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INDUCED VARIABILITY IN MORPHOLOGICAL, YIELD, CHEMICAL AND ANATOMICAL FEATURES OF TWO SESAME CULTIVARS BY USING GAMMA IRRADIATION

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ABSTRACT

The present work was conducted to study the effect of different doses of gamma irradiation (0 ,3 ,8 ,12 ,16 and 20 kr) on vegetative and yield component attributes of two sesame cultivars; Giza 32 and Giza 24 in M_1, M_2 and M_3 generations. The data revealed the following results (relative to the control) 1-The all doses had significant inhibited on the different attributed in M_1, whereas, the low dose 3 kr had an stimulatory effect in M_2 and the other doses caused inhibited the mean of different traits. 2- Various numbers of macromutants (chlorophyll and morphological) were isolated in M_2 generation of two sesame cultivars, Giza 32 and Giza 24 with different doses. Five different types of chlorophyll mutations in each sesame cultivar; albina, xantha , chlorina, varigate and striate were detected. 3- The morphological mutations recorded in M_2 generation were; sterile, giant, dwarf, heavy branching/ high yield , early flowering, giant/ high yield, dwarf/ early, late/ high yield, long capsule and late flowering. Macromutants frequency differed according to the mutation type and the used dose. 4- Ranges of distribution in progenies of seeds treated with doses from 8 to 20 kr were mostly narrower and did not reach the maximum of the control limits. Meanwhile, at low gamma ray doses ; 3 kr the range were wider in plus and minus directions. 5- In the two cultivars, coefficient of variation values increased in most studied traits as a result of gamma ray treatments. 6- Correlation coefficients between seed yield/plant were positively and highly significant correlated with all studied characters. 7- Path coefficient analysis showed that number of capsule/ plant had the greatest effect upon seed yield followed by 1000 seed weight, while number of branches/ plant was the lowest in this respect. 8- In M_3 , the anatomical studies proved that the morphological differences of certain mutants are associated with differences in their internal make–up. 9- Chemical determination of dry seeds revealed that the percentages of oil excelled the control for the respect in 11 mutant families within the two cultivars.

INTRODUCTION

Sesame (*Sesamum indicum L*.) belongs to the family Pedaliaceae. It is one of the important and perhaps, very a ancient oil seeds cultivated by man. Although sesame is a very important oil crop and it is also a valuable source of protein in many countries. It contains more than 50 % edible oil and 20- 27 % protein, of which 92 % is digestible. It also contains all the major fatty acids found in meat with comparable proportions (Yermanos *et al*, 1964).

It is well known that the useful variability is a demand for crop improvement. Mutation induction is of a value to increase variability. Among mutagenic agents gamma irradiation has been used successfully in sesame crop to variability in quantitative and qualitative traits from whom; Kobayashi (1975), Ragab (1978), Kamala and Sasikalo(1983), Murty and Bhatia(1983), Ashri (1988) , Swamy *et al* (1988) , Murty and Opopeza (1989), Kamala (1990), Murty and Bhatia (1990) and Sorour *et al* (1999).

In this study an attempt has been made to initiate a long term-program aiming to improve sesame cultivars through mutation breeding. Gamma irradiation effects on M_1 plants were studied and considerable number of macro- mutations were isolated in M_2 and M_3 for different morphological characters and yield components.

MATERIALS AND METHODS

The present work was carried out during the three successive summer seasons of 1996, 1997 and 1998 at the Experimental Station, Faculty of Agriculture, Cairo University, Giza. Seeds of sesame cv. Giza 32 and Giza 24 were secured from oil Crop Section , Agriculture Center Research Ministry of Agriculture). In a preliminary trial, radiosensitivity of two sesame cultivars as reflected by germination capacity was tested using 15 gamma ray doses from 0 (control) to 100 kr , emitted from cobalt^{-60} at the dose rate of 6.53 rad/sec. Irradiation treatments were carried out at the Middle Estern Regional Radioisolates Center for the Arab Countries at Dokki, Giza. Preliminary study was made on for group of 400 seeds for each treatment at seed Testing Dept. Lab., Agric. Research Center at Giza to determinate germination capacity, L.D. 50% and seedling length (14 days after sowing) according to the International Rules of Seed Testing (Anon, 1966). Based on the results of this trial , only six gamma ray doses ; 0,3,8,12, 16 and 20 kr were chosen for main experiment. The irradiated seeds were sown at the following day of treatment on june 20, 1996 to raise M_1 – generation. The experimental design for each cultivar was complete randomized block design (CRBD) with three replicates , each replicate consists of 5 rows of 3.5 m in length and 60 cm in width. Sesame seeds were sown in hills 10cm a part in Giza 32 and Giza 24 (according to the recommendation of Oil Crops Section, Agriculture Center Research, Ministry of Agriculture). During two seasons M_1 and M_2 data were recorded at flowering time. Each treatment for each cultivar was represented by 60 randomly labeled plants (20 plants from each replicate). At harvest data were recorded on M_1 plants as follows: plant height (cm), number of branches/plant, number of capsules/plant and seed yield per plant. Seed yield of each treatment were kept for the following season. Random seed samples, from bulked seeds of each treatment obtained from M_1 plants, were sown on june 15th 1997 to raise M_2 – generation under the same conditions of the previous season. After 18- 20 days from sowing, seedlings were screened and examined to sort out the presence of chlorophyll mutations. The normal plants were counted and the chlorophyll mutant ones were determined and classified according to the system described by Gustafsson (1947). Chlorophyll mutation frequency was estimated according to the formula suggested by Gual (1960) as follows: U= m /f where: U= % of mutation frequency of the embryo germ track cells, m= percent of chlorophyll mutants among all M_2 – plants , f= a constant value i.e. 20% which is the mean segregation ratio that proved not to be 25%.

The M_2 plants of the treated progenies were examined repeatedly during the season, capsule and seeds after they reached maturity. Plants that visually deviated in their characters from the control were detected and labeled. These plants (considered as visible or macromutations) were grouped into ten types according to plant height, flowering date (number of days from sowing to the opening of first flower) , and numbers of branches, capsule and seeds. The macromutation frequency was estimated according to Gaul's (1960) formula previously mentioned. At harvest time, data were recorded on M_2 plants as follows: plant height (cm), number of branches /plant, number of capsules/ plant, seed yield/ plant and 1000 seed weight. The progeny of each mutant plant selected in the M_2 – generation were sown as a single M_{3-} family on 20 june 1998 added the control and the following studies were made:

1-Anatomical studies:

Specimens were taken from Giza 32 cultivar after four weeks from sowing were taken from fourth internode of the main stem of the dwarf, giant and heavy branching mutants plus the control for microscopical examinations. Samples were killed and fixed for at least 48 hr. in F.A.A., washed in 50% ethyl alcohol, dehydrated in n- butyl alcohol series (Sass, 1951), and embedded in paraffin wax (melting point 56 ^{oc}). Sections were cut to a thickness of 20 microns and stained with crystal violet/ erythrosin (Jackson, 1926). Mounting was in Canada balsam.

2-Chemical analysis:

Chemical examinations were performed on three families from each macromutant and the two parental cultivars , included oil content determinations, the techniques for extraction and the methods used by A.O.A.C.(1975).

3- Statistical analysis:

Data were subjected to different methods of statistical analysis according to computer software designed for statistical analysis (MSTAT, 1986).

RESULTS AND DISCUSSION

1-**The preliminary study:**

1-Germination capacity and seedling length:

The data in Table (1) show that the germination capacity was decreased with increasing doses. The maximum decrease was at 20 kr being 36, 33.7 % for Giza24 and Giza 32, respectively. On germination basis, the lethal dose (L.D. 50%) of gamma- rays for Giza 24 ranged from 16 to 20 kr and from 12 to 16 kr for Giza 32. The present results were in line with those found by Ragab(1978) on sesame.

The down- wardly curved relationship between gamma- ray dosage and germination capacity, found herein, might be due to an increase in the production of active radicales that are responsible for seed lethality or due to the increase of radiation induced gross chromosome breakages (Brock, 1965). Thus, radiation damage to seed germination may be due to the disturbance, caused at the physiochemical level of the cells (physiological damage , or acute chromosomal damage or combined effect of both (Gual, 1964).

Table (1): Effect of gamma irradiation on seed germination and seedling length sesame M_1. Percentages are computed in proportion to the control as 100%.

DOSE Kr.	GIZA 24		GIZA 32	
	Germination %	Seedling Length	Germination %	Seedling Length
0	100	8.20	100	9.03
3	96.91	8.41	94.90	9.60
8	95.72	8.24	86.73	8.88
12	81.55	7.71	55.41	8.31
16	56.55	6.43	42.06	7.91
20	36.08	3.82	33.67	3.44
LSD 5%	0.15			0.32

It is obvious that, relative to the control of each cultivar, the mean seedling length was higher at 3 kr with significant difference. Meanwhile, progressive and mostly significant reduction was achieved in other irradiation treatments. The maximum shortening percentage was accompanied with the highest dose, being 61.9% and 53.41%, for Giza 32 and Giza 24,respectively. The present results concerning the effect of low and high gamma irradiation on the manifestation of seedling length in two sesame cultivars are in accordance with those reported by Ragab (1978).

It could be concluded the results of the preliminary study that, generally, all the used doses depressed the percentage germination capacity and seedling height. This depression was mostly more appreciable in Giza 32 indicating its more sensitivity to radiation than the other cultivar.

II- M_1- Generation

The effect of different doses of gamma irradiation on flowering age of M_{1}- plants of two cultivars are presented in Table (2).

Results revealed that, flowering age in both cultivars were longer time at all used doses with significant differences compared with the controls. Data in Table (2) revealed also that the inhibitory effect on flowering age as a result of seed treatment with gamma – rays increased gradually with increasing the dose and reached its maximum at 20 kr. The same trend found by Ragab (1978) on sesame .

The effect of different doses of gamma irradiation on vegetative and yield component traits of M_1- plants of two sesame cultivars are presented in Table (2). It is obvious that all vegetative and yield component in both cultivars were lower at all used doses with significant differences in most cases. Also, the inhibitory effect on all this characters as a result of seed treatment with gamma rays increased gradually with increasing the dose and reached its maximum at 20 kr. At this dose the reduction below the control amounted to 53.36, 37.58, 45.34 and 66.96 % for plant height, number of branches/ plant , number of capsules/ plant and seed yield/ plant, respectively in Giza 24 and 29.23, 27.57, 50.29 and 72.44 % in Giza 32 for the four traits . The same results obtained by Sorour *et al* (1999) on sesame.

Table (2): Effect of different doses of gamma rays on some characters of M_1- plants of 24 and Giza 32 sesame cultivars.

Dose	Giza 24					Giza 32				
Kr.	Flow. age	Plant height	No.of branches /plant	No.of capsules /plant	Seed yield /plant	Flow age.	Plant height	No.of branch / plant	No.of capsules /plant	Seed yield /plant
0	54.0	112.5	4.8	54.7	7.8	55.2	156.0	4.1	53.3	7.3
3	57.4	108.4	4.0	51.6	7.3	56.8	152.4	4.0	49.3	7.2
8	59.6	98.9	4.0	49.4	6.4	57.5	150.3	3.8	47.4	6.1
12	60.4	74.2	3.3	35.4	4.9	57.8	139.3	3.4	43.8	5.2
16	60.8	62.2	3.1	33.6	4.3	58.3	133.3	3.1	34.3	4.8
20	61.0	52.3	3.0	29.9	2.6	58.9	110.4	3.0	26.0	2.0
LSD 5%	1.8	2.9	1.0	2.2	2.8	1.0	3.31	n. s	3.0	1.9

The depressive effects of this high dose, on yield components, were mostly higher in Giza 32 cultivar, indicating higher sensitivity to the physical mutagen. This may be due to differences in the genetic background of the different varieties (Boreyko, 1971).

Reduction in growth following mutagenic treatment of seeds was attributed to inhibition of auxin synthesis (Gurdon, 1954), production of diffusable growth retarding substances (Mackey,1951), changes in specific activity of enzymes (Endo, 1967) and inhibtion of DNA synthesis (Mikaelson, 1968).

III- M_2 - Generation

During different stages of plant growth a number of individual plants bearing abnormal characters appeared within the M_2-treated progenies within each cultivar. They were offtypes of qualitative nature with showed sharp deviation in a given character (s) and therefore they were considered as macromutants. Macromutants were either distinguished in the seedling stage and those were referred as chlorophyll mutants, or at flowering and mature stages and they were referred as morphological mutants. The chlorophyll mutants were discussed alone because they were detected in the seedling stage and some of them caused early death of some plants.

1-Chlorophyll mutations

The frequency and spectrum of chlorophyll mutations of the two sesame cultivars are given in Table (3). The total mutation frequency was relatively higher in Giza 24 (2.45%) than in Giza 32 (2.15%). In two cultivars , the highest mutation frequency was obtained at 20 kr where it amounted to 0.69 and 0.63% for Giza 24 and Giza 32, respectively.

Concerning chlorophyll mutation spectrum, five different types of chlorophyll mutations were detected in M_2 , Table (3). Two of them are lethal (albina and xantha) and the rest are viable (chlorina, varigata and striata).

The total frequency of lethal type was 1.87% (1.08 + 0.79 %) for Giza 24 and 1.64% (1.06 + 0.58) for Giza 32. The viable types were remarkably less frequent than the lethal ones, being 0.58%(0.42+0.09+0.07%) for Giza 24 and 0.72% (0.29+ 0.27+ 0.16%) for Giza 32. The chlorophyll mutation spectrum changed according to the dose as the five type were detected in all the used except the varigate type which did not detected within all irradiated progenies(except 12 kr for Giza 24 and 3 and 20 kr for Giza 32) and striata type at all gamma ray (except 3 and 8 kr for Giza 24 and Giza 32, respectively).

Table (3) : Frequency and spectrum of chlorophyll mutations observed in M_2 generation.

Cultivars	Dose Kr.	Seedling Number	Chloropyll mutation frequency %					
			Albina	Xantha	Chlorina	Varigate	Striata	Total
	0	1821	0.00	0.00	0.00	0.00	0.00	0.00
	3	1744	0.20	0.13	00.0	0.00	0.07	0.40
	8	1581	0.17	0.09	0.17	0.00	0.00	0.43
Giza 24	12	1544	0.09	0.18	0.09	0.09	0.00	0.45
	16	1311	0.16	0.16	0.16	0.00	0.00	0.48
	20	1222	0.23	0.23	00.0	0.00	0.00	0.69
Total			1.08	0.79	0.42	0.09	0.07	2.45
	0	1901	0.00	0.00	0.00	0.00	0.00	0.00
	3	1881	0.11	0.06	0.00	0.06	0.00	0.23
Giza 32	8	1611	0.00	0.16	0.00	0.00	0.16	0.32
	12	1502	0.29	0.00	0.29	0.00	0.00	0.58
	16	1331	0.45	0.15	0.00	0.00	0.00	0.60
	20	1240	0.21	0.21	0.00	0.21	0.00	0.63
Total			1.06	0.58	0.29	0.27	0.16	2.16

In the two cultivars, the albina chlorophyll mutation type exhibited the highest frequent type followed by xantha, chlorina, varigate and striata. The present results proved that gamma ray treatment is efficient for inducing high frequency and wide spectrum of chlorophyll mutations.

Data revealed that there was a linear increase in chlorophyll mutation frequency with increasing the mutagen dosage in M_2- plants. The highest frequency was obtained with 20 kr. It was realized also a close relationship between biological damage in M_1 – generation (reduction in germination and seedling length) and the frequency of chlorophyll mutations in M_2- generation since the increase in both was associated with the increase in the dosage of the mutagen. This is in accordance with Gaul, (1960).

2- Morphological mutants

The morphological macromutants were classified into ten different types according to plant height, development of branches and capsule, date of flowering. The various types of macromutants recoverable in the M_2 – generation and their frequencies at different gamma- ray doses are presented in Table (4)). It is evident that the frequency differed according to the cultivar, the mutation type and the mutagen dose. Giza 24 scored the highest frequency (3.71) flowed by Giza 32 (3.15). The dwarf type scored the highest frequency (0.63 and 0.64 %for Giza 24 and Giza 32, respectively), meanwhile, the giant/ high yield type for Giza 24 and late flowering for Giza 32 recorded the lowest frequency. It is obvious that there is a linear relationship between the used dose and the macromutations frequency. Therefore, the highest dose scord the highest frequency. The dependency between dose and macromutations frequency was early reported by Gustafsson (1947). It is worthy to mention that the current results gave indication that there is a positive correlation between the frequency of chlorophyll mutation and those of morphological one, a matter which was confirmed by the findings of Singh (1980). Similar mutants were induced by using various gamma ray treatment in sesame plant by Kobayashi (1975), Ragab (1978), Murty and Bhatia (1983), Kamala and sasikala (1983), Ashri (1988), Murty and Oropeza (1989) and Sorour *et al* (1999).

Table (4): Frequency and spectrum of morphological macromutants observed in M_2- generation.

Cultivars	Dose kr.	No.of Plants	Morphological mutations frequency %										
			G.	D.	G/H	H.	E.	L	D/E	L/H	LC	S	Total
	0	1790	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3	1633	0.04	0.12	0.00	0.04	0.00	0.18	0.00	0.04	0.08	0.00	0.48
	8	1490	0.10	0.00	0.00	0.20	0.00	0.10	0.10	0.10	0.00	0.09	0.69
Giza 24	12	1433	0.00	0.18	0.00	0.00	0.18	0.00	0.09	0.09	0.36	0.00	0.81
	16	1202	0.24	0.24	0.00	0.00	0.00	0.00	0.24	0.06	0.00	0.04	0.82
	20	1160	0.18	0.09	0.09	0.09	0.09	0.18	0.00	0.09	0.09	0.00	0.91
Total			0.56	0.63	0.09	0.33	0.27	0.40	0.34	0.38	0.53	0.13	3.71
Giza 32	0	1839	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3	1778	0.02	0.04	0.04	0.00	0.24	0.04	0.02	0.00	0.02	0.02	0.24
	8	1541	0.06	0.12	0.00	0.12	0.06	0.00	0.06	0.06	0.12	0.00	0.54
	12	1419	0.05	0.00	0.00	0.20	0.00	0.05	0.05	0.00	0.00	0.20	0.65
	16	1289	0.12	0.12	0.12	0.00	0.24	0.00	0.00	0.00	0.00	0.00	0.60
	20	1185	0.18	0.36	0.00	0.18	0.00	0.00	0.00	0.18	0.00	0.00	1.12
Total			0.37	0.64	0.16	0.50	0.34	0.09	0.13	0.24	0.14	0.22	3.15

G = giant D= dwarf E = early flowering L = late flowering
H = heavy branching G/h =giant/ high yield DE = dwarf/early flowering
Lh = late/ high yield Lc = length of capsule S = sterile

It could be concluded that gamma rays is an efficient tool in inducing high frequency of chlorophyll as well as morphological mutations. The absence of both mutation types in M_1 and their appearance in M_2 generation might be attributed to one of these two assumptions: 1- The induction of mutants, each of which was controlled by one or few number of recessive genes, in M_1 and their segregation in a homozygous state in the M_2. 2-The induction of mutants, in M_1, each of which was governed by a number of genes in one plant as a result of segregation in the second generation. It is worthmentioning to note that some of these mutants have undergone simultaneous changes in a number of characters. Such multiple phenotypic changes have often been observed following mutagenic treatments (Brock,1965 and 1970; Emery *et al* .,1965; and Gregory, 1968). It seems unlikely that the mutation of a single gene could pleiotropically affect such a diverse set of characters. More probably a number of genes has been mutated either within a linked gene complex or distributed more widely over the genome.

It could be concluded that six gamma ray doses induced ten macromutant types in M_2. All these mutants represent a plant material of prospective breeding value since they exhibit a great degree of variability in both qualitative and quantitative traits of economic importance. Most of these mutants were induced by relatively high gamma ray doses 12 to 20kr.

3-Mean performance and degree of variability

Data in Table 5, revealed that most treatment progenies within each cultivar reduced the means of the studied characters under the control. While, increase was achieved only at the lowest used dose; 3 kr relative to the control of each cultivar. These results are in agreement with the results obtained by many workers; Kabayashi (1958), Robles and Banegase (1971), Ragab (1978), Kamala (1990) and Sorour *et al* (1999) on sesame.

Irradiation progeny for 3kr in both cultivars exhibited wider ranges of distribution. On the contrary, the distribution range from 8 to 20 kr were narrower relative to the control.

Coefficient of variation (C.V.%) values showed elevation for all treatment progenies above the control for all traits (Table 5).

4- Correlation studies

A-Simple correlation coefficients:

Phenotypic correlation coefficients between seed yield/ plant and each of the four attributes plant height, number of branches, number of capsules and 1000 seed weight are presented in Table (6) . The data revealed that seed yield /plant was positively and highly significant correlated with different characters. The positive and significant values of correlation between seed yield and four characters indicated that selection for plants of high values of any of these characters will simultaneously lead to selection for high seed yield. The same results obtained by Sorour *et al* (1999) on sesame.

When, considering the feasibility of estimating the character, besides the values of correlation coefficients obtained in this study the number of branches, number of capsules/ plant and 1000 seed weight will be the recommended characters for the breeder, in selecting for high seed yield. Therefore, number of branches or/ and number of capsules/ plant may be used as a criterion for preliminary screening of the breeding material and the final selection can be biased on 1000 seed weight.

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Table (6): Simple correlation coefficients between five sesame Traits from pooled M2 data (2 cultivars X 6 doses).

Characters	Plant Height	No. of Branches/ Plant	No. of Capsules/ Plant	1000 seed Weight
Seed yield	0.5941**	0.9174**	0.9009**	0.8949**
Plant height		0.7891**	0.8143**	0.2132
No.of branches			0.8032**	0.1392
No. of capsules				0.4144**

B-Path- coefficient analysis:

It is evident from Table 7 that seed yield per plant (Y) was the result of number of branches per plant (N), Number of capsule per plant (S), 1000 seed weight (I) and composite variables that included all other factors affecting seed yield in this study (X).

It is clear from table (7) that number of capsules per plant had the greatest effect as indicated by its direct effect (pys) as well as its total correlation (Rys). Moreover, path- coefficient analysis indicated that weight of 1000 seeds had more direct effect on yield (0.1353) which was the lowest in this respect. However, inspite that number of capsules per plant and 1000 seed weight correlation's (Table, 7).

Sample correlation coefficients without taking into consideration the interaction between the component traits is misleading. For example, by simple correlation coefficient number of branches/ plant showed high significant positive correlation with seed yield being the highest in this respect compared with other yield component traits (Table, 6).

Path- coefficient analysis (Table, 7) reveled that it has the lowest direct effect on yield (0.1353). The high contribution of this attribute was indirectly through number of capsule per plant (0.5213). In the meantime, the indirect effect of number of branches/ plant via 1000 seed weight was positive although of low magnitude (0.0981). The positive indirect effect of number of capsule per plant via both number of branches per plant and 1000 seed weight gave a clue to its highest total correlation with seed yield (0.9368). Conversely, the association of 1000 seed weight with seed yield as indicated by simple correlation was considerably lower than that number of branches/ plant (Table 7), but it exhibited higher direct effect upon yield than that of number of capsule/ plant as it is obvious from the coefficient analysis (Table, 7).

In the present study , the residual effect was which 0.2736 which suggest to be including undefined factors affecting seed yield. It may be attributed to sampling error or other characters such as growth parameters and physiological characters that were not taken into consideration in the present study. It could be stated that selection for number of capsules per plant is effective for sesame seed yield improvement since it had the highest direct influence upon yield (0.6213).

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Table (7): Path coefficient analysis of the direct and indirect effects of no. of branches, no. of capsules, and 1000 seed weight upon sesame seed yield using simple correlation coefficient.

Type of effect	coefficient
Effect of number of branches / plant	
Direct effect, pyn	0.1353
Indirect effect via no. of capsules	0.5213
Indirect effect via 1000 seed weight	0.0981
Total correlation (ryp)	0.7547
Effect of number of capsules / plant	
Direct effect, pys	0.6213
Indirect effect via no. of branches	0.2034
Indirect effect via 1000 seed weight	0.1121
Total correlation (rys)	0.9368
Effect of 1000 seed weight	
Direct effect, pyi	0.4133
Indirect effect via no. of branches	0.1293
Indirect effect via no. of capsules	0.1521
Total correlation (ryi)	0.6947
Residual, Pyx	0.2736

IV- M3-Generation

a- Chemical analysis:

Chemical analysis was performed on seeds of all families from all macromutants in the M_3 generation, each M_3 -family and control of both cultivars were represented by three plants.

With respect to oil content (Table 8) data revealed that, relative to the control, families of all mutant types could be divided into three groups. Families (13 families) of the first group (designated by *) showed a significant reduction, below the control, in oil content.

The second group which exhibited an increase, over the control , (designated by **) was recorded in 11 families within the mutant families of the two cultivars. The third group comprises all remaining families within each type of mutants where the oil content was insignificantly different compared to the control of each cultivar.

The maximum increase in oil content was achieved in heavy branching mutant in both cultivars Giza 24 (G24hy4) and Giza 32 (G32hy3). The increase of the mutant families over the control amounted to 6.94 and 10.26

Table (8): Percentage of oil content in dry seeds of normal and different selected mutant families in M3- generation of two sesame cultivars (mean of plants / family, two sample each).

Giza 24				Giza 32			
Entry	**Oil content%**	**Entry**	**Oil content%**	**Entry**	**Oil content%**	**Entry**	**Oil content%**
Control	54.62	Control	54.62	Control	54.09	Control	54.09
G24 G1	54.60	G24 Lh1	54.50	G32 G1	54.12	G32 H7	54.00
G2	54.54	Lh2	54.62	G2	54.00	G32 Lh1	53.99
G3	53.53	Lh3	54.60	G3	53.92	Lh2	53.98
G4	53.56	Lh4	54.63	G4	53.82	G32 Lc1	55.22**
G5	54.61	Lh5	54.58	G5	53.91	Lc2	56.11**
G6	53.40*			G6	53.98	Lc3	59.64**
G24 D1	53.99			G7	53.62		
D2	54.22			G32 D1	53.02*		
D3	53.32*			D2	53.11		
D4	53.44			D3	53.91		
D5	54.41			D4	53.11		
D6	54.50			D5	53.23		
D7	53.31*			D6	52.32*		
G24 Gh1	54.58			D7	53.19		
Gh2	54.65			D8	53.41		
Gh3	54.02			D9	53.69		
Gh4	54.32			G32Gh1	53.21		
G24 E1	54.34			Gh2	52.91*		
E2	54.21			Gh3	52.02*		
E3	54.36			G32 E1	52.62*		
G24 L1	54.60			E2	53.22		
L2	54.64			E3	53.80		
L3	54.56			E4	53.89		
L4	54.60			E5	53.92		
L5	54.63			G32 L1	54.02		
G24 DE1	53.50			L2	54.15		
DE2	52.90*			L3	56.24**		
DE3	52.39*			G32DE1	52.69*		
G24 H1	55.91**			DE2	52.91*		
H2	55.41			DE3	52.88*		
H3	55.83**			G32 H1	55.61**		
H4	58.41**			H2	53.81		
H5	56.20**			H3	53.69		
H6	55.70			H4	53.89		
H7	56.11**			H5	53.88		
H8	55.98**			H6	53.92		
New LSD	1.22		1.22		1.04		1.04

G = giant D= dwarf E = early flowering
L = late flowering H = heavy branching
G/h = giant/ high yield D/E= dwarf/early flowering
L/h = late/ high yield Lc = length of capsule

% for the two cultivars in the same order. Murty and Bhatia (1983) and Kamala and Sasikala (1985) found that some mutants of sesame had increased in oil content. Contrary, Ragab (1978) observed a reduction in oil content for all different mutants compared with the control.

Finally, it could be concluded in view of the previous survey that seeds of two sesame cultivars when treated with six gamma ray doses induced ten macromutant types in M_2 . From their progenies in M_3 two groups of promising families are selected which are superior in the qualitative and quantitative. All of the mutant families of the two groups represent varieties of prospective breeding value since they are of great economic importance. Most of these families were induced by relatively high gamma ray doses; 12 to 20 kr. Therefore, it could be stated that seed treatment with a relatively high doses of gamma- irradiation was very effective for improving sesame crop qualitatively and quantitatively. This fact may be taken as an argument that mutation breeding is an useful technique in breeding new strain of agricultural plants. Detailed studies on these macromutant lines are necessary aiming to score more improvement in qualitative and quantitative aspect of seed yield via selection in generations succeeding M_3.

In addition such studies must involve detailed information on these mutant lines in connection with 1- complete evaluation of the nutritive value of dry seed 2- the correlation between seed quality and the chemical composition of seed. 3- the degree of plant resistance to sesame diseases and insects.

Anatomical studies:

Microscopical examination revealed that giant, dwarf and heavy branching mutants exhibited several histological changes as obvious from the following:

1-Giant mutant:

It is clear from table 9 and figure 1 (a and b) that the whole internode diameter was thinner by 10.26 % below the control. Different tissues which comprise the stem shared by various extents in this reduction; i.e. cortex, vascular cylinder and pith diameter. Cortex thickness reduction could be attributed to the reduction in cell diameter and number of cell layers. The decreased thickening of the vascular cylinder was contributed by the reduction in the thickness of xylem tissue. Also, the reduction in pith was 9.50 %. It is clear from the longitudinal sections (Fig. 2, a and b) that the length of cortical and pith cells increased in giant mutant over the control. This increase in the vertical dimension was at the expense of their width which was reduced as compared with the control.

2-Dwarf mutant :

It is realized from table 9 and fig. 1 (a and c) that the whole internode diameter was thinner in the dwarf mutant as compared with the control. Most of the included tissues participated by different magnitudes in reducing the diameter of the mutant stem; i.e. thickness of cortex, vascular cylinder thickness. The reduction in cortex thickness could be attributed to the reduction in both number of cell layer and cell diameter. A noticeable reduction was occurred in the vascular cylinder thickness as a result to the reduction in amounts of vascular elements. Pith diameter was narrower due to the reduction in cell diameter and number of cell layers.

Fig1

Fig 2

Table (9): Mean of certain histological counts and measurements (µ) in the fourth internode of the main stem of sesame Giza 32 cultivar for control and three mutants in M_3 – generation.

Characters	Control	Giant	Dwarf	Heavy Branching
Transverse sect:				
Diameter of stem (µ)	1939.2	1740	1440	3104
Thick. Of epidermis (µ)	17	17	13.6	17
Thick. Of cortex (µ)	153.6	144	136.3	337.6
No. of cortical layers	8-10	6-8	6-8	10-12
Thick. of vascular cylinder (µ)	227.2	169	144.1	304
Pith diameter (µ)	1120.6	1013.6	770.6	1536
Longitudinal sect. Cortical cell:				
Length (µ)	154.7	191.3	83.6	163.1
Width (µ)	28.1	25.5	40.8	33.6

The longitudinal sections (Fig. 2 a and c) proved that parenchyma cells of cortex and pith in dwarf mutant were reduced relative to the control in their vertical and horizontal dimensions.

3-Heavy branching:

It is obvious from table (9) and fig. 1 (a and d) that, relative to the control, the whole stem diameter was larger in heavy branching as compared with the control. Most of the included tissues participated by different magnitudes in increasing the diameter of the mutant stem ; i.e., thickness of cortex, thickness of vascular cylinder and pith. The increase in cortex thickness could be attributed to the increase in both number of cell layer and cell diameter. The increase thickening of vascular cylinder was contributed by the increase in the thickness of xylem tissue. It could be concluded that the cambial activity was enhanced in the mutant stem, therefore, all the constituents of secondary elements were appreciably more produced and increased in size especially the xylem vessels which had decidedly wider cavities and this amounted to more total active conducting area to- cope with gigas growth. The length of cortical and pith cells in longitudinal sections decreased in heavy branching mutant as compared to the control. (Fig. 2 a and d). Meanwhile, the width of cortical and pith cells were increased than the control.

REFERENCES

Anon, (1966). The International Rules for Seed Testing. F.A.O Publications.

A.O.A.C. (1975). Official Methods of analysis for the Association of Official Chemists. 12 Ed., Washington , D.C.; USA.

Ashri, A.(1988). Mutagenic studies and breeding of peanut (A. hypogaea L.) and sesame *(Sesamum indicum* L.*) .* Proc. of a Workshop " Improvement of Grain Legume Production Using Induced Mutations." Pullman 15 July, 1986, Joint FAO/ IAEA, 509- 510.

Boreyko,A.M. (1971). Effect of X- ray and gamma rays on the germinating rate and survival of soybean plants as dependent on genotype. Tsitol. Genet., 5: 432- 435.

Brock, K.D. (1965).Response of *Trifolium subterraneun* to x- ray and thermal neutrons. Radiation Bot., 5: 543- 555.

Brock, R.D. (1970). Mutations in quantitatively inherited traits induced by neutron irradiation . Rad. Bot., 10: 209- 230.

Emery, D.A.; W. Gregory and J.P.J.Losch (1965). Breeding value of the x-ray induced macromutants. 1- Variations among normal appearing F_2 families segregated from cross between macromutants of peanuts. Crop Sci., 4: 87- 90.

Endo, T. (1967). Comparisons of the effects of gamma rays and malichydrazids on enzyme systems of maize. Seed . Radiation . Bot., 7: 35- 40.

Gaul, H. (1960). Critical analysis of the methods for determining the mutation frequency after seed treatment with mutations. Genet. Agraria, 12 : 297- 318.

Gaul , H.(1964). Mutations in plant breeding . Rad. Bot., 4: 155- 232.

Gregory, W.C.(1968). A radiation breeding experiment with peanuts. Radiation Bot., 8: 81-147.

Gurdon, S.A. (1954). Occurrence, formation and inactivation of auxins. A. Rev. RI .Physiol., 5: 341- 378.

Gustafsson, A. (1947). The mutation system of the chlorophyll apparatus . Lund Univ. Arssler, N.F. Avd., 36: 1- 40.

Jackson, G. (1926). Crystal violet and erthrosin in plant anatomy stain Tech., 1 : 33- 34.

Kamala, T. (1990). Gamma ray effects on polyenically controlled characters in sesame *(Sesamum indicum L.*) J. Nuclear Agric . Biol., 19: 179-183.

Kamala, T. and S. Sasikala (1983). High yielding mutants in sesamum . J. Indian Bot. Soc., 62; 120- 123.

Kamala, T. and S. Sasikala (1985). Gamma- ray and colchicine- induced mutant in " TMV5" and " IS103" Sesamum. Indian J. Agric. Sci. Vol 55, no. 3: 155-155.

Kobayashi , T. (1958). Radiation genetics of sesame. Part III. Morphological changes and mutants induced by ionizing radiation. Jap.J. Genet., 33: 239-261.

Kobayashi, T. (1975). Induced beneficial mutants in cultivated sesame affecting quantitative characters. Proc. of the first Sci. Conf. Of the I.A.E.C. Held in Baghdad , Iraq, 7-12th April.

Mackey, J. (1951). Neutron and x- ray experiment in barely. Hereditas, 37: 42- 64.

Mikaelson, K. (1968). Effects of fast neutrons on seedling growth and metabolism in barely. Neutron irradiation of seeds, 11:63-70. Technical Report series No. 42, International Atomic Energy, Vienna.

MSTAT (1986). Computer software designed for statistical analysis. Version. O/Em. Copyrighted June 1982- 1986. Michiganstat Univ. Revised 7/1/1986 by : Dept of Crop and Soil Sci., Michigan State Univ.

Murty, G.S.S.and C.R.Bhatia (1990).Inheritance of polypetalous corolla mutation in sesame. Plant Sciences, 100(1): 7- 10.

Murty, G.S.S. and C.R. Bhatia (1983). Sesame mutants. Mutation Breeding Newsletter No.22: 5-6.

Murty, B.B. and F. Oropeza (1989). Diversity pattern in sesamum mutants selected for a semi- arid cropping system. Theor. Appl. Genet., 77: 275- 286.

Ragab, A.S.I. (1978). Studies on the effect of gamma irradiation on sesame (*Sesamum indicum* L.). M.Sc. Thesis, Fac. of Agric. , Cairo Univ.

Robles, S.R. and R. Banegase (1971). Effect different doses of gamma irradiation co^{60} on sesame (*Sesamum indicum* L.). In XII informe de investigation, Monterrey, Nuevo, Leon, Mixico 177 pp. (C.F. Field Crop Abst. 26 : 2949, 1973).

Sass, J.F. (1951). Botanical Microtechnique. Iowa State College press, Ames , Iowa, pp. 228.

Singh, C.B. (1980). Indicator parameters of mutation frequency and mutation spectrum. India J. of Genetics and Plant breeding, 40 (1): 22- 25.

Sorour, W.A.I.; M.H. Hussein and M.A. EL- Imam (1999). Gamma- ray induced mutations in sesame *(Sesamum indicum L.).* 1- Selection of useful mutants. Bull. Fac. Agric., Cairo Univ., 50: 516- 531.

Swamy, M.; B.A. Satyan; K.S. Prakash and P.G.Reddy (1988). Induced variability in polygenic traits of sesamum through hybridization and mutation. International Congress of Genetics, Toronto, Canada, 20-27, August, 1988.

Yermanos, D.M.; R.T. Edwards and S.C. Jemstreat (1964). Sesame : an oil seed crop with potential in California. Calif. Agric., 18: 2-4.

J. Agric. Sci. Mansoura Univ., 25 (6), June, 2000.

التباين المستحدث فى الصفات المورفولوجية ، المحصوليه ، الكميائيـة والتشـريحية لصنفين من السمسم باستخدام أشعة جاما0

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تم تعريض بذور صنفى السمسم جيزة 24 و جيزة 32 لخمسة عشر جرعة مختلفة من أشعة جاما من صفر الى 100 ك راد . وقد أجريت تجربة تمهديه لتحديد الجرعات المميتة مع دراسة نسبة الأنبات وطول البادرة . ومن نتائج هذه التجربة تم اختيار ستة جرعات (20،16،12،8،3،0 ك راد). وقد تم دراسة تأثير هذه الجرعات على الصفات الخضريه وصفات المحصول فى الجيل الأول والثاني وكذلك الجيل الثالث .

وكانت أهم النتائج المتحصل عليها

1-كان لكل الجرعات تأثيرا مثبطا لمختلف الصفات التي درست في الجيل الأول 0بينما كان للجرعة المنخفضة (3 ك راد)ا تأثير منشط علي هذه الصفات في الجيل الثاني، في حين أن باقي الجرعات سببت نقصا لمختلف الصفات مقارنة بالكنترول.
2- زيادة نسبة التكرار للطفرات الكلورفيلية كان مرتبطا بزيادة الجرعة ، وقد تم تمييز خمس طرز من هذه الطفرات.
3- تم تمييز عشر طرز من الطفرات المورفولوجية وكانت الطرز القزمية أعلي تكررا كما تختلف نسبة تكرارها باختلاف الجرعة.
4 -مدى التوزيع التكرارى للصفات التي درست يكون غالبا ضيقا في الجرعات من 8 الي 20 ك راد . بينما في الجرعة 3 ك راد يكون مدى التوزيع التكرارى فيها واسعا وذلك في كلا الاتجاهين الموجب والسالب .
5- يزداد معامل الاختلاف في معظم الصفات التي تمت دراستها عن الكنترول في كلا الصنفين.
6- معامل الارتباط كان أيجابيا ومعنويا بين محصول البذور للنبات وباقي الصفات.
7-أظهر معامل المرور أن عدد الكبسولات للنبات له اكبر تأثير علي محصول النبات يليه وزن 1000بذره بينما كانت صفة عدد الأفرع للنبات ذات تأثير أقل0
8 - أثبتت الدراسات التشريحية في الجيل الثالث أن اختلاف هذه الطفرات مورفولوجيا مرتبطا باختلافات في تركيبها الداخلى .
9- أظهر التحليل الكيمائي للبذور الجافة في الجيل الثالث زيادة في النسبة المئوية للزيت في 11 عائلة مطفرة في الصنفين. وأظهرت هذه العائلات أهمية أقتصادية حيث أنها جمعت بين المحصول العالي من البذور و النسبة المئوية العالية من الزيت.

Table (5): Effect of different doses of gamma rays on some characters of M_2 plants of Giza 24 and Giza 32 sesame cultivars.

Cultivars	Dose Kr.	Plant height (cm)			No. of branches / plant			No. of capsules / plant			Seed yield / plant			1000 seed weight		
		Range	X	C.V.%	Range	X	C.V.%	Range	X	C.V.%	Range	X	C.V.%	Range	X	C.V.%
Giza 24	0	90-138	114	12.4	4-9	4.5	21.2	30-70	54.8	18.2	4-12.4	8.1	30.0	3-3.9.0	3.5	14.4
	3	83-145	120	14.5	4-9	4.6	30.4	27-74	57.8	22.2	3-15.2	8.9	41.4	2.9-4.1	3.8	16.2
	8	73-130	103	19.9	4-8	4.2	37.1	25-72	54.0	27.1	2.8-14	8.0	38.1	2.9-3.5	3.2	19.4
	12	55-110	82.3	22.4	3-7	3.7	39.4	22-62	48.8	25.3	1.9-9.0	6.8	32.7	2.8-3.2	3.1	22.4
	16	50-95	70.6	13.0	3-6	3.6	29.4	20-55	34.3	18.9	1.8-8.3	4.9	24.2	2.8-3.2	3.0	15.4
	20	45-75	57.8	12.9	3-5	3.5	24.2	17-40	29.0	18.1	1.5-5.3	2.9	22.4	2.8-3.1	3.0	14.9
	LSD		2.81			n.s			2.11			0.1			0.2	
Giza 32	0	113-190	157	9.4	3-8	4.1	25.4	35-80	53.0	20.2	3-10.4	7.8	51.3	2.9-3.7	3.3	8.4
	3	110-195	158	12.3	3-9	4.5	28.3	30-94	56.9	24.3	3.5-11	8.9	65.3	2.8-3.8	3.9	9.3
	8	108-183	153	15.2	4-7	4.0	34.3	29-88	54.0	25.4	4.1-10	7.9	64.1	2.7-3.7	3.1	16.3
	12	106-169	141	17.9	3-7	3.7	31.5	25-74	42.1	28.2	3.3-7	5.4	53.1	2.7-3.3	3.0	14.5
	16	90-155	122	11.1	3-5	3.5	28.1	20-51	38.8	23.1	3.5-6	4.9	50.2	2.7-3.0	2.9	12.3
	20	80-160	120	10.3	3-5	3.4	27.2	15-45	33.1	21.2	3.5-9.9	3.9	45.2	2.7-2.2	2.8	11.4
	LSD		3.01			0.3			2.32			1.0			0.2	