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Effect of Gamma rays on sprouting and survival percentage of Gladiolus

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Abstract
An experiment entitled "Mutation studies in Gladiolus" was carried out during rabi season of the year 2021- 2023 at the farm of Horticulture Section, College of Agriculture, Nagpur. The experiment of was laid out in factorial randomized block design with three replications, four varieties *viz.* Pusa Suhagin. Arka Naveen, Dhanvantari and Punjab Dawn and five treatments consists of Control, 35 Gy, 45 Gy, 55 Gy, 65 Gy. The different varieties with different treatment of Gladiolus with gamma rays had significantly influenced Significantly reduced the sprouting percentage of plants and survival percentage of plants in M1 and M2 generation of Gladiolus.

Keywords: Mutation, Gamma rays, sprouting, survival, gladiolus

1. Introduction
Gladiolus, often called the "Queen of bulbous flower crops," is indeed a prized ornamental flower in the global market. Its tall, striking spikes, adorned with a range of elegant florets, make it a favorite for floral arrangements. The sequential blooming of gladiolus allows for an extended display, while its durability enhances its appeal as a cut flower. With a variety of colors and shapes, it brings beauty and sophistication to gardens and interiors alike, making it a cherished choice among florists and flower enthusiasts. Its long-lasting quality in vases further solidifies its reputation in the floral industry. In the international floriculture trade, gladiolus ranks fifth among ornamental geophytes according to NHB., 2018 database. The rising demand for gladiolus in the floriculture market underscores the importance of genetic improvements, particularly aimed at enhancing vase life and facilitating rapid development. Given that gladiolus is primarily vegetatively propagated, mutation breeding offers a promising avenue for innovation. This approach allows for the targeted modification of specific traits in outstanding varieties without disrupting other desirable characteristics, which is particularly beneficial given the crop's complex genetic structure and high heterozygosity. By utilizing corms and cormels for propagation, growers can effectively perpetuate beneficial mutations identified in irradiated plants. This method not only helps in developing new forms of gladiolus with improved qualities but also enables the preservation of genetic diversity within the species (Sharma et al., 2017) [11]. As the floriculture industry continues to evolve, such genetic advancements will be crucial in meeting consumer preferences and enhancing the overall appeal of gladiolus. Mutation breeding offers an alternative by inducing variability, often altering one or two traits without affecting the entire plant. This method employs induced mutagenesis using physical and chemical mutagens, leading to the creation of new and promising ornamental plant forms. Although ionizing radiation is commonly used to induce variability (Chemagin *et al.*, 1997) [3]. Based on this awareness, this study aims to induce physical mutations in the Gladiolus crop and examine their effects on various morphological and genetic traits at different mutagenic doses.

Materials and Methods
The investigation entitled, "Mutation studies in Gladiolus" was carried out at the field of Experimental farm, Horticulture Section, College of Agriculture, Nagpur during rabi season of the year 2021-22 and 2022-23. The best quality corms of gladiolus were obtained from Directorate of floriculture research, Pune (M.S) consisiting of four varieties of different colour *viz* Pusa Suhagin, Arka Naveen, Dhanvantari and Punjab Dawn.

Total 6000 corms were procured 1500 of each variety. The corms irradiated with four doses of gamma rays (35 gy,45 gy, 55 gy and 65 gy) at Bhabha Atomic Research Centre, Tombey, Mumbai. The gamma rays treated corms were planted in November, 2021. The corms were planted at 30 X25 cm distance on the experimental field in Factorial Randomized Block Design (FRBD) of three replications with five treatments and four varieties. All the standard cultural practices were followed as per the university guidelines.

The plants that had showed variation were isolated from the population of the M1 generation and planted separately for M2 generation however for non variant plants again planting was carried out in Factorial Randomized Block Design (FRBD) in November 2022 to raise the

M2 population and to find out variants. Collect of corms and cormels were carried out from each variant separately, ensuring proper storage conditions. The crop was raised under uniform and standard cultural practices. Corms having uniform diameter ranging between 4-6 cm were selected for the experiment. Corms were planted at 30 cm row to row and 25 cm plant to plant distance. To keep field free from weeds during the experimental period the field was periodically inspected and weeding was done manually. Irrigation was done periodically by flooding method of irrigation. The last irrigation was applied two weeks prior to harvesting of corms and cormels from the experimental field. The harvested corms of vM1 were used as base population in vM2 generation. Variations cause due to mutagenic treatments were observed carefully by inspecting the variations in vegetative growth and flowering characteristics between treated and non-treated corms in vM1 and vM2 generations

Gladiolus is an important cut flower crop which possesses a great potential for export market to European countries especially during winter. The basic chromosome number of gladiolus is X=15 (Shukla *et al*. 2018) Gladiolus is an important flower crop and is very popular as cut flower both in the domestic and international market. 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 (Sathyanarayan *et al*. 2022) [11]. Mutations are induced in different crops to create variability for further improvement. In vegetatively propagated plants, mutation breeding offers great potentialities as the mutated part can be conveniently perpetuated by vegetative means resulting in the development of new forms. Gladiolus is highly heterozygous in its genetic constitution which makes it promising test material for inducing physical mutagenesis (Sahariya *et al*., 2017) [10]. Corms of different gladiolus variety were treated with different doses of gamma rays, EMS and DES were taken under study. Higher doses of all mutagens adversely affected growth and flowering parameters of gladiolus. Keywords: Gladiolus, mutation, gamma rays, EMS Introduction Gladiolus (*Gladiolus grandiflorus* L.), the queen of bulbous flowers is one of the major commercial flowers, which is being cultivated in various parts of the country and, has ever increasing demand in the flower markets. It is a monocotyledonous flowering bulbous plant, belonging to family Iridaceae and subfamily Ixoideae. It is the largest genus in the family Iridiaceae with 260 species, which are mainly native to South Africa. It is mainly grown for cut spikes, garden decoration and for exhibition. Gladiolus is preferred due to its wide range of adaptability, various coloured florets of different shapes and sizes and good shelf life (Tiwari *et al*. 2010) [14]. Gladiolus is vegetatively propagated by corms and its highly heterozygous nature and polyploidy makes the crop ideal material for genetic manipulation through mutation breeding (Kumari *et al*. 2015) [10]. Mutation breeding has played a major role in the development of many new colour/shape mutants in ornamental plants (Broertjes and Van Harten 1988) [1]. Induced mutation is one of the most widely used techniques for creating additional variability in flower character.

Results and Discussion

1. sprouting (%)

The perusal of data presented in Table 1 regarding Sprouting percentage which was greatly varied due to gamma doses and it was observed that as doses of gamma rays increased sprouting percentage decreased in gladiolus during both years.

vM1 generation Effect of varieties

At 60 DAP, the significantly maximum sprouting percentage was recorded in cv. Pusa Suhagin (88.09%) whereas the minimum sprouting percentage was recorded in cv. Dhanvantari (78.90%).

Effect of irradiation doses

At 60 DAP, the significantly maximum sprouting percentage was recorded in treatment G1 (100 %) and whereas the minimum sprouting percentage was recorded in G5 (74.56%).

Interaction effect

The interaction effect of varieties (V) and induced mutagens (G) on sprouting percentage of gladiolus was found to be non-significant.

vM2 generation Effect of varieties

At 60 DAP, the significantly maximum sprouting percentage was recorded in cv.Pusa Suhagin (86.53%) and whereas the minimum sprouting percentage was recorded in cv. Dhanvantari (76.64%).

Effect of irradiation doses

At 60 DAP, the significantly maximum sprouting percentage was recorded in treatment G1 (100%) and whereas the minimum sprouting percentage was recorded in G5 (70.29%).

Interaction effect

The interaction effect of varieties (V) and different irradiation doses (G) on sprouting percentage of gladiolus was found to be non-significant.

In 1955, Sax observed that low doses of radiation stimulate sprouting by enhancing oxygen uptake and enzyme activity. Apte (1958) [2] later found that high radiation doses negatively affect plant growth by disrupting auxins, growth substances, chromosome structure, and cell division, leading to delayed sprouting or plant death. Grabowska and Mynett (1970) [4] further confirmed that higher radiation doses produce toxic substances, which harm the plant and suppress growth

Table 1: Effect of gamma rays on sprouting percentage of gladiolous in vM1 and vM2 generation vM1 Generation

Gamma rays doses	vM1 Generation				
	Pusa Suhagin (V1)	Arka Naveen (V2)	Dhanvan Tari (V3)	Punjab Dawn (V4)	Mean
G1- Control (No irradiation)	100.0	100.00	100.0	100.0	100.00
G2-35 Gy gamma rays	89.6	90.89	80.1	82.1	85.70
G3-45 Gy gamma rays	84.0	81.18	73.7	82.3	80.30
G4-55 Gy gamma rays	79.27	80.91	64.1	74.6	74.70
G5-65 Gy gamma rays	79.17	78.22	62.7	61.4	70.30
Mean	86.42	86.24	76.13	80.07	82.21

Vm2 Generation

Gamma rays doses	vM2 Generation				
	Pusa Suhagin (V1)	Arka Naveen (V2)	Dhanvan Tari (V3)	Punjab Dawn (V4)	Mean
G1- Control (No irradiation)	100.00	99.67	99.33	98.67	99.42
G2-35 Gy gamma rays	83.19	83.19	76.08	82.21	81.17
G3-45 Gy gamma rays	71.63	71.43	71.27	75.57	72.47
G4-55 Gy gamma rays	71.69	70.52	62.31	71.92	69.11
G5-65 Gy gamma rays	73.31	72.97	60.76	67.64	68.67
Mean	79.96	79.55	73.95	79.20	78.17

Sources		Vm2 Generation	
	S.Em. (+-)	C.D. (5%)	C.V. (%)
Varieties	1.59	NS	12.03
Treatments	1.78	5.15	
Varieties X Treatments	3.57	10.31	

Similar results were obtained by different researchers. At low doses, certain plant chemicals promote sprouting and germination (Sax, 1955), but higher doses can produce toxic substances, damaging cells and hindering growth (Grabowska & Mynett, 1970) [4]. Pandey & Gaur (1984) [9] found that low-dose irradiation of cormels increased sprouting by stimulating enzyme activity and sugar content, while high doses delayed sprouting by inhibiting enzyme activity. Srivastava *et al.* (2007) [13] suggested that low-dose irradiation stimulates enzymes crucial for plant metabolism, aiding sprouting.

Survival (%)

Table 2: Effect of gamma rays on survival percentage of gladiolus in vM1 and vM2 generation

vM1 Generation

Gamma rays doses	vM1 Generation				
	Pusa Suhagin (V1)	Arka Naveen (V2)	Dhanvan Tari (V3)	Punjab Dawn (V4)	Mean
G1- Control (No irradiation)	100	100	100	100	100
G2-35 Gy gamma rays	91.25	92.68	82.49	87.89	88.5
G3-45 Gy gamma rays	88.17	90.15	74.68	76.44	82.71
G4-55 Gy gamma rays	85.44	86.99	68.76	73.25	78.77
G5-65 Gy gamma rays	78.36	80.55	67.36	70.28	74.56
Mean	88.09	90.3	78.9	82.58	84.9

Source		vM1 Generation		
	F test	SE(m) (±)	C.D. (5%)	CV%
Varieties	NS.	0.77	0.21	12.66
Treatments	Sig.	1.26	3.58	
Varieties X Treatments	Sig.	2.19	6.24	

vM2 Generation

Gamma rays doses	vM2 Generation				
	Pusa Suhagin (V1)	Arka Naveen (V2)	Dhanvan Tari (V3)	Punjab Dawn (V4)	Mean
G1- Control (No irradiation)	100.00	100.00	100.00	100.00	100.00
G2-35 Gy gamma rays	88.78	89.95	80.15	77.34	84.05
G3-45 Gy gamma rays	83.69	78.23	73.11	69.54	76.14
G4-55 Gy gamma rays	81.12	76.41	69.10	70.35	74.25
G5-65 Gy gamma rays	79.05	74.85	60.85	66.42	70.29
Mean	86.53	83.89	76.64	76.73	80.95
Source		**vM2 Generation**			
	F test	**SE(m) (±)**	**C.D. (5%)**	**CV%**	
Varieties	NS.	0.22	0.65	8.33	

Treatments	Sig.	1.84	5.12	
Varieties X Treatments	Sig.	2.41	6.21	

Vm1 generation Effect of varieties

The perusal of data presented in Table 2 at 45 DAP shows the significantly maximum survival percentage was recorded in cv.Pusa Suhagin (86.42%) whereas the minimum survival percentage was recorded in cv. Dhanvantari (76.13%) in vM1 generation.

Effect of irradiation doses

At 45 DAP, the significantly maximum survival percentage was recorded in treatment G1 (100.00 %) and whereas the minimum survival percentage was recorded in G5 (70.30 %) vM1 generation.

Interaction effect

Interaction effect of irradiation doses and variety were found to be significant in respect of survival percentage in vM1 generation. The maximum survival percentage was found in all four varieties when planted without irradiation doses (100%). Among irradiated corms, cv.Arka Naveen has the maximum percentage of survival when treated with 35 Gy irradiation (90.89%) amongst other where as cv.Punjab Dawn when treated with 65 Gy has shown the minimum survival percentage (61.40%).

vM2 generation

The data presented in Table 4.1 and depicted through Fig. 4.2 indicated that survival percentage in vM2 generation as given below.

Effect of varieties

The significantly maximum survival percentages was recorded in cv. Pusa Suhagin (79.96 %) and whereas the minimum survival percentage was recorded in cv. Dhanvantari (73.95%) at 45 DAP.

Effect of irradiation doses

For vM2 generation the significantly maximum survival percentage was recorded in treatment G1 (99.42 %) and whereas the minimum survival percentage was recorded in G5 (68.67 %).

Interaction effect

The interaction effect of varieties (V) and different irradiation doses (G) on survival percentage of gladiolus was found to be non-significant. The data revealed that gamma rays treatment had reduced the plant survival percentage in both generations over control.

Various levels of mutagens were not responded well on early sprouting but physical mutagens influences the activity of enzymes. Enzymes play a pivotal role in various plant metabolism activities consequently result in stimulating plant growth by (Misra and Bajpai, 1983) which some growth parameters increased due to different levels of gamma irradiation. It has been documented that auxin played some role in plant growth. Various growth parameters increased at lower doses of gamma irradiation, whereas, decreased as doses of gamma irradiation increased. It might be due to some enzyme activities and related to the increased activity of gibberellins and auxins and disappearance of the inhibitors. Present finding are also experimentally substantiated with the observation made by earlier workers (Misra and Bajpai, 1983, Pandey and Gaur, 1984 and Karki *et al.*2010) [9].

A significant decrease in survival percentage after irradiation with gamma rays due to inactivation or decrease in auxin concentration that disturb cell division and resulting in poor survival and growth (Sangasiri *et al*.,2015). The reduction in plant survivability after irradiation might have causes due to the effect of mutagen on meristematic cell or due to acute chromosomal damage, chromosomal aberration, delay mitosis, induce enzyme activity such as lipase catalyse and production (Tiwari *et al*.,2010) [14].

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