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Effects of salt and drought stress on growth traits of *Zea mays* seedlings

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Abstract: The present study was conducted to access the salt (NaCl) and drought effects on maize genotypes. Three maize genotypes *viz*., P1429, L5971 and L6103 were grown in pots filled with pure sand. One concentration of NaCl 0.50mMolar and 50% drought were used to access the effects of NaCl drought on maize genotype. The 10 seeds of each maize genotype were sown in each pot and were let to germinate. After 7 days of germination the seedlings were started to give the treatments of salt and drought for collection of data for different parameters including dry and fresh shoot weights, root and leaf weight, shoot, root and leaf length. The data was collected four times after every 7 days. The data was statistically analyzed for analysis of variation to find out the association of variation among the studied traits. It was found from our study that different level of stress condition like salt (NaCl) and drought varies in these three genotypes or varieties; however it was also found that NaCl effect on the water scarcity for plants was low. A noteworthy increase in the length of roots was observed under drought stress as compared to salt stress where all growth traits performed well under NaCl stress. The combined statistical analysis showed that genotype L6103 performed better under NaCl, control and drought stress conditions. Due to this reason we can use hybrid 6103 genotype to surge the grain yield and fodder of *Zea mays* under drought salt, normal as well as under drought stress conditions.

[Mazhar T, Ali Q, Rashid MS, Mailk A. **Effects of salt and drought stress on growth traits of Zea mays seedlings.** *Life Sci J* 2020;17(7):48-54]. ISSN: 1097-8135 (Print) / ISSN: 2372-613X (Online). http://www.lifesciencesite.com. 8. doi:10.7537/marslsj170720.08.

Keywords: salt, drought, *Zea mays*, root length, shoot length

Introduction

Zea *mays* is often know as corn, it's a major kharif cereal crop which was first cultivated by local people of southern Mexico approximately 10000 years ago (Benz, 2001). In many parts of world maize is known to be as an essential food with higher nutritional values. Corn is being used a source of feed for animals while humans utilize it as a food and also used as a fuel and raw material in industries around the world (Asif et al., 2020; Masood et al., 2020). In Pakistan after rice and wheat and maize is known as third largest growing cereal crop (Jones et al., 1986; Kadioglu and Terzi 2007). The average grain yield of maize in Pakistan is low in contrast to other maize growing areas of the world. Nonetheless, lesser yield of maize in Pakistan is not because of the cultivars response but it appears to be insufficient supply of water, abiotic stresses and due to imbalanced minerals nutrition. The soils of Pakistan are mainly alkaline in chemical, along with calcareous in nature and low organic matter (Khattak 1991; Nazir et al., 2020; Sillanpaa 1982; Rana et al., 2020). In Africa maize distribute at any rate one of the absolute every day calories expended and represents 17% to 60% of individuals all out day protein supply as assessed by FAO sustenance accounting reports (Ali et al., 2020; Diallo 2001). Maize fulfills every day calories of every individual in country and rural poor of eastern and central African people. It is the third most significant cereal on the earth after rice and wheat contributes generously to all oats cereal crops in the world economy as an exchange, sustenance, feed, and mechanical cereal crop (Khalil et al., 2020ab; Pingali, 2001; FOA, 2009). Maize is the world's generally developed grain both for feed and cereal generation and position top in cereal yield per unit zone of land, making it the most beneficial type of nourishment plants (Aldrich et al 1975). Till 2020 the demand of maize crop worldwide is projected to go beyond that of both rice and wheat (Iqra et al., 2020). This would mean an increase in the interest for maize as animals feed (particularly for poultry and pigs). The maize has been used as staple food by South-East Asia and Eastern countries from last many centuries, where interest for growing maize has been anticipated to expand the most (Aldrich et al., 1975).

Material and methods

Maize is a cereal crop which is grown throughout the whole world for its grain and other by products. Maize is very sensitive to abiotic or environment stress conditions involving drought, heat, cold and salt stress as important stress condition.

For this purpose study was plane to conduct in greenhouse of IMBB (Institute of Molecular Biology and Biotechnology), University of Lahore to estimate effects of salt and drought stress on maize seedling growth. For our study we have selected three varieties L6103, P1429 and L5971. Seeds from selected maize genotypes were used to grow in 9 pots, filled with 1.5 kg washed sand. Seed of each variety was sown in triplicate pots with all the ingredients require. To carry out our research we have used following sets for treatment. We use only one concentration of NaCl or salt which (0.5 m Molar NaCl) in other stress condition 50% drought was used while the third condition was used as control or normal water condition on all of three maize genotypes to check how resistant they were under these stress conditions. The treatments were applied after the germination of maize seeds and data was recorded after 7 days of treatment for various seedling traits of maize. The data recorded for two times from two weeks was pooled to carried analysis of variance and all pairwise comparison for maize variety in different stress conditions. Data was collected for various morphological traits including the Fresh plant weight, leave length, shoot length root length, leave weight, shoot weight, root weight, dry leave weight, dry shoot weight, dry root weight, dry plant weight and root shoot ratio. The recorded data was statistically analyzed through the use of analysis variance technique (Steel et al., 1997) by using SPSS23.1 software.

Result and discussion

Fresh Plant weight

The results shown in figure 1 indicate that L6103. Hybrid performed well under drought as well as in NaCl stress as compared to the variety P1429, L5971. The heaviest plant weight of hybrid under NaCl stress was noted as 10.39 g other hybrid treatment followed by the 6.29 in P1429 and 6.79 in L5971 under NaCl treatment, L6103 weight is 29.19g in control and 24.59 g in P1429 control treatment while the lowest plant weight was found in L5971 which is 17.19 g. The heaviest plant weight found in varieties under drought stress noted as 13.99g in L6103 and 12.19g in P1429 and 11.79g in L5971. The lowest plant weight found in three hybrid seed was under the treatment 0.50mM NaCl noted as 6.19g in P1429. Under the drought stress the plant weight of hybrid is low as compared to the NaCl stress. The heaviest plant weight of hybrid under drought stress was noted as 14.29g in L6103. The low plant weight was noted under the treatment 100% drought noted as 11.79g in L5971. The plant weight of variety P1429 was noted 12.29 under the control followed by 100% drought. This shows that hybrid variety L6103 not only performed better under control stress as compare to other varieties P1429 and L5971 but also performed better under the drought stress as compared to P1429 and L5971. Fresh plant weight indicated that the selection of stress tolerance maize genotypes may be helpful for improving grain yield of maize (Ali et al., 2016; Ali et al., 2014; Masood et al., 2020; Danish et al., 2020).

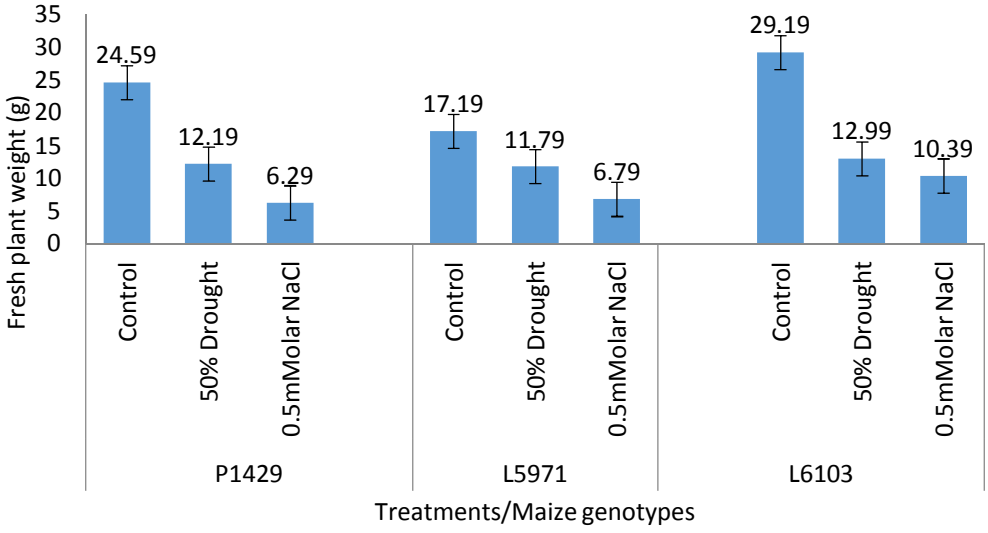

Figure 1. Fresh plant weight under control, salt and drought stress conditions

Leaf length

The results in the figure 2 indicate that hybrid P1429 under drought and control as compare to other hybrid verity L6103, L5971. The longest leaf under control was noted as 18.2 in p1429 and other hybrid followed as 17.4 in L5971 and 15 in L6103 under control treatment. L6103 leaf length under NaCl is 15 and 9.5 in L5971 and the smallest leaf length under NaCl stress is 9 in p 1429. The longest leaf length under drought stress noted as 16.5 in p 1429 and 14.5 in L5971 and 10 in L6103 hybrid verity. The lowest leaf length under treatment of 0.5mM NaCl was noted as 9 in P1429. Under NaCl stress leaf length is small as compare to either stress Control and droughty. The smallest leaf length under drought stress was noted as 10 in L6103. In this we can see that hybrid P1429 performed better in all stress condition as compare to other hybrids. Higher leaf length indicated that the selection of stress tolerance maize genotypes may be helpful for improving grain yield of maize (Ali et al., 2016; Ali et al., 2014; Khan et al., 2020; Iqra et al., 2020).

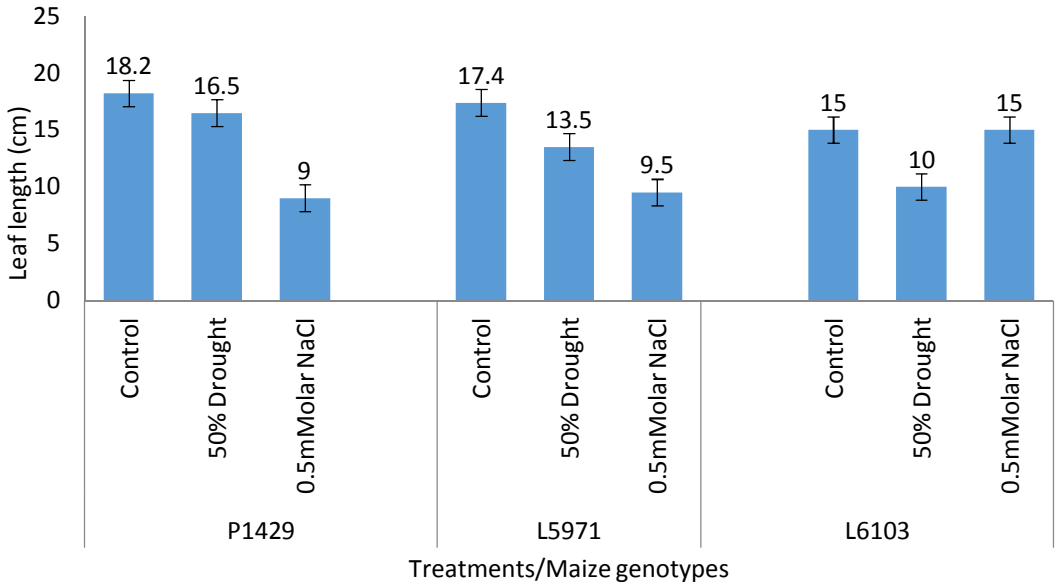

Figure 2. Leaf length under control, salt and drought stress conditions

Dry shoot weight

The results in the figure 3 indicate that hybrid L6103 under NaCl and control perform better as compare to other hybrid verity P1429, L5971. The heaviest dry shoot weight under control stress was noted as 1.3 in L6103 and other hybrid followed as 0.7 in L5971 and 0.5 in P1429 under Control treatment. L6103 dry shoot weight under NaCl is 1 and 0.8 in L5971 and the lowest shoot weight under NaCl stress is 0.6 in P1429. The heaviest shoot weight under drought stress noted as 0.8 in p 1429 and also 0.8 in L6103 and 0.4 in L5971 hybrid verity. The lowest shoot weight under drought stress was noted as 0.4 in L5971. Under drought stress dry shoot weight is small as compare to other stress control and NaCl. The lowest shoot weight under 0.5mM NaCl stress was noted as 0.6 in P1429. In this we can see that hybrid L6103 performed better in all stress condition as compare to other hybrids. Higher dry shoot weight indicated that the selection of stress tolerance maize genotypes may be helpful for improving grain yield of maize (Ali et al., 2016; Ali et al., 2014; Ahmad et al., 2020; Danish et al., 2020).

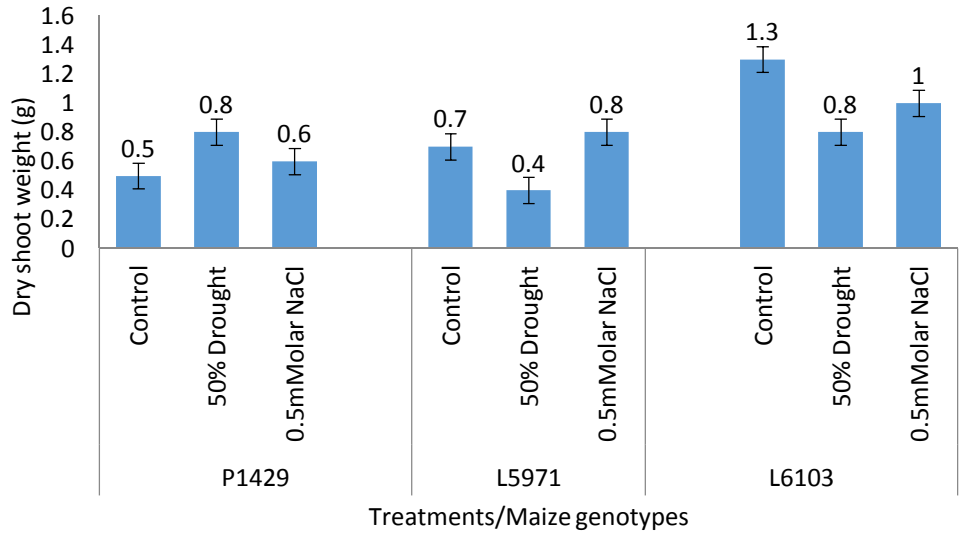

Figure 3. Dry shoot weight under control, salt and drought stress conditions

Dry leaf weight

The results in the figure 4 indicate that hybrid P1429 and L5971 perform better under drought and control as compare to other hybrid verity L6103. The heaviest dry leaf weight under Control stress was noted as 9.33 in P1429 and other hybrid followed as 9.33 in L5971 and 6.13 in L6103 under Control treatment. L6103 leaf length under NaCl is 6.13 and 1.13 in L5971 and the lowest dry leaf weight under NaCl stress is 0.13 in P1429. The heaviest dry leaf weight under drought stress noted as 7.53 in P1429 and 7.53 in L5971 and 1.13 in L6103 hybrid verity. The lowest dry leaf weight under treatment of 0.5mM NaCl was noted as 6.13 in L6103. Under NaCl stress dry leaf weight is small as compare to other stress Control and drought. The lowest dry leaf weight under drought stress was noted as 1.13 in L6103. In this we can see that hybrid P1429 and L5971 performed better in all stress condition as compare to other hybrids. Higher dry leaf weight indicated that the selection of stress tolerance maize genotypes may be helpful for improving grain yield of maize (Ali et al., 2016; Ali et al., 2014; Masood et al., 2020; Nazir et al., 2020).

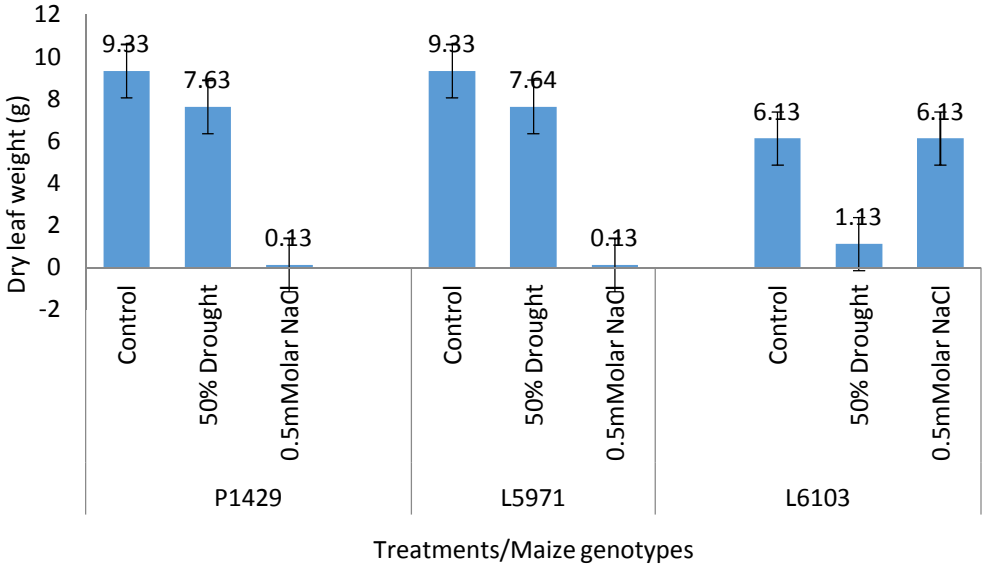

Figure 4. Dry leaf weight under control, salt and drought stress conditions

Dry plant weight

The results shown in figure 5 indicate that L6103 Hybrid performed well under drought as well as in NaCl stress as compared to the variety P1429, L5971. The heaviest dry plant weight of hybrid L6103 under NaCl stress was noted as 7.38 g other hybrid treatment followed by the 3.28 in P1429 and 3.28 in L5971 under NaCl treatment, L6103 weight is 26.18 g in Control and 21.58 g in P1429 control treatment while the lowest plant weight was found in L5971 which is 14.98 g. The heaviest dry plant weight found in varieties under drought stress noted as 10.98 g in L6103 and 10.78g in L5971 and 9.18g in P1429. The lowest dry plant weight found in three hybrid seed was under the treatment 0.50mM NaCl noted as 63.28g in P1429 also 3.28g in L5971. Under the drought stress the dry plant weight of hybrid is low as compared to the NaCl stress. The heaviest plant weight of hybrid under drought stress was noted as 10.98g in L6103. The low plant weight was noted under the treatment 100% drought noted as 9.18g in P1429. The dry plant weight of Variety P1429 was noted 9.18g under the control followed by 100%drought. This shows that hybrid variety L6103 not only performed better under Control stress as compare to other varieties P1429 and L5971 but also performed better under the drought stress as compared to P1429 and L5971. Higher dry plant weight indicated that the selection of stress tolerance maize genotypes may be helpful for improving grain yield of maize (Ali et al., 2016; Ali et al., 2014; Iqra et al., 2020; Masood et al., 2020; Nazir et al., 2020).

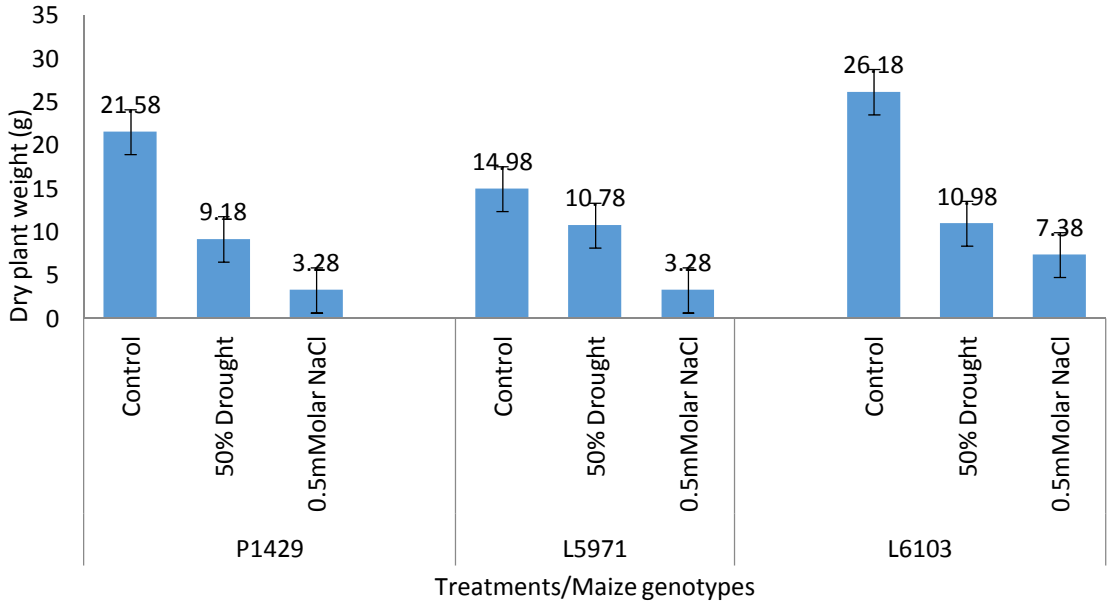

Figure 5. Dry plant weight under salt and drought stress conditions

Root shoot length ratio

The result in the figure 6 show that the hybrid L6103 performed better under NaCl stress as compare to other hybrid verity P1429 and L5971. The highest root shoot length ratio under NaCl was noted as 0.30 in L6103 and other hybrid followed as 0.20 in L5971 and 0.18 in P1429 under NaCl stress. Root shoot length ratio of L5971 is 0.151 under Control stress and 0.092 in L6103 and the smallest root shoot length ratio was noted as 0.083 in P1429. The highest root shoot length ratio under 100% drought stresses was noted as 0.257 in P1429 followed as 0.155 in L5971 and 0.117 in P1429. The smallest root shoot length ratio under Control stress was noted as 0.092 in L6103, but in this L5971 performed better among these three hybrid verity in all these stress conditions. Higher root shoot length ratio indicated that the selection of stress tolerance maize genotypes may be helpful for improving grain yield of maize (Ali et al., 2013; Ali et al., 2014; Masood et al., 2020; Danish et al., 2020).

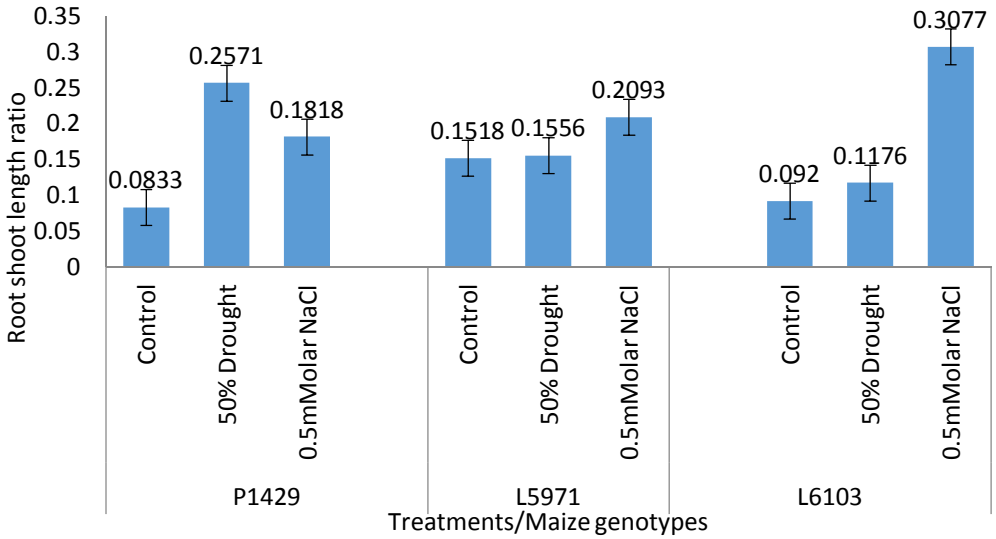

Figure 6. Root shoot length ratio under control, salt and drought stress conditions

Conclusion

The main purpose of this research was to determine the salt and drought effects on maize genotypes. Three maize genotypes hybrid P1429, L5671 and L6103 were selected to conclude the impact of drought and NaCl stress. *Zea mays* seedlings sown in pots were treated with 0.50mMolar of NaCl solution mixed in water and applied through the rooting medium. All seeds were already treated to prevent any fungal disease. However the results revealed that the genotype hybrid L6103 performed better in both drought and NaCl stress as compared to the other genotypes which showed less resistance to drought and NaCl stress.

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7/12/2020