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Research Article

Developing Wheat and Barley Local Landraces Resistant to Lodging with Shorten Stature and Lengthy Spike Using Nuclear Techniques in Lebanon

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ABSTRACT

A mutation experiment was conducted at the Lebanese Agricultural Research Institute (LARI), Lebanon, Tel Amara station in 2014 on two wheat genotypes (Seri 82 and Breiji) and one barley genotype (Assi), using different gamma radiation doses of 150, 200, 250 and 300 Gamma rays (Gy) in order to develop Wheat and Barley local landraces that are resistant to lodging with shorten stature and lengthy spike using nuclear techniques. Several traits were studied over 4 years which started from 2011 on four Mutated (M) generations which are M1, M2, M3 and M4 populations in comparison to non-treated ones. The selected spikes of Barley (Assi) treated with M4 generation with 150 and 200 Gy were characterized by, shorten stature with an average plant height respectively of 60 cm and 63 cm compared to 67 cm for non-treated ones, lengthy spike (6 cm for 0 Gy compared to 6.5 cm for 150 Gy and 200 Gy) and resistance to lodging (20% for 0 Gy to 15% for 150 Gy and 200 Gy). Selected spikes of Bread wheat (Seri 82) (250 and 300 Gy) treated with M4 lines showed a shorten stature compared to the mother plants with an average plant height respectively of 44 and 43cm compared to 65cm for non-treated variety. The spike length for parent obtained was 8.6 cm, mutant lines recorded as 9.6 cm. Selected spikes of Breiji (Durum wheat) lines (250 and 300 Gy) were recorded as 65 cm and 68 cm while parents 75 cm. An increase of spike length was observed in mutant lines compared to parents (11 cm for parent and 11.3 cm and 11.6 cm respectively for mutant lines). Those mutant lines showed more lodging tolerance compared to parent plants (25% for mutant lines and 40% for parent popular genotype Seri 82, Breiji and Assi).

Keywords: Mutation induction; Gamma radiation; Wheat; Barley; Lodging; Spike length; Plant height

INTRODUCTION

Wheat is one of the most important cereal crops in the world, grown both in arid and semiarid regions [1]. Current estimates indicate that 25% of the world's agricultural land is now affected by drought stress. Selection for drought tolerance typically involves evaluating genotypes for either Hypocotyl (HY) potential or stable performance under varying degrees of water stress [2].

Wheat and barley crops are susceptible to lodging, the bending over of the stems near the ground level. The incidence of lodging has been greatly reduced by the introduction of the short, stiff-straw cultivars of the Green Revolution in the 1960's and 1970's. Nevertheless, lodging is still a problem particularly with high inputs of nitrogen fertilizer and water. Lodging is not desirable due to uneven maturity of the crop, increased moisture content of the grain, decreased grain quality due to grain shriveling as measured by test weight and increased harvesting costs. Plant growth regulators have been used to control lodging in wheat and barley and herbicides, fungicides and various cultural practices and environmental conditions also have an effect on lodging [3].

Realizing the potential role of induced mutations for improvement

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of crop plants, the Lebanese Agricultural Research Institute (LARI) in Lebanon with assistance of International Atomic Energy Agency (IAEA) started a mutation research activity in 2011. This was conducted at the Lebanese Agricultural Research institute (LARI), Tel Amara station on two wheat genotypes (Seri 82 and Breiji) and on one barley genotype (Assi), treating with different gamma radiation doses of 150, 200, 250 and 300 Gy. The main objective is to confer specific changes such as improvement of plant structure, increase of length spike, reduction of plant height, resistance against diseases and lodging and improved physiological characters (drought tolerance, uniform maturity), in the native well adapted crop varieties as well improved varieties to make them more productive.

MATERIALS AND METHODS

Two varieties of wheat (Seri 82 and Breiji) and one variety of barley (Assi) were selected for the radiation study. These were collected to be mutated with gamma rays in order to develop promising mutant lines with improved physiological characters. The characteristics of these genotypes were shown respectively [4].

- **Seri 82:** It is characterized by high yielding variety widely grown till 1996 when collapsed due to yellow rust.
- **Breiji:** It is a local land race that was known for more than sixty years ago used and mostly liked for good quality bread locally-homemade. It is still grown for its high quality bread in the different areas of the country, in the valley as well as in the small fields of the hilly sites in the Bekaa, South and the mountainous areas where farmers produce it mainly for home use. However, it was noticed from phenotypic characterization that Breiji was showing lodging up to 50% under telomeric conditions. Breiji expressed also infestation of yellow rust.
- **Assi:** Hexaploid barley characterized by its early maturity and resistance to drought. It was released on 1997. It is resistant to rust and can be cultivated in the dry regions like central and north Bekaa.

Mutation induction with gamma rays was done for the above mentioned genotypes (Seri 82, Breiji) at three rates-0, 250 and 300 Grays using sensitivity test. Assi is treated differently respecting a sensitivity test done earlier with 0, 150, 200 Grays at the Syrian commission for atomic energy and planted at LARI/ Tal Amara station in 2011. A mutation breeding protocol was followed as following [5-7].

In 2011, 3500 seeds of each Seri 82 and Breiji were irradiated with 250 and 300 Gy of Gamma rays, Assi was treated differently with 150 and 200 Gy of Gamma rays, due to the recommendation of the results of sensitivity test. The treated seeds were planted at LARI, Tal Amara. Germination percentage, survival rate and flowering time have been recorded for each treatment and compared to the untreated. All survive plants were harvested separately, threshed and planted as plant to row progenies to develop M2.

In 2012, the M2 mutant variants were planted in the field of LARI, Tal Amara. Evaluation and selection was done within M2 population, 76 plants based on shorter stature, lengthy spikes and better resistance to lodging were selected to develop M3 population.

In 2013, the M3 plants were planted as plant to row progenies, continuing evaluation resulted in selecting 16 mutant variants which showed a shorter stature, lengthy spikes and better resistance to lodging to raise M4.

In 2014, the 16 line of M4 population were sown in the field for evaluation for the selected trait. Out of 16 variants, 8 mutant variants M5 stage were selected based on better resistance to yellow rust and increased yield compared with the original variety. The selected mutant variants were included in a yield trial to study their performance and stability for selected characters in a hot spot for yellow rust screening to select the best.

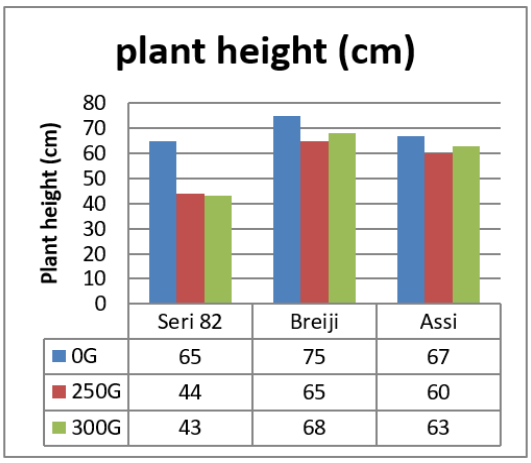
Selected fields were fallows shallow plowings were done. Planting was done with seeder on 6 rows of 1.2 m length 20 cm distance, 1.5 M2 each plot with two replications. Several attributes were studied before harvesting (Days to heading; Days to maturity; Plant height; Spike length; Agronomic score; Lodging; Germination rate) and after the harvesting (Grain yield and 1000 Kernel weight).

RESULTS AND DISCUSSION

After successive selections of mutant populations for M2, M3 and M4 during the years 2012, 2013 and 2014 respectively based on the shorten stature, lengthy spikes and better lodging resistance, 18 spikes of different varieties were collected. Data regarding different plant characters of the three mutated genotypes are presented as follow:

Plant height

The selected spikes of the treated M4 wheat (Seri 82 and Breiji) and Barley (Assi) varieties showed a shorten stature compared to the non-treated varieties (Figure 1). The plant height for Seri 82 decrease from 65 cm to 43 cm with the increase of the radiation dose from 0 to 300 Gy respectively (Figure 2). The same decrease is also noticed within the varieties Breiji 75 cm for 0 Gy to 65 cm for 250 Gy and Assi 67 cm for 0 Gy to 60 cm for 150 Gy. Borzoueiet et al., in 2010 and Jamali et al., in 2008, noticed that wheat plants with a shorten stature will reduce the riskiness of lodging within rain fed or under supplemental irrigation conditions and will help to improve the productivity [8,9].



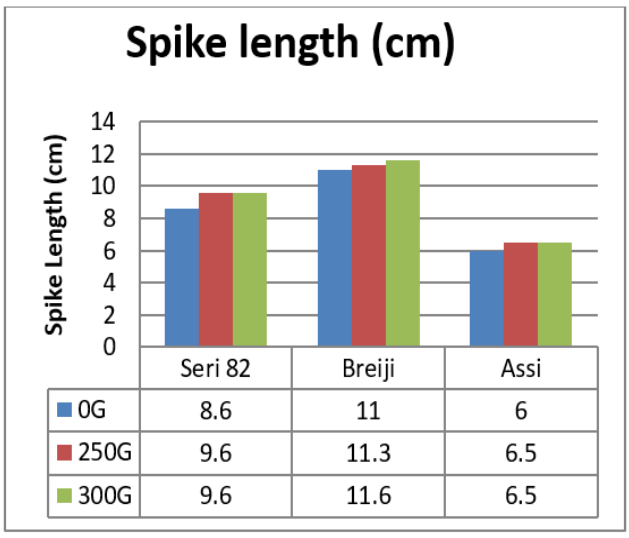
	Seri 82	Breiji	Assi
0G	65	75	67
250G	44	65	60
300G	43	68	63

Figure 1: Plant height for the M4 populations of the two wheat genotypes (Seri 82 and Breiji) and the barley genotype (Assi) with respect of the radiation dose.

Figure 2: The increase of spike length with the increase of radiation dose is easily observed in all varieties. **Note:** a) Assi; b) Breiji and c) Seri 82.

Spike length

An increase of spike length was observed for treated M4 wheat and barley populations in comparison with the non-treated ones (Figure 3). The spike length for Seri 82 increases from 8.6 cm for 0 Gy to 9.6 cm for 300 Gy (Figure 3). The same increase is also noticed within the varieties Breiji (11 cm for 0 Gy to 11.6 cm for 300 Gy) and Assi (6 cm for 0 Gy to 6.5 cm for 200 Gy). Although, several publications underline a significance positive correlation between spike length and grain yield. Khan et al., noticed that spike length is in significance negative correlation with grain yield [10].

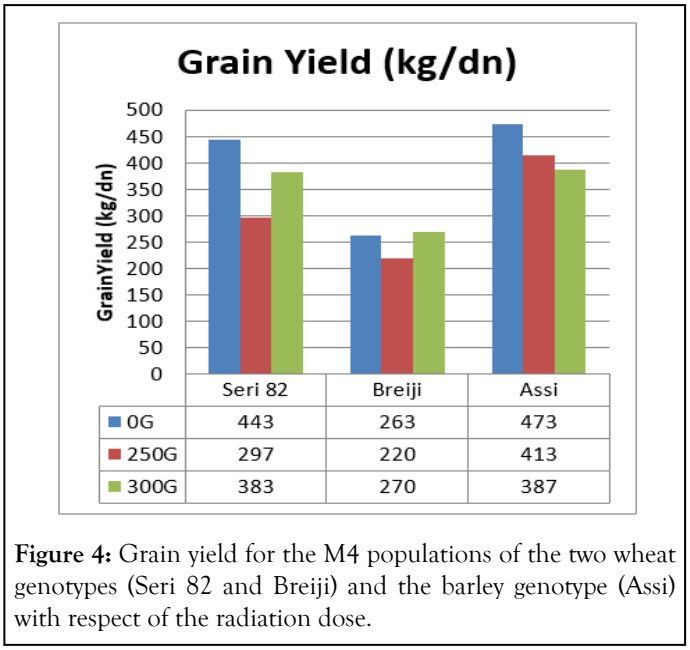


	Seri 82	Breiji	Assi
0G	8.6	11	6
250G	9.6	11.3	6.5
300G	9.6	11.6	6.5

Figure 3: Spike length for the M4 populations of the two wheat genotypes (Seri 82 and Breiji) and the barley genotype (Assi) with respect of the radiation dose.

Grain yield

For grain yield, the mutant varieties did not show a consistent increase (Figure 4). This is maybe due to weather conditions in this year. This trait should be studied furthermore in the future. The increase of spike length and the decrease of the plant height have not been translated into an obvious increase in the productivity of these mutant varieties [10].

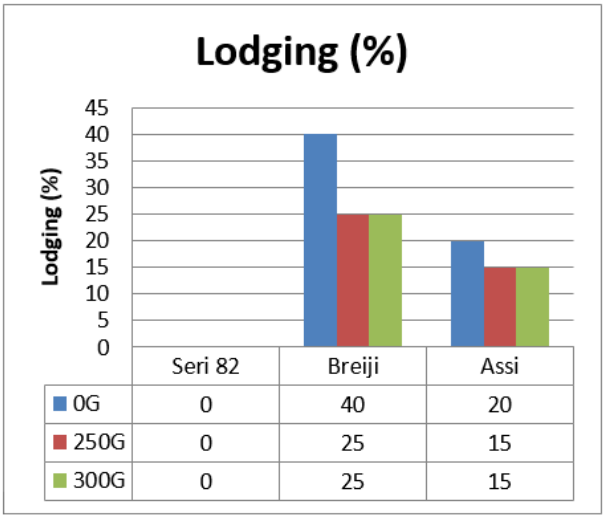


	Seri 82	Breiji	Assi
0G	443	263	473
250G	297	220	413
300G	383	270	387

Figure 4: Grain yield for the M4 populations of the two wheat genotypes (Seri 82 and Breiji) and the barley genotype (Assi) with respect of the radiation dose.

Lodging

A decrease in the lodging percentage was noticed in the treated M4 populations of Breiji (40% for 0 Gy to 25% for 300 Gy) and of Assi (20% for 0 Gy to 15% for 200 Gy). However, Seri 82 did not show any sign of lodging within the treated or the non-treated populations (Figure 5).



	Seri 82	Breiji	Assi
0G	0	40	20
250G	0	25	15
300G	0	25	15

Figure 5: Lodging percentages for the M4 populations of the two wheat genotypes (Seri 82 and Breiji) and the barley genotype (Assi) with respect of the radiation dose.

For the days to heading, days to maturity traits and 1000 kernel weight, the treated plants did not show a considerable difference between the stages.

CONCLUSION

It is well known that the performance of genotypes relative to each other can vary according to the environment, so that genotypes which are superior in one environment, may not be correspondingly superior elsewhere. The so-called green revolution

based on the introduction of improved varieties with high yield potential, together with technological packages (fertilizers, pesticides, etc.) is not sustainable due to the high cost entailed and the negative impact on natural resources. Therefore, local germplasm often preferred to improved varieties because of its greater tolerance to severe biotic and abiotic stresses.

The results of this study showed that the two genotypes Breiji and Assi responded well to the treatment by Gamma radiation by reducing their plant height which will be translated in improving lodging resistance. In the future, an additional study concerning further selection from M5 populations related to the studied traits in addition to the resistance to yellow rust and under supplemental irrigation might be useful in order to monitor the overall performance of treated genotypes.

CONFLICT OF INTERESTS

Author declares no conflict of interests.

REFERENCES

1. Tunio SD, Korejo MN, Jarwar AD, Waggan MR. Studies on Indigenous and Exotic Weed Competition in Wheat. 2006.
2. Riaz R, Chowdhry MA. Estimation of variation and heritability of some physio-morphic traits of wheat under drought condition. Asian J Plant Sci. 2003.
3. Ottman M. Lodging Control for Wheat and Barley in Arizona. 2011.
4. Khairallah S, Breidi J. Wheat Genetic Resources in Lebanon Country. 2010.
5. Acquaah G. Principles of Plant Genetics and Breeding. John Wiley and Sons. 2009.
6. Awan MA. Mutation breeding for crop improvement: A review. Proc Pak Acad Sci. 1999.
7. Konzak CF. Mutations and mutation breeding. Wheat and wheat improvement. 1987;13:428-443.
8. Borzouei A, Kafi M, Khazaei H, Naseriyan B, Majdabadi A. Effects of gamma radiation on germination and physiological aspects of wheat (*Triticum aestivum L.*) seedlings. Pak J Bot. 2010;42(4):2281-2290.
9. Jamali KD, Ali SA. Yield and yield components with relation to plant height in semi-dwarf wheat. Pak. J. Bot. 2008;40(4):1805-1808.
10. Khan AJ, Azam F, Ali A. Relationship of morphological traits and grain yield in recombinant inbred wheat lines grown under drought conditions. Pak J Bot. 2010;42(1):259-267.