Biological and Clinical Sciences Research Journal
ISSN: 2708-2261
www.bcsrj.com
DOI: https://doi.org/10.54112/bcsrj.v2020i1.25
Biol. Clin. Sci. Res. J., Volume, ***2020****: 25*
Original Research

EVALUATION OF MAIZE SEEDLING TRAITS UNDER SALT STRESS

NASEEM S, *ALI Q, MALIK A

Institute of Molecular Biology and Biotechnology, The university of Lahore, Lahore, Pakistan
Corresponding author: saim1692@gamil.com

(Received, 4th March 2020, Revised 5th September 2020, Published 16nd September 2020)

Abstract: *Maize is an important cereal crop lies at third after wheat and rice in Pakistan. It is very sensitive to salt, heat, drought, cold and heavy metal stresses. To evaluate the effects of salt (NaCl) on maize plant we have conducted a research experiment in the Green House of Institute of Molecular Biology and Biotechnology, The University of Lahore, Lahore. We select hybrid P1429, P5971 and P6103 of Maize to access the effect of different concentrations of NaCl stress included control, 0.25Molar NaCl, 0.5Molar NaCl, 0.75Molar NaCl, and 1Molar NaCl applications. The pots were filled with pure sand and seeds of each hybrid were sown in each pot and were let to germinate. After 7 days of germination the data was collected for leaf length, root length, shoot length and root/shoot length ratio. The pots were then given the treatment and data of above mentioned traits was recorded, the application of treatments and data recording were repeated 4 times. The data recorded (4 times each after one week) was subjected to pooled analysis of variance to find significant differences among hybrids and treatments. The result of our study showed that there were significant correlation among root length, shoot length and leaf length of seedlings, from average performance of hybrid P6103 was better as compared with other two hybrids under higher salt stress conditions. It was suggested from our study that the hybrid P6103 may be used as salt tolerance hybrids for improving grain and fodder yield of maize under salt stress condition.*

Keywords: maize, salt stress, NaCl, root length, shoot length

Introduction

Maize (Corn) belongs to the grass family and has been grown throughout the world. It is an important cereal crop after wheat and rice. Among them the maize crop has more ability in term of production per hectare. The increase in yield requires a continuous increase in supply for improved and enhanced germplasm for improving the fodder and grain yield and productivity of corn plant. The growing area of corn has been decreasing through every year while very low expectation of increasing area and production in coming future (Ali et al., 2013; Ashraf et al., 2020). Therefore, there is an urgent requirement or need for vertical or continuous increase for fodder and grain yield/hectare for insuring the household and livestock food and fee security throughout the world (Boomsma et al., 2009; Cakir, 2004). However, the global warming changing, with a result for climatic change, causing a negative effect on corn crop grain yield and productivity which is increasing the food shortage and insecurity, although it has been noted that the current climatic effects caused a change in the relation for maize has become inconclusive along with the model dependent in corn growth, development, grain productivity and yield (Ali et al., 2011; Buckler et al., 2009; Edreira and Otegui, 2012). It has been found form various research works on climatic changing effects that the increase in temperature and rainfall are interlinked with each other, the increase in the temperature is also causing drought along with salt stress in the temperate, subtropical and tropical regions of world, there is an average increase in temperature up to 3-4°C till end of 21th century throughout the world and South East Asia continent (Buckler et al., 2009; Mupangwa et al., 2007; Mustafa et al., 2013; Saif-ul-malook et al., 2014).

Materials and Methods

The seeds of hybrid P1429, P5971 and P6103 were sown in pots. The base of the pots were covered with soil and the rest was filled with sand in each plastic pot about 8 to 10 seeds were sown in the sand at the depth of 3cm. the pots with both given conditions were irrigated with tap water initially. Treatment was given with different levels of NaCl (0.25Molar, 0.5Molar, 0.75Molar, 1Molar) and control. Data collection: the sampling of the plants was done at the time of harvesting. After every 7 days of treatment, 2 plants from each pot were randomly harvested carefully and various factors such as leaf length, root length, shoot length and root/shoot length ratio were

[Citation: Naseem, S., Ali, Q., Malik, A. (2020). Evaluation of maize seedling traits under salt stress. *Biol. Clin. Sci. Res. J.,* **2020***:* 25 doi: https://doi.org/10.54112/bcsrj.v2020i1.25]

recorded. The data was analyzed for analysis of variance by using SPSS 23.1 version.

Result and discussions

Leaf length

The result we obtain from our finding and calculation showed that there was a significant difference between the treatments of different concentration of NaCl stress (Table 1). The coefficient of variance was lower which indicated that the results were reliable and accurate which may be used for further analysis and may be used to select genotypes to improve yield and increase their resistance against the stress. The average length of leaf was recorded as 10.8867±0.5505cm under different treatments. The average performance of all three hybrids was higher for control (13.6333±0.69602cm) followed by 1Molar NaCl (12.00±0.57735cm). The results from table 2 showed that the performance of hybrid P6103 was higher for treatments of NaCl with higher concentrations 0.5Molar NaCl, 0.75Molar NaCl and 1Molar NaCl as compared with other hybrids which showed better performance on lower concentrations of salt stress. The average leaf increase it indicated that the growth of leaf is good under the different concentrations of NaCl treatments and it show that they show tolerance against the different concentrations of stress and promote growth and yield of plant (Ali et al., 2016; Ali et al., 2014; Chai et al., 2016; Edreira and Otegui, 2012).

Table 1. Mean performance of maize genotypes for leaf length under different salt concentrations

Treatments	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
				Lower limit	Upper limit		
Control	13.6333	1.20554	0.69602	10.6386	16.6281	12.50	14.90
0.25 Molar NaCl	8.0000	1.32288	0.76376	4.7138	11.2862	6.50	9.00
0.5 Molar NaCl	10.7333	1.12398	0.64893	7.9412	13.5255	9.50	11.70
0.75 Molar NaCl	10.0667	0.40415	0.23333	9.0627	11.0706	9.70	10.50
1Molar NaCl	12.0000	1.00000	0.57735	9.5159	14.4841	11.00	13.00
Grand Mean	10.8867		0.5505				
Coefficient of variation	9.67						

Table 1a. Means for group in homogeneous subsets for leaf length

Treatments	P1429	P5971	P6103
Control	8.0000		
0.25 Molar NaCl	10.0667	10.0667	
0.5 Molar NaCl	10.7333	10.7333	10.7333
0.75 Molar NaCl		12.0000	12.0000
1Molar NaCl			13.6333
Sig. p<0.05	0.110	0.353	0.085

Shoot length

The results have shown that there was significant difference between the treatments of different concentration of NaCl stress (Table 2). The coefficient of variance was lower it means the result were reliable and accurate which indicated that we used it in further analysis for selection of maize genotypes for yield and enhanced tolerance against salt stress. The average length of shoot was recorded as 10.4800 ± 0.77393cm under different treatments. The average performance of all three hybrids was higher for control (12.00±0.57735cm) followed by 1Molar NaCl (14.6667±1.20185cm). The results from table 2a showed that the performance of hybrid P6103 was higher for treatments of NaCl with higher concentrations 0.5Molar NaCl and 0.75Molar NaCl as compared with other hybrids which showed better performance on lower concentrations of salt stress. The average shoot increase it indicated that the growth of leaf is good under the different concentrations of NaCl treatments and it show that they show tolerance against the different concentrations of stress and promote growth and yield of plant (Ali et al., 2015; Ali et al., 2012; de Azevedo Neto et al., 2006; Farre and Faci, 2006; Kanwal et al., 2019).

Table 2. Mean performance of maize genotypes for shoot length under different salt concentrations

Treatments	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
				Lower limit	Upper limit		
Control	12.0000	1.00000	0.57735	9.5159	14.4841	11.00	13.00
0.25 Molar NaCl	6.8333	1.25831	0.72648	3.7075	9.9591	5.50	8.00
0.5 Molar NaCl	8.5000	.50000	0.28868	7.2579	9.7421	8.00	9.00

[Citation: Naseem, S., Ali, Q., Malik, A. (2020). Evaluation of maize seedling traits under salt stress. *Biol. Clin. Sci. Res. J.*, **2020***:* 25 doi: https://doi.org/10.54112/bcsrj.v2020i1.25]

0.75 Molar NaCl	10.4000	.36056	0.20817	9.5043	11.2957	10.00	10.70
1Molar NaCl	14.6667	2.08167	1.20185	9.4955	19.8378	13.00	17.00
Grand Mean	10.480		0.77393				
Coefficient of variation	10.246						

Table 2a. Means for group in homogeneous subsets for shoot length

Treatments	P1429	P5971	P6103
Control	5.3000		
0.25 Molar NaCl	6.5000	6.5000	
0.5 Molar NaCl		7.5000	7.5000
0.75 Molar NaCl			8.1667
1Molar NaCl			
Sig. p<0.05	0.197	0.340	0.691

Root length

The results showed significant differences between the treatments of different concentration of NaCl stress. The average length of root was recorded that (10.1533 ± 0.62821cm) under different treatments (Table 3). The average performance of all three hybrids was higher for control (12.1667±0.56862cm) followed by 0.75Molar NaCl (12.400±0.79373cm) and 1Molar NaCl (10.40±0.65574cm). The results from table 3a showed that the performance of hybrid P6103 was higher for treatments of NaCl with higher concentrations 0.75Molar NaCl and 1Molar NaCl as compared with other hybrids which showed better performance on lower concentrations of salt stress. The average root length increase it indicated that the growth of root is good under the different concentrations of NaCl treatments and it show that they show tolerance against the different concentrations of stress and promote growth and yield of plant (Aaliya et al., 2016; Abbas et al., 2016; Ali et al., 2017; Farooq et al., 2015; Karahara et al., 2004; Sheng et al., 2008).

Table 3. Mean performance of maize genotypes for root length under different salt concentrations

Treatments	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
				Lower limit	Upper limit		
Control	9.8000	0.40000	0.23094	8.8063	10.7937	9.40	10.20
0.25 Molar NaCl	6.0000	0.30000	0.17321	5.2548	6.7452	5.70	6.30
0.5 Molar NaCl	12.1667	0.56862	0.32830	10.7541	13.5792	11.70	12.80
0.75 Molar NaCl	12.4000	0.79373	0.45826	10.4283	14.3717	11.50	13.00
1Molar NaCl	10.4000	0.65574	0.37859	8.7710	12.0290	9.70	11.00
Grand Mean	10.1533		0.62821				
Coefficient of variation	9.973						

Table 3a. Means for group in homogeneous subsets for root length

Treatments	P1429	P5971	P6103
Control	6.0000		
0.25 Molar NaCl		9.8000	
0.5 Molar NaCl		10.4000	
0.75 Molar NaCl			12.1667
1Molar NaCl			12.4000
Sig. p<0.05	1.000	0.795	0.992

Root/shoot length ratio

The result showed significant differences between the treatments of different concentration of NaCl stress (Table 4). The coefficient of variance is lower it means the result is reliable and accurate it indicate that we used it in future to improve their yield and increase their resistance against the stress. The average dry shoot weight was recorded that (0.6273 ± 0.06500) under different treatments. The average root/shoot length ratio increased which indicated that the growth of leaf, roots and shoot was good under the different concentrations of NaCl treatments which showed tolerance against the different concentrations of stress and promote growth and yield of maize plant. The average performance of hybrid P6103 was better under the treatments of .25Molar NaCl, 0.5Molar NaCl and 1Molar NaCl concentration as compared with other maize hybrids. The different comparison of maize hybrids show that the root/shoot length ratio of seedlings was lower under 0.25Molar

[Citation: Naseem, S., Ali, Q., Malik, A. (2020). Evaluation of maize seedling traits under salt stress. *Biol. Clin. Sci. Res. J.*, **2020***:* 25 doi: https://doi.org/10.54112/bcsrj.v2020i1.25]

NaCl is (0.2800) followed by 0.5Molar NaCl (0.4567), control (0.7000). 0.75M NaCl (0.8000) while highest under 1Molar NaCl (0.9000) concentration. The result indicated that the effect of various salt concentrations affected the plants but if the stress concentration is lower than the growth of leaves is higher it means the concentrations effect the growth but improving some traits it can provide more tolerance in future (Mazhar et al., 2020; Shu and Liu, 2001; Tahir et al., 2020; Zubair et al., 2016).

Table 4. Mean performance of maize genotypes for root/shoot length ratio under different salt concentrations

Treatments	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
				Lower limit	Upper limit		
Control	0.7000	0.10000	0.05774	0.4516	0.9484	0.60	0.80
0.25 Molar NaCl	0.2800	0.07211	0.04163	0.1009	0.4591	0.20	0.34
0.5 Molar NaCl	0.4567	0.14012	0.08090	0.1086	0.8047	0.30	0.57
0.75 Molar NaCl	0.8000	0.10000	0.05774	0.5516	1.0484	0.70	0.90
1Molar NaCl	0.9000	0.10000	0.05774	0.6516	1.1484	0.80	1.00
Grand Mean	0.6273		0.06500				
Coefficient of variation	10.103						

Table 4a. Means for group in homogeneous subsets for root/shoot length ratio

Treatments	P1429	P5971	P6103
Control	0.2800		
0.25 Molar NaCl	0.4567	0.4567	
0.5 Molar NaCl		0.7000	0.7000
0.75 Molar NaCl			0.8000
1Molar NaCl			0.9000
Sig. p<0.05	0.422	0.167	0.312

The results from table 5 indicated that there was positive and significant correlation among all of the studied traits. Root length and shoot length showed strong and significant correlation which indicated that the selection of maize genotypes for salt stress tolerance may be helpful to improve grain and fodder yield of maize under slat stress conditions.

Table 4. Pooled correlation among different traits of maize under drought stress conditions

Traits	Shoot length	Root length	Leaf length
Root length	0.8019*		
Leaf length	0.6701*	0.2307	
Root/shoot length ratio	0.4503*	-0.2250	0.4914*

* =Significant at 5% probability level

Conflict of interest

The authors declared absence of any type of conflict of interest in manuscript publication

References

Aaliya, K., Qamar, Z., Ahmad, N. I., Ali, Q., Munim, F. A., and Husnain, T. (2016). Transformation, evaluation of gtgene and multivariate genetic analysis for morpho-physiological and yield attributing traits in Zea mays. *Genetika* **48**, 423-433.

Abbas, H. G., Mahmood, A., and Ali, Q. (2016). Zero tillage: a potential technology to improve cotton yield. *Genetika* **48**, 761-776.

Ali, F., Ahsan, M., Ali, Q., and Kanwal, N. (2017). Phenotypic stability of Zea mays grain yield and its attributing traits under drought stress. *Frontiers in plant science* **8**, 1397.

Ali, F., Kanwal, N., Ahsan, M., Ali, Q., Bibi, I., and Niazi, N. K. (2015). Multivariate analysis of grain yield and its attributing traits in different maize hybrids grown under heat and drought stress. *Scientifica* **2015**.

Ali, Q., Ahsan, M., Ali, F., Aslam, M., Khan, N. H., Munzoor, M., Mustafa, H. S. B., and Muhammad, S. (2013). Heritability, heterosis and heterobeltiosis studies for morphological traits of maize (Zea mays L.) seedlings. *Advancements in Life sciences* **1**.

Ali, Q., Ahsan, M., Kanwal, N., Ali, F., Ali, A., Ahmed, W., Ishfaq, M., and Saleem, M. (2016). Screening for drought tolerance: comparison of maize hybrids under water deficit condition. *Advancements in Life Sciences* **3**, 51-58.

Ali, Q., Ahsan, M., Tahir, M. H. N., and Basra, S. M. A. (2012). Genetic evaluation of maize (Zea mays L.) accessions for growth related seedling traits. *International Journal for Agro Veterinary and Medical Sciences* **6**, 164-172.

Ali, Q., Ali, A., Ahsan, M., Nasir, I. A., Abbas, H. G., and Ashraf, M. A. (2014). Line× Tester analysis for morpho-physiological traits of Zea mays L seedlings. *Advancements in Life sciences* **1**, 242-253.

Ali, Q., Hammad, M., Tahir, N., Ahsan, M., Basra, S. M. A., Farooq, J., and Elahi, M. (2011). Correlation and path coefficient studies in maize (Zea mays L.) genotypes under 40% soil moisture contents. *African Journal of Bacteriology Research* **3**, 77-82.

Ashraf, A., Rashid, M., Ali, Q., and Malik, A. (2020). Genetic Advances and Heritability Analysis for Seedling Growth Traits in Zea mays under Heavy Metal Stress. *Genetics and Molecular Research* **19**.

Boomsma, C. R., Santini, J. B., Tollenaar, M., and Vyn, T. J. (2009). Maize morphophysiological responses to intense crowding and low nitrogen availability: An analysis and review. *Agronomy Journal* **101**, 1426-1452.

Buckler, E. S., Holland, J. B., Bradbury, P. J., Acharya, C. B., Brown, P. J., Browne, C., Ersoz, E., Flint-Garcia, S., Garcia, A., and Glaubitz, J. C. (2009). The genetic architecture of maize flowering time. *Science* **325**, 714-718.

Cakir, R. (2004). Effect of water stress at different development stages on vegetative and reproductive growth of corn. *Field Crops Research* **89**, 1-16.

Chai, Q., Gan, Y., Zhao, C., Xu, H.-L., Waskom, R. M., Niu, Y., and Siddique, K. H. (2016). Regulated deficit irrigation for crop production under drought stress. A review. *Agronomy for sustainable development* **36**, 3.

de Azevedo Neto, A. D., Prisco, J. T., Enéas-Filho, J., de Abreu, C. E. B., and Gomes-Filho, E. (2006). Effect of salt stress on antioxidative enzymes and lipid peroxidation in leaves and roots of salt-tolerant and salt-sensitive maize genotypes. *Environmental and Experimental Botany* **56**, 87-94.

Edreira, J. I. R., and Otegui, M. E. (2012). Heat stress in temperate and tropical maize hybrids: Differences in crop growth, biomass partitioning and reserves use. *Field Crops Research* **130**, 87-98.

Farooq, M., Hussain, M., Wakeel, A., and Siddique, K. H. (2015). Salt stress in maize: effects, resistance mechanisms, and management. A review. *Agronomy for Sustainable Development* **35**, 461-481.

Farre, I., and Faci, J. M. (2006). Comparative response of maize (Zea mays L.) and sorghum (Sorghum bicolor L. Moench) to deficit irrigation in a Mediterranean environment. *Agricultural water management* **83**, 135-143.

Kanwal, N., Ali, F., Ali, Q., and Sadaqat, H. A. (2019). Phenotypic tendency of achene yield and oil contents in sunflower hybrids. *Acta Agriculturae Scandinavica, Section B—Soil & Plant Science* **69**, 690-705.

Karahara, I., Ikeda, A., Kondo, T., and Uetake, Y. (2004). Development of the Casparian strip in primary roots of maize under salt stress. *Planta* **219**, 41-47.

Mazhar, T., Ali, Q., and Malik, M. S. R. A. (2020). Effects of salt and drought stress on growth traits of Zea mays seedlings. *Life Science Journal* **17**.

Mupangwa, W., Twomlow, S., Walker, S., and Hove, L. (2007). Effect of minimum tillage and mulching on maize (Zea mays L.) yield and water content of clayey and sandy soils. *Physics and chemistry of the earth, parts A/B/C* **32**, 1127-1134.

Mustafa, H. S. B., Ahsan, M., Aslam, M., Ali, Q., Bibi, T., and Mehmood, T. (2013). Genetic variability and traits association in maize (Zea mays L.) accessions under drought stress. *Journal of Agricultural Research (03681157)* **51**.

Saif-ul-malook, M. A., Ali, Q., and Mumtaz, A. (2014). Inheritance of yield related traits in maize (Zea mays) under normal and drought conditions. *Nat Sci* **12**, 36-49.

Sheng, M., Tang, M., Chen, H., Yang, B., Zhang, F., and Huang, Y. (2008). Influence of arbuscular mycorrhizae on photosynthesis and water status of maize plants under salt stress. *Mycorrhiza* **18**, 287-296.

Shu, L., and Liu, Y. (2001). Effects of silicon on growth of maize seedlings under salt stress. *Agro-Environmental Protection* **20**, 38-40.

Tahir, M., Rashid, M., Ali, Q., and Malik, A. (2020). Evaluation of Genetic Variability in Wheat and Maize under Heavy Metal and Drought Stress. *Genetics and Molecular Research* **19**.

Zubair, M., Shakir, M., Ali, Q., Rani, N., Fatima, N., Farooq, S., Shafiq, S., Kanwal, N., Ali, F., and Nasir, I. A. (2016). Rhizobacteria and phytoremediation of heavy metals. *Environmental Technology Reviews* **5**, 112-119.