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Genetic variability of tuberose mutants with regard to sprouting of bulbs and vegetative growth parameters in the VM_2 generation

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Abstract
An experiment was carried out to study the distinctiveness, uniformity and stability of traits in the γ-ray irradiated (20 Gy) variants of mutant population of tuberose cv. 'Hyderabad Single' in the second generation. Results indicated that untreated control bulbs recorded significantly early sprouting of bulbs (15.50 days) and the plants recorded significantly highest plant height (51.75 cm), leaf width (2.05 cm), leaf length (50.50 cm), plant spread (47.60 cm) and maximum number of tillers (20.50) produced per clump in comparison to 44 variants of mutant population obtained by irradiation of bulbs of cv. 'Hyderabad Single'.

Keywords: Tuberose, vegetative parameters, second generation

Introduction

Tuberose (*Polianthes tuberosa* Linn.) is one of the most popular fragrant flowers of tropical and subtropical regions of the world. In India, tuberose is popularly called as 'Rajnigandha' or 'Nishigandha' as it blooms during the night hours. In tuberose, floret colour has been limited to white and only a very few promising cultivars have been observed with increased floret yield coupled with fragrance, in different parts of tuberose growing areas in the world. In India, flower colour of all the existing varieties in tuberose has been limited to white only, although some varieties show pinkish tinge at the bud stage only. Tuberose is a monocot with long, slender and grass-like foliage with little landscape value. Spikes which bear bright white florets are loosely arranged on the spike that can reach 3-4 feet in height. In India, the total flower production of tuberose was estimated to the tune of 2865 MT of which loose flowers production alone was constituted to be 2059 MT, whereas cut flower production was restricted to 807 MT (National Horticulture Data Base – 2018-19) [12].

Mutation was recognized as one of the most important breeding tools in the development of new varieties/cultivars through genetic manipulation (Kumari and Kumar, 2015) [10]. Mutations could be induced in the ornamental plants by using either with physical mutagens (x-rays, γ-rays, etc.,) or chemical mutagens (EMS, etc.,) to create variation in the genetic make-up of the plants in return to get higher flower yield, disease resistance, early maturity, etc.,. Gamma rays are known to influence the plant growth and development by inducing certain cytological, genetical, biochemical, physiological and morphogenetic changes in the cells/tissues (Abdullah *et al.*, 2009) [1]. Compared to the chemical mutagens, physical mutagens and gamma irradiation have provided a high number of useful mutants and is still has potential for improving the plant species propagated through vegetative means (Jyothi *et al.*, 2019) [5]. Keeping all these things in view, the present investigation has been programmed to irradiate the bulbs of most popular tuberose cv. 'Hyderabad Single' to obtain the mutants with high genetic potential with regard to plant growth, development and flower yield.

Materials and Methods

The present investigation was carried out at the Floriculture Block, College of Horticulture, Anantharajupeta, Annamyya district of Andhra Pradesh during the period from August, 2019 to May, 2020. The experiment was conducted in a Completely Randomized Design with two replications by using 44 variants of mutant population with untreated bulbs of cv. 'Hyderabad Single' as control, thus totaling to 45 treatments. Tuberose bulbs of cv. 'Hyderabad Single' were irradiated with γ-rays in a chamber with a source of ^{60}Co at the rate of 20 Gy at the Bhabha Atomic Research Center (BARC), Mumbai. The present experiment material was obtained from the variants of mutant population which was obtained from VM_1 generation and these bulbs were planted in poly bags for their further evaluation in the VM_2 generation. Irradiated bulbs of tuberose were planted in the poly bags possessing dimensions of 14 x 16 inch with 10 kg soil capacity. Poly bags were filled with potting medium consisting of red earth, FYM and cocopeat in the ratio of 3:1:1. The experiment was laid out to study the vegetative, floral and bulb characteristics in the γ-ray irradiated variants of mutant population in the second generation. The data arrived on different characters were statistically analyzed based on the procedure outlined by Panse and Sukhatme (1961) [13].

Results and Discussions

Significant variation was observed in the data pertaining to number of days to sprouting of bulbs among the variants of mutant population in the VM_2 generation (Table 1). Untreated control bulbs recorded significantly early sprouting (15.50 days) in comparison to irradiated bulbs and was found at par with the variants M_{32}, M_{50}, M_{63}, M_{119}, M_{146}, M_{164}, M_{226C}, M_{392}, M_{351}, M_{354C}, M_{369}, M_{456C}, M_{462}, M_{473C}, M_{496C} and M_{498}, whereas significantly highest number of days taken to sprouting of bulbs was noticed in the irradiated mutant of M_{389c} (69.50 days) and was found at par with M_{44}, M_{54}, M_{56}, M_{142C}, M_{162}, M_{178}, M_{183}, M_{189C}, M_{202}, M_{221C}, M_{292C}, M_{333}, M_{389C}, M_{463} and M_{465}. Remaining all other variants were found intermediate for number of days taken to sprouting of bulbs. Variation noticed in the number of days to sprouting of bulbs among different variants of mutant population in tuberose cv. 'Hyderabad Single' irradiated at 20 Gy might be attributed to the damage caused to chromosomes or certain disturbances caused at the cellular level or even might be both. Tiwari and Singh (2018) [20] noticed varied differences in sprouting of the bulbs of gladiolus irradiated with γ-rays at different levels of irradiation in comparison to the untreated control bulbs. Khan and Tyagi (2009) [8] reported that differences evidenced in sprouting might be attributed to the effects of mutagens on the meristematic tissues. The present results were found in conformity with the earlier findings of Rather and John (2002) [14] in dutch iris, Srivastava *et al.* (2007) [19] and Kumar *et al.* (2012) [9] in gladiolus and Berenschot *et al.* (2008) [2] in petunia.

Significant difference were noticed in the plant height (Table 1) of tuberose plants among different variants of mutant population irradiated with 20 Gy of gamma rays in the VM_2 generation. Significantly highest plant height (51.75 cm) was registered with untreated control plants, whereas significantly lowest plant height (20.30 cm) was observed with M_{465}. The remaining all other variants were found intermediate in plant height between these two treatments. Untreated control plants recorded significantly highest plant height compared to all other variants of mutant population, the reason might be due to the irradiation of tuberose bulbs with γ-rays at 20 Gy. Kumari and Kumar (2015) [10] have noticed significant reduction in plant height of variants of mutant population in gladiolus and they attributed that it could be due to the production of lower quantities of endogenous growth hormones in the variants of mutant population with special reference to cytokinins as a result of breakdown or lack of synthesis of cytokinins due to irradiation effect on the genetic structure. The present results were found in conformity with the earlier findings of Sisodia and Singh (2014) [18] who opined that height of irradiated plant was reduced due to γ-ray irradiation in different cultivars of gladiolus when compared with the untreated plants.

Significant variation was noticed in the analyzed data pertaining to leaf width of tuberose among the variants of mutant population assessed in the VM_2 generation (Table 1). Significantly highest leaf width (2.05 cm) was noticed with untreated control and was found at par with mutants M_{32}, M_{33}, M_{34}, M_{37}, M_{44}, M_{50}, M_{63}, M_{119}, M_{81}, M_{146}, M_{226C}, M_{162}, M_{189}, M_{202}, M_{292C}, M_{354C}, M_{369}, M_{389C}, M_{408}, M_{410}, M_{456}, M_{462}, M_{468} and M_{498}, whereas significantly lowest leaf width (1.15 cm) was observed with mutants M_{351} as well as M_{463} and was found at par with mutants M_{21}, M_{116}, M_{119}, M_{142C}, M_{164}, M_{178}, M_{183}, M_{221C}, M_{226C}, M_{264C}, M_{301C}, M_{333}, M_{339C}, M_{342}, M_{351}, M_{409C}, M_{440C}, M_{473C}, M_{496C}, and M_{465}. Among the variants of mutant population, M_{54} was found intermediate in leaf width between these two groups. From the data it was evident that width of leaf in the variants of mutant population studied against untreated control plants was strictly controlled by the genetic and environmental factors that might have spatially and temporally coordinated the expansion of cell and the activity of cell cycle. An increase or decrease in leaf width of tuberose might have been influenced by mutagenic effect on cell activity. Nathalie *et al.* (2010) [11] reported similar kind of observation in the variants of mutant population studied in *Arabidopsis thaliana*. Similar kind of observation was also reported by Singh *et al.* (2017) [15] in different irradiated cultivars of tuberose. Zargar *et al.* (1998) [21] documented that γ-ray irradiation significantly reduced the leaf width in chrysanthemum plants anything above 20 Gy of irradiation.

Significant differences were observed in the statistically analyzed data pertaining to leaf length of tuberose among the variants of mutant population in the VM_2 generation (Table 1). Significantly highest leaf length (50.50 cm) was noticed with untreated control plants followed by M_{410} (44.0 cm) which was significantly highest among the variants of mutant population. Significantly lowest leaf length (19.10 cm) was observed in the mutant M_{465} followed by M_{339C} (27.40 cm) among the variants of mutant population. Reduction in the vegetative growth can be attributed to a change in the level of auxin or might be due to destruction of enzyme system, thus leading to inhibition of synthesis of auxin thereby a reduction might have happened in the mitotic activity of vegetative parts of the plant. Kainthura *et al.* (2016) [6] noticed a significant reduction in the leaf length of different tuberose cultivars treated with graded levels of γ-ray irradiation. Dwivedi and Banerjee (2008) [4] have reported similar kind of observation in the γ-ray induced mutant of chrysanthemum cv. 'Lalima'. Zargar *et al.* (1998) [21] reported a significant reduction in the length of leaf of chrysanthemum through induced γ-ray irradiation at and above 20 Gy.

Significant differences were noticed in the analyzed data collected on plant spread among the variants of mutant population evaluated against untreated control plants of cv. 'Hyderabad Single' in the VM_2 generation (Table 1).

Significantly highest plant spread was noticed with M_{116} (47.60 cm) and was found at par with M_{21}, M_{37}, M_{54}, M_{63}, M_{183}, M_{301C}, M_{369}, M_{389C} and untreated control (45.25 cm), whereas significantly lowest plant spread was noticed with M_{496c} (28.00 cm) and was found at par with M_{33}, M_{119}, M_{162}, M_{164}, M_{178}, M_{221C}, M_{226C}, M_{264C}, M_{339C}, M_{351}, M_{354C}, M_{409C}, M_{410}, M_{440C}, M_{463} and M_{468C}. Remaining all other variants were found intermediate between these groups with regard to plant spread. Singh *et al.* (2009) [17] noticed similar kind of result in African marigold cv. 'Pusa Narangi Gainda' irradiated with different doses of γ-ray irradiation which increased plant spread with 100 Gy irradiation compared to control plants.

Significant variation existed in the analyzed data pertaining to number of tillers produced per clump in the VM_2 generation of variants of mutant population in tuberose cv. 'Hyderabad Single' (Table 1). Among the population, untreated control plants recorded significantly highest number of tillers per clump (20.50) followed by M_{54} (11.00), whereas significantly lowest number of tillers produced per clump was observed in M_{44} (4.00) and was found at par with the variants M_{21}, M_{32}, M_{34}, M_{37}, M_{44}, M_{116}, M_{164}, M_{183}, M_{162}, M_{202}, M_{221C}, M_{264C}, M_{292C}, M_{333}, M_{342}, M_{369}, M_{409C}, and M_{440C}. Remaining all other variants were found between these two groups. Significant reduction observed in number of tillers per clump in the γ-ray irradiated tuberose bulbs might be attributed to retarded growth and development of plants as a result of irradiation of mutagen. Kanakamanay (2008) [7] reported similar kind of observation in kacholam treated with γ-ray irradiation at 20 Gy. Cherry and Leasman (1967) [3] reported significant reduction in the vegetative growth that led to a delayed onset of mitosis and inhibition of DNA synthesis.

Table 1: Effect of γ-ray irradiation on sprouting and vegetative growth parameters of VM_2 generation of tuberose cv. 'Hyderabad Single'

Treatments	No. of days for sprouting	Plant height (cm)	Leaf width (cm)	Leaf length (cm)	Plant spread (cm^2)	Number of shoots per clump
M_{21}	41.00	40.50	1.55	39.50	47.00	6.50
M_{32}	32.00	32.75	1.75	31.75	35.75	7.50
M_{33}	41.00	35.75	1.70	35.00	30.25	8.50
M_{34}	44.00	34.50	1.80	33.50	34.00	6.50
M_{37}	39.00	32.25	1.70	32.25	43.75	7.00
M_{44}	48.00	43.50	1.75	34.00	35.50	4.00
M_{50}	31.00	36.10	1.65	28.00	35.60	9.00
M_{54}	54.00	40.45	1.60	30.00	46.25	11.00
M_{63}	36.00	38.10	1.80	37.10	44.00	8.50
M_{81}	42.50	37.70	1.85	37.00	39.00	8.00
M_{116}	56.00	35.45	1.55	34.30	47.60	5.00
M_{119}	31.00	33.50	1.45	32.50	31.70	10.50
M_{142C}	57.00	35.90	1.55	35.10	42.00	8.50
M_{146}	35.50	34.60	1.65	33.50	41.10	9.00
M_{162}	46.50	36.50	1.65	35.50	31.00	8.00
M_{164}	37.50	43.30	1.45	42.30	32.30	8.00
M_{178}	62.00	33.40	1.35	32.60	29.10	7.00
M_{183}	49.50	37.30	1.50	36.20	43.50	5.50
M_{189C}	50.50	42.75	1.85	42.00	41.50	8.00
M_{202}	49.00	44.25	1.85	43.25	37.50	6.00
M_{221C}	65.50	34.10	1.50	33.00	29.25	7.50
M_{226C}	37.00	30.25	1.30	29.50	31.50	9.50
M_{264C}	33.50	36.25	1.20	35.75	30.75	7.50
M_{292C}	59.00	33.90	1.65	33.00	35.25	6.50
M_{301C}	43.00	34.50	1.55	33.25	44.25	9.00
M_{333}	59.00	28.90	1.40	28.00	45.00	7.50
M_{339C}	44.00	28.40	1.35	27.40	32.75	8.00
M_{342}	37.50	39.80	1.55	38.70	37.35	7.50
M_{351}	36.00	35.00	1.15	34.00	32.10	8.50
M_{354C}	33.50	36.30	1.75	35.60	31.00	8.00
M_{369}	37.00	34.05	1.70	33.40	44.80	6.50
M_{389C}	69.50	36.45	1.70	30.75	44.00	9.00
M_{408C}	41.50	37.35	1.80	36.50	34.00	9.50
M_{409C}	40.00	41.00	1.20	40.00	31.50	6.00
M_{410}	44.00	45.60	1.70	44.00	33.10	10.50
M_{440C}	42.50	37.70	1.40	36.50	31.00	7.50
M_{456C}	33.00	42.20	1.90	41.20	35.75	8.50
M_{462}	34.00	34.80	1.65	34.00	36.80	8.00
M_{463}	51.50	36.55	1.15	35.65	32.00	10.00
M_{468C}	40.00	39.10	1.65	38.00	31.00	8.50
M_{473C}	31.00	34.30	1.50	33.20	35.75	8.50
M_{496C}	37.00	34.95	1.45	34.00	28.00	8.00
M_{498}	36.00	39.90	1.65	38.75	40.50	8.00
M_{465}	53.00	20.30	1.35	19.10	34.00	10.00
Untreated	15.50	51.75	2.05	50.50	45.25	20.50
CD @ 5%	23.410	1.462	0.432	6.950	5.406	3.863
SEm±	8.219	0.513	0.152	2.440	1.898	1.356

No variegation was observed in the leaves of all the variants of mutant population studied in the VM_2 generation in comparison to the untreated control plants of cv. ‘Hyderabad Single.

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