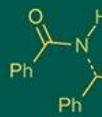


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Effect of gamma rays and EMS on plant height and plant spread in annual chrysanthemum

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Abstract

An experiment entitled "Mutation studies in annual chrysanthemum" was carried out during rabi season of the year 2021-2023 at the farm of Horticulture Section, College of Agriculture, Nagpur. The experiment of M₁ generation was laid out in randomized block design with three replications and eight treatments. However, the experiment of M₂ generation was laid out in progeny rows with eight treatments consists of Control, 100 Gy, 200 Gy, 300 Gy, 400 Gy and 0.1% EMS, 0.2% EMS, 0.3% EMS.

The different treated seeds of annual chrysanthemum with gamma rays and EMS had significantly influenced the vegetative characters and also created the variability. Significantly reduced the plant height and number of branches of annual chrysanthemum in M₁ and M₂ generations.

Keywords: Chrysanthemum, gamma rays, ems mutagenesis, mutation breeding, vegetative variability, randomized block design

Introduction

Annual chrysanthemum (*Chrysanthemum coronarium* L.) is one among important commercially cultivated flower crops grown in India. It is a winter season annual, native to Mediterranean region distributed throughout Europe, Northern Africa and Asia and propagated by seeds producing daisy like, golden yellow to white flowers. It is different from florist chrysanthemum in many aspects. The crop is relatively short durated and less photosensitive thus capable of coming up throughout the year. It is hardier, vigorous and grows taller. Its flowers are in various shades of yellow white, having single or double forms. Mutation breeding is one of the established methods by which one can induce variability in vegetatively propagated crops and it also offers advantage over conventional breeding for the improvement of one or more traits within a short span of time. Mutation derived varieties have had a significant impact on the array and choiced of genetic resources available in modern agriculture. Spontaneous mutation or bud sports have played an important role in the evolution of many garden chrysanthemums. In addition to spontaneous mutation, another type of mutation that have a high potential for bringing about the further genetic improvement, is induced mutation through physical and chemical mutagens. The introduction of induced mutation has also attracted considerable attention in chrysanthemums due to the fact that any mutation in dominant genes is easily expressed in the first generation and thus the selection of mutations of directly perceptible characters like flower colour, shape, size *etc.* is generally very easy and directly be put in commercial use.

EMS is a chemical mutagen of the alkylating group and has been widely used in plants because it causes high frequency of gene mutations and low frequency of chromosome aberrations. This mutagen has been used to treat seeds and recently to treat *in vitro* explants of many species. In India the crop has been naturalized and locally called 'Bijli' in Nagpur (Meshram *et al.* 2008) ^[11], 'Baboona' in Haryana (Mishra *et al.* 2002) ^[12] 'Guldhak' in Punjab, 'Market' in Delhi and 'Gendi' in Uttar Pradesh. The major flower growing states in India are Tamil Nadu, Andhra Pradesh, Karnataka (Banglore, Dharwad, Belgaum, Hosur), Maharashtra (Ahmadnagar and Pune), West Bengal, Uttar Pradesh, Haryana, Gujarat and Delhi.

The important flowers having more demand are Flowers are sold in market loose as well as cut flowers. Among the flowers used for domestic market, annual chrysanthemum is considered as one of the important commercial loose flower. There is a great scope of increasing area under this crop. Increasing flower yield with quality flowers, extending the duration of flower production are the prime importance in the cultivation of annual chrysanthemum. This can be achieved by proper dose of nutrients.

Materials and Methods

The investigation entitled, "Mutation studies in annual chrysanthemum" was carried out at the field of college garden, Horticulture Section, College of Agriculture, Nagpur during rabi season of the year 2021-22 and 2022-23. The best quality seeds of annual chrysanthemum variety "PDKV Bijli Super" were obtained from, Horticulture Section, College of Agriculture, Nagpur (M.S). The 100 seeds were sown on nursery beds. The seeds of annual chrysanthemum variety PDKV Bijli Super was irradiated with four doses of gamma rays (100 Gy, 200 Gy, 300 Gy and 400 Gy) at chemistry lab of Rashtra Sant Tukdoji Maharaj Nagpur university. The seeds of annual chrysanthemum variety PDKV Bijli Super were selected for treatment. The seeds were treated with different Ethyl methane sulphonate (EMS) concentrations immersed in Ethyl methane sulphonate (EMS) solution for 2 hours. In control, the seeds were immersed in distilled water for 2 hours. After the treatments, the seeds were dipped in STS (sodium thiosulphate) solution (0.3%) for 15 minutes to remove the stresses of the solution on seed.

Uniform and healthy seedlings were selected for transplanting. The gamma rays treated seedlings transplanted on 7th November, 2021. The chemical treated seedlings and untreated seedlings (control) were planted. These seedlings were planted at 45 X 30 cm distance on the experimental field in Randomized Block Design (RBD) of three replications with eight treatments. All the standard cultural practices were followed, except pinching and disbudding operations.

The plants that had showed variation were isolated from the population of the M₁ generation and of these variants were

transplanted as per induced mutagenic treatments and non-treated control separately on 15 November 2022 as progeny rows to raise the M₂ population. Collect seeds from each variant separately, ensuring proper storage conditions to maintain seed viability. Document the seed collection process, including the quantity and quality of seeds obtained from each variant. Establish a systematic timeline for data collection and observations. Regularly record data points such as plant height, leaf morphology, flowering time, and any other relevant traits to track the development of the M₂ population.

Results and Discussion

1. Plant height (cm)

M₁ generation

The data furnished in Table 1. and graphically illustrated in Fig. 1. had shown the significant influence of the gamma radiation and EMS treatments on the plant height.

During M₁ generation at 30 days after transplanting, plant height was decreased due to gamma rays and EMS treated seeds of annual chrysanthemum over control T₁ (26.98cm). Among the induced mutagen maximum plant height (25.47cm) was recorded in the treatment at (0.1%) EMS treatment T₆ which was at par with the treatment T₇ (24.98cm) and treatment T₂ (24.84cm) respectively and minimum (14.17cm) in gamma rays T₅ (400 Gy).

At 60 days after transplanting, plant height was decreased due to gamma rays and EMS treated seeds of annual chrysanthemum over control T₁ (59.27cm). Among the induced mutagen maximum plant height (58.16cm) was recorded in the treatment at (0.1%) EMS treatment T₆ which was at par with the treatment T₇ (57.68cm) and treatment T₂ (57.55cm) respectively and minimum (34.21cm) in gamma rays T₅ (400 Gy).

At 90 days after transplanting, plant height was decreased due to gamma rays and EMS treated population of chrysanthemum over control T₁ (98.84cm). Among the induced mutagen maximum plant height (96.40cm) was recorded in the treatment at (0.1%) EMS treatment T₆ which was at par with the treatment T₇ (94.03cm) and treatment T₂ (93.79cm) respectively and minimum (71.02cm) in gamma rays T₅ (400 Gy).

Table 1: Effect of induced mutagens on plant height of annual chrysanthemum in M₁ generation

Treatment Details	Plant height in M ₁ generation (cm)		
	30 DAT	60 DAT	90 DAT
T ₁ -Control	26.98	59.27	98.84
T ₂ -Gamma rays 100 Gy	24.84	57.55	93.79
T ₃ -Gamma rays 200 Gy	21.88	54.23	89.23
T ₄ -Gamma rays 300 Gy	18.12	43.54	84.21
T ₅ -Gamma rays 400 Gy	14.17	34.21	71.02
T ₆ -EMS @ 0.1%	25.47	58.16	96.40
T ₇ -EMS @ 0.2%	24.98	57.68	94.03
T ₈ -EMS @ 0.3%	21.52	53.76	88.14
'F' test	Sig.	Sig.	Sig.
S.E (m)±	0.48	0.51	1.71
CD at 5%	1.47	1.55	5.17

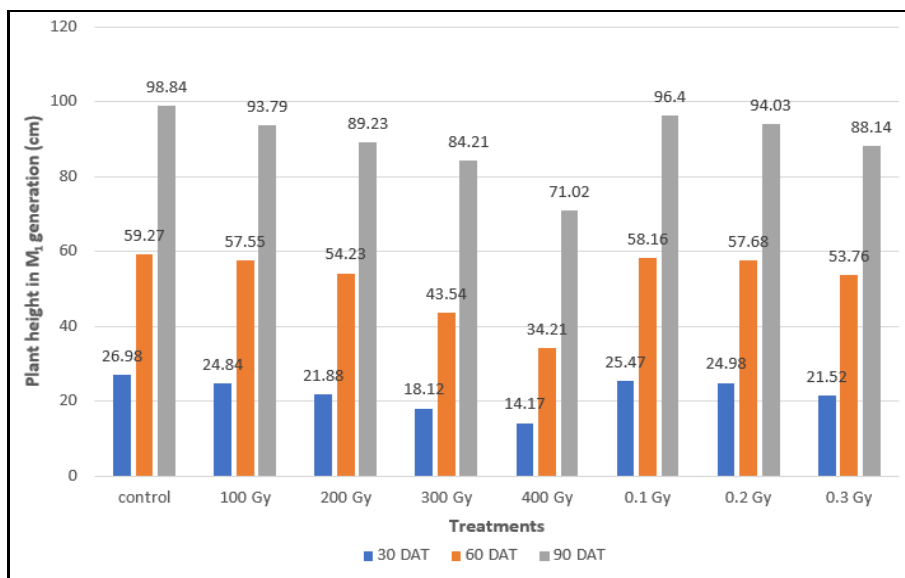


Fig 1: Effect of induced mutagens on plant height of annual chrysanthemum in M₁ generation

M₂ generation

The result presented in Table 2 and graphically represented in Fig. 2 had shown significant differences among the progenies of different gamma rays and EMS treatments in respect of plant height on annual chrysanthemum.

As compared to the control treatment T₁, the mean height of plant was found to be significantly decreased due to the radiation treatment and it was ranged between (68.03cm) to (94.01cm) recorded.

Table 2: Effect of induced mutagens on plant height of annual chrysanthemum in M₂ generation

Treatment Details	Range		Plant height in M ₂ generation (cm)				
	Min	Max	Mean	Variance	SD	SE	CV (%)
T ₁ -Control	91.02	108.21	95.87	35.60	5.96	1.99	6.21
T ₂ -Gamma rays 100 Gy	80.03	97.21	89.82	78.08	8.84	5.10	9.84
T ₃ -Gamma rays 200 Gy	76.10	94.02	84.42	98.55	9.92	5.15	11.75
T ₄ -Gamma rays 300 Gy	61.05	85.01	75.67	99.17	10.09	6.06	13.33
T ₅ -Gamma rays 400 Gy	53.00	74.07	68.03	115.24	10.73	7.49	15.05
T ₆ -EMS @ 0.1%	90.32	96.20	94.01	38.19	6.17	1.85	6.54
T ₇ -EMS @ 0.2%	86.00	94.22	90.18	71.25	8.44	2.37	9.35
T ₈ -EMS @ 0.3%	78.00	96.03	83.11	97.55	9.88	5.31	11.88
t-test	Sig.						

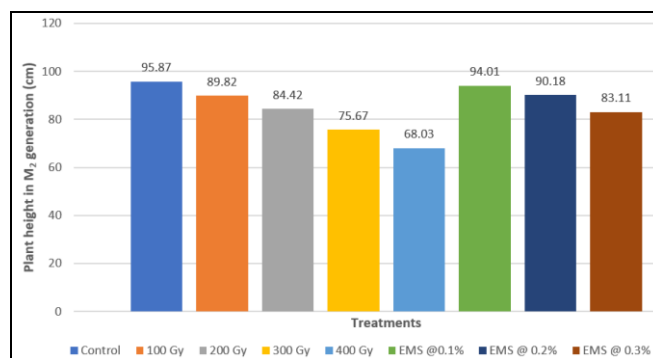


Fig 2: Effect of induced mutagens on plant height of annual chrysanthemum in M₂ generation

The control treatment T₁ had recorded (95.87cm) plant height. Among the induced mutagen maximum plant height (94.01cm) was recorded in the treatment at (EMS @ 0.1%) treatment T₆ at 50% flowering, which was at par with the treatment T₇ (90.18cm) and treatment T₂ (89.82cm) respectively and minimum plant height was (68.03cm) recorded in gamma rays T₅ (400 Gy).

The variance was increased in all the radiation treatments as compared to the control treatment and the maximum variance (115.24) was noticed in the treatment (400 Gy) T₅

and the minimum variance (35.60) was seen in T₁ i.e. control. While in EMS treatment the maximum variance (97.55) was seen in (EMS @ 0.3%) T₈ and minimum (38.19) in (EMS @ 0.1%) T₆. Whereas, the coefficient of variation was increased in all the radiation treatments than the control treatment. The maximum coefficient of variation (15.05%) was registered in the treatment T₅ (400 Gy) and in the EMS treatment maximum coefficient of variation (11.88%) was noticed in (EMS @ 0.3%) T₈ and minimum (6.54%) in (EMS @ 0.1%) T₆. Similarly, the standard

deviation was increased in all the radiation treatments as compared to the control treatment.

Significant results were observed with maximum plant height in M_1 generation followed by M_2 generation, irrespective of different doses of gamma rays and EMS. Thus, from the result it is apparent that, in general the gamma rays and EMS treatments had reduced the height of plant as compared to the non-treated plants in both the generations. As the dose of gamma rays and EMS increased, there was a decrease in the height of chrysanthemum plants. Similarly, the plant height was maximum in M_1 generation as compared to M_2 generation. The decrease in plant height after exposure of the seeds to the EMS and gamma rays has been due to disturbances of chromosomal aberrations and auxin synthesis. The results obtained are in conformity with the findings of Kapadiya *et al.* (2014) ^[9] and Vaidya *et al.* (2016) ^[10] in chrysanthemum. Inactivation of auxin and decrease in auxin content with an increase in the radiation dose might be responsible for the reduction of plant height. Moreover, the reduction of plant height was also depends on the nature and extent of chromosomal damage (Banerji and Datta, 2002) ^[2].

2. Plant spread (cm)

M_1 generation

The data furnished in Table 3 and graphically illustrated in

Fig. 3 had shown the significant influence of the gamma radiation and EMS treatments on plant spread which was clearly indicated that plant spread was decreased due to gamma rays and EMS treated population of annual chrysanthemum over control T_1 (68.41 cm) during M_1 generation. Among the induced mutagen maximum plant spread (61.65 cm) was recorded at (0.1% EMS) T_6 . Which was at par with the treatment T_7 (56.33 cm) and treatment T_2 (54.22 cm) respectively and minimum plant spread (34.85 cm) in gamma rays (400 Gy) T_5 .

Table 3: Effect of induced mutagens on plant spread of annual chrysanthemum in M_1 generation

Treatment Details	Plant spread in M_1 generation (cm)
T_1 -Control	68.41
T_2 -Gamma rays 100 Gy	54.22
T_3 -Gamma rays 200 Gy	49.97
T_4 -Gamma rays 300 Gy	41.93
T_5 -Gamma rays 400 Gy	34.85
T_6 -EMS @ 0.1%	61.65
T_7 -EMS @ 0.2%	56.33
T_8 -EMS @ 0.3%	49.04
'F' test	Sig.
S.E (m)±	3.05
CD at 5%	9.18

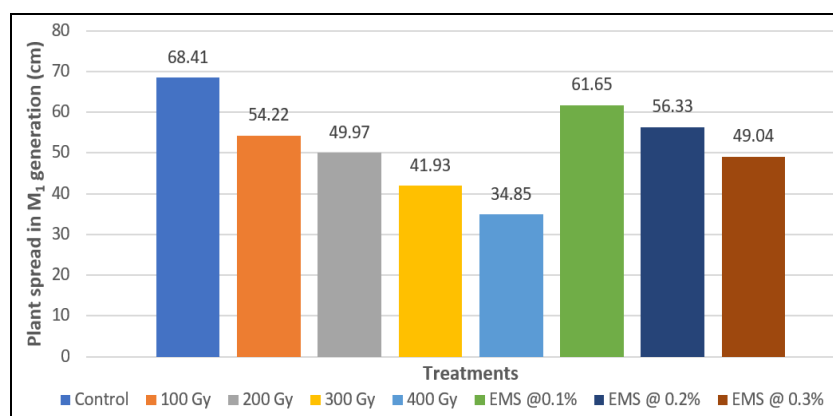


Fig 3: Effect of induced mutagens on plant spread of annual chrysanthemum in M_1 generation

M_2 generation

The result presented in Table 4 and graphically represented in Fig. 4 had shown significant differences among the

progenies of different gamma rays and EMS treatments in respect of plant spread of annual chrysanthemum.

Table 4: Effect of induced mutagens on plant spread of annual chrysanthemum in M_2 generation

Treatment Details	Range		Plant spread in M_2 generation (cm)				
	Min	Max	Mean	Variance	SD	SE	CV (%)
T_1 -Control	60.90	97.51	66.80	13.89	3.72	2.15	5.57
T_2 -Gamma rays 100 Gy	48.21	71.90	54.41	79.95	8.94	5.16	16.43
T_3 -Gamma rays 200 Gy	39.87	69.90	47.32	80.02	8.96	4.64	18.93
T_4 -Gamma rays 300 Gy	23.89	64.21	32.96	96.05	9.84	5.69	29.88
T_5 -Gamma rays 400 Gy	34.00	52.00	22.33	98.09	9.90	5.24	34.78
T_6 -EMS @ 0.1%	58.20	85.10	60.89	14.07	3.75	2.17	6.16
T_7 -EMS @ 0.2%	52.80	73.04	54.96	53.45	7.31	4.22	13.30
T_8 -EMS @ 0.3%	38.28	63.89	46.68	78.75	8.87	5.12	19.01
t-test	Sig.						

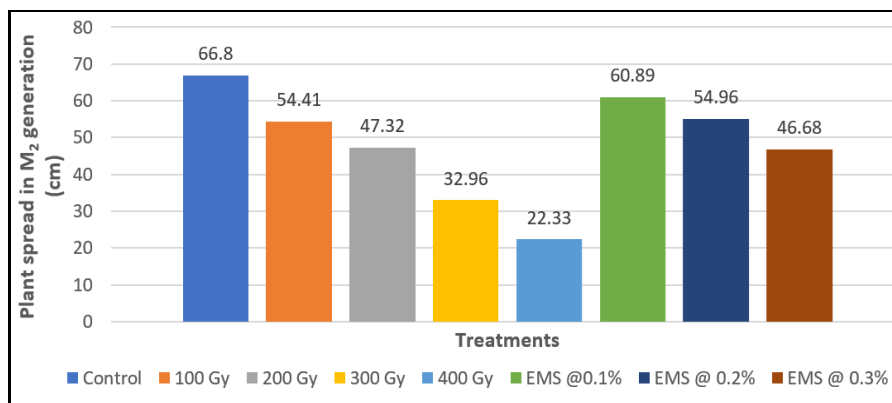


Fig 4: Effect of induced mutagens on plant spread of annual chrysanthemum in M₂ generation

As compared to the control treatment (T₁), the mean plant spread was found to be significantly decreased due to the gamma radiation and EMS treatment and it was ranged between (22.33 cm) to (60.89 cm)

The control treatment (T₁) had recorded (66.80 cm) plant spread. Among the induced mutagen maximum plant spread (60.89 cm) was recorded in the treatment at (0.1% EMS) treatment (T₆) which was at par with the treatment T₇ (54.96 cm) and treatment T₂ (54.41 cm) respectively and minimum plant spread was (22.33 cm) in gamma rays (400 Gy) (T₅).

The variance was increased in all the radiation treatments as compared to the control treatment and the maximum variance (98.09) was noticed in the treatment 400 Gy (T₅) and the minimum variance (13.89) was seen in (T₁) i.e. control. While in EMS treatment the maximum variance (78.75) was seen in (0.3% EMS) T₈ and minimum (14.07) in (0.1% EMS) T₆. Whereas, the coefficient of variation was increased in all the radiation treatments than the control treatment.

The maximum coefficient of variation (34.78%) was registered in the treatment 400 Gy (T₅) and in the EMS treatment maximum coefficient of variation (19.01%) was noticed in (0.3% EMS) T₈ and minimum (6.16) in (EMS @ 0.1%) T₆. Similarly, the standard deviation was increased in all the radiation treatments as compared to the control treatment.

From the presented data, it is evident that, the treatments of gamma rays (100 Gy, 200 Gy, 300 Gy and 400 Gy) and EMS (0.1%, 0.2% and 0.3%) had significantly reduced the plant spread over the control. Due to increase in the dose of gamma rays and EMS, there was a corresponding reduction in plant spread. The reduced in plant spread may be ascribed due to the less number of branches with the gamma irradiated plants and EMS treated plants. However, Gunckel and Sparrow (1961) [7] explained that, the reduction in plant spread could be due to physiological, morphological and cytological disturbances caused by radiation and EMS. Similar results in chrysanthemum are documented by Gupta *et al.* (2003) [8], Sharma *et al.* (2003) [8] and Dilta *et al.* (2006) [5] who reported the significant reduction in the spread of the gamma rays treated plants and the reduction of plant spread was increased with an increase in the dose of gamma rays.

References

1. Banerji BK, Datta SK. Gamma ray induced flower shape mutation in chrysanthemum cv. 'Jaya'. J Nucl Agric Biol. 1992;21(2):73-79.
2. Banerji BK, Datta SK. Induction and analysis of gamma ray induced flower head shape mutation in 'Lalima' chrysanthemum (*Chrysanthemum morifolium*). Indian J Agric Sci. 2002;72(1):6-10.
3. Datta SK. Gamma ray induced mutant of chrysanthemum. J Nucl Agric Biol. 1985;14:131-133.
4. Datta SK, Gupta MN. 'Hemanti'-A new chrysanthemum cultivar evolved by gamma irradiation. Prog Hortic. 1982;14(1):33-37.
5. Dilta BS, Sharma YD, Dhiman SR, Verma VK. Induction of somatic mutation in chrysanthemum by gamma irradiation. Int J Agric Sci. 2006;2(1):77-81.
6. Fu R, Andersen RL, Cheng Z, Liu ZR. Studies on induced mutation of fruit trees *in vitro*. Acta Hortic. 1995;403(2):56-61.
7. Gunckel JE, Sparrow AH. Ionization radiations: Biochemical, physiological and morphological aspects and their effects on plants. In: Encyclopedia of Plant Physiology. Vol. 16. Berlin: Springer; 1961. p. 555-611.
8. Gupta YC, Dilta BS, Bhalla R, Sharma BP. Effect of gamma rays on vegetative and flowering parameters of chrysanthemum. J Ornam Hortic. 2003;6(4):328-334.
9. Kapadiya DB, Chawla SL, Patel AI, Ahlawat TR. Exploitation of variability through mutagenesis in chrysanthemum (*Chrysanthemum morifolium* Ramat) var. Maghi. Bioscan. 2014;9(4):1799-1804.
10. Vaidya PP, Dalal SR, Mahadik MK. Vegetative mutagenesis studies in chrysanthemum. Adv Life Sci. 2016;5(12):4831-4835.
11. Meshram N, Badge S, Panchbhair DM. Studies on annual chrysanthemum (*Chrysanthemum coronarium* L.) under Nagpur conditions. 2008.
12. Mishra RL, Singh B, Raghava SPS. Commercial floriculture in Haryana: Status and prospects. 2002.