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EFFECT OF CHEMICAL MUTAGENS ON *TAGETES ERECTA*

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ABSTRACT

Two mutagenic reagents, Diethyl sulphate (DES) and Sodium Azide (SA), were used to study their effects on the morphological characteristics of *Tagetes erecta* (L.) cvs. Petite Yellow and Hawaii , as well as the possibility of mutation induction in the M1 and M2 generations. Seeds were treated with different DES and SA concentrations : 0 (distilled water) 1000, 2000, 3000, 4000 and 5000 ppm. for six hours.

DES mutagen at low concentration (1000 ppm.) increased the seed germination percantage, while high concentrations (2000 - 5000 ppm.) decreased it . No Petite Yellow plants were survived after being treated with the high concentration (5000 ppm.) treatment . The DES concentrations of 1000, 2000 and 4000 ppm caused decreases in the plant height of both cultivars in the M1- generation. The DES doses from 2000 to 5000 ppm. significantly decreased the plant height in M2-generation in Hawaii Cv. There were no significant increases in the number of branches per plant in Petite Yellow , but there were significant differences in Hawaii in both generations. The concentration of 2000 ppm. DES significantly delayed the flowering in the M1- generation of Petite Yellow while 1000 and 5000 ppm. concentrations delayed the flowering in the M1-generation of Hawaii . DES concentrations of 3000 and1000 ppm markedly increased the dry weight in the M2-generation of Petite Yellow and Hawaii plants respectively.

SA mutagen at low concentration (2000 ppm.) significantly increased the percentage of germinated seeds, of Petite Yellow in the M2- generation. There were no significant differences among the treatments on plant height of Petite Yellow , while there were significant differences in both generations of Hawaii . There were no significant differences between the effects of the different treatments on the number of branches and the number of days to flowering in both cultivars . However, there were significant differences among the treatments on the number of inflorscences per plant. The differences were not significant for the dry weight of both cultivars in both generations .

Generally, the results had also indicated that DES and SA was effective in inducing morphological changes and mutations , and the induced changes were found to affect the following characters ; growth habit, flower colour and the number and size of ray florets .

INTRODUCTION

Tagetes erecta (African Marigold) is a cultivated plant in the tropical regions, New Mexico , Arizona to Argentina (Bailey, 1941) . Taxonomically, *Tagetes erecta* belongs to the family *Compositae* or *Asteraceae* , the plant is a tender perennial or annual with a strong scented vegitative and flowering organs, the flower colour ranges from light sulfur-yellow to deep orange .

The African Marigolds are very useful as cut-flowers except under circumstances where their odour is objectionable . Plants are used as an outdoor pot plant , or for decorative flower beds or borders .

The aim of this work was to study the effects of some concentrations of the two mutagenic reagents; Diethyl Sulphate (DES) and Sodium Azide (SA) on the morphological characteristics of the African Marigolds as well as on the possibility of mutation induction to produce new forms.

MATERIALS AND METHODS

The experiments were carried out during 1995 and 1996 in the Flowers and Ornamental Plants Research Gardens of the Faculty of Agriculture, Alexandria University.

Two cultivars of marigold (*Tagetes erecta*, L.) produced by Excel Co. U.S.A . were used in this study . The first cultivar was Petite Yellow , with dwarf double - lemon yellow blooms on compact vegetative growth , and is excellent for pots , borders and edgings . The second cultivar was Hawaii , which has rich orange , double, large, carnation - like flowers , globe shaped blooms with odorless foliage and is suitable for borders and as cut flowers .

The chemicals used in the study were : Sodium Azide (SA) .and Diethyl Sulphate (DES) . obtained from Merck Co. Germany .

M_1 - Generation

The Layout of the experiment was a randomized complete block design containing three replicates (Steel and Torrie, 1980) . Every replicate contained 12 treatments for each cultivar. 30 seeds of Petite Yellow and 20 seeds of Hawaii were used for each treatment in every replicate. The utilized seeds were prepared for chemical treatments as follows : 1800 seeds were specified to the field experiments, divided into 24 parts . (12 parts $\times$ 90 seeds for Petite yellow and 12 parts $\times$ 60 seeds for Hawaii) and each part was put in a bag . Six bags from each cultivar were soaked for 12 hours in distilled water at 23 °C before being soaked in the different chemical concentrations on April 5 , 1995 and the other six bags were kept soaked in the different chemical rates and then washed by distilled water .Water - soaked seeds were soaked in Sodium Azide (SA) and Diethyl Sulphate (DES) solutions for 6 hours on April 5 , 1995 .

The used concentrations were : 0 ppm (Control) , 1000 ppm, 2000 ppm, 3000 ppm, 4000 ppm and 5000 ppm.

Chemically treated and non-treated seeds were sown on April 6 , 1995 . The seeds of each treatment were divided into three equal parts . Every part was sown in a thirty centimeters diameter clay pot filled with a mixture of equal parts of sand and clay (One pot for every replicate) . The pots were placed in partial shade. On May 18, 1995 . The seedlings were individually transplanted to 15 cm. pots using clay soil , when they reached a height of 4 cm. in Petite yellow and 8 cm. in Hawaii .

The following parameters were recorded in the M_1 - generation ; seed germination percentage, plant height (cm), number of main branches, flowering date (days from sowing to the appearance of the first inflorescence on the plant) , number of inflorescences per plant and variation (in vegetative growth and inflorescences).

Selfing was carried out in all changed plants to investigate the genetic bases of the changes in the different characteristics .

M_2 - Generation

Seeds of all selfed M_1-plants from each mutagenic treatment as well as from the control plants were collected . On March 13, 1996 , seeds obtained from the M_1- generation were sown . A sample of 150 selfed seeds from each treatment was sown in 3 wooden trays (50 seed per tray) containing soil mixture of 1 sand and 1 clay by volume . The trays were placed in partial shade according to the experimental layout of a randomized complete block design with 3 replicates and watered daily . Every replicate contained 12 treatments . M_2- plants were individually transplanted to 15 cm. diameter clay pots (when they reached 4 cm. for Petite Yellow and 8 cm. for Hawaii) containing clay soil .

Data were recorded on the characters of M_2 - generation plants in the same manner mentioned in the M_1- generation .

RESULTS AND DISCUSSION

Seed germination

Effect of DES on the Petite Yellow cultivar

Data presented in Table 1 show that there was a significant effect of DES in the M_1 only , while in the M_2 there were no significant differences among the different concentrations of DES . The lowest DES concentration (1000 ppm.) caused a slight increase in the germination percentage over the control . The other concentrations caused significant reductions in the germination percentage . There was an apparent trend towards decreasing the germination percentage with increasing the chemical concentration .

Effect of DES on the Hawaii cultivar

The effect of the different DES concentrations on the seed germination was not significant in both generations . There was an apparent trend towards decreasing the germination percentage with increasing the chemical concentration from 1000 to 5000 ppm. DES . Regarding the 5000 ppm. DES concentration , no plants were survived in the M_2 .

These results are similar to the findings of Hussein *et al.* (1974) on *Saliva splendens* , Sello; Boreiko and Boreiko (1982) on broad beans ; Mohan *et al.*(1982) on soybeans ; Yanev (1990) on durum wheat and Kim *et al.*(1995 a) on barley . They found that the germination percentage decreased with increasing the mutagenic concentration and presoaking and soaking time .

Effect of SA on the Petite Yellow cultivar

The reported data showed that there was no significant effect of SA in the M_1 - generation , while in the M_2 - generation , there were significant differences among the different concentrations of SA , on the percentage of germinated seeds . The concentrations (1000,2000 and 4000 ppm.) of SA increased in the germination percentage over the control in both generations.

Effect of SA on the Hawaii cultivar

The effect of the different concentrations on the seed germination was not significant in both generations . The different concentrations did not cause significant reductions in the germination percentage . The concentrations (1000 and 3000 ppm.) of SA caused a slight increase in the germination percentage over the control in the M_1 - generation .

These findings are similar to the findings of many investigators . who indicated that there were some stimulation effects on the germination of seeds as a result of treating the seeds with low concentrations of mutagenic chemicals; Zilonkovski (1978) on *Vicia faba* ; Hasegawa and Inoue (1980) on barley; Mohan *et al.* (1982) on soybeans ; Rao and Reddi (1987) on rice; Mahna *et al.* (1991 b) on *Vigna mungo* ; Bohmova and Repiska (1994) on barley and Kim *et al.* (1995 a) on barley.

The stimulating effect of the low and sometimes intermediate concentrations of the used chemicals (DES and SA) on the seed germination may be due to enzymatic activation and awakening meristemic cell division in seed .

The reduction in the percentage of germinated seeds as a result of treating with high concentrations of chemicals are related to the damage of embryo which might arise from ionizing chemicals . Also this reduction may be due to the effect of the high concentrations which inhibits the synthesis of enzymes .

In both generations , there was a significant difference between the two cultivars in the percentage of germinated seeds . This difference may be due to the difference in the genetic factors, such as sensitivity, between the two cultivars as mentioned by Abd El- Maksoud (1980).

Plant height

Effect of DES on the Petite Yellow cultivar

The results showed that there were significant differences among the different concentrations in the M_1 - generation , while there were no significant differences in the M_2 - generation (Table 2).

Generally, the DES concentrations decreased the plant height in the M1- generation.

Effect of DES on the Hawaii cultivar

The different concentrations caused significant reduction in plant height in both generations . There was an apparent trend towards decreasing , the plant height with increasing the chemical concentration. Increasing plant height was recorded at the concentration of 2000 ppm. DES , while a decreasing effect was noticed at the concentrations of 4000 and 5000 ppm. DES in the M_1 - generation . But in M_2 - generation , the decrease in plant height was recorded at all concentrations except that of 1000 ppm. DES .

These results were similar to the findings of; Hussein *et al.* (1974) on *Salvia splendens* ; Mordvinova (1976) , and Mordvinova and Lysikov (1976) on maize ; Sinha (1990) on *Lindenbergia indica* and EL- Torky (1992) on *Euonymus japonicus*).

Table 1: Mean values of germination percentage of *Tagetes erecta* seeds as affected by Diethyl Sulphate (DES) and Sodium Azide (SA) in the M_1 and M_2 generations of Petite Yellow and Hawaii cultivars.

Treatment	Mean Germination Percentage			
DES	Petite Yellow		Hawaii	
PPM	M_1	M_2	M_1	M_2
0000	28 a	9	60	13
1000	29 a	8	59	12
2000	17 b	6	45	8
3000	14 b	7	52	7
4000	5 c	6	41	8
5000	4 c	00	34	7
L.S.D. $_{0.05}$	6.62	N.S	N.S	N.S

Treatment	Mean Germination Percentage			
SA	Petite Yellow		Hawaii	
PPM	M_1	M_2	M_1	M_2
0000	25	9 bc	65	20
1000	26	14 ab	71	18
2000	30	16 a	62	11
3000	22	9 bc	68	12
4000	26	13 abc	58	9
5000	13	8 c	55	12
L.S.D. $_{0.05}$	N.S	5.92	N.S	N.S

Table 2: Mean values of plant height (in cm.) of *Tagetes erecta* as affected by Diethyl Sulphate (DES) and Sodium Azide (SA) in the M_1 and M_2 generations of Petite Yellow and Hawaii cultivars.

Treatment	Mean Plant Height (cm.)			
DES	Petite Yellow		Hawaii	
PPM	M_1	M_2	M_1	M_2
0000	12.73a	12.48	42.52 ab	35.66 a
1000	9.39c	12.83	36.77 bc	33.58 ab
2000	9.78bc	12.16	51.05	28.95 bc
3000	11.77ab	14.08	41.58 abc	27.22 c
4000	9.56 c	13.68	30.33 bc	29.08 bc
5000	00.00	00.00	29.57 c	28.37 c
L.S.D. $_{0.05}$	2.03	N.S	12.80	5.09

Treatment	Mean Plant Height (cm.)			
SA	Petite Yellow		Hawaii	
PPM	M_1	M_2	M_1	M_2
0000	12.60	11.80	31.94b	40.59 bc
1000	14.14	12.31	26.44b	37.52bcd
2000	14.10	13.17	42.45a	49.30a
3000	13.68	12.83	35.83ab	42.87 ab
4000	15.68	11.53	30.19 b	32.80cd
5000	11.60	12.57	35.54ab	31.22 d
L.S.D. $_{0.05}$	N.S	N.S	10.18	7.80

Within each column, any two means that have different letters are significantly different at the 5% level of probability .
N.S = not significant

The stimulated effect of lower concentrations recorded for plant height agreed completely with the findings of Warfield (1973) on *Saintpaulia ionantha ;* Mani (1991) on *Sorghum bicolor* ; Restaino (1991) on *Capsicum annuum* ; Abd EL- Maksoud and EL- Mahrouk (1992) on *Asparagus* densiflorus .

Effect of SA on the Petite Yellow cultivar

Generally , the different concentrations did not cause any significant differences. The low SA concentrations (1000,2000,3000 and 4000 ppm.) increased the plant height , whereas the 5000 ppm. concentration decreased it in the M_1 – generation. In the M2- generation the concentration 2000 ppm. caused the maximum increase in plant height.

Effect of SA on the Hawaii cultivar

The different concentrations caused significant differences in the two generations, 2000 ppm. SA increased the plant height in both generations. The high concentrations decreased the plant height in the second generation.

The results of the Petite Yellow seemed to agree with those reported by Zilonkovski (1978) on *Vicia faba* ; Guimaraes and Ando (1981) on rice and EL- Den (1995) on barley but the proportional decrease in the plant height in Hawaii cv. with increasing the SA concentrations found in the present study was similar to the findings of Hasegawa and Inoue (1986) on barley ; Rao and Reddi (1987) on rice and Reddy *et al.* (1994) on Triticale .

These results might be attributed to the physiological damage caused by DES and SA and its hydrolysis products .

Number of branches per plant

Effect of DES on the Petite Yellow cultivar

DES did not cause any significant increase in the number of branches per plant in both generations (Table 3)

Effect of DES on the Hawaii cultivar

The applied concentrations of DES caused significant differences in the number of branches per plant in both generations, but the effect was more obvious in the M2-generation.

There are frequent reports showed that DES had no effect on the number of branches per plant as found in the case of the Petite Yellow cultivar in the present investigation ; e.i., EL- Torky (1992) on *Euonymus japonicus* ; Abd El- Maksoud and EL- Mahrouk (1993) on *Cardiospermum halicacabum* ; Vandana (1994 a) on *Vicia faba* , but other reports showed that DES had affected the number of branches per plant as found in the case of the Hawaii cultivar in the present study , i.e. Prasad and Tripath (1986) on barley and Vandana and Dubey (1993).

Effect of SA on the Petite Yellow and Hawaii cultivars

The results indicated that the applied concentrations of SA did not cause any significant increase in the number of branches per plant in both

cultivars although other reports showed that SA had affected the number of branches per plant such as . Prasad and Tripath (1986) on barley ; Rao and Reddi (1987) on rice ; Sinha (1990) on *Lindenbergia indica* ; Mahna *et al.* (1991b) on *Vigna mungo* ; Abd EL- Maksoud and EL- Mahrouk (1992) on *Asperagus* densiflorus and EL- Torky (1992) on *Euonymus japonicus* . This result may be due to the sensitivity of varieties to the chemical concentrations.

Flowering date

Effect of DES on Petite Yellow cultivar

Data showed that the average number of days from seed sowing till the beginning of flowering was affected by the different DES concentrations only in the M_1 - generation(Table 4). The plants emerged form the seeds treated with 1000 ppm. DES flowered earlier than those treated with any other concentration . Plants treated with 2000 ppm. DES were the latest ones in flowering .

Effect of DES on the Hawaii cultivar

In the M_1 - generation , the control plants flowered earlier than the plants of all other treatments except those of the 3000 ppm. DES treatment , while in the M_2 - generation , there were no significant differences among the treatments . Plants treated with the concentration of 5000 ppm. DES were the latest ones in flowering in both generations .

Effect of SA on Petite Yellow cultivar

Data showed that there were significant differences among the different treatments only in the M_2 - generation .

The results obtained in the M_1 generation showed that the time to flowering was decreased at the 2000 ppm. SA concentration showing the earliest flowering (1.53 day earlier than the control) . The 1000 , 3000 , 4000 and 5000 ppm. SA concentrations caused slight delay in flowering date .

Effect of SA on Hawaii cultivar

Data showed that there were no significant differences among the concentrations in both generations .

The results obtained on the M_1 - generation showed that the 2000 and 4000 ppm. SA concentrations caused a slight delay in flowering date . However, in the M_2 - generation the flowering date was increased at all concentrations . The 5000 ppm. concentration showed the latest flowering.

The effect of SA on flowering date appears in two manners

a) Early flowering , as reported by Rao and Reddi (1987) on rice ; Mordvinova *et al.* (1988) on maize and Adamska *et al.* (1996) on winter swede rape .
b) Late flowering , which was reported by Mahna *et al.* (1991a) on *Vinga aconitifola* and Reddy *et al.* (1994) on wheat .

The Variability among the two cultivars in both generations can be attributed to the environmental variation or to the response to the chemical concentrations.

Table 3: Mean values of the number of main branches of *Tagetes erecta L.* as affected by Diethyl Sulphate (DES) and Sodium Azide (SA) in the M_1 and M_2 generations of Petite Yellow and Hawaii cultivars.

Treatment	Mean number of branches			
DES	Petite Yellow		Hawaii	
ppm	M_1	M_2	M_1	M_2
0000	5.50	7.98	4.50 a	5.31 bc
1000	5.90	7.31	4.11ab	6.20ab
2000	6.00	7.82	4.58a	3.61c
3000	6.67	7.77	2.25 c	7.22a
4000	6.60	6.11	3.17bc	5.12
5000	0.00	0.00	2.32 c	5.89ab
L.S.D. $_{0.05}$	N.S	N.S	1.13	1.75

Treatment	Mean number of branches			
SA	Petite Yellow		Hawaii	
ppm	M_1	M_2	M_1	M_2
0000	6.28	6.35	4.06	5.75
1000	6.50	6.48	3.44	5.58
2000	5.67	6.21	3.25	4.62
3000	7.50	8.83	5.09	4.53
4000	6.50	6.11	4.28	5.17
5000	5.17	7.47	4.22	3.92
L.S.D. $_{0.05}$	N.S	N.S	N.S	N.S

Table 4: Mean number of days till flowering of *Tagetes erecta* as affected by Diethyl Sulphate (DES) and Sodium Azide (SA) in the M_1 and M_2 generations of Petite Yellow and Hawaii cultivars.

Treatment	Mean number of days till flowering			
DES	Petite Yellow		Hawaii	
Ppm	M_1	M_2	M_1	M_2
0000	47.94 bc	49.17	75.18 b	79.08
1000	41.81 c	43.75	81.52 a	83.72
2000	58.92 a	61.08	76.73 ab	81.32
3000	56.80 ab	58.83	73.42 b	83.89
4000	52.78 ab	53.86	77.50 ab	82.39
5000	00.00	00.00	80.43 a	84.61
L.S.D. $_{0.05}$	8.92	N.S	4.87	N.S

Treatment	Mean number of days till flowering			
SA	Petite Yellow		Hawaii	
ppm	M_1	M_2	M_1	M_2
0000	49.17	49.50 cd	76.08	78.75
1000	51.42	51.33 bcd	73.60	80.75
2000	47.64	47.72 d	76.12	84.08
3000	56.25	58.42 ab	75.12	81.50
4000	57.37	59.75 a	76.17	86.83
5000	54.42	56.75 abc	74.75	87.33
L.S.D. $_{0.05}$	N.S	8.01	N.S	N.S

Within each column, any two means that have different letters are significantly different at the 5% level of probability.
N.S = not significant

It is known that low and intermediate concentrations of chemicals , generally , stimulate cell growth, increase the rate of growth and produce earlier flowering in specific cases as reported by Warfield (1973) , Hussien *et al.* (1974) and Adamska *et al.* (1996) . On the other hand , High concentrations of chemicals seemed to inhibit cell growth, decrease the rate of growth and delay the flowering as found and reported by Neagu (1974) and Vandana and Dubey (1993).

Number of inflorescences per plant

Effect of (DES) on the Petite Yellow cultivar

The results of the number of inflorscences per plant showed that there were significant differences among the different treatments in both generations .

Generally , low and intermediate concentrations (2000 and 3000 ppm. DES) increased the number of inflorescences per plant in the M_1 generation, while 4000 ppm decreased it in both generations (Table 5).

Effect of DES on the Hawaii cultivar

The results indicated that there were no significant differences among the different treatments in the M_1 - generation , while there were significant differences in the M_2 - generation . The 3000 ppm. DES concentration increased the number of inflorescences per plant which is similar to the conclusions reported by AL - Saheal and Gamil (1982) on bread wheat and Vandana (1994b) on *Vicia faba* .

Effect of (SA) on the Petite Yellow cultivar

There were significant differences among the different treatments in the M_1 - generation , while there were no significant differences in the M_2 - generation . The 3000 ppm. SA concentrations increased the number of inflorescences per plant .

Effect of (SA) on the Hawaii cultivar

Data revealed that there were no significant differences among the treatments in both generations . The 3000 and 4000 ppm. SA concentrations increased the number of inflorescences per plant .

Dry weight

Effect of DES on the Petite Yellow cultivar

The mean values of the dry weight per plant were affected by DES concentrations . The effects of the chemical treatments were not significant in the M_1- generation, while they were significant in the M_2 - generation (Table 6).

Effect of DES on the Hawaii cultivar

There was an apparent trend towards decreasing the dry weight with increasing the chemical concentration . Significant increase in dry weight was recorded only at the concentration of 1000 ppm. DES , while decreasing effect was noticed at most of the other concentrations in both generations .

The proportional decrease in the dry weight with increasing the DES concentrations found in the present study was similar to the findings of

Sichkar *et al.* (1975) on winter wheat ; Abd EL - Maksoud and EL- Mahrouk (1992) on *Asparagus densiflorus* .

Effect of SA on the Petite Yellow cultivar

According to the data , the low SA concentrations (1000 and 2000 ppm.) as well as the high concentration (5000 ppm.) caused stimulation of the dry weight .

Effect of SA on the Hawaii cultivar

The low concentrations (1000 and 2000 ppm.) increased the dry weight, while 3000 , 4000 and 5000 ppm. decreased it. The variability between the two generations can be attributed to the environmental factors prevailed during the growth period of both generations .

Induction of mutations

Habit of growth

In the M_1- generation of the Hawaii cultivar , growth habit of some plants was changed showing an inhibition in the vegetative growth resulting in dwarfed growth . These changes in the growth habit were observed at 4000 ppm.SA and 5000 ppm. DES treatments . In the M_2 - generation , there was one dwarfed plant at the dose of 5000 ppm .DES. Other investigators obtained similar results such as Warfield (1973) on *Saintpoulia ionantha* ; Yang and Lee (1982) on banana ; Rao and Reddi (1987) on rice , Restaino (1991) on *Capsicum annuum* ; Kim *et al.* (1995 b) on barley ; Adamska *et al.* (1996) on winter swede rape.

The dwarfed growth can be attributed to the effect of DES and SA on the apical bud which inhibits its growth.

Flower changes

Flower colour

The results of this investigation showed that different concentrations of SA had affect this character (Table 7).

In the Hawaii cultivar

The induced changes in the M_1 - generation , showed red flowers at 4000 ppm. SA. The gained selfed seeds from these plants did not germinate

In the Petite Yellow cultivar

The results of this investigation showed that there were two kinds of flower colour variations included red flowers and stems at the concentrations of 1000 and 2000 ppm. SA and light yellow flowers was observed at 4000 ppm. SA.

Similar results were found by Warfield (1973) on *Saintpaulia ionantha* with EMS ; Prasad and Tripathi (1986) on barley ; Vandana (1994 b) on *Vicia faba* ; Kim *et al.* (1995 b) on barley ; Adamska *et al.* (1996) on winter swede rape.

This change in flower colour can be attributed to the effect of the chemical treatment together with the temperature and light on the development of pigments . The phenotypic expression of the genes concerned should be dependent upon the temperature , since temperature is one of the factors controlling reaction velocity . The amount of an end -

product of pigments , as well as its rate of formation , should be greater at a higher temperature provided , the temperature coefficient of competing processes is not higher than that of the reactions leading to the end - product under consideration .

This result is in agreement with that reported by Al- Halawany (1992) on *Catharanthus roseus* L .

Number and size of ray florets

Smaller flowers than normal were obtained at different concentrations of the two mutagens DES and SA with certain changes in the number of ray florets as well as deformities in the ray florets in the two

Table 5: Mean values of the number of main inflorescences per plant of *Tagetes erecta L.* as affected by Diethyl Sulphate (DES) and sodium Azide (SA) in the M_1 and M_2 generations of petite Yellow and Hawaii cultivars.

Treatment	Mean number of inflorescences per plant			
DES	Petite Yellow		Hawaii	
Ppm	M_1	M_2	M_1	M_2
0000	4.75 b	7.18 a	3.83	4.14 abc
1000	4.50 b	6.28 ab	2.67	3.78 bc
2000	5.72 a	4.67 b	5.00	2.91 c
3000	6.00 a	7.32 a	3.58	5.26 a
4000	3.50 c	4.67 b	3.25	4.83 ab
5000	0.00	0.00	3.08	4.78 ab
L.S.D. $_{0.05}$	0.88	1.92	N.S	1.48

Treatment	Mean number of inflorescences per plant			
SA	Petite Yellow		Hawaii	
ppm	M_1	M_2	M_1	M_2
0000	3.55 bc	5.12	3.50	4.50
1000	4.72 ab	4.63	2.89	3.03
2000	5.52 a	4.67	2.67	3.42
3000	4.33 ab	6.70	3.60	4.68
4000	4.69 ab	4.66	3.40	4.26
5000	2.50 c	4.72	3.41	4.09
L.S.D. $_{0.05}$	1.29	N.S	N.S	N.S

Table 6: Mean values of the dry weight of Tagetes erecta as affected by Diethyl Sulphate (DES) and Sodium Azide (SA) in the M_1 and M_2 generations of petite Yellow and Hawaii cultivars.

Treatment	Mean dry weight of plant (gr.)			
DES	Petite Yellow		Hawaii	
Ppm	M_1	M_2	M_1	M_2
0000	1.13	1.05 b	4.14	4.47 b
1000	1.73	1.50 ab	7.48	9.22 a
2000	0.76	0.97 b	5.60	4.55 b
3000	1.67	1.85 a	3.99	3.68 b
4000	1.72	1.57 ab	2.51	2.56 b
5000	0.00	0.00	3.17	3.93 b
L.S.D. $_{0.05}$	N.S	0.62	N.S	2.86

Treatment	Mean dry weight of plant (gr.)			
SA	Petite Yellow		Hawaii	
ppm	M_1	M_2	M_1	M_2
0000	1.12	1.03	6.14	6.85
1000	1.56	1.44	8.89	7.13
2000	1.32	1.13	10.95	10.67
3000	1.16	1.12	4.11	4.32
4000	1.09	1.04	4.88	5.62
5000	1.36	1.21	2.77	2.98
L.S.D. $_{0.05}$	N.S	N.S	N.S	N.S

Within each column, any two means that have different letters are significantly different at the 5% level of probability. N.S = not significant

generations of both cultivars . Similar results were found by other researchers ; i.e. , Warfield (1973) who produced mutations from double to single flower on *Saintpaulia ionantha* . Petal number can be attributed to the effect of chemical on flower bud during the time of its initiation . The chemicals treatment induced changes in the size of ray florets as reported by Neagu (1974) on sunflower ; Vandana (1994 b) on *Vicia faba* .

The small flowers obtained in this work may be attributed to the effect of chemicals on the whole flower bud which inhibited its growth .

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تأثير المطفرات الكيميائية على نبات القطيفة

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أجرى هذا البحث فى حدائق أبحاث الزهور ونباتات الزينة بمحطة البحوث الزراعية التابعة لكلية الزراعة - جامعة الإسكندرية خلال العامين 1995,1996 .

وقد اختير لهذه الدراسة صنفين من نبات القطيفة *Tagetes erecta* L. أحدهما قصير وهو الصنف Petite Yellow والثاني طويل وهو الصنف Hawaii .

كان الهدف الرئيسي من البحث هو دراسة تأثير التركيزات المختلفة من مادتي الداى إيثيل سلفيت (DES) والصوديوم إزايد (SA) المطفرتان على إحداث تغييرات مورفولوجية تزيد من القيمة

التنسيقـــية للنبات وكذلك إنتـــاج طفرات ذات صفات مرغوبة يمكن إكثارها واستخدامها كأصـــــناف جديـــدة .

وقد عـومـلت البذور تحت الدراسة بـالتركيزات الآتية من المطفران (DES) و (SA) :صفر (مقارنة) , 1000 , 2000 , 3000 , 4000 , 5000 جزء فى المليون لمدة 6 ساعات.

ويمكـــن تلخيـــص النتائـــج التى تـــم الحصـــول عليها فيما يلى :

أ ـ بالنســبة للمطـــفر (DES) :

1. أدى التركيز 1000 جزء فى المليون إلى زيادة نسبة إنبات البذور بينما خفضت التركيزات من 2000 إلى 5000 جزء فى المليون من هذه النسبة ولم يكن هناك فروقاً معنوية بين المعاملات فى الصنفين القصير والطويل فى الجيل الثانى بينما كانت الفروق معنوية فى الصنف القصير فى الجيـــل الأول.
2. أدت المعاملة بالتركيز العالى 5000 جزء فى المليون إلى موت جميع البادرات فى الصنف القصير .
3. أدت المعاملـة بـالتركيزات 1000 و2000 و4000جـزء فـى المليـون فـى الصـنف القصـير والتركيـز 5000 جزء فى المليون فى الصنف الطويل إلى قصـــر النبات فى الجيل الطفورى الاول وكذلك التركيزات من 2000 الى 5000 جزء فى المليون ادت الـى نقص فى ارتفاع الصنف الطويل خلال الجيل الطفورى الثانى.
4. لم يكن هناك فروقاً معنوية بين المعاملات بالنسبة لكل من متوسط عدد الفروع فى الصنف القصير بينما كانت الفروق معنوية فى الصنف الطويل فى الجيلين بالنسبة لصفة التفريع .
5. بالنسبة لعدد الأيام حتى بدء التزهير فقد وجد فى كلا الجيلين أن تـأثير التركيز 2000 جزء فى المليون على الصنف القصير أدى إلى أطالة هذه الفترة وكانت الإطالة معنوية فى الجيل الأول ، بينما أدت جميع المعاملات إلى إطالة هذه الفترة لبدء التزهير فى الصنف الطويـل فى الجيل الطفورى الاول .
6. كانت هناك فروقاً معنوية بين جميع المعاملات بالنسبة لمتوسط عدد النورات لكل نبات فى الصنف القصير بينما كانت غير معنوية فى الجيل الأول ومعنوية فى الجيل الثانى فى الصنف الطـــويـــل .
7. أدت المعاملة بالتركيزين 3000 و 1000 جزء فى المليون إلى زيادة معنوية فى الوزن الجاف للنبات فى الصنفين القصير و الطويل علـى الترتيب فى الجيل الثانى وكانت الفروق غير معنوية فى الجيل الأول.

ب ـ بالنســبة للمطـــفر (SA) :

1. أدى التركيز2000 جزء فى المليون إلى زيـادة نسبة إنبـات البذورمعنويا فى الصنف القصير ولم يكن هناك فروقاً معنوية بين المعاملات فى كلا الصنفين فى الجيل الأول ولكن الفروق كانت معنوية فى الجيل الثانى فى الصنف القصـــير .
2. لم يكن هناك فروقاً معنوية بين المعاملات بالنسبة لطول النبات فى الصنف القصير ــ بينما كانت هنـاك فروق معنوية بين المعاملات فى الصنف الطويل فى كلا المـــوسمـــين .
3. لم يكن هناك فروقاً معنوية بين المعاملات بالنسبة لمتوسط عدد الفروع.
4. بالنسبة لعدد الأيام حتى بدء التزهير فقد كانت هناك فروقاً معنوية بين المعاملات فى الجيل الثانى للصنف القصير ، بينما كانت الفروق بين جميع المعاملات غير معنوية فى كلا الجيلين فى الصنف الطويـــل .
5. لم يكن هناك فروقاً معنوية بين جميع المعـاملات بالنسبة لمتوسط عدد النورات لكل نبات فى الصنف الطويل ، بينما كانت الفروق معنوية فى الجيل الأول وغير معنوية فى الجيل الثانى فى الصنف القصـــير .
6. أدت المعاملة بالتركيز 2000 جزء فى المليون إلى زيادة كل من الوزن الجاف فى جيلى الصنفين رغم أن الفروق كانت غير معنوية.

أدت المعاملـة باستخدام كلا من DES و SA إلـى استحداث بعض التغيرات والطفرات وكانت الصفات التى حدثت بها تغيرات وطفرات هي : طبيعـــة النمو و لون الأزهـار و عـــدد وشكـــل الأزهـــار الشعاعـــية .

Table 7: Frequencies of included changes in the flower color of *Tagetes erecta* at different concentrations of Sodium Azide (SA) by the two cultivars of Hawaii and Petite Yellow.

Treatment ppm	M_1 No. of plants Hawaii			M_2 No. of plants Hawaii			M_1 No. of plants Petite Yellow			M_2 No. of plants Petite Yellow		
	Survived	F.C.M	%	Survived	F.C.M	%	Survived	F.C.M	%	Survived	F.C.M	%
0000	26	0	0	22	0	0	24	0	0	20	0	0.0
1000	28	0	0	19	0	0	22	3R.	13.64%	22	0	0.0
2000	21	0	0	13	0	0	29	1R.	3.45%	33	0	0.0
3000	23	0	0	12	0	0	20	0	0	18	0	0.0
4000	20	2R.	10%	8	0	0	27	1 L.Y.	37%	21	0	0.0
5000	15	0	0	13	0	0	11	0	0	12	0	0.0

F.C.M. = flower color modified.
R. = Red.
L.Y. = light yellow.