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STUDIES ON VARIATION IN BIOMETRICAL TRAITS IN C_2 GENERATION OF AFRICAN MARIGOLD

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ABSTRACT

Studies on variation in biometrical traits in C_2 generation of African marigold was conducted in non replicated trial with six treatments. The seeds of diploid white marigold were treated with 0.0, 0.5, 1.0, 1.5, 2.0 and 2.5 % colchicine at room temperature for 12 hrs. and the seeds collected from individual plants of C_1 generation were used for the experiment to raise C_2 generation and germinated in protray. Thirty days old seedlings were transplanted in the field with spacing of 45 × 30 cm in ridges and furrow. Observations on biometrical traits were recorded on each and every plant in each treatment and the data were subjected to statistically analysed. Germination percentage and survival rate were found to be less as compared to control in C_2 generation. Number of branches plant^{-1}, days to first flower initiation, number of flowers plant^{-1}, length of flower along with pedicel and disc diameter decreased in all the treatments than control, whereas plant height, stem diameter, length of leaf, breadth of leaf, weight of flower and diameter of fully opened flower increased in all the treatments than control. Significant variation among the treatments for all the biometrical traits were recorded in C_2 generation of African marigold and hence, offers scope for identifying variants.

(Key words: Marigold, colchicine, variation)

INTRODUCTION

Marigold is one of the commercially exploited flower crop that belongs to the family *Asteraceae* and genus *tagetus*. Marigold has Indian origin although it appears that its natural origin is Mexico compared to other flowering annuals. Marigold is one of the most commonly grown flower in India and used extensively on religious and social functions in different forms. They have special importance especially on Diwali and Dashera. There is a constant demand for flowers throughout the year for functions, festivals, marriages and floral decorations. Because of ease in cultivation, wide adaptability to varying soil and climatic conditions, long duration of flowering and attractively coloured flowers endowed with excellent keeping quality, marigold has become one of the most popular flower in India. Due to its variable height and colour, marigold is especially used for decoration and included in landscape plants. *Tagetes* species vary in size from 0.01 - 2.2 m tall. Most species have pinnate green leaves. Blooms are naturally in golden, orange, yellow and white colours, often with maroon highlights. Floral heads are typically with both ray and disc florets. Marigold in general tends to be planted as annuals, although the perennial varieties are gaining popularity.

Marigold is grown for loose flowers, making garlands, decoration during puja and several religious functions, besides its use in landscape gardening. Apart from its significance in ornamental horticulture, it has been valued for other purposes too. The aromatic oil extracted from marigold, is called as "Tagetes oil". It is used in preparation of high grade perfumes and also as an insect fly repellent. Recently dried flower petals of marigold are used as poultry feed in order to improve the colour of egg yolk as well as broiler's skin. Flowers of African marigold can be used for extraction of L-limonene, ocimene, L-linalylacetate, L-linalool. Marigold petals are used for extraction of xanthophylls. Lutein which is the major constituent of xanthophylls is used for colouring food stuffs. Purified extract of marigold petals containing lutein dipalmitate is marketed as an ophthalmologic agent under the name adaptinol.

Total area under marigold crop in India during the year 2016-2017 was 56.04 thousand ha. with the production of 497.59 thousand metric tonnes of loose flowers and 4.28 lakhs number of cut flowers (Anonymous, 2017). Major marigold growing states are Karnataka, Maharashtra, Andhra Pradesh and West Bengal. The major centers of flower marketing are metropolitan cities like Mumbai, Kolkatta, Chennai, Bangalore, Delhi in India and Pune, Mumbai, Nasik, Ahmednagar, Sangali, Kolhapur, Thane, Satara and Nagpur in Maharashtra.

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In horticulture, the induction of variation is a valuable route to obtain useful and novel characteristics that are not present in the diploid progenitor. These characteristics can include increased, cell size (which leads to large reproductive and vegetative organs), enhanced enzymatic activity, prolonged flowering time, no seed (or few seeds) as well as increased pest resistance and stress tolerance (Dhooghe *et al*., 2009). It has been claimed that the induction of variability can enhance the production of secondary metabolites with medicinal properties (Dhawan and Lavania, 1996).

Keeping in mind the above views, this study was conducted to estimate the extent of variability for biometric traits in C_2 generation of African Marigold.

MATERIALS AND METHODS

The seeds of individual plants harvested from each treatment of C_1 generation were used for the experiment to raise C_2 generation. Black coloured protray of 52.5 × 26.5 cm^2 size were filled with potting mixture of coco pit and vermicompost. Seeds of diploid white marigold were sown in tray which was then gently covered with soil. Trays were watered lightly with the help of hands. After about 3 to 4 days the seeds started germinating and potential germination was completed within ten days. Thirty days old uniform well developed and healthy seedlings of 10-15 cm length were selected for transplanting. One day before the transplanting light irrigation was given to the plot. Seedlings were transplanted in the field with spacing of 45 × 30 cm^2 in ridges and furrow. Light irrigation was given immediately after transplanting. The plants were time to time supplemented with nutrients along with RDF for the proper growth and development of flower bud. Irrigation was given to the plants at proper interval. Weeding, plant protection were adopted as and when found essential. Observation on germination per cent (%), survival rate (%), plant height (cm), stem diameter (cm), number of branches $plant^{-1}$, days to first flower initiation, leaf dimensions (cm^2), number of flowers $plant^{-1}$, weight of flower (g), diameter of fully opened flower (cm), length of flower along with pedicel (cm), disc diameter (cm) were recorded on each and every plant in each treatment. For recording germination percentage (%) the number of seeds germinated in each treatment were counted from third day onwards and the germination percentage was calculated as per the formula given below:

$$\frac{\text{No. of seedling germinated}}{\text{Total no. of seeds of each progeny}} \times 100$$

For survival rate (%) the germinated seedlings were transplanted in the field and the number of seedlings survived after 40 days were counted and percentage survival rate was calculated as follows for each treatment as per the formula given below:

$$\frac{\text{No. of seedlings survived after 40 days of transplantation}}{\text{Total no. of seedlings transplanted in each progeny}} \times 100$$

The data recorded were analysed statistically by following non replicated trial as described by Panse and Sukhatme (1954).

RESULTS AND DISCUSSION

The effect of various treatments of colchicine on germination in C_2 generation are presented in table 1. Reduced germination per cent in all the treatments was observed in C_2 generation as compared to control.The germination percentage in C_2 ranged from 67.96 (T_5- 2.5% colchicine) to 98.00 (control) per cent. Reduction of germination percentage was highest in T_5– 2.5% colchicine (67.96%) followed by T_4-2.0% colchicine (81.92%) of C_2 generation while, lowest in T_1-0.5% colchicine (92.48%) as compared to control. The experimental findings on germination per cent indicated that concentration of colchicine has a direct influence on germination. Increase in the concentration of colchicine resulted in decrease in germination as compared to control. Similar to this results Mensah *et al.* (2007) in sesame, Adelanwa *et al.* (2011) in tomato, Roychowdhury and Tah (2011 a) in carnation, Anbarasan *et al.* (2014) in sesame and Ajayi *et al*. (2014b) in cowpea and Rathod (2017) in white marigold reported that increase in the dose of colchicine decreased the percentage of germination as compared to control.

The use of colchicine resulted in reduction in the survival of seedlings. Increasing the concentration of colchicine caused decline in seedling survival. Data in table 1 reveals that the maximum survival was recorded in T_1– 0.5% colchicine (90.00%) while, minimum in T_5– 2.5% colchicine (57.88%) as compared to their respective control (97.00%) in C_2 generation. Decrease in survival rate with increase in concentration of colchicine might be due to the cause of tissue necrosis when soaked in different concentrations of colchicine solution. This is because colchicine not only have an effect on cell division but spreads through the cell, interfering with cellular mechanism and causing toxicity at high concentration as reported by Rathod (2017). Colchicine apparently affects the viscosity of cytoplasm so the cell cannot function normaly. According to the above result, Nair (2004) in ryegrass, Mensah *et al.* (2007) in sesame, Ramesh *et al.* (2011) in mulberry, Roychowdhury and Tah (2011a) in carnation, Ajayi *et al.* (2014b) in cowpea, He *et al.* (2016) in chrysanthemum, Niu *et al.* (2016) in Jatropha, and Rathod (2017) in white marigold also observed and reported decrease in survival rate with increase in the colchicine dose of treatment. It is evident that higher the concentration of colchicine not only affects the survivability but also results in the delayed emergence of buds. The mortality may be due to poor seedling vigour resulting from inability to overcome the toxic effect of colchicine. It may also be due to physico-chemical disturbances of cells and reduced rate of cell division.

Plant height is an important measure of growth. It is one of the visible measurement and is a function of the internode and leaf emergence, since leaves are born on stem. Leaf area development and biomass production shows a close relationship with plant height. The data regarding the effect of colchicine treatments on plant height are presented in table 1. Plant height increased significantly in all the treatments as compared to control. Maximum plant height was observed in T_1-0.5% colchicine (142.96 cm) while, the minimum was in T_4-2.0% colchicine (125.78 cm) as compared to control (114.00 cm). The maximum range for plant height was recorded in T_3– 1.5% colchicine (146 cm) and minimum range was recorded in T_5-2.5% colchicine (52 cm) as compared to control (22 cm). The coefficient of variation for the plant height increased in all the treatments as compared to the control. The maximum variation was in T_3-1.5% colchicine (20.86%), T_2– 1.0% colchicine (20.11%) and T_4– 2.0% colchicine (20.10%) and minimum in T_1–0.5% colchicine(14.55%) and T_5 -2.5% colchicine (9.45%) as compared to control (5.47%) respectively. The range for the coefficient of variation was 9.45% to 20.86%. Similar to this results, Khaing *et al.* (2007) in *Gymnostachyum* species, Jasna *et al.* (2010) in French marigold, Torres (2011) in tomatillo (*Physalisixocarpa*), Nashar and Ammar (2016) in calendula also found that colchicine treated plants had the larger average plant height than the plants from the control group.

Stem diameter increased significantly in all the treatments as compared to control. Maximum stem diameter was observed in T_5-2.5% colchicine (2.37 cm) while, the minimum was in T_4– 2.0% colchicine (2.10 cm) as compared to control (1.91 cm). Maximum range for the trait was noticed in T_1 – 0.5% colchicine (2.8 cm) and minimum in T_5– 2.5% colchicine (1.5 cm) as compared to control (1.2 cm). The coefficient of variation for the stem diameter increased in all the treatments as compared to the control. The maximum variation was observed in treatment T_3– 1.5% colchicine (21.64%) followed by T_2– 1.0% colchicine (21.56%) and T_4-2.0% colchicine (20.20%) and minimum in T_5– 2.5% colchicine (18.36%) and T_1– 0.5% colchicine (17.33%) as compared to control (14.00%) respectively. The range for the coefficient of variation was 17.33% to 21.64%. The results on stem diameter revealed that increase in the concentration of colchicine linearly increased the stem diameter of treated plants as compared to control. Similar to this result Rathod (2017) in white marigold also observed and reported increase in stem diameter due to colchicine treatment.

The highest mean value for the character number of branches plant^{-1} was recorded in T_1-0.5% colchicine (3.29) and the lowest in T_3– 1.5% colchicine (1.75). In general the number of branches decreased in all the treatments as compared to their control(4.14). Maximum range for number of branches plant^{-1} was noticed in T_1– 0.5% colchicine (9) and minimum in T_5– 2.5% colchicine (5)and T_3– 1.5% colchicine (5) as compared to control (2). The variability studies showed that the coefficient of variation increased against their control in all the treatments. The variation for the character ranged from 46.86% to 75.39% as compared to control (18.91%). The highest variation was recorded in T_3-1.5% colchicine (75.39%) followed by T_2-1.0% colchicine (55.82%) and T_4– 2.0% colchicine (55.01%) and the lowest in T_1 – 0.5% colchicine (52.08%) and T_5– 2.5% colchicine (46.86%). The table 1 revealed that increase in colchicine concentration led to a decrease in number of branches plant^{-1} as compared to control. Similar to this result Adelanwa *et al.* (2011) in tomato and Nashar and Ammar (2016) in Calendula and Rathod (2017) in White Marigold also observed that number of branches plant^{-1} decreased due to colchicine treatment.

It is observed from the table that the maximum mean value for days to first flower initiation was in T_5– 2.5% colchicine (75.42 days) and was statistically significant, while the minimum days to flowering was recorded in T_3– 1.5% colchicine (62.18 days) as compared to their respective controls (76.87 days). Maximum range for days to first flower initiation was observed in T_2– 1.0% colchicine (63) and minimum range in T_3– 1.5% colchicine (26 days) as compared to control (26 days). The coefficient of variation increased in all the treatments for days to first flower initiation as compared to control. The maximum coefficient of variation was observed in T_3– 1.5% colchicine (15.19%) followed by T_2 – 1.0% colchicine (13.38), T_4 – 2.0% colchicine (12.58), T_5 – 2.5% colchicine (12.50) while, the minimum in T_1 – 0.5% colchicine (11.43%) as compared to control(11.26%). The results on days to first flower initiation revealed that time taken for flowering was more in control as compared to colchicine treatments. Early flowering in treated plants may be due to the reason that plants might have received shock due to colchicine, reduction in height of plants and vigorous growth. In accordance to this result Rathod (2017) reported that in white marigold days to first flower initiation was more in control as compared to colchicine treatments. In contrary to this Ajayi *et al.* (2014 a) in cowpea reported delay in flowering with increased exposure period of colchicine.

The mean value for length of leaf increased significantly in all the treatments of colchicine as compared to control. The maximum mean value for the character was observed in T_1– 0.5% colchicine (5.56 cm) and minimum in T_4 – 2.0% colchicine (4.23 cm) as compared to control (3.92 cm). Highest range for length of leaf was recorded in T_1-0.5% colchicine (7.9 cm) and lowest range in T_5– 2.5% colchicine (5.0 cm) as compared to control (0.9 cm). The coefficient of variation increased in all the treatments for length of leaf as compared to control. The maximum coefficient of variation was observed in T_3-1.5%colchicine (32.10%) while, the minimum in T_5– 2.5% colchicine (25.89%). The range of coefficient of variation in treated population was 25.89% to 32.10% as compared to control (5.71%). The mean value for breadth of leaf increased in all the treatments of colchicine as compared to control. The maximum mean value for the character was observed in T_2– 1.0% colchicine (0.97 cm) and minimum in T_5– 2.5% colchicine (0.82 cm) as compared to control (0.81 cm). Highest range for breadth of leaf was recorded in T_3– 1.5% colchicine (1.9 cm) and lowest range in T_5– 2.5% colchicine (1.1cm) as compared to control

(1.0 cm). The coefficient of variation increased in all the treatments for breadth of leaf as compared to control. The maximum coefficient of variation was observed in T_3-1.5% colchicine (38.61%), while the minimum in T_5-2.5% colchicine (34.71%). The range of coefficient of variation in treated population was 34.71% to 38.61% and that of control was (31.71%). The results on leaf dimension revealed that colchicine treatment at lower concentration had increased length and breadth of leaf and at higher concentration had reduced length and breadth of leaf. In addition to increase and decrease of length and breadth treated plant showed thicker leaves as compared to untreated control. Similar to this result Ajayi *et al.* (2010) in water yam, Gantait *et al.* (2011) in Gerbera, Adelanwa *et al.* (2011) in tomato, Azmi *et al.* (2016) in Moth orchid, He *et al.* (2016) in chrysanthemum, Niu *et al.* (2016) in Jatropha and Rathod (2017) in White marigold reported significant difference in leaf breadth and length in treated plants as compared to untreated plants.

The highest number of flowers plant^{-1} was recorded in T_3 – 1.5 % colchicine (43.24) followed by T_1- 0.5% colchicine (41.95) and lowest number of flowers plant^{-1} in T_5 – 2.5% colchicine (37.84) as compared to control (86.06).Maximum range for number of flowers plant^{-1} was observed in T_1– 0.5% colchicine (185)and minimum range in T_5– 2.5% colchicine (77) as compared to control (33). The coefficient of variation for the character increased in all the treatments as compared to the control. The highest coefficient variation was noticed in T_3– 1.5% colchicine (61.08%) and the lowest in T_5– 2.5% colchicine (42.25%). The variation for the character ranged from 42.25% to 61.08% as compared to control (9.99%). Data in table 1 revealed that the mean number of flowers plant^{-1} decreased in colchicine treatment as compared to control. The mean number of flowers plant^{-1}in different treatments though found to be less, lots of variations within treatment were observed. 186 flowers plant^{-1} were obtained. Similar to this result Rathod (2017) reported variation within colchicine treatments in white marigold. In contrary, Jasna *et al.* (2010) observed that the mean number of flowers plant^{-1} were more in treated plants than the plants from the control group in marigold.

The weight of flower increased in some treatments and decreased in some treatments as compared to control. The highest mean value for the character was in T_3– 1.5% colchicine (10.44 g) and lowest in T_5– 2.5% colchicine (8.31 g) as compared to their control (10.11 g). Maximum range for weight of flowers was recorded in T_3–1.5% colchicine (18.6 g) and minimum in T_5– 2.5% colchicine (3.5g) as compared to control (2.3g). The variations for the character were found to be increased in all the treatments. Maximum variation was observed in T_3- 1.5% colchicine (33.66%) followed by T_4– 2.0% colchicine (25.84%), T_2– 1.0% colchicine (25.07%) and T_1– 0.5% colchicine (24.14%) and the minimum variation in T_5– 2.5% colchicine (14.42%) as compared to control (7.54%).The data on weight of flowers revealed that though the mean value of flower weight were less than control, wide variation was observed in all the treatments as compared to control. Similar to this result Rathod (2017) also reported wide range of variation for flower weight in white marigold.

The mean value for diameter of fully opened flower showed significant difference. The maximum mean value for the characters was observed in T_3– 1.5% colchicine (4.21cm) and minimum in T_2– 1.0% colchicine (3.71 cm) and control showed a mean value of 3.88 cm. Highest range for this trait was recorded in T_1– 0.5% colchicine (6.0 cm) and lowest range in T_5– 2.5% colchicine (2.5 cm) as compared to control (1.1 cm). The coefficient of variation increased in all the treatments for diameter of fully opened flower as compared to control. The maximum coefficient of variation was observed in T_3– 1.5% colchicine (20.38%), while the minimum in T_5– 2.5% colchicine (17.39%). The range of coefficient of variation in treated population was 17.39% to 20.38%.The result on diameter of fully opened flower revealed that the mean diameter of fully opened flower increased in some treatments and decreased in some treatments. But the wide range of variation observed in all the treatments indicated the presence of high within treatment variation. In accordance to this result Rathod (2017) also reported increase in the diameter of fully opened flower due to colchicine treatments in white marigold.

The mean value for length of flower along with pedicel decreased in all the treatments of colchicine as compared to control. The maximum mean value for the characters was observed in T_4– 2.0% colchicine (5.15 cm) and minimum in T_3– 1.5% colchicine (4.64 cm) as compared to control (5.33 cm). Highest range for length of flower along with pedicel was noticed in T_2-1.0% colchicine (8.0 cm)and lowest range in T_5– 2.5% colchicine (2.0 cm) as compared to control (1.5 cm). The coefficient of variation increased in all the treatments for length of flower along with pedicel as compared to control. The maximum coefficient of variation was observed in T_3 – 1.5% colchicine (16.02%) while the minimum in T_5 – 2.5% colchicine (11.33%). The range of coefficient of variation in treated population was from 11.33% to 16.02% and that of control was (10.06%). The data on the mean length of flower along with pedicel revealed that colchicine treatment lead to decrease in length as compared to control and also resulted in wide range of variation. In contrary to this result Rathod (2017) reported increase in length of flower along with pedicel due to colchicine treatment in white marigold.

The mean value for disc diameter decreased in all the treatments of colchicine as compared to control. The maximum mean value for the characters was observed in T_5– 2.5% colchicine (1.80 cm) and minimum in T_3– 1.5% colchicine (1.58 cm) and that of control was 1.79 cm. The maximum range for disc diameter was noticed in T_3– 1.5% colchicine (2.5 cm) and minimum in T_5– 2.5% colchicine 1.1 cm) as compared to control (0.6 cm). The coefficient of variation increased in all the treatments for disc diameter as compared to control. The maximum coefficient of variation was observed in T_3– 1.5% colchicine (25.56%) followed by T_2-1.0 % colchicine (23.00%),T_4– 2.0% colchicine (20.18%)

Table 1. Effect of colchicine treatments on different biometrical traits

Characters	Parameters	Colchicine treatments in percentage					
		T_1 (0.5%)	T_2 (1.0%)	T_3 (1.5%)	T_4 (2.0%)	T_5 (2.5%)	Control (0.0%)
Germination percentage (%)	Mean	92.48	89.40	87.74	81.92	67.96	98.00
Survival rate (%)	Mean	90.00	85.35	85.16	80.43	57.88	97.00
Plant height (cm)	Mean	142.96	130.31	134.99	125.78	131.80	114.00
	Range	80	153	146	142	52	22
	SD	25.28	26.21	28.15	20.81	12.45	6.23
	Cv (%)	14.55	20.11	20.86	20.10	9.45	5.47
Stem diameter (cm)	Mean	2.21	2.14	2.16	2.10	2.37	1.91
	Range	2.8	1.8	2.1	1.6	1.5	1.2
	SD	0.38	0.47	0.46	0.44	0.42	0.27
	Cv (%)	17.33	21.56	21.64	20.20	18.36	14.00
No. of branches plant^{-1}	Mean	3.29	2.41	1.75	2.56	2.73	4.14
	Range	9	6	5	6	5	2
	SD	1.71	1.35	1.28	1.41	1.32	0.78
	Cv (%)	52.08	55.82	75.39	55.01	46.86	18.91
Days to first flower initiation	Mean	69.63	73.34	62.18	74.01	75.42	76.87
	Range	35	63	26	48	34	41
	SD	9.81	7.96	9.43	8.66	9.31	9.44
	Cv (%)	11.43	13.38	15.19	12.58	12.50	11.26
Length of leaf (cm)	Mean	5.56	4.81	4.66	4.30	5.21	3.92
	Range	7.9	6.9	6.7	5.7	5.0	0.9
	SD	1.50	1.49	1.52	1.35	1.23	0.22
	Cv (%)	27.10	31.58	32.10	28.69	25.89	5.71
Breadth of leaf (cm)	Mean	0.96	0.97	0.87	0.95	0.82	0.81
	Range	1.7	1.3	1.9	1.4	1.1	1.0
	SD	0.31	0.38	0.32	0.33	0.32	0.29
	Cv (%)	35.68	37.52	38.61	38.58	34.71	31.71
No. of flowers plant^{-1}	Mean	41.95	41.52	43.24	41.56	37.84	86.06
	Range	185	146	127	111	77	33
	SD	23.19	24.64	26.41	25.20	15.99	8.60
	Cv (%)	55.29	59.35	61.08	60.62	42.25	9.99
Weight of flower (g)	Mean	8.83	9.02	10.44	9.15	8.31	10.11
	Range	18.0	14.9	18.6	15.2	3.5	2.3
	SD	2.26	2.13	2.36	3.51	1.20	0.76
	Cv (%)	24.14	25.07	33.66	25.84	14.42	7.54
Diameter of fully opened flower (cm)	Mean	3.75	3.71	4.21	4.14	3.90	3.88
	Range	6.0	5.5	5.0	4.0	2.5	1.1
	SD	0.86	0.67	0.72	0.80	0.68	0.42
	Cv (%)	17.84	19.34	20.38	19.37	17.39	10.79
Length of flower along with pedicel (cm)	Mean	4.94	4.73	4.64	5.15	4.91	5.33
	Range	2.5	8.0	6.5	4.5	2.0	1.5
	S.D	0.74	0.69	0.75	0.65	0.55	0.54
	Cv (%)	13.18	14.71	16.02	14.37	11.33	10.06
Disc diameter (cm)	Mean	1.73	1.63	1.58	1.79	1.80	1.79
	Range	2.0	2.4	2.5	1.8	1.1	0.6
	SD	0.34	0.40	0.37	0.36	0.24	0.22
	Cv (%)	19.47	23.00	25.56	20.18	13.49	12.34

while the minimum in T_5– 2.5% colchicine (13.49%). The range of coefficient of variation in treated population was 13.49% to 25.56% and that of control was 12.34%. The results on disc diameter revealed that the mean disc diameter decreased in colchicine treatment as compared to control and did not show much difference in the mean value. But this trait showed high variation in some treatments which indicates the presence of within treatment variation. Similar to this result Rathod (2017) also reported decrease in disc diameter due to the influence of colchicine treatment in white marigold.

The results obtained in this study revealed that germination and survival rate per cent were reduced in C_2 generation. In C_2 generation plant height, stem diameter, length of leaf, breadth of leaf, weight of flower and diameter of fully opened flower, increased significantly in all the treatments as compared to central. But days to first flower initiation, number of flower plant, number of branches plant^{-1}, length of flower along with pedicel and disc diameter reduced significantly in all the treatments as compared to contol. Significant variation among the treatments for all the biometrical traits were recorded in C_2 generation of African marigold and thus, offers scope for identifying variants.

REFERENCES

Adelanwa, M. A., M. L. Habeeb and E. B. Adelanwa, 2011. Morphological studies of the effect of colchicine and paradichlorobenzene on tomato (*Lycopersicon esculentum*). J. Env. Issues and Agri. In Developing Countries, **3**(2):122-127.

Ajayi, A. T., A. O. Ohunakin, O. S. Osekita and O. C. Oki, 2014a. Influence of colchicine treatments on character expression and yield traits in Cowpea (*Vigna Unguiculata* L. Walp). Global J. Sci. Frontier Res. **14**(5): 15 – 20.

Ajayi, A.T., A. I. Adesoye, R. Aseiduand A. Sartie, 2010. Colchicine induced variation in survival rate and morphological characteristics of water yam (*Dioscoreaalata*). Crop Res. **47**: 485-492.

Ajayi, A.T., O.S. Osekita, J. O. Maku and O.M. Owoyemi, 2014b. Colchicine-Induced variation in cowpea (*Vigna unguiculata.*Walp). Res. J. Agri. And Env. Sci. **1**(1):7-14.

Amiri, S. 2010. The Effect of trifluralin and colchicine treatments on morphological characters of Datura.Trakia J. Sci. **8**(4): 47-61.

Anbarasan, K., R. Rajendran, D. Sivalingam and AL. C. Chidambaram, 2014. Studies on the effect of EMS and colchicine in M_1 generation of Sesame *(Sesamum indicum* L.) Var. TMV3. Int. Let. Nat. sci. **11**(2): 209-214.

Anonymous, 2017. Area, production and productivity of flowers. Indian Horticulture database.http://www.nhb.gov.in

Azmi, T. K. K., D. Sukma, S. A. Aziz and M. Syukur, 2016. Polyploidy induction of Moth Orchid (*Phalaenopsisam abilis* (L.) Blume) by colchicine treatment on pollinated flowers. The J. agri. Sci. **11**(2):62-73.

Dhawan, O. P. and U. C. Lavania, 1996. Enhancing the productivity of secondary metabolites via induced polyploidy a review. Euphytica, **87**: 89-95.

Dhooghe, E., W. Grunewald, L. Leus. and M. C. Van Labeke, 2009. In vitro polyploidisation of Helleborus species. Euphytica, **165**: 89-95.

Gantait, S., N.Mandal, S. Bhattacharyya and P. K. Das, 2011. Induction and identiûcation of tetraploids using *in vitro* colchicine treatment of *Gerbera jamesonii* Bolus cv. Sciella. Plant Cell Tiss. Organ Cult.**106**: 485-493.

He, M., W. Gao, Y. Gao, Y. Liu, X. Yang, H. Jiao and Y. Zhou, 2016. Polyploidy induced by colchicines in *Dendranthema indicum* var. aromaticum, a scented chrysanthemum. Eur. J. Hortic. Sci. **81**(4):219-226.

Jasna, A., N. Sarajlic, B. Becici, S. Murtic and A. Turalija, 2010. The effect of concentration, exposure time and type of colchicine treatment on the morphological characteristics of French marigold (*Tagetes patula* L. var. nana).Faculty of Agril.and Food_Sci. Sarajevo,**56**:353-358.

Khaing, T. T., A. L. T. Perera, V. A. Sumanasinghe and D. S. A. Wijesundara, 2007. Improvement of *Gymnostachyum* species by induced mutation. Tropical Agri. Res.**19**: 265-272.

Mensah, J. K., B. O. Obadoni, P. A. Akomeah, B. Lkhajiajbe and J. Ajibolu, Janet, 2007. The effects of sodium azide and colchicine treatments on morphological and yield traits of sesame seed (*Sesame indicum* L.). Afr. J. Biotechnol, **6**(5): 534-538.

Nair, R. M. 2004.Developing tetraploid perennial ryegrass (*Lolium perenne* L.) populations. New Zealand J. Agri. Res. **47**: 45-49.

Nashar, EI. Y. I. and M. H. Ammar, 2016. Mutagenic influences of colchicine on phenological and molecular diversity of *Calendula officinalis* L. Genet. Mol. Res. **15**(2): 15027745.

Niu, L., Y. B. Tao, M. S. Chen, Q. Fu, Y. Dong, H. He and Z. F. Xu, 2016. Identification and characterization of tetraploid and octoploid *Jatropha curcas* induced by colchicine. Caryologia, **69**(1):58-66.

Panse, V.G. and P.V. Sukhatme, 1954, Statistical methods for agriculture workers. ICAR, New Delhi 2nd pp. 63-66.

Ramesh, H. L., V. N. Yogananda Murthy and Munirajappa, 2011. Colchicine induced morphological variation in mulberry variety M_5. The Bioscan, **6**(1):115-118.

Rathod, A. 2017. Effect of colchicine on polyploidy induction in White marigold. M. Sc. Thesis (unpub.) submitted to Dr. PDKV, Akola.

Roychowdhury, R. and J. Tah, 2011. Assessment of chemical mutagenic effects in mutation breeding programme for M_1 generation of Carnation (*Dianthus caryophyllus*).Res. Plant Bio. **1**(4): 23-32.

Torres, V. R. 2011. Development of tomatillo (*Physalis ixocarpa* Brot.) autotetraploids and their chromosome and phenotypic characterization. Breeding Sci. **61**: 288–293.

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