



EFFECT OF PHYSICAL AND CHEMICAL MUTAGENS ON DIFFERENT CULTIVARS OF TUBEROSE (*POLIANTHES TUBEROSA* LINN.) WITH PARTICULAR REFERENCE TO INDUCTION OF GENETIC VARIABILITY

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Abstract- Four cultivars of tuberose (*Polianthes tuberosa* Linn.), viz. Kalyani Single, Kalyani Double, Suvasini and Prajwal were used to study the mutagenic effectiveness of various physical and chemical mutagens viz. Gamma rays, X-rays and EMS, by treating the healthy and uniform bulbs of tuberose with different doses each of gamma rays viz., (5, 15 Gy), X-rays (6, 12 Gy) and EMS (0.1, 0.2%) along with the untreated bulbs as control and evaluated for various vegetative and floral characters. The findings of the experiment showed that the treatments of the mutagens at lower doses had significant stimulative effect on vegetative parameters viz., sprouting percentage, days to sprouting while the parameter pertaining to survival rate, leaf length, number of spikes per plant, florets per spike, flowering duration and vase life were observed with decreasing trend. Higher doses of all mutagens had detrimental effects on the vegetative and floral characters. Mutants exhibited variation from the parent plant with respect to the vegetative characters.

Keywords- *Polianthes tuberosa*, Gamma rays, X-rays, EMS.

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Introduction

Tuberose (*Polianthes tuberosa* Linn.), an ornamental bulbous plant native to Mexico, is a leading cut flower grown in tropical and subtropical regions of the world as well as India. The long spikes of the flower are used as cut flower especially for their long lasting mesmerizing fragrance along with good postharvest life, both as cut flower as well as loose flower. The crop finds prime position in the perfumery industry. Tuberose being a commercially potential crop, its introduction and popularization of suitable cultivars has not gained much importance to the commercial growers, as very few cultivars of tuberose are in production world over. In India, there are several varieties under cultivation having three types 'single', 'semi double' and 'double'. In spite of its ever increasing demand, there is a big limitation associated with it is that in all its the existing varieties, flower colour is limited to white only, although some varieties show pinkish tinge at bud stage. Since self-incompatibility exists in tuberose [13] so, there is limitation of convention breeding methods involving hybridation in it. Mutation breeding appears to be efficient and cost-effective breeding technique that can be exploited for the creation of new and novel ornamental cultivars of commercial importance in tuberose. Hence, the present study was conducted to know the effect of physical and chemical mutagens on the vegetative and floral characteristics of the existing potential cultivars of tuberose as influenced by different mutagens for further improvement, with particular reference to induction of genetic variability.

Materials and Methods

The experiment was conducted at Model Floriculture Center of Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Uttarakhand. The experimental material comprised of the uniform and healthy bulbs (1.5-2.0 cm in diameter) of four tuberose cultivars viz., Kalyani Single (V₁), Kalyani Double (V₂), Suvasini (V₃) and Prajwal (V₄) obtained from the germplasm being maintained at the Model Floriculture Center, Pantnagar. The bulbs of tuberose were irradiated

with gamma rays [5 Gy] (T₁), gamma rays [15 Gy] (T₂) at the dose rate of 1 Gy per 5.18 sec in Gamma chamber-900 with ⁶⁰Co source at the gamma irradiation facility of National Botanical Research Institute, Lucknow, X-rays [6 Gy] (T₃), X-rays [12 Gy] (T₄) using the X-ray machine at Department of Entomology, G. B. Pant University of Agriculture & Technology, Pantnagar and treated with EMS [0.1%] (T₅), EMS [0.2%] (T₆) by dipping the bulbs of tuberose in the freshly prepared solution of 0.1 and 0.2 per cent EMS for 12 hours and dried under shade for 4 hours before planting them in field while the untreated bulbs were used as control (T₇). The irradiated bulbs were planted in already prepared beds immediately after irradiation and treatments. The treated bulbs as well as the untreated bulbs (Control) were planted in open field using factorial randomized block design with three replications. All the recommended package of practices for cultivation were followed throughout the year. The data were recorded on growth and flowering parameters and statistically analyzed [Table-1-4]. The data generated from present investigations were subjected to the statistical analysis in accordance with the procedure outlined [4]. The significance of differences among treatment means were tested by F-test. Wherever, the F-test was found to be significant, critical difference was calculated. The mean value of genotypes in each replication was used for statistical analysis. The data were analyzed for a factorial randomized block design to test the significance of differences between the genotypes for various characters.

Results and discussion

Vegetative character

The perusal of data presented in [Table-1] reveals that mutagenic treatments had significant effects on vegetative characters of tuberose cultivars. Within cultivars, earliest spouting per plant (36.27 days) was observed in cv. Suvasini while maximum days to sprouting (39.46 days) was observed in cv. Kalyani Single. Among treatments, minimum days to sprouting (35.93 days) were observed with 5 Gy gamma ray (T₁) treated bulbs, while 15 Gy gamma rays (T₂) treated bulbs took

maximum days (39.23 days) to sprout. Among interaction, minimum days to sprouting (32.10 days) were observed in 5 Gy gamma rays treated bulbs of cv. Prajwal (T₁V₄) while maximum days to sprouting (44.30 days) were observed in cv. Kalyani Single with 15 Gy gamma ray treatment (T₂V₁). Similarly, irrespective of treatments, maximum sprouting percentage (82.91%) was observed in cv. Suvasini (V₃) while minimum sprouting percentage (75.13%) was observed in cv. Prajwal (V₄). Within treatments, maximum sprouting percentage (88.79%) was observed in 0.2 per cent EMS treatment while minimum sprouting percentage

(64.03) was reported with 15 Gy gamma rays (T₂). Among interaction, maximum sprouting percentage (90%) was observed in cv. Kalyani Single with treatment 6 Gy X-rays (T₃V₁) and 0.2 per cent EMS (T₆V₁), in cv. Kalyani Double with 0.1% EMS (T₅V₂) and 0.2% EMS (T₆V₂), in cv. Suvasini with 12 Gy X-ray (T₄V₃) and control (T₇V₃), in cv. Prajwal with 0.2% EMS (T₆V₄). Whereas, minimum sprouting percentage (56.31%) was observed in cv. Prajwal with 15 Gy gamma rays (T₄V₄) treatment.

Table-1 Effect of different mutagenic treatments on different vegetative characters on different cultivars of tuberose

Treatments	Days taken to sprouting					Percentage sprouting				
	V ₁	V ₂	V ₃	V ₄	Mean	V ₁	V ₂	V ₃	V ₄	Mean
T ₁	39.00	37.70	34.90	32.10	35.93	71.45	37.70	78.67	64.03	68.75
T ₂	44.30	34.20	39.00	39.40	39.23	67.41	34.20	73.10	56.31	64.03
T ₃	40.40	37.90	39.10	33.90	37.83	90.00	37.90	78.27	83.10	84.14
T ₄	36.80	38.70	37.30	37.30	37.52	78.27	38.70	85.17	73.45	79.31
T ₅	37.30	34.40	36.40	42.50	37.65	78.67	34.40	90.00	78.67	83.13
T ₆	38.20	38.20	34.50	37.60	37.13	90.00	38.20	85.17	90.00	88.79
T ₇	40.20	39.80	32.70	40.90	38.40	85.17	39.80	90.00	80.35	86.38
Mean	39.46	37.27	36.27	37.67	37.67	80.14	37.27	82.91	75.13	79.22
	SEm±		CD at 5%			SEm±		CD at 5%		
Varieties	0.83		2.36			3.04		8.61		
Treatments	1.10		3.12			2.29		6.51		
Interaction	2.20		6.24			6.07		17.22		

There was a differential response of mutagenic treatments on days to sprouting and sprouting percentage among different cultivars. Sprouting was earlier in treatments than the control at lower dose, while there was delay in sprouting at higher doses of mutagens. Percentage sprouting was also highly influenced by mutagenic treatments. Percentage survival was lesser in treatments than the control. It was less in higher doses as compared to lower doses in same cultivar. Stimulation in sprouting at lower dose of mutagenic treatments may be because at low level of mutagen the substances such as enzymes are set free by low radiation and cause stimulation in growth [11]. Deterioration may be attributed to the fact that at higher doses treatments damages physiology of the plant which

effects photosynthesis and respiration resulting in the improper growth of the plant and hampered root system [10].

Irrespective of cultivars, maximum mean plant height per plant (25.89 cm) was observed in cv. Kalyani Double (V₂) while minimum mean plant height per plant (22.28 cm) was recorded in cv. Kalyani Single (V₁). Among treatments, 0.2 per cent EMS (T₆) gave maximum (26.13 cm) mean plant height while minimum (22.34 cm) mean plant height per plant was observed in 15 Gy gamma ray (T₂) treatment. Among mean interactions, maximum plant height (29.52 cm) was found with 15 Gy gamma rays in cv. Suvasini (T₂V₃) and minimum (18.64 cm) with 5 Gy gamma rays in cv. Suvasini (T₁V₃) [Table-2].

Table-2 Effect of different mutagenic treatments on different vegetative characters on different cultivars of tuberose

Treatments	Numbers of leaves per plant (cm)					Plant height (cm)					Plant spread (cm)				
	V ₁	V ₂	V ₃	V ₄	Mean	V ₁	V ₂	V ₃	V ₄	Mean	V ₁	V ₂	V ₃	V ₄	Mean
T ₁	44.00	39.00	54.00	52.00	47.25	20.92	24.73	18.64	27.04	22.83	20.96	17.40	19.02	18.38	18.94
T ₂	37.00	39.00	34.00	43.00	38.25	19.28	21.70	29.32	19.05	22.34	12.56	19.58	21.74	12.31	16.55
T ₃	36.00	44.00	42.00	42.00	41.98	23.83	25.49	19.85	20.43	22.40	19.08	22.90	22.29	16.49	20.19
T ₄	37.00	49.87	45.00	42.00	43.47	24.30	27.58	22.22	23.36	24.36	17.95	20.14	16.04	20.00	18.53
T ₅	51.00	47.00	44.00	42.00	46.00	23.58	28.82	21.68	24.53	24.65	18.89	18.12	14.79	21.69	18.37
T ₆	54.59	35.00	32.00	39.00	40.15	22.00	26.51	26.49	29.52	26.13	16.33	19.01	17.25	23.40	18.99
T ₇	43.00	39.00	59.73	42.00	43.95	22.08	26.41	26.41	24.66	24.89	15.29	19.71	22.25	19.36	19.15
Mean	43.23	41.84	44.39	43.14	43.15	22.28	25.89	23.52	24.08	23.94	17.29	19.55	19.06	18.80	18.68
	SEm±		CD at 5%			SEm±		CD at 5%			SEm±		CD at 5%		
Varieties	0.33		0.93			0.52		1.46			0.30		0.86		
Treatments	0.43		1.23			0.39		1.11			0.40		1.14		
Interaction	0.87		2.45			1.03		2.93			0.80		2.28		

Irrespective of treatments, plant spread per plant was found maximum (19.55 cm) in cv. Kalyani Double (V₂) while minimum (17.29 cm) was found in cv. Kalyani Single (V₁). Within treatments, 6 Gy X-rays (T₃) treatment gave maximum plant spread per plant (20.19 cm) while minimum (16.55 cm) was found in 15 Gy gamma rays (T₂). Among interactions, maximum plant spread per plant (23.40 cm) was found in cv. Prajwal with 0.2% EMS (T₆V₄) while minimum plant spread (12.31 cm) was observed in the cv. Prajwal with 15 Gy gamma rays (T₂V₄) [Table-2]. Plant height and spread decreased in most of the cultivars with increased dose of mutagen irrespective of treatments when compared to control. Decrease in plant spread was lesser in lower dose as compared to higher dose of mutagenic treatment.

Among cultivars, number of leaves per plant were found maximum (44.39) in cv. Suvasini (V₃) while minimum number of leaves per plant (41.84) were found in cv. Kalyani Double (V₂). Within treatments, 5 Gy gamma rays (T₁) gave maximum (47.25) number of leaves while minimum number of leaves (38.25) was found in 15 Gy gamma rays treatment (T₂). Among interactions, maximum number of leaves per plant (59.73) was found in cv. Suvasini with control (T₇V₃) while minimum number of leaves (32) were observed in cv. Suvasini with 0.2 per cent EMS treatment (T₆V₃) [Table-2].

Reduction in vegetative growth can be attributed to changes in auxin level or might be due to inactivation of auxin, destruction of enzyme system, inhibition of auxin synthesis or inhibition of mitotic activities and chromosome damage

associated with secondary physiological damage [5, 6, 12]. [1] analyzed gamma rays-induced mutation in 'Lalima' chrysanthemum (*Chrysanthemum morifolium* L.), using gamma induced mutant 'Pink' of *Dahlia variabilis* [3], in gamma rays induced mutation in *Chrysanthemum paludosum* [7] and *Glebionis segetum* [8] and also reported decrease in leaf length with the increase in dose of mutagen.

Floral characters

Data presented in [Table-3] reveals that days to spike emergence was found maximum (187.43 days) in cv. Kalyani Single (V₁) while minimum days to spike emergence (156.94 days) were found in cv. Suvasini (V₃), irrespective of treatments. Within treatments, 0.2 per cent EMS (T₆) took maximum days (252.86) to spike emergence while earliest spike emergence was observed in control (T₇) after 82.48 days. Among interactions, maximum days to spike emergence (270.74) were found in cv. Kalyani Double with 0.2 per cent EMS (T₆V₂) while

earliest spike emergence was observed in the cv. Prajwal with control (T₇V₄) after 74 days. Days taken to spike emergence increased in all cultivars with increased dose of mutagen irrespective of treatment when compared to control. Increase in days taken to spike emergence was lesser in lower dose as compared to higher dose of the mutagenic treatment. Delay in spike emergence might be due to disturbance in biochemical pathway, which assists in flower induction pathway [9]. Spike length per plant was found maximum (75.35 cm) in cv. Suvasini (V₃) irrespective of the treatment while minimum spike length (70.42 cm) was found in cv. Kalyani Double (V₂). Among treatments, maximum spike length (76.06 cm) was observed in 6 Gy X-rays (T₃) while shortest spikes (64.92 cm) were observed in 5 Gy gamma rays (T₁) treatment. Among interactions, longest spikes (89.21 cm) were observed in cv. Kalyani Single with 0.2 per cent EMS (T₆V₁) treatment, while minimum spike length (54.38 cm) was observed in cv. Kalyani Double with 5 Gy gamma rays (T₁V₂) [Table-3].

Table-3 Effect of different mutagenic treatments on days to spike emergence, spike length and rachis length on different cultivars of tuberose

Treatments	Days to spike emergence					Spike length					Rachis length				
	V ₁	V ₂	V ₃	V ₄	Mean	V ₁	V ₂	V ₃	V ₄	Mean	V ₁	V ₂	V ₃	V ₄	Mean
T ₁	180.63	82.75	79.09	214.67	139.28	56.63	54.38	81.92	66.79	64.92	23.38	25.58	30.21	23.75	25.73
T ₂	243.38	229.67	82.44	234.67	197.54	72.08	73.83	88.08	64.13	74.53	27.08	26.71	28.29	31.63	28.43
T ₃	91.67	78.70	183.15	159.67	128.30	71.41	73.50	80.00	79.33	76.06	27.29	31.96	32.21	26.38	29.46
T ₄	199.67	121.41	183.02	174.67	169.69	64.58	87.83	67.25	71.75	72.85	26.45	26.25	22.08	30.67	26.45
T ₅	243.17	259.66	227.44	120.67	212.73	75.75	74.04	77.00	76.13	75.73	26.25	27.62	26.13	28.46	27.11
T ₆	269.83	270.74	253.77	217.10	252.86	89.21	63.33	58.83	73.75	70.94	25.92	23.56	24.96	23.92	24.59
T ₇	83.67	82.58	89.67	74.00	82.48	78.00	66.04	74.42	82.92	75.34	25.33	25.33	37.13	24.04	27.96
Mean	187.43	160.79	156.94	170.78	168.98	72.91	70.42	75.35	73.35	72.92	26.00	26.72	28.72	26.98	27.10
	SEm±	CD at 5%				SEm±	CD at 5%				SEm±	CD at 5%			
Varieties	1.03	2.92				1.10	3.12				0.38	1.08			
Treatments	1.36	3.86				1.46	4.13				0.29	0.82			
Interaction	2.72	7.73				2.91	8.26				0.76	2.16			

Rachis length per plant among the cultivars, irrespective of the treatments was found maximum (28.72 cm) in cv. Suvasini (V₃) while, minimum (26.00 cm) was found in cv. Kalyani Single (V₁). Among treatments, 6 Gy X-rays rays (T₃) resulted in maximum rachis length per plant (29.46 cm) while minimum (24.59 cm) was found in 0.2 per cent EMS (T₆). Among interactions, maximum rachis length (32.21 cm) was found in cv. Suvasini with 6 Gy X-rays (T₃V₃) treatment and minimum (22.08 cm) was observed in Suvasini with 12 Gy X-rays (T₄V₃) [Table-3]. Generally, there was decrease in spike length and rachis length with increase in dose of mutagen when compared to control.

Number of florets per spike were found maximum (20.11) in cv. Suvasini (V₃) while, minimum (16.56) were recorded in cv. Kalyani Double (V₂), irrespective of treatments. Within treatments, 0.2 per cent EMS (T₆) gave maximum number of florets per spike (25.77) while minimum number of florets per spike (11.01) were found in 5 Gy gamma rays (T₁). Among interactions, maximum number of florets per spike (35.50) was recorded in cv. Kalyani Double with 0.2 per cent EMS (T₆V₂) and minimum number of florets per spike (4.68) were observed in the Kalyani

Double at 6 Gy X-rays (T₃V₂) treatment. There was a differential response among cultivars in number of florets per spike for different mutagenic treatments. Generally there was decrease in number of florets per spike with increased dose of mutagen when compared to control. Decrease in number of florets per spike was lesser in lower dose as compared to higher dose of mutagenic treatment. Among the cultivars, maximum flowering duration (21.83 days) were observed in cv. Kalyani Double (V₂) while minimum (12.54 days) flowering duration was found in cv. Kalyani Single (V₁). Within treatments, maximum flowering duration (19.19 days) was observed with 5 Gy gamma rays (T₁), while minimum flowering duration (12.69 days) was found in 0.2 per cent EMS. Among interactions, maximum flowering duration (28.87 days) was found in cv. Kalyani Double at 5 Gy gamma rays (T₁V₂) and minimum flowering duration (9.69 days) was observed in cv. Kalyani Single with 0.2 per cent EMS (T₆V₁), in cv. Prajwal with 15 Gy gamma rays (T₂V₄) and with 0.2 per cent EMS (T₆V₄) in the same cultivar [Table-4]. Generally, there was decrease in flowering duration with increased dose of mutagen when compared to control.

Table-4 Effect of different mutagenic treatments on number of florets per spike, duration of flowering and vase life on different cultivars of tuberose

Treatments	Number of florets per spike					Duration of flowering (days)					Vase life (days)				
	V ₁	V ₂	V ₃	V ₄	Mean	V ₁	V ₂	V ₃	V ₄	Mean	V ₁	V ₂	V ₃	V ₄	Mean
T ₁	10.10	5.85	10.35	17.74	11.01	12.69	28.69	19.69	15.69	19.19	7.24	5.24	10.24	10.04	8.19
T ₂	11.00	17.70	26.18	26.18	14.81	11.69	23.69	15.69	9.69	15.19	8.24	6.44	11.24	8.25	8.55
T ₃	14.92	4.68	12.00	23.29	14.23	14.69	21.69	22.69	16.69	18.94	6.24	9.25	8.45	9.25	8.29
T ₄	16.95	13.13	25.08	11.75	15.96	10.69	18.69	17.69	11.69	14.69	8.25	10.24	11.24	8.24	9.49
T ₅	33.10	19.97	26.17	20.62	24.97	12.69	18.69	15.69	13.69	15.19	12.24	11.25	7.45	9.15	9.52
T ₆	34.25	35.50	16.98	16.33	25.77	9.69	18.69	12.69	9.69	12.69	13.25	8.25	7.45	9.15	7.45
T ₇	12.60	19.12	24.00	25.89	20.40	15.69	22.69	21.69	15.69	18.94	7.45	8.25	7.25	9.92	8.21
Mean	18.83	16.56	20.11	17.20	18.18	12.54	21.83	17.97	13.26	16.40	8.96	8.41	9.41	9.04	8.97
	SEm±	CD at 5%				SEm±	CD at 5%				SEm±	CD at 5%			
Varieties	0.73	2.08				0.19	0.53				0.23	0.66			
Treatments	0.97	2.75				0.25	0.70				0.31	0.87			
Interaction	1.94	5.49				0.49	0.14				0.62	0.17			



Plate-1 View of Experimental Site at Model Floriculture Centre



Kalyani Double



Kalyani Single



Prajwal



Suvasini

Plate 2: Different cultivars used for the experiment

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