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Study On Evaluating Genetic Variability of Gladiolus (*Gladiolus grandiflorus L.*) Cultivars under Agro-Climatic Conditions of Prayagraj

Ronanki Srinidhi [a++*] and Devi Singh [b#]

[a] Department of Horticulture (Floriculture and Landscaping), Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj – 211007, Uttar Pradesh, India.
[b] Department of Horticulture, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj – 211007, Uttar Pradesh, India.

Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Aim: An experiment to Study on genetic variability of Gladiolus (*Gladiolus grandiflorus* L.) 20 Cultivars. Based on the present investigation it was concluded that the high magnitude of heritability (in broad sense) coupled with high genetic gain was observed for most of traits exhibiting additive genetic effect. The analysis of variance for different quantitative characters reviled significant differences among the varieties for parameters like Growth, Spike yield and Vase life with Corms weight/plant (g) of gladiolus.
Study Design: Randomized block design with three replications.
Place and Duration of study: Experiment was conducted at the Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, during September, 2023 to March, 2024 to find out the best performing variety for this region.

[++] Research Scholar;
[#] Associate Professor;
**Corresponding author: E-mail: rsrinidhi0101@gmail.com;*

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Results: The highest corms yield/plant (g/plant) of genotype was observed in Friendship (106.72) followed by Chandini and Sunayana. It was observed that PCV was higher than GCV for all the traits studied highest GCV and PCV is recorded as weight of daughter corm (21.30 and 22.17). In the present study the heritability estimates in broad sense were classified into 3 groups such as high (>75%), moderate (60% - 75%), low (<60%). The heritability estimates were found to be high (more than 75%). In the present study the heritability estimates in broad sense were classified into 3 groups such as high (>75%), moderate (60% - 75%), low (<60%). The heritability estimates were found to be high (more than 75%).

Conclusion: Genotypic and phenotypic correlation coefficient analysis revealed that Corms weight/plant (g) showed positive significant association with plant height, number of leaves per plant, number of shoots per plant, rachis length (cm), no. of floret per spike, no. of spike per plant, floret diameter (cm), spike length (cm), vase life, corm weight per plot (g), weight of mother corm per plot, weight of daughter corm, corm diameter (cm), no. of corm per hectare, no. of cormels per hectare and corm yield/plant at both levels genotypic and phenotypic.

Keywords: Gladiolus grandifloras; gladiolus; GCV; PCV; heritability; correlation.

1. INTRODUCTION

"Gladiolus (*Gladiolus grandiflorus* L.), also referred to as the "Queen of bulbous flowers," is a plant native to South Africa and a member of the Iridaceae family with the somatic chromosome number 2n = 2x = 30", [1,2,3]. "The gladiolus is a beautiful cut flower with fascinating spikes and florets of bright colors, attractive shapes and a range of sizes that open up gradually form the bottom to the top. Since the beginning of civilization gladiolus flowers have been connected to people" [4,5,6]. "The path coefficient analysis method splits the correlation coefficients into direct and indirect effects which help in assessing the relative influence of each important character on the ultimate yield and flower quality. Therefore, path coefficient was worked out in gladiolus" [7,8,9,10]. "The correlation between various components and yield can present a confusing picture, for this reason path coefficient affords a much more realistic interpretation of the factor involved" [11,12,13,14]. **"**Gladiolus a native of South Africa, belonging to the family Iridaceae, It is popularly called as "Queen of bulbous" flowers. In Europe it is also known as "corn flag" because *Gladiolus illyricus* a wild species is found growing as weed in the corn fields" [15,16,17,18]. "In India, gladiolus is produced over an area of 9.37 thousand hectares, yielding 707 million spikes" [19,20,21]. "Gladiolus cultivation is ideal according to India's agro climatic conditions. 66,671,000 spikes of cut flowers were produced across an area of 1,460,000 ha, with an output productivity of 45665.07 spikes in India. West Bengal, Himachal Pradesh, Sikkim, Karnataka, Uttar Pradesh, Tamil Nadu, Punjab and Delhi are among the Indian states where it is commercially grown. Having genetic diversity is a requirement for crop enhancement programs. It can therefore be enhanced by employing selection for other features that are highly heritable and related to yield" [22,23,24,25,26].

2. MATERIALS AND METHODS

The experiment was conducted at the Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, during September, 2023 to March, 2024 to find out the best performing variety for this region. The experiment was laid out RBD 3 replication with 20 varieties are given for data recording purpose as different treatment in randomized pattern. The following varieties of gladiolus plant were used for the study Chandini, Friendship, Sunayana, Australia fair, Jyostna, High Hopes, Pusa Manmohak, Suchitra, Pink Parsol, Creamy Green, Bindiya, Pusa Rajat, Shubham, Pusa Shanti, Pusa Red Valentine, Sancerre, Anjali, Swarnima, Hunting Song, Plum tart.

2.1 Statistical Analysis

OPISTAT was used for statistical analysis.

2.1.1 Analysis of variance

The analysis of variance was worked out to test the differences among genotype by F- test.

2.1.1.1 Variability parameter

a) Mean

Mean (X) = Σx/ N

b) Coefficient of variation (CV)

$$PCV = \sqrt{\frac{\text{Phenotypic variance}}{\text{Grand mean}}} \times 100$$

$$GCV = \sqrt{\frac{\text{Genotypic variance}}{\text{Grand mean}}} \times 100$$

c) Heritability (Broad sense)

$$h^2 = (\sigma^2_g \sigma^2_g / \sigma^2_g + \sigma^2_e \sigma^2_p)$$

d) Genetic advance

$$GA = h^{2\cdot} K.\sigma_p$$

e) Correlation coefficient analysis

$$r_{xy}(g) = \sqrt{\frac{C_0 V.\ x_y\,(g)}{r_x\,(g).\ r_y\,(g)}}$$

3. RESULTS AND DISCUSSION

3.1 Analysis of Variance

The analysis of variance for different quantitative characters reviled significant differences among the varieties for parameters like Growth, Spike yield and Vase life with Corms weight/plant (g) of gladiolus. Table 1 the mean values, range, grand mean, coefficient of variation, and critical difference of 20 gladiolus varieties shows for character corms yield/plant (g/plant) exhibited a wide range of variation from 53.16 to 106.72 with a grand mean of 90.55. The highest corms yield/plant (g/plant) of genotype was observed in Friendship (106.72) followed by Chandini and Sunayana. While lowest corms yield/plant (g/plant) was observed for Australia fair (53.16). Patel et al [21] investigation was conducted “to study the relative performance of twenty-four varieties of gladiolus for their growth parameters under Faizabad (U.P., India) conditions. The plants of cultivar Yellow stone, Friendship Pink and Yellow Stone attended maximum height at 30, 60 days after planting and a harvesting stage respectively. The total number of leaves per plant in all cultivars varies from 4.9 to 9.4”.

3.2 Genotypic Coefficient of Variation (GCV) & Phenotypic Coefficient of Variation (PCV)

High magnitude of GCV and PCV were recorded for weight of daughter corm (21.30 and 22.17). While as moderate estimates were observed for plant height (30 das) (11.01), number of leaves per plant at 30 das (14.34), number of leaves per plant at 60 das (10.52), low estimates were observed for plant height (60 das) (8.10), plant height (90 das), floret/spike. (Table 2). Gautam et al*.* [27] resulted “high GCV and PCV were exhibited for number of corm produced per mother corm, corms yield per plant, weight of daughter corm, number of leaves/ plant 30days. Therefore, it is concluded that the characters which showed high GCV, PCV and heritability coupled with genetic advance should be considered for direct selection”. Patel et al.[21] resulted that “the highest GCV and PCV were recorded for the characters *viz.,* weight of daughter corm (g) (33.6786 and 47.569), number of leaves per plant at 30 DAS (25.70 and 37.81), number of leaves per plant at harvest (24.73 and 35.25), number of shoots per plant (25.47 and 31.19), weight of mother corm (25.18 and 33.90), corm weight (25.11 and 33.38), days taken for corm sprouting (23.7566 and 23.7566) and the lowest GCV and PCV were recorded for floret diameter (17.50 and 40.95”). The high heritability in broad sense was observed for the characters viz. corm weight / plot (g) (94.04), weight of daughter corm (92.35), days taken for corm sprouting (87.44), spike length (cm) (85.76), (Table 2) Chandra et al.[28] reported “heritability estimates ranged from 33.91 (number of spikes per plant) to 99.01 (spike weight)and resulted high heritability values observed, suggested that additive gene action may exist and thatsimple selection for such traits may be used to improve them. weight of mother corm / plot (g) (85.83), corm yield/plant (g) (85.16), vase life (days) (84.94), no. of days taken for first floret open (84.39), no. of days taken for last floret open (83.22), number of leaves per plant at 30 das (81.19), no. of cormels per hectare (76.60) and no. of corm per hectare (71.49)”. Vinutha et al. [29] reported that “highest heritability estimates was recorded in spike length (99.95%), plant height (99.86%) and days for first floret opening (99.77%). The genetic advance estimates were found to be high for no. of cormels per hectare (1504937.09), no. of corm per hectare (49395.96), weight of mother corm / plot (g) (180.77), corm weight / plot (g) (161.33), no. of days taken for first floret open (25.49) and corm

Table 1. Analysis of variance for 25 different growth, flowering and corm yield of Gladiolus

Sl.No.	Source	Mean Sum of Squares (MSS)		
		Replication	Treatment	Error
	Degrees of freedom	2	19	38
1	Plant height (30 das)	4.912	36.127**	7.059
2	Plant height (60 das)	24.233	43.943**	16.075
3	Plant height (90 das)	3.172	111.729**	36.064
4	Number of leaves per plant at 30 DAS	0.051	0.908**	0.065
5	Number of leaves per plant at 60 DAS	0.202	1.25**	0.253
6	Number of leaves per plant at 90 DAS	1.322	1.485**	0.58
7	no. of shoots per plant	0.004	0.038**	0.008
8	Days taken for corm sprouting	0.109	1.892**	0.086
9	Rachis length (cm)	1.363	48.43**	11.475
10	Days for spike emergence	73.087	94.368**	23.237
11	Days for colour break stage	7.336	114.776**	27.784
12	No. of Floret Per Spike	1.467	1.157*	0.598
13	No. of spike per plant	0.01	0.02**	0.008
14	No. of Days taken for first floret open	5.607	577.573**	33.533
15	No. of days taken for last floret open	0.067	0.846**	0.053
16	Floret diameter (cm)	0.523	2.349**	0.793
17	Spike length (cm)	13.608	143.572**	7.531
18	Vase life (days)	0.028	0.829**	0.046
19	Corm weight / plot (g)	77.374	19979.855**	413.734
20	Weight of mother corm / plot (g)	646.608	28398.436**	1481.626
21	Weight of daughter corm	13.674	4104.191**	110.339
22	Corm diameter (cm)	0.01	0.341**	0.073
23	No. of corm per hectare	213478736.9	2733461294.803**	320704977.8
24	No. of cormels per hectare	21668047983	2303022142403.61**	2.12825E+11
25	Corm Yield/Plant (g)	48.507	396.926**	21.784

** Significant at 5% ; ** Significant at 1%*

yield/plant (g) (21.26)". Similarly, Naresh et al. (2015) found "high heritability coupled with high genetic advance as per cent of mean was noticed in plant height at maturity, number of cormels per plant, number of corms per plant, days taken to sprouting of corm and weight of corm and cormels per plant". The genetic advance as mean percentage estimates (Table 2) were found to be high for number of leaves per plant at 30 das (23.98), days taken for corm sprouting (31.00), no. of days taken for first floret open (34.07), corm weight / plot (g) (22.24), weight of mother corm / plot (g) (30.54), weight of daughter corm (42.17), no. of corm per hectare (20.87), no. of cormels per hectare (25.21) and corm yield/plant (g) (23.48). Singh et al. [30] found "high heritability coupled with high genetic advance as a percentage of the mean for traits such as the number of leaves at 30DAS, corm yield per plant, number of cormels per hectare, cormel diameter, number of corms per hectare, and number of corms per plant. This suggests that these traits are under strong genetic control and have the potential for effective selection and improvement".

3.3 Correlation Coefficient

Genotypic and phenotypic correlation coefficient analysis(Table 3a,b) revealed that Corms weight/plant (g) showed positive significant association with plant height, number of leaves per plant, number of shoots per plant, rachis length (cm), no. of floret per spike, no. of spike per plant, floret diameter (cm), spike length (cm), vase life, corm weight per plot (g), weight of mother corm per plot, weight of daughter corm, corm diameter (cm), no. of corm per hectare, no. of cormels per hectare and corm yield/plant at both levels genotypic and phenotypic. Similar

results were also observed in the experiment conducted by [22] studied "the correlation analysis which was carried out among 22 diverse varieties of gladiolus for 20 characters related to growth and flowering. It showed positively significant association with plant height, which ultimately increases the rachis length, thereby increasing the value of the genotype". Sirohi et al*.,* (2001), observed "positive correlation in number of florets per spike with number of florets remain open at a time (0.537), plant height (0.792), spike length (0.544) and rachis length (0.656)". "The results of correlation coefficient reveal that for yield improvement through selection, much emphasis should be given on the characters like spike yield, corm yield, plant height, spike length, days to spike initiation and days to floret initiation" Pattanaik et al. (2015).

Table 2. Estimation of component of variance and genetic parameters for growth, flowering and corm yield of 20 varieties in Gladiolus

Sl.No.	Characters	GCV	PCV	h2 (Broad Sense)	Genetic Advancement 5%	Gen.Adv as % of Mean 5%
1	Plant height (30 das)	8.38	11.01	57.85	4.88	13.12
2	Plant height (60 das)	4.90	8.10	36.62	3.80	6.11
3	Plant height (90 das)	4.67	7.28	41.16	6.64	6.17
4	Number of leaves per plant at 30 DAS	12.92	14.34	81.19	0.98	23.98
5	Number of leaves per plant at 60 DAS	7.93	10.52	56.80	0.90	12.31
6	Number of leaves per plant at 90 DAS	5.77	9.86	34.23	0.66	6.95
7	no. of shoots per plant	7.47	10.00	55.79	0.15	11.49
8	Days taken for corm sprouting	16.09	17.21	87.44	1.49	31.00
9	Rachis length (cm)	6.80	9.45	51.77	5.20	10.07
10	Days for spike emergence	6.68	9.40	50.50	7.13	9.78
11	Days for colour break stage	6.76	9.46	51.07	7.93	9.95
12	No. of Floret Per Spike	4.08	8.36	23.77	0.43	4.09
13	No. of spike per plant	5.46	9.38	33.91	0.08	6.55
14	No. of Days taken for first floret open	18.00	19.60	84.39	25.49	34.07
15	No. of days taken for last floret open	4.72	5.17	83.22	0.97	8.86
16	Floret diameter (cm)	5.70	9.06	39.56	0.93	7.39
17	Spike length (cm)	6.42	6.94	85.76	12.85	12.25
18	Vase life (days)	5.80	6.29	84.94	0.97	11.00
19	Corm weight / plot (g)	11.13	11.48	94.04	161.33	22.24
20	Weight of mother corm / plot (g)	16.00	17.27	85.83	180.77	30.54
21	Weight of daughter corm	21.30	22.17	92.35	72.23	42.17
22	Corm diameter (cm)	7.08	9.54	55.04	0.46	10.81
23	No. of corm per hectare	11.98	14.17	71.49	49395.96	20.87
24	No. of cormels per hectare	13.98	15.98	76.60	1504937.09	25.21
25	Corm Yield/Plant (g)	12.35	13.38	85.16	21.26	23.48

Table 3a Estimates of genotypic correlation coefficient for Growth characters, Spike yield and vase life with Corms weight/plant (g)

	Plant height	Number of leaves per plant	Number of shoots per plant	Days taken for corm sprouting	Rachis length (cm)	Days for spike emergence	Days for colour break stage	No. of Floret Per Spike	No. of spike per plant	No. of Days taken for first floret	No. of days taken for last floret	Floret diameter (cm)	Spike length (cm)	Vase life	Corm weight per plot (g)	Weight of mother corm per plot	Weight of daughter corm	Corm diameter (cm)	No. of corm per hectare	No. of cormels per hectare	Corm Yield/Plant
Plant height	1	0.574**	0.474**	-0.629**	0.440**	-0.461**	-0.461**	0.386*	0.426**	-0.525**	-0.428**	0.448**	0.521**	0.586**	0.571**	0.512**	0.359*	0.541**	0.565**	0.444**	0.442**
Number of leaves per plant		1	0.565**	-0.787**	0.652**	-0.547**	-0.557**	0.453**	0.432**	-0.753**	-0.596**	0.575**	0.565**	0.671**	0.676**	0.641**	0.462**	0.680**	0.628**	0.469**	0.691**
Number of shoots per plant			1	-0.618**	0.576**	-0.513**	-0.622**	0.452**	0.456**	-0.629**	-0.604**	0.557**	0.557**	0.659**	0.528**	0.582**	0.578**	0.573**	0.604**	0.488**	0.566**
Days taken for corm sprouting				1	-0.708**	0.669**	0.669**	-0.541**	-0.524**	0.760**	0.750**	-0.643**	-0.759**	-0.834**	-0.752**	-0.686**	-0.574**	-0.769**	-0.757**	-0.583**	-0.713**
Rachis length (cm)					1	-0.526**	-0.575**	0.320*	0.496**	-0.725**	-0.661**	0.581**	0.678**	0.705**	0.707**	0.612**	0.537**	0.646**	0.656**	0.515**	0.626**
Days for spike emergence						1	0.668**	-0.459**	-0.476**	0.550**	0.585**	-0.633**	-0.663**	-0.683**	-0.602**	-0.539**	-0.544**	-0.684**	-0.668**	-0.613**	-0.601**
Days for colour break stage							1	-0.456**	-0.452**	0.494**	0.584**	-0.554**	-0.642**	-0.697**	-0.614**	-0.584**	-0.568**	-0.679**	-0.698**	-0.643**	-0.514**
No. of Floret Per Spike								1	0.280*	-0.483**	-0.475**	0.398*	0.400*	0.525**	0.509**	0.394*	0.455**	0.458**	0.420**	0.348*	0.438**
No. of spike per plant									1	-0.503**	-0.413*	0.440**	0.524**	0.587**	0.463**	0.409*	0.375*	0.487**	0.536**	0.350*	0.432**
No. of Days taken for first floret										1	0.608**	-0.591**	-0.570**	-0.656**	-0.646**	-0.525**	-0.441**	-0.565**	-0.645**	-0.381*	-0.568**
No. of days taken for last floret											1	-0.519**	-0.744**	-0.819**	-0.771**	-0.730**	-0.673**	-0.696**	-0.727**	-0.685**	-0.765**
Floret diameter (cm)												1	0.634**	0.615**	0.683**	0.588**	0.512**	0.693**	0.635**	0.505**	0.534**
Spike length (cm)													1	0.776**	0.858**	0.730**	0.709**	0.668**	0.831**	0.820**	0.728**
Vase life														1	0.780**	0.751**	0.588**	0.767**	0.781**	0.750**	0.692**
Corm weight per plot (g)															1	0.825**	0.706**	0.665**	0.711**	0.791**	0.773**
Weight of mother corm per plot																1	0.585**	0.664**	0.650**	0.711**	0.761**
Weight of daughter corm																	1	0.548**	0.594**	0.599**	0.684**
Corm diameter (cm)																		1	0.801**	0.576**	0.634**
No. of corm per hectare																			1	0.730**	0.691**
No. of cormels per hectare																				1	0.641**
Corm Yield/Plant																					1

Table 3b Estimates of phenotypic correlation coefficient for Growth, Spike yield and Vase life with Corms weight/plant (g)

	Plant height	Number of leaves per plant	Number of shoots per plant	Days taken for corm sprouting	Rachis length (cm)	Days for spike emergence	Days for colour break stage	No. of Floret Per Spike	No. of spike per plant	No. of Days taken for first floret	No. of days taken for last floret	Floret diameter (cm)	Spike length (cm)	Vase life	Corm weight per plot (g)	Weight of mother corm per plot	Weight of daughter corm	Corm diameter (cm)	No. of corm per hectare	No. of cormels per hectare	Corm Yield/Plant
Plant height	1	0.585**	0.472**	-0.637**	0.447**	-0.486**	-0.469**	0.423**	0.428**	-0.525**	-0.434**	0.449**	0.518**	0.588**	0.573**	0.510**	0.361*	0.540**	0.562**	0.448**	0.447**
Number of leaves per plant		1	0.572**	-0.790**	0.652**	-0.553**	-0.558**	0.451**	0.447**	-0.757**	-0.600**	0.581**	0.576**	0.677**	0.679**	0.647**	0.462**	0.685**	0.638**	0.469**	0.694**
Number of shoots per plant			1	-0.628**	0.583**	-0.521**	-0.631**	0.475**	0.470**	-0.629**	-0.615**	0.554**	0.559**	0.665**	0.531**	0.582**	0.580**	0.573**	0.605**	0.490**	0.565**
Days taken for corm sprouting				1	-0.708**	0.700**	0.668**	-0.560**	-0.525**	0.764**	0.749**	-0.658**	-0.764**	-0.835**	-0.754**	-0.691**	-0.577**	-0.773**	-0.763**	-0.586**	-0.727**
Rachis length (cm)					1	-0.542**	-0.574**	0.324*	0.503**	-0.728**	-0.662**	0.590**	0.684**	0.707**	0.707**	0.615**	0.537**	0.650**	0.661**	0.516**	0.632**
Days for spike emergence						1	0.693**	-0.439**	-0.536**	0.565**	0.619**	-0.634**	-0.702**	-0.716**	-0.623**	-0.556**	-0.555**	-0.707**	-0.700**	-0.623**	-0.598**
Days for colour break stage							1	-0.467**	-0.455**	0.497**	0.582**	-0.567**	-0.648**	-0.698**	-0.615**	-0.588**	-0.570**	-0.684**	-0.705**	-0.645**	-0.523**
No. of Floret Per Spike								1	0.326*	-0.503**	-0.497**	0.409*	0.439**	0.554**	0.530**	0.417**	0.466**	0.483**	0.455**	0.353*	0.442**
No. of spike per plant									1	-0.511**	-0.409*	0.465**	0.521**	0.586**	0.466**	0.414*	0.383*	0.492**	0.537**	0.360*	0.458**
No. of Days taken for first floret										1	0.613**	-0.593**	-0.571**	-0.658**	-0.646**	-0.524**	-0.441**	-0.564**	-0.645**	-0.382*	-0.570**
No. of days taken for last floret											1	-0.534**	-0.748**	-0.819**	-0.773**	-0.736**	-0.677**	-0.701**	-0.732**	-0.689**	-0.781**
Floret diameter (cm)												1	0.644**	0.626**	0.689**	0.590**	0.514**	0.696**	0.641**	0.507**	0.529**
Spike length (cm)													1	0.777**	0.860**	0.731**	0.714**	0.668**	0.830**	0.827**	0.741**
Vase life														1	0.781**	0.753**	0.590**	0.768**	0.782**	0.753**	0.703**
Corm weight per plot (g)															1	0.825**	0.706**	0.666**	0.712**	0.792**	0.780**
Weight of mother corm per plot																1	0.586**	0.663**	0.649**	0.713**	0.765**
Weight of daughter corm																	1	0.549**	0.597**	0.599**	0.686**
Corm diameter (cm)																		1	0.801**	0.578**	0.638**
No. of corm per hectare																			1	0.735**	0.700**
No. of cormels per hectare																				1	0.642**
Corm Yield/Plant																					1

4. CONCLUSION

Based on the present investigation it was concluded that the high magnitude of heritability (in broad sense) coupled with high genetic gain was observed for most of traits exhibiting additive genetic effect. The analysis of variance for different quantitative characters reviled significant differences among the varieties for parameters like Growth, Spike yield and Vase life with Corms weight/plant (g) of gladiolus. The highest corms yield/plant (g/plant) of genotype was observed in Friendship (106.72) followed by Chandini and Sunayana. It was observed that PCV was higher than GCV for all the traits studied highest GCV and PCV is recorded as weight of daughter corm (21.30 and 22.17). In the present study the heritability estimates in broad sense were classified into 3 groups such as high (>75%), moderate (60% - 75%), low (<60%). The heritability estimates were found to be high (more than 75%). Genotypic and phenotypic correlation coefficient analysis revealed that corms weight/plant (g) showed positive significant association with plant height, number of leaves per plant, number of shoots per plant, rachis length (cm), no. of floret per spike, no. of spike per plant, floret diameter (cm), spike length (cm), vase life, corm weight per plot (g), weight of mother corm per plot, weight of daughter corm, corm diameter (cm), no. of corm per hectare, no. of cormels per hectare and corm yield/plant at both levels genotypic and phenotypic. Revealed that the highest direct positive effect on Corm Yield/Plant was exhibited by number of leaves per plant, number of shoots per plant, rachis length (cm), days for colour break stage, mno. of floret per spike, no. of spike per plant, no. of days taken for first floret, corm weight per plot (g), weight of mother corm per plot, weight of daughter corm and no. of corm per hectare at both levels of genotypic and phenotypic.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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