USING X- RAYS DOSES OF SOME RICE CULTIVARS TO INDUCE NEW MUTANTS TOLERANT TO STRESS CONDITIONS

DRAZ, A. E., M. I. ABOYOUSEF, F. N. MAHROUS, I. A. TALHA, B. A. ZAYED and A. A. EL-GOHARY

Rice Research Department, Field Crops Research Institute, ARC, Egypt.

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Abstrac

Seeds of four rice varieties, i.e. Sakha 101, Sakha 104, Giza 177 and Giza 178 were treated with 150, 200, 250 and 300K.R. X – rays during 2007. From 2007 up to 2012 seasons, selection was performed in M2, M3, M4, M5 and M6 generation. Sixteen homogeneous and stabile lines were grown during 2013 season under different conditions in three locations (Sakha, Gemmiza as normal soil and EL-Sirw as saline soil stations). The experimental design was a split plot design with four replications. The main plots were devoted to irrigation intervals, while, sub plots were devoted to induced mutants under different conditions in three stations. During 2014 and 2015 seasons, all the induced mutants were evaluated in RCB design with four replications under conditions of Sakha Agric. Res. Station. Data were recorded on days to maturity (day), 1000-grain weight, grain yield (t/ha) and yield reduction %. Data were recorded on days to maturity (day), 1000-grain weight, grain yield (t/ha) and yield reduction %**.** The desirable values of early maturity, grain yield (t/ha) and grain yield reduction were recorded for Giza 178 M8-4, Sakha 104 M8-4,101 M8-4, and Giza 177 M8-4under different irrigation intervals 3, 6 and 9 days in different research stations (Sakha, Gemmiza and El-Sirw) during 2013 season. Also, these mutants of Sixteen Entries were differed in Sakha Research Station during 2014 and 2015 seasons, whereas, Giza 178M8-4, Sakha 104 M8-4, Sakha 101 M8-4 and Giza 177 M8-4 recorded the desirable values for days to maturity and highest values for 1000 grain weight and grain yield, Sakha 101 M8-4, Giza 177 M8-4, Giza 178M8-4 and Sakha 104 M8-4 could be used as new promising lines tolerant to stress conditions better than their parents.

Key words: *Oryza sativa*, Mutation breeding, Physical mutagens.

INTRODUCTION

Increasing the productivity and tolerance to stress conditions is the main target for rice breeding program. So, 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.

Mutations 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 tillering ability, blast resistance, low amylase 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 (Khin2006). More than 2200 crop varieties were released by the end of the last century using irradiation mutagenesis, among them 434 are rice varieties (Elayaraja *et al.* 2005), (Wu *et al.* 2005) and (Mohamed *et al.* 2006). Mutagens causing changes in major gene also induce mutants at loci governing the quantitative characters. Mutagen agents, including gamma rays, offered great possibilities for increasing genetic variability of quantitative traits like yield. Mutation breeding in ricewas established in Egypt since 1960. While, the present study aimed to evaluate sixteen promising mutant lines produced from four commercial cultivars, i.e. Sakha 101, Sakha 104, Giza 177 and Giza 178 under Sakha, Gemmiza and El sirw stations to renovate some defects, i.e. low tillering, blast susceptibility, late and sterile tillers as well as low restoration ability.

MATERIALS AND METHODS

Seeds of four rice *(Oryza sativa L.)* varieties, i.e. Sakha 101, Sakha 104, Giza 177 and Giza 178 were treated with 150, 200, 250 and 300 K.RX – rays during 2007. From 2007 to 2012 seasons, the recurrent selection was performed in F_2, F_3, F_4, F_5 and F_6 generations compared to their parents, sixteen homogenous and stable lines with their parents were evaluated in three experiments. The first experiment was conducted at El Sirw as saline soil and Sakha as normal to evaluate eight lines of Sakha 104 and Giza 178 mutants with their parents. The second experiment was conducted at Gemmiza and Sakha Stations to evaluate eight lines of Sakha 101 and Giza 177 mutants with their parents under irrigation intervals in split plot design with four replications for both experiments, the date of sowing date was 1st May during 2013 season for both experiments. The third experiment was conducted at Sakha

Agriculture Station to evaluate the sixteen mutants with their parents in RCB design with four replications. The date of sowing was 1st May during 2014 and 2015 seasons. The remain cultural practices were applied as recommended by (RRTC 2012). The data were recorded on days to maturity duration, 1000 grain weight, grain yield (t/ha) and yield reduction % as recommended by IRRI (1998). Statistical analysis was done according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

1- The first experiment:-

The mean performance of the entries for total duration and grain yield under two different conditions is presented in Table (1), the lowest value for total duration to maturity was recorded under El-Sriw station (132 days), but the highest value for grain yield was recorded under Sakha station (8.99 t/ha), indicating that, soil structure of El-Sriw station is affected by the salinity and subsequently the grain yield was decreasing.

For irrigation intervals the desirable values for total duration to maturity (132 days) and grain yield (8.07 t/ha) were recorded under 3- day irrigation interval comparing to irrigation every 9 days which recorded the lowest values, indicating that the two characters were highly affected by shortage of water.

The rice mutants Sakha 104 M_8-3, Sakha 104 M_8-4, Giza 178 M_8-3 and Giza 178 M_8-4 recorded desirable and highest values for total duration to maturity and grain yield. From these results, it could be concluded that those promising materials could be offered to breeding programs as new developed genotypes better than the original varieties. Similar results were reported by (Hammad and El- Geddawi 1988) who mentioned that irradiating seeds with suitable doses of gamma rays produced physiological and/or genetic changes in plant tissues which may affect the yield per plant.

The interaction between locations and irrigation intervals, locations and mutants, irrigation intervals and mutants, as well as the interaction among locations, irrigation intervals and mutants were highly significant indicated to the two characters were highly affected by soil fertility and shortage of water.

Table 1. Effect of locations (L), irrigation intervals (I) and mutant lines, as well as their interactions on total duration to maturity (days) and grain yield (t/ha) during 2013 season.

Main effect and interaction	2013 season	
	Total duration (days)	Grain yield (t/ha)
Locations: (L)		
Sakha	134.48	8.99
El Sirw	132.94	4.59
LSD 5%	0.630	0.094
Irrigation intervals: (I)		
3 days	132.77	8.07
6 days	133.64	7.34
9 days	136.25	4.93
LSD 5%	0.337	0.031
Mutant lines (M):		
Sakha 104 (CK)	136.28	5.92
Sakha 104M8-1	135.56	6.27
Sakha 104M8-2	134.61	6.48
Sakha 104M8-3	133.56	7.03
Sakha 104M8-4	131.44	7.39
Giza 178 (CK)	136.50	6.34
Giza 178M8-1	135.22	6.65
Giza 178M8-2	134.06	6.8
Giza 178M8-3	133.17	7.36
Giza 178M8-4	131.78	7.63
LSD 5%	0.404	0.051
Interaction :		
L x I	**	**
L x M	**	**
I x M	**	**
L x I x M	**	**

*,** indicate significant at 0.05 and 0.01 probability level.

The results in Table (2) showed the total duration to maturity of Giza 178 and Sakha 104 with their mutants under different irrigation intervals at Sakha and El Sirw stations. Earliness was recorded for the mutants Giza 178M_8-4 and Sakha 104 M_8-4 under irrigation every 3- day intervals in the two stations, while under 9 days interval, most of the entries were delayed and the differences were insignificant among Giza 178 and Sakha 104 comparing with their developed mutants. This means that Giza 178 and Sakha 104 varieties compared with their mutants were affected by long

irrigation intervals and salinity condition. These results may be explained by recovering ability for those entries under shortage of water in different growth conditions. These findings were similar to 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 others.

The results in Table (3) showed the grain yield of Giza 178 and Sakha 104 with their mutants under different irrigation intervals at Sakha and El Sirw stations. Highest grain yield value was recorded for the mutants Giza 178M_8-4 (11.88 t/ha) and Sakha 104 M_8-4 (10.35 t/ha) under irrigation every 3 days in Sakha Station, while in El-Sirw Station the grain yield value was (6.7 t/ha) for each of Giza 178M_8-4 and Sakha 104 M_8-4. On the other hand, the lowest values were recorded for Sakha 104 and Giza 178 under 9 days interval in El-Sirw Station most of the entries were affected but the differences were insignificant among Giza 178 and

Table 2. Total duration to maturity (days) as affected by the interaction among locations (L), irrigation intervals (I) and mutant lines during 2013 season.

Location (L)	Mutants line (M)	Irrigation interval (I)		
		3 days	6 days	9 days
Sakha	Sakha 104 (CK)	135.00	135.67	139.00
	Sakha 104M_8-1	134.00	134.33	138.00
	Sakha 104M_8-2	133.00	134.00	138.00
	Sakha 104M_8-3	133.00	133.33	135.00
	Sakha 104M_8-4	130.00	132.00	134.67
	Giza 178 (CK)	135.00	135.67	138.67
	Giza 178M_8-1	133.00	134.33	138.00
	Giza 178M_8-2	133.00	133.00	137.33
	Giza 178M_8-3	132.00	133.00	136.00
	Giza 178M_8-4	131.00	130.67	135.00
El Sirw	Sakha 104 (CK)	134.25	135.5	138.66
	Sakha 104M_8-1	134.00	135.00	138.00
	Sakha 104M_8-2	133.00	133.66	136.00
	Sakha 104M_8-3	132.33	132.67	135.00
	Sakha 104M_8-4	130.00	131.00	131.00
	Giza 178 (CK)	135.00	136.00	138.67
	Giza 178M_8-1	134.00	135.33	136.66
	Giza 178M_8-2	132.00	134.00	135.00
	Giza 178M_8-3	131.33	133.00	133.66
	Giza 178M_8-4	130.00	131.33	132.66
LSD 5%	1.213			

Table 3. Grain yield (t/ha) as affected by the interaction among locations (L), irrigation intervals (I) and mutant lines during 2013 season.

Location (L)	Mutants line (M)	Irrigation interval (I)		
		3 days	6 days	9 days
Sakha	Sakha 104 (CK)	9.04	8.22	6.63
	Sakha 104M_8-1	9.64	8.96	6.95
	Sakha 104M_8-2	9.93	9.23	7.05
	Sakha 104M_8-3	10.15	9.44	7.43
	Sakha 104M_8-4	10.35	9.52	7.73
	Giza 178 (CK)	10.24	8.97	6.84
	Giza 178M_8-1	10.68	9.13	7.10
	Giza 178M_8-2	10.93	9.35	7.40
	Giza 178M_8-3	11.73	9.44	7.68
	Giza 178M_8-4	11.88	9.55	8.40
El Sirw	Sakha 104 (CK)	5.05	5.10	1.50
	Sakha 104M_8-1	5.00	5.58	1.50
	Sakha 104M_8-2	5.08	5.73	1.85
	Sakha 104M_8-3	6.58	6.13	2.45
	Sakha 104M_8-4	6.70	6.53	3.50
	Giza 178 (CK)	5.12	4.50	2.38
	Giza 178M_8-1	5.50	5.00	2.50
	Giza 178M_8-2	5.58	5.03	2.50
	Giza 178M_8-3	6.600	5.37	3.35
	Giza 178M_8-4	6.70	5.33	3.93
LSD 5%	0.152			

Sakha 104 comparing with their mutants in stations, indicating that, Giza 178 and Sakha 104 comparing with their mutants were affected by shortage of water and salinity effect. These results may be due to recovering ability for those mutants under stress conditions, these results 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.

For grain yield reduction under El Sirw station, the data in Table (4) showed that the yield reduction ranged between 0.130 to 0.950 t/ha for Giza 178 with their mutants when irrigated every 6 days comparing to 3 days interval. On the other hand, yield reduction ranged from 2.040 to 2.530 t/ha under irrigation every 9 days interval and mutants Giza 178 M_8-3 or Giza 178 M_8-4 recorded the lowest yield reduction, indicating that the two mutants could be used as source of tolerance to water stress.

For Sakha 104 with their mutants, the yield reduction ranged from 0.070 to 0.830 t/ha under 6 days interval, while, the yield reduction under 9 days interval was ranged from 3.03 to 4.080 t/ha and Sakha 104 M_8-4 recorded the lowest value, indicating that this mutant may be tolerant to long irrigation intervals under EL-Sriw station.

Table 4. Grain yield (t/ha) reduction (%) of some rice mutants under different irrigation intervals in EL- Sirw station during 2013 season.

Cultivars/ Promising lines	Irrigation intervals				
	3 days	6 days	Red.% Compared to 3- day	9 days	Red. %Compared to 6 days
Sakha 104 (control)	5.03	5.10	0.07	1.50	3.60
Sakha 104M8-1	5.00	5.58	0.58	1.50	4.08
Sakha 104M8-2	5.08	5.73	0.65	1.85	3.88
Sakha 104M8-3	6.58	6.13	0.55	2.45	3.68
Sakha 104M8-4	6.70	6.53	0.83	3.50	3.03
Giza178 (control)	5.45	4.50	0.95	2.38	2.12
Giza178M8-1	5.50	5.00	0.50	2.50	2.50
Giza178M8-2	5.58	5.03	0.55	2.50	2.53
Giza178M8-3	6.60	5.73	0.13	3.35	2.38
Giza178M8-4	6.70	6.33	0.63	3.93	2.04

Table 5. Grain yield (t/ha) reduction (%) of some rice mutants under different irrigation intervals in Sakha station during 2013 season.

Cultivars/ Promising lines	Irrigation intervals				
	3 days	6 days	Red.% Compared to 3-day	9 days	Red. % Compared to 6 days
Sakha 104 (control)	9.04	8.22	0.824	6.63	1.59
Sakha 104M8-1	9.64	8.96	0.675	6.95	2.01
Sakha 104M8-2	9.93	9.23	0.395	7.05	2.18
Sakha 104M8-3	10.15	9.44	0.714	7.43	2.01
Sakha 104M8-4	10.35	9.52	0.828	7.73	1.80
Giza178 (control)	10.24	8.97	1.270	6.83	2.15
Giza178M8-1	10.68	9.13	1.543	7.10	2.03
Giza178M8-2	10.93	9.35	1.580	7.40	1.95
Giza178M8-3	11.73	9.44	2.297	7.68	1.76
Giza178M8-4	11.88	9.55	2.325	8.40	1.15

For grain yield reduction (%) under Sakha Station, the results in Table (5) showed that the yield reduction ranged from 1.270 to 2.325 t/ha for Giza 178 with their mutants when irrigated every 6 days interval comparing to 3 days interval, On the other hand, yield reduction ranged from 1.15 to 2.150 t/ha under irrigation every 9 days interval and mutants, Giza 178 M_8-3 or Giza 178M_8-4 recorded the lowest yield

reduction (%), indicating that the two mutants could be used as a source of tolerance to water stress. For Sakha 104 with their mutants, the yield reduction (%) ranged from 0.395 to 0.824 t/ha under 6 days interval, while, the yield reduction under 9 days interval was ranged from 1.59 to 2.180 t/ha and Sakha 104 M_8-4 recorded the lowest value, indicating that this mutant may be tolerant to long irrigation intervals under Sakha Station.

The second experiment:

The mean performances for the studied characters under study were shown in Table (6). The lowest value for total duration was recorded under Sakha station (132.3 days), but the highest value for grain yield was recorded under Gimmiza Station (8.93 t/ha), indicating that, soil structure in Sakha station was of low fertility comparing to Gemmiza and subsequently the grain yield decreased in Sakha Station.

Table 6. Effect of locations (L), irrigation intervals (I) and mutant lines , as well as their interaction for total duration (days) and grain yield (t/ha) during 2013 season.

Main effect and interaction	2013 season	
	Total duration (day)	Grain yield (t/ha)
Locations: (L)		
Sakha	132.30	8.47
El Gimmeza	134.01	8.93
LSD 5%	1.098	0.185
Irrigation intervals : (I)		
3 days	132.25	10.11
6 days	133.25	9.75
9 days	135.48	6.24
LSD 5%	0.217	0.127
Mutant lines (M):		
Sakha 101(CK)	141.77	8.31
Sakha 101M_8-1	141.00	8.98
Sakha 101M_8-2	140.06	9.76
Sakha 101M_8-3	138.83	9.84
Sakha 101M_8-4	138.39	10.41
Giza 177 (CK)	126.50	7.27
Giza 177M_8-1	126.78	7.5
Giza 177M_8-2	127.17	7.92
Giza 177M_8-3	127.50	8.31
Giza 177M_8-4	128.56	8.72
LSD 5%	0.410	0.198
Interaction :		
Lx I	**	**
L x M	**	**
I x M	**	**
L x I x M	**	**

*,** indicate significant at 0.05 and 0.01 probability level.

For irrigation intervals the desirable values for total duration to maturity (132.25 days) and grain yield (10.11 t/ha) were recorded under 3 days as irrigation interval comparing to irrigation every 9 days which recorded the lowest values, indicated to the two characters were highly affected by shortage of water under different conditions.

For rice mutants, Sakha 101 M_8-3, Sakha 101 M_8-4, Giza 177 M_8-3 and Giza 177 M_8-4 recorded desirable and highest values for total duration and grain yield, indicating that, they could be offered to breeding programs as new developed pure lines better improved than the original variety.

The results in Table (7) show the total duration to maturity of Sakha 101 and Giza 177 comparing with their mutants in Sakha and Gemmiza stations. The mutants of Sakha 101 M_8-3 and Giza 177 M_8-2 were earlier under 3 days irrigation interval in each of Sakha and Gemmiza stations comparing to other irrigation intervals.In the same line, the mutants of Sakha 101 M_8-1and Giza 177 M_8-4 especially under stress conditions recorded desirable values, indicating that those mutants (Sakha 101 M_8-2 and Giza 177 M_8-4) could be used as desirable promising lines in breeding programs.Similar results were obtained by (Tanisaka and Sanjeev 2000), who reported that, many early and semi dwarf rice lines were produced using gamma radiation treatments. Also, (Labrada *et al*. 2001) mentioned that, a gradual decrease in plant height and days to heading was recorded with increase in radiation dose.

The results in Table (8) show the grain yield of Sakha 101 and Giza 177 comparing with their mutants under Sakha and Gemmiza stations. The mutants of Sakha 101 M_8-3 and Giza 177 M_8-2 had high yield under 3 days irrigation interval in each of Sakha and Gemmiza stations comparing to other irrigation intervals, while the mutants of Sakha 101 M_8-1and Giza 177 M_8-1 especially under 9 days irrigation interval recorded the desirable values, indicating that those mutants (Sakha 101 M_8-1 and Giza 177 M_8-1) could be used as donor to drought tolerance in breeding programs. Similar results were obtained by (Swamy and Kumar 2013), who found that the morphological, genetic and molecular levels revealed the existence of genetic variation for drought tolerance within the rice gene pool and the improvement made in managed drought screening and selection for grain yield under drought have significantly contributed to progress in breeding program.

Table 7. Total duration (day) as affected by the interaction among of locations (L), irrigation intervals (I) and mutant lines during 2013 season.

Location (L)	Mutants line (M)	Irrigation intervals (I)		
		3 days	6 days	9 days
Sakha	Sakha 101 (CK)	140.00	141.33	144.00
	Sakha 101M_8-1	139.00	140.00	143.00
	Sakha 101M_8-2	137.00	138.33	142.00
	Sakha 101M_8-3	136.00	137.33	141.00
	Sakha 101M_8-4	135.33	137.00	142.00
	Giza 177 (CK)	125.00	126.00	127.00
	Giza 177M_8-1	125.00	126.67	128.00
	Giza 177M_8-2	125.33	126.67	128.67
	Giza 177M_8-3	126.33	127.00	129.00
	Giza 177M_8-4	127.00	128.00	130.00
El Gimmeza	Sakha 101 (CK)	141.00	141.50	143.00
	Sakha 101M_8-1	140.00	141.00	143.00
	Sakha 101M_8-2	140.00	141.00	142.00
	Sakha 101M_8-3	138.00	139.00	141.67
	Sakha 101M_8-4	138.00	138.00	140.00
	Giza 177 (CK)	126.00	127.00	128.00
	Giza 177M_8-1	126.00	127.00	128.00
	Giza 177M_8-2	125.00	128.00	129.33
	Giza 177M_8-3	125..	128.00	129.67
	Giza 177M_8-4	127.00	129.00	130.00
LSD %	1.231			

Table 8. Grain yield (t/ha) as affected by the interaction among of locations (L), irrigation intervals (I) and mutant lines during 2013 season.

Location (L)	Mutants line (M)	Irrigation intervals (I)		
		3 days	6 days	9 days
Sakha	Sakha 101 (CK)	9.72	9.53	5.43
	Sakha 101M_8-1	10.24	9.84	5.60
	Sakha 101M_8-2	10.62	10.41	8.59
	Sakha 101M_8-3	11.56	11.00	6.45
	Sakha 101M_8-4	12.05	11.81	6.73
	Giza 177 (CK)	8.50	7.95	4.55
	Giza 177M_8-1	8.93	8.25	4.95
	Giza 177M_8-2	9.15	8.65	5.30
	Giza 177M_8-3	9.55	8.75	5.33
	Giza 177M_8-4	9.93	8.85	5.80
El Gimmeza	Sakha 101 (CK)	9.70	9.56	5.89
	Sakha 101M_8-1	11.00	10.82	6.38
	Sakha 101M_8-2	11.09	11.00	6.85
	Sakha 101M_8-3	11.15	11.61	7 .2 5
	Sakha 101M_8-4	12.26	11.98	7.64
	Giza 177 (CK)	8.75	8.06	5 .7 8
	Giza 177M_8-1	8.80	8.32	5.79
	Giza 177M_8-2	9.20	8.90	6.31
	Giza 177M_8-3	9.75	9.46	6.83
	Giza 177M_8-4	10.45	10.14	7.16
LSD 5%	0.595			

Under Gemmiza station, the data in Table (9) for Sakha 101 with their mutants showed that the grain yield reduction ranged from 0.150 to 0.340 t/ha under 6 days interval, while, the yield reduction under 9 days was ranged from1.670 to 3.340 t/ha and Sakha 101 M_8-2 recorded the lowest value, while the yield reduction of Giza 177 with their mutants ranged from 0.180 to 0.210 t/ha when irrigated every 6 days comparing to 3 days interval, On the other hand, yield reduction ranged from 1.280 to 2.680 t/ha under irrigation every 9 days and mutants Giza 177 M_8-2 or Giza 177 M_8-3 recorded the lowest yield reduction, indicating that the two mutants could be used as tolerance donor to water stress in the breeding program under Gemmiza station. Similar results were obtained by (Nada 2016), who found that, the grain yield reduction was 0.488 (t/ha) under 8 days irrigation interval comparing to 4 days irrigation interval. Moreover, the total water used was 4833 and 5184 m^3/fed for two irrigation intervals with an average of about 5000 m^3 /fed with an average water saving of 445 m^3/fed without a significant reduction in the yield.

The results in Table (10) show the grain yield reduction under different irrigation intervals of the rice varieties, Sakha 101, and Giza 177, comparing with their mutants. The grain yield reduction of Sakha 101 with their mutants ranged from 0.190 to 0.236 t/ha under 6 days interval, but under 9 days interval the yield reduction ranged from 4.104 to 5.090 t/ha, indicating that Sakha 101M_8-1 recorded the desirable value for yield reduction under 6 and 9- day irrigation intervals.

Table 9. Grain yield reduction (t/ha.) of some rice mutants under different irrigation intervals in Gemmiza during 2013 season.

Cultivars/ Promising line	Irrigation interval				
	3 days	6 days	Red. Compared to 3 days	9 days	Red. Compared to 6 days
Sakha 101 (control)	9.75	9.56	0.19	7.89	1.67
Sakha 101M8-1	11.45	11.22	0.23	8.38	2.84
Sakha 101M8-2	12.25	12.10	0.15	8.85	3.25
Sakha 101M8-3	12.75	12.41	0.34	9.25	3.17
Sakha 101M8-4	12.75	12.68	0.27	9.64	3.34
Giza177 (control)	8.25	8.06	0.19	6.78	1.28
Giza177M8-1	8.50	8.32	0.18	6.79	1.53
Giza177M8-2	9.10	8.90	0.20	7.31	1.59
Giza177M8-3	9.75	9.56	0.19	7.83	1.73
Giza177M8-4	10.45	10.24	0.21	7.56	2.68

For Giza 177 with their mutants, the grain yield reduction ranged from 0.505 to 1.08 t/ha under 6 days interval, while, yield reduction under 9 days interval was 3.050 to3.400 t/ha. Moreover, Giza 177 M_8-3 and Giza 177 M_8-4 recorded the desirable values of yield reduction under 6 and 9 days intervals respectively; It could be attributed to root depth and root/shoot ratio of the new mutants. In the same line (Mohamed *et al*. 2006) reported that water stress well affect cell expansion by change in physical and metabolic.Consequences, limits leaf area led to prevent light absorption and decreases photosynthesis and grain yield.

Table 10. Grain yield reduction (t/ha) of some rice mutants under different irrigation intervals in Sakha during 2013 season.

Cultivars/ Promising lines	Irrigation intervals				
	3 days	6 days	Red. Compared to 3 -day	9 days	Red. Compared to 6- day
Sakha 101 (control)	9.72	9.53	0.190	5.43	4.11
Sakha 101M8-1	10.04	9.84	0.196	5.60	4.24
Sakha 101M8-2	10.62	10.41	0.208	5.93	4.49
Sakha 101M8-3	11.56	11.33	0.228	6.45	4.88
Sakha 101M8-4	12.05	11.82	0.236	6.73	5.09
Giza177(control)	8.50	7.95	0.550	4.550	3.400
Giza177M8-1	8.93	8.35	0.578	4.950	3.400
Giza177M8-2	9.25	8.65	0.602	5.300	3.350
Giza177M8-3	9.75	8.75	0.998	5.530	3.230
Giza177M8-4	9.93	8.85	1.080	5.800	3.050

3- The third experiment:

The mean performance for total duration to maturity (days), 1000 – grain weight (g) and grain yield (t/ha) of sixteen rice mutants with their parents were shown in Table (11) showed that high significant differences were found among the rice mutants with their parents for the total duration to maturity, 1000- grain weight and grain yield during 2014 and 2015 seasons in Sakha Station. For total duration the desirable values were recorded for Sakha 101M_8-4, Sakha 104 M_8-4, Giza 177 M_8-4 and Giza 178M_8-4 for each ofthese rice mutants comparing to their parents during two seasons, that meaning could be select those rice mutants as early maturing promising lines in the rice breeding program

Table 11. The mean performance for total duration (days), 1000 - grain weight (g) and grain yield (t/ha) of some rice cultivars and promising lines under normal conditions in Sakha station during 2014-2015 seasons.

Cultivars/ Promising lines	2014 season			2015 season		
	Total duration (day)	1000- grain weight (g)	Grain yield (t/ha)	Total duration (day)	1000- grain weight (g)	Grain yield (t/ha)
Sakha 101 (CK)	143.33	28.33	9.88	145.00	28.40	9.72
Sakha 101M_8-1	141.33	31.33	10.19	141.00	31.40	10.24
Sakha 101M_8-2	140.00	31.67	10.61	141.00	31.50	10.62
Sakha 101M_8-3	140.00	31.67	10.71	140.00	31.67	11.06
Sakha 101M_8-4	139.00	32.00	11.13	140.00	32.00	12.03
Sakha 104 (CK)	135.00	28.00	9.22	135.00	28.05	9.04
Sakha 104M_8-1	132.00	32.33	9.87	133.00	31.50	9.94
Sakha 104M_8-2	131.00	30.33	10.61	132.00	31.55	9.72
Sakha 104M_8-3	129.00	31.13	10.69	130.00	31.67	10.15
Sakha 104M_8-4	128.67	32.33	11.23	129.00	31.95	10.35
Giza 177 (CK)	125.00	26.00	8.26	125.00	26.35	8.50
Giza 177M_8-1	124.33	26.67	9.39	124.00	26.50	8.93
Giza 177M_8-2	125.33	27.33	9.51	125.00	27.65	9.15
Giza 177M_8-3	127.00	27.67	9.93	128.00	27.90	9.51
Giza 177M_8-4	128.33	28.33	10.19	129.00	28.22	9.93
Giza 178 (CK)	135.33	21.67	9.18	135.00	10.24	10.24
Giza 178M_8-1	132.00	22.66	9.74	133.00	10.68	10.68
Giza 178M_8-2	131.00	23.00	9.99	132.00	10.93	10.93
Giza 178M_8-3	129.67	23.67	10.60	131.00	11.73	11.73
Giza 178M_8-4	129.33	24.35	10.64	130.00	11.89	11.89
LSD 5%	0.995	0.651	0.088	1.112	0.119	0.070

Moreover, the rice mutants Sakha 101 M_8-4 and Sakha 104 M_8-4 recorded the desirable values for 1000-grain weight comparing to other mutants, indicating that these rice mutants could be considered as promising lines for theirheavy grains.

Sakha 104 M_8-4, Sakha 101 M_8-4and Giza 178 M_8-4 rice mutants recorded the desirable and highest values for grain yield under Sakha station during two the seasons respectively. As well as, Giza 177 M_u-4 recorded the highest value comparing to their parent Giza 177, meaning that these rice mutants could be considered as promising lines in rice breeding program. The results indicated that, increasing the dose of X- rays induced higher variation inside each variety and develop new recombination with some advantages comparing to the commercial variety. These results were similar to those of (Deng and Wu1990) who reported that, the mutants have higher grain number per panicle and grain yield than the control. In other study by (Pialli *et al.* 1993) Gamma rays were more effective for inducing viable mutant. The same 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 cultivar. They added that, Kashmir basmati a tall and early maturing variety was originated as a mutant from the late maturing variety basmati 370. High yielding potential for the rice mutant may be referred to increasing in physiological capacity to mobilize photosynthetic assimilate and transport it to organs having economic value.

REFERENCES

1. Ahloowalia, B.S., M. Maluszynski and K. Nichterlein. 2004. Global impact of mutation-derived varieties.Euphytica 135: 187-204.
2. Akbar, A. and B. Manzoor. 2003. Radio sensitivity studies in basmati rice. Pak. J. Bot., 35(2):197-207.
3. Awan, M.A., A.A. Sheema and G.R. Tahir. 1984. Evaluation and genetic analysis of semi-dwarf mutants in rice (Oryza sativa L.). A Technical document issued by the international atomic energy agency Vienna.
4. Deng, D.S.and W. Wu. 1990. Early mutant "Fu-06" used for hybrid rice breeding. New letter 27:6.
5. Elayaraja, K., M. Parakash, K. Saravanan, S.B. Kumar and J. Ganesan. 2005. Studies on variability, heritability and genetic advance for certain quantitative characters in mutant population of rice (Oryza sativa L.). Crop Research –Hisar, 1:134-137.
6. El-Degwy, I.S. 2013. Mutation induced genetic variability in rice (Oryza sativa L.). International Journal of Agricultural and Crop Sciences, 5-23/2789-2794.
7. Gomez, K.A. and A.A. Gomez. 1984. Statistical Procedures for Agrictural Research, 2nd Ed. John Wiley and Sons, Inc. New York.
8. Hammad, D.H.A. and I.H. EL-Geddawi. 1988. Effect of gamma irradiation on yield and chemical constituents of sugar beet. Paper presented at the fourth conf. of Nuclear Sciences and application 6-10 March.
9. IRRI. 1998. Standard Evaluation System for rice 3rd Edition, International Rice Testing Programm.
10. Khin, T. 2006. Rice mutation breeding for varietals improvement in Myanmar.PL.Mut. Rep., 1(1):34-36.
11. Labrada, P., M.M. Wert and A.G. Cepro. 2001. Radio- sensitivity in rice variety Perla Centro. Agricola 28 (2) : 5-8.
12. Mohamad, O., B. Mohd.Nazir, I. Alias, S. Azlan, H. Abdul Rahim, M.Z. Abdullah, O. Othman, K. Hadzim, A. Saad, H. Habibuddin and F. Golam 2006. Development of

improved rice varieties through the use of induced mutations in Malaysia. Plant Mut. Rep., 1:27-34.

13. Nada, A.M. A. 2016. Performance of some rice varieties under different planting methods and water intervals. Ph.D. Thesis, Agron., Dept., Fac. Of Agric. Kafrelsheikh Univ., Egypt.
14. Pialli, M.A., M. Subramanian and S. Murugan. 1993. Effectiveness and efficiency of gamma rays and EMS for chlorophyll mutation on up land rice. Annals of Agricultural Research 14 (3): 302-305.
15. RRTC- proceeding (2012). Proceeding of the 8th National program work shop (final results of 2011).
16. Shehzad, T., A.A. Abdallah, M.H. Amar and A. F. Abdelkhalik(2011).Agronomic and molecular evaluation of induced mutant rice (Oryza sativa L.) lines in Egypt. Pak. J. Bot., 43(2): 1183-1194.
17. Soomro, A.M., M.H. Naqvi, H.R. Bughio and M.S. Bughio. 2006. Sustainable enhancement of rice production through the use of mutation breeding.Plant Mut. Rep., 1:13-17.
18. Swamy, B.P. and A. Kumar. 2013. Genomics-based precision breeding approaches to improve drought tolerance in rice. J. Sci. Direct,. 31:1308-1318.
19. Tanisaka L. and S.Sanjeev. 2000. Gamma-rays induced genetic variability in M1 and M_2 populations of rice (Oryza sativa L.). Advances in parent sciences, 6 (1): 24-33.
20. Wu, J.L., C. Wu, C. Lei, M. Baraoidan, A. Bordeos, M.R.S. Madamba, M. Ramos, R. Mauleon, A. Portugal, V.J. Ulat and R. Bruskiewich(2005). Chemical and irradiation induced mutants of indica rice IR64 for forward and reverse genetics. Plant Mol. Biol., 59:85-97.

استخدام أشعة أكس علي بعض أصناف الأرز لإستحداث طفرات جديدة متحملة لظروف التقسية

عبد السلام دراز ، محمود أبو يوسف ، فوزى نعيم محروس، إبراهيم طلحة ، بسيونى زايد ، على الجوهرى

قسم بحوث الأرز – معهد بحوث المحاصيل الحقلية – مركز البحوث الزراعية – مصر

تم استخدام بذور أربعة أصناف هي سخا ١٠١ ، سخا ١٠٤ ، جيزة ١٧٧ ، جيزة ١٧٨ ومعاملتها بأشعة إكس حيث تم استخدام أربعة جرعات مختلفة من الأشعة وهي ١٥٠ ، ٢٠٠ ، ٢٥٠ ، ٣٠٠ كيلو رونتجن فى عام ٢٠٠٧ وتم خلال المواسم من ٢٠٠٧ حتي ٢٠١٢ الانتخاب في الاجيال الطفورية من الجيل الطفورى الثاني حتي الجيل الطفورى السادس لتكون هذه السلالات متماثلة وراثيا وثابتة في البيئات المختلفة في الجيل المطفر السادس وتقييمها في ثلاث محطات وهي سخا ، السرو ، الجميزة. فى تصميم القطع المنشقة مرتين حيث تم وضع فترات الري في القطع الرئيسية بينما السلالات الطفورية في القطع الشقية خلال موسم ٢٠١٣م ، وفى خلال موسمي ٢٠١٤ ، ٢٠١٥ تم تقييم السلالات الطفورية والاباء في تصميم قطاعات الكاملة العشوائية في أربعة مكررات في محطة بحوث سخا وتم أتباع التوصيات الفنية طبقا لمركز بحوث الأرز. والبيانات تم تسجيلها علي صفات طول فترة النمو (يوم) ، وزن ١٠٠٠ حبة (جم) ، محصول الحبوب (طن / هكتار) وانخفاض المحصول . أظهرت النتائج أن القيم المرغوبة لطول فترة النمو ومحصول الحبوب سجلت للطفرات جيزة ١٧٨-٤ و سخا ١٠٤-٤ مع فترات الري المختلفة (٣ ، ٦ ، ٩ أيام) في محطتي بحوث سخا والسرو كما سجلت الطفرات سخا ١٠١-٤ ، جيزة ١٧٧-٤ تحت ظروف التقسية المختلفة القيم المرغوبة والمرتفعة لصفات طول فترة النمو ومحصول الحبوب مع فترة الري ٩ أيام تحت ظروف محطتى بحوث الجميزة وسخا بالمقارنة بالطفرات الاخري خلال موسم ٢٠١٣ م. وقد سجلت هذه الطفرات أفضل القيم وأعلاها عن أبائها المنتجة منها خلال أعوام ٢٠١٤ و٢٠١٥ م تحت ظروف محطة بحوث سخا ومن النتائج السابقة نستطيع أن نوصي بأن الجرعة الرابعة من المعاملة بالإشعاع للأصناف سخا ١٠١ ، جيزة ١٧٧، جيزة ١٧٨ ، سخا ١٠٤ أدت للحصول على سلالات مبشرة متحملة لظروف التقسية.