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MORPHOLOGICAL CHARACTERIZATION OF GLADIOLUS (*GLADIOLUS X HYBRIDUS* HORT.) FOR RESISTANCE TO *FUSARIUM* WILT DISEASE

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ABSTRACT
Four gladiolus genotypes were evaluated under field conditions for vegetative and floral characters at ICAR-Indian Institute of Horticultural Research, Bengaluru during 2011- 2012. The results revealed that 'Arka Amar' and 'Arka Aayush' were resistant genotypes, whereas, 'IIHRG-12' and 'Pink Friendship' were susceptible to *Fusarium* wilt disease. The genotype 'IIHRG-12' took minimum number of days (53.44 days) to spike emergence and flowering (63.96 days). Among all the genotype tested genotype, 'IIHRG-12' recorded maximum plant height (137.76 cm), spike length (119.40 cm) and rachis length (51.92 cm). The genotype 'Arka Amar' was found superior for floret diameter (10.39 cm), number of florets per spike (16.52), number of marketable spikes per corm (2.44) and vase life (8.87 days). Genotype 'Pink Friendship' recorded the maximum spike weight (83.00 g). Based on results obtained, the genotypes 'Arka Amar' and 'IIHRG-12' can be utilized in breeding programs for improvement of vegetative and floral characters in gladiolus.

INTRODUCTION

Gladiolus derived from the Latin word *'gladius'* meaning a sword shape leaves of the plants. It belongs to family Iridaceae and native from Cape region in South Africa. It is also known as the 'queen of bulbous ornamental' with majestic cut spikes having florets of massive form, brilliant colours, attractive shapes, varying sizes and excellent keeping quality (Suman *et al.*, 2011). Wide variation is exhibited among cultivars for their growth habit, size, shape and colour of florets mainly due to interspecific crosses among several species. One of the main constraints of gladiolus cultivation is the *Fusarium* wilt disease caused by *Fusarium oxysporum* f. sp. *gladioli*, which causes severe economic losses in production of this cut flower. The pathogen may cause as much as 60–100 per cent damage to gladiolus depending on varietal response (Pathania and Misra, 2000). Wilfret (1981) evaluated 'Florida Flame' and found tolerant to *Fusarium* wilt with large florets and long spike. Jones and Jenkins (1974) evaluated 19 selections/cultivars and reported that North Carolina selections 63-5-1 and 66-109-5, and cultivars Follies Bergere, Prince Bernhart, Fiat Lux and Beverly Ann appeared resistant. Shaukat *et al.* (2013), Bhujbal *et al.* (2013), Negi *et al.* (2014), Angadi *et al.* (2014) and Thakur and Dhatt (2015) have also evaluated different genotypes of gladiolus for various vegetative and flowering traits.

Looking into the importance of the crop, efforts are needed for systematic characterization of genotypes against *Fusarium* wilt disease. Thus, there is a need for characterization of genotypes which are resistant and susceptible for wilt disease, so they can be effectively utilized in breeding programs. Therefore, present investigation was undertaken to find out superior genotypes for vegetative and floral traits which can be utilized in further breeding programs for development of *Fusarium* wilt resistance genotypes.

MATERIALS AND METHODS

The field experiment was conducted at ICAR-Indian Institute of Horticultural Research, Hesaraghatta Lake Post, Bengaluru in randomized complete block design (RCBD) with four genotypes (Arka Amar, Arka Aayush, IIHRG-12 and Pink Friendship) and five replications during 2011-2012 (Table 1 and Fig.1). The genotypes 'Arka Amar' and 'Arka Aayush' were resistant, whereas, 'IIHRG-12' and 'Pink Friendship' were susceptible to *Fusarium* wilt disease. Forty corms were planted at a spacing of 30 x 20 cm in each bed. Before planting, corms were treated with Bavistin and Captan @ 2 g/litre each for 30 minutes. Standard package of practices was followed to raise the successful crop. The observations were recorded for vari-

ous vegetative and floral traits *viz.*, sprouting of corms (%), days to sprouting, days to spike emergence, days to flowering, plant height (cm), spike length (cm), rachis length (cm), floret diameter (cm), number of florets per spike, number of marketable spikes per corm, total spikes per corm, number of florets remained open at a time, flowering duration (days), spike weight (g), vase life (days) and floret colour (RHS colour chart). Statistical analysis of data was carried using SAS-GLM (SAS, 2009) V 9.2.

RESULTS AND DISCUSSION

Gladiolus genotypes exhibit variability with respect to vegetative and floral characters (Table 2). The genotype 'Arka Aayush' recorded 100% sprouting of corms followed by 'Arka Amar', 'IIHRG-12' and 'Pink Friendship'. The genotype 'Arka Amar' (10.20 days) took minimum number of days to sprouting was followed by 'Arka Aayush' (11.00 days), 'Pink Friendship' (11.00 days) and 'IIHRG-12' (11.20 days). These results are in agreement with the findings of Nimbalkar *et al.* (2007) and Chourasia *et al.* (2015). The variation in days to sprouting of corm amongst genotypes might be due the genotypic differences of individual genotypes.

The spike emergence was recorded earliest in 'IIHRG-12' (53.44 days) followed by 'Pink Friendship' (56.00 days) and 'Arka Aayush' (61.64 days), whereas, it was delayed in 'Arka Amar' (64.04 days). The days to spike emergence is an important varietal character in gladiolus that might be primarily governed by the genetic makeup of the varieties. The similar variations in different genotypes have also reported by Rajiv Kumar (2009).

The days to flowering was recorded earliest in 'IIHRG-12' (63.96 days) and 'Pink Friendship' (66.22 days) followed by 'Arka Aayush' (73.96 days) and 'Arka Amar' (75.72 days) nearly advocates the findings of Rajiv Kumar (2014). Similarly, Kumar and Yadav (2005) recorded earliest heading, first floret showing color, full opening of the first floret in genotype 'Smoky Lady'.

Highly significant variations for plant height were recorded among different genotype which was ranged from 121.92 cm ('Pink Friendship') to 137.76 cm ('IIHRG-12'). The variation in plant height among the various genotypes might be due to genotype-environmental interaction effects. The similar results have also been reported by Swaroop (2010) and Rajiv Kumar (2014). Significant variations for spike length were recorded among different genotypes. The genotype 'IIHRG-12' recorded the longest spike (119.40 cm) followed by 'Arka Amar' (115.00 cm) and 'Arka Aayush' (110.20 cm). Non significant variations were recorded for rachis length among different genotypes. The genotype 'IIHRG-12' recorded the longest rachis (51.92 cm) followed by 'Pink Friendship' (50.15 cm) and 'Arka Amar' (49.50 cm). Shaukat *et al.* (2013) and Rajiv Kumar (2014) also reported similar variation in spike length and rachis length among genotypes.

Maximum floret diameter (10.39 cm) was recorded in genotype 'Arka Amar' followed by 'Pink Friendship' (10.22 cm) and 'IIHRG-12' (10.04 cm) (Table 3). The variation in floret diameter might be due to hereditary traits of all the genotypes. Sindhu *et al.* (2014) also reported similar variation in floret size.

Table 1: Flower colour (RHS colour chart) of genotypes

Genotype	Floret colour (RHS colour chart)
Arka Amar	Red (46.D) having Red (45.B) margin and White (155.B) line on tepals with Yellow (2.C) blotch.
Arka Aayush	Red (41.C) having Red (41.A) margin. Blotch Red (46.B) with Yellow (13.C) border.
IIHRG-12	Purple Violet (82.A) having Purple (77.A) margin with Green White (157.C) line on lower lip.
Pink Friendship	Floret Red (56.A) middle having Red (55.C) margin and Green White (157.D) blotch.

Table 2: Performance of different genotypes of gladiolus for vegetative traits and floral traits

Genotypes	Days to sprouting	Days to spike emergence	Days to flowering	Plant height(cm)	Spike length(cm)	Rachis length(cm)
Arka Amar	10.20	64.04	75.72	137.04	115.00	49.50
Arka Aayush	11.00	61.64	73.96	124.12	110.20	46.64
IIHRG-12	11.20	53.44	63.96	137.76	119.40	51.92
Pink Friendship	11.00	56.00	66.22	121.92	109.80	50.15
SEm ±	0.19	0.88	0.54	17.90	25.30	11.75
CD @ 5%	0.60	1.29	1.41	5.83	9.71	-
CV	4.03	1.59	1.04	3.25	4.43	6.92

Table 3: Performance of different genotypes of gladiolus for floral traits

Genotypes	Floret diameter (cm)	Number of florets remains open at a time	Number of florets per spike	Number of spikes per corm	Number of marketable spikes per corm	Flowering Duration(days)
Arka Amar	10.39	7.88	16.52	2.92	2.44	13.88
Arka Aayush	8.71	6.90	16.48	2.40	2.28	13.84
IIHRG-12	10.04	5.70	14.08	2.56	2.36	11.92
Pink Friendship	10.23	5.27	14.88	1.32	1.10	13.88
SEm ±	0.14	0.07	1.14	0.12	0.15	1.51
CD @ 5%	0.52	0.37	1.47	0.47	0.75	-
CV	3.81	4.14	6.88	14.87	19.04	9.19

Arka Amar | Arka Aayush | IIHRG-12 | Pink Friendship

Figure 1: Gladiolus genotypes used in the study

Table 4: Performance of different genotypes of gladiolus for spike weight and vase life

Genotypes	Spike weight (g)	Vase life (days)
Arka Amar	69.14	8.87
Arka Aayush	61.27	7.56
IIHRG-12	51.94	8.00
Pink Friendship	83.00	8.30
SEm ±	21.16	0.15
CD @ 1%	6.17	0.52
CV	6.93	4.74

The highest number of florets remained opened at a time was recorded in genotype 'Arka Amar' (7.88) followed by 'IIHRG-11' (6.90) and 'IIHRG-12' (5.70). Thus, desirable performance was consistently recorded in genotype 'Arka Amar'. Punam *et al.* (2009) recorded the maximum number of florets open at a time in 'Candyman' (7.04) followed by 'Eigth Wonder' (6.93), 'Jyotsna' (6.86) and 'Arka Kesar' (6.69). Number of florets per spike was recorded maximum in 'Arka Amar' (16.52) followed by 'Arka Aayush' (16.48) and 'Pink Friendship' (14.88), however, it was recorded minimum in 'IIHRG-12' (14.08).

The genotype 'Arka Amar' recorded the highest number of marketable spikes per corm (2.44) followed by 'IIHRG-12' (2.36) and 'Arka Aayush' (2.28). Further, genotype 'Pink Friendship' recorded the fewest number of marketable spikes per corm (1.10) which was significantly different from other genotypes.

The genotype 'Arka Amar' recorded highest number of spikes per corm (2.92) followed by 'IIHRG-12' (2.56) and 'Arka Aayush' (2.40), however, lesser number of spikes per corm (1.32) was recorded in 'Pink Friendship' which was significantly different from other genotypes.

The genotype 'Arka Amar' was found best for characters *viz.,* number of spikes per corm and number of marketable spikes per corm, whereas, the lowest number of marketable spike per corm was recorded in 'Pink Friendship'. The number of spikes per corm ranged from 1.32 to 2.92, which nearly agrees findings of Gupta *et al.* (2001). The variation in number of spikes per corm might be due to variability in genetic constitution of the varieties controlling the apical dominance.

On the perusal of data presented in Table 4 indicated that the genotypes revealed highly significant variations for vase life, ranged from 7.56 days to 8.87 days. The genotype 'Arka Amar' had longest vase life (8.87 days) and it was on par with 'Pink Friendship' (8.30 days) and IIHRG-12 (8.00 days), however, 'Arka Aayush' recorded shortest vase life (7.56 days). The longest flowering duration was recorded in 'Arka Amar' (13.88 days) and 'Pink Friendship' (13.88 days) under field condition. The 'Arka Amar' was rated as superior genotype for vase life. The vase life is an important varietal character which may be affected by the sensitivity of the crop to the ethylene as ethylene is senescence promoting hormone. The results are in accordance with the findings of Swaroop (2010) and Jana and Das (2015).

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