Egypt. J. Agric. Res., 73 (2), 1995.

EFFECT OF GAMMA RADIATION ON FIBER TECHNOLOGICAL CHARACTERS AND YIELD OF SOME EGYPTIAN AND UPLAND COTTON CULTIVARS

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(Manuscript received 6 Deccember 1993)

Abstract

The dry seeds of the two Egyptian cotton cultivars Giza 77 (extra-long staple) and Giza 75 (long-staple), *Gossypium barbadens* L., and one upland cotton cultivar (McNaire 220), G. *hirsutum* L., were exposed to four Y-ray doses (0.0, 5.0, 10.0 and 15.0 Kr) emitted from Cobalt-60 to study the direct effect of Gamma rays on fiber technological characters and yield during two successive growing seasons 1990 and 1991. It was found that Giza 77 was superior than the other cultivar with respect to all fiber properties except seed cotton yield. With respect to Giza 75, it was intermediate in all studied characters. Whereas, McNaire 220 ranked the third in most characters except in seed cotton yield, lint percent and seed index, where it ranked flist. It was also the second in micronaire reading. The 5-Kr dose did not affect lint percent of Giza 75, fiber length at 2.5% and 50% Sl of the three cultivars and micronaire reading of McNair 220. Generally, increasing the doses of y rays decreased the values of most traits studied. The highest decrease was obtained at 15-kr dose. The exceptions were; seed cotton yield and micronaire reading of the three cultivars; and fiber flat-bundle strength at zero and 1/8 inch gauge lengths of McNaire 220, where increasing the dose increased the values of these traits, a matter that needs further investigation..

INTRODUCTION

The gamma-rays are used to induce useful mutations in order to improve cotton yield and quality. Little work had been carried out to study the direct effects of y-rays on the quality of the cotton fibers. The present investigation was designed to

study the impact of y doses on some cotton cultivars. With respect to the technological properties of cotton fiber, El-Didi and El-Nady (1960), using y-rays doses (550-339r) did not observe any change in the halo-length of Ashmoni cultivar. Whereas, Abd El-Aziz (1988), using y- ray doses from 5 to 50Kr, found that it significantly affected fiber length at 2.5% SL. Abd El-Aziz (1988) pointed out that lint fineness, expressed as a micronaire value, was not affected by irradiation doses. While Fotiadis and Miller (1973) found that the means of fiber fineness were significantly increased with Gamma irradiation. Abd El-Hamid *et al.* (1972) and Abd El-Aziz (1988) obtained signifcant decrease in fiber strength. On the other hand, Ibrahim *et al.* (1987) observed an increase in fiber strength with increasing the irradiation dose up to 20Kr. Fotiadis and Miller (1973) found that fiber elongation was significantly decreased by Gamma-irradiation. Concerning yield characters, El-Didi and El-Nady (1960) concluded that y-rays had no effect on seed cotton yield. Razaev (1972), Fotiadis and Miller (1973) , Ibrahim *et al.*(1978), El-Helow (1981), Atta *et al.* (1982), and Abd El-Aziz (1988) came to the conclusion that Gamma irradiation doses decreased seed cotton yield per plant. Ibrahimov and Papov (1962) and Tariq (1979) found that Y-rays increased seed cotton yield. El-Didi and El-Nady (1960) and Ibrahim *et al.* (1978) revealed that the lint percent was not affected by the used Gamma-rays doses. Shilbaya (1966) pointed out that the y-rays of 10 Kr showed a decrease in the mean of lint percentage. Kadambavanasundaram and Madhave Menon (1975) reported that seed index of two *G.hursutum* cultivars was reduced in M_2 - plant irradiated by y-rays. On the other hand, Rahoumah (1984) indicated that the y-ray dose of 10 Kr increased the means of seed index. However Abd El-Aziz (1988) found that the seed index was not significantly affected by-doses of 5.50 Kr.

MATERIALS AND METHODS

The experimental field work was conducted at the Agricultural Experimental Station, Agricultural Research Center, Giza, ARE, during 1990 and 1991. Two Egyptian cotton cultivars namely Giza 77 and Giza 75 and the American cotton cultivar McNaire 220 were used. Air dried seeds of each cultivar were exposed to the following doses of Gamma-rays; 0,5,10 and 15 Kr and sown in a complete randomized block design with three replicates for each season. 30 plants from each treatment (10 plants / replicate) were labelled in the field and assigned for recording the following data :

1- Cotton fiber properties :

All tests of cotton fiber properties were carried out at the Cotton Technology Laboratories, Cotton Research Institute, Agricultural Research Center, Giza, under controlled conditions of 65% relative humidity and 70± 2°F. The fiber properties were estimated as means of 3 replicates (2 samples per plot). Fiber length parmeters at 2.5% SL and at 50% SI were obtained by the Digital Fibroghraph method according to ASTM (D 1447-67, 1976). Fiber fineness and maturity in combination by shiffield Micronaire (in micronaire units) ASTM (D-1448-59,1976) was also determined. Fiber flat - bundle strength at 1/8 inch (T_2) and at zero inch gauge length (T_0) (in g /tex) was determined, and Fiber flat-bundle elongation (%) by the Stelometer Strength - Elongation tester according to ASTM (D-1445, 1967) was investigated.

2- Yield properties :

Seed cotton yield / plant, Lint percentage / plant (weight of lint/weight of seed cotton yield x 100) and Seed index/plant as the average weight of three replicates of 100 seeds were studied .

One of the important goals of this investigation was to compare between the effect of different doses of Gamma-rays on fiber and yield properties for each cotton cultivar. Therefore, data of the two growing seasons, 1990 and 1991 of each variety were combined. Analysis of variance and covariance were applied to avoid fluctuations which occurred from year to year. The significant differences between the means of Gamma-ray doses were determined by the New Least Significant Difference test (Waller and Duncan 1969). Data percentages were transformed to Arc Sign before being statistically analized. The radio-sensitivity percent (RP%) for each cultivar was calculated as follows : RP % = Average doses effect control mean control mean x 100.

RESULTS AND DISCUSSION

The results of y-ray doses on fiber properties and yield of cotton cultivars were as follows:

1- Cotton fiber properties :

1- Fiber length at 2.5% SL : The Egyptian extra-long staple cultivar Giza 77 had longer fibers (1.263 inch) than the long-staple cultivar Giza 75 (1.222 inch), while the American cultivar McNaire 220 showed the shortest staple length (1.122 inch), (Table 1) . The three cultivars treated with 5 Kr did not show any significant differnces as compared with the control. On the other hand, the higher doses (10 and 15 Kr) caused highly significant shortening in fiber length at 2.5% SL, being for 15 Kr 2.59 %, 2.06 % and 1.39% below the control for McNaire 220, Giza 77 and Giza 75, respectively. Relatively to the control, the Radiosensitivity R.P. of McNaire 220 (-1.61%) was more than those of Giza 77 (-1.27%) and Giza 75 (-0.90%).

2- Fiber length at 50% SL : It is clear from table (1) that Giza 77 had longer fibers at 50 % SL (0.580 inch) than Giza 75 (0.554 inch). While McNaire 220 had the shortest fibers at 50% SL (0.500 inch). The trend of these cultivars at 50% SL was the same as in 2.5% SL. There were no significant deifferences in fiber length at 50% SL of the three cultivars treated with 5 Kr dose. It could be noticed that 5 Kr dose showed the lowest effect on fiber length than both 10 Kr and 15 Kr doses in Giza 77. No significant differences among the three doses were observed for Giza 75 and MNaire 220. The radiosensitivity percentages were -2.93 %, 2.20 % and -1.81 % for Giza 77, McNaire 220 and Giza 75, respectively.

3- Fiber fineness and maturity in combination (Micronaire reading) : Giza 77 had finer fibers (3.40) followed by McNaire 220 (3.85) then Giza 75 (4.02) (Table 1 and Fig. 1-a). With respect to the effect of Y-rays doses, the maximum increments in micronaire reading were produced by 15 Kr dose being 10.70% in Giza 75, 9.41 % in Giza 77 and 7.53 % in McNaire 220. The two doses 5 and 10 Kr did not affect significantly micronaire reading of Mcnaire 220, while 15 Kr gave the highest value of micronare naire reading compared with the control. Generally it could be said that increasing y-ray doses increased fiber maturity in the two Egyptian cultivars. This might be due to the fact that Gamma-irradiation had activated and increased cellulose deposition in the fiber wall. Fotiadis and Miller (1973) came to the same results, while Abd El-Hamid *et al.* (1972) and Ibrahim *et al.* (1978) indicated contradicting results.

4- Fiber flat-bundle strength at zero inch gauge length, T0 (g/tex): as shown in

table 2 and Fig. 1-b the Egyptian cultivars showed stronger fibers (49.30 g/tex in Giza 77 and 47.62g / tex in Giza 75), than the Upland McNaire 220 cultivar (37.11 g / tex). It is also obvious that increasing the dose had caused high significant reduction in (T_0). This reduction reached 8.53% in Giza 75, 6.23% in Giza 77 and 3.77% in McNair 220. The different doses produced stronger fibers in McNaire 220 compared with the control. Comparison between the various doses revealed that 5 Kr produced stronger fibers than both 10 and 15 Kr in the three cultivars. The radiosensitivity percentages were -5.15% in Giza 77, -5.08 % in Giza 75 and 5.00 % in McNaire 220.

5- Fiber flat -bundle strength at 1/8 inch gauge length, T_2 (9/tex) : as shown in Table 2 and Fig. 1-c, the values of (T_2) had the same trends of (T_0) in all cases. Generally, it could be concluded that the values of fiber strength decreased with increasing y-ray doses. These results are in line with those of Abd El-Hamid *et al.* (1972), Abd El-Aziz (1988), and Ibrahim *et al.* (1978).

6- Fiber elongation % (E%): Giza 77 had higher fiber elongation percent (7.33 %) followed by Giza 75 (6.67%) then McNaire 220 (5.83 %) (Table 2). All doses caused high significant reduction in (E%) being more pronounced by increasing the dose to 15 Kr. The radiosensitivity percentages were -10.23%, 9.26% and 8.85 % for Giza 77, McNaire 220 and Giza 75, respectively. These results are in agrement with those of by Abd El-Aziz (1988).

It is therefore evrident that irradiation with Y-rays had led to an obvious reduction in almost all fiber properties except the micronaire value which increased in the three cultivars. The increase in maturity of McNaine 220 possibly contributed to the increase in fiber strength, while In its the Egyptian cotton cultivars Giza 77 and Giza 75, there were reductions in fiber strength irrespective of the increase in micronaire reading. This might be due to the existence of other factors affecting fiber strength other than fiber maturity as expressed with micronaire value.

2- Yield properties :

1- Seed contton yield: the response of seed cotton yield per plant to the different doses is shown in Table 3 and Fig. 1-d. It is clear that McNaire 220 was higher in seed cotton yield (37.4 g) than Giza 77 (27.0 g) and Giza 75 (23.5 g). All doses caused high significant reduction in seed cotton yield. This reduction gradually increased with dose increase and reached its maximum at the highest dose 15 Kr (65.9%, 62.3% and 58.7% for Giza 77, McNaire 220 and Giza 75 cultivars, re-

Table 1. Statistical analysis of the conbined data of the two growing seasons 1990 and 1991 for fiber length at 2.5% SL, fiber length at 50% SL, and fiber fineness and maturity in micronaire reading.

Y - rays	Fiber length at 2.5 % SL (inch)						Fiber length at 50 % SL (inch)						Fiber fineness and maturity (mic. unit)					
dose/ K	Giza 77		Giza 75		McNaire 220		Giza 77		Giza 75		McNaire 220		Giza 77		Giza 75		McNaire 220	
	Mean	± SE	Mean	± SE	Mean	± SE	Mean	± SE	Mean	± SE	Mean	± SE	Mean	± SE	Mean	± SE	Mean	± SE
0.0	1.263	0.013	1.222	0.013	1.122	0.004	0.580	0.006	0.554	0.007	0.500	0.003	3.40	0.045	4.02	0.101	3.85	0.034
5.0	1.260	0.014	1.217	0.015	1.115	0.006	0.573	0.005	0.548	0.007	0.493	0.002	3.51	0.031	4.21	0.069	3.91	0.044
10.0	1.244	0.021	1.212	0.014	1.105	0.005	0.542	0.005	0.543	0.004	0.491	0.003	3.52	0.038	4.24	0.148	4.03	0.078
15.0	1.237	0.020	1.205	0.015	1.093	0.008	0.554	0.008	0.542	0.006	0.483	0.002	3.72	0.084	4.45	0.018	4.14	0.037
Arerage	1.251		1.214		1.109	0.567		0.547		0.490		3.530		4.230		3.980		
Radiosensit-ivity (P%)	-1.270		-0.900		-1.610	-2.930		-1.810		-2.200		5.000		6.970		4.880		
P-value	<0.010		<0.010		<0.010	<0.010		<0.010		<0.010		<0.010		<0.010		<0.010		
New L.SD																		
(0.05)	0.007		0.007		0.012	0.012		0.011		0.010		0.010		0.150		0.250		
(0.01)	0.010		0.009		0.017	0.017		0.017		0.015		0.140		0.210		0.360		

Table 2 . Statistical analysis of the conbined data of the two growing seasons 1990 and 1991 for fiber flat-bundle strength at zero "and 1/8" and fiber flat - bundle elongation .

Y - rays	Fiber flat- bundle strength at zero (g/text)						Fiber flat- bundle strength at 1/ 8 (g/text)						Fiber flat- bundle elongation %							
dose /	Giza 77		Giza 75		McNaire 220		Giza 77		Giza 75		McNaire 220		Giza 77		Giza 75		McNaire 220			
	Mean ± SE		Mean ± SE		Mean ± SE		Mean		Mean		Mean		Mean		Mean		Mean			
0.0	49.30	0.213	47.62	0.102	37.11	0.124	36.00	0.073	33.62	0.651	20.50	0.056	7.33	15.71	6.67	14.97	5.83	13.98		
5.0	47.10	0.272	46.32	0421	39.39	0.280	34.72	0.261	33.19	0.613	22.98	0.099	7.15	15.49	6.26	14.48	5.43	13.56		
10.0	46.96	0.224	45.71	0.396	38.76	0.491	34.61	0.249	32.36	0.572	21.13	0.102	6.89	15.23	6.14	14.34	5.24	13.22		
15.0	46.23	0.494	43.56	0.677	33.51	0.575	33.63	0.094	31.00	0.476	21.07	0.018	5.70	14.44	5.84	14.00	5.19	13.18		
Average	47.40		45.80		38.44		34.81		32.54		21.47		6.77		6.23		5.42			
Radiosensit-ivity (P%)	-5.15		-5.08		-5.00		-4.42		-4.28		-6.29		-10.23		-8.85		-9.26			
P-value	<0.01		<0.01		<0.01		<0.01		<0.01		<0.01		<0.01		<0.01		<0.01			
New L.SD																				
(0.05)	0.19		0.44		0.29		0.31		0.27		0.29		0.20		0.17		0.19			
(0.01)	0.25		0.60		0.39		0.41		0.37		0.39		0.27		0.24		0.26			

Table 3 .Statistical analysis of the conbined data of the two growing seasons 1990 and 1991 for seed cotton yield, lint percent, and seed index.

Y - rays	Seed cotton yield (g)						Lint percent (%)						Seed index (g)					
dose	Giza 77		Giza 75		McNaire 220		Giza 77		Giza 75	McNaire 220			Giza 77		Giza 75		McNaire 220	
/ K	Mean	± SE	Mean	± SE	Mean	± SE	Mean		Mean	Mean			Mean	± SE	Mean	± SE	Mean	± SE
0.0	27.0	1.55	23.5	1.16	37.4	0.43	34.8	36.2	35.2	36.4	36.0		38.1	10.1	0.03	10.03	0.06	10.3	0.05
5.0	16.6	0.73	17.1	0.72	27.2	0.65	33.8	35.5	43.4	34.4	36.3		37.1	10.4	0.06	10.50	0.08	10.6	0.03
10.0	15.0	0.76	13.1	0.54	23.1	0.43	31.9	33.4	32.4	32.4	34.9		36.2	10.5	0.05	10.50	0.04	10.7	0.02
15.0	9.2	0.50	9.7	0.60	14.1	0.60	31.1	33.9	31.2	31.2	32.5		34.8	10.6	0.03	10.50	0.28	10.6	0.02
Average	17.0		15.9		25.5		32.9		33.3	35.4			10.4		10.5		10.6		
Radiosensit-ivity (P%)	-49.6		-43.4		-42.5		-7.2		-7.1	-8.9			2.9		1.9		3.2		
P-value	<0.01		<0.01		<0.01		<0.01		<0.01	<0.01			<0.01		<0.01		<0.01		
New L.SD																			
(0.05)	1.2		0.8		1.4		0.3		0.6	0.6			0.20		--		0.2		
(0.01)	1.6		1.1		1.9		0.4		0.7	0.8			0.3		--		0.3		

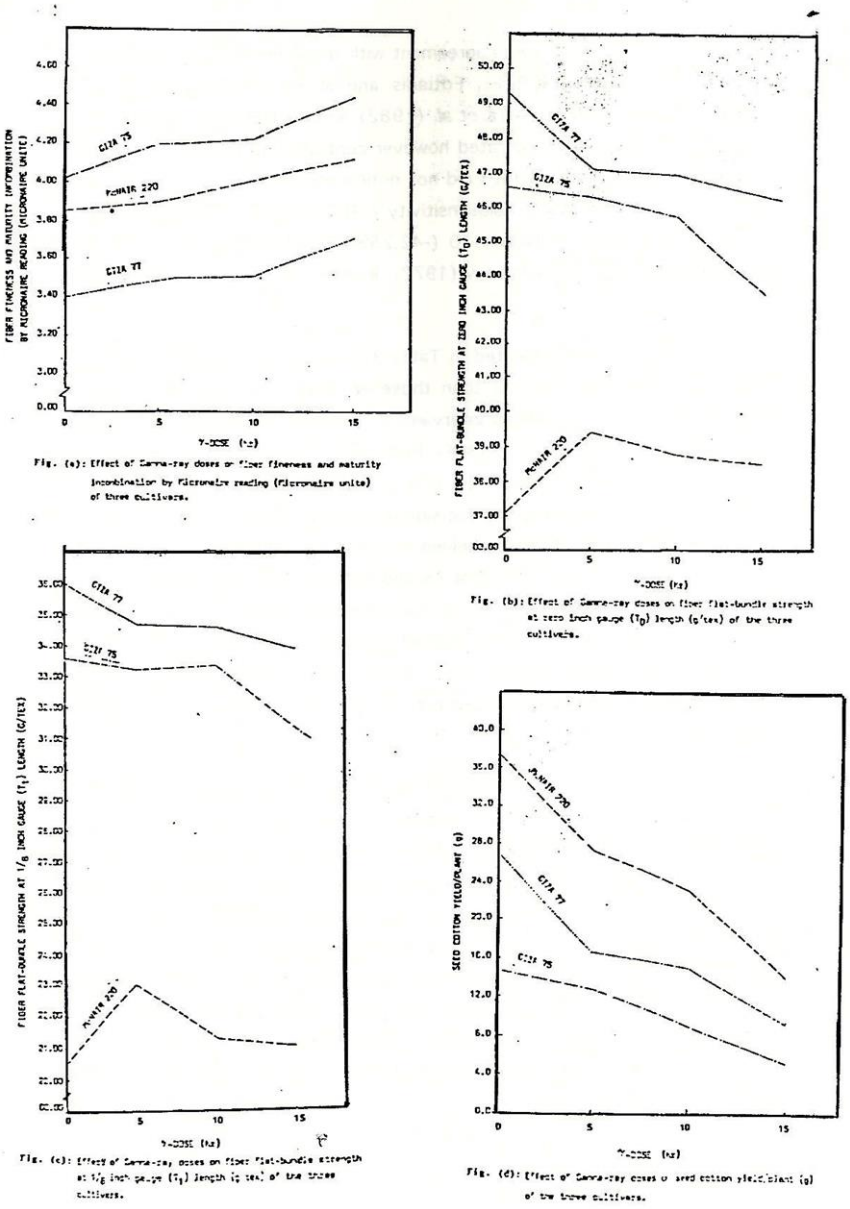

Fig. (a): Effect of Gamma-ray doses on fiber fineness and maturity incombination by Micronaire reading (Micronaire units) of three cultivars.

Fig. (b): Effect of Gamma-ray doses on fiber flat-bundle strength at zero inch gauge (T_0) length (g/tex) of the three cultivars.

Fig. (c): Effect of Gamma-ray doses on fiber flat-bundle strength at 1/8 inch gauge (T_1) length in teal of the three cultivars.

Fig. (d): Effect of Gamma-ray doses o seed cotton yield/plant (g) of the three cultivars.

Fig. 1 : Effect of Gamma- ray doses on fiber micronaire reading, flat - bundle strength at zero and 1/8 inch lengths and seed contton yield per plant.

spectively). These results are in agreement with those obtained by Ibrahimov and Prpov (1962), Rezeav (1972), Fotiadis and Miller (1973), Ibrahim *et al.* (1978), El-Helow (1981), Atta *et al.* (1982) and Abd El-Aziz (1988). Razeav (1972) and Tariq (1979) indicated however contradicting results. On the other hand, El-Didi and El-Nady (1960) did not notice any effect. Relative to the control, Giza 77 showed more radiosensitivity (-49.6%) when compared with Giza 75 (-43.4 %) or with McNaire 220 (-42.25%) Such intervarietal RP response was previously reported by Rezaev (1972), Ibrahim *et al.* (1978), Tariq (1979) and Atta *et al.* (1982).

2- Lint percentage : data presented in Table 3 showed that McNaire 220 yielded higher lint percentage (36.0%) than those of Giza 75 (35.2%) and Giza 77 (34.8). The dose 5 Kr exhibited intervarietal response, whereas Giza 75 differed significantly from the control (34.4%). Both Giza 77 and McNaire 220 gave significant lower lint percentages below that of the control (33.8 % and 36.3% respectively). The higher doses showed significant reduction in lint percentage. The highest reduction in lint % was acheived at the y-rays dose 15 Kr, being, 10.6%, 11.4% and 14.5% for Giza 77, Giza 75 and McNaire 220, respectively. Shilbaya (1966) is in agreement with the present findings, while El-Didi and El-Nady (1960) and Ibrahim *et al.* (1978) showed that lint % was not affected by used Gamma radiation. Relative to the control, McNaire 220 was more radiosensitive (-8.9%) compared with (-7.2%) and Giza 75 (-7.1%) for Giza 77 and Giza 75, respectively.

3- Seed index (g) : comparative means of seed index are presented in Table 3. It could be observed that the three doses gave heavier seeds than the control. The three doses were not statistically different, except for the doses 5 and 15 Kr where they showed significant differences in Giza 77. These results are in agreement with the findings of Ibrahim *et al.* (1978) and Rahoumah (1984). On the other hand, kadambavanasundaram and Medhave Memon (1975) reported that seed index of tow *G.hirsutum* cultivars was reduced in M_2 - plants irradiated with y-rays. Abd El-Aziz (1988) found that seed index was not significantly affected by gamma irradiation with doses ranging from 5 to 50Kr. Relative to the control, McNaire 220 was more radiosensitive R.P. (3.2%) followed by Giza 77 (2.9%) then Giza 75 (1.9%).

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تأثير المعاملة بأشعة جاما على الصفات التكنولوجية للتيلة والمحصول لبعض أصناف القطن المصرى والأبلند الأمريكى

على احمد الاشوط ، احمد حنفى عفيفى
فوقية قدرى الخطيب

معهد بحوث القطن . مركز البحوث الزراعية . الجيزة.

تم تعريض البذور الجافة لصنفين من القطن المصري (جيزة ٧٧ فائق الطول وجيزة ٧٥ طويل) وصنف واحد من القطن الابلند الأمريكي هو ماكنير ٢٢٠ الي أربعة جرعات من أشعة جاما هي : ٠،٥، ١٠ ، ١٥ كيلوواد المنبعثة من الكوبالت ٦٠ لدراسة التأثير المباشر لأشعة جاما علي الصفات التكنولوجية للتيلة والمحصول خلال موسمي ١٩٩٠ ، ١٩٩١، وقد وجد أنّ الصنف جيزة ٧٧ يتفوق علي الصنفين الآخرين في أغلب صفات التيلة فيما عدا محصول القطن الزهر حيث كان الثاني، وفيما يختص بصنف جيزة ٧٥ فكان وسطا في أغلب الصفات المدروسة تقريباً . وشغل الصنف ماكنير ٢٢٠ المرتبة الثالثة بالنسبة لأغلب الصفات فيما عدا محصول القطن الزهر وتصافي الحليج ووزن المائة بذرة (دليل البذرة) حيث كان ترتيبه الأول وكان في المرتبة الثانية بالنسبة لقراءة الميكرونير. ولم تؤثر المعاملة ٥ كيلو راد علي تصافي الحليج للصنف جيزة ٧٥ وطول التيلة عند نسبتي ٢,٥٪ ، ٥٠٪ (SL) للثلاثة اصناف وكذا قراءة الميكرونير لصنف ماكنير ٢٢٠ ويمكن القول بصفة عامة بأنة كلما زادت الجرعة كلما نقصت قيم أغلب الصفات المدروسة. وقد وصل هذا النقص اقصاه عند الجرعة ١٥ كيلو راد، ويستثني من ذلك : دليل البذرة وقراءة الميكرونير في الاصناف الثلاثة ، ومتانة خصلة الشعيرات عند مسافتي صفر ، ١/٨ بوصه بين فكي الجهاز للصنف ماكنير ٢٢٠ حيث أدت زيادةو الجرعة الي زيادةو في قيم هذه الصفات. وهى نتيجة مهمة للمعاملة بأشعة الجاما تحتاج الي مزيد من الدراسة.