

Effect of Limited Irrigation on Growth Parameters of *Antirrhinum Majus*

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Research Article

Keywords: *Antirrhinum majus*, limited irrigation, seasonal flower, urban landscape, water consumption

Posted Date: March 24th, 2023

DOI: <https://doi.org/10.21203/rs.3.rs-2655931/v1>

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Abstract

The aim of this research is to observe the change in the development parameters of the *Antirrhinum majus* plant, which is the most widely used seasonal flower that causes excessive water consumption in green areas in cities, by subjecting it to limited irrigation. In this context; four different irrigation issues (completion of the amount of evaporating water (mm) obtained from the evaporation pot to 100% (control), 75%, 50% and 25% of the usable water holding capacity depending on the relationship of the pot volume) were created. To determine the effect of different water levels, 18 growth parameters were examined. As a result of the research; In *Antirrhinum majus* plant, on the other hand, in 17 of 18 parameters, it was observed that there was more improvement in 75% water application (25% water reduction) than 100% water application (0% water reduction). It is recommended to reduce water by 25% when using *Antirrhinum majus* plant in urban areas. In this case, significant water savings will be achieved in the urban landscape. *Antirrhinum majus* plants, which do not have any problems in their development despite the water shortage, are frequently used in urban landscapes.

Introduction

Plants constantly take water from the soil through their roots in order to continue their development. While most of this water taken from the soil is given to the atmosphere by transpiration, the other part is stored in plant tissues. Therefore, it is necessary to have sufficient moisture in the root zone of the plants (Aküzüm and Çakmak 1992; Bayramoğlu et al. 2013). The most important source of moisture in the soil is natural precipitation. However, in arid and semi-arid regions, the water needs of the plant cannot be met because the rainfall is insufficient during the plant growing season. For this reason, the missing moisture in the root of the plant is provided by irrigation water (Güngör et al. 2002; Bayramoğlu et al. 2013). In semi-humid regions, the part of the plant water requirement that is met by precipitation is higher. In addition, irrigation is usually required in semi-humid regions, even in humid regions, irrigation can be done for support purposes during dry periods (Yıldırım 2008; Bayramoğlu et al. 2013). For this purpose, the amount of water needed by the plant should be calculated at each irrigation. Depending on the type of plant, the amount of water it will consume is different. Since the amount of water to be consumed by each plant is different, plant water consumption should be determined (Jensen 1968; Selvi 2012; Bayramoğlu et al. 2013).

Plant water consumption values are determined by direct measurement methods or calculations using climate data. The water consumption of plants used in plant designs in landscape areas is high. Ideal development and homogeneous appearance of landscape plants are provided by irrigation (Orta 2009; Bayramoğlu et al. 2013).

The increasing difficulties experienced due to the decrease in water resources have led people to seek new solutions in terms of effective use of water. Especially in the outdoor areas such as parks and gardens, the large size of water consumption has necessitated the development of new landscaping methods where water is used as little as possible in landscaping. In this direction; In the general title of

Water-Effective Landscape Arrangement, different new landscaping concepts such as Rational Use of Water and Less Water Use have emerged (Yazgan et al. 2017).

In recent years, with the increase in temperature due to changing climatic conditions and the deterioration of precipitation patterns, the problem of thirst has come to the fore; It has led designers, planners and local governments to new searches for more rational use of water. Water is an extremely effective factor for the survival of ornamental plants used in plant design studies, which is a stage of landscape architecture applications. The fact that water consumption has reached large dimensions in urban open spaces such as parks and gardens has made it necessary to use water as little as possible in landscape studies (Barış 2007). The prerequisite for the plant to benefit from irrigation in sufficient amounts is expressed as giving the water requirement of the plants, which cannot be met by precipitation, with irrigation water. However, due to limited water resources, limited irrigation practices have become widespread today. limited irrigation; It is an irrigation approach based on the strategy of reducing costs and increasing income by putting plants under water stress (English and Raja 1996; Bayramoğlu et al. 2013).

Gül et al. (2012), seasonal flowers are among the plants that consume a lot of water used in urban spaces (Yazıcı et al. 2014). In order to prevent water consumption for irrigation purposes in urban areas, it is recommended to reduce seasonal flowers (Çetin and Mansuroğlu 2018). But seasonal flowers are among the indispensable plants of the urban landscape. Alp et al. (2011) stated, seasonal flowers are used in the arrangement of various areas such as parks, gardens, houses, groves, medians, intersections, squares, balconies, flower pots, roofs, modular flower beds, creating an effect of color and vitality in the urban landscape, eliminating monotony, They are plants that create an effect, close the space in a short time, can be changed every year, are low in cost, stay in flower for months, and are easily grown in greenhouses.

The aim of this research is to examine the change in development parameters by applying limited irrigation systems to *Antirrhinum majus* plant from the family Scrophulariaceae, which is among the indispensable seasonalities of the urban landscape and causes unnecessary water consumption by giving more water without knowing its needs.

Material And Method

This research was carried out in Atatürk University Plant Production Application and Research Center Greenhouses in 2022. The herbal material used in the research is *Antirrhinum majus*. *Antirrhinum majus* is a plant whose commercial value has increased in recent years. Germination period of *Antirrhinum majus* seeds is between December and April. In regions with cold climates, sowing should be between March and April. The city where the experiment was set up has a cold climate. On March 1, 2022, *Antirrhinum majus* F1 hybrid seeds with 90% germination were sown. It is a mixture of peat-fiber-vegetable soil consisting of 65% peat and 35% soil in the content of the growing medium where the seed is planted. The organic matter ratio in the mixture is 75%. It has a Ph value between 5–7.

Germination began to occur in *Antirrhinum majus* seeds 9 days after sowing. Significantly germinated after 15 days. When the plants reached the size of surprise, they were taken into 5 liter pots. As stated by Oral and Açıkgöz (1991), the growing medium to be used in the pot will consist of 2 parts loamy soil, 1 part peat, 1 part sand developed by the John Innes Horticultural Institute, one of the best growing mediums used in garden flowers. The experimental soil, washed and sieved river sand and peat were mixed at a rate of 50%, 25% and 25%, respectively, to create a growing medium.

In the irrigation application, when the plants were transplanted into pots, the soil was brought to the field capacity (FC) for all subjects and the irrigation levels were applied. After the plants were transplanted into the pots, the subjects other than the control group were irrigated at the levels of 75-50-25%, respectively. Control and irrigation levels were initiated with irrigation after diversionary water applications.

The irrigation interval was determined based on the evaporation amount measured from the evaporation pot to reach 5–10 mm. Irrigation was carried out when the predicted evaporation was reached. The entire amount of evaporation in the control group, and 75-50-25% in the other groups, was applied to the subjects at an equal height on the entire pot surface in a measured manner.

The amount of water given to the control group was calculated according to Eq. 1 (Güngör et al. 1999).

Equation 1:

$$I = k_p \times E_p \times A$$

I: Irrigation water (liter x pot⁻¹)

k_p: Evaporation vessel coefficient (1 for control, 0.75-0.50-0.25 for other applications)

E_p: Total evaporation read from the reduced evaporation pan (mm)

A: Pot area (m²)

On April 8, 2022, *Antirrhinum majus* plant was transplanted into 5-liter pots. Six replications were prepared for each irrigation application. The number of repetitions of each of the 25%, 50%, 75%, and 100% irrigation applications is 6. *Antirrhinum majus* plants were placed in a total of 24 pots. After planting in pots, the plants were watered and brought to field capacity.

After the pots of the *Antirrhinum majus* plant are brought to the field capacity by watering, a 60 cm diameter, 25 cm deep, 15 cm high wooden bottom support unit made of 2 mm gray hair and a water-filled evaporation measuring instrument specially made in Atatürk University Central Workshops was used. The amount of evaporated water was measured using a millimetric wooden ruler. Average, maximum, minimum temperature and humidity measurements were made with the help of a temperature-humidity measuring instrument.

During the research, the ambient temperature was kept constant at 25–30°C. Irrigation was applied according to the amount of evaporation in the environment. In the research, four different irrigation issues (completion of the amount of evaporating water (mm) obtained from the evaporation pot to 100% (control), 75%, 50% and 25% of the usable water holding capacity depending on the relationship between the pot volume) was created. First of all, the pot capacity (field capacity) of each pot and accordingly the usable water holding capacity (UWHC) were determined (Çamoğlu 2013). The pots were brought to the field capacity (FC) with planting. Water consumption was calculated according to evaporation in the next stages of the pots brought to the field capacity. The experiment was continued by reducing the water to 100% for the control group and 75-50-25% for the other pot groups. Irrigation day intervals throughout the study changed depending on the amount of evaporation. The water given in the research is the drinking water of Atatürk University and it is stated that it is suitable for irrigation. After the irrigation application, the development parameters of the plants (flowering time, flowering period, flower stalk length, leaf chlorophyll value, leaf number, leaf surface area, plant root length, plant root fresh weight, etc.) were observed and concluded.

The cumulative evaporation amount measured from the modified (reduced) evaporation pot placed in the greenhouse was measured in mm and the amount of water in ml was given in proportion to the pot volume. The cumulative amounts of irrigation water applied to the flower seedlings in the control group and other irrigation groups in the trial design during the period until the seedling planting date (08 April 2022) and the last irrigation application (31 May 2022) were given in ml.

Irrigation applications were started on 08 April 2022 and all pots were brought to field capacity. The research was terminated on May 30, 2022, the date of death of all recurrences of the application, which was given 25% water. During the 53-day vegetation period, a total of 259 mm of evaporation occurred from the evaporation pot. Accordingly, the average evaporation amount is 4.77 mm/day. Within the irrigation groups, 259 mm of irrigation water was applied to the control group (100% irrigation application), and this value was 64.75-129.5-194.25 mm at 25% – 50% – 75% in the other groups, respectively. The irrigation water values and evaporation amounts applied during the research are given in Table 1.

Table 1. Irrigation water in research subjects (mm)

Date	Evaporation amount (mm)	25%	50%	75%	100%
8.04.2022	10	2,5	5	7,5	10
11.04.2022	15	3,75	7,5	11,25	15
12.04.2022	6	1,5	3	4,5	6
13.04.2022	6	1,5	3	4,5	6
15.04.2022	12	3	6	9	12
18.04.2022	20	5	10	15	20
20.04.2022	10	2,5	5	7,5	10
22.04.2022	14	3,5	7	10,5	14
25.04.2022	16	4	8	12	16
27.04.2022	11	2,75	5,5	8,25	11
29.04.2022	14	3,5	7	10,5	14
2.05.2022	9	2,25	4,5	6,75	9
4.05.2022	6	1,5	3	4,5	6
6.05.2022	3	0,75	1,5	2,25	3
9.05.2022	9	2,25	4,5	6,75	9
11.05.2022	5	1,25	2,5	3,75	5
13.05.2022	10	2,5	5	7,5	10
16.05.2022	21	5,25	10,5	15,75	21
18.05.2022	11	2,75	5,5	8,25	11
20.05.2022	11	2,75	5,5	8,25	11
23.05.2022	15	3,75	7,5	11,25	15
25.05.2022	5	1,25	2,5	3,75	5
28.05.2022	10	2,5	5	7,5	10
30.05.2022	10	2,5	5	7,5	10
Toplam	259	64,75	129,5	194,25	259

Irrigation was done when the daily evaporation reached 5–10 mm in the greenhouse. Accordingly, the irrigation interval varies between 1–3 days as seen in Table 1. The highest evaporation occurred on 16

May 2022. This value was determined as 21 mm/day in the control group. The least evaporation was on May 6, 2022. This value was determined as 3 mm/day in the control group.

In the relationship between temperature, relative humidity and evaporation measured in the research; Between 08/04/2022 and 30/05/2022, temperature, humidity and evaporation remained constant in the period until the 20th of April. Between 27/4/2022 and 15/05/2022, there was an increase in relative humidity, and temperature and evaporation remained constant.

Results And Discussion

Plant height, plant diameter, flower stem thickness, flower diameter, flower length were measured with a digital caliper, and leaf chlorophyll values were measured with a SPAD-502 chlorophyll meter on April 29, 2022 (the 22nd day of water restriction for seedlings).

The trial schedule in *Antirrhinum majus* is given in Table 2.

Table 2
Trial schedule in *Antirrhinum majus* plant

Seed Planting	Planting Seedlings in Pots	Measurement 1	Measurement 2	Dry weight measurement
1.03.2022	08.04.2022	29.04.2022	30.05.2022	09.06.2022
	39th day of sowing	60th day of sowing	91st day of sowing	Flowers, vegetative parts and roots of the plant were dried for 11 days.
	Beginning of water shortage	22nd day of water restriction application to seedlings	53. day of water restriction application to seedlings	
		The date on which flowering occurs in most applications	The date on which all recurrences dry up in the application given 25% water.	

As seen in Table 2, on the 53rd day of the water shortage (May 30, 2022), it was observed that the plants in the application of *Antirrhinum majus* plant, which was given 25% water, dried up. The experiment was terminated by stopping the water restriction application of the *Antirrhinum majus* plant.

The flowers, vegetative parts and roots of the plant were dried for 11 days in order to measure the plant flower, vegetative parts and root dry weight from 30.05.2022, which is the 53rd day of the water restriction application to the seedlings, when all replications were dried in the application where 25% water was given in the *Antirrhinum majus* plant. Dry weight measurements were made on 09.06.2022, when all plant

parts were completely dry. Leaf area amount of all applications of *Antirrhinum majus* was measured on 30.05.2022, which is the day when all replications dried (53rd day of water curtailment) in the application given 25% water.

Antirrhinum majus plant was irrigated at a rate of 25%, 2 of 6 repetitions had flowering, and 4 repetitions did not bloom. In the application where 50% irrigation was applied, all recurrences showed an average of 27 days after the water restriction applied to the seedlings, and after 34 days in all repetitions of the applications with 75% irrigation, flowering occurred. Flowering occurred in 5 out of 6 repetitions of the 100% irrigation application. Flowering was observed after 36 days in the repetitions of the applications with 100% irrigation. These results show that giving 25% water to the *Antirrhinum majus* plant reduces the flowering rate. Flowering occurred in the application with 75% irrigation, 3 days before the application with 50% irrigation, and 2 days before the application with 100% irrigation. In 50% and 75% irrigations, flowering occurred in all repetitions. The application with flowering in the shortest time is 75% irrigation (25% water restriction).

Table 3

Change in growth parameters according to irrigation applications in *Antirrhinum majus*

Water Application Rate	%25	%50	%75	%100
Number of Flowers (22nd day), pieces	0	0	0,16	0
Number of Flowers (53rd day), pieces	0,5	2,33	7,16	8
Flower Stem Thickness (22nd day), mm	2,13	2,63	2,63	2,78
Flower Stem Thickness (53rd day), mm	2,92	3,99	5,05	4,25
Flower Diameter (22nd day), mm	0	0	4,95	0
Flower Diameter (53rd day), mm	2,96	16,38	23,22	18,84
Flower Length (22nd day)	0	0	6,37	0
Flower Length (53rd day), mm	3,58	20,51	24,27	21,64
Flower Fresh Weight (53rd day), grams	0,07	0,57	3,43	2,64
Flower Dry Weight, grams	0,06	0,34	1,01	0,61
Leaf Chlorophyll Value (22nd day)	41	43,70	40,48	32,78
Leaf Chlorophyll Value (53rd day)	30,13	39,85	38,95	32,45
Plant Height (22nd day), cm	8,25	8,90	11,73	10,03
Plant Height (53rd day), cm	10,33	12,25	15,58	13,66
Plant Diameter (22nd day), cm	8,81	10,58	13,03	9,31
Plant Diameter (53rd day), cm	10	13,5	18,16	13,5
Vegetative Part Wet Weight (53rd day), grams	4,19	9,71	14,64	11,87
Vegetative Part Dry Weight, grams	1,06	1,98	3,05	2,29
Number of Plant Shoots (53rd day), pieces	9,5	11,83	13,16	11,33
Leaf Area, mm ²	91,20	224,39	299,26	261,23
Number of Buds (53rd day), pieces	2,33	7,83	19,66	10,66
Root Length (53rd day), cm	15,68	21,00	19,75	15,15
Root Fresh Weight (53rd day), grams	2,13	3,64	4,79	3,07
Root Dry Weight, grams	0,37	0,45	0,68	0,40

As seen in Table 3, the number of flowers of the *Antirrhinum majus* plant was measured at 22 days of water shortage, and it was observed that 75% of water was applied in the application compared to other applications. In the measurements made on the 22nd day of the water shortage, the highest value in the average number of flowers was seen in the 75% application in the first place, and flowering did not occur in the other applications. The average number of flowers of the *Antirrhinum majus* plant was measured after the 53rd day of the water shortage (the day when the experiment was terminated with the drying of the 25% applications), and it was observed that the average number of flowers was higher in the application with 100% water compared to the other applications. In the measurements made on the 53rd day of the water shortage, it was seen that the highest value in the average number of flowers was in the first row, 100%, in the second row 75%, in the third row 50%, and in the fourth row 25%.

In the measurement made on the 22nd day of the water shortage, it was observed that the flower stem thickness was higher in the application where 100% water was given to the *Antirrhinum majus* plant (0% water reduction). Respectively, the stem thickness is 100% in the first row, 75% and 50% in the second row, and 25% in the third row. This shows that as the amount of irrigation increased in the first 22 days of water restriction, the stem thickness also increased. As a matter of fact, Turan (2013), in his study to determine the effect of different irrigation intervals and water amounts on the yield and quality characteristics of *Chrysanthemum morifolium* Ramat (*Chrysanthemum*), stated that increasing water amount increases the flower stem thickness (Uçar and Kazaz 2016).

In the measurement made on the 53rd day of the water shortage, in the water restriction study applied to the *Antirrhinum majus* plant, it was observed that the flower stem thickness was higher in the application with 75% water (25% water reduction). Flower stem thickness is 75% in the first row, 100% in the second row, 50% in the third row, and 25% in the fourth row, respectively.

In the measurement made on the 22nd day of the water shortage, it was observed that the flower diameter was higher in the application where 75% water was given to the *Antirrhinum majus* plant than the other applications. In other applications, flower formation did not occur. In the measurement made on the 53rd day of the water shortage, in the water restriction study applied to the *Antirrhinum majus* plant, it was observed that the flower diameter was higher in the application with 75% water compared to the other applications. Flower diameter is 75% in the first row, 50% in the second row, 100% in the third row, and 25% in the fourth row, respectively.

The average flower length of *Antirrhinum majus* was measured on the 22nd day of water shortage, while the average flower length was measured as 6.37 cm in the application with 75% water, while flowering did not occur in other applications. After the 53rd day of the water shortage, the average flower height values were checked for the second time and it was seen that the application with 75% water was higher than the applications with 100%, 50% and 25% water, respectively.

In the measurement made on the 53rd day of the water shortage, it was observed that the average flower fresh weight was higher in the application where 75% water was given to the *Antirrhinum majus* plant

than the other applications. The average flower fresh weight is 75% in the first row, 100% in the second row, 50% in the third row, and 25% in the fourth row, respectively.

It was observed that the average flower dry weight of *Antirrhinum majus* was higher than the other applications in the application with 75% water. The average dry weight of flowers is 75% in the first row, 100% in the second row, 50% in the third row, and 25% in the fourth row, respectively. The fact that the average dry weight of flowers in 75% application is higher than other applications shows that water restriction applied at the rate of 25% is more effective in the amount of flowering in *Antirrhinum majus* plant.

Leaf chlorophyll value of *Antirrhinum majus* plant was measured on the 22nd day of water shortage, and it was observed that the chlorophyll value in the application given 50% water was higher than the other applications. Chlorophyll values were checked for the second time 53 days after sowing and it was seen that the chlorophyll value was higher in 50% application than in other applications. In the measurements made on the 22nd day of the water shortage, the highest value in the average chlorophyll value was seen in the first order of 50%, in the second place 25%, in the third place 75%, and in the fourth place 100%. In the measurement made on the 53rd day of seed sowing, the highest value in the average chlorophyll value was seen in the first order of 50%, in the second place 75%, in the third place 100%, and in the fourth place 25%. In both periods, giving 50% water in the measurement (50% water shortage) caused an increase in the chlorofil value.

In the water restriction study applied to the *Antirrhinum majus* plant in the measurement made on the 22nd day of the water shortage, it was observed that the plant height was higher in the application with 75% water compared to other applications. Plant height is 75% in the first row, 100% in the second row, 50% in the third row, and 25% in the fourth row, respectively. In the measurement made on the 53rd day of the water shortage, in the water restriction study applied to the *Antirrhinum majus* plant, it was observed that the plant height was higher than the other applications in the application with 75% water. Plant height is 75% in the first row, 100% in the second row, 50% in the third row, and 25% in the fourth row, respectively.

In the water restriction study applied to the *Antirrhinum majus* plant in the measurement made on the 22nd day of the water shortage, it was observed that the plant diameter was higher in the application with 75% water compared to the other applications. Plant diameter is 75% in the first row, 50% in the second row, 100% in the third row, and 25% in the fourth row, respectively. In the measurement made on the 53rd day of the water shortage, in the water restriction study applied to the *Antirrhinum majus* plant, it was seen that the plant diameter was higher than the other applications in the application with 75% water. Plant diameter is 75% in the first row, 100% and 50% in the second row, and 25% in the third row, respectively.

In the measurement made on the 53rd day of the water shortage, it was seen that the average vegetative part wet weight of *Antirrhinum majus* was higher than the other applications in the application where water was given at the rate of 75%. Respectively, the average vegetative part wet weight is 75% in the first

rank, 100% in the second rank, 50% in the third rank, and 25% in the fourth rank. The fact that the average vegetative part wet weight in the 75% application is higher than the other applications shows that the water restriction applied at the rate of 25% is more effective in the development of the vegetative parts of the *Antirrhinum majus* plant.

It was observed that the average vegetative part dry weight of *Antirrhinum majus* was higher than the other applications in the application with 75% water. The average dry weight of flowers is 75% in the first row, 100% in the second row, 50% in the third row, and 25% in the fourth row, respectively. The fact that the average vegetative part dry weight in the 75% application is higher than the other applications shows that the water restriction applied at the rate of 25% is more effective in the development of the vegetative parts of the *Antirrhinum majus* plant. Indeed, Demir et al. (2021), in their study to determine the effects of hybrid corn varieties on some growth parameters under limited irrigation, they stated that 75% application, which provides 25% water saving compared to 100%, prolongs the growing period.

The average number of plant shoots of *Antirrhinum majus* was measured on the 53rd day of water restriction (the day when the experiment was terminated with the drying of the 25% application), and it was observed that the application with 75% water was higher than the applications with 50%, 100% and 25% water, respectively.

It was observed that the leaf area of *Antirrhinum majus* was more than the other applications in the application with 75% water. The average leaf area is 75% in the first row, 25% in the second row, 100% in the third row, and 50% in the fourth row, respectively. The fact that the average leaf area is higher than the other applications in 75% application (25% water reduction) shows that the 25% applied water restriction is more effective in the development of leaf area in *Antirrhinum majus* plant. Indeed, Demir et al. (2021), in their research to determine the effect of limited irrigation on some growth parameters of hybrid corn varieties, stated that the application with 75% water increased the yield more than other water applications.

In the water restriction study applied to *Antirrhinum majus* plant in the measurement made on the 53rd day of the water shortage, it was seen that the number of buds in the application given 75% water was higher than the other applications. The average number of new buds is 75% in the first row, 100% in the second row, 50% in the third row, and 25% in the fourth row, respectively.

In the water restriction study applied to the *Antirrhinum majus* plant in the measurement made on the 53rd day of the water shortage, it was observed that the root length was higher in the application where 50% water was given (50% water reduction was applied). Root length is 50% in the first row, 75% in the second row, 25% in the third row, and 100% in the fourth row, respectively.

In the water restriction study applied to the *Antirrhinum majus* plant in the measurement made on the 53rd day of the water shortage, it was observed that the root wet weight was higher in the application with 75% water compared to the other applications. Root wet weight is 75% in the first row, 50% in the second row, 100% in the third row, and 25% in the fourth row, respectively.

It was observed that the average root dry weight of *Antirrhinum majus* was higher than the other applications in the application with 75% water. The average dry weight of flowers is 75% in the first row, 50% in the second row, 100% in the third row, and 25% in the fourth row, respectively. The fact that the average vegetative part dry weight in the 75% application is higher than the other applications shows that the water restriction applied at the rate of 25% is more effective in root development in the *Antirrhinum majus* plant. As a matter of fact, Ekinici and Başbağ (2019) stated in their research on the effects of restricted irrigation on some morphological characteristics of *Gossypium hirsutum* L. (Cotton) plant that water shortage increases root growth. According to Kaçar (2007), it is an indication that the main root of the cotton plant develops faster in arid conditions so that the plant can reach the soil moisture (Ekinici and Başbağ 2019).

The differences between irrigation applications on growth parameters of *Antirrhinum majus* plant according to Duncan's multiple comparison test are given in Table 4.

Table 4

Differences between irrigation applications on growth parameters in *Antirrhinum majus* plant according to Duncan multiple comparison test

Growth Parameters	Irrigation Applications	Duncan $\pm$ standart sapma
Number of Flowers (22nd day), pieces	%25	0,00 ^a $\pm$ 0,00
	%50	0,00 ^a $\pm$ 0,00
	%75	0,16 ^a $\pm$ 0,41
	%100	0,00 ^a $\pm$ 0,00
Number of Flowers (53rd day), pieces	%25	0,50 ^a $\pm$ 1,22
	%50	2,33 ^{ab} $\pm$ 1,21
	%75	7,16 ^b $\pm$ 5,19
	%100	8,00 ^b $\pm$ 8,98
Flower Stem Thickness (22nd day), mm	%25	2,13 ^a $\pm$ 0,18
	%50	2,63 ^{ab} $\pm$ 0,62
	%75	2,63 ^{ab} $\pm$ 0,39
	%100	2,78 ^b $\pm$ 0,31
Flower Stem Thickness (53rd day), mm	%25	2,92 ^a $\pm$ 0,55
	%50	3,99 ^b $\pm$ 0,64
	%75	5,05 $\pm$ 0,88
	%100	4,25 ^{bc} $\pm$ 0,93
Flower Diameter (22nd day), mm	%25	0,00 ^a $\pm$ 0,00
	%50	0,00 ^a $\pm$ 0,00
	%75	4,95 ^a $\pm$ 12,14
	%100	0,00 ^a $\pm$ 0,00
Flower Diameter (53rd day), mm	%25	2,96 ^a $\pm$ 7,26
	%50	16,38 ^b $\pm$ 2,86
Note: Lowercase letters represent difference.		

Growth Parameters	Irrigation Applications	Duncan $\pm$ standart sapma
	%75	23,22 ^b $\pm$ 6,00
	%100	18,84 ^b $\pm$ 15,03
Flower Length (22nd day)	%25	0,00 ^a $\pm$ 0,00
	%50	0,00 ^a $\pm$ 0,00
	%75	6,37 ^a $\pm$ 15,60
	%100	0,00 ^a $\pm$ 0,00
Flower Length (53rd day), mm	%25	3,86 ^a $\pm$ 9,47
	%50	22,04 ^b $\pm$ 2,81
	%75	30,50 ^b $\pm$ 7,32
	%100	23,87 ^b $\pm$ 18,58
Flower Fresh Weight (53rd day), grams	%25	0,07 ^a $\pm$ 0,18
	%50	0,57 ^a $\pm$ 0,62
	%75	3,43 ^b $\pm$ 1,30
	%100	2,64 ^b $\pm$ 2,61
Flower Dry Weight, grams	%25	0,06 ^a $\pm$ 0,15
	%50	0,34 ^{ab} $\pm$ 0,30
	%75	1,01 ^c $\pm$ 0,34
	%100	0,61 ^{bc} $\pm$ 0,54
Chlorophyll Value (22nd day)	%25	41,03 ^b $\pm$ 5,89
	%50	43,70 ^b $\pm$ 4,45
	%75	40,48 ^b $\pm$ 5,01
	%100	32,78 ^a $\pm$ 3,52
Chlorophyll Value (53rd day)	%25	30,13 ^a $\pm$ 6,77
Note: Lowercase letters represent difference.		

Growth Parameters	Irrigation Applications	Duncan $\pm$ standart sapma
	%50	39,85 ^b $\pm$ 4,58
	%75	38,95 ^b $\pm$ 4,97
	%100	32,45 ^{ab} $\pm$ 6,97
Plant Height (22nd day), cm	%25	8,25 ^a $\pm$ 1,21
	%50	8,90 ^a $\pm$ 2,24
	%75	11,73 ^b $\pm$ 2,21
	%100	10,33 ^{ab} $\pm$ 2,71
Plant Height (53rd day), cm	%25	10,33 ^a $\pm$ 1,63
	%50	12,25 ^{ab} $\pm$ 1,17
	%75	15,58 ^c $\pm$ 1,49
	%100	13,66 ^{bc} $\pm$ 2,48
Plant Diameter (22nd day), cm	%25	8,82 ^a $\pm$ 1,77
	%50	10,58 ^{ab} $\pm$ 2,11
	%75	13,03 ^b $\pm$ 3,02
	%100	9,32 ^a $\pm$ 2,52
Plant Diameter (53rd day), cm	%25	10,00 ^a $\pm$ 2,19
	%50	13,50 ^b $\pm$ 1,87
	%75	18,16 ^c $\pm$ 1,60
	%100	13,50 ^b $\pm$ 4,37
Vegetative Part Wet Weight (53rd day), grams	%25	4,19 ^a $\pm$ 0,73
	%50	9,71 ^b 1,83
	%75	14,64 ^c $\pm$ 1,87
	%100	11,87 ^{bc} $\pm$ 5,61

Note: Lowercase letters represent difference.

Growth Parameters	Irrigation Applications	Duncan ± standart sapma
Vegetative Part Dry Weight, grams	%25	1,06 ^a ± 0,50
	%50	1,98 ^b ± 0,22
	%75	3,05 ^c ± 0,34
	%100	2,29 ^{bc} ± 0,14
Number of Plant Shoots (53rd day), pieces	%25	9,50 ^a ±2,17
	%50	11,83 ^{ab} 1,60
	%75	13,16 ^b ± 2,48
	%100	11,33 ^{ab} ± 2,07
Leaf Area, mm ²	%25	91,20 ^a ± 4,06
	%50	224,39 ^b ± 47,39
	%75	299,26 ^b ± 45,39
	%100	261,23 ^b ± 51,02
Number of Buds (53rd day), pieces	%25	2,33 ^a ± 2,07
	%50	7,83 ^a ± 6,40
	%75	19,6 ^b ± 8,33
	%100	10,6 ^a ± 9,58
Root Length (53rd day), cm	%25	15,68 ^a ± 5,89
	%50	21,00 ^a ± 9,14
	%75	19,75 ^a ± 4,97
	%100	15,15 ^a ± 2,75
Root Fresh Weight (53rd day), grams	%25	2,13 ^a ± 0,93
	%50	3,64 ^{bc} ± 1,40
	%75	4,79 ^c ± 0,73
Note: Lowercase letters represent difference.		

Growth Parameters	Irrigation Applications	Duncan $\pm$ standart sapma
Root Dry Weight, grams	%100	3,07 ^{ab} $\pm$ 1,28
	%25	0,37 ^a $\pm$ 0,50
	%50	0,45 ^a $\pm$ 0,22
	%75	0,68 ^a $\pm$ 0,34
	%100	0,40 ^a $\pm$ 0,14
Note: Lowercase letters represent difference.		

As seen in Table 4, the difference between all treatments was found to be insignificant according to the number of flowers in the measurements made on the 22nd day according to the Duncan Multiple Comparison test. In the measurements made on the 53rd day, the difference between all treatments according to the number of flowers was found to be insignificant.

According to Duncan Multiple Comparison test, the difference between all applications was found to be insignificant in terms of flower stem thickness in the measurements made on the 22nd day. In the measurements made on the 53rd day, the difference between all treatments was found to be very significant according to the flower stem thickness ($p < 0.01$).

In the measurements made on the 22nd day, the difference between all applications according to flower diameter is insignificant. In the measurements made on the 53rd day, the difference between the 25% irrigation application according to the flower diameter and the other applications was found to be very significant ($p < 0.01$).

In the measurements made on the 22nd day, the difference between all treatments according to flower size was found to be insignificant. In the measurements made on the 53rd day, the difference between the 25% water application according to the flower size and the other applications was found to be very significant ($p < 0.01$).

In the measurements made on the 53rd day, it is seen that the difference between 25% and 50% irrigation applications and 75% and 100% irrigation applications according to the wet weight of the flower is very important ($p < 0.01$). The difference between 75% and 100% irrigation applications was insignificant.

In the measurements made according to the Duncan Multiple Comparison test, it was observed that there was a very significant difference between all groups according to the dry weight of flowers ($p < 0.01$).

In the measurements made on the 22nd day, the difference between all applications was found to be insignificant according to the chlorophyll value in 25%, 50% and 75% applications. The difference

between 100% and other applications was found to be very significant ($p < 0.01$). In the measurements made on the 53rd day, the difference was insignificant according to the leaf chlorophyll value in the 50% and 75% applications. The difference between 50% and 75% applications and other applications was significant ($p < 0.05$). As a matter of fact, Kırnak and Doğan (2017) also stated that the effect of different irrigation water levels on chlorophyll under each irrigation system was found to be significant at the $p < 0.05$ level in their study to determine the effect of restricted irrigation on some quantitative parameters in melon plants.

In the measurements made on the 22nd day, the difference between all applications according to plant height was found to be insignificant. In the measurements made on the 53rd day, the difference between all applications was found to be very significant ($p < 0.01$).

In the measurements made on the 22nd day, the difference between all applications was found to be insignificant according to the plant diameter value. As a matter of fact, Doğan et al. (2020) also stated that different irrigation practices do not make a significant difference in plant diameter values in their study to determine the effect of different irrigation levels on the vegetative characteristics of *Pelargonium domesticum* (Ceylangözü). In the measurements made on the 53rd day, the difference between 50% and 100% applications according to plant diameter value was insignificant, the difference between 50% and 100% applications and other applications was very significant ($p < 0.01$).

In the measurements made on the 53rd day, it was observed that there was a very important difference between all groups according to the wet weight of the vegetative part ($p < 0.01$).

It was observed that there was a very significant difference between all groups according to the dry weight of the vegetative parts ($p < 0.01$).

In the measurements made on the 53rd day, it is seen that the difference between 75% irrigation application and other irrigation applications is significant according to the number of shoots ($p < 0.05$). The difference between 50% and 100% irrigation applications was insignificant.

It was observed that there was a very significant difference between the 25% water application according to the leaf area and the other applications ($p < 0.01$).

In the measurements made on the 53rd day, the difference between the whole 75% water application and the other applications according to the number of buds was found to be very significant ($p < 0.01$).

In the measurements made on the 53rd day, the difference between all applications according to root length was found to be insignificant.

In the measurements made on the 53rd day, the difference between all applications according to the root wet weight was found to be very significant ($p < 0.01$).

It was observed that there was no difference between all groups in terms of root dry weight.

Conclusion And Recommendations

Seasonal flowers, one of the plant materials used in the urban landscape, are known to consume a lot of water. Among the seasonal flowers, *Antirrhinum majus* is the most widely used. As a matter of fact, Demirel et al. (2018) stated, studies on the application of water restriction on ornamental plants are insufficient. In this study, which was carried out to fill this gap, the effects of different water applications were tried to be determined according to 18 parameters related to plant growth.

In *Antirrhinum majus* plant, on the other hand, it was observed that 75% of water application (25% water reduction) showed more improvement in 17 of 18 parameters than 100% water application (0% water reduction). In *Antirrhinum majus*, only the number of flowers decreased with water shortage. In *Antirrhinum majus* plant, 75% water application (25% water reduction) has a positive effect on plant growth, as well as higher values than 100% water application (0% water reduction). As a result, it is recommended to reduce water by 25% when *Antirrhinum majus* plant is used in urban areas. In this case, significant water savings will be made. *Antirrhinum majus* plant, which allows water saving, should be widely used in urban areas.

Declarations

Acknowledgements: This research was supported by Atatürk University Scientific Research Projects Coordination Unit as a Basic Research Project with the code FBA-2021-9142. We would like to thank Atatürk University Scientific Research Projects Coordination Unit for their support.

Conflicts of Interest: The authors declare no conflict of interest.

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