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STUDIES ON THE INDUCTION OF NEW GENETIC VARIABILITY FOR QUANTITATIVE TRAITS BY GAMMA RAYS IN RICE (*Oryza sativa* L.).

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ABSTRACT

The present investigation was carried out at the Farm of the Rice Research and Training Center, Sakha, Kafr El Sheikh Egypt during rice growing seasons 2006 and 2007. Dry seeds of the four rice varieties namely; Sakha 101, Sakha 102, Sakha 104, and Egyptian Yasmine were irradiated with 100, 200 and 400 Gy gamma rays. The seeds of the different treatments in addition to the parental varieties (as control) were grown and transplanted individually in a randomized complete block design with three replications for each treatments along with the control to study the response of different rice varieties to different doses of Gamma rays for some agronomic characters, grain yield and its components and to select some useful mutants carrying desirable characters from different populations in M_2 generation such as earliness, short stature, resistance to blast, and high yielding ability. The results of the M_1 generation indicated that in general, germination percentage decreased and the reduction was significant for the Sakha 101cv, while number of days to heading, plant height and panicle length were decreased by increasing the doses of Gamma rays for most of the studied varieties. On the other hand, the mean values of number of panicles per plant were increased by increasing the dose of gamma rays for the Sakha 101, Sakha 102 cvs. The spikelet sterility increased with the increase in the dose of gamma rays for all studied varieties and therefore, grain yield per plant was decreased. In the M_2 generation, increasing the dose of gamma rays decreased germination %, and plant height for the two rice varieties; Sakha 102, and Egyptian Jasmine. The mean values of number of panicles per plant were increased for the Sakha 101, 102 and Sakha 104 cvs, while it decreased with Egyptian Yasmine. One hundred grain weight was decreased for Sakha 102, Sakha 104 and Egyptian Yasmine, while the Sakha101variety was not affected by gamma rays for this trait. Panicle length and chlorophyll content was increased by the dose of gamma rays for the three varieties; Sakha 101, Sakha 104, and Egyptian Yasmine. Sterility % was increased and the highest increase was observed for the indica rice variety Egyptian Jasmine and therefore, grain yield per plant was decreased for these varieties. Wide ranges of variability were detected in M_2 irradiated populations of all varieties for most of the characters studied comparing with the controls, indicating the possibility of selecting mutants with desirable traits to be tested in subsequent generations. The genetic parameters of studied characters for both control and M_2 irradiated populations of all varieties indicated that, in most cases, there were considerable increases by irradiation for both phenotypic and genotypic variances, genetic coefficient of variation, heritability as well as expected genetic advance.
Keywords: Rice, Yield traits, Genetic variability, Heritability.

INTRODUCTION

Rice is not only the most important food crop but a model plant that has attracted broad interests in basic and applied research. The publication of the draft rice genome (Patnaik *et al* ., 2006; Li *et al* ., 2005; and Chemma and Atta,2003) presents exciting opportunities to assign function to each of the estimated 5000 genes, many of which are potentially useful for improvement of rice as well as other cereals. To achieve this goal, diverse genetic resources including germplasm, near isogenic lines, mapping and mutant populations held and developed by rice growing countries are important to the identification of genetic variation utilized for trait improvement. Ionizing radiation mutagenesis has been routinely used to create genetic variability for breeding research and genetic studies. More than crop varieties were released by the end of the last century using irradiation mutagenesis; among them 434 are rice varieties were developed (Wang,1991). Induced mutagenesis, with the discovery of an array of radiation mutagens and improved treatments methods, offers a possibility for the induction of desired changes in various attributes, which can be exploited as such or through recombination breeding. Previous reports on rice suggest that micro- mutational approach might prove effective in improving complex quantitative traits like yield, maturity, height, etc. The idea of producing artificial mutations and utilizing them for breeding cultivars plants was indicated as early as 1901, and the first induced mutations in rice were achieved by Icchijima, 1934 by the use of X-rays. The induction of mutations for factors which govern the heredity of quantitative characters is a promising tool for creating new genotypes. It is an established fact that mutagen, besides causing changes in major genes, also induce mutations at loci governing the quantitative characters. These micro-mutations can be detected in the form of increased variance M_2 generation. Since most of the economic traits show polygenic inheritance, more information on the induction of genetic variability in them through mutations is needed. In Egypt, mutation breeding method was started for rice in 1960 by Serry and Masooad, when they used X-rays and gamma rays for treating the old rice cvs, Arabi, Nahda and Agami M.1. There are many kinds of ionizing radiation, namely X-rays, gamma rays, protons, neutrons, alpha and beta particles. However, gamma rays are widely employed for mutation studies as they have shorter wavelength and possess more energy per photon than X-rays and penetrate deeply into the tissue. The new rice varieties Sakha 101, Sakha 102, Sakha 104, and Egyptian Jasmine are a popular varieties virtue of its early to moderate maturing and higher yield, but now some of them having some defects such as susceptibility to blast, late maturity, also their cooking quality has some defects, keeping in view the drawbacks of these varieties, a study was undertaken to explore the possibility of improving them with respect to these defects through quantitative mutational approaches. So, the present study was undertaken in order to analysis the influence of gamma rays on mean values and variance of some quantitative characters of rice in the M2 generation and also to explore the possibilities of isolating desirable phenotypic mutants for their utilizing directly or indirectly cross breeding programs for the quick improvement the defects of these cultivars.

MATERIALS AND METHODS

Four varieties of rice were used in the present study, namely, Sakha 101, Sakha 102, Sakha 104, and Egyptian Jasmine. These varieties were obtained from the genetic stock of the Rice Research Section, Field Crop Research Institute, Agricultural Research Center, Egypt. The Present study was carried out at the Farm of the Rice Research & Training Center (RRTC), Sakha, Kafr El-Sheikh, Egypt, during 2006 and 2007rice growing seasons with different doses of gamma rays. Samples of 250 of high quality and purified dry seeds of uniform size from each variety (stabilized at 13% moisture level) were irradiated in the Co^{60} source at the National Center for Radiation Research and Technology, Nasr city, Cairo, Egypt. The doses administered were 100, 200 and 400 Gy and dry unirradiated seeds were used as control. In 2006 season seeds of the above mentioned four rice varieties, were treated by different doses of gamma irradiation along with their respective controls. All the seeds of all varieties were directly sown after treatments in germination plastic plates in order to raise M_1 plants. Germination percentage was recorded at 15 days after sowing. After thirty days from sowing, seedlings were transplanted (one seedling/hill) in the experimental plots. Distances between plants and rows was 20cm apart, respectively, were maintained. Fertilizers were applied as recommended rate and time of application. Weeds were chemically controlled by applying 2 liters of Saturn/Feddan four days after transplanting. To avoid out-crossing, first three panicles in each of the 50 randomly selected plants in each treatment were bagged at the time of panicles emergence. At the time of maturity, the seeds were harvested from the three bagged tillers, as well as unpaged tillers, separately from each individual plant. In 2007 season, the M_2 generation was raised in a randomized complete block design with three replications. The seeds from the main tillers in each of the 50 selected plants were planted in nursery beds. Thirty days old seedlings were transplanted in a well prepared field. Progeny of the selected plants in each treatment was transplanted in a progeny row trial, with three replications, with spacing 20 x 20 cm. Each replication had 50 rows per treatment. The population was carefully screened in the nursery beds for chlorophyll mutations and the identification and classification of chlorophyll was done as proposed by Gustafsson, 1947. Viable mutation in M_2 progeny was examined periodically through the entire growth period for visible mutations affecting various morphological attributes. In order to study the magnitude and nature of induced polygenic variability in M_2 generation, observations on various quantitative traits i.; germination percentage chlorophyll mutation, days to heading (days), plant height (cm), number of panicles/ plant, sterility percentage , one hundred grain weight (g), grain yield/ plant (g) were recorded on all the plants in each treatment. The data obtained were subjected to the statistical analysis to estimate means and standard error (Duncan, D. B. (1955). For comparing the mean values and variance within and between families, the analysis of variance was done for each character of each variety to estimate genotypic and phenotypic variances, genotype coefficient of variation (GCV), heritability (h^2), genetic advance, genetic advance of main(GS%), separately as suggested by Panse and Sukhatme, 1957.

RESULTS AND DISCUSSION

M_1 generation:

For M1 generation gamma rays treatments in general affected significantly the germination percentage in all the studied varieties, Table (1). Germination percentage in general was decreased by increasing the dose of gamma radiation in all the tested varieties, and the highest germination percentage was recorded at 100 Gy in Egyptian Yasmine (93.0%), while the lowest percentage was observed at 400 Gy treatments for Sakha 101(51.66%). Sabbour *et al.* (1993); and Chemma *et al.*, (2003) found a decrease in germination percentage with increasing the dose in M_1 generation.

The results indicated that gamma rays caused earliness in all the studied varieties with different effects according to the variety and its background, these results were in close agreement with that obtained by Sanjeev (2000); Shadakshari *et al.* (2001); Kumar (2005); Do *et al.* (2006), Le, x.T (2006). Plant height at maturity was decreased significantly for all varieties studied by increasing the dose of gamma rays (Table,1). Significant differences were obtained between the untreated and all treatments in all varieties studied and among treatments itself for all varieties except for Sakha 101. The most affected variety was Sakha 104 (23 cm) at 400Gy. The lowest reduction in plant height was found to be 7 cm for the rice variety Jasmine. The same results were obtained by Sanjeev (2000); Shadakshari *et al.* (2001); Kumar (2005); Do *et al.* (2006); Mohamed *et al.* (2006); Le, x. T (2006).

Number of panicles/plant,(Table 1) was increased with gamma rays treatments and the cases of significant increases were found in the varieties ; Sakha 101 at 200 and 400 Gy; Sakha 102 at 400 Gy; Sakha 104 and Egyptian Yasmine at100Gy. These findings indicated that these varieties are more sensitive to higher doses of gamma rays. The maximum increase in number of panicles/plant was found for the variety Egyptian Yasmine (26.86 panicles) ,and this could be reflected on the yield for the respective treatment, while the lowest increase was observed for the variety Sakha 101 (22.06 panicles). It could be concluded that the most effective dose of gamma rays was 400 Gy for this character in most of the varieties studied and this could be attribute to varietal genetic differences. Similar results were reported by Gomma *et al.* (1995a) and Abdul-Majeed (1997).

Sterility percentage was significantly increased by increasing the dose of gamma rays in all studied varieties (Table 1). The highest sterility percentage was recorded at 400 Gy treatment followed by 200 Gy. The most affected varieties were Sakha 102 (55.99%) and Sakha 101 (54.28%), respectively. The most effective treatment in all varieties was 400 Gy, while the lowest increase in sterility percentage was detected at 100 Gy treatments. The pervious results reported that the decrease in seed fertility or the increase in sterility percentage with gamma rays was mainly due to chromosomal aberrations in the mitotic division and mitotic of the pollen formation stage Sarawagi *and* Soni (1993); Gomma *et al.* (1995b) Meheter *et al.* (1996), Mohankumar (1998)and Chemma *et al.* (2003) also reported the same findings.

Grain yield per plant was decreased with the increasing gamma rays doses in all the varieties. The lowest value of grain yield per plant was recorded at 400 Gy in all the studied varieties, while the lowest decrease in grain yield per plant was detected at 100 Gy. The decreasing trend in grain yield per plant may be attributed to the increasing in sterility percentage (Table, 1). Similar results were reported by El-Shouny *et al.* (1991); Katoch *et al.* (1992) and Sarawagi *and* Soni (1993) as well as Abd Allah *et al.* (2002).

From the foregoing results, it could be concluded that all the treatments proved to be effective, as was evident from the tendency of the treated genotypes showing decreased germination percentage and increased spikelet sterility, among other deleterious effects. Decrease in germination or increase in sterility percentage increased with increasing dose of the mutagen employed. Such linear dose- event relationship with respect to M_1 indices has been reported in rice by several workers in the past. Comparing of the four rice varieties for their relative irradiation sensitivity revealed that in general, most of japonica rice varieties were more sensitive to mutagenic treatments than indica rice varieties. Differential sensitivity of the genotypes to mutagenic treatments has been attributed to various factors including genetic differences.

Generation:

Regarding to M2 generation, the overall frequency of chlorophyll mutations in the M_2 of four rice varieties are given in Table (2). The frequency of chlorophyll mutations varied from variety to another and between treatment to treatment. In general, gamma ray induced different numbers of chlorophyll mutations in all studied varieties. In this regard, irrespective of the indica and japonica rice varieties, some varieties were more responsive to certain mutagen than the others, while some varieties like Egyptian Jasmine were quite sensitive to gamma rays treatment. Thus the mutation frequencies in the M_2 generation seem to be depend upon genotypic and the selection from the data cleared in Table (2). The number of chlorophyll mutations increased by increasing gamma rays doses up to 200 Gy where it produced the highest number of chlorophyll mutations in all studied varieties as shown in table (2). In Table (3) the chlorophyll mutations were divided in two types; i.e. albino and partial albino (xantha, viridis and others). With respect to the varieties, the maximum frequency of chlorophyll mutations was observed for Egyptian Jasmine (72) and Sakha 102 (58). While, the lowest chlorophyll mutations was obtained from Sakha 104 (35). These chlorophyll mutations may be attributed to chromosomal aberrations. These results have been reported by Pillai *et al.* (1993); Kumar (1998) and Singh *and* Santhi, (2001).

Table (1): The mean values of germination %, days to heading (days), plant height (Cm), no. of panicles/plant (gm), sterility % and grain yield/plant(g) as affected by gamma rays for the rice varieties studied in M_1 generation.

Variety	Treatments (Gy)	Germination %		Days to heading (day)		Plant height (cm)		No. of panicles /plant		Sterility(%)		Grain yield/plant (g)	
		Actual	100% of control	Actual	100% of control	Actual	100% of control	Actual	100% of control	Actual	100% of control	Actual	100% of control
Sakha 101	Control	99.33a	100.00	109.00a	100.00	94.88a	100.00	18.35b	100.00	8.00c	100.00	45.00a	100.00
	100	90.00b	90.00	94.66c	86.23	88.13b	92.88	17.00b	92.64	13.31bc	166.37	30.05b	66.79
	200	85.00b	85.00	105.00b	96.33	84.06b	88.59	19.53b	106.43	25.60b	320.00	35.00b	77.77
	400	51.66c	51.66	109.00a	100.00	85.66b	90.28	22.06a	120.21	54.28a	678.50	23.66c	52.57
Sakha 102	Control	100.00a	100.00	96.00a	100.00	109.66a	100.00	18.03b	100.00	8.66d	100.00	39.66a	100.00
	100	90.00b	90.00	92.00b	95.83	106.46ab	97.08	16.93b	93.89	26.90c	310.62	34.51b	87.01
	200	87.00b	87.00	93.00b	96.87	105.00bc	95.75	18.40b	102.05	42.56b	491.45	26.63c	67.14
	400	80.00c	80.00	92.00b	95.83	102.13c	93.13	24.73a	137.16	55.99a	646.53	18.15d	45.76
Sakha 104	Control	100.00a	100.00	100.00a	100.00	106.00a	100.00	19.00a	100.00	11.00b	100.00	43.00a	100.00
	100	90.00b	90.00	91.00b	91.000	91.93c	86.72	20.06a	93.89	22.46ab	204.18	30.03b	69.83
	200	90.00b	90.00	93.00b	93.00	85.00d	90.10	17.06b	102.05	34.40ab	312.72	27.73b	64.48
	400	70.00c	70.00	92.00b	92.00	83.00d	78.30	17.06b	137.16	47.48a	341.63	20.04c	46.61
Egyptian Jasmine	Control	96.66a	100.00	113.33a	100.00	90.00a	100.00	22.33b	100.00	10.66c	100.00	36.66a	100.00
	100	93.00a	96.21	109.00b	96.17	93.00b	93.93	26.86a	102.28	30.82b	289.11	25.66b	69.99
	200	85.00b	87.93	109.00b	96.17	91.13b	92.05	19.66b	88.04	38.86a	364.54	33.78a	92.14
	400	78.00c	80.69	93.00c	82.30	86.56c	86.42s	20.20b	90.46	31.72b	297.56	34.30a	93.56

Letters M_2

Table (2): Frequency of chlorophyll mutations in M_2 generation in studied varieties.

Variety	Doses (Gy)	Chlorophyll mutants	Frequency of chlorophyll mutants (%)
Sakha 101	Cont.	-	-
	100	8	19.04
	200	24	57.14
	400	10	23.80
Sakha 102	Cont.	-	-
	100	18	31.03
	200	32	55.17
	400	8	13.79
Sakha 104	Cont.	-	-
	100	10	28.57
	200	17	48.57
	400	8	22.95
Egyptian Yasmine	Cont.	-	-
	100	14	24.59
	200	50	63.93
	400	8	13.11

Table (3): Spectrum of M_2 chlorophyll mutations.

Variety	Doses (Gy)	Albino	Xantha	Virdis	Others	Total no. of mutant seedlings
Sakha 101	Cont.	-	-	-	-	-
	100	3	2	1	2	8
	200	10	7	5	2	24
	400	2	3	4	1	10
Sakha 102	Cont.	-	-	-	-	-
	100	5	4	7	2	18
	200	12	11	6	3	32
	400	2	2	3	1	8
Sakha 104	Cont.	-	-	-	-	-
	100	4	3	2	1	10
	200	9	3	3	2	17
	400	3	2	2	1	8
Egyptian Jasmine	Cont.	-	-	-	-	-
	100	10	1	1	2	14
	200	25	3	10	12	50
	400	5	-	2	1	8

Regarding chlorophyll content (Table, 4) the results revealed an inconsistent trend in mean values by increasing the dose of gamma rays. On the other hand, the average chlorophyll content was increased significantly by increasing the dose of gamma rays for the three japonica rice varieties Sakha; also 101, Sakha 102 and Sakha 104. The highest increase of this trait was at the treatment 400 Gy. Within these three varieties, significant differences were detected between means of both control and the different doses of gamma rays for the variety Sakha 101; between the control and all other treatments for the variety Sakha 104, moreover, between the control and all other treatments except 100 Gy for the variety Sakha 102. The opposite trends of the first one and the other three varieties indicated that the varieties differed in their response to gamma rays regarding this trait. These findings were in agreement with those reported by Wang *et al.* (1993) and Muhamed *et al.* (2003).

Table (4): Means, and standard error (SE) of chlorophyll content, days to heading, plant height, no. of panicle/plant, 100-grain weight, sterility % and grin yield/plant as affected by gamma rays for the studied varieties in M_2 generation.

Treatment / Character	Variety			
	Sakha 101	Sakha 102	Sakha 104	Egyptian Jasmine
Chlorophyll cont.				
Control	46.01a± 1.99	46.09a± 2.43	46.09a± 2.43	39.19a± 1.61
100Gy	48.33b ± 1.09	46.89a ± 0.81	49.71 b± 1.73	39.68 a± 1.31
200Gy	49.24b ± 0.22	48.82 b± 1.76	50.85b ± 2.73	39.68 a± 1.31
400Gy	50.13b ± 2.64	48.11b ± 1.27	50.74 b± 2.25	38.67a ± 4.15
Days to heading(day)				
Control	109a ± 0.28	96 b±0.44	105a±1.67	118c±1.74
100Gy	110a ± 0.61	103 a±0.12	104ab±1.94	123a ±1.69
200Gy	109a ± 0.53	103 a±0.42	104ab±2.88	126a±2.88
400Gy	109a ± 1.52	103 a±0.47	106a±0.40	128a±3.42
Plant height (cm).				
Control	92 a±1.75	109 a± 1.98	105 a± 1.44	120 a±1.50
100Gy	95.18 a±1.11	108.6 a±7 2.61	106.66 a± 2.51	94.33 c±1.60
200Gy	93.10 a ±0.11	103.32 b± 1.78	102.66a± 1.89	94.00c ±1.72
400Gy	90.56 a± 1.57	88.66 c± 1.66	100.33 b ±120	86.33 d±1.39
No. of panicles/plant.				
Control	23.00 a ±0.82	20.00 a± 1.52	22.00 a± 1.58	19.00 a ±0.76
100Gy	18.34 b ±0.18	19.54 b ±1.42	17.95 b± 1.94	14.33 c ±1.29
200Gy	21.91 a± 0.01	23.00 c± 1.45	22.66 a ±0.81	16.00 b ±1.44
400Gy	25.00 c± 2.42	20.60 a±2.77	17.00 b± 2.77	16.00 b± 1.64
100-grain weight(g)				
Control	2.80a ± 0.009	2.74 a ±0.001	2.67 b± 0.002	2.67 a±0.004
100Gy	2.60 a ± 0.19	2.71 a±0.001	2.70 ab±0.002	2.74 a± 0.002
200Gy	2.73 a± 0.06	2.67 a±0.001	2.79 a±0.004	2.80 a± 0.008
400Gy	3.00 a ±0.006	2.56 b±0.006	2.56 c±0.002	2.39 b± 0.007
Sterility (%)				
Control	7.66 c± 0.47	8.33 b± 0.20	8.00 b± 1.11	9.35 d± 0.01
100Gy	14.00 b± 1.39	9.68 b± 0.20	13.65 ab± 0.45	15.68 c± 2.46
200Gy	16.00 b± 2.29	9.86 b± 1.09	15.28 a± 0.63	26.16 b± 2.48
400Gy	25.53 a± 2.60	20.36 a± 0.44	18.77 a± 0.19	33.59 a± 1.17
Grain yield(g)				
Control	45.00 a±1.54	40.50 a± 1.83	42.0 a± 1.62	33.63a± 0.36
100Gy	40.80 b ±1.61	38.33a± 0.218	39.33ab± 1.39	29.26b±1.47
200Gy	39.16 b ±0.17	43.00ab± 0.47	44.00a±1.54	31.5ab±1.24
400Gy	48.00 ca ±0.87	33.00 b± 0.77	33.60c± 0.44	23.26c±1.35

Variations due to gamma irradiation treatments were not of much significance in all the varieties treated except Sakha 102. The heritability broad sense estimates were found to be low for treatments with different doses of gamma rays in all the varieties studied for this trait. The values ranged from 24 to 47% in Sakha 104 and Egyptian Jasmine cvs, respectively. The lower values of heritability for this trait were mainly attributed to the lower values of genotypic variance. The genetic advance (GS %) as percent of mean by irradiation ranged from 1.86 to 5.51% for Sakha 104 andSakha 102 Cvs, respectively.

Regarding days to heading, the results of the present study (Table, 4) show that delay in heading occurred gradually by increasing the doses of gamma rays and maximized with 400 Gy for Sakha104 and Egyptian Jasmine. This means that the four rice varieties are differ in their radio-sensitivity, and the variety Egyptian Jasmine are more radio-sensitivity than other tested varieties, where, it was the most affected variety for this trait with 10 days delay in heading. These findings indicated that the differences in radio-sensitivity between rice varieties depend largely on the genetic constitution and background within a species, beside the physical and physiological conditions of irradiated material.

On the other hand, Chemma *et al.* (2003) reported that the differential radio-sensitivity of indica and japonica sub-species appeared to be due to the differences in the physical and chemical nature of husk in addition to some genetic factors. The same results were found by Sanjeev (2000); Shadakshari *et al.* (2001); Kumar (2005); Do *et al.* (2006) and Le, (2006). Induced variation by gamma rays was not of much significance in the varieties Sakha 101, Sakha 102 and Sakha 104. However, in case of Egyptian Yasmine induced variations were significantly increased more than that of the control, indicating the differential response of genotypes to the mutagen used. Heritability (Hb) estimates were found to be moderate to high for treatments in all the studied varieties. This is indicative of the fact that irradiation not only induces higher proportion of chromosomal and physiological changes but also brings about a high frequency of gene mutations. Expected genetic advance was higher than the control .This finding can, therefore, also be of considerable values in planning mutations experiment with respect to the choice of reliable stage of selection for the improvement of earlier plants.

Concerning plant height, insignificant differences between mean values of the control and the treatment 100 Gy were observed for the rice varieties Sakha 101, Sakha 102 and Sakha 104(Table, 4). The most affected varieties were Egyptian Jasmine, and Sakha 102 which decreased by 33.67, and 20.34 cm, respectively. These findings indicated that the differential response in the mutagenic effectiveness and efficiency in different varieties was mainly attributed to the genetic background of the material under study and it plays an important role in the occurrence of the mutations. Similar results were found by Sanjeev (2000); Shadakshari *et al.* (2001); Kumar (2005); Do *et al.* (2006); Mohamed et al (2006) and Le, (2006). Genotypic variance (GV) value for all varieties was significantly higher by irradiation than the control or untreated seeds (Table, 5). Genetic coefficients of variation (GCV %) increased also in irradiated population and ranged from 3.39% for Sakha 101 to 11.12% for Egyptian Jasmine. The heritability (Hb) in broad sense and genetic advance were comparatively high in the gamma ray-treated populations than those in the control. The values ranged from 46% for Sakha 101 to 95% for Egyptian Jasmine. The expected genetic advances upon selection as percents of the mean (GS %) were higher by irradiation and amounted 0.76 for Sakha 102 and 10.65% for Sakha104. Similar results were obtained by Gomma *et al.* (1995a); Meheter *et al.* (1996) and Uttam *et al.* (2005).

Number of panicles/plant in the three Japonica varieties; Sakha 101; Sakha 102 and Sakha 104 (Table, 5) were increased by using 200 and 400 Gy. Significant differences were observed between the control and most of the treatments on one hand and among the treatments itself for all the varieties on the other hand. The highest increase in number of panicles per plant was recorded for the variety Sakha 101, while the most affected variety was Egyptian Yasmine. These results indicated that the effectiveness of gamma rays was found with the increase of the doses of gamma rays with either plus or minus effect. Furthermore, the results revealed that the varieties responded differently. These results were in disagreement with Gomma *et al.* (1995b). Mean while, Abdul-Majeed (1997) found that no definite trend was evident with regard to such character.

Genetic coefficients of variation (GCV%) was found to be higher in the irradiated populations compared with the controls(Table,5) .These results are in agreement with the previous reports in rice that the gamma rays induced considerable genetic variation for number of panicles per plant. Heritability Estimates (Hb) was increased by irradiation and the highest heritability values were found at Egyptian Yasmine (92%). Genetic advance as the percentages of the mean (GS%) were increased by irradiation comparing with the controls.

It is clear from Table (4) that one hundred grain weight was decreased significantly by increasing the dose of gamma rays up to 400Gy for all the studied varieties. However, there were no differences between the control and each 100 and 200 Gy treatments. These results were in agreement with those reported by Mohamed *et al.* (2006). Significant increases in genotypic variance (GV) for this trait were obtained by irradiation as compared with the respective control (Table, 5). The genetic coefficients of variation (GCV %) values were increased by irradiation and ranged from 2.70% to 13.69%. Heritability in broad sense values (Hb) were higher in all irradiated populations as compared with the original varieties and ranged from 74% to 92%. The expected genetic advance (GS %) were also higher by irradiation and ranged from 2.79% to 60.86%. These results means that the four rice varieties are differ in their radio sensitivity, whereas some of them more radio- resistant than the others. Similar results have been reported by Bordholi *and* Taluker (1999); Shanthi and Singh (2001) and Elayaraja *et al.* (2005).

Differences were significant among the gamma rays treatments for the sterility percentage in all varieties studied Table (4). It is worthy to note that sterility percentage was increased by increasing the doses of gamma ray. The most effective dose was 400 Gy, where this treatment recorded the highest sterility percentage in all varieties. Remarkable increase in sterility percentage was found in indica rice variety Egyptian Jasmine (24.24%). The lowest sterility percentage was obtained from the treatment 100 Gy for all the studied varieties .The differential response in the mutagenic effectiveness and efficiency in different varieties indicated that the genetic back-ground of the material under study plays an important role in the occurrence of the mutations. The same results were obtained by Mohankumar (1998) and Chemma *et al.* (2003). Genetic coefficient of variation (GCV), were increased by irradiation and ranged from 9.93% to 16.66%. Low to high heritability (Hb) values were obtained for this trait and ranged from 44% to 89%. The genetic advance as percent of means (GS %) values in irradiated populations were higher and reached 28.12% for Egyptian Yasmine followed by 26.38% for Sakha 102(Table,5). High estimates of genetic parameters for this trait by irradiation were found by Meheter *and* Talukar (1996); Bordholi and Talukar (1999) and Elayaraja *et al.* (2005).

From Table (4) the data showed that significant differences were found among the gamma rays treatments for grain yield per plant for all varieties studied in one hand and between the control and the treatments on the other hand. The mean values of grain yield per plant decreased consistently by increasing the dose of gamma rays in indica rice variety Egyptian Yasmine. While, it decreased by increasing the dose of gamma rays up to 200 Gy, then increased at 400 Gy for the variety Sakha 101 and it decreased for 100 Gy and 400 Gy and then increased at 200 Gy for the varieties Sakha 102 and Sakha 104.

The most effective treatments were 200 Gy for Sakha 102 and Sakha 104; 400 Gy for Sakha 101. The same results were obtained by Sarawagi and Soni (1993) and Road (2003). Genotypic variances (GV) were ranged from medium to high among irradiated population, where the values of (GV) reached the maximum for Sakha 102 (34.00) while, the minimum value was detected for Sakha 104 (11.33). Genotypic coefficients of variation (GCV %) were higher by irradiation and ranged from 7.46% in Sakha 101 to 15.76% in Sakha102. Broad sense heritability (Hb) values were ranged from 69% in Sakha 104 to79% in Sakha101. Percentages of the expected gain from selection (GS %) were higher by irradiation and reached its maximum of 27.57% for Sakha102, while the minimum value was found to be 13.62% for Sakha 101(Table, 5). These results are in agreement with those reported by Meheter *et al.* (1996); Bordholi and Talukar (1999); Kalamani and Sakila (2000); Santhi and Singh(2001),Abd Allah.(2002) and Elayaraja *et al.* (2005).

Table (5): Genetic parameters of chlorophyll content, days to heading, plant height, no. of panicle/plant, 100-grain weight, sterility % and grain yield/plant of both control and irradiation populations in M_2 generation.

Character \ Population		PV	GV	GCV	PCV	Hb	GS	GS %
Chlorophyll content								
Sakha 101	cont.	0.02	0.04	0.08	0.05	0.04	0.06	0.09
	Irrad.	1.41**	0.43**	1.39**	2.53**	0.30	0.74	1.59
Sakha 102	cont.	0.95	0.11	0.73	2.15	0.11	0.22	0.48
	Irrad.	9.84**	3.80**	4.30**	6.92**	0.38	2.49	5.51
Sakha 104	cont.	0.08	0.03	0.06	0.07	0.02	0.01	0.08
	Irrad.	2.84**	0.70**	1.82**	3.68**	0.24	0.85	1.86
Egyptian Jasmine	cont.	0.98	0.10	0.83	2.62	0.10	0.25	0.68
	Irrad.	2.95**	1.40**	3.13**	4.55**	0.47	1.67	4.45

Table (5): Continued.

Days to heading (day)								
Sakha 101	cont.	0.007	0.001	0.02	0.42	0.14	0.02	0.01
	Irrad.	2.12**	1.08**	0.95**	1.33**	0.50	1.49	1.37
Sakha 102	cont.	0.40	0.30	0.56	0.21	0.21	0.51	0.52
	Irrad.	9.64**	8.83**	2.85**	2.98**	0.91	5.82	5.95
Sakha 104	cont.	0.93	1.05	1.02	1.71	0.35	1.23	1.23
	Irrad.	5.86**	4.49**	2.03**	2.32**	0.76	3.78	3.63
Egyptian Jasmine	cont.	1.45	1.35	0.92	1.86	0.24	1.15	0.91
	Irrad.	25.66**	17.22**	3.30**	4.03**	0.67	6.99	5.56
Plant height(cm)								
Sakha 101	cont.	1.45	0.03	0.18	1.25	0.2	0.04	0.04
	Irrad.	15.31**	9.93**	3.39**	4.21**	0.46	3.70	3.98
Sakha 102	cont.	2.47	1.02	0.92	1.44	0.41	0.37	0.33
	Irrad.	105.78**	81.16**	8.99**	10.26**	0.76	16.06	0.76
Sakha 104	cont.	1.93	0.45	0.60	1.26	0.23	0.65	0.59
	Irrad.	34.44**	31.16**	5.45**	5.67**	0.91	11.00	10.65
Egyptian Jasmine	cont.	5.03	1.68	1.22	2.11	0.33	1.52	1.43
	Irrad.	108.21**	103.77**	11.12**	11.36**	0.95	22.22	0.95
Panicle numbers								
Sakha 101	cont.	1.00	0.17	1.04	2.96	0.17	0.35	1.73
	Irrad.	2.79**	1.92**	6.68**	8.05**	0.68	2.33	11.23
Sakha 102	cont.	0.52	0.09	1.47	1.66	0.17	0.07	0.35
	Irrad.	1.20**	0.94*	4.61**	5.21**	0.78	1.76	8.37
Sakha 104	cont.	0.17	0.17	1.33	1.57	0.17	0.34	1.92
	Irrad.	0.74**	0.64**	4.51**	4.85**	0.86	1.52	8.57
Egyptian Jasmine	cont.	1.59	0.38	2.42	2.00	0.23	0.59	3.27
	Irrad.	3.08**	2.77**	10.33**	10.67**	0.92	3.28	20.3
100-grain weight(g)								
Sakha 101	cont.	0.006	0.001	1.10	1.71	0.16	0.02	0.70
	Irrad.	0.13**	0.12**	13.69**	14.20	0.92	0.68	26.87
Sakha 102	cont.	0.001	0.002	0.001	0.003	0.002	0.001	0.004
	Irrad.	0.06**	0.005**	2.70**	3.01	0.80	0.73	2.79
Sakha 104	cont.	0.001	0.003	0.007	0.009	0.001	0.001	0.009
	Irrad.	1.00**	0.75**	10.82**	39.52**	0.75*	1.54	60.86
Egyptian Jasmine	cont.	0.001	0.004	0.007	0.006	0.004	0.002	0.004
	Irrad.	0.12**	0.89**	11.09**	12.87**	0.74	0.52	19.63
Sterility %								
Sakha 101	cont.	1.05	0.038	1.77	4.31	0.03	0.06	0.57
	Irrad.	14.68**	7.91**	9.93**	37.84**	0.53	4.18	4.77
Sakha 102	cont.	1.10	0.10	3.16	3.48	0.09	0.19	1.09
	Irrad.	5.39**	4.82**	16.20**	24.39**	0.89	4.25	26.38
Sakha 104	cont.	1.95	0.002	2.00	6.63	0.08	0.06	0.08
	Irrad.	12.05**	5.32**	16.20**	24.39**	0.44	3.15	22.13
Egyptian Jasmine	cont.	2.55	0.23	4.35	6.51	0.09	0.29	2.63
	Irrad.	26.90**	18.60**	16.66**	20.09**	0.68	7.26	28.12
Grain yield /plant(g)								
Sakha 101	cont.	1.97	1.03	1.27	0.82	0.38	0.88	2.10
	Irrad.	17.0**	13.5**	7.46**	8.37**	0.79	6.70	13.62
Sakha 102 Irrad.	cont.	0.08	0.08	0.04	0.09	0.02	0.06	0.04
	Irrad.	46.0**	34.0**	15.76**	18.33**	0.73	10.19	27.57
Sakha 104	cont.	0.70	0.30	0.50	0.65	0.09	0.48	0.17
	Irrad.	16.26**	11.33**	9.18**	11.00**	0.69	5.72	15.63
Egyptian Jasmine	cont.	0.55	0.93	0.65	0.38	0.05	0.43	0.54
	Irrad.	42.0**	30.17**	13.75**	16.23**	0.74	9.47	23.74

REFERENCES

Abdallah, A. A; A. B. El-Abd and A.A. El- Hissewy (2002). Effect of gamma rays on some root characters and grain yield in M_2 generation of different rice varieties (*Oryza sativa* L.), Six Arab Conference on the Peaceful uses of Atomic Energy, Cairo, Egypt, 14- 18 Dec. vol. IV, 193-200.

Abdul-majeed, A.A. (1997). Varietal differences in the effect of gamma irradiation on rice (*Oryza sativa* L.) seeds. Sarhad. J.l of Agric, 13 (4): 363-396.

Bordholi, P. K and P. Talukar (1999). Comparison of genetic variances in M_1 and M_2 generations induced by gamma rays in rice. Annals of Biology, Ludhiana. 15 (1): 21- 24.

Chemma, M.A.A. ; R. Muhamed and Q. Zia-ul (2003). Effect of gamma rays on M_1 generation in Basmati rice. Pakistan Journal of Botany. 33 (3): 811-813.

Do, K. T.; M. S.; P. Q. Hung and C. T. Nguyen (2006). Rice mutation improvement for short duration, High yield and Tolerance to adverse conditions in Mekong Delta of Vietnam. Plant mutation Reports, Vol. 1, No. 1:-48: 53.

Duncan, D. B. (1955). Multiple ranges and multiple F-tests. Biometrics, 11: 1-42.

Elayaraja, K.; M. Prakash; 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. 12(1): 134-137.

EL Shony, K.A.: A.A.Mohamed and S.A.Azer. (1991). Induction of Lax compact panicle mutation by gamma rays in rice.Egyptian Journal of Agronomy 16: 1-2, 203-

Gomaa, M. E.; A. A. El-Hissewy; A. B.Khattab and A. A. Abd-Allah (1995a). Improvement of yield and some Related characters of rice (*Oryza sativa* L.), BY Irradiation. Menofiya J. of Agric. of Res, Vol. 20, No. 2: 395-408.

Gomaa, M. E.; A. A. El-Hissewy; A.B. Khattab and A.A. Abd-Allah (1995b). Days to heading and plant height of rice (*Oryza sativa* L.), Affected by Gamma Rays. Menofiya J. of Agric.l of Res., Vol. 20, No. 2: 409-421.

Gustafsson, A. (1947). Mutations in agricultural plants. Hereltas. 33:1-100.

Icchijima, K. (1934). On the artificially induced mutations and polyploidy plants of rice occurring in subsequent generations. Pro. Imp. Acad. 10: 355-391.

Kalamani, A and M. Sakila (2000). Assessment of Induced genetic variability in M_3 generation in rice. Research on crops. 1 (2): 258-260.

Katoch, P. C. ; E. J. Masar and P.Plaha (1992). Effect of gamma irradiation on variation in segregation generations of F_2 seeds of rice. Indian Journal of Genetics and plant breeding 52 (3): 213-218.

Kumar, A. R. C. (2005). Stable dwarf mutants of a high quality tall rice variety white Ponni. Mutation breeding Newsletter and Reviews. (1): 15- 16.

Kumar, M. D. H. (1998). Frequency and spectrum of chlorophyll mutations induced by gamma rays in two rice varieties. Karnataka- J. of Agric. Sci. (3): 637- 640.

Le, X. T. (2006). Development of photoperiod-insensitive mutant lines using gamma irradiation of Traditional aromatic rice. Plant mutation reports. 1 (1): 53.

Li, J.W.; W.Chanjian; L.cailin; B.Maraoidan; B.Alicia; and H.Leung. 2005. Chemical and irridation induced mutants of indica rice for forward and reverse genetics. Plant molecular biology, 59:85-97.

Meheter, S. S. ; A. P. Patil; R. C. Mahajan and B. R. Shinde (1996). Variability, heritability, character association and genetic divergence studies in M_2 generation of gamma irradiation upland paddy. Crop Research Hisar. 12 (2): 155- 161.

Mohamed, O. ; B. N. Mohd; 1. Alias; S. Azlan; H. Abdul-Rahim; M. Z. Abdullah; O. Othman; K. Hadzim; A. Saad; H. I Habibuddin and F. Golam (2006). Development of Improved Rice varieties through use of induced mutation in Malaysia. Plant mutation Report. 1, (1):27-33.

Mohankumar, H. D (1998). Gamma ray induced variation in M_1 generation of two rice varieties. Karnatake-Journal of Agriculture Science. 11 (4): 920-926.

Muhamed, A. ; A. A. Chemma; A. A. M. Rashid; Z. Qumar. (2003). Effect of gamma rays on M_1 generation in Basmati rice. Pakistan, Journal of Botany. 35(5): 791-795.

Panse, V.G.and P.V. Sukhatme. (1957). Statistical methods for agriculture workers. Indian Council of Agric.Res.New Delhi, India.

Patnaik, D.; D. Chaudhary.; and G.J.N.Rao . 2006. Genetic improvement of long grain aromatic rice through mutation approach. Plant mutation report, Vol.1, May 2006.

Pillai, M. A. ; M. Subramanian and S. Murugan. (1993). Effectiveness and efficiency of gamma rays and EMS for chlorophyll mutation on upland rice. Annals of Agricultural research. 14 (3) 302-305.

Sabbour, Am; A. A. Mohamed and M. A. Khattab (1993). Radio sensitivity of two rice varieties treated with gamma rays. Bulletin of Faculty of Agriculture, University of Cairo. 44 (3): 663- 684.

Sanjeev, S. (2000). Gamma rays induced mutating is Basmati rice (*Oryza sativa* L.), Indian J. of Genetic and plant breeding 60 (2): 143- 144.

Sanjeev, S. ; J. Sing and K. R. Singh (2001). Gamma ray, EMS and sodium azide induced effectiveness and efficiency of chlorophyll mutations in basmati rice (*Oryza sativa* L.), Crop Research Hisar 22 (1): 113-120.

Santhi, P. and J. Singh (2001). Variability studies in induced mutants of Mahsuri rice (*Oryza sativa* L.), Mardars Agricultural Journal. 88 (10/12): 707- 709.

Sarawgi, A. K. and D. K. Soni (1993). Induced genetic variability M_1 and M_2 population of rice (*Oryza sativa* L.) advances in plant sciences. 6 (1): 24- 33.

Serry,E.S. and M.A. Masoud. (1960) . Genetic variability and heritability in segregating generation of rice crosses. Annals of Agricultural Research, 16 (2);: 201-205.

Shadakshari, G. Y. ; H. Chandrappa; S. R. Kulkami and E.h. Shashidhar (2001) induction of beneficial mutants in Indian J. of Genetic and plant Breeding. 61 (3): 274-276.

Sing, J.; P. Santhi (2001). Induced chlorophyll mutants in Basmati rice (Oryza sativa L.) Mardars agricultural journal. 85(8/10): 507-511.

Uttam, C.; C. P. Katoch and K. Vijay (2005). Variability studies in some macromutions induced by EMS and gamma rays in Basmati rice T-23. Annals of Biology. 21 (2): 137-141.

Wang, C. L. ; M. Shen; N. K. Zhao and F. Q, Chen (1993). Mutagenic effects of combined treatment of C s 137 gamma rays and sodium azide on *Oryza sativa* L. Acta-Agricultural-Nucleatae-Sinica. 7 (1): 21- 28.

Wang, L.Q.1991.Induced mutation improvement in China, A review. Plant Mutation Breeding in Crop Improvement. Proc.Int.Symp.Breedto crop improvement.IAEA, pp: 9-32.

دراسات علي احداث تباينات وراثية جديدة فى الصفات الكمية في الأرز بواسطة اشعة جاما

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مركز البحوث و التدريب في الأرز، معهد بحوث المحاصيل الحقلية، مركز البحوث الزراعية ،سخا ، كفر الشيخ، مصر.

اقيمت هذه الدراسة بمزرعة مركز البحوث و التدريب في الأرز، سخا ، كفر الشيخ، مصر وذلك خلال موسمي ٢٠٠٦ و ٢٠٠٧ علي التوالي .في هذه الدراسة تم تعريض البذور الجافة لأصناف الأرز، سخا ١٠١ ، سخا ١٠٢ ،سخا ١٠٤ وياسمين المصرى للتشعيع بالجرعات التالية : ١٠٠، ٢٠٠ ، ٤٠٠ جراى من اشعة جاما. تم زراعة البذور من المعاملات المختلفة و الأصناف الأبوية (كمعاملة مقارنة) وبعد ٣٠ يوم تم شتل النباتات فرديا في تصميم القطاعات الكاملة العشوائية في ثلاث مكررات لكل صنف لدارسة استجابة اصناف الأرز المختلفة للجرعات المختلفة من اشعة جاما لبعض الصفات الخضرية ، محصول الحبوب و مكوناتة ولانتخاب بعض الطفرات المفيدة من العشائر المختلفة للجيل الطفوري الثاني مثل التبكير، قصر الساق ،المقاومة للفحة والقدرة المحصولية العالية. اشارت نتائج الجيل الأول لانخفاض نسبة الأنبات معنويا للصنف سخا ١٠١ بينما قل عدد الأيام للطرد و طول النبات وطول السنبلة و عدد السنابل بزيادة جرعات اشعة جاما لمعظم الأصناف المختبرة. وعلي الجانب الأخر وجد زيادةفي متوسط القيم لعدد السنابل للنبات زاد بزيادة جرعة اشعة جاما للأصناف سخا ١٠١ ،و سخا ١٠٢ .نسبة العقم بالسنيبلات ايضا بزيادة الجرعات الأشعاعية لكل الأصناف المدروسة و من ثم قل المحصول .في الجيل الثاني الاشعاعى وجد ان زيادة الجرعة الأشعاعية ادت الي نقص في نسبة الأنبات و طول النباتات للصنفين سخا١٠٢ وياسمن مصري .متوسط القيم لعدد السنابل بالنبات زاد للاصناف سخا ١٠١ وسخا ١٠٢ و سخا ١٠٤ بينما قل للصنف ياسمين مصري. قل وزن المئة حبة قل في الأصناف سخا ١٠٢ و سخا ١٠٤ و ياسمين مصري بينما لم تتأثر في سخا ١٠١ بالمعاملات لهذة الصفة . زاد طول السنبلة و محتوي الكلوروفيل بزيادة الجرعة الأشعاعية وذلك للاصناف الثلاثة سخا ١٠١ وسخا ١٠٤ و ياسمين مصري .نسبة العقم زادت بزيادة الجرعة وكانت اعلي زيادة لها للصنف ياسمين المصري و من ثم انخفض محصول الحبوب بالنبات لتلك الأصناف . ولقد لوحظ ان هناك مدي واسع من التباين لعشائر الجيل الثاني مقارنة بالمعاملة القيلسية (الاباء) مشيرة الي امكانية انتخاب طفرات لبعض الصفات المرغوبة فسي الأجيال التالية .

اشارت القياسات الو راثية للصفات المدروسة لكل من الاباء و عشائر الجيل الاشعاعى الثاني لكل الأصناف انه في معظم الحالات وجدت زيادات عالية ومعنويه لكل من التباين الوراثي و المظهري و معامل التباين الوراثي ودرجة التوريث و التحسين الوراثي المتوقع.