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Original Research Article

EFFECTS OF DROUGHT AND BIOGAS WASTE WATER APPLICATIONS ON MAIZE SEEDLING GROWTH

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Abstract: *Plant growth and development are influenced by a variety of biotic and abiotic factors. Drought and salinity are major constraints for the growth of plants all over the world. Maize has received attention because of their massive production in drought and salt stress. So, an experiment was conducted for improving the knowledge about the performance of maize seedlings behind the drought tolerance in different varieties of maize. Seeds of maize were submitted to different stress treatments like drought, wastewater, and biogas with the objective of evaluating the effects of drought, wastewater, and biogas treatments on early seedling growth. EV-1097Q, Raka-Poshi, Pak-Afgoi seeds were sown in 36 pots which were filled with 1.5kg of sand. Then stress treatments were applied and results were observed. The results were observed for eleven variables which are root length, shoot length, leaf area, and root shoot weight ratio. From the results, it was found that these selected genotypes of maize showed a different level of tolerance to the stress treatments. Most of the genotypes have shown negative results which means that they did not tolerate the stress treatments. In the future, there is a need for exploratory research for understanding the mechanism behind tolerance.*

Keywords: maize, genotypes, drought stress, wastewater, biogas water stress

Introduction

Environmental stressors or biotic and abiotic factors have a severe effect on the production of many crops, especially grain crops, all over the world. Abiotic factors like high temperature, salinity, drought, metal toxicities and deficiency of minerals are most important and they affect the yield and growth of crops. Drought and salinity are the most significant environmental constraint that limit crop yield in arid and semiarid countries (Sarshad et al., 2021). Because of abiotic factors there is a need of such plants that can resist environmental stresses. Maize in many parts of the world is grown as a staple food (Ali et al., 2013b; Ali et al., 2016; Ali et al., 2014c). It can grow in those areas where other cereal grains fail to grow. Maize may be consumed in a variety of forms like wet feed (high moisture), including silage, dry fodder, and direct grazing as pasture or after harvesting by animals, whereas maize is often consumed as silage (Ali et al., 2013a; Carlson et al., 2020; Iqbal et al., 2017). Maize is the world's largest third most significant food staple in terms of worldwide output from the Southern to the Northern Hemispheres, and from dry and semi-arid to humid and semi-humid environments (Ramirez-Cabral et al., 2017; Song et al., 2019). Maize is also a cereal crop and it is second after wheat that is mostly grown worldwide. It has been found that maize are highly sensitive to drought and have ability to cope up water logging better than other cereal crops (Mendoza-Grimón et al., 2021; Satyavathi et al., 2019). Both are the world's most grown cereal crops after, rice, barley etc. although in some places, such as Sudan, it may be the most profitable crop. The genetic histories of various plant groups and orders influence their reactions to environmental conditions (Akram et al., 2020; Reddy, 2019). Furthermore, plants within the same family, like maize, and, at a closer range, various genotypes of same species, can exhibit discernible differences in response to drought and salt stressors. Researchers have been studying various plant kinds in order to classify them as resistant, semi-tolerant, or sensitive to water deficit in order to provide recommendations to farmers (Boomsma et al., 2009; Cakir, 2004).

Maize yield must be increased in order to ensure future food security, particularly in food-insecure nations. Water stress, on the other hand, lowered maize output by around 40% on a global scale, according to a meta-analysis (Daryanto et al., 2016; Quiroga et al., 2017) based on 35 years of accessible data. The intensity of the drought, the length of the exposure time, and the growth stage are all factors that impact maize yield loss. Drought exposure reduces total maize biomass significantly during the seedling stage, and also affects maize phenotypic and reduces yield from the jointing to lactation phases (Lunduka et al., 2019; Quiroga et al., 2017). Maize C_4 metabolism allows it to maintain photosynthetic activity and dry matter synthesis in adverse circumstances such as high temperature, drought, and salt (Fang et al., 2021; Mi et al., 2021; Song and Jin, 2020; Zubair et al., 2016). So from these studies the research gap has been find out that there is a need to analyze can other stresses also results in tolerance like polluted water and biogas water. The purpose of this study is to investigate the effects of biogas, drought and wastewater stress on seedling traits of maize.

Materials and Methods

A field experiment was conducted for one season at the Institute of Molecular Biology and Biotechnology, The University of Lahore, Lahore Pakistan experimental farm. Average daily temperature was ranged from 30-50°C throughout the experimental season. Three genotypes of maize (EV-1097Q, Raka-Poshi and Pak Afgoi) were selected as an experimental genotype material. Biogas water and waste water was added in the sand along with control plant. The following sets of biogas water and waste water treatments were kept for study that are, T_1 (50% Drought), T_2 (Waste Water), T_3 (Biogas Water), T_4 (control). Seeds were grown in pots that were marked properly. Each pot was filled with 1.5 kg of sand. Data was recorded for root length, shoot length, leaf area and root shoot weight ratio. The data was statistically analyzed through analysis of variance techniques by using SPSS23.1 software.

Results and Discussion

It has been persuaded from table 1 that there were significant differences among the genotypes, treatments and interaction between genotypes to treatments. The results has shown that the average shoot length was found as 3.67cm, root length (10.43cm), leaf area (3.35cm^2), root shoot length ratio (0.35) and root shoot weight ratio (1.47). The higher root shoot weight ratio, shoot length and root length indicated that maize genotypes showed tolerance against drought stress, hence may be used to developed higher yielding maize grain and fodder genotypes against stress conditions. The coefficient of variation was found lower for all of the studied traits which revealed that there was consistency among the results and may be used for further analysis and reliability of study (Ali et al., 2017; Ali et al., 2013b; Ali et al., 2014b; Cakir, 2004).

Table 1 Analysis of variance for maize under different treatments

Source of variations	SL	RL	LA	RSLR	RSWR
Replications	0.0061	0.0016	0.0024	0.0121	0.0023
Genotypes	0.0801*	0.0852*	0.8521*	0.7012*	0.6154*
Treatments	0.0036*	0.0541*	0.3724*	5.2010*	3.2014*
Genotypes ×Treatments	0.0989*	0.1092*	0.242*	6.0153*	4.0505*
Error	0.0423	0.0345	0.4012	3.0115	3.0136
Grand Mean	3.67	10.43	3.35	0.35	1.47
CV	7.14	5.20	7.43	5.174	9.234

* = Significant at 5% probability level, SL = Shoot length, RL = Root length, LA = Leaf area, RSLR = Root shoot length ratio, RSWR = Root shoot weight ratio

The results from figure 1 showed there was variable behavior of maize genotypes under different treatments. The genotypes EV-1097Q showed higher shoot length (3.8cm) under the treatment of biogas wastewater followed by waste water treatment (3.7cm). The genotype Raka-Poshi showed higher shoot length (3.9cm) under 50% drought applications while lower under waste water (3.5cm). The genotype Pak-Afgoi showed higher shoot length (3.8cm) under biogas wastewater while lower under 50% drought (3.5cm). The higher performance of Raka-Poshi under drought stress indicated that the genotype has tolerance for drought stress. The selection of genotypes on the basis of shoot length indicated that the grain and fodder yield of maize may be enhanced under stress conditions (Aaliya et al., 2016; Ahsan et al., 2013; Ali et al., 2015; Ali et al., 2014a; Mazhar et al., 2020).

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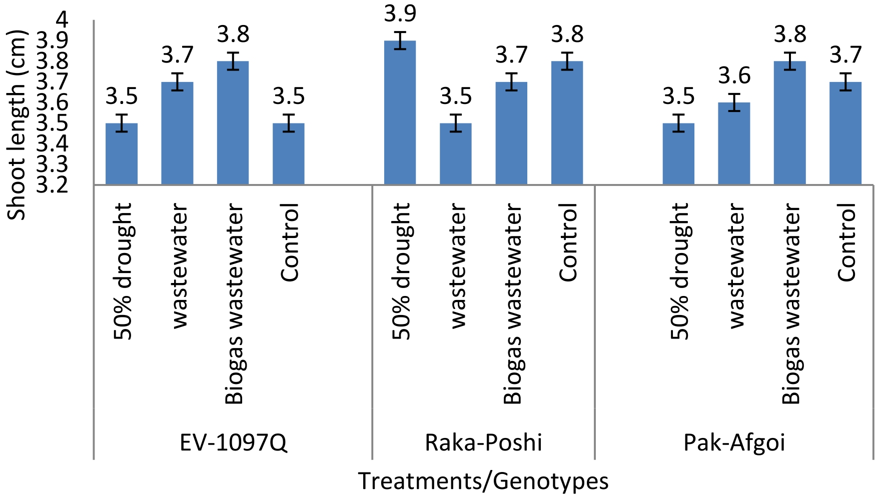

Figure 1: Shoot Length of different genotypes of maize under drought, biogas water, and wastewater stresses

The results from figure 2 showed there was variable behavior of maize genotypes under different treatments. The genotypes EV-1097Q showed higher root length (10.5cm) under the treatment of biogas wastewater followed by waste water treatment (10.6cm). The genotype Raka-Poshi showed higher root length (10.6cm) under 50% drought applications while lower under waste water (10.4cm). The genotype Pak-Afgoi showed higher root length (3.8cm) under biogas wastewater and 50% drought (10.5cm) while lower under waste water (10.2cm). The higher performance of Raka-Poshi under drought stress indicated that the genotype has tolerance for drought stress. The selection of genotypes on the basis of root length indicated that the grain and fodder yield of maize may be enhanced under stress conditions (Ali and Ahsan, 2015; Ali et al., 2011; Farooq et al., 2011; Mazhar et al., 2020).

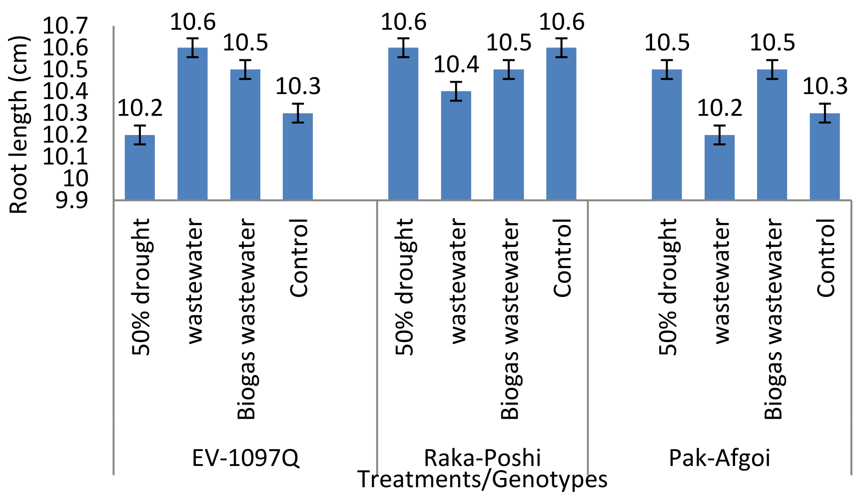

Figure 2: Root Length of different genotypes of maize under drought, biogas water, and wastewater stresses

The results from figure 3 showed there was variable behavior of maize genotypes under different treatments. The genotypes EV-1097Q showed higher leaf area (4.60cm^2) under the treatment of wastewater followed by biogas wastewater treatment (2.97cm^2). The genotype Raka-Poshi showed higher leaf area (3.85cm^2) under 50% drought applications while lower under waste water (2.97cm^2). The genotype Pak-Afgoi showed higher leaf area (4.08cm^2) under biogas wastewater and 50% drought (3.47cm^2) while lower under waste water (2.52cm^2). The higher performance of Raka-Poshi under drought stress indicated that the genotype has tolerance for drought stress. The selection of genotypes on the basis of leaf area indicated that the grain and fodder yield of maize may be enhanced under stress conditions. The higher leaf area indicated that the photosynthetic rate was higher which leads towards increase the accumulation of organic compounds hence increased the growth and development of maize seedling (Mustafa et al., 2018; Sarwar et al., 2022; Sarwar et al., 2021).

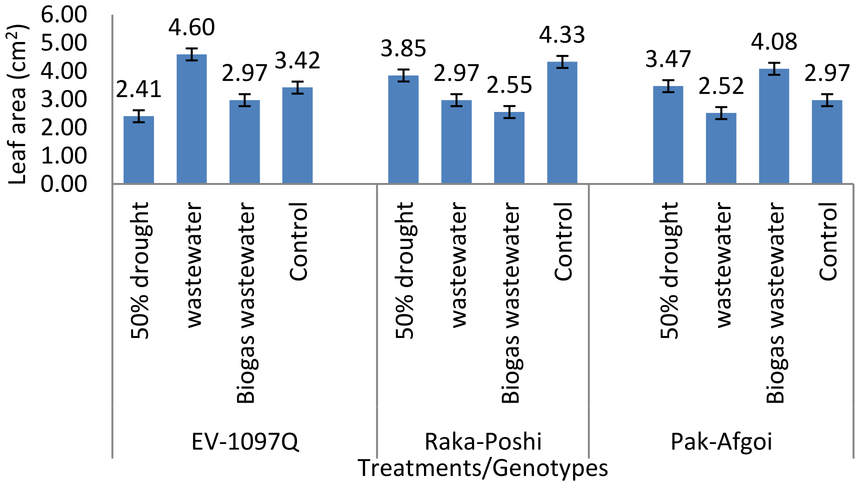

Figure 3: Leaf area of different genotypes of maize under drought, biogas water, and wastewater stresses

The results from figure 4 showed there was variable behavior of maize genotypes under different treatments. The genotypes EV-1097Q showed higher root shoot length ratio (0.35) under the treatment of wastewater followed by biogas wastewater treatment (0.36). The genotype Raka-Poshi showed higher root shoot length ratio (0.37) under 50% drought applications while lower under waste water (0.34). The genotype Pak-Afgoi showed higher root shoot length ratio (0.36) under biogas wastewater and waste water (0.35) while lower under 50% drought (0.33). The higher performance of Raka-Poshi under drought stress indicated that the genotype has tolerance for drought stress. The selection of genotypes on the basis of root shoot length ratio indicated that the grain and fodder yield of maize may be enhanced under stress conditions. The higher root shoot length ratio indicated that the photosynthetic rate was higher which leads towards increase the accumulation of organic compounds hence increased the growth and development of maize seedling (Ali et al., 2016; Farooq et al., 2011; Mazhar et al., 2020; Mustafa et al., 2018).

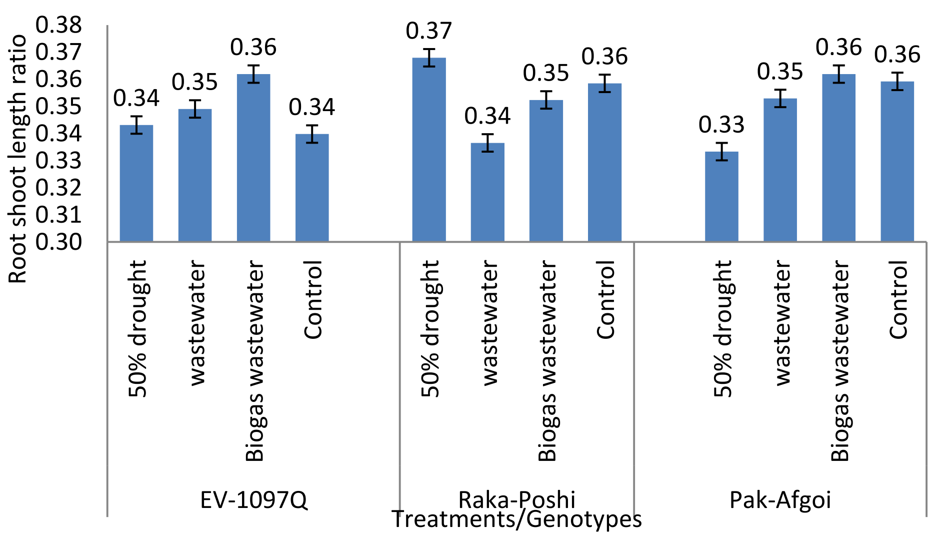

Figure 4: Root shoot length ratio of different genotypes of maize under drought, biogas water, and wastewater stresses

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The results from figure 3 showed there was variable behavior of maize genotypes under different treatments. The genotypes EV-1097Q showed higher root shoot weight ratio (2.40) under the treatment of wastewater followed by 50% drought (1.48) while lower under biogas wastewater treatment (0.89). The genotype Raka-Poshi showed higher root shoot weight ratio (2.29) under 50% drought applications while lower under biogas wastewater (1.11). The genotype Pak-Afgoi showed higher root shoot weight ratio (1.60) under biogas wastewater and waste water (1.43) while lower under 50% drought (1.00). The higher performance of Raka-Poshi under drought stress indicated that the genotype has tolerance for drought stress. The selection of genotypes on the basis of root shoot weight ratio indicated that the grain and fodder yield of maize may be enhanced under stress conditions. The higher root shoot weight ratio indicated that the photosynthetic rate was higher which leads towards increase the accumulation of organic compounds hence increased the growth and development of maize seedling (Ali et al., 2015; Ali et al., 2013b; Farooq et al., 2011; Mi et al., 2021).

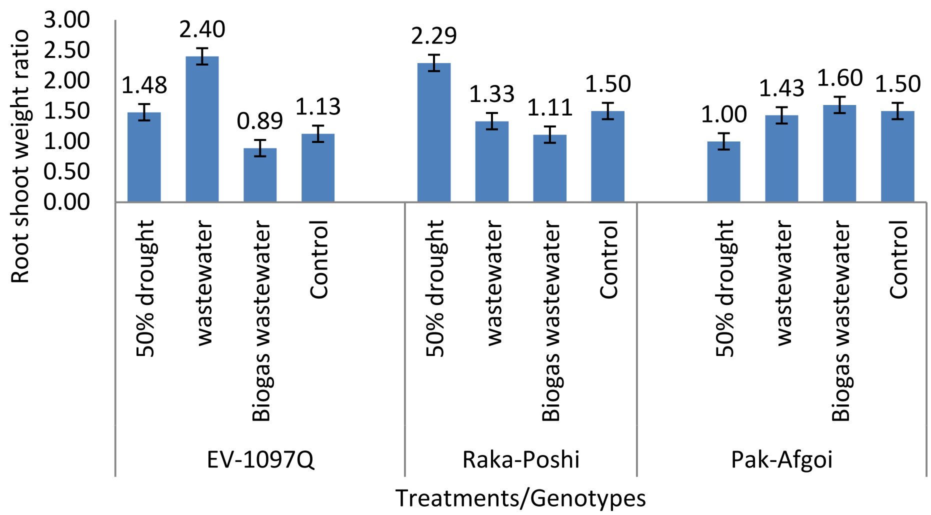

Figure 5: Root shoot weight ratio of different genotypes of maize under drought, biogas water, and wastewater stresses

Conflict of interest

The authors declared absence of conflict of interest.

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.

Ahsan, M., Farooq, A., Khaliq, I., Ali, Q., Aslam, M., and Kashif, M. (2013). Inheritance of various yield contributing traits in maize (Zea mays L.) at low moisture condition. *African Journal of Agricultural Research* **8**, 413-420.

Akram, M. A., Wang, X., Hu, W., Xiong, J., Zhang, Y., Deng, Y., Ran, J., and Deng, J. (2020). Convergent variations in the leaf traits of desert plants. *Plants* **9**, 990.

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., and Ahsan, M. (2015). Correlation analysis for various grain contributing traits of Zea mays. *African Journal of Agricultural Research* **10**, 2350-2354.

Ali, Q., Ahsan, M., and Ali, F. (2013a). Genetic advance, heritability, correlation, heterosis and heterobeltiosis for morphological traits of maize (Zea mays L). *Albanian Journal of Agricultural Sciences* **12**, 689-698.

Ali, Q., Ahsan, M., Ali, F., Aslam, M., Khan, N. H., Munzoor, M., Mustafa, H. S. B., and Muhammad, S. (2013b). 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., Khan, N. H., Waseem, M., and Ali, F. (2014a). An overview of Zea mays for the improvement of yield and quality traits through conventional breeding. *Nat Sci* **12**, 71-84.

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

Ali, Q., Ali, A., Waseem, M., Muzaffar, A., Ahmad, S., Ali, S., Awan, M., Samiullah, T., Nasir, I., and Tayyab, H. (2014c). Correlation analysis for morpho-physiological traits of maize (Zea mays L.). *Life Science Journal* **11**, 9-13.

Ali, Q., Elahi, M., Ahsan, M., Tahir, M. H. N., and Basra, S. M. A. (2011). Genetic evaluation of maize (Zea mays L.) genotypes at seedling stage under moisture stress. *International Journal for Agro Veterinary and Medical Sciences* **5**, 184-193.

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.

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

Carlson, R., Tugizimana, F., Steenkamp, P. A., Dubery, I. A., Hassen, A. I., and Labuschagne, N. (2020). Rhizobacteria-induced systemic tolerance against drought stress in Sorghum bicolor (L.) Moench. *Microbiological Research* **232**, 126388.

Daryanto, S., Wang, L., and Jacinthe, P.-A. (2016). Global synthesis of drought effects on maize and wheat production. *PloS one* **11**, e0156362.

Fang, Q., Wang, Y., Uwimpaye, F., Yan, Z., Li, L., Liu, X., and Shao, L. (2021). Pre-sowing soil water conditions and water conservation measures affecting the yield and water productivity of summer maize. *Agricultural Water Management* **245**, 106628.

Farooq, J., Khaliq, I., Kashif, M., Ali, Q., and Mahpara, S. (2011). Genetic analysis of relative cell injury percentage and some yield contributing traits in wheat under normal and heat stress conditions. *Chilean Journal of Agricultural Research* **71**, 511.

Iqbal, M. S., Jabbar, B., Sharif, M. N., Ali, Q., Husnain, T., and Nasir, I. A. (2017). In silico MCMV silencing concludes potential host-derived miRNAs in maize. *Frontiers in plant science* **8**, 372.

Lunduka, R. W., Mateva, K. I., Magorokosho, C., and Manjeru, P. (2019). Impact of adoption of drought-tolerant maize varieties on total maize production in south Eastern Zimbabwe. *Climate and development* **11**, 35-46.

Mazhar, T., Ali, Q., and Malik, M. (2020). Effects of salt and drought stress on growth traits of Zea mays seedlings. *Life Science Journal* **17**, 48-54.

Mendoza-Grimón, V., Amorós, R., Fernández-Vera, J. R., Hernádez-Moreno, J. M., and Palacios-Díaz, M. d. P. (2021). Effect of Different Water Quality on the Nutritive Value and Chemical Composition of Sorghum bicolor Payenne in Cape Verde. *Agronomy* **11**, 1091.

Mi, N., Cai, F., Zhang, S., Zhang, Y., Ji, R., Chen, N., Ji, Y., and Wang, D. (2021). Thermal Time Requirements for Maize Growth in Northeast China and Their Effects on Yield and Water Supply under Climate Change Conditions. *Water* **13**, 2612.

Mustafa, H. S. B., Mahmood, T., Hameed, A., and Ali, Q. (2018). Enhancing food security in arid areas of Pakistan through newly developed drought tolerant and short duration mustard (Brassica juncea L.) Canola. *Genetika* **50**, 21-31.

Quiroga, G., Erice, G., Aroca, R., Chaumont, F., and Ruiz-Lozano, J. M. (2017). Enhanced drought stress tolerance by the arbuscular mycorrhizal symbiosis in a drought-sensitive maize cultivar is related to a broader and differential regulation of host plant aquaporins than in a drought-tolerant cultivar. *Frontiers in plant science* **8**, 1056.

Ramirez-Cabral, N. Y., Kumar, L., and Shabani, F. (2017). Global alterations in areas of suitability for maize production from climate change and using a mechanistic species distribution model (CLIMEX). *Scientific reports* **7**, 1-13.

Reddy, P. S. (2019). Breeding for abiotic stress resistance in sorghum. *In* "Breeding sorghum for diverse end uses", pp. 325-340. Elsevier.

Sarshad, A., Talei, D., Torabi, M., Rafiei, F., and Nejatkhah, P. (2021). Morphological and biochemical responses of Sorghum bicolor (L.) Moench under drought stress. *SN Applied Sciences* **3**, 1-12.

Sarwar, M., Anjum, S., Alam, M. W., Ali, Q., Ayyub, C., Haider, M. S., Ashraf, M. I., and Mahboob,

W. (2022). Triacontanol regulates morphological traits and enzymatic activities of salinity affected hot pepper plants. *Scientific Reports* **12**, 1-8.

Sarwar, M., Anjum, S., Ali, Q., Alam, M. W., Haider, M. S., and Mehboob, W. (2021). Triacontanol modulates salt stress tolerance in cucumber by altering the physiological and biochemical status of plant cells. *Scientific reports* **11**, 1-10.

Satyavathi, C. T., Solanki, R., Kakani, R., Bharadwaj, C., Singhal, T., Padaria, J., Khandelwal, V., Srivastava, R., Tomar, R., and Iqubal, M. (2019). Genomics assisted breeding for abiotic stress tolerance in Millets. *In* "Genomics Assisted Breeding of Crops for Abiotic Stress Tolerance, Vol. II", pp. 241-255. Springer.

Song, L., and Jin, J. (2020). Improving CERES-Maize for simulating maize growth and yield under water stress conditions. *European Journal of Agronomy* **117**, 126072.

Song, L., Jin, J., and He, J. (2019). Effects of severe water stress on maize growth processes in the field. *Sustainability* **11**, 5086.

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.

[Citation: Zahoor, M.J., Robina, K., Rafi, R., Abbas, H.G. (2022). Effects of drought and biogas wastewater applications on maize seedling growth. *Biol. Clin. Sci. Res. J.,* **2022***: 93*. doi: https://doi.org/10.54112/bcsrj.v2022i1.93]