*Biological Forum – An International Journal* **16(6): 85-88(2024)**

**ISSN No. (Print): 0975-1130**
**ISSN No. (Online): 2249-3239**

# Assessment of Single and Dual Dose of Gamma Rays on Gladiolus Cultivars

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*(Received: 05 April 2024; Revised: 23 April 2024; Accepted: 16 May 2024; Published: 15 June 2024)*
*(Published by Research Trend)*

**ABSTRACT: The investigation aimed to examine how gamma irradiation affected the different cultivars and identify favorable mutations concerning quality and agronomic traits. Medium-sized corms from seven gladiolus cultivars, *viz.,* 'Nova Lux,' 'Praha,' 'Black Star,' 'Nathan Red,' 'Priscilla,' 'Punjab Dawn,' and 'Tiger Flame', were used as experimental material. These corms were exposed to different doses of gamma rays, such as 0.0 Kr (control) and 6.5 kR. Subsequently, in 2021–22, they were again subjected to gamma irradiation at a dose of 6.5 kR to assess the impact of dual exposure to gamma radiation. Observations were recorded for the entire plant population. The research revealed a random decline in the survival rate of plants across all cultivars when exposed to higher doses of gamma rays. The gamma irradiation showed an inhibitory effect on vegetative characteristics, *viz.,* plant height, number, length, and width of leaves, in all the cultivars except 'Punjab Dawn' and 'Priscilla', which were least affected when irradiated with gamma rays. The number of tillers and corms increased, whereas the number and size of floret, spike length, rachis length, vase life, weight, and size of corms and cormels were reduced. The plants could not produce flower spikes in the first generation of all the varieties except 'Punjab Dawn' Praha, Nathan Red, and 'Priscilla'. The mutation spectrum and frequency were highest in 'Praha', and most of the variations were observed in the form of chimeras and abnormalities. Some desirable mutants were identified in all the cultivars except 'Black Star'. In conclusion, these findings shed light on the complexities of mutational responses and offer insights into potential avenues for targeted trait enhancements in gladiolus cultivation.**

**Keywords:** gamma irradiation, dual exposure, gladiolus cultivars, mutants.

## INTRODUCTION

Gladiolus, a prominent ornamental plant, holds significant economic value in the floriculture industry due to its striking blooms and vibrant colors (Cantor *et al.,* 2011). The cultivation and breeding of gladiolus aim to enhance desirable traits such as flower color, size, shape, and yield production. Traditional breeding methods, while effective, are often time-consuming and limited in scope. This has spurred interest in using mutagenesis, particularly gamma radiation, to induce genetic variation that can be harnessed for breeding purposes (Shu *et al.,* 2012). Gamma radiation, a potent physical mutagen, has been widely employed to create novel mutants in various plant species (Çelik and Atak 2017). Its ability to induce a broad spectrum of genetic changes makes it a valuable tool for generating new cultivars with improved traits. In the context of gladiolus, gamma radiation exposure can result in mutations that enhance ornamental qualities, such as a novel color pattern or increased flower size, as well as agronomic traits like disease resistance and environmental stress tolerance. Traditional methods often result in low mutation rates and unpredictable outcomes, making it difficult to obtain desirable traits. Gamma radiation can cause extensive DNA damage, leading to detrimental mutations or plant sterility. Additionally, the labor-intensive process requires significant time and resources for screening large populations to identify beneficial mutants. Prospecting novel mutants in commercial cultivars of gladiolus through single and double gamma ray exposure involves several key steps. Initially, selecting healthy and genetically diverse gladiolus cultivars is essential. These cultivars are then exposed to varying doses of gamma radiation, both in single and dual exposure steps, to induce mutations. Post-irradiation, plants undergo rigorous phenotypic screening to identify mutants exhibiting desirable traits such as improved flower quality, disease resistance, and enhanced stress tolerance. This research assesses the mutagenic effects of 6.5 kR gamma rays on gladiolus varieties, focusing on enhancing vegetative, floral, and corm characteristics.

## MATERIALS AND METHODS

The experiment was conducted at the Model Floriculture Centre, Govind Ballabh Pant University of Agriculture and Technology, situated in Pantnagar, Udham Singh Nagar District, Uttarakhand. This site is geographically positioned at a latitude of 29° North, longitude 79.3° East, and an elevation of 243.84 meters above mean sea level in the Tarai region of Uttarakhand. The irradiated planting material was evaluated using a Randomized Block Design (RBD) with a two-factorial concept after exposure to gamma irradiation. Each treatment combination included three replications, each consisting of 10 corms. The corms were planted with a spacing of 30 cm between rows and 20 cm between plants. Observations were recorded for the entire plant population from each replication of the treatment combinations. The detailed experimental plan is as follows: The design used was a factorial randomized block design with 7 varieties and 2 treatments, including 1 gamma-ray dose of 6.5 kR on unirradiated corms and 1 dose of 6.5 kR on pre-irradiated corms (including the control). The corms used had a diameter of 4-6 cm. Planting occurred in October of 2021, 2022, and 2023, with the corms being uplifted in late April of 2021, 2022, and 2023

## RESULT AND DISCUSSION

The study examined the impact of gamma irradiation on various traits of gladiolus varieties, including plant survival percent, plant height, leaf length, diameter of floret, spike length, rachis length, number of corms, and number of cormels, as illustrated in Table 1. For plant survival percent, Nova Lux showed a high survival rate under control conditions (92.53%), which significantly dropped to 63.92% with single irradiation and further to 43.90% with dual irradiation. Similar trends were observed in other varieties, such as Praha and Black Star, where survival rates also decreased with irradiation treatments. When plants are exposed to irradiation, they may not live as long. This could be because of mutagens that affect meristem cells or sudden chromosomal damage, chromosomal aberrations, delayed mitosis, and increased enzyme activity like lipase production and catalysis (Tiwari *et al.,* 2010).

Plant height was affected by irradiation, with control plants generally being taller. For instance, Praha had a height of 64.27 cm under control conditions, which reduced to 53.52 cm with single irradiation and 52.84 cm with dual irradiation. Leaf Length followed a similar pattern; Nova Lux had a leaf length of 29.34 cm under control, which decreased to 25.24 cm with single irradiation and 18.30 cm with dual irradiation. Disruption of meristematic growth may affect cell progression (Raghuvanshi and Singh 1979). In addition, the decrease in plant height and leaf length after irradiation may be due to the reduction of vertical cell layers. The responses of different cultivars to different doses of gamma radiation may be due to differences in tissue sensitivity to radiation (Broertjes and Van Harten 1988). The results are also supported by the findings of Patel *et al.* (2018); Tirkey *et al.* (2019).

The diameter of florets was also influenced by the treatments. Praha's floret diameter under control was 7.51 cm, but this decreased to 7.42 cm with single irradiation and 7.43 cm with dual irradiation. A significant reduction in the size of the lowest inflorescence was observed especially as a result of gamma radiation treatment of bulbs, which is consistent with the results of previous studies. Kumari *et al.* (2013) noted the gamma-ray shortening effect of chrysanthemum.

Spike Length was highest in control plants, such as Praha with 72.46 cm, compared to 68.47 cm and 53.00 cm under single and dual irradiation, respectively. Rachis Length followed this trend, with control plants having longer rachis lengths. For instance, Praha had a rachis length of 39.27 cm under control, reducing to 28.52 cm with single irradiation and 27.84 cm with dual irradiation. Raghava *et al.* (1988) observed a gradual decline of spike and bract in three gladiolus cultivars, namely 'Wild Rose', 'Little Giant' and 'Monster', after gamma irradiation treatment. Dhara and Bhattacharya (1972) reported similar results in gladioli. The number of corms and cormels also showed significant differences between treatments. The observed reduction in spike length might be attributed to a decrease in internal auxin production, which in turn hampers the overall growth of the plant (Singh *et al*., 2011). This finding aligns with our previous observations regarding various other traits influenced by gamma irradiation in gladiolus, such as changes in leaf count and width, which could also be linked to hormonal imbalances induced by the treatment. The results were also supported by the finding of Tirkey and Singh (2019).

Nova Lux under control conditions produced 1.00 corms, which slightly decreased to 0.9 with single irradiation and remained at 1.0 with dual irradiation. The number of cormels was highest in control plants of Praha (20.35), which dropped to 11.11 with single irradiation and further to 10.46 with dual irradiation. Different mutagens, such as gamma rays, can significantly impact various vegetative, flowering, and yield parameters, including the induction of ornamental variants in the gladiolus variety 'Psittacinus hybrid'. Specifically, these mutagens can alter the number, size, and weight of corms and cormels, contributing to the overall variability and enhancement of these traits (Patel *et al*., 2018).

Grabowska and Mynett (1970) suggested that the changes recorded in the number of bulbs and corms per plant could be due to disturbances in plant physiology affecting photosynthesis and damage to the root system that prevented plant growth. Tiwari *et al.* (2010) also found a reduction in the number of gladiolus corms per plant.

In conclusion, the study clearly demonstrates that gamma irradiation has a significant impact on the morphological and reproductive traits of gladiolus varieties (Fig. 1). Across all measured parameters, including plant survival percent, plant height, leaf length, diameter of floret, spike length, rachis length, number of corms, and number of cormels, the control groups consistently outperformed those subjected to single and dual irradiation treatments. The reduction in plant performance under irradiation conditions highlights the sensitivity of gladiolus varieties to gamma radiation. While gamma irradiation can be a useful tool for inducing genetic variability, its application should be carefully managed to minimize detrimental effects on plant growth and productivity.

**Table 1: Impact of gamma irradiation on various traits (vegetative, floral and corms traits) of gladiolus varieties.**

| Traits | Plant Survival Percent | | | | Plant Height | | | | Leaf Length | | | | Diameter of Floret | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Varieties | Control | Single | Dual | Mean | Control | Single | Dual | Mean | Control | Single | Dual | Mean | Control | Single | Dual | Mean |
| Nova Lux | 92.53 | 53.92 | 43.9 | 63.45 | 55.84 | 42.28 | 38.36 | 46.49 | 29.34 | 25.24 | 18.3 | 24.29 | 7.45 | 7.59 | 6.66 | 7.23 |
| Praha | 92.15 | 55.12 | 42.02 | 63.1 | 64.27 | 53.52 | 52.84 | 57.88 | 37.4 | 38.72 | 21.04 | 32.39 | 7.51 | 7.42 | 7.43 | 7.45 |
| Black Star | 91.1 | 51.75 | 31.94 | 58.26 | 63.35 | 43.12 | 42.35 | 50.61 | 35.57 | 24.96 | 19.55 | 26.69 | 7.42 | 7.11 | 6.71 | 7.08 |
| Nathan Red | 91.91 | 33.66 | 25.2 | 50.25 | 69.57 | 38.81 | 35.35 | 48.91 | 37.84 | 27.88 | 18.06 | 27.93 | 7.12 | 6.61 | 6.36 | 6.7 |
| Priscilla | 92.46 | 83.73 | 76.03 | 84.07 | 49.91 | 45.24 | 41.26 | 46.47 | 29.19 | 29.27 | 19.36 | 25.94 | 9.6 | 9.2 | 8.25 | 9.02 |
| Punjab Dawn | 92 | 74.97 | 61.82 | 76.26 | 60.96 | 43.72 | 40.64 | 49.44 | 30.19 | 26.99 | 24.22 | 27.13 | 7.29 | 6.41 | 6.48 | 6.73 |
| Tiger Flame | 92.19 | 78.76 | 73.12 | 81.35 | 62.95 | 46.01 | 43.01 | 51.65 | 35.21 | 30.39 | 24.99 | 30.19 | 7.66 | 7.24 | 7.17 | 7.36 |
| Mean | 92.05 | 61.7 | 50.57 | | 60.98 | 44.67 | 41.97 | | 33.53 | 29.06 | 20.79 | | 7.72 | 7.37 | 7.01 | |
| CD | T | V | T×V | | T | V | T×V | | T | V | T×V | | T | V | T×V | |
| | 0.789 | 1.206 | 2.088 | | 0.795 | 1.214 | 2.103 | | 0.834 | 1.274 | 2.206 | | 0.114 | 0.174 | 0.302 | |
| Traits | Spike Length | | | | Rachis Length | | | | No. of Corms | | | | No. of Cormels | | | |
| Varieties | Control | Single | Dual | Mean | Control | Single | Dual | Mean | Control | Single | Dual | Mean | Control | Single | Dual | Mean |
| Nova Lux | 65.78 | 50.89 | 44.63 | 53.77 | 30.84 | 17.28 | 13.36 | 21.49 | 1.0 | 0.9 | 1.0 | 1.0 | 18.38 | 9.79 | 4.01 | 10.73 |
| Praha | 72.46 | 68.47 | 53 | 64.64 | 39.27 | 28.52 | 27.84 | 32.88 | 0.9 | 0.8 | 0.7 | 0.8 | 13.98 | 7.08 | 5.24 | 8.77 |
| Black Star | 56.76 | 51.27 | 54.99 | 54.34 | 38.35 | 18.12 | 17.35 | 25.61 | 1.0 | 0.9 | 0.8 | 0.9 | 20.35 | 11.11 | 10.46 | 13.97 |
| Nathan Red | 72.26 | 64.43 | 56.53 | 64.41 | 44.57 | 13.81 | 10.35 | 23.91 | 1.4 | 1.1 | 0.6 | 1.0 | 11.94 | 5.34 | 4.18 | 7.15 |
| Priscilla | 51.23 | 48.48 | 44.46 | 48.05 | 24.91 | 20.24 | 16.26 | 21.47 | 0.7 | 0.7 | 1.9 | 1.1 | 7.45 | 4.8 | 12.02 | 8.09 |
| Punjab Dawn | 56.01 | 54.66 | 44.44 | 51.7 | 35.96 | 18.72 | 15.64 | 24.44 | 1.5 | 0.9 | 1.6 | 1.3 | 4.35 | 3.53 | 2.31 | 3.4 |
| Tiger Flame | 68.33 | 55.82 | 51.42 | 58.52 | 37.95 | 21.01 | 18.01 | 26.65 | 1.1 | 1.1 | 1.1 | 1.1 | 27.12 | 15 | 11.43 | 17.85 |
| Mean | 63.26 | 56.29 | 49.92 | | 35.98 | 19.67 | 16.97 | | 1.09 | 0.93 | 1.11 | | 13.94 | 7.23 | 6.23 | |
| CD | T | V | T×V | | T | V | T×V | | T | V | T×V | | T | V | T×V | |
| | 0.519 | 0.793 | 1.373 | | 0.436 | 0.666 | 1.154 | | 0.023 | 0.035 | 0.060 | | 1.790 | 2.734 | 4.735 | |

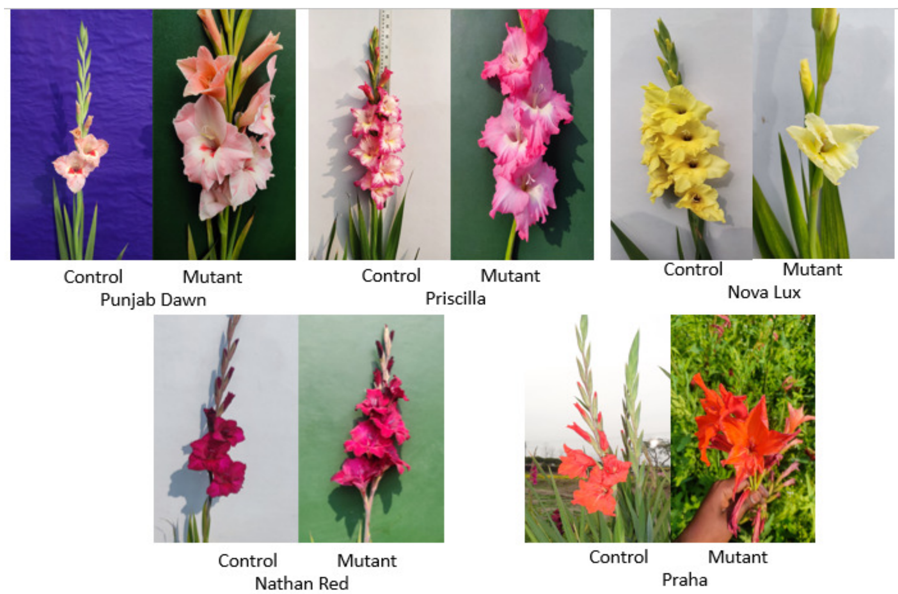


**Fig. 1**. Desirable mutants from the different varieties.

## CONCLUSIONS

These findings provide valuable insights for future research and practical applications in the cultivation and breeding of gladiolus and potentially other horticultural crops. Mutation breeding can be used to produce a variety of modifications in the gladiolus' morphological framework. For crop development, the available spontaneous variability is supplemented by the generation of a broad spectrum of genetic variability using physical mutagens such as application of gamma rays.

## FUTURE SCOPE

Future studies could explore the genetic basis of observed mutations in gladiolus using advanced molecular techniques. Developing new varieties with enhanced traits such as larger flowers, varied colors, and longer vase life could be pursued. Expanding this research to other ornamental plants and conducting long-term field trials will help assess the stability and adaptability of these mutations under different conditions.

**Acknowledgements.** We thank G.B. Pant University of Agriculture & Technology, Pantnagar for providing resources and facilities. Special thanks to our advisors and colleagues for their support.

**Conflict of Interest.** None.

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**How to cite this article:** Yograj Kushwaha, Bhagwan Das Bhuj, Ranjan Srivastava, N.K. Singh and Satish Chand (2024). Assessment of Single and Dual Dose of Gamma Rays on Gladiolus Cultivars. *Biological Forum – An International Journal, 16*(6): 85-88.