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Performance of gladiolus genotypes: growth, flowering and corm production

Sanghamitra Pattanaik, Amitava Paul[1] and Pravu Charan Lenka[2]
Krishi Vigyan Kendra
Orissa University of Agriculture and Technology
Shyamakhunta, Mayurbhanj - 757 049, India
E-mail: dina_neha@yahoo.co.in

ABSTRACT

Variance analysis was made for 20 quantitative traits in 29 genotypes of gladiolus. High variation in terms of range was recorded for almost all the traits except days to sprouting, number of leaves, flowering duration, number of florets/spike, floret diameter, number of cormels/plant, number of corms/plant, and number of spikes/corm. Tallest plants (159.25cm) were recorded in the variety Windlin, early spike-initiation was recorded in 'Intrepid' (45.5 days), and the highest number of florets per spike was recorded in 'Hunting Song' (20). Maximum floret diameter was recorded in 'Senset Jubilee' (7.28cm), while spike yield was highest in 'Ballerina' (139.05 q/ha). Maximum number of corms per plant was recorded in 'Hunting Song' (3.0).

Key words: Gladiolus, flowering, corm

INTRODUCTION

Gladiolus (*Gladiolus grandiflorus* L.), generally called "glad", is the second most important cut flower grown from storage organs. Gladiolus belongs to the family Iridaceae, and has originated in the tropical region of South Africa. Centre of origin of the genus is located in Cape Florist Region where most species were discovered. Gladiolus was introduced to cultivation during the 19th Century in India. It is mainly cultivated in Karnataka, West Bengal, Maharastra, Punjab, Haryana, Uttar Pradesh, Tamil Nadu, Jammu and Kashmir, Uttarakhand, Delhi, Sikkim, Himachal Pradesh and Odisha. In Odisha, it is cultivated over an area of 2350 ha, with production of 2329 lakh spikes (OAS, 2011). Success in plant breeding depends upon existing genetic variability within the breeding material. It is well-known that larger the variability, greater the scope for selection and improvement. Genotypic variability, more specifically additive variance, is the most important for a plant breeder, as, it determines genetic gain through selection. Before aiming at improvement in yield, it is necessary to be equipped with information on genetic variability and heritability in respect of important characters associated with yield. Analysis of Variance (ANOVA) for quantitative traits revealed highly significant differences among the 29 genotypes for all the traits under study. This variation can be utilized by adopting a suitable selection scheme for improvement in these traits in gladiolus. Existence of genetic variation is of paramount importance for starting a judicious plant breeding programme. In gladiolus, genetic variability for growth, flower and corm production was studied under different agroclimatic conditions. Soorianathasundaram and Nambisan (1991) studied gladiolus cultivars for genetic variability and observed higher heritability values for spike weight and spike length. Mahanta and Paswan (1995) reported maximum heritability for weight of the corm, followed by number of cormels per plant, and diameter of the cormel. Sheikh *et al* (1995) observed a high genetic advance in the case of plant height, days to flower and spike length, and, heritability estimates were high for all the characters studied. Pratap and Rao (2006) observed highest GCV for characters like plant height, number of florets/ spikes, and days to flowering. High genetic advance was noticed for traits like plant height, number of spikes and days to flowering. Significant differences among genotypes and their interaction effects warranted grouping of the genotypes to identify those that were genetically diverse, to ensure success in breeding programmes. Therefore, the present study was planned to obtain information on the range of variability present for various, important economic traits.

[1]Department of CIHAB, Palli Siksha Bhavan (Institute of Agriculture), Viswa Bharati, Sriniketan, Odisha, India
[2]Department of Fruit Science, Orissa University of Agriculture and Technology, Bhubaneswar, Odisha, India

MATERIAL AND METHODS

The present investigation was carried out in the experimental field of Krishi Vigyan Kendra, Mayurbhanj (North Central Plateau Agro-Climatic Zone), Odisha, during two consecutive post-rainy seasons of 2009-10 and 2010-11. Krishi Vigyan Kendra, Mayurbhanj, which falls under Orissa University of Agriculture and Technology, Bhubaneswar, is located at 21^{o}16' to 22^{o}34' N Latitude and 85^{o}40' to 87o11' E Longitude, at an altitude of 592m above mean sea level. Mayurbhanj district experiences a sub-tropical climate, with average annual rainfall of 1648.2mm, distributed mainly from June to October. Annual maximum and minimum temperatures are 39^{o}C and 14^{o}C, respectively, and relative humidity ranges from 70% to 90%. Soil at the experimental site is clay-loam, with 5.3% organic carbon and is acidic (pH 5.42) in nature. Genotypes under the present study were collected from Bidhan Chandra Krishi Viswavidyalaya, West Bengal, and Directorate of Horticulture, Government of Odisha, Mayurbhanj. The experiment was conducted in randomized (complete) block design (RBD), with two replications, during the two growing seasons (i.e., post-rainy seasons of 2009-10 and 2010-11) to assess the performance of 29 gladiolus genotypes. Bulbs were planted at a spacing of 30cm row-to-row, and 20cm plant-to-plant. All the recommended package of practices and plant protection measures were duly followed during the crop growth period for raising a healthy crop. Data were recorded for yield and twenty (20) contributing traits thereof, viz., days to sprouting, plant height (cm) at 30 and 60 days after planting (DAP), number of leaves, days to spike initiation, days to floret initiation, flowering duration, spike length (cm), rachis length (cm), number of florets per spike, floret diameter (cm), spike weight (g), number of corms per plant, number of cormels per plant, corm diameter (cm), corm weight (g), number of spikes/corm, number of spikes per m^2, spike yield (q/ha), and corm yield (q/ha). Ten plants, at random, from each sub-plot were earmarked for recording experimental data, excluding the bordering plants. Statistical software Windostat version 8.6 from Indostat services was used for data analysis.

RESULTS AND DISCUSSION

Correlation coefficient analysis measures mutual relationships between various plant characters and determines component characters upon which selection can be based for genetic improvement in yield. Phenotypic and genotypic variance was calculated from the total variance and used for determining phenotypic and genotypic coefficient of variability. Coefficient of variation indicates only the extent of variability present in different characters, but does not indicate their heritable portion. Estimates for phenotypic coefficient of variation ranged from 8.52% for number of leaves, to 50.92% for corm weight (q/ha); whereas, for genotypic coefficient of variation, this was 7.99% to 50.52%, exhibited by the same two characters (Table 1). Estimates for phenotypic co-efficient of variation

Table 1. Genotypic and phenotypic coefficient of variability, heritability and genetic advance for 20 quantitative traits in gladiolus

Trait	Range		Grand	Coefficient of variation (%)		Heritability	Genetic	Genetic
	Min.	Max.	Mean	PCV	GCV	%	advance %	advance as % of Mean
Days to sprouting	6.00	8.75	7.06	11.25	8.18	52.93	0.87	12.26
Plant height (cm) at 30 days	37.45	90.27	61.62	20.57	20.56	99.88	26.08	42.32
Plant height (cm) at 60 days	57.00	159.25	105.76	17.16	17.12	99.47	37.20	35.17
No. of leaves	6.00	8.75	7.62	8.52	7.99	88.01	1.18	15.44
Days to spike initiation	45.50	82.00	62.56	16.33	16.28	99.33	20.90	33.41
Days to floret initiation	61.00	91.00	72.59	13.69	13.62	99.01	20.26	27.91
Flowering duration (days)	17.00	28.25	22.30	12.81	12.52	95.59	5.62	25.22
Spike length (cm)	39.50	82.00	63.66	14.19	14.14	99.28	18.47	29.01
Rachis length (cm)	8.25	31.50	21.32	29.52	29.27	98.36	12.75	59.80
No. of florets/spike	9.50	20.00	14.91	18.53	17.89	93.26	5.31	35.59
Floret diameter (cm)	4.05	7.28	5.45	17.12	16.53	93.22	1.79	32.88
Spike weight (gm)	18.25	65.85	40.32	31.41	31.35	99.64	25.99	64.46
No. of corms/plant	1.00	3.00	1.83	25.60	23.60	84.95	0.82	44.80
No. of cormels/plant	0.00	2.50	1.43	45.42	38.03	70.12	0.94	65.60
Corm diameter (cm)	6.50	28.80	14.36	44.01	43.63	98.31	12.80	89.12
Corm weight (gm)	6.20	46.63	19.63	50.55	50.02	97.92	20.02	101.96
No. of spikes/bulb	0.90	1.81	1.30	23.41	22.00	88.30	0.56	42.59
No. of spikes/m2	14.40	28.96	20.84	23.41	22.00	88.30	8.88	42.59
Yield of corms (q/ha)	7.95	59.68	25.24	50.92	50.52	98.44	26.06	103.26
Yield of spikes (q/ha)	28.48	139.05	69.90	48.36	47.36	95.91	66.80	95.55

were high (>40%) for number of cormels per plant, corm diameter (cm), individual corm weight (g), corm weight (q/ ha), and, low (< 20%) for days to spike emergence, days to first floret opening, flowering duration (days), spike length (cm), number of florets per spike, etc. Values for genotypic coefficient of variation were high (> 40%) for corm diameter (cm), corm weight (g) corm weight (q/ha), spike weight (q/ ha), and, low (< 20%) for days to spike emergence, days to first floret opening, flowering duration (days), spike length, and number of florets per spike. PCV for all the characters studied indicated that the variation was due to the genetype, and not due to environmental factors.

Maitra and Staya (2004) recorded higher GCV than PCV in gladiolus for most of the characters studied, but, there was close relation between GCV and PCV in some of the characters. GCV was highest for characters like corm weight, spike weight and corm diameter. Balaram *et al* (2000) reported both PCV and GCV to be high for characters like spike length, spike weight, weight of daughter corm, and number of cormels per corm. Pratap and Mohan Rao (2006) reported maximum GCV for characters like number of florets per spike, and days to flowering. Bichoo *et al* (2002) reported high GCV for number of cormels per plant.

The high value of PCV, along with GCV, indicates a greater variability for characters like corm weight (q/ha) and spike weight (q/ha). In the present study, genotypic and phenotypic correlations showed a similar trend, but, genotypic correlation was a higher magnitude than phenotypic correction in most of the cases. Heritability estimate is used for determining that portion of the phenotype which is due to the genotype. Estimate for genetic advance are also very important for an insight into the speed of genetic gain through selection. Among the quantitative characters studied, estimates for heritability were very high for plant height, days to spike emergence, days to floret opening, spike length, spike weight, flowering duration, corm weight, and spike weight. Corm weight and spike weight showed high heritability (98.44 to 95.91%), along with high genetic advance, as percentage of mean at 103.26% and 95.55%, respectively. Early generation selection could be practical for improving these characters due to the reliability of additive gene action for selection.

High heritability was over 90% in days to spike emergence, and days to first floret opening along with genetic advance; over 100% in corm weight gives an indication for scope of improvement in these crops. The present findings are in accordance with Balaram *et al* (2000) and Balamurugan *et al* (2002). Pratap and Manohar Rao (2006) also reported high heritability and high genetic advance for number of cormels and corm weight. Mahanta and Paswan (1995) reported maximum heritability (99.38%) for corm weight, followed by number of cormels and diameter of the cormel. Results on PCV, GCV, heritability and genetic advance revealed that selection for corm weight, spike weight, number of corms per plant, and number of spikes per m^2 could be effective for improvement in spike yield and corm yield.

The range of variance for plant height was 57cm to 159.25cm (Table 2). ‘Windlin’ was significantly superior to all the other varieties; lowest height was recorded in ‘Moralo’. The range for days to spike emergence was 45.50 to 82.0, with a mean of 62.56 days. Early spike-emergence was recorded in ‘Intrepid’, while maximum days taken to spike emergence was seen in ‘Blue Frost’. Days to first floret opening varied from 61.0 to 91.0, with a grand mean of 72.59 days. Values for days taken to first floret opening were lowest in ‘American Beauty’, and highest in ‘Blue Frost’. Number of florets per spike varied from 9.50 to 20.0, with a grand mean of 14.91. Maximum numbers of florets per spike were recorded in ‘Hunting Song’, while ‘Moralo’ recorded minimum number of florets per spike. Spike weight (g) varied from 18.25g to 65.85g, with 40.32g as the mean value. Maximum spike weight was recorded in the genotype Ballerina, and, minimum in ‘Moralo’. Number of spikes per corm varied from 0.90 to 1.81, with a mean value of 1.30. The genotype Peter Pears recorded maximum number of spikes per corm; whereas, the genotype Venutrie recorded minimum corm yield (q/ha), which varied from 7.95 to 59.68q, with a mean value of 25.24q. ‘Red Beauty’ recorded maximum corm weight (q/ha), while, the genotype Novalux recorded minimum value of co-efficient of variation; it was observed that variability was highest in the number of cormels per plant (35.11), followed by number of corms per plant (14.04) and spike yield (13.84). Considerable variability for weight of cormels produced per corm, number of cormels per corm, and weight of corm was earlier reported by Negi *et al* (1982). Soorianthasundaram and Nambisan (1991) reported considerable amount of genotypic variability in gladiolus for characters like spike weight, spike length, number of florets, number of cormels, and daughter corm weight. Mahanta and Paswan (1995) reported a good amount of genotypic variability for weight of corm, and number of cormels per plant. Sanghamitra *et al* (2014) reported that path analysis (with corm yield as dependent variable) indicated that characters like days to first floret

Table 2. Mean *per se* performance of 29 genotypes for 20 quantitative traits in gladiolus

Genotype	Days to sprouting	Plant height at 60 DAP* (cm)	No. of leaves/ plant	Days to spike emergence	Days to first floret opening	Flowering duration (days)	Spike length (cm)	Rachis length (cm)	No. of florets/ spike	Floret diameter (cm)	Spike weight (g)	No. of corms/ plant	No. of cormels/ plant	Corm diameter (cm)	Corm weight (g)	No. of spikes/ corm	No. of spikes/ m^2	Corm yield (q/ha)	Spike yield (q/ha)
Candiman	7.75	70	8.00	69.5	85.50	21.00	55.5	23.00	15.00	5.50	60.50	2.00	1.00	13.25	16.58	1.79	28.68	21.23	138.86
Hunting Song	7.75	99	8.00	57	68.25	19.00	41	24.25	20.00	6.07	28.00	3.00	1.00	12.35	20.45	1.28	20.48	26.18	45.88
Piseilla	6.75	68	8.00	76	85.00	25.75	61	29.00	14.50	4.30	49.00	2.00	1.50	25.65	30.00	1.20	19.20	38.40	75.24
Venutrie	8.00	121	8.75	55.25	65.50	19.50	59.75	20.50	14.00	5.75	30.00	1.00	2.00	20.50	27.25	0.90	14.40	34.88	34.58
Chipper	6.50	116.25	7.75	56	64.50	20.75	70	23.25	17.25	5.95	49.75	2.00	1.00	10.90	19.50	0.95	15.20	24.95	60.51
Edgewonder	8.75	105.75	8.00	54.75	65.00	19.25	65.5	24.50	19.75	5.22	40.75	2.00	1.00	21.58	28.70	1.40	22.48	36.72	73.89
Ballerina	7.00	105.5	8.00	52.5	63.50	23.00	65.5	31.50	10.50	5.75	65.85	2.00	1.00	8.20	12.50	1.65	26.48	16.00	139.05
Friendship	7.25	119	8.00	54.25	64.00	20.00	74.75	26.25	17.00	5.15	40.90	1.00	2.00	10.25	14.00	1.13	18.00	17.90	58.91
Mayur	8.75	107.25	7.00	71	82.50	22.75	70.5	25.25	19.00	7.00	51.00	2.00	2.00	18.15	24.13	1.35	21.68	30.88	88.49
Sunset Jubilee	6.00	110	7.00	50	62.50	22.75	66.5	29.25	18.00	7.28	43.05	1.50	2.00	15.85	20.85	1.23	19.68	26.70	67.67
Intrepid	7.00	99.5	7.00	45.5	62.00	25.50	70.5	26.25	16.50	4.05	35.55	2.00	1.00	10.15	19.05	1.24	19.92	24.38	56.73
American Beauty	7.00	104	8.00	48.5	61.00	20.00	59.25	25.25	15.50	5.05	42.30	2.00	2.00	21.73	35.95	1.04	16.72	46.02	56.51
Wedding Bouquet	7.00	101.25	6.50	58.25	67.50	20.00	60	19.50	14.00	6.95	41.30	2.00	2.00	24.38	33.30	1.00	16.00	42.63	52.86
Moralo	6.75	57	7.00	55.75	69.00	18.50	39.5	19.25	9.50	4.15	18.25	1.50	2.00	14.75	22.42	1.22	19.48	28.70	41.03
Appalase	7.00	115	7.25	53	61.50	21.50	70.25	29.75	12.00	5.68	29.75	2.25	2.25	23.98	33.25	1.39	22.20	45.77	52.76
Melody	6.00	104.25	6.00	54.75	61.50	23.50	76.5	24.50	17.00	5.72	40.65	2.00	1.75	18.88	23.58	1.15	18.48	30.20	60.07
Spic and Span	6.75	102.25	7.00	66.5	77.25	22.00	62.75	16.25	12.50	6.25	39.05	2.00	2.00	7.75	9.65	1.58	25.20	12.35	79.00
Rose Supreme	6.75	106.75	8.00	70.5	79.50	28.25	58.75	22.00	13.00	4.40	55.15	2.00	2.50	7.35	6.55	1.70	27.20	8.40	120.02
Oskar Red	6.00	105	7.00	64	74.25	25.25	62.25	17.50	13.00	4.15	50.88	2.00	1.00	12.25	12.60	1.15	18.48	16.15	75.04
Peter Pears	6.50	109	8.00	67.75	80.00	18.50	65.25	24.00	15.50	6.10	46.20	2.25	1.75	10.75	15.30	1.81	28.96	19.58	107.06
Novalux	6.00	109	8.00	71.75	79.25	24.75	71	20.00	15.00	5.15	61.58	2.00	1.00	6.50	6.20	1.75	27.96	7.95	137.71
Ripling Water	6.50	119.25	8.00	62	66.25	25.50	72	10.50	12.00	6.05	33.25	1.00	1.00	14.00	18.15	1.45	23.20	23.25	61.57
Greenbay	6.75	108.75	8.00	58	64.75	21.25	57.75	12.00	16.50	6.00	37.50	2.00	1.00	10.10	14.63	1.59	25.44	18.70	76.20
Windlin	7.00	159.25	8.50	58	65.75	25.75	82	26.75	18.50	4.63	22.25	1.00	0.00	7.60	7.38	1.00	16.00	9.45	28.48
Psetatinous	6.75	98.75	7.25	66	75.75	25.00	62	20.50	12.50	4.15	54.00	1.50	1.75	7.50	6.35	1.37	21.96	8.13	94.90
Blue Frost	8.00	119.75	8.00	82	91.00	17.00	61	8.25	14.00	4.13	25.50	1.00	1.00	11.85	13.90	1.00	16.00	17.77	32.64
Green Star	8.50	111	8.00	78	87.50	24.00	58.25	9.00	12.00	6.00	24.50	2.00	0.00	9.63	10.88	1.23	19.72	13.95	38.60
White Prosperity	7.00	111.5	8.00	79.5	85.50	21.25	66.25	16.00	16.00	6.25	25.25	2.00	1.00	11.95	19.60	1.20	19.20	25.08	37.76
Red Beauty	7.00	104	7.00	78.25	89.75	25.50	61	14.25	12.50	5.10	27.50	2.00	2.00	28.80	46.63	1.00	16.00	59.68	35.20
Grand mean	7.06	105.76	7.62	62.56	72.59	22.30	63.66	21.32	14.91	5.45	40.32	1.83	1.43	14.36	19.63	1.30	20.84	25.24	69.90
SE(m) ±	0.38	0.93	0.15	0.59	0.7	0.42	0.7	0.56	0.5	0.17	0.53	0.12	0.25	0.58	1.01	0.07	1.18	1.13	4.83
CD $(P=0.05)$	1.09	2.64	0.45	1.67	1.98	1.2	1.98	1.61	1.43	0.48	1.52	0.36	0.71	1.64	2.86	0.21	3.34	3.21	13.7
CV	10.91	1.76	4.17	1.89	1.93	3.8	1.93	5.34	6.8	6.3	2.67	14.04	35.11	8.1	10.31	11.33	11.33	8.98	13.84

*Days after planting

opening, number of corms per plant, no. of cormels per plant, and corm weight had a positive direct effect, maximum positive direct effect was seen in corm weight, followed by number of corms/plant.

In view of the relative contribution of traits in determining spike yield and corm yield, and *per se* performance of the genotypes Mayur, Windlin and Peter Pears, these are promising and may be used as parents in future hybridization programmes.

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