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Effect of physical mutagen on growth and quality characters of tuberose (*Polianthes tuberosa* L.)

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Abstract

An investigation was carried out at the Department of Horticulture college of Agriculture Parbhani during 2016-2018 on the studies on mutation breeding in tuberose (*Polianthes tuberosa* L.) was studied and isolation of promising mutants were done. The experimental material Phule Rajani of tuberose variety treated with five doses 0.5Kr, 1Kr, 1.5Kr, 2.0Kr, 2.5Kr along with untreated sample (control).in generation VM₁. Results indicated that the mutagenic treatment at lower doses had significant stimulative effect on some parameters that is, sprouting percentage., Leaf length, Chlorophyll content, rachis length, spike length, number of opened florets whereas most of parameters had showed decreased at desired level content. that is number of days for bulb sprouting, survival percentage, plant height, Leaf area, stem diameter, number of unopened florets, weight of flower. Higher doses of all mutagen were detrimental for growth parameters. and lower doses of mutagen were beneficial for quality parameters seven mutants obtained in VM₁ generation. In VM₁ generation Early mutant, Tall mutant, Flower bud colour mutant, Big flower mutant, Number of petal increased mutant, Number of spikes increased mutant. green tinge on flowers tip.

Keywords: Tuberose, gamma radiation, mutation, isolation, mutants, growth, quality

Introduction

Floriculture is the ever evolving business having great potential for employment generation and economic development. The global exports of floriculture has been growing at an annual average growth rate of 10.3per cent even at a time of global economic slowdown and at this growth rate world exports of floriculture are expected to reach US\$25 billion by 2012. Estimates of the annual consumption of commercially grown flowers worldwide range from US\$ 40-60 billion. About 80 percent of floriculture consumption is accounted for by six countries, including Germany, USA, UK, France, Netherlands and Switzerland. In India also, there is increasing trend of flower consumption in various social and religious functions. In fact, India is the second largest grower of flowers after China. India has about 309 million ha of area are under floriculture producing 1653 million tons of loose flowers and 593 million tones of cut flowers (Anonymous 2017) ^[1]

Mutation is a method by which novelty can be created in already well-established cultivar. There is no visual difference between artificially produced induced mutants and spontaneous mutants found in nature. As in traditional cross breeding, propagation, usually through *in vitro* techniques and leads to fixation of mutation event. For the past 40 years, the International Atomic Energy Agency has sponsored extensive research and development activities on mutation induction to enhance the genetic diversity in the germplasm of food and industrial crops and these efforts have resulted in the official release of over 2,700 new crop varieties in some 170 species. This mutant has created tremendous economic impact in Agriculture throughout the world. (Buiatti *et.al.* 1969) ^[7]. Thus, mutation induction has proven to be a workable, sustainable, highly-efficient, environmentally acceptable, flexible, unregulated, nonhazardous and a low-cost technology to enhance crop improvement.

Mutation is a single cell event and different mutagen has different mechanism of action. Several mutagens like radiations, ultraviolet light and a variety of chemicals have been utilized for this purpose. The induced mutagenesis in plants has been shown to create variations for large number of characters both by physical and chemical mutagens when seeds and vegetative parts are used (Gustafsson, 1972) ^[19].

Since self-incompatibility exists in tuberose (Sreethramu *et al.*, 2000) ^[37] so, there is limitation of conventional breeding methods involving hybridization in it. Mutation breeding

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appears to be well standardized, efficient and cost-effective breeding techniques that can be exploited for the creation of novel ornamental cultivars of commercial importance in tuberose. Although mutation breeding is a random (chance) process but reports are available that classical mutagenesis combined with management of chimera and *in vitro* mutagenesis can be used for inducing genetic variation in already adapted, modern genotypes resulting in developing new and novel varieties.

Material and Methods

A study was conducted at the department of Horticulture. Vasantrao Naik Marathwada Krishi Vidyapeeth Parbhani

during 2016-2018 on the studies on mutation breeding in tuberose variety Phule Rajni. The experimental site is geographically situated 19° North Altitude and 76.4° East Longitude bulb of tuberose were subjected to gamma radiation treatment.

Phule Rajni This cultivar is single type with high superior quality of loose and cut flower production. Bulb of cultivar were collected from Mahatma Phule Krishi Vidhyapeeth Rahuri. (Maharashtra) Bulb were treated gamma radiation from Bhabha Atomic Research Centre Trombay Mumbai

Results and Discussion

Table 1: Effect of physical mutagen on growth characters of tuberose in VM₁ generation

Treatment	Treatment detail	Sprouting percent	Survival percent	Plant height	Number of leaves per plant	Leaf length	Chlorophyll
T1	0.5Krad	92.86	96.6	60.33	28.8	36	48.66
T2	1Krad	88	88.5	58.33	24	33.4	47.3
T3	1.5Krad	86.66	87	54.66	25.4	31.4	27.35
T4	2 krad	76.8	76.5	32.2	25.2	15.75	41.53
T5	2.5Krad	67.6	64.66	21.2	9.2	22.4	46.6
T6	Control	95.8	97	56.66	23.6	34.2	43.76
	SE(m) \pm	1.22	0.94	3.06	2.61	1.99	1.63
	CD at 5%	3.63	2.8	9.09	7.76	5.92	4.85

Significantly maximum sprouting percentage (95.80%) was recorded with the treatment T₆ control than followed by treatment T₁ (92.86 %) and it was followed by the treatment T₂ (88.00 %), T₃ (86.66 %), significantly minimum sprouting percentage in treatment T₅ (67.60 %).it was followed by T₄ (76.80 %). Sprouting Percentage was highly influenced by mutagenic treatments. Percentage sprouting was lesser in treatments than the control further it was less in higher doses as compared to lower doses. The present findings are in confirmation with the result of Ramesh *et al.* (2012) ^[30] who worked as gamma irradiation on mulberry. Patil and Dhaduk (2009) ^[28] and Karki and Shrivastava (2010) ^[22] also reported similar results while working on gamma rays induced mutation on gladiolus. These workers concluded that, lower doses of mutagen could be used as safe and effective tools to induce variations presented in Table maximum survival percentage recorded as control treatment T₆ (97.00%) followed by T₁ (96.60%) and T₃ (87.00%) and minimum survival percentage recorded in treatment T₅ (64.66%) followed by treatment T₄ (76.50%). Thus from the result it is apparent that, the different doses of gamma ray significantly reduced the survival percentage in both the generation than the control treatment T₆. The plant survival percentage was maximum in VM₁ generation as compared to VM₂ generation. Datta *et al.* (1985) ^[13] reported that significant reduction in plant survival percentage due to gamma rays have also been reported by Banerji and Datta (1990) ^[3] are also of the same opinion. All the gamma rays significantly reduce plant height over control treatment T₆ (56.66cm) except treatment T₁ significantly maximum plant height (60.33cm) was recorded with the treatment T₁ than rest of the gamma rays and it was followed by the treatment T₂ (58.33cm), T₃ (54.66cm). Significantly minimum plant height was recorded with the treatment T₅ (21.20cm) followed by the treatment T₄ (32.20cm). From the observation recorded it can be seen that the gamma rays had reduced the height of plant as compared to the control in both the generation. Similarly as the dose of gamma rays increased. There was a decrease in the height of tuberose plants. The results obtained are in conformity with the finding Datta *et al.* (1985) ^[12]. Raghava *et al.* (1988) ^[29]

Banerji and Datta (1990, 1992, 2002^a and 2002^b) ^[2, 3, 4, 5], Shukla and Datta (1993^a) ^[32], Datta (1994). Dwivedi *et al.* (2000) ^[16], Bhattacharya (2003) ^[6], Gupta *et al.* (2003) ^[18], Lyakh and lagron (2005) ^[25] and Dilta *et al.* (2006) who had observed the significant reduction in the plant height

The data presented in Table 1 The dose of gamma rays increased number of leaves per plant decreased maximum number of leaves per plant in treatment T₁ (28.80) followed by T₃ (25.00), T₄ (25.00) while minimum number of leaves per plant recorded with the treatment T₅ (9.20) followed by T₆ (23.60) and T₂ (24.00). The length of leaf significantly reduced the leaf length over the control T₆ (34.20cm). All the treatments of gamma rays significantly reduced the number of leaves per plant over the control in both the generation. The decrease in number of leaves per plant due to increasing gamma rays. The results are in agreement with the finding of Datta *et al.* (1985) ^[13], Banerji and Datta (1990, 1992 and 2002b) ^[2, 3, 4], Datta (1992a) Shukla and Datta (1993a) ^[33] Sing *et al.* (2000), Gupta *et al.* (2003) ^[18], Sharma *et al* (2003) ^[14], Dilta *et al.* (2006) who reported the leaves of tuberose plant were decreased after radiation. The reduction was increased with an increase in the dose.

Among the various gamma rays significantly maximum length recorded with the treatment T₁ (36.00cm) it was followed by T₂ (33.40cm), T₃ (31.40cm). Minimum length was recorded with treatment T₄ (15.75cm). it was followed by T₅ (22.40cm) It is revealed that, the different doses of gamma rays had significantly reduced leaf length as compared to the control treatment in VM₁ and VM₂ generations. The findings of the present investigation are in dose conformity with the finding of Gupta and Jugran (1978) ^[17] who had observed the reductions in leaf size due to radiation treatments. Banerji and Datta (1992, 2002^a and 2002^b) ^[3, 4, 5] Dwivedi *et al.* (2000) ^[16], Sing *et al.* (2001) ^[35], Gupta *et al.* (2003) ^[18] and Dilta *et al.* (2006) Noticed the significant reduction in leaf length after gamma radiation as compared to the control

All the gamma rays treatments significantly reduced the chlorophyll content index over the control treatment T₆ (46.76cc). Among the various gamma rays treatments significantly maximum chlorophyll content index (48.66cc)

was recorded with treatment T₁ than rest of the treatment and it was followed by the treatment T₂ (47.30 cci), T₅ (46.60 cci), T₄ (41.53 cci). However significantly minimum chlorophyll content index was recorded with treatment T₃ (27.35 cci). Reduction in chlorophyll content of leaves with the gamma rays in VM₁ generation plants might be due to the reduction in rate of various physiological processes of the plant.

Shukla and Datta (1993^a) [32] observed the chlorophyll variegated leaves in chrysanthemum cv. Maghi after gamma radiation. Similarly, Datta and Gupta (1980), Nirmala and Elongbam (2007) [26] and Krupa Malkewicz (2009) [24] also observed the chlorophyll variegation due to the gamma radiation in chrysanthemum cv. Liliath. A Persual data presented in Table 1 minimum days for sprouting per plant (10.70 days) was observed in 0.5 kr gamma ray T₁, it was followed by T₂ (12.25 days), T₃ (15.80 days) and the control treatment had recorded T₆ (9.25 days) while maximum days to

bulb sprouting (23.60 days) was observed in 2.5 kr gamma ray it was followed by T₄ (17.80 days). The increase in number of day for bulb sprouting with on increase in the dose of gamma rays. Sprouting is the inherent capacity of the plant material to unfold the buds and produce new flush of shoots (Dandin and Kumar, 1989) [9]. There was a different response of mutagenic treatment over the control. There was delay in sprouting at higher doses of mutagens. The results are in conformity with the findings of Karki and Shrivastva (2010) [22]. Who found similar results in varieties of gladiolus treated with 0.5K_R and 1.5K_R gamma rays. Furthermore Dilta et.al (2003) [14]. In chrysanthemum and Patil and Dhaduk (2009) [28] on gladiolus have also reported similar results while working on gamma rays induced mutation in respective crops

2. Effect of physical mutagen on quality characters of tuberose in VM₁ generation

Table 2: Effect of physical mutagen on quality characters of tuberose in VM₁ generation

Treatment	Treatment Detail	Number of day for bulb Sprouting	Leaf area	Stem diameter	Number of Unopened Florets	Weight of Flowers
T1	0.5Krad	10.7	46.22	6.18	23.8	1.02
T2	1Krad	12.25	46.3	6.04	18.55	0.93
T3	1.5Krad	15.8	39.41	5.44	21	0.87
T4	2 krad	17.8	38.63	5.98	10.8	0.8
T5	2.5Krad	23.6	34	6.18	8	1.13
T6	Control	9.25	51.78	6.12	16.4	0.99
	SE(m) \pm	0.51	0.56	0.16	1.64	0.05
	CD at 5%	1.53	1.67	0.5	4.87	0.15

The data presented in Table 2 had shown the significant influence of the gamma radiation treatments on the leaf area (cm²). Among the various gamma rays significantly reduced the leaf area than the control T₆ (51.78cm²).

The maximum leaf area recorded in treatment T₂ (46.30cm²) it was followed by T₁ (46.22cm²). While minimum leaf area observed in treatment T₅ (34.00cm²) it was followed by T₄ (38.63cm²) and T₃ (39.41cm²). There was differential response for mutagenic treatments in general there was non linear increase in leaf area lower doses of gamma irradiation increase in leaf area and higher doses of gamma irradiation lower leaf area of plant as compared to control.

Leaf area decreased at 2Krad treatment of gamma dose. Similar results were also found by Sisodia et.al. (2015) in gladiolus maximum leaf area was recorded in control. The similar results on leaf area have been reported by Singh and Sisodiya (2015) in gladiolus.

The results of the present investigation are also supported by the findings of Gupta and Jugran (1978) [17] who have observed the reduction in leaf area due to the radiation with an increase in the exposure of gamma rays in chrysanthemum cv. Otome Sakura. Similarly, Banerji and Datta (1993, 2002a and 2002b) [2, 4, 5] Dwivedi et.al. (2000) [16], Gupta et.al. (2003) [14] Dilta et.al. (2006) [15] and Senapati and Rout (2008^a) noticed the significant reduction after radiation than the control.

The data furnished in Table 2 had shown the significant influenced of gamma radiation treatment on the stem diameter. The control treatment T₆ (6.12mm) recorded stem diameter. The maximum stem diameter was recorded with treatment T₁ (6.18mm), T₅ (6.18mm) followed by T₂ (6.04mm) T₄ (5.98mm) while minimum stem diameter was recorded at treatment T₃ (5.44mm). The diameter of cut spike was not significantly affected due to gamma radiation treatments. Diameter of the stem increased in 0.5K_R and 2.5K_R as compared to control (6.12mm) however decreased in treatment 1.5K_R and 2.0 K_R diameter of stem (5.4mm) and

(5.98mm). These findings Guo wei et.al. (2009) in tuberose where they reported that higher dose of gamma irradiation after morphological characters including diameter of stem.

The data presented in Table 2 depicted through has shown the significant influence of the gamma radiation. All the gamma rays treatments significantly reduced the unopened florets. Among the various gamma rays significantly maximum number of unopened florets (23.80) was recorded with the treatment T₁ than rest of the gamma rays treatments and it was followed by the treatments T₃ (21.00) and T₂ (18.55) the control treatment had recorded T₆ (16.40) while minimum number of unopened florets was recorded with treatment T₅ (8.0) it was followed by T₄ (10.80). There was a differential response for different mutagenic treatments. In general there was non linear decreases number of unopened florets.

Significantly reduction in the number of unopened florets per plants. The decrease in floret head production with higher dosage is mainly due to decrease in plant growth as reported by Dwivedi and Banerji (2008) in dablia cv "Pinki". Simulative in mutation in both micro and higher organism. Karki (2008) while studying effect of gamma rays on gladiolus concluded that gamma rays has significant effect on number of unopened floret per spike an 0.5 Krad of gamma rays resulted in maximum number of florets per spike and maximum number of unopened florets per spike.

The data furnished in Table 2 and depicted through had shown that significant influence of the gamma radiation treatments on the weight of flower. All the gamma rays treatment significantly reduced the weight of flower except treatment T₅. Control treatment had recorded T₆ (0.99g). Among the various gamma rays treatment significantly maximum weight of flower T₅ (1.13g) it was followed by T₁ (1.02g) and T₂ (0.93g) however significantly minimum weigh of flower was recorded with the treatment T₄ (0.80g) it was followed by T₃ (0.87g). In general it could be concluded that, the weight of flower was increased in all radiation in VM₁ and VM₂ generation as compared to the control.

Contradictory results have been reported by Anandhi *et.al.* (2013) reported that this inferior result might be due to the chromosomal aberrations and disturbances in the production and distribution of auxin which might have resulted in abnormal physiological, morphological and cytological processes caused by the gamma radiation. Datta and Gupta (1998) who had observed marked differences in weight of rose flower cv. Junior miss (Original cultivar) and its gamma rays induced mutant. Banerji and Datta (2002^a) had also recorded

comparatively less flower weight in the gamma rays induced mutant the original chrysanthemum cv. Lalima. However, Datta (1992^a) had reported an increase in the weight of flower head due to the gamma rays treatment than the original chrysanthemum. From VM₁ generation we got mutants which having characteristics Early mutants, Dwarf mutants, Tall plant mutant, Flower colour mutant, small flower mutant. number of petal increased in mutant, number of spikes increased in mutant, Late mutant.



Fig 1: Mutants in VM₁ generation

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