Evaluation of M_2 Wheat (*Triticum aestivum* L.) Mutants for Yield and its Contributing Traits

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Abstract: The present research was conducted to evaluate the M_2 wheat mutant population for yield and its contributing traits. The experiment was conducted at Nuclear Institute of Agriculture (NIA), Tando Jam, during rabi season 2015-2016, in split plot design with three replications. Two wheat varieties (T. D-1 and ESW-9525) were treated with different levelsof gamma rays (150Gy, 200Gy, 250Gy, 300Gy and control) from NIMRA (Nuclear Institute of Medicine and Radiotherapy), Jamshoro. The mutated plants were evaluated along with parental lines (control) for yield and its contributing traits under field conditions. Genetic parameters viz., mean performance, were calculated such as days to 75 % heading, days to 75 % maturity, plant height (cm), spikelets spike^{-1} and spike length (cm). Mean square showed that there were significant differences between wheat varieties for days to 75% heading, days to 75% maturity, plant height (cm), spikelets spike^{-1} and spike length (cm) treatments of gamma radiation caused significant variation in all the traits studied. The interaction between treatments × varieties showed highly significant differences for the entire traits indicating that varieties responded differently for radiation treatments. Mean performance forspike length indicated that the longer spike (11.52 cm) was observed in T.D-1 at treatment four (T_4=250 Gy) and treatment two (150 Gy) in ESW-9525 . Whereas, the shortest spike (10. 83 cm) wasobserved in the variety T.D-1 under control. The results regarding maximum mean performance ofspikelets spike^{-1} (24. 74) were recorded in ESW-9525 under treatment five at 300 Gy whereas the minimumvalue forspikelets spike^{-1} (18.76) were observed in T.D-1 under T_1 (18.76) at 0 Gy and T_4 at 250 Gy.

Keywords: Wheat, Mutation, Mutant, Population, Yield.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is the “versatile cereal food” and represented as the “stuff of life” or “king of cereals” [1, 2]. It belongs to poaceae family and one of the first domesticated cereals. It is basic staple food in major part of Europe, West Asia, and North Africa (CIMMYT, 2009). Wheat is a principle source of food for population in the world, in Pakistan it stands first among the cereals and occupies about 66% of the annual food cropped area [3]. Although commonly called bread wheat. There are many uncertainly related species that make up the genus *Triticum*. Some of the species closely related to common wheat would be einkorn, emmer, durum, and spelt and contains three distinct genomes (AABBDD) and is hexaploid (2n=6x=42). Wheat being the essential food and it provides more calories in human diet than other cereals. Wheat prevails over all crops in acreage and production. Variation in the individuals either induced by environment or due to the hereditary change during genetic recombination. According to [4] states that mutation is defined as any sudden and drastic heritable change in gene sequence which is not traceable or ascribable to segregation or recombination. Mutation plays a key role in evolving of new species. In plants, mutations can be artificially induced by mutagenic agents and their utilization for production of new superior varieties from traditional variety, this process is called mutation breeding. By the application of radiation and chemical mutagens, mutation breeding is being used to introduce wheat varieties. According to the mutation theory as propounded by Hugo De Vries (1901), a new species arise not by gradual accumulation of small variations, but by the appearance of permanent and sudden change in a character which is unpredictable. Irradiation is an ionic no-heat process that proceeds to receive attention as a preservation and functional modification agent in polymer research and application [5]. It was considered as one of the physical modification methods of nature polysaccharide [6, 7].

MATERIALS AND METHODS

Present study was performed to determine the effects of yield and yield contributing traits of hexaploid wheat (*Triticum aestivum* L.) varieties (T.D-1 and ESW-9525) irradiated with different doses of gamma rays (150Gy, 200Gy, 250Gy, 300Gy and control) from NIMRA (Nuclear Institute of Medicine and Radiotherapy), Jamshoro, were sown along with

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parental lines under field conditions. The experiment was conducted at Nuclear Institute of Agriculture (NIA), TandoJam during rabi season 2015-2016 in split plot design with three replications.

Statistical Analysis

The collected data was subjected to analysis; the analysis of variance [8], after the comparison of mean was done through least significant difference 0-5% [9].

RESULTS

The present research was conducted to evaluate the effects of different doses of gamma rays for yield components of two varieties with five treatments in hexapliod wheat. The experiment was laid out in split plot design with three replications at Nuclear Institute of Agriculture (NIA), Tandojam to evaluate the M_2 wheat mutant population for yield and yield components developed through gamma rays, the quantitative traits viz. days to 75 % heading, days to 75 % maturity, plant height (cm), spikelets spike^{-1} and spike length (cm), in two wheat varieties namely T.D- 1 and ESW-9525. The data obtained for each character were analyzed statistically and differences among the mean were tested using Duncan's Multiple Range Test (DMRT). Mean square results showed that there were highly significant differences at ($p<0.01$) probability level between wheat varietiesTD-1 and ESW-9525 for above mentioned traits. The analysis of variance results for treatments (Gamma radiation doses i.e 150Gy, 200Gy, 250Gy, 300Gy and control), indicated that the characters days to 75% heading, grains spike^{-1}were highly significant at ($p<0.01$) probability level. Whereas, significant for days to 75% maturity, plant height (cm), spike length (cm), at ($p<0.05$) probability level.

Days to 75% Heading

The resultsregarding days to 75% heading is presented in Table **2**. It shows that treatment four T_4 (250 Gy) took maximum days (52.51), for days to 75% heading followed by treatment T_2 150 Gy (51.47). The variety T. D-1 took maximum days (52.97) for days to 75% heading followed by ESW-9525 (49.49). The maximum value for days to 75% heading (54.60) recorded by variety T.D-1 under T_4, whereas minimum value for days to 75% heading (48.49) was recordedin variety ESW-9525 under T_5.

Days to 75% Maturity

For the character days to 75% maturity, T_4 (250 Gy) took maximum days (133.32), followed by treatment three and five (132.49, 132.27, respectively). The variety ESW-9525 took maximum days (134.64) for days to 75% maturity followed by T.D-1 (127.76). The maximum days to 75% maturity (135.71) took by variety ESW-9525 under T_3, whereas the minimum

Table 1: Mean Squares for Different Morphological Traits of Wheat Genotypes

Source of variation	Replication (A)	Treatment (B)	Error (A×B)	Varieties (C)	(B×C)	Error (A×B×C	Total
	D.F= 2	D.F= 4	D.F= 8	D.F= 1	D.F= 4	D.F=10	29
Days to 75% heading	4.8420	4.0548*	0.5982	90.8280**	2.2412$^{n.s}$	0.8135	138.617
Days to 75% maturity	0.711	29.705**	0.237	355.490**	17.047**	0.483	550.643
Plant height	1.64	10.96*	1.26	3366.35**	37.52**	1.38	3587.45
Spike length	0.06561	0.28120*	0.02763	0.02187*	0.03660$^{n.s}$	0.01821	1.82743
Spikelets spike^{-1}	1.580	0.885*	0.089	181.794**	0.595$^{n.s}$	0.390	195.490

Table 2: Effect of Different Doses of Gamma Rays Treatments on Days to 75% Heading of Wheat Genotypes

Varieties	Treatment					Mean
	T_1 (0 Gy)	T_2 (150 Gy)	T_3 (200 Gy)	T_4 (250 Gy)	T_5 (300 Gy)	
V1= T.D-1	51.76	53.46	52.50	54.60	52.54	52.97
V2=ESW-9525	50.46	49.49	48.59	50.43	48.49	49.49
Mean	51.11	51.47	50.54	52.51	50.52	
LSD at 0. 05%	Treatments = 1.093, Varieties = 0.777, Treatments × Varieties = 1.737					

Table 3: Effect of Different Doses of Gamma Rays Treatments on Days to 75% Maturity of Wheat Genotypes

Varieties	Treatment					Mean
	T_1 (0 Gy)	T_2 (150 Gy)	T_3 (200 Gy)	T_4 (250 Gy)	T_5 (300 Gy)	
V1= T.D-1	122.13	125.55	129.26	131.49	130.37	127.76
V2=ESW-9525	133.53	134.66	135.71	135.14	134.17	134.64
Mean	127.83	130.10	132.49	133.32	132.27	
LSD at 0.05%	Treatments = 0.688, Varieties = 0.598, Treatments × Varieties = 1.338					

Table 4: Effect of Different Doses of Gamma Rays Treatments on Plant Height (cm) of Wheat Genotypes

Varieties	Treatment					Mean
	T_1 (0 Gy)	T_2 (150 Gy)	T_3 (200 Gy)	T_4 (250 Gy)	T_5 (300 Gy)	
V1= T.D-1	72.33	72.35	69.09	73.84	72.23	71.97
V2=ESW-9525	97.00	92. 24	96.22	87.98	92.32	93.15
Mean	84.66	82. 29	82.66	80.91	82.27	
LSD at 0.05%	Treatments = 1.586, Varieties = 1.012, Treatments × Varieties = 2.263					

days to 75% maturity took by variety T.D-1 under T_1 (122.13), Table **3**.

The mean performance for plant height at different doses of gamma rays is given in Table **4**. The maximum value for the trait of plant height was recorded in (T_1= 0 Gy) (84.66 cm) followed by the T_3 and T_2. The variety ESW-9525 produced highest plant height (93.15 cm) followed by T.D-1 (71.97 cm). The highest plant height (97.00 cm) was recorded in ESW-9525 under T_1. Whereas, lowest plant height (69.09 cm) observed by the variety T.D-1 under T_3 at 200 Gy.

Spike Length (cm)

For the character spike length, (T_2=150 Gy) produced longer spike (11.46) followed by T_4 and T_5 (11.42, 11.41cm, respectively). The variety ESW-9525 produced longer spike (11.33 cm) followed by T.D-1 (11.28 cm). The longest spike (11.52 cm) was observed in T.D-1 at T_4 (250 Gy) and T_2 (150 Gy) in ESW-952 (11.52 cm). Whereas, the shortest spike (10.83 cm) observed by the variety T.D-1 under control.

Spikelets Spike^{-1}

Table **6** showed mean performance of spikelets spike^{-1}. In this table (T_2= 150 Gy) produced maximum spikelets spike^{-1} followed by T_5, T_3 and T_4. The variety ESW-9525 produced maximum spikelets spike^{-1} (23.86) followed by the variety T.D-1 (18.93). The maximum spikelets spike^{-1} (24.74) were recorded in ESW-9525 under T_5 at 300 Gy while the minimum spikelets spike^{-1} were observed in T.D-1 under T_1 and T_4 (18.76) at 0 and 250 Gy, Table **6**.

DISCUSSION

Genetic improvement of any crop depends upon the mode and frequency of the genetic variability and percentage of relationship of heritable and non heritable variation between yield and its contributing characters. If the desirable variation is not available, the plant breeders create the genetic variability in their breeding material by using different breeding techniques. Mean square results showed that there were highly significant differences at ($p<0.01$)

Table 5: Effect of Different Doses of Gamma Rays Treatments on Spike Length (cm) of Wheat Genotypes

Varieties	Treatment					Mean
	T_1 (0 Gy)	T_2 (150 Gy)	T_3 (200 Gy)	T_4 (250 Gy)	T_5 (300 Gy)	
V1= T.D-1	10.83	11.40	11.29	11.52	11.35	11.28
V2=ESW-9525	11.03	11.52	11.31	11.32	11.47	11.33
Mean	10.93	11.46	11.30	11.42	11.41	
LSD at 0.05%	Treatments = 0.235, Varieties = 0.116, Treatments × Varieties = 0.259					

Table 6: Effect of Different Doses of Gamma Rays Treatments on Spikelets Spike^{-1} of Wheat Genotypes

Varieties	Treatment					Mean
	T_1 (0 Gy)	T_2 (150 Gy)	T_3 (200 Gy)	T_4 (250 Gy)	T_5 (300 Gy)	
V1= T.D-1	18.76	19.44	18.93	18.76	18.78	18.93
V2=ESW-9525	23.03	24.17	23.66	23.69	24.74	23.86
Mean	20.90	21.81	21.30	21.22	21.76	
LSD at 0.05%	Treatments = 0.422, Varieties = 0.538, Treatments × Varieties = 1.203					

probability level among wheat varieties TD-1 and ESW-9525 for the traits, days to 75% heading, days to 75% maturity, plant height, spikelets spike^{-1} and significant for spike length at ($p<0.05$). The results regarding days to 75% heading depicts that variety T.D-1 took maximum days (54.60) at treatment four (T_4= 250 Gy) and the variety ESW-9525 took minimum days (48.49) for days to 75% heading, the mean performance for days to 75% maturity shows that the variety ESW-9525 took maximum days (135.71) under T_3 at 200 Gy and minimum (122.13) days to 75% maturity took by variety T.D-1 under T_1. Results for plant height reveals that the highest plant height (97.00 cm) was recorded in ESW-9525 under T_1. Whereas, lowest plant height (69.09 cm) was observed the variety T.D-1 under T_3 at 200 Gy. Mean performance for spike length indicated that the longer spike (11.52 cm) was observed in T.D-1 at treatment four (T_4=250 Gy) and treatment two (150 Gy) in ESW-9525. Whereas, the shortest spike (10.83 cm) observed in the variety T.D-1 under control. The results for mean performance was regarding maximum spikelets spike^{-1} (24.74) were recorded in ESW-9525 under treatment five at 300 Gy whereas the minimum spikelets spike^{-1} (18.76) were observed in T.D-1 under T_1 (18.76) at 0 Gy and T_4 at 250 Gy.

CONCLUSION

It is concluded that Variety ESW-9525 showed greater performance in grain yield plant^{-1} due to increase in the yield components, same time it was also observed that T_4 = 250Gy prove to be suitable dose for obtaining mutant plants for most of the trait studied, followed by T_3 = 200Gy.

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