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Induced Mutations in some Safflower Genotypes

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Abstract

This investigation was carried out for induce mutations in safflower (*Carthamustinctorius* L) at the Experimental and Research Farm, Faculty of Agriculture, Al-Azhar University. The results showed access anumbers of promising mutants in M3 generation. The results shows that the Di methyl Sulfoxide (chemical mutagen) was more effective than other two treatments (γ-ray & electric shock), as well as the line 32 (L_1 was more responsible than the other two genotypes for induction of stable promising mutants according to final results at M3especially high seed yield. The promising mutants were softness and earliness than the parental genotypes.

The earliestgeno types of flowering (116.83day) in M_3 was obtained from plants of L1h1. The highest seed yield/plant (128.00 and 127.17 g) was obtained from plants of L_2t_3 and L_1h_2, respectively.

The results supported that the mutagen treatment scan be used to get new safflower genotypes is characterized by spineless, earliness and high seed yield andthus can involve in breeding program to get new varieties suitable for cultivation in reclaimed lands.

Introduction:

Safflower seeds have been found 4,000 year-old in Egyptian tombs and using by Chinese approximately 2,200 years ago. Safflower (*Carthamus tinctorius*L.) is one of the important oil seed crops and has been traditionally grown for its flowers as a source of dye for coloring food and fibers. Subsequently, it is grown for edible oil, animal meal, bird feed, medicinal uses, as a potential candidate crop for production of plant made pharmaceuticals, biofuel and specialty type oils. Oil of Safflower is the richest source of linoleic acid, with average linoleic acid content around 78% of the total seed oil fatty acids (Velasco *et al.*, 2005).

India cultivated about 0.42 million ha, produced of 0.23 million tons of seed and average productivity of 547 kg/ha, so it is consider the leading producer of safflower in the world (FAOSTAT, 2006). Despite its vast potential and growth adaptability to a wide range of agro-ecological conditions, safflower remained as a neglected crop due to low seed oil content (28-36%), spines, fiber rich seed meal and vulnerability to a number of diseases and pests. Safflower species are known to possess several desirable genes such as, drought hardiness, shattering tolerance, non-dormancy of seeds, and resistance to safflower fly, rust, and powdery mildew (Sujatha, 2007).

Artificial induction of mutations by using of physical and chemical mutagens such as radiation, chemicals and electric shock are considered to be one of the useful tools for plant improvement by increasing of genetic variability in many plant species, especially the self-fertilized plants.

(Kharkwal, 2000; Hassan *et al.*, 2001; Mihov *et al.*, 2001 Wani and Anis,2001, Soliman *et al.*, 2003), Fahmy *et al.*, 1997; Geetha and Vaidyanathan, 1998; Hajduch *et al.,* 1999 and Solanki and Sharma, 1999).

In Egypt, safflower area decreased year after year at Upper Egypt, because the genotypes suffering from many problems as lateness (185 days at maturity), full thorns on leaf and heads, low seed yield and low seed oil content. Therefore, the present study aimed to induce mutations for earliness, spineless and high seed yield with high oil content as a promising mutant that could be used in breeding program to get new varieties.

Materials and Methods:

Three mutagens i.e. gamma ray (γ -ray) and Di methyl Sulfoxide and electric shock were used for induction of mutation on three safflower genotypes (Line32 , Line37 and Line40) during three seasons 2013/2014, 2014/2015 and 2015/2016. The gamma ray doses were 10 kr and 20 kr while the concentrations of Di methyl Sulfoxide were (1000 ppm), (2000ppm) and (3000ppm). The electric shock in the presence of the used chemical solutions as follows: Monosodium phosphate (30000 ppm/liter), Monosodium phosphate (50000 ppm/liter) and Sodium nitrate (50000 ppm/liter).

Three safflower lines; Line 32, line37 and Line 40 were obtained from Oil Crop Research Section, Field Crop Research Institute, Agricultural Research Center (ARC) were used in this study. The selected variants at the present study included apparent morphological characters, especially earliness and softness change, as well as the change in seed yield attribute characters. These variants were screened to isolate M1 and M2 generations. These mutants characterized with, thorns leaves, flowering date (earliness, lateness), and high seed weight. In M3 generation the stable M2 mutant lines were screened and recorded, especially these possessed softness and earliness.

Gamma ray:

40 grams from seeds from each line were backed in paper bags and subjected to gamma ray doses of 10 Kr (r1) and 20 Kr (r2) and the exposure time was 30 minutes in October, 2013 in Middle Eastern Regional Radioisotope Center for the Arab countries at NRC, Dokki, Cairo, Egypt.

Di methyl Sulfoxide:

40 grams from the seeds from each line were soaked in prepared aqueous solution of Di methyl Sulfoxide (DMS) of three different concentrations (1000 ppm (h1), 2000 ppm (h2) and 3000 ppm (h3) for 24 hours.

Electric shock:

40 grams from seeds from each line were germinated and exposed to electric shock inside special electric analysis set to invent the DNA activity through the cell division during germination of the seeds for mutations induction (Ahmad 2011).

The used chemical solutions were as follow:

No	Chemical components	Concentration	Brief
1	Monosodium phosphate $NaH_2(PO_4)_3$	(50000 ppm/liter)	(t_1)
2	Sodium nitrate $NaNO_3$	(50000 ppm/liter)	(t_2)
3	Monosodium phosphate $NaH_2(PO_4)_3$	(30000 ppm/liter)	(t_3)

Heritabilites are estimated by several methods that use different genetic populations and produced estimates that may vary. Common methods include the variance components method and parent-offspring regression. In this investigation we used the parent- offspring regression as estimate for heritability.

The significance was estimated by T test by comparison between groups (comparison between mutated plants with unmutated plants).

Results and Discussion

At the first season of the investigation all mutagenic treatments induced mutants of different desired traits in this crop such as smooth leaves, red and orange petals, earlier flowering and more yielding plants.

Table (1) shows that chosen mutant in M1 generation after applying the mutagen treatments. It is clear from results in Table 1, that mutant differ from the original plants of different safflower genotypes in four main characters i. e. seed yield / plant (S.Y/P), number of days from sowing to flowering (N.D.F), thorns and sleek and petal color. Results show that all treatments (Radiation, Chemicals and Electric shock) have led to mutations in all safflower genotypes.

Table 1. List of mutants chosen in M1 generation in 2013/2014 season

Genotype	M.N	S.Y/P	N.D.F	Thorns	Sleek	Colour flower		
						Orange	Red	Yellow
(L1)		26.5	130	√				√
(L2)		15.1	131	√				√
(L3)		8.9	130	√				√
L1 r1	3	78.5	130	√		√		
L1 r1	4	42.7	129	√				√
L1 r1	10	56.4	130	√		√		
L1 r1	16	51.8	130			√		
L1 r2	6	69.7	128			√		
L1 r2	12	28.1	129	√		√		
L2 r1	1	61.5	127		√	√		
L2 r1	3	57.1	128		√			√
L2 r1	6	76.0	127		√	√		
L2 r1	7	37.4	128		√	√		
L2 r2	7	29.8	129		√		√	
L2 r2	8	65.9	130		√	√		
L2 r2	9	26.5	129		√			√
L2 r2	10	20.7	129		√	√		
L3 r1	7	68.0	128		√	√		
L3 r2	1	102.8	127	√				√
L3 r2	3	99.6	128	√		√		
L1h1	4	32.3	125	√				√
L1h1	6	16.1	125	√				√
L1h1	9	59.2	126	√		√		
L1h1	10	65.2	125		√	√		
L1h1	11	85.9	127		√	√		
L1h1	15	28.3	125		√			√
L1h2	6	9.9	125		√	√		
L1h2	8	44.8	124		√		√	
L1h2	11	19.0	124	√				√
L1h2	20	19.1	126		√	√		
L1h3	4	39.7	127		√	√		
L1h3	6	34.2	128		√	√		
L1h3	8	39.9	126		√	√		
L1h3	12	44.3	128		√			√
L2h1	7	70.7	127		√	√		
L2h1	8	78.9	127		√	√		
L2h1	10	112.2	128		√			√
L2h1	12	132.8	128	√				√

Genotype	M.N	S.Y/P	N.D.F	Thorns	Sleek	Colour flower		
						Orange	Red	Yellow
(L1)		26.45	130	√				
(L2)		15.11	131	√				
(L3)		8.89	131	√				
L2h2	3	97.55	129	√				√
L2h2	4	90.6	128	√				√
L2h2	5	107.2	128	√				√
L2h3	5	122.6	128		√			√
L2h3	13	82.39	128		√			√
L3h1	5	80.54	126		√	√		
L3h1	7	77.35	125		√	√		
L3h2	5	86.55	124		√	√		
L3h2	10	60.72	125	√				√
L3h3	2	177.9	128		√	√		
L3h3	5	125.3	128		√		√	
L3h3	7	97.95	129		√			√
L1t1	13	106.9	126		√	√		
L1t1	9	115.3	125		√		√	
L1t2	4	39.73	127		√			√
L1t2	6	23.32	125		√			√
L1t2	7	103.7	126		√			√
L1t2	11	120.1	127		√			√
L1t3	3	104.6	126	√		√		
L2t1	5	157.7	127		√			√
L2t1	11	102.4	128		√			√
L2t1	16	153.2	127		√			√
L2t1	20	214.2	126		√			√
L2t2	5	107	125	√				√
L2t2	13	132.6	125		√			√
L2t2	19	247.6	126	√				√
L2t2	20	307.3	126	√				√
L2t3	2	93.42	126		√	√		
L2t3	6	107.2	126	√				√
L2t3	9	77.3	127	√				√
L2t1	1	85.8	129	√		√		
L2t1	5	57.13	129	√				√
L2t2	4	97.54	128		√			√
L2t3	1	140	126		√	√		
L2t3	3	102	127	√				√

Obtained plants in M_1 which shows in Table 1 were planted to get a second and third generation. The number of plants which maintain the mutations in M_2 and M_3 are shown in Table 2.

Table 2. Number of plants which have mutation in different generation

Radiation				chemical				electric shock			
	M1	M2	M3		M1	M2	M3		M1	M2	M3
L1r1	22	8	4	L1h1	7	8	6	L1t1	5	4	2
L1r2	20	4	2	L1h2	11	8	4	L1t2	5	8	4
L2r1	15	8	4	L1h3	8	6	4	L1t3	5	3	1
L2r2	14	8	4	L2h1	19	8	4	L2t1	18	6	4
L3r1	14	4	1	L2h2	20	8	3	L2t2	13	7	4
L3r2	16	4	2	L2h3	3	6	2	L2t3	7	7	3
				L3h1	21	5	2	L3t1	10	6	2
				L3h2	20	6	2	L3t2	8	4	1
				L3h3	14	5	3	L3t3	10	6	2

Results in Table (2) shows that the numbers of plants which maintain of mutations until the third generation were 70 plants.

The means and variances of the mutants which cached from all mutagenic treatment were calculated and compared with that of the same number of plants representing control treatment for the two main traits i.e. seed yield/plant and number of days from sowing to flowering (Table 3).

Effect of Gamma rays:

Data in Table (3) and Fig. 1 and 2 shows that Gamma rays led to obtain early plants in flowering. Line No.2 was more response to treatment of gamma rays than another genotypes in flowering date.L_2r_1 gave the earliest (127.5 day) plants its early 5 days compared with untreated plants L_2 (132.67 day). In general, treatment r_1 was more effective than another to induce mutation and gave mutant with early flowering.

All plants which maintain the mutations until M3 were surpassed untreated plants in seed yield. Line No. 3 was most responsive to radiation and plants of L_3 r_2 and L_3 r_1 were given 112.13 and 105.01 g of seed yield, respectively compared with 40.28 g obtained from untreated plants. So, the increasing percentage from untreated plants was 179.04 and 161.67%, respectively.

Line No.2 occupied the second place about the responsive to radiation. L_2r_2 and L_2r_1 gave 89.96 and 74.30 g, respectively, compared with 31.51 g obtained from untreated plants. Mutants L_2r_2 and L_2r_1 surpassed original plants in seed yield /plant with 185.49 and 135.49 %, respectively.

Table 3. Means and variances for safflower genotypes under different treatments of mutagenic through generation.

Radiation

Lines (characters)	Seasons / treat.	N.D.F means ± S.E M1	N.D.F means ± S.E M2	N.D.F means ± S.E M3	N.D.F variance M1	N.D.F variance M2	N.D.F variance M3	S.Y /P means ± S.E M1	S.Y /P means ± S.E M2	S.Y /P means ± S.E M3	S.Y /P variance M1	S.Y /P variance M2	S.Y /P variance M3
L1	r1	130.44±0.12	127.75±0.31*	127.21±1.06*	0.26*	0.79*	8.98*	66.69±6.04*	34.43±2.73*	71.05±6.48*	655.95*	59.41*	1006.49*
	r2	128.23±0.12*	128.25±0.48	128.42±0.71	0.19*	0.92*	2.00*	80.31±10.18*	23.32±5.46	93.07±9.61*	1517.37*	119.05*	1107.71*
	Cont.	130.33±0.33	129.6±0.24	130.67±0.33	0.33	0.3	0.33	26.45±0.39	25.7±0.21	62.87±0.39	0.6	0.18	0.6
L2	r1	127.43±0.20*	126.88±0.44*	127.54±0.51*	0.29*	1.55*	1.81*	70.52±7.67*	31.55±7.11*	74.3±9.98*	411.788*	404.32*	2389.88*
	r2	129.3±0.15	130±0.38	130.21±0.56	0.23*	1.14*	2.50*	60.24±8.83*	51.64±3.95*	89.96±9.96*	779.55*	124.53*	2379.82*
	Cont.	130.67±0.33	132.25±0.48	132.67±0.67	0.33	0.92	1.33	15.11±0.42	12.12±0.70	31.51±0.42	0.71	1.97	0.71
L3	r1	128.88±0.13	129.5±0.29	127±0.89*	0.125	0.33*	4.00*	109.53±17.54*	25.06±2.73*	112.13±10.10*	2461.69*	29.84*	1223.15*
	r2	127.6±0.04*	128.5±0.29*	128.25±0.48	0.02	0.33*	0.92*	81.76±6.8*	46.61±3.18*	105.01±14.60*	461.99*	40.32*	2345.83*
	Cont.	130.25±0.48	130.5±0.50	130.33±0.33	0.92	0.5	0.33	8.89±0.32	8.25±0.50	40.28±0.32	0.4	0.51	0.4

Chemical

Lines (characters)	Seasons / treat.	N.D.F means ± S.E M1	N.D.F means ± S.E M2	N.D.F means ± S.E M3	N.D.F variance M1	N.D.F variance M2	N.D.F variance M3	S.Y /P means ± S.E M1	S.Y /P means ± S.E M2	S.Y /P means ± S.E M3	S.Y /P variance M1	S.Y /P variance M2	S.Y /P variance M3
L1	h1	125.73±0.15*	122±0.57*	116.83±0.40*	0.49*	0.57*	1.27*	115.51±8.65*	17.8±2.90	93.2±12.54*	1644.35*	67.17*	3299.83*
	h2	124.25±0.14*	121.38±0.18*	120.92±0.38*	0.41*	0.27*	1.14*	43.41±6.74*	24.64±1	127.17±8.28*	908.49*	7.93*	1645.95*
	h3	127.93±0.18	125.5±0.22*	125.5±0.48*	0.50*	0.30*	1.37*	64.41±7.39*	23.13±3.78	90.8±8.39*	820.05*	85.54*	1055.14*
	Cont.	130.33±0.33	129.6±0.24	130.67±0.33	0.33	0.3	0.33	26.45±0.39	25.7±0.21	62.87±0.39	0.6	0.18	0.6
L2	h1	127.43±0.20*	121.38±0.18*	127.33±0.31*	0.57*	0.27	0.79	101.28±10.80*	27.72±1.38*	53.51±4.09*	1634.32*	15.25*	385.25*
	h2	128.36±0.20	125.5±0.33*	130±0.38	0.55*	0.86*	1.14	128.06±12.87*	36.67±2.74*	47.67±3.96*	2318.34*	60.03*	375.72*
	h3	128.19±0.16	130.5±0.22	128.56±0.22	0.43*	0.3	0.3	118.65±13.61*	24.03±5.43*	58.2±6.67*	2961.72*	176.68*	800.69*
	Cont.	130.67±0.33	132.25±0.48	132.67±0.67	0.33	0.92	1.33	15.11±0.42	12.12±0.70	31.51±0.42	0.71	1.97	0.71
L3	h1	125.71±0.29*	129.8±0.49	126.83±0.56*	0.57	1.20*	1.87*	83.12±6.37*	46.84±12.99*	97.29±9.66*	283.71*	844.32*	1679.81*
	h2	124.27±0.27*	128±0.26*	125.5±0.67*	0.82	0.40*	2.67*	102.05±11.07*	37.16±4.72*	73.52±6.89*	1347.04*	133.84*	854.81*
	h3	127.88±0.23*	132.6±0.24	128±0.49	0.41	0.30*	1.20*	140.23±18.16*	30.91±4.43*	97.32±6.65*	2638.70*	98.29*	530.82*
	Cont.	130.25±0.48	130.5±0.50	130.33±0.33	0.92	0.5	0.33	8.89±0.32	8.25±0.50	40.28±0.32	0.4	0.51	0.4

Electric shock

Lines (characters)	Seasons / treat.	N.D.F means ± S.E M1	N.D.F means ± S.E M2	N.D.F means ± S.E M3	N.D.F variance M1	N.D.F variance M2	N.D.F variance M3	S.Y /P means ± S.E M1	S.Y /P means ± S.E M2	S.Y /P means ± S.E M3	S.Y /P variance M1	S.Y /P variance M2	S.Y /P variance M3
L1	t1	125.21±0.21*	124.5±0.19*	127±0.48*	0.84*	0.14*	0.92*	136.17±14.40*	9.55±1.08	94.21±19.13*	3942.30*	4.63*	3292.67*
	t2	127.20±0.20*	126.88±0.23*	127.21±0.33*	0.8*	0.41*	0.86*	88.02±9.14*	38.07±6.39*	100.05±9.16*	1672.35*	327.10*	1929.43*
	t3	126.67±0.33*	125.67±0.33*	126.33±0.33*	0.33*	0.33*	0.33*	65.63±29.64*	16.41±4.34	90.4±12.03*	2635.70*	56.63*	1302.10*
	Cont.	130.33±0.33	129.6±0.24	130.67±0.33	0.33	0.3	0.33	26.45±0.39	25.7±0.21	62.87±0.39	0.6	0.18	0.6
L2	t1	127.81±0.16	125.83±0.31*	125.5±0.37*	0.56*	0.57	0.8	155.25±10.39*	20.44±1.41*	104.64±6.40*	2635.70*	11.88*	738.38*
	t2	125.2±0.14*	127±0.31*	127.05±0.22*	0.38*	0.67	0.33	180.68±20.51*	25.88±5.65*	75.4±7.48*	8413.09*	223.1*	1119.04*
	t3	126.14±0.25*	127.14±0.34*	127.33±0.22*	0.9*	0.81	0.3	115.7±6.82*	15.67±1.79	128±10.63*	650.23*	22.38*	2373.69*
	Cont.	130.67±0.33	132.25±0.48	132.67±0.67	0.33	0.92	1.33	15.11±0.42	12.12±0.70	31.51±0.42	0.71	1.97	0.71
L3	t1	129.2±0.37	128±0.37	128.5±0.31	0.7	0.8*	0.57*	76.94±6025*	50.5±5.31*	102.96±7.13*	650.23*	169.19*	914.13*
	t2	128.4±0.51	129.75±0.48	130±0.29	1.3*	0.92*	0.33*	113.17±12.27*	45.31±12.37*	100.92±9.63*	753.34*	612.20*	1112.72*
	t3	126.2±0.20*	126.67±0.49*	127±0.83*	0.2	1.47*	4.17*	122.63±7.70*	27.88±1.22*	49.42±2.70*	296.12*	8.93*	130.74*
	Cont.	130.25±0.48	130.5±0.50	130.33±0.33	0.92	0.5	0.33	8.89±0.32	8.25±0.50	40.28±0.32	0.4	0.51	0.4

In spite of Line No.1 gave the highest seed yield (62.87g), but it was taken the third place about responsive to radiation treatments. L_1r_2 and L_1r_1 gave 93.07 and 71.05 g, respectively, compared with 62.87 g obtained from untreated plants. Mutants L_1r_2 and L_1r_1 surpassed original plants in seed yield /plant with 48.04 and 13.01 %, respectively.

Results obtained from effect of radiation illustrate that; treatment r_2 was more effective than another to induce mutation and gave mutant with high yielding. The results agreed with those of Mia and Shaikh (1997) and Sheeba *et al*. (2005).

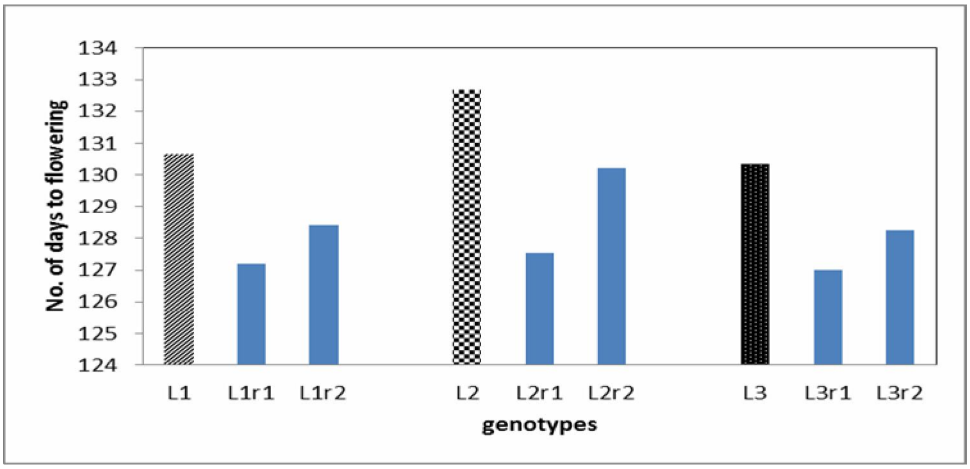

Fig.1: Number of days to flowering of safflower genotypes under different gamma rays treatments

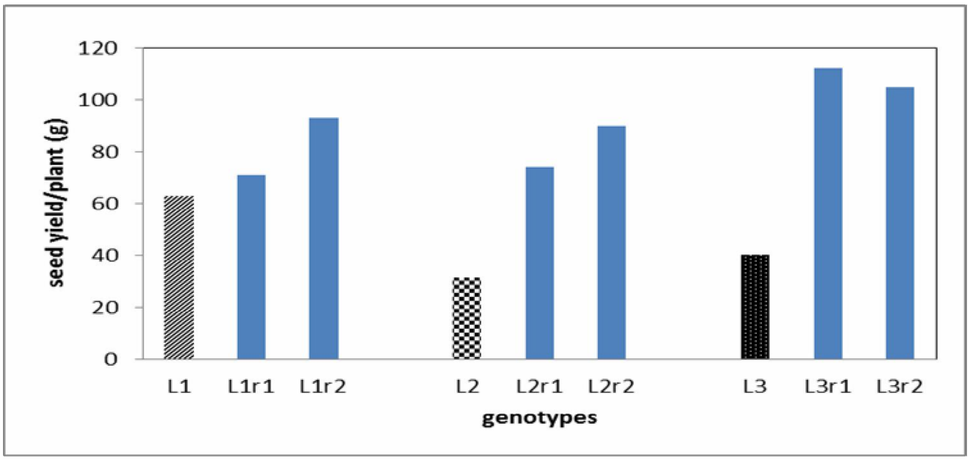

Fig.2: Seed yield/ plant of safflower genotypes under different gamma rays treatments

The parent-offspring regression coefficients values (Table 4) represent heritability in narrow sense reached 0.51 and 0.68 for N.D.F and -0.19 and 0.02 for S.Y/plant of M_2 and M_3 generation respectively.

Effect of Chemical treatments:

Results in Table (3) and Fig. 3 and 4 illustrated that Line No.1 was more response to chemicals treatment about flowering than another genotypes and its gave early flowering plants.L_1h_1, L_1h_2 and L_1h_3 gave the earliest (113.83,120.92 and 125.5 day, respectively) plants its earlier 13.84, 9.75 and 5.17 days, respectively, than untreated plants L_1 (132 .67 day). In general, treatment r_1 was more effective than another to induce mutation and gave mutant with early flowering.

All plants which maintain the mutations until M3 were surpassed untreated plants in seed yield. The highest seed yield /plant (127.17 g) was obtained from L_1h_2, but untreated plant L_2 gave 62.87 g. So, L1h2 surpassed untreated plants with 102.27% for seed yield / plant.

Line No.3 occupied the second place in seed yield/plant. Where, both of L_3h_1 and L_3h_2 gave 97.3g. This means that L_3h_1 and L_3h_2increased 142.5 % in seed yield/plant more than L_3 which gave 40.3 g. This result coincides with Dhole *et al*. (2003).

The parent-offspring regression coefficients values (Table 5) represent heritability in narrow sense reached 0.72 and 0.89 for N.D.F and 0.10 and -1.07 for S.Y/plant of M_2 and M_3 generation respectively.

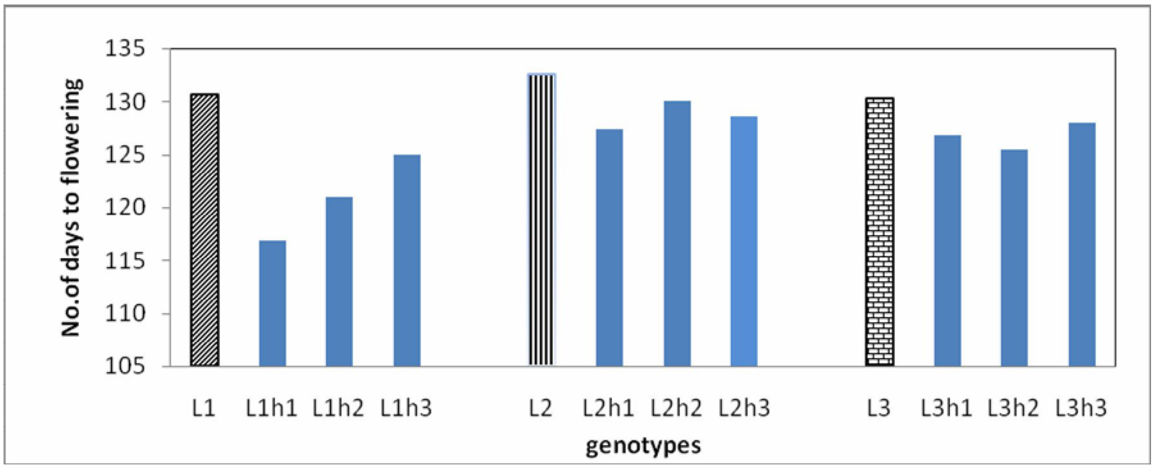

Fig.3: Number of days to flowering of safflower genotypes under different chemical treatments

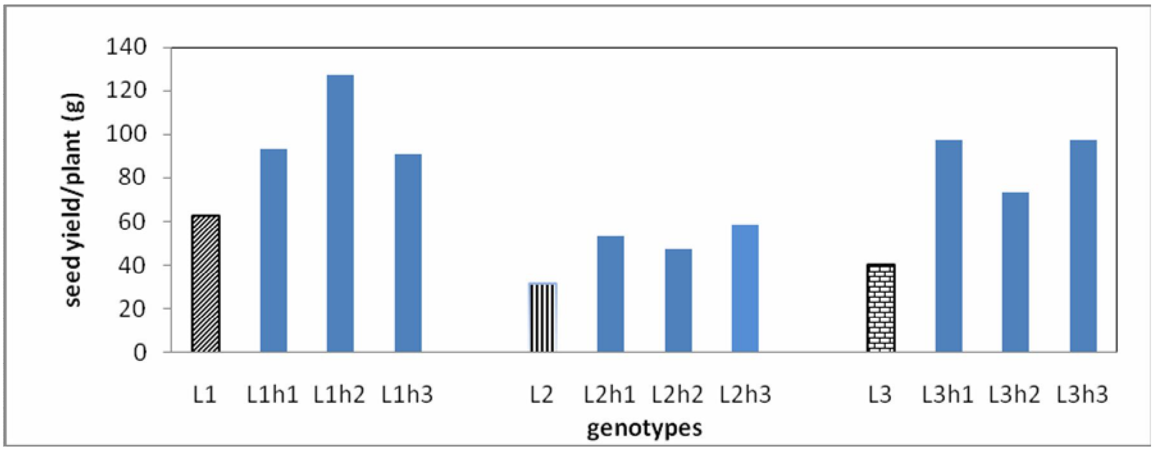

Fig.4: Seed yield/ plant of safflower genotypes under different chemical treatments

Effect of Electric shock:

Using of electric shock caused to obtain early plants in flowering from all genotypes. Results in Table (3) and Fig. 5 and 6 revealed that the earliest plants were obtained from L_2t_1 (125.5 day). L_2t_1 was earlier 12.53 days than untreated plants L_2 (132.67 day).

All plants which maintain the mutations until M3 were surpassed untreated plants in seed yield. Line No. 2 was most responsive to electric shock and gave plants with high seed yield/plant. Average of seed from treated plants was 95, 102.7 and 84.7 from treated plants of L_1,L_2 and L_3 respectively. The highest seed yield (128g) was obtained from L_2t_3 with percentage of increasing 306.22 % from seed yield of untreated plants (31.51 g). This result coincides with (Ahmad 2011) when used electric shock on wheat.

The parent-offspring regression coefficients values (Table 6) represent heritability in narrow sense reached 0.59 and 0.70 for N.D.F and -0.10 and -0.49 for S.Y/plant of M_2 and M_3 generation respectively.

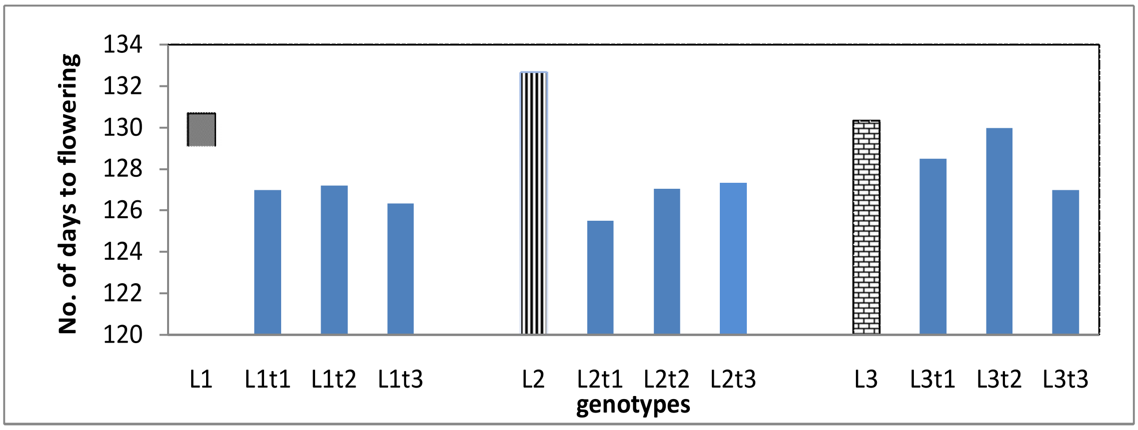

Fig.5: Number of days to flowering of safflower genotypes under different electric shock treatments

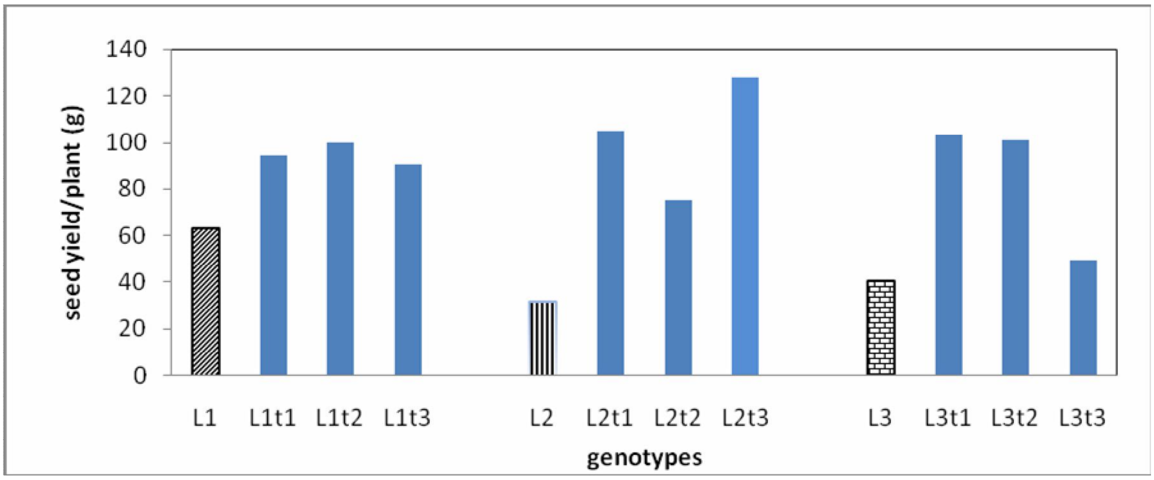

Fig.6: Seed yield/plant of safflower genotypes under different electric shock treatments

Table 4. The morphological variation and parent-offspring regression in mutated plants derived from gamma rays treatments

Characters / genotype	N.D.F.F			S.Y/P			
	M1	**M2**	**M3**	**M1**	**M2**	**M3**	**color flower- Texture plant**
line 32 (L1)	130.33	130.55	130.67	26.45	25.70	62.87	thorns - yellow
line 37 (L2)	131.23	132.25	132.67	15.11	12.12	31.51	thorns - yellow
line40 (L3)	130.9	131	130.33	8.89	8.25	40.28	thorns - yellow
L1 r1-3	130	127	127	78.48	49.73	84.77	thorns - orange
L1 r1-4	129	127	128	42.70	63.16	111.42	thorns - yellow
L1 r1-10	130	127	128	56.37	67.28	117.33	thorns - orange
L1 r1-16	130	128	127	51.84	47.33	53.12	sleek -orange
L1 r2-6	128	128	128	69.74	61.70	102.45	sleek -orange
L1 r2-12	129	128	128	28.12	36.27	78.41	thorns - orange
L2 r1-1	127	126	127	61.51	39.79	50.52	sleek -orange
L2 r1-3	128	126	128	57.13	89.42	96.50	sleek - yellow
L2 r1-6	127	126	127	75.99	44.17	75.55	sleek -orange
L2 r1-7	128	127	127	37.39	44.34	67.63	sleek -orange
L2 r2-7	129	130	130	29.79	81.52	100.56	sleek - red
L2 r2-8	130	130	129	65.90	62.87	60.12	sleek -orange
L2 r2-9	129	129	130	26.47	56.51	150.12	sleek - yellow
L2 r2-10	129	130	130	20.74	74.70	75.17	sleek -orange
L3 r1-7	128	129	130	67.99	30.65	137.99	sleek -orange
L3 r2-1	127	128	128	102.75	47.11	190.45	thorns - yellow
L3 r2-3	128	128	127	99.63	51.62	99.74	thorns - orange
regression coefficients		0.51	0.68		-0.19	0.02	

Table 5. The morphological variations and parent-offspring regression in mutated plants derived from chemicals treatments

Characters / genotype	N.D.F.F			S.Y/P			
	M1	M2	M3	M1	M2	M3	color flower- Texture plant
line 32 (L1)	130.25	130.57	130.67	26.45	16.7	62.87	thorns -yellow
line 37 (L2)	131.34	126.84	132.67	15.11	12.12	31.51	thorns- yellow
line40 (L3)	130.25	126.53	130.33	8.89	8.25	40.28	thorns - yellow
L1h1-4	125	121	117	32.28	22.80	157.21	sleek - yellow
L1h1-6	125	121	116	16.11	28.23	139.51	sleek - yellow
L1h1-9	126	120	116	59.15	39.95	83.78	sleek- orange
L1h1-10	125	123	116	65.16	26.03	93.99	sleek- orange
L1h1-11	127	121	117	85.87	31.50	56.51	sleek -orange
L1h1-15	125	122	116	28.29	16.60	247.33	thorns- yellow
L1h2-6	125	121	120	9.90	29.87	91.21	sleek -orange
L1h2-8	124	121	120	44.79	34.91	119.87	sleek - red
L1h2-11	124	123	121	19.04	32.84	124.73	sleek - yellow
L1h2-20	126	121	122	19.05	27.57	168.34	sleek -orange
L1h3-4	127	125	126	39.68	35.95	167.64	sleek -orange
L1h3-6	128	126	126	34.20	50.48	89.54	sleek -orange
L1h3-8	126	126	125	39.85	50.12	125.33	sleek -orange
L1h3-12	128	125	125	44.26	34.29	66.29	sleek - yellow
L2h1-7	127	122	127	70.66	43.26	80.33	thorns -orange
L2h1-8	127	121	128	78.89	34.48	63.48	thorns - orange
L2h1-10	128	122	128	112.24	30.93	105.05	thorns - yellow
L2h1-12	128	121	127	132.75	39.53	32.27	thorns- yellow
L2h2-3	129	126	130	97.55	59.93	62.69	thorns -yellow
L2h2-4	128	125	129	90.60	51.83	95.72	thorns- yellow
L2h2-5	128	125	129	107.21	45.72	73.16	thorns - yellow
L2h3-5	128	130	128	122.56	47.36	65.74	sleek - yellow
L2h3-13	128	129	129	82.39	29.74	120.46	sleek - yellow
L3h1-5	126	129	127	80.54	91.25	133.85	sleek- orange
L3h1-7	125	129	126	77.35	28.58	203.31	sleek- orange
L3h2-5	124	128	125	86.55	43.63	90.35	sleek -orange
L3h2-10	125	128	126	60.72	41.94	134.50	thorns- yellow
L3h3-2	128	130	128	177.9	31.50	138.89	sleek -orange
L3h3-5	128	130	129	125.28	51.58	103.88	sleek - red
L3h3-7	129	129	128	97.95	47.65	109.77	sleek - yellow
regression coefficients		0.72	0.89		0.10	-1.07	

Table 6. The morphological variations and parent-offspring regression in mutated plants derived from electric shock treatments

Characters / genotype	N.D.F.F			S.Y/P			
	M1	M2	M3	M1	M2	M3	color flower- Texture plant
line 32 (L1)	130.19	129.39	130.67	26.45	16.70	62.67	thorns - yellow
line 37 (L2)	131.23	132.43	132.67	15.11	12.12	31.51	thorns- yellow
line40 (L3)	130.15	130.55	130.33	8.89	8.25	40.28	thorns- yellow
L1t1-13	126	125	127	106.90	16.42	215.72	sleek -orange
L1t1-9	125	124	126	115.25	20.22	112.07	sleek - red
L1t2-4	127	126	127	39.73	55.69	123.99	sleek- yellow
L1t2-6	125	127	126	23.32	84.24	137.39	sleek- yellow
L1t2-7	126	126	125	103.70	52.88	78.15	sleek - yellow
L1t2-11	127	126	127	120.09	64.56	86.40	sleek - yellow
L1t3-3	126	125	126	104.64	21.12	133.99	thorns - orange
L2t1-5	127	125	125	157.65	30.47	145.86	sleek - yellow
L2t1-11	128	126	126	102.35	24.46	100.80	sleek -yellow
L2t1-16	127	125	125	153.22	27.65	90.24	sleek - yellow
L2t1-20	126	126	126	214.21	32.63	87.71	sleek - yellow
L2t2-5	125	126	127	107.00	66.04	145.73	thorns yellow
L2t2-13	125	126	128	132.58	31.21	58.42	sleek- yellow
L2t2-19	126	126	127	247.60	34.23	118.57	thorns- yellow
L2t2-20	126	127	127	307.30	32.18	130.64	thorns- yellow
L2t3-2	126	127	127	93.42	14.47	202.13	sleek- orange
L2t3-6	126	127	128	107.21	29.56	183.5	thorns- yellow
L2t3-9	127	128	127	77.30	22.84	251.36	thorns - yellow
L2t1-1	129	128	128	85.80	74.33	145.33	thorns orange
L2t1-5	129	129	129	57.13	53.59	140.33	thorns - yellow
L2t2-4	128	129	130	97.54	16.09	154.33	sleek -yellow
L2t3-1	126	126	127	139.98	33.73	50.50	sleek -orange
L2t3-3	127	126	128	102.00	26.59	78.53	thorns -yellow
regression coefficients		0.599	0.70		-0.10	-0.49	

Conclusion:

Using of different mutagen treatment was effective tools to obtained new safflower genotypes, spineless, earliness and high seed yield. We can used this new genotypes in breeding program to obtain new varieties are suitable for cultivation at reclaimed desert lands as a new oil crops in Egyptian agriculture.

Reference

Ahmad, M.S. (2011). A new technique for induction of mutations in plant (induction of mutation in bread wheat) Egypt. J. Plant Breed(15) 2: 193-205.

Dhole, V. J.; J.J. Maheshwari and Shanti Patil (2003). Studies on mutations induced by EMS in soybean (*Glycinemax* L.) Agricultural Science Digest, 23(3): 226-228.

Fahmy, E.M.; M.A. Rashed; M.T.M. Sharabash and A.H.A. Hammad (1997). "Effect of gamma rays on yield and its components for some soybean cultivars (*Glycine max* L. Merill)". Arab Universities Journal of Agricultural Sciences, 5: 57-68.

FAOSTAT, (2006). FAO Statistical Databases, http://apps.fao.org.

Geetha, K. and P. Vaidyanathan (1998). "Studies on induction of mutations in soybean (*Glycine max* L. Merill) through physical and chemical mutagens". Agricultural- Sciences Digest Karnal, 18:27-30.

Hajduch, M.; F. Debre.; B. Bohmova and B. Pretova (1999). "Effect of different mutagenic treatments on morphological traits of M2 generation of soybean". Soybean Genetics Newsletter .March 4pp; accessible via the World Wide Web at http:www.Soygenetics.Org. International Letters of Natural Sciences; 42:76-82.

Hassan, S.; M.A. Javed.; S.U.K. Khattak and M.M. Iqal (2001). "A high yielding better quality chickpea mutant variety (NIFA-95)". Mutation Breeding Newsletter, 45:6-7.

Kharkwal, M.C. (2000). "Induced mutations in Chickpea (*Cicer arietinum* L.) IV. Types of macromutation induced". Indian Journal of Genetics, 60:305-320.

Mia, M.F.U. and M.A.Q. Shaikh (1997). Induction of large seeded mutants in groundnut (*Arachis hypogaea* L.) SABRAOJ, 29:103-104.

Mihov, M.; A. Mehandjiev and M. Stoyanova (2001)."Mutagenesis as a breeding method in lentil". Mutation Breeding Newsletter, 45:32-34.

Sheeba, A.; J. Anbumalarmathi. ; S. Babu and S.M. Ibrahim. (2005). Mutagenic effect of gamma rays and EMS in M1generation in sesame (*Sesamum indicum* L.). Research on Crops, 6:303-306.

Solanki, I.S. and B. Sharma (1999). "Induction and exploitation of polygenic variability in lentil". Journal of Genetics and Breeding, 53: 79 - 86.

Soliman, S.S.A.; M.S. Eisa.; T.A. Ismail.; A. Nadia.; Naguib and F.E Azza (2003). "Induction of salt tolerance mutants in Faba bean (*Vicia faba* L.). Promising line mutants under saline and normal soil condition". Zagazig J. Agric. Res, 30:213-229.

Sujatha, M. (2007). "Advances in safflower biotechnology". Functional Plant Science and Biotechnology. Global Science Books. Ed. Texeira Da Silva, 1:160-170.

Velasco, L.; B. Perez-Vich and J.M. Fernandez-Martinez (2005). "Identification and genetic characterization of a safflower mutant with a modified tocopherol profile". Plant Breeding, 124:459–463.

Wani, A.A. and M. Anis (2001). "Gamma rays induced bold seeded high yielding mutant in Chickpea". Mutation Breeding Newsletter, 45:20-21.

إستحداث الطفرات فى بعض الطرز الوراثية للقرطم

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الملخص

أجرى هذا البحث بالمزرعة التجريبية البحثية بكلية الزراعة جامعة الأزهر–فرع أسيوط خلال ثلاث مواسم شتوية ٢٠١٤/٢٠١٣، ٢٠١٥/٢٠١٤، ٢٠١٦/٢٠١٥ بهدف استحداث طفرات فى القرطم ، تم استخدام مطفر فيزيائى وهو أشعه جاما بجرعات (٢٠،١٠ كيلو راد)، واستخدم مطفر كيميائى وهو الداى ميثيل سلفوكسيد بتركيزات (١٠٠٠ ، ٢٠٠٠ ، ٣٠٠٠ جزء فى المليون)، واستخدام مطفر كهربى فى وجود محلول كيميائى أحادى فوسفات الصوديوم بتركيزات (٣٠ ، ٥٠ جم / لتر)، نترات الصوديوم بتركيز (٥٠ جم / لتر) وذلك على ثلاث سلالات من القرطم هى سلاله ٣٢، سلاله ٣٧، سلاله ٤٠. أوضحت النتائج أن الداى ميثيل سلفوكسيد (مطفر كيميائى) كان أكثر فاعلية من أشعة جاما والمطفر الكهربى وفقا للنتائج النهائية فى الجيل الثالث الطفرى. أكدت النتائج أن السلاله٣٢ كتركيب وراثى كانت أكثر استجابه لاستحداث الطفرات عن باقى الطرز الوراثية. فيما يتعلق بالمحصول العالى وتبين وجود طفرات عديمة الأشواك، مبكرة عن الطراز الأبوي.

أبكر نباتات من حيث التزهير (١١٦,٨٣ يوم) تم الحصول عليها من نباتات L1h1 فى حين أعلى محصول بذور للنبات (١٢٨و ١٢٧,١٧ جم/نبات) تم الحصول عليه من نباتات L2h3 و L1h2 على التوالى.

أوضحت النتائج انه يمكن باستخدام المطفرات الحصول على طرز وراثية جديدة خاليه من الأشواك ومبكرة ومرتفعة المحصول يمكن الاستفادة بها في برامج التربية للحصول على أصناف جديدة تصلح للزراعة فى الأراضي الصحراوية المستصلحة.