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IDENTIFICATION OF GENETIC VARIABILITY PRODUCED THROUGH RADIATION IN OKRA.

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ABSTRACT

The dry and soaked seeds of four parental varieties of Okra, six F_1 hybrids and six F_{1r} hybrids among them were treated with gamma-rays emitted from cobalt-60 source. The used doses of irradiations were zero (control), 5, 10 and 15 kr of gamma irradiation. The performances of studied economical traits were evaluated in the irradiated generations. It was observed that the medium doses of radiation caused increasing variability among genotypes for most studied traits. The results also cleared the presence of heterosis for most studied traits. The results indicated that medium dose (10 Kr.) increased the vigoursity estimated from the mid-parents for some studied traits specially in soaked condition. The results also cleared that the dose of 10 kr exhibited positive and economical values of heterosis versus the better parent. It could be also obtained that all varieties and hybrids showed different responses to doses of gamma rays. The results also indicated that the magnitudes of non-additive genetic variances including dominance (σ^2D) were larger than their corresponding additive genetic variances (σ^2A) for most of studied traits. In the same time, the obtained values of additive genetic variances (σ^2A) indicated the importance of (σ^2A) for the inheritance of that traits and could not be neglected. The results also indicated the presence of a quite values of heritability in broad and narrow senses for most studied traits.

Therefore, the possibility of improving Okra traits through selection programs within segregating generations is available to produce superior F_1 hybrids.

INTRODUCTION

Okra, *Hibiscus esculentus* L, is considered a popular vegetable crop in Egypt and many countries all over the world. The improvement of both quantitative and qualitative traits depends on the presence of genetic variability that permits effective selection. Hybridization and mutation are the main sources of inducing genetic variability in plant. The present investigation was carried out to determine the effects of several doses of gamma irradiation on variability, means, heterosis, gene effects and heritability values for four varieties of Okra and the 12 F_1 hybrids among them.

Safaa (1972) evaluated 10 F_1 hybrids of Okra. The resuls indicated that some hybrids exhibited good fruit quality and high yielding ability. The promising hybrids were: Esmaily x Climson and Esmaily x Dwarfgreen long pod. In this respect, Mohamed (1983) reported that F_1 hybrids showed average degree of heterosis for plant height was 143.9%. In the same time, Askar (1986) cleared that F_1 hybrids showed heterosis values (24.5%) for plant height trait. Similarly, Dhillons and Sharma (1982), Agarrado and Rasco (1986), Swamy Rao (1974), Thaker *et al* (1982) and Veeraragavathatham and Irulappam (1990) obtained different values of heterosis for pod length, pod diameter, pod weight, number of pods per plant and total yield per plant traits.

Reddy *et al* (1985), Abraham and Bhatia (1984) , Korla and Sharma (1984), Dhall *et al* (2001), Dhankhar and Dhankhar (2002), Abd-Allah (2003), Ghai *et al* (2004) and Arvind Kumar and Mishra (2004) studied the effect of radition on Okra and obtained different responses. They observed a wide range of variability for all studied economical traits.

Wankhade *et al* (1995) and Mamta Rani and Arora (2003) stated the importance of additive genetic variances in the inheritance of economical studied traits of Okra. On the other hand, Ramesh and Singh (1999), Sood (2001) and Mata Rani and Arora (2003) observed that non-additive genetic variances including dominance played a major role in the inheritance of Okra studied traits. In the same time, Chandra *et al* (1997), Panda and Singh (2003) and Sushmita and Das (2003) illustrated the importance of both additive and non-additive genetic variances including dominance in the inheritance of studied economical traits of Okra.

Concerning heritability, Singh and Singh (1997), Dhankhar and Dhankhar (2002, 2003) and Yadav *et al* (2002) obtained highly estimates of heritability for total yield/plant, number of fruits/plant and fruit length traits. In the same time, they obtained moderate values for days to flowering, number of branches/plant and number of nods/plant traits.

MATERIALS AND METHODS

The genetic materials used in this investigation included four varieties of Okra belonging to species *Hibiscus esculentus*, L. The seeds of these varieties were obtained from previous study conducted at the Department of Genetics, Faculty of Agriculture Mansoura University. These varieties were Romi (P_1), Balady (P_2), Mansoura Red (P_3) and Cairo Red (P_4).

This investigation was conducted at El-Bramoun Horticultural research station, Vegetable research division, Mansoura. In the growing season of 2003, the seeds of the parental varieties were cultivated. All possible crosses were made to obtain the seeds of six F_1 hybrids and six F_1 reciprocal hybrids through diallel crosses mating design. In the same time, all varieties were selfed to obtain more seeds from each variety. Lot of dry and soaked seeds of varieties and their F_1 hybrids were exposed to three doses (5,10 and 15) kr. of gamma rays, in addition to the control of Gamma-rays omitted from Co-60 at the Middle Eastern Regional Radioisotope Center for the Arab Countries at Docky, Giza, Egypt. In the growing season of 2004, the seeds (dry and soaked) of parent varaities and $F_{1,}$ F_{1r} hybrids were planted for evaluation in a field trial experiment. The experimental design was a randomized complete blocks design with three replications. Plots were two rows. Each row was 3.0 m. long and 0.7 m. wide. All agricultural practices were applied as recommended for Okra.

Data were recorded on the following traits :-

- number of days to flowering (N.D.F.),
- number of first fruiting node (N.N.F),

- number of seeds per fruits (N.S./F),
- plant height in centimeters (P.H. cm.),
- number of branches per plant (N.B./P.),
- number of lecules per fruit (N.L./F.),
- number of fruits per plant (N. F. /P.),
- weight of fruits/plant in kilograms (W.F./P. kg.),
- fruit length in centimeters (F.L. cm.),
- fruit diameter in centimeters (F. D. cm.), and
- number of leaves per plant (N. L./P.).

The analyses of variance were made according to Cochran and Cox (1957) and Steel and Torrie (1960). The form of the analysis of variances was presented in Table 1.

Table1:- The form of analysis of variance and the expectation of mean squares for doses and seed conditions for genotypes.

S.V.	d.f	M.S	E.M.S
R (c)	c(r – 1)		
conditions	c – 1	Ms_8	$\sigma^2e + rd\sigma^2gc$
genotypes.	g – 1	Ms_7	$\sigma^2e + r\sigma^2gcd + rg\sigma^2cd + rc\sigma^2gd + rgc\sigma^2d + rcd\sigma^2g$
doses	d – 1	Ms_6	$\sigma^2e + r\sigma^2gcd + rg\sigma^2cd + rc\sigma^2gd + rgc\sigma^2d$
Gen. X Cond.	(g –1)(c – 1)	Ms_5	$\sigma^2e + r\sigma^2gcd + rd\sigma^2gc$
Gen. X dos.	(g – 1)(d – 1)	Ms_4	$\sigma^2e + r\sigma^2gcd + rc\sigma^2gd$
con. X dos.	(c – 1)(d – 1)	Ms_3	$\sigma^2e + r\sigma^2gcd + rc\sigma^2cd$
g. X c. X d.	(g – 1)(c – 1)(d – 1)	Ms_2	$\sigma^2e + r\sigma^2gcd$
Error	c(gd – 1)(r – 1)	Ms_1	σ^2e

Tests of significance were made according to least significant difference (L.S.D.) as outlined by Sendecor and Cochran (1967).

Heterosis values were measured versus the mid-parents and the better parent according to the following equations:

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

The analyses of variance of diallel crosses were made as outlined by Griffing's method 3 (1956). The form of the analysis of variances and the expectations of mean squares are presented in Table 2.

Table 2: The form of analysis of variances and the expectations of mean squares of diallel crosses.

S.V.	d.f	M.S	E.M.S
GCA	P – 1	Mg	$\sigma^2e + 2\sigma^2s + 2(P-2)\,\sigma^2g$
SCA	P(P – 3)/2	Ms	$\sigma^2e + 2\sigma^2s$
Rec.	P(P – 1)/2	Mr	$\sigma^2e + 2\sigma^2r$
Error	(g – 1)(r – 1)	Me	σ^2e

General and specific combining ability variances were determined and translated to genetic parameters according to Hallauer and Miranda (1988) and Matzinger and Kempthorne (1956) as follows :-

$\sigma^2 g = ½ \sigma^2 A$ & $\sigma^2 A = 2\sigma^2 g$.

$\sigma^2 s = \sigma^2 D$ & $\sigma^2 D = \sigma^2 s$.

Heritability values in broad ($h^2_{b.s}$) and narrow ($h^2_{n.s}$) senses were made according to the following equations :-

$$h^2_{b.s} = \frac{\sigma^2 A + \sigma^2 D}{\sigma^2 A + \sigma^2 D + \sigma^2 e} \times 100 \qquad h^2_{n.s} = \frac{\sigma^2 A}{\sigma^2 A + \sigma^2 D + \sigma^2 e} \times 100$$

This investigation was conducted to evaluate the effect of different doses of gamma-rays on variances, means, heterosis and the nature of gene action associated with it. The interaction effects between genotypes, radiation doses and conditions were also investigated.

The analyses of variance were made for all studied traits and the results are presented in Table 3.

Table 3: The results of analysis of variances and the mean squares for all studied traits.

S.V	d.f	N.D.F	N.N.F	N.S/F	P.H	N.B/p	N.L/F	N.F/P	W.F/P	F.L	F.D	N.L/P
Condition	1	4.85	0.344	6.0	1437.6	162.8	18968	87725	4.313**	0.578	0.068	0.01
R (C)	4	13.3	0.626	134.6	335.5	8.81	7921	6272	0.305	0.395	0.054	0.31
Genotypes	15	375.2**	12.93**	7781.8**	9097.2**	71.5**	50744**	27592**	0.850**	12.49*	5.320**	20.1**
G x C	15	13.42**	0.986**	973.9**	4582**	15.5**	28092**	17778**	0.331	1.09	0.490**	4.37**
Doses	3	135.5**	8.48**	3663.5*	10539.9**	6.27**	2943**	37467**	6.675**	3.49*	0.413*	0.93**
C x D	3	14.15**	0.015	976.3**	6137.7**	23.0**	22370**	21424**	1.069**	3.49**	0.024	0.93**
G x D	45	15.1**	1.57**	730.4**	2351.6**	33.5**	36347**	15341**	0.946*	0.71	0.722**	1.98**
G x D x C	45	11.3**	0.79*	513.6**	2437.2*	25.2**	27264**	13341**	0.733*	2.65	0.383**	0.58**
Error	252	3.44	0.373	29.4	98.2	2.24	3921	6010	0.204	1.41	0.031	0.17

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

The results revealed that the mean squares of genotypes showed highly significance for all studied traits. In the same time, the mean squares of the interactions of genotypes x conditions (G x C) as well as doses were significant for all studied traits except of fruit length(F.L) trait. The results also indicated that the mean squares of the interaction of condition x doses (C. x D.) and the interaction of genotypes x doses (G. x D.) showed highly significance for all studied traits except of number of the first fruiting node.(N.N.F) and fruit length (F.L) traits for the interactions of conditions x doses (C x D) and genotypes x doses (G. x D.), respectively. In the same time, the mean squares of the interactions of genotypes x doses x conditions (G. x D. x C.) were significant and/or highly significant for all studied traits. These findings illustrated that the presence of variability among genotypes for all studied traits were mainly due to different genotypes, doses and conditions (particularly) in addition to the interactions among them. Similar results were observed by Dhall *et al* (2001), Dhankhar and Dhankhar (2002), Abd-Allah (2003) and Ghai *et al* (2004).

The means of four parental varieties, the six F_1 hybrids and six F_1 reciprocal hybrids for all doses and at two conditions were calculated and the results are presented in Table 4. The results indicated that there were no parental showed the highest mean for all studied traits. Where, different parental varieties exhibited different means for all studied traits. It could be also noticed that the parental variety Mansoura red (P_3) showed the highest means for most studied traits followed by the parental variety balady (P_2). In the same time, the magnitudes of means in soaked condition were particularly highly than those of the dry condition for most studied traits. Concerning the means of the F_1 hybrids, the results illustrated that the F_1 hybrids which involved the parental variety Mansoura red (P_3) exhibited the highest means. The results also cleared a wide range between means for all studied traits affected by the doses of gamma irradiation and the conditions of seed treatments.

The results also revealed that the F_1 hybrids P_3 x P_4, P_1 x P_3, P_2 x P_3 and the F_1 reciprocal hybrids P_4 x P_2 showed the highest mean values for most studied traits. These findings were in agreement with the results obtained earlier and cleared that the F_1 hybrids, F_{1r} reciprocal hybrids which included the parental varieties P_3 or/and P_2 exhibited the high means. It could be also regarded that the low or medium doses of gamma radiation caused particularly increasing of means for most studied traits.The mid-parents (M. P.), better parent (B.P.), means of F_1 hybrids as well as ranges and heterosis values versus the mid- and the better parent were determined for all doses at dry and soaked conditions and the results are shown in Table 5 .

The results illustrated that the means of F_1 hybrids significantly exceeded the mid-parents for many studied traits specially at 10Kr of gamma irradiation in dry and/or soaked conditions. The results also revealed that the highest heterosis values against the mid-parents were : 57.39%, 40.0%, 25.52% and 20.6% for number of leaves per plant (N.L./P) (dry), number of branches per plant (N.B./P) (dry), weight of fruits/plant (W.F/P.) (dry) and number of fruits per plant (N.F./P.) (dry), respectively. In the same time, the dose of 15kr of gamma irradiation gave heterosis values for number of first fruiting node (N.N.F) (15.80%), number of seeds per fruit (N.S./F.) and weight of fruits per plant (W.F./P.) (20.80). The results also indicated that number of days to flowering (N.D.F) trait showed insignificant negative heterosis values (desirable) versus the mid-parents.

- The results also cleared that the calculated values of heterosis against the better parent were negative, although these values were significant. It could be also noticed that the dose of 10kr of gamma irradiation gave (positive) economical heterosis (B.P.) for number of branches per plant (N.B./P.), number of lecules per fruit (N.L. /F.), number of fruits per plant (N. F./P.), and weight of fruits per plant (W.F./P.) traits with the values of 5.0%, 9.78%, 10.42% and 7.53%, respectively. Similarly, number of days to flowering (N.D.F.) trait showed insignificant and negative high values of heterosis (desirable) versus the B.P. These results were expected and explained the high values of non-additive genetic variances including dominance. It could be also concluded that the dose of 10kr increased the heterosis values as a results of increasing the means of F_1 hybrids for most studied traits. These results were in agreement with the results obtained by Mohamed (1983), Askar (1986), Dhillons and Sharma (1982) and Veeraragavatfatham and Irulafpan (1990).

Table 4: The effect of radiation doses on the means of parental varieties, F_1 hybrids and F_{1r} reciprocal hybrids for all studied traits.

Geno.	Dose	N.D.F		N.N.F		N.S./F		P.H.		N.B./P.		N.L./F.		N.F./P.		W.F./P.		F.L.		F.D.		N.L./P.	
		D	S	D	S	D	S	D	S	D	S	D	S	D	S	D	S	D	S	D	S	D	S
P1	0	51.3	57.3	2.0	2.7	64.7	91.0	200	281	6.0	8.7	299	341	587	591	2.93	2.52	6.7	7.5	4.5	4.8	5.0	6.0
	5	51.3	51.3	2.7	2.7	71.7	99.0	289	252	5.7	7.0	257	259	397	472	1.98	2.58	8.2	8.9	4.5	4.4	5.0	6.0
	10	52.3	50.3	2.0	2.0	78.7	99.3	211	220	8.0	10.0	239	340	505	622	2.16	2.74	5.9	5.6	4.7	4.0	5.0	6.0
	15	53.7	51.3	2.7	1.7	71.0	89.7	328	238	8.3	2.7	257	125	603	591	3.35	3.09	5.9	5.5	4.8	4.8	5.0	6.0
P2	0	56.7	58.0	2.0	4.0	66.7	85.7	157	257	9.7	4.0	338	168	428	604	2.59	2.49	4.0	4.1	7.0	7.5	7.0	7.0
	5	55.3	52.0	3.0	3.0	74.0	91.0	209	224	9.0	9.0	336	332	444	698	2.78	3.28	4.5	4.0	7.8	7.0	7.0	7.3
	10	56.3	57.7	3.7	3.7	141.3	92.0	193	203	4.7	6.0	203	258	362	512	1.85	2.72	3.9	3.6	5.7	5.5	9.0	7.0
	15	55.7	60.7	2.0	3.0	70.0	86.3	188	199	6.3	5.7	243	269	441	466	2.52	2.24	4.1	4.3	6.4	5.9	9.7	9.0
P3	0	67.7	66.0	6.7	5.3	76.7	113	230	241	6.3	8.7	266	285	425	436	2.49	2.83	5.0	5.0	5.3	5.3	7.0	7.0
	5	66.3	63.0	4.0	4.0	75.3	115.7	192	203	16.7	9.0	450	271	601	603	3.58	2.50	5.1	5.5	5.1	4.7	6.0	7.0
	10	66.7	66.0	3.0	3.0	136.7	117	286	252	6.3	10.3	312	422	486	503	2.79	2.71	4.2	5.1	4.5	4.6	7.7	7.7
	15	69.3	58.0	4.7	4.0	84.0	120.3	229	211	15.0	9.0	336	243	368	532	1.96	2.89	4.7	5.0	5.2	5.0	7.7	7.7
P4	0	58.0	61.7	4.7	4.7	140.7	102.7	203	237	11.3	10.3	219	342	588	544	3.21	2.43	4.9	4.4	6.4	6.0	10.0	8.0
	5	60.3	60.0	2.7	3.7	95.3	81.7	193	302	23.0	11.0	688	523	534	651	2.89	3.03	4.6	4.3	6.1	5.4	8.0	9.0
	10	65.7	60.0	4.7	5.3	123.7	87.7	247	291	5.0	9.0	115	366	496	634	2.76	4.07	4.3	3.9	6.6	6.2	8.3	8.3
	15	63.0	61.7	4.0	3.0	122.7	147.7	282	271	5.3	5.7	266	335	570	668	2.72	3.51	4.0	3.8	6.2	6.0	9.3	9.7
P1 x P2	0	52.0	52	3.0	3.0	62.7	59.7	249	262	4.7	6.3	132	232	426	522	2.01	2.25	5	6.0	5.7	5.4	5.0	5.0
	5	50.7	53	3.0	3.0	105	87	239	301	4.7	3.7	151	147	605	673	3.11	3.37	6.5	6.0	5.5	5.1	7.3	7.0
	10	53.0	53.3	3.0	3.0	101	97.3	284	319	4.0	5.0	164	203	167	605	2.79	3.69	7.1	6.4	5.4	5.1	7.3	7.7
	15	55.0	56.3	3.0	2.0	107	94.7	312	260	8.3	5.3	436	183	544	660	3.34	3.93	5.7	5.8	5.1	5.0	7.3	7.7
P1 x P3	0	52.0	54	2.7	3.0	89.0	64.7	227	234	13.0	3.0	381	335	614	557	3.17	2.56	6	5.0	4.9	4.4	6.0	6.0
	5	54.0	54	2.7	2.3	86.0	88.7	262	271	4.3	3.7	180	185	489	681	2.56	3.27	4.9	6.7	4.7	4.7	7.0	6.3
	10	56.0	55	4.0	3.0	110	72.3	307	243	4.3	6.0	304	204	559	570	3.23	3.11	6.7	7.1	5.4	5.5	7.0	6.7
	15	55.7	54.7	3.7	3.0	104	75.0	322	225	6.0	4.7	232	213	721	523	3.91	2.77	5.4	4.7	5.3	4.6	7.0	6.3
P1 x P4	0	55.3	52.7	3.0	3.0	67.7	54.3	266	339	6.0	6.7	210	223	636	591	2.65	2.64	8	6.4	5.5	5.2	5.0	5.0
	5	52.0	55	3.0	2.7	71.3	93.7	229	289	3.3	4.0	104	192	683	605	3.05	2.55	5.6	4.5	4.7	5.6	5.0	6.0
	10	54.3	54.7	2.7	3.0	81.3	100	189	304	11.0	4.7	4.37	200	703	621	4.29	3.61	4.4	5.2	5.5	4.8	5.3	6.0
	15	55.0	58.3	2.0	3.7	74.7	61.0	302	298	4.7	4.7	215	253	462	543	2.46	2.94	4.4	3.7	5.0	5.6	5.0	6.3
P2 x P3	0	53.0	52.3	3.0	3.3	125	113	251	236	7.0	3.3	176	194	422	559	2.12	2.71	4.2	4.5	5.5	4.5	8.0	7.0
	5	57.7	53.7	3.0	3.0	117	121	225	247	4.7	3.7	152	163	571	491	3.21	2.09	5.5	5.6	6.5	5.0	8.0	7.0
	10	57.0	54.7	2.0	3.0	131	122	261	286	6.0	5.3	246	204	455	675	2.39	3.97	4.8	5.4	5.9	5.9	8.0	7.3
	15	57.7	59.0	2.7	3.0	125	116	313	264	3.3	4.3	197	195	542	459	2.99	2.79	5.2	6.5	4.7	5.3	8.0	7.3
P2 x P4	0	54.7	60.0	4.0	3.7	137	94.3	254	207	7.7	4.7	310	155	486	507	2.1	2.35	4.3	4.5	6.2	5.3	9.0	8.0
	5	56.0	56	4.0	3.0	96.0	91.3	216	214	11.3	7.0	395	273	560	618	2.52	2.70	6.2	4.0	5.4	5.1	8.0	7.0
	10	55.7	56.3	2.3	3.0	102	102	273	214	9.0	7.7	360	286	550	575	3.25	3.71	3.9	5.4	4.8	5.8	8.3	7.3
	15	55.7	57.0	3.7	3.0	95.3	95.0	231	213	7.0	8.3	283	266	575	572	2.76	3.81	5.	5.3	5.6	5.5	8.3	8.0

D: dry S: soaked

Table4: Continued

Geno.	Dose	N.D.F		N.N.F		N.S./F		P.H.		N.B./P.		N.L./F.		N.F./P.		W.F./P.		F.L.		F.D.		N.L./P.	
		D	S	D	S	D	S	D	S	D	S	D	S	D	S	D	S	D	S	D	S	D	S
P3 x P4	0	64.7	57.3	5.8	4.7	107	81.7	203	249	5.0	10	189	252	415	611	2.5	2.91	4	4.9	5.1	6.1	6.0	7.0
	5	54.3	54.7	4.3	3.0	109	116	270	266	10.3	5	367	230	484	622	2.17	2.83	4.5	4.5	5.4	6.0	7.0	8.3
	10	61.3	57.3	3.0	3.0	112	120	275	284	4.7	5.3	196	266	544	505	3.18	3.15	4.2	5.0	5.4	5.8	6.7	9.7
	15	53.7	58.0	3.0	2.7	80.7	93.7	251	279	7.0	5.7	200	222	630	515	3.56	3.79	5.3	4.0	6.1	6.0	6.3	9.0
P2 x P1	0	51.0	53.7	4.0	3.0	117	110	208	262	6.7	7.0	86.0	276	569	475	2.79	2.48	6.0	6.1	5.1	5.4	8.0	7.0
	5	52.7	55.0	3.0	3.3	121	118	288	230	5.0	5.7	204	252	568	567	2.92	2.54	7.4	6.5	5.0	5.6	8.0	7.0
	10	60.6	55.3	2.7	2.7	133	125	264	267	7.3	6.3	308	265	716	627	3.38	4.62	6.3	4.6	5.5	4.9	9.0	7.3
	15	54.3	57.7	3.0	4.0	89.0	110	235	322	3.3	6.0	116	342	666	608	3.57	3.96	5.1	4.2	5.2	5.6	7.3	7.3
P3 x P1	0	64.0	63.7	4.7	4.7	105	106	246	252	7.3	3.0	255	125	559	499	2.24	2.59	4.5	6.0	5.2	5.5	7.0	6.0
	5	59.7	58.7	4.3	4.3	107	117	226	239	11.0	9.0	481	243	620	629	2.98	3.27	4.8	3.6	5.9	5.2	8.0	7.0
	10	62.3	61.0	3.7	3.7	118	123	240	243	11.3	6.3	464	177	498	513	2.73	2.91	6.1	5.7	5.5	5.8	7.3	7.0
	15	63.7	61.0	4.0	4.0	103	108	276	277	5.7	5.0	301	244	516	517	2.81	3.25	6.1	4.6	6.1	5.3	7.3	7.3
P4 x P1	0	59.0	60.7	5.0	5.0	108	109	240	257	8.3	8.7	332	238	537	585	2.04	3.39	3.5	6.1	6.2	6.4	7.0	7.3
	5	61.3	59.7	4.7	4.7	96.0	127	295	226	5.7	7.3	183	276	589	642	2.39	2.82	5.2	4.0	5.3	5.6	6.0	8.0
	10	58.0	59.3	3.7	3.7	128	150	267	241	4.3	5.0	186	238	534	649	2.9	4.41	5.1	4.5	5.0	5.3	8.3	10.0
	15	65.7	62.3	4.3	4.3	123	106	252	259	10.0	18.0	424	225	556	528	4.04	2.98	4.5	4.9	5.2	5.4	8.0	9.3
P3 x P2	0	57.0	55.0	3.7	3.7	115	113	236	266	7.7	5.7	198	165	531	453	2.43	2.70	4.5	3.5	5.0	5.4	9.0	9.0
	5	55.3	55.0	3.0	3.0	106	118	258	276	4.7	3.0	125	133	603	594	2.55	2.48	3.7	4.4	5.3	5.4	8.0	7.0
	10	66.7	60.3	3.3	3.3	104	123	284	267	12.0	3.0	514	114	632	492	3.67	2.82	3.7	5.0	5.2	5.5	7.7	7.3
	15	59.3	56.0	3.0	3.0	104	113	333	266	6.7	5.7	325	225	525	582	2.83	3.45	4.1	5.1	5.3	5.6	8.3	7.3
P4 x P2	0	58.0	59.3	4.3	4.3	144	142	301	260	6.0	6.0	267	230	681	469	3.82	3.34	5.4	4.6	5.6	5.4	8.3	8.0
	5	60.7	58.3	4.3	4.3	145	151	289	227	8.3	3.3	338	132	399	570	2.03	2.38	4.7	5.1	5.6	6.4	8.0	8.0
	10	62.7	60.0	4.3	4.3	150	157	271	254	7.0	3.3	169	150	491	565	2.24	2.94	5.1	3.8	5.3	5.5	8.0	8.0
	15	61.3	58.3	4.3	4.3	143	146	271	273	3.3	4.7	215	230	462	526	2.56	3.29	4.4	4.3	5.5	6.1	8.0	8.0
P4 x P3	0	61.0	58.7	5.0	5.0	117	138	268	269	6.7	10.0	226	342	550	528	2.41	3.21	5.6	4.8	5.6	5.5	8.0	8.0
	5	57.3	59.3	5.0	4.3	124	97.7	217	217	9.0	4.3	267	102	581	653	2.54	2.53	6.0	5.3	5.4	6.2	7.7	6.7
	10	55.0	62.0	4.7	4.7	126	90.7	278	286	19.7	7.0	702	316	542	600	2.92	3.77	5.6	5.2	5.5	5.7	8.0	8.0
	15	64.7	68.7	4.7	5.3	111	112	270	284	8.3	8.7	247	285	526	511	3.33	2.30	4.8	4.8	5.6	5.5	8.0	8.0

D: dry S: soaked

Table 5: Means, ranges of parental varieties and their F_1 hybrids in addition to heterosis versus the mid and better parents for all doses and conditions for all studied traits.

	dose	N.D.F		N.N.F.		N.S./F		P.H.		N.B./P.		N.L./F.		N.F./P.		W.F./P.		F.L.		F.D.		N.L./P.	
		D	S	D	S	D	S	D	S	D	S	D	S	D	S	D	S	D	S	D	S	D	S
M.P	0	58.4	60.8	3.85	4.2	87.18	98.1	197.5	254.0	8.33	7.93	280.5	284	507	543.8	2.81	2.57	5.15	5.25	5.8	5.9	7.25	7.0
	5	58.3	56.6	3.1	3.35	79.08	96.8	220.8	245.3	13.6	9.0	432.8	346.3	494	606	2.81	2.85	5.6	5.68	5.88	5.38	6.5	7.33
	10	60.3	58.5	3.35	3.5	120.1	99.0	234.3	241.5	6.0	8.83	217.3	346.5	462.3	567.8	2.39	3.06	4.58	4.55	5.38	5.08	7.5	7.25
	15	60.4	60.4	3.35	2.93	86.93	111.0	256.8	229.8	8.73	5.78	275.5	243	495.5	564.3	2.64	3.93	4.68	4.65	5.65	5.43	7.93	8.1
Range	0	51.3-67.7	57.3-66.0	2-6.7	2.7-5.3	64.7-140.7	85.7-113	157-230	237-281	6-11.3	4-10.3	219-338	168-342	425-588	436-604	2.49-3.12	2.43-2.83	4-6.7	4.1-7.5	4.5-7	4.8-7.5	5-10	6-8
	5	51.3-66.3	51.3-63.0	27-4.0	2.7-4.0	71.7-95.3	81.7-115.7	192-289	203-302	5.7-23	7.11	257-688	259-523	397-601	472-698	1.98-3.58	2.5-3.28	4.5-8.2	4-8.9	4.5-7.8	4.4-7	5-8	6-9
	10	52.3-66.7	50.3-66.0	2.0-4.7	2-5.3	71.7-141.3	87.7-117	193-286	203-291	4.7-8.0	6.10.3	115-312	258-422	362-505	503-634	1.85-2.79	2.71-4.07	3.9-5.9	3.6-5.6	4.5-6.6	4-5.5	5-9	6-8.3
	15	53.7-69.3	51.3-68.0	2.0-4.7	1.7-4.0	70-122.7	8 6.3-147.7	188-328	199-271	5.3-15	2.7-9	266-336	125-335	368-603	466-668	1.96-3.35	2.24-3.51	4-5.9	3.8-5.5	4.8-6.4	4.8-6	5-9.7	6-9.7
F_1	0	56.81	56.6	4.10	3.9	107.9	98.8	245.5	257.8	7.15	6.2	230.2	230.6	535.5	529.7	2.51	2.76	5.1	5.2	5.5	5.4	7.2	6.95
	5	55.98	56.1	3.55	3.35	106.9	110.6	251.2	250.3	6.85	4.95	245.6	194.0	562.7	612.1	2.69	2.75	5.4	5.0	5.4	5.5	7.35	7.1
	10	58.55	57.5	3.36	3.35	116.4	115.2	266.1	267.4	8.4	5.43	342.5	218.6	557.6	583.1	3.0	3.57	5.25	5.3	5.35	5.5	7.6	7.7
	15	58.5	59.0	3.48	3.55	105.2	102.5	280.7	268.4	6.15	6.76	265.9	253.8	560	545.3	3.19	3.25	5.0	4.9	5.4	5.45	7.4	7.65
Range	0	51-64.7	52-63.7	2.7-5.8	3-5	62.7-137	54.3-142	203-301	207-339	4.7-13	3-10	86-381	125-342	415-681	453-611	2.01-3.82	2.25-3.39	3.5-8.0	3.5-6.5	4.9-6.2	3.5-6.4	5-9	5-9
	5	50.7-62.3	53-59.7	2.7-5	2.3-4.7	71.3-145	87-151	216-295	214-301	3.3-11.3	3-9	104-481	102-276	399-683	491-653	2.03-3.21	2.09-3.37	3.7-7.4	3.6-6.7	4.7-6.5	4.7-6.4	5-8	6-8.3
	10	53-66.7	53.3-62	2-4.7	2.7-4.7	81.3-150	88.7-157	189-307	214-319	4-19.7	3-7.7	164-702	114-316	455-716	492-675	2.24-4.29	2.82-4.62	3.7-7.1	3.8-7.1	3.7-7.1	4.8-5.9	5.3-9	6-10
	15	53.7-65.7	54.7-68.7	2-5.7	2-5.3	74.7-143	61.146	231-333	213-322	3.3-10	4.3-18	116-436	183-342	462-721	459-660	2.46-4.04	2.3-3.96	4.1-6.1	3.7-6.5	4.1-6.1	4.6-6.1	5-8.3	6.3-9.3
H(M.P)	0	-2.72	-6.91	6.49	-7.14	23.8**	0.71	24.3**	1.50	-14.2*	-21.8**	-17.9**	-18.8**	5.62	-2.59	-10.68	7.39	-0.97	-0.95	-5.17	-8.47	-0.7	13.6*
	5	-3.98	0.88	14.52**	0.0	35.3**	14.2**	13.8**	2.04	-49.6**	-45**	-43.2**	-43.9**	-26.6**	1.01	-4.27	-3.51	-3.57	-11.97	-8.16	2.23	13.1*	-3.14
	10	-2.90	-1.71	0.30	-4.29	-3.08	16.36**	13.6**	10.7**	40**	-38.5**	57.4**	-36.9**	20.6**	2.69	25.5**	16.7**	13.8*	16.5**	-0.56	8.27*	1.33	6.21
	15	-3.15	-2.32	3.88	15.8**	21.0**	-7.66	9.31	16.8**	-29.5**	16.9**	-3.5	4.44	13.0**	3.37	20.8**	-17.3	6.84	5.38	-4.42	0.37	-6.68	-5.6
H(B.P)	0	-16.11**	14.24*	-38.81**	-26.4**	-23.3**	-12.57*	6.74*	-8.26*	-36.7**	-39.8**	-31.9**	-32.6**	-8.93	-12.3*	-19.5**	-2.47	-23.9**	-30.7**	-21.4**	-28	-28**	-13.1*
	5	-15.57**	-10.95*	-11.25**	-16.2**	12.2*	-4.41	-13.1*	-17.1**	-70.2**	-55**	-64.3**	-62.9**	-6.37	-12.3*	-24.8**	-16.2**	-34.2**	-43.8**	-30.8**	-21.4**	-8.13	-21.1**
	10	-12.22**	-12.88*	-28.51**	-36.8**	-17.6**	-1.54	-6.96	-8.11	5.0	-47.3**	9.38*	-48.2**	10.4*	-8.03	7.53	-12.3*	-11.0*	-5.36	18.9*	0.0	-15.5*	-7.23
	15	-15.58**	-13.24*	-25.96**	-11.2*	-14.3*	-30.6**	-14.4*	-0.9	-59**	-24.9**	-20.9*	-24.2**	-7.13	-18.4*	-4.78	-7.41	-15.3*	-10.9*	-15.6*	-9.17	-23.7**	-21.1**

D: dry S: soaked *,** significant at 0.05 and 0.01 levels of probability, respectively

The analyses of variance of diallel crosses mating design were made separately for all doses at two conditions in addition to the control and the results are presented in Table 6.

Table 6: The results of the analyses of variance of diallel crosses for all doses at each condition for all studied traits.

	d.f		Dos.	N.D.F	N.N.F	N.S./F	P.H.	N.B./P.	N.L./F.	N.F./P.	W.F./P.	F.L.	F.D.	N.L./P.
GCA	3	D.	0	45.46**	1.409**	114.78**	613.8**	3.72**	5863.6**	448.1	0.155**	0.885**	0.343**	3.73**
			5	6.54**	1.259**	466.46**	302.03**	9.36**	6962.1**	3618.2	0.224**	1.276**	0.283**	2.204**
			10	19.37**	0.648**	109.9**	658**	14.69	20425**	2691*	0.588**	2.291**	0.088**	0.898**
			15	8.326**	0.602**	117.5**	1533**	3.084**	2179**	3749	0.415**	0.276**	0.174**	1.268**
		s.	0	12.13**	1.21**	906.2**	756.0**	8.86**	1434.9	4501.5**	0.238**	2.501	0.312**	3.204**
			5	6.23**	0.24**	147.82**	592.9**	2.27**	2857.3**	3522.2	0.204**	0.911	0.480**	0.315**
			10	9.58**	0.80**	362.0**	52.72**	0.38**	2951.2**	2476.0	0.511**	1.219	0.29**	0.972**
			15	16.06**	0.676**	601.0**	111.8**	15.05**	956.5	5255.6**	0.397	0.781	0.32**	0.871**
SCA	2	D.	0	1.617	0.419*	359.78**	653**	7.58**	21125.5**	9045.5*	0.465**	0.015	0.041*	0.704**
			5	15.82**	0.259	297.4**	30.01	17.81**	43169.7**	8975.5**	0.076	1.396**	0.041**	1.083**
			10	3.371	0.120	88.12**	757.5**	1.01**	1308	3449**	0.218**	1.86**	0.042**	0.194**
			15	7.37**	0.120	218.6**	1193**	1.564**	1867**	5149	0.226**	0.655**	0.316**	0.194**
		s.	0	20.95**	0.04	27.57	1344.2**	17.40**	6036.6	1574.5	0.031	0.211	0.188**	0.120**
			5	1.68**	0.028	108.17**	507.8**	1.84**	667.8	2559.7	0.195	0.901	0.153**	0.065
			10	1.28**	0.176*	256.7**	2664**	2.527**	5998.9**	2884.2	0.472	0.197	0.081**	0.843**
			15	5.84**	0.009	49.04**	1602**	6.58**	3747.2**	2417.4	0.206	0.16	0.028	0.361
Res.	6	D.	0	18.21**	0.882**	428.09**	791.2**	3.96	3039.6	8472.7*	0.484**	2.282**	0.148**	1.62**
			5	13.29**	0.148	336.88**	1427.8**	5.07**	9483.2**	5311.4*	0.126	0.700**	0.298**	0.241**
			10	20.54**	0.148**	544.7**	962.4**	30.8**	42313**	10721**	0.197**	0.525**	0.103**	1.157**
			15	27.84**	1.38**	526.9**	1078**	6.66**	14512**	7453*	0.216	0.278**	0.10**	1.009**
		s.	0	14.13**	0.62**	1069.1**	923.9**	0.97	5075.6	2097.2**	0.136**	0.182	0.298**	1.204**
			5	6.38**	0.97**	573.9**	1139.2**	4.82**	4861.7**	2436.9	0.117	1.121	0.197**	0.685**
			10	10.76**	0.50**	823.3**	718.6**	2.42**	2908.5**	3949.6	0.225	0.741	0.053**	1.621**
			15	15.2**	1.194**	528.5**	975.1**	16.88**	4683.5**	1672.9	0.250	0.659	0.134**	0.926**
Error	22	D.	0	2.98	0.134	12.36	5.02	2.008	1969.1	2336.5	0.072	0.083	0.011	0.009
			5	0.403	0.161	7.04	33.0	0.714	847.7	1784.1	0.070	0.016	0.007	0.018
			10	1.494	0.105	12.19	3.78	0.312	472.3	594.4	0.044	0.047	0.004	0.091
			15	0.269	0.105	9.25	98.76	0.199	352.9	2155	0.092	0.035	0.007	0.058
		s.	0	0.91	0.057	16.23	23.17	0.84	5015.3	519.3	0.027	0.048	0.013	0.009
			5	0.86	0.129	8.99	25.73	0.27	449.6	1222.7	0.048	0.013	0.004	0.055
			10	0.89	0.057	6.83	8.29	0.33	550.2	2224.6	0.185	0.025	0.004	0.065
			15	1.17	0.196	6.90	7.77	0.44	603.5	1881.1	0.224	0.025	0.017	0.134

D: dry S: soaked *, significant at 0.05 and 0.01 levels of probability, respectively.**

The results revealed that the mean squares of general combining ability (GCA) and specific combining ability (SCA) showed highly significance for most studied traits at two conditions at all doses. In the same time, the results also indicated that the mean squares of general combining ability were larger than their corresponding the mean squares of specific combining ability for most studied traits at all doses with respect to dry and soaked conditions. The results also cleared that the mean squares of reciprocal variances were highly significant for all studied traits at all doses with few exceptions.

These findings indicated the importance of the choice of parents to produce promising hybrids.

The variances of general combining ability (σ^2g), specific combining ability (σ^2s) and reciprocal variances (σ^2r) were obtained for all doses at dry and soaked conditions and the results are shown in Table 7. The results illustrated that the variances of SCA (σ^2s) were larger than those the variances of GCA (σ^2g) for all studied traits at most doses. In the same time, the results indicated that the low or medium doses of gamma irradiation increased the variances of σ^2g and σ^2s for many studied traits.

Table 7: The estimates general combining ability variances (σ^2g), specific combining ability of (σ^2s) and reciprocal effect (σ^2r) variances for all doses at each condition for all studied traits.

		Dos.	N.D.F	N.N.F	N.S./F	P.H.	N.B./P.	N.L./F.	N.F./P.	W.F/P	F.L.	F.D.	N.L./P.
σ^2g	D	0	10.96	0.248	197.03	-9.79	-0.97	-3815.5	-1232.1	-0.08	0.218	0.075	0.76
		5	-2.32	0.25	42.3	68.0	-2.11	-9051.9	-1339.3	0.037	-0.03	0.067	0.280
		10	4.0	0.132	5.45	-24.9	3.42	4779.3	-189.5	0.093	-0.110	0.012	0.176
		15	0.24	0.121	-12.8	85.0	0.38	78.0	-350	0.047	-0.095	-0.04	0.269
	S	0	-2.21	0.294	519.7	450.4	-2.14	-1025.1	731.8	0.052	0.573	0.075	0.77
		5	1.14	0.060	9.913	21.26	0.108	547.4	240.6	0.003	0.003	0.082	0.063
		10	2.07	0.155	26.33	-652.8	-0.538	-861.9	-102.3	0.01	0.256	0.052	0.032
		15	2.55	0.167	138.0	-372.6	2.118	-697.7	709.6	0.048	0.155	0.073	0.128
σ^2s	D	0	-0.68	0.142	173.7	324.0	2.79	9578.2	3354.5	0.197	-0.034	0.015	0.348
		5	-7.81	0.049	145.2	-1.49	8.55	21161.0	3595.7	0.003	0.69	0.003	0.533
		10	0.94	0.008	37.97	376.9	0.349	417.9	1427.3	0.087	0.91	0.019	0.052
		15	3.55	0.008	104.7	547.1	0.68	757.1	1497	0.067	0.31	0.16	0.068
	S	0	10.02	-0.01	5.67	660.51	8.28	510.4	527.61	0.002	0.084	0.087	0.06
		5	0.413	-0.051	49.60	241.1	0.788	109.1	668.5	0.074	0.444	0.075	0.01
		10	0.201	0.060	124.9	1327.9	1.099	2724.4	329.8	0.144	0.086	0.039	0.385
		15	2.34	-0.094	21.07	797.1	3.072	1571.9	268.2	-0.01	0.086	0.01	0.114
σ^2r	D	0	7.62	0.374	207.8	393.08	0.98	535.3	3068.1	0.206	1.10	0.068	0.806
		5	6.44	0.006	164.9	697.4	2.17	4317.8	1763.6	0.028	0.342	0.145	0.112
		10	9.52	0.522	266.3	479.3	15.2	20920.0	5063.3	0.077	0.24	0.050	0.533
		15	13.79	0.638	258.8	489.6	3.23	7079.6	2649	0.062	0.122	0.047	0.476
	S	0	6.61	0.282	526.4	450.0	0.065	30.15	789.01	0.052	0.07	0.142	0.60
		5	2.76	0.42	282.5	556.7	2.28	2206.0	607.1	0.035	0.554	0.097	0.32
		10	4.94	0.222	408.2	355.2	1.044	1179.0	862.8	0.020	0.358	0.025	0.778
		15	7.02	0.499	260.8	433.7	8.222	2040.2	-1041	0.013	0.317	0.060	0.396

D: dry S: soaked

The results also indicated the presence of positive reciprocal variances (σ^2r) for all studied traits. These findings indicated the importance of reciprocal (σ^2r) for all studied traits at all doses. It could be also noticed that the low doses of gamma irradiation increased the variances due (σ^2r) for all studied traits with few exceptions. It could be also concluded the presence of important values of σ^2g, σ^2s and σ^2r for all studied traits at all doses. In addition, the low doses of gamma irradiation increased the variability for most studied traits.

The different variance components which are expected to be present in the mean squares were obtained for all studied traits at all doses and the results are presented in Table 8.

The results showed that the magnitudes of non-additive genetic variances including dominance were larger than their corresponding additive genetic variances for most studied traits. The results also indicated that the obtained values of additive genetic variances could not be neglected. However, the obtained values of genetic parameters cleared the importance of both additive and non-additive genetic variances in total genetic variability for all studied traits, although the values of σ^2D were larger than those the values of σ^2A. These results were completely in agreement with the results obtained by Chandra *et al* (1997), Ramesh and Singh (1999), Mamta Rani and Arora (2003), Sood (2001), Panda and Singh (2003), Sushmita and Das (2003).

Heritability in broad sense ($h^2_{b.s}\%$) is an estimation of the amounts of genetic variances (additive and non-additive) relative to the phenotypic variances. Heritability in narrow ($h^2_{n.s}\%$) sense estimated the amounts of additive genetic variances relative to the phenotypic variances. Therefore, the values of heritability in broad and narrow senses were calculated for all doses at two conditions for all studied traits and the results are presented in Table 9.

The results revealed that the calculated values of heritability in broad sense were larger than their corresponding values of heritability in narrow sense for most doses at two conditions for most studied traits. These results were expected where, the magnitudes of σ^2D were larger than those σ^2A for most studied traits at all doses. The results also revealed that the obtained values of heritability in narrow sense explained the importance values of additive genetic variances for most studied traits. The results also illustrated that the values of heritability in broad sense ranged from (22.28 to 66.7%); (25.18 to 76.68%); (14.93 to 72.06%); (5.78 to 54.93%); (1.64 to 92.50%); (6.26 to 43.74%); (3.9 to 60.35%); (11.75 to 69.29%); (43.75 to 83.20%) and (26.61 to 89.37%) for number of days to flowering (N.D.F.), number of first fruiting node (N.N.F), number of seeds per fruits (N. S. /F), Plant height in centimeters (P.H. cm.), number of branches per plant (N.B./P.), number of lecules per fruit (No. L. /F.), number of fruits per plant (N. F. /P.), weight of fruit/plant in kilograms (W.F./P. kg.), fruit length in centimeters (F. L. cm.), fruit diameter in centimeters (F. D. cm.) and number of leaves per plant (N. L./P.) traits, respectively. In this respect, the results revealed that the obtained highest values of heritability in narrow sense were : 83.69% (Dry) and 99.79% (Soaked) for number of branches per plant (N.B./P.) and number of seeds per fruits (N. S. /F), respectively. These results were in agreement with the results obtained by Singh and Singh (1997), Dhankhar and Dhankhar (2002, 2003), Yadav *et al* (2002).

It could be concluded that, the studied traits showed different responses to gamma radiation. On the other hand, the high doses of gamma rays could cause damaging effects. Therefore the possibility of improving Okra traits through selection programs in the segregating generations of Okra hybrids is available.

Table 8: The estimates of additive, non-additive genetic variances for all doses at each condition for all studied traits.

		Dos.	N.D.F	N.N.F.	N.S./F	P.H.	N.B./P.	No.L./F.	N.F./P.	W.F/P.	F.L.	F.D.	N.L./P.
σ^2A	D	0	-21.9	0.496	394.1	-19.58	-1 94	-7631.0	-2464.2	-0.16	0.436	0.150	0.15
		5	-4.64	0.500	84.6	136	-4.22	-18103.8	-2678.6	0.074	-0.06	0.134	0.50
		10	-8.0	0.264	10.90	-49.8	6.84	9558.6	-379.0	0.186	-0.22	0.024	0.35
		15	0.48	0.242	-25.6	170	0.76	156	-700	0.094	-0.19	-0.08	0.53
	S	0	-4.42	0.588	1039.4	900	-4.28	-2050.6	1463.6	0.104	1.146	0.150	1.5
		5	4.28	0.120	19.826	42.52	0.216	1094.8	481.2	0.006	0.006	0.164	0.10
		10	4.14	0.310	52.66	-1305.6	-1.076	-1723.8	-204.6	0.02	0.512	0.104	0.06
		15	5.10	0.334	276	-745.2	4.236	-1395.4	1419.2	0.096	0.311	0.146	0.25
σ^2D	D	0	-0.68	0.142	173.7	324.0	2.79	9578.0	3354.5	0.147	-0.03	0.015	0.34
		5	7.81	0.049	145.2	-1.49	8.55	21161	3595.7	0.003	0.69	0.003	0.53
		10	0.94	0.008	37.97	376.9	0.349	417.0	1427.3	0.087	0.91	0.052	0.05
		15	3.55	0.008	104.7	547.1	0.680	757.0	1497	0.067	0.31	0.068	0.06
	S	0	10.02	-0.01	5.67	660.57	8.28	510.43	527.6	0.002	0.084	0.087	0.06
		5	0.413	-0.05	49.60	241.1	0.788	109.1	668.5	0.074	0.444	0.075	0.01
		10	0.201	0.06	124.9	1327.9	1.099	2724.4	329.8	0.144	0.086	0.039	0.385
		15	2.34	-0.09	21.07	797.1	3.072	1571.9	268.2	-0.01	0.086	0.01	0.110

D: dry S: soaked

Table 9: The estimates of heritability values in broad ($h^2_{b.s}$) and narrow ($h^2_{n.s}$) senses for all doses at two conditions for all studied traits.

		Dos.	N.D.F	N.N.F	N.S./F	P.H.	N.B./P.	N.L./F.	N.F./P.	W.F/P.	F.L.	F.D.	N.L./P.
$h^2_{b.s}$	D.	0	66.71	55.62	72.06	43.33	22.37	43.74	14.14	11.75	25.34	67.55	69.56
		5	31.67	76.68	57.20	15.55	59.99	37.18	20.54	44.00	63.76	47.56	89.37
		10	44.79	30.26	14.93	40.38	31.66	31.80	15.63	69.29	79.65	43.75	39.30
		15	22.28	25.18	22.75	54.93	92.50	10.94	14.23	51.11	43.32	60.87	53.16
	S.	0	42.68	62.87	45.06	43.62	81.55	-	60.35	56.68		60.4	72.40
		5	42.65	11.27	19.24	32.74	28.28	31.19	38.59	48.77		70.29	26.61
		10	42.72	57.01	29.77	5.78	1.64	36.65	3.9	44.44		83.20	34.75
		15	47.64	25.67	52.60	10.52	45.76	6.26	48.70	26.63		66.95	41.11
$h^2_{n.s}$	D.	0	68.84	43.24	50.01	-	-	-	-	-	27.51	61.51	56.56
		5	-	69.83	36.14	15.72	-	-	-	42.29	-	46.39	45.79
		10	40.1	29.37	3.33	-	30.14	30.47	-	47.21	15.32	23.96	34.24
		15	2.65	24.37	-	13.02	83.69	1.87	-	29.84	-	-	47.19
	S.	0	-	63.96	44.48	-	-	-	44.36	55.61		38.23	69.68
		5	36.31	19.49	5.51	4.91	6.1	28.37	16.15	3.1		48.24	24.66
		10	40.75	47.77	8.89	-	-	99.79	-	5.42		60.60	4.95
		15	32.68	35.72	48.87	-	26.52	-	40.96	-		62.66	28.44

D: dry S: soaked

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"توصيف التباينات الوراثية الناتجة عن الاشعاع فى الباميا"

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فى هذه الدراسة تم استخدام أربعة آباء مختلفة من الباميا وكذلك كل الهجن الممكنة الناتجة منها (ستة هجن وستة هجن عكسية). حيث تم تعريض بذورها الجافة وكذلك المنقوعة لأشعة جاما بجرعات صفر ، ٥ ، ١٠ ،١٥ كيلوراد لمعرفة مدى تأثير التعرض للإشعاع فى أحداث تباينات وراثية تكون أداة لتحسين الباميا. وقد تم تقييم متوسط الأداء لجميع الصفات الاقتصادية تحت الدراسة وذلك فى الأجيال الأشعاعية. وبينت نتائج هذه الدراسة ما يلى:-

- لوحظ أن الجرعة المتوسطة ١٠كيلو/ راد كانت ذات التأثير المتزايد فى إستحداث التباين داخل التراكيب الوراثية المختلفة فى معظم الصفات المدروسة. ومن الملاحظ أيضاً أن الأصناف مثلها مثل الهجن قد أبدت استجابات مختلفة للجرعات المختلفة من أشعة جاما.
- أوضحت نتائج الدراسة وجود قوة هجين لمعظم الصفات المدروسة.
- أدت الجرعة ١٠كيلو/ راد إلى زيادة متوسط الهجن عن متوسط الآباء لبعض الصفات المدروسة وخاصة فى حالة البذور المنقوعة.
- بينت النتائج أن الجرعة ١٠كيلو/ راد أدت إلى تواجد قيم موجبة وذات قيمة اقتصادية لقوة الهجين وذلك مقارنة بأفضل الآباء.
- أشارت النتائج إلى أن التباين غير الإضافى شاملا تباين السيادة كان أعلى قيمة مقارنة بالتباين الاضافى لمعظم الصفات تحت الدراسة.
- وفى نفس الوقت أوضحت قيم التباين الاضافى المتحصل عليها أهمية هذا الجزء من التباين لمثل هذه الصفات وأنه لا يمكن إهماله.
- وأوضحت النتائج أيضاً وجود قدر معقول من معامل التوريث فى كل من المدى الواسع والضيق بالنسبة لمعظم الصفات.
- وأخيراً فقد أكدت النتائج على إمكانية تحسين صفات الباميا من خلال برامج الانتخاب فى الأجيال الانعزالية المتعاقبة من أجل إنتاج الهجن المتفوقة.