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ORIGINAL ARTICLE

Assessment of Mutagenic Population of Tuberose (*Polianthes Tuberosa* L.) Based on Vegetative, Biochemical and Disease Incidence Traits

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ABSTRACT

Mutation breeding appears to be well standardized, efficient and cost-effective breeding techniques that can be exploited for the creation of novel ornamental cultivars. Tuberose (Polianthes tuberosa Linn.) is one of the most important bulbous perennial flowering plant, occupies second position after gladiolus in area and production in India. The present investigation was carried at college of Horticulture, Anantharajupeta during 2018-19. Bulbs of Tuberose variety 'Hyderabad Single' were exposed to LD $_{50}$ dose of gamma rays (20 Gy) at BARC, Mumbai. Each treated bulb was taken as individual treatment (mutant) and observed for various vegetative (Sprouting per cent, Plant height, leaf length, leaf width, plant spread, number of shoots) , biochemical (SPAD chlorophyll content) and disease incidence (Alternaria leaf spot) characters along with untreated bulbs (control). Among 500 treated bulbs, 265 mutants were survived and these were evaluated and classified based on ranges of vegetative characters, biochemical (SPAD chlorophyll content) and disease incidence (Per cent disease index) characters. Among 265 mutants, M_2, M_7, M_{21}, M_{32}, M_{33}, M_{211} and M_{236} had taken minimum number of days for sprouting (10 DAS), M_{250}, M_{276}, M_{410} recorded a maximum height of 50.00 cm, M_7 recorded a maximum plant spread of 53.0 cm, maximum leaf length was recorded in M_{116} and M_{250} (49.70 cm), M_{12}, M_{34}, M_{38}, M_{63}, M_{95}, M_{106}, M_{107} and M_{276} had recorded maximum leaf width, more number of shoots per clump was recorded in M_2 and M_{248} (20.00), maximum SPAD values was recorded in M_{30}, M_{111}, M_{189}, M_{222}, M_{426},M_{459} (49.8), minimum PDI was recorded in M_{29}, M_{69}, M_{82}, M_{166}, M_{257}, M_{401}, M_{427}, M_{440}, M_{444} (0), respectively.

Keywords: Tuberose, Vegetative characters, SPAD chlorophyll content, PDI

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INTRODUCTION

Among the tropical ornamental bulbous flowering plants cultivated for production of long lasting flower spikes, Tuberose (*Polianthes tuberose* L.) occupies a prominent place. It is cultivated commercially for both cut as well as loose flowers and is one of the major bulbous crops. It has pleasant fragrance, long vase-life of spike and wide adaptability to varied climate and soil. The essential oil of Tuberose is one of the most high-priced perfumes [8]. In India, it occupies second position after gladiolus with the total area of 14.92 thousand hectare and production of 106.49 thousand MT loose flowers and 89.83 lakh cut flowers [1-2].

There is constant demand for novelty in existing crops in floriculture industry. So, development of new cultivars through conventional or modern breeding techniques has been a prime objective in commercial

floriculture. Since self-incompatibility exists in tuberose [9] there is limitation of convention breeding methods involving hybridization in it.

Induction of mutations has proven to be sustainable, highly-efficient, environmentally acceptable, flexible, unregulated, nonhazardous and a low-cost technology to enhance crop improvement for the creation of novel ornamental cultivars having aesthetic value and also commercial cultivars having high demand for their flowers and oils extracted from tuberose. Among various mutagens, the gamma irradiations at 1 K rads to 7.5 K rads proved best according to crop response in vegetatively propagated crops [5].

During mutation breeding, to avoid excessive loss of actual experimental materials, radio-sensitivity tests were conducted to determine LD_{50} doses before massive irradiation of similar material. After arriving LD_{50} value for gamma rays a huge plant material of tuberose is exposed to LD_{50} value and further studied for quality traits. Hence the present experiment was conducted to evaluate the mutant population of tuberose based on vegetative, biochemical and disease incidence traits and classified based on ranges.

MATERIAL AND METHODS

The present investigation on 'Assessment of mutagenic population of Tuberose (*Polianthes tuberosa* L.) based on ranges of vegetative, biochemical and disease incidence traits' was conducted at College of Horticulture, Anantharajupeta, Dr. Y.S.R. Horticultural University, Andhra Pradesh during year 2018-19. Bulbs of tuberose var 'Hyderabad Single' was procured from AICRIP on Flower crops, Rajendranagar, Hyderabad. These were irradiated at Babha Atomic Research Centre, Mumbai using physical mutagen, gamma rays at LD_{50} dose (20 Gy) with untreated as control. The treated bulbs were planted in polybags of size 14x14 inch containing potting media of 2:1:1 ratio of soil, FYM and cocopeat. The experiment containing 265 mutants were evaluated for various vegetative (Sprouting per cent, Plant height, leaf length, leaf width, plant spread, number of shoots) , biochemical (SPAD chlorophyll content) and disease incidence (Alternaria leaf spot) attributes and classified based on rages.

RESULTS AND DISCUSSION

The mutants developed from the bulbs of tuberose treated with LD_{50} value (20Gy) were evaluated for vegetative, biochemical and disease incidence traits and classified based on ranges of attributes.

Vegetative characters

The range for days taken to sprouting varied from 10-185 days after sowing. The mean value for control plants was 33.2. Among the plants whose bulbs were subjected to 20 Gy irradiation, M_2, M_7, M_{21}, M_{32}, M_{33}, M_{211} and M_{236} had taken minimum number of days for sprouting (10 DAS), whereas, M_{178} had taken maximum number of days for sprouting (185 DAS) as given in Appendix-A. Among the irradiated plants 122 mutants (46.03 %) were classified as early, 101 (38.11 %) mutants as medium and 42 (15.84 %) mutants as late (Table 1).

The mean plant height for untreated, control plants was 44.50 cm. Among the plants whose bulbs were subjected to 20 Gy irradiation, M_{250}, M_{276}, M_{410} recorded a maximum height of 50.00 cm while M_{308} recorded the minimum height of 12.00 cm as given in Appendix-A. The range for plant height varied from less than 40 to more than 50 cm. Among the irradiated plants 125 mutants (47.16 %) were classified as short, 140 mutants as medium tall (52.83 %) and no mutants under range of tall (Table 1).

Alterations in the morphological pattern of any type, through mutagens, are regarded as morphological mutations. Based on segregation pattern of morphological mutants, Reddy and Gupta [7] and Thakur and Sethi [10] observed that most of the true breeding mutants are controlled by single recessive genes, however, Konzak *et al.* [3] argued that the different morphological mutants that bred true in future generations like tall, dwarf, semi dwarf, bushy, prostate and bold seeded mutant types were found to be under the influence of polygenes. Qin *et al.* [6] reported that a dominant dwarf mutation is controlled by a single dominant gene in cow pea.

The general mean value recorded for plant spread in untreated plants was 53.90 cm. Among the mutagenic plants, M_7 recorded a maximum plant spread of 53.0 cm while M_{178} recorded the minimum plant spread of 13.5 cm as given in Appendix-A. The range for plant height varied from 13.5 to 53.0 cm. Among the irradiated plants 19 mutants (7.16 %) were classified as light, 89 mutants (33.58 %) were classified as medium and 157 mutants as heavy spread (59.24 %) (Table 1).

The data recorded for the control mean for leaf length was 44.10 cm. Among the mutagenic population maximum leaf length was recorded in M_{116} and M_{250} (49.70 cm) while the minimum leaf length was recorded in M_{308} (11.60 cm) and it is presented in Appendix-A. The leaf length recorded for irradiated plants ranged from less than 40 cm to more than 50 cm. Based on the range, 149 mutants (56.22 %) were grouped in short, 116 mutants (43.77 %) in medium tall and no mutants under tall group (Table 1).

The range for leaf width varied from less than 2.0 to more than 3.0 cm. The mean value for control plants was 2.10 cm. Among the plants whose bulbs were subjected to 20 Gy irradiation, M_{12}, M_{34}, M_{38}, M_{63}, M_{95}, M_{106}, M_{107} and M_{276} had recorded maximum leaf width (2.30 cm), whereas, M_{308} had recorded minimum leaf width (0.70 cm) as given in Appendix-A. Among the irradiated plants, 176 mutants (66.41 %) were classified as narrow, 89 mutants (33.58 %) as medium and no mutants as broad (Table 1).

Table 1 Classification of mutagenic population (265 plants) based on ranges of vegetative, Biochemical and Disease incidence

S.No	Parameter	Range	Number of putative mutants in each group	Percentage (%)	Control mean
I	**Plant growth parameter**				
1	**Days taken for sprouting**				
	Early	10-68	122	46.03	33.20
	Medium	68-116	101	38.11	
	Late	116-185	42	15.84	
2	**Plant height (cm)**				
	Short	<40	125	47.16	44.50
	Medium tall	40-50	140	52.83	
	Tall	>50	0.00	0.00	
3	**Plant spread (cm)**				
	Light	13.5-26.6	19	7.16	53.90
	Medium	26.6-39.8	89	33.58	
	Heavy	39.8-53	157	59.24	
4	**Leaf length (cm)**				
	Short	<40	149	56.22	44.10
	Medium	40-50	116	43.77	
	Long	>50	0.00	0.00	
5	**Leaf width (cm)**				
	Narrow	<2	176	66.41	2.10
	Medium	2-3	89	33.58	
	Broad	>3	0.00	0.00	
6	**Number of shoots per clump**				
	Few	1-7	127	47.92	15.70
	Medium	7-14	118	44.52	
	Many	14-20	20	7.54	
V	**Biochemical traits**				
1	**SPAD Chlorophyll content**				
	Low	31-37	8	3.01	48.06
	Medium	37- 43.5	98	36.98	
	High	43.5-49.8	159	60.00	
VI	**Disease Index**				
1	**Per cent Disease Index (PDI)**				
	Immune	<5	12	4.52	16.35
	Resistant	5-10	65	24.52	
	Moderately Resistant	11-20	161	60.75	
	Moderately Susceptable	21-40	26	9.81	
	Susceptable	41-60	1	0.37	

The size of leaves are tightly controlled by environmental and genetic factors that must spatially and temporally coordinate cell expansion and cell cycle activity. The increase and reduction in leaf width might be influenced by physical mutagen on cell activity of plant [4].

The data recorded for the control mean for number of shoots per clump was 15.70. Among the mutagenic population, more number of shoots per clump was recorded in M_2 and M_{248} (20.00) while the less number of shoots per clump was recorded in M_{29}, M_{49}, M_{82}, M_{370} and M_{438} (1.00) and it was presented is Appendix-

G. The number of shoots per clump recorded for irradiated plants ranged from 1.0-20.0. Based on the range, 127 mutants (47.92 %) were grouped under few, 118 mutants (44.52 %) under medium and 20 mutants (7.54 %) under many (Table 1).The variation in number of shoots per clump might be due to the modification of gene expression for the tillering trait depending on the growing condition or mutation induction [11].

Biochemical traits

The maximum SPAD values was recorded in M_{30}, M_{111}, M_{189}, M_{222}, M_{426},M_{459} (49.8) while minimum SPAD values was recorded in M_{244} (31.00) while the untreated control recorded 48.06 as given in Appendix- A. From the data recorded, the range for SPAD values in mutant population ranged from 31 to 49.8. Based on the range plotted, 8 mutants (3.01 %) were classified as low, while 98 mutants (36.98 %) were classified as medium whereas 159 mutants (60 %) were classified as high (Table 1). The variation in SPAD chlorophyll values might be due to occurrence of mutation in chlorophyll synthesis [2].

Disease Incidence

Per cent Disease Index for Alternaria Leaf Spot

The minimum PDI was recorded in M_{29}, M_{69}, M_{82}, M_{166}, M_{257}, M_{401}, M_{427}, M_{440}, M_{444} (0) and maximum PDI was recorded in M_{117} (41.17%) (Appendix- A). The control plants recorded an average of 16.35 %. A range of less than 5 to 60 was observed in the mutant population. Based on the ranges plotted for mutants, 12 mutants (4.52 %) were grouped under Immune, 65 mutants (24.52 %) were categorised as resistant, 161 mutants (60.75 %) were grouped as moderately resistant, 26 mutants (9.81 %) was classified as moderately susceptible and one mutant (0.37%) was classified under susceptible range (Table 1).

It can be concluded that, among 265 mutants survived after LD 50 treatment, M_2, M_7, M_{21}, M_{32}, M_{33}, M_{211} and M_{236} had taken minimum number of days for sprouting (10 DAS), M_{250}, M_{276}, M_{410} recorded a maximum height of 50.00 cm, M_7 recorded a maximum plant spread of 53.0 cm, maximum leaf length was recorded in M_{116} and M_{250} (49.70 cm), M_{12}, M_{34}, M_{38}, M_{63}, M_{95}, M_{106}, M_{107} and M_{276} had recorded maximum leaf width, more number of shoots per clump was recorded in M_2 and M_{248} (20.00), maximum SPAD values was recorded in M_{30}, M_{111}, M_{189}, M_{222}, M_{426},M_{459} (49.8), minimum PDI was recorded in M_{29}, M_{69}, M_{82}, M_{166}, M_{257}, M_{401}, M_{427}, M_{440}, M_{444} (0), respectively.

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APPENDIX A: Effect of LD_{50} on vegetative, biochemical and disease incidence traits in Tuberose (C-CONTOL, M-MUTANT)

	Days To Sprouting		Plant Height		Leaf Length		Leaf Width		Number Of Leaves		Plant Spread		Number of Shoots Per Clump		Spad Chlorophyll		PDI	
N	C	M	C	M	C	M	C	M	C	M	C	M	C	M	C	M	C	M
2	10	10	46.0	44.5	46	44	2.0	2.2	126	110	52.5	52.5	16	20	49.1	45.0	37.7	39.1
7	12	10	40.7	45.0	40	44	2.0	2.2	117	61	55.0	53.0	14	13	46.9	42.5	48.5	36.8
12	24	28	41.5	44.0	41	43.5	2.0	2.3	115	89	54.4	48.0	14	12	48.3	40.2	24.1	25.4
21	13	10	46.3	43.0	46	42.5	2.2	2.2	120	78	55.0	47.8	16	15	48.5	40.1	19.2	21.6
29	28	175	41.3	35.0	41	34.5	2.2	2.2	114	19	53.3	41.5	16	1	47.6	47.7	20.4	0.0
30	28	30	41.4	32.5	41	31.5	2.1	2.1	117	45	53.7	31.0	16	4	48.7	49.8	7.1	5.9
31	10	12	46.2	40.0	46	39.6	2.1	2.1	121	50	54.3	49.0	17	11	47.9	48.6	15.0	26.9
32	24	10	40.2	41.0	40	40.5	2.0	2.1	115	67	54.3	50.0	15	8	52.3	46.2	8.0	8.6
34	14	15	41.5	46.0	41	45.3	2.3	2.3	118	39	54.3	49.0	15	9	48.5	40.5	16.1	18.4
38	28	12	43.5	45.0	43	44.5	2.3	2.3	115	48	55.0	47.0	15	10	47.9	47.7	22.2	16.7
49	34	30	43.6	31.0	43	30.8	2.2	2.0	118	28	54.2	41.8	15	1	48.5	46.2	13.0	12.5
63	26	45	41.0	40.8	41	40.2	2.1	2.3	124	80	54.2	44.6	15	14	44.8	39.6	17.7	9.3
69	36	50	41.3	40.0	41	39.5	2.2	2.2	121	32	53.3	32.8	15	3	48.3	45.0	12.5	0.0
82	24	19	40.0	40.0	40	39.6	2.2	2.1	115	33	52.3	33.0	16	1	46.0	40.8	24.4	0.0
95	31	22	43.6	39.0	43	38.7	2.0	2.3	115	68	52.4	44.7	15	8	48.0	41.8	10.9	6.3
106	26	70	43.6	40.0	43	39.6	2.2	2.3	110	62	54.2	42.3	17	14	45.2	48.9	15.4	14.3
107	18	94	47.0	46.0	47	45.5	2.2	2.3	125	25	53.3	41.8	16	5	47.6	48.1	11.8	9.1
111	34	120	42.5	47.0	42	46.5	2.1	1.9	121	52	54.0	42.6	16	9	47.6	49.8	18.6	14.7
116	28	75	42.6	50.0	42	49.7	2.2	2.2	108	102	54.4	45.8	15	10	48.3	43.0	13.2	26.2

41.2	0.0	16.7	8.8	8.3	10.6	21.4	8.0	16.7	28.6	0.0	12.5	9.1	14.7	0.0	7.4	9.6	0.0	17.4	0.0	0.0	10.0
21.7	14.6	14.5	15.6	15.0	15.5	14.7	16.0	16.2	24.0	25.0	12.0	13.6	12.8	7.4	20.4	10.5	9.5	7.1	16.7	3.8	15.6
49.7	45.6	44.0	49.8	47.6	49.8	48.7	31.0	42.9	45.2	41.7	41.9	45.6	43.3	42.5	48.3	49.8	43.9	47.0	40.0	42.3	49.8
47.3	48.5	48.5	47.9	47.1	47.9	47.9	48.8	47.0	48.3	44.8	50.3	45.9	49.0	48.0	50.3	47.9	49.0	48.8	48.9	44.9	47.3
4	2	3	6	14	8	8	14	20	9	3	7	5	1	5	14	6	4	1	7	4	10
15	17	16	17	16	15	15	16	16	16	16	15	15	16	16	16	16	16	15	15	16	15
28.8	39.0	13.5	30.8	48.0	29.0	42.5	44.0	44.5	40.5	21.0	49.5	16.7	18.5	32.0	47.0	42.0	30.0	33.0	35.5	32.0	41.0
52.4	53.3	53.3	54.8	54.4	54.3	54.4	52.4	54.7	54.3	54.0	56.9	54.4	52.3	54.3	53.3	54.4	52.3	52.4	55.0	52.0	54.9
21	20	20	52	119	63	92	98	45	54	23	90	30	18	22	144	60	33	25	73	20	63
110	117	110	121	120	110	110	112	108	106	121	108	121	103	113	125	118	112	110	110	113	123
1.8	1.6	1.1	1.8	1.8	1.5	1.8	2.1	1.7	2.1	1.9	2.3	0.7	1.8	2.0	1.8	1.9	2.0	2.1	1.6	2.1	2.0
2.2	2.2	2.1	2.1	2.0	2.2	2.2	2.0	2.1	2.1	2.1	2.0	2.1	2.1	2.1	2.0	2.0	2.1	2.0	2.1	2.0	2.1
45.3	40.5	21	33.5	43.4	33.4	40.6	38	39	49.7	32.1	49.4	11.6	33.6	39.5	49.6	35.6	40.6	33.5	34.5	43.7	29.5
41	44	46	41	45	47	42	47	43	45	44	45	46	43	40	47	48	45	45	44	45	41
46.0	41.0	21.5	34.0	44.0	34.0	41.0	38.5	39.5	50.0	32.5	50.0	12.0	34.0	40.0	50.0	36.0	41.0	34.0	35.0	44.0	30.0
41.7	44.0	46.5	41.0	45.2	47.3	42.5	46.9	43.6	45.6	44.3	45.2	46.6	43.5	40.2	47.8	48.0	45.2	45.2	44.5	45.2	41.6
62	130	185	110	10	30	10	30	60	13	139	65	20	100	90	20	78	90	100	79	90	13
28	41	24	36	38	38	38	34	40	26	34	41	26	44	26	40	30	32	36	28	50	36
117	166	178	189	211	222	236	244	248	250	257	276	308	370	401	410	426	427	438	440	444	459