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Effect of physical and chemical mutagens on morphological characters and vegetative abnormalities in commercial varieties of gladiolus (*Gladiolus grandiflorus* L.)

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ABSTRACT

The current study was conducted to investigate entitled "Effect of physical and chemical mutagens on morphological characters and vegetative abnormalities in commercial varieties of gladiolus was laid out in Factorial Randomized Block Design with three replications, nine treatments, and 18 treatment combinations separately during rabi season of 2020-21 and 2021-22 at Department of Horticulture, Janta College, Bakewar, Etawah. The corms of two cultivars American Beauty and Nova Lux were irradiated with gamma 1kR, 2 kR, 3 kR, 4kR and 5 kR and for chemical mutagenesis the corms were dipped in a solution of 0.4% EMS, 0.6% EMS and 0.8% EMS. The Gamma irradiation of corms has been done at Gamma chamber at CSIR-National Botanical Research Institute, Lucknow (India) during First week of November 2020. In M2 generation results indicated that the mutagenic treatments at lower doses had significant stimulative effect on some parameters. The maximum length of largest leaf (2kR gamma irradiation), width of longest leaf (1kRgamma irradiation) and number of leaves per plant (2kR gamma irradiation) were recorded. The maximum vegetative abnormalities (%) were observed under the treatment @ (5kR Gamma irradiation), followed by @ (0.8% EMS solution) under the south-western agro-climatic conditions of Uttar Pradesh. Thus it could be concluded that Gamma irradiations and EMS at lower concentrations gave better results.

Key words*: Gladiolus, Yield, Corm, Gamma irradiation, EMS.*

Introduction

Gladiolus is a commercial cut flower bulbous crop of India, belongs to the Iridiaceae family and sub-family Ixioidaceae. Its name native from Latin word "Gladius" meaning sword due to its foliage shape and so called as "Sword lily". It is also known as "Corn Flag". It was originated in South Africa and is assigned as "Queen of bulbous ornamentals" because of its huge and tremendous popularity amongst the bulbous ornamentals crops. It is highly well-liked due to its regal spikes bearing brilliantly hued florets. In any floral arrangement, the exuberance of gladiolus'colourful spikes is a treat. Together with its extended vase life, these qualities make it the second most popular commercial cut flower after the rose. Pliny the Elder invented the term gladiolus, which is derived from the Latin word gladius, which means "sword" (A.D. 23-79). Gladiolus ranks fifth alongside tulip, lily, fressia, and hippeastrum among the geophytes in worldwide florist trade (Anon, 2016), and first in India's domestic bulbous flower trade. There are approximately 260 species in tropical and subtropical South Africa, Central Europe, the Mediterranean, Western Asia, and Asia Minor. The variability created by any breeding method (hybridization or mutation) enhances the scope for selection (Kumari and Kumar, 2015). Mutagenesis has played a major role in the development of many new colour/shape mutants in ornamental plants (Broertjis and Harten, 1978). The demand of gladiolus is increasing therefore; it needs attention towards genetic improvement. Improvement in any crop depends on the natural variability available in it. Breeders have been resorting to generate variation through artificial hybridization and/or mutation breeding in many ornamental crop and these methods have served the breeders effectively (Singh, 2006). The main advantage of mutation induction is that the changes can be retained through vegetative propagation. Gladiolus are vegetatively propagated by corms and cormels most suited for commercial exploitation through mutation breeding without any homozygosity and loss of any desirable characters. (Shukla *et al.,* 2018). Gamma rays are ionizing radiation that interacts with atoms and molecules, producing free radicals in cells (Patil *et al*., 2017). Chemical mutagenesis is simple and an efficacious approach to acquire a valuable material for breeding as it possess the ability of inducing high frequency non-lethal point DNA mutations and generate genetic diversity in the plants (Deepa *et al.,* 2022).

Materials and Methods

The gladiolus (*Gladiolus grandiflorus* L.) cultivars American Beauty (V1), Nova Lux (V2), which have been found promising for vegetative traits, were executed in the course of Rabi season in 2020 and 2021 at Department of Horticulture, Janta College, Bakewar, Etawah. Healthy and uniform corms of desirable size (2-4.5 cm) were used for mutagenic treatments and subsequent planting. The corms were treated with subsequent doses of gamma irradiations viz. 1kR, 2kR, 3kR, 4kR and 5 kR and for chemical mutagenesis the corms were dipped in a solution of 0.4% EMS, 0.6% and 0.8% EMS treatment-wise. The gladiolus corms were subjected to Co-60 gamma radiations at National Botanical Research Institute, Lucknow, India in November, 2020. Source of Gamma rays was ^{60}Co Low dose irradiator. The corms were treated with gamma irradiations viz. 1kR, 2kR, 3kR, 4kR and 5 kR planted within 24 hours of treatment. In case of chemical mutagens, Chemical mutagen EMS was used at various concentrations to induce variability. For each treatment 9 corms were selected. The corms were pre soaked in water for six hours. The pre soaked corms were subjectedto various mutagenic treatments namely EMS 0.4%, 0.6%and 0.8% EMS. After treatment corms were washed in tap water before the planting in main field. The corms soaked in normal water were used as control. For M2 generation, the corms harvested from M1 generations, planted again during the first week of November, 2021. The experiment was laid out in a Factorial Randomized Block Design with replicated thrice. The plants were maintained under uniform cultural conditions throughout the period of investigation.A total of 18 treatment combinations were deduced and the plants sown at a spacing of 25cm x 25cm at a depth of 5-7 cm. The treatment combinations were T1V1 (Control and American Beauty), T2V1 (1 kR Gamma irradiation + American Beauty), T3V1 (2 kR Gamma irradiation + American Beauty), T4V1 (3 kR Gamma irradiation + American Beauty), T5V1 (4 kR Gamma irradiation + American Beauty), T6V1 (5 kR Gamma irradiation + American Beauty), T7V1 (0.4 % EMS+ American Beauty), T8V1 (0.6 % EMS+ American Beauty), T9V1 (0.8 % EMS+ American Beauty), T1V2 (Control + Nova Lux), T2V2 (1 kR Gamma irradiation + Nova Lux), T3V2 (2 kR Gamma irradiation + Nova Lux), T4V2 (3 kR Gamma irradiation + Nova Lux), T5V2 (4 kR Gamma irradiation + Nova Lux), T6V2 (5 kR Gamma irradiation + Nova Lux), T7V2 (0.4 % EMS + Nova Lux), T8V2 (0.6 % EMS + Nova Lux), T9V2 (0.8 % EMS + Nova Lux). Untreated corms of both the varieties were used as control. The corms harvested from each treatment of M1 generation were stored in cold storage from June to September and were planted in the month of November in field for raising M2 generation. Uniform cultural practices for growing of the Gladiolus were followed for the experimental plots. Uniformly the crop was irrigated depending upon the conditions of the weather. The data was statistically analyzed for significance and graphically represented with standard error 5% as recommended by Panse and Sukhatme (1967).

Results and Discussion

The corms of gladiolus were treated with different concentrations of gamma rays and MES and their comparative effect on the quality parameters are as follows-

Length of largest leaf (cm)

The maximum length of largest leafwere observed in corms treated with 2 kR gamma rays (65.75 cm) followed by corms irradiated with 1kR gamma rays (65.20cm) and minimum length of leaf were found at 5kR (56.76cm) followed by 0.8% EMS (57.78cm) in M1 generation while in M2 generation it was found highest in 2kR (65.18cm) followed by in control (64.06 cm) and lowest was found at 5kR (55.55cm) followed by 0.8% EMS (58.30cm) Out of two varieties maximum length of largest leafwere noticed in both generation Nova Luxcv (68.53 cm) and (66.56 cm). The reduction in leaf length due to gamma ray and X- ray irradiation was associated with abnormalities which are resulting from disturbances by phytochromes (Moh, 1962). Sparrow (1961), while working on cytological effect of radiation, concluded that the decrease in vegetative growth is a result of radiation induced cytological changes such as chromosomal damages, inhibited mitotic division, degeneration of nuclei, cell enlargement, etc. (Shukla *et al.* 2018).

Width of longest leaf (cm)

Results observed that maximum width of longest leaf were observed in corms treated with 1kR gamma rays (2.85 cm) followed by corms treated with 0.4% EMS (2.82 cm) and minimum width of leaf were found at 5kR (2.22cm) followed by 4kR (2.40 cm) in M1 generation while in M2 generation it was found highest in 1kR (2.78cm) followed by in control (2.72 cm) and lowest was found at 5kR (2.05 cm) followed by 0.8% EMS (2.30cm). Out of two varieties maximum width of longest leaf were noticed in Nova Lux cv. (3.12cm) in M1 and (2.96cm) in M2 generation. The reduction in leaf length and width due to gamma ray and X- ray irradiation was associated with abnormalities which are resulting from disturbances by phytochromes (Moh, 1962, Sparrow (1961), while working on cytological effect of radiation, concluded that the decrease in vegetative growth is a result of radiation induced cytological changes such as chromosomal damages, inhibited mitotic division, degeneration of nuclei, cell enlargement, etc. similar results was observed by Shukla *et al.* (2018).

Number of leaves per plant

In M1 generation the maximum number of leaves was observed in corms treated with 2kR gamma rays (9.70) followed by 1kR (9.33) and minimum was recorded in 0.8% EMS treated corms (8.35) followed by 4kR gamma rays (8.70) while in M2 generation it was observed in corms treated with 2kR gamma rays (9.60) followed by 1kR (9.46) and minimum was noticed in 0.6% EMS treated corms (8.13) followed by 5kR gamma rays (8.20). In M1 generation between the varieties maximum number of leaves observed in cv American Beauty (9.05) and

Doses of Gamma irradiation and EMS Treatments	Length of largest leaf (cm)					
	vM1 Generation (Cultivars)			vM2Generation (Cultivars)		
	American Beauty	Nova Lux	Mean	American Beauty	Nova Lux	Mean
T1-Control	62.93	66.26	64.60	62.36	65.76	64.06
T2-1 kR	63.53	66.86	65.20	61.06	65.83	63.45
T3-2 kR	64.13	67.36	65.75	63.80	66.56	65.18
T4-3 kR	61.26	68.53	64.90	59.53	67.23	63.38
T5-4 kR	57.46	63.93	60.70	56.76	62.70	59.73
T6-5 kR	54.80	58.73	56.76	53.16	57.93	55.55
T7- 0.4 %	64.26	64.96	64.61	62.43	63.90	63.16
T8- 0.6 %	60.86	62.60	61.73	59.96	61.13	60.55
T9- 0.8 %	57.13	58.43	57.78	57.66	58.93	58.30
Mean	60.71	64.18	62.45	59.64	63.33	61.48
SD	3.65	3.77	4.07	3.48	3.54	3.94
S.Em.+	0.70	0.72	0.55	0.67	0.68	0.53
CV %	6.02	5.88	6.53	5.85	5.59	6.42

minimum in cv Nova Lux (8.93) while in M2 generation it was observed in maximum cv American Beauty (8.97) and minimum in cv Nova Lux (8.78). Patil and Dhaduk (2009) reported that in gladiolus the number of leaves increases at lower doses due to activation of physiological substances present in corms while higher doses retard cell division by arresting mitotic cell division and causing ill effects on auxins and leads to reduced growth characters in plant. Number of leaves started to decreased as the dose of gamma rays increases up to 5 KR irradiation produced minimum number of leaves per plant. The reduction in number of leaves may be due to changes in auxin level or due to inactivation of auxins was hypothesized by Datta and Datta (1953). Inhibition of mitotic activities and chromosome damage associated with secondary physiological damage could also be the cause for reduction in vegetative growth as reported by Sparrow (1961) who studied the cytological effects of ionization of different plants. Similar results have also been reported by Shukla *et al.* (2018), Rizwi *et al*. (2021).

Vegetative abnormalities (%): In M1 generation the maximum vegetative abnormalities was observed incorms treated with 5kR gamma rays (12.96%) followed by 4kR (9.25%) and minimum was noticed in untreted corms (0.00%) followed by 0.4% EMS (0.33%) while in M2 generation maximum abnormalities was observed in 5kR gamma rays (11.11%) followed by 4kR (9.25%) and minimum was noticed in untreated corms (0.00%) followed by 0.4% EMS (0.33%). In M1 generation between the varieties maximum abnormalities was observed in cv American Beauty (6.17%) and minimum in cv Nova Lux

Doses of Gamma irradiation and EMS Treatments	Width of longest leaf (cm)					
	vM1 Generation (Cultivars)			vM2Generation (Cultivars)		
	American Beauty	Nova Lux	Mean	American Beauty	Nova Lux	Mean
T1-Control	2.60	2.98	2.79	2.69	2.75	2.72
T2-1 kR	2.63	3.07	2.85	2.65	2.91	2.78
T3-2 kR	2.66	2.84	2.75	2.75	2.66	2.70
T4-3 kR	2.47	3.12	2.80	2.39	2.96	2.68
T5-4 kR	2.10	2.71	2.40	2.03	2.60	2.31
T6-5 kR	1.85	2.59	2.22	1.75	2.35	2.05
T7- 0.4 %	2.79	2.85	2.82	2.62	2.67	2.65
T8- 0.6 %	2.66	2.75	2.70	2.49	2.50	2.49
T9- 0.8 %	2.32	2.51	2.41	2.20	2.40	2.30
Mean	2.45	2.82	2.64	2.39	2.65	2.52
SD	0.34	0.27	0.36	0.35	0.24	0.33
S.Em.+	0.06	0.05	0.04	0.06	0.04	0.04
CV %	13.95	9.74	13.67	14.96	9.39	13.11

Doses of Gamma irradiation and EMSTreatments	Number of leaves per plant					
	vM1 Generation (Cultivars)			vM2Generation (Cultivars)		
	American Beauty	Nova Lux	Mean	American Beauty	Nova Lux	Mean
T1-Control	8.86	8.73	8.80	9.26	8.40	8.83
T2-1 kR	9.86	8.80	9.33	9.80	9.13	9.46
T3-2 kR	9.93	9.46	9.70	9.86	9.33	9.60
T4-3 kR	8.93	9.66	9.30	8.80	9.93	9.36
T5-4 kR	8.66	8.73	8.70	8.86	8.86	8.86
T6-5 kR	8.93	8.66	8.80	8.33	8.06	8.20
T7- 0.4 %	9.20	9.20	9.20	8.73	8.93	8.83
T8- 0.6 %	8.86	8.70	8.78	8.13	8.13	8.13
T9- 0.8 %	8.26	8.43	8.35	8.93	8.26	8.60
Mean	9.05	8.93	8.99	8.97	8.78	8.87
SD	0.99	0.89	0.93	1.08	0.99	1.03
S.Em.+	0.19	0.17	0.12	0.20	0.19	0.14
CV %	11.00	9.99	10.44	12.12	11.38	11.70

Fig. 1 **Fig. 2** **Fig. 3**

Plate 1. Vegetativegrowth shown in American Beauty @2 kR Gamma, **Fig. 2.** Nova Lux@ 2kR Gamma, **Fig. 3.** American Beauty @ 5kR Gamma irradiation.

(4.97%) while in M2 generation it was observed in maximum cv American Beauty (5.38%) and minimum in cv Nova Lux (3.77%). Such changes may occur due to physiological disturbances that may be because of reshuffling of histogen layers (Banerji and Datta, 2002). Vegetative abnormalities were not observed at control. Similar results have been observed by (Kapadiya *et al.,* 2016) in Chrysanthemum, who reported vegetative abnormalities increased significantly due to effect of higher mutagenic levels. The frequency of abnormalities was increased with increase indoses of mutagens. It may possibly due to the in activation and/or disturbances in the auxin synthesis (Gordon, 1956) and extent of chromosomal aberrations (Sparrow and Evan, 1961). Similar evidences have been documented by (Misra *et al.* 2009) in chrysanthemum.

Conclusion

According to the aforementioned results, it could be summarized that the lower doses of Gamma irradiations and EMS gave significant results for varied growth characters. In M1 and M2 generation Lower concentration of Gamma irradiation @ 2kR produced largest leaf, maximum number of leaves, gamma irradiation @ 1kRinduced maximum width of longest leaf and higher concentration lead to minimum values for vegetative traits, and gamma irradiation @ 5kR induced maximum vegetative abnormalities traits. In M1 and M2 generation lower concentration of gamma irradiation @ 1 kR and 2kR induced more number of leaves per plant.

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Doses of Gamma irradiation and EMS Treatments	Vegetative abnormalities (%)					
	vM1 Generation (Cultivars)			vM2Generation (Cultivars)		
	American Beauty	Nova Lux	Mean	American Beauty	Nova Lux	Mean
T1-Control	0.00	0.00	0.00	0.00	0.00	0.00
T2-1 kR	3.70	3.70	3.70	3.70	0.33	2.01
T3-2 kR	3.70	3.70	3.70	7.40	3.70	5.55
T4-3 kR	7.40	7.40	7.40	3.70	3.70	3.70
T5-4 kR	11.11	7.40	9.25	11.11	7.40	9.25
T6-5 kR	14.81	11.11	12.96	11.11	11.11	11.11
T7- 0.4 %	3.70	0.33	2.01	0.33	0.33	0.33
T8- 0.6 %	3.70	3.70	3.70	3.70	3.70	3.70
T9- 0.8 %	7.40	7.40	7.40	7.40	3.70	5.55
Mean	6.17	4.97	5.57	5.38	3.77	4.58
SD	7.11	6.38	6.72	7.11	6.12	6.62
S.Em.+	1.36	1.22	0.91	1.36	1.17	0.90
CV %	115.29	128.39	120.65	132.08	162.07	144.56

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Conflict of Interest: **None**

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