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Influence of gamma irradiation (^{60}Co) on vegetative and propagule parameters in gladiolus varieties

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Abstract

A field experiment was carried out to see the effect of gamma irradiation on vegetative and propagule parameters in gladiolus varieties during winters of 2015-16 and 2016-17. Uniform and healthy corms of sixteen gladiolus varieties (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 irradiated with different doses (0, 25, 35, 45, 55 and 65 Gy) of gamma rays from ^{60}Co source and planted under open field condition in Randomized Block Design (RBD) with factorial concept. Each treatment was replicated thrice. Plants treated with higher doses (35 Gy and 65 Gy) showed deleterious effect of gamma irradiation although at lowest dose (25 Gy) plants were not affected much. In M_1 generation, minimum days to sprouting was taken by variety Yellow Stone (11.72 days), whereas Punjab Morning (11.11 days) in M_2 generation. Plant height was reduced after irradiation as compare to untreated plants and was recorded minimum at highest doses. However, maximum leaf area index was found in variety Lemon Beauty at 25 Gy (0.188 in M_1 and 0.183 in M_2) during both generations. Cultivar American Beauty had maximum number of corms per hill (1.81) and corm weight per hill (85.40 g) in M_1 generation. Number of cormels per plant was also reduced with the increase in gamma rays dose. During M_1 , maximum number of cormels per hill was seen in variety Tiger Flame (17.69) which was statistically at par with Snow Princess (17.42), whereas variety Snow Princess (31.54) recorded maximum number of cormels per hill during M_2 generation.

Keywords: Corms and Cormels, Gy, gamma irradiation and hill

Introduction

Gladiolus (*Gladiolus* spp.) is one of the major commercial flowers, which is being cultivated in various parts of the country. It belongs to Iridaceae family and originated from South Africa (Singh, 2006) [15]. It's fascinating spikes exhibiting varying size and form of florets with smooth, ruffled, deeply crinkled or lacinated tepals which are blotched or possess distinct patches or markings of various colours and colour combinations (Kadam *et al.*, 2014) [5]. 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) [21]. On account of availability of huge market for cut flowers due to rise in socio-economic status, change in life style of people and want for novelty, every year a large number of varieties are being added to the public domain (Singh, 2014) [17]. The demand of gladiolus is increasing therefore; it needs attention towards genetic improvement (Sisodia and Singh, 2014) [17]. The primary objective of any crop improvement programme is to create variability and to select the best recombinants possessing desirable characteristics. The variability created by any breeding method (hybridization or mutation) enhances the scope for selection (Kumari and Kumar, 2015) [7]. Mutagenesis has played a major role in the development of many new colour/shape mutants in ornamental plants (Broertjes and Harten, 1988) [3]. Gladiolus is vegetatively propagated through corms and cormels. After identification of a superior genotype it can be further multiplied by corms and cormels. Its highly heterozygous nature and polyploidy makes the crop ideal material for genetic manipulation through mutation breeding. Therefore, keeping this in view the present experiment was conducted to study the effect of gamma irradiation (^{60}Co) on growth and propagule parameters in gladiolus varieties.

Materials and Methods

The present investigation was carried out during 2015-16 and 2016-17 at Horticulture Research Farm, Department of Horticulture, B.H.U., Varanasi (India). Uniform and healthy corms of gladiolus varieties viz. 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 with different doses

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(0, 25, 35, 45, 55 and 65 Gy) of gamma rays at Division of Floriculture, Botanic Garden & Eco-education, C.S.I.R. - National Botanical Research Institute, Lucknow (India). On the following day the irradiated corms were planted under open field condition in Randomized Block Design with factorial concept and each treatment was replicated thrice. Untreated plants (0 Gy) were considered as control. Various parameters were observed during M₁ and M₂ generation on growth and corm parameters *i.e.*, days to sprouting, plant height, leaf area, leaf area index, number of corms per hill, weight of corm per hill, diameter of corm, number of cormels per hill and weight of cormels per hill. Height of plants was recorded at 30 and 60 days after planting. Observations on corm and cormel characters were after proper cleaning. Corms harvested from M₁ generation (2015-16) were stored in cold store from May-October and again planted as M₂ generation in November (2016-17). The analysis of variance of data was done as per design of the experiment as suggested by Panse and Sukhatme (1985) [10].

Result and Discussion

Vegetative parameters

Minimum days to sprouting were recorded in untreated plants (13.55 days) which was earlier than treated plants during both the generation. However, during M₂ generation untreated plants and plants treated with 35 Gy of gamma rays were statistically similar. In M₁ generation, minimum days to sprouting was taken by variety Yellow Stone (11.72 days), whereas Punjab Morning (11.11 days) in M₂ generation. In M₁ generation Yellow Stone under untreated corms took minimum days to sprouting (8.33 days), which was at par with days to sprouting in untreated corms of Punjab Morning (9.33 days) and Yellow Stone at 25 Gy (9.93 days) however, it was significantly earlier than other treatment combinations. Delay in sprouting at higher doses has been attributed to the destruction of auxins or due to inhibition of auxin synthesis (Gordon, 1956) [4]. These results corroborate observation made by Mahure *et al.* (2010) [9], Rather and Jhon (2000) [11] and Srivastava *et al.* (2007) [21]. They observed that lower dose proved very favourable, however higher doses of gamma adversely affected vegetative and floral traits in different flower crops. Untreated plants exhibited maximum plant height in M₁ generation in all the varieties whereas minimum plant height was recorded in plants treated with 65 Gy. Similar trend was recorded after 60 days in both the generations. The difference between height of untreated and 25 Gy treated plants was very less whereas a drastic reduction in plant height was recorded at 55 Gy and 70 Gy in both the generation after 30 as well as 60 days which shows that effect of gamma rays was more pronounced at higher doses in all the varieties. During M₂ generation some cultivars *viz.* Green Star, Lemon Beauty and Shubhangini showed slightly increase in plant height at 25 Gy of gamma rays in compare to control. The varietal differences might be due to the different growth behaviour of the genotypes. Some genotypes are early type and had faster growth whereas some were late type. Plant height reduction could be due to reduced amount of endogenous growth regulators especially cytokinin as a result of breakdown or lack of synthesis due to irradiation (Kumari and Kumar, 2015) [7]. These results are in conformity with the results of Sisodia and Singh (2014) [17], who reported that height of plant was affected due to gamma doses in different gladiolus varieties. Maximum leaf area (92.52 cm²) and leaf area index (0.154) was recorded in control during M₁ generation, whereas plants treated with 25 Gy of gamma rays

showed maximum leaf area and leaf area index during M₂ generation. Maximum leaf area index was found in variety Lemon Beauty at 25 Gy (0.188 in M₁ and 0.183 in M₂) during both generations. It might be due to influence of various gamma doses or genetic constitution of varieties which were sensitive to doses of gamma rays. These results are corroborated with the results of Sisodia and Singh (2014) [17] in gladiolus, who recorded a slight change in leaf area and leaf area index in various gladiolus varieties; and shah *et al.* (2017) also noticed narrow leaves in varieties of tuberose which were irradiated with gamma rays.

Corm and cormel parameters

Maximum number of corms/hill was noticed at dose 25 Gy (1.89), whereas untreated plants (2.57) produce maximum corms/hill in M₂ generation. The minimum number of corms per plant was recorded at highest dose of gamma rays (65 Gy). A comparison among response of different varieties reveals that maximum number of corms/hill was seen in variety American Beauty (1.81) which was statistically at par with cultivar Mohini (1.67), Nova Lux (1.61), Red Beauty (1.56), Shubhangini (1.56) and Punjab Morning (1.55) varieties in M₁ generation. However, the interaction between variety and dose of gamma radiation was found non-significant in both the generations, *i.e.*, M₁ and M₂. Increased in gamma rays doses decreased the corm diameter in both M₁ and M₂ generations, but more increasing trend was noticed in M₂ than in M₁ generation. During both the generations, *i.e.*, M₁ and M₂, a declining trend was observed with increasing dose of gamma rays from 25 Gy to 65 Gy. In M₁, maximum corm diameter was seen in untreated plants which were followed by 25 Gy. During M₁, maximum corm diameter was recorded in variety Red Beauty under untreated condition, whereas minimum corm diameter was recorded in variety Green Star and 65 Gy treatment combinations. Reduction in corm size and weight was recorded after irradiation by Banerji *et al.* (2000) [2] in gladiolus cultivars Kajal and Nilofar. The low yield at higher doses might be due to the reduced vegetative growth as a result of gamma treatments. The reduction in vegetative growth at highest dose (65 Gy) has been so drastic that it failed in translocation of limited photosynthates to the storage organ. At lower doses of gamma-rays, more production and bigger size of corms were obtained, while higher doses resulted in less and smaller sized corms than control in tuberose (Ali, 2002). Weight of corms/hill decreased with increasing dose of gamma radiation in both the generations, *i.e.*, M₁ and M₂. During M₁, maximum weight of corms/hill was observed at gamma rays dose of 25 Gy (78.85 g) which was statistically superior with untreated condition, *i.e.*, untreated, whereas minimum weight of corms/hill was recorded under dose 65 Gy which was statistically superior with 45 Gy and 55 Gy. Significant differences were also observed among varieties for the trait during both the generations. During M₁, maximum weight of corms/hill was recorded in variety American Beauty which was followed by Lemon Beauty, Mohini, Punjab Dawn, Nova Lux and Priscilla. These results are in parallel line with the findings of Rather and Jhon (2000) [11], who recorded reduction in weight of bulbs after gamma irradiation of Iris. During M₁, maximum number of cormels/hill was seen in variety Tiger Flame (17.69) which was statistically at par with variety Snow Princess (17.42), whereas variety Snow Princess (31.54) recorded maximum number of cormels per hill during M₂ generation. Maximum weight of cormels/hill was observed in untreated plants (5.60 g) and was followed by

plants treated with 25 Gy and 35 Gy of gamma rays. Minimum weight of cormels/hill was observed at 65 Gy and was statistically at par with 55 Gy and 45 Gy. During M₂, maximum weight of cormels/hill was recorded in untreated plants and followed by plants treated with 25 Gy of gamma rays. Present findings are in close conformity with the observations made by several earlier workers Talukdar (2005)^[20], Kumar (2009) and Sisodia and Singh (2015)^[18] reported

significant difference in weight of cormels per hill in different varieties of gladiolus. The reduction in size, weight and multiplication of corm and cormels may be attributed to the fact that due to treatment damage, physiology of the plant in higher doses was disturbed, which affected photosynthesis and root system resulting in the improper growth of the plant and hampered root system (Kumari, 2015)^[8].

Table 1: Effect of gamma irradiation on days to sprouting in different varieties of gladiolus

Treatment \ Variety	2015-16							2016-17						
	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	12.33	13.33	13.17	13.67	14.33	14.00	13.47	11.50	10.67	12.50	13.00	13.67	14.33	12.61
American Beauty	14.83	13.83	18.33	17.67	17.83	20.33	17.14	13.17	13.33	13.83	15.33	13.00	-	13.73
Dhanvantari	16.67	18.83	19.33	20.33	20.67	21.17	19.50	13.67	13.83	14.67	14.50	13.33	15.33	14.22
*Green Star	15.33	18.67	20.00	20.17	20.17	20.66	19.17	16.67	15.83	-	-	-	-	16.25
Gulal	17.00	18.67	20.67	21.83	22.83	23.00	20.67	16.50	17.50	17.33	18.33	20.17	22.83	18.78
Lemon Beauty	12.83	13.50	15.67	17.00	17.67	20.00	16.11	11.67	12.17	12.67	13.00	15.50	17.33	13.72
Mohini	12.17	13.83	15.00	16.00	18.83	22.33	16.36	11.17	11.50	13.17	12.17	12.33	13.17	12.25
Nova Lux	15.17	17.17	17.33	18.50	20.50	20.17	18.14	13.83	14.17	14.50	14.33	13.83	17.17	14.64
Punjab Dawn	13.33	14.00	15.17	17.17	16.67	21.33	16.28	13.67	14.17	11.17	15.33	17.50	19.67	15.25
Punjab Morning	9.33	10.83	12.17	12.33	16.50	21.67	13.81	8.83	9.50	10.67	11.83	12.33	13.50	11.11
Red Beauty	14.67	15.17	18.67	18.50	20.67	22.00	18.28	14.00	15.00	14.67	16.33	15.50	16.83	15.39
Snow Princess	14.17	15.00	15.17	15.67	17.50	18.17	15.95	14.67	15.83	16.17	16.67	-	-	15.84
Shubhangini	11.50	12.00	13.17	14.00	14.17	15.67	13.42	11.67	13.33	14.50	10.67	13.50	15.67	13.22
Tiger Flame	16.83	18.33	19.67	19.67	20.17	20.83	19.25	17.00	18.33	18.67	18.50	16.83	17.33	17.78
Yellow Stone	8.33	9.83	10.67	12.50	13.67	15.33	11.72	9.17	9.17	11.17	11.33	14.83	-	11.13
Priscilla	12.33	14.50	13.83	14.67	15.50	16.50	14.56	11.83	11.50	12.67	13.67	10.50	11.67	11.97
Mean	13.55	14.84	16.13	16.86	17.98	19.57		13.06	13.49	13.89	14.33	14.49	16.24	

Factors	2015-16	2016-17
	C.D.	C.D.
Variety (A)	0.66	2.58
Treatment(B)	0.40	0.30
Variety × Treatment	1.60	NS

Table 2: Effect of gamma irradiation on plant height (30 days after planting) in different varieties of gladiolus

Treatment \ Variety	2015-16							2016-17						
	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	32.21	31.68	26.15	22.19	16.36	14.36	23.82	38.17	35.02	32.09	30.35	27.04	21.05	30.62
American Beauty	35.14	34.14	31.08	29.18	22.61	19.74	28.65	41.10	38.17	34.60	33.02	25.67	-	34.51
Dhanvantari	31.02	30.52	26.12	25.29	22.10	18.48	25.59	42.05	38.92	37.48	35.22	29.88	26.53	35.01
*Green Star	37.08	35.82	32.78	27.29	23.44	20.33	29.46	38.26	40.12	-	-	-	-	39.19
Gulal	27.13	25.13	23.63	21.71	20.20	16.48	22.38	39.41	36.67	36.13	32.96	30.94	29.47	34.26
Lemon Beauty	34.64	33.10	30.95	28.55	24.64	21.46	28.89	48.75	51.88	40.95	36.53	32.01	27.73	39.64
Mohini	30.62	29.81	26.46	23.65	21.10	18.46	25.01	40.20	39.65	37.45	34.03	30.67	28.48	35.08
Nova Lux	29.76	27.63	25.64	22.66	20.22	18.23	24.02	46.37	39.62	38.25	33.57	30.73	28.88	36.24
Punjab Dawn	36.20	32.25	34.20	30.53	22.32	20.16	29.28	44.37	41.62	34.13	31.28	30.95	26.03	34.73
Punjab Morning	38.86	34.19	30.29	28.42	26.31	22.26	30.06	54.13	51.58	42.17	37.75	32.93	25.50	40.68
Red Beauty	36.57	35.34	32.19	28.93	26.57	21.94	30.25	41.37	37.57	39.00	36.73	31.93	26.12	35.45
Snow Princess	38.62	36.70	33.74	28.81	24.33	15.56	29.63	43.14	42.48	36.07	32.50	-	-	38.55
Shubhangini	35.86	35.04	32.81	25.02	26.38	19.95	29.18	38.37	39.32	35.41	34.48	30.62	27.15	34.23
Tiger Flame	40.33	37.40	31.76	26.07	25.31	22.09	30.49	40.59	37.85	33.19	30.97	26.21	25.06	32.31
Yellow Stone	33.53	32.44	30.28	25.21	23.12	17.78	27.06	38.95	35.98	32.45	29.50	27.65	-	32.91
Priscilla	30.85	28.45	25.46	21.90	20.91	17.68	24.21	40.02	36.93	34.18	30.30	29.46	23.50	32.40
Mean	34.27	32.48	29.60	25.96	22.87	19.06		42.47	40.22	36.24	33.28	29.76	26.29	

Factors	2015-16	2016-17
	C.D.	C.D.
Variety (A)	1.42	2.01
Treatment(B)	2.33	3.17
Variety × Treatment	5.71	7.78

Table 3: Effect of gamma irradiation on plant height (60 days after planting) in different varieties of gladiolus

Treatment \ Variety	2015-16							2016-17						
	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	53.79	52.64	42.99	40.59	43.47	22.58	42.68	54.33	54.43	54.98	48.37	40.97	35.10	48.03
American Beauty	63.83	61.19	54.52	55.67	44.02	41.03	53.38	62.37	58.74	56.47	52.27	40.85	-	54.14
Dhanvantari	53.36	53.27	42.64	45.25	43.76	23.99	43.71	63.97	57.48	57.70	54.65	47.35	38.30	53.24
*Green Star	64.79	61.48	51.14	41.80	41.85	36.35	49.57	66.90	67.97	-	-	-	-	67.44
Gulal	50.18	48.37	45.02	42.97	40.69	35.69	43.82	54.67	62.38	55.70	49.65	47.76	39.40	51.59
Lemon Beauty	65.74	63.27	56.77	53.16	46.86	36.37	53.69	56.68	54.87	51.52	49.47	47.19	42.19	50.32
Mohini	60.34	56.32	50.17	44.26	35.96	20.41	44.58	60.52	58.72	58.01	52.82	48.65	38.95	52.95
Nova Lux	54.87	52.45	48.74	44.80	42.17	36.30	46.55	66.52	57.88	57.22	49.45	47.86	43.28	53.70
Punjab Dawn	65.29	61.90	55.91	49.30	40.48	29.99	50.48	64.00	60.28	52.17	47.77	42.58	35.36	50.36
Punjab Morning	71.87	67.68	62.30	57.63	34.90	36.68	55.18	68.67	65.28	51.90	49.80	47.53	42.03	54.20
Red Beauty	55.59	49.04	46.44	42.56	39.73	36.19	44.92	59.27	52.03	61.12	54.37	44.47	33.11	50.73
Snow Princess	60.79	53.14	49.73	41.19	41.68	37.65	47.36	62.92	62.62	49.48	47.92	-	-	55.74
Shubhangini	57.07	54.43	51.83	40.89	37.46	34.97	46.11	57.52	62.52	57.08	51.18	47.75	32.27	51.39
Tiger Flame	61.98	58.83	53.80	48.32	41.95	35.80	50.11	60.03	53.88	49.20	46.68	44.26	38.97	48.84
Yellow Stone	61.17	55.40	49.08	45.80	42.54	35.35	48.22	57.68	52.98	47.93	44.73	42.60	-	49.18
Priscilla	59.54	51.11	50.26	44.65	42.53	40.18	48.04	58.77	54.73	50.97	45.60	42.17	29.90	47.02
Mean	60.01	56.28	50.71	46.18	41.25	33.72		60.53	57.92	54.10	49.65	45.14	37.41	

Factors	2015-16	2016-17
	C.D.	C.D.
Variety (A)	1.98	2.78
Treatment(B)	3.23	4.39
Variety × Treatment	7.93	NS

Table 4: Effect of gamma irradiation on leaf area (cm²) in different varieties of gladiolus

Treatment \ Variety	2015-16							2016-17						
	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	88.37	89.12	83.18	78.32	73.87	66.95	79.97	91.20	89.60	84.10	81.10	73.77	73.47	82.21
American Beauty	103.68	87.75	95.68	83.53	72.00	63.57	84.37	102.50	106.83	98.03	86.27	75.00	-	93.73
Dhanvantari	107.38	109.03	99.15	90.03	75.35	57.98	89.82	106.80	109.37	95.73	87.07	75.93	67.77	90.45
*Green Star	83.63	86.77	75.58	72.12	62.35	48.87	71.55	87.42	85.69	-	-	-	-	86.56
Gulal	91.03	92.42	86.10	72.13	68.98	49.87	76.76	90.50	93.17	86.07	74.03	70.33	71.17	80.88
Lemon Beauty	110.07	112.67	102.52	86.70	78.35	64.28	92.43	109.80	113.27	104.13	84.93	72.53	70.97	92.61
Mohini	85.98	89.53	83.27	75.90	56.50	52.70	73.98	85.80	87.33	82.93	75.80	66.87	64.87	77.27
Nova Lux	86.72	89.52	75.87	78.45	65.28	55.85	75.28	85.30	89.20	76.27	75.77	64.40	61.77	75.45
Punjab Dawn	94.80	95.50	82.12	74.97	66.52	51.45	77.56	93.60	94.30	84.20	75.57	66.07	61.37	79.19
Punjab Morning	93.43	87.42	76.98	68.60	50.87	47.83	70.86	91.80	86.00	73.27	69.37	61.87	57.90	73.37
Red Beauty	93.65	87.10	75.30	66.85	58.52	48.42	71.64	93.50	90.10	78.73	68.33	55.60	57.80	74.01
Snow Princess	85.65	86.77	73.58	73.38	64.57	58.67	73.77	86.10	89.87	75.63	73.50	-	-	81.28
Shubhangini	86.20	84.67	82.02	76.12	67.85	58.13	75.83	86.80	85.73	81.13	77.40	65.70	59.37	76.02
Tiger Flame	92.97	98.25	87.12	84.53	71.63	62.50	82.83	94.10	98.13	86.90	84.23	74.03	60.20	82.93
Yellow Stone	88.43	89.53	85.05	75.73	68.37	56.45	77.26	85.00	88.43	83.53	75.40	68.70	-	80.21
Priscilla	88.35	86.75	79.40	76.85	71.55	65.53	78.07	88.70	85.87	80.60	77.63	73.30	65.67	78.63
Mean	92.52	92.05	83.93	77.14	67.03	56.82		92.77	93.80	84.80	77.80	64.30	51.50	

Factors	2015-16	2016-17
	C.D.	C.D.
Variety (A)	7.18	6.48
Treatment(B)	4.39	4.10
Variety × Treatment	7.18	15.86

Table 5: Effect of gamma irradiation on leaf area index in different varieties of gladiolus

Treatment \ Variety	2015-16							2016-17						
	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	0.147	0.148	0.139	0.130	0.123	0.112	0.133	0.152	0.149	0.140	0.135	0.123	0.039	0.123
American Beauty	0.173	0.146	0.160	0.139	0.120	0.106	0.141	0.171	0.178	0.164	0.144	0.125		0.156
Dhanvantari	0.179	0.182	0.166	0.150	0.126	0.097	0.150	0.178	0.182	0.160	0.145	0.127	0.113	0.151
*Green Star	0.139	0.145	0.126	0.120	0.104	0.081	0.119	0.145	0.142	-	-	-	-	0.144
Gulal	0.152	0.154	0.144	0.120	0.115	0.083	0.128	0.151	0.155	0.143	0.123	0.117	0.035	0.121
Lemon Beauty	0.183	0.188	0.171	0.145	0.131	0.107	0.154	0.183	0.189	0.173	0.142	0.121	0.035	0.141
Mohini	0.144	0.149	0.139	0.126	0.094	0.088	0.123	0.143	0.146	0.138	0.126	0.111	0.075	0.123
Nova Lux	0.144	0.149	0.126	0.131	0.109	0.093	0.125	0.142	0.149	0.127	0.126	0.108	0.093	0.124
Punjab Dawn	0.158	0.159	0.137	0.125	0.111	0.086	0.129	0.156	0.157	0.140	0.126	0.110	0.036	0.121
Punjab Morning	0.156	0.146	0.128	0.114	0.085	0.080	0.118	0.153	0.144	0.122	0.116	0.103	0.030	0.111

Red Beauty	0.156	0.145	0.126	0.112	0.098	0.081	0.120	0.156	0.150	0.131	0.114	0.093	0.080	0.121
Snow Princess	0.143	0.144	0.122	0.122	0.108	0.098	0.123	0.144	0.150	0.126	0.122			0.136
Shubhangini	0.144	0.141	0.137	0.127	0.113	0.097	0.126	0.145	0.143	0.135	0.129	0.109	0.099	0.127
Tiger Flame	0.155	0.164	0.145	0.141	0.119	0.104	0.138	0.157	0.164	0.145	0.141	0.124	0.100	0.139
Yellow Stone	0.148	0.149	0.142	0.126	0.114	0.094	0.129	0.142	0.148	0.139	0.126	0.115		0.134
Priscilla	0.147	0.145	0.132	0.128	0.119	0.109	0.130	0.148	0.143	0.134	0.129	0.122	0.110	0.131
Mean	0.154	0.153	0.140	0.129	0.112	0.095		0.155	0.156	0.141	0.130	0.115	0.070	

Factors	2015-16	2016-17
	C.D.	C.D.
Variety (A)	0.012	0.011
Treatment(B)	0.007	0.007
Variety × Treatment	0.029	0.026

Table 6: Effect of gamma irradiation on number of corms/hill in different varieties of gladiolus

Treatment \ Variety	2015-16							2016-17						
	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	1.83	2.33	1.83	1.17	1.00	1.00	1.53	2.17	1.83	1.67	1.50	1.50	1.17	1.64
American Beauty	2.00	2.33	1.67	1.33	1.83	1.67	1.81	2.33	2.17	2.17	1.67	1.67	-	2.00
Dhanvantari	1.50	1.33	1.17	1.17	1.50	1.00	1.28	2.33	2.50	1.83	1.67	1.33	1.33	1.83
*Green Star	1.33	1.50	1.17	1.33	1.17	1.33	1.31	2.00	1.17	-	-	-	-	1.59
Gulal	1.50	1.83	1.17	1.00	1.67	1.26	1.40	2.17	1.83	1.67	1.83	1.33	1.50	1.72
Lemon Beauty	1.50	2.17	1.33	1.17	1.00	1.67	1.47	2.83	2.67	2.33	2.17	1.50	1.50	2.17
Mohini	2.33	2.17	1.50	1.17	1.83	1.00	1.67	3.17	2.67	2.67	2.33	2.17	1.50	2.42
Nova Lux	1.50	2.33	1.33	1.50	1.83	1.17	1.61	2.50	2.17	2.33	1.67	1.83	1.17	1.94
Punjab Dawn	1.83	2.33	1.67	1.00	1.00	1.33	1.53	3.33	3.00	3.00	2.50	2.50	1.67	2.67
Punjab Morning	1.17	1.67	1.83	1.00	1.67	1.99	1.55	2.50	2.67	2.17	1.83	1.67	1.17	2.00
Red Beauty	1.83	2.17	1.17	1.00	1.83	1.33	1.56	2.33	2.33	2.17	2.00	1.50	1.50	1.97
Snow Princess	1.50	1.50	1.17	1.33	1.83	1.50	1.47	2.83	2.67	2.33	2.17	-	-	2.50
Shubhangini	1.83	1.50	1.00	1.50	1.83	1.67	1.56	3.17	2.67	2.50	2.17	1.67	1.67	2.31
Tiger Flame	1.83	1.67	1.00	1.00	1.83	1.33	1.44	2.17	2.33	1.67	1.50	1.33	1.00	1.67
Yellow Stone	1.83	1.50	1.17	1.83	1.33	1.00	1.44	2.50	1.67	1.67	1.50	1.50	-	1.77
Priscilla	2.17	1.83	1.00	1.00	1.83	1.17	1.50	2.17	2.00	1.67	2.00	1.50	1.17	1.75
Mean	1.72	1.89	1.32	1.22	1.56	1.34		2.57	2.34	2.12	1.90	1.64	1.36	

Factors	2015-16	2016-17
	C.D.	C.D.
Variety	0.27	0.4
Treatment	0.16	0.2
Variety × Treatment	NS	NS

Table 7: Effect of gamma irradiation on number of corms/hill different varieties of gladiolus

Treatment \ Variety	2015-16							2016-17						
	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	12.50	13.17	7.67	5.50	3.50	1.33	7.28	16.17	16.83	14.17	6.33	5.17	4.00	10.44
American Beauty	12.67	11.00	9.00	7.33	4.67	3.00	7.94	13.33	10.33	10.33	7.67	6.67	-	9.67
Dhanvantari	4.50	4.00	2.83	2.33	1.33	1.67	2.78	6.67	7.67	7.33	4.17	3.83	3.33	5.50
*Green Star	5.67	6.00	2.50	1.83	1.33	1.17	3.08	5.67	4.61	-	-	-	-	
Gulal	7.67	8.00	6.50	5.17	4.17	3.00	5.75	8.33	8.83	7.83	5.17	4.83	4.67	6.61
Lemon Beauty	8.33	7.33	5.33	3.67	2.00	1.17	4.64	8.00	7.83	6.33	6.17	4.17	3.33	5.97
Mohini	7.00	6.33	4.00	3.33	2.17	1.33	4.03	8.17	8.00	8.33	5.83	3.83	4.00	6.36
Nova Lux	13.83	11.50	7.67	5.00	3.67	2.00	7.28	9.33	6.33	4.50	3.33	3.83	2.33	4.94
Punjab Dawn	10.67	7.67	4.50	3.83	2.67	1.00	5.06	9.17	7.67	6.67	5.67	3.67	4.67	6.25
Punjab Morning	8.83	6.17	3.00	5.17	1.67	1.83	4.44	10.00	9.83	9.83	8.50	5.83	4.83	8.14
Red Beauty	20.67	16.83	8.33	6.33	3.17	2.33	9.61	18.00	16.50	14.50	12.50	4.67	5.67	11.97
Snow Princess	31.83	23.67	19.83	17.50	7.33	4.33	17.42	35.83	38.33	27.83	24.17	-	-	31.54
Shubhangini	7.00	6.17	4.17	2.00	2.00	1.50	3.81	10.33	10.50	9.83	8.17	10.33	5.00	9.03
Tiger Flame	30.33	26.00	24.00	13.17	7.67	5.00	17.69	35.17	34.17	36.67	18.17	13.67	11.50	24.89
Yellow Stone	17.67	11.83	7.50	3.83	3.33	2.72	7.81	17.83	14.67	15.17	10.17	6.83	3.26	11.32
Priscilla	13.33	11.33	5.83	2.33	3.17	3.00	6.50	14.33	11.00	10.33	7.17	7.83	-	10.13
Mean	13.28	11.06	7.67	5.52	3.36	2.27		14.61	13.69	12.54	9.06	6.15	4.78	

Factors	2015-16	2016-17
	C.D.	C.D.
Variety	1.36	1.31
Treatment	0.83	0.83
Variety × Treatment	3.33	3.21

Table 8: Effect of gamma irradiation on corm diameter (mm) in different varieties of gladiolus

Treatment \ Variety	2015-16							2016-17						
	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	49.70	49.55	47.16	44.52	41.45	39.84	45.37	49.27	45.71	41.68	45.37	39.19	29.80	41.84
American Beauty	61.47	50.35	53.07	45.43	41.67	37.30	48.21	69.23	67.56	63.60	60.71	61.71	-	64.56
Dhanvantari	45.88	45.94	43.87	43.95	40.08	36.60	42.72	55.86	52.13	49.89	43.02	48.92	32.32	47.02
*Green Star	46.53	41.87	42.13	41.21	36.23	34.75	40.45	45.64	46.99	-	-	-	-	46.32
Gulal	54.35	50.75	50.52	47.62	45.23	43.17	48.61	53.64	52.38	51.24	47.25	38.80	33.24	46.09
Lemon Beauty	63.80	57.10	58.42	51.88	47.69	44.91	53.97	62.89	58.08	56.21	56.45	51.19	30.58	52.57
Mohini	59.61	57.10	58.41	50.22	46.69	41.93	52.33	58.30	56.25	50.08	49.13	44.98	35.71	49.08
Nova Lux	46.71	46.63	43.54	44.53	40.41	35.76	42.93	47.26	46.48	45.65	44.04	38.33	39.43	43.53
Punjab Dawn	47.22	44.92	41.81	40.59	38.18	37.49	41.70	52.43	47.41	45.20	45.19	38.20	29.75	43.03
Punjab Morning	52.19	39.02	47.81	43.29	46.44	42.35	45.18	51.49	47.63	41.86	40.80	40.75	24.40	41.16
Red Beauty	67.35	51.22	47.86	43.81	39.34	37.60	47.86	56.69	55.89	50.58	47.61	30.78	23.70	44.21
Snow Princess	47.17	49.10	44.19	43.71	40.36	36.29	43.47	53.11	58.65	49.74	48.48	40.67	24.42	45.84
Shubhangini	45.72	47.29	44.15	42.72	39.30	40.31	43.25	51.76	48.92	44.11	45.60	-	-	47.60
Tiger Flame	47.13	43.56	42.83	41.23	40.56	36.64	41.99	44.88	44.94	44.45	41.07	39.53	33.53	41.40
Yellow Stone	54.95	45.86	50.40	47.99	43.50	41.53	47.37	51.20	52.46	49.82	47.90	39.24	28.54	44.86
Priscilla	52.56	48.71	48.65	44.13	42.54	38.44	45.84	53.26	51.32	47.88	38.78	41.02	-	46.45
Mean	52.65	48.06	47.80	44.80	41.85	39.06		54.03	52.32	48.74	46.26	42.29	29.05	

Factors	2015-16	2016-17
	C.D.	C.D.
Variety	5.21	4.86
Treatment	3.19	3.13
Variety × Treatment	12.77	12.01

Table 9: Effect of gamma irradiation on weight of corms/hill (g) in different varieties of gladiolus

Treatment \ Variety	2015-16							2016-17						
	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	63.24	73.49	52.24	37.89	34.43	23.45	47.46	77.9	65.91	49.21	50.10	53.14	29.81	54.35
American Beauty	121.00	135.78	79.07	61.13	65.03	50.41	85.40	144.5	134.26	104.99	78.00	60.81	-	104.52
Dhanvantari	74.22	58.96	49.75	28.80	35.57	26.35	45.61	118.8	127.34	80.01	42.69	32.94	37.91	73.29
*Green Star	48.99	50.44	45.08	38.49	36.75	29.73	41.58	64.27	66.68	-	-	-	-	65.48
Gulal	59.24	69.17	44.92	38.73	32.71	30.06	45.80	88.7	75.06	65.86	72.70	27.49	38.92	61.46
Lemon Beauty	102.35	116.03	66.64	54.24	47.49	38.25	70.83	197.4	185.85	119.01	102.74	72.74	37.55	119.22
Mohini	108.60	91.71	60.19	52.22	48.89	31.43	65.51	152.0	128.03	109.74	106.55	59.96	50.28	101.10
Nova Lux	66.98	104.17	54.34	48.21	46.29	36.24	59.37	115.3	99.91	97.48	55.13	48.13	38.68	75.77
Punjab Dawn	88.82	99.53	69.24	44.69	37.87	26.78	61.15	166.4	149.74	127.66	114.06	97.18	36.97	115.33
Punjab Morning	53.11	52.27	72.55	41.89	39.40	45.46	50.78	117.4	125.26	87.98	78.49	41.07	29.04	79.88
Red Beauty	65.92	74.22	40.14	38.99	34.63	26.55	46.74	87.3	87.30	76.74	79.83	29.84	33.01	65.67
Snow Princess	79.04	71.12	50.25	49.45	46.24	27.02	53.85	153.4	144.42	102.84	82.40	-	-	120.77
Shubhangini	57.14	50.89	46.95	48.50	42.26	38.75	47.42	103.3	87.02	119.93	72.08	40.10	42.23	77.45
Tiger Flame	89.32	81.32	46.73	48.04	51.04	33.92	58.39	108.8	117.08	79.59	73.45	38.45	27.60	74.16
Yellow Stone	70.95	52.50	45.81	47.51	38.80	24.54	46.68	100.4	66.95	67.14	40.27	45.25	-	64.00
Priscilla	89.42	80.07	53.74	49.98	48.89	31.96	59.01	92.6	85.44	91.28	101.82	41.50	34.49	74.52
Mean	77.40	78.85	54.85	45.55	42.89	32.56		121.62	111.97	91.96	76.69	49.19	36.37	

Factors	2015-16	2016-17
	C.D.	C.D.
Variety	8.18	7.45
Treatment	5.01	4.67
Variety × Treatment	20.05	NS

Table 10: Effect of gamma irradiation on weight of cormels/hill (g) in different varieties of gladiolus

Treatment \ Variety	2015-16							2016-17						
	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	5.46	4.22	2.60	1.88	1.58	0.84	2.88	6.48	5.24	3.56	2.64	1.91	0.97	3.47
American Beauty	4.52	3.32	2.87	1.78	1.15	1.02	2.35	6.06	5.10	4.26	2.91	2.38	-	4.14
Dhanvantari	2.66	2.32	1.73	1.35	1.21	0.93	1.56	4.68	4.17	3.51	2.70	2.20	2.57	3.30
*Green Star	3.28	4.32	1.55	1.34	1.22	0.46	1.86	1.92	1.63	-	-	-	-	1.78
Gulal	5.47	5.27	3.67	2.57	1.61	1.39	3.33	2.78	2.32	1.69	1.56	1.29	1.10	1.79
Lemon Beauty	6.73	5.85	4.15	2.95	1.71	1.01	3.73	5.17	4.84	3.67	3.54	2.49	1.75	3.58
Mohini	3.47	3.16	2.09	1.97	1.83	1.25	2.01	2.52	2.15	2.57	1.60	1.25	1.17	1.88
Nova Lux	7.42	6.33	5.17	4.49	3.54	2.02	4.83	3.24	2.60	1.77	1.25	4.03	1.16	2.34
Punjab Dawn	2.88	2.25	1.31	1.85	1.68	0.51	1.38	3.67	2.92	2.58	1.99	1.82	1.36	2.39
Punjab Morning	2.73	1.93	0.99	1.56	1.02	1.34	1.33	2.48	2.09	1.92	1.74	1.27	0.88	1.73

Red Beauty	7.27	4.84	4.39	2.79	1.86	1.51	3.78	7.47	5.13	4.71	3.47	2.36	1.82	4.16
Snow Princess	9.48	10.32	8.23	7.31	4.61	2.37	7.05	10.36	10.57	8.26	7.66	-	-	9.21
Shubhangini	3.87	3.18	2.82	1.80	1.85	0.77	2.19	4.29	3.66	2.99	1.95	1.03	1.00	2.49
Tiger Flame	9.86	9.76	8.57	7.86	5.95	4.01	7.67	10.39	9.87	10.15	8.51	6.32	4.35	8.26
Yellow Stone	6.55	4.95	4.14	2.97	1.47	1.20	3.55	7.14	5.47	4.46	3.43	1.74	-	4.45
Priscilla	8.03	5.51	5.13	3.03	3.34	2.04	4.51	8.32	6.18	5.76	3.71	4.29	2.56	5.14
Mean	5.60	4.85	3.71	2.91	1.91	1.28		5.67	4.82	4.12	3.24	2.46	1.72	

Factors	2015-16	2016-17
	C.D.	C.D.
Variety	0.39	0.38
Treatment	0.24	0.28
Variety × Treatment	0.97	1.05

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