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Responses of Different Turfgrass Mixtures to Drought

Farklı Çim Karışımlarının Kuraklığa Tepkileri

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Abstract

In this study, the responses of the most frequently used grass plants in landscape areas to drought were determined. To ensure the continuity of grass areas and to keep them green in all seasons, mixtures are widely used instead of a single species. Therefore, eight different grass mixtures were used as experimental material. The experiment was carried out under laboratory conditions at two different temperatures, 20ºC±1 and 30ºC±1. The plant was put into water stress by applying four different irrigation treatments at both temperatures. The four different irrigation treatments were determined as completing the lost moisture to the pot capacity when 40±5% of the usable water holding capacity was consumed (control) and 75%, 50% and 25% of the water applied to the control subject. Plant water consumption of grass mixtures was determined under different temperatures and irrigation treatments and changes in their visual quality were examined. Plant water consumption values varied between 3.5 and 2 mm for 20ºC±1 and 4.4 and 2.0 mm for 30ºC±1. No significant difference was observed between the varieties in terms of plant water consumption values at both temperatures. Since the I75 treatments of the 4M-JG, 4M-J, 4M-S, 4M-D and 7M varieties were above the visual quality limit at 30ºC±1 temperature, it was determined that 25% water restriction could be applied to these varieties. At 20ºC±1 temperature, it was observed that the I100, I75 and I50 subjects of all varieties were above the acceptable visual quality limit.

Keywords: Turfgrass, Landscape, Irrigation, Drought, Visual quality

Özet

Bu çalışmada, peyzaj alanlarında en sık kullanılan ve çok su tükettiği bilinen çim bitkilerinin kurak koşullara verdiği tepkiler belirlenmiştir. Çim alanların devamlılığı ve her mevsim yeşil kalabilmesi için tek tür yerine karışımlar yaygınca kullanılmaktadır. Bu nedenle, deneme materyali olarak sekiz farklı çim karışımı kullanılmıştır. Deneme, 20ºC±1'i ve 30ºC±1'i olmak üzere iki farklı sıcaklıkta laboratuvar koşullarında gerçekleştirilmiştir. Her iki sıcaklıkta da dört farklı sulama seviyesi uygulanarak bitki su stresine sokulmuştur. Dört farklı sulama seviyesi olarak kullanılabilir su tutma kapasitesinin %40±5'i tüketildiğinde eksilen nemin saksı kapasitesine tamamlanması (kontrol) ve kontrol konusuna uygulanan suyun %75'i, %50'si ve %25'i belirlenmiştir. Farklı sıcaklık ve sulama seviyeleri altında çim karışımlarının bitki su tüketimi saptanmış ve görsel kalitelerinde meydana gelen değişimler incelenmiştir. Bitki su tüketimi değerleri 20ºC±1 için 3,5 ve 2,0 mm; 30ºC±1 için 4,4 ve 2,0 mm arasında değişmiştir. İki ortam sıcaklığında da çeşitler arasında bitki su tüketim değerleri açısından önemli bir fark gözlenmemiştir. 30ºC±1 ortam sıcaklığında 4M-JG, 4M-J, 4M-S, 4M-D ve 7M çeşitlerinin I75 konuları görsel kalite sınırının üzerinde bulunduğu için bu çeşitlerde %25 oranında su kısıtı yapılabileceği saptanmıştır. 20ºC±1 ortam sıcaklığında ise bütün çeşitlerin I100, I75 ve I50 konularının kabul edilebilir görsel kalite sınırının üzerinde olduğu görülmüştür.

Anahtar Kelimeler: Çim, Peyzaj, Sulama, Kuraklık, Görsel kalite

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1. Introduction

Excessive consumption of water resources due to drought and population growth caused by global warming adversely affects the availability of water (Arnell, 1999). The distorted city formation that develops with unbalanced construction triggers global warming and damages plants. Although the plant varieties in the cities differ according to the climatic conditions of the region, it can be said that the most important factor affecting plant density and vitality is water (Imadi et al., 2016). Plants cannot survive and develop in the absence of water. Since the lack of water sources threatens the future of plants, the importance of studies on this subject is increasing day by day. Due to the large water consumption in open green areas, water management in landscape areas should be well provided. Although there is a lot of data on the amount of irrigation water used in agricultural areas, the limited data on water consumption in landscape areas worsens the situation (Demirel, 2022). A more balanced and efficient irrigation application should be made in order not to jeopardize the future of these areas. To achieve this, it should be known how much water each plant used in the landscape consumes.

While the density of plants in cities is decreasing day by day, the importance of green areas that increase the quality of life, and especially grass areas that create a surface effect, is increasing (Cengiz et al., 2023). Looking at the open green areas in the city, it is seen that most of them are covered by turfgrass and they form a wide living space (Demirel and Camoglu, 2014). Grass varieties are used in many areas, including landscapes, sports fields and public squares (Cengiz and Demirel, 2022).

Grass, which is one of the most common plants in the world, has a wide range of uses and requires regular watering and maintenance (Demirel, 2022). Grass species are distinguished from each other by features such as length, color, texture, shade resistance, and compression resistance. It is not possible to consider it as an ecological approach, as the maintenance costs of grass areas are quite high (Öztürk-Tel and Erdoğan, 2021). For the areas where grass is applied to maintain its vitality in all seasons and adapt to changing conditions, grass mixtures created from different species are mostly preferred instead of a single species. A successful grass plant selection is related to knowing how to use the grass, where to grow it, and what the acceptable level of continuity and appearance is (Arslan and Çakmakçı, 2004). Because each type of grass has good and bad characteristics, strengths and weaknesses. Mixtures are formed by mixing a certain amount of grass species selected according to the desired properties. Thus, separate mixtures are prepared for different areas and different conditions, ensuring that the healthiest application is made. As the effects of global climate change are increasingly felt, the water consumption required to ensure the survival and sustainability of plants used in landscape areas has reached significant levels, bringing with it the need for more effective and strategic water management (Çöp and Akat, 2021; İlhan et al., 2024). To minimize the water used in landscape areas, grass mixtures that consume less water and are resistant to drought should be preferred.

It is seen that studies on how grass varieties, which consume more water than most plants, will be affected by water and heat stress are insufficient. In this research, plant water consumption and visual quality values of eight different grass mixtures at different water and temperature levels were determined. The visual quality of turfgrass is directly related to soil water content (Demirel, 2014). Therefore, it should be known how much water restriction can be made without compromising the visual quality.

2. Material and Method

2.1. Material

In this study, eight different grass mixtures were used as study material (Figure 1). In order to reach more people, the mixtures were selected from the best-selling products of an existing company.

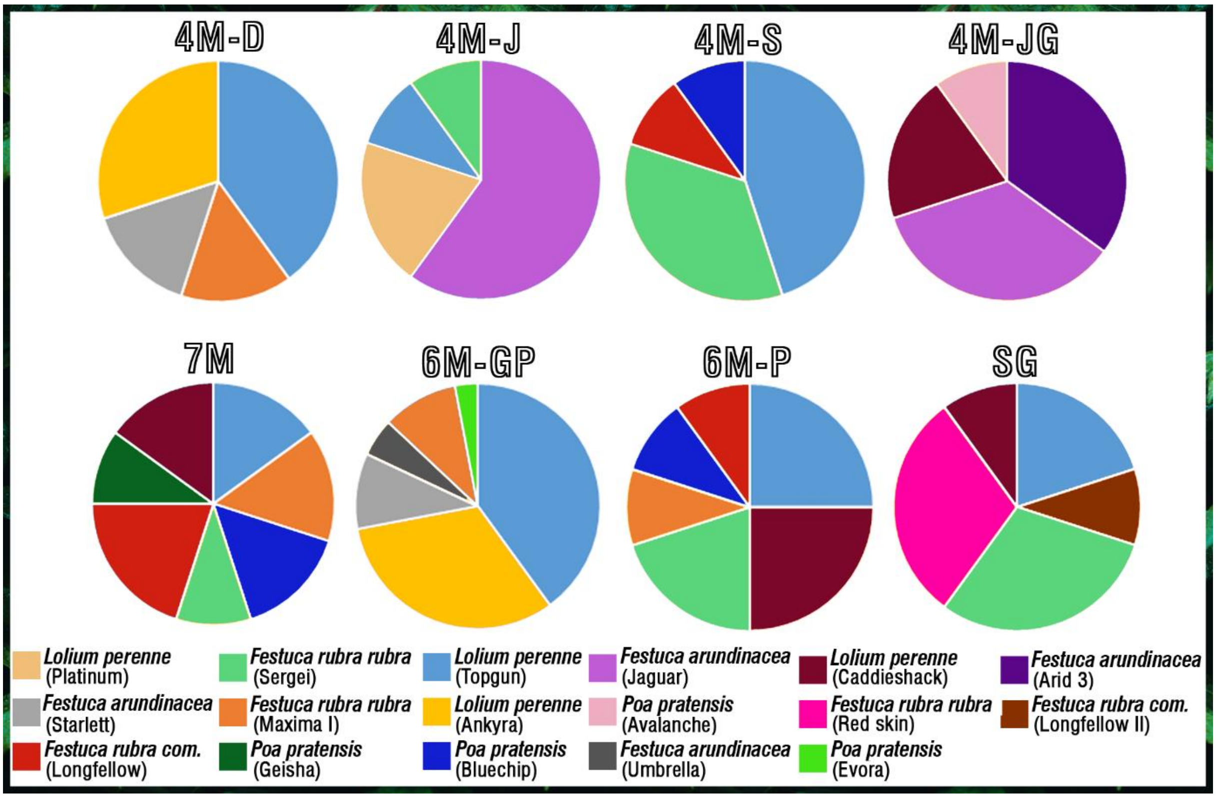


Figure 1. Grass mixtures and proportions used in the experiment

Characteristics of eight grass mixtures (Figure 1) selected as plant material (Anonim, 2019);

4M Dynamic:

• It is structured quickly. • It has a medium-fine texture. • Shows fast germination. • It has a high tolerance to harsh winter conditions.

4M Joker:

• It works very well under harsh conditions such as drought, high heat, and salinity. • Provides high performance with low maintenance. • It has a dense texture and strong root structure. • It has a very high resistance to treading. • It is resistant to diseases.

4M Star:

• It allows you to have a green area appearance in a short time. • It grows slowly, forms lately. • It is finely textured. • Ideal for heavily treaded areas. • Resistant to short mowning. • High tolerance to harsh winter conditions.

4M Joker Gold:

• It is very resistant to high heat, drought, and salinity. • Ideal for areas with full sun or partial shade. • Thanks to its deep root structure, it benefits from moist areas in the lower parts of the soil. Thus, while many other grass seed mixtures turn yellow with drought, 4M Joker Gold retains its green parts for a long time even in arid conditions.

6M Greenpower:

• It is structured quickly. • Ideal for heavily treaded areas. • Resistant to short mowning. • It has a high tolerance to harsh winter conditions. • Creates areas that can renew themselves.

6M Prestige:

• It provides a perfect image with its fine texture and dark green color. • Its short mow increases the tolerance to treading and lack of light. • Since the growth rate is slow, it forms slowly.

Shadow Grass:

• It is a mixture prepared for dark-shaded areas. • It is dark green and finely textured. • Resistant to treading. • Performs well in all climatic conditions.

7M Sultan:

• It is very dark green, very fine and densely textured. • It is very resistant to treading. • It grows slowly. • It has high resistance to diseases. • Thanks to its high-quality Poa pratensis content, it has a very high self-renewal ability.

2 grams of grass seeds are planted in each pot with a diameter of 20 cm. 1500 grams of loamy garden soil per pot was used and 100 grams of grass covering soil was added to the seeds (Figure 2).

Figure 2. Soil and seed preparation

2.2. Study Area

The research was carried out in the COSMOTLAB (Crop Stress Monitoring and Thermography Laboratory) of Çanakkale Onsekiz Mart University, Faculty of Agriculture (Figure 3). The experiment was conducted under controlled conditions with temperatures of 20±1ºC and 30±1ºC, and relative humidity of 40±5%. The lighting of the plants was in the form of a photoperiod of 16/8 hours under a special lighting system with a spectrum created by the combination of 450 nm - 660 nm - 730 nm.

Figure 3. Experiment area

2.3. Method

Before the experiment, the pot capacity (field capacity) of each pot was determined. Before this process, the weights of all pots to be used in the experiment were equalized, taking into account the tare of all pots, and plant and soil weights.

All pots were filled with water several times, after which they were covered with an anti-evaporation cover. As soon as the water flow from under the pots ended, the weight of the pots was weighed and the pot capacities were determined (Çamoğlu, 2013).

In the study, 4 different irrigation treatments were created in which 100% (I100/control), 75% (I75), 50% (I50) and 25% (I25) of the lost moisture were applied to eight different grass mixtures grown under laboratory conditions (Table 1). Each irrigation treatment consists of 3 repetitions. After the grass seeds were planted in the pot and the grass germination was completed, the application of irrigation treatments began. Before moving on to the treatments, all pots are watered evenly. In the study, irrigation was carried out twice a week if the ambient temperature was 20ºC, and 3 times a week if it was 30ºC. Before watering, all pots were weighed and the amount of irrigation water was calculated according to the decreased moisture. The irrigation water is provided from the tap water. The amount of water was measured with the help of measuring cylinders and slowly given to the pots.

Table 1. Irrigation treatment in the experiment

Treatment	Information
I100	If 40±5% of the moisture in the pots is consumed, all of the reduced moisture is added to the pot capacity (control)
I75	75% of the water consumed in the I100
I50	50% of the water consumed in the I100
I25	25% of the water consumed in the I100

Eq. 1 was used in the calculation of plant water use (James, 1988).

$$ET=I+P-D\pm R\pm \Delta S \quad (1)$$

Inequality; ET = Evapotranspiration (mm), I = Amount of irrigation water (mm), P = Precipitation (mm), D = Drenaige (mm), R = Surface runoff (mm), Δs = Moisture change between two samples (mm).

Since the experiment was carried out under controlled conditions under laboratory conditions, precipitation and surface runoff were neglected. In addition, the water that seeped under the pots at the end of irrigation was added back to the pot. Therefore, drainage has also been neglected. Considering these Equation 1 changed to $ET=I \pm \Delta S$.

In the experiment, visual quality and general appearance were monitored weekly. The Munsell color scale was used to evaluate the color changes of plants (Wilde and Voigt, 1977). The scoring was made between these two values: 9 for dark/vivid green and 1 for yellow/faded color. In the study, 6 was taken as the minimum acceptable value in the visual quality evaluation of the grass (Emekli and Baştuğ, 2007; Demirel and Çamoğlu, 2014). While determining the visual quality differences between the treatments, the color condition, density and general appearance of the plants in the pot were taken into consideration. Ratings were done weekly by 4 people, so 4 values were averaged for each pot. The average visual quality was determined by taking all the weekly values into account.

3. Results and Discussion

3.1. Evapotranspiration (ET)

As a result of the data obtained from the experiment, the ET values calculated for 20ºC and 30ºC are given in Table 2 and Table 3, respectively.

Table 2. ET values of grass mix at 20ºC±1 (mm day^{-1})

Treatment	4M-JG	4M-J	4M-S	4M-D	6M-GP	6M-P	7M	SG
I100	3,3	3,3	3,2	3,3	3,5	3,2	3,3	3,3
I75	2,9	3,0	3,0	3,0	3,1	3,0	3,0	3,0
I50	2,5	2,5	2,5	2,5	2,6	2,5	2,5	2,5
I25	2,0	2,0	2,0	2,0	2,1	2,0	2,0	2,0

Plant water use values ranged from 3.2-3.5 mm at 20ºC±1 for 100%, 2.9-3.1 mm for 75%, 2.5-2.6 mm for 50%, and 2.0-2.1 mm for 25%.

Table 3. ET values of grass mix at 30ºC±1 (mm day^{-1})

Treatment	4M-JG	4M-J	4M-S	4M-D	6M-GP	6M-P	7M	SG
I100	4,2	4,4	4,0	4,2	4,3	4,3	4,2	4,1
I75	3,7	3,8	3,6	3,7	3,8	3,8	3,7	3,7
I50	3,1	3,2	3,0	3,1	3,2	3,2	3,1	3,1
I25	2,5	2,6	2,5	2,5	2,6	2,6	2,5	2,5

Plant water use values for 30ºC±1 varied from 4.4-4.0 mm for 100%, 3.6-3.8 mm for 75%, 3.0-3.2 mm for 50%, 2.5-2.6 mm for 25%. As expected, plant water use increased at 30ºC±1.

When the studies on ET in grass varieties were examined, it was found that Beard and Kim (1989) found that the daily water consumption of the plant for perennial grass was 8.5-10 mm/day; Aydınşakir et al. (2003) found that the daily water consumption of Bermudagrass grass plant was 8.3 mm/day for the field and 11.8 mm for the lysimeter. In the experiment conducted by Emekli and Baştuğ (2007) in open field conditions, variety, Bermudagrass grass water consumption was found to be 9.80-7.43-5.10-2.82 mm/day in different irrigation applications, respectively. When the studies on different grass species and the values obtained from this experiment were compared, a difference can be seen. The reason for this difference is that the grass varieties used in those studies and the plant materials in this experiment are different, mixtures were used instead of a single variety. In addition, there were differences in the growing environment such as temperature, wind and humidity.

3.2. Visual Quality

The visual quality assessment results obtained as a result of the observations made in the plants every week are given in Table 4 and Table 5 for 20ºC and 30ºC, respectively. Weekly visual quality values were rated starting the 14th day after seeding (DAS14). In the tables, values above 6, which is the lowest acceptable limit, are shown in bold in the average visual quality value section.

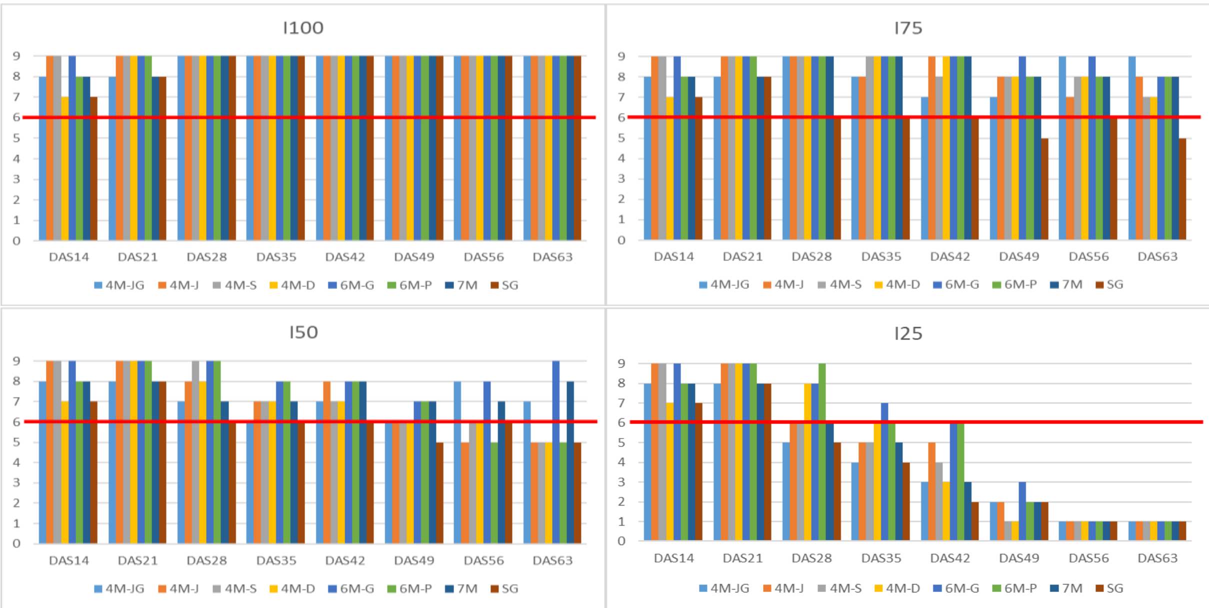
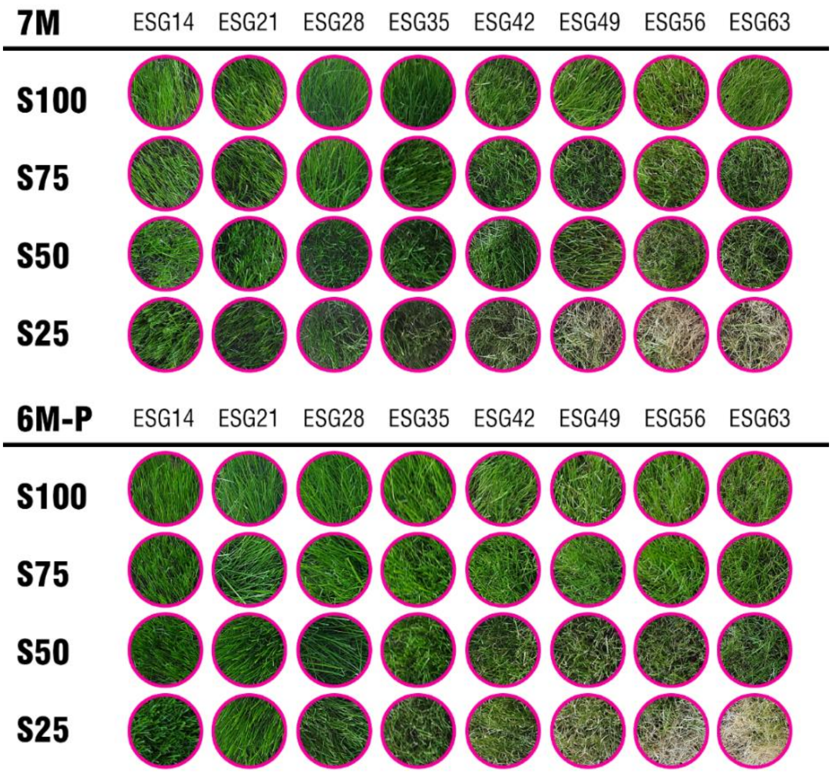


Figure 4. Visual quality assessments of grass mixes by weeks at 20ºC±1 temperature

According to the visual quality assessment carried out weekly at a temperature of 20ºC±1 from the 14th day after seeding (DAS14), on average: I100 treatments ranged from 8.6-9.0; I75 ranged from 8.1-8.5; I50 ranged from 6.1-8.4; I25 ranged from 3.8 to 5.5.

Figure 5. Visual quality assessments of grass mixes by weeks at 30ºC±1 temperature

According to the visual quality assessment made at a temperature of 30ºC±1: I100 treatments ranged from 8.3 to 6.7; I75 ranged from 7.3 to 5.6; I50 ranged from 5.3 to 3.7; I25 ranged from 2.6 to 1.7. Weekly changes in the visual quality of the eight grass mixes are given in Figure 4 and Figure 5.



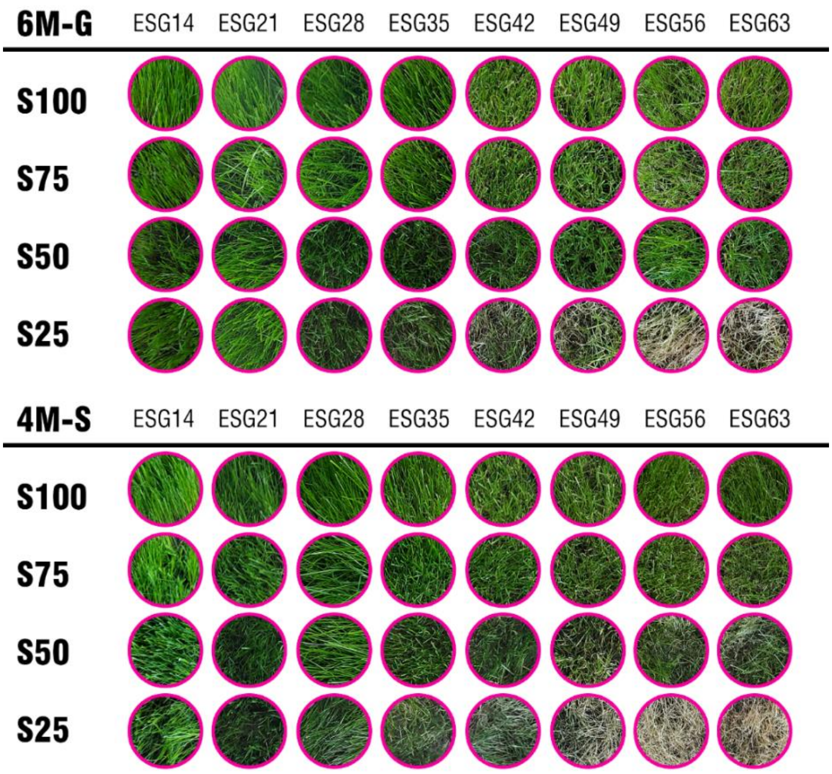
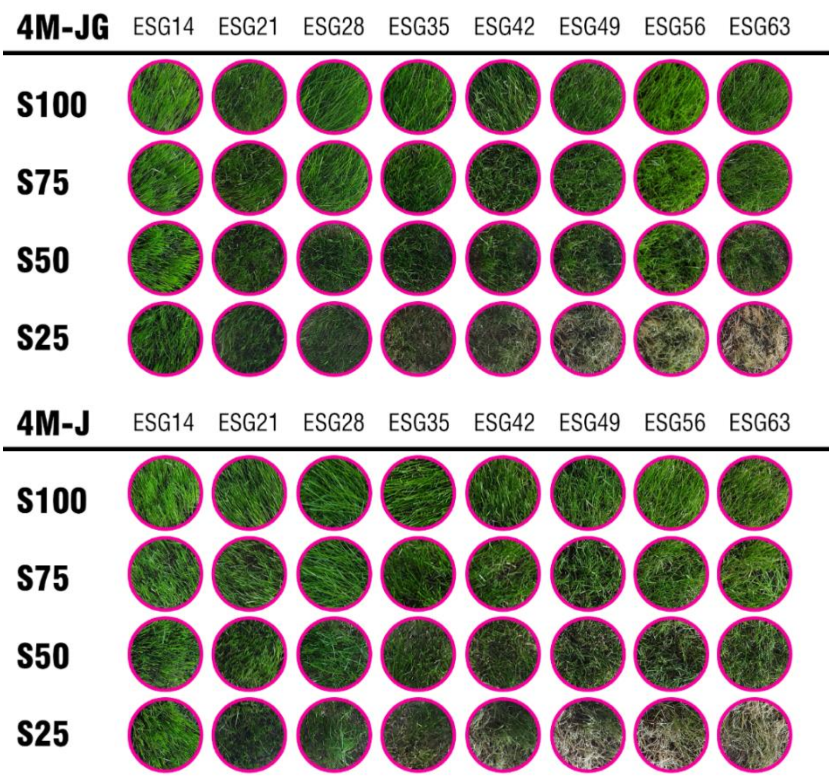


Figure 6. Weekly visual changes of grass mixtures at 20ºC±1 temperature



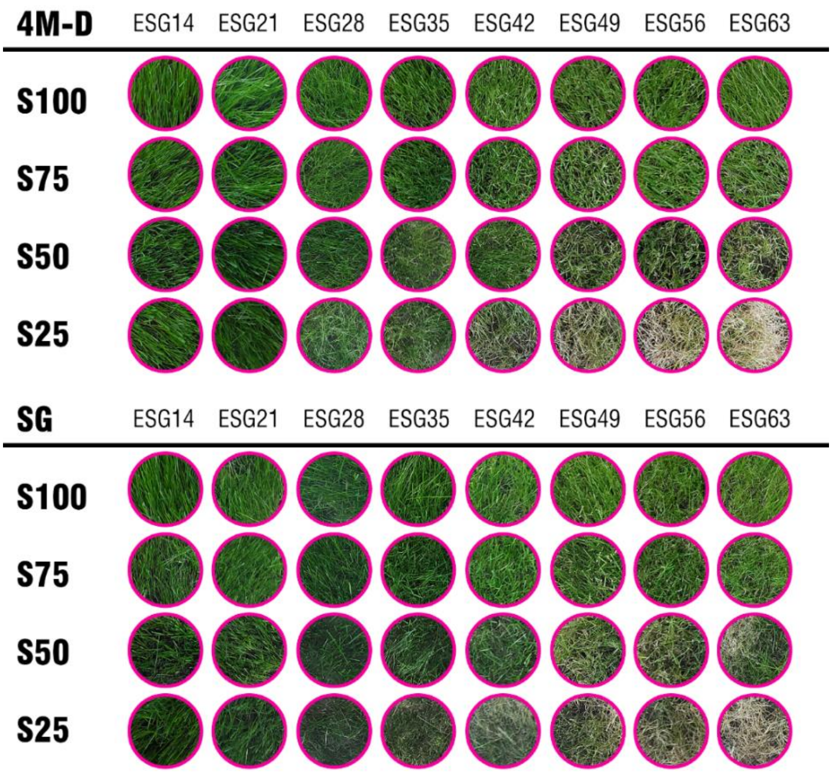


Figure 6. (Cont.)

Figure 7. Weekly visual changes of grass mixtures at 30ºC±1 temperature

Figure 7. (Cont.)

At a temperature of 20ºC±1, it was observed that the I100, I75 and I50 treatments of all mixes were above the acceptable visual quality limit. At the temperature of 30ºC±1, I100 treatments of all mixes and I75 treatments of 4M-JG, 4M-J, 4M-S, 4M-D and 7M mixes were found to be above the visual quality limit.

In some visual quality studies with a scale of 1-9 on grass varieties: Ahmad et al. (2003) found values between 1.0 and 9.0 for the two grass varieties. Zorer et al. (2004), in their study in Van province, found values between 3.6-8.7; Karcher et al. (2008) stated that they found a value between 3.7-6.5 in the grass varieties they used in their experiment in the USA under arid conditions. Cereti et al. (2010) in their study of different varieties of Lolium perenne in Italy found values between 7.6-8.3 in four periods; Varoğlu (2010) found values between 6.1-6.2 in different varieties of Lolium perenne in his experiment in Izmir. The values observed in this experiment were compared with the visual quality evaluations in the aforementioned studies. The reason for the difference between the studies and this experiment can be shown as the fact that most of the existing studies were carried out with a single species, unlike the grass mixtures in this experiment. The differences in water treatments, the differences in the growing environment such as temperature, wind and humidity, and the fact that this experiment was carried out under controlled laboratory conditions can be seen as the reasons.

4. Results

In the study, one control and three different restricted irrigation levels were applied to eight different grass mixtures and their responses to drought under water stress were examined. I25 and I50 treatments of all varieties at the temperature of 30ºC±1 eventually fell below the visual quality limit. Since the I75 treatments of 4M-JG, 4M-J, 4M-S, 4M-D and 7M mixes are above the visual quality limit, it has been determined that 25% water restriction can be made in these mixes. At the temperature of 20ºC±1, it was observed that all mixes were above the acceptable visual quality limit of I100, I75 and I50 treatments. Although some I50 treatments have fallen below the limit in recent weeks, it has been predicted that they will not dry out completely and will be able to renew themselves. No significant difference was observed between the mixes in terms of plant water consumption values at both temperatures.

Since the landscape is seen as discardable for human life, possible water scarcity will have an impact on landscape areas before agricultural areas. It is not known what and how the effects of the limited water conditions caused by decreasing water resources will be on the grass plants that are frequently used especially in landscape areas. Due to the lack of literature, many people irrigate their lawns incorrectly or wastewater by choosing the wrong species. For this reason, it is of great importance to determine the grass varieties that require less water without deteriorating the visual quality.

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