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STATISTICAL ESTIMATES OF THE MAIN CHARACTERISTICS OF SESAME MUTATED GENERATIONS

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ABESTRACT

Three field experiments were carried out at the Experimental and Research Station, Faculty of Agriculture, Cairo University in Giza during 2001, 2002 and 2003 seasons to study the effect of some mutagens on morphological and yield traits of sesame and to estimate the genotypic and phenotypic coefficients of variation, broad sense heritability and genetic advance from selection for several important traits in sesame mutant populations (M_2 and M_3 generations). Two commercial cultivars viz., Giza 32 and Toshka 1 were treated with (gamma rays) and ethyl methane sulphonate (EMS) mutagens. The results revealed significant differences among the mutagenic treatments across mutated generations with regard to their effect on plant characteristics under study. The results indicated that sesame cultivars may be treated safely at 400 Gy and 500 Gy (gamma rays) and at 0.5 and 1.0% (EMS), and for obtaining positive mutations. Selection of mutants in the segregating M_2 generation exhibited a number of useful sesame mutants. These mutants include: mutants with plant habit (determinate), short flowering period-type (early maturing) and mutants with more capsules per plant, long capsule, multi capsules per leaf axil, multi carpellate, shortened internodes and semi shattering capsule. Coefficient of variability indicated that seed yield per plant, number of capsules per plant, number of fruiting branches, flowering date and fruiting zone length were greatly affected by mutagens than oil content and 1000-seed weight. Estimates of phenotypic coefficient of variability (PCV) was generally higher than the genotypic coefficient of variability (GCV) for all studied traits but the difference was small, indicating little influence of environment in the expression of these characters. The PCV and GCV estimates were the highest for number of capsules per plant and seed yield per plant. Low values in this respect were recorded for days to flowering, 1000-seed weight and seed oil content. Estimates of correlation coefficients revealed that highly significant and positive correlations were found between seed yield per plant and each of number of capsules per plant, fruiting zone length, number of fruiting branches and plant height, suggesting that seed yield per plant is a function of these parameters and selection based on these traits could further improve the yield potential. High heritability and genetic advance estimates were observed for plant height, number of branches per plant, number of capsules per plant and seed yield per plant in M_2 and M_3 generations, indicating the effectiveness of selection for the improvement of these traits.

Keywords: Sesame, mutagens, gamma rays, ethyl methane sulphonate (EMS), correlation, heritability, genetic advance.

INTRODUCTION

Sesame (*Sesamum indicum* L.) produces seeds, which are rich in both protein and oil. It is a source of good quality vegetable oil with antioxidative constituents, i.e. sesamolin, sesamin and sesamol. Egypt has been facing a drastic shortage of edible oil and only 8 percent of its total consumption is met through local production. This wide gap between production and consumption is a serious threat to the economy of Egypt. This gap will continue to be increased for coming years mainly due to the high population growth rate. So, it is imperative to increase the domestic production of edible oil to curtail down the import expenses. However, to fulfill this wide gap, it is absolutely essential to increase our local production of edible oil. So high yielding varieties of oil crops with good plant characteristics are needed.

The use of mutagens in crop improvement helps to understand the mechanism of mutation induction and to quantify the frequency as well as the pattern of changes in different selected plants by mutagens. Mutation breeding generates a knowledge base that guides future users of mutation technology for crop improvement.

Mutation is often induced through physical mutagens such as X-rays, gamma rays, fast neutrons, thermal neutrons, ultraviolet and beta radiations (Elliot, 1958). In addition to physical mutagens, a large number of chemical mutagens are also used to induce mutations in crop plants. Most of these belong to the special class of alkylating agents and include ethyl methane sulphonate (EMS), diethyl sulphate (DES), ethylene imine (EI), ethyl nitroso urea (ENU) and methyl nitroso urea (MNU) (Siddiqui, 1994).

The mutation breeding is one of the most effective techniques of plant improvement. In mutagenesis, the choice of mutagen is the most important factor and various methods have been developed to ascertain the most effective and efficient mutagens and mutagenic treatments for the induction of desirable characters in a cultivated crop.

Sheeba *et al*. (2005), reported that more than 50% reduction in germination in higher dosages of gamma rays (60 and 70 Krad) and EMS (1.4 and 1.6%), and noted that the mean values for productive traits showed a proportional increase and reached maximum at a medium dose of gamma rays (50 Krad) and EMS (1.0%).

Plant–induced mutation is an effective method for increasing genetic variability and developing new varieties. In sesame, many mutants and varieties have been developed by gamma rays or chemical mutagens (Ibrahim *et al*., 1983; Kobayashi, 1986; Murty and Dropeza, 1989; Ashri, 1998; Sorour *et al*., 1999; Sheeba *et al*., 2005; Mensah *et al.,* 2007).

Success in any breeding program depends on the amount of genetic variability present for the different characters in a population. The variability in quantitative characters increases considerably by treating the biological material with different mutagenic agents. In highly self-pollinated crops like sesame, where the variability is limited, this approach helps to generate a new variability. Heritability with genetic advance is of more value in predicting the effect of selection. So, the estimation of the extent of induced variability in M_2 and M_3 generations will be of great value for carrying out further selection.

To increase production of the crop, there is a need to have a better understanding of its genetic background. However, there is paucity of information on the locally cultivated varieties, which lack variability because of their self-pollination status. The present study was therefore undertaken to assess the effect of two mutagens (gamma rays and ethyl methane

sulphonate) on sesame plant. Our hope was that the two mutagens would induce true variability to enable us to successfully select the best variants.
The objectives of this work were:

1. To study the effect of physical (gamma rays) and chemical (EMS) mutagens on morphological and yield traits of sesame and to select mutant lines having better characteristics than both the original cultivars Giza 32 and Toshka 1.
2. To estimate genetic parameters for several important traits in sesame mutant populations in M_2 and M_3 generations.

MATERIALS AND METHODS

This work included three experiments that were carried out at the field of Experimental Station, Fac. of Agric., Cairo University, Giza, Egypt during the three seasons of 2001, 2002 and 2003.

Plant materials and mutagen treatments:

Two local cultivars of sesame (*Sesamum indicum* L.); i.e. Giza 32 (brown seeded) and Toshka 1 (white seeded) were treated with physical (gamma rays) and chemical (Ethyl Methane Sulfonate, EMS) mutagens.

Dry seeds of the two cultivars were subjected to two doses of gamma rays, i.e. 400 and 500 Gy (Gy = Gray; 1 Gray = 10 Krad). The source of radiation used was ^{60}Co at the Atomic Energy Establishment at Inchass. Dose rate during treatments was 6.53 rad./sec.

Another set of two seeds of each cultivar, for each treatment were presoaked in distilled water for four hours and then treated with two concentrations of EMS, i.e. 0.5 and 1.0% for three hours. After the treatment, the seeds were thoroughly washed with tap water ten times.

Field Evaluation:

Treated and untreated seeds were planted in the next day in the field during 2001 to raise the M_1 generation. Untreated seeds of each cultivar were used as control. Germination (%) and plant height (cm) at maturity were recorded for determination of LD_{50}. Germination percentage was determined by dividing number of seedlings emerged in each treatment (fifteen days after sowing) on the total number of seeds sown, multiplied by hundred.

The mutation frequency for the materials grown in bulk was estimated by dividing the number of variants confirmed by the total number of M_2 plants for each treatment in the bulk population (Gaul, 1964).

Bulked seeds of each M_1 treatment were sown to raise M_2 generations during 2002 season. Single plant selections based on high seed yield and other yield dependent components were made from the M_2 generation. Each selected mutant was planted in a single row 5.0 m in length, keeping inter and intra-row spacing of 50 cm and 20 cm, respectively, in the succeeding generation (M_3) for their confirmation. Data for thirty six M_3 breeding lines were recorded on single plant basis for plant height, number of fruiting branches, stem height to the first capsule, fruiting zone length, number of capsules on main stem, number of capsules per plant, 1000- seed weight, seed yield per plant and seed oil%.

The rest seed of the M_2 generation for each treatment was bulked to grow M_3 generation in 2003 season. In successive generations, all the treated and control seeds were sown in a randomized complete blocks design with four replicates. Each treatment was sown in five rows (5 meters long and spaced 50 cm apart, where plants were 20 cm apart). Cultural practices were carried out as usually schemed. Ten guarded individual plants were taken at random from each treatment. Observations were recorded on the following characters: days to flowering, plant height, number of fruiting branches, number of capsules per plant, 1000–seed weight, seed yield per plant and seed oil content (%) for estimating variability. Oil percentage was determined using Soxhlet apparatus and hexan as solvent according to A.O.A.C. (1990).

Statistical analyses:

The data were subjected to analysis of variance and correlation coefficients were calculated according to (Steel *et al*., 1997). Genetic parameters were worked out following (Singh and Chaudhry, 1979). The phenotypic and genotypic variances were calculated from the variance components derived according to the pertinent means squares (MS) expectation of randomized complete blocks design. Data were statistically analyzed using the MSTAT-C software package (Freed *et al.,* 1989).

Statistics such as means, phenotypic (PCV) and genotypic (GCV) coefficients of variation were computed based on the method suggested by Singh and Chaudary (1979), as the following formula:

PCV = (Phenotypic standard deviation/mean value of the trait) x 100

GCV = (Genotypic standard deviation/mean value of the trait) x 100

The broad sense heritability percentages (h_b^2) and expected genetic advance (GA) were estimated for the studied characters using the method outlined by Johanson *et al.* (1955) as follows:

h_b^2 = (Genotypic variance / Phenotypic variance) x 100

The expected genotypic advance (GA) under selection as percentage of mean, assuming the extreme 5 percent of individuals are saved was calculated using the following formula:

GA = k x (phenotypic variance)$^{0.5}$ x h_b^2

Where ‘k’ is constant (which varies depending upon the selection intensity and, if the latter is 5%, it stands at 2.06), h_b^2 is the heritability (broad sense).

GA (as % of mean) = (GA/mean value) x 100

RESULTS AND DISSECTION

1. Physical (gamma rays) and chemical (EMS) sensitivity study:

1.1. Influence of different treatments on seed germination:

Germination (%) was reduced with the corresponding increases in physical (gamma rays) dose and chemical (EMS) concentration in both sesame commercial cultivars (Figure 1). More than 50% germination was recorded at 500 Gy and EMS 1.0 %. Almost the same pattern of reduction was observed at 400 Gy and EMS 0.5% in both cultivars but with less reduction at 500 Gy in cultivar Giza 32 as compared to Toshka 1. However, at 1.0% EMS, the reduction in germination percentage was almost parallel.

1.2. Influence of different treatments on plant height:

Reduction in plant height was observed in the treated as compared to the control population (Figure 2). The reduction in plant height was high, in corresponding to the higher dose in physical (gamma rays) and chemical (EMS) mutagens. Maximum reduction was noted by using 1.0% EMS in both of the sesame cultivars.

From the results of germination and plant height, it may be concluded that sesame cultivars may be treated safely at 400 Gy and 500 Gy (gamma rays) and at 0.5 and 1.0% (EMS) for obtaining positive mutations.

Studying the radio-sensitivity of sesame germplasm, Rajput *et al.* (1994) noted that the reduction effect on the germination percentage was not considerably greater up to 400 Gray (Gy). However, at 600 Gy and 800 Gy it was significantly reduced in all the varieties of sesame. They also observed a decreased plant height with the increase of dose. In some varieties, the inhibition in plant height was greater. However, in the present study; both varieties showed a similar trend of radio-sensitivity. Pathirana (1991) observed a reduction in germination in an irradiated population of sesame. He also noted similar trends in plant height. In another study, Pathirana (1994) noted that a 50% survival of germinated seeds was due to the range of 750-1000 Gy.

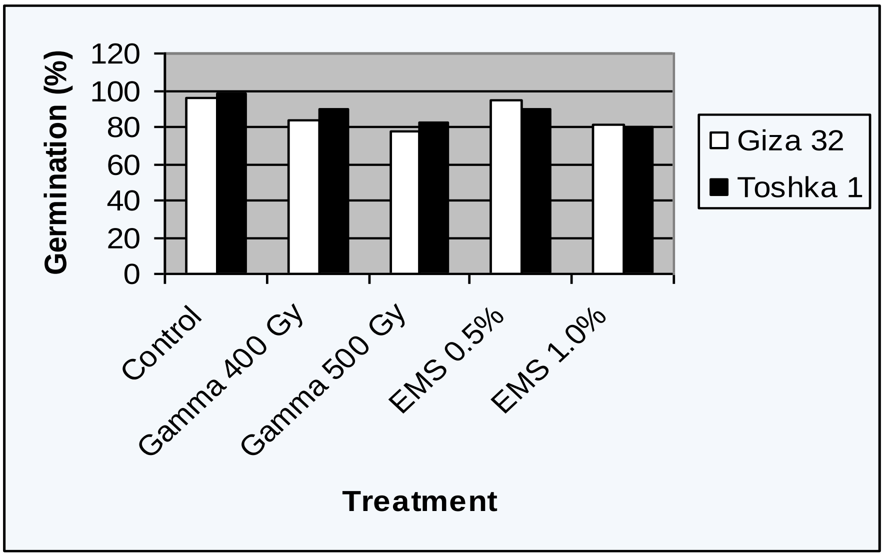

Figure (1). Germination (%) of sesame cultivars as affected by chemical and physical mutagens.

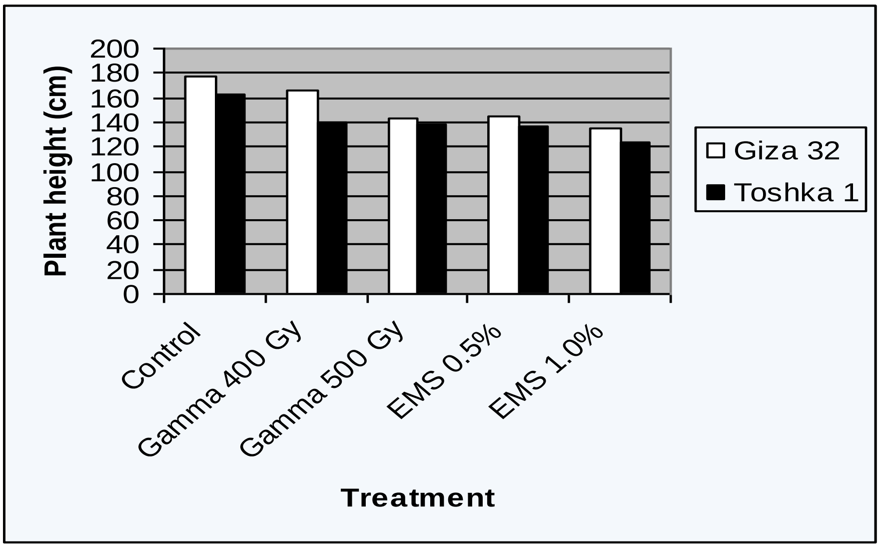

Figure (2). Plant height of sesame cultivars as affected by chemical and physical mutagens.

2. Mutants and mutagen:

A total of 215 variants were isolated from the M_2 population consisting of 11,619 plants. It has been observed from the present study that (gamma rays), is more lethal and caused more gross morphological changes or higher mutation frequency than chemical EMS (Ethyl Methane Sulfonate) mutagens.

Out of 4 different treatments, the dose of 400 Gy gamma rays was ideal with the highest mutation frequency (2.69% and 2.473%) for the commercial cultivars (Giza 32 and Toshka 1), in the M_2 (Table 1). The highest mutation frequency obtained via this dose, could be attributed to the mode of action of two different mutagens. The gamma rays could directly damage the DNA by heating (Gowda *et al*., 1996).

Table (1). Effect of different treatments of mutagens (gamma rays and EMS) on traits of sesame cultivars (Giza 32 and Toshka 1).

Treatment	Giza 32					
	M_1		M_2		M_3	
	Seed treated	Number of plants at harvest	Number of plants	Number of selected variants	Mutation Frequency %	N0. of true breeding mutants
Control	300	285	-	-	-	-
400 Gy gamma	300	231	1668	45	2.69	14
500 Gy gamma	300	211	1359	28	2.06	8
0.5 % EMS	300	235	1847	39	2.11	11
1.0 % EMS	300	206	1243	15	1.20	6
Total	-	1168	6117	127	2.07	39
	Toshka 1					
Control	300	274	-	-	-	-
400 Gy gamma	300	244	1356	33	2.43	11
500 Gy gamma	300	218	1232	20	1.62	9
0.5 % EMS	300	267	1689	24	1.42	8
1.0 % EMS	300	221	1322	11	0.83	4
Total	-	1224	5599	88	1.57	32

Among 215 variants in the M_2, 71 true breeding mutants for plant height, plant habit (determinant), plants with more capsules, long capsule, multi capsules per leaf axil, shortened internodes, different seed colour, seed size, semi shattering capsule and early maturing were isolated.

3. Selection and morphological characters of induced mutants:

A number of useful sesame mutants has been selected from the present study. Potential mutants suitable for the breeding objectives were selected after a careful screening during the vegetation period, carrying mutations for short flowering determinate growth habit, plants with more capsules, long capsule, multi capsules per leaf axil, shortened internodes, non-branching, multi carpellate, white seeded, large seeded, closed capsule, semi shattering capsule and early maturing. These mutants were selected in M_2 generation and maintained by selfing in M_3 generation.

In short flowering period determinate mutant, stem growth is interrupted by the start of flowering, which leads to a reduced flowering period with homogeneous capsule maturation. Determinate mutants may offer a good method of effectively manipulating plant height, reducing lodging because of their short stature. The short flowering period-type determinate mutant that was selected in the present study had large dense leaves and multi capsules per leaf axil. This mutant will need to be studied further to asses their exact growing habit and their potential use in breeding programs.
Short flowering period mutations leading to uniform maturation, which were induced by gamma rays and ethyl methan sulfonate (EMS), were also reported in Thailand (Wongyai, 1997).

Thirty nine mutants were originated from the commercial cultivar Giza 32 and thirty two mutants from Toshka 1. Moreover, photographs of some samples of the mutants are shown in Figures (3, 4 and 5).

4. Analysis of variance:

Data presented in (Table 2) revealed significant and highly significant differences between treatments with regard to plant characteristics under study. These results hold true for the successive generations, i.e. M_1, M_2 and M_3. The high degree of variability observed in M_1 generation might be attributed to the general genetic damage, happened by the direct effect of gamma–rays (Sorour *et al*., 1999). However, the highly significant variation detected in M_2 in the mutagenic populations derived from both mother commercial cultivars and expressed in all characters, is due to the induced genetic variability by the mutagen . Induced variability released in M_3 generation, however, seems less pronounced compared to those in M_1 and M_2 generations. This is expected since selection of mutant plants was practiced during M_2 generation, and M_3 populations represent off springs derived from non-selected M_2 plants (bulk).

Figure 3. Sequence of capsules in untreated Giza 32 (a), and Toshka 1 (b), multicapsules per leaf axil mutants (c, d and e), and multi carpellaet capsule mutant (f).

Figure 4. Capsules of untreated Giza 32 (a), long capsules mutant (b), and capsules of Toshka 1 (untreated).

Figure 5.Non-dehiscent mutant after harvest (a), and semi-dehiscent mutant (b).

Table (2). Mean squares of the studied traits in M_1, M_2 and M_3 generations.

Characters	Mean squares					
	Giza 32			Toshka 1		
	M_1	M_2	M_3	M_1	M_2	M_3
Flowering date (days)	522.56**	442.47**	311.63**	795.43**	563.48**	424.14**
Plant height (cm)	689.45**	514.77**	305.22**	843.45**	541.25**	395.40**
Fruiting branches per plant	11.59**	15.15**	6.42*	10.64**	16.14**	8.28*
Stem height to the first capsule (cm)	144.28**	229.47**	104.24**	198.14**	358.55**	148.66**
Fruiting zone length (cm)	548.29**	1214.17**	372.16**	678.88**	975.25**	312.57**
Capsules per plant	742.33**	2344.24**	358.42**	655.88**	1957.78**	297.60**
Capsules on the main stem	548.71**	768.81**	329.50**	684.11**	859.44**	459.99**
Seed yield per plant (g)	30.54**	35.24**	15.85**	45.68**	37.80**	19.77**
1000-seed weight (g)	0.14*	0.09*	0.08*	0.16**	0.11*	0.09*
Seed oil %	0.34**	0.21**	0.09*	0.26**	0.13**	0.08*

***, ** Significant at 0.05 and 0.01 probability levels, respectively.**

5. Correlations and coefficients of variability:

Knowledge of the interrelationships between seed yield and other characters is important to be able to practice effect selection (Ariyo, 1995).Consistent with this; efforts were made to evaluate the nature of interrelationships between different yield components. Data presented in Table 93) number of capsules per plant, fruiting zone length, number of fruiting branches and plant height showed highly significant and positive correlations with seed yield per plant. The highest estimates of correlation coefficients were obtained between seed yield and each of number of capsules per plant (0.75) followed by fruiting zone length (0.59), number of fruiting branches (0.56) and plant height (0.51). Implicit in this is that these parameters could be used as predictors of seed yield in selection programs. The correlation between yield and seed oil content was also positive but negligible. On the contrary, 1000-seed weight and flowering date showed a negative correlation coefficient with seed yield. These findings are in agreement with those of the earlier workers who found a positive association between single plant yield and number of capsules for sesame (Backiyarami *et al*., 1998).

Data presented in Table (3) revealed that the coefficient of variation was highest (38.09%) in the case of seed yield per plant followed by number of capsules per plant (35.69%), number of fruiting branches (28.19%), flowering date (24.04%) and fruiting zone length (22.72%). The lowest coefficient of variation was noted in oil content percent (0.08%) followed by 1000-seed weight (2.47%).

Table (3). Means, standard error and coefficient of variability (C.V. %) of studied traits and their correlations with seed yield in the M_3 generation of sesame (2003 season).

Characters	Mean	Standard error	C.V.%	Correlation with yield
Flowering date (days)	x	19.05	24.04	- 0.12
Plant height (cm)	172.26	8.16	16.80	0.51**
Fruiting branches	10.11	2.42	28.19	0.56**
Stem height to the first capsule (cm)	64.55	15.68	14.55	- 0.44*
Capsules per plant	2250	29.45	35.69	0.75**
Fruiting zone length (cm)	80.29	5.93	22.72	0.59**
1000-seed weight (g)	3.24	0.08	2.47	- 0.17
Seed oil content %	56.41	0.19	0.80	0.25
Seed yield per plant (g)	27.30	6.81	38.09	-

***, ** Significant at 0.05 and 0.01 probability levels, respectively.**

6. Phenotypic (PCV) and genotypic (GCV) coefficients of variability:

It is difficult to compare the variance among the range of various characters because they are not unit free (Baye, 1996). Thus, estimates of phenotypic coefficient of variability (PCV), and genotypic coefficient of variability (GCV), heritability (in broad sense) and genetic advance as a percentage of the mean were evaluated and compared (Tables 4 and 5). The genetic changes in quantitative characters could be realized with the increase in GCV in M_2 and M_3.

Data showed that the maximum PCV and GCV estimates for the number of capsules and seed yield per plant were recorded when using EMS (1.0%) and 500 Gy gamma in both generations.

The phenotypic (PCV) was generally higher than the genotypic (GCV) coefficient of variability for all studied traits, but the small difference between them indicated little influence of environment in the expression of characters. It is evident to note that the coefficient of variability could be divided into three groups, characters showing high values of PCV and GCV; i.e. number of capsules per plant and seed yield per plant , whereas plant height and number of fruiting branches had moderate values. Moreover, low values of PCV and GCV were recorded for days to flowering, 1000–seed weight and seed oil content. High GCV estimates indicate that worthwhile improvement could be achieved for such characters through simple selection. Although GCV provides information on the genetic variability present in various quantitative characters, it is not possible to determine the amount of the variation that was heritable from only the genotypic coefficient of variation.

7. Heritability and genetic advance:

Heritability and genetic advance from selection as a percentage of the mean for different characters in mutated generations of sesame are given in Tables (4 and 5). Concerning the heritability values it is clear that there were great differences among the different traits.

Characters could be grouped into two categories according to their heritability values as follows: (1) Characters of high heritability values including number of capsules per plant, 1000seed weight, seed yield per plant and oil content. (2) Characters of moderate heritability values including days to flowering, plant height and number of fruiting branches.

In the M_2 generation, estimates of broad sense heritability ranged from 41.44% for number of fruiting branches to 99.98% for seed oil content % and in the M_3 generation, they ranged from 53.17% for number of fruiting branches to 99.98% for seed oil content % across the two commercial cultivars (Tables 4 and 5).

In general, the high heritability estimates for most studied traits in the two generations indicated that environmental factors did not greatly affect phenotypic variation for such traits; rather genetic constitution of the varieties was responsible for the variation.

A high variance combined with a moderate to high heritability for economic traits such as number of capsules and seed yield per plant suggested that induced variability through mutation breeding can be exploited for improving such characters. In general, it was found that EMS (1.0%) in Giza 32 and Toshka 1 produced a high mean with a high variance. This enhanced variability in these genotypes due to mutagenic treatments provides an opportunity for selection and for further improvement in their characters.

From the results in Tables (4 and 5), genetic advance (GA) ranged from 0.32 % for days to flowering to 74.20% for number of capsules per plant in the M_2 generation. However, in the M_3 generation GA as percentage of mean varied from 0.83% for days to flowering to 94.13% for number of capsules per plant. Genetic advance as percent of means showed the same trend as PCV and GCV in both generations.

Heritability and genetic advance for different characters were found to be high in the treated populations. The heritability and genetic advance for number of capsules per plant, number of fruiting branches and seed yield per plant were considerably higher in both generations using chemical rather than physical mutagen treatments. Chavan and Chopde (1982), Prabhakar (1985), Pugalendi (1992) and Anitha Vasline *et al.* (2000) reported similar results in sesame. A moderate heritability coupled with a low genetic advance as percent of mean was observed for days to flowering in both cultivars. Kandasamy *et al*. (1989), Govidarasu *et al*. (1990) and Pathak and Dixit (1992) reported high heritability coupled with low genetic advance for days to first flower. The maximum heritability and genetic advance as a percentage of the mean for number of capsules and seed yield per plant were recorded when using EMS (1.0%) and 500 Gy gamma in the M_2 and M_3 generation of Toshka 1. The number of branches per plant behaved similarly to number of capsules and seed yield per plant when using EMS (1.0%) in Toshka 1. In general, the heritability estimates were considered high for such traits that exceeded 80% where genetic improvement might be possible for these characters. Characters with this high heritability were reported to be more dependable for selection on the basis of their phenotypic performance (Sangha and Sandhu, 1978). The mutants isolated with high mean values, high heritability and genetic advance may be useful in crop improvement programs.

Table (4). Estimates of PCV, GCV, heritability (h_b^2) and genetic advance (GA) as percentage of mean for seven sesame characters in M_2 generation.

Characters	Mutagenic	Giza 32				Toshka 1			
		PCV	GCV	h_b^2	GA as % of mean	PCV	GCV	h_b^2	GA as % of mean
Days to flowering	400 Gy gamma	1.12	0.90	46.55	0.89	2.14	0.74	52.00	0.64
	500 Gy gamma	2.25	0.93	56.63	2.20	3.00	0.95	50.14	0.47
	0.5 % EMS	1.70	0.52	42.81	0.79	0.81	0.37	44.20	0.32
	1.0 % EMS	2.01	1.63	84.05	3.08	2.72	1.44	79.43	2.15
Plant height (cm)	400 Gy gamma	17.22	13.14	64.10	25.12	20.15	18.23	80.00	36.17
	500 Gy gamma	19.41	15.35	69.50	30.51	22.80	19.50	82.40	38.19
	0.5 % EMS	20.11	18.10	66.30	27.70	19.21	17.05	76.22	33.41
	1.0 % EMS	25.53	21.73	71.03	36.15	24.74	20.36	85.29	40.55
Fruiting branches per plant	400 Gy gamma	21.17	17.40	45.12	20.74	23.20	20.40	75.14	43.12
	500 Gy gamma	25.30	22.11	50.19	24.00	27.45	23.30	77.25	40.50
	0.5 % EMS	24.51	20.20	41.44	28.09	24.77	19.51	72.23	50.40
	1.0 % EMS	28.36	25.35	59.23	30.15	29.55	27.90	81.63	53.15
Capsules per plant	400 Gy gamma	34.32	27.00	64.21	34.50	28.75	25.33	83.25	70.42
	500 Gy gamma	38.61	30.15	84.80	50.33	35.83	31.40	87.15	74.20
	0.5 % EMS	35.17	30.55	80.22	52.14	30.11	26.24	82.47	65.03
	1.0 % EMS	49.43	44.15	86.70	65.12	44.54	36.13	96.81	81.14
1000-seed weight (g)	400 Gy gamma	5.14	4.82	69.13	15.11	7.70	6.27	95.77	45.12
	500 Gy gamma	5.42	4.01	86.70	46.34	6.40	6.12	96.83	42.11
	0.5 % EMS	4.90	4.45	69.43	34.44	5.20	4.90	90.15	37.50
	1.0 % EMS	5.53	5.21	82.15	72.10	7.00	6.43	97.20	52.11
Seed yield per plant (g)	400 Gy gamma	30.00	26.15	81.83	53.46	29.73	24.19	83.40	44.60
	500 Gy gamma	35.93	32.11	86.19	57.17	36.61	34.11	95.50	56.14
	0.5 % EMS	31.13	28.03	78.40	55.10	37.22	30.70	92.06	63.55
	1.0 % EMS	39.76	36.39	91.15	60.28	40.40	39.60	96.13	69.72
Oil content (%)	400 Gy gamma	1.60	1.42	79.20	32.14	2.69	1.49	98.21	34.43
	500 Gy gamma	2.30	1.89	97.10	37.75	2.09	1.82	99.35	19.13
	0.5 % EMS	2.10	1.53	99.00	20.28	1.95	1.27	99.40	27.47
	1.0 % EMS	2.17	2.00	99.03	35.11	2.50	2.04	99.98	38.61

PCV = Phenotypic coefficient variability, GCV = Genotypic coefficient variability, h_b^2 = Heritability (broad sense), GA = Genetic advance from selection.

Concerning the genetic advance under selection , it is clear from Tables (4 and 5) that the predicted genetic advance expressed was high for number of capsules per plant; moderate for plant height, number of fruiting branches, 1000–seed weight, seed yield per plant and oil content %. However days to flowering showed low genetic advance under selection values. As GCV measures only the extent of genetic variability present for a character, it should be considered in combination with heritability and genetic advance while assessing the effect of phenotypic selection. Little variation between the phenotypic (PCV) and genotypic (GCV) coefficient of variation estimates for all studied traits coupled with high heritability indicated that selection for these traits would be very effective.

Table (5). Estimates of PCV, GCV, heritability (h_b^2) and genetic advance (GA) as percentage of mean for seven sesame characters in M_3 generation.

Characters	Mutagenic	Giza 32				Toshka 1			
		PCV	GCV	h_b^2	GA as % of mean	PCV	GCV	h_b^2	GA as % of mean
Days to flowering	400 Gy gamma	1.68	1.03	49.70	0.94	2.12	1.93	55.19	0.83
	500 Gy gamma	1.88	1.24	56.11	1.37	1.56	1.06	60.21	0.98
	0.5 % EMS	2.14	1.65	53.56	1.15	2.70	2.08	70.41	1.05
	1.0 % EMS	2.68	1.98	70.20	3.37	3.05	2.68	77.20	2.46
Plant height (cm)	400 Gy gamma	20.14	16.50	66.63	26.40	25.27	20.10	58.32	31.13
	500 Gy gamma	23.27	18.15	63.64	28.20	29.90	22.18	61.65	26.70
	0.5 % EMS	24.12	21.27	63.18	28.73	26.14	20.90	65.88	40.15
	1.0 % EMS	28.16	20.02	70.15	30.11	31.39	26.25	87.15	47.20
Fruiting branches per plant	400 Gy gamma	19.30	14.23	53.17	24.66	24.30	19.22	66.17	40.11
	500 Gy gamma	25.36	20.43	59.13	31.77	29.41	25.26	63.25	49.36
	0.5 % EMS	20.16	14.39	63.00	33.55	20.96	17.26	72.13	46.63
	1.0 % EMS	24.00	19.35	76.93	38.14	30.12	27.14	69.45	55.78
Capsules per plant	400 Gy gamma	50.53	44.62	81.10	80.56	43.20	38.17	82.44	75.8
	500 Gy gamma	54.20	48.13	86.91	86.00	44.75	30.20	86.50	80.81
	0.5 % EMS	49.68	45.46	86.18	91.89	42.27	40.51	88.31	80.20
	1.0 % EMS	51.33	50.36	89.71	94.13	46.14	36.90	90.93	88.40
1000-seed weight (g)	400 Gy gamma	4.70	4.33	81.20	18.10	6.68	5.71	90.13	44.40
	500 Gy gamma	5.17	4.01	84.07	29.34	6.45	5.49	88.90	53.14
	0.5 % EMS	5.79	5.14	90.16	33.31	7.22	6.15	91.33	67.19
	1.0 % EMS	6.12	5.59	93.70	36.17	7.97	6.89	95.74	76.11
Seed yield per plant (g)	400 Gy gamma	28.17	25.23	80.13	23.39	30.36	28.77	82.15	28.14
	500 Gy gamma	34.23	35.71	82.38	27.21	40.11	33.35	80.25	21.53
	0.5 % EMS	30.81	27.25	80.92	29.40	35.40	28.63	88.23	27.54
	1.0 % EMS	42.71	38.15	86.00	29.15	39.90	29.81	86.60	32.17
Oil content (%)	400 Gy gamma	1.96	1.35	98.13	35.62	2.26	1.83	99.11	30.31
	500 Gy gamma	2.02	1.45	97.66	32.17	1.57	1.26	98.27	30.65
	0.5 % EMS	2.14	1.88	99.20	33.41	2.61	2.09	99.20	33.36
	1.0 % EMS	2.51	2.05	99.98	38.44	2.93	2.34	99.97	40.25

PCV = Phenotypic coefficient variability, GCV = Genotypic coefficient variability, h_b^2 = Heritability (broad sense), GA = Genetic advance from selection.

CONCLUSION

It is concluded from this study that desirable mutation/variability in sesame can be created through gamma rays and Ethyl-Methane-sulfonate (EMS), and various traits can be improved in M_2 and M_3 generations. The study clearly indicated that the plant height, capsule number and oil content characters provide a good selection base as they had high values of heritability and a moderate genetic advance. Emphasis should be placed on these characters for formulating reliable selection indices for the development of high yielding sesame genotypes. The useful mutant isolated through the present study need to be tested further on a wide scale to establish any changes and also to assess its performance in later generations.

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التقديرات الإحصائية للصفات الرئيسية للأجيال الطفرية من السمسم

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أجريت ثلاثة تجارب حقلية فى محطة التجارب والبحوث الزراعية بكلية الزراعة - جامعة القاهرة خلال ثلاثة مواسم (٢٠٠١ ، ٢٠٠٢ ، ٢٠٠٣) لدراسة تأثير المطفرات على الصفات المظهرية و المحصولية فى السمسم. اشتملت الدراسة على معاملة اثنان من اصناف السمسم التجارية (جيزة ٣٢ ، توشكى ١) بالمطفر الفيزيائي (أشعة جاما) والمطفر الكيميائي (ايثايل ميثان سلفونيت EMS). تم تقدير معاملى الاختلاف المظهرى و الوراثى و كفاءة التوريث فى المعنى العام والتقدم الوراثى المتوقع بالانتخاب فى الجيل الطفرى الثانى والثالث.

أظهرت النتائج أن هناك اختلافات معنوية بين المعاملات المستخدمة لجميع الصفات تحت الدراسة فى الاجيال الثلاثة. كذلك أوضحت النتائج أن الأصناف تحت الدراسة يمكن معاملتها بأمان بالمطفر الفيزيائي (أشعة جاما) بالجرعتين (Gray ٥٠٠ ، 400) وكذلك بالمطفر الكيميائي ايثايل ميثان سلفونيت (EMS) بالتركيزين (%1.0 ، 0.5) وكذلك الحصول على نسبة عالية من الطفرات النافعة.

تم انتخاب عدد من الطفرات المفيدة فى الجيل الطفرى الثانى و هى : طفرات ذات نباتات محدودة النمو ، مبكرة فى فترة التزهير والنضج ، مقاومة للرقاد ، وطفرات تتميز بزيادة عدد الكبسولات على النبات، وقصر السلاميات ، وزيادة طول الكبسولة ، وتعدد عددالكبسولات فى ابط كل ورقة وذات كبسولات متعددة الكرابل.

أظهرت تقديرات معامل الاختلاف (CV) فى الجيل الطفرى الثالث قيما مرتفعة لصفات محصول البذرة للنبات ، وعدد الكبسولات على النبات ، وعدد الأفرع الثمرية على النبات ، وميعاد التزهير وطول المنطقة الثمرية ، بينما كانت القيم منخفضة لصفتى محتوى البذور من الزيت ووزن الألف بذرة.

أوضحت النتائج أن تقديرات معامل الاختلاف المظهري (PCV) كانت بصفة عامة اعلى من تقديرات معامل الاختلاف الوراثى (GCV) لجميع الصفات تحت الدراسة، وكان الفارق بين التقديرين قليلا إلى حد ما ، و هذا يعنى ان التأثيرات البيئية على تعبير الصفات قليلة ولاتشكل جزء كبير من التباين الكلى المظهرى ، كذلك أظهرت النتائج أن أكبر قيم لمعامل الاختلاف المظهرى والوراثى كانت لصفتى عدد الكبسولات على النبات ومحصول النبات من البذور ، بينما تم الحصول على أقل قيم لمعامل الاختلاف المظهرى والوراثى لصفات ميعاد التزهير ، وزن الألف بذرة ومحتوى البذور من الزيت.

أظهرت صفات عدد الكبسولات على النبات و طول المنطقة الثمرية وعدد الأفرع الثمرية وطول النبات ارتباط موجب عالى المعنوية بمحصول البذورعلى النبات.

أشارت النتائج إلى أن التقديرات المرتفعة لكفاءة التوريث والتقدم الوراثى المتوقع من الانتخاب كان لصفات طول النبات و عدد الافرع الثمرية بالنبات ، عدد الكبسولات بالنبات و محصول بذور النبات فى الجيل الطفرى الثانى والثالث ، مما يشير إلى فعالية الانتخاب فى تحسين هذه الصفات.