

Effect of gamma irradiation on morphological changes, flowering and induced mutants in gladiolus

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ABSTRACT

Investigation was carried out for 3 years (2011-12, 2012-13 and 2013-14). Gamma doses, *i.e.*, 0.0, 1.5, 2.5, 3.5, 4.5 and 5.5 kR were applied on seven gladiolus varieties (Aldebaran, Jyotsana, Legend, Praha, Punjab Dawn, Pusa Kiran and Tiger Flame). Maximum plant height and leaf area index were registered with control which was at par with 1.5 kR irradiation. Early colour show of floret petal was recorded with 5.5 kR and it was exhibited late with control. Lower dose of gamma irradiation (1.5 kR) exhibited the maximum diameter of 1st floret. Maximum spike length was recorded with control and it was at par with 1.5 kR. Various morphological changes were observed on the plants and flowers in Pusa Kiran, Jyotsana and Praha varieties at 2.5 and 4.5 kR gamma irradiation doses. A mutant was identified during vM₁ and vM₂ in variety Tiger Flame at 4.5 kR dose of gamma irradiation. This mutant was isolated during vM₃ having yellow colour lower petals, whereas in parent genotype petals colour was orange. Flowers of mutant are arranged densely on the spike due to short internodal length, resulting in attractive look.

Key words: Gladiolus, gamma rays, flowering, leaf area index, mutant.

INTRODUCTION

Presently gladiolus is one of the most common cut flowers grown in India because of its majestic spikes containing attractive, elegant and delicate florets of various shades, sequential opening of flowers for a longer duration and good keeping quality of cut spikes. The demand of gladiolus is increasing therefore; it needs attention towards genetic improvement. The prime strategy in mutation-based breeding has been to upgrade the well-adapted plant varieties by altering one or two major traits, which limit their productivity or enhance their quality value. Worldwide more than 2,250 varieties have been released that have been derived either as direct mutants or from their progenies. Induction of mutations with radiation has been the most frequently used method for direct development of mutant varieties (Ahloowalia *et al.*, 1). However, according to the FAO/IAEA database, of the 552 mutant cultivars of floricultural plants (Maluszynski *et al.*, 7), most were in chrysanthemum (232), followed by rose (61), dahlia (36), alstroemeria (35) and carnation (18). Very meagre information on genetic improvement of gladiolus is available through gamma irradiation. Earlier workers demonstrated that the mutation could induce variation in gladiolus (Raghava *et al.*, 8; Bhuj and Singh, 4). Hence, an effort was made to carry out research on application of gamma doses in gladiolus varieties to find out its influence on morphological and flower traits in the induced mutants.

MATERIALS AND METHODS

The present investigation was carried out 3 years, *i.e.* 2011-2012, 2012-2013 and 2013-2014 at Department of Horticulture, BHU, Varanasi. Corms of seven gladiolus varieties, *viz.*, Aldebaran, Jyotsana, Legend, Praha, Punjab Dawn, Pusa Kiran and Tiger Flame were exposed to gamma irradiation doses at 0.0, 1.5, 2.5, 3.5, 4.5, 5.5 kR. Gamma irradiation work was done at National Botanical Research Institute, Lucknow. These treated corms were planted in the beds at 30 cm × 20 cm distance during 2011. Corms were harvested during April and stored in cold storage at 4°C. These corms were again planted during November 2012, subsequently corms were harvested and planted in 3rd year during November 2013 to observe different characters. The experiment was laid out in randomized block design with 5 replications. Various parameters were observed during 1st and 2nd years on growth and flowering, *i.e.*, days to sprouting, plant height, leaf area index, days to colour show, diameter of first floret, length of spike at colour show and data were pooled for statistical analysis. Various morphological changes were observed during 1st and 2nd years; hence, study was carried out during 3rd year (2013-2014) to see the stability of induced mutants. Flower colour of induced mutants was observed with flower colour chart developed by Royal Horticultural Society, London and compared with colour of parent plants.

RESULTS AND DISCUSSION

Earliest sprouting was recorded with 5.5 kR

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treatment which was statistically significant to all other treatments and late sprouting was observed in control (Table 1). Among the varieties, delayed sprouting was observed in var. Praha which was statistically higher than other varieties. Interaction of 5.5 kR gamma irradiation with var. Jyotsana resulted in earliest sprouting of corms followed by 3.5 kR with var. Praha and 2.5 kR with var. Praha. Present findings are also lent credence with observation made by Mahure *et al.* (6), Rather and Jhon (9) and Srivastava *et al.* (11). They observed that lower dose proved very favourable, however higher doses of gamma adversely affected vegetative and floral traits in different flower crops. Leaf area index (LAI) recorded during both years of experimentation was influenced due to various doses of gamma irradiation (Table 1). Maximum LAI was recorded with control. Gamma irradiation at 1.5 kR dose registered second rank followed by 2.5, 3.5 and 5.5 kR. No significant difference was observed between control and 1.5 kR irradiation. Among varieties, Tiger Flame resulted in maximum LAI followed by var. Jyotsana and Punjab Dawn. Reduction in plant growth, leaf width and other vegetative characters may primarily be attributed to inhibition or delay in mitosis. Rather and Jhon (2000) recorded reduced leaf length and width due to application of higher gamma doses in Dutch iris. Maximum plant height (40.14 cm) was registered with control, which was statistically at par with 2.5 and 1.5 kR of gamma irradiation. Minimum plant height was registered with 5.5 kR of gamma irradiation and it was significantly lower than other treatments (Table 2). Among varieties, Jyotsana resulted in maximum

plant height, which was significantly higher than other varieties. Interaction of 1.5 kR with var. Jyotsana resulted in maximum plant height followed by 2.5 kR with var. Jyotsana. Decrease in plant height at higher doses of gamma irradiation might be due to reduction in the number of vertical cell layers, which resulted in shorter internode, reduction in number of thus internode or any combination of these processes. Results of present experiment are also in the line with the observations made by Rather and Jhon (9) who recorded short plant height and reduced leaf length and width due to application of higher gamma doses in Dutch iris.

It is apparent from the Table 2 that days to colour show was influenced due to gamma irradiation during both the years of investigation. Gamma doses at 3.5, 4.5 and 5.5 kR found lethal and var. Legend failed to produce any spike. Early colour show was recorded with gamma irradiation dose at 5.5 kR. Whereas, late colour show was exhibited with control followed by 1.5 and 2.5 kR gamma doses. Earlier, Mahure *et al.* (6) observed that lower dose proved favourable for early flowering in chrysanthemum. The present findings are also in line with the observations of Srivastava *et al.* (11), who recorded early flowering with 20 and 40 Gy in comparison to control on days to flowering. Data pertaining to the diameter of 1st floret was found significant due to various gamma irradiation treatments and different varieties (Table 3). The maximum floret diameter was recorded with 1.5 kR treatment, which was at par with control and 2.5 kR and significant to other treatments. Among varieties, Tiger Flame exhibited the maximum diameter of 1st floret followed

Table 1. Effect of gamma irradiation on days to sprouting and leaf area index in different gladiolus varieties.

Variety	Days to sprouting							Leaf area index						
	Control	1.5 kr	2.5 kr	3.5 kr	4.5 kr	5.5 kr	Mean	Control	1.5 kr	2.5 kr	3.5 kr	4.5 kr	5.5 kr	Mean
Aldebaran	13.60	14.90	13.60	14.40	15.90	15.00	14.56	0.119	0.133	0.129	0.112	0.091	0.084	0.111
Jyotsana	11.80	8.90	10.00	11.00	10.30	5.20	9.53	0.142	0.186	0.174	0.171	0.149	0.069	0.148
Legend	11.50	6.80	6.10	5.50	6.60	6.00	7.08	0.159	0.067	0.075	0.064	0.051	0.055	0.078
Praha	18.10	17.20	16.70	16.50	16.70	10.00	15.86	0.133	0.134	0.135	0.111	0.093	0.118	0.120
Punjab Dawn	12.80	14.20	16.60	11.90	14.50	6.60	12.76	0.178	0.163	0.134	0.134	0.176	0.055	0.140
Pusa Kiran	11.90	12.80	10.10	11.70	10.20	11.90	11.43	0.162	0.144	0.138	0.134	0.116	0.118	0.135
Tiger Flame	15.20	12.80	12.20	14.90	15.30	6.30	12.78	0.155	0.176	0.175	0.178	0.169	0.079	0.155
Mean	13.55	12.51	12.18	12.27	12.78	8.71		0.149	0.143	0.137	0.129	0.120	0.092	
CD (P = 0.05)														
Treatment				0.76								0.006		
Variety				0.83								0.006		
Treatment × Variety				2.03								0.015		

by var. Jyotsana and Punjab Dawn. No significant difference was observed between var. Tiger Flame and Jyotsana. The interaction of gamma dose and gladiolus variety were also found significant. In general, higher doses of gamma irradiation were not found beneficial. In an experiment of gamma rays in rose varieties, size of flower reduced in var. Potluck, Blue Blood and Mountie, whereas it was increased in var. Dark Red Mountie (Arnold *et al.*, 2). Maximum length of spike at colour show stage was recorded with control followed by 1.5,

4.5, 3.5, 2.5 and 5.5 kR treatments (Table 3). However, no significant difference was observed between control and lower dose of gamma irradiation (1.5 kR). Among varieties, Jyotsana registered the maximum length of spike which was statistically higher than other varieties. Interaction of control with var. Jyotsana and 4.5 kR with var. Jyotsana exhibited the maximum spike length followed by var. Tiger Flame with control. At higher doses effect of gamma irradiation was more pronounced, which resulted in smaller spike length and

Table 2. Effect of gamma irradiation on the plant height (cm) and days to colour show in different gladiolus varieties.

Variety	Plant height (cm)							Days to colour show						
	Control	1.5 kr	2.5 kr	3.5 kr	4.5 kr	5.5 kr	Mean	Control	1.5 kr	2.5 kr	3.5 kr	4.5 kr	5.5 kr	Mean
Aldebaran	39.76	37.77	42.53	38.91	34.41	31.45	37.47	99.60	100.60	100.50	47.40	47.00	48.70	73.96
Jyotsana	43.71	51.36	51.31	47.39	46.32	20.50	43.43	90.30	82.60	79.60	87.90	80.70	41.00	77.01
Legend	44.40	24.85	18.91	19.23	20.44	22.33	25.02	75.00	39.10	43.60	0.00	0.00	0.00	26.28
Praha	35.29	30.11	38.48	36.28	37.37	32.63	34.98	85.60	91.80	95.80	43.30	42.60	42.90	67.00
Punjab Dawn	36.27	41.79	38.54	40.41	37.72	17.03	35.28	85.40	86.20	83.70	84.60	85.50	40.40	77.63
Pusa Kiran	43.13	43.04	41.06	38.88	38.66	33.98	39.79	83.30	80.50	80.10	40.00	36.50	40.30	60.11
Tiger Flame	38.47	41.31	42.15	37.77	38.95	18.04	36.11	98.50	99.70	95.10	97.10	94.90	47.40	88.78
Mean	40.14	38.60	38.99	36.98	36.26	25.13		88.24	82.92	82.62	57.18	55.31	37.24	
CD (P = 0.05)														
Treatment				2.35							1.50			
Variety				2.54							1.63			
Treatment × Variety				6.24							3.99			

Table 3. Effect of gamma irradiation on diameter of 1st floret (cm) and length of spike at colour show stage (cm) in different gladiolus varieties.

Variety	Diameter of 1 st floret (cm)							Length of spike at colour show stage (cm)						
	Control	1.5 kr	2.5 kr	3.5 kr	4.5 kr	5.5 kr	Mean	Control	1.5 kr	2.5 kr	3.5 kr	4.5 kr	5.5 kr	Mean
Aldebaran	10.21	11.06	10.35	4.37	4.25	4.12	7.39	60.62	66.81	64.74	29.00	25.79	29.80	46.12
Jyotsana	8.12	10.37	9.92	10.17	9.76	3.35	8.61	70.04	64.59	65.61	68.49	84.86	29.70	63.88
Legend	8.02	4.60	4.20	0.00	0.00	0.00	2.80	59.51	29.87	30.99	0.00	0.00	0.00	20.06
Praha	9.60	9.47	9.28	4.34	4.12	4.37	6.86	51.35	58.22	53.53	29.70	19.48	25.60	39.64
Punjab Dawn	8.52	9.29	9.15	8.52	8.24	3.40	7.85	65.48	64.70	60.73	49.18	47.85	24.33	52.04
Pusa Kiran	8.93	9.07	9.45	4.97	4.12	3.70	6.70	64.75	57.61	61.87	29.21	28.82	22.27	44.08
Tiger Flame	10.04	10.35	10.34	9.20	9.08	4.55	8.92	76.74	67.50	65.14	62.86	62.47	10.23	57.49
Mean	9.06	9.17	8.95	5.93	5.65	3.35		64.07	58.47	30.69	38.34	38.46	20.27	
CD (P = 0.05)														
Treatment				0.39							2.46			
Variety				0.42							2.66			
Treatment × Variety				1.04							6.53			

reduced flower size. This might be due to reduction in plant growth. Banerji and Datta (3) also reported similar findings while working with chrysanthemum var. Lalima due to gamma irradiation.

Various morphological changes were observed on the plants and flowers in gladiolus varieties. In varieties Pusa Kiran, Jyotsana and Praha these changes were apparently observed. In a plant abnormal spike growth was observed at 4.5 kR dose of gamma irradiation in var. Pusa Kiran. In this plant much wider leaf, abnormal and short spike were observed. In variety Jyotsana, white colour on petals was developed. These white colour chimeras appeared on two petals. Apart from this, pink stripes were also observed on edges in mutant isolated from 2.5 kR gamma irradiation dose. In another plant of var. Jyotsana small size florets were produced when gamma dose was applied at 4.5 kR. In this plant, white colour chimera was also appeared. Gamma dose at 2.5 kR resulted in orientation of florets on both side of spike from var. Praha. Morphological changes in gladiolus were also noticed by earlier workers. Kasumi *et al.* (5) found a mutated sectorial chimeric flower colour variant obtained by gamma irradiation of cormels of gladiolus var. Traveler. Morphological abnormalities in the foliage and florets were also observed in the irradiated material of gladiolus (Singh and Kumar, 10).

A mutant was isolated in cultivar Tiger Flame at 4.5 kR gamma irradiation dose. Lower petals of this mutant were yellow. Flowers were arranged densely on the spike due to less internodal length which gave a very appealing and attractive look. Lower petals were found of yellow colour in comparison to parent. Flowers of mutant were smaller than parent. Two lower petals of mutant were yellow (Yellow 10 B) colour, whereas, in parent upper portion of 2nd and 3rd petals were of orange red (C) colour and throat was also orange (N 25 B), lower portion of petal was yellow (2 B). Difference on shape and size of the petals was also observed. Petals of parent were larger in size and ovate in shape, whereas, petals of mutant were smaller in size and have elliptical shape. The parent colour of 4th, 5th and 6th petals were orange red (33 B), orange red (33 B) and red (40 B), respectively. However, in mutant colour of 3rd, 4th and 5th florets colour were orange red (33 C), orange red (33 C) and red (37 A), respectively (Table 6). In a study a desirable and stable mutant isolated from the var. Wild Rose in 1 kR treatment and was released as Shobha (Raghava *et al.*, 8), while studying the effect of gamma rays from ⁶⁰Co in three varieties of gladiolus, namely Little Giant, Mansoer and Wild Rose. In another study, gamma irradiation was done in different varieties of gladiolus, whereas, sensitivity to radiation was observed only in var. Fidelio. In vM₁ and vM₂ generations, the mutant exhibited white coloured tepals with slight ruffling (Bhuj and Singh, 4). This

mutant produced desirable qualitative and quantitative traits and later released as variety Shubhangini.

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