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Effects of gamma rays on rusts, yield, and seed quality of some wheat genotypes

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ABSTRACT

Application of physical modification techniques such as the radiation of gamma rays could induce rust resistance and improve the performance of wheat plants through the development of new products. During the growing seasons of 2020-2021 and 2021-2022, two field experiments were done to see how well five types of bread wheat (NING MAI 50-0CHN, SAKHA 93, GIZA 168, SIDS 12, and SKAUZ) did when they were exposed to 5, 10, 15, 20, and 25 Kr of gamma rays. The experiments looked at how well the rust was controlled, how much yield was produced, and how the seedlings grew. Results showed that wheat genotypes significantly differed in rust infection and other parameters in both seasons at different gamma-ray ratios. Sakha 93 gave high resistance to yellow rust with high seedling dry weight and seedling vigor index 2, but Giza 168 gave the highest leaf rust resistance with increased doses of gamma rays. On the other hand, the SKAUZ genotype surpassed other genotypes in germination percentage and grain yield in both seasons. A dose of 25 kr was the most beneficial for rust resistance and yield attributes in comparison to the control, while a dose of 5 kr caused improvement in seedling parameters. Results exhibited that the interaction effect between wheat genotypes and gamma rays was significant on all studied traits in both seasons. Finally, it is concluded that gamma rays play an important role in inducing rust resistance and improving grain yield.

Keywords: Gamma rays, Bread Wheat, Rusts, Seedling parameters, Yield components.

INTRODUCTION

Rusts are the most damaging and active disease. Stripe rust pathogen (*Puccinia striiformis f. sp. tritici*) is the most common of all wheat rust pathogens, and it thrives in warm winters. Stripe rust has caused yield losses ranging from 10 to 70% in most wheat-growing locations (Chen, 2005; Gad *et al.,* 2022). Furthermore, the most prevalent disease in wheat plants is leaf rust caused by *Puccinia triticina f. sp. tritici*, which causes yield loss due to reduced kernel weights and decreased kernel numbers per head (Goyeau *et al.,* 2007; El-Orabey *et al.,* 2020; Abd El-Rahman *et al.,* 2021). Currently, leaf rust is causing significant crop losses throughout vast geographical regions and locations. (Basnet *et al.,*2014 a, b).

Breeding against biotic stresses in wheat is a well-established strategy (Solomon, 2022). The availability of resistance sources heavily influences the methods and strategies used to induce and improve crop plant resistance to biotic stressors. There are two types of breeding strategies: traditional and modern. Classical breeding procedures such as exotic line introduction, hybridization, composite crossing, multiline, and backcross breeding were previously used for this purpose (Swelam *et al.,* 2010; Balkan *et al.,*2021). However, this strategy was long, expensive, and inefficient for establishing crop resistance. As a result, breeders developed molecular genetic tools such as mutation to generate effective resistance in crop plants in less time. Mutagenic agents are classified as either physical or chemical mutagens. Physical mutagens, such as gamma rays, have long been employed to induce desirable mutants in crops such as wheat, rice, barley, and maize (Njau *et al.,* 2006; Abd El-Hady *et al.,* 2008; Sharma *et al.,* 2011; Marcu *et al.,* 2013; Balkan *et al.,* 2021). Many agronomically essential features, including as shorter developing stages and enhanced tolerance or resistance to biotic stressors, can be developed via induced mutations (Maluszynski and Kasha, 2002; Kenzhebayeva *et al.,* 2013; Balkan *et al.,* 2021).

Wheat is represented by 250 officially released mutant cvs. in the FAO/IAEA Mutant Varieties Database (http://www-mvd-iaea-org), of which 153 mutants were produced using gamma irradiation. Induction against biotic stressors was represented by 49 mutants among these 153 mutant cvs., 45 of which were engineered to increase resistance to rust infections (FAO/IAEA, 2015). Njoro-BW1 is the only mutant variety which officially released in Africa in Kenya in 2001 (Njau *et al.,* 2006). This genotype was developed using gamma irradiation, with the key improved characteristics being drought tolerance, resistance to wheat rusts, and high yielding (FAO/IAEA, 2015). As a result, no officially released wheat mutant cvs. have been created in Egypt so far, leaving a significant deficit in this field.

High productivity of wheat yield is a goal of the farmer and this could be achieved through optimizing the cultural practices, especially pre-sowing seed treatments. Gamma rays' application is one approach to decrease the negative effect of biotic stress and increase yield and seedlings' quality of wheat growth (Gornik *et al.,* 2008; Balkan *et al.,* 2021; Solomon, 2022). In nutrition and agriculture, gamma irradiation is extremely useful for sterilizing as well as the preservation of food and cereal grain (Mokobia and Anomohanran, 2005). According to Farag and El-Khawaga (2013), high doses resulted in a decrease in plant height and spike length. Shubhra et al. (2013) discovered that a dose of 20 Kr was the most favorable because of its promising days to flowering, plant height, test weight, and grain yield per plant; however, larger doses over 30 Kr resulted in a significant loss in the mean value for all the examined features. As a result, the current field study was designed to use direct seed gamma irradiation to induce mutations for tolerance against key diseases such as stripe and leaf rust in five Egyptian wheat genotypes.

MATERIALS AND METHODS

Plant materials:

Field investigations were carried out at El-Gemmeiza Agricultural Research Station, Gharbya, Egypt during 2020-2021 and 2021-2022 growing seasons. Five bread wheat genotypes namely (NING MAI 50-0CHN, SAKHA 93, GIZA 168, SIDS 12, and SKAUZ) are presented in Table (1) which were exposed to five doses of gamma rays viz. 5, 10, 15, 20, and 25 Kr at the National Center for Research and Radiation Technology, Atomic Energy Authority, Nasr City, Egypt. One set of grains of each genotype was kept as a control (without irradiation). The plants regenerated from gamma ray-treated grains formed the M1 generation, while the self-progeny of these plants formed the M2 generation.

Experimental design:

A randomized complete block design with three replicates was used to evaluate wheat genotypes (as control plants) and their mutants to yield and rust diseases. The area of each plot was 1.5 × 2.0 m containing 5 rows 2.0 m long and 30 cm apart. Wheat seeds of the tested materials were sown in the last week of November. The highly susceptible wheat genotype (Morocco) was sown on the border rows of the experimental area for the early development and spread of disease. Artificial inoculation of stripe rust was carried out during mid-January while leaf rust was carried out during mid-February to create stripe and leaf rust epidemics. The cultural practices were performed as recommended.

Table 1. Name and pedigree of five bread wheat genotypes.

Genotypes	**Pedigree or Sources**
SIDS 12	BUC//7C/ALD/5/MAYA74/ON//1160-
SAKHA 93	SAKHA-92/TR-810328
GIZA 168	Mrl / Buc // Seri CM 93046-8M-0Y-0M-2Y-0B- OGZ
NING MAI 50- 0CHN	1 STEMRRSN#6067
SKAUZ	2 EBWYT#530

Disease assessment:

Once rust symptoms were sufficiently matured and the spreader plants were 50% infected, striped and leaf rust infections were examined. At weekly intervals, the yellow and leaf rust response data of adult plants were graded four times as rust severity using Cobb's scale modified by Peterson et al. (1948). According to Roelfs *et al.* (1992) plant response was expressed in five infection types, Immune (0), no uredia or other macroscopic infection indication, while small uredia surrounded by necrosis considered resistant (R). Small to medium uredia surrounded by chlorosis or necrosis, Moderately Resistant (MR). Susceptible (S), large uredia without chlorosis or necrosis. Moderately Susceptible (MS), medium-sized uredia with chlorosis.

Data recorded:

The following traits were measured:

1) Height of the plant (cm). 2) The number of spikes per plant. 3) The length of the spike (cm). 4) The number of spikelets. 5) The number of grains. 6) A weight of 1000 grains (g). 7) Grain yield per plant (g). 8) According to (ISTA, 1985), the germination percentage (G percent) was measured by counting only normal seedlings eight days after planting. 9) Seedling length (cm): an average of ten normal seedlings was measured eight days after sowing. 10) Seedling dry weight (g): the seedling dry weight was obtained by drying 10 normal seedlings in a hot-air oven at 110C° for 17 hours (Krishnasamy and Seshu, 1990). 11) Seedling Vigor Index 1 (SVI1): was calculated according to the following equation of (Abdul-Baki *et al.,* 1973): Seedling Vigor Index 1= Seedling length x germination percentage.

12) Seedling Vigor Index 2= Seedling dry weight (g) x germination percentage.

Data Analysis:

According to Gomez and Gomez (1984) statistically evaluated data from both seasons is using analysis of variance (ANOVA). At 5% probability, the means of treatments were evaluated using the Least Significant Difference (LSD).

RESULTS

Disease assessment:

The interactions between wheat genotypes and gamma rays had a highly significant effect on rust severity. In both crop seasons, leaf and stripe rust severity decreased with increasing radiation (Tables 2, 3). For leaf rust, the disease severity was 50 MS, 30 MS, 10 MS, TrMR, and no symptoms of the disease at other radiation rates in 2021 and 20 MS, 10 MS, TrMS, and no symptoms of the disease at other radiation rates in 2022 in SKAUZ wheat genotype and 10 R, 5 R, TrR, and no symptoms of disease at other radiation rates in 2021 and 5 R, and no symptoms of the disease at other radiation rates in 2022 in GIZA 168 at rates 0, 5, 10, 15, 20 and 25 Kr, respectively (Table 2). For yellow rust disease, all genotypes showed significant differences in infection at different gamma-ray ratios. The disease severity was 80 S, 60 S, 40 S, 30 S, TrS, 10 MS in 2021 and 90 S, 60 S, 50 S, 30 S, 5 S, 30 MS in 2022 in SIDS 12 and was TrMR, and there were no symptoms of the disease at other radiation rates in 2021 and 5 MR-MS, TrMR, and no symptoms of the disease at other radiation rates in 2022 in SAKHA 93 at rates 0, 5, 10, 15, 20, and 25 Kr, respectively (Table 3).

Table 2. Leaf rust was affected by the interaction between various gamma rays and wheat lines during the 2021 and 2022 growing seasons.

wheat lines	**Leaf Rust**											
	2021						**2022**					
	0Kr	**5Kr**	**10Kr**	**15Kr**	**20Kr**	**25Kr**	**0Kr**	**5Kr**	**10Kr**	**15Kr**	**20Kr**	**25Kr**
NING MAI 50-0CHN	30 MS	10 MS	TrMR-MS	0	0	0	20 MS	10 MS	5 MR-MS	5 MR	0	0
SAKHIA 93	20 MR	10 MR	TrR	0	0	0	10 MR	10 R	0	0	0	0
GIZA 168	10 R	5 R	TrR	0	0	0	5 R	0	0	0	0	0
SIDS 12	20 R	10 R	0	0	0	0	10 R	TrR	0	0	0	0
SKAUZ	50 MS	30 MS	10 MS	TrMR	0	0	20 MS	10 MS	TrMS	0	0	0

Table 3. Yellow rust was affected by the interaction between various gamma rays and wheat lines during the 2021 and 2022 growing seasons.

wheat lines	Yellow Rust											
	2021						2022					
	0Kr	5Kr	10Kr	15Kr	20Kr	25Kr	0Kr	5Kr	10Kr	15Kr	20Kr	25Kr
NING MAI 50-0CHN	50 MS	10 MS	TrMS	0	0	0	TrS	40 MS	TrMS	TrMS	0	0
SAKHA 93	TrMR	0	0	0	0	0	5MR-MS	TrMR	0	0	0	0
GIZA 168	TrS	50 MS	10 MS	TrMS	0	0	5 S	5 S	40 MS	10 MS	0	0
SIDS 12	80 S	60 S	40 S	30S	TrS	10MS	90 S	60 S	50 S	30 S	5 S	30 MS
SKAUZ	TrS	50 MS	5 MS	TrMR-MS	0	0	5 S	TrS	20 MS	TrMS	0	0

The numbers in (Tables 2, 3) refer to the disease severity (%) of the leaf and yellow rust pathogens, *Puccinia* triticina *f. sp. Tritici* and *Puccinia striiformis f. sp. Tritici*, respectively, whereas the letters refer to the reaction/infection types, namely, Immune (0), resistant (R), moderately resistant (MR), moderately susceptible (MS), and susceptible (S). Tr stands for Trace.

Wheat genotypes performance:

Highly significant differences were detected among the tested wheat genotypes regarding plant height, number of spikes/p, spike length, number of spikelets, number of grains, 1000 grain weight, grain yield/plant, germination percentage, seedling length, seedling dry weight, as well as seedling vigor index (Tables 4,5, 6, 7, 8, 9, and 10). SKAUZ gave the highest germination percentage, while NING MAI 50-0CHN gave the highest seedling length and seedling vigor index. Sakha 93 had the heaviest seedling dry weight. However, the SKAUZ genotype gave the highest number of spikelets per plant and grain yield.

Gamma rays' effects:

The data listed in Tables (4, 5, 6, 7, 8, 9, and 10) shown that the treatments had a substantial effect on all traits tested in both seasons. In comparison to other metrics such as plant height, number of spikes per plant, and spike length, the number of spikelets, the number of grains, 1000 grain weight, and grain yield, the application of a modest dose resulted in much higher germination parameters

Table 4. Plant height, number of spikes per plant, and spike length as affected by different gamma rays and wheat lines during the 2021 and 2022 growing seasons.

Treatments	Plant height (cm)		Number of Spikes/ plants		Spike length (cm)	
	2021	2022	2021	2022	2021	2022
A.Lines						
NING MAI 50-0CHN	102.3	96.1	11	13	14	14
SAKHA 93	101.2	87.0	11	14	13	14
GIZA 168	106.3	91.4	11	14	16	16
SIDS 12	114.7	97.4	12	15	17	17
SKAUZ	108.3	94.3	12	15	14	14
F. test	**	**	NS	**	**	**
L.S.D (0.05)	1.36	1.42	-	0.85	1.1	1.5
B.Radiation						
Control (0 Kr)	100.1	100.0	11	12	14	14
50 GY (5 Kr)	103.3	94.3	11	13	14	15
100 GY (10)	106.8	93.4	12	14	15	15
150 GY (15Kr)	108.7	94.2	13	14	16	16
200 GY (20 Kr)	109.7	90.3	11	15	16	17
250 GY (25 Kr)	110.8	88.0	10	16	14	14
F.test	**	**	**	**	*	**
L.S.D (0.05)	1.61	1.56	1.2	1.28	1.5	1.2
AXB	**	**	NS	NS	NS	NS

Table 5. Number of spikelets per spike, number of grains, 1000 grain weight, grain yield as affected by gamma radiation and wheat lines during the 2021 and 2022 growing seasons.

Treatments	Number of spikelets/ spikes		Number of grains/ spikes		1000 grain weight (g)		Grain yield(g)/ plant	
	2021	2022	2021	2022	2021	2022	2021	2022
A.Lines								
NING MAI 50-0CHN	23	25	69.4	78.1	46.778	45.722	25.111	27.833
SAKHA 93	24	25	68.3	70.7	47.389	47.056	27.444	31.278
GIZA 168	25	26	75.4	79.4	51.50	50.111	26.611	27.444
SIDS 12	26	27	57.3	56.8	39.00	38.167	25.889	28.667
SKAUZ	24	25	74.8	74.5	46.389	45.000	33.556	35.167
F. test	*	NS	**	**	**	**	**	**
L.S.D (0.05)	1.32	-	1.13	1.59	1.8481	1.0305	1.4277	2.3177
B.Radiation								
Control (0 Kr)	23	25	60.1	62.7	40.600	40.267	23.533	25.733
50 GY (5 Kr)	24	25	66.2	69.1	42.867	42.267	26.200	27.533
100 GY (10 Kr)	24	25	66.7	65.6	46.200	44.533	27.733	30.067
150 GY (15Kr)	24	26	71.9	74.5	48.533	46.667	28.933	31.333
200 GY (20 Kr)	25	25	73.5	79.3	49.067	48.200	29.133	31.933
250 GY (25 Kr)	26	27	75.9	80.3	50.000	49.333	30.800	33.867
F.test	**	NS	**	**	**	**	**	**
L.S.D (0.05)	1.39	-	1.84	1.83	2.1019	1.6821	1.6824	1.4476
AXB	NS	NS	**	**	**	**	**	**

Table 6. Plant height is affected by the interaction between various gamma rays and wheat lines during the 2021 and 2022 growing seasons.

Treatments	Plant height (cm)											
	2021						2022					
	0	5 Kr	10 Kr	15 Kr	20 Kr	25 Kr	0 Kr	5 Kr	10 Kr	15 Kr	20 Kr	25 Kr
NING MAI 50-0CHN	97.0	95.0	105.0	104.0	106.0	107.3	97.0	100.0	99.0	97.0	95.0	91.0
SAKHA 93	97.0	100.0	101.0	102.0	104.0	104.0	97.0	86.3	85.0	86.0	84.0	84.0
GIZA 168	98.0	106.7	106.0	108.4	109.3	110.0	98.0	100.0	94.0	94.0	86.0	85.0
SIDS 12	106.0	111.0	116.3	118.0	118.3	118.3	105.0	100.0	94.0	100.0	95.3	92.3
SKAUZ	103.0	104.0	106.0	110.7	111.3	114.0	102.0	94.0	97.0	95.0	91.3	87.0
F. test	**						**					
L.S.D (0.05)	3.60						3.51					

Table 7. Number of grains per spike is affected by the interaction between various gamma rays and wheat lines during the 2021 and 2022 growing seasons.

Treatments	Number of grains/spike											
	2021						2022					
	0 Kr	5 Kr	10 Kr	15 Kr	20 Kr	25 Kr	0 Kr	5 Kr	10 Kr	15 Kr	20 Kr	25 Kr
NING MAI 50-0CHN	63.7	67.0	64.0	72.7	75.6	73.3	76.3	83.0	67.3	79.6	80.3	82.0
SAKHA 93	72.0	74.0	67.0	65.3	61.3	70.0	74.6	73.3	67.7	64.667	71.0	73.0
GIZA 168	76.0	73.7	74.7	75.3	76.7	76.0	71.3	75.0	73.0	84.6	86.3	86.0
SIDS 12	20.7	41.0	52.7	70.0	77.3	82.3	40.0	40.0	46.3	69.7	82.3	84.0
SKAUZ	68.0	75.3	75.0	76.3	76.7	78.0	72.0	74.3	73.6	74.0	76.6	76.3
F. test	**						**					
L.S.D (0.05)	4.1025						4.1025					

Table 8. 1000 grain weight as affected by the interaction between various gamma rays and wheat lines during the 2021 and 2022 growing seasons.

Treatments	1000 grain weight (g)											
	2021						2022					
	0 Kr	5 Kr	10 Kr	15 Kr	20 Kr	25 Kr	0 Kr	5 Kr	10 Kr	15 Kr	20 Kr	25 Kr
NING MAI	42.333	43.667	48.000	48.333	47.667	50.667	42.667	43.667	45.000	46.667	48.000	48.333
SAKHA 93	46.000	45.667	48.667	49.000	46.667	48.333	45.000	45.333	47.667	46.000	48.333	50.00
GIZA 168	47.000	50.00	51.33	50.33	54.333	56.00	47.000	48.000	49.333	51.00	52.00	53.333
SIDS 12	23.000	28.667	36.667	47.333	50.33	48.00	23.333	29.667	36.667	45.667	45.667	48.000
SKAUZ	44.667	46.333	46.333	47.667	46.333	47.00	43.333	44.667	44.000	44.00	47.000	47.000
F. test	**						**					
L.S.D (0.05)	4.700						3.7612					

Table 9. Grain yield is affected by the interaction between various gamma rays and wheat lines during the 2021 and 2022 growing seasons.

Treatments	Grain yield (g)/ plant											
	2021						2022					
	0 Kr	5 Kr	10 Kr	15 Kr	20 Kr	25 Kr	0 Kr	5 Kr	10 Kr	15 Kr	20 Kr	25 Kr
NING MAI	23.333	24.667	23.667	26.000	26.333	26.667	27	25	27.33	28.666	29.333	29.666
SAKHA 93	23.333	25.333	28.667	28.667	28.667	30.000	28.666	29.0	32.0	31.666	31.666	34.666
GIZA 168	25.000	25.333	26.000	26.333	27.000	30.000	26.666	25.33	27.666	27.333	27.666	30
SIDS 12	17.667	24.000	27.667	28.333	28.333	29.333	17.333	24.666	28.666	31.666	34.333	35.333
SKAUZ	28.333	31.667	32.667	35.333	35.333	38.000	29.0	33.666	34.666	37.333	36.666	36.666
F. test	**						**					
L.S.D (0.05)	3.762						3.237					

Table 10. Effect of different gamma rays on seedling parameters of wheat lines

Treatments	Germination%	Seedling length	Dry weight	SVI1	SVI2
A.Lines					
NING MAI 50-0CHN	77	24.0	0.532	1842	41
SAKHA 93	75	23.3	0.540	1736	42
GIZA 168	71	22.3	0.250	1595	19
SIDS 12	77	21.2	0.264	1630	21
SKAUZ	79	21.6	0.192	1716	15
F. test	**	**	**	**	**
L.S.D (0.05)	5.7	1.1	0.042	146	4.4
B. Radiation					
Control (0 Kr)	78	24.2	0.51	1880	41
50 GY (5 Kr)	84	23.3	0.385	1950	32
100 GY (10 Kr)	72	22.3	0.312	1593	21
150 GY (15Kr)	70	21.8	0.338	1561	27
200 GY (20 Kr)	74	22.0	0.259	1599	19
250 GY (25 Kr)	76	21.4	0.330	1639	26
F. test 5%	**	**	**	**	**
L.S.D (0.05)	6.2	1.2	0.046	160	5
AXB	**	*	**	**	**

Interaction effects:

Wheat genotypes interacting with gamma rays have a significant effect on germination percentage (Fig.1). When treated with modest doses up to 5 kr, Sids 12 provided the best germination percentage, followed by SKAUZ. Giza 168, on the other hand, produced the lowest readings when given with a high dose of up to 25 kr.

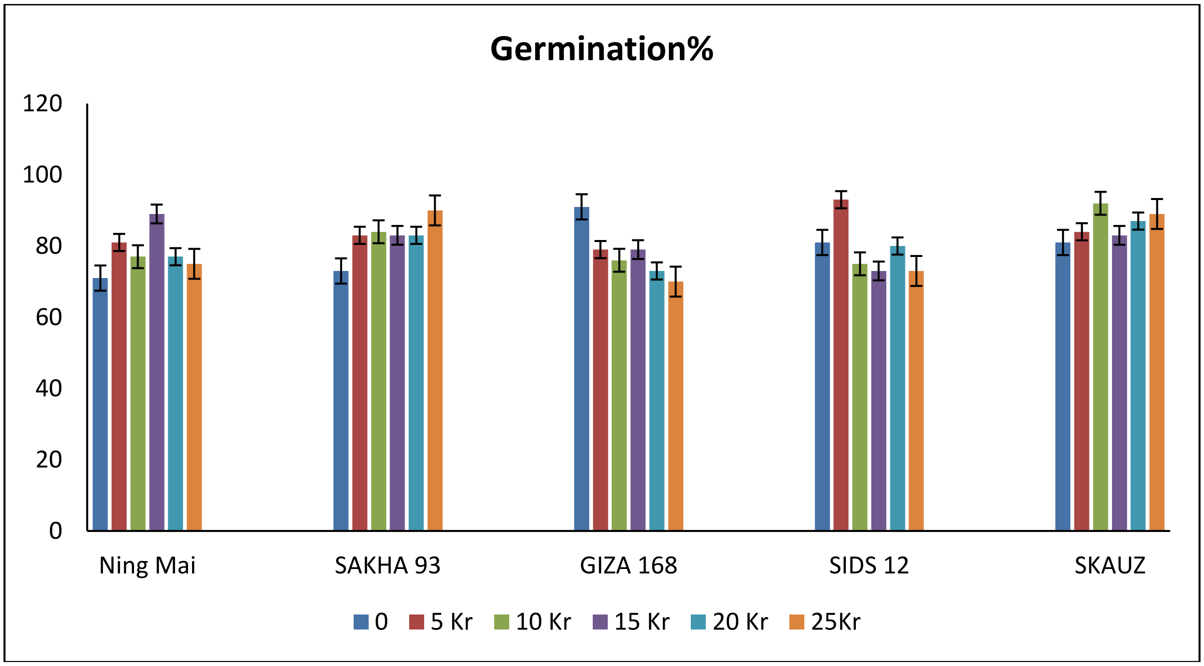

Fig 1. Germination percentage as affected by gamma rays and wheat genotypes.

DISCUSSIONS

Wheat production is influenced by yellow and leaf rust, which produce considerable grain yield losses due to their ability to form new races, wide dispersion, and ability to spread over large distances (Hasan *et al.,* 2016; Gebril *et al.,* 2018a, b; El-Orabey *et al.,* 2019; Gad *et al.,* 2019 a, b; Gebrel *et al.,* 2019; El-Naggar *et al.,* 2020; Gad *et al.,* 2020; Gebrel *et al.,* 2020; Shahin *et al.,* 2022). During 2020/2021 and 2021/2022 growing seasons, the performance of five bread wheat genotypes was evaluated for rusts control, yield components, and seedling parameters by their exposure to five doses of gamma rays i.e. (5, 10, 15, 20, and 25 Kr). At M2 generation, the response of wheat genotypes to leaf rust infection altered from moderately susceptible to moderately resistant and resistant in their mutants. However, in their mutants, the responses of these *cvs*. to stripe rust infection were modified from susceptible to moderately susceptible and resistant (G-M2). The obtained results are in harmony with those obtained by Boyd and Minchin (2001), who discovered that four of the wheat mutants had lower levels of yellow rust infection while three had higher levels of infection. The infection characteristics that changed were those seen once hyphal development was established. All the mutants' resistance phenotypes were developmentally controlled. The alterations in infection characteristics were different for each mutant, implying that various genes were changed. Some yellow rust mutants had changed their resistance phenotypes to brown rust and/or powdery mildew. Thus, our results concluded that mutagenized Sakha 93 and Giza 168 wheat genotypes at M2 generation can be considered promising for resistance toward the two rusts under study.

The superiority of SKAUZ over other genotypes may be attributed to its genetic makeup and the ability to achieve the highest yield components, which led to raising grain yield. Similar data were also obtained by other researchers, such as Melki and Marouani (2010), who investigated the effects of low doses (0, 10, 20, and 30 Gy) of radioactive cobalt (^{60}Co) rays on seed germination, shoot growth, and epicotyl growth of hard wheat (*Triticum durum* Desf.) under laboratory and glasshouse conditions and discovered that irradiated wheat seeds retained their germination speed and capacity levels when compared to the control. However, with the 20-Gy dose, root number and root length improved by +18 and +32%, respectively. Furthermore, the 20-Gy irradiation dose resulted in a +33 % in epicotyl length. In plants cultivated on a liquid medium, a 20-Gy irradiation treatment increased root length by 32% and root number by 75%. Under glasshouse growing circumstances, the same treatment resulted in a lower root length increase of +23 %. These findings suggest that deep development stimulation of hard wheat roots after gamma ray treatment could be exploited for drought control. Singh and Datta (2010) investigated the effect of gamma irradiation at 0, 0.01, 0.03, 0.05, 0.07, and 0.1 kGy on wheat plant flag leaf area, stomatal conductance, transpiration and photosynthetic rate, and plant and grain nutritive value and discovered that gamma irradiation improved plant nutrition but did not enhance grain nutritional quality, particularly in terms of micronutrients. Irradiated grains have greater levels of grain carotene, a precursor of vitamin-A. Low grain micronutrient levels appear to be driven by a restriction in source-to-sink nutrient translocation rather than a limitation in plant root nutrient uptake capacity.

Al-Naggar et al. (2013) discovered that 350 Gy was the optimal gamma-ray dose for irradiating the wheat genotypes investigated to induce beneficial mutants. The highest estimates of genetic parameters were demonstrated by the M2 populations deduced from Sids-4 and Maryout-5 for means, ranges, phenotypic (PCV) and genotypic (GCV) coefficients of variation, Sahel-1 and Maryout-5 for heritability, and Aseel-5, Sids-4, and Maryout-5 for genetic advance under water stress (WS) conditions. A total of 57 putated-induced mutants were selected for high grain and yield plants in M2 populations; 23 of them were selected under WS and 34 under well watering (WW). The 57 M3 families were evaluated along with their parents under WW and WS. Out of them, seven M3 families outperformed their parents by at least 15% while using WS. Under WW and WS, the most superior M3 family was SF3 (56.34 and 65.36 percent superiority over its parent Giza-168), followed by SF6 (48.03 and 62.62 percent superiority over its parent Sahel-1). The seven best M3 families are considered putative drought-tolerant mutants. On the other hand, the highest germination percentage was observed by using low doses of radiation, and similar observations were reported by Melki and Marouani (2010) and Al-Naggar et al. (2013).

CONCLUSION

According to the findings, pre-sowing treatments with gamma-ray dosages of 5, 10, 15, 20, and 25 kr were successful in generating rust resistance, enhancing plant development, and improving seedling quality. The dose of 25 kr was the most effective for rust resistance and yield attributes in comparison to the control, while the dose of 5 kr caused improvement in seedling parameters.

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تأثير أشعة جاما علي أمراض الأصداء ومحصول وجودة التقاوي في بعض التراكيب الوراثية للقمح

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إن استخدام التقنيات الفيزيائية الحديثة لاستحثاث المقاومة لأمراض الاصداء من خلال معاملة تقاوي القمح بجرعات مختلفة من أشعة جاما يعمل علي تحسين أداء نمو نباتات القمح من خلال ظهور وتطور سلالات جديدة. حيث أجريت تجربتان حقليتان خلال موسمي 2021/2020 و2022/2021 وتم اختيار خمسة سلالات من قمح الخبز: [NING MAI 50- 0CHN, SAKHA 93, GIZA 168,SIDS 12,SKAUZ] وتم تعريضهم لخمسة جرعات مختلفة من أشعة جاما.حيث تم دراسة وقياس شدة الإصابة بالأصداء [صدأ الأوراق والصدأ الأصفر] وصفات النمو والمحصول ومكوناته ودليل البادرات. أشارت النتائج إلي وجود اختلافات معنوية في شدة الاصابة بالاصداء وصفات البادرة وطول النبات وعدد الحبوب بالسنبلة ووزن الالف حبة ومحصول الحبوب بكلا الموسمين. حيث اظهر التركيب الوراثي سخا 93 اعلي مقاومة للصدأ الاصفر بينما التركيب جيزة 168 اعطي اعلي مقاومة للصدأ البرتقالي بزيادة التعرض لجرعات الاشعاع . اظهر التركيب Skauz تفوق عن التراكيب الاخرى في نسبة الانبات ومحصول الحبوب ومن ناحية اخري فان التركيب سخا 93 اعطي اثقل وزن للبادرة واعلي دليل لقوة البادرة 2. كذلك اوضحت النتائج ان تاثير تركيز اشعة جاما 25 كيلو راد زاد من مقاومة القمح لامراض الاصداء ومحصول الحبوب بالمقارنة بالكنترول بينما الجرعات المنخفضة 5 كيلو راد كان لها تاثير أفضل من الجرعات العالية بالنسبة لنسبة الإنبات. اسنتج من هذه الدراسة أن تعريض تقاوي القمح لاشعة جاما كان له دور هام في استحثاث المقاومة لامراض الاصداء وزيادة المحصول.

الكلمات المفتاحية :أشعة جاما ، قمح الخبز ، الاصدأء ، معاملات الشتلات ، مكونات المحصول.