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Yield and quality of chrysanthemum varieties as influenced by chemical mutagens in VM_1 generation

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Abstract
An experiment entitled "Yield and quality of chrysanthemum varieties as influenced by chemical mutagens in VM_1 generation" was carried out at Department of Horticulture, Vasantrao Naik Marathwada Krishi Vidyapeeth Parbhani. (Maharashtra) during *kharif* season of the year 2017-2018. The experiment was laid out in Factorial Randomised Block Design with thirty treatment combinations. The treatments comprised of two factors i.e. factor A and factor B. Factor A consist of 3 varieties (V_1-Raja Pandharpuri, V_2- Brown and V_3-Shinaton) and factor B consist of 10 levels of chemical mutagen (colchicine T_1 -0.01%, T_2 -0.02%, T_3 -0.03%, T_4 - Ethylmethanesulphonate (EMS) 0.01%, T_5 -0.05%, T_6 -0.1%, T_7 -0.5%, T_8 -1.0%, T_9 -1.5%, T_{10} – Control) in Chrysanthemum. The different treatments to rooted cuttings of chrysanthemum varieties with colchcine and EMS had significantly influenced the yield and quality characters and also create the variability. Significant reduction occurs in both colchicine and EMS treated seedlings of chrysanthemum varieties in terms of number of flowers plant^{-1}, yield of flowers plant^{-1}, number of ray florets flower^{-1}, peduncle length, peduncle diameter, vase life of cut flowers, Whereas weight of single flower and diameter of flower was increased due to the colchicines and decreased due to EMS treated population of chrysanthemum varieties over control.

Keywords: Chrysanthemum, varieties, chemical mutagen, yield, quality

Introduction
Chrysanthemums are one of the prettiest varieties of perennials that start blooming early in the fall. This is also known as favorite flower for the month of November. Chrysanthemum is one of the most beautiful and perhaps the oldest flowering plant, commercially grown in different parts of the world. It is commonly known as the "Queen of the East" and "Autumn Queen" and is the symbol of royalty in Japan. Now a days the test of people for flower in terms of colour, different shape, size, novelty of flower structure have change and improved, so in accordance to full the wish and demand of people the newly improved variety is required continuously. Mutation breeding plays an important role in plant breeding and helps in the creation of genetic variation to create novelty.

However, various workers emphasizes that artificial induction of mutation by colchicine (Col), ethyl methane sulphonate (EMS) and sodium azide (SA) provides tool to overcome the limitations of variability in plants that induces specific improvement without disturbing their better attributes. Colchicine is a chromosome doubling agent that possesses antimicrotubular action. EMS is a common alkylating agent, whereas sodium azide is responsible for creating point mutation in DNA level. However, these chemicals have also proved their worth as mutagens to induce genetic variability. Thus, they become important tool to enhance agronomic traits of crop plants (Mostafa, 2011) [12]. The mutagenic effectiveness was maximum in EMS. The highest mutagenic efficiency was recorded in Col. The effectiveness of the three chemicals on *Dianthus* is ranked as EMS>Col>SA (Roychowdhury and Tah 2011) [14]. Colchicine (0.0625 per cent) has been successfully used for development of flower colour mutation in Chrysanthemum Cv. Sharad Bahar. The original colour of Sharad Bahar was purple whereas mutant colour was Terracotta Red. The mutant has been released in the name of 'ColchiBahar' (Datta, 1987) [1]. The use of colchicine as a means of chromosome doubling has opened a large reservoir of possibilities in plant breeding work. The fact that numerical changes in chromosome number fundamentally entail a mutation which may be expressed in a number of characters of the plant indicates the significance of the above statement (Derman, 1990) [2]. Therefore keeping in view these facts, the present investigation was undertaken with following objectives.

Material and Method

Chrysanthemum raised by using shoot tip cuttings of 6 to 8 cm have been collected. Shoot tip cuttings of Chrysanthemum *cv.* Raja Pandharpuri were collected from the Department of Horticulture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani (Dist. Parbhani), Maharashtra State and other two verities *cv.* Brown and Shinaton were collected from College of Agriculture, Nagpur. Dr. PDKV, Akola Cuttings were first treated with 0.2 % Bavistin for 5 min. and then planted in pot filled with coco peat and sand. All inter cultural operations like weeding, watering, application of Humic acid and plant protection measures were carried out as when required.

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 after was loosen and ridge and furrow were prepared at 45 cm apart, recommended dose of farm yard manure and chemical fertilizers for chrysanthemum is 15 tones ha^{-1} FYM and 300:200:200 NPK kg ha^{-1}. The one third dose of nitrogen and full dose of phosphorous and potassium will be applied at the time of transplanting. The remaining dose of nitrogen (N) will be applied one month after transplanting.

Uniform and healthy rooted cuttings were selected for transplanting. The rooted cuttings were treated with different concentrations of colchicine and Ethyl methane sulphonate (EMS) by immersed in colchicine and Ethyl methane sulphonate (EMS) solution for 4 and 2 hours respectively. In control the rooted cuttings were immersed in distilled water for 2 hours. After the treatments, these cuttings were immersed in STS (sodium thio-suiphate) solution (0.3%) for 15 minutes to remove stresses of solution on plant parts. Then, these cuttings were washed in running tap water for few minutes. The field should be irrigated one day prior to transplanting. The treated cuttings were transplanted on main field. These cuttings were planted at 45 X 30 cm distance on experimental field in Factorial Randomized Block Design (FRBD) with three replications. All the standard cultural practices were followed, except the pinching and disbudding operations

Results and discussion

Yield parameters

Significant reduction occurs in both colchicine and EMS treated seedlings of chrysanthemum varieties in terms of number of flowers $plant^{-1}$, yield of flowers $plant^{-1}$ over control. Number of flowers $plant^{-1}$ was decreased due to the colchicines and EMS treated population of chrysanthemum varieties over control T_{10} (122.49). Among the chemical mutagen maximum number of flowers $plant^{-1}$ (117.13) was recorded at 0.01% EMS (T_4) which was at par with T_1 (113.60), T_5 (113.00), T_6 (108.90), T_2 (108.40) and minimum (97.57) in EMS 1.5% (T_9). Whereas, among varieties maximum number of flowers $plant^{-1}$ (154.81) was recorded in variety Brown (V_2) and minimum (53.47) in Raja Pandharpuri V_1. And yield of flowers $plant^{-1}$ was decreased due to the colchicines and EMS treated population of chrysanthemum varieties over control T_{10} (175.76 g). Among the chemical mutagen maximum yield of flowers $plant^{-1}$ (169.29 g) was recorded at 0.01 % colchicine (T_1) which was at par with T_4 (166.86 g), T_2 (160.42 g) and minimum (104.96 g) in EMS 1.5% (T_9). Whereas, among varieties maximum (188.61 g) yield of flowers $plant^{-1}$ was recorded in variety Brown (V_2) and minimum (68.39 g) in Raja Pandharpuri V_1. The interaction effect of chrysanthemum varieties (V) and chemical mutagens (T) yield of flowers $plant^{-1}$ was found to be non significant. Whereas yield of flowers $plant^{-1}$ was maximum (231.74g) in treatment combination (V_2T_{10}) of Brown in control treatment which was at par with (V_2T_1) (228.25g), (V_2T_2) (214.50g), (V_2T_4) (213.45g), (V_3T_4) (208.47g) and minimum (53.21g) in (V_1T_9) i.e. variety Raja Pandharpuri at 1.5 % EMS.

There was a decreased in branches of lateral bud, while the other control plants are splitted with more number of lateral branches. So that the number of bud was reduced ultimately number of flower plant $^{-1}$ and yield of flowers $plant^{-1}$. (Lertsutthichawan *et al.* 2017) [10] The results obtained are in conformity with the findings of El-Nashar and Ammar (2016) [3] when treated with colchicine. While treated with EMS Kapadiya *et al.* (2014) [7] reported decreasing trend in number of flower $plant^{-1}$ and yield of flowers $plant^{-1}$ with increasing levels of mutagenic treatments in *Dendranthema grandiflora* Tzvelev.

Quality parameters

Significant reduction occurs in both colchicine and EMS treated chrysanthemum varieties in terms of number of ray florets $flower^{-1}$, peduncle length, peduncle diameter, vase life of cut flowers, Whereas weight of single flower and diameter of flower was increased due to the colchicines and decreased due to EMS treated population of chrysanthemum varieties Among the chemical mutagen maximum weight of single flower (1.62 g) and diameter of flower (5.60 cm) was recorded at 0.03 % colchicine (T_3) and minimum (1.18 g) (3.48 cm) in EMS 1.5% (T_9) respectively. Whereas, among varieties maximum weight of single flower (1.64 g) and diameter of flower (5.45 cm) was recorded in variety Shinaton (V_3) and minimum (1.31 g) (3.79 cm) in Brown (V_2) over control T_{10} (1.51 g) (4.91cm) respectively.

Flowers harvested from colchicine treated chrysanthemum plants had significantly attained the bigger size than the flower of non-treated (control) plants which obviously improved weight of flower. Larger stomata and larger leaves in derived mutant plantlets which improved flower growth and their physiological process the increased in dimension and size was probably due to the fact that cells with a larger complement of chromosomes grow larger to maintain a constant ratio of cytoplasmic to nuclear volume. This increase in size may translate to an increase in plant and its organs He *et al.* (2016) [5] observed greater flower diameter in *Dendranthema indicum.* Kazi (2013) [8]. On other hand the flowers harvested from EMS treated plants chrysanthemum plants had attained the smaller size than the flower non-treated (control) plants. Kapadiya *et al.* (2014) [7], Vaidya *et al.* (2016) [15] reported, decreasing trend in diameter of flower head with increasing levels of mutagenic treatments in chrysanthemum. Decrease in the flower diameter with the EMS treated plants could be attributed due to the poor growth of flower heads due to some physiological, morphological and cytological disturbances caused by the mutagenic treatment.

The number of ray florets $flower^{-1}$ was decreased due to the colchicines and EMS treated population of chrysanthemum varieties over control T_{10} (294.13). Among the chemical mutagen maximum number of ray florets $flower^{-1}$ (281.26) was recorded at 0.01% EMS (T_4) which was at par with T_1 (274.43), T_5 (272.17), T_2 (266.32), T_6 (264.11) and minimum (230.27) in EMS 1.5% (T_9). Whereas, among varieties maximum (286.71) number of ray florets $flower^{-1}$ was recorded in variety Brown (V_2) and minimum (242.54) in Raja Pandharpuri V_1. The interaction effect of chrysanthemum varieties (V) and chemical mutagens (T) on number of ray florets flower^{-1} was found to be non significant. The number of ray florets flower^{-1} has been reduced when increase in dosed of colchicine treatments. This was might be due to phenotypic characters and cytological characters sometimes work vice versa. The reduction in number of ray florets flower^{-1} with higher dose of EMS. This might be due to inactivation or decreased in auxin content or disturbances in auxin synthesis. The results obtained are in conformity with the findings of Kapadiya *et al.* (2014) [7], Vaidya *et al.* observed decreasing trend in number of disc florets per head.

Among the chemical mutagen maximum peduncle length (16.67 cm) and peduncle diameter (0.45 cm) was recorded at 0.01% EMS (T_4) and minimum (7.58 cm) (0.25 cm) in EMS 1.5% (T_9) respectively over control T_{10} (17.83 cm) (0.51 cm). Whereas, among the varieties maximum peduncle length (14.65 cm) was recorded in variety Raja Pandharpuri (V_1) and minimum (11.63 cm) in Brown (V_2). in peduncle diameter it was maximum (0.41 cm) in variety Shinaton (V_3) and minimum (0.29 cm) in Raja Pandharpuri V_1. On interaction effect among varieties (V) treated with chemical mutagens (T) on peduncle length of chrysanthemum varieties maximum peduncle length (18.12 cm) was recorded in treatment combination V_1T_4 of variety Raja Pandharpuri at 0.01% EMS which was at par with V_1T_1 (17.42 cm), V_3T_4 (16.08 cm), V_1T_6 (15.89 cm), V_2T_4 (15.81 cm) and minimum (5.12 cm) in (V_2T_9) variety Brown at EMS 1.5% 5.12 cm VM_1 generation. On peduncle diameter it was maximum (0.55 cm) in treatment combination V_1T_4 of variety Raja Pandharpuri at 0.01% EMS which was at par with V_3T_5 (0.48 cm) and minimum (0.22 cm) in (V_2T_9) variety Brown at EMS 1.5% 5.12 cm VM_1 generation.

There is reduction in peduncle length and diameter when treated chemical mutagen. The slow growth occurred by the colchicine and EMS treatments, which reduced the plant height, spread and number of branches so as the decreased in peduncle length and diameter. Kapadiya *et al.* (2014) [7] decreasing trend was observed in peduncle length in chrysanthemum when treated with colchicine. Kushwah *et al.* (2018) [9], Rafiq *et al.* (2017) [13], also had similar opinion. Decreasing trend in peduncle length and diameter were observed by Hridhya and Remesh (2016) [6] when treated with EMS.

Among the chemical mutagen maximum vase life (8.45days) was recorded at 0.01 % colchicine (T_1) which was at par with T_4 (8.24 days), T_5 (8.03 days), T_6 (7.81 days) and minimum (6.85 days) in EMS 1.5% (T_9). Whereas, among varieties maximum vase life (8.58 days) was recorded in variety Raja Pandharpuri (V_1) and minimum (6.90 days) in Shinaton (V_3) over control T_{10} (8.72 days). The interaction effect of chrysanthemum varieties (V) and chemical mutagens (T) on vase life was found to be non significant. Increase in concentration of colchicine and EMS prove to be injurious by promoting physiological disturbances and retarded cell division by arresting the mitotic division and ill effects on a thereby reduction of vase life. These result are opposite to result of Gantait *et al.* (2011) [4], Manzoor *et al.* (2018) [11] it might be because of difference in methodology of experiment and crop.

Table 1: Effect of chemical mutagens on yield and quality parameter of chrysanthemum varieties in VM_1 generation

Treatments	Number of flowers plant^{-1}	Yield of flowers plant^{-1} (g)	Weight of single flower (g)	Diameter of flower (cm)	Number of ray florets flower^{-1}	Peduncle length (cm)	Peduncle diameter (cm)	Vase life of cut flowers (days)
Factor A – Varieties (V)								
V_1 - Raja Pandharpuri	53.47	68.39	1.36	4.30	242.54	14.65	0.29	8.58
V_2 - Brown	154.81	188.61	1.31	3.79	286.71	11.63	0.37	7.42
V_3 - Shinaton	117.17	183.19	1.64	5.45	259.53	13.17	0.41	6.90
SE (m) ±	2.36	2.99	0.03	0.16	5.15	0.28	0.01	0.15
CD at 5%	6.69	8.50	0.08	0.46	14.61	0.80	0.04	0.42
Factor B – Chemicals (T)								
T_1 - Colchcine 0.01 %	113.60	169.29	1.57	5.07	274.43	15.78	0.38	8.45
T_2 - Colchcine 0.02 %	108.40	160.42	1.57	5.38	266.32	12.65	0.33	7.57
T_3 - Colchcine 0.03 %	99.38	152.10	1.62	5.6	246.51	11.25	0.27	6.75
T_4 - EMS 0.01 %	117.13	166.86	1.5	4.77	281.26	16.67	0.45	8.24
T_5 - EMS 0.05 %	113.00	153.64	1.45	4.55	272.17	14.85	0.41	8.03
T_6 - EMS 0.1 %	108.90	141.00	1.38	4.1	264.11	13.96	0.36	7.81
T_7 - EMS 0.5 %	104.13	127.33	1.31	3.75	253.78	11.1	0.32	7.25
T_8 - EMS 1.0 %	100.25	115.93	1.26	3.56	246.28	9.86	0.27	6.92
T_9 - EMS 1.5 %	97.57	104.96	1.18	3.48	230.27	7.58	0.25	6.58
T_{10} - Control	122.49	175.76	1.51	4.91	294.13	17.83	0.51	8.72
SE (m) ±	4.30	5.47	0.05	0.16	9.40	0.51	0.01	0.27
CD at 5%	12.21	15.51	0.15	0.46	26.67	1.45	0.04	0.77
Interaction effect (VXT)								
SE (m) ±	7.45	9.47	0.09	0.28	16.27	0.89	0.02	0.47
CD at 5%	N/S	26.86	N/S	N/S	N/S	2.52	0.07	N/S

Table 2: The interaction Effect of chemical mutagens on yield and quality parameter of chrysanthemum varieties in VM_1 generation.

S. No.	Treatment combinations	Number of flowers plant^{-1}	Yield of flowers plant^{-1} (g)	Weight of single flower (g)	Diameter of flower (cm)	Number of ray florets flower^{-1}	Peduncle length (cm)	Peduncle diameter (cm)	Vase life of cut flowers (days)
1	V_1C_1	54.22	76.35	1.48	4.95	251.88	17.42	0.32	9.90
2	V_1C_2	50.78	70.32	1.49	5.08	246.60	12.40	0.27	8.78
3	V_1C_3	49.62	72.54	1.54	5.26	223.54	11.20	0.25	7.33
4	V_1C_4	56.37	78.65	1.44	4.65	259.58	18.12	0.34	9.12
5	V_1C_5	55.67	75.24	1.42	4.59	252.74	15.24	0.30	8.87

6	$V_1 C_6$	53.22	63.54	1.29	3.76	247.14	15.89	0.27	8.55
7	$V_1 C_7$	52.88	59.35	1.18	3.43	239.60	13.46	0.25	8.12
8	$V_1 C_8$	52.06	54.36	1.14	3.28	233.14	13.07	0.23	7.56
9	$V_1 C_9$	51.17	53.21	1.11	3.27	202.60	10.28	0.22	7.28
10	$V_1 C_{10}$	58.76	80.32	1.46	4.75	268.57	19.42	0.45	10.25
11	$V_2 C_1$	161.34	228.25	1.5	4.27	301.64	14.66	0.37	8.07
12	$V_2 C_2$	155.78	214.5	1.48	4.29	289.81	11.42	0.30	7.72
13	$V_2 C_3$	136.78	190.36	1.5	4.40	262.24	9.11	0.25	6.40
14	$V_2 C_4$	166.84	213.45	1.36	4.00	311.60	15.81	0.47	8.20
15	$V_2 C_5$	161.62	190.21	1.26	3.62	297.19	14.87	0.44	7.87
16	$V_2 C_6$	158.24	181.65	1.22	3.54	290.00	12.77	0.42	7.77
17	$V_2 C_7$	148.34	160.24	1.20	3.40	270.32	8.60	0.33	6.88
18	$V_2 C_8$	142.44	147.23	1.15	3.18	261.91	7.12	0.28	6.55
19	$V_2 C_9$	140.25	128.47	1.02	3.00	250.60	5.12	0.25	6.40
20	$V_2 C_{10}$	176.43	231.74	1.38	4.23	331.76	16.84	0.54	8.38
21	$V_3 C_1$	125.25	203.25	1.72	6.00	269.76	15.25	0.44	7.39
22	$V_3 C_2$	118.64	196.43	1.74	6.78	262.56	14.12	0.41	6.20
23	$V_3 C_3$	111.75	193.4	1.82	7.13	253.74	13.44	0.30	6.52
24	$V_3 C_4$	128.17	208.47	1.69	5.66	272.61	16.08	0.55	7.41
25	$V_3 C_5$	121.72	195.47	1.68	5.43	266.58	14.43	0.48	7.35
26	$V_3 C_6$	115.23	177.82	1.63	5.00	255.18	13.22	0.40	7.12
27	$V_3 C_7$	111.18	162.4	1.55	4.43	251.43	11.24	0.37	6.74
28	$V_3 C_8$	106.24	146.21	1.48	4.21	243.80	9.38	0.31	6.66
29	$V_3 C_9$	101.28	133.21	1.41	4.16	237.61	7.33	0.28	6.07
30	$V_3 C_{10}$	132.27	215.21	1.70	5.74	282.04	17.24	0.55	7.52
SE (m) ±		7.45	9.47	0.09	0.28	16.27	0.89	0.02	0.47
CD at 5%		N/S	26.86	N/S	N/S	N/S	2.52	0.07	N/S

V_1 - Raja Pandharpuri

T_{10} - Control

T_1 – Colchicine 0.01%

T_5 – EMS 0.05%

V_2 - Brown

T_{10} - Control

T_5 - EMS 0.05%

T_6 - EMS 0.1%

V_3 - Shinaton

T_{10} - Control T_1 - Colchicine 0.01% T_5 - EMS 0.05%

Fig 1: Effect of chemical mutagens on peduncle length of chrysanthemum varieties (Long stem mutant)

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