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Effects of ethyl methane sulphonate on the yield and qualtiy of crossandra (*Crossandra infundibuliformis* (L.) Nees.)

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Abstract
The experiment aims to examine the effects of chemical mutagen *viz.*, Ethyl Methane Sulphonate (20, 30, 40, 50 and 60 mM) on various characters *viz.*, days to first flowering, days for spike to complete flowering, number of spikes per plant, number of flowers per spike, length of spike, corolla tube length, diameter of flower, number of flowers per plant, yield of flowers per plant, 100 flower weight and quality parameters. The results indicate that all the treatments affected the growth of the plants but sensitivity of crossandra to different concentrations was different. Sensitivity to EMS was determined by various measurements on the VM_1 generation. In general, the variance was increased for all the characters under study in the treated populations compared with control suggesting an increase in genetic variability. However, the concentration 30 mM has recorded the more number of spikes and flowers, flower diameter and yield of flowers per plant than control.

Keywords: Crossandra, correlation, number of spikes, flower yield

Introduction
Crossandra (*Crossandra infundibuliformis* (L.) Nees) is an important loose flower crop, commercially grown in southern parts of India. Though it is not having any fragrance it became very popular due to its excellent color and demand in the market. Efforts were initiated through to induce variability through EMS and their effects on growth parameters were investigated. The application of mutagenesis has vast potential for increasing the available genetic variation. Induction of mutations based on physical/chemical mutagens is one of the major breeding approaches for plant improvement. Therefore, induced mutagenesis through irradiation or chemical treatment has become a very important method for plant breeding, including flower breeding. Particularly EMS has been successfully used on chrysanthemum, yielding a frequency of 5.2% mutants. Though there are number of chemical mutagens, for practical purpose of induction of mutation, EMS is really functional. A wide range of variations in petal color (pink-salmon, light-pink, bronze, white, yellow and salmon color) have been recorded (Jain, 1974) [3]. By the year 2000, over 2200 mutant varieties of ornamental plants had been released worldwide (IAEA, 2005) [2], including 175 plant species with induced mutant varieties (Maluszynski *et al.*, 2000). Hence, the present investigation was carried out to study the effects of ethyl methane sulphonate on yield and quality parameters.

Material and Methods
The present investigation "Studies on induced mutagenesis in crossandra (*Crossandra infundibuliformis* (L.) Nees) was carried out at Department Floriculture & Landscape Architecture, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore. The treatment details *viz*., Control (Wet) – Untreated seeds, 20, 30, 40, 50 and 60 mM. Fresh, healthy seeds of crossandra were soaked in water for $1^1/_2$ hours to soften the seed coat. The duration of pre-treatment with water was determined by a preliminary blank experiment. It was observed that there was about 10-15 per cent radicle emergence 6 hours after soaking in water while there was no radicle emergence when the seeds were soaked for 3 hours. An initial pre-soaking period of $1^1/_2$ hours in water was therefore adopted for treatment with mutagens.

The required concentration of EMS solution was prepared in double distilled water (pH 7.0). The treatment was performed at the room temperature of 25± 1 °C from 6.00 a.m. to 12.00 noon with intermittent shaking during the treatment period. After the treatment with chemical, the seeds were thoroughly washed in running tap water for 30 minutes and were spread gently over a blotting paper to remove the excess moisture on the seed coat. To ensure uniform absorption of the mutagen, the volume of the mutagen solution was maintained at a proportion of five times to that of seed volume (Raut, 1969) [9]. After imposing treatments, seeds were sown in protrays containing sterilized cocopeat. Lethal Dose was determined by measuring the seed germination, seedling height, survival percentage and emergence of the M_1 generation under field conditions. When the seedlings attained four leaf stages, they were transplanted in the main field. Data's were recorded on germination, survival and growth characters in the M_1 generation. The data of the field observations were analyzed using 'F' test for significance following the methods described by Panse and Sukhatme (1964) [7]. The values recorded in percentage were transformed in to angular values prior to analysis wherever necessary.

Result and Discussion

Among the treatments EMS at 30 mM has recorded the number of spikes and flowers, flower diameter and yield of flowers per plant than control. The days for first flowering were significantly reduced at lowest dose of 20 mM (75 days) and increased at the highest concentration of 60 mM (117.19 days) while in control it was 83.18 days. The highest doses had negative shifts for the days for first flowering. The highest doses of gamma ray were significantly increased the number of days for a spike to complete flowering whereas the lowest doses took lesser number of days for a spike to complete flowering. The lowest dose at 10 kR (30.09 days), 20 kR (36.21) reduced the number of days while highest dose also increased the number of days 50 kR (40.09) as compared to control (49.19 days). The number of flowers per plant due to different concentrations of EMS ranged from 1667.26 and 1151.33 at 30 mM and 60 mM, respectively over control. All the doses of gamma rays increased the flower yield than control. The flower yield per plant showed a significant difference among the gamma ray treatments. There was an increase in flower yield per plant (81.84 g) at 10 kR, (86.34 g) at 20 kR as compared to the control (58.26 g) while the highest dose 50 kR recorded also highest yield of 74.84 g than control. The higher doses might have affected the physiological process leading to flowering. As a result of floral initiation flower bud development were delayed and flowering phase within the crop duration was reduced. But the lower dose of mutagens might have caused a stimulated effect on physiological process of flowering and thus induced early flowering. This is in line with the findings of Kalavani (1991) and Balakrishnan (1997) [1] in chrysanthemum, Singh *et al.* (2009) [10] in Marigold, Mostafa *et al.* (2014) [6] in *Celosia argentea*, Patil (2014) [8] in gladiouls and Singh *et al.* (2015) in tuberose.

The differences in weight of 100 flowers were significant among different EMS concentrations. The maximum weight of 100 flowers (6.09 g) was recorded at 30 mM whereas, minimum of 4.46 was observed at 60 mM concentration over control (4.64 g). But at lower doses, the number of flowering branches might have increased 1eading to increased number of flowers per p1ant. The shift in mean was in negative direction except at lower doses. This may be related to the inhibitory effect of ionizing radiations and alkalizing effect of chemical mutagens. Brock (1964) postulated that mutagenic treatments induce differential changes in the polygenic system. Irulapan (1979) and Balakrishnan (1997) [1] also registered such shift in the mean values towards negative direction.

The population of nematodes varied from 47.45 to 189.14 at 10 kR to 50 kR, respectively in the treated plots while in the control it was 204.81. The population of nematodes was decreased at lowest concentrations and increased at highest concentrations.

The genotype treated with lowest dose 20 kR increased the wilt percentage by 25.33 per cent while the highest dose 50 kR decreased the wilt percentage by 14.72 at 50 kR as compared to 24.18 per cent in control. The per cent of reduction ranged from 11.62 to 39.12 at 10 kR and 50 kR, respectively.

The per cent of wilted genotype in the field condition ranged from 23.18 to 31.07 at 30 Mm and 60 mM, respectively while in control recorded 17.61 per cent. Increase in the EMS concentration increased the wilt per cent in the field. All the EMS treatments exhibited negative shifts over control.

Table 1: Effect of Ethyl Methane Sulphonate on yield and quality characters of Crossandra

Treatments	DFF	NSP	NFS	LS	CTL	DF	NFP
Control (wet)	83.19	33.69	23.06	5.60	2.18	2.34	1505.01
20 mM	75.00	52.41	35.41	8.40	2.43	2.52	1600.51
30 mM	89.04	61.24	36.19	8.75	2.55	3.06	1667.26
40 mM	107.18	47.24	24.56	6.88	2.40	2.51	1343.01
50 mM	114.37	30.21	21.06	5.35	2.38	2.49	1148.76
60 mM	117.19	28.13	20.80	5.22	2.32	2.35	1151.33
Mean	97.66	42.15	26.84	6.70	2.37	2.54	1402.64
SEd	1.56	0.98	0.51	7.11	0.04	0.04	25.86
CD (P = 0.05)	3.24	2.03	1.05	0.12	0.08	0.09	53.62

Table 2: Effect of Ethyl Methane Sulphonate on yield and quality characters of Crossandra

Treatment	100 flower weight (g)	YPP (g)	SL (days)	NP (5g roots)	WP (%)
Control (wet)	4.64	52.49	3.00	204.81	20.93
20 mM	5.95	71.32	3.00	62.17	32.15
30 mM	6.09	82.31	3.00	47.45	27.78
40 mM	5.05	48.56	3.00	165.31	30.03
50 mM	4.84	39.66	2.00	173.00	32.35
60 mM	4.46	35.13	2.00	189.14	34.64
Mean	5.17	54.91	2.66	140.31	29.64
SEd	0.09	1.15	0.44	2.43	0.45
CD (P = 0.05)	0.18	2.39	0.09**	5.04	0.94

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