ISSN 1023-1072

Pak. J. Agri., Agril. Engg., Vet. Sci., 2018, 34 (2): 108-112

GENETIC VARIABILITY STUDIES IN WHEAT HYBRID CUM MUTATED F_3M_2 POPULATION FOR AGRO-MORPHOLOGICAL TRAITS

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ABSTRACT

A field experiment was conducted at the experimental farm of Wheat Research Station Tandojam. The objective of the experiment was to determine the genetic variability in seven F_3M_2 mutated hybrid populations of bread wheat (*Triticum aestivum* L.) developed through crossing between eight parents. The F_1 hybrids were treated with three radiations doses (100, 150, 200Gy) of gamma rays and their control. The experiment was laidout in a Randomized Complete Block Design (RCBD) with three replications. The means of treated populations were compared to their untreated parental lines for selected traits viz. plant height, number of fertile tillers per plant, spike length, number of spikelets per spike, number of grains per spike, seed index and grain yield per plant. The mean squares revealed that all the genotypes under the treatments as well as untreated populations differed significantly ($P\leq$ 0.01) for all the traits under study. The mutated hybrids Soghat-90 × Sarsabz at T_2 (150 Gy) recorded the highest value of plant height, while Khirman × RWM-9313 at T_2 (150 Gy) recorded the highest values for number of fertile tillers per plant, number of grains per spike and grain yield per plant. On the other hand, parent Marvi-2000 gave the highest values of spike length and seed index, while parent Khirman gave the highest number of spikelets per spike. Results indicated that moderate to high doses of gamma rays (150, 200Gy) could produce desirable mutant. Hence, offering the better scope of selection towards the improvement and can be utilized for the development of new superior varieties of wheat.

Keywords: hybridization, mutation breeding, wheat crop, yield, yield components

INTRODUCTION

Wheat demand is likely to increase by 60% to fulfill feeding requirements of increasing population by 2050 (Rosegrant and Agcaoili, 2010). However, the crop growth has remained stagnant due to climate change and increase in various biotic and abitoic stresses in major wheat producing countries of the world (FAO, 2017). Pakistan is one of the major wheat producing country and is ranked among top ten countries of the world in both area and production. During 2016-17, wheat crop was cultivated on an area of 9.052 million ha and 25.750 million tons wheat was produced (GoP, 2016).

Future challenges of wheat crop can be meet in best way if we change our basic strategy to utilize diverse materials and various genetic resources to widen germplasm pool using various breeding techniques. Variation of traits is primary need of any breeding program for crop improvement, which can be created in different ways. Hybridization, mutation breeding and various other biotechnological techniques are being applied to induce genetic variation. In nature variation mainly exists due to mutation. To speed up mutation process, both physical and chemical mutagens can be used to induce genetic variability (Yusuff *et al*., 2017). Cross breeding also creates useful variation but some time integrated approaches yield best results that can be more effective (Singh *et al*., 2012). Nagaraju *et al.* (2015) evaluated ninety-two mutant lines developed through hybridization cum mutation in both emmer and durum wheat genotypes for various quantitative traits. All the genotypes including parents formed 11 groups based on D^2 statistics analysis techniques. Yield, plant height and number of grains per spike were found as main contributing traits towards genetic diversity and variability in

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mutated populations. In order to cope environmental stresses and changing climate scenario, there will be immediate need to create new genetic variability by utilizing various genetic resources. Present study was carried out to assess the genetic variation in population, which was developed by utilizing both hybridization and mutation breeding techniques in same population at a same time to create huge genetic variation for different agro-morphological traits of economic interests and selected desirable plants from such hybrid cum mutants.

MATERIALS AND METHODS

This study was carried out at the experimental farm of Wheat Research Station, Tandojam. The seven F_3M_2 population viz.SD-1200/14 × IB-25/99, RWM-9313 × Kiran-95, Soghat-90 × Sarsabz, Marvi-2000 × Khirman, Khirman × RWM-9313, Khirman × Kiran-95 and Marvi-2000 × Soghat-90 were developed through crossing between eight parents viz. SD-1200/14, IB-25/99, RWM-9313, Kiran-95, Soghat-90, Sarsabz, Marvi-2000 and Khirman. The F_1 material was treated with different doses of gamma rays as T_0 = Control, T_1 = 100 Gy, T_2 = 150 Gy, T_3 =200 Gy based on radio-sensitivity and lethal dose studies of hexaploid wheat crop in order to get maximum mutation frequency. Seed of parental lines and their crosses in F_3M_2 generation was sown in the Randomized Complete Block Design (RCBD) with three replications. The seeds were dibbled with hand, keeping the space at 15 cm between plant to plant and 30 cm distance between row to row. Four rows of each genotype per replication were raised, ten plants per replication for each genotype were selected randomly and labeled for data recording.

Data on the quantitative characters of parental varieties and mutated hybrids (F_3M_2) were recorded. The height of the main tillers was recorded in centimeters at the time of harvesting from the ground surface level to the tip of the spike excluding awns. Mean for varieties and of mutated hybrids were calculated statistically. The numbers of fertile tillers, from each selected plant were counted at the time of crop harvest plant and tagged for observations in each replication. The spike length of the main spike of each selected plant was measured in centimeters from the emergence of first spikelet to the tip of last spikelet without awns. The numbers of spikelets per spike were counted on total spikelets born on main spikes of selected plants. Grain number was counted by threshing main spike of selected plants separately. Seed index was measured as one hundred grains were taken at random from the grains of each selected plant and weighed in grams on electrical balance. For grain yield, all the spikes of individual selected plants were threshed. All the grains were weighed in grams using electrical balance and recorded as yield grams per plant.

All the data were subjected to statistical analysis for meaningful comparison of the parents and their mutated hybrids. ANOVA was obtained by Fisher @ $P \geq 0.01$ (1918) whereas Duncan (1955) multiple range test (DMRT) were performed by Gomez and Gomez @ $P \geq 0.05$ (1984). Anova was obtained @ $P \geq 0.01$ to include more strong partition of various factors as population under study was highly heterogeneous and segregating. Whereas Duncan multiple range test (DMRT) were performed by Gomez and Gomez @ $P \geq 0.05$ because at this probability level breeder do not lose any effective selection.

RESULTS AND DISCUSSION

The analysis of variance (mean squares) for different quantitative traits of seven F_3M_2 mutated hybrid populations and their eight parents is depicted in Table 1. Parents and their hybrid cum mutant were highly significant ($P \geq 0.01$) for the traits plant height, number of fertile tillers per plant, spike length, number of spikelets per spike, number of grains per spike, seed index and grain yield per plant. Thus, indicating the existence of great genetic variation among the genotypes for the entire characters under study. Therefore, suggesting the utilization of significant source material for the improvement of wheat. The data regarding average performance of F_3M_2 mutated hybrid populations treated by three various gamma rays doses and their eight untreated parental lines, are presented in Table 2.

Plant height (cm)

The mutant of the cross Soghat-90 × Sarsabz produced tallest plants (90.57 cm) at T_2 (150 Gy) whereas, the mutated hybrid Marvi-2000 x Khirman at T_2 (150Gy), Khirman x RWM-9313 at T_1 (100Gy) and Marvi-2000 × Soghat-90 at T_3 (200 Gy) produced the shortest plants (55.33, 52.43 and 52.87 cm), respectively. These hybrids cum mutants were potential source for short and long height (Table 2). Lower doses of gamma rays have induced changes for long height and higher doses have reduced the plant height. Lower dose might have affected few genes and higher dose have influence in many genes. This might be due to variation in doses. Singh and Balyan (2009) had successfully developed short height and good quality trait mutant plants from cultivar Kharchia.

Number of fertile tillers per plant

The maximum tillers (11.53) per plant were obtained in the mutated progeny of Khirman × RWM-9313 at T_2 (150 Gy) and parent Kiran-95 which produced 10 fertile tillers. The lowest number of fertile tillers 3.13 was produced by cross SD-1200/14 x IB 25/99 at T_1 (100Gy) control. Shrivastava *et al.* (2011) found two mutant lines possessing high tillering, eight early maturing, three for spike length and grain yield and one for plant height traits form mutated populations.

Spike length

Results in Table 2 depicts that spike length ranged from 9.38 in cross RWM-9313 x Kiran-95 at T_2 (150 Gy) to 13.13 in parent Marvi-2000. Among the mutated populations Marvi-2000 × Soghat-90 displayed the longest spikes (12.65 cm) at the lowest gamma rays dose of 100 Gy. Whereas small spike length were recorded in cross RWM-9313 x Kiran-95 and Marvi-2000 x Soghat-90. Khan and Verma (2015) in their studies found decrease in spike length in mutant population in comparison to parental lines.

Number of spikelets per spike

Regarding the number of spikelets per spike (Table 2), data revealed that maximum number of spikelets per spike (21.6) was obtained from the parental line Khirman, followed by the mutated hybrid populations Marvi-2000 × Khirman 21.2 at T_3 (200 Gy). Also, check IB-25/99 and Marvi-2000 reflected high values of spikelets per spike 21.2 and 20.80, respectively. Nazarenko (2015) found that high doses could create large and wide range of mutant plants. Least number of spikelets per spike was produced mutated population RWM-9313 x Kiran-95 at T_3 (200 Gy) 15.2 and Khirman x Kiran-95 at T_0 (control) 15.3. Khan *et al*. (2003) also reported the decrease in spikelet number with increasing radiation dose. Our findings are in close agreement with Nazareko (2015) and had opposite view with Khan *et al*. (2003).

Number of grains per spike

Results of number grains per spike showed wide variation, it ranged from 40.27 to 71.27. The mutated hybrid Khirman × RWM-9313 at T_2 (150 Gy) revealed the highest number of grains 71.27 per spike. The other high grain producing mutated populations were Marvi-2000 x Khirman 65.4 at T_3 (200 Gy) and Parent Marvi-2000 65.33. The lowest number of grains per spike were produced by mutated population Khirman x Kiran-95 cross (40.27 at T0), 41.2 at T_1 and 41.33 at T_3 (Table 2). Jamil and Khan (2002) reported that dose of 20 Krad were found more effective, which increased numbers of grains and grain yield due to radiation induced effect.

Seed index (100-seed weight)

Hundred seed index ranged from 2.72 to 4.43 g. Marvi-2000 exhibited the highest 100-seed weight (4.43 g). Among the mutated hybrid populations RWM-9313 × Kiran-95 gave the maximum 100-seed weight (14.19 g) at T_1 (100 Gy). The lowest seed index of 2.72 and 280 g was produced by mutated population of Marvi-2002 x Soghat-90 at 200 Gy and Soghat-90x Sarsabz crosss at control, respectively (Table 2). Khan and Verma (2015) in their studies found more spikes per plant and high seed weight over mother parent which depict effectiveness of induced mutation for these particular traits.

Table 1. Analysis of variance (mean squares) of F_3M_2 mutated hybrids and their eight parents for seven important characters of bread wheat (*Triticum aestivum* L.)

Source of variation	D.F	Plant height (cm)	No. of fertile tillers per plant	Spike length (cm)	No. of spikelets per spike	No. of grains per spike	Seed index (100-seed weight) (g)	Grain yield per plant (g)
Genotypes	35	242.32**	7.89**	2.87**	9.13**	188.60**	0.44**	32.48**
Replication	2	12.03	0.95	0.12	1.60	24.68	0.05	2.46
Error	70	13.53	1.35	0.21	1.38	23.9	0.04	3.34

** = Significant at $P \leq 0.01$

Table 2. Mean performance of F_3M_2 mutated hybrids and their untreated parental lines for different quantitative characters of bread wheat (*Triticum aestivum* L.)

Genotypes	**Plant height (cm)**	**No. of fertile tillers per plant**	**Spike length (cm)**	**No. of spikelets per spike**	**No. of grains per spike**	**Seed index (100-seed weight) (g)**	**Grain yield per plant (g)**
SD-1200/14	76.65dg	4.53gl	11.54eh	18.4fj	53.07ej	3.73fj	7.4fj
IB-25/99	64.97klm	5.6bj	10.33lo	21.2ab	59.27bf	3.17mn	7.63fj
RWM-9313	80.55be	4.87el	10.45kn	18.67di	52.27fj	3.87ch	8.6ci
Kiran-95	82.9bc	10.0a	12.15be	17.6gl	54.07di	3.95bg	19.14a
Soghat-90	75.51eh	4.73fl	9.75nq	18.27fk	48.73hl	3.9bg	8.17ei
Sarsabz	81.63bcd	7.00bc	11.15gk	19.33bg	61.93bcd	3.43jm	12.4b
Marvi-2000	73.15ghi	4.33hl	13.13a	20.8abc	65.33ab	4.43a	11.19bcd
Khirman	84.35b	6.87bcd	11.53eh	21.6a	59.27bf	3.95bg	13.06 b
SD-1200/14×IB 25/99							
T_0 =Control	73.53 ghi	3.4kl	11.42 ei	20.13af	62.27bc	3.53il	5.97ij
T_1 = 100 Gy	72.12 ghi	3.13l	10.75im	20.53ad	54.13dh	3.71gj	4.83j
T_2 = 150 Gy	71.52gj	5.73bj	11.71 dg	19.73af	58.93bg	3.45im	9.37ch
T_3 = 200 Gy	75.63eh	4.27hl	11.53eh	21.2ab	58.73bg	3.74fi	7.18gj
RWM-9313× Kiran-95							
T_0 =Control	79.9be	4.53gl	10.33lo	18.27fk	52.6fj	4.06bcd	8.53ci
T_1 = 100 Gy	84.33b	5.73bj	10.23lp	18.27fk	51.13gk	4.19ab	10.25bf
T_2 = 150 Gy	77.36cg	5.00dl	9.38q	17.2hm	44.27klm	4.05be	7.71fj
T_3 = 200 Gy	75.87dh	4.73fl	9.74nq	15.2n	47.07hm	3.97bg	8.23di
Soghat-90 × Sarsabz							
T_0 =Control	63.89lm	5.47bj	10.72im	18.4fj	53.4ei	2.8op	6.15ij
T_1 = 100 Gy	79.52bf	5.27bk	9.69 opq	16.27lmn	47.53hm	3.9bg	8.85ci
T_2 = 150 Gy	90.57a	4.87el	9.83nq	16.8in	43.4klm	4.15abc	6.51hij
T_3 = 200 Gy	68.99il	6.4bg	10.27lp	17.6gl	50.6hk	3.1no	8.03el
Marvi-2000× Khirman							
T_0 =Control	63.98 lm	5.13ck	10.21lp	16.53jn	45.4jm	3.86ch	8.21ei
T_1 = 100 Gy	72.17ghi	5.93bi	11.22fj	18.53ei	50.2hk	3.81dh	9.16ch
T_2 = 150 Gy	55.33n	4.2il	11.33fj	19.07ch	59.4bf	3.29lmn	6.78hij
T_3 = 200 Gy	66.0jm	4.00jkl	11.84cg	21.2ab	65.4ab	3.75ei	7.02hij
Khirman×RWM- 9313							
T_0 =Control	75.37eh	5.53bj	10.9hl	19.33bg	62.07bc	3.37lmn	8.91ci
T_1 = 100 Gy	52.43n	7.07b	12.55abc	20.00af	58.93bg	3.46im	10.97be
T_2 = 150 Gy	74.93ei	11.53a	12.33bcd	19.07ch	71.27a	3.71gj	20.79a
T_3 = 200 Gy	83.07bc	6.67be	11.67 dg	19.07ch	54.93ch	3.87ch	11.39bc
Khirman× Kiran- 95							
T_0=Control	65.2klm	5.2bk	9.83nq	15.33mn	40.27m	4.10 bcd	7.81fi
T_1=100 Gy	72.4ghi	4.33hl	10.6jm	16.53jn	41.2lm	3.74fi	6.23ij
T_2=150 Gy	70.0hk	4.73 fl	10.0mq	16.4kn	41.33lm	3.69gk	6.82hij
T_3=200 Gy	73.6fi	6.13bh	10.63jm	16.0lmn	46.2im	3.58 hl	9.17ch
Marvi-2000× Soghat-90							
T_0=Control	63.97lm	5.33bj	9.53pq	18.93ch	49.73hk	3.40kn	6.58hij
T_1=100 Gy	80.89bcd	5.6bj	12.65ab	20.4ae	53.8ei	4.03bf	10.12bg
T_2=150 Gy	62.77m	6.53bf	11.91cf	20.0af	60.67be	3.11n	9.39ch
T_3=200 Gy	52.87n	4.27hl	10.43kn	19.4bg	59.73bf	2.72p	6.00ij
LSD at 5%	5.98	1.89	0.74	1.91	7.89	0.30	2.97

Grain yield per plant

Concern to grain yield per plant (Table 2), the mutated population of Khirman × RWM-9313 at T_2 (150 Gy) gave higher grain yield of 20.79 g per plant, followed by parent Kiran-95 19.14 g and proved superior strain among all the populations. The mutated population of Marvi-2000 x Soghat-90 produced minimum grain yield per plant of 6.00 g. Sial *et al.* (2010) evaluated twenty-one stable wheat-mutant under normal and late condition out of which six mutants showed superiority in yield than check varieties at normal sowings while three mutants produced more yield than check varieties at late sowings.

CONCLUSION

The mutated hybrid Soghat- 90 ×Sarabz at T_2 (150 Gy) gave the highest value of plant height, while, Khirman ×RWM-9313 at T_2 (150 Gy) gave the highest values of number of fertile tillers per plant, number of grains per spike and grain yield per plant. On the other hand, parent Marvi-2000 gave the highest values of spike length and seed index, while parent Khirman gave the highest number of spikelets per spike. These findings indicated that hybridization cum mutation breeding generates more desirable variation than direct mutation.

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(Accepted: September 24, 2018)