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Growth and flowering of chrysanthemum varieties influenced by induced mutagenesis in M_1 generation

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Abstract
The present experiment was conducted at Department of Horticulture, Vasantrao Naik Marathwada Krishi Vidyapeeth Parbhani.(Maharashtra) during the year 2019-2020 in Factorial Randomized Block Design (FRBD) of three replications. The present work was undertaken to observe the response of chrysanthemum varieties V_1-Pink Cloud,V_2- Devi and V_3-Bidhan Agnisikha over EMS T_1 -0.05%, T_2 - 0.1%, T_3 -0.5%, T_4 -1.0%, T_5- Gamma rays 0.5 kR, T_6 -1.0 kR, T_7 -1.5 kR, T_8 -2.0 kR, T_9 - Control treatments. The different treatments to rooted cuttings of chrysanthemum varieties with EMS and gamma rays had significantly influenced the vegetative and flowering characters and also created the variability. Significant reduction occurred in both EMS and gamma rays treated seedlings of chrysanthemum varieties in terms of plant height, branches per plant and leaf area. The higher dose of EMS and gamma rays delayed the flower bud initiation, flower formation and 50% flowering.

Keywords: Chrysanthemum, induced mutation, chemical and physical mutagen, EMS, gamma rays, M_1 generation

Introduction
Chrysanthemum (*Chrysanthemum indicum* L.) is among the most widely cultivated herbaceous perennial plants which is commonly known as "Autumn Queen" or "Queen of East" and belongs to the family Asteraceae. Flower of Chrysanthemum used for garland making wreath as a religious offering in hall decoration, used as pot plants for beautifying indoors and outdoors, as cut flowers for making bouquets and vase decoration. Chrysanthemum is an allogamous flower that possesses a high degree of heterozygosiy due to self - incompatibility. It also results in a complex inheritance of genetic factors, coupled with frequent polyploidy, which poses a severe handicap in conventional breeding and is taken advantage of mutation breeding. It can be easily propagated through vegetative means hence, the most suitable for mutagenesis.
Mutation breeding is a field, where the practical gains would grow with the increase in our understanding about the basic information on the standardization of doses, frequency and spectrum of mutations, mutagenic effectiveness and efficiency of physical mutagen (gamma radiation) and chemical mutagen (EMS.). It applies especially to the crops like Chrysanthemum, where there is enormous scope for developing novel cultivars to cater for the demand of florist's trade. Mutagenesis has been mainly used as a valuable supplement to other methods of breeding in vegetatively propagated crops for developing the better varieties.

Material and Methods
Chrysanthemum cultivars Pink Cloud, Devi and Bidhan Agnisikha of seedlings raised by using shoot tip cuttings of 6 to 8 cm has been collected from the Department of Horticulture, Dr. PDKV, Akola. Cuttings were first treated with 0.2% bavistin for 5 min. and then planted in a pot filled with coco peat and sand. An experimental land was ploughed one to two times followed by harrowing were given to bring the soil to the fine tilth. The soil then loosened, and ridge and furrow were prepared at 45 cm apart. The field should be irrigated one day before transplanting. Uniform and healthy rooted cuttings were selected for treatment. The rooted cuttings were treated with different Ethyl methane sulphonate (EMS) concentrations immersed in Ethyl methane sulphonate (EMS) solution for 2 hours. In control, the rooted cuttings were immersed in distilled water for 2 hours. After the treatments, these cuttings were dipped in STS (sodium thiosulphate) solution (0.3%) for 15 minutes to remove the stresses of the solution on plant parts.

Then, these cuttings were washed in running tap water for few minutes. Remaining rooted cuttings were irradiated with four doses of gamma rays (0.5, 1.0, 1.5 and 2.0 kR) in Gamma Cell-200 (Cobalt – 60) at Bhabha Atomic Research Centre (BARC), Trombay, Mumbai. These cuttings were planted at 45 X 30 cm distance on the experimental field in Factorial Randomized Block Design (FRBD) of three replications with nine blocks in a row of three different varieties. All the standard cultural practices were followed, except the pinching and disbudding operations.

Result and Discussion

A) Growth parameters

Significant reduction occurs in induced mutagens treated seedlings of chrysanthemum varieties in terms of plant height, number of branches per plant and leaf area over control. Among the induced mutagen, the maximum plant height (49.40 cm) was recorded in 0.5 kR gamma rays (T_5) which was at par with T_6 (47.11 cm), T_1 (46.77 cm) and minimum (28.96 cm) in gamma rays 2.0 kR (T_8). However, among the varieties maximum plant height (45.76 cm) was recorded in variety Devi (V_2) and minimum (36.80 cm) in Bidhan Agnisikha (V_3). Also for number of branches per plant, among the induced mutagen maximum branches per plant (7.53) was recorded at 0.5 kR gamma rays (T_5) which was at par with T_1 EMS 0.05% (7.20) and minimum (3.59) branches per plant were observed in gamma rays 2.0 kR (T_8). Among the varieties maximum branches per plant was recorded in variety Bidhan Agnisikha V_3 (6.26) which was at par with variety V_1 (5.94) and minimum in Devi V_2 (5.54). The interaction effect among varieties (V) treated with induced mutagens (T) on number of branches per plant of chrysanthemum varieties maximum number of branches (8.60) was recorded in treatment combination V_3T_5 of variety Bidhan Agnisikha at 0.5 kR gamma rays which was at par with V_3T_1 (8.20) and minimum (2.80) in (V_3T_8) variety Bidhan Agnisikha at 0.5 kR gamma rays. In case of leaf area, among the induced mutagen maximum leaf area (31.36 cm^2) was recorded at EMS 0.05% (T_1) and minimum (18.63 cm^2) leaf area was observed in gamma rays 2.0 kR (T_8). Among the varieties maximum leaf area was recorded in variety Devi V_2 (28.72 cm^2) and minimum in Bidhan Agnisikha V_3 (21.21 cm^2).

Thus, from the result it is apparent that, in general the gamma rays and EMS treatments had reduced the height of plant, number of branches and leaf area as compared to the non-treated plants. The decrease in plant height after exposure of the rooted cuttings 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) [6] and Vaidya *et al.* (2016) [11] in chrysanthemum. However, less number of branches might be due to inhibitory effect of the higher mutagenic dose on the plant growth. Gupta *et al.* (2003) [5], Sharma *et al.* (2003) [10] and Dilta *et al.* (2006) [2] had also reported the similar results in chrysanthemum. Whereas reduction in leaf area may be due to inactivation or decrease in auxin content or disturbances in auxin synthesis. The results obtained in the present study are in conformity with the findings of Vaidya *et al.* (2016) [11], Kapadiya *et al.* (2014) [6] stated that, reduction in leaf area in chrysanthemum when treated with gamma rays and EMS.

B) Flowering parameters

Significant delay in flowering occurred in induced mutagens treated seedlings of chrysanthemum varieties in terms of days to first flower bud initiation, days required to fully opened flower from bud emergence, days required to 50% flowering over control. Among the induced mutagen minimum days to first flower bud initiation (95.08 days) was recorded at 0.05% EMS (T_1) which was at par with T_2 (96.13 days), T_3 (99.87 days), T_5 (101.94 days), T_4 (103.47 days) and maximum days to first flower bud initiation (109.11 days) was in 2.0 kR gamma rays (T_8). Among the varieties minimum (88.12 days) days to first flower bud initiation was recorded in variety Pink Cloud V_1 and maximum (110.38 days) in Bidhan Agnisikha (V_3). In case of, days required to fully opened flower from bud emergence, among the induced mutagen minimum days required to fully opened flower from bud emergence (23.65 days) was recorded at 0.05% EMS (T_1) which was at par with T_2 (24.22 days), T_3 (25.59 days) and maximum days required to fully opened flower from bud emergence (29.11 days) was in 2.0 kR gamma rays (T_8). Among the varieties minimum (22.08 days) days required to fully opened flower from bud emergence was recorded in variety Devi (V_2) and maximum (30.54 days) in Bidhan Agnisikha (V_3). Whereas, for days required to 50% flowering, among the induced mutagen minimum days required to 50% flowering (115.10 days) was recorded at 0.05% EMS (T_1) which was at par with T_2 (116.88 days), T_3 (119.67 days), T_5 (122.14 days), T_6 (123.46 days) and maximum days required to 50% flowering (129.8 days) was in 2.0 kR gamma rays (T_8). Among the varieties minimum (109.59 days) days required to 50% flowering was recorded in variety Pink Cloud V_1 and maximum (131.36 days) in Bidhan Agnisikha (V_3).

The delay in bud initiation might be due to the reduction in the rate of various physiological processes of the plant after the gamma radiation. All the treatments of gamma rays and EMS prove to be injurious by promoting physiological disturbances and retarded cell division by arresting the mitotic division and ill effects which had delayed the days to fully opened flower from bud emergence in chrysanthemum plants. In chrysanthemum Padmadevi and Janaharlal (2011) [7], Kapadiya *et al.* (2014) [6] and Vaidya *et al.* (2016) [11] reported maximum delayed in days to flowering when treated with gamma rays and EMS and minimum in control.

Table 1: Effect of induced mutagens on growth and flowering of chrysanthemum varieties in M_1 generation

Treatments	Plant height (cm)	Branches per plant	Leaf area (cm^2)	Days required to first flower bud initiation	Days required to fully opened flower from bud emergence	Days required to 50% flowering
Factor A – Varieties (V)						
V_1 (Pink Cloud)	43.09	5.94	23.86	88.12	25.44	109.59
V_2 (Devi)	45.76	5.54	28.72	104.53	22.08	123.58
V_3 (Bidhan Agnisikha)	38.34	6.26	21.21	110.38	30.54	131.36
SE (m)	0.81	0.11	0.51	1.99	0.53	2.09
CD at 5%	2.27	0.33	1.44	5.66	1.52	5.94

Factor B – Induced mutagens (T)						
T_1 (EMS) 0.05%	46.77	7.2	31.36	95.08	23.65	115.1
T_2 (EMS) 0.1%	44.04	6.47	26.26	96.13	24.22	116.88
T_3 (EMS) 0.5%	42.29	5.93	22.7	99.87	25.59	119.67
T_4 (EMS) 1.0%	37.91	4.73	21.07	103.47	26.86	123.46
T_5 Gamma 0.5 kR	49.4	7.53	27.55	101.94	26.42	122.14
T_6 Gamma 1.0 kR	47.11	5.2	24.33	105.39	27.29	126.81
T_7 Gamma 1.5 kR	32.59	4.07	19.85	107.15	27.98	128.18
T_8 Gamma 2.0 kR	28.96	3.59	18.63	109.11	29.11	129.81
T_9 Control	52.49	8.53	33.31	90.95	23.06	111.37
SE (m)	1.38	0.20	0.88	3.46	0.92	3.62
CD at 5%	3.93	0.58	2.51	9.82	2.63	10.31

Table 2: The interaction effect of induced mutagens on growth and flowering of chrysanthemum varieties in M_1 generation

Treatment combination	Plant height (cm)	Branches per plant	Leaf area (cm^2)	Days required to first flower bud initiation	Days required to fully opened flower from bud emergence	Days required to 50% flowering
V_1T_1	47.64	6.8	29.43	80.52	23.18	102.64
V_1T_2	42.69	6.2	25.14	84.72	23.69	103.44
V_1T_3	41.26	5.8	22.98	87.44	24.98	107.66
V_1T_4	38.46	5.2	21.79	91.35	25.22	111.28
V_1T_5	49.31	7.2	25.38	88.41	25.88	109.42
V_1T_6	47.12	5.4	24.16	93.46	26.69	116.47
V_1T_7	36.34	4.6	19.58	94.56	27.56	117.79
V_1T_8	32.52	4.2	18.34	97.19	28.91	119.1
V_1T_9	52.49	8.1	31.66	75.46	22.84	98.48
V_2T_1	50.15	6.6	38.67	99.38	19.14	118.96
V_2T_2	49.13	5.8	30.66	100.47	19.84	120.83
V_2T_3	46.82	5.4	24.56	102.76	21.66	122.93
V_2T_4	39.84	5.2	22.97	106.3	23.93	126.78
V_2T_5	54.79	6.8	33.84	105.35	22.64	121.8
V_2T_6	51.44	4.8	27.72	108.46	23.46	127.4
V_2T_7	33.78	4.2	22.18	110.7	24.25	129.38
V_2T_8	29.56	3.8	21.33	111.79	25.46	130.02
V_2T_9	56.31	7.3	41.43	95.6	18.47	114.09
V_3T_1	42.53	8.2	25.97	105.33	28.64	123.7
V_3T_2	40.3	7.4	22.98	103.2	29.14	126.35
V_3T_3	38.79	6.6	20.55	109.4	30.12	128.43
V_3T_4	35.44	3.8	18.46	112.76	31.42	132.33
V_3T_5	44.1	8.6	23.44	112.06	30.75	135.22
V_3T_6	42.78	5.4	21.12	114.25	31.72	136.58
V_3T_7	27.66	3.4	17.79	116.2	32.14	137.67
V_3T_8	24.82	2.8	16.24	118.42	32.96	140.43
V_3T_9	48.67	10.2	26.82	101.79	27.88	121.54
SE (m)	2.39	0.35	1.53	5.99	1.61	6.28
CD at 5%	N/S	1.01	N/S	N/S	N/S	N/S

Conclusion

The different treatments to rooted cuttings of chrysanthemum varieties with EMS and gamma rays had significantly influenced the vegetative growth and flowering characters and also created the variability.

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