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Anupam Tiwari
Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pardesh, India

Anil K Singh
Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pardesh, India

Sumit Pal
Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pardesh, India

Correspondence
Anupam Tiwari
Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pardesh, India

Effect of gamma irradiation on growth and floral characters of gladiolus varieties

Anupam Tiwari, Anil K Singh and Sumit Pal

Abstract
A field experiment was carried out to see the effect of gamma irradiation on growth and floral characters of gladiolus varieties during winters of 2015-16 and 2016-17. Corms of sixteen gladiolus varieties *viz*., African Star, American Beauty, Dhanvantari, Green Star, Gulal, Lemon Beauty, Mohini, Nova Lux, Priscilla, Punjab Dawn, Punjab Morning, Red Beauty, Shubhangini, Snow Princess, Tiger Flame and Yellow Stone were exposed to five doses of gamma rays 25 Gy, 35 Gy, 45 Gy, 55 Gy and 65 Gy along with one control (untreated). Experiment was laid out in Randomized Block Design with three replications. Reduction in number of sprouts per hill, number of leaves per hill, length of longest leaf and width of longest leaf was recorded with increased dose of gamma rays. However, maximum number of sprouts (2.48) and leaf width (2.66) recorded in plants treated with 25 Gy of gamma rays. Minimum days to spike emergence was recorded in variety Priscilla (67.53 days in M_1 and 68.19 day in M_2) during both the generation, whereas spike of variety American Beauty was longest (74.76 cm) in M_1 as well as in M_2 (84.74 cm).

Keywords: gamma, irradiation, mutation, spike

Introduction
Gladiolus (*Gladiolus* spp.) is also known as "queen of bulbous flowers" and one of leading grown geophytes in worldwide. It is very popular because of its majestic spikes containing attractive, elegant and delicate florets of various shades, sequential opening of flowers for a longer duration and good keeping quality of cut spikes (Singh, 2006) [15]. The exuberance of colourful spikes of gladiolus is a delight in any floral bouquet. Thus, it possesses a great potential for export market especially during winter. The demand of gladiolus is increasing, therefore; it needs attention towards genetic improvement. Induced mutation is a method by which novelty can be created in already well-established cultivars and it also creates genetic variation (Singh, 2014) [14]. It is a well-known fact that genetic variations have practical implication in crop improvement. Mutation breeding has played a major role in the development of many new colour or shape mutants in ornamental plants (Broertjes and Van Harten, 1988) [3]. Radiation technology has proven to be useful for mutation breeding and has contributed towards improvements in ornamental crops. Among the mutant varieties, about 90% of these mutant varieties were generated by using radiation (Asharaf *et al*., 2003) [1]. Gamma rays (γ) are ionizing radiations and interact with atoms and molecules to produce free radicals in cells. The advantages of ionizing radiations as mutagens are accurate dosimetry, reasonable reproducibility and uniform penetration of multicellular system particularly by gamma rays (Jain, 2005) [4]. Gamma rays are known to influence plant growth and development by inducing cytological, genetical, biochemical, physiological and morphogenetic changes in cells and tissues (Tiwari *et al*., 2010) [18]. Many researchers demonstrated that the mutation could induce variation in gladiolus and it varies from variety to variety. On the light of above facts present study was carried out to evaluate the effect of gamma irradiation on different vegetative and floral characters of gladiolus varities.

Materials and Methods
The present investigation was carried out during winters of 2015-2016 and 2016-2017 at Horticulture Research Farm, Department of Horticulture, B.H.U., Varanasi (India). Corms of sixteen gladiolus varieties, *viz*., African Star, American Beauty, Dhanvantari, Green Star, Gulal, Lemon Beauty, Mohini, Nova Lux, Priscilla, Punjab Dawn, Punjab Morning, Red Beauty, Shubhangini, Snow Princess, Tiger Flame and Yellow Stone were exposed to 25 Gy,

The application of the vortex-assisted MSPD method to the analysis of real samples showed TCS in some fish liver and fish gill samples at trace levels. 35 Gy, 45 Gy, 55 Gy and 65 Gy of gamma rays. The gamma irradiation of corms has been done at Division of Floriculture, Botanic Garden & Eco-education, C.S.I.R. - National Botanical Research Institute, Lucknow (India). Source of gamma rays was (^{60}Co) Low Dose Irradiator. The corms planted in first year (2015-16) set up the M_1 generation. For M_2 generation (2016-17), the corms harvested from these plants were again planted during first week of November in the same manner. The experiment was laid out in Randomized Block Design with 3 replications. Uniform cultural practices to grow the crop of gladiolus were followed for all the experimental plots. Various parameters were observed during M_1 and M_2 generations on growth and flowering *i.e*. number of sprouts per hill, number of leaves per hill, length and width of longest leaf, days to spike initiation, days to colour show and length of spike at colour show. The analysis of variance of data was done as per design of the experiment as suggested by Panse and Sukhatme (1985) [9].

Result and Discussion

Growth characters

Gamma irradiation had significant effect on number of sprouts per hill. Maximum number of sprouts (2.48) recorded in plants treated with 25 Gy of gamma rays. Number of sprouts per hill was slightly increased at lower doses, but decreased at higher dose during M_1 generation, whereas decreased as irradiation dose increased during M_2 generation. American Beauty (2.08) was recorded with maximum number of sprouts per hill during M_1 which was statistically at par with the Priscilla (2.03), Tiger Flame (2.00), Yellow Stone (1.94), Lemon Beauty (1.92), Punjab Morning (1.89) and Mohini (1.88). It is important to mention that corm of variety Green Star treated with 35 Gy to 65 Gy of gamma rays failed to sprout during M_2 generation. These results are corroborated with the results of Kumari and Kumar (2015) [6] had recorded the M_1 generation with 25 Gy of gamma rays most favourable for production of more sprouts per hill. While discussing the enhancement of sprouting, the low dose levels of mutagens are responsible for stimulating sprouting substances such as enzymes, which are set free by irradiation to play an important role in plant metabolic activities resulting in stimulated growth and development of plants. In M_1 generation, maximum number of leaves per hill (11.33) was recorded in untreated as well as in plants treated with 25 Gy of gamma rays, whereas in M_2 generation it was maximum in untreated plants only. Number of leaves per hill decreased with increased dose of mutagen, when compared to untreated plants in all varieties except African Star, Dhanvantari, Green Star, Mohini, Red Beauty, Snow Princess and Pricilla on where number of leaves increased in M_1 generation. Observations recorded reveal that in M_1 generation, variety Mohini resulted in maximum number of leaves per plant (11.98), whereas maximum number of leaves during was observed during M_2 generation in variety Nova Lux (10.57). These results are in concurrent with findings of Kumari *et al*. (2013) [7], who reported reduction in leaf length in chrysanthemum after 10, 15 and 20 Gy gamma irradiation. Reduction in vegetative growth after irradiation might be due to interference in normal mitosis and frequent occurrence of mitotic aberrations, inhibition of rate of assimilation and consequent change in the nutrient level in the plant and inactivation of vital enzymes especially those associated with respiration (Kiong *et al*., 2008) [5].

During M_1 generation of observation, maximum leaf length was observed in untreated plants (43.32 cm) which was statistically at par with 25 Gy of gamma rays. Untreated plants resulted in maximum length of leaf followed by 25 Gy, 35 Gy, 45 Gy, 55 Gy and 65 Gy during both generations. Maximum length of leaf was recorded with variety Tiger Flame (42.43cm) in M_1 generation, whereas Lemon Beauty showed maximum leaf length during M_2 generation. Interaction of 25 Gy gamma rays with variety Lemon Beauty registered maximum length of longest leaf (51.32 cm) during M_1 generation. However, maximum length of longest leaf was registered with untreated Lemon Beauty (65.26 cm) during M_2 generation. Varieties treated with 25 Gy of gamma rays recorded wider leaves in comparison to control during M_1 generation. These results are in parallel line with the findings of Kumari and Kumar (2015) [6], who also recorded narrow leaves when in dormant corms of gladiolus were treated with higher doses of gamma rays. During M_1, maximum width of leaf was seen in variety Lemon Beauty treated with 25 Gy gamma rays (3.73 cm) whereas untreated Lemon Beauty (3.73 cm) widest among all treated varieties during M_2 generation. Similar results of decrease in leaf size were also reported earlier by Sahariya *et al*. (2017) [11] and Singh and Kumar (2013) [13] in gladiolus. Sisodia and Singh (2015) [17], who reported that interaction of cv. Praha with 1.5 kR and Tiger Flame with 2.5 kR registered maximum length of leaves during M_1 and M_2 generation respectively.

Floral characters

Due to gamma irradiation, significant delay in flowering was observed during both the generations. Increase in gamma rays dose significantly delayed spike emergence in M_1 as well as M_2 generation, but in both the generations, significant differences between untreated and 25 Gy treated plants were not recorded. Minimum days to spike emergence was recorded in variety Priscilla (67.53 days in M_1 and 68.19 day in M_2) during both the generation, however cv. American Beauty was statistically similar in M_2 generation. In M_1 generation minimum days to spike initiation in treatment combinations were recorded in Priscilla with 25 Gy gamma rays treatment (62.83 days), whereas interaction effect of gamma rays and varieties found non-significant during M_2 generation. The results are in conformity with the work of Sisodia and Singh (2014) [14] who recorded late spike emergence with 2.5 kR of gamma rays in M_1 generation, whereas, all other doses of gamma rays produced early spike. Delay in spike emergence might be due to disturbance in biochemical pathways which assists in flower induction pathway as per Bagnall *et al*. (1995) [2], who worked on flowering responses to altered expression of phytochrome in mutants and transgenics lines of Arabidopsis.

In M_1 generation, untreated plants took least number of days for the colour show *i.e*. 97.12 days, whereas a significant delay in colour show was recorded as the gamma rays dose increased above 25 Gy (99.58 days). Irrespective of gamma irradiation during M_1 variety Priscilla (84.27 days) taken minimum days to colour show, whereas variety American Beauty taken minimum days to colour show of first floret in M_2 generation. These results are in agreement with Singh and Sisodia (2015) [17] who observed that days to colour show was influenced due to gamma irradiation and early colour show was recorded in plants treated with 5.5 kR of gamma rays. During both the generations, maximum spike length at colour show stage was recorded in plants treated with 25 Gy of gamma rays (66.82 cm in M_1 and 70.02 cm in M_2) which was

statistically at par with untreated plants. Irrespective of gamma irradiation, spikes of variety American Beauty were longest *i.e*. 74.76 cm in M_1 as well as in M_2 *i.e*. 84.74 cm, whereas variety Gulal produced shortest spikes in both the generations *i.e*. 46.78 cm in M_1 and 51.05 cm in M_2 generation. However, maximum spike length was found in the interaction between variety American Beauty and 25 Gy (84.98 cm) which was statistically at par with untreated varieties American Beauty and Green Star during M_1 generation. At higher doses effect of gamma irradiation was more pronounced, which resulted in smaller spike length and reduced flower size. These results are in close conformity with the findings of Sisodia and Singh (2015) [17] in gamma irradiated gladiolus. The average reduction in the floral parameters was also higher in the M_1 as compare to M_2 generation. These results were also in conformity with the findings of Rather *et al*. (2002) [10], who reported more reduction in spike length in vM_1 (31.35 per cent) as compared to vM_2 (15.24 per cent) generation. The decrease in quantitative traits has been attributed to physiological disturbances or chromosomal damage of the cells of the plants caused by the mutagens (Kumari, 2015) [6].

Table 1: Effect of gamma irradiation on number of sprouts per hill in different varieties of gladiolus

	2015-16							2016-17						
Treatment \ Variety	**0 Gy**	**25 Gy**	**35 Gy**	**45 Gy**	**55 Gy**	**65 Gy**	**Mean**	**0 Gy**	**25 Gy**	**35 Gy**	**45 Gy**	**55 Gy**	**65 Gy**	**Mean**
African Star	2.00	2.33	1.50	1.17	1.27	1.33	1.60	1.33	1.50	1.17	1.00	1.33	1.00	1.22
American Beauty	3.00	3.17	2.17	1.67	1.33	1.17	2.08	2.33	1.67	1.50	1.17	1.00		1.53
Dhanvantari	1.67	2.17	1.83	1.83	1.50	1.67	1.78	2.00	1.67	1.67	1.33	1.17	1.00	1.47
*Green Star	1.83	3.00	1.50	2.00	1.50	1.27	1.85	2.00	1.83	-	-	-	-	1.92
Gulal	1.83	2.50	1.50	1.83	1.67	1.33	1.78	1.67	1.33	1.17	1.00	1.17	1.00	1.22
Lemon Beauty	2.50	2.50	1.83	1.67	1.50	1.50	1.92	2.00	1.33	1.33	1.00	1.67	1.33	1.44
Mohini	2.33	2.83	1.67	1.43	1.33	1.67	1.88	2.67	2.33	1.67	1.50	1.00	1.00	1.70
Nova Lux	2.17	2.33	2.17	1.67	1.50	1.33	1.86	1.50	1.50	1.17	1.00	1.17	1.33	1.28
Punjab Dawn	2.17	2.50	1.83	1.33	1.50	1.17	1.75	1.83	2.33	1.50	1.17	1.50	1.00	1.56
Punjab Morning	1.83	2.33	2.17	1.67	1.83	1.50	1.89	2.67	2.33	2.67	1.50	2.00	1.17	2.06
Red Beauty	2.17	2.33	1.50	1.17	1.17	1.67	1.67	2.00	1.33	1.67	1.83	1.17	1.00	1.50
Snow Princess	2.17	2.17	1.83	1.50	1.83	1.33	1.81	1.50	1.67	1.50	1.17	-	-	1.46
Shubhangini	2.00	1.67	1.17	1.50	1.67	1.33	1.56	2.33	2.50	1.50	1.33	1.00	1.00	1.61
Tiger Flame	1.83	2.83	2.33	1.83	1.67	1.50	2.00	1.83	1.50	1.33	1.17	1.17	1.00	1.33
Yellow Stone	2.50	2.67	1.67	1.83	1.67	1.33	1.94	2.17	1.67	1.50	1.33	1.50	-	1.63
Priscilla	2.67	2.33	2.17	2.17	1.67	1.17	2.03	2.33	2.17	1.50	1.33	1.17	1.17	1.61
Mean	2.17	2.48	1.80	1.64	1.54	1.39		2.01	1.79	1.52	1.26	1.29	1.08	

Factors	**2015-16**	**2016-17**
	C.D.	**C.D.**
Variety (A)	0.20	0.38
Treatment(B)	0.18	0.30
Variety × Treatment	NS	NS

Table 4.2: Effect of gamma irradiation on number of leaves in different varieties of gladiolus

	2015-16							2016-17						
Treatment \ Variety	**0 Gy**	**25 Gy**	**35 Gy**	**45 Gy**	**55 Gy**	**65 Gy**	**Mean**	**0 Gy**	**25 Gy**	**35 Gy**	**45 Gy**	**55 Gy**	**65 Gy**	**Mean**
African Star	10.06	10.31	9.47	8.78	8.58	7.06	9.04	9.52	9.94	7.83	7.67	6.67	5.73	7.89
American Beauty	9.06	8.94	9.08	8.78	7.17	8.67	8.62	8.52	8.57	7.75	7.17	6.50	-	7.70
Dhanvantari	14.14	14.92	10.86	9.81	8.92	7.31	10.99	13.60	12.55	11.02	9.52	7.66	6.19	10.09
*Green Star	10.42	10.50	9.92	9.50	8.58	7.75	9.44	9.12	10.06	-	-	-	-	9.59
Gulal	14.17	14.03	9.53	9.00	8.92	7.92	10.59	9.88	10.13	8.92	7.56	7.67	6.14	8.38
Lemon Beauty	13.28	12.81	9.83	9.61	7.89	8.28	10.28	13.63	13.66	11.86	5.67	9.74	7.87	10.41
Mohini	13.33	13.67	12.53	10.72	9.50	8.78	11.42	12.74	12.44	10.53	9.06	8.63	6.71	10.02
Nova Lux	11.19	11.00	9.06	9.00	8.33	7.19	9.30	12.79	13.30	11.98	9.37	8.16	7.84	10.57
Punjab Dawn	12.67	12.44	11.14	10.75	8.67	8.33	10.67	10.65	10.63	8.64	6.50	7.50	5.90	8.30
Punjab Morning	10.42	10.13	9.21	9.96	7.17	7.67	9.09	12.13	12.07	11.13	10.50	8.75	7.67	10.38
Red Beauty	9.46	9.63	8.88	8.29	7.12	6.63	8.33	9.88	9.76	7.00	5.00	6.23	6.00	7.31
Snow Princess	11.04	11.12	10.63	9.29	7.33	7.33	9.46	8.92	9.26	6.33	4.17	-	-	7.17
Shubhangini	10.79	10.71	9.96	8.96	7.54	6.50	9.08	10.50	10.75	8.67	7.53	6.83	6.50	8.46
Tiger Flame	10.88	9.38	9.12	8.79	7.50	8.31	9.00	10.25	10.34	9.17	7.83	7.33	5.33	8.38
Yellow Stone	11.38	11.29	10.13	9.79	8.79	8.06	9.91	10.34	9.01	7.83	6.17	6.17	-	7.90
Priscilla	9.04	10.37	9.46	8.46	7.88	6.81	8.67	10.84	10.92	9.83	7.00	5.33	6.18	8.35
Mean	11.33	11.33	9.92	9.34	8.12	7.66		10.95	10.89	9.23	7.38	7.37	6.51	

Factors	**2015-16**	**2016-17**
	C.D.	**C.D.**
Variety (A)	0.44	1.09
Treatment(B)	0.26	0.69
Variety × Treatment	1.08	N/A

Table 4.3: Effect of gamma irradiation on length of longest leaf (cm) in different varieties of gladiolus

	2015-16							2016-17						
Treatment \ Variety	**0 Gy**	**25 Gy**	**35 Gy**	**45 Gy**	**55 Gy**	**65 Gy**	**Mean**	**0 Gy**	**25 Gy**	**35 Gy**	**45 Gy**	**55 Gy**	**65 Gy**	**Mean**
African Star	45.28	43.22	39.14	36.52	33.97	30.39	38.09	43.60	43.78	43.90	37.08	31.07	28.08	37.92
American Beauty	47.31	45.97	39.94	36.35	34.14	29.69	38.90	49.70	47.13	45.48	41.02	24.54	-	41.57
Dhanvantari	45.20	43.08	39.67	37.48	38.98	28.93	38.89	52.60	46.25	46.13	42.72	37.23	32.93	42.98
*Green Star	50.29	44.30	39.35	38.66	32.35	31.08	39.34	48.46	53.10	-	-	-	-	50.78
Gulal	37.02	34.70	33.65	31.86	30.22	28.31	32.63	46.70	43.45	45.03	38.38	36.65	29.65	39.98
Lemon Beauty	50.22	51.32	48.26	44.31	27.05	26.14	41.22	65.30	65.23	52.32	63.18	63.07	54.65	60.63
Mohini	43.45	42.22	37.79	33.84	31.65	27.32	36.05	50.00	49.25	48.10	41.63	37.21	29.30	42.58
Nova Lux	40.42	38.66	37.65	35.83	32.79	28.62	35.66	55.20	46.47	46.10	38.63	36.93	33.57	42.82
Punjab Dawn	43.80	43.37	41.69	39.84	30.56	26.92	37.70	53.60	50.00	39.67	36.95	32.28	29.23	40.29
Punjab Morning	43.06	43.66	37.41	35.38	33.28	29.37	37.03	64.50	60.70	48.23	45.03	42.30	37.20	49.66
Red Beauty	39.68	40.31	37.03	31.70	28.22	26.86	33.96	48.00	40.98	53.82	43.13	41.37	38.97	44.38
Snow Princess	33.85	34.07	30.42	28.04	24.60	23.70	29.11	51.80	51.53	41.18	36.68	-	-	45.30
Shubhangini	32.18	32.90	30.64	31.83	29.41	26.56	30.59	46.40	51.42	45.38	40.65	38.97	36.60	43.24
Tiger Flame	49.49	49.48	43.18	40.29	38.85	33.28	42.43	48.40	35.80	40.58	34.95	34.07	34.42	38.04
Yellow Stone	46.18	47.79	41.91	36.50	34.12	32.14	39.77	47.10	42.13	38.57	33.83	32.33	-	38.79
Priscilla	45.66	46.32	42.31	36.95	33.72	27.30	38.71	47.70	43.90	40.33	34.20	31.90	31.83	38.31
Mean	43.32	42.58	38.75	35.96	32.12	28.54		51.37	47.87	44.99	40.54	37.14	34.70	

Factors	**2015-16**	**2016-17**
	C.D.	**C.D.**
Variety (A)	4.21	4.32
Treatment(B)	2.58	2.90
Variety × Treatment	10.32	10.59

Table 4.4: Effect of gamma irradiation on number of width of longest leaf (cm) in different varieties of gladiolus

	2015-16							2016-17						
Treatment \ Variety	**0 Gy**	**25 Gy**	**35 Gy**	**45 Gy**	**55 Gy**	**65 Gy**	**Mean**	**0 Gy**	**25 Gy**	**35 Gy**	**45 Gy**	**55 Gy**	**65 Gy**	**Mean**
African Star	2.10	2.13	2.01	1.98	1.87	1.56	1.94	2.10	2.05	2.17	1.91	1.87	1.63	1.96
American Beauty	3.62	3.67	3.51	3.21	2.93	2.48	3.23	3.50	3.53	3.44	2.83	2.30	-	3.12
Dhanvantari	2.81	2.93	2.42	2.23	1.81	1.56	2.29	3.10	2.90	2.72	2.59	2.30	2.18	2.63
*Green Star	2.22	2.70	2.08	2.04	1.78	1.45	2.04	2.31	2.47	-	-	-	-	2.39
Gulal	1.99	2.04	1.81	1.62	1.49	1.33	1.71	2.20	2.15	2.16	1.88	1.76	1.63	1.96
Lemon Beauty	3.62	3.73	2.99	2.39	2.48	2.03	2.87	3.70	3.60	3.27	3.03	2.44	2.14	3.03
Mohini	2.58	2.61	2.35	2.17	1.99	1.84	2.26	2.60	2.45	2.27	2.27	1.93	1.74	2.21
Nova Lux	2.53	2.56	2.30	2.05	1.83	1.77	2.17	2.50	2.52	2.27	2.01	1.87	1.85	2.17
Punjab Dawn	2.45	2.50	2.19	2.03	1.97	1.88	2.17	2.30	2.28	2.20	1.93	1.21	0.59	1.75
Punjab Morning	2.06	2.08	2.03	1.96	2.03	1.75	1.98	2.10	2.04	1.85	1.77	1.83	1.54	1.86
Red Beauty	2.84	2.91	2.50	2.27	2.05	1.89	2.41	2.80	2.83	2.59	2.25	1.68	1.70	2.31
Snow Princess	2.05	2.10	1.96	1.82	1.92	1.78	1.94	2.10	1.99	1.90	1.74	-	-	1.93
Shubhangini	2.62	2.65	2.38	2.39	2.24	2.12	2.40	2.70	2.65	2.55	2.31	2.27	1.86	2.39
Tiger Flame	2.39	2.46	2.25	2.11	2.02	1.76	2.17	2.40	2.42	2.30	1.97	1.86	1.73	2.11
Yellow Stone	2.43	2.58	2.09	1.96	1.85	1.92	2.14	2.40	2.36	2.05	2.15	1.90	-	2.17
Priscilla	2.83	2.85	2.54	2.37	2.15	1.84	2.43	2.80	2.78	2.55	2.17	1.92	1.71	2.32
Mean	2.57	2.66	2.34	2.16	2.03	1.81		2.62	2.57	2.42	2.19	1.94	1.69	

Factors	**2015-16**	**2016-17**
	C.D.	**C.D.**
Variety (A)	0.24	0.27
Treatment(B)	0.15	0.17
Variety ×Treatment	0.60	0.67

Table 4.5: Effect of gamma irradiation on days to spike initiation in different varieties of gladiolus

	2015-16							2016-17						
Treatment \ Variety	**0 Gy**	**25 Gy**	**35 Gy**	**45 Gy**	**55 Gy**	**65 Gy**	**Mean**	**0 Gy**	**25 Gy**	**35 Gy**	**45 Gy**	**55 Gy**	**65 Gy**	**Mean**
African Star	71.33	72.33	77.83	81.17	84.50	-	77.43	77.00	78.17	78.67	81.67	84.33	86.33	81.03
American Beauty	65.00	67.33	70.50	74.00	76.50	79.17	72.08	69.33	66.17	70.83	68.00	72.50	-	69.37
Dhanvantari	85.17	86.33	90.33	93.50	95.67	97.33	91.39	84.67	83.83	86.17	87.67	86.67	86.83	85.97
*Green Star	79.67	83.33	83.67	85.67	-	-	83.08	78.83	80.67	-	-	-	-	79.75
Gulal	81.67	83.33	83.83	85.00	87.83	89.17	85.14	79.00	79.33	81.67	80.33	84.50	86.50	81.89
Lemon Beauty	91.33	90.67	94.83	95.17	94.83	98.50	94.22	92.83	91.83	93.67	94.67	94.83	93.67	93.58
Mohini	84.00	85.17	86.33	86.83	-	-	85.58	84.67	85.00	85.50	85.50	85.67	86.63	85.49
Nova Lux	78.00	78.33	79.50	83.00	84.50	86.50	81.64	79.83	79.00	82.00	83.83	84.83	85.33	82.47
Punjab Dawn	73.17	73.67	76.33	81.33	83.83	85.17	78.92	77.33	81.17	84.17	83.67	84.67	86.83	82.97
Punjab Morning	81.00	80.67	83.83	85.83	84.67	88.67	84.11	80.83	78.83	82.50	81.83	81.33	84.67	81.67

Red Beauty	82.00	83.67	86.17	88.33	89.50	-	85.93	83.67	81.33	84.33	85.33	84.67	87.50	84.47
Snow Princess	82.50	84.83	86.67	88.33	91.75	91.33	87.57	78.83	76.00	81.21	82.50	-	-	79.64
Shubhangini	78.83	81.67	83.83	84.50	86.17	89.67	84.11	79.17	79.33	81.00	80.83	82.00	84.33	81.11
Tiger Flame	88.83	88.83	90.00	91.17	93.33	95.00	91.19	85.83	86.67	86.50	89.50	91.67	90.17	88.39
Yellow Stone	79.50	80.17	86.50	89.67	93.50	-	85.87	76.17	82.50	78.50	85.17	87.67	-	82.00
Priscilla	66.83	62.83	65.83	68.67	73.50	-	67.53	64.67	68.00	66.17	65.83	71.33	73.17	68.19
Mean	79.30	80.20	82.87	85.14	87.15	90.05		79.59	79.81	81.53	82.42	84.05	86.00	

Factors	**2015-16**	**2016-17**
	C.D.	**C.D.**
Variety (A)	2.54	2.71
Treatment(B)	1.78	1.41
Variety ×Treatment	4.99	4.62

Table 6: Effect of gamma irradiation on days to colour show in different varieties of gladiolus

	2015-16							**2016-17**						
Treatment \ Variety	**0 Gy**	**25 Gy**	**35 Gy**	**45 Gy**	**55 Gy**	**65 Gy**	**Mean**	**0 Gy**	**25 Gy**	**35 Gy**	**45 Gy**	**55 Gy**	**65 Gy**	**Mean**
African Star	87.00	84.83	91.83	94.00	97.67	-	91.07	87.00	88.83	91.83	94.00	97.67	99.54	93.15
American Beauty	81.00	83.83	88.67	92.33	93.67	96.67	89.36	83.50	80.33	86.17	84.83	88.17	0.00	84.60
Dhanvantari	98.83	100.33	104.67	109.50	111.83	113.50	106.44	98.83	100.33	102.33	105.50	106.83	104.50	103.05
*Green Star	98.83	103.00	103.50	103.33	-	-	102.17	97.33	100.22	-	-	-	-	98.78
Gulal	99.17	103.50	102.00	103.67	104.17	107.83	103.39	97.17	98.50	101.00	100.67	104.17	107.83	101.56
Lemon Beauty	109.67	109.00	112.50	113.67	112.17	116.50	112.25	109.67	109.00	112.50	113.67	112.17	114.50	111.92
Mohini	102.33	102.67	105.50	105.33	-	-	103.96	102.33	102.67	105.50	105.33	104.17	106.22	104.37
Nova Lux	95.50	96.83	100.17	101.50	103.17	105.67	100.47	95.50	96.83	100.17	101.50	103.17	105.67	100.47
Punjab Dawn	92.00	93.17	97.00	101.17	102.57	104.54	98.41	92.00	93.17	97.00	101.17	102.57	104.54	98.41
Punjab Morning	98.83	102.67	104.67	105.83	103.83	107.17	103.83	98.83	99.67	101.67	103.83	101.83	103.17	101.50
Red Beauty	101.50	103.00	106.67	109.50	111.83	-	106.50	101.50	99.33	102.67	104.50	106.83	104.66	103.25
Snow Princess	101.67	104.00	107.33	108.33	109.17	110.50	106.83	92.67	90.50	94.33	98.33	0.00	0.00	93.96
Shubhangini	98.50	105.46	105.50	100.50	103.33	106.67	103.33	98.50	97.46	99.50	100.50	103.33	105.67	100.83
Tiger Flame	107.83	109.00	111.33	112.00	114.33	113.33	111.30	105.83	107.00	107.33	109.17	111.33	112.33	108.83
Yellow Stone	100.33	106.50	111.33	108.22	111.67	-	107.61	95.33	100.50	98.33	104.22	107.67	0.00	101.21
Priscilla	81.00	85.50	87.33	83.00	84.54	-	84.27	83.00	87.50	85.33	86.17	89.54	91.33	87.15
Mean	97.12	99.58	102.50	103.24	104.57	108.24		96.11	96.77	99.04	100.89	102.82	105.00	

Factors	**2015-16**	**2016-17**
	C.D.	**C.D.**
Variety (A)	1.59	2.41
Treatment(B)	1.93	1.60
Variety ×Treatment	3.75	4.09

Table 7: Effect of gamma irradiation on length of spike at colour show stage (cm) in different varieties of gladiolus

	2015-16							**2016-17**						
Treatment \ Variety	**0 Gy**	**25 Gy**	**35 Gy**	**45 Gy**	**55 Gy**	**65 Gy**	**Mean**	**0 Gy**	**25 Gy**	**35 Gy**	**45 Gy**	**55 Gy**	**65 Gy**	**Mean**
African Star	57.95	59.97	56.88	52.63	51.79	-	55.84	68.88	72.03	68.38	59.85	52.80	45.15	61.18
American Beauty	83.39	84.98	79.87	76.82	73.75	49.75	74.76	90.68	94.22	82.88	86.45	69.45	-	84.74
Dhanvantari	63.74	66.65	59.50	56.04	41.29	34.14	53.56	65.67	68.63	62.65	59.53	49.18	46.38	58.67
*Green Star	80.09	81.97	74.26	57.83	-	-	73.53	80.12	84.67	-	-	-	-	82.40
Gulal	52.92	53.92	50.54	46.21	43.99	33.08	46.78	56.23	57.70	51.02	47.42	46.17	47.78	51.05
Lemon Beauty	76.17	75.83	72.37	69.30	41.30	33.01	61.33	79.73	79.35	68.12	62.55	64.05	65.50	69.88
Mohini	60.76	61.70	54.42	52.18	-	-	57.26	62.90	64.33	60.93	57.97	53.72	50.65	58.42
Nova Lux	61.62	61.74	55.88	51.88	46.21	41.75	53.18	64.82	66.88	62.02	55.67	56.85	52.38	59.77
Punjab Dawn	69.60	70.05	62.71	63.28	51.83	39.10	59.43	74.92	75.97	68.67	65.95	60.17	48.10	65.63
Punjab Morning	61.55	64.20	60.17	52.24	48.30	44.85	55.22	70.63	72.88	65.60	61.53	52.35	49.12	62.02
Red Beauty	66.54	67.99	60.22	54.42	46.85	-	59.20	67.85	66.18	62.22	59.35	44.00	40.35	56.66
Snow Princess	67.91	67.33	60.12	52.57	38.92	35.23	53.68	71.28	74.90	67.82	65.05	-	-	69.76
Shubhangini	55.90	60.05	51.89	48.10	37.08	32.11	47.52	57.85	59.30	56.73	49.02	52.43	44.47	53.30
Tiger Flame	72.46	72.67	65.21	60.67	56.31	48.74	62.68	76.22	75.30	68.65	66.95	59.08	52.03	66.37
Yellow Stone	63.60	61.93	57.01	47.01	46.26	-	55.16	61.60	64.90	55.38	55.85	54.78	-	58.50
Priscilla	58.39	58.07	50.08	47.34	42.49	-	51.27	63.25	57.72	51.92	51.38	48.12	41.43	52.30
Mean	65.79	66.82	60.69	55.53	47.60	39.18		68.83	70.02	63.53	60.30	54.51	48.61	

Factors	**2015-16**	**2016-17**
	C.D.	**C.D.**
Variety (A)	5.66	7.10
Treatment(B)	3.47	4.54
Variety ×Treatment	13.87	17.29

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