentage of genetic advances ranges from 24.25% to 69.41% of the mean. The highest and lowest percentages of the mean genetic advance were found for plant height 51.77% and the number of shoots per corm 0.79% .

Keywords Gladiolus, GCV, PCV, Heritability, Genetic advance as percentage of mean.

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INTRODUCTION

One of the most important floricultural crops is gladiolus which originated from South Africa and is popular as the Queen of bulbous flowers. Gladiolus is botanically known as *Gladiolus grandiflora*, derived from the Latin word, *Gladius* due to its sword-structured leaves. It belongs to Genus *Gladiolus* Species *Grandifloras* Order *Iridaceae* Family *Iridaceae*, Subfamily *Crocoideae*. Spike is the inflorescence of the gladiolus. Its fascinating spikes exhibit varying sizes and forms of florets with smooth, ruffled, deeply crinkled or laciniate petals that are blotched or possess distinct patches or markings of various colors and color combinations. It is one of the most important bulbous crops grown commercially for cut flowers, bouquets, floral arrangements, interior decoration, and garden display purposes (Lepcha *et al*.) The basic chromosome no of gladiolus is n=15 and has 260 species of perennial herb and is popularly known as the Sword-Lily and Cornily. It consists of a magnificent inflorescence with florets of dazzling colors. The size and shape of the florets are different due to long-keeping quality. It is one of the most attractive cut flowers worldwide. Gladiolus grows from the round symmetrical shaped structure called corms which are enveloped in several layers of brownish fibrous tunics. The individual florets are attached directly to the axis. The outermost three segments make up the calyx and the next whorl of the three segments comprise corolla. It has bright, beautiful, and differently colored flowers and is used in cut flowers, herbaceous borders, bedding, rockeries

and pots. Gladiolus can be cultivated on all types of soils and is considered 6.0-7.0 pH for good growth and spike production. It can also be grown from plains to an altitude of 2500 m. It is a winter crop but can be grown in July-August in low rainfall areas with mild climatic conditions. It is propagated through corms and seeds but seeds normally require 2-4 seasons to come to flowering and hence followed only in breeding programs to evolve cultivars. (Singh *et al.* 2022). Worldwide Gladiolus is cultivated in an area of 11660 ha with an estimated yield of 106 crore cut flowers. Gladiolus had been cultivated all over the world in the late sixteen century. The most important producer of Gladiolus is Asia, Mediterranean Europe, South Africa, Tropical Africa, United States of America, Netherland, Portugal, Italy, Belgium, Brazil, Australia and India. It is grown over an area of 15 ha (NHB 2019) with a production of 7 lakh spikes in Andhra Pradesh. It occupies third place in the area and production of cut flowers grown in India after the rose and carnation. It has the eighth rank of bulbous flower in World trade, in cut flower trade, with 4th in the international market. Gladiolus is grown generally in *rabi* season and can be grown around the year. In India, gladiolus can be grown successfully in tropical, subtropical and temperate climates. The commercial floriculture sector has recorded a fast pace of growth during the last decade and the export has grown manifold the area has expanded to 1,67000 ha with a production of 9,87,000 MT of loose flowers and 4.8 million cut flowers (NHB 2020).

MATERIALS AND METHODS

31 genotypes of gladiolus were used as the experimental materials for this study, which was conducted at the Crop Research Center (CRC), School of Agriculture, Department of Genetics and Plant Breeding, ITM University, Gwalior, Madhya Pradesh. Physically located at 26.22 N 78.18 E. With an average annual rainfall of 700 mm, the area is part of Madhya Pradesh grid Agroclimatic zone. The area around Gwalior is typically 197 meters above mean sea level. A high of 47°C is reached throughout the summer months as the temperature continues to rise. On the other side, the wintertime is at its peak, with temperatures ranging from 1°C to 3°C. Thirty-one genotypes of gladiolus were used in the experiment, which was sourced from Naini Agricultural Institute, SHUATS, Prayagraj, Uttar Pradesh and Directorate of Floricultural Research Pune, Maharashtra in a Randomized Block Design (RBD) with three replications, the experiment was carried out in 2022–2023. The 30 ×15 cm spacing was used to plant 10 corms of each genotype. To cultivate a productive crop, all suggested agronomic procedures and management techniques were applied and data was recorded for various growth, floral and yield parameters. To determine how these component characters under study affect growth and yield parameters, the data collected during the trial for these traits were analyzed using statistical tools for Analysis of Variance to detect the variability among them by using the standard procedure suggested by (Steel and Torrie 1980). Heritability and genetic advance were determined as per formulae suggested by (Hanson *et al.* 1956).

RESULTS AND DISCUSSION

Analysis of variance stipulated significant differences at 1% and 5% for 13 different characters of 31 gladiolus varieties, marking the presence of genetic

Table 1. Analysis of variance for 13 different characters of gladiolus. *Significance 5% and ** Level of significance 1%.

Sl. No.	Character	Mean sum of squares		
		Replications df = 2	Treatments df = 30	Error df =60
1	Days for germination	93.3	128.14**	60.62
2	Plant height	3.49	1899.20*	1
3	Spike initiation	0.202	981.05**	0.03
4	Days to flowering	16.88	1514.5	7.21
5	Spike length	1.5	517.13	1.66
6	Number of floret per spike	1.71	22.74	3.1
7	Number of floret per plant	0.07	29.12	0.22
8	Number of leaves per plant	2.94	5.67***	0.09
9	Rachis length	2.45	556.66***	0.12
10	Number of shoots per corm	4.49	4.17	2.21
11	Durability of spikes	2.41	31.73**	0.23
12	Number of corms per plant	1.1	141.60***	0.19
13	Number of cormel per plant	1.37	1.43**	0.09

Table 2. Mean performance for 13 characters of 31 genotypes of gladiolus. DFG - Days for germination, PH- Plant height, SI- Spike initiation, NFS- Number of florets per spike, NFP- Number of florets per plant, LPP- Number of leaves per plant, NSC - Number of shoots per corm, DOS- Durability of spike, NCP- Number of corms per plant, SL- Spike length, NCRP- Number of cormels per plant, RL- Rachis length, DTF - Days to flowering.

Genotypes	DFG	PH	SI	DTF	SL	NFS	NFP	LPP	RL	NSC	DOS	NCP	NCRP
Sannare	21	58.8	97.3	92.3	83.7	19.3	13.3	5	60.7	2.33	26.3	1.33	37
Friendship	17.3	65.3	82	90	79.8	11.7	11.7	6.66	49	1.66	28.3	3	36
Mohini	21.3	69.1	85.7	93.3	68	13	14.7	6.33	45	1.66	27.3	1.66	14
Urmi	16.3	71.9	88.7	90.7	82.1	14	15	7	56.7	1.33	29.7	1.33	9
Yellow stone	16.7	67.7	85.7	92	95.4	16	18	6.66	65.4	1.66	28.7	1.66	10.3
Hunting song	16	63.2	87	93.3	67	9.33	13.7	6.33	37	2	29	2.33	24
Pusa shubham	17.3	65.2	89.3	97.7	69.8	9.66	10	7.33	39.8	3	29.7	3.33	20.3
Peter pears	18.3	69.1	91	97	89.6	15.7	14.6	6.31	59.6	2	31	2	22
Suchitra	19.3	74.8	86	89.3	103	17	18.7	7.33	72.7	1.33	29.7	2.66	21.7
Creamy green	19	68.6	93	97.3	104	16.3	20.7	5.66	74.4	3.33	31.7	3	17
White prosperity	18.3	64.4	92.6	92.7	98.9	17.7	18.7	6.83	70.9	1.66	29.7	2	18
Pusa chirag	17.3	74	94.6	97	88.2	13.7	13.3	8	61.2	1	28.7	3.33	15.3
Indrani	22.3	73.6	90.3	109	88.4	13	16	8	61.4	1	31	2	16.3
American beauty	23.3	75.6	91.3	95.3	84.8	15	14.7	8.33	57.8	1.33	30.7	2.66	17
Bindiya	21.7	79.1	90.3	90.7	78.9	12.7	11.7	8	51.9	1	32.7	1	15.3
Neelam	20	101	88.3	95.7	93.6	11.3	19.3	7	66.6	1	29	1.33	15.3
Arun	18	89.3	85.3	103	101	17.7	21.3	7.66	73.7	1.33	30	1	14.3
Royal supreme	19.7	107	95	110	100	15	21.3	6.33	73.1	2	24.7	1.33	21.7
Snow princess	22	84.4	93.7	111	105	18.3	19.7	7	77.9	1	22	2	26
Swapnil	17.7	130	97	114	96.1	18.2	15.7	6.66	69.1	1	19.7	2.66	29.3
Chandani	9	114	52.7	60.3	99.3	11.7	13.3	9.62	41.6	4	24.7	2.97	17.3
Cheops	16	108	56	66.7	84.9	11	11	9	34.2	3	24.7	2.66	14.7
Dhanwantari	9	139	48	56.3	80.7	11.7	11.3	8	42.7	3.32	26	2.33	15.7
Gunjan	14	111	59	68	60.8	11.7	14.3	9.33	41.4	2.66	27	2.66	17.8
Pusa-suhagin	12	113	67.7	75.7	85.7	16	15.1	8	64	2.33	26.6	2.33	19
Priscilla	9	119	48.3	58	62.8	18.7	13	10	61.3	2.66	24.7	1.82	23.3
Red ginger	10.7	97.3	43.3	55.3	113	13.3	14	9	52.4	2.66	23.3	1.66	23
Red majesty	9	82	53.7	65.7	86.8	16.7	14.3	11.7	59	2.33	26.3	2.33	34.3
Souvic biscuit	10	85.7	53.7	60.3	97.3	12.3	12.3	8.33	55.7	3.34	22.7	2.66	27.7
Phule- neeelrekha	11	88.7	55.7	72	95.3	14.3	16	8	51.7	2.66	22.3	2.66	15.7
Joshika	10	85.7	93.7	121	99.3	14	14	7.66	64.1	2.66	21.7	3.33	23.7
CD	0.27	1.64	0.24	0.66	2.11	0.88	0.78	0.49	0.54	0.58	0.78	0.5	0.75
SE(m)	0.1	0.58	0.09	0.23	0.75	0.31	0.28	0.17	0.19	0.2	0.28	0.18	0.26
SE(d)	0.14	0.82	0.12	0.33	1.05	0.44	0.39	0.25	0.27	0.29	0.39	0.25	0.37
CV	1.02	1.15	0.19	0.46	1.46	3.75	3.13	3.93	0.57	16.9	1.77	13.71	2.24

variability in the population. The data presented in (Table 1) indicates the mean performance of gladiolus for different characters. The mean sum of the square of different genotypes and mean performance is represented in (Tables 1 - 2).

Genetic coefficient of variation and phenotypic coefficient of variation

For a variety of features, estimates of variability were calculated, including coefficients of variation (phenotypic and genotypic), heritability (broad sense), genetic advance, and genetic advance as a percentage of the mean. The results are shown in (Table 3 Fig. 1).

Variability

The data showed that for all of the studied features of gladiolus, the phenotypic coefficient of variability was larger than the genotypic ones. Characters like days to sprouting (53.513% and 27.845%), and number of cormels per plant (32.975% and 29.991%) were found to have high PCV and GCV. The rachis length (24.014% and 24.006%), number of corms per plant (33.838 and 33.767), and number of leaves per plant (18.62% to 17.836%) all showed intermediate

Table 3. Estimation of genotypic and phenotypic coefficient of variation heritability and genetic advance as percent mean for 13 characters of gladiolus.

Sl. No.	Characters	GCV	PCV	Heritability (%)	GA (%)	GAM (%)
1	Days for germination	27.84	53.51	27.07	5.085	29.84
2	Plant height	31	31.03	99.84	51.77	63.82
3	Spike initiation	23.01	23.01	99.99	37.25	47.4
4	Days to flowering	26.44	26.63	98.58	45.84	54.08
5	Spike length	14.81	14.88	99.03	26.87	30.37
6	Number of floret per spike	17.99	21.84	67.86	4.34	30.54
7	Number of florets per plant	20.44	20.68	97.7	6.32	41.62
8	Number of leaves per plant	17.83	18.62	95.38	2.74	35.88
9	Rachis length	24	24.01	99.93	28.04	49.43
10	Number of shoots per corm	36.16	75.8	22.76	0.79	35.55
11	Durability of spike	11.9	12.03	97.48	6.6	24.25
12	Number of corms per plant	33.76	33.83	99.57	14.06	69.41
13	Number of cormels	29.99	32.97	82.72	12.52	56.19

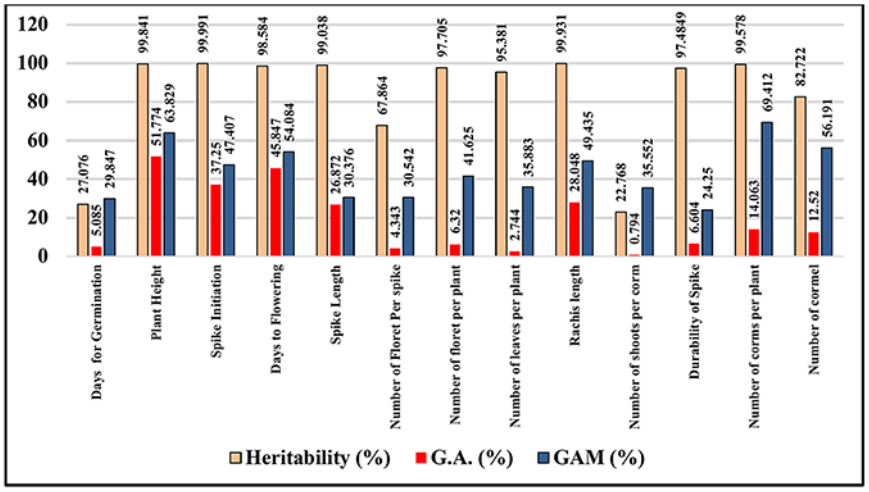

Fig. 1. Graphical representation of heritability and genetic advance for thirteen characters in gladiolus.

values. Characteristics such as spike length (14.889 to 14.817%), and days taken for spike emergence (23.015% and 23.014%) had the lowest PCV and GCV (Table 3).

Heritability

Heritability is significant to a breeder because it describes the likelihood and extent of advancement through selection. The efficiency of selection will increase as a character's heritability does. Higher heritability alone cannot produce competent selection in later generations unless it is combined with a high percentage of genetic progress. Consequently, genetic advance is a crucial selection factor. A higher estimate of heritability and rapid genetic development is anticipated to provide greater opportunity for improvement with each succeeding generation.

Heritability in a broad sense ranges from 27.07% to 99.99% among the characters under study. High heritability was recorded for spike initiation (99.99%) followed by rachis length (99.93%) plant height (99.84%), number of corms per plant (99.57%), spike length (99.03) days to flowering (98.58), number of florets per plant (97.70%), durability of the spike (97.48%) number of leaves per plant(95.38%). Heritability was found moderate for the number of

florets per spike and the number of cormels (Fig. 1). The lowest heritability was detected for the number of shoots per corm followed by the number of days for germination. On the other hand, higher heritability estimates and rapid genetic advance leads to offering better opportunities for improvement generation after generation. Higher heritability was estimated for plant height (99.84%) coupled with high genetic advance for the same (51.77%) followed by days to flowering (45.84%) which shows the presence of additive gene action. Minimum genetic advance estimated for the number of shoots per corm (0.79%) and number of leaves per plant (2.74%) (Fig. 1).

The high value of genetic advance indicates additive gene action for the characters like plant height, days to flowering, spike initiation and rachis length whereas for remaining characters whose genetic advance ranges from 0.79% to 26.87% show that they possess non-additive gene action. The same result was reported by Kumar *et al.* (2010), Maurya *et al.* (2011), Singh *et al.*(2022).

CONCLUSION

The 31 genotypes were analyzed for significant differences in each of the assessed variables. The character, plant height, which has low participation of environmental influence in the manifestation of these features, has a high degree of heritability and high genetic advance. Therefore, following selection procedures has a greater potential for improvement. The level of environmental interference for the expression of a trait is greater for qualities with high heritability and poor genetic progress. Hence, improvement for such traits requires hybridization and mutation rather than selection breeding.

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