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Gamma Rays Induced Mutation Studies in Marigold Cv. Double Orange in M_1 Generation

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ABSTRACT

The present investigation was carried out in UAS, Dharwad. Seeds of marigold cv. Double Orange were irradiated with 0, 100, 200, 300, 400, 500 and 600 Grays of gamma rays to induce mutation. Seeds were sown just after irradiation and 30-days old seedlings were transplanted. Reduction in germination percentage, survival percentage, plant height and number of leaves with increase in dose of gamma rays, where as lethality was found increased with increasing doses of gamma rays. In flower characters like flower diameter and number of petals per flower was significantly increased at 600 Gy. While, number of flowers per plant and flower yield per plant was reduced with increase in dose of gamma rays. The maximum frequency of chlorophyll mutants (xantha, chlorina, viridis and albina) and morphological mutants were observed in higher doses (500 and 600 Gray) of gamma rays. Stimulating effect of gamma irradiation on flower characters was observed at 500 and 600 Gray.

Key words: *Gamma rays, Mutation, Gray, Irradiation, Lethality.*

INTRODUCTION

African marigold (*Tagetes erecta* L.) is one of the most commonly grown commercial flower crop in India, belongs to the family Asteraceae. Increased flower production, quality of flowers and perfection in the form of plants are important objectives to be reckoned in commercial flower production. In India marigold ranks first among the loose flowers followed by chrysanthemum, jasmine, tuberose, crossandra and barleria[1] Today, there is a huge demand for natural colours of marigold, calendula, hibiscus, gomphrena, petunia *etc*., in the international market. Marigold is one such potential flower crops for natural colour extraction.

Considering its importance, there is a need for its improvement, in plant breeding, several methods may be used to increase the genetic variability within a crop. One of the main method attempted to achieve the recombination breeding, where plant breeder tries to combine beneficial characters from different sources into one genotype.

Mutation breeding on the other hand, makes use of the possibility of altering genes by exposing seeds or other parts to chemical or physical mutagens.

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Due to its heterozygosity in genetic constitution, inducing physical mutagenesis makes it promising test material. Where only one or a few characters are to be improved upon without changing the entire genotype. Hence mutation breeding offers promising possibilities.

MATERIAL AND METHODS

A field experiment was conducted during *Kharif* season 2015-16 in the Department of Horticulture, University of Agricultural Sciences, Dharwad. Uniform and healthy seeds of marigold cv. Double Orange were irradiated with 0, 100, 200, 300, 400, 500 and 600 Grays of gamma rays (^{60}Co). The treated seeds were sown in nursery bed along with control. Seeds were sown thinly and 2 cm deep and covered with *Gliricidia* leaves. The nursery beds were kept moist during entire period. The seeds germinated in 4 to 5 days after sowing and seedlings became ready for transplanting after 4 weeks of sowing. Thirty days old healthy and uniform seedlings were transplanted at a distance of 60 cm between rows and 45 cm between plants. Observations on germination and survival percentage were recorded at 10^{th} and 30^{th} day after sowing, respectively. Observations on growth parameters (plant height and number of leaves per plant), flowering parameters (flower diameter and number of petals per flower) and yield parameters (number of flowers per plant and flower yield per plant) were recorded for all plants in M_1 generation.

RESULTS AND DISCUSSION

In the present study, the germination and survival percentage decreased with increase in the dose of gamma irradiation. Gamma irradiation was effective in reducing the germination, survival percentage and increased lethality percentage. The treatment with 500 and 600 Gy had less survival (60.86 % and 50.23 %, respectively) and greater lethality (39.13 % and 49.76 %, respectively). The above results attributed to the effect of mutagens on the somatic tissues of the seed and disturbances at cellular level, caused at physiological level or at physical level, including chromosomal damages or due to the combined effect of both. Similar results were also reported by Singh *et al.*[4] in marigold (Table 1).

Totally there were as many as 84 chlorophyll mutants were observed in the study (Table 2) resulting in a mutation frequency of 6.03 %. Majority of them were xantha type. Maximum number of chlorophyll mutants were observed in 500 Gy with a frequency of 15.88 %. While the lowest number of chlorophyll mutants were observed in 100 Gy with a frequency of 0.53 %. The maximum frequency of xantha and albina mutants were found in 500 Gy with a frequency of 5.71 % and 4.28 %, respectively. The higher frequency of chlorina mutant was reported in 400 Gy with a frequency of 3.07 %, whereas, viridis mutants were found maximum (5.82 %) in 600 Gy. It might be due to saturation effect for gamma rays which is attributed to rigors of diplontic and haplontic selection in biological material[6].

In contrast to chlorophyll mutants, occurrence of morphological mutants was lower but in wider spectrum (Table 3). There were 42 leaf modified mutants, 19 flower character modified mutants and 7 dwarf mutants, respectively. Totally 68 morphological mutants were recorded. Maximum frequency (23.29 %) of mutants were observed in 600 Gy. According to Sparrow and Gunckel, these morphological abnormalities or changes after irradiation might be due to secondary effect of nongenetic physiological disturbances.

Growth parameters like plant height and number of leaves per plant was significantly influenced by irradiation dose (Table 4). At higher doses there was drastic reduction in plant height and number of leaves per plant, whereas minimum plant height and number of leaves per plant was recorded in 600 Gy (65.10 cm and 221.49). Slow growth of chemical treated plants due to physiological disturbances, decrease in auxin supply and slow rate of cell division and respiration[7].

Flower characters like flower diameter and number of petals per flower was significantly influenced by irradiation doses (Table 4). Irradiation doses from 100 Gy to 500 Gy did not result significant change in flower diameter and number of petals per flower in comparison to control. Flower diameter and number of petals per flower was significantly increased at 600 Gy (9.55 cm and 246.30 cm). Similar observations were reported by Puneet *et al.*[2] in gladiolus.

With respect to number of flowers per plant and flower yield per plant (Table 4), irradiation doses showed significant differences. Control and plants treated with 100 to 400 Gy were on par with each other. At higher doses such as 500 and 600 Gy a sudden decrease in number of flowers per plant was found, compared to control. It might be due to the reduced vegetative growth as a result of gamma treatments. Similar finding were reported by Puneet *et al.*[2] in gladiolus, Singh *et al.*[4] in marigold and Rather *et al.*, 2011 in pot marigold.

Table 1: Effect of gamma radiation on germination, survivability of seedlings and lethality in M_1 generation in marigold cv. Double Orange

Treatment	Germination (%)	Survival (%)	Lethality (%)
T_1: Control	92.40	99.57	0
T_2: 100 Gray	82.00	92.68	7.31
T_3: 200 Gray	72.20	88.88	11.35
T_4: 300 Gray	68.00	82.35	17.64
T_5: 400 Gray	52.00	65.38	34.61
T_6: 500 Gray	46.00	60.86	39.13
T_7: 600 Gray	43.00	50.23	49.76

Table 2. Chlorophyll mutant spectrum induced by gamma rays in M_1 generation in marigold cv. Double Orange

Treatment	Xantha		Chlorina		Viridis		Albina		Number of mutant seedlings	Total mutation frequency (%)
	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent		
T_1: Control	0	0	0	0	0	0	0	0	0	0
T_2: 100 Gray	0	0	2	0.53	0	0	0	0	2	0.53
T_3: 200 Gray	3	0.93	1	0.32	3	0.94	0	0	7	2.19
T_4: 300 Gray	7	2.5	2	0.71	4	1.43	2	0.71	15	5.35
T_5: 400 Gray	5	2.94	8	3.07	5	2.94	3	1.76	21	10.71
T_6: 500 Gray	8	5.71	4	2.86	5	3.57	6	4.28	23	15.88
T_7: 600 Gray	4	3.88	3	2.91	6	5.82	3	2.91	16	15.52
Total	27		20		23		14		84	6.03

Table 3: Morphological mutant spectrum induced by gamma rays in M_1 generation in marigold cv. Double Orange

Treatment	Leaf modification		Flower character		Dwarf plants		Number of mutant seedlings	Total mutation frequency (%)
	Number	Per cent	Number	Per cent	Number	Per cent		
T_1: Control	0	0	0	0	0	0	0	0
T_2: 100 Gray	0	0	0	0	0	0	0	0
T_3: 200 Gray	3	0.94	0	0	0	0	3	0.94
T_4: 300 Gray	7	2.5	0	0	0	0	7	2.5
T_5: 400 Gray	11	6.47	4	2.35	0	0	15	8.82
T_6: 500 Gray	9	6.43	8	5.71	2	1.42	19	13.56
T_7: 600 Gray	12	11.65	7	6.79	5	4.85	24	23.29
Total	42		19		7		68	6.71

Table 4: Effect of gamma irradiation on the growth, flower quality and yield attributes of marigold cv. Double Orange

Treatment	Plant height (cm)	Number of leaves per plant	Flower diameter (cm)	Number of petals per flower	Number of flowers per plant	Flower yield (g/plant)
T_1: Control	96.56	295.22	7.77	202.04	71.30	499.10
T_2: 100 Gray	91.21	285.54	7.80	201.10	69.45	486.18
T_3: 200 Gray	90.61	259.82	7.71	200.44	66.76	467.33
T_4: 300 Gray	85.59	257.14	8.30	215.80	65.52	458.61
T_5: 400 Gray	84.88	281.94	8.33	211.48	68.45	479.14
T_6: 500 Gray	77.79	251.33	8.46	218.70	59.27	414.86
T_7: 600 Gray	65.10	221.49	9.55	246.30	53.95	377.62
Mean	84.53	264.64	8.27	213.69	64.96	454.69
S. Em. ±	1.81	13.29	0.39	10.09	2.18	15.26
C. D. at 5 %	5.13	37.67	1.10	28.61	6.18	43.27

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