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Evaluation of Genetic Variability in Wheat and Maize under Heavy Metal and Drought Stress

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ABSTRACT. There are certain conditions which cause a change in the growth pattern of plants. These circumstances are significantly effective in growth and cultivation of major crops. The effects of higher levels of copper sulphate through fertilizers can be effective in reducing the growth of a healthy plant. An experiment was conducted in the greenhouse of Institute of Molecular Biology and Biotechnology, The University of Lahore. Treatment of heavy metal and drought was given to both maize and wheat plant seedlings. Measurement of root length, shoot length and leaf length were taken in fresh and dried condition were taken after initial growth, 1st and 2nd dose. Data was analyzed in SPSS v. 22. ANOVA was applied to check the significant effects of different condition groups and heavy metal on growth of wheat and maize. Out of both plants, maize showed better results in all conditions, while regarding treatment, 20 ml biogas liquid waste, 80 ml H_2O and 0.5 mM $CuSO_4$ showed better results than 1 mM $CuSO_4$ and 120 ml H_2O treatments. It was found that the higher concentration of $CuSO_4$ and lower H_2O in soil can significantly reduce the growth of wheat and maize. It was concluded that addition of high concentration of $CuSO_4$ and less amount of water to wheat or maize crops will significantly reduce the crop productivity. The higher genetic advance and heritability for root length and shoot length was recorded for maize genotypes as compared by wheat genotype.

Keywords: Wheat; Maize; Copper sulphate; Water; Drought; Biogas; Growth pattern

INTRODUCTION

The variation in soil ‘climate conditions correlated with process affecting soil nitrogen and their relation with ‘plant‘ can ‘lead’ to improvements in the accessibility of nitrogen % need by plant (Freitas et al., 1994). Furthermore, the release of the new cultivars of different crop plants requirements hinders standardized nitrogen fertilization recommendations for wheat and maize crops (Raun and Johnson, 1999). The interest in maximizing wheat yields has encouraged growers to adopt intensive management practices. It should be noted that both an optimized nitrogen management for a less responsive cultivar and a restrictive management may result in crops with little yield potential. High nutrient levels can also harm crops causing both damages to the environment through leaching and nitrate volatilization and economic losses to farmers, because only 33% of all nitrogen fertilizers applied to cereal crops are absorbed in harvested grains (Simili et al., 2008). A positive response and up to 156’$kgha^{-1}$ of N was observed for ‘wheat grown under irrigated zones, with grain yield at 6472’$kgha^{-1}$. The highest yields were generally obtained with fertilization rates of nitrogen ranging about 70 ‘to’ 120 kgha-1 (Espindula et al., 2010).When a heavy metal becomes bioavailable to plant, the entrance of ions of heavy metal into the plant depends on the level of heavy metal, either by the symplast or from the apoplast (Bubb and Lester, 1991). During salt treatment the wheat and maize plants react differently for different morphological traits. High concentration of Sodium (Na^+) can affect the water holding capacity in ‘the’ root zone (Munns, 2002; Zubair et al., 2016). This study was conducted to evaluate the effect of heavy metal ($CuSO_4$) and drought stress on growth pattern of wheat and maize genotype.

MATERIALS AND METHODS

Experiment was conducted in the greenhouse of Institute of Molecular Biology and Biotechnology, The University of Lahore. The seeds of maize and wheat were grown in pots. Treatment of heavy metal, salt and biogas liquid waste water were applied 4 times while after 7days of each treatment data was recorded for root length, shoot length and leaf length. Data was analyzed in SPSS *v*. 22. For analysis of variance and after 2^{nd} dose, under any circumstances, the mean root, shoot and leaf length, number of roots and root dry weight of both type of plants was almost equal. The mean dry root weight was better for maize than wheat (Table 1).

Traits	Wheat	Maize	p-value	Pooled CV%
Root Length (cm)	4.93 ± 0.14	4.28 ± 2.00	0.280	3.820
Shoot length (cm)	3.78 ± 0.14	3.57 ± 2.03	0.726	4.236
Leaf Length (cm)	6.08 ± 0.19	4.86 ± 2.28	0.077	5.347
No. of Roots	4.92 ± 1.31	3.50 ± 2.07	0.057	7.263
Dry root weight (g)	0.05 ± 0.02	0.02 ± 0.02	0.003	3.135

Table 1. Comparison of growth pattern of wheat and maize.

Traits	Wheat	Maize
Root Length (cm)	(12.34) 89.30	(18.27) 91.45
Shoot length (cm)	(17.01) 84.12	(13.24) 93.33
Leaf Length (cm)	(11.27) 86.54	(11.05) 95.39
No. of Roots	(10.89) 82.58	(15.21) 92.54
Dry root weight (g)	(18.54) 83.76	(16.36) 89.54

Table 2. Comparison of genetic advance (in parenthesis) and heritability of wheat and maize.

RESULTS AND DISCUSSION

The results from Table 1 indicated that the coefficient of variance was reported as lower for all traits of wheat and maize, which indicated that there was consistency among the results and reliable inferences may be drawn from results. The genetic advance (Table 2) for root length was reported higher for maize (18.27%) while lower 13.24% for shoot length as compared with root length of wheat (12.34%) and 17.01% for shoot length of wheat. The higher genetic advance of dry root weight was reported for wheat (18.54%) while for maize (16.36%) genetic advance was recorded for dry root weight. The heritability for all studied traits was found higher for maize under heavy metal and salt stress conditions. With current climate change, drought and higher temperature are expected to make 40% of the existing maize growing region in the world inadequate for today's varieties (Iqra et al., 2020ab; Masood et al., 2020). If effective adaptation action is taken, it is estimated that these changes will reduce maize and some other food crop yields by 10-20%, resulting in a definite decrease in human health. Wheat'(*Triticum aestivum L.*) is grown worldwide where it is most widely produced cereal & staple food crop. Wheat is slightly salt tolerant, with such a threshold value of 7 dS. It has large adaptations to changes in the environment, and therefore its range of cultivation is broad (Asif et al., 2020; Shirazi et al., 2005; Mazhar et al., 2020).

CONCLUSION

The addition of high concentration of $CuSO_4$ and lower amount of water to wheat or maize crops will significantly reduce the crop productivity. While lower concertation of $CuSO_4$ can show better output. Additionally, 20 ml biogas liquid waste water has also shown better results in both maize and wheat. From our study it was recommended to use biogas liquid waste water for improving stress tolerance and yield of maize and wheat.

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