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Horticulture

Influence Gamma Irradiation on Morphological Changes, Post Harvest Life and Mutagenesis in Gladiolus

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Abstract

Present investigation was carried out for 3 years (2011-12, 2012-13 and 2013-14) at Varanasi, India to find out influence of various gamma doses i.e. 1.5, 2.5, 3.5, 4.5 and 5.5 kR along with untreated (control) in different varieties of gladiolus viz., Aldebaran, Jyotsana, Legend, Praha, Punjab Dawn, Pusa Kiran and Tiger Flame. Maximum number of opened florets in vase was recorded with control during 1st year, whereas during 2nd year it was higher with 2.5 kR. Among varieties maximum opened florets were exhibited with cvs. Jyotsana and Tiger Flame during 1st and 2nd, respectively. Gamma dose at 1.5 kR registered maximum number of opened florets at a time during both years. Longevity of first floret was more with 2.5 kR treatment. Maximum vase life was recorded with 5.5 and 2.5 kR during 1st and 2nd year respectively. Among the varieties, maximum vase life was recorded with cv. Punjab Dawn followed by cvs. Tiger Flame during 1st and 2nd years. Various morphological changes were observed with different doses (3.5, 4.5 and 5.5 kR) and an unstable mutant in variety Pusa Kiran was observed at 2.5 kR. However, a stable mutant during 3rd year of investigation was recorded in cv. Tiger Flame at 3.5 kR gamma irradiation. This mutant has orange yellow colour flowers. Variation on flower shape, size and colour was exhibited than parent.

Highlights

- Gamma doses 1.5 and 2.5 kR were found beneficial for post harvest life.
- Among the varieties Jyotsana, Tiger Flame and Pusa Kiran positively responded with gamma doses.
- A stable mutant of orange yellow colour was evolved in variety Tiger Flame at 3.5 kR gamma dose.

Keywords: Gladiolus, gamma irradiation, post harvest, vase life, mutant.

Among the bulbous ornamental plants, gladiolus a member of family Iridaceae and sub family Ixiodeae, is one of the most popular ornamental plants grown commercially for its fascinating flowers in many part of the world. Among the commercial flowers, gladiolus is one of the most important flowers 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 (Singh, 2006). The demand of gladiolus is increasing therefore; it needs attention towards genetic improvement. These have mostly been evolved through conventional breeding but a

few through mutation breeding. Mutation is recognized as one of the most important technology for the development of new varieties through genetic manipulation. Mutation technique by using ionizing radiations and other mutagens have successfully produced a large number of new promising varieties in different ornamental plants. Mutation breeding has been successfully applied for varietal improvement of many crop species. About 70% of the world's mutant varieties have been induced through gamma-rays. Therefore, present experiment was aimed to find out influence of gamma doses on morphological changes, flowering and induced mutants in gladiolus.

Materials and Methods

The present investigation was carried out at Horticulture Research Farm and at Post-harvest Laboratory, Department of Horticulture, Banaras Hindu University, Varanasi, Uttar Pradesh during 2011-2012, 2012-2013 and 2013-2014. The experimental site lies approximately in the centre of North-Gangetic alluvial plain; on the left bank of river Ganga is homogeneously fertile with uniform textural makeup. Varanasi city situated at 250 10' North latitude and 830 03' East longitudes. The altitude is 123.23 meter above the mean sea level. The climate of Varanasi is humid subtropical with large variation between summer and winter temperature. During the experiment the maximum temperature ranges from 14.2°C to 43.0°C in summer and minimum temperature 7.1°C to 28.1°C in winter. Gladiolus corms of 7 varieties viz., Aldebaran, Jyotsana, Legend, Praha, Punjab Dawn, Pusa Kiran and Tiger Flame were exposed to gamma doses at 1.5 kR, 2.5 kR, 3.5 kR, 4.5 kR and 5.5 kR at National Botanical Research Institute, Lucknow. These treated corms were planted in the beds with a spacing of row to row 30 cm and corm to corm 20 cm during November 2011. Corms were harvested during April and store in cold storage at 4°C. These corms were again planted during November 2012 subsequently corm 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 on flowering and morphological changes

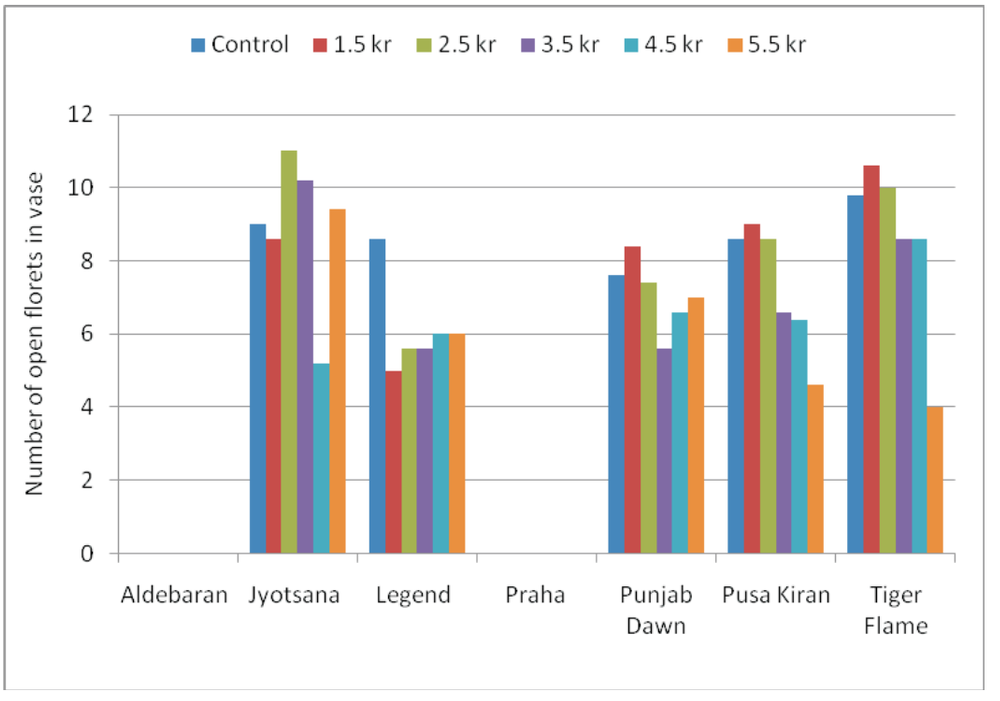

Fig. 1. Number of open florets in vase as influenced by gamma doses and varieties in gladiolus (1st year)

i.e., rachis length, durability of 2nd floret in field, diameter of 5th floret and days to withering during 1st and 2nd years and during 3rd year to see the stability of induced mutants. Flower colour of induced mutant was observed with flower colour chart developed by Royal Horticultural Society, London and compared with colour of parent plant.

Results and Discussion

Number of opened florets in vase

Data pertaining to the number of florets opened in the vase solution are presented in Fig. 1 and Fig. 2. Various treatments of gamma irradiation, varieties and their interaction influenced significantly number of florets opened in the vase during both years of the investigation. Maximum number of opened florets in vase was recorded with control; however, it was at par with 2.5 kR and 1.5 kR treatment. Increased dose of gamma irradiation i.e., 3.5 kR, 4.5 kR and 5.5 kR resulted in reduced number of opened florets. During 2nd year higher dose (5.5 kR) of gamma irradiation failed to produce florets, hence, treatment 5.5 kR was not included in the analysis. Among rest treatments lower doses of gamma irradiation (2.5 kR and 1.5 kR) found beneficial and resulted in maximum opened. During 1st year, 5 varieties were included for post harvest studies. These varieties were Jyotsana, Legend, Punjab Dawn, Pusa Kiran and Tiger Flame. However, during 2nd year, post harvest studies were done on 4 varieties i.e., Jyotsana, Punjab Dawn, Pusa Kiran and Tiger Flame. Spikes of cvs. Aldebaran, Legend and Praha were either not emerged or found abnormal; hence, these varieties were not included for post harvest study. Cultivar Jyotsana exhibited maximum number of open florets which was at par with cv. Tiger Flame. During 2nd year maximum number of opened florets in vase was recorded with cv. Tiger Flame followed by cvs. Jyotsana, Punjab Dawn and Pusa Kiran. During 1st year interaction of 2.5 kR with cv. Jyotsana resulted in maximum open florets in vase. However, during 2nd year interaction of 1.5 kR with var. Tiger Flame resulted in maximum number of open florets in vase. The results are in close conformity with findings of Anu *et al.,* (2003) who carried out an experiment on gamma irradiation in different varieties of tuberose and found out that vase life of cut spikes increased at lower doses of gamma irradiation and reduced at higher doses of gamma rays. In a study, differentiation of the conductive tissues increased as kinetin and gibberellins concentration increased. The flower spike elongated and differentiation of the individual flower occurred as a result of low doses of gamma irradiation in gladiolus (Awad and Harried, 1985).

Florets opened at a time

Findings of the number of florets opened at a time were influenced by different gamma doses, varieties and interaction have been presented in Table 1. Among the various gamma doses 1.5 kR resulted in maximum number of florets opened at a time (4.52) followed by 2.5 kR (4.44), control (4.36), 4.5 kR (3.92), 3.5 kR (3.76) and 5.5 kR (3.60) during 1st year. Similar trend has also been observed during 2nd year observations and gamma dose at 1.5 kR exhibited maximum number of opened florets at a time (5.15) which was statistically at par with 2.5 kR and significant to other treatments. During 1st year maximum number of opened florets at a time was recorded with cv. Punjab Dawn (4.53) which was at par with cvs. Jyotsana, Tiger Flame and Pusa Kiran, whereas, these were significant to cv. Legend. During 2nd year cv. Punjab Dawn recorded maximum number of opened florets at a time (4.64) and it was at par with cvs.

Tiger Flame and Jyotsana. Interaction of treatment 2.5 kR and cv. Jyotsana gave pronounced effect on number of opened florets at a time during 1st year. During 2nd year interaction of 1.5 kR with cv. Tiger Flame recorded maximum number of florets opened at a time. Pandey and Gaur (1984) reported that low irradiation of 1 kR exhibited slight earlier sprouting. They further observed a rise in sugar content due to gamma irradiation which probably played some role in augmenting some metabolic processes in the plant and resulted in increased vase life and longevity of flower in gladiolus. Sugar is directly related to the flower quality, longevity and vase life in general. The results of Hayashi and Todoriki (1996) suggest that sugar solution following irradiation prolonged the vase life of cut chrysanthemum. Present findings are also lent credence with the observation made by several earlier workers. Life of tuberose flower increased significantly due to gamma irradiation and a dose of 5 rad irradiation found most beneficial over other treatments (Kumar *et al.,* 2003).

Table 1. Effect of gamma irradiation on number of florets opened at a time in the different varieties of gladiolus

Varieties	I year							II year						
	Treatments							Treatments						
	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*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jyotsana	4.40	4.40	5.60	4.00	4.00	4.40	4.46	4.20	5.20	5.00	3.40	3.60	-	3.56
Legend**	3.60	3.00	2.40	2.60	2.60	3.60	2.96	-	-	-	-	-	-	-
Praha*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Punjab Dawn	4.20	5.40	5.00	4.60	4.40	3.60	4.53	4.40	5.20	5.00	5.40	3.20	-	3.86
Pusa Kiran	5.00	4.60	5.00	3.40	4.00	3.40	4.23	5.00	4.60	5.00	0.00	0.00	-	2.43
Tiger Flame	4.60	5.20	4.20	4.20	4.60	3.00	4.30	5.00	5.60	4.00	3.60	3.40	-	3.60
Mean	4.36	4.52	4.44	3.76	3.92	3.60		4.65	5.15	4.75	3.10	2.55	-	
C.D. (0.05)														
Treatments	0.31							0.50						
Varieties	0.34							0.45						
Treatments × Varieties	0.76							0.99						

(*) Not included in the statistical analysis.
(**) Not included in the statistical analysis during 2nd year.

Table 2. Effect of gamma irradiation on floret longevity (days) in the different varieties of gladiolus

Varieties	I year							II year						
	Treatments							Treatments						
	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*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jyotsana	4.00	5.40	5.80	4.60	3.40	2.40	4.26	4.00	5.20	6.00	4.20	3.60	-	3.83
Legend**	3.00	3.00	3.60	3.00	3.00	2.40	3.00	-	-	-	-	-	-	-
Praha*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Punjab Dawn	4.40	5.00	5.60	4.00	3.00	3.40	4.23	4.40	5.20	5.20	4.00	3.00	-	3.63
Pusa Kiran	4.40	5.20	5.20	3.20	3.60	3.00	4.10	4.40	5.20	5.20	0.00	0.00	-	2.46
Tiger Flame	4.40	5.00	4.60	4.00	3.00	2.60	3.93	4.40	5.00	5.60	3.80	3.20	-	3.66
Mean	4.04	4.72	4.96	3.76	3.20	2.76		4.30	5.15	5.50	3.00	2.45	-	
C.D. (0.05)														
Treatments	0.43							0.38						
Varieties	0.39							0.34						
Treatments × Varieties	0.95							0.75						

(*) Not included in the statistical analysis.
(**) Not included in the statistical analysis during 2nd year.

Table 3. Effect of gamma irradiation on water uptake (ml) in the different varieties of gladiolus

Varieties	I year							II year						
	Treatments							Treatments						
	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*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jyotsana	14.00	22.60	20.00	20.00	20.60	27.60	20.80	12.40	22.00	20.60	15.20	14.20	-	14.06
Legend**	22.00	9.40	17.40	14.80	12.00	11.20	14.46	-	-	-	-	-	-	-
Praha*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Punjab Dawn	18.00	13.20	8.00	12.60	12.60	13.40	12.96	18.20	14.00	8.20	13.40	13.60	-	11.23
Pusa Kiran	17.20	14.60	16.00	11.20	11.00	8.60	13.10	18.60	18.00	15.20	0.00	0.00	-	8.63
Tiger Flame	18.60	13.40	12.00	14.60	17.20	18.60	15.73	20.60	14.40	12.60	14.00	14.20	-	12.63
Mean	17.96	14.64	14.68	14.64	14.68	15.88		17.45	17.10	14.15	10.65	10.50	-	
C.D. (0.05)														
Treatments	2.10							2.10						
Varieties	1.92							1.92						
Treatments × Varieties	4.69							4.69						

(*) Not included in the statistical analysis.
(**) Not included in the statistical analysis during 2nd year.

Table 4. Effect of gamma irradiation on vase life (days) in the different varieties of gladiolus

Varieties	I year							II year						
	Treatments							Treatments						
	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*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jyotsana	8.40	9.00	11.00	11.00	11.00	11.00	10.23	7.60	9.00	10.60	10.40	8.60	-	7.70
Legend**	9.00	10.20	11.00	9.60	8.60	9.60	9.66	-	-	-	-	-	-	-
Praha*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Punjab Dawn	13.60	13.00	11.20	13.60	15.00	14.60	13.50	12.60	12.00	12.60	12.80	13.60	-	10.60
Pusa Kiran	10.00	9.20	9.60	10.60	9.60	9.40	9.73	9.00	8.60	10.00	0.00	0.00	-	4.60
Tiger Flame	9.60	9.20	13.60	13.00	13.00	10.20	11.43	8.60	9.40	13.00	13.00	12.40	-	9.40
Mean	10.12	10.12	11.28	11.56	11.44	10.96		9.45	9.75	11.55	9.05	8.65	-	
C.D. (0.05)														
Treatments	0.56							0.77						
Varieties	0.51							0.68						
Treatments × Varieties	1.25							1.53						

(*) Not included in the statistical analysis.
(**) Not included in the statistical analysis during 2nd year.

Table 5. Characteristic of gladiolus mutant (3.5 kR gamma dose) along with parent Tiger Flame

Characters	Parentage (Tiger Flame)	Mutant
Length of leaf	38.7 cm	51.3 cm
Width of leaf	3.7 cm	3.3 cm
Width of scape	6.2 cm	4.6 cm
Number of leaves	7	7
Rachis length	58.6 cm	60.3 cm
Number of florets/spike	16	17
Length of floret	10 cm	9.8 cm
Width of floret	8.25 cm	8.5 cm
Floret colour	Deep orange	Light orange upper petal, streaks formation
Throat colour	Orange with shade of yellow	Orange red
Length of 1st petal	7.5 cm	6.9 cm
Length of 2nd petal	7.0 cm	7.0 cm
Length of 3rd petal	7.3 cm	5.6 cm
Length of 4th petal	8.3 cm	7.6 cm
Length of 5th petal	9.5 cm	8.4 cm
Length of 6th petal	8.6 cm	7.4 cm
Width of 1st petal	3.8 cm	3.6 cm
Width of 2nd petal	2.5 cm	2.9 cm
Width of 3rd petal	2.9 cm	2.8 cm
Width of 4th petal	4.5 cm	4.2 cm
Width of 5th petal	5.0 cm	4.6 cm
Width of 6th petal	4.9 cm	4.6 cm
Pistil length	6.9 cm	7.8 cm
Stamen length	4.1 cm	4.8 cm
Petal 1colour*	Upper portion- Orange red 30 A Lower portion - green yellow 1 C Throat- orange 25 C	Orange red 33 A Throat- greyed orange 170 B
Petal 2 colour*	Upper portion- orange red C Lower portion- yellow 2 B Throat- orange N 25 A	Yellow 7 D Edge- orange red 33 B Throat- greyed orange 170 A
Petal 3 colour*	Upper portion- orange red C Lower portion- yellow 2 B Throat- orange N 25 B	Yellow 7 D Edge- orange red 33 B Throat- greyed orange 170 B
Petal 4 colour*	Orange red 33 B	Orange red 30 A
Petal 5 colour*	Orange red 33 B	Orange red 32 D
Petal 6 colour*	Red 40 B	Orange red 30 A

*Flower colour (RHS colour chart, The Royal Horticultural Society, London).

Longevity of first floret in vase

Effect of doses of gamma irradiations and varieties found significant on floret longevity of first floret during both years of investigations (Table 2). Treatment 2.5 kR recorded maximum longevity of first floret (4.96 days) which was significant to control, 3.5 kR, 4.5 kR and 5.5 kR treatments and at par with 1.5 kR treatments during 1st year. Similar to the 1st year gamma dose at 2.5 kR registered maximum longevity of first floret which was at par with 1.5 kR dose of gamma irradiation and significant to other treatments during 2nd year. Among varieties, cv. Jyotsana recorded maximum longevity of first floret (4.26 days) which was at par with cvs. Punjab Dawn, Pusa Kiran and Tiger Flame during 1st year. During 2nd year cultivar Jyotsana recorded maximum longevity of first floret (3.83 days). Interaction of 2.5 kR with cv. Jyotsana registered maximum longevity of first floret in vase (6.00 days) during 1st and 2nd years. It is indicating that lower doses of gamma irradiation (1.5 kR, 2.5 kR and 3.5 kR) found beneficial to enhance the post harvest life of cut gladioli in comparison to higher dose of gamma irradiation i.e. 4.5 kR and 5.5 kR. The results are in close conformity with findings of Anu *et al.,* (2003) who carried out an experiment on gamma irradiation in different varieties of tuberose and found out that vase life of cut spikes increased at lower doses of gamma irradiation and reduced at higher doses of gamma rays. Longevity of flower is genetically influenced and varies greatly among cultivars. It has also been observed differences in the longevity of flower of various cultivars correlate with stem diameter and stem turgidity. In general, thicker stem prevents breaking and contains more respiratory substrates for flowers, thus, prolong vase life. These studies are in congruence with the observations made by Fjeld *et al.,* (1994) and Anu *et al.,* (2003) who carried out experiments on gamma irradiation in flower crops.

Water uptake

It is evident from the Table 3 maximum water uptake was recorded with control (17.96 ml) which was statistically at par with treatment 5.5 kR during 1st year of investigation. No significant difference was observed among 5.5 kR, 2.5 kR, 4.5 kR, 3.5 kR and 1.5 kR doses of gamma irradiation on water uptake. During 2nd year of observation maximum uptake of water (17.45 ml) was recorded with control which was at par with 1.5 kR treatment (17.10 ml). Cultivar Jyotsana recorded maximum water uptake during 1st and 2nd years. Interaction among gamma irradiation and different varieties on water uptake was found significant and maximum water uptake was recorded with interaction of 5.5 kR and cv. Jyotsana (27.60 ml) during 1st year. However, during 2nd year interaction of 1.5 kR gamma dose with cv. Jyotsana gave pronounced effect on water uptake which was statistically at par with interaction of 2.5 kR with cv. Jyotsana and significant to all other treatment combinations. Present findings are also lent credence with the observation made by several earlier workers. The results of Hayashi and Todoriki (1996) suggest that sugar solution following irradiation prolonged the vase life of cut chrysanthemum. Life of tuberose flower increased significantly due to gamma irradiation and a dose of 5 rad irradiation found most beneficial over other treatments (Kumar *et al.,* 2003).

Vase life

During 1st year of observation treatment 3.5 kR exhibited maximum vase life (11.56 days) of cut gladiolus which was significant to 5.5 kR, control and 1.5 kR doses of gamma irradiation and statistically at par with 4.5 kR and 2.5 kR during 1st year (Table 4). During 2nd year of investigation treatment 2.5 kR resulted in maximum vase life (11.55 days) followed by 1.5 kR, control, 3.5 kR and 4.5 kR. Among the varieties, maximum vase life was recorded with cv. Punjab Dawn (13.50 days) followed by cvs. Tiger Flame during 1st and 2nd years. Significant effect due to interaction of gamma doses and varieties were found on the vase life of gladiolus during both the years of investigations. Interaction of 4.5 kR with cv. Punjab Dawn registered maximum vase life during 1st and 2nd years. In a comprehensive post harvest study Palanikumar *et al.,* (2003) found that irradiation of roses at 0.025 kGy and pulsing with sucrose resulted in the storage of flowers upto five days without any effect on post-harvest life and quality. It was further concluded that irradiated flowers recorded lowest amount of respiration at senescence and vase life was maximum in these flowers. Beneficial effect of lower doses (2.5 to 10 kR) was also observed in the post-harvest life of cut roses in which maximum opening of flower bud was

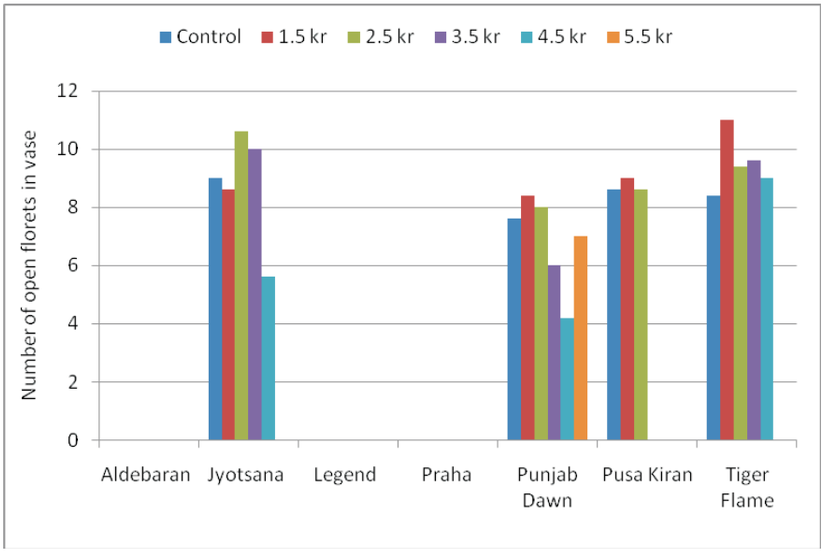

Fig. 2. Number of open florets in vase as influenced by gamma doses and varieties in gladiolus (2nd year)

observed and longevity was found better than untreated flowers (De *et al.,* 1997). They also found that higher TSS and lower total of free amino acids than in untreated flowers (control) which probably played some role in enhancing vase life of the flowers. Significant increase in vase life was observed by Fjeld *et al.,* (1994) when they supplemented irradiation level in cut roses. The increase in vase life with increase in irradiation was most pronounced in cvs. Cardinal and Madelon varieties of roses.

Morphological changes due to gamma irradiation

Various qualitative changes observed on the gladiolus plants and flowers in gladiolous variety Pusa Kiran. In a plant abnormal spike growth was observed at 3.5 kR dose of gamma irradiation (Fig. 3). In gladiolus one floret emerged from a node in general, whereas emergence of two flower buds emerged from all the nodes in a spike at 4.5 kR gamma dose. It is clearer from Fig. 4. In another plant increased nodal distance was observed when corms of gladiolus cv. Pusa Kiran treated with 5.5 kR. On same plant pink coloured streaks were also noticed (Fig. 5). It is interesting to note that a yellow colour mutant plant was appeared in cv. Pusa Kiran when treated with gamma doses at 2.5 kR during VM1 (1st year) of investigation (Fig. 6), however it was not a stable mutant. Corm harvested from this plants when planted during 2nd year, yellow colour was not appeared during 2nd generation (VM2). Present finding are also in lent credence with the several workers who irradiated gladiolus and other flowering plants to create variation in the genotypes and evolve the varieties through mutagenesis. Banerji *et al.,* (2000) irradiated corms of gladiolus cvs. Kajal and Nilofar with 300 and 600 Gy of gamma rays. They observed morphological abnormalities in foliage and floret increased in exposure. Chlorophyll variation was observed in leaf and spike. Flower colour mutation was detected in few plants as sectorial chimeric forms in M1V1 in comparison to cv. Kajal. Morphological abnormalities in the foliage and florets were also observed in the irradiated material of gladiolus (Banerji and Dutta, 1998 and Singh and Kumar, 2013).

Induced mutant

A mutant in variety Tiger Flame was evolved when treated with 3.5 kR of gamma irradiation. This is a stable mutant and stability persisted in 3rd generation (VM3). Flower shape, size and colour were distinctly different from parent (Table 5 and Fig. 7-12). Flower petals shape of parent is ovate, whereas,

Fig. 3

Fig. 4

Fig. 5

Fig. 6

Fig. 3. 3.5 kR, Abnormal spike growth
Fig. 4. 4.5 kR, Emergence of two flower buds from all nodal points,
Fig. 5. 5.5 kR, Pink colour on streaks, increased nodal distance
Fig. 6. 2.5 kR, Yellow colour mutant plant observed during 1st year.

Fig. 7

Fig. 8

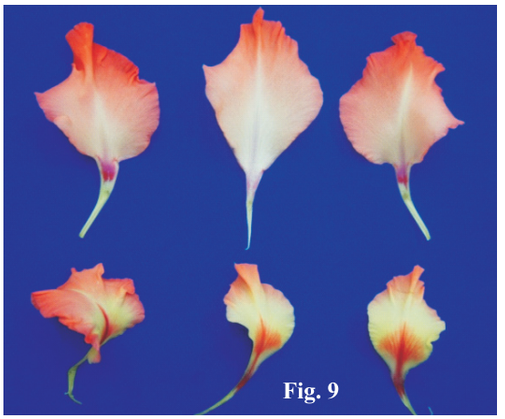

Fig. 9

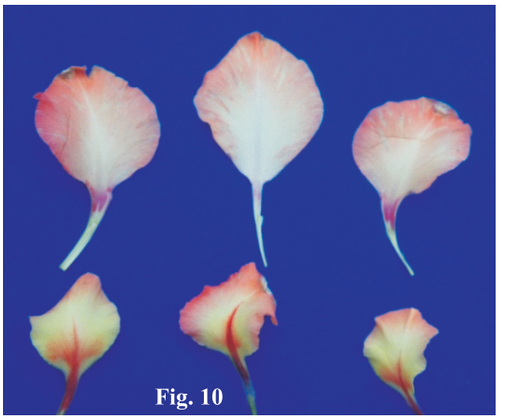

Fig. 10

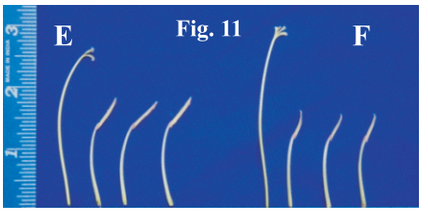

Fig. 11

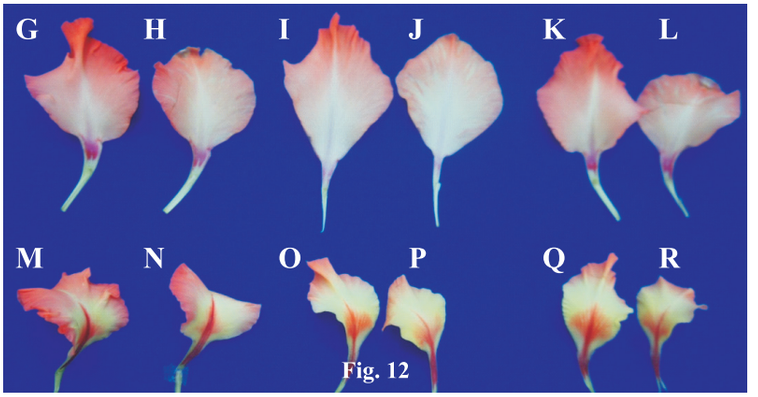

Fig. 12

Stable mutant (VM3) of variety Tiger Flame at 3.5 kR.
Fig. 7. Flower (A. Parent, B. Mutant)
Fig. 8. 5th Petal (C. Parent, D. Mutant), Fig. 9. Parent petals, Fig. 10. Mutant petals
Fig. 11. Stigma and style (E. Parent, F. Mutant)
Fig. 12. Petals (G, I, K. Parents upper petals, H, J, L. Mutant upper petals, M, O, Q. Parents lower petals, N, P, R. Mutants lower petals).

in mutant flower petals shape is elliptical in all the petals (1-6 petals). It is apparent from Fig. 7 to Fig. 12. In mutant 1st petal colour was orange (red 33 A), throat was of greyed orange colour (170 B), whereas in parent upper portion of 1st petal was orange red (30 A), lower portion of petal was green yellow (1 C) and throat was of orange (25 C) colour. 2nd petal of mutant was yellow (7 D), edge found of orange red (33 B) and throat colour was greyed orange (170 A), however in 2nd petal of parent colour of upper portion was orange red (C), lower portion colour was yellow (2 B) and throat was different (orange N 25 A). Upper portion of 3rd petal of parent was orange red (C), lower portion was of yellow colour (2 B) and throat of petal was of orange colour (N25 B), whereas in mutant 3rd petal colour was yellow (7 D), edge was of orange red (33 B) colour and throat was greyed orange (170 B). Similarly difference in colour was also observed in 4th, 5th and 6th petals between mutant and parent (Table 5 and Fig. 8, 9, 10 and 12). Apart from this prominent streaks were also observed in the upper petals (4, 5, 6) in mutant flower, whereas it is completely absent in parent. Present findings are in line with the study of Raghava *et al.,* (1988) who found a desirable and stable mutant with shell pink colour florets observed in VM2 generation as chimera in 1 kR treatment was isolated from the cv. Wild Rose with roseine purple floret colour floret colour in VM4 generation. This mutant was named and released as Shobha. Misra (1982) detected colour mutant in gladiolus cv. Ratna's Butterfly in the mutant described all segments in the upper half of the flower have a violet colour with lighter flakes in between. The studies are also corroborated with the observation made by Misra (1986) who irradiated gladiolus cv. Green Finch, Mayur, Rose Momento and Wind Song. Colour changes in petals, fusion increased floral organ, notching in the petal were recorded in all the varieties.

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