1st International & 28th National Conference on Nuclear Science & Technology 2022 (ICNST22)
Nuclear Science & Technology Research Institute

Investigation of bread wheat mutants under salinity stress conditions

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Abstract

Salinity is one of the major limitations in bread wheat production worldwide. Mutation breeding using gamma rays can be used to increase tolerance to salt stress. The current study was done to evaluate 15 bread wheat mutants under salinity stress conditions during the growing season of 2017-08 (M5 generation), 2018-19 (M6 generation), and 2019-20 (M7 generation). The results showed that wheat mutants had various reactions to salinity stress. Compared to control wheat cultivars (Arg, Bam, and Narin) M14 and M15 showed the highest grain yield and 1000-grain weight. Hence, these mutants can be considered as a promising salt-tolerant wheat mutant and can be used to release new salt-tolerant wheat cultivars.

Keywords: Cluster analysis, Gamma irradiation, Mutation breeding

Introduction

Bread wheat (*Triticum aestivum* L.) is the most important crop on the world which provides up to 47% of human daily energy [1]. There are several limitations to wheat cultivation, including salinity stress. About 23% of agricultural lands are considered as saline lands [2]. Salinity in soil or water is one of the important stresses in arid and semi-arid regions that limits crop production. About 77 million hectares of total arable land in the world are affected by salinity stress [3]. Modern plant breeding is based on the diversity, selection, evaluation and reproduction of desirable genotypes. The basis of breeding work is to have maximum genetic diversity, so nuclear radiation plays an important role in plant breeding by increasing genetic diversity. The aim of the present experiment was to investigate the resistance of salinity-tolerant wheat mutants under salinity stress and also to compare them with commerical wheat cultivars suitable for cultivation in saline soil.

Experimental

Preparation of the materials

In order to evaluate wheat mutants under salinity stress, this experiments were performed in randomized complete block design with three replications. For this experiment, 15 wheat mutants and three control cultivars (Arg: control 1, Bam: control 2 and Narin: control 3) were used as control cultivars. To produce these mutants, mutations were done using gamma rays at doses of 150 and 200 Gy in two wheat cultivars seeds, Bam and Arg in gamma cell of agriculture research school of Nuclear Science and Technology Research Institute of Iran. Irradiated seeds were then planted for five consecutive generations and in each generation, the better mutants were selected for planting in the next generation. To investigate wheat mutants under salinity stress, they were cultivated in Milshbar Ardakan salinity research station (soil EC = 10 $dS.m^{-1}$, irrigation water EC = 6.1 $dS.m^{-1}$) during the cropping years of 2017-18 (M5 generation), 2018-19 (M6 generation), and (2019-20 (M7 generation). Bartlett test was done to evaluate homegenity of variances among years and then mixed analysis of variance was done in SAS (9.4) environment.

Results and discussion

The effect of genotype on plant height, spike length, 1000-seed weight, grain yield, biomass and harvest index was significant (p-value <0.01). The highest and the lowest plant heights were observed in M15 and M10 mutants, respectively. Comparing the mutants with the control cultivars, it was found that the highest decrease in plant height was recorded in M10 mutant (Figure 1). Comparison of spike lengths of the mutants with the control cultivars showed that the spike length increased in all mutants except M8 and M11. The greatest percentage of increase in spike length was recorded in M15 mutant (Figure 1). The highest increase in 1000-seed weight (14%) was recorded in M14 (32.6 g) and M15 (34.3 g) mutants (Figure 1), while the 1000-seed weight of M8 and M11 mutants compared to control cultivars was Showed a decrease of 4 and 2%, respectively (Figure 1). The highest grain yield during three years of experiment was observed in M14 (320

g.m^{-2}) and M15 (324 g.m^{-2}) mutants and the lowest grain yield was recorded jointly in M8 and control 3 by 5% reduction compared to controls. The biomass of all mutants were higher than control cultivars except M8 (Figure 1). The highest percentage increase in harvest index compared to the average of control cultivars was recorded in M15 mutant (18%).

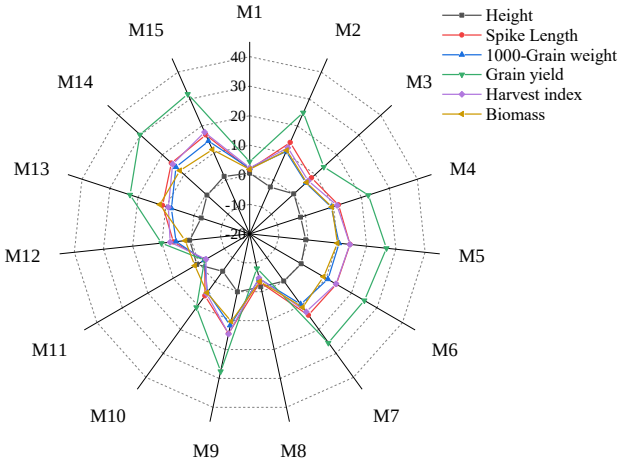

Figure 1. Change (%) of plant height, spike length, 1000-seed weight, grain yield, harvest index and biomass of wheat mutants compared to the average of three control (mean data of three cropping seasons).

The results of clustering of mutants and control cultivars using all the studied traits under salinity stress showed that the studied genotypes can be divided into four groups that are more similar to each other (Figure 2). Accordingly, M1, M11, M12, control 1 and 2 were in the first group (average grain yield 255.4 g.m^2), M3 and M10 arweree in the second group (average grain yield 176.5 g.m^2), M8 and Control 3 were in the third group (mean grain yield 228.7 g.m^2) and other mutants were in were in the fourth group (mean grain yield 311.1 g.m^2).

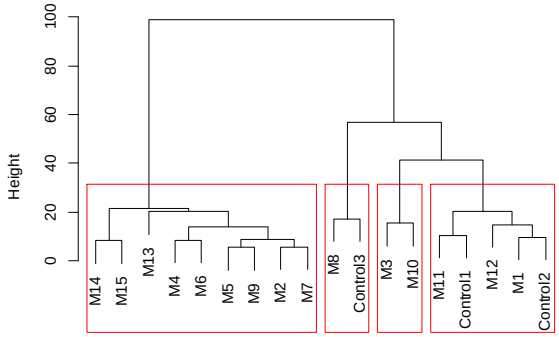

Figure 2. Clustering of studied wheat genotypes in salinity stress condition based on all studied traits.

There are different studies in which the effect of salt stress on wheat genotypes was evaluated. Almost all studies have reported that salt stress decrease wheat grain yield and its components [4]. Rascio et al., [5] evaluated wheat mutants (created by gamma irradiation) under salinity stress conditions. They reported that wheat mutants had a better performance under salinity conditions, compared to their maternal cultivars. It has been reported that those wheat mutants who had a greater grain weight, biomass, and photosynthesis rate, had a lower Na and a higher K absorption under salinity stress condition [6].

Conclusions

Finally, the results indicated that M14 and M15 were the most salt-tolerance mutants, they had the highest 1000-grain weight and grain yield under salt stress conditions and they can be selected for the future studies under salinity conditions and have the potential to introduce as new salt-tolerance cultivars.

Acknowledgments

We appreciate collaboration and financial support of Nuclear Science and Technology Research Institute of Iran and Seed and Plant Improvement Research Department, Yazd Agricultural and Natural Research and Education Center, AREEO in conducting this research.

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