GMR

Genetic Advances and Heritability for Different Seedling Traits of Wheat and Maize under Heavy Metal and Salt Stress

K. Afzal, M.S. Rashid, Q. Ali* and A. Malik

Institute of Molecular Biology and Biotechnology, The University of Lahore, Lahore, Pakistan

Corresponding author: Q. Ali
E-mail: saim1692@gamil.com
Genet. Mol. Res. 19 (3): gmr16039983
Received: July 17, 2020
Accepted: July 24, 2020
Published: July 31, 2020

ABSTRACT. Maize (*Zea mays*) and wheat (*Triticum aestivum*) both are an important cereal crop plants. Both are grown as food and feed for human and livestock. Wheat and maize are highly sensitive to heat, drought, salinity and heavy metal toxicity. For evaluation of genotypes of maize and wheat under heavy metal and salt stress, an experimented was conducted in the greenhouse of Institute of Molecular Biology and Biotechnology, The University of Lahore. The treatments of salt and heavy metal for wheat and maize were kept as following: T1: control (normal irrigation condition) T2: 0.5 mM $ZnSO_4$ T3: 1 mM $ZnSO_4$ T4: 0.5 mM NaCl T5: 1 mM NaCl and T6: 20 ml Biogas. It was observed from results that the performance of wheat and maize genotypes were highly variable under heavy metal and salt treatment. The treatments 1 mM $ZnSO_4$ and 0.5 mM NaCl were found as the higher toxic treatments for wheat and maize which were predicted as they may cause to decrease the photosynthetic rate, productivity and growth of plants. It was found from results that maize hybrid 30Y87 performed better under most of the stress treatments as compared with wheat variety Ujala-2016 while the higher genetic advance and heritability were reported for wheat variety which revealed that the wheat variety may be used to grow under salt and heavy metal stress conditions.

Keywords: Wheat; Maize; NaCl, $ZnSO_4$; Root Length; Shoot Length

INTRODUCTION

Human and animal use maize (*Zea mays*) as an important grain and fodder crops respectively. Both are grown in different parts of the world under different climatic conditions. Maize grain has high food value and we use corn oil for catering purpose whereas its green feedstuff has a high percentage of protein (Dowswell et al., 1996). In Pakistan due to the growing status of maize, people have given considerable attention to bring improvement in its agricultural characteristics (Munns et al., 2006; Zubair et al., 2016). However, we have to do extensive work to identify maize genotypes for salt affected soils. Wheat (*Triticum aestivum*) is the chief human eatable grain food in most parts of the world as well as in Pakistan. It is used in making cakes, pieces of bread, biscuits, and different other products. Wheat grain provides 53 to 59 percent different types of regular calories as well as proteins in daily consumption for humans. When maize and wheat are grown under salt stress conditions there is a significant decrease in the grain yield and crop productivity (Ouda et al., 2008). Wheat is a reasonably salt-tolerant crop and its yield is significantly reduced as the soil salinity level increases to 100 mM NaCl (Munns et al., 2006). Metallic ions are important part of enzymes and coenzymes in plant as well as animal cell, however the excess of metallic ions is dangerous for both animal and plant cells. Earth's layer is naturally covered by diverse type of heavy metals. Higher concentrations heavy metals in water and food can cause harmful effects in living organisms (Rydzewska, 2001; Topolska et al., 2004; Donderski & Brzezinska, 2005; Tkaczuk, 2005; Nasiadek et al., 2005).

MATERIALS AND METHODS

For evaluating wheat and maize for salt stress as well as heavy metal stress we have conducted an experiment in the greenhouse of IMBB, The University of Lahore. The seeds of selected genotypes of wheat and maize were sown in 12 pots, 6 pots for each crop. The treatments of salt and heavy metal for wheat and maize were kept as following: T1: control (normal irrigation condition) T2: 0.5 mM $ZnSO_4$ T3: 1 mM $ZnSO_4$ T4: 0.5 mM NaCl T5: 1mM NaCl and T6: 20 ml Biogas. Treatment of each stress was given after 7 days of germination of wheat and maize seedlings. Treatments were applied 4 times and data was recorded for each treatment. The seedling data was recorded for these traits included leaf length, leaf width, root length, number of roots and shoot length. The recorded data was analyzed statistically through analysis of variance (ANOVA) techniques through using the SPSS23.1 software.

RESULTS AND DISCUSSION

Different treatments were applied on wheat (Ujala-2016) and maize (30Y87) genotypes that showed different affects in their morphological traits. The results showed that the coefficient of variance was found lower for all studied traits which revealed the consistency of results for all traits in wheat and maize. The results from root length indicated that treatment 5 and 1 showed higher toxic effects that may became the cause of decrease in photosynthetic rate and growth and development of plant will also be decreased (Asif et al., 2020; Iqra et al., 2020 ab). Genetic advance (12.45%, 15.53%) and heritability (87.32%, 89.43%) for maize and wheat respectively were found higher for root length (Table 1). It was found that Ujala-2016 (wheat genotype) performed better under all stress treatments for seedling leaf length as compared to 30Y87 (maize genotype). The results from leaf length indicated that treatment 4 and 5 showed higher toxic effects for leaf length. Genetic advance (14.22%, 17.35%) and heritability (76.87%, 86.54%) for maize and wheat respectively were found higher for leaf length. It was found that 30Y87 (maize genotype) performed better under all stress treatments for seedling shoot length as compared to Ujala-2016 (wheat genotype). Genetic advance (13.23%, 18.24%) and heritability (89.32%, 93.23%) for maize and wheat respectively were found higher for shoot length. The results from no. of roots indicated that treatment 5 and 0 showed higher toxic effects on shoot length. It was found that 30Y87 (maize genotype) performed better under all stress treatments for seedling number of roots as compared to Ujala-2016 (wheat genotype). Genetic advance (16.43%, 15.34%) and heritability (88.54%, 92.54%) for maize and wheat respectively were found higher for number of roots. The results from leaf width indicated that treatment 4 and 5 showed higher toxic effects on leaf width of both maize and wheat. It was found that 30Y87 (maize genotype) performed better under all stress treatments for seedling leaf width as compared to Ujala-2016 (wheat genotype). Genetic advance (19.36%, 16.26%) and heritability (93.14%, 91.40%) for maize and wheat respectively were found higher for leaf width (Masood et al., 2020; Mazhar et al., 2020).

Sources	Root Length	Leaf Length	No. of Roots	Shoot Length	Leaf Width
		Maize			
Coefficient of variation	3.83	1.41	16.51	3.75	6.50
Genetic Advance (%)	12.45	14.22	16.43	13.23	19.36
Heritability (%)	87.32	76.87	88.54	89.32	93.14
		Wheat			
Coefficient of variation	10.12	5.348	9.23	6.37	4.45
Genetic Advance (%)	15.53	17.35	15.34	18.24	16.26
Heritability (%)	89.43	86.54	92.54	93.23	91.40

Table 1. Genetic components for morphological traits of maize and wheat seedlings from analysis of pooled data.

CONCLUSION

It was observed from results that the performance of wheat and maize genotypes was highly variable under heavy metal and salt treatment. The treatments 1 mM $ZnSO_4$ and 0.5 mM NaCl were found as the higher toxic treatments for wheat and maize which may decrease the photosynthetic rate, productivity and development of plants. It was found from results that 30Y87 performed better under most of the stress treatments as compared with Ujala-2016 however the genetic advance and heritability were found higher for wheat genotype as compared with maize. It was concluded that the wheat genotypes may be used to grow under heavy metals and salt stress condition.

REFERENCES

Dowswell RC, Paliwal RL, Ronald-Cantrell L (1996). Maize is the third World Winrock Development-Oriented Literature Series. ISBN 13: 978-0813389639. https://doi.org/10.1201/9780429042171

Munns R (2002). Comparative physiology of salt and water stress. Plant Cell Environ 25: 239-250. https://doi.org/10.1046/j.0016-8025.2001.00808.x

Zubair M, Shakir M, Ali Q, Rani N, Fatima N (2016). Rhizobacteria and phytoremediation of heavy metals. Environ Technol Rev 5: 112-119. http://dx.doi.org/10.1080/21622515.2016.1259358

Ouda SAE, Mohamed SG, Khalil FA (2008). Modeling the effect of different stress conditions on maize productivity using yield-stress model. Int J Nat Eng Sci 2: 57-62.

Topolska K, Sawicka-Kapusta K, Cieslik E (2004). The effect of contamination of the krakow region on heavy metals content in the organs of bank voles (Clethrionomys glareolus, Schreber, 1780). Polish J Environ Stud 13: 103-109.

Donderski W, Brzezinska MS (2005). The influence of heavy metals on the activity of chitinases produced by planktonic, benthic and epiphytic bacteria. Polish J Environ Stud 14: 851-859.

Tkaczuk C (2005). The effect of selected heavy metal ions on the growth and conidial germination of the aphid pathogenic fungus Pandora neoaphidis (Remaudiere et Hennebert) Humber. Polish J Environ Stu 14: 897.

Nasiadek M, Krawczyk T, Sapota A (2005). Tissue levels of cadmium and trace elements in patients with myoma and uterine cancer. Human Exp Toxicol 24: 623-630. https://doi.org/10.1191/0960327105ht575oa

Asif S, Ali Q, Malik A (2020). Evaluation of salt and heavy metal stress for seedling traits in wheat. Biol Clin Sci Res J 2020: 5.

Iqra L, Rashid M, Ali Q, Latif I, Malik A (2020). Genetic variability for salt tolerance in wheat. Biol Clin Sci Res J 2020: 16.

Iqra L, Rashid MS, Ali Q, Latif I, Mailk A (2020). Evaluation for Na^+/K^+ ratio under salt stress condition in wheat. Life Sci J 17: 43-47. https://doi/org/10.7537/marslsj170720.07

Masood M, Ahsan M, Sadaqat HA, Awan F (2020). Screening of maize (*Zea mays L*.) inbred lines under water deficit conditions. Biol Clin Sci Res J 2020: 7. https://doi.org/10.31830/2348-7542.2019.004

Mazhar T, Ali Q, Rashid MS, Mailk A (2020). Effects of salt and drought stress on growth traits of *Zea mays* seedlings. Life Sci J 17: 48-54. https://doi/org/10.7537/marslsj170720.08