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Effect of Gamma-Rays on M_1, M_2 and M_3 Progenies for an Egyptian Cotton Cross

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ABSTRACT

The present investigation was carried out to study the effects of irradiation by using gamma ray with dose 10 kr on the mean performance and variation as well as the heterosis, potence ratio, inbreeding depression and heritability for the cross between two parents Giza 92 and Giza 93 where either both the parents were treated by irradiation or one parent with addition the cross between two untreated parents was used as control. To obtain the M_1, M_2 and M_3 with addition F_1 and F_2 the trials were conducted during 2015, 2016 and 2017 seasons at Sakha Station. The results indicated that the treatment with irradiation decreased the mean performance for yield and its component traits and increased the variability traits. Moreover the crossing between both treated parent or one treated parent increased variability for yield and its component comparing with the crossing alone. Positive coefficient of skewness were found for seed and lint cotton yield, boll weight and lint percentage while negative coefficient of skewness for fiber quality, moment coefficient of kurtosis were less than 3 for all traits in M_1, M_2 and M_3 for most of populations. The results of skewness curves suggested that Giza 93 irradiation and its crosses had response to selection for seed and lint cotton yield. The effect of irradiation for heterosis, inbreeding depression and heritability for seed and lint cotton yield and lint percentage were higher than the effects of boll weight and quality fiber.

INTRODUCTION

Useful variability is an essential demand for plant breeder to practice effective selection that leads to crop improvement. Among used the different breeding methods used, hybridization and mutation induction have been used as an important tools to increase existing variability and to create additional variability for qualitative and quantitative traits in cotton. Hybridization is a mean of reorganizing genes from the parents involved in the cross in a new genetic matrix. Moreover, the contents of the chromosomes may change due to genetic recombination (Fasoulas, 1988). Most of the Egyptian cotton varieties were produced by using various forms of the pedigree-selection method following hybridization with the aim of combining characters from two or more parents into a single line or lines. Inducing mutations have been successfully used in field crops to create genetic and phenotypic variations not previously observed. Incorporating the induced mutations into breeding programs may improve targeted traits more rapidly than traditional breeding techniques (Herring *et al*., 2004 and Lowery *et al*., 2007).

Much work have been done on the Egyptian cotton using gamma (γ) rays as a tool combined with hybridization to induce genetic variability in the genetic pool and to create useful mutations could be used in the breeding programs. Results of these studies proved that γ rays shifted means away from those of the control for cotton cultivars and their hybrids and significantly increased the phenotypic and genotypic variations (Okaz,1978; El-Gharbawi *et al*., 1984; Raafat and Haikal, 1986 and Raafat, 1995).

In addition, many recent studies on the Egyptian cotton indicated the effectiveness of both hybridization and mutagen treatment each alone in inducing genetic variability in the studied materials with respect of the measured traits, moreover, treating cotton cultivars with mutagenic agents alone or followed by hybridization between the treated cultivars proved to be more effective in inducing variability in the different attributes as compared to hybridization alone (Amer, 2004; Orabi, 2008 and Amer *et al*., 2016).

The main objective of this study was to investigate effectiveness of irradiation to induce variability as well as the effect of heterosis, inbreeding depression, potence ratio and heritability by two recommended tools in this respect which are hybridization and mutagenic agents either one parent or both parents and combined with the other tool.

MATERIALS AND METHODS

The present study was conducted through three successful seasons (2015 - 2017) at Sakha Experimental Farm, A.R.C, Kafr El-Sheikh Governorate, Egypt. The materials used in this study comprised two Egyptian cotton varieties (Giza 92 and Giza 93) belonging to *Gossypium barbadense L.* Selfed seeds of both varieties were obtained by Cotton Breeding Department, Cotton Resarch Institute, Agric. Res. Center (A.R.C), Giza, Egypt.

Pure seeds of both varieties were divided into two parts the first part was untreated and used as control while the second part was irradiated by 10 kr. dose of gamma (γ) rays at the rate of 2.96 rad/second emitted from cobalt-60 (Co60) gamma cell 3500 source which is located at the Middle Eastern Regional Radioisotopes Center for the Arab Countries, Dokki, Giza, Egypt. The irradiated parts were divided to two parts the first part was sown as following

The first season (2015):

Population 1: Giza 92 irradiated seeds that produced treated plants represented the female parent and at flowering time pollinated by Giza 93 treated plants to produce F_1M_2 seeds of hybrid 1.

Population 2: Giza 92 untreated seeds that produced untreated plants represented the female parent and at flowering time pollinated by Giza 93 treated plants to produce F_1M_2 seeds of hybrid 2.

Population 3: Giza 92 irradiated seeds that produced treated plants represented the female parent and at flowering time pollinated by Giza 93 untreated plants to produce F_1M_2 seeds of hybrid 3.

Population 4: Giza 92 untreated seeds that produced plants represented the female parent and at flowering time pollinated by Giza 93 untreated plants to produce F_1 seeds of hybrid 4 (Control hybrid seeds).

The second Season (2016):-

The hybrid seeds were divided to two parts the first were sown in second season to obtain M_3 for crosses 1, 2, 3 as well as F_2 of cross 4

The third Season (2017):-

The all seeds of 12 population (P_1 treated (M_1), P_2 treated (M_2), P_1 untreated, P_2 untreated as well as and F_1 (M_2), F_2 (M_3), F_1 and F_2 of four crosses) were sown in third season. Populations were distributed in a randomized complete blocks design with three replications. Each plot consisted of four rows 4m long, spaced 65 cm between rows and 40 cm between hills, with one plant left per hill. Data were recorded on 20 guarded plants for each plot for the studied traits and harvested as individual plants.

All cultural practices were applied as followed in the ordinary cotton cultures at Sakha Experimental Farm.

Characters studied:-

1- Boll weight (gm), measured as average of 10 normally matured bolls.
2- Seed cotton yield per plant (gm).
3- Lint yield per plant (gm).
4- Lint percentage, obtain by the formula:

Lint% = 100 x (lint cotton yield per plant/ seed cotton yield per plant).

5- Fiber span length (mm): it was determined by the digital fibrograph.
6- Fiber fineness: it was expressed as micronaire reading.
7- Fiber strength: it was measured by the pressley instrument at zero inch gauge length and expressed as pressley index.
8- Uniformity ratio (U.R): determined as follows: U.R = Mean length / U.H.M.

Statistical procedures:-

Heterosis Percent:- Heterosis is expressed as the percent increase in the mean of the F_1 hybrid above the average of the two parents (M.P) or above the better parent (B.P). Therefore, it was measured for the studied traits in M_1 and M_2 generations from the formula:

Heterosis from the mid-parent

$$\text{H (M.P) \%} = \frac{\bar{F}_1 - \overline{M}.P}{\overline{M}.P} \times 100$$

Heterosis from the better-parent

$$\text{H (B.P) \%} = \frac{\bar{F}_1 - \bar{B}.P}{\bar{B}.P} \times 100$$

Potence ratio (P): Degree of dominance h_1 and h_2 for the studied characters in the F_1 and F_2 were calculated using the potence ratios according to Romero and Frey (1973) as follows:

$$h_1 = \frac{\bar{F}_1 - \overline{M}.P}{\overline{H}.P - \overline{M}.P} \qquad h_2 = \frac{2 \times (\bar{F}_2 - \overline{M}.P)}{\overline{H}.P - \overline{M}.P}$$

Where: $\overline{M.P}$ **= mid parent value.**

$\overline{HP}$ **= higher parent value**

Inbreeding depression percent: It enlarges the difference between F_1 and F_2 and is calculated for all the studied characters in the M_2 using the formula:

Inbreeding depression (I.D %) = $(\bar{F}_1 - \bar{F}_2 / \bar{F}_1) \times 100$

In the M_1 and M_2 generations, data were statistically analyzed according to the regular analysis of variance of a factorial arrangement in a randomized complete blocks design as outlined by Snedecor and Cochran (1982).

The least significant difference (L.S.D) was calculated to test the significance of differences between populations as follows:

$$\textbf{L.S.D} = t_{0.05} \times S_d$$

Where,

t is the tabulated t at 5% level at the error degrees of freedom.

S_d is the standard error calculated for each type of comparisons as follows:

Heritability estimates:

a. Heritability in broad sense (h^2b) :

$$h^2b = \frac{VF_2 - VE}{VF_2} = \frac{\frac{1}{2}D + \frac{1}{4}H}{\frac{1}{2}D + \frac{1}{4}H + E} \quad \textbf{(Allard, 1960)}$$

Where:

V_E is the environmental variance calculated as the average variance of P_1, P_2 and F_1.

V F_2 is the total phenotypic variance in F_2.

Moment coefficient of skewness: $\text{M.C.S} = \frac{M_3}{\sqrt{(M_2)^3}}$

Where:

$$M_3 = \frac{\sum (x - \bar{x})^3}{n} \qquad M_2 = \frac{\sum (x - \bar{x})^2}{n}$$

The values of M.C.S take each of positive, negative and zero values.

5) Moment coefficient of kurtosis: $\text{M.C.K} = \frac{M_4}{(M_2)^2}$

Where: $M_2 = \frac{\sum (x - \bar{x})^2}{n}$ $\quad M_4 = \frac{\sum (x - \bar{x})^4}{n}$

Kurtosis provides a measurement about the extremities (i.e. tails) of the distribution of data, and therefore provides an indication of the presence of outliers. A normal distribution has kurtosis = 3 is called mesokurtic. Distribution with kurtosis < 3 is called platykurtic. Compared to a normal distribution, its tails are shorter and thinner, and often its central peak is lower and broader. A distribution with kurtosis >3 is called leptokurtic. Compared to a normal distribution, its tails are longer and fatter, and often its central peak is higher and sharper (Pearson 1905).

RESULTS AND DISCUSSION

The analysis of variance of 12 genotypes are results in Table (1), the results indicated that the mean squares of genotypes were significant different for all traits. The results suggested that the all genotypes were different.

Table 1. The analysis of variance mean squares for yield and fiber properties.

Source	df	Boll weight	Seed cotton yield/plant	Lint cotton yield/plant	Lint %	Fiber length (mm)	Micronaire value	Fiber strength	Uniformity index
Replications	2	0.053*	389.3	72.01*	0.638	0.660	0.076*	0.037	7.854
Genotypes	11	0.089**	6476.7**	776.02**	5.540**	1.820**	0.195**	0.274**	28.750**
Error	22	0.014	148.45	17.56	0.07	0.426	0.019	0.080	8.419

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

I. The performance and its variances:

The mean performance for all population was shown in Table (2). For boll weight the results in Table (2) showed that the boll weight of four parents had insignificant effects with irradiation treatment comparing unirradiated parent.

As well as the hybrids between the different parents in two generation exhibited the same trend except for two generation of cross [P_2 x P_3 cross (3)] had significant negative effects for boll weight comparing with its parents the two generation of cross between untreated parent.

With regard the seed cotton yield, the results in Table (2) show that the irradiation treatment affected by decreasing the seed cotton yield for two parents. The effect of G.92 was insignificant while the effect of G.93 was significant. While the M_2 (F_1's) exhibited increasing for cotton seed yield comparing with the F_1's of P_2 x P_4 cross (4) with significant values indicated the vigor's heterosis are affected with irradiation by increasing value

For M_3 (F_2's) of two crosses P_1 x P_4 cross (2) and P_2 x P_3 cross (3) exhibiting insignificant effect values. The first F_2 had insignificant increasing while the second F_2 had insignificant decreasing while F_2 of P_1 x P_4 cross (2) had significant increasing comparing with that F_2 of P_2 x P_4 cross (4) of control. These results were in harmony with those obtained by Amer *et al* 2016.

Considering the lint yield, the results in Table (2) illustrated the parents affected with irradiation and exhibited significant decrease values comparing with its untreated parent. The M_2 (F_1's) of three crosses of [P_1 x P_3 cross (1), P_1 x P_4 cross (2) and P_2 x P_3 cross (3)] exhibited significant increase as comparing to the M_2 (F_1) of P_2 x P_4 cross (4) of control. The M_3 (F_2's) of three previous crosses only one M_3 (F_2) of cross P_1 x P_4 cross (2) exhibited significant increase comparing by F_2 of control cross , while the other two of M_3 (F_2's) hybrid exhibited insignificant values of increase or decrease. The Table (2) showed that the irradiation parents had significant decreasing comparing with the cross between untreated parents. With respect the lint percentage while F_1's exhibited significant decrease comparing with F_1 of cross control except M_2 (F_1) of cross P_1 x P_4 cross (2) exhibited insignificant increase., while M_3 (F_2's) exhibited significant decrease value comparing with F_2 of cross between untreated parents.

For fiber length the results in Table (2) illustrated that the fiber length of parent were increased by irradiation with significant values of same time the M_2 (F_1's) were increased for fiber length comparing the F_1 (control) between untreated parents with significant values, on the other hand the M_3 (F_2) exhibited insignificant increase values for comparing F_2 control cross between untreated parent.

Considering the fiber strength the results in Table (2) suggested that fiber strength did not affect with significant values for all population with irradiation. For uniformity ratio the results showed the same trend of fiber strength. With regard the micronaire values exhibited the same trend with insignificant effects for all population except for G.93 irradiated these results suggested that the irradiation don't affect for fiber quality at the dose 10 kr.

The data in Table (2) show that the variances of parents for boll weight were insignificant and the effects of the irradiation were insignificant for M_1 G.93 irradiated comparing with untreated parents. With regard the variance of M_2 (F_1) for boll weight the data showed that these variances affected with insignificant values comparing with F_1 of control cross. On other hand the variance of F_2 had insignificant increasing comparing with the variance of F_2 of cross between untreated parents except the M_3 (F_2) of P_2 x P_3 cross (3) exhibited significant affect for variance.

For seed cotton yield/plant, lint cotton yield/plant and lint % the data in Table (2) show that the irradiation affected with significant increasing variance for G.92 comparing with its untreated while the variety M_1 G.93 show insignificant effects of variance comparing its untreated.

Table 2. Mean performance and variance of parents, F_1, F_2 generations in four crosses for all studied traits

SOV, Genetic parameters		Boll weight		Seed cotton yield/plant		Lint cotton yield/plant		Lint %	
		Mean	**Variance**	**Mean**	**Variance**	**Mean**	**Variance**	**Mean**	**Variance**
G. 92 treated M_1 (P_1)		3.0± 0.066	0.11	148.8± 7.021	1232.35	56.0± 2.951	217.74	37.4± 0.346	2.99
G.92 untreated (P_2)		3.0± 0.034	0.02	167.7± 4.690	461.97	64.0± 1.816	69.22	38.1± 0.104	0.23
G. 93 treated M_1 (P_3)		2.9± 0.031	0.02	107.4± 4.299	461.97	39.5± 1.664	69.22	36.8± 0.095	0.23
G.93 untreated (P_4)		3.1± 0.051	0.07	148.5± 4.386	480.90	55.8±1.725	74.35	37.5± 0.088	0.19
P_1 x P_3	M_2 F1	3.0± 0.139	0.17	246.0± 14.01	1765.58	85.7± 5.188	242.22	34.8± 0.570	2.92
(1)	M_3 F2	2.9± 0.065	0.18	132.6± 7.995	2684.32	45.6± 2.723	311.40	34.4± 0.293	3.61
P_1 x P_4	M_2 F1	3.2± 0.082	0.04	237.1± 13.40	1077.30	83.7± 4.832	140.08	35.3± 0.775	3.60
(2)	M_3 F2	2.9± 0.054	0.12	150.7± 7.600	2426.11	52.3± 2.752	318.09	34.6± 0.323	4.38
P_2 x P_3	M_2 F1	2.8± 0.114	0.16	207.6± 23.81	6800.45	72.3± 8.303	827.26	34.8± 0.294	1.04
(3)	M_3 F2	2.7± 0.048	0.10	113.6± 8.051	2722.45	39.4± 2.920	358.17	34.4± 0.311	4.05
P_2 x P_4	F1	3.3± 0.077	0.07	181.1± 5.574	372.80	63.7± 1.984	47.26	35.2± 0.277	0.92
(4)	F2	3.1± 0.060	0.15	118.2± 5.841	1433.16	41.7± 2.198	203.00	35.2± 0.221	2.06
SOV, Genetic parameters		Fiber length (mm)		Micronaire value		Fiber strength		Uniformity index	
		Mean	Variance	Mean	Variance	Mean	Variance	Mean	Variance
G. 92 treated M_1 (P_1)		36.0±0.202	1.02	3.6±0.051	0.07	11.0±0.105	0.27	88.1±0.124	0.38
G.92 untreated (P_2)		34.7±0.149	0.46	3.8±0.035	0.02	11.1±0.094	0.19	88.1±0.108	0.25
G. 93 treated M_1 (P_3)		36.3±0.136	0.46	3.5±0.032	0.02	10.9±0.086	0.19	87.8±0.099	0.25
G.93 untreated (P_4)		34.2±0.126	0.40	3.0±0.035	0.03	11.9±0.059	0.09	88.4±0.150	0.56
P_1 x P_3	M_2 F1	37.5±0.367	1.21	3.3±0.081	0.06	11.5±0.148	0.20	87.3±0.807	5.86
(1)	M_3 F2	36.0±0.179	1.34	3.1±0.063	0.17	11.2±0.075	0.24	87.8±0.105	0.46
P_1 x P_4	M_2 F1	36.5±0.740	3.28	3.5±0.143	0.12	11.2±0.194	0.23	88.7±0.224	0.30
(2)	M_3 F2	35.8±0.214	1.93	3.2±0.059	0.15	11.5±0.067	0.19	87.8±0.161	1.09
P_2 x P_3	M_2 F1	37.1±0.394	1.86	3.2±0.081	0.08	11.4±0.149	0.27	88.3±0.200	0.48
(3)	M_3 F2	35.5±0.236	2.34	3.1±0.039	0.06	10.8±0.324	4.40	87.2±0.202	1.71
P_2 x P_4	F_1	35.3±0.115	0.16	3.3±0.076	0.07	11.3±0.111	0.15	87.4±0.122	0.18
(4)	F_2	35.4±0.178	1.33	3.0±0.053	0.12	11.2±0.079	0.26	87.3±0.282	3.34

With regarding the effects of irradiation on M_2 F_1's and M_3 F_2's the data in Table (2) show signification variation increasing comparing with F_1's and F_2's cross between untreated of parent for seed lint yield and lint percentage. These results were in harmony with those obtained by Amer 2004, Orabi 2008 and Amer *et al.*, 2016.

With respect of fiber quality, the data in Table (2) showed that the variance of M_1 G.92 was increased comparing with its untreated for all traits of fiber while the M_1 G.93 exhibited insignificant increasing for variance with the irradiation.

With regarding the variance of M_2 F_1's for fiber length and uniformity ratio were increased with significant values comparing with F_1 of control cross, While the M_3 F_2 were affected with insignificant values. On other hand the variance of Micronaire values and Fiber strength were affected by irradiation by different values comparing the control.

For testing the normality of variance curves of two generation of four crosses as well as its parents, two numerical measures of shape were used to give more precise evaluation which was skewness and kurtosis.

Skewness measure the lock of symmetry of distribute on around the mean. The skewness for normal is zero and any symmetric data have skewness were zero. Negative values for skewness indicated that data are skewed left while positive values of skewness indicted that the data are skewed right. The data in Table (3) indicated that the curve of boll weight and lint % were normality and skewed to right direction for most populations while the curve of seed and lint cotton yields were normality except for M_1 G.93 treated and M_2 F_1 for P_1 x P_4 cross (2) as well as M_3 F_2 for two crosses P_1 x P_3 cross (1) and P_2 x P_3 cross (3).

The Curves of fiber traits were normality for most properties except for fiber length in G.93 untreated (P_4) population and M_2 F_1 in two crosses [P_1 x P_4 cross (2) and P_2 x P_3 cross (3)]; for uniformity index for M_2 F_1 for two crosses [P_1 x P_4 cross (2) and P_2 x P_3 cross (3)] and M_3 F_2 for cross P_1 x P_4 cross (2) as well as for micronaire value in G.93 untreated and M_2F_1 of P_1 x P_3 cross (1).

The results of the moment of Skeweness and Kurtosis suggested that its tails are longer and fatter and its peak is higher and sharper as well as its peaks were skewered for right direction. Kurtosis provides measurements about the extremities of distribution of data and therefore provides an indication of presence of outliers normal distribution has kurtosis coefficient equal 3 (three) is called mesokurtic distribution with kurtosis less < 3 is called platy kurtic comparing with normal curve it tails are shorter and trimmer and often its central peak is lower and brooder on other hand kurtosis >3 is called leptokurtic compared to normal distribution, its tails are longer and fatter and often its control peak is higher and sharper Pearson (1905) except for F_2 for seed and lint yields as well as G.93 treated and fiber strength for F_2 in P_2 x P_3 cross (3).

The kurtosis coefficient moments of kurtosis were presented in Table (4) showed that moments of kurtosis were less than 3 for all variances of all generation except untreated G.93 for variance of both weight as well M_3F_2 variances of seed cotton yield/plant, lint cotton yield/plant, fiber length, uniformity index and fiber strength for crosses P_1xP_3 cross (1), P_1xP_4 cross (2), and P_2 x P_3 cross (3) respectively. So these shapes of curves were leptokurtic its trials are longer and falter and central peak is higher and sharper. These results are in partially agreements with those obtained by Orabi (2008).

Table 3. The moment coefficient of skewness for parents, F_1, F_2 generations in four crosses for all studied traits

SOV, Genetic parameters		Boll weight	Seed cotton yield/plant	Lint cotton yield/plant	Lint %	Fiber length (mm)	Micronaire value	Fiber strength	Uniformity index	S.E skeweness
G. 92 treated M_1 (P_1)		0.126	0.357	0.425	0.509	-0.209	0.872	0.694	-0.498	0.464
G.92 untreated (P_2)		0.141	-0.017	-0.029	-0.102	-0.139	-0.839	-0.247	0.055	0.501
G. 93 treated M_1 (P_3)		-0.091	2.695*	3.097*	0.967*	0.430	-0.829	0.543	-0.860	0.464
G.93 untreated (P_4)		0.681	0.315	0.317	0.814	1.173*	1.451*	-0.086	-0.129	0.464
P_1 x P_3	M_2 F1	-0.504	1.681*	1.032	1.826	-1.461*	0.981	-0.632	-1.481	0.717
(1)	M_3 F2	0.383	2.066*	1.962*	0.444	-0.061	-0.083	0.124	0.256	0.365
P_1 x P_4	M_2 F1	0.083	1.321*	-0.251*	0.019	-0.962*	-1.805*	0.043	0.800*	0.083
(2)	M_3 F2	-0.578	0.297	0.226	0.662	-0.177	0.227	-0.579	-0.903*	0.365
P_2 x P_3	M_2 F1	-0.725	0.153	0.097	-0.916	-1.926*	-0.844	-0.678	-1.602*	0.637
(3)	M_3 F2	0.316	0.751*	0.742*	0.189	0.472	-0.582	-3.979	-0.098	0.365
P_2 x P_4	F1	1.170	-1.358	-0.939	0.463	0.307	-0.036	0.923	-0.674	0.637
(4)	F2	0.645	0.325	0.630	0.231	-0.187	0.155	-0.084	-3.175	0.365

***, Significance of difference the zero**

Table 4. The moment coefficient of Kurtosis for parents, F_1, F_2 generations in four crosses for all studied traits

SOV, Genetic parameters		Boll weight	Seed cotton yield/plant	Lint cotton yield/plant	Lint %	Fiber length(mm)	Micronaire value	Fiber strength	Uniformity index	S.E kurtosis
G.92 treated M_1 (P_1)		-0.877	-1.594	-1.413	-1.023	-0.150	0.609	-0.755	0.032	0.902
G.92 untreated (P_2)		-0.900	-1.508	-1.601	-1.384	-1.068	-0.115	-1.411	-1.105	0.972
G.93 treated M_1 (P_3)		-0.578	11.602*	13.280*	0.107	-0.709	0.367	0.428	-0.084	0.902
G.93 untreated (P_4)		3.467	-1.784	-1.844	0.047	3.005	2.374	-1.193	-0.983	0.902
P_1 x P_3	M_2 F1	-0.378	2.394*	-0.740*	2.979	0.396	1.869	-0.102	0.481	1.400
(1)	M_3 F2	0.105	6.916	6.585	-0.252	-0.257	-1.184	-0.996	0.121	0.717
P_1 x P_4	M_2 F1	-2.030	2.883	1.312	-0.829	0.164	3.354	-1.788	0.148	1.741
(2)	M_3 F2	-0.036	-0.514	-0.839	0.613	0.437	0.398	0.095	0.180	0.717
P_2 x P_3	M_2 F1	0.957	-0.713	-0.874	0.756	4.883	0.848	-0.424	4.302	1.232
(3)	M_3 F2	-0.192	-0.234	-0.367	-0.563	-0.930	0.092	15.827*	-1.213	0.717
P_2 x P_4	F1	1.983	1.122	0.181	0.026	-1.074	-0.891	-0.666	0.189	1.232
(4)	F2	0.135	0.095	0.773	0.002	-0.636	-0.678	-1.133	14.745*	0.717

***, Significance of differe**

II. The effect of irradiation on heterosis, inbreeding depression, potence ratio and heritability:

With respect of heterosis, inbreeding depression, potence ratio and heritability were presented in Table (5). With concerning the effects of irradiation on heterosis, the data in Table (5) illustrated that the control cross exhibited significant heterosis of boll weight over mid-parent and better- parent , while the other crosses exhibited insignificant heterosis except the P_2 x P_3 cross (3) that exhibited negative significant heterosis relative to better parent. With regard the seed and lint cotton yields Table (5) showed that the all crosses between P_1 x P_3 cross (1), P_1 x P_4 cross (2) and P_2 x P_3 cross (3) exhibited highly significant heterotic effects; while the control P_2 x P_4 cross (4) exhibited significant value of heterotic effect. For lint percentage, the data showed that all crosses exhibited negative highly significant. Also the effects of irradiation were not obvious illustrated for heterosis of lint percentage.

With concerning fiber quality, the effect of irradiation on its heterosis were not significant except for fiber length in crosses between treated parents which exhibited significant heterosis over mid-parent, while the cross between untreated parents exhibited insignificant heterosis, as well as negative significant heterosis for micronaire value which were exhibited by the cross P_1 x P_3 (1) and P_2 x P_3 cross (3) over mid- parent and better-parent. With regard to fiber strength only cross P_1 x P_3 cross (1) exhibited significant heterosis over mid-parent and P_1 x P_4 cross (2) exhibited negative significant heterosis over better- parent.

Table 5. The heterosis over the mid parents (M.P), better-parent (B.P), Inbreeding depression (I.D), potence ratio and heritability (h^2b %) for yield and fiber characters.

Characters	Boll weight						Seed cotton yield/plant					
	Heterosis		potence ratio		I.D	h^2b %	Heterosis		potence ratio		I.D	h^2b %
Genotypes	M.P	B.P	F_1	F_2			M.P	B.P	F_1	F_2		
P_1 x P_3(1)	1.69	0.00	1.00	-2.00	3.33	41.52	92.04**	65.32**	5.70	0.43	46.10**	57.04
P_1 x P_4(2)	4.92	3.23	3.00	-3.00	9.38**	41.37	59.50**	59.34**	589.67	13.67	36.44**	61.66
P_2 x P_3(3)	-5.08	-6.67*	-3.00	-5.00	3.57	30.49	50.93**	23.79**	2.32	-0.79	45.28**	5.42
P_2 x P_4(4)	8.20*	6.45*	5.00	1.00	6.06*	64.92	14.55*	7.99	2.40	-4.16	34.73**	69.40
LSD 0.05	0.17	0.20			0.20		17.83	20.59			20.59	
LSD 0.01	0.24	0.27			0.27		24.30	28.05			28.05	
Characters	Lint cotton yield/plant						Lint %					
	Heterosis		potence ratio		I.D	h^2b %	Heterosis		potence ratio		I.D	h^2b %
Genotypes	M.P	B.P	F_1	F_2			M.P	B.P	F_1	F_2		
P_1 x P_3(1)	79.48**	53.0**	4.60	-0.52	46.8**	43.35	-6.20**	-6.95**	-7.67	-18.00	1.15	43.41
P_1 x P_4(2)	49.73**	49.6**	278.00	-36.0	37.5**	54.71	-5.74**	-5.87**	-43.00	-57.00	1.98*	48.38
P_2 x P_3(3)	39.71**	12.97**	1.68	-1.01	45.5**	10.13	-7.08**	-8.66**	-4.08	-4.69	1.15	87.74
P_2 x P_4(4)	6.34*	-0.47	0.93	-4.44	34.5**	68.67	-6.88**	-7.61**	-8.67	-8.67	0.00	78.31
LSD 0.05	6.13	7.08			7.08		0.39	0.45			0.45	
LSD 0.01	8.36	9.65			9.65		0.53	0.61			0.61	
Characters	Fiber length (mm)						Micronaire value					
	Heterosis		potence ratio		I.D	h^2b %	Heterosis		potence ratio		I.D	h^2b %
Genotypes	M.P	B.P	F_1	F_2			M.P	B.P	F_1	F_2		
P_1 x P_3(1)	3.73**	3.31**	9.00	-2.00	4.00*	33.22	-7.04*	-5.71	5.00	18.00	6.06	70.12
P_1 x P_4(2)	3.99**	1.39	1.56	0.78	1.92	18.71	6.06	16.67	-0.67	0.33	8.57*	50.01
P_2 x P_3(3)	4.51**	2.20	2.00	0.00	4.31*	60.37	-12.33**	-8.57*	3.00	3.67	3.13	33.42
P_2 x P_4(4)	2.47	1.73	3.40	3.80	-0.28	74.34	-2.94	10.00*	0.25	1.00	9.09*	65.32
LSD 0.05	0.96	1.10			1.10		0.20	0.23			0.23	
LSD 0.01	1.30	1.50			1.50		0.27	0.32			0.32	
Characters	Fiber strength						Uniformity index					
	Heterosis		potence ratio		I.D	h^2b %	Heterosis		potence ratio		I.D	h^2b %
Genotypes	M.P	B.P	F_1	F_2			M.P	B.P	F_1	F_2		
P_1 x P_3(1)	5.02*	4.55**	11.00	10.00	2.61	7.56	-0.74	-0.91	-4.33	-2.00	-0.57	0.00
P_1 x P_4(2)	-2.18	-5.88**	-0.56	0.11	-2.68	0.00	0.51	0.34	3.00	-3.00	1.01	61.79
P_2 x P_3(3)	3.64	2.70	4.00	-2.00	5.26*	95.16	0.40	0.23	2.33	-5.00	1.25	81.03
P_2 x P_4(4)	-1.74	-5.04*	-0.50	-0.75	0.88	46.18	-0.96	-1.13	-5.67	-6.33	0.11	90.11
LSD 0.05	0.41	0.48			0.48		4.25	4.90			4.90	
LSD 0.01	0.56	0.65			0.65		5.79	6.68			6.68	

*** and ** significant at 0.05 and 0.01, respectively**

For potence ratio, the data in Table (5) showed that the potence ratio in all crosses were positive more than the unity for seed cotton yield, lint yield and lint percentage. These results due to the presence of the dominance effect controlled the genetic system. These results agreed with the presence heterosis. The potence ratio or fiber qualities were shown in Table (5). The data indicated that the potence ratio were higher than unity for two generations except for fiber length in P_2 x P_3 cross (3), micronaire value in P_1 x P_4 cross (2) and fiber strength in two generations of P_2 x P_4 cross (4).

Concerning the inbreeding depression, the data in Table (5) showed that all traits exhibited inbreeding depression values were positive in all crosses except for fiber length in P_2 x P_4 cross (4), uniformity index in P_1 x P_3 cross (1) , and fiber strength in P_1 x P_4 cross (2).

These results were in harmony with the reduction mean of F_2 for most studied traits in all crosses. These results were in harmony with those obtained by El-Hoseiny (2013).

With respect to the heritability values, the data in Table (5) showed relatively moderate (exceeded 30%) for boll weight in the crosses which its parents were treated with irradiation while the crosses of untreated parents exhibited high values of heritability.

For seed cotton yield, the all crosses exhibited high values of heritability except for the P_2 x P_3 cross (3) that exhibited low value of heritability, while the lint yield exhibited moderate value in P_1 x P_3 cross (1) and high values in two crosses P_1 x P_4 cross (2) and P_2 x P_4 cross (4), while the cross P_2 x P_3 cross (3) exhibited low value of heritability.

The lint percentage heritability values were moderate in two cross P_1 x P_3 cross (1), P_1 x P_4 cross (2) and high value in two crosses P_2 x P_3 cross (3) and P_2 x P_4 cross (4). These results were in harmony with those obtained by Amer *et al* (2016)

With respect of fiber quality, the data in Table (5) indicated that these traits exhibited high values of heritability except for fiber length in P_1 x P_3 cross (1) it was moderate and in P_1 x P_4 cross (2) was low, while the two crosses P_1 x P_3 cross (1) and P_1 x P_4 cross (2) exhibited low values of heritability for uniformity index and fiber length respectively. Also the cross P_2 x P_3 cross (3) exhibited moderate heritability values for micronaire value. From these results it may be concluded that the irradiation with 10 kr did not affect in the heritability values.

CONCLUSION

It may concluded that the dose of 10kr for gamma rays active effect to induce the changes for genetic variation.

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تأثير اشعة جاما على الاجيال الطفرية الأول والثانى والثالث لهجين من القطن المصرى

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اجرى هذا البحث لدراسة تاثير اشعة جاما بجرعة عشرة كيلو راد على التباين والمتوسط لصفات وزن اللوزة ومحصول الزهر والشعر وصفات الجودة بالاضافة الى تاثير الاشعة على الدلالات الوراثية وهى قوة الهجين ودرجة السيادة – الانحدار الوراثى – الكفاءة الوراثية لهجين بين صنفين جيزه 92 ، جيزه 93 وذلك بعد معاملتهما باشعة جاما 10 كيلو راد او بدون الاشعاع لكليهما اوتشعيع احد الابوين وتهجينه مع الاب الاخر الغير مشع وبذلك يكون لدينا اربعة هجن كا الاتى:1- الاب الاول مشع × الاب الثانى مشع. 2.الاب الاول مشع × الاب الثانى غير المشع . 3-الاب الاول غير المشع × الاب الثانى المشع . 4- الاب الاول غير المشع × الاب الثانى غير المشع (كنترول) , واجريت التجربة فى محطة البحوث الزراعية بسخا فى المواسم الزراعية 2015، 2016، 2017 وذلك للحصول على الاجيال الطفرية الثلاثة الأول والثانى والثالث ثم زراعة العشائر وعددها اثنى عشرة عشيرة فى الموسم الثالث 2017 فى تجربة قطاعات كاملة عشوائية ذات ثلاثة مكررات . وكانت اهم النتائج المتحصل عليها :1- تاثرت المتوسطات بالنقص للمحصول ومكوناته بينما زادت التباينات الوراثية بالاشعاع .2- كان التباين فى الجيلين الطفريين الأول والثالث اعلى من التباين فى الجيل الطفرى الثانى مما يدل على فاعلية الانتخاب فى الجيل الطفرى الاول 3- كانت قيم معامل الالتواء العزمى موجبة وذلك فى صفات محصول القطن الزهر والشعر ووزن اللوزه وتصافى الحليج مما يل على ان معظم النباتات فى النصف الايسر من المنحنى 4- كان معامل التفلطح اقل من 3 لجميع الصفات فى الاجيال الطفرية الأول والثانى والثالث ما عدا محصول القطن الزهر والشعرللصنف جيزة 93 معامل والجيل الثانى (جـ 92 × جـ 93) المعامل وكذلك الجيل الاول الطفرى للهجين (جـ 92 معامل × جـ 93 غير معامل) فى صفتى الطول والانتظام، وبالتالى فان معظم القيم غير متجمعة حول المتوسط العام النسبى وبالتالى فان الانتخاب سيكون مجديا فى هذه الحالة 5- تشير قيم معامل الالتواء الى ان الصنف جيزه 93 المعامل بالاشعاع وهجنه يمكن التحسين فيها بالانتخاب مما يدل على ان الاستجابه للانتخاب تؤدى الى التحسين فى صفات المحصول و مكوناته. 6- زيادة قوة الهجين والانحدار للتربية الداخلية والكفاءة الورا ثية لصفات المحصول الزهر والشعر وتصافى الحليج اعلا من التاثير فى صفة وزن اللوزه.7- كانت الجرعة 10 كيلو راد من اشعة جاما لها دور منشط فى احداث التغيرات فى التباين الوراثى.