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Chandana Shivaswamy
Research Scholar, Department of Floriculture and Landscape Architecture, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari, Gujarat, India

Sudha Patil
Assistant Professor, Department of Floriculture and Landscape Architecture, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari, Gujarat, India

Mallika Sindha
Research Scholar, Department of Floriculture and Landscape Architecture, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari, Gujarat, India

KS Solanki
Research Scholar, Department of Floriculture and Landscape Architecture, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari, Gujarat, India

Corresponding Author:
Chandana Shivaswamy
Research Scholar, Department of Floriculture and Landscape Architecture, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari, Gujarat, India

Impact of chemical mutagens on the morphological traits of China aster

Chandana Shivaswamy, Sudha Patil, Mallika Sindha and KS Solanki

Abstract
In present investigation, seedlings of China aster var. Arka Kamini were treated with different doses (0.05%, 0.10%, 0.15%, 0.20% and 0.25%) of chemical mutagens *i.e.,* Diethyl sulphonate and Ethyl methyl sulphonate. Different vegetative, floral and yield characters were taken under study and analyzed in RBD comprising 11 treatments and 3 replications. Significantly maximum flowering duration, flower diameter, shelf life, vase life, number of flowers/plant, flower yield and early first flower bud initiation was observed in T_9 (0.20% EMS). However, maximum survival percentage of plants (94.17) and plant height (32.25 cm) was observed in 0.15% EMS and 0.15% DES respectively. The maximum number of primary branches/plant (4.38) and stalk length (22.31 cm) was recorded in control. 0.25% EMS recorded maximum plant spread in E–W direction (24.65 cm) while, undesirable results were obtained in 0.25% DES.

Keywords: China aster, diethyl sulphonate, Ethyl methyl sulphonate, chemical mutagens

1. Introduction
China aster [*Callistephus chinensis* (L.) Nees] is an important commercial flower crop which belongs to the family Asteraceae and native to China as well as Europe. The genus *Callistephus* derived its name from two Greek words '*kalistos*' and '*stephos*' meaning 'most beautiful' and 'a crown', respectively. China aster is one of the important flower crops, grown as cut flower, loose flower, bedding plant and as pot plants. The flowers of China aster are used for flower arrangement, interior decoration, garland making, worshipping, etc. (Munikrishnappa *et al.,* 2013) [6].
Chemical mutagenesis is an effective and simple method for obtaining valuable starting material for plant breeding as chemical mutagens has ability to induce a high frequency of non-lethal point DNA mutations and generate diversity in various crops. Among chemical mutagens, alkylating agents like ethyl methyl sulphonate and diethyl sulphonate, are the most frequently used in various flower crops and other crops, as they can cause a high frequency of nucleotide substitution variation and has a potential to generate many new mutants with desirable characters. Hence, the present investigation was conducted and the emphasis was laid on finding out desirable variations caused by chemical mutagens in China aster cv. Arka Kamini.

2. Materials and Methods
The present experiment was carried out at the Floriculture Research Farm, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari, Gujarat, during winter season of year 2020-21. Total 11 treatments including diethyl sulphonate (DES) and ethyl methyl sulphonate (EMS) were taken *viz.*, 0.05% DES (T_1), 0.10% DES (T_2), 0.15% DES (T_3), 0.20% DES (T_4), 0.25% DES (T_5), 0.05% EMS (T_6), 0.10% EMS (T_7), 0.15% EMS (T_8), 0.20% EMS (T_9), 0.25% EMS (T_{10}) and Control (T_{11}). Forty seedlings were selected per treatment per replication and were treated with different concentrations of chemical mutagens by immersing their roots in the chemical solutions of 250 ml each for 3 hours. After the treatments, these seedlings were removed from the chemical solutions and washed in running tap water for 20 minutes to remove the chemical mutagens adhering to roots of the treated seedlings. Seedlings were kept in normal water to keep plant as untreated for control and seedlings were planted on the raised beds in RBD and replicated thrice. Observations were recorded on all vegetative, flowering and yield parameters.

Moreover, vegetative and flowering abnormalities were also been studied. The crop was observed critically and tagged all variation to isolate for further study. The observed data were statistically analysed as per Panse and Sukhatme (1985) [8].

3. Results and Discussion

The data on different vegetative characters showed significant difference in all the treatments (Table 1). The results revealed that highest survival percent *i.e.,* 94.17 was observed in T_8 (0.15% EMS) which was found at par with all the treatments whereas, T_5 (0.25% DES) recorded minimum survival (56.67%). The reduction in survival percent is because of the effect of mutagens on meristematic cell or might be due to gene mutation, acute chromosomal damage, delay in onset of mitosis and chromosomal aberration that induces enzyme activity such as catalyse and lipase and also due to some hormonal activity (Roychowdhury and Tah, 2011) [10].

Maximum plant height (32.25 cm) was recorded in T_3 (DES @ 0.15%) which was at par with T_{10}, T_9 and T_2 *i.e.* 31.87 cm, 30.76 cm and 27.43 cm, respectively, while, plants remained dwarf (15.34 cm) in T_1 (0.05% DES). Plant height is a quantitative trait which is predominantly controlled by polygenes and each gene contributes a small effect which externally expressed in plant morphology (Kapadiya, 2014) [3]. The stimulatory effect of chemical mutagens at lower concentrations recorded for plant height agreed completely with the findings of Sudha *et al.* (2017) [11] in gladiolus and Patil *et al.* (2019) [9] in carnation. Maximum number of primary branches (4.38) were found in T_{11} (control) which was at par with treatment T_9 and T_{10} *i.e.* 4.30 and 4.15, respectively. The least number of primary branches per plant (1.33) was observed in treatment of 0.25% DES (T_5). Moreover, maximum plant spread (24.65 cm) was reported in T_{10} in E-W direction which was at par with T_9 (23.35 cm) and T_{11} (23.09 cm). In case of plant spread in N–S direction, maximum plant spread (23.73 cm) was reported in plants treated with T_9 which was at par with T_{11} (23.23 cm) and T_{10} (22.35 cm). However, minimum plant spread of 10.30 cm and 10.53 cm was recorded in plants treated with T_5 in both the directions. These findings are in conformity with Nashar and Asrar (2016) [7] in calendula.

The mean data of all the floral characters are presented in Table 2. In flowering characters, T_9 produced bud in minimum days (43.50) which was at par with all the treatments as well as control except T_1, T_4, T_6 and T_5. Similarly, minimum days to first flower opening (55.40) was observed in treatment T_3 (0.15% DES) which was at par with all the treatments except T_4 (0.20% DES) and T_5 (0.25% DES). Similar type of stimulatory effect was observed earlier by Kayalvizhi *et al.* (2016) [4] in tuberose as well as Vinodh and Kannan (2020) [12] in crossandra may be due to physiological dwarfing because of chemical mutagens where all energy was utilised for early flowering.

Significantly maximum duration of flowering in China aster var. Arka Kamini was observed in plants treated with 0.20% EMS (T_9) *i.e.* 44.87 days which was followed by treatment T_{10} (37.20 days) while minimum duration of flowering was observed in T_5 (0.25% DES) *i.e.* 25.43 days. Maximum diameter of flower head (6.62 cm) was produced by plants of T_9 which was at par with T_3 (6.46 cm), T_2 (6.14 cm), T_{10} (6.36 cm) and control (6.31 cm). These results are in parallel line with Vinodh and Kannan (2020) [12] in crossandra. Moreover, significantly maximum stalk length (22.31 cm) was observed in control which was at par with T_3 (20.75 cm) while the smallest stalk length was observed in plants treated with T_5 *i.e.* 6.95 cm.

In case of postharvest life of loose and cut flowers of china aster, significantly maximum shelf life (5.33 days) was recorded in T_9 (EMS @ 0.20%) followed by T_{11} *i.e.* control (4.73 days) while, minimum shelf life (3.17 days) was observed in DES @ 0.25%. Similarly, maximum vase life (7.20 days) was observed in flowers produced by plants treated with T_9 which was at par with T_5 *i.e.* 7.03 days and control *i.e.* 7.00 days whereas, minimum shelf life (4.10 days) was observed in T_5. Increase in concentration of chemical mutagens proved to be injurious by promoting physiological disturbances and retarded cell division by arresting the mitotic division and ill effects on quality thereby reduction of vase life may be observed (Ghormade, 2020) [2]. The results are in conformity with Patil *et al.* (2019) [9] in carnation.

As far as yield is concerned, significantly maximum number of flowers per plant (24.90) was produced by plants treated with 0.20% EMS (T_9) which was at par with control (23.64), T_{10} (23.42) and T_8 (21.72). Minimum number of flowers/plant (10.12) was obtained in T_5 (DES @ 0.25%). Maximum flower yield per plant (72.94 g) was obtained in T_9 *i.e.* 0.20% EMS which was at par with control (70.94 g) and EMS @ 0.25% (70.29 g) while minimum flower yield per plant (30.46 g) was obtained in T_5. Similarly, maximum flower yield/hectare (5.63 t/ha) was obtained in T_9 which was at par with control (4.86 t/ha) whereas rest of the mutagenic treatments had adverse effect on yield which was lower than control and minimum flower yield (1.27 t/ha) was obtained in T_5. Increase in flower yield per plant was also recorded with increase in dosage of DES and EMS started to decrease beyond certain level. Production of flowers in terms of number and diameter are directly related to yield. High amount of variation in DES was might be because the chemical mutagens can produce single base substitutions with different mutation spectra due to which broad variation occur in yield parameters as compared to control (Khan *et al.,* 2009) [5]. Similar results were observed by Archana and Patil (2013) [1] in gladiolus.

Table 1: Effect of different chemical mutagens on vegetative characteristics of China aster var. Arka Kamini

Treatments	Survival percentage	Plant height (cm)	No. of primary branches per plant	Plant spread E-W (cm)	Plant spread N-S (cm)
T_1: DES @ 0.05%	85.83	15.34	2.65	14.76	14.87
T_2: DES @ 0.10%	82.67	27.43	1.99	19.16	17.31
T_3: DES @ 0.15%	82.50	32.25	1.59	20.02	16.54
T_4: DES @ 0.20%	69.17	17.41	1.44	11.59	11.86
T_5: DES @ 0.25%	56.67	15.26	1.33	10.30	10.53
T_6: EMS @ 0.05%	85.83	17.17	1.63	13.68	12.18
T_7: EMS @ 0.10%	93.33	24.38	2.98	14.89	14.54
T_8: EMS @ 0.15%	94.17	25.14	3.55	15.26	15.74

T_9: EMS @ 0.20%	92.50	30.76	4.30	23.35	23.73
T_{10}: EMS @ 0.25%	83.33	31.87	4.15	24.65	22.35
T_{11}: Control	93.33	25.21	4.38	23.09	23.23
S.Em. ±	4.87	1.87	0.19	1.21	1.13
C.D. at 5%	14.38	5.52	0.56	3.58	3.33
C.V.%	10.10	13.59	12.14	12.11	11.75

Table 2: Effect of different chemical mutagens on floral and yield characteristics of China aster var. Arka Kamini

Treatments	Days to first flower bud initiation	Days to first flower opening	Duration of flowering (days)	Diameter of flower (cm)	Stalk length (cm)	Shelf life (days)	Vase life (days)	Number of flowers per plant	Flower yield per plant (g)	Flowers yield per hectare (t)
T_1: DES @ 0.05%	49.80	62.13	31.43	5.46	14.92	4.20	5.13	14.33	43.02	2.74
T_2: DES @ 0.10%	44.63	56.63	34.73	6.14	18.50	4.33	5.33	15.71	47.15	3.50
T_3: DES @ 0.15%	43.67	55.40	36.57	6.46	20.75	4.50	5.53	16.13	48.42	3.83
T_4: DES @ 0.20%	52.40	64.63	27.87	4.79	8.59	3.67	4.70	11.36	34.13	1.75
T_5: DES @ 0.25%	54.50	67.33	25.43	3.44	6.95	3.17	4.10	10.12	30.46	1.27
T_6: EMS @ 0.05%	52.60	61.77	32.07	4.68	10.67	4.13	5.20	14.29	52.89	3.44
T_7: EMS @ 0.10%	49.43	61.17	33.27	5.29	11.05	4.57	5.90	19.97	59.96	4.18
T_8: EMS @ 0.15%	48.63	60.13	37.00	5.39	13.41	5.23	6.00	21.72	65.18	4.51
T_9: EMS @ 0.20%	43.50	55.47	44.87	6.62	18.82	5.33	7.20	24.90	72.94	5.63
T_{10}: EMS @ 0.25%	44.93	57.30	37.20	6.36	17.99	4.53	7.03	23.42	70.29	4.33
T_{11}: Control	45.43	55.50	36.93	6.31	22.31	4.73	7.00	23.64	70.94	4.86
S.Em. ±	2.12	2.42	2.06	0.19	0.97	0.2	0.25	1.4	2.42	0.16
C.D. at 5%	6.27	7.14	6.07	0.56	2.85	0.59	0.74	4.14	7.15	0.48
C.V.%	7.64	7.02	10.38	5.94	11.23	7.9	7.58	13.67	7.75	7.67

4. Conclusions

On the basis of the results obtained from the investigation, it can be concluded that 0.20% EMS recorded desirable and best results over DES and control. Early first flower bud initiation along with maximum plant spread N-S, duration of flowering, diameter of flower, shelf life, vase life, number of flowers per plant, flower yield per plant, flower yield per plot and therefore, maximum flowers yield per hectare was observed in T_9 (0.20% EMS). Similarly, maximum survival percentage of plants (94.17) was observed in T_8, plant height (32.25 cm) was found maximum in T_3. Maximum number of primary branches per plant (4.38) and stalk length (22.31 cm) were recorded in control. T_{10} recorded maximum plant spread in E–W direction (24.65 cm) while, undesirable results were obtained in T_5 (0.25% DES).

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