Journal Crop and Weed, 11(1):113-119(2015)

Genotypic and phenotypic variability and correlation studies in gladiolus

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Received: 25-06-2014, Revised: 02-05-2015, Accepted: 04-05-2015

ABSTRACT

The genetic variability and characters association of different quality parameters were studied in 29 gladiolus genotypes grown in a two year field experiments. High and moderate to high GCV and PCV were recorded for almost all the characters under study emphasizing the existence of variation in the population. High estimates of heritability coupled with high and moderate to high genetic gain (expressed as per cent of mean) for corm weight, spike weight, number of corms plant^{-1}, number of spikes bulb^{-1}, and number of spikesm^{-2} indicate the predominance of additive gene action for the expression of these characters, and therefore, these are more reliable for effective selection. The results of PCV, GCV, heritability and genetic advance reveal that selection for corm weight, spike weight, number of corms per plant, number of spikesbulb^{-1} and number of spikes m^{-2} would be effective for improvement of spike yield and corm yield whereas selection for rachis length and floret diameter would be effective for improving flowering attributes. Correlation at genotypic and phenotypic levels showed similar trend but genotypic correlation was of higher magnitude than phenotypic correlation in most of the cases indicating the association between the characters is mainly due to the genotype. 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.

Keywords: Correlation, GCV, gladiolus, heritability, PCV

Gladiolus (*Gladiolus grandiflorus* L.), generally called “glad” is the second most important cut flowers grown from storage organs. Gladiolus was named for the shape of its leaves, and stems from the Latin word gladius, meaning “sword”. Gladiolus was also called “Xiphium”, from the Greek word Xiphos, also meaning sword. Hence, it is known as the “Sword Lily” or “Corn Lily”. Gladiolus belongs to family Iridaceae and was originated in tropical region of South Africa. The Centre of origin of the genus is located in the Cape Florist Region, where most species were discovered. Gladiolus was introduced into cultivation during 19th Century in India. Gladiolus is a tender herbaceous perennial, grown from seeds and corms. The corms produce a number of cormels or offsets, sometimes called as spawn. It is cultivated year round and grows better in cooler climate at elevations of 700-3000 m above the mean sea level. It is mainly cultivated in Karnataka, West Bengal, Maharashtra, Punjab, Haryana, Uttar Pradesh, Tamil Nadu, Jammu and Kashmir, Uttarakhand, Delhi, Sikkim, Himachal Pradesh and Odisha. In Odisha, it is cultivated in 2350 ha with the production of 2329 lakh spikes (DOH, 2012).

To improve the production and productivity of gladiolus flowers, the primary consideration should be to bring about genetic improvement of the crop and development of superior varieties by selection among and within the population through the use of scientific breeding programme based upon the available genetic variability. It is, therefore, essential to assess the quantum of genetic variability, nature of character association with respect to different characters, which would help plant breeders in planning a successful breeding programme. The present investigation was, therefore, undertaken with a view to assess the nature of variability, heritability and genetic advance and to determine the nature of association (at genotypic and phenotypic levels) of different quantitative parameters of gladiolus flower itself and among themselves through correlation and to understand how the spike yield and corm yield are influenced by its different component characters.

An attempt has therefore been made to study the genotypic and phenotypic correlation coefficients among different quantitative characters and to understand how the spike yield and corm yield are influenced by its different component characters

MATERIALS AND METHODS

The experimental materials for present studies consisting 29 diverse genotypes of gladiolus were sown at the experimental field of Krishi Vigyan Kendra, Mayurbhanj (North Central Plateau Agro-Climatic

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Zone), OUAT, Bhubeneswar (21° 16′ to 22° 34′ N and 85° 40′ to 87° 11′ E and 592 m msl), Odisha during two consecutive post-rainy seasons (2009-10 and 2010-11). The soil type of the experimental site was clay loam with organic carbon content of 5.3% with low pH 5.42. The genotypes under present study were collected from BCKV, West Bengal and Directorate of Horticulture, Government of Odisha, Mayurbhanj. The experiment was arranged in randomized complete block design with two replications. The bulbs were planted at the spacing of 30 cm row to row and 20 cm plant to plant. All the recommended package and practices and protective measures were duly followed during the crop growing period for raising a healthy crop.

Data were recorded for yield and its twenty contributing traits *viz.* days to sprouting, plant height at 30 and 60 DAP, number of leaves, days to spike initiation, days to floret initiation, flowering duration, spike length, rachis length, number of florets spike^{-1}, floret diameter, spike weight, number of corms plant^{-1}, number cormels plant^{-1}, corm diameter, corm weight, number of spikes bulb^{-1},, number of spikes m^{-2}, spike yield, corm yield. Data on days to sprouting, days to spike initiation, days to floret initiation, flowering duration were recorded on whole plot basis. Ten randomly selected plants from each plot were earmarked for the purpose of recording data excluding the border plants.

Data collected during the two growing seasons on these traits were pooled, and analysis of variance was done as suggested by Panse and Sukhatme (1978). Variability was estimated following Burton and De Vanae (1953). Heritability and genetic advance were calculated according to Hanson *et al.* (1956) and Johnson *et al.* (1955), respectively. Genotypic and phenotypic correlation coefficients among twenty parameters were also estimated as per the procedure suggested by Johnson *et al.* (1955) and Al. Jibouri *et al.* (1958) to study how these component characters under study influence spike yield and corm yield. The software used for the statistical analysis was Windostat version 8.6 from Indostat services.

RESULTS AND DISCUSSION

The analysis of variance revealed that all the characters exhibited highly significant difference among the genotypes, which was evident from the higher range for all the characters (Table 1). The estimates of PCV and GCV values for all the characters under study were almost same indicating little influence of environment and consequently greater role of genetic factors influencing the expression of these characters.

The estimates of GCV and PCV respectively were high (> 20 %) for number of cormels per plant, corm diameter, individual corm weight, corm yield, spike yield, plant height at 30 DAP, rachis length, spike weight, number of corms per plant, number of spikes per bulb, number of spikes per m^2, and medium(10 - 20 %) for days to sprouting, plant height at 60 DAP, days to spike initiation, days to floret initiation, flowering duration, spike length, number of florets spike^{-1}, floret diameter and low(< 10%) for number of leaves.

In the present study, most of the characters exhibited high to moderate PCV and GCV values, while no. of leaves plant^{-1} exhibited low GCV and PCV, emphasizing the existence of variation. Similar results of low PCV and GCV for the characters like days to flowering, number of leaves and number of florets were also observed earlier by Soorianthsundaram and Nambisan (1991). GCV was recorded maximum for the characters like corm weight, spike weight and corm diameter (Maitra and Satya , 2004). Anuradha and Gowda (1990) reported high PCV and GCV for rachis length and low for number of spike, floret diameter, floret length and number of leaves. Balaram (2000) reported that both PCV and GCV were high for characters like plant height, spike length, spike weight, weight of daughter corm and number of cormels per corm. The high value of PCV along with GCV indicates that there is more variability in the characters like corm weight and spike weight. Balamurugan (2002) noticed high GCV in gladiolus for number of side shoots, whereas low for longevity of individual florets and duration of first floret. Bichoo (2002) reported high GCV for number of cormels per plant. Pratap and Mohan Rao (2006) observed maximum GCV for characters like plant height, number of florets per spike and days to flowering.

The genotypic coefficient of variation does not offer full scope to estimate the variation that is heritable, and therefore, estimation of heritability becomes necessary. The magnitude of heritability ranged from 99.88% (plant height at 30 DAS) to 52.93% (days to sprouting). Except for characters like days to sprouting and number of cormels plant^{-1}, where heritability estimates were low (52.93%) or moderate (70.12%), respectively, all the other characters under study showed high amount of heritability (84.95% to 99.88%). High heritability suggests the major role of genetic constitution in the expression of characters, and such traits are considered to be dependable from breeding point of view. However, the estimates of heritability alone are not sufficient for predicting the effect of selection. According to Johnson *et al.* (1955) heritability used in conjunction with genetic advance provides better information for selecting the best individuals than the heritability alone. Heritability estimate and genetic advance as percentage of mean also throw light on the nature of gene action controlling the inheritance of a character (Panse, 1957). The value of genetic advance as per cent of mean (genetic gain) ranged from 12.26 (days to sprouting) to 103.26 (yield of corms). Corm weight and spike weight showed high heritability (98.44 % and 95.91 %) along with high genetic advance as percentage of mean (103.26 % and 95.55 %, respectively). Rachis length (98.36 % and 59.8 %), spike weight (99.64 % and 64.46 %), number of corms plant^{-1} (84.95% and 44.8%), number of spikes bulb^{-1} (88.3 % and 42.59 %), number of spikes m^{-2} (88.3 % and 42.59 %) also exhibited high heritability coupled with high to moderate genetic advance as percentage of mean. Above results indicate the predominance of additive gene action for these traits and early generation selection could be practical to improve these characters due to reliability of additive gene action for selection. Days taken to sprouting exhibited low amount of heritability with low genetic advance (52.93 % and 12.26 %) indicating importance of non-additive gene effects. In the present study, high heritability (e" 90 %) observed in plant height, days to spike initiation, days to floret initiation, spike length, rachis length along with genetic advance more than 100% in corm weight gives an indication for improvement of these crops. The present findings are in accordance with the findings of Anuradha and Gowda (1990), Sorianathasundaram and Nambisan (1991), Mahanta and Paswan (1995), Sheikh *et al*. (1995), Balaram *et al*. (2000), Deepti (2000), Balamurugan *et al.* (2002), Bichoo *et al.* (2002), and Pratap and Rao (2006).

High estimates of heritability accompanied with high to moderate genetic advance for corm weight, spike weight, number of corms plant^{-1}, number of spikes bulb^{-1}, and number of spikes m^{-2} indicate the predominance of additive gene action for the expression of these characters (Johnson *et al*., 1955; Panse, 1957). Hence, selection for the above characters would be effective for improvement of yield in this population.

A perusal of the table 1, wherein the results of PCV, GCV, heritability and genetic advance have been furnished, revealed that selection for corm weight, spike weight, number of corms plant^{-1}, number of spikes bulb^{-1}, number of spikes m^{-2} would be effective for improvement of spike yield and corm yield, whereas selection for rachis length and floret diameter would be effective for improving flowering attributes.

Correlation measures the degree of association between the characters which ensure simultaneous improvement in one or two or more variables and negative correlation bring out the need to obtain a compromise between the desirable traits. High correlations between two characters indicated that selection for the improvement of one character leads to the simultaneous improvement in the other character depending upon the magnitude of association between them. Yield is a complex character resulting from complex interaction of several yield components. The yield characters are interrelated, therefore, the change in any character, brings about a series of changes in other characters. Thus to bring about a change in the yield or in the other characters to a desired level, an understanding of associations between the yield and yield contributing characters is essential. An estimate of genotypic and phenotypic correlation coefficient among different pairs of characters under study is presented in table 2. The genotypic and phenotypic correlations showed similar trend but genotypic correlation were at higher magnitude than phenotypic correlation in most of the cases. Very close values of genotypic and phenotypic correlation were also observed between some characters combinations that might be due to reduction in error (environmental) variance to minor proportions as reported by Dewey and Lu (1959). The spike weight (g) exhibited highly significant and positive (genotypic and phenotypic) correlation coefficients with number of spikes bulb^{-1} (0.510 and 0.480), spike yield (q ha^{-1}) (0.882 and 0.865) both at genotypic and phenotypic levels. The number of corms plant^{-1} was positively correlated at both genotypic and phenotypic level with number of cormels plant^{-1}, corm diameter number of spikes bulb^{-1}, corm yield and spike yield. The number of spikes bulb^{-1} exhibited highly significant positive correlation at both genotypic and phenotypic level with spike yield, but had significantly negative association with corm yield and corm diameter. It was also positively and significantly correlated with spike weight both at genotypic and phenotypic level. The number of spikes m^{-2}exhibited highly significant positive association both at genotypic and phenotypic levels with spike yield indicating the importance of these characters for yield improvement. The corm diameter was also significantly and positively correlated with corm yield (q ha^{-1}) suggesting of getting good spike yield by planting the bigger corms. The corm yield (q ha^{-1}) was found significantly and negatively correlated with corm

Table 1: Genotypic and phenotypic coefficient of variability, heritability and genetic advance for 20 quantitative characters of gladiolus

		Test of significance	Range		Grand Mean	Coefficient of variation (%)		Heritability %	Genetic advance %	Genetic advance as % of mean
Characters				Min	Max		PCV	GCV		
1.	Days to sprouting	1.26*	6.00	8.75	7.06	11.25	8.18	52.93	0.87	12.26
2.	Plant height at 30 days (cm)	321.23**	37.45	90.27	61.62	20.57	20.56	99.88	26.08	42.32
3.	Plant height at 60 days (cm)	658.97**	57.00	159.25	105.76	17.16	17.12	99.47	37.20	35.17
4.	No. of leaves	0.84**	6.00	8.75	7.62	8.52	7.99	88.01	1.18	15.44
5.	Days to spike initiation	208.75**	45.50	82.00	62.56	16.33	16.28	99.33	20.90	33.41
6.	Days to floret initiation	197.41**	61.00	91.00	72.59	13.69	13.62	99.01	20.26	27.91
7.	Flowering duration (days)	16.31**	17.00	28.25	22.30	12.81	12.52	95.59	5.62	25.22
8.	Spike length (cm)	163.14**	39.50	82.00	63.66	14.19	14.14	99.28	18.47	29.01
9.	Rachis length (cm)	79.19**	8.25	31.50	21.32	29.52	29.27	98.36	12.75	59.80
10.	No. of florets spike^{-1}	15.27**	9.50	20.00	14.91	18.53	17.89	93.26	5.31	35.59
11.	Floret diameter (cm)	1.74**	4.05	7.28	5.45	17.12	16.53	93.22	1.79	32.88
12.	Spike weight (g)	320.66**	18.25	65.85	40.32	31.41	31.35	99.64	25.99	64.46
13.	No. of corms plant^{-1}	0.44**	1.00	3.00	1.83	25.60	23.60	84.95	0.82	44.80
14.	No. of cormels plant^{-1}	0.85**	0.00	2.50	1.43	45.42	38.03	70.12	0.94	65.60
15.	Corm diameter (cm)	79.92**	6.50	28.80	14.36	44.01	43.63	98.31	12.80	89.12
16.	Corm weight (g)	196.94**	6.20	46.63	19.63	50.55	50.02	97.92	20.02	101.96
17.	No. of spikes bulb^{-1}	0.19**	0.90	1.81	1.30	23.41	22.00	88.30	0.56	42.59
18.	No. of spikes m^{-2}	47.62**	14.40	28.96	20.84	23.41	22.00	88.30	8.88	42.59
19.	Yield of corms (q ha^{-1})	330.31**	7.95	59.68	25.24	50.92	50.52	98.44	26.06	103.26
20.	Yield of spikes (q ha^{-1})	2286.10**	28.48	139.05	69.90	48.36	47.36	95.91	66.80	95.55

Note: ** Significant at 5 % level, ** Significant at 1 % level*

Table 2: Genotypic (g) and phenotypic (p) correlation coefficient of 20 quantitative characters in gladiolus

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	rg		0.061	0.05	0.525*	0.263	0.319	-0.492*	-0.278	-0.161	0.262	0.191	-0.328	-0.054	-0.198	0.22	0.23	-0.171	-0.171	0.238	-0.267
	rp		0.041	0.036	0.315	0.185	0.241	-0.345	-0.197	-0.116	0.211	0.099	-0.234	-0.012	-0.172	0.166	0.158	-0.107	-0.107	0.156	-0.189
2	rg			0.490*	0.181	-0.471*	-0.528*	-0.042	0.358	0.294	0.144	0.403*	0.044	-0.140	0.154	0.194	0.21	-0.031	-0.031	0.219	-0.017
	rp			0.488*	0.172	-0.469*	-0.524*	-0.042	0.357	0.292	0.14	0.389	0.043	-0.130	0.124	0.192	0.208	-0.026	-0.026	0.217	-0.018
3	rg				0.321	-0.09	-0.225	0.109	0.655**	-0.074	0.323	0.182	-0.222	-0.401*	-0.342	-0.246	-0.228	-0.236	-0.236	-0.222	-0.284
	rp				0.3	-0.09	0.222	0.104	0.651**	-0.072	0.308	0.177	-0.22	-0.368	-0.286	-0.241	-0.277	-0.222	-0.222	-0.219	-0.278
4	rg					0.152	0.11	-0.13	-0.044	-0.065	0.124	-0.134	-0.031	-0.237	-0.531*	-0.294	-0.277	0.101	0.101	-0.282	0.061
	rp					0.146	0.112	-0.128	-0.04	-0.059	0.101	-0.123	-0.024	-0.24	-0.385	-0.274	-0.266	0.096	0.096	-0.264	0.061
5	rg						0.969**	0.171	-0.112	-0.506*	-0.23	-0.096	-0.017	0.027	-0.172	-0.059	-0.147	0.121	0.121	-0.154	0.072
	rp						0.962**	0.168	-0.112	-0.56*	-0.222	-0.091	-0.017	0.02	-0.154	-0.057	-0.148	0.113	0.113	-0.154	0.069
6	rg							0.128	-0.216	-0.49*	-0.232	-0.138	0.023	0.09	-0.129	-0.043	-0.107	0.158	0.158	-0.116	0.128
	rp							0.124	-0.215	-0.481	-0.222	-0.134	0.023	0.08	-0.111	-0.041	-0.109	0.148	0.148	-0.117	0.124
7	rg								0.371	0.058	-0.18	-0.266	0.287	-0.01	-0.115	-0.148	-0.232	0.166	0.166	-0.229	0.258
	rp								0.36	0.049	-0.18	-0.257	0.278	-0.011	-0.106	-0.143	-0.22	0.15	0.15	-0.221	0.241
8	rg									0.245	0.286	0.107	0.174	-0.382	-0.173	-0.091	-0.141	-0.067	-0.067	-0.133	0.04
	rp									0.242	0.276	0.098	0.173	-0.339	-0.143	-0.089	-0.137	-0.06	-0.06	-0.13	0.04
9	rg										0.337	0.024	0.395	0.241	0.316	0.157	0.153	0.074	0.074	0.162	0.289
	rp										0.33	0.033	0.393	0.214	0.261	0.153	0.149	0.075	0.075	0.159	0.283
10	rg											0.291	0.005	0.174	-0.236	0.020	0.05	-0.132	-0.132	0.04	-0.118
	rp											0.279	0.005	0.166	-0.184	0.017	0.047	-0.114	-0.114	0.037	-0.102
11	rg												0.029	0.272	0.131	0.149	0.179	0.074	0.074	0.177	-0.004
	rp												0.028	0.224	0.103	0.142	0.174	0.079	0.079	0.175	0.008
12	rg													0.263	0.168	-0.213	-0.278	0.510*	0.510*	-0.282	0.882**
	rp													0.235	0.14	-0.211	0.277	0.480*	0.480*	-0.28	0.865**
13	rg														0.041	0.137	0.216	0.365	0.365	0.218	0.316
	rp														0.031	0.116	0.199	0.307	0.307	0.201	0.265
14	rg															0.506*	0.449*	0.036	0.036	0.454*	0.131
	rp															0.409*	0.386	0.004	0.004	0.396	0.081
15	rg																0.967**	-0.412*	-0.412	0.967**	-0.361
	rp																0.947**	-0.382	-0.382	0.949**	-0.347
16	rg																	-0.418*	-0.418*	1.000**	-0.400*
	rp																	-0.383	-0.383	0.998**	-0.389
17	rg																		1	-0.413*	0.841**
	rp																		1	-0.413	0.828**
18	rg																			-0.413	0.841**
	rp																			-0.379	0.828**
19	rg																				-0.400*
	rp																				0.390
20	rg																				1.00
	rp																				1.00

Note : *1. Days to sprouting 2. Plant height at 30 days(cm) 3. Plant height at 60 days (cm) 4. No. of leaves plant^{-1} 5. Days to spike initiation 6. Days to floret initiation 7. Flowering duration 8. Spike length 9. Rachis length 10. No. of floretsspike^{-1} 11. Floret diameter 12. Spike weight (g) 13. No. of corms plant^{-1} 14. No. of cormels plant^{-1} 15. Corm diameter (cm) 18. No. of spikes m^{-2} 16. Corm weight (g) 17. No. of spikes bulb^{-1} 19. Corm yield (q ha^{-1}) 20. Spike yield (q ha^{-1}) *Significant at 5%; **Significant at 1%*

weight and spike yield at genotypic level. It is to be mentioned here that negative association may arise primarily from developmentally induced relationship (Adams, 1967). The developing structures of plant competing for a common factor, possibly limit the nutrient supply and if one structure is more favoured than the other for any reason, a negative correlation may arise in between them. Component compensation of parents allows an opportunity to have reasonable compromise and balance between one or two components resulting high yield. The optimal genetic level for each component would differ depending on the type of the environment encountered (Grafius, 1965). Pleiotropy and /or linkage may also be genetic reasons for this type of negative association. The pleiotropy that affects both characters in the desired direction will be strongly acted upon by selection pressure and rapidly brought towards fixation. The present findings are also in agreement with the findings of Patil *et al.* (2004) and Sheikh *et al*. (2006). Wide difference between genotypic and phenotypic correlations between two characters is due to dual nature of phenotypic correlation, which is determined by genotypic and environmental correlation and heritability of the character (Falconer, 1981). The results of correlation coefficient in the present investigation implies that spike yield and corm yield are the two most important characters which should be considered for yield improvement of gladiolus population.

The height of the plant at 60 days was significantly and positively associated with spike length at both genotypic and phenotypic levels. It was observed that plant height was negatively correlated with corm yield and spike yield at both phenotypic and genotypic levels. In contrary to the present findings, Gowda (1989), Neeraj and Jha (2001) reported significant positive correlation between plant height with spike length. Misra and Saini (1990) reported positive significant correlation of number of florets spike^{-1} with height of the plant. Deshraj and Mishra (1998), Neeraj and Jha (2001) reported significant positive association of number of florets per spike with plant height. In the present experiment, plant height at 30 DAP showed negative significant correlation with days to spike initiation, days to floret initiation at both genotypic and phenotypic level. Plant height at 60 days after planting showed significant negative correlation with number of corms plant^{-1}. It also showed negative correlation with days to spike initiation, rachis length, spike weight, number of cormels plant^{-1}, number of spikes bulb^{-1}, number of spikes m^{-2}, corm yield and spike yield at both the levels. Days to spike initiation and days to floret initiation showed significant negative association with rachis length; Number of florets spike^{-1} also correlated negatively with number of cormels plant^{-1}, number of spikes bulb^{-1}. Reports on the nature of character association in these traits are scanty. Maitra and Satya (2004) reported that days to flower bud initiation exhibited high negative correlation with plant height, spike length, number of florets spike^{-1} which is *at par* with the present findings. The results of the correlation coefficient implies that characters like plant height, spike length, days to spike initiation, days to floret initiation are to be considered while going for yield improvement at least for the present population of gladiolus under study. Vanlalruati *et. al.* (2013) studied on the association of various morphological traits through correlation and path co-efficient analysis showed that leaf area, diameter of florets, length of florets length of flower spike, weight of spike florets spike exhiited significant and positive correlation with that of spike yield. The results of correlation coefficient presented in table 2 revealed that for yield (spike corm^{-1}) 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.

ACKNOWLEDGEMENT

The authors are thankful to Vice-Chancellor, Visva Bharati and Vice-Chancellor, OUAT for their assistance and moral support.

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