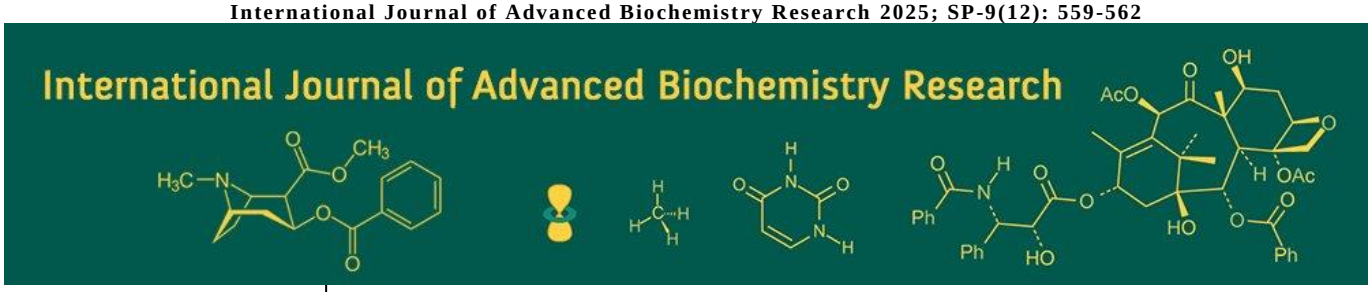

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Snehal V Deshmukh
Horticulture Section,
College of Agriculture,
Dr. P.D.K.V., Akola,
Maharashtra, India

Dr. RP Gajbhiye
Professor, College of
Agriculture, Dr. P.D.K.V.,
Akola, Maharashtra, India

Dr. DM Panchabhai
Director of Instructions,
Dean, Faculty of Agriculture &
Dean, Post Graduate Studies,
Dr. P.D.K.V., Akola,
Maharashtra, India

Akshay A Thakare
Horticulture Section,
College of Agriculture, Nagpur,
Dr. P.D.K.V., Akola,
Maharashtra, India

Corresponding Author:
Snehal V Deshmukh
Horticulture Section,
College of Agriculture,
Dr. P.D.K.V., Akola,
Maharashtra, India

Studies of gamma irradiation on morphological characters in gladiolus

Snehal V Deshmukh, RP Gajbhiye, DM Panchabhai and Akshay A Thakare

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Abstract
An experiment entitled "Mutation Studies in Gladiolus" was conducted during the *rabi* seasons of 2021-2023 at the Horticulture Section Farm, College of Agriculture, Nagpur. The study was laid out in a factorial randomized block design (FRBD) with three replications, involving four varieties of gladiolus viz. Pusa Suhagin, Arka Naveen, Dhanvantari, and Punjab Dawn and five gamma-irradiation treatments: 0 Gy (Control), 35 Gy, 45 Gy, 55 Gy, and 65 Gy.
The application of gamma rays to different gladiolus varieties had a significant influence on various morphological parameters, particularly causing a notable reduction in plant height, number of leaves per plant, length of leaf and width of leaf of plants in both the M_1 and M_2 generations.

Keywords: Mutation, gamma rays, plant height, number of leaves, length of leaf, width of leaf, gladiolus

Introduction
Gladiolus is a high-value, commercially significant geophyte crop, extensively cultivated for the cut flower industry in both domestic and global markets. The substantial demand necessitates ongoing genetic enhancement programs to develop novel cultivars with superior ornamental and agronomic traits.
Mutation breeding is a well-established methodology for inducing genetic variability in highly heterozygous, vegetatively propagated ornamental species like gladiolus. The application of physical mutagens, such as gamma irradiation, provides a promising approach to create stable, new phenotypes (mutants) by altering the plant's genetic material. Previous research has demonstrated that varying doses of gamma radiation can induce a spectrum of physiological and morphological changes, ranging from detrimental effects at higher doses (e.g., inhibited mitosis, reduced plant height, delayed flowering) to beneficial or stimulatory effects at lower doses (e.g., enhanced photosynthetic efficiency, altered flower colour, increased corm production).
Therefore, the present investigation was specifically conducted to quantitatively assess the dose-dependent impact of gamma radiation exposure on the key morphological and phenological parameters of gladiolus germplasm.

Research Methodology
The experiment entitled "Mutation studies in *Gladiolus*" was executed over two consecutive *rabi* cropping seasons (2021-22 and 2022-23) at the horticultural experimental fields of the College of Agriculture in Nagpur, Maharashtra, India. The study utilized elite, disease-free corms sourced from the Directorate of Floriculture Research (DFR), Pune, Maharashtra. The experimental material comprised four distinct Gladiolus cultivars selected for their varying floral pigmentation profiles: 'Pusa Suhagin', 'Arka Naveen', 'Dhanvantari', and 'Punjab Dawn'.
The data analysis revealed a significant influence of gamma irradiation dosage, cultivar genotype, and their interaction on the morphological parameter of plant height across two consecutive cultivation seasons (2021-22 and 2022-23).

Plant Height

The general trend indicated that low-dose irradiation treatments enhanced plant height while high doses were inhibitory. Specifically, optimal vegetative growth, characterized by maximum plant height at 30 DAP (43.16 cm in Year 1 and 37.73 cm in Year 2), was associated with control treatment and exposure of 35 Gy. Conversely, the maximum radiation dose of 65 Gy consistently induced a significant reduction in height (36.30 cm in Year 1 and 30.15 cm in Year 2), demonstrating a potent depressive effect on cellular division and elongation. Furthermore, inherent genetic variability among the *Gladiolus* cultivars resulted in statistically significant differences in height. 'Pusa Suhagin' emerged as the tallest cultivar (mean of 42.14 cm), while 'Arka Naveen' was categorized as a dwarf phenotype (mean of 36.65 cm). The statistically significant interaction effect underscored the genotype-by-treatment response. Significantly maximum plant height was recorded in cv. Pusa Suahgin in control treatment (45.17 cm) which was at par with cv. Pusa Suhagin treated with 35 Gy gamma rays (44.13 cm) where as minimum plant height was recorded in cv. Arka Naveen treated with 65 Gy gamma rays (32.38 cm) in first year where as The interaction effect of varieties (V) and different irradiation doses (G) on plant height of gladiolus after 30 DAP was found to be non-significant in second year. These results confirm a dose-dependent radiosensitivity that varies significantly among different *Gladiolus* genotypes.

Table 1: Effect of gamma rays on plant height of gladiolus in vM_1 and vM_2 generation

Gamma rays doses	vM_1 Generation					vM_2 Generation				
	Pusa Suhagin	Arka Naveen	Dhanvantari	Punjab Dawn	Mean	Pusa Suhagin	Arka Naveen	Dhanvantari	Punjab Dawn	Mean
G_1	45.17	43.40	42.90	43.85	43.16	42.00	32.57	36.38	39.98	37.73
G_2	44.13	39.89	41.26	41.21	41.29	41.70	32.44	34.76	30.38	34.82
G_3	43.09	34.24	39.70	40.62	39.66	38.32	31.28	31.87	30.27	32.94
G_4	40.25	33.36	39.99	43.57	39.92	38.49	29.08	31.27	30.30	32.29
G_5	38.03	32.38	37.80	36.65	36.30	37.18	27.25	28.71	27.45	30.15
Mean	42.14	36.65	40.33	41.18	40.07	39.54	30.52	32.60	31.68	33.59

Source		vM_1 Generation				vM_2 Generation		
	F test	SE(m)±	C.D. (5%)	CV%	F test	SE(m)±	C.D.(5%)	CV%
Varieties	Sig	0.65	1.87	16.32	Sig	1.54	4.46	17.84
Treatments	Sig	0.72	2.09		Sig	1.72	4.99	
Varieties X Treatments	Sig	1.45	4.09		NS	3.45	-	

Number of leaves per plant

Data presented in Table 2 reveal that with respect of number of leaves per plant, different cultivars resulted in non significant difference in first year where as significant in second year of experiment. Maximum number of leaves per plant (4.93) was recorded with cultivar Pusa Suhagin after 30 days of planting of corms, while minimum number of leaves (4.30) was recorded with cv. Arka Naveen. During second year of the experiment maximum number of leaves per plant (5.02) was recorded with cv. Pusa Suhagin followed by Punjab Dawn (4.94) and minimum number of leaves per plant (4.22) was recorded with cv. Arka Naveen. The effect of gamma irradiation on different cultivars of gladiolus was non significant during first and significant during second year. Maximum numbers of leaves per plant (5.22) was recorded with 35 Gy treatment followed by control (5.20). While minimum numbers of leaves per plant were observed with 65 Gy treatment (3.91).

Data of second year experiment showed that maximum number of leaves per plant (5.38) was recorded with control treatment followed by 35 Gy treatment (35.12). While minimum number of leaves per plant (3.95) were observed with 65 Gy treatment.

Interaction among gamma irradiation and variety showed that, the number of leaves/plant of gladiolus were found to be non-significant for first year. For second year significant result was found for Interaction effect of irradiation doses (G) and variety (V). The maximum number of leaves were found in cv. Pusa Suhagin in control treatment (5.12) and minimum number of leaves were recorded in cv.Arka Naveen at 65 Gy gamma irradiation treatment (3.16).

Table 2: Effect of gamma rays on number of leaves of gladiolus varieties in vM_1 and vM_2 generation

Gamma rays doses	vM_1 Generation					vM_2 Generation				
	Pusa Suhagin	Arka Naveen	Dhanvantari	Punjab Dawn	Mean	Pusa Suhagin	Arka Naveen	Dhanvantari	Punjab Dawn	Mean
G_1	5.26	5.06	5.13	5.32	5.20	5.89	5.10	5.17	5.36	5.38
G_2	5.17	5.05	5.47	5.18	5.22	5.55	4.71	5.04	5.19	5.12
G_3	5.13	4.19	4.83	5.00	4.79	5.02	4.19	4.88	4.93	4.76
G_4	4.93	4.01	4.59	4.63	4.54	4.54	3.95	4.64	4.84	4.49
G_5	4.16	3.16	4.25	4.07	3.91	4.12	3.16	4.11	4.39	3.95
Mean	4.93	4.30	4.85	4.84	4.73	5.02	4.22	4.77	4.94	4.74

Source		vM_1 Generation				vM_2 Generation		
	F test	SE(m)±	C.D. (5%)	CV%	F test	SE(m)±	C.D.(5%)	CV%
Varieties	Sig	0.11	0.33	9.35	Sig	0.10	0.29	8.14
Treatments	Sig	0.13	0.37		Sig	0.11	0.33	
Varieties X Treatments	NS	0.26	-		Sig	0.23	0.66	

Length of leaf (cm)

The data analysis and represents in table 3. revealed a non-significant influence of gamma irradiation dosage, cultivar genotype, and their interaction on the morphological parameter of length of leaf across two consecutive cultivation seasons (2021-22 and 2022-23). The general trend indicated that low-dose irradiation treatments enhanced length of leaf were inhibitory. The significantly maximum length of leaf was recorded in cv. Pusa Suhagin (29.76 and 29.22 cm) which was at par with cv. Punjab Dawn (29.15 and 29.13 cm) and the minimum length of leaf was recorded in cv. Arka Naveen (25.20 and 24.84 cm).

The data analysis confirmed a non significant, inhibitory effect of high-dose gamma irradiation on the length of leaf of *Gladiolus*. Specifically, in the maximum applied dose of 65 Gy consistently resulted in reduction in length of leaf 24.12 and 22.27) of across two consecutive cultivation cycles.

The results on length of leaves reduction with increase in gamma radiation doses was reported by Raghava *et al.* (1988) [12] and Banerji *et al.* (1994) [3].

Table 3: Effect of gamma rays on length of leaf (cm) of gladiolus varieties in vM_1 and vM_2 generation

Gamma rays doses	vM_1 Generation					vM_2 Generation				
	Pusa Suhagin	Arka Naveen	Dhanvantari	Punjab Dawn	Mean	Pusa Suhagin	Arka Naveen	Dhanvantari	Punjab Dawn	Mean
G_1	32.12	28.07	31.79	32.05	31.01	31.02	29.82	29.63	25.41	28.97
G_2	31.17	27.74	29.45	31.40	29.94	30.57	26.97	27.92	23.71	27.29
G_3	30.89	25.17	27.60	30.08	28.43	29.34	23.50	26.86	21.82	25.38
G_4	28.55	23.49	25.40	28.12	26.39	28.38	22.13	24.19	19.53	23.56
G_5	26.08	21.52	24.79	24.09	24.12	26.80	21.79	21.32	19.18	22.27
Mean	29.76	25.20	27.81	29.15	27.98	29.22	24.84	25.98	21.93	25.49

Source	vM_1 Generation				vM_2 Generation			
	F test	SE(m)±	C.D.(5%)	CV%	F test	SE(m)±	C.D.(5%)	CV%
Varieties	Sig	0.70	1.61	9.92	Sig	0.89	2.59	13.64
Treatments	Sig	0.80	2.30		Sig	1.00	2.89	
Varieties X Treatments	NS	1.60	-		NS	1.89	-	

Width of leaf (cm)

The data presented in Table 4 indicate that, during the first year, significant varietal differences were observed for leaf width at 30 DAP. The widest leaves were recorded in cv. Pusa Suhagin (2.67 cm), which remained statistically at par with cv. Punjab Dawn (2.48 cm) and cv. Dhanvantari (2.41 cm), whereas cv. Arka Naveen (1.96 cm) exhibited the narrowest leaves. In the second year, a similar varietal response was noted, with cv. Pusa Suhagin (2.18 cm) registering the maximum leaf width, statistically comparable to cv. Punjab Dawn (2.12 cm), while cv. Arka Naveen (1.51 cm) again recorded the minimum leaf width.

Table 4: Effect of gamma rays on width of leaf (cm) 30 DAP of gladiolus varieties in vM_1 and vM_2 generation

Gamma rays doses	vM_1 Generation					vM_2 Generation				
	Pusa Suhagin	Arka Naveen	Dhanvantari	Punjab Dawn	Mean	Pusa Suhagin	Arka Naveen	Dhanvantari	Punjab Dawn	Mean
G_1	3.17	2.54	3.26	2.95	2.98	2.88	2.13	2.56	2.57	2.54
G_2	3.09	2.12	2.98	2.78	2.74	2.44	1.83	2.35	2.26	2.22
G_3	2.81	2.09	2.55	2.55	2.50	2.11	1.40	1.67	2.17	1.84
G_4	2.25	1.59	1.97	2.40	2.05	1.96	1.19	1.42	1.92	1.62
G_5	2.01	1.45	1.30	1.71	1.62	1.52	1.01	0.97	1.67	1.29
Mean	2.67	1.96	2.41	2.48	2.38	2.18	1.51	1.79	2.12	1.90

Source	vM_1 Generation				vM_2 Generation			
	F test	SE(m)±	C.D. (5%)	CV%	F test	SE(m)±	C.D.(5%)	CV%
Varieties	Sig	0.08	0.26	10.06	Sig	0.10	0.28	20.77
Treatments	Sig	0.06	0.19		Sig	0.11	0.32	
Varieties X Treatments	Sig	0.13	0.39		NS	0.22		

A significant effect of irradiation dosage on leaf width was also evident. In the first year, treatment G_1 (2.98 cm) resulted in the maximum leaf width, followed by G_2 (2.79 cm), while G_5 (1.62 cm) produced the minimum width. During the second year, G_1 (2.54 cm) again recorded the highest leaf width, remaining at par with G_2 (2.22 cm), whereas G_5 (1.29 cm) consistently exhibited the lowest values.

The interaction effect (G × V) on leaf width at 30 DAP was found to be significant in the first year, indicating that varietal responses to irradiation were not uniform. The maximum leaf width was obtained in cv. Dhanvantari under the control treatment (3.26 cm), which was statistically comparable to cv. Pusa Suhagin under the control treatment (3.17 cm) and cv. Pusa Suhagin treated with 35 Gy (3.09 cm). The minimum interaction mean was observed in cv. Dhanvantari treated with 65 Gy (1.30 cm). In contrast, during the second year, the G × V interaction for leaf width at 30 DAP was non-significant, indicating a more uniform varietal response to irradiation doses under that year's environmental conditions.

A comprehensive study conducted by Patil (2010) [9] on three gladiolus cultivars viz. American Beauty, Nova Lux, and Eurovision—aimed at inducing genetic variability through gamma irradiation. Corms were exposed to doses of 1, 2, 3, 4, 5, 6, and 7 kR. Lower doses ranging from 1 to 3 kR were found to be insufficient to cause adverse effects and, in some instances, even exerted a stimulating influence on growth. However, doses ≥ 4 kR resulted in a marked reduction in leaf length and suppressed vegetative growth

parameters in gladiolus. Similar findings were reported by Pranom *et al.* (1986) [11] and Banerji *et al.* (1994) [3], who observed reduced plant height and fewer leaves with increasing gamma irradiation levels.

The adverse effects of higher irradiation doses may be attributed to disturbances in auxin metabolism, including the inactivation of auxin (Datta and Datta, 1953) [4], destruction of enzyme systems (Bairagi, 1969) [2], or inhibition of auxin synthesis (Gordon, 1954) [5]. Additionally, gamma irradiation may impede plant growth through suppression of mitotic activity, chromosomal aberrations, and associated secondary physiological damage (Gunckal, 1957) [6]. The observed reductions in plant height, leaf length, and number of leaves likely result from a decrease in the number of vertical cell layers, shorter internodal length, fewer internodes, or a combination of these structural modifications.

References

1. Awad ARE, Elbahr K. Growth regulators and gamma irradiation treatments affecting sprouting and endogenous hormones in gladiolus. Acta Hortic. 1986;177(2):612.
2. Bairagi R. Radiosensitive phase in plant germination. In: Proceedings of the 2nd International Conference on the Peaceful Use of Atomic Energy; Geneva; 1969. Vol. 27. p. 299-304.
3. Banerji BK, Datta SK, Sharma SC. Gamma irradiation studies on gladiolus cv. White Friendship. J Nucl Agric Biol. 1994;23(3):127-133.
4. Datta PK, Datta C. High dosage of X-irradiation and inhibition of growth in rice seedlings. Sci Cult. 1953;18:500-502.
5. Gordon SA. Occurrence, formation and inactivation of auxins. Annu Rev Plant Physiol. 1954;5:341-378.
6. Gunckel JE. The effects of ionizing radiation on plants: morphological effects. Q Rev Biol. 1957;32:46-56.
7. Karki K, Srivastava R, Chand S. Effect of gamma irradiation in gladiolus (*Gladiolus grandiflorus* L.). In: Abstracts of National Symposium on Life Style Floriculture: Challenges and Opportunities; Nauni, Solan (HP): YSP University of Horticulture & Forestry; 2010. p. 14.
8. Misra RL, Bajpai PN. Mutational studies in gladiolus (*Gladiolus* L.): effect of physical and chemical mutagens on sprouting and survival of corms. Haryana J Hortic Sci. 1983;12(1-2):16.
9. Patil SD, Patil HE, Dhaduk BK. Response of gamma radiation on vegetative and floral characters of commercial varieties of gladiolus (*Gladiolus grandiflorus* L.). In: Abstracts of National Symposium on Life Style Floriculture: Challenges and Opportunities; Nauni, Solan (HP): YSP University of Horticulture & Forestry; 2010a. p. 21.
10. Patil SD, Patil HE, Dhaduk BK. Effect of gamma radiation on morphological and cytological characters of gladiolus (*Gladiolus grandiflorus* L.). In: Abstracts of National Symposium on Life Style Floriculture: Challenges and Opportunities; Nauni, Solan (HP): Dr. Y.S. Parmar University of Horticulture & Forestry; 2010b. p. 21-22.
11. Pranom P, Sangtham K, Orwan M. Production of gladiolus: effect of gamma irradiation on certain characteristics of gladiolus var. Spic and Span, Norwich Canary. Research and Development Institute Research Report. Kasetsart University, Thailand; 1986. p. 85.
12. Raghava SPS, Negi SS, Sharma TVRS, Balkrishna KA. Gamma ray induced mutants in gladiolus. J Nucl Agric Biol. 1988;17(1):5-10.
13. Singh AK. Flower crops: cultivation and management. New Delhi: New India Publishing Agency; 2006. p. 147.