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EVALUATION OF STABLE WHEAT MUTANT LINES FOR YIELD AND YIELD ASSOCIATED TRAITS

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ABSTRACT

Twelve mutant lines developed through intraspecific crosses cum radiation-induced mutagenesis were evaluated along with four local check varieties Sarsabz, Kiran-95, TJ-83 and Khirman. Two mutants MASR-3 and MASR-64 matured earlier than other entries including check varieties. Mutant MASR-64 and MASR-6 produced higher grain yield (5420 kg ha^{-1} and 5380 kg ha^{-1}). Mutant MASR-3, MASR-9, MASR-14, and MASR-64 produced higher 1000-grain weight (45.2, 47.7, 45.7, and 45.0g, respectively). Highest number of grains spike^{-1} was recorded in MASR-64 (79.9), MASR-6 (71.8) and MASR-8 (68.0). Higher grain yield (5420 kg ha^{-1}, 5380 kg ha^{-1}) produced by mutant MASR-64 and MASR-6, respectively. Main spike yield ranged between 1.9 and 4.15g. MASR-64 produced highest grains spike^{-1} (79.9) and highest main spike yield (4.15g). Mutant MASR-64 has shown improvement in most of the traits. It is early maturing, high yielding, endowed with higher number of grains spike^{-1} and main spike yield, hence it could be a promising selection for future breeding.

Keywords: Early maturity, genetic variability, grain yield, mutation

INTRODUCTION

Wheat is the major grain crop of the world and is the stable food of millions of people globally. This crop is widely adapted to wide range of climatic conditions. A large variety of food that include bread, chapaties, cakes, noodles, crackers, breakfast food, biscuits, cookies and many other confectionary items are prepared from wheat. Wheat is among the four major crops of the Pakistan. Total area in Pakistan under wheat cultivation is 9.042 million hectares with annual production of 23.86 million tons and average yield of 2639 kg ha^{-1} (Anonymous, 2010). Wheat is self pollinated C_3 crop and natural variation in it is very low. To improve yield and other traits in wheat crop, many breeding techniques are being used successfully. Mutation breeding is one of the important techniques to induce variation. Nuclear techniques such as induced mutation had significantly contributed in developing superior crop varieties of seed and vegetatively propagated crops. Those released mutant cultivars in different crops had great economic impact on agriculture and food productions and added billion of dollars in the economy of many countries including Pakistan (Ahloowali *et al*., 2004; Jain, 2010). More than 3000 varieties of different crops have been officially released by mutation breeding technique. The genetic variability can be induced by physical and chemical mutagenic agents from whom mutants for desirable traits can be selected (Jain, 2006; Jain *et al*., 2010). Mutant populations have now been created **for** many cereal crops, including rice (Singh *et al*., 1998; Suzuki *et al.*, 2008), *Triticum durum* (Sakin and Yildirim, 2004) and hexaploid bread wheat (Slade *et al.*, 2005). It is reported that crop improvement is limited because of complexity of many traits. Major challenge is to know linking sequence and information about function of genes in determining these traits. These approaches rely on disturbing of these important genes by mutagenesis and other reverse genetic techniques (Parry *et al*., 2005; Parry *et al.*, 2009). Care may be taken as large-scale plant mutagenesis may induce greater changes in gene expression patterns than transgene insertion (Batista *et al.*, 2008). Natural or induced genetic diversity can be promoted for the improvement of all major food crops and the use of mutagenesis to create novel variation in particularly valuable crops with limited

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genetic variability. The use of mutagenesis in **breeding** has involved the selection of individual mutants with improved traits and their incorporation into **breeding** programmes (Parry *et al*., 2009). The mutants developed in wheat had great potential for direct release and to include them in cross breeding programme (Sakin *et al.*, 2005). Many wheat cultivars developed in the world through induced mutation have been released which possess tolerance to many biotic and abiotic stresses and improved traits. Present study was conducted to evaluate stable mutants for yield and yield associated traits. Positive desirable mutant will be selected and would be incorporated in future breeding programs.

MATERIALS AND METHODS

Twelve mutant lines developed through intraspecific crosses cum radiation-induced mutagenesis were evaluated at normal sowing in the month of November (dated 11-11-2008) along with four local check varieties Sarsabz, Kiran-95, T.J-83 and Khirman. Better performing mutants were evaluated in advance strain test during 2008-2009 at experimental farm of Nuclear Institute of Agriculture (NIA), Tandojam. The experiment was laid out in randomized complete block design (RCBD) having three replications. Each genotype was sown with 4 rows, 5m long and 30 cm inter-row spacing. The net plot size was $6m^2$. The traits measured from each genotype in this experiment were days to heading, days to maturity, grain filling period, plant height, 1000-grain weight, grain yield, biological yield and harvest index. At maturity five random plants from each genotype were selected to study agronomic/morphological traits i.e. spike length, number of spikelets $spike^{-1}$, number of kernels in a spike, number of grains $spikelet^{-1}$ and main spike yield. Days to heading were recorded when 75% of the spike were extruded from the flag leaf. Grain filling period was calculated by subtracting days to heading from days to maturity. Harvest index was calculated as per following formula:

$$\text{Harvest index} = \frac{\text{Grain yield}}{\text{Biological yield}} \text{X } 100$$

Data were analyzed by analysis of variance method and the means were compared using Duncan's Multiple Range Test (D'MRT) according to Steel and Torrie (1981).

RESULTS AND DISCUSSION

Mutant lines showed wide variation in various measured traits. Some of the mutant lines had shown superiority over other entries and check varieties for different yield and associated traits. Four stable mutant lines (MASR-9, MASR-11, MASR-64 and MASR-3) headed earlier (64.7, 70.3, 70.0 and 71.0 days, respectively) than other entries including check varieties. Among check varieties, Sasabz headed earlier (73.3days) than other checks, whereas, Khirman showed lengthy vegetative period (93 days). Jamil and Khan (2002) reported that radiation intensity delays heading and increases maturity period. Our findings are not in agreement with their findings. We observed early heading and early maturing genotypes developed through induced mutation. Maturity period is one of the important trait that help genotypes in many different ways to cope with various abiotic and biotic stresses. Early maturing genotypes could escape heat stress and drought stress by completing their life cycle earlier to other late maturing entries. Two mutants MASR-3 and MASR-64 matured earlier (123.3 and 122.0 days) than other entries including short duration check Sarsabz and T.J-83. While genotype MASR-23 took very long time to ripe (Table 1). Wide variation in irradiated population of wheat in case of plant height, ear length, tillering, awning and time to maturity were also observed previously by Mucci (1962). Grain filling period ranged from 41.7 to 63.6 days. Five mutant MASR-9, MASR-14, MASR-17, MASR-22 and MASR-23 took more days to fill their grains (63.6, 60.3, 61.3, 60.3 and 61.3 days, respectively) than other entries including checks. Among checks, Sarsabz took more days to fill its grains than other checks (59.7 days). Thousand kernel weights is important yield contributing trait. Yield of wheat can be increased by increasing seed number or seed weight (Sramkova *et al.*, 2009). 1000-grain weight ranged from 31.7 to 47.7g. Mutant MASR-3, MASR-9, MASR-14, and MASR-64 produced higher 1000-grain weight (45.2, 47.7, 45.7, and 45.0g, respectively) than other entries including check varieties. Among check varieties, Sarsabz and Kiran-95 produced heavy grains. Rahimi *et al.* (2011) reported the effect of gamma rays on 1000-grain weight, harvest index and grain yield of wheat crop and found that the lower dose improved these traits. Similarly mutant lines used in this study showed some improvement in 1000-grain weight, harvest index and the maturity period.

Mutant MASR-64 and MASR-6 produced more grain yield (5420 kg ha^{-1} and 5380 kg ha^{-1}). However, the difference between checks (Kiran-95 and Sarsabz) and mutant lines was non significant in case of yield. Four other mutants (MASR-11, MASR-13, MASR-14 and MASR-22) produced higher grain yield (5207, 5181, 5193 and 5265 kg ha^{-1}, respectively) than two checks TJ-83 and Khirman. MASR-22 produced higher biological yield (16333 kg ha^{-1}), followed by MASR-14, MASR-8, MASR-3, MASR-6, MASR-8, MASR-13, MASR-15, MASR-17, MASR-23, Sarsabz, T.J-83 and Khirman. Non- significant differences were observed among other mutants and check varieties in case of biological yield. Harvest index of the test genotypes ranged from 19.3 to 44.0 %. MASR-9 gave highest harvest index (44.0 %), followed by check Kiran-95, MASR-11 and Sarsabz (40.0, 39.7, and 38.2 %, respectively) (Table-1). Mutant lines also showed variation in plant height; ranged from 79.3 to 115.3 cm (Table-2). Millado *et al.* (1972) studied the effect of different doses of gamma radiations on wheat plant height, number of tillers $plant^{-1}$ and 1000-grain weight and concluded that in general 10 KR and 15 KR doses could cause increase in the mean value of each traits studied.

Table1. Mean performance of mutant lines and check for different yield and yield associated traits

Genotypes/ Mutants	Days to heading	Days to maturity	Grain filling period (days)	1000-grain weight (g)	Grain yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest index (%)
MASR-3	71e	123.3i	52.3f	45.2b	4629de	13767ab	33.6efg
MASR-6	77c	130.3efg	53.3ef	43.2c	5380a	14217ab	37.8bc
MASR-8	74d	129fgh	55.0e	39.9fg	4447e	15217ab	29.2h
MASR-9	64.6f	128.3gh	63.6a	47.7a	4112f	9333c	44.0a
MASR-11	70.3e	128h	57.6d	43.6c	5207ab	13100b	39.7b
MASR-13	73d	132de	59.0cd	40.7ef	5181ab	14767ab	35.0de
MASR-14	74d	134.3bc	60.3bc	45.7b	5193ab	15600ab	33.3efg
MASR-15	74d	132.7cd	58.7cd	42.9c	4935bcd	14550ab	33.9ef
MASR-17	74d	135.3b	61.3b	39.8fg	4457e	14050ab	31.7g
MASR-22	74d	134.3bc	60.3bc	39.6g	5265ab	16333a	32.2fg
MASR-23	76c	137.3a	61.3b	34.7i	4480e	13833ab	32.3fg
MASAR-64	70e	122i	52.0fg	45b	5420a	14667ab	36.9cd
Sarsabz	73.3d	133 cd	59.6bc	41.8d	5395a	14100ab	38.2bc
Kiran-95	81.6b	131def	49.3h	41.2de	5402a	13500b	40.0b
TJ-83	82.3b	132.7cd	50.3gh	35.7h	5007bc	14333ab	34.9de
Khirman	93a	134.7bc	41.7i	31.7j	3035g	15667ab	19.3i
LSD at (0.05)	1.224	1.988	1.8493	0.913	182.0	1.327	2.1712

Spike length ranged from 11.6 to 14.8 cm. Check variety Khirman had higher spike length (14.8cm), followed by MASR-6 (14.3cm). Mutant line MASR-9 had smaller spikes. MASR-6 possess more number of spikelet $spike^{-1}$ (25.1), followed by check variety Khirman (23.9) and MASR-8 (22.6). Highest number of grains $spike^{-1}$ was recorded in MASR-64 (79.9), MASR-6 (71.8) and MASR-8 (68.0). Higher grain yield (5420 and 5380 kg ha^{-1}) produced by mutant MASR-64 and MASR-6 respectively could be attributed to their more number of grains $spike^{-1}$and higher main spike yield. Morad *et al*. (2011) studied the effect of mutation on yield and yield components of four wheat cultivars and concluded that gamma radiation induced greater variability and improvements in different traits such as spike length, spikelet $spike^{-1}$, grains $spike^{-1}$, 1000-grain weight. Similarly this study reports some improvements in various traits of mutant lines. Mutant lines also showed improvements in spike length, spiklet $spike^{-1}$, grains $spike^{-1}$, 1000-grain weight. Great variations in main spike yield and other traits were observed in mutant genotypes. Main spike yield ranged from 1.9 to 4.1g. MASR-64 produced highest main spike yield (4.15g), followed by MASR-3 and MASR-6 (Table-2). Singh and Balyan (2009) induced mutation breeding in bread wheat (*Triticum aestivum* L) cv. Kharchia-65 and reported selection of positive mutant for different traits such as reduced plant height, improve grain quality, etc.

Table 2. Mean performance of mutant lines and check for different yield and yield associated traits

Genotypes/ Mutants	Plant height (cm)	Spike length (cm)	Spikelets spike^{-1}	Grains spike^{-1}	Main spike yield (g)
MASR-3	101.7gh	13.9bcd	19.8def	62.0cde	2.9b
MASR-6	109.3b	14.3ab	25.1a	71.8b	2.89b
MASR-8	106.7cde	13.9abc	22.6bc	68.0bc	2.85bc
MASR-9	79.3i	11.6e	17.2h	52.0f	2.33bcd
MASR-11	106.3de	12.3de	19.7def	57.8ef	2.50bcd
MASR-13	103.3fg	12.7cde	18.8efg	55.6ef	2.37bcd
MASR-14	115.3a	12.6cde	18.6fgh	57.3ef	2.52bcd
MASR-15	108bcd	12.7cde	19.1efg	62.2cde	2.65bcd
MASR-17	100h	13.7abc	20.4def	63.8bcd	2.63bcd
MASR-22	109bc	12.8cde	18.3gh	56.3ef	2.42bcd
MASR-23	103.7fg	12.2bcd	19.9def	59.2cde	2.25de
MASR-64	103.3fg	12.5cde	21.4cd	79.9a	4.15a
Sarsabz	105.3	13.8abc	21.cde	59.2cde	2.28cde
Kiran-95	103fg	13.0cd	18.8efg	63.5bcd	2.68bcd
T.J-83	102gh	13.6abc	20.6cde	66.87bcd	2.37bcd
Khirman	114.3a	14.8a	23.9ab	58.87def	1.96e
LSD at (0.05)	2.329	1.143	1.921	7.785	0.5058

CONCLUSION

Genetic variability is very essential for the success of any breeding programs. Genotypes possessing desirable traits are selected from variable populations. Wide variation among tested mutant lines was observed for different parameters. Two mutant MASR-3 and MASR-64 showed positive mutation and matured earlier than other entries. Positive changes in grains spike^{-1} and main spike yield were also observed. Mutant lines, MASR-64, MASR-6 and MASR-8 produced more grains spike^{-1} and main spike yield than parents and contesting check varieties. This study showed positive effects in the use of mutation in inducing improvement for some desirable traits.

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