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MEAN PERFORMANCE AND GENETIC VARIABILITY FOR YIELD AND ITS CONTRIBUTING TRAITS IN M_2 GENERATION INDUCED BY GAMMA RAYS UNDER WATER STRESS.

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ABSTRACT

A field experiment was performed during season 2018/2019 at the Experimental Farm, Faculty of Technology and Development, Zagazig University. Four diverse bread wheat genotypes i.e (Gemmeiza 11, Sids12, Shandaweel-1and Sahel-1), were involved in the present study and treated with different doses of gamma rays, i.e. (0, 150, 250 and 350 Gy) under water stress treatment it was irrigated immediately after sowing and first irrigation was after 45 days for sowing and second irrigation up to flowering stage. to study mean performance and genetic variability in M_2 generation influenced by gamma rays.

Results showed that subjected wheat varieties to gamma rays doses resulted a significant variation for No. of spikes/plant, spike grain weight/gm. and No. of grains/pike, but non-significant for grain yield /plant in all cases revealing the great influence of the gamma rays doses on genetic makeup of wheat varieties. Mean performance for grain yield/plant (g.) in M_2 generation for wheat cultivars changed from 14.49 (g.); (Sahel-1) to 19.35 (g.); (Gemmieza-11). Regarding mean effects of gamma rays doses it ranged from 15.22 (g), (350 Gy) to 17.56 (g.) (150 Gy). PCV was relatively higher than its respective GCV for spike length, No. of spikes /plant, No. spikelets / spike, No. of infertile spikelets/spike, No. of fertile spikelets/spike, spike grain weight and grain yield/plant, indicating their influenced by the mutagen changes. Whereas, narrow difference between PCV and GCV was for No. of grain /spike and 1000- grain weight which coupled with ECV estimates. Heritability in broad sense, was high ($\geq$ 75) for spike length, spike grain weight, no. of grain /spike and 1000-grain weight. With highest of genetic advance for no. of infertile spikelets/spike. Whereas, moderately it was for spike length, no. of tillers /plant, no. of grain /spike, spike grain weight, 1000-grain weight and grain yield/plant, indicating *greater scope for selection and improvement of these traits under water stress direction.*

Conclusively, *the use of gamma rays its importance of influence mutation in some wheat genotypes, indicated greater scope for selection and improvement of wheat traits under water stress direction.*

Key words: Mean Performance, Genetic Variability, Yield, Contributing traits in M_2 Generation Gamma Rays

INTRODUCTION

Mutation induction activities had peaks in the 1950s - 1980s and enjoyed major successes in terms of mutant variety releases (Micke *et al*., 1990). Large number of improved varieties of many crop species has been released, revealing the economic value of the technology (Jankowicz-Cieslak *et al*., 2017). Two breeding procedures, i.e., mutation used to induce new genetic variation. Controversy exists among the breeders on the relative incidence of induced polygenic variations (through induced mutagenesis) in negative or positive direction and shift of the mean in the M_2 and later generations (Siddiqui and Singh, 2010).

Ahmed *et al*., (2015) found that the analysis of variance revealed that treatment means were non-significant for 1000 grain weight, whereas, significant for spike length and grain yield. Mean squares for genotypes revealed highly significant effects for all the traits under study. On an average, Khirman (Mutant) genotype produced highest grain yield /plant as against its normal genotype which yielded, yield /plant. They concluded that when Khirman was treated with (250 Gy) gamma rays, it produced highest gran yield/ plant as compared to other gamma irradiation treatments. Bano *et al*., (2017), showed that there were significant differences between wheat varieties for spikelets /spike and spike length. Treatments of gamma radiation caused significant variation in all the traits studied but interaction between them showed highly significant effect for the entire traits indicating that varieties responded differently for radiation treatments. Mean performance for spike length indicated that the longer spike, was observed in T.D-1 250 Gyand 150 Gy in ESW-9525 .Whereas, the shortest spike, was observed in the variety T.D-1 under control. The maximum mean performance of spikelets/ spike (24. 74) was recorded in ESW-9525 under treatment five at 300 Gy, whereas the minimum value for spikelets/ spike.

Riaz and Gul (2015) observed considerable amount of variation among genotypes for the studied traits. Results indicated high GCV and PCV for grains / spike, 1000-grain weight and grain yield / plot. Balkan (2018), showed the M_2

showed a response to selection for grain yield and its components in bread wheat. Meanwhile, phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) were moderate for the grain yield, the number of grains / spike and grain weight / spike. Taneva *et al.,* (2019), recorded moderate PCV grain yield (16.92%) GCV valued grain yield 10.2%. The estimated values of broad-sense heritability were (72.4%) for thousand grain weight and (36.3%). grain yield.

MATERIALS AND METHODS

The field experiments were conducted during the growing season 2018/2019, According to the previous preliminary experiment, seeds of four wheat cultivars for (Gemmeiza-11, Sids-12, Shandweel-1 and Sahel-1) were irradiated with 150, 250 and 350G_y of gamma irradiation and sown immediately in the field on 25th November. Individual seed was sown in rows with 3 meter length and 30 cm width at 10 cm space between plants in plots with 4 rows to obtain M_2 generation. Water stress treatment it was irrigated immediately after sowing and first irrigation was after 45 days for sowing and second irrigation up to flowering stage. The recommended cultural practices for wheat production at Inchas, Sharkia Governorate were followed in M_2 generation for induce genetic variability, at the Experimental farm, Faculty of Technology and Development, Zagazig University, Egypt. The wheat genotypes were obtained from Agricultural Research Center, Giza, Egypt. For used in the present study. Name, pedigree and origin of these genotypes are presented in Table (1). Physical and chemical analyses of soil for the experimental site are given in Table (2).

The following data were recorded on ten plants: Spike length/cm., number of spikelets / spike, number of infertile spikelets / spike and number of fertile spikelets / spike.number of spikes/plant, number of grains / spike, spike grain weight/g., 1000-grain weight (gm.) and grain yield/plant (gm.):

Statistical analysis:-

Data were statistically analyzed using spilt plot design in M_2 generation with three replication. Data were statically analyzed, and mean values were compared by using the least significant test (L. S. D) at 5% level (Steel *et al*., 1997). The following equations, (proposed by Burton, 1952) were used to estimate genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) coefficients of variations, as follows:

$$GCV = (\delta g/ \ddot{x})\ 100, \qquad PCV = (\delta ph/ \ddot{x})\ 100$$

Where: $\ddot{x}$ = Mean of the respective population.

Table (1): Pedigree and origin of the four parental bread wheat genotypes.

Genotypes	Pedigree	Origin
Gemmieza- 11	Bow"s"/Kvz"s"//7c/seri82/3/ Giza 168/Sakha61GM7892-2GM-1GM-2GM-1GM-0GM	Egypt
Sids- 12	BUC//7C/ALD/5/MAYA74/ON//1160147/3/BB/GLL/4/HAT ″S ″/S/MAYA	Egypt
Sahel-1	-VUL//CMH74A.630/4*SX.SD7096-4SD-1SD-1SD-OSD	Egypt
	N.S.732/pim/Vee"s" CR735-4SD-1SD-1SD-OSD	
Shandawell- 1	Site/Mo/4/NACLTh.Ac//3*Pvn/3/Mirlo/Buc. CMss	Egypt

Source: Wheat Research Section, Field Crops Research Institute, Agricultural Research Center (ARC), Giza, Egypt.

Table (2): Soil mechanical and chemical analyses of the experimental site at 30 cm soil depth.

Soil	Properties
Mechanical analysis :	
Sand (%)	**17.6**
Silt (%)	**21.5**
Clay (%)	**60.9**
Soil texture	**Clay**
Chemical analysis :	
PH	**7.85**
EC mmhose /cm	**98.1+- 7.2**
Total N (ppm)	**1.1+-0.1 ppm**
Available P (ppm)	**19.12+- 0.55 ppm**
Available K (ppm)	**350 pm**

Estimation of heritability (h_b^2):

Heritability in broad sense (h_b %) and genetic advance as % of population mean (G.s %) were computed according to Hanson *et. al*., (1956) following to Singh and Choudhary (1985).

Broad-sense heritability (h_b^2) was estimated by the following formula:

$$h^2_b = \delta^2 g / \delta^2_{ph} \times 100$$

The expected genetic advance (GA) from selection was calculated in each M_2 (Singh and Chaudhury, 2000) as follows:

$$GA = h^2_b \, k \, \delta_{ph} / \ddot{x}, \times 100$$

Where, k = 2.64 for 1 % selection intensity used in this study.

RESULTS AND DISCUSSION

Mean performance of M_2 generation as influenced by gamma rays:-

Results presented in Tables (3 and 4) show the mean performance of spike length (cm) as influenced by gamma rays of M_2 generation for Gemmeiza-11, Shandawel-1, Sids-12 and Sahel-1 wheat cultivars. It is obvious that values of spike length varied from 12.01 cm; in Sahel-1 to 15.48 cm; Gemmeiza-11, while, the effect of gamma rays treatments decrease in this trait which was observed due at 150 Gy dose with value of (13.89 cm), it was more than control (13.67). Moreover mean performance for no. of spikelets/spike showed significant differences among four bread wheat genotypes. Shandweel-1 produced the heights value (23.70) otherwise Sids-12 was the lowest value (21.02). While the effects gamma rays doses it varied 21.76 (350 Gy), to 22.87 (150 Gy) for no. of spikelets\spike. The results of mean performance for no. of infertile spikelets/spike in four wheat genotypes in M_2 generation it varied from 1.258 (Sids-12) to 3.216 (shandaweel-1). Regarding effect of gamma rays doses it changed from 1.741 (control) to 2.283 (350 Gy) for this trait under water stress. Regarding mean performance for no. of fertile spikelets\spike as influenced by gamma rays on M_2 generation in four wheat verities, Gemmeiza-11 give heights value 20.98, but Sids-12 give lowest fertile spikelets\spike (19.82). Gamma rays effects treatments exhibited the higher values of 21.01 and 20.99 for control and 150 Gy, respectively. But, the 350 Gy treatment give the lowest value (19.49) for no. of fertile spikelets\spike. Similar findings were also reported by Ahmed *et. al.,* (2015) and Bano *et al.,* (2017).

As presented in Tables (5 and 6) subjected wheat varieties to gamma rays doses resulted in significant variation for No. of spikes/plant, spike grain weight/gm. and No. of grains/pike, but non-significant for grain yield/plant in all cases revealing the great influence of the gamma rays doses on genetic makeup of wheat varieties Similar findings were also reported by Ahmed *et al.,* (2015) and Bano *et al.,* (2017). Wheat cultivar Sahel-1 produced the greatest number of spikes /plant (6.09), whereas Sids-12 was the lowest (5.20) for no. of spikes /plant. Regarding mean effect of gamma rays doses it varied from 5.43 (150 Gy) to 5.78 (250 Gy) for that trait.

Sids-12 produced the highest no. of grain/spike (82.11 grain) but the Sahel-1 cultivar recorded the lowest no. of grain/spike (63.56 grain). While effect of gamma rays doses fluctuated from, 68.73 grain (350Gy), 70.57 grain (150 Gy) and 73.34 grain (250 Gy) it's were more than(control) 67.13 grain\spike under water stress. Spike grain weight mean performance changed from 2.73 g. (Sahel-1) to 4.00 g. (Gemmeiza-11). Meanwhile, mean effects of gamma rays doses for this trait it ranged from 3.02 (350 Gy) to 3.62 (150 Gy).

Table (3): Mean performance of spike length and number of spikelets/spike for Gemmeiza-11, Shandawel-1, Sids-12 and Sahel-1 as influenced by gamma rays irradiation treatments and their interaction in M_2 generation under water steers**.**

Treatments	Spike length/cm				Mean	Number of spikelets /spike				Mean
	Control	150Gy	250Gy	350Gy		Control	150Gy	250Gy	350Gy	
Gemmieza-11	15.2	15.63	15.86	15.23	15.48	23.6	23.6	22.4	21.6	22.80
Sids-12	13.7	14.4	13.5	13.01	13.38	21.2	21.5	20.8	20.6	23.70
Shandawel-1	13.42	12.92	13.63	13.58	13.65	23.8	23.8	23.6	23.6	21.02
Sahel-1	12.38	12.64	11.58	11.45	12.01	22.2	22.6	21.0	21.26	21.76
Mean	**13.67**	**13.89**	**13.64**	**13.31**		**22.70**	**22.87**	**21.95**	**21.76**	
L.S.D										
G	0.371					0.764				
Ga	0.625					0.730				
G × Ga	1.143					1.474				

Table (4): Mean performance of number of infertile spikelets/spike and spike number spikes/plant for Gemmeiza-11, Shandawel-1, Sids-12 and Sahel-1 as influenced by gamma rays irradiation treatments and their interaction in M_2 generation under water steers**.**

Treatments	Number of infertile spikelets/spike				Mean	Number spikes/plant				Mean
	Control	150Gy	250Gy	350Gy		Control	150Gy	250Gy	350Gy	
Gemmieza-11	1.76	1.96	1.83	1.76	1.832	5.50	5.70	4.83	6.30	5.58
Sids-12	0.93	0.93	1.26	1.90	3.216	5.33	5.23	5.53	4.74	5.77
Shandawel-1	3.00	3.36	3.23	3.26	1.258	6.36	4.93	5.83	5.96	5.20
Sahel-1	1.26	1.33	1.80	2.20	1.649	5.50	5.86	6.96	6.06	6.09
Mean	**1.741**	**1.899**	**2.033**	**2.283**		**5.67**	**5.43**	**5.78**	**5.76**	
L.S.D	0.392					0.661				
G	0.467					0.630				
Ga	0.898					1.272				
G × Ga	0.392					0.661				

Table (5): Mean performance of number of grain/spike and spike grain weight for Gemmeiza-11, Shandawel-1, Sids-12 and Sahel-1 as influenced by gamma rays treatments and their interaction in M_2 generation under water stress**.**

Treatments	Number of grain/spike				Mean	Spike grain weight(g)				Mean
	Control	150Gy	250Gy	350Gy		Control	150Gy	250Gy	350Gy	
Gemmieza-11	67.93	67.93	68	71.5	68.84	3.93	4.00	4.51	3.57	4.00
Sids-12	66.06	84.9	94.76	82.73	65.27	3.42	4.19	3.12	3.03	3.04
Shandawel-1	64.06	66.33	64.06	66.66	82.11	2.99	3.02	3.14	3.02	3.43
Sahel-1	70.5	63.13	66.56	54.06	63.56	2.85	3.31	2.32	2.44	2.73
Mean	**67.13**	**70.57**	**73.34**	**68.73**		**3.29**	**3.62**	**3.27**	**3.02**	
L.S.D										
G	4.624					0.341				
Ga	5.678					0.235				
G × Ga	10.847					0.530				

Table (6): Mean performance of 1000-grain weight and grain yield /plant for Gemmeiza-11, Shandawel-1, Sids-12 and Sahel-1 as influenced by gamma rays treatments and their interaction in M_2 generation under water stress.

Treatments	1000-Grain weight				Mean	Grain yield plant (g)				Mean
	Control	150Gy	250Gy	350Gy		Control	150Gy	250Gy	350Gy	
Gemmieza-11	59.52	58.62	51.57	53.8	55.87	17.8	21.58	18.83	19.22	19.35
Sids-12	40.69	44.32	37.84	42.89	46.39	17.54	17.94	14.57	12.38	15.81
Shandawel-1	45.31	47.25	47.16	45.84	41.43	17.11	13.91	16.38	15.85	15.60
Sahel-1	44.31	50.15	42.48	43.61	45.13	14.12	16.84	13.58	13.44	14.49
Mean	**47.45**	**50.08**	**44.76**	**46.53**		**16.64**	**17.56**	**15.84**	**15.22**	**19.35**
L.S.D										
G	3.572					2.686				
Ga	2.338					2.238				
G × Ga	5.381					4.477				

Regarding mean performance for 1000-grain weight in M_2 generation four wheat cultivars as influenced by gamma rays Gemmeiza-11 produced heights weight for 1000-grain (55.87 g.), whereas Sids-12 was thelowest for 1000-grain weight (41.43 gm.) whereas mean effect of gamma rays doses gave 50.08 g. (150 Gy) it was more than (control) 47.45 g. Mean performance for grain yield/plant (g.) in M_2 generation for wheat cultivars varied from 14.49 g. (Sahel-1) to 19.35 g. (Gemmieza-11). Regarding mean effects of gamma rays doses it ranged from 15.22 g. (350 Gy) to 17.56 g. (150 Gy). Similar findings were also reported by Ahmed *et al.,* (2015) and Bano *et al.*, (2017).

Genetic variability of M_2 generation as influenced by gamma rays:-

Results presented in Table (7) showed some genetic parameters for studied wheat traits as influenced by gamma rays doses on M_2 generation. Estimates of PCV and GCV could be divided into three groups. The first group was high and included no. of infertile spikelets/spike. The second grope was moderate and contained grain yield/plant (g), spike grain weight (g), and no. of grain /spike. The third grope was low and included spike length (cm.), no. of spikes /plant, no. spikelets / spike, no. of fertile spikelets/spike and 1000-grain weight (g). PCV was relatively higher than its respective GCV for spike length, no. of spikes /plant, no. spikelets / spike, no. of infertile spikelets/spike, no. of fertile spikelets/spike, spike grain weight, grain yield/plant, indicating their influenced by the mutagen changes. Whereas, narrow difference between PCV and GCV was for no. of grain /spike and 1000- grain weight which coupled with ECV estimates. These results are in agreement with those obtained by Balkan (2018) and Taneva *et. al.*, (2019)

Estimates of ECV was high for no. of grain /spike, while it was moderate for (cm), 1000-grain weight, grain yield/plant. Whereas, it was low for spike length, no. of spikes /plant, no. spikelets / spike, no. of infertile spikelets/spike, no. of fertile spikelets/spike and spike grain weight. Heritability in broad sense under water stress, was high (≥ 75) for spike length, spike grain weight, no. of grain /spike and 1000-grain weight. Highest genetic advance was for no. of infertile spikelets/spike. But moderate estimates was recorded for spike length, no. of grain /spike, spike grain weight , 1000-grain weight and grain yield/plant indicating greater scope for selection and improvement of these traits under water stress direction. These results are in agreement with those obtained by Balkan (2018), nd Taneva *et. al.*, (2019)

Regarding heritability in broad sense was moderate for no. spikelets / spike, no. of infertile spikelets/spike, and no. of fertile spikelets/spike, but the traits of grain yield/plant, and no. of spikes /plant exhibited low values of heritability in broad sense. With low genetic advance for traits no. of spikes /plant, no. spikelets / spike and no. of fertile spikelets/spike.

Table (7). Estimates of some genetic parameters for wheat mutant traits in gamma rays experiment in M_2 generation.

Parameters / Traits	$\$^2$Ph	$\$^2$G	ECV	PCV	GCV	H_b (%)	G.s %
Days to heading 50 %	23.90	22.193	1.709	5.539	5.338	92.847	10.59
Plant height /cm.	57.93	50.138	7.793	8.063	7.501	86.55	14.37
Peduncle length/cm.	7.557	5.548	2.008	7.152	6.128	73.42	10.82
Spike length/cm.	2.114	1.645	0.467	10.66	9.407	77.86	17.10
Number of tillers /plant	1.042	0.545	0.496	15.67	11.34	52.33	16.89
Number of spikes /plant	0.714	0.179	0.534	14.911	7.470	25.09	7.710
Number of tillers non production/plant	0.306	0.152	0.154	65.23	45.95	49.64	66.70
Number spikelets / spike	1.915	1.196	0.718	6.192	4.894	62.47	7.969
Number of Infertile spikelets /spike	0.853	0.575	0.277	46.41	38.12	67.44	64.48
Number of fertile spikelets/ Spike	1.198	0.594	0.604	5.376	3.786	49.59	5.492
Number of grain /spike	134.9	94.35	40.62	16.787	14.04	69.90	24.17
Spike grain weight (g):-	0.423	0.337	0.086	19.69	17.57	79.68	32.32
1000-grain weight (g):-	43.10	34.384	8.717	13.91	12.42	79.77	22.85
Grain yield/plant (g)	11.05	3.955	7.094	20.36	12.18	35.79	15.02
Straw yield/plant (g)	20.44	9.034	11.41	18.53	12.32	44.18	16.87
Biological yield/plant (g)	55.72	24.124	31.60	18.33	12.06	43.29	16.34
Harvest index %	6.007	1.665	4.34	6.158	3.242	27.72	3.516
Protein content %	2.172	2.126	0.046	14.26	14.11	97.88	28.76

PCV: phenotypic coefficient of variation GCV: Genotypic coefficient of variation
ECV: Environmental coefficient of variation Hb(%) : Heritability in broad sense

Conclusively, the use of gamma rays its importance of influence mutation in some wheat genotypes, indicated greater scope for selection and improvement of wheat traits under water stress direction.

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متوسط السلوك و الاختلافات الوراثية لمحصول الحبوب و مساهماته للجيل الثاني الطفري المستحدث بواسطة أشعة جاما تحت تأثير الاجهاد المائي

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أُجري هذا البحث بالمزرعة التجريبية بكلية التكنولوجيا والتنمية جامعة الزقازيق خلال الموسم الزراعي 2018/ 2019 حيث تم اجراء معاملة أربعة أصناف من قمح الخبز و هى جميزة-11 و سدس -12 و شندويل -1 و ساحل -1 بسبعة جرعات من أشعة جاما وهى (0, 50, 150, 250, 350, 450, 550 جراي) و من النتائج التي تم الحصول عليها من التجربة المعملية و التي أجريت بهدف الحصول على الجرعة الأمثل لإحداث الطفرات تم أنتخاب ثلاثة جرعات بالإضافة الى الكنترول وهى (0, 150, 250, 350 جراي) وزراعتها خلال الموسم الاول للانتخاب منها و الحصول على البذور, في الموسم الثاني تمت زراعة البذور المتحصل عليها بالاضافة الى الاباء. باستخدام القطاعات العشوائية المنشقة حيث كانت الاصناف في الوحدات الرئيسية و معاملات الصوديوم في الوحدات الفرعية. وتم تعريض الاصناف ومعمالات الاشعاع للإجهاد المائي عن طريق أستخدام ريتين فقط طوال مراحل النمو وهى كما يلي (الرية الاولى بعد 40يوم من الزراعة والرية الثانية أثناء الطرد و التزهير). وذلك لتقييم السلوك الوراثي و بعض المقاييس الوراثية لصفات المحصول مساهماته في الجيل الثاني الطفري.

وكانت أهم النتائج المتحصل عليها كما يلي :

أظهر تحليل التباين أن هناك فروق ذات دلالة إحصائية بين الاربعة أصناف لجميع الصفات تحت الدراسة ما عدا عدد السنابل/نبات, بينما كانت الفروق الراجعة للجرعات المختلفة من أشعة جاما معنوية للصفات (عدد السنيبلات/ سنبلة, عدد السنيبلات الخصبة/سنبلة , وزن حبوب السنبلة , وزن الألف حبة و محصول الحبوب /نبات) بينما

أظهر التفاعل بين الجرعات المختلفة و الأصناف فروقا معنوية لصفات وزن الحبوب /سنبلة و وزن الالف حبة.

كما أظهرت الفروق بين التباين الظاهري أعلى نسبيا من التباين الوراثي لصفات طول السنبلة , عدد السنابل/نبات, عدد سنيبلات / سنبلة , عدد السنيبلات الخصبة/سنبلة, عدد السنيبلات الغير خصبة/سنبلة , وزن حبوب السنبلة, ومحصول حبوب/نبات. كما أعطت صفات طول السنبلة , وزن حبوب السنبلة و وزن 1000 حبة كفاءة توريث بلمعنى العام عالية بقيم أكبر من 75% .

التوصية: إن استخدام أشعة جاما ذات أهمية في إستحداث الطفرات في بعض التراكيب الوراثية للقمح ، يؤدي إلى وجود مجال أكبر من الاختلافات الوراثية لإنتخاب وتحسين صفات القمح تحت الإجهاد المائي.