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ARAŞTIRMA MAKALESİ **RESEARCH ARTICLE**

Determination of Desalinated Sea Water Usage Possibilities in *Muscari armeniacum* (Grape Hyacinth) Cultivation

Muscari armeniacum (Üzüm Sümbülü) Yetiştiriciliğinde Tuzdan Arındırılmış Deniz Suyu Kullanım Olanaklarının Belirlenmesi

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Abstract

In the current period of time, many environmental problems have occurred in the world with the population increase, industrialization and construction, along with migration from rural areas to urban areas. Among the environmental problems that occur due to all these developments; the decrease in potable and usable freshwater resources, global warming, climate change and drought are the leading environmental problems. This study was carried out in the open field of a private apartment building in Izmir, Turkey to determine the possibility of using desalinated seawater in the cultivation of *Muscari armeniacum* Leichtlin ex Baker. Depending on the purpose of the study, *Muscari armeniacum* Leichtlin ex Baker was grown using desalinated seawater and tap water (control). To determine the effect of desalinated seawater on plant growth, leaf length, leaf width, root length, underground part weight, number of bulblets and upper part weight were measured. It was observed that *Muscari armeniacum* Leichtlin ex Baker plants showed normal growth when desalinated seawater was used throughout the experiment. According to the statistical analysis, the difference between desalinated sea water and tap water was significant only in leaf length and leaf width parameters. While the average leaf length was 54.47 cm and leaf width were 5.71 mm in tap water (control), the average leaf length was 53.47 cm and leaf width were 5.19 mm in desalinated sea water treatment. The effect of irrigation water sources on other parameters was statistically insignificant. As a result of the study, desalinated seawater can be used for the cultivation of *Muscari armeniacum* Leichtlin ex Baker. It is recommended that studies evaluating the possibilities of using desalinated sea water in the cultivation of different ornamental plant species will contribute to the literature.

Keywords: Desalination, *Muscari armeniacum*, Ornamental plant cultivation, Irrigation

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Öz

İçinde bulunduğumuz zaman diliminde kırsal alanlardan kentsel alanlara doğru yapılan göçler ile birlikte gerçekleşen nüfus artışı, sanayileşme ve yapılaşma ile birlikte dünya üzerinde birçok çevre sorunu meydana gelmiştir. Tüm bu gelişmelere bağlı olarak meydana gelen çevre sorunları içerisinde; içilebilir ve kullanılabilir tatlı su kaynaklarındaki azalma, küresel ısınma, iklim değişikliği ve kuraklık bu çevre sorunlarının başında gelmektedir. Bu çalışma, *Muscari armeniacum* Leichtlin ex Baker yetiştiriciliğinde tuzdan arındırılmış deniz suyunun kullanım olasılığını belirlemek amacıyla Türkiye'nin İzmir ilinde özel bir apartman dairesine ait açık alanda gerçekleştirilmiştir. Çalışmanın amacına bağlı olarak *Muscari armeniacum* Leichtlin ex Baker, tuzdan arındırılmış deniz suyu ve musluk suyu (kontrol) kullanılarak yetiştirilmiştir. Tuzdan arındırılmış deniz suyunun bitki gelişimi üzerindeki etkisini belirlemek için yaprak uzunluğu, yaprak genişliği, kök uzunluğu, toprak altı kısım ağırlığı, yavru soğan sayısı ve üst aksam ağırlığı parametreleri ölçülmüştür. *Muscari armeniacum* Leichtlin ex Baker bitkileri, deneme süreci boyunca tuzdan arındırılmış deniz suyu kullanımında normal büyüme gösterdiği gözlemlenmiştir. Yapılan istatistiksel analizlere göre, tuzdan arındırılmış deniz suyu ve musluk suyu kullanımlarının bitkiler üzerinde sadece yaprak uzunluğu ve yaprak genişliği parametrelerinde gösterdiği farklılık önemli olarak görülmüştür. Musluk suyu (kontrol) kullanımında ortalama yaprak uzunluğu 54.47 cm, yaprak genişliği 5.71 mm olurken, tuzdan arındırılmış deniz suyu arıtımında ortalama yaprak uzunluğu 53.47 cm, yaprak genişliği ise 5.19 mm olarak gerçekleşmiştir. Sulama suyu kaynaklarının diğer parametrelere etkisi istatiksel olarak önemsiz bulunmuştur. Çalışmanın sonucu olarak *Muscari armeniacum* Leichtlin ex Baker bitkisi yetiştiriciliğinde tuzdan arındırılmış deniz suyu kullanılabilir olduğu görülmüştür. Tuzdan arındırılmış deniz suyunun farklı süs bitkisi türlerinin yetiştiriciliğinde kullanım olanaklarının değerlendirildiği çalışmaların yapılmasının literatüre katkı sağlayacağı yönünde tavsiyelerde bulunulmuştur.

Anahtar Kelimeler: Tuzdan arındırma, *Muscari armeniacum*, Süs bitkisi yetiştiriciliği, Sulama

1. Introduction

The excessive increase in population, construction and industrialization in the world causes many environmental problems. Global warming and climate change, increase in urban heat island effect, decrease in natural resources due to high use and drought are the most important of these problems (Beyaz, 2023). Especially the decrease in freshwater resources and unconscious-high water consumption is the factor that affects the present and the future most deeply. Water is the most valuable natural resource and is very important for all living life on earth (Bakanoğulları et al., 2022). Water is the most common compound in the world as a resource and covers most of the planet. Unfortunately, only a very small portion of this resource is available. 97.4% of the world's water resources are salt water and 2.6% are fresh water. Only 0.8 per cent of freshwater resources are potable and usable. The remaining part of fresh water that is potable and usable is glaciers, snow-covered areas and unusable (Polat, 2013). In this case, different practices are carried out to protect freshwater resources. For example, in countries such as the USA, Saudi Arabia, Australia and China, treated wastewater is used for reuse in urban open-green areas for irrigation, ornamental plant cultivation and agricultural irrigation (Laurenson et al., 2012; Zhang and Shen, 2019; Singh, 2021). In addition, arid landscape approaches to minimize water use in urban areas also appear as a different application in this regard (Kavuran and Yılmaz, 2022). In addition to all these, the transformation of salty water, i.e. seawater, which constitutes the majority of the world's water amount, into potable and usable fresh water stands out as an unlimited potential in terms of creating water supply (Nasar, 2014).

For seawater to be used for drinking water or domestic use, many countries carry out studies for desalination processes, establish facilities and make them available to their citizens. Saudi Arabia, United Arab Emirates, USA, Libya, Libya, Japan, and Spain are examples of these countries (Alabdula'aly, 1997; Polat Bulut, 2021). In addition to the potability of seawater, there are many studies in the literature on its use in agricultural production. Martinez-Mate et al. (2018), in their study, focused on the use of desalinated seawater (DSW) in hydroponic systems in regions experiencing water scarcity and lettuce production with this system in Southeast Spain. They stated that lettuce production in hydroponic systems is more efficient than traditional methods in terms of water efficiency and greenhouse gas emissions. They also found that although DSW increased energy use by 17% in hydroponic systems, greenhouse gas emissions were low. In the study, they stated that the energy dependence required for DSW can be met with renewable systems. Therefore, they suggested that the use of hydroponic systems with DSW in regions where freshwater resources are scarce may be a highly efficient strategy in terms of production. Aznar-Sánchez et al. (2021), in their study, examined farmer profiles and behaviours of farmers in Southeast Spain towards the use of DSW for irrigation purposes. They determined that although the use of DSW as an alternative water use is planned in Southeastern Spain, the demand of farmers is low at this point. They suggested that necessary programmes should be carried out to increase the use of DSW by farmers. At this point, a survey was conducted in the study area. As a result of the survey, they determined that there are different farmer typologies in the region and that farmers have different attitudes and preferences towards DSW. As the main finding of the study, they have determined that the pricing of the use of DSW is mainly effective on farmers. As a result, they made recommendations to encourage the use of DSW by farmers. Martínez-Alvarez et al. (2023), in their study, examined the supply of DSW for agricultural uses in Southeast Spain from a multidisciplinary perspective. In the study, they stated that DSW has been used steadily in the region in the last 10 years and has given successful results in agricultural production. On the other hand, they also examined the energy consumption and cost related to the supply of DSW. At this point, they suggested that if the energy need is met by using renewable energy sources, the costs can be reduced considerably. However, from different perspectives, they also stated that the use of traditional freshwater resources and DSW will provide maximum benefit.

Among the studies conducted on the production of agricultural plants from desalinated seawater, Maestre-Valero et al. (2020) investigated the usability of desalinated sea water in irrigation in the young stages of plants for citrus production. In the study they carried out during two crop periods, they irrigated with only tap water (Control), a mixture of 50% tap water and 50% desalinated sea water, and only desalinated sea water. Although they did not observe any statistical difference in the development parameters of the plants in their results, they determined concentrations that could increase element-based toxicity in the leaves of some plants. On the other hand, they stated that the use of desalinated sea water as irrigation water in the young stages of plants would not pose a problem. Antolinos et al. (2020) mentioned that both soilless plant cultivation and alternative water sources are very important in arid and semi-arid climates. They grew two different types of tomatoes in hydroponic systems using only desalinated sea water, only tap water, and a mixture of the two. Although the dry matter content, colour and acidity values showed differences because of the trial, they stated that these differences were at a tolerable level and acceptable to the consumer. As a result, they showed that desalinated seawater can be used in hydroponic systems and that it can be more cost-effective.

This study was carried out to determine the possibility of using desalinated sea water (DSW) as irrigation water in the cultivation of *Muscari armeniacum* Leichtlin ex Baker for the conservation and sustainable use of freshwater resources.

2. Material and Method

The study was conducted between March 2023 and June 2023, when Muscari armeniacum has the highest utilization criteria for landscape architecture (Kılıçaslan and Dönmez, 2016), in the open area of a private apartment building in the Buca district of Izmir. *Muscari armeniacum* Leichtlin ex Baker (Grape Hyacinth) with bulb circumference of 5-6 cm was used as plant material in the study. Grape Hyacinth bulbs were obtained from Asya Tulip company, which produces and trades bulbous plants in Karatay district of Konya.

Grape Hyacinth bulbs were grown in 6-litre plastic pots measuring 31x19x17 cm. A mixture of peat and perlite (v/v) was prepared as growing medium and this mixture was filled into the growing pots. The analysis of peat and perlite used in the mixture are given in *Tables 1* and *2*.

Table 1. Analysis values of the peat used in the growing medium.

Parameters	Analysis Values
pH	5.5-6.8
EC (µS/cm)	220
Organic Matter (%)	54-60
Humidity (%)	53.43
Purity (%)	95

Table 2. Analysis values of perlite used in the growing medium.

Parameters	Analysis Values
Density	70-80 kg/m^3 (±%10)
Grain Diameter	0-6 mm
Thermal Conduction Coefficient	0.040-0.045 Kcal/mhC
Chemical Composition	SiO_2 (%74)
	Al_2O_3 (%14)
	Na_2O (%3)
	K_2O (%5)
	MgO (%0.5)
	CaO (%0.5)
	Fe_2O_3 (%1)
pH	7
Melting Point	1200 ^oC

In the study, only tap water (control) and only desalinated sea water were applied to grape hyacinth bulbs. Sea water was obtained from Ilıca Public Beach in Çeşme district of İzmir, where 38°18'31.08'' north parallel and 26°22'29.33'' east meridian intersect. The seawater was boiled in a 5 litre aluminium teapot and the steam from the jug was directed to the condensation vessel through a hose. The water vapour was condensed by cooling the condensation vessel with ice moulds and desalinated sea water (DSW) was obtained. The pH (Joytech pH Meter) and EC (Zauss TDS and EC Meter) values of tap water and desalinated seawater were measured before and after desalination (*Table 3*). Tap water and desalinated seawater were added to the growing medium with the help of a nosed flower watering can until water came out of the drainage holes of the plastic containers.

Table 3. pH and EC values of tap water and seawater before and after desalination

	pH	EC (µS/cm)
Before Desalination of Sea Water	7.5	19990
After Desalination of Sea Water	7.6	860
Tap Water	7.8	464

The study was established according to the random plots experimental design with three replications. Grape hyacinth bulbs were planted in the growing medium at a depth of 4 cm and planting distance of 7x6 cm on 4 March 2023. In each replicate (in pots), 12 grape hyacinth bulbs were used. Plants were grown for 12 weeks with only desalinated seawater and tap water.

Leaf length and leaf width parameters were measured every 4 weeks to determine plant growth. On 4 June 2023, root length, root weight, number of bulbs and top weight were measured after uprooting. The measurements were made as follows.

•Leaf length: It is the measurement made with the help of a ruler from the exit point to the tip of the leaves of the plant.

•Leaf width: It is the measurement made with callipers from the widest part of the leaf.

• Root length: It is the measurement made with the help of a ruler from the base of the onion to the end point.

•Underground part weight: It is the measurement obtained by weighing the onions, bulbs, bulblets and roots on a precision balance.

•Upper part weight: It was obtained by weighing the leaves, flower stems and flowers cut from the onion nose on a precision balance.

•Number of bulblets: It was obtained by counting the number of daughter bulbs formed by the mother bulb after harvesting.

Normality test was performed on the monthly measurement data obtained from each parameter. In normality test, skewness/ kurtosis values of all data were divided by standard deviation values. All the results obtained were between -1.96 and 1.96 and it was determined that all of the data showed normal distribution (Büyüköztürk, 2011). Independent Groups T test was applied to the data using SPSS 27 (IBM SPSS Statistics, Chicago, USA) statistical programme and the differences of irrigation methods on the measurement parameters were determined (p=0.05).

3. Results and Discussion

As a result of the statistical analyses, it was determined that tap water (control) and desalinated sea water treatments caused a significant difference between the treatments on leaf length at the end of the 4th, 8th and 12th week at 95% confidence interval. In all three periods, leaf length values of tap water treatment were greater than desalinated sea water treatment (*Figure 1*).

The results of the Independent Groups T test on the averages of leaf length values are given in *Table 4*.

Table 4. Independent Groups T test results for the effect of treatments on the mean values of leaf length in the measurement periods of the experiment

	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Week 4 Leaf Length	0.986792	0.376755	12.555845	4.00	0.000232*	4.333333	0.345125
Week 8 Leaf Length	1.475032	0.291347	10.925935	4.00	0.000399*	1.250000	0.114407
Week 12 Leaf Length	0.491371	0.521951	3.355151	4.00	0.028433*	1.000000	0.298049
Significance:	p<0.05: There is a significant difference (*). / p>0.05: No significant difference						

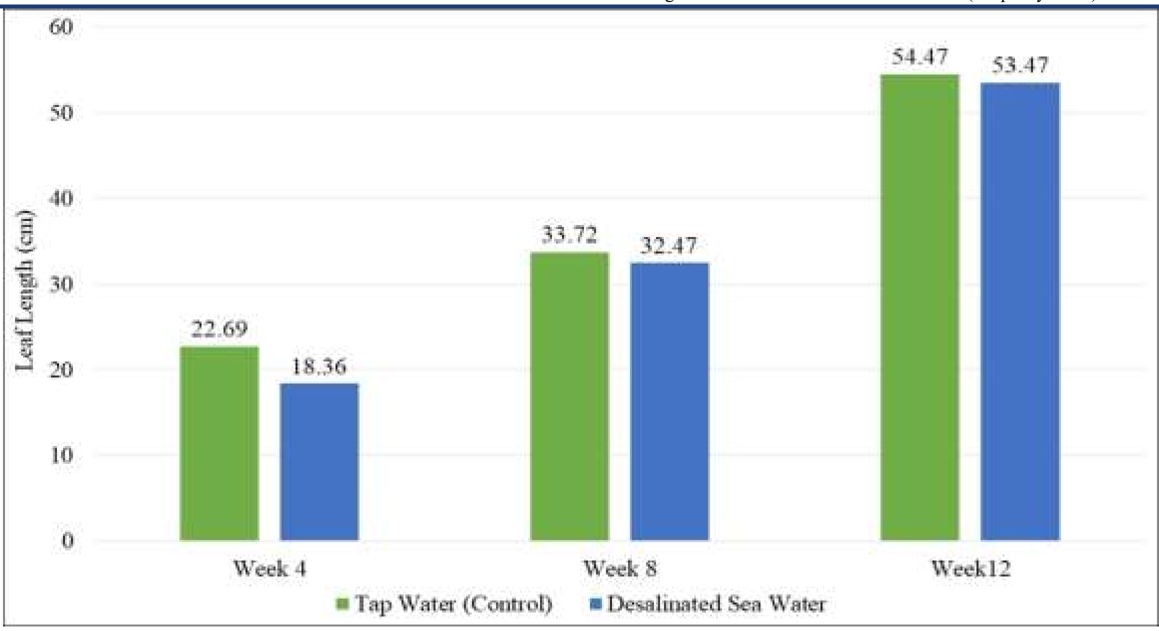

Figure 1. Effect of irrigation treatments on leaf length at different periods

Tanrıverdi (2019), in his study listing geophyte plants found in the flora of Yalova province, determined that the leaf length values of the *Muscari armeniacum* plant varied between 10-40 cm. In this study, similar leaf length results were obtained at the end of the 4th and 8th weeks, but greater values were obtained at the end of the 12th week than in this study.

Leaf width values varied between 5 mm and 7 mm in tap water (control) treatments and between 4 mm and 6 mm in desalinated sea water treatments. The results of Independent Groups T test on the averages of leaf width values are shown in *Table 5*.

Table 5. Independent Groups T test results for the effect of the treatments on the mean leaf width values in the measurement periods of the experiment

	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Week 4 Leaf Width	0.235294	0.652994	5.728716	4.00	0.004597*	0.063333	0.110554
Week 8 Leaf Width	0.000000	1.000000	5.656854	4.00	0.004813*	0.053333	0.094281
Week 12 Leaf Width	0.000000	1.000000	5.656854	4.00	0.004813*	0.053333	0.094281
Significance:	p<0.05: There is a significant difference (*). / p>0.05: No significant difference						

At the end of the 4th, 8th and 12th week, the leaf length of plants treated with tap water was found to be higher than that of desalinated sea water (*Figure 2*).

Gürsoy (2009) conducted biological studies on *Muscari armeniacum* and *Muscari neglectum* plants naturally distributed in Western Anatolia and investigated morphological, anatomical, palynological, seed germination and growing media of the plants. The leaf width values of *Muscari armeniacum* plant was between 1 and 5 mm on the studies. The leaf width values were obtained from this study coincide with Gürsoy (2009)'s study.

Root length values varied between 11 and 14 cm in tap water (control) treatments and between 11 and 14 cm in desalinated sea water treatments. The results of Independent Groups T test on the averages of root length values are shown in *Table 6*.

Table 6. Independent Groups T-test results for the effect of treatments on the mean root length values measured at the uprooting period of the experiment.

	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Root Length	3.287564	0.144017	1.244223	4.00	0.281346	0.193333	0.155385
Significance:	p<0.05: There is a significant difference (*). / p>0.05: No significant difference						

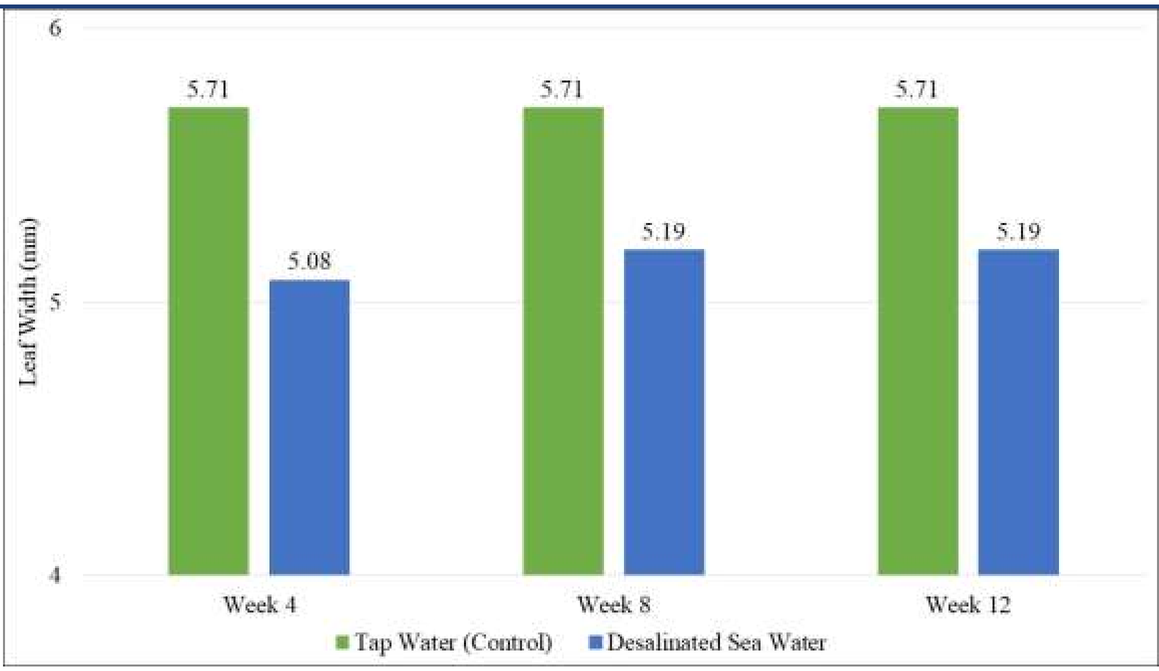

Figure 2. Effect of irrigation treatments on leaf width at different periods

The mean values of the measurement values of the root length parameter after uprooting in the experiment are shown in *Figure 3*.

Kahraman (2020) investigated the effect of 1 cm deep shallow planting, 4 cm deep medium depth planting and 7 cm deep planting depths on the growth and development of *Muscari armeniacum* plants. The lowest root length value was determined at 8.56 cm deep planting depth and the highest root length value was determined at 11.50 cm medium depth planting depth. In this study, similar root length values were found.

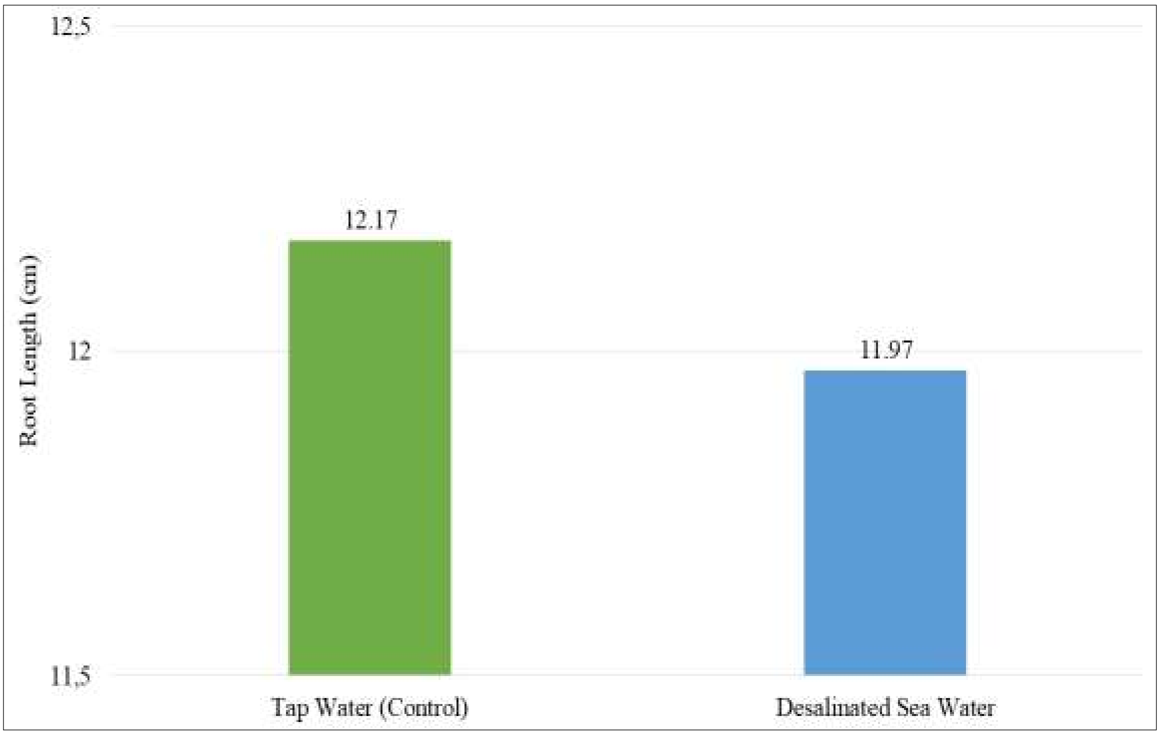

Figure 3. Effect of irrigation treatments on root length

Underground part weight values ranged between 12.18 g and 13.33 g in tap water (control) treatments and between 12.08 g and 12.66 g in desalinated seawater treatments (*Figure 4*). As a result of the statistical comparison analyses performed on the averages of the measurement values, it was observed that there was no significant difference between the two different treatments at 95% confidence interval values in the post-removal measurements of tap water (control) and desalinated sea water treatments. The results of the Independent Groups T test on the averages of the weight values of the underground part are shown in *Table 7*.

Navarro et al. (2023) used desalinated seawater in the cultivation of *Citrus macrophylla* and sour orange plants in two different irrigation methods as continuous and open irrigation. As a result of their 140-day experiment, they stated that although toxicity differences were observed in plant leaves, the use of desalinated seawater did not statistically differ in root development in plant growth parameters.

Table 7. Independent Groups T test results for the effect of treatments on the mean underground part weight values measured at the uprooting period of the experiment

	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Underground Part Weight	0.425847	0.549637	0.719475	4.00	0.511642	0.280000	0.389173
Significance:	p<0.05: There is a significant difference (*). / p>0.05: No significant difference						

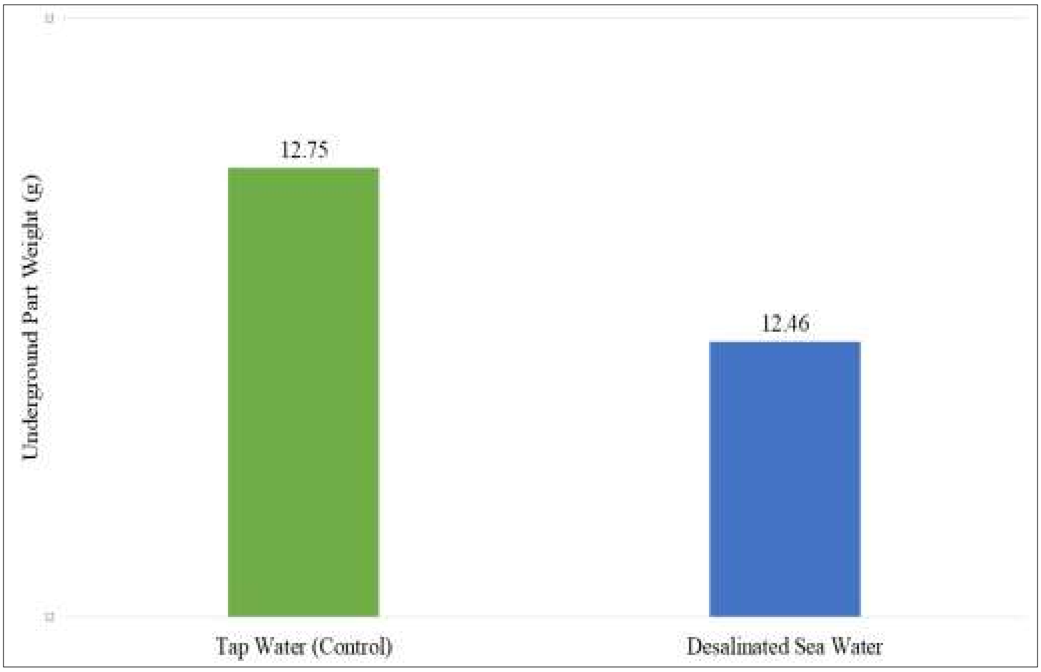

Figure 4. Effect of irrigation treatments on underground part weight

The values of the weight of the upper part varied between 10 and 17 g in tap water (control) treatments and between 10 and 16 g in desalinated sea water treatments. According to the statistical analyses, it was observed that there was no significant difference between the two different treatments at 95% confidence interval values in the measurements of tap water (control) and desalinated sea water treatments after uprooting. The results of the Independent Groups T test on the averages of the upper part weight values are shown in *Table 8*.

Table 8. Results of Independent Groups T-test for the effect of treatments on the mean upper part weight values measured during the uprooting period of the experiment

	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Upper Part Weight	2.037905	0.226598	1.879645	4.00	0.133336	0.690000	0.367091
Significance:	p<0.05: There is a significant difference (*). / p>0.05: No significant difference						

The averages of the measurement values of the upper part weight parameter after dismantling in the experiment are shown in *Figure 5*.

Kahraman (2019) investigated the effects of taking flower buds at different developmental stages on onion and plant growth of *Muscari armeniacum* plant and found that the effect of taking flower buds at different developmental stages on the weight of the upper part of the plant was statistically insignificant. In this study, it was observed that desalinated sea water as a different irrigation application did not cause a significant difference on the weight of *Muscari armeniacum* plant tops.

The number of bulblets varied between 1 and 5 in tap water (control) treatments and between 0 and 6 in desalinated sea water treatments. As a result of the statistical comparison analyses performed on the averages of the measurement values, it was observed that there was no significant difference between the two different treatments at 95% confidence interval values in the measurements of tap water (control) and desalinated sea water treatments after disassembly. The results of the Independent Groups T-test on the number of bulbs are shown in *Table 9*.

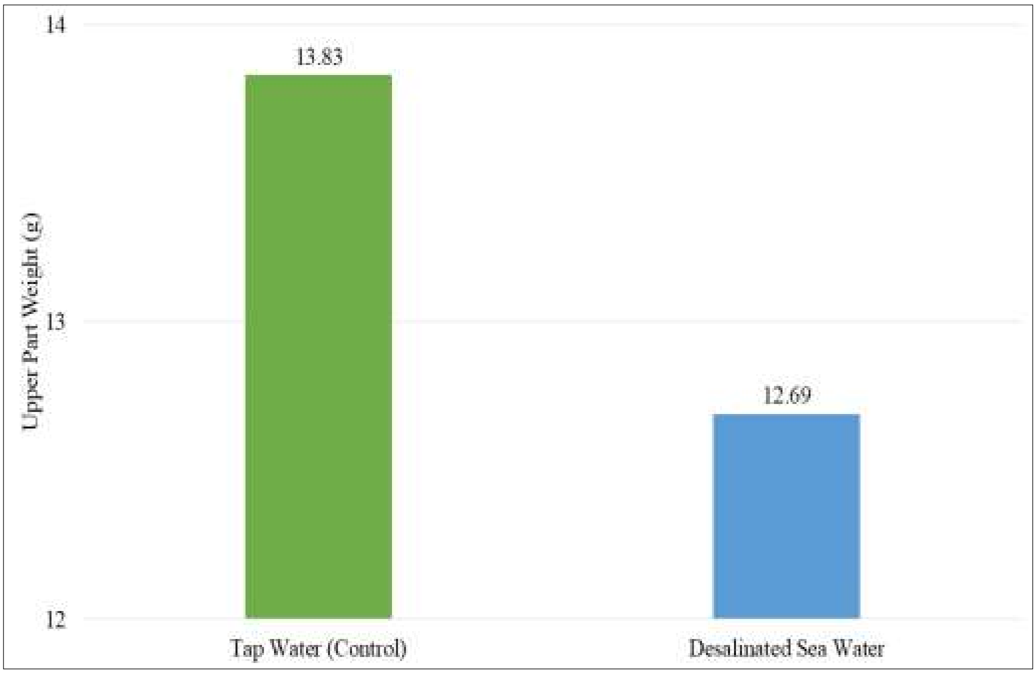

Figure 5. Effect of irrigation treatments on upper part weight

Table 9. Independent Groups T-test results for the effect of treatments on the mean number of bulblets measured at the disembarkation period of the experiment.

	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Number of Bulblets	2.117727	0.219300	0.840169	4.00	0.448100	0.166667	0.198373
Significance:	p<0.05: There is a significant difference (*). / p>0.05: No significant difference						

The averages of the measurement values of the parameter of the number of bulblets after disassembly in the experiment are shown in *Figure 6*.

Jeon et al. (2011), investigated the effect of different growth regulators on direct shoot and bulblets formation of *Muscari armeniacum*. They used MS media supplemented with NAA, DA and TDZ in tissue culture. After the completion of the experimental period, they reported that they did not observe phenotypic variations in the plants and that 1-1.5 bulblets were formed per plant on average. Plant growth regulators had insignificant effect on the number of bulblets. In this study, it was determined that irrigation treatments did not have a significant difference on the number of bulblets.

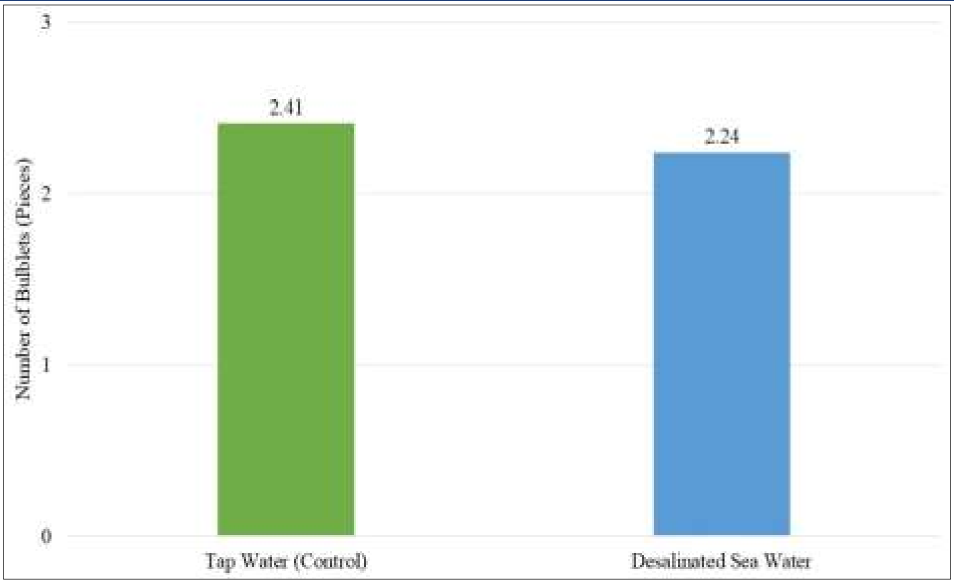

Figure 6. Effect of irrigation treatments on number of bulblets

4. Conclusions

In this study, DSW did not inhibit the growth and development of *Muscari armeniacum* Leichtlin ex Baker. As seen in the measurement parameters, the values when DSW was used were mostly below the values when the plant reached its optimum form in the control irrigation. However, the measured values obtained using DSW were tolerable, although lower than the values of the control plants. The use of DSW may have different physiological effects in different plant species. The use of DSW in ornamental plant cultivation and urban areas will contribute to the protection and sustainability of freshwater resources. For this purpose, the effects of DSW use in the cultivation of different ornamental plant species and irrigation of urban areas on plant species and the environment should be investigated.

Ethical Statement

There is no need to obtain permission from the ethics committee for this study.

Conflicts of Interest

We declare that there is no conflict of interest between us as the article authors.

Authorship Contribution Statement

Concept: Gür, N.; Kahraman, Ö., Design: Gür, N.; Data Collection and Processing: Gür, N.; Statistical Analyses: Gür, N.; Kahraman, Ö., Literature Search: Gür, N., Writing, Review and Editing: Gür, N.; Kahraman, Ö.

References

Alabdula'aly, A. I. (1997). Fluoride content in drinking water supplies of Riyadh, Saudi Arabia. *Environmental Monitoring and Assessment*, 48: 261-272. https://doi.org/10.1023/A:1005795820508

Antolinos, V., Sanchez-Martinez, M. J., Maestre-Valero, J. F., Lopez-Gomez, A. and Martinez-Hernandez, G. B. (2020). Effects of irrigation with desalinated seawater and hydroponic system on tomato quality. *Water*, 12(2): 518. https://doi.org/10.3390/w12020518

Aznar-Sanchez, J. A., Belmonte-Urena, L. J., Velasco-Munoz, J. F. and Valera, D. L. (2021). Farmers' profiles and behaviours toward desalinated seawater for irrigation: Insights from South-east Spain. *Journal of Cleaner Production*, 296: 126568. https://doi.org/10.1016/j.jclepro.2021.126568

Bakanoğulları, F., Bahar, E., Kıvrak, C. and Gür, M. (2022). Assessment of meteorological and agricultural drought analysis in Kırklareli province. *Journal of Tekirdag Agricultural Faculty*, 19(4): 756-768. https://doi.org/10.33462/jotaf.1060752

Beyaz, R. (2023). Germination and seedling properties of *Lotus cornicula*tus L. under simulated drought stress. *Journal of Tekirdag Agricultural Faculty*, 20(4): 879-889. https://doi.org/10.33462/jotaf.1226444

Büyüköztürk, Ş., Çokluk, Ö. and Köklü, N. (2011). Normalization Test. In: Statistics for Social Sciences. Pegem Akademi Publications, Turkey.

Gürsoy, M. (2009). *Biological studies on some muscari miller species (Muscari armeniacum Leichtlin Ex Baker, Muscari neglectum Guss.) distributed in Western Anatolia*. (Master's Thesis). Celal Bayar University, Institute of Science and Technology, Manisa, Türkiye.

Jeon, S. M., Chung, M. Y. and Kim, C. K. (2011). Effect of plant regulators on direct shoot formation and bulblet formation from flower stalk culture of *Muscari armeniacum* 'Early Giant'. *Current Research on Agriculture and Life Sciences*, 29: 21-27. (In Korean)

Kahraman, Ö. (2019). Effects of taking flower buds at different developmental periods on bulb and plant development of *Muscari armeniacum* Leichtlin ex Baker. *Anadolu Journal of Agricultural Sciences*, 34(1): 12-17. https://doi.org/10.7161/omuanajas.444180

Kahraman, Ö. (2020). Growing of *Muscari armeniacum* (Grape Hyacinth) at different planting depths. *Journal of Agriculture and Nature*, 23(6): 1441-1448. https://doi.org/10.18016/ksutarimdoga.vi.707845

Kavuran, D. and Yılmaz, R. (2022). Selection of appropriate plant species in xeriscape studies: Süleymanpaşa, Tekirdağ example. *Landscape*, 4(2): 69-91. https://doi.org/10.53784/peyzaj.1167964

Kılıçaslan, N. and Dönmez, Ş. (2016). The use of bulbous plants growing naturally in the lake's region in landscape architecture. *Turkish Journal of Forestry*, 17(1): 73-82.

Laurenson, S., Bolan, N. S., Smith, E. and McCarthy, M. (2012). Use of recycled wastewater for irrigating grapevines. *Australian Journal of Grape and Wine Research*, 18(1): 1-10. https://doi.org/10.1111/j.1755-0238.2011.00170.x

Maestre-Valero, J. F., Martínez-Alvarez, V., Jódar-Conesa, F. J., Acosta, J. A., Martin-Gorriz, B., Robles, J. M., ... and Navarro, J. M. (2020). Short-term response of young mandarin trees to desalinated seawater irrigation. *Water*, 12(1): 159. https://doi.org/10.3390/w12010159

Martínez-Alvarez, V., Imbernón-Mulero, A., Gallego-Elvira, B., Soto-García, M. and Maestre-Valero, J. F. (2023). Multidisciplinary assessment of the agricultural supply of desalinated seawater in south-eastern Spain. *Desalination*, 548: 116252. https://doi.org/10.1016/j.desal.2022.116252

Martinez-Mate, M. A., Martin-Gorriz, B., Martínez-Alvarez, V., Soto-García, M. and Maestre-Valero, J. F. (2018). Hydroponic system and desalinated seawater as an alternative farm-productive proposal in water scarcity areas: Energy and greenhouse gas emissions analysis of lettuce production in southeast Spain. *Journal of Cleaner Production*, 172: 1298-1310. https://doi.org/10.1016/j.jclepro.2017.10.275

Nasar, M. (2014). Exploitation survey of sea water in agriculture of coastal deserts in Libya. *Proceedings of the International Academy of Ecology and Environmental Sciences*, 4(2): 72.

Navarro, J. M., Antolinos, V., Botía, P. and Robles, J. M. (2023). Deficit Irrigation applied to lemon trees grafted on two rootstocks and irrigated with desalinated seawater. *Plants*, 12(12): 2300. https://doi.org/10.3390/plants12122300

Polat, A. (2013). Reuse of treated wastewater for the sustainability of water resources. *Turkish Journal of Scientific Reviews*, (1): 58-62.

Polat Bulut, A. (2021). Seawater use and purification technologies for increasing water needs. *Turkish Journal of Scientific Reviews*, 14(2): 124-137.

Singh, A. (2021). A review of wastewater irrigation: Environmental implications. *Resources, Conservation and Recycling*, 168: 105454. https://doi.org/10.1016/j.resconrec.2021.105454

Tanrıverdi O, D. (2019). *Geophytes of Yalova Province and their use possibilities in landscape.* (Master's Thesis). Bursa Uludağ University, Institute of Science and Technology, Bursa, Türkiye.

Zhang, Y. and Shen, Y. (2019). Wastewater irrigation: past, present, and future. *Wiley Interdisciplinary Reviews: Water*, 6(3): 1234. https://doi.org/10.1002/wat2.1234