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Stability analysis for earliness and corm characters in gladiolus (*Gladiolus hybridus* Hort.)

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ABSTRACT

A field study was conducted in gladiolus (*Gladiolus hybridus* Hort.) in the floriculture field of Department of Floriculture and Landscaping, KRCCH (University of Agricultural Sciences, Dharwad) during 2005-2006. Fourteen promising cultivars were planted under three environments, viz, shade-house, polyhouse and the open condition, and tested for various characters related to earliness. Genotypes x Environment interactions were significant for days to spike emergence and days from first floret to last floret opening. For days to corm sprouting, genotypes Sylvia (4.24), American Beauty (7.87), Candiman (9.6), White Prosperity and Priscilla (12.09) showed low mean values, *i.e.*, early sprouting. For days taken from first to last floret opening, genotypes Eighth Wonder (15.87), Melody (14.51), Friendship (14.49), Pricilla (14.29), Pacifica (13.80), White Prosperity (13.80) and Vedanapoli (13.56) were stable, with high mean values. On the basis of mean performance, the genotype Vedanapoli was stable for number of daughter corms per plant (2.22). Genotypes Pacifica (6.13cm) and Eighth Wonder (6.09cm) were stable for corm diameter, with high mean values. Though 'Vedanapoli' showed unpredictable performance for average weight of corm, ten cormel weight and number of cormels per plant, it gave the highest corm yield per plant and showed predictable performance for corm diameter, exhibiting a great promise for hybridization with consistent corm yield outcome.

Key words: Gladiolus, stability, environment

INTRODUCTION

Gladiolus (*Gladiolus hybridus* Hort.) is a glamorous bulbous flower combining beauty and perfection. It is one of the most attractive and popular bulbous flowers much-acclaimed for its majestic spikes possessing attractive, elegant and delicate florets. It is said to be the 'Queen of bulbous flower crops' and is commonly called 'Sword lily; It belongs to the family Iridaceae with its origin in South Africa. India, with its varied climatic conditions in different parts, offers the possibility of growing gladiolus round the year, in one or the other part of the country. However, phenotypic expression of a character is governed mainly by genetic makeup of the plant, the environment in which it grows and interaction between genotype and the environment. Genotype environmental interactions (GxE) pose a major problem in developing new cultivars and choosing suitable cultivars for any specific location, to identify the most desirable genotypes. Presence of a high (GxE) interaction complicates breeding work because it is difficult to predict how genotypes selected under a given set of conditions will perform under a different set of conditions (Ceccarelli, 1989). Stable genotypes are of great importance because environmental conditions may vary from season to season and year to year. Although a number of gladiolus varieties are recommended for cultivation, information on stability is lacking on flowering attributes, yield and quality parameters of corms and cormels which are a major source of propagation in this crop. Therefore, the present study was undertaken taking fourteen gladiolus genotypes under three different environments.

MATERIAL AND METHODS

The present experiment was laid out at the floricultural field of Department of Floriculture and Landscaping, Kittur Rani Channamma College of Horticulture (University of Agricultural Sciences, Dharwad) during 2005-2006. Fourteen promising cultivars, viz., American Beauty, Sylvia, Melody, Summer Sunshine, Vedanapoli, Magic, Copper King, Red Ginger, Candiman, Priscilla, Jester Yellow, White Friendship, White Prosperity, Eighth Wonder and Pacifica were planted under three environments, viz., shade-house, polyhouse and the open condition, and tested for various characters related to earliness. Corms of optimum size 4-5cm dia were planted at 30x30cm spacing at a depth of 5-6cm. Beds of 45cm height and 65cm width were prepared by thoroughly digging to 30cm depth. Well-decomposed FYM was applied @25 t ha^{-1} and mixed well into the soil. Recommended dose of NPK fertilizer @ 100:60:60kg ha^{-1} (Anony., 2002) was applied through urea, SSP and MOP, respectively. Fifty percent of nitrogen and the full dose of phosphorus and potash were applied as basal dose, and the remaining fifty per cent of nitrogen was applied 45 days after planting. Uniform cultural practices were imposed throughout experimentation. Observations were recorded on number of days taken for corms to sprout, days taken to spike initiation, days taken for first floret opening, days taken from first floret to last floret opening, number of daughter-corms per plant, number of cormels per plant, diameter of daughter corms, and average weight of daughter-corms and cormels. Analysis was made following three replications and observations were recorded from five labeled plants. Stability was analyzed with SPAR package for analysis using Eberhart and Russell (1966) model, which provided three parameters of stability, *i.e* mean, regression co-efficient (b_i) computed using students t-test and deviation mean squares (S^2d_i), computed using F-Test.

RESULTS AND DISCUSSION

Analysis of Variance (Table 1) for genotypes was highly significant for days to corm sprouting, spike emergence, days taken for spike initiation, days taken for first floret opening and days taken from first floret to last floret opening, indicating significant difference among genotypes. Such variation was also reported earlier by Arora and Sharma (1991) in gladiolus. Significant difference among environments was also observed for all characters, except days to spike emergence. Similar difference was also observed by Mishra and Gupta (2005) in carnation.

Significant linear portion of environmental variance indicated considerable additive environmental variance. Environmental variance was observed to be of considerable magnitude as indicated by significance of environment (linear) component for number of cormels per plant and corm diameter. Similar results were obtained by Dhaduk *et al* (2004) in tomato. Genotype x Environment interaction was not significant for days taken to spike emergence and days taken for first floret opening. Hence, the genotypes are seen to be stable for these traits across environments. Genotype x Environment interaction and pooled deviation mean squares (non-linear) were found to be significant for all the corm characters, indicating contribution of both linear and non-linear components to GE interaction variance for these characters.

Variance due to environment + (genotype x environment) and variance due to environment (linear) were highly significant for all characters, except days required for first flower opening. Significant pooled deviations were observed for all the characters indicating that this quantum of variance, which is unpredictable, formed a major part of the Genotype x Environment interaction among genotypes. The non-significant Genotype x Environment (linear) interactions for these characters and significant pooled

Table 1. Pooled analysis of variance (mean square) for earliness and corm characters in gladiolus

S.N	Source of variation	Df	Days for corm sprouting	Days for spike initiation	Days for first floret opening	Days from first to last floret opening	Number of corms per plant	Number of cormels per plant	Corm diameter (cm)	Average corm weight (g)
1	Genotype	13	68.52**	180.94**	179.56**	6.13	1.256**	4576.20*	2.14**	1310.8**
2	Environment	2	15.93**	11.17	14.95	19.38**	0.36	8726.34**	1.70**	770.75
3	Genotype x Environment	26	0.46**	4.56	9.23	2.39**	0.154**	1103.96**	0.17**	206.01**
4	Environment +(genotype x environment)	28	1.56**	5.02*	9.6	3.60**	0.169**	1648.41**	0.28**	246.35**
5	Environment (linear)	1	31.86**	22.34*	29.96	38.76**	0.73*	17452.7**	3.40**	1541.47*
6	Genotype x environment (linear)	13	0.59**	3.9	5.34	2.11	0.14	1426.32	0.18	92.50
7	Pooled deviation	14	0.31**	4.8*	12.18**	2.48**	0.15**	725.76**	0.15**	296.69**
8	Pooled error	78	0.07	3.5	7.52	0.07	0.03	2	0.018	1.55

* and ** indicate significance at 5% and 1%, respectively, Df - Degree of freedom

deviation mean squares suggest a greater importance of non-linear component of the genotype-environment interaction and presence of both predictable and unpredictable components in the genotype x environment interaction. Such pooled deviations were also reported by Narayannakutty (2005) in snake gourd. Significant Genotype x Environment interaction leads to identification of stable genotypes.

Stability parameters, viz., mean, regression co-efficient (b_i) and deviation from regression (S^2d_i) were computed using Eberhart and Rusell model (1966) given in Table 2, 3 & 4. An ideal genotype, according to Eberhart and Russell (1966), would be one having high mean, unit regression co-efficient (b_i=1) and low deviation mean squares (S^2d_i=0). If regression co-efficient (b_i) is greater than unity with high mean values, the genotype is considered to possess below-average stability and is highly sensitive to environments. Regression co-efficient (bi<1) with high mean values indicates above-average stability and can adapt to poor environments. If regression co-efficient (b_i) is equal to unity (b_i=1) with high mean values, this indicates average sensitivity to environmental changes and adaptation to various environments.

Stable genotypes are those that interact less with the environment, giving consistent performance across environments. An ideal genotype, according to Eberhart and Russell (1966), is one that interacts less with the environment with high mean values, regression coefficient (b_i=1) close to unity and (S^2d_i=0) not deviating significantly from zero.

For days to corm sprouting (Table 2), genotypes Sylvia (4.24), American Beauty (7.87), Candiman (9.6), WhiteProsperity and Priscilla (12.09) showed low mean values, which is advantageous for earliness and regression coefficient around unity, with non-significant deviation from regression. Hence, these genotypes were stable and predicable. Genotype x Environment interactions were significant for days taken to corm sprouting and days from first floret to last floret opening, suggesting variable performance of cultivars under different environments. Variance due to environment + (genotypex environment) and variance due to environment (linear) were highly significant for all characters except for day taken for first floret opening.

Genotype x Environment interaction was not significant for days taken for spike emergence and days taken for first floret opening and, hence, the genotypes were stable for these traits across environments. Therefore, stability for these characters has not been tabulated for days taken from first to last floret opening (Table 1). Genotypes Eighth Wonder (15.87), Melody (14.51), Friendship (14.49), Priscilla (14.29), Pacifica (13.80), White Prosperity (13.80) and Vedanapoli (13.56) were stable, with high mean values and regression coefficient around unity but were unpredictable, as observed by their significant deviation from regression coefficient. Such varied responsiveness of genotypes in changing environments has been earlier reported by Deshraj and Mishra (1998) in gladiolus for the same traits. This parameter is an important estimate for determining self-life of gladiolus. But, due to the influence of environment on genotype, it is unpredictable. Therefore, flowering duration is seen to ultimately depend on the season and the environment.

Table 2. Stability parameters for corm sprouting and days from first to last floret opening

Variety	Number of days required for sprouting			Days taken from first to last floret opening		
	Mean	b_i	S^2d_i	Mean	b_i	S^2d_i
American Beauty	7.87	0.29	0.04	12.33	-0.04	0.51**
Sylvia	4.24	0.95	-0.02	10.09	0.68	3.60**
Melody	9.29	1.09	0.46**	14.51	2.16	4.20**
Summer Sunshine	14.42	1.27	0.04	12.44	2.68	6.85**
Vedanapoli	18.62	1.36	0.00	13.56	-0.20	2.98**
Copper King	18.53	1.32	1.13**	12.78	0.69	4.47**
Red Ginger	6.22	0.40	0.10*	12.25	1.75	0.17**
Candiman	9.60	0.37	-0.01	12.80	0.16	0.77**
Priscilla	12.09	0.52	-0.02	14.29	0.95	7.17**
Jester Yellow	15.04	1.21	1.31**	11.73	0.95	0.46**
White Friendship	13.60	0.38	0.47**	14.49	0.67	1.16**
White Prosperity	10.56	1.67	0.06	12.91	2.14	0.62**
Eighth Wonder	20.24	1.66	0.45**	15.87	0.43	0.28**
Pacifica	12.96	1.52	-0.02	13.80	0.98	1.19**
Mean	12.38			13.13		
SEm±	0.39	0.36		1.11	0.94	

*, ** - Deviation from regression differed significantly from zero at p = 0.05 and p = 0.01, respectively

On the basis of mean performance, genotype Vedanapoli was stable for the number of daughter-corms per plant (2.22) (Table 3). Genotypes Sylvia, Priscilla, American Beauty and Copper King showed high mean values, with (b_i=1), but were not predictable as these showed significant deviation from the regression slope. Genotype Melody produced the maximum number of cormels (170.96) and was seen to be stable for this trait, whereas, the other genotypes showed unpredictable performance for number of cormels due to their significant deviation from the regression slope. Varied response for yield of rhizomes was earlier reported (Khar *et al*, 2005) in ginger grown under different environments.

Table 3. Stability parameters for number of corms and cormels per plant as influenced by varieties and environment in gladiolus

Variety	No. of corms per plant			No. of cormels per plant		
	Mean	b_i	S^2d_i	Mean	b_i	S^2d_i
American Beauty	2.18	2.68	0.63**	62.13	-0.01	1919.58**
Sylvia	3.44	2.63	0.06**	104.64	2.09	364.42**
Melody	1.33	-0.70	-0.01	170.96	1.56	-0.33
Summer Sunshine	1.53	0.87	0.06**	42.27	0.19	1211.73**
Vedanapoli	2.22	1.02	0.04	118.81	3.91	1547.87**
Copper King	2.02	2.62	0.93**	25.11	0.16	156.24**
Red Ginger	1.53	2.25	0.00	74.60	0.85	447.94**
Candiman	1.82	0.78	0.00	35.98	-0.10	75.19**
Priscilla	2.76	3.76	0.18**	88.04	1.17	194.85**
Jester Yellow	1.09	0.15	-0.01	51.58	0.23	556.27**
White Friendship	1.60	0.99	0.11**	76.51	0.39	2417.17**
White Prosperity	1.40	-2.10	0.00	40.44	0.78	563.57**
Eighth Wonder	1.42	-0.48	0.02	95.73	1.31	657.82**
Pacifica	1.29	-0.48	0.02	91.89	1.44	39.03**
Mean	1.83			77.05		
	0.27	1.72		10.76	0.76	

** - Deviation from regression differed significantly from zero at p = 0.01

Genotypes Pacifica (6.13cm) and Eighth Wonder (6.09cm) were stable for corm diameter, with high mean values (Table 4). Genotypes Summer Sunshine, Candiman, Jester Yellow and White Prosperity showed high mean values, but were linearly not predictable. Such response of genotypes in changing environments was reported earlier by Ibrahim and George (1985) for tuber diameter in the sweet potato. Genotypes Summer Sunshine, Copper King, Red Ginger, Candiman and White Friendship were stable, with high mean values and non-significant regression co-efficient, but were linearly unpredictable for weight of 10 cormels per plant. Genotypes Melody, Priscilla and White Prosperity were stable but showed low mean values and, hence, were poorly adapted to different environments. Genotypes Summer Sunshine, Vedanapoli, Candiman, Priscilla and Jester Yellow showed high mean values, but were linearly unpredictable for average weight of corms. Genotypes White Friendship, White Prosperity and Pacifica were stable and predictable, but showed lower mean values and were, hence, poorly adapted to different environments.

Table 4. Stability parameters for average corm weight per plant and corm diameter as influenced by variety and environment in gladiolus

Variety	Average corm weight (g)			Corm diameter (cm)		
	Mean	b_i	S^2d_i	Mean	b_i	S^2d_i
American Beauty	51.34	-0.47	56.53**	5.42	0.40	0.56**
Sylvia	29.33	0.77	15.76**	4.30	0.53	0.37**
Melody	40.70	0.81	93.87**	5.12	1.72	-0.01
Summer Sunshine	98.25	3.00	2138.94**	7.16	3.32	0.17**
Vedanapoli	55.80	0.53	340.51**	5.69	0.17	0.00
Copper King	41.98	0.65	16.26**	5.04	0.55	0.05**
Red Ginger	47.44	1.26	208.86**	5.81	1.20	-0.01
Candiman	97.33	1.71	840.02**	7.65	1.61	0.05**
Priscilla	65.56	1.06	111.94**	5.88	0.28	0.30**
Jester Yellow	71.32	2.28	162.81**	6.50	0.72	0.11**
White Friendship	47.61	0.93	0.38	5.74	1.22	0.12**
White Prosperity	39.85	1.15	-0.42	5.97	1.27	0.41**
Eighth Wonder	49.64	-0.41	160.26**	6.09	-0.10	0.00
Pacifica	39.97	0.72	0.28	6.12	1.11	-0.01
Mean	55.43			5.89		
	12.17	1.64		0.28	0.80	

* - Deviation from regression differed significantly from zero at p = 0.05
** - Deviation from regression differed significantly from zero at p = 0.01

The present study demonstrates that excepting time taken from first to last floret opening, all the other characters studied are not influenced by environment to any great extent. In view of improvement in flowering habit, there is a further need for studies on this aspect. As corms are the main source of propagation in gladiolus, genotypes showing high yields with stables performance across environments should be selected. Hence for mass production of corms, Vedanapoli and Melody can be considered as ideal genotypes.

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