Genetic Advances and Heritability Analysis for Seedling Growth Traits in *Zea mays* under Heavy Metal Stress

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Genet. Mol. Res. 19 (3): gmr16039981
Received: July 17, 2020
Accepted: July 24, 2020
Published: July 31, 2020

ABSTRACT. Maize (*Zea mays L.*) is an important cereal crop grown throughout the world for its grain and fodder. Maize is very sensitive to salt, drought, heavy metal and cold stress conditions. An experiment was conducted in the green house of Institute of Molecular Biology and Biotechnology, The University of Lahore. EV-1097Q and B-316 maize genotypes were selected to access the effect of heavy metal stress with different concentrations. Seeds were grown in 42 pots filled with pure 2 kg sand. Different concentrations of heavy metals $ZnSO_4$ includes control, viz., T1 (0.25 mM $ZnSO_4$), T2 (0.5 mM $ZnSO_4$), T3 (0.75 mM $ZnSO_4$), and T4 (1 mM $ZnSO_4$) were applied 4 times with 7days intervals. Data was recorded 4 times after each treatment for root length, shoot length, leaf length, dry plant weight and fresh plant weight. The collected data was pooled and analysed for analysis of variance and significant differences for different treatments and maize genotypes. The results revealed that there were significant differences among maize genotypes for studied traits on all treatments of heavy metals, the genotype EV-1097Q performed batter for all morphological traits as compared with B-316 genotype. The genetics advance and heritability were found higher for genotype EV-1097Q. The results from our study concluded that the EV-1097Q may be used to produce higher grain yielding maize genotypes under heavy metal stress conditions.

Keywords: Maize; Heavy Metals; $ZnSO_4$; Genetic Advance; Heritability; Root Length

INTRODUCTION

Maize (*Zea mays*) is an important cereal cash crop grown throughout the world after wheat and rice for its grain and fodder. Its grain is a rich source of numerous significant nutrients and utilized for multipurpose (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). However, we have to do extensive work to identify maize genotypes for salt affected soils. It was originated in Mexico and was one of the first plants developed by agriculturists 7000-10000 years back. Maize (*Zea mays L.*) is a C_4 plant which has high genetic potential. During 2017 maize production for Pakistan was 5.7 million tonnes. It is short duration crop which can use sunlight more efficiently (Masood et al., 2020; Mazhar et al., 2020). Maize is very stable, profitable, and dependable agricultural crop of Pakistan. The *Zea mays* is a most important among the cereal crop which are used as food, feed and its raw materials are used in various important industrial by-products. Maize has an important and significant position among existing plant cropping systems for Pakistan maize growing areas. Maize is very sensitive to drought, salt, heat and cold stress conditions (Donderski and Brzezinska, 2005; Masood et al., 2020; Zubair et al., 2016). There is need to develop maize genotypes which can grow under abiotic stress conditions.

MATERIALS AND METHODS

The proposed study was conducted to access the impact of $ZnSO_4$ on maize that was grown in pots filled with soil in greenhouse The University of Lahore, Lahore. The seeds are sown in the sand in each pot in triplicate under randomized complete block design. The treatments of heavy metals $ZnSO_4$ includes control, *viz*., T1 (0.25 mM $ZnSO_4$), T2 (0.5 mM $ZnSO_4$), T3 (0.75 mM $ZnSO_4$), and T4 (1 mM $ZnSO_4$) were applied 4 times with 7days intervals. Data was recorded 4 times after each treatment for root length, shoot length, leaf length, dry plant weight and fresh plant weight. The collected data was pooled and analyzed for analysis of variance and significant differences for different treatments and maize genotypes.

RESULTS AND DISCUSSION

The results persuaded that there were significant differences among the maize genotypes for all treatments, the interactions among the treatments were also significant. It was also found that the both of maize genotypes performed differently under heavy metal stress conditions. The higher root length and shoot length was found for genotype EV-1097Q under accumulative effects of all stress treatments. The coefficient of variance was also found lower for all studied traits which revealed consistency among the results and showed the reliability of results that the selection of maize genotypes on the basis of root length and shoot length may be helpful to improve the maize grains yield and productivity under heavy metal stress conditions (Ouda et al., 2008; Asif et al., 2020; Mazhar et al., 2020). It was found from results that the genetic advance for root length (16.34%, 16.13%), leaf length (17.42%, 18.05%), dry plant weight (19.43%, 18.89%), shoot length (19.21%, 16.03%) and fresh plant weight (21.06%, 17.90%) was recorded for EV-1097Q and B-316 respectively. The heritability was frond for root length (89.02%, 91.78%), leaf length (96.07%, 84.14%), dry plant weight (92.03%, 88.14%), shoot length (89.79%, 89.01%) and fresh plant weight (92.47%, 88.21%) was recorded for EV-1097Q and B-316 respectively. The higher genetic advance indicated that the traits were controlled by additive type of gene action and the increase of decrease in trait may be fixed in following generation of crop plant while higher heritability revealed dominance type of gene action which may be helpful to select genotypes of crop plants to develop hybrids. In our current study the genotype EV-1097Q showed higher heritability which revealed that it may be used for the production of hybrids of maize to improve grain and fodder yield even under abiotic stress conditions (Iqra et al., 2020ab; Masood et al., 2020; Topolska et al., 2004).

Sources	Root Length	Leaf Length	Dry plant weight	Shoot Length	Fresh plant weight
		EV-1097Q			
Coefficient of variation	4.13	7.81	11.11	8.15	9.29

Genetic Advance %	16.34	17.42	19.43	19.21	21.06
Heritability %	89.02	96.07	92.03	89.79	92.47
		B-316			
Coefficient of variation	8.01	6.45	7.56	7.09	9.05
Genetic Advance %	16.13	18.05	18.89	16.03	17.90
Heritability %	91.78	84.14	88.14	89.01	88.21

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

CONCLUSION

It was concluded from our study that the EV-1097Q performed batter for all studied traits under accumulative effect of $ZnSO_4$ and also showed higher heritability which revealed that it may be used for the production of hybrids of maize to improve grain and fodder yield even under abiotic stress conditions.

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