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SEED SETTING BEHAVIOUR AMONG RESISTANT AND SUSCEPTIBLE GENOTYPES OF GLADIOLUS (*GLADIOLUS XHYBRIDUS* HORT.) FOR FUSARIUM WILT DISEASE

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ABSTRACT
Gladiolus (family Iridaceae) is one of the most important flowering geophytes commercially cultivated for cut flower trade in India and abroad. A total of eight intervarietal cross combinations of resistant and susceptible gladiolus genotypes were made and tested at ICAR-Indian Horticultural Research Institute, Hesaraghatta Lake Post, Bengaluru during 2011-2012 with an objective to find out the potentiality of seed setting in different cross combinations.The cross combination 'IIHRG-12 × Arka Amar' recorded maximum number of seeds per cross (157.33), early capsule maturity (30.33 days) and highest seed germination (96.89%). The genotype 'IIHRG-12' as a female parent in cross combination contributed to higher number of seeds per capsule and per cross. Inclusion of 'IIHRG-12' as male parent also has increased comparatively high number of seeds than any of the cross combinations tested.

INTRODUCTION

Gladiolus, the queen of bulbous ornamentals, is a leading geophyte grown worldwide for cut flower trade and garden displays (Kumar *et al.,* 2015). It occupies a pristine place in the garden for its magnificent inflorescence, wide array of colours, and fascinating varieties of shapes and sizes (Pragya *et al.*, 2010). Gladiolus, the largest genus of the petaloid monocot plant family Iridaceae, is thought to comprise some 255 species (Goldblatt and Manning, 1998). The modern cultivated gladiolus (*Gladiolus* x*hybridus* Hort.) have been developed from 20-25 species which offer a diversity of colours, shapes, and sizes available in few other flowering plants. It is cultivated in almost all countries of the world where spring and summer conditions are favorable (Cantor and Tolety, 2011).

One of the main constraints of gladiolus cultivation is the fusarial wilt disease caused by fungus *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% damage to gladiolus depending on varietal response (Pathania and Misra, 2000). Improvement of any crop depends on its natural variability which again depends on its reproductive biology. Hybridization, the crossing of one cultivar with another and selection, will probably continue as the most reliable source of new cultivars. The goal of hybridizing is to create superior cultivars by bringing new combinations of genes within chromosomes together through cross pollinations (Hartline, 1996). Considering the economical criteria of the production and commercialization, gladioli flowers must satisfy simultaneously numerous esthetical requirements. The development of desirable varieties with wide genetic base is possible only through sexual propagation in conventional breeding.

The study on the potentiality of seed set in the intervarietal and interspecific crosses is one of the most important pre-requisites for successful breeding program.Extremely low seed set in a few intervarietal crosses, and failure of seed set in some interspecific crosses are apparently realized as major problems in breeding of bulbous flowers including gladiolus (Van Tuyl,1997). In the present study, hybridization in gladiolus was carried out to assess seed setting behaviours of intervarietal crosses aimed at development of new cultivars with resistance to *Fusarium* wilt disease and better quality of spike.

MATERIALS AND METHODS

The experiment was carried out with four gladiolus genotypes i.e. Arka Amar, Arka Aayush, IIHRG-12 and Pink Friendship. A total of eight cross combinations were made such as Arka Amar x IIHRG-12, IIHRG-12 x Arka Amar, Arka Amar x Pink

Friendship, Pink Friendship x Arka Amar, Arka Aayush x IIHRG-12, IIHRG-12 x Arka Aayush, Arka Aayush x Pink Friendship and Pink Friendship x Arka Aayush. Flower colour of all the genotypes was recorded by using RHS colour charts given in Table 1.

Hybridization procedure

Hybridization was done by hand emasculation and hand pollination. The crossing was done between *Fusarium* wilt resistant ('Arka Amar' and 'IIHRG-11') and susceptible ('Pink Friendship' and 'IIHRG-12') genotypes. From each spike three florets were selected. All the anthers were removed carefully with forceps and bagging was done (Misra *et al.,* 2003). Emasculation was done in the afternoon and pollination was done on next day in the morning hours. Flowers were pollinated between 10 a.m. and 11.30 a.m. by gently rubbing dehisced anther against the sticky stigmatic surface. Lower three buds *viz*., B1, B2, B3 were used for hybridization and remaining part of spike was removed as soon as the pollination of third bud was completed. After pollination, the florets were covered with perforated butter papers bags, tied with thread and labelled.

Capsule harvesting and seed extraction

Capsules generally matured in 4-6 weeks after pollination (Misra *et al.,* 2003) depending upon genotypes and weather under Bangalore condition. The spikes that consisted of matured capsules were cut below the first capsule with scissor. Each capsule was separated and kept in small brown paper bags. Before seed extraction, all matured capsules were allowed to dry. Thereafter, each capsule was split longitudinally along the suture and seeds were extracted from individual capsule. Seeds of an individual capsule were kept in perforated butter paper bags. An individual butter paper bag was labelled, indicating pollination date, parentage, harvesting date, and number of seeds. The number of seeds in a pod varies considerably, depending upon the extent of compatibility of the cross.

Sowing of hybrid seeds and aftercare

Before sowing, the seeds were rubbed between two layers of cloth to remove the waxy covering. Seeds were sown in seed pans containing media (cocopeat, sand, soil and FYM @ 3:2:0.5:0.5 v/v). The seeds were sown in 2 cm deep furrows with the individual seeds not closer than 2.5 cm. Before sowing, media was drenched with Bavistin and Captan @ 2g/l each. Seed pans were kept moist by watering with fine rose can. Seeds started germination after 10-15 days of sowing. The observations recorded are days taken for capsule maturity, number of seeds per capsule, number of seeds per cross and seed germination percentage. The experimental design used was RCBD for total number of seeds and maturity, factorial RCBD for number of seeds per capsule and factorial CRD for seed germination percentage. The statistical analysis was carried using SAS-GLM (SAS, 2009) V 9.2 available at Statistics Laboratory, ICAR-IIHR, Bengaluru.

RESULTS AND DISCUSSION

Total number of seeds and days to capsule maturity

On the perusal of data presented in Table 2 indicated highly significant variations for total number of seeds per cross and days taken for capsule maturity among different cross combinations. The total number of seeds per cross varied from 3.33 to 157.33. The cross combination 'Pink Friendship x Arka Amar' (56.67), 'Arka Aayush x IIHRG-12' (49.67), 'Pink Friendship x Arka Aayush' (43.33) and 'Arka Amar x Pink Friendship' (23.33) produced more number of seeds per cross, while, cross combination 'Arka Aayush x Pink Friendship' produced minimum number of seeds per cross (3.33). These findings nearly agree with the results of Dhaduk *et al.* (1987).

The cross combinations recorded significant variations for days taken to capsule maturity (30.33 days to 36.67 days).The cross combination 'Arka Aayush x IIHRG-12' had taken maximum days for capsule maturity (36.67) followed by 'Arka

Table 1: Flower colour of genotypes used for crossing

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 andGreen White (157.D) blotch.

Table 2: Effect of different cross combination on total number of seeds and days to capsule maturity

Cross combination	Total number of seeds/cross	Days taken for capsule maturity
Arka Amar x IIHRG-12	125.33	31.33
IIHRG-12 x Arka Amar	157.33	30.33
Arka Aayush x IIHRG-12	49.67	36.67
IIHRG-12 x Arka Aayush	152.33	30.67
Arka Amar x Pink Friendship	23.33	30.67
Pink Friendship x Arka Amar	56.67	32.67
Pink Friendship x Arka Aayush	43.33	31.33
Arka Aayush x Pink Friendship	3.33	34.00
SEm ±	9.11	1.06
C.D. @ 5 %	27.65	3.23
CV	20.66	5.72

Table 3: Effect of different cross combination on seed set per capsule

Cross combination (A)	Bud stages (B)			Mean
	B1(First bud)	B2(Second bud)	B3(Third bud)	
Arka Amar x IIHRG-12	50.67	47.33	27.33	41.78
IIHRG-12 x Arka Amar	65.67	61.67	30.00	52.44
Arka Aayush x IIHRG-12	22.00	15.00	12.67	16.55
IIHRG-12 x Arka Aayush	65.67	51.33	35.33	50.78
Arka Amar x Pink Friendship	14.33	7.67	1.33	7.78
Pink Friendship x Arka Amar	41.67	12.00	3.00	18.89
Pink Friendship x Arka Aayush	23.33	17.33	2.67	14.44
Arka Aayush x Pink Friendship	2.67	0.67	0.00	1.11
Mean	35.75	26.63	14.04	-
Grand mean	25.47			
Types of comparisons	CD @ 5%			
A	5.95			
B	3.64			
A x B	10.27			

Table 4: Effect of different cross combination on seed germination (%)

Cross combination (A)	Bud stages (B)			Mean
	B1(First bud)	B2(Second bud)	B3(Third bud)	
Arka Amar x IIHRG-12	88.00	80.00	73.33	80.44
IIHRG-12 x Arka Amar	94.67	97.33	98.67	96.89
Arka Aayush x IIHRG-12	96.00	89.33	88.00	91.11
IIHRG-12 x Arka Aayush	93.33	90.67	93.33	92.44
Mean	93.00	89.33	88.33	
Grand mean	90.22			
Types of comparisons	SEm	SEd	CD @ 5%	CD @ 1%
A	2.1	2.97	6.16	8.37
B	1.81	2.57	-	-
A x B	3.63	5.15	-	-

Aayush x Pink Friendship' (34.00) and 'Pink Friendship x Arka Amar' (32.67). However, cross combination 'IIHRG-12 x Arka Amar' had taken minimum days for capsule maturity (30.33) which was statistically on par with cross combinations 'IIHRG-12 x Arka Aayush' and 'Arka Amar x Pink Friendship'.

Number of seeds per capsule

Interaction between cross combinations and bud stages (first bud, second bud and third bud) on seed setting was found significant (Table 3). Similarly, significant difference was recorded in seed setting in the entire cross combinations and all bud stages. Maximum number of seeds per capsule was recorded in first bud which is followed by second and third bud. In all cross combination, the first bud produced maximum number of seeds. Treatment combination, *viz.*, 'IIHRG-12 x Arka Amar' produced the highest number of seeds in first capsule which differ significantly from the same cross combination in the second and the third capsule.The mean number of seeds per capsule varied from 14.04 to 35.75. Maximum number of seeds were recorded in cross combination 'IIHRG-12 x Arka Amar' (52.44) followed by 'IIHRG-12 x Arka Aayush' (50.78) which were statistically on par. However, minimum number of seeds per capsule was recorded in cross combination 'Arka Aayush x Pink Friendship' (1.11).The number of seeds per capsule per cross varied from 1.11 to 52.44 with mean value of 25.33. Misra *et al*. (2001) also reported wide variations with respect to seeds per capsule. Choudhary *et al*. (2014) also evaluated forty five inter and intraspecific hybrids for seed parameters in cotton.

The genotype 'IIHRG-12' as a female parent in cross combination appeared to have contributed to higher number of seeds per capsule. Even incorporation of this genotype as male parent also seemed to have increased comparatively high number of seeds than any of the cross combinations tested. Thus, genotype 'IIHRG-12' as both female and male parent must have contributed to produce maximum number of seeds per capsule in cross combinations studied. This genotype could have genetic trait to assist in augmenting the number of seeds per capsule. Bhujbal *et al*. (2013) and Chourasia *et al*. (2015) also evaluated genotypes for growth, flowering and corm characters and found highly significant varietal differences indicated the presence of high amount of variability.

Seed germination (%)

Interaction effect of both the factors *viz*., cross combination and bud stages was non-significant (Table 4). Similarly, on par results were obtained for seed germination percentage in all bud stages. The significant variation was recorded in seed germination percentage in all cross combinations. Seed germination in cross combinations varied from 80.44% to 96.89%. The maximum seed germination was recorded in cross combinations 'IIHRG-12 x Arka Amar' (96.89 %), followed by 'IIHRG-12 x Arka Aayush' (92.44 %) and 'Arka Aayush x IIHRG-12' (91.11 %) which were statistically on par.

However, minimum seed germination was recorded in 'Arka Amar x IIHRG-12' (80.44%).

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