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Research Article

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Lentil, germination, treated wastewater

The Effects of Treated Wastewater Concentrations on Germination and Seedling Growth of Different Lentil Cultivars

Abstract
Global climate change and rapidly increasing world population has put pressure on fresh water resources and this pressure has pushed the agriculture sector to seek alternative water resources. At the forefront of these sources is treated wastewater. In this study, the effects of different concentrations of treated wastewater levels (Control, 25% treated wastewater, 50% treated wastewater, 75% treated wastewater, 100% treated wastewater), on germination and seedling growth on two different lentil cultivars (Ceren and Ankara yeşili) were investigated. The study was carried out under controlled conditions with 4 replications according to the randomized plot design at the factorial level. As a result of the study, statistically significant differences were observed between the varieties in terms of all characteristics and the best results were obtained from the 75% treated wastewater concentration. It was revealed that the level of treated wastewater increased the germination and seedling growth compared to the control subject.

INTRODUCTION

Water is the most important resource for humanity but it has been under great threat in recent years due to the rapid increase in population and global warming. Therefore, existing water resources should be well protected and used rationally. When we look at the sectoral use of water resources in the world, the agricultural sector is first with 70% and this makes the agriculture sector more important in terms of the rational use of water resources. However, the increase in water needs of urban life and developing industry, the irregularity of the precipitation regime due to global climate change, the pollution of usable water resources and the destruction of some of them will make it necessary to limit the amount of water to be allocated to agriculture in the near future. This situation makes it necessary to use the soil and water potential allocated for agricultural purposes with the highest possible efficiency and to obtain the highest efficiency to be obtained from a unit of water used (Korukçu and Büyükcangaz, 2003). This is possible with intensive agriculture in which the appropriate amount of water and fertilizer is applied together with high-yielding varieties (Singh et al., 2009). However, due to the increasing demand for water in urban and industrial areas and the decrease in water resources, it is not possible to allocate more water to the agricultural sector and the increase in the irrigated area is gradually decreasing. Therefore, it is necessary to focus on alternative water sources, especially in the agricultural sector, and industrial and urban treated wastewater is the leading alternative water source. In arid and semi-arid regions, treated wastewater is considered to be an important source of irrigation water and a good fertilizing agent, thanks to the valuable elements it contains (AI-Rashed and Sherif, 2000; Chung et al., 2011; Babayan et al., 2012; Al-Dulaimi et al., 2012). The agricultural use of domestic wastewater helps to protect the environment and also brings with it other national objectives such as providing sustainable agriculture while conserving scarce water resources. Although the use of waste water has many benefits in irrigation, some precautions should be taken to prevent short and long-term environmental risks, since the reuse of this water in an inappropriate way can create serious environmental and health problems (Angelakis et al., 1999). Grains belonging to the Poaceae family, which include wheat, barley, oats, and rye, take the first place in the consumption of plant-based nutrients, followed by species belonging to the Fabaceae family, with examples such as beans, broad beans, and lentils. Legumes play a key role in human and animal nutrition due to the high protein content in their fruits, roots, stems and leaves. Lentil is a legume with a high nutritional content that contains 23-31% protein, vitamins A, B, C and K (Doğan et al., 2014), and it has the same rate as soybeans in terms of calories (Akçin, 1988). It is very important for humans thanks to the amino acids threonine and lysine in its content. These amino acids are almost similar in nutritional value to beef (Aydoğan et al., 2003; Baysal, 1988). Lentils have a key role in meeting the nutritional needs of not only humans but also animals. And it is preferred in the first place due to the fact that it contains less cellulose along with the nutritional values it contains (Aydoğan et al., 2003).

In this study, the effects of control and four different diluted treated wastewater concentrations on germination and seedling growth of two different lentil cultivars were investigated.

MATERIAL and METHODS

The study was carried out under laboratory conditions in 2020 in the rapid breeding and climate room in the Agricultural Application and Research area of Bilecik Şeyh Edebali University. The treated wastewater used in the study was taken from the municipal wastewater treatment plant located in Söğüt district of Bilecik province. The chemical values of the treated wastewater are given in Table 1.

Table 1. Chemical analysis results of the treated wastewater used in the study

Chemical properties of treated wastewater	Average values
Total Suspended Solids (mg/lt)	37.5
Chemical Oxygen Demand (mg/lt)	83.7
Biological Oxygen Demand (mg/lt)	25.2
pH	7.6
Total Nitrogen (mg/lt)	10.0
Total Phosphorus (mg/lt)	0.9

The experiment was set up in a randomized plot design with 4 replications under controlled conditions. Ceren and Ankara yeşili lentil cultivars were used, with a total of 30 lentil seeds in each replication. In the study, treated wastewater doses of 25%, 50%, 75%, 100% and control were used. The definitions of the treated wastewater concentration used in germination are given in Table 2.

Table 2. Treated wastewater concentrations for the experiment

Study subjects	The defination of study subjects
Control	100 % pure water was used
% 25	25 % wastewater and 75 % pure water was used
% 50	50 % wastewater and 50 % pure water was used
% 75	75 % wastewater and 25 % pure water was used
% 100	100 % wastewater was used

Before setting up the experiment, lentil seeds were kept in 3% sodium hypochlorite solution for surface sterilization for 10 minutes, then washed and sterilized by rinsing in distilled water. After the sterilization process was completed, filter papers were placed under the pots to be germinated and 30 lentil seeds were placed on each. After the seeds were placed in the pots, 20 ml of treated wastewater at different doses diluted on them was added and placed in the climate chamber set at 25 °C. Germination was followed for 8 days and seeds which rootlets exceeded at least 2 mm were considered germinated. As the water decreases during germination, the top is completed. After the 8th day of germination, 10 samples were taken from each germination pot and seedling and rootlet lengths were determined from these samples. After the measurements were made, the wet weights of the same samples were weighed and dried in an oven at 65 °C until they reached a constant weight, and their dry weights were determined. To determine the Vigor index, root and shoot lengths were added for each application and multiplied by the germination rate (Abdul-Baki and Anderson, 1973; Doğrusöz et al., 2021). The obtained data were subjected to the variance analysis test by using the Minitab 19 package program according to the randomized plot design, and the LSD multiple comparison test was used to compare the means (Minitab, 2019).

RESULTS and DISCUSSION

In the study, the effects of different concentrations of treated wastewater on germination rates, root lengths, shoot lengths, seedling fresh weight, seedling dry weight and vigor index of 2 different lentil cultivars were found to be statistically significant. In the study, Ceren variety gave better results in terms of germination rate, shoot length and vigor index, while Ankara yeşili gave better results in terms of root length, seedling fresh weight and seedling dry weight. The difference between the varieties in terms of germination rate was found to be statistically significant. The highest germination rate was obtained from Ceren variety with 97.33% and the lowest value was obtained from Ankara yeşili variety with 94.33%. According to the control subject, as the concentration of treated wastewater increased, the germination rate increased, and the highest germination rate was obtained as 99.16% from Ceren cultivar, which applied 50% treated wastewater concentration. The lowest germination rate was obtained as 92.50% from the Ankara yeşili cultivar, where 25% and 100% treated wastewater concentration was applied. Although the highest germination rate was obtained from Ceren 50% döşe. The 75% and 100% doses of the same cultivar were statistically in the same group with 50% dose. In parallel with the results we obtained, Özcan and Oluk (2005), Saravanamoorthy and Kumari (2007); Dash, (2012); Gassama et al. (2015); Kardeş et al. (2019); Kardeş et al. (2020) reported that treated wastewater increases the germination rate up to a certain concentration and then decreases in their studies on different plants. When we look at the shoot and root lengths, statistically significant differences were found between the varieties and Ceren cultivar gave better results in terms of shoot length and Ankara yeşili gave better results in terms of root length. The shoot length increased as the treated wastewater concentration increased. The highest shoot length was obtained from the interaction of Ceren × 100 % as14.35 cm, and the lowest shoot length value was obtained from the interaction of Ankara yeşili × 25 % as 6.10 cm. As the treated wastewater concentration increased, the root length increased up to a certain level and then decreased. The highest average root length value was obtained from 75% concentration with 6.20 cm and the lowest root length was obtained from the control subject with 4.80 cm. When we look at the variety × concentration interactions, the highest root length value was obtained from Ankara yeşili × 75% and Ceren × 75% interactions with 6.20 cm, and the lowest root length value was obtained from the Ceren × 25 % interaction with 4.33 cm. Other researchers have obtained similar results in their studies on different plants and reported that as the concentration of treated wastewater increases up to a certain point, the root and shoot lengths increase and then decrease (Özcan and Oluk, 2005; Munir et al., 2007; Dash, 2012; Daifi et al., 2015; Daud et al., 2016; Kardeş et al., 2020). When we look at the seedling fresh and dry weights, significant differences were found between the varieties and higher results were obtained from the Ankara yeşili variety than the Ceren variety. As the treated wastewater concentration increased, the seedling fresh weight values increased and the highest average value was obtained from 100 % concentration with 1.26 mg, and the lowest average value was obtained from 25 % concentration as 0.89 mg. Seedling dry weight values also varied between 0.14-0.19 mg, and the highest seedling dry weight was obtained from 25 % concentration and the lowest dry weight was obtained from 100% treated wastewater concentration. When we look at the variety × concentration interaction, the highest seedling fresh weight was obtained with 1.39 mg from Ankara yeşili × 100% interaction, and the lowest value was obtained from the Ceren × Control interaction with 0.70. In similar studies on the subject, researchers reported that as the treated wastewater concentration increased, the fresh and dry weight of seedlings increased at a certain rate and then decreased (Khan et al., 2011; Daifi et al., 2015; Daud et al., 2016; Kardeş et al., 2020).

Table 3. Average values of lentil cultivars and treated wastewater concentration

	Germination percentage (%)	Shoot length (cm)	Root length (cm)	Seedling fresh weight (g)	Seedling dry weight (g)	Vigor index
Cultivars						
Ankara Yeşili	94.33 a	7.46 b	5.70 a	1.18 a	0.21 a	1293.83 b
Ceren	97.33 b	10.57 a	5.10 b	0.94 b	0.12 b	1531.03 a
Concentration						
Kontrol	95.00 ab	6.38 c	4.80 d	0.90 b	0.18 ab	1062.37 c
25%	93.33 b	6.48 c	5.11 cd	0.89 b	0.19 a	1074.97 c
50%	98.33 a	9.81 b	5.13 c	1.13 a	0.17 abc	1472.24 b
75%	97.08 a	10.93 a	6.20 a	1.13 a	0.16 bc	1667.16 a
100%	95.41 ab	11.48 a	5.71 b	1.26 a	0.14 c	1650.42 a

Vigor index, that is, seedling strength index, is a parameter used as a combination of germination rate and seedling physical properties. As a result of the analyzes, a significant difference was found between the varieties in terms of vigor index and higher results were obtained from Ceren variety than Ankara yeşili variety. The effect of the treated wastewater concentration on the vigor index was found to be significant and the highest vigor index average value was obtained from the concentration of 75% with1667.16, and the lowest average value was obtained from the control subject with 1062.37. When we look at the variety×concentration interaction, the highest value was obtained from Ceren × 75% interaction as 1968.92, and the lowest value was obtained from Ceren × control interaction as 1055.83.

Table 4. Effect of Cultivar × Treated wastewater interaction on germination and seedling growth characteristics

Cultivars	Concentration	Germination percentage (%)	Shoot length (cm)	Root length (cm)	Seedling fresh weight (g)	Seedling dry weight (g)	Vigor index
Ankara Yeşili	Kontrol	93.33 cd	6.13 d	5.35 b	1.10 bc	0.25 a	1068.90 d
	25%	92.50 d	6.10 d	5.90 a	1.02 bc	0.24 a	1092.78 d
	50%	97.50 abc	8.40 c	5.00 b	1.27 ab	0.22 ab	1309.90 c
	75%	95.83 abcd	8.05 c	6.20 a	1.14 abc	0.19 b	1365.40 c
	100%	92.50 d	8.60 c	6.05 a	1.39 a	0.19 b	1362.17 c
Ceren	Kontrol	96.67 abcd	6.63 d	4.35 c	0.70 e	0.13 c	1055.83 d
	25%	94.17 bcd	6.85 d	4.33 c	0.75 de	0.14 c	1057.17 d
	50%	99.16 a	11.23 b	5.28 b	0.99 cd	0.12 c	1634.58 b
	75%	98.33 ab	13.80 a	6.20 a	1.12 bc	0.12 c	1968.92 a
	100%	98.33 ab	14.35 a	5.38 b	1.14 abc	0.10 c	1938.67 a

Due to the water shortage in arid and semi arid regions, the use of treated wastewater, especially in the agricultural sector, has become an important issue (Jalali et al., 2007). The use of treated wastewater in agriculture is a very important issue in terms of both waste management and water resources management. With the use of treated wastewater in agriculture, it will be an alternative source to clean water resources and will also reduce the use of fertilizers thanks to the nutrients it contains, as seen in our study.

CONCLUSION

In this study, the effects of domestic treated wastewater on lentil germination were investigated and the results of the study showed that the treated wastewater concentration increased the germination rate up to 75% and then decreased it again. These results show us that the nutrients in the treated wastewater create a fertilizer effect up to a certain level and encourage germination and seedling growth. With the use of treated wastewater for agricultural irrigation, it will be an alternative source to the diminishing water resources and better management of water resources will be provided. However, when using treated wastewater for agricultural irrigation purposes, it is recommended to be diluted to avoid soil and groundwater pollution.

REFERENCES

Abdul-Baki, A.A., Anderson, J.D. 1973. Vigor determination in soybean seed by multiple criteria 1. Crop science, 13(6), 630-633.

AI-Rashed, M.F., Sherif, M.M. 2000. Water resources in the gcc countries: an overview. Water Resour. Mgt., 14(1): 59-73.

Akçin, A. 1988. Edible Grain Legumes. Selcuk University, Faculty of Agriculture Publications: 43: 377.

Al-Dulaimi, R.I., Ismail, N.B., Ibrahim, M.H. 2012. The effect of ındustrial wastewater in seed growth rate: a review. Int. J. Sci. Res. Pub. 2: 1-4.

Angelakis, A. N., Do Monte, M. M., Bontoux, L., Asano, T. 1999. the status of wastewater reuse practice in the mediterranean basin: need for guidelines. Water Research, 33 (10): 2201-2217.

Aydoğan, A., Aydın, N., Karagöz, A., Karagül, V., Horan, A., Gürbüz, A. 2003. iç anadolu ve kuzey geçit bölgelerindeki yeşil mercimek (*lens culinaris* medik.) genetik kaynaklarının toplanması, karakterizasyonu ve ön değerlendirmesi. Türkiye, *5*: 13-17.

Babayan, M., Javaheri, M., Tavassoli, A., Esmaeilian, Y. 2012. effects of using wastewater in agricultural production. African Journal of Microbiology Research, 6(1): 1-9.

Baysal, A.S., Basoglu, S. 1988. Role of chickpeas and lentils in human nutrition. chickpeas and lentils symposium. January 14-15 1988, Turkish Grain Board Press, 17-23, Antalya, Turkey.

Chung, B.Y., Song, C.H., Park, B.J., Cho J.Y. 2011. Heavy metals in brown rice (*Oryza sativa* L.) and soil after long-term ırrigation of wastewater discharged from domestic sewage treatment plants. Pedosphere 21: 621-627.

Daifi, H., Alemad, A., Khadmaoui, A., El hadi, M., El kharrim, K. and Belghyti, D. 2015. effect of purified ındustrial wastewater on the growth of tomato plant (*Lycopersicon esculentum*). *Int. J. Pure App. Biosci.* 3 (4): 57-64.

Dash, A.K. 2012. Impact of domestic wastewater on seed germination and physiological parameters of rice and wheat. Int. J. Res. Rev. Appl. Sci.,12: 280-286.

Daud, M.K., Hassan, S., Azizullah, A., Jamil, M., Rehan, N., Irum, R., Qaiser, M.K., Zhu, S.J. 2016. physiological, biochemical, and genotoxic effects of wastewater on maize seedlings. Polish Journal of Environmental Studies, 25(2): 563-571.

Doğan, Y., Toğay, Y., Toğay, N. 2014. Mardin Kızıltepe koşullarında farklı ekim zamanlarının mercimek (*Lens culinaris* Medic.) çeşitlerinde verim ve verim öğelerine Etkisi. Tekirdağ Ziraat Fakültesi Dergisi, 11(2), 51-58.

Gassama, U.M., Puteh, A.B., Abd-Halim, M.R., Kargbo, B. 2015. ınfluence of municipal wastewater on rice seed germination, seedling performance, nutrient uptake, and fchlorophyll content. Journal of Crop Science and Biotechnology, 18(1): 9-19.

Çopur Doğrusöz, M., Gülümser, E., Başaran, U.,Hanife, M. (2021). Alkali stresinin farklı mürdümük geneotiplerinde (*Lathyrus sativus* L.) çimlenme gelişimine etkisi. ISPEC Journal of Agricultural Sciences, 5(2), 257-266.

Jalali, M., Merikhpour, H., Kaledhonkar, M. J., Van Der Zee, S. (2008). effects of wastewater ırrigation on soil sodicity and nutrient leaching in calcareous soils. agricultural water management, 95(2): 143-153.

Kardeş, Y. M., Karaer, M., Erbas Köse, Ö. D., Mut, Z. 2020. The effect of treated wastewater applications on germination and seedling growth in three different corn (Z*ea mays* L.) cultivar. Bilecik Seyh Edebali University Journal of Science, *7*(1), 113-120.

Kardeş, Y. M., Mut, Z., Gültaş, H.T., Erbas Köse, Ö.D., Karaer, M. 2019. Effect of treated wastewater on germınatıon and seedlıng growth of two different bean (*Phaseolus vulgaris* L.) cultivar. III. International Eurasian Agriculture and Natural Sciences Congress, 17-19 October, Antalya, Turkey.

Khan, M. A., Shaukat, S. S., Hany, O., Jabeen, S. 2010. Irrigation of sorghum crop with waste stabilization pond effluent: growth and yield responses. Pak. J. Bot, 42(3): 1665-1674.

Korukçu, A., Büyükcangaz, H. 2003. Su ve sulama yönetimine bütünsel yaklaşım. 2. Ulusal Sulama Kongresi. 16-19 Ekim, Kuşadası, İzmir.

Minitap (2020) Version 19. http://www.minitab.com/enus/products/minitab.

Munir, J., Rusan, M., Hinnawi, S., Rusan, L. 2007. long term effect of wastewater ırrigation of forage crops on soil and plant quality parameters. Desalination, 215: 143-152.

Özcan, S., Oluk, S. 2005. Effects of treated wastewaters on seed germinatıon and seedlıng growth to the some grass species. Kastamonu Eğitim Dergisi, 159.

Saravanamoorthy, M.D., Kumari, B.D.R. 2007. effect of textile wastewater on morphophysiology and yield on two varieties of peanut (*Arachis hypogaea* L.). J. Agric. Technol., 3: 335-343.

Singh, R., Kumar, S., Nangare, D.D., Meena, M.S. 2009**.** Drip ırrigation and black polyethylene mulch ınfluence on growth, yield and water-use efficiency of tomato. African Journal of Agricultural Research, 4(12): 1427-1430.