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Response of gamma irradiation on vegetative parameters of tuberose (*Polianthes tuberosa* L.) cv. pearl double

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Abstract
The present investigation was carried out to study the Response of gamma irradiation on vegetative parameters of tuberose (*Polianthes tuberosa* L.) cv. Pearl Double. The results revealed that lowest decline trends were recorded on days to 50% sprouting (74.33, 71.33), sprouting percentage at 30 DAP (21.67, 28.33), plant survival percentage (96.67, 95.00), plant height (cm) at 60 & 90 DAP (35.53, 36.56 & 41.09, 44.30), Leaves/plant at 60 & 90 DAP (24.93, 25.07 & 26.07, 28.40), Leaf length (cm) at 60 & 90 DAP (29.27, 29.22 & 29.30, 29.24) and Leaf width at (cm) 60 & 90 DAP (1.68, 1.72 & 1.69, 1.75) at 2.50 Gy and highest declined trends at 20.0 Gy gamma irradiation in V_1M_1 (1st year 2017-18) and V_1M_2 (2nd year 2018-19) generation respectively as compare to control.

Keywords: Tuberose, gamma radiation and vegetative growth

Introduction
Tuberose (*Polianthes tuberosa* Linn.) is a bulbous ornamental plant, consist of basic chromosome number X=30, 2n=60 in case of single and X=25, 2n=50 in double type. Its native from Mexico, where its cultivation was reported before 1522 (Trublood, 1973) [14]. It belongs to the family Amaryllidaceae and commonly known as Gulcheri (Hindi) and Rajanigandha (Bengali). In India, four types of tuberose cultivars *viz.* single, semi-double, double and variegated are cultivated commonly. The single type tuberose have one row of corolla along with high strong fragrance than the double type flower and commercially utilized and for extraction of perfume and cosmetic industry.

Tuberose is well adapted to North Indian plains and gaining popularity among flower growers. It is cultivated on limited scale in Ajmer, Jaipur, Kota and Udaipur districts of Rajasthan. Tuberose (*Polianthes tuberosa* Linn.) species cultivated have narrow genetic base and less natural genetic variability either in flower bud colour pinkish tinge, greenish, only white type flower colour in single, semi- double, double cultivar and variegated traits are exist in India. Limited work has been done in India on tuberose improvement through induced physical mutagen *i. e.* gamma rays at NBRI, Lucknow, results in 'Rajat Rekha' colour of silvery white streak along the middle of the leaf blade and 'Swarn Rakha' contains golden yellow streaks along the margin with double type due to diplomatic selection on Rajat Rekha variety is reverted from mutation. Previous attempts were made for inducing mutation in *P. tuberosa* by ionizing radiation (Abraham and Desai, 1976) [1]. The mainly extensive contributions to novel species of *Polianthes* were prepared by Rose (1903) [13].

It is hampering conventional breeding and for the reason that common crosses cannot be attempted. In India, several improved tuberose cultivars have been developed by selection, hybridization and mutation breeding. Therefore it is a vast scope for non- conventional breeding methods such as mutation crop breeding. It is vegetative propagated by bulblets and bulbs. After identification and selection of distinct genotypes it could be further simply multiplied through bulbs and bulblets. Mutation breeding is an essential pathway for production of latest genotypes in vegetative propagated species (Broertjes, 1972) [3] and to improve natural genetic source (Jain, 2006) [6]. Mutation induction continues to be an attractive tool for inducing genetic changeability in ornamentals (Mahawer *et al.*, 2011) [8].

Mutation induction in vegetatively propagated crops has considerable attention because the mutant's selection of directly phenotypic characteristics like form, colour, shape and sizes are usually not hard. Another reason is that being heterozygous nature it shows relatively higher mutation frequencies both in induced as well as spontaneous mutations. Mutagen agents were used to induce useful phenotypic visibilities in plants for more than seventeen years (Foster and Twell, 1996) [4].

The mainly frequent process to develop mutant cultivars in flower crops is mutation breeding, accounting for about 90 per cent of obtained varieties which includes 22% with X-rays and 64% with gamma rays (Jain, 2005) [5]. Physical mutagens like UV light (X-rays, neutrons and gamma rays) and ionizing radiation also a series of substance agents are familiar examples of mutagens that have high competence in generation of mutation in animals, plants and bacteria. The advantages of physical mutagens are correct reasonable reproducibility, dissymmetry, higher and uniform penetration of multi cellular method particularly by gamma irradiation. Gamma rays have provided a more number of useful mutants (Predieri, 2001) [12] and are still showing a higher potential for improvement of vegetatively propagated plants.

Materials and Methods

A field experiment two year V_1M_1 (1st year 2017-18) and V_1M_2 (2nd 2018-2019) was carried out during January 2017 to March 2019 at Horticulture Farm, MPUAT, Udaipur, which is situated at 73°42' E longitude and 24°35' N latitude at an elevation of 579.5 m above MSL. The region comes under Agro Climatic Zone IV A (Sub-humid Southern Plain and Aravali Hills) of Rajasthan. The field had moderately leveled topography and clay loam texture of soil. The Pearl Double bulbs were treated with the different doses of gamma rays *viz*. 2.5, 5.0, 7.5, 10, 12.5, 15, 17.5 and 20 Gy at Gamma Chamber, Nuclear Research Laboratory, I.A.R.I, New Delhi during 28 January, 2017. And gamma radiation treated bulbs replicated thrice with nine treatments in a Randomized Block Design (RBD).

Result and Discussion

Data pertaining in Table 1 recorded days to 50 per cent bulb sprouting of tuberose cultivar Pearl Double significantly affected by bulb treatment of gamma irradiation doses from 2.5-20 Gy. Days to 50 per cent bulb sprouting were highest delayed at 20 Gy (82.67, 79.67) followed by 17.5 Gy (80.00, 77.00), While lowest declined days to 50 per cent bulb sprouting at 2.5 Gy (74.33, 71.33) in V_2M_1 and V_2M_2 generation respectively over the control. Sprouting per cent at 30 days after planting of tuberose cultivar Pearl Double significantly affected by bulb treatment of gamma irradiation doses from 2.5-20 Gy. The lowest declined per cent sprouting were observed at 2.5 Gy (21.67, 28.33) followed by 5.0 Gy (20.00, 26.67), whereas highest declined in sprouting percent were recorded at 20 Gy (8.33, 15.00) in V_2M_1 and V_2M_2 generation respectively over the control at 30 days after planti ng. Plant survival of tuberose cultivar Pearl Double significantly affected by bulb treatment of gamma irradiation doses from 2.5-20 Gy. The minimum declined plant survival per cent were observed at 2.5 Gy (96.67, 95.00) followed by 5.0 Gy (93.33, 91.67), while highest declined in plant survival per cent were recorded at 20 Gy (76.67, 75.00) in V_2M_1 and V_2M_2 generation respectively as compared to control. Navabi *et al*. (2016) reported higher doses reduction of growth rate and survival in tuberose. Most of the bulbs sprouted and grew with a short time decline at the dose of 10.0 Gy. The reason of the reduce survival could be due to the severe damage to cell damage, cellular components and genetic material. Misra and Bajpai (1983) [9], Awad and Elbahr (1986) [2], Pranom *et al.*, (1986) [11] and Karki and Srivastava (2010) [7] also observed similar finding in slight earliness in sprouting of gladiolus corms when treated with lower doses of gamma rays. Enzymes play an important role in plant metabolism to accelerate metabolism activities and consequently result in stimulating plant growth (Misra and Bajpai, 1983) [9].

Data pertaining in Table 2 noticed that the plant height at 60 days after planting of tuberose cultivar Pearl Double significantly affected by bulb treatment of gamma irradiation doses from 2.5-20 Gy. The minimum declined in plant height at 60 DAP were observed at 2.5 Gy (35.53, 36.56 cm) followed by 5.0 Gy (33.50, 34.53 cm), while maximum declined in plant height were recorded at 20 Gy (25.78, 26.80 cm) followed by 17.5 Gy (26.77, 29.02 cm) at V_2M_1 and V_2M_2 generation respectively over the control. Plant height at 90 days after planting of tuberose cultivar Pearl Double significantly affected by bulb treatment of gamma irradiation doses from 2.5-20 Gy. The minimum declined in plant height at 90 DAP were observed at 2.5 Gy (41.09, 44.30 cm) followed by 5.0 Gy (39.06, 42.27 cm), while maximum declined in plant height (30.34, 33.55 cm) were recorded at 20 Gy gamma irradiation in V_2M_1 and V_2M_2 generation respectively as compared to control. Leaves / plant at 60 days after planting of tuberose cultivar Pearl Double significantly affected by bulb treatment of gamma irradiation doses from 2.5-20 Gy. The minimum declined in leaves / plant at 60 DAP were observed at 2.5 Gy (24.93, 25.07) followed by 5.0 Gy (23.87, 24.60), whereas maximum declined in leaves/plant (20.00, 20.73) were recorded at 20 Gy with gamma irradiation in V_2M_1 and V_2M_2 generation respectively over the control. Leaves / plant at 90 days after planting of tuberose cultivar Pearl Double significantly affected by bulb treatment of gamma irradiation doses from 2.5-20 Gy.

The minimum declined in leaves/plant at 90 DAP were observed at 2.5 Gy (26.07, 28.40) followed by 5.0 Gy (25.00, 27.87), while maximum declined in leaves / plant were recorded at 20 Gy (21.87, 21.33) followed by 17.5 Gy (22.40, 22.93) with gamma irradiation in V_2M_1 and V_2M_2 generation, respectively as compare to control. Data pertaining in Table 3 noticed that the leaf length at 60 days after planting of tuberose cultivar Pearl Double significantly affected by bulb treatment of gamma irradiation doses from 2.5-20 Gy. The minimum declined in leaf length at 60 DAP were observed at 2.5 Gy (29.27, 29.22 cm) followed by 5.0 Gy (27.31, 27.26 cm), while maximum declined in leaf length were recorded at 20 Gy (19.99, 19.86 cm) followed by 17.5 Gy (20.34, 20.29 cm) with gamma irradiation in V_2M_1 and V_2M_2 generation respectively as compare to control. Leaf length at 90 days after planting of tuberose cultivar Pearl Double significantly affected by bulb treatment of gamma irradiation doses from 2.5-20 Gy. The lowest declined in leaf length at 90 DAP were observed at 2.5 Gy (29.30, 29.24 cm) followed by 5.0 Gy (27.34, 28.27 cm), while highest declined in leaf length (20.23, 21.83 cm) were recorded at 20 Gy followed by 17.5 Gy (21.04, 22.27 cm) gamma irradiation of tuberose bulb planting cv. Pearl Double in V_2M_1 and V_2M_2 generation respectively as compared to control. Data pertaining in Table 3 noticed that the leaf width (cm) at 60 days after planting of tuberose cultivar Pearl Double recorded non-significant influence by bulb treatment of gamma irradiation doses from 2.5-20 Gy. The minimum declined in leaf width at 60 DAP were observed at 2.5 Gy (1.68, 1.72 cm) followed by 5.0 Gy

(1.66, 1.70 cm), while maximum declined in leaf width (1.51, 1.55 cm) were recorded at 20 Gy followed by 17.5 Gy (1.56, 1.60 cm) gamma irradiation of tuberose bulb cv. Pearl Double in V_2M_1 and V_2M_2 generation respectively as compared to control. The leaf width at 90 days after planting of tuberose cultivar Pearl Double showed non-significant influence by bulb treatment of gamma irradiation doses from 2.5-20 Gy. The lowest declined in leaf width at 90 DAP were observed at 2.5 Gy (1.69, 1.75 cm) followed by 5.0 Gy (1.66, 1.73 cm) while, highest declined in leaf width (1.52, 1.56) were recorded at 20 Gy followed by 17.5 Gy (1.57, 1.62 cm) in gamma irradiation of tuberose bulb planting cv. Pearl Double V_2M_1 and V_2M_2 generation respectively as compared to control. Navabi *et al*. (2016) [10] reported higher doses more reduction in plant height, length and width of plant leaf in tuberose. Similar result recorded Abraham and Desai (1976) [1] that when intensity of doses increases, the height of lily plant shorten and tuberose could be due to physiological, morphological and cytological disturbance caused by gamma radiation.

Table 1: Response of gamma irradiation on days to 50% sprouting, sprouting percentage at 30 DAP plant survival percentage in Tuberose cv. Pearl Double

Treatments	Days to 50% sprouting		Sprouting percentage at 30 DAP		Plant survival percentage	
	V_1M_1	V_1M_2	V_1M_1	V_1M_2	V_1M_1	V_1M_2
T_1-V_1G_0 (Control)	73.67	71.00	23.33	31.67	100.00	100.00
T_2-V_1G_1 (2.50 Gy)	74.33	71.33	21.67	28.33	96.67	95.00
T_3-V_1G_2 (5.00 Gy)	75.00	72.00	20.00	26.67	93.33	91.67
T_4-V_1G_3 (7.50 Gy)	76.00	72.67	18.33	25.00	91.67	90.00
T_5-V_1G_4 (10.00 Gy)	77.00	73.67	16.67	23.33	88.33	86.67
T_6-V_1G_5 (12.50 Gy)	78.00	74.67	15.00	21.67	83.33	81.67
T_7-V_1G_6 (15.00 Gy)	79.67	76.67	13.33	20.00	81.67	80.00
T_8-V_1G_7 (17.5.0 Gy)	80.00	77.00	10.00	18.33	78.33	76.67
T_9-V_1G_8 (20.00 Gy)	82.67	79.67	8.33	15.00	76.67	75.00
S.Em.±	1.80	1.79	2.12	1.73	2.55	2.92
C.D. (P=0.05)	5.39	5.38	6.34	5.20	7.63	8.75
C.V. %	4.02	4.18	22.48	12.88	5.02	5.86

Table 2: Response of gamma irradiation on plant height (cm) and leaves/plant at 60, 90 DAP in Tuberose cv. Pearl Double

Treatments	Plant height (cm) at 60 DAP		Plant height (cm) at 90 DAP		Leaves/plant at 60 DAP		Leaves/plant at 90 DAP	
	V_1M_1	V_1M_2	V_1M_1	V_1M_2	V_1M_1	V_1M_2	V_1M_1	V_1M_2
T_1-V_1G_0 (Control)	41.63	42.66	47.19	50.55	25.93	26.27	27.53	29.47
T_2-V_1G_1 (2.50 Gy)	35.53	36.56	41.09	44.30	24.93	25.07	26.07	28.40
T_3-V_1G_2 (5.00 Gy)	33.50	34.53	39.06	42.27	23.87	24.60	25.00	27.87
T_4-V_1G_3 (7.50 Gy)	31.10	32.13	36.66	39.87	23.07	23.40	24.07	26.80
T_5-V_1G_4 (10.00 Gy)	29.38	30.41	34.93	38.15	22.13	22.33	24.13	25.73
T_6-V_1G_5 (12.50 Gy)	28.08	28.20	33.10	36.61	21.93	22.20	23.53	24.13
T_7-V_1G_6 (15.00 Gy)	27.17	27.80	32.31	35.54	21.60	21.80	23.00	23.47
T_8-V_1G_7 (17.5.0 Gy)	26.77	29.02	31.55	34.76	20.93	21.27	22.40	22.93
T_9-V_1G_8 (20.00 Gy)	25.78	26.80	30.34	33.55	20.00	20.73	21.87	21.33
S.Em.±	1.42	1.25	1.09	1.18	0.87	0.81	0.86	1.02
C.D. (P=0.05)	4.25	3.76	3.27	3.53	2.62	2.42	2.58	3.05
C.V. %	7.92	6.78	5.21	5.17	6.67	6.06	6.17	6.89

Table 3: Response of gamma irradiation on leaf length (cm) and leaf width (cm) at 60, 90 DAP Tuberose cv. Pearl Double

Treatments	Leaf length (cm) at 60 DAP		Leaf length (cm) at 90 DAP		Leaf width at (cm) 60 DAP		Leaf width at (cm) 90 DAP	
	V_1M_1	V_1M_2	V_1M_1	V_1M_2	V_1M_1	V_1M_2	V_1M_1	V_1M_2
T_1-V_1G_0 (Control)	30.60	30.50	30.62	30.55	1.70	1.75	1.73	1.77
T_2-V_1G_1 (2.50 Gy)	29.27	29.22	29.30	29.24	1.68	1.72	1.69	1.75
T_3-V_1G_2 (5.00 Gy)	27.31	27.26	27.34	28.27	1.66	1.70	1.66	1.73
T_4-V_1G_3 (7.50 Gy)	25.99	26.28	26.03	27.60	1.64	1.68	1.65	1.71
T_5-V_1G_4 (10.00 Gy)	24.66	24.94	24.69	26.26	1.63	1.67	1.63	1.69
T_6-V_1G_5 (12.50 Gy)	22.34	22.95	23.03	24.94	1.60	1.64	1.61	1.67
T_7-V_1G_6 (15.00 Gy)	21.40	21.35	22.09	23.03	1.58	1.62	1.59	1.64
T_8-V_1G_7 (17.5.0 Gy)	20.34	20.29	21.04	22.27	1.56	1.60	1.57	1.62
T_9-V_1G_8 (20.00 Gy)	19.99	19.86	20.23	21.83	1.51	1.55	1.52	1.56
S.Em.±	0.85	0.86	0.80	1.05	0.05	0.08	0.06	0.07
C.D. (P=0.05)	2.56	2.58	2.40	3.15	NS	NS	NS	NS
C.V. %	5.99	6.02	5.56	7.23	5.04	8.01	5.90	6.72

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