Response of some rice varieties to different doses of X rays on the yield and its related characters

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ABSTRACT

This experiment was carried out at the experimental farm of Sakha Agricultural Research Station, Kafr Elsheikh , Egypt during 2016 and 2017 seasons, the materials including six rice varieties treated with three doses of X rays. The experimental design was a split plot design, the main plots were devoted to doses of X-rays, while, sub plots were devoted to rice varieties with three replications, the date of sowing for M_1 was after seed treated during May 1st 2016 and M2 was planted in 1 st May during 2017 season, the data were recorded on total duration, plant height and yield components. The results showed that all the studied characters affected by different doses of X rays and the dose (300 Kr) recorded the desirable values for most studied characters. Moreover, the variety Giza 171 was highly affected by the different doses of X rays, whereas, the high dose of X rays recorded the shortest plant height compared to Giza 159. Also, GZ6296 was highly affected by different doses of X rays especially for seed set % which referred to the genetic makeup (Indica / japonica) for this line indicating the occurrence of some rearrangement for the genetic background. On the other side, M_2 generation recorded highest values for all the studied characters of all the treated varieties compared to M_1 generation, meaning that, during M_2 generation some different rearrangement was occurred on the molecular levels for the genetic structure of the rice varieties thus exchanging the gene expression for the morphological and yield characters. In M_1 generation over the all genotypes, irradiation doses significantly decrease most of the studied characters; in contrast, total duration and plant height were significantly increased by irradiation treatments in M_1 generation. In M_2 generation the irradiation doses significantly increased the mean value over all the genotypes for number of panicles/ plant, panicle length, panicle weight, seed set %, 1000 grain weight, grain yield / plant and harvest index %, vice versa for total duration and plant height decreased . Genotype x dose treatment interaction was significant for all the traits, these results suggested, that promising lines of the varieties Giza 171 and Giza 159, E. Yasmin could be used to improve some characters such as, short stature, early maturity and highly grain yield.

Keywords: Rice varieties, mutation, X-rays.

Introduction

The mutation breeding is one of the breeding methods to develop new promising lines with maintaining the plant type and improving one or two economic characters not presented in the genetic background of the original parents. Mutation breeding are considered an important method for developing mutants lines with good characters, i.e. early maturity, short stature, disease and insect resistance. Moreover, it is a strong tool to renovate the defect in the cultivated varieties of rice. A total of 344 mutants of rice have been developed and released as new varieties with improved grain yield as well as disease and cold tolerance. Out of these a total of 225 (56%) mutants were induced by gamma rays, 25 % with X- rays 7% with fast neutrons and 12 % with other radiations sources **(Ahloowalia *et al.*2004).** Induced mutants have played a vital role for the improvement of rice by developing a large number of semi dwarf, early maturity, high fertility ability, blast resistance, low amylose content and high yielding varieties in the world **(Soomro *et al.*2006).** For improvement of any trait, the genetic variability is required. Induced mutations with the discovery of array of radiation mutagen and improvement treatment methods, offer possibility for the induction of desired changes in various attributes, which can be exploited as much or through recombination breeding **Akbar and Manzoor (2003) and Khin (2006).** Nuclear techniques, in contrast to conventional breeding techniques, are widely applied in agriculture for improving genetically diversity. Unlike conventional breeding procedures which involve the production of new genetic combinations from already existing parental genes, nuclear technology causes exclusively new gene combinations with high mutation frequency. Basic tool of nuclear technology for crop improvement is the use of ionizing radiation which causes induced mutations in plants. These mutations might be beneficial and have higher economical values **(Abdul Majeed *et al.*, 2010).**Mutagenesis has already been used to improve many useful traits for example plant size, flowering time and fruit ripening, fruit color, self-compatibility, self-thinning, and resistance to pathogens. Nowadays, the number of cultivars derived from mutation induction increases constantly **(Hearn, 2001; Maluszynski and Ahloowalia 1995**), therefore, the main objective of this investigation was response of some rice varieties to different doses of X rays on yield and its related characters

Materials and methods

This experiment was conducted at experimental farm of Rice Research and Training Center- Sakha-Kafre Elsheikh – Egypt during 2016 and 2017 seasons.

The seeds of Giza 171, Giza 159, E. Yasmin, GZ6296, GZ9399 and SP70 were treated since 2016 season with different doses of X- rays radiation at the rate of 200, 250 and 300 Kilo rad (Kr). The mutants were planted after treatments to get M_1 and M_2 generation mutants and make selection and purification in M_2 at the farm of Rice Research and Training Center (RRTC), Sakha, Kafr El-Sheikh, Egypt during two 2016 and 2017 successive seasons.

The aim of this investigation was to study the effect of X-rays radiation on morphological, yield and its attributes of some rice varieties. In 2016 season irradiated and non-irradiated seeds of the six varieties were grown on 1st May to arise M1 generation. The experiments design was split plot design with three replications, the main plots were devoted to the doses of X- rays and sub plots were devoted to the genotypes. Each sub – plot consisted of 30 rows, 5 meter long, 20 cm between rows and 20 cm between hills. At harvesting time on October, a total plant number per plot was scored and 50 plants of each plot were randomly taken (50 x 6=600 plants / dose) to estimate the average of rice characteristics in M_1.

In 2017 season, bulked seed from each dose were sown on 1 st May to give M_2 generation in the same design of experiment. At harvesting time on October, a total plant number per plot was scored and 50 plants of each plot were randomly taken (50 x 6=600 plants/dose) to estimate the average of rice characteristics in M_2. All the culture practices were done as recommendations described by **(RRTC, 2015)**. The data were recorded on morphological and yield characters as recommended by Standard Evaluation System (SES) **IRRI 2008.** Data were recorded on individual plant base, the studied characters were i.e total duration, plant height, number of panicles per plant, panicle length, panicle weight, seed set %, 1000 - grain weight, grain yield per plant, harvest index%. The statistical analysis of variance for split plot design was done as described by **Steel and Torrie (1980)** using COSTAT computer software package.

Results and Discussion

Statistical analysis indicated that the effects of irradiation doses on all the studied traits were significant over the all the genotypes.

Results in Table 1 revealed the effect of different doses of X- rays and rice varieties as well as, their interaction on total duration, plant height and number of panicles /plant. Results showed that the total duration, plant height and number of panicles per plant were highly affected by different doses of X rays through M_1 and M_2 generations. The desirable values for the previous traits were recorded with the dose 300 Kr X- rays radiations in M_2 generation, but, the undesirable values for the same traits were recorded with untreated. Also, the results in the Table 1 clarified that there were a significant differences among the varieties mutants in some characters namely total duration, plant height and number of panicles per plant. The X rays doses gradually decreased total duration and plant height by increasing dose and vice versa, for number of panicle / plant increasing by increasing the dose.

Table 1. Effect of different doses of X rays and rice varieties in M_1 and M_2 generations as well as their interaction on total duration, plant height and no. of panicles per plant during 2016 and 2017 seasons.

Main effect and interaction	**2016 season**			**2017 season**		
	M_1 mutation generation			**M_2 mutation generation**		
	Total Duration (Day)	**Plant Height (Cm)**	**No. of panicles / plant**	**Total Duration (Day)**	**Plant Height (Cm)**	**No. of panicles / plant**
Doses : (D)						
Control	137.33	104.49	17.33	137.61	104.29	15.95
200	135.00	91.94	16.28	128.88	100.83	18.09
250	133.94	86.35	14.16	127.61	98.67	18.55
300	131.83	81.09	11.85	125.89	96.78	20.33
LSD 0.05	**0.600**	**1.084**	**0.735**	**0.294**	**0.445**	**0.479**
Varieties: (V)						
Giza 171	142.08	109.32	13.43	141.00	113.69	17.34
Giza 159	134.92	105.51	15.93	133.08	106.08	16.60
E. Yasmin	141.17	93.40	14.02	137.83	103.29	17.15
GZ6296	127.58	75.22	15.43	117.75	90.41	17.90
GZ 9399	127.25	76.13	14.95	117.50	93.37	19.50
SP70	134.17	86.22	15.68	132.83	94.00	20.89
LSD 0.05	**0.562**	**0.765**	**0.626**	**0.515**	**0.877**	**0.501**
Interaction						
D * V	**	**	**	**	**	**

It means that the mutants which produced from the treated varieties with different X- rays radiation had less duration and short stature of plant while, had more number of tillers than their parents, in other words, treating the varieties under study by (300 Kr) X- rays radiations produced mutants had desirable characters total duration, plant height and number of panicles per plant as the results to exchange in genetic structure or constitution. These results were hold true in the two studied seasons, in the same trend the result was obtained by **Pillai *et al* (1993)** they found that, Gamma-rays were more effective for inducing viable mutants.

Results in Table 2 revealed the effect of the interaction between doses of X rays and rice mutants. Data showed that, total duration was highly affected by doses of X rays and rice mutants in M_1 and M_2 generations during two seasons, the desirable values for the total duration was (124.33 day) for the dose 200 Kr for the line GZ9399 in M_1 generation during 2016 season and (113.00 and 113.67day) for the line GZ6296 and GZ9399 with 200 Kr in M_2 generation during 2017 season. These results indicated that the total duration was highly affected by doses of X rays and varieties of rice. These findings were similar with those obtained by **(Shehzad *et al.* 2011)** who reported that in M_6 generation most of the mutant lines were morphologically and genetically stable and recorded the desirable characters comparing with the other generations.

Table 2. Total duration (day) as affected by the interaction between doses of X rays and rice mutants in M_1 and M_2 generations during 2016 and 2017 seasons.

Varieties	2016 season				2017 season			
	M_1 mutation generation				**M_2 mutation generation**			
	Doses				Doses			
	Control	200 KR	250 KR	300 KR	Control	200 KR	250 KR	300 KR
Giza 171	151.00	143.67	139.66	134.00	151.33	140.33	137.66	134.66
Giza 159	140.67	137.33	133.33	128.33	141.00	134.00	133.67	123.66
E. Yasmin	146.00	143.33	139.33	136.00	146.67	139.33	135.00	130.33
GZ6296	126.00	126.66	128.67	129.00	126.33	113.00	113.33	118.33
GZ9399	125.00	124.33	129.00	130.66	125.33	113.67	113.66	117.33
Sp70	135.33	134.66	133.66	133.00	135.00	133.00	132.33	131.00
LSD 5%	**1.124**				**1.029**			

Results in Table 3 revealed the effect of the interaction between doses of X rays and rice varieties on plant height. Data showed that, plant height was highly affected by doses of X rays and rice varieties in M_1 and M_2 generation mutants during two seasons, the desirable value for the plant height was (58.50 cm) with the dose 300 Kr for the line GZ9399 in M_1 generation during 2016 season and (90.00 and 90.33 cm) for the line GZ6296 with 300 and 250 Kr in M_2 during 2017 season. These results indicated increasing of X rays decreased of the plant height because the exchanges in the genetic structure a constitution, these results were harmony with **Mashev *et al.* (1995)** mentioned that used high irradiation dose of 5000–15000R to achieve a decrease in plant height and an increase in yield and suggested that even higher irradiation dose could be used to develop yield efficient plant types. Also, these results were in harmony with those obtained by **Sanjeev (2000)** who found that many early maturing and semi dwarf rice lines were produced using gamma radiation treatments.

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Table 3. Plant height (cm) as affected by the interaction between doses of X rays and rice mutants in M_1 and M_2 generations during 2016 and 2017 seasons.

Varieties	2016 season				2017 season			
	M_1 mutation generation				**M_2 mutation generation**			
	Doses				Doses			
	Control	200 KR	250 KR	300 KR	Control	200 KR	250 KR	300 KR
Giza 171	120.77	106.17	106.17	104.17	121.10	116.00	111.67	106.00
Giza 159	114.67	105.28	101.10	101.00	114.00	106.67	102.00	101.67
E. Yasmin	107.98	93.80	89.16	82.67	106.83	103.00	102.67	100.66
GZ6296	89.83	75.83	74.67	60.56	90.67	90.67	90.33	90.00
GZ9399	96.67	85.33	64.00	58.50	95.83	94.00	92.33	91.33
Sp70	97.00	85.22	83.00	79.66	97.33	94.67	93.00	91.00
LSD 5%	1.529				1.755			

Results in Table 4 showed that the effect of the interaction between doses of X rays and varieties of rice for number of panicles per plant. In M_1 generation, the X-rays doses gradually decreased number of

panicles/ plant by increasing the dose. The highest number of panicles/ plant recorded with the line SP70 with the dose 300 Kr of X rays in M_2 generation during 2017 season, while the lowest values were observed for almost rice varieties untreated in M_2 generation. These results were confirmed with those obtained by **Fujii and Matsumura (1958)** they found that, sensitivity to radiation widely varied not only among different species but also among different commercial varieties within the same species.

Table 4. Number of panicles/ plant as affected by the interaction between doses of X rays and rice mutants in M_1 and M_2 generations during 2016 and 2017 seasons.

Varieties	2016 season				2017 season			
	M_1 mutation generation				**M_2 mutation generation**			
	Doses				Doses			
	Control	200 KR	250 KR	300 KR	Control	200 KR	250 KR	300 KR
Giza 171	17.00	14.57	12.15	10.00	16.83	17.03	17.50	18.00
Giza 159	17.77	16.33	15.60	14.05	15.40	16.50	17.00	17.50
E. Yasmin	15.86	14.92	13.57	11.75	16.00	16.53	16.87	18.00
GZ6296	17.00	17.72	16.66	10.33	15.20	16.67	17.41	22.33
GZ9399	19.66	17.63	11.50	11.00	15.00	19.50	21.00	22.50
Sp70	16.67	16.53	15.50	14.00	17.26	21.11	21.50	23.67
LSD 5%	1.252				1.002			

Results in Table 5 revealed the effect of doses of X- rays and rice varieties as well as, their interaction in M_1 and M_2 generation on panicle length, panicle weight and seed set. Results showed that panicle length, panicle weight and seed set% were highly affected by doses of X- rays through M_1 and M_2 generation during two seasons. The desirable values for the previous traits in Table 5 recorded with non-treatment compared to doses of X- rays in M_1, which the X-rays doses gradually decreased panicle length, panicle weight and seed set by increasing the dose during 2016 season, but, during 2017 season in M_2 generation the desirable values for these traits recorded with the dose 300 Kr X rays. Also, the results in the Table 5 clarified that there were a significant differences among the varieties mutants for the same characters; the varieties Giza 171, Sp70 and Giza 159 recorded the highest values for these traits in M_1 generation during 2016 season. While, in M_2 generation the varieties E. Yasmin and GZ6296 recoded the desirable values for these traits. The mutants caused improvement for attributes yield traits comparing to control treatment through M_1 and M_2 generations, so, it suggested select in these varieties to improve these traits. These results were agreement with those obtained by **Hammad and El-Geddawi (1988)** who mentioned that, irradiating seeds with suitable doses of gamma rays produced physiological and/or genetically changes in plant tissues which may affect the yield per plant.

Table 5. Effect of different doses of X rays and rice varieties in M_1 and M_2 generations as well as their interaction on panicle length, panicle weight and seed set during 2016 and 2017 seasons.

Main effect and interaction	**2016 season**			**2017 season**		
	M_1 mutation generation			**M_2 mutation generation**		
	Panicle length (Cm)	**Panicle weight (g)**	**Seed set (%)**	**Panicle length (Cm)**	**Panicle weight (g)**	**Seed set (%)**
Doses : (D)						
Control	22.41	4.40	92.43	21.70	4.10	91.37
200	21.38	3.05	90.36	22.49	4.30	91.82
250	19.91	2.65	87.91	23.55	4.59	93.56
300	17.85	2.27	82.35	24.70	4.98	96.33
LSD 0.05	**0.451**	**0.078**	**1.098**	**0.452**	**0.075**	**0.875**
Varieties: (V)						
Giza 171	22.08	3.54	87.43	23.60	4.36	92.80
Giza 159	21.92	3.47	90.94	23.87	4.73	92.73
E. Yasmin	21.98	3.22	82.68	25.67	5.51	92.89
GZ6296	16.81	2.30	90.59	20.28	3.73	95.20
GZ 9399	18.50	2.46	89.42	21.82	4.01	92.58
SP70	21.04	3.56	88.51	23.45	4.62	93.41
LSD 0.05	**0.554**	**0.078**	**0.920**	**0.519**	**0.079**	**0.518**
Interaction						
D * V	**	**	**	**		**

Results in Table 6 showed that the effect of the interaction between doses of X rays and varieties of rice for panicle length. The longest panicles were recorded with the dose 200 Kr for the variety E. Yasmin with non- treated in M_1 generation, while, in M_2 generation the longest panicles were for the rice variety E. Yasmin with the dose 300 Kr of X rays during 2017 season.

Table 6. Panicle length (cm) as affected by the interaction between doses of X rays and rice mutants in M_1 and M_2 generation during 2016 and 2017 seasons.

Varieties	2016 season				2017 season			
	M_1 mutation generation				**M_2 mutation generation**			
	Doses				Doses			
	Control	200 KR	250 KR	300 KR	Control	200 KR	250 KR	300 KR
Giza 171	23.33	23.39	21.18	20.41	22.33	23.17	24.06	24.83
Giza 159	23.17	23.00	22.46	19.05	22.93	23.43	23.58	25.53
E. Yasmin	24.44	22.54	21.50	19.41	23.53	25.56	26.39	27.20
GZ6296	18.17	18.00	17.06	14.00	18.00	18.40	21.43	23.26
GZ9399	21.66	20.50	16.83	15.00	21.10	21.36	21.93	22.86
Sp70	23.67	20.83	20.44	19.22	22.33	23.03	23.90	24.53
LSD 5%	1.107				1.039			

Results in Table 7 showed that panicle weight was highly affected by the different doses of X- rays and varieties of rice in M_1 and M_2 generations, the highest values for panicle weight recorded with non- treatment for E. Yasmin variety in M_1 during 2016 season, while, in M_2 generation the heaviest panicle recorded with the dose 300 Kr for same variety during 2017 season.

Table 7. Panicle weight (g) as affected by the interaction between doses of X rays and rice mutants during 2016 and 2017 seasons.

Varieties	2016 season				2017 season			
	M_1 mutation generation				**M_2 mutation generation**			
	Doses				Doses			
	Control	200 KR	250 KR	300 KR	Control	200 KR	250 KR	300 KR
Giza 171	4.08	3.51	3.46	3.10	4.00	4.15	4.40	4.90
Giza 159	4.38	3.97	3.30	2.25	4.25	4.46	4.90	5.30
E. Yasmin	5.93	2.32	2.31	2.31	5.13	5.33	5.64	5.94
GZ6296	3.49	2.29	2.10	1.31	3.45	3.55	3.83	4.07
GZ9399	4.16	2.84	1.42	1.4	3.65	3.81	4.07	4.50
Sp70	4.40	3.34	3.29	3.22	4.11	4.49	4.70	5.16
LSD 5%	**0.157**				**0.158**			

Results in Table 8 showed that the effect of the interaction between doses of X rays and varieties of rice for seed set %. The highest values of seed set % were for the lines GZ6296 and GZ9399 rice varieties with non- treatment in M_1 generation during 2016 season, while in M_2 the highest values were observed with the dose 300Kr of X rays for the variety GZ6296 and E. Yasmin during 2017 season.. From the results in Table 8 the X rays doses gradually increased the seed set % by increasing the dose in M_2, vice versa, in M_1 seed set % decreased by increasing the dose, the mutations in M_2 improved the seed set character, so, we should select for the plants have high seed set %.

Table 8. Seed set (%) as affected by the interaction between doses of X rays and rice mutants during 2016 and 2017 seasons.

Varieties	2016 season				2017 season			
	M_1 mutation generation				**M_2 mutation generation**			
	Doses				Doses			
	Control	200 KR	250 KR	300 KR	Control	200 KR	250 KR	300 KR
Giza 171	91.05	90.11	87.90	80.66	90.88	91.27	92.60	96.46
Giza 159	94.01	91.83	90.58	87.32	92.12	91.70	93.18	93.94
E. Yasmin	88.12	84.12	81.20	77.30	88.37	89.91	95.57	97.71
GZ6296	94.87	92.88	92.13	82.48	93.47	94.71	94.77	97.85
GZ9399	94.57	93.55	88.06	81.5	90.45	91.35	92.10	96.42
Sp70	91.97	89.64	87.59	84.82	92.96	92.00	93.09	95.60
LSD 5%	**1.840**				**1.036**			

Results in Table 9 revealed the effect of doses of X- rays and varieties as well as, their interaction on 1000 - grain weight (g), grain yield per plant (g) and harvest index (%). Results showed that, 1000 - grain weight (g), grain yield per plant (g) and harvest index (%) were highly affected by doses of X- rays through M_1 and M_2 generations. The X- rays doses gradually decreased 1000 - grain weight, grain yield / plant and harvest index % by increasing the dose in M_1, the highest values for the these traits recorded with non-treatment compared to doses of X- rays treatments in M_1 generation during 2016 season, but, during 2017 season in M_2 generation the desirable values for these traits recorded with the dose 300 Kr X-rays. Also, the results in the Table 9 clarified that there were a significant differences among the varieties mutants for the same characters; there the variety SP70 and E. Yasmin recorded the highest values for these traits in M_1 generation during 2016 season. While, in M_2 generation the varieties SP70, GZ6296 and E. Yasmin recoded the desirable values for these traits. The mutants caused improvement for attributes yield traits compared to non-treatment in M_1 and M_2 generation, so, it suggested that, the recurrent selection in these varieties could be used to improve the studied traits. The same trend of results were reported by **Awan *et. al.* (1984),** who found that all the mutants possess high yield potential with higher harvest index values compared to their parent variety. They added that, Kashmir basmati a tall and early maturing variety was originated as a mutant from late maturing variety basmati 370. High yielding potential for the rice mutant may be referred to increasing to physiological capacity to mobilize photosynthetic and transport it to organs having economic value.

These results were in similar trend with those obtained by **Deng and Wu (1990)** who reported that, the mutants have higher grains number per panicle and grain yield than the control.

Table 9. Effect of different doses of X rays and rice varieties in M_1 and M_2 generations as well as their interaction 1000 grain weight, grain yield per plant and harvest index % during 2016 and 2017 seasons.

Main effect and interaction	2016 season			2017 season		
	M_1 mutation generation			M_2 mutation generation		
	1000- grain weight (g)	**Grain yield / plant (g)**	**Harvest index (%)**	**1000- grain weight (g)**	**Grain yield / plant (g)**	**Harvest index (%)**
Doses : (D)						
Control	25.74	44.98	46.00	25.67	43.99	45.41
200	24.79	27.25	43.73	26.28	45.82	48.46
250	23.51	20.92	39.96	27.33	47.59	51.36
300	22.76	18.85	33.70	28.17	50.59	55.36
LSD 0.05	**0.395**	**0.840**	**0.811**	**0.304**	**0.584**	**0.540**
Varieties: (V)						
Giza 171	23.02	27.13	36.67	25.11	44.37	46.22
Giza 159	24.42	28.22	39.77	27.75	41.30	46.18
E. Yasmin	23.52	29.06	47.21	27.04	50.97	55.13
GZ6296	23.27	23.98	38.55	25.80	51.60	52.74
GZ 9399	22.93	23.96	36.14	25.81	45.18	47.91
SP70	28.07	35.65	46.76	29.67	48.55	52.72
LSD 0.05	**0.313**	**0.627**	**0.822**	**0.183**	**0.591**	**0.675**
Interaction						
D * V	**	**	**	**	**	

Results in Table 10 showed that the effect of the interaction between doses of X rays and varieties of rice for 1000 grain weight (g). The highest values of 1000 grain weight (g) was for the line Sp70 rice variety with non- treatment, the X- rays treatments gradually decreased 1000 - grain weight by increasing the dose in M_1 during 2016 season, while in M_2 generation the highest values were observed with 300 Kr of X rays for the same variety which with increasing the dose increase 1000 - grain weight in M_2 during 2017 season. From the results in Table 10 the mutations improved the 1000 - grain weight character, indicating to those rice mutants could be considered as promising lines with heavy grains.

Table 10. 1000 grain weight (g) as affected by the interaction between doses of X rays and rice mutants during 2016 and 2017 seasons.

Varieties	2016 season				2017 season			
	M_1 mutation generation				**M_2 mutation generation**			
	Doses				Doses			
	Control	200 KR	250 KR	300 KR	Control	200 KR	250 KR	300 KR
Giza 171	23.20	23.10	22.98	22.80	23.22	24.12	26.25	26.86
Giza 159	26.70	25.38	23.08	22.50	23.21	27.75	28.00	28.77
E. Yasmin	26.25	22.98	22.47	22.36	26.10	26.85	27.17	28.03
GZ6296	24.35	24.47	23.47	20.78	24.09	24.27	27.13	27.69
GZ9399	24.18	23.87	22.00	21.67	24.86	25.23	25.60	27.53
Sp70	29.78	28.95	27.06	26.48	29.25	29.50	29.83	30.10
LSD 5%	**0.627**				**0.366**			

Results in Table 11 revealed that the effect of the interaction between doses of X rays and varieties for grain yield/ plant. Data showed that, the grain yield per plant was highly affected by doses of X rays and varieties in M_1 and M_2 generation mutants, the desirable values for the grain yield were (49.40 and 48.62 g) for the non-treatment for the line SP70 and E. Yasmin respectively through M_1 generation and (57.28 g) for the variety E. Yasmin with 300 Kr through M_2 generation, the X- rays treatments gradually increased grain yield / plant by increasing the dose. These results indicate that the grain yield was highly affected by doses of X rays and varieties of rice. These findings were similar to those obtained by **(Shehzad *et al.* 2011)** who reported that, the mutant lines characteristics were better than their parents for resistance to lodging, blast disease, high yield potential, as well as early maturity

Table 11. Grain yield (g) as affected by the interaction between doses of X rays and rice mutants in M_1 and M_2 generations during 2016 and 2017 seasons.

Varieties	2015 season				2016 season			
	M_1 mutation generation				**M_2 mutation generation**			
	Doses				Doses			
	Control	200 KR	250 KR	300 KR	Control	200 KR	250 KR	300 KR
Giza 171	38.30	24.91	22.77	22.58	38.73	44.70	46.00	48.06
Giza 159	40.92	27.21	22.50	22.24	39.78	40.75	41.46	43.20
E. Yasmin	48.62	23.13	22.25	22.24	48.23	48.79	49.62	57.27
GZ6296	47.86	21.76	17.43	8.88	44.35	52.71	53.73	55.60
GZ9399	44.78	31.54	10.75	8.75	43.10	43.70	45.83	48.10
Sp70	49.40	35.00	29.82	28.39	49.73	44.31	48.90	51.26
LSD 5%	**1.255**				**1.184**			

Table 12. Harvest index % as affected by the interaction between doses of X rays and rice mutants in M_1 and M_2 generation during 2016 and 2017 seasons.

Varieties	2016 season				2017 season			
	M_1 mutation generation				**M_2 mutation generation**			
	Doses				Doses			
	Control	200 KR	250 KR	300 KR	Control	200 KR	250 KR	300 KR
Giza 171	40.26	39.40	36.83	30.18	40.50	45.93	46.00	52.45
Giza 159	41.93	41.17	39.45	36.51	40.00	44.86	47.99	51.86
E. Yasmin	51.68	49.20	46.53	41.42	52.61	49.33	58.79	59.77
GZ6296	47.97	42.60	35.19	28.44	45.39	54.11	55.41	56.03
GZ9399	43.90	42.06	35.08	23.51	43.56	46.32	47.00	54.74
Sp70	50.24	47.95	46.68	42.16	50.10	50.19	52.98	57.28
LSD 5%	**1.644**				**1.350**			

Results in Table 12 showed that the effect of the interaction between doses of X rays and varieties of rice on harvest index %. The desirable values of harvest index recorded with non-treatment for the lines E.Yasmin, SP70 and GZ 6296 the X-rays treatments gradually decreased harvest index % by increasing the dose in M_1 generation during 2016 season, while during M_2 generation the desirable values were observed with 300 Kr of X rays for the varieties SP70 and E. Yasmin during M_2. These results were confirmed with those obtained by **Awan *et. al.* (1984),** who found that all the mutants possess high yield

potential with higher harvest index values compared to their parent cultivar. From these results the rice mutants in recurrent selection program could be used to develop new promising line with desirable characters.

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إستجابة بعض أصناف الأرز لجرعات مختلفة من الاشعة السينية (أشعة إكس) علي النمو وصفات المحصول والصفات المرتبطة به

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أجريت هذه التجربة في المزرعة البحثية لقسم بحوث الارز – محطة البحوث الزرعية بسخا- كفرالشيخ – مصر خلال موسمي زراعة ٢٠١٦-٢٠١٧ وذلك لدراسة استجابة المحصول ومكوناته لبعض أصناف الارز لجرعات مختلفة من الاشعة السينية. شملت الدراسة ستة تراكيب وراثية من الأرز تم معاملاتها بجرعات مختلفة من الاشعة السينية. تم إجراء التجربة في القطع المنشقة مرة واحدة حيث تم وضع جرعات الاشعة السينية في القطع الرئيسية بينما تم وضع أصناف الأرز في القطع المنشقة في ثلاث مكررات. تم زراعة البذور بعد المعاملة مباشرة في الاول من مايو للحصول علي الجيل المطفر الأول والثاني خلال موسمي ٢٠١٦ و ٢٠١٧ م ، تم أخذ القراءات علي صفات طول فترة النمو وارتفاع النبات والمحصول ومكوناته. توضح النتائج أن معظم الصفات المدروسة تأثرت بجرعات الأشعة حيث سجلت الجرعة ٣٠٠ كيلو راد أفضل القيم المرغوبة للصفات تحت الدراسة علاوة علي ذلك وجد أن الصنف جيزة ١٧١ تأثر بجرعات الاشعة حيث وجد أن الجرعة العالية من هذه الاشعة سجلت القيم المرغوبة لصفة ارتفاع النبات بالمقارنة للصنف جيزة ١٥٩ . علي الجانب الآخر في الجيل المطفر الثاني سجلت كل الصفات المدروسة أفضل القيم المرغوبة للأصناف المعاملة مقارنة بالجيل المطفر الأول ، وهذا يعني أن الجيل المطفر الثاني حدث فية إختلافات ترتيبية أو تنظيمية علي المستوي الجزيئي للتركيب الوراثي للأصناف للصفات المورفولوجية والمحصولية المدروسة حيث أنه في الجيل الأول أدت المعاملات الإشعاعية إلي نقص معنوي لكل الصفات المدروسة عدا طول فترة النمو وارتفاع النبات بينما في الجيل الثاني المطفر أدت المعاملات الاشعاعية إلي زيادة معنوية لصفات عدد السنابل / نبات ، طول السنبلة ، وزن السنبلة ، نسبة العقد ، وزن الالف حبة ، محصول الحبوب للنبات الفردي ودليل الحصاد بينما قلت طول فترة النمو وارتفاع النبات. كما وجد تفاعل معنوي بين التركيب الوراثي والجرعة الاشعاعية لكل الصفات كما أن تأثير الجرعة يعتمد علي التركيب الوراثي المستخدم.

من خلال النتائج السابقة يمكن التوصية بعمل إنتخاب للسلالات المبشرة للأصناف جيزة ١٧١ وجيزة ١٥٩ والياسمين المصري وكذلك السلالات المبشرة لتحسين صفات ارتفاع النبات وقصر فترة النمو وصفات المحصول .