

Effect of gamma-irradiation on the performance of different *Gladiolus (Gladiolus grandiflorus L.)* cultivars

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ABSTRACT

An experiment titled "Effect of Gamma-irradiation on the performance of different gladiolus (*Gladiolus grandiflorus* L.) cultivars" was conducted at the Department of Floriculture and Landscaping, College of Horticulture, Mandsaur, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior (M.P.) from November 2022 to April 2023. The objective of the study was to evaluate the effects of gamma irradiation on different cultivars at three levels: 0.75, 1.75 and 2.75 kr along with an untreated (control). Four cultivars of gladiolus viz. Jyotsana, Happy End, Dhanvantari and Green Star were taken. The research was carried out under field conditions using a Factorial Randomized Block Design (FRBD) comprising 16 treatments replicated three times. In this experiment, different morphological characteristics i.e., sprouting of 50% corms, plant height at 45 days after planting, number of leaves per plant at 45 days after planting and number of corms per hill were studied. Data revealed that the earliest sprouting of 50% corms was recorded with 0.75 kr gamma irradiation in cultivar Jyotsana. The maximum number of sprouts per hill was recorded with 0.75 kr gamma irradiation in cultivar Green Star, maximum plant height was also reported with 0.75 and 1.75 kr gamma rays in cultivar Jyotsana. Treatment 0.75 kr gamma irradiation with Green Stars shows the best performance concerning the number of leaves per plant. The maximum length of the longest leaf was observed. 0.75 kr gamma-ray in cultivar Jyotsana, maximum width of the longest leaf was observed. 1.75 kr gamma-ray in cultivar Happy End, the maximum number of corms per hill was observed. 0.75 kr gamma-ray in cultivar Green Star and maximum corm diameter was recorded at 0.75 kr gamma irradiation in cultivar Jyotsana.

Key words: Corm, gladiolus cultivar performance, gamma irradiation and mutation breeding.

INTRODUCTION

Gladiolus (*Gladiolus grandiflorus* L.), often referred to as the "sword lily" because of its

sword-like leaves, was named by the Roman naturalist Pliny the Elder (A.D. 23-79). This charming plant is part of the Iridaceae family

and encompasses over 260 species (Singh, 2006). *Gladiolus* showcases six perianth leaves, three stamens and a single pistil arranged in a spike-shaped inflorescence that contains hermaphroditic florets. It typically propagates through underground corms (Kaur *et al.*, 2022). As a widely sought-after ornamental plant, gladiolus holds significant economic importance in the floriculture industry, known for its stunning blooms and vibrant colors (Cantor *et al.*, 2002). In India, commercial gladiolus cultivation thrives in several states, including Maharashtra, West Bengal, Uttar Pradesh, Uttarakhand, Punjab, Haryana, Delhi, Rajasthan and Madhya Pradesh. Breeding programs focus on enhancing desirable traits like flower color, floret size, shape and spike yield (Yograj Kushwaha *et al.*, 2024). However, conventional breeding is often a lengthy process when it comes to improving genetic qualities in floriculture crops (Pawadashetti *et al.*, 2022). Today, various biotechnological tools have been introduced, such as micropropagation, somaclonal variation, *in vitro* selection, induced mutagenesis, genetic transformation, stress resistance breeding, fragrance breeding and molecular marker technology (Singh *et al.*, 2024). Artificial mutations play a crucial role in mutation breeding, serving as a method for generating hereditary variability (Kaur *et al.*, 2022). A key advantage of mutation induction is that these changes can be preserved through vegetative propagation. Importantly, gamma rays have proven effective in developing and releasing numerous new ornamental varieties (Dogra *et al.*, 2018). Higher radiation doses can be detrimental, doses ranging from 0.5 to 5.0 krad are advised for gamma irradiation in gladiolus (Dogra *et al.*, 2018).

MATERIALS AND METHODS

Experiment site and plant material: The present

study was carried out at Experiment Farm, Department of Floriculture and Landscaping, K.N.K. College of Horticulture, Mandsaur, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior (M.P.) during November 2022 to April 2023. Mandsaur is situated on the Malwa plateau in the western part of Madhya Pradesh at 23.39° N latitude and 75.10° E longitude and an altitude of 435.02 meters above mean sea level. Four cultivars were taken viz., Jyotsana, Happy End, Dhanvantari and Green Star for this study.

Irradiation treatments and statistical model:

Uniform-size corms were irradiated with gamma radiation doses 0.75, 1.75 and 2.75 kr from source ⁶⁰Co at IARI, New Delhi. As a point of comparison, we also included an untreated control group. This setup allowed us to explore the intriguing effects of gamma exposure on plant development. Treated corms were carefully planted under field conditions using a factorial randomized block design (FRBD), comprising 4 treatments replicated 3 times for each variety that ensure reproducibility. Intercultural operations such as weeding, staking, irrigation and fertilization were done as needed.

Soil and environmental factors: The soil composition consists of 41% sand, 31% silt and 28% clay. The soil pH is 7.1 while the electrical conductivity stands at 0.31 ds/m, as determined using an EC meter. Additionally, the available nitrogen content is 161 kg N/ha available phosphorus is 15 kg P₂O₅/ha and available potash is 205 kg K₂O/ha which were assessed using the flame photometer method. Mandsaur experiences a sub-tropical climate with winter temperatures dropping to a minimum of 5°C and soaring to a maximum of 44°C in summer. This region mainly receives rainfall from mid-June to mid-September with occasional winter showers. The Southwest monsoon is the primary contributor

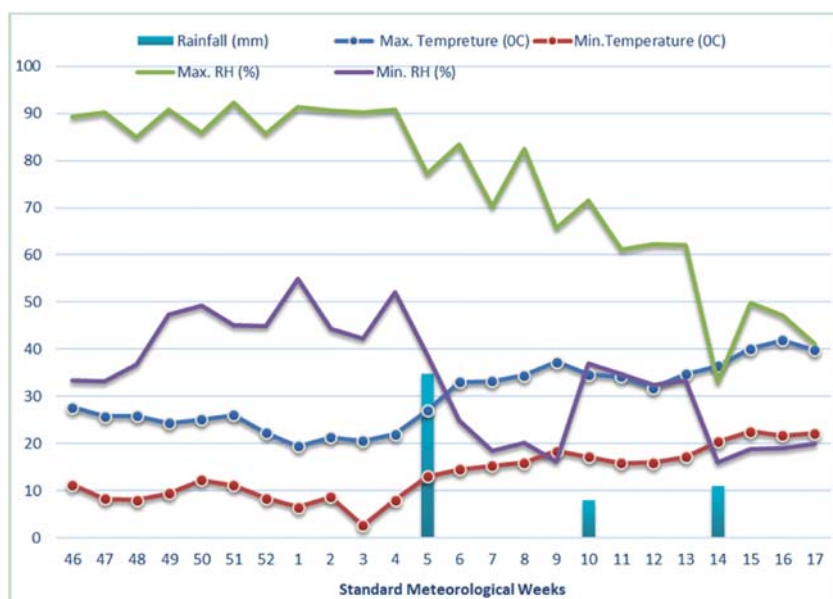


Fig. 1: Mean weekly meteorological parameters during the crop period {(46 Weeks: 12-11-22 to 18-11-22), November 2022 to April 2023}

to the annual precipitation of 714.8 mm. Detailed meteorological data recorded during the study period is summarized and visually represented in accompanying graphs. Soil and environment factor are very crucial for growth and development of the plants.

Data collection and methods: Various parameters were observed during the experiment *i.e.* growth, corms and morphological changes. Days taken to 50% sprouting, number of sprouts per hill, plant height (cm), number of leaves per hill, length of longest leaf (cm), width of longest leaf (cm), number of corms per hill and corm diameter (cm).

RESULTS AND DISCUSSION

The study demonstrated that gamma irradiation at low doses (0.75-1.75 kr) significantly enhanced key growth and yield traits in gladiolus, while higher doses (2.75 kr) suppressed performance, underscoring the hermetic effect of radiation. Cultivar-specific responses further highlighted

genetic variability in mutagen tolerance, with Jyotsana and Green Star emerging as promising candidates for mutation breeding (Table 1) where C denoted as cultivar and G denoted as gamma irradiation doses.

Sprouting dynamics and early growth : Cultivar Jyotsana irradiated at 0.75 kr exhibited the earliest 50% sprouting (10.67 days, C_1G_2), outperforming the control (11.83 days) and higher doses (12.25 days at 1.75 kr). This acceleration aligns with prior reports where low-dose irradiation enhanced α -amylase activity, sugar mobilization, and oxygen uptake in corms (Misra and Bajpai, 1983; Karki *et al.*, 2010). Conversely, delayed sprouting at 1.75 kr (12.25 days) may reflect temporary metabolic stress. Notably, Green Star produced the highest sprout count (4.22 sprouts/hill, C_4G_2) while Dhanvantari does poor performance (1.40 sprouts/hill, C_3G_4) suggests sensitivity to irradiation. likely due to its genetic propensity for lateral bud activation under mild mutagenic stress Srivastava *et al.* (2007).

Table 1: Effect of gamma irradiation on days taken to 50% sprouting, number of sprouts per hill, plant height (cm), number of leaves per hill, length of longest leaf (cm), width of longest leaf (cm), number of corms per hill and corm diameter (cm) in gladiolus..

Treatments	50% SP	NSPH	PH	NLPH	LLL	WLL	NCPH	CD
Cultivars								
C ₁ (Jyotsana)	11.33	2.47*	38.04*	7.48*	32.64*	1.94*	2.47*	4.27*
C ₂ (Happy End)	12.50	1.72*	29.46*	5.04*	24.37*	3.12*	1.72*	4.11*
C ₃ (Dhanvantari)	11.42	1.56*	37.75*	4.75*	30.63*	2.15*	1.56*	3.97*
C ₄ (Green Star)	12.17	3.31*	29.20*	9.27*	26.12*	2.02*	3.31*	3.60*
S. Em +	0.18	0.12	0.45	0.33	0.39	0.07	0.12	0.08
CD at 5%	0.51	0.35	1.31	0.94	1.13	0.19	0.35	0.23
Gamma dose								
G ₁ (0.00 kr)	11.83	1.85*	34.00*	5.19*	28.44*	2.35	1.85*	3.93
G ₂ (0.75 kr)	11.50	2.71*	34.06*	7.71*	29.11*	2.31	2.71*	4.06
G ₃ (1.75 kr)	12.25	2.15*	34.06*	7.04*	28.76*	2.40	2.15*	4.04
G ₄ (2.75 kr)	11.83	2.36*	32.32*	6.60*	27.46*	2.17	2.36*	3.92
S. Em±	0.18	0.12	0.45	0.33	0.39	0.07	0.12	0.08
CDat 5%	0.51	0.35	1.31	0.94	1.13	0.19	0.35	0.23
Interaction effect (CX G)								
C ₁ G ₁	11.00	1.67	38.64*	5.13	31.93*	2.07	1.67	4.32
C ₁ G ₂	10.67	2.93	38.78*	8.67	33.78*	1.92	2.93	4.34
C ₁ G ₃	12.00	2.45	37.30*	8.47	31.88*	1.93	2.45	4.27
C ₁ G ₄	11.67	2.83	37.44*	7.67	32.97*	1.85	2.83	4.14
C ₂ G ₁	13.00	1.22	30.73*	3.61	24.30*	3.01	1.22	4.13
C ₂ G ₂	12.00	1.93	29.43*	5.80	24.41*	3.16	1.93	4.07
C ₂ G ₃	12.67	1.53	29.39*	6.00	25.23*	3.28	1.53	4.33
C ₂ G ₄	12.33	2.20	28.29*	4.73	23.53*	3.04	2.20	3.91
C ₃ G ₁	11.33	1.57	40.06*	4.45	32.77*	2.26	1.57	3.87
C ₃ G ₂	11.00	1.73	38.71*	5.13	31.43*	2.22	1.73	4.12
C ₃ G ₃	11.67	1.53	37.95*	5.00	30.31*	2.26	1.53	3.99
C ₃ G ₄	11.67	1.40	34.28*	4.40	28.03*	1.85	1.40	3.91
C ₄ G ₁	12.00	2.95	26.57*	7.55	24.74*	2.07	2.95	3.39
C ₄ G ₂	12.33	4.22	29.34*	11.24	26.82*	1.94	4.22	3.69
C ₄ G ₃	12.67	3.08	31.62*	9.28	27.63*	2.11	3.08	3.57
C ₄ G ₄	11.67	3.00	29.26*	9.00	25.30*	1.95	3.00	3.73
S. Em ±	0.36	0.24	0.91	0.65	0.78	0.13	0.24	0.16
CD at 5%	1.03	0.70	2.62	1.89	2.25	0.39	0.70	0.46

Abbreviation: *Significant, 50% SP - Days taken to 50% sprouting (days), NSPH - Number of sprouts per hill, PH - Plant height (cm) at 45 DAP, NLPH - Number of leaves per hill at 45 DAP, LLL - Length of longest leaf (cm) at 45 DAP, WLL - Width of longest leaf (cm) at 45 DAP, NCPH - Number of corms per hill, CD - Corm diameter (cm).

Plant morphology and photosynthetic efficiency: In cultivar and gamma irradiation, Jyotsana displayed superior vigour under 0.75-1.75 kr while in interaction C₃G₁ achieving maximal plant height (40.06 cm) and leaf length (33.78 cm, C₁G₂), likely due to radiation-induced

cell elongation and auxin-mediated internode expansion (Singh and Kumar, 2013). In contrast, Green Star, though shorter (26.57 cm, C₄G₁), produced the highest leaf count (11.24 leaves/hill, C₄G₂) indicating compensatory growth strategies. The reduced leaf width in Jyotsana

(1.94 cm) compared to Happy End (3.12 cm) underscores intrinsic genetic differences in leaf architecture, as observed by Pandey *et al.* (2012).

Corm yield and quality, dose-dependent responses : Low-dose irradiation (0.75 kr) maximized corm production in Green Star (4.22 corms/hill, C₄G₂), likely due to enhanced photosynthetic efficiency and resource partitioning (Sahariya *et al.*, 2017). Conversely, Dhanvantari's minimal yield (1.40 corms/hill, C₃G₄) at 2.75 kr highlights cellular damage from excessive radiation, consistent with DNA strand breakage and meristematic inhibition (Dogra *et al.*, 2018). Corm diameter, a critical market trait, peaked in Jyotsana (4.34 cm, C₁G₂) under 0.75 kr but declined at 2.75 kr (3.91 cm, C₃G₄), emphasizing the need for dose optimization. The hermetic effect of 0.75 kr stimulating growth while avoiding cytotoxicity aligns with Safeena and Thangam's (2019) observations in gladiolus.

CONCLUSION

The investigation showed that gamma irradiation doses of 0.75 kr and 1.75 kr were helpful to various growth and corm parameters of gladiolus.

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