

## PHENOTYPIC VARIABILITY AND MUTANT SELECTION IN *GLADIOLUS HYBRIDUS* VARIETY

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### Abstract

The present investigation was carried out to study impact of gamma rays on gladiolus variety 'Punjab Glance'. A gradual decrease in the corm sprouting, plant height, spike length, and florets per spike was observed with increasing doses (150 to 200 Gy). The highest efficiency was achieved at 50 Gy that gave rise to the maximum spike length (66.25 cm), florets per spike (9.78), and survival rate (97.73 %). Leaf and floral abnormalities were also recorded at higher doses. The highest efficiency was achieved at 50 Gy that gave rise to a unique bright orange with a yellow blotch floret colour. In this context, mutation breeding emerges as a powerful and proven strategy for inducing genetic variability in ornamental crops, offering a viable pathway to develop novel and commercially desirable traits.

### Introduction

Gladiolus is among the top most economically significant ornamental bulbous crops grown worldwide primarily for their attractive flower spikes, availability of a wide range of colours, and long vase life. The scope of conventional breeding in gladiolus was often confined because of its limited genetic pool, heterozygous nature, polyploidy, and long breeding cycle. In such conditions, mutation breeding has become a potent alternate method to produce useful genetic variations in cultivars. Induced mutagenesis has been widely used in ornamental plants for the improvement of flower colour, spike height, flowering behaviour, and vegetative features (Choudhary and Kumar 2024). In this regard, mutation breeding has become one of the most powerful and cost-effective methods to increase the genetic diversity of ornamental plants, especially in those species that have limited genetic variability. Mutation breeding induces stable genetic changes to the genome artificially which helps to develop novel traits like flower colour changes, different plant forms and better post-harvest features, etc. These traits are in fact, the current needs of the floriculture industry (Deshmukh *et al.* 2025).

In view of the above, mutation breeding is an effective means to create genetic variability and thereby enable ornamental crops to have novel traits. When it comes to physical mutagens, gamma rays have been the most popular mutagenic agents for their high ability to penetrate. When a living being is exposed to gamma rays, it causes stable and heritable genetic mutations that can be passed into the offspring. Changes to the DNA induced by gamma irradiation include single-base substitutions, chromosomal rearrangements, and gene deletions. These modifications finally manifest as phenotypic variability in the progenies of plant populations (Ud-Din *et al.* 2025).

Ornamentals remain the best choice for mutation induction methods since great number of the traits related to the economy, like flower details or plant form are readily assessed post mutagenic exposure. Furthermore, many ornamental species often propagated vegetatively (Banerji and Dutta 2002). Among the commercially cultivated flowers, the gladiolus ranks high and it is also grown

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in several parts of the country. Gladiolus was extremely in its genetic composition, hence considered as one of the promising candidates for irradiation mutagenesis (Singh *et al.* 2025). Besides this the features which made Gladiolus a favourite among breeders where it's wide adaptability, availability of different coloured flowers of varied shapes and sizes and long vase life (Ravikumar and Seenivasan 2020). Therefore, the current study mainly focused on the evaluation of effect of gamma rays on different morphological characters of gladiolus.

### Materials and Methods

The study was conducted in the experimental field of the Department of Floriculture and Landscaping, Punjab Agricultural University (PAU) Ludhiana India, from 2019 to 2024. Healthy, uniform and disease-free gladiolus (*Gladiolus hybridus* L.) cv. 'Punjab Glance' corms (5 cm) were selected for the experiments. The corms were exposed to different doses of gamma rays (00, 50, 100, 150 and 200 Gy) using a low-dose gamma irradiator at the College Orchard of the Department of Fruit Science. Corms without irradiation were used as a control. After post-radiation, the corms were kept under normal environmental conditions and were immediately field-planted. The experimental layout was CRD with five treatments and three replications. The treated and untreated corms were sown with a distance of 30 cm × 20 cm throughout the experimental period. The recommended standard agronomic practices for gladiolus cultivation were followed (Deshmukh *et al.* 2025). Analysed the collected data by ANOVA for a completely randomized designed and tested the significance of treatment effects at 5% level of probability, and critical difference (CD) values were calculated for comparison of treatment means.

### Results and Discussion

Plants exposed to gamma irradiation showed variation in floral colour. Treatment with 50 Gy gamma irradiation brought about a change in floret colour to light yellow with a dark yellow blotch from bright orange with a yellow blotch (Orange Group 41D) in the control (Fig. 1). The emergence of the present new colour variant shows that somatic mutation was induced by the lower dose of irradiation. Besides colour variation, the irradiated plants showed several morphological changes. A considerable number of morphological changes in various forms were observed. For example, changes in leaf margin, and apex were recorded. In addition, leaf fission and fusion also occurred, which clear evidences are showing the strong impact of mutagenic treatment on vegetative features. The leaf abnormalities may be due to harmful effects on auxins or other growth substances influencing chromosomes and the plant tissue (Tiwari *et al.* 2010). Gamma irradiation caused morphological and floral changes in gladiolus cv. 'Punjab Glance' in a dose-dependent manner, and the decrease at higher doses may have been due to auxin inhibition and radiation-induced chromosomal abnormalities, which interfere with cell division and growth processes. Similarly, Choudhary *et al.* (2023) revealed correlation between the irradiation doses and induction of different traits in gladiolus, implying that the changes in the levels of the irradiation fluctuated plant performance and the manifestation of the traits.

The gamma rays treated plants exhibited higher survival rate at lower doses and vice versa (Table 1). The maximum survival rate (97.73 %) was observed in cultivars treated with 50 Gy whereas the minimum was observed in cultivars treated with 150 and 200 Gy doses of gamma rays as compared to the control (98.09 %). The reduction in survival rate was found to be maximum at higher doses because of genetic loss due to chromosomal aberrations and gene mutation (Kushwaha *et al.* 2024). Significant variation was measured in days taken to sprouting (15.17) in 50 Gy and maximum in 150 Gy (26.11). It might have been due to auxin synthesis, whereas delayed and stunted growth was observed due to auxin inhibition (Yadav *et al.* 2025).

The plant height was significantly influenced by different doses of gamma rays as presented in Table 1. The plant height was 76.06 cm at 50 Gy and 46.61cm at 150 Gy as compared to control (90.96). Leaf area did not change much among the different treatment groups. The highest leaf area was recorded at 150 Gy (110.86 cm<sup>2</sup>) and the lowest in the control (108.81cm<sup>2</sup>). However, the variation among treatments was statistically non-significant, which means that gamma irradiation hardly influenced leaf expansion in gladiolus cv. 'Punjab Glance'. In fact, the present study's finding of a non-significant effect of gamma irradiation on leaf area is in line with some recent findings on gladiolus. The change in plant height might depend upon nature and extent of chromosomal damage. Yadav *et al.* (2025) reported that irradiation had strong influence on the growth and flowering characteristics of gladiolus cultivars. But, many vegetative features were showed variable changes based on the radiation intensity.

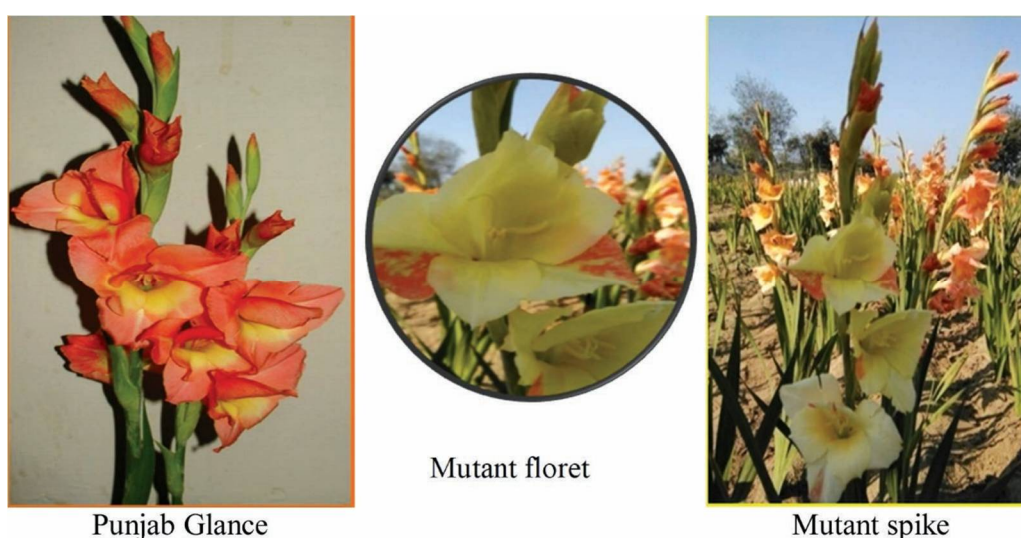


Fig.1. Variation in floret colour in Gladiolus cv. Punjab Glance induced by gamma irradiation.

There was a significant delay in flowering in the treated corms compared with the control (Table 1). The flowering time was still longest (87.33) for the corms treated with 150 Gy and shortest (80.00) for those at 50 Gy compared to the control. Kushwaha *et al.* (2024) have also reported similar observations across different gladiolus cultivars. Floral abnormalities of the kind of bud fasciation, abnormal pikes, and asymmetrical spikes were observed at higher doses. It was found that at the higher doses of gamma rays (100 Gy, 150 Gy) some plants did not form buds, flowers and remained in the vegetative stage. Different doses of gamma irradiation had a very significant influence on the spike length. It went down as the dose of gamma rays went up gradually. Higher dose cause destruction of auxin, failure of assimilation, mechanisms, or inhibition of mitotic and chromosomal changes or damage with association of secondary physiological damage (Dobanda 2004). The shortest spike length (32.33 cm) was at 150 Gy as compared to the control (76.39). 50 Gy treatments resulted in maximum number of florets per spike as compared to control. The number of florets reduced with a gradual rise in dose of gamma rays culminating in the minimum (5.28) at 150 Gy. Floret size was not affected by different levels of gamma irradiation according to the comparison between means, the diameter of florets was statistically same among the treatments with different doses of gamma ray irradiation. Though

there was small numerical variation between treatments, their values were statistically comparable to the control. The size of the florets was quite stable and less responsive to different types of mutagenic treatments in gladiolus cv. 'Punjab Glance' as evidenced by the unchanged floret size. The non-significant effect points to the fact that gamma irradiation had a major impact on plant vigour and flowering behaviour rather than the sizes of individual florets. The length of flowering period was significantly varied among treatment groups (CD = 0.728 at P = 0.05). The maximum flowering period was noted at 150 Gy (13.10 days), whereas the minimum was in the control (12.16 days). The data suggests that moderate levels of gamma irradiation slightly lengthened the flowering time however heavy doses negatively affected the general plant growth (Table 2). There were no/few florets observed at higher doses because of changes in plant metabolic activities and negative response of plant hormones to irradiations (Sudha 2014). In fact, Yadav *et al.* (2025) also found that gamma irradiation had a significant effect on flowering behavior and spike traits of gladiolus.

**Table 1. Effect of gamma irradiation on vegetative characters of Gladiolus variety 'Punjab Glance'.**

Treatments (Gy)	Survival rate	Days to sprouting	Plant ht. (cm)	Leaf area (cm <sup>2</sup> )	Days to flowering	Spike length (cm)	Florets/spike
0 (control)	98.09	12.26	90.96	108.81	80.48	76.39	11.90
50	97.73	15.17	76.06	109.66	80.00	66.25	9.78
100	96.08	23.13	51.06	109.93	85.66	32.33	6.83
150	72.11	26.11	46.61	110.86	87.33	30.28	5.28
200	52.25	28.24	35.44	109.36	84.89	24.86	5.11
CD(p=0.05)	0.96	0.85	4.96	NA	1.61	4.31	1.49

**Table 2. Effect of gamma irradiation on floral characters of Gladiolus variety 'Punjab Glance'.**

Treatments (Gy)	Floret dia. (cm)	Flowering duration (days)	Corms/ plant	Cormels/ corm	Corm dia. (cm)	Cormel dia. (cm)
0 (control)	7.23	12.16	2.33	25.73	6.20	2.34
50	7.30	12.73	2.04	10.59	6.21	1.99
100	7.33	12.93	1.85	9.92	6.23	2.05
150	7.36	13.10	1.91	7.95	6.21	2.16
200	7.50	13.06	1.44	6.11	6.23	2.26
CD(P=0.05)	NA	0.728	0.36	2.17	NA	0.055

The maximum corms per plant (2.04) were found in 50 Gy and minimum (1.44) at 200 Gy as compared to control. Similarly the maximum cormels per plant were produced at 50 Gy (10.59) and minimum at 200 Gy (6.11). Corm diameter did not differ significantly among the various applied doses of gamma irradiation. The largest corm diameter was obtained at 50 Gy (5.63 cm), The values were progressively reduced with increased dose of radiation. The differences between treatments were insignificant from a statistical viewpoint, which means that gamma irradiation barely affected the size of the corm. Cormel diameters were highly variable depending on the treatment. The biggest cormel size was found at 200 Gy (1.20 cm), followed by 150 Gy (1.18 cm),

100 Gy (1.15 cm) and 50 Gy (1.12 cm), while the lowest in the control (1.10 cm). The data clearly demonstrate that gamma irradiations had strong effect on the cormels formation and higher levels of radiation resulted in larger cormels (Table 2). Significant variation was measured in days taken to sprouting revealed that higher doses of gamma rays were detrimental for irradiation of corms and results were in accordance reported by Misra and Bajpai (1983) who stated that higher doses adversely affect sprouting in cv. 'Oscar'. The decrease in the production of corms and cormels might be due to the negative impact of the treatments that affected the root system. Inactivation of enzymes and hormones lead to cessation of growth in auxiliary buds present on the corms (Wi *et al.* 2007). The corm diameter did not differ significantly in the present study revealing that the main propagule size remains quite unchanged even after mutagenic treatments. Gamma irradiation had impact on the propagation characteristics and mutation frequency in gladiolus, especially in the features related to cormel development (Yadav *et al.* 2025).

Current study shows that gamma irradiation can be a great way to create a lot of visible different forms of Gladiolus cv. 'Punjab Glance' by changing the features that make the flowers beautiful and come in handy to fresh flowers sales quite a lot. Looking back, amongst the doses that had been tried, the relatively small doses of 50-100 Gy turned out to be best because they not only resulted in useful new forms but also allowed their growth to a good extent, on the contrary, higher doses of 150-200 Gy were found to be quite harmful to plants. Introducing the chosen mutants into well-structured breeding programs that have a clear roadmap will go a long way in using them effectively for the bringing forth of new cultivars. Therefore, the findings prove that gamma radiation can be a great asset in the equipping new gladiolus plants with better floral traits and colour-based novelty. Mutagenesis thereby represents an excellent means for generating new varieties of vegetatively propagated ornamental plants in order to fulfil the ever-increasing requirements of the floriculture industry.

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