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The Effect of Irrigation Water Quality and Growing Medium on Growth Parameters of Chokeberry*

Sulama Suyu Kalitesi ve Yetiştirme Ortamının Aronyanın Büyüme Parametreleri Üzerine Etkisi

Ayşe Akyüz[1], Bilal Cemek[2]

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Abstract: This study aimed to determine the effect of irrigation water quality and growing medium differences on the growth parameters of the chokeberry plant. The effects of control (0.65 dS m^{-1}), 2 dS m^{-1}, 4 dS m^{-1}, 8 dS m^{-1}, and 10 dS m^{-1} electrical conductivity irrigation water and 2 different growing medium (peat and soil) were evaluated on plant growth. For this purpose, specific leaf area (SLA), leaf area ratio (LAR), leaf weight ratio (LWR), stem weight ratio (SWR), root weight ratio (RWR), net assimilation rate (NAR), relative growth rate (RGR), and leaf thickness (LT) parameters were evaluated. Differences were observed in growth parameters depending on irrigation water salinity and growing medium. The SLA value varied between 26.47 (control) and 3.07 cm^2 day^{-1} (10 dS m^{-1}) in soil medium and between 25.07 (control) and 2.88 cm^2 day^{-1} (10 dS m^{-1}) in peat medium. The values of LAR ranged between 127.98-12.65 cm^2 day^{-1} in soil and 134.14-61.33 cm^2 day^{-1} in peat, and LWR between 0.25-0.03 g g^{-1} (soil) and 0.43-0.05 g g^{-1} (peat). The SWR value varied between 0.41-0.18 g g^{-1} in soil and 1.22-0.29 g g^{-1} in peat. The RWR value ranged between 0.63-0.37 g g^{-1} in the soil medium and 1.62-0.31 g g^{-1} in the peat medium. NAR and RGR are the most potent parameters used to evaluate plant growth and to express growth and development. NAR and RGR parameters reached the highest value in soil medium in 2 dS m^{-1} application, while in peat medium in control application.

Keywords: Aronia, irrigation water quality, growth parameters

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Öz: Bu çalışmada sulama suyu kalitesi ve yetiştirme ortamı farklılığının aronya bitkisinin büyüme parametrelerine etkisinin belirlenmesi amaçlanmıştır. Sulama suyu kalitesindeki değişimin bitki gelişimine etkisini belirlemek amacıyla kontrol (0.65 dS m^{-1}), 2 dS m^{-1}, 4 dS m^{-1}, 8 dS m^{-1} ve 10 dS m^{-1} elektriksel iletkenlikte sulama suyu ve 2 farklı yetiştirme ortamının (torf ve toprak) etkisi değerlendirilmiştir. Bu amaçla oransal yaprak alanı (YAO), özgül yaprak alanı (ÖYA), oransal yaprak ağırlığı (OYA), oransal gövde ağırlığı (OGA), oransal kök ağırlığı (OKA), net asimilasyon oranı (NAO), nisbi büyüme hızı (NBH), yaprak kalınlığı (YK) parametreleri değerlendirilmiştir. Sulama suyu tuzluluğu ve yetiştirme ortamına bağlı olarak büyüme parametrelerinde farklılıklar gözlemlenmiştir. YAO değeri toprak ortamında 26.47 (kontrol)-3.07 cm^2 $gün^{-1}$ (10 dS m^{-1}), torf ortamında ise 25.07 (kontrol) ile 2.88 cm^2 $gün^{-1}$ (10 dS m^{-1}) arasında değişim göstermiştir. ÖYA toprak ortamında 127.98-12.65 cm^2 $gün^{-1}$, torf ortamında 134.14-61.33 cm^2 $gün^{-1}$, OYA 0.25-0.03 g g^{-1} (toprak), 0.43-0.05 g g^{-1} (torf) arasında değerler almaktadır. OGA değeri toprak ortamında 0.41-0.18 g g^{-1}, torf ortamında 1.22-0.29 g g^{-1} arasında değiştiği belirlenmiştir. OKA değeri ise toprak ortamında 0.63-0.37 g g^{-1}, torf ortamında 1.62-0.31 arasında değer almaktadır. Bitki gelişimini değerlendirmek, büyüme ve gelişmeyi ifade etmek adına kullanılan en güçlü parametreler NAO ve NBH'dir. NAR ve NBH parametreleri toprak ortamında en yüksek değerine 2 dS m^{-1} uygulamasında ulaşırken, torf ortamında kontrol uygulamasında ulaşmıştır.

Anahtar Kelimeler: Aronya, sulama suyu kalitesi, büyüme parametreleri

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[1] Ayşe Akyüz, Ondokuz Mayıs University, Agricultural Structures and Irrigation , ayseakyol86@gmail.com (Corresponding author)
[2] Prof. Dr. Bilal Cemek, Ondokuz Mayıs University, Agricultural Structures and Irrigation, bcemek@omu.edu.tr

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INTRODUCTION

Chokeberry, which originates from North America and belongs to the Rosaceae family, is a deciduous multi-stemmed shrub-type plant (Hardin, 1973). Chokeberry attracts attention both as an ornamental plant and as an effective fruit in the treatment and prevention of diseases (Brand, 2010).

Regardless of soil type, chokeberry grows best at 6-6.5 pH (Walther and Schnell, 2009), in moist soils, and in areas with good sunshine (Brand, 2010). As in all plants, it is very important to provide optimum moisture content in the root zone for better development. In chokeberry cultivation, irrigation water quality and soil water content affect fruit quality and yield (Won et al., 2017).

In order to determine the effects of different conditions on plant quality, it is very important to determine leaf, stem, root dry, and fresh weights, leaf area, net assimilation rate, and relative growth rate, which are crucial concepts in monitoring plant growth. Growth analyses are critical for identifying relationships among plant growth, development, and factors affecting yield and productivity. Parameters like RGR (relative growth rate) and its component NAR (net assimilation rate) must be thoroughly understood to explain plant dry matter accumulation and plant growth and development (Uzun, 1997). Cemek et al. (2005) determined the effects of different greenhouse covers on the growth and yield of eggplant. Öztürk and Demirsoy (2006) demonstrated the effect of shading on the growth of strawberries by quantitative analyses. Öner and Sezer (2007) determined the effects of light and temperature on growth parameters in maize. Öztürk et al. (2014) determined the effect of shading on the net assimilation rate and relative growth rate of strawberry plants. Fast-growing plants always have high NAR values, and plants with high net assimilation rates grow faster (Li et al., 2016). Kıran et al. (2017) examined the effect of rootstock/scion combinations on the morphological characteristics of eggplant plants under salinity and drought stress.

The change in irrigation water quality causes differences in plant development. The effects of factors directly affecting plant growth, such as light, temperature, irrigation water quantity, and salinity on plant growth have been examined in different studies. However, since there is no study for chokeberry, this study aims to contribute to the literature in this respect. This study aimed to determine the changes in growth parameters of aronia plant due to different growing media and changes in irrigation water quality.

MATERIAL AND METHOD

The research was conducted at the Samsun Ondokuz Mayıs University Faculty of Agriculture greenhouse unit during 2021-2022. The plants were protected from rainfall and grown in a greenhouse covered with polyethylene material to ensure they were not affected by precipitation while allowing open-air access from the sides to reflect outdoor temperature conditions.

In this study, one-year-old chokeberry plants of the Viking variety were grown under different irrigation water qualities, and the effect of different doses of salt applications on their vegetative growth was determined. The research was carried out according to the random plots experimental design with 3 replications and 3 plants in each replicate. Two different medium (peat and soil) were used to observe the effect of the growing medium. The soil used in the study was analyzed at Ondokuz Mayıs University, Faculty of Agriculture, Department of Soil Science and Plant Nutrition (Table 1). The peat used is standard seedling peat with a pH of 6 and 1.5 g fertilizer per liter (Klasmann TS1®).

Table 1. Characteristics of the soil used in the experiment.
Çizelge 1. Denemede kullanılan toprağın özellikleri.

Saturation (%)	Structure	dS m^{-1}		%			ppm	Mek 100g^{-1}			
		pH	EC	$CaCO_3$	OM	N	P	Ca	Mg	K	N
51	Loamy	7.77	0.32	2.05	2.65	0.08	20.5	32.37	14.48	0.41	0.95

Five different treatments were examined for their effects: control (0.65 dS m^{-1} (S1)), 2 dS m^{-1} (S2), 4 dS m^{-1} (S3), 8 dS m^{-1} (S4), 10 dS m^{-1} (S5) electrical conductivity of irrigation water. The salts used for preparing waters were calculated with the help of QBASIC computer program as $CaCl_2$, $MgSO_4$, and NaCl salts, with

Sodium Adsorption Rate (SAR) = 5 and Ca Mg^{-1} ratio me l^{-1} as 1 1^{-1} (Ünlükara et al., 2015). The amounts of salts used for preparing irrigation waters for each application are given in Table 2.

Table 2. Amounts of salts to prepare 1L of water solution.
Çizelge 2. 1L çözelti hazırlamak için gerekli tuz miktarları.

Irrigation Water Subjects	Salt Sources (g)		
	NaCl	$MgSO_4$	$CaCl_2$
2dS m^{-1}	0.56	0.45	0.31
4dS m^{-1}	0.87	1.75	0.75
8dS m^{-1}	1.50	5.00	1.75
10dS m^{-1}	2.00	6.12	2.50

For the plants whose field capacity was determined (Ünlükara et al., 2008a; Ünlükara et al., 2008b), the amount of irrigation water to be applied in each irrigation was determined with the help of equation (1) (Ünlükara et al., 2015).

$$I = (W_{fc} - W_a) / (1-L) \quad (1)$$

In equality; I, the amount of water applied in each irrigation (L), W_{fc}, field capacity weight of the pot (kg), Wa is the weight of the pots weighed before irrigation and LF taken 0.15 (Maas and Hoffman 1977, Ayers and Wescot, 1989).

Fruit harvest was carried out on September 23 in the first year of the experiment and on September 20 in the second year. Along with fruit harvest, destructive harvests were conducted on randomly selected one plant from each replication in each treatment to determine the plant's vegetative growth parameters quantitatively. Plants were separated into roots, stems, and leaves. The leaves of each plant were fixed on A4 paper, scanned, and transferred to a computer (Cemek et al., 2011; Cemek et al., 2020). The area of the scanned leaves was determined according to Tunca et al. (2018). The root parts were washed thoroughly and cleaned from soil and peat. The fresh weights of roots, stems, and leaves were determined by weighing them on a precision balance sensitive to 0.001 g. Then, the plant materials were placed in paper bags and dried in an oven at 80 °C for 72 hours, and their dry weights were measured. Quantitative growth parameters given in Table 3 were determined with these values (Uzun, 1996).

Table 3. Quantitative growth parameters (Uzun, 1996).
Çizelge 3. Kantitatif büyüme parametreleri (Uzun, 1996).

Specific Leaf Area (SLA)	The leaf area of the plant (cm^2) × The total leaf dry mass of the plant (g) $^{-1}$
Leaf Area Ratio (LAR)	The total leaf area of the plant (cm^2) × The total dry mass of the plant (g) $^{-1}$
Leaf Weight Ratio (LWR)	The total leaf dry mass of the plant (g) × The total dry mass of the plant (g) $^{-1}$
Stem Weight Ratio (SWR)	The total stem dry mass of the plant (g) × The total dry mass of the plant (g) $^{-1}$
Root Weight Ratio (RWR)	The total root dry mass of the plant (g) × The total dry mass of the plant (g) $^{-1}$
Net Assimilation Rate (NAR)	(1 A^{-1})dA dt^{-1} (g cm^{-2} day^{-1})*
Relative Growth Rate (RGR)	Net assimilation rate (NAR) × Leaf area ratio (LAR)[day^{-1}]
Leaf Thickness (LT)	1 / Specific Leaf Area (SLA) $^{-1}$

*A:Total area of the plant; t: Time in days

The data obtained from the study were statistically analyzed, correlation analysis, analysis of variance, and comparisons between parameters and treatments were performend. The graphs were drawn using the RStudio package program (2023.06.1+524 (2023.06.1+524)).

RESULTS AND DISCUSSION

The calculated growth parameters of chokeberry plants grown under different irrigation water quality are given in Table 4 (soil) and Table 5 (peat).

Table 4. Descriptive statistics of growth parameters of chokeberry plants at different irrigation water quality in the soil medium.

Çizelge 4. Toprak ortamında farklı sulama suyu kalitesinde aronya bitkilerinin büyüme parametrelerine ilişkin tanımlayıcı istatistik değerleri.

Water Quality	SLA			LAR		
	Mean±SD	Max	Min	Mean±SD	Max	Min
S1	100.39±17.69	127.98	85.51	20.95±3.77	26.47	15.90
S2	91.93±16.35	122.00	73.30	21.39±3.92	28.54	17.47
S3	87.19±27.64	123.97	51.24	15.00±4.18	18.84	8.79
S4	57.19±24.29	86.44	25.71	7.38±2.17	10.26	4.78
S5	47.81±34.23	88.50	12.65	4.27±1.18	6.12	3.07
	LWR			SWR		
	Mean±SD	Max	Min	Mean±SD	Max	Min
S1	0.21±0.04	0.30	0.16	0.28±0.05	0.37	0.23
S2	0.23±0.05	0.34	0.18	0.31±0.05	0.40	0.25
S3	0.17±0.01	0.20	0.14	0.30±0.07	0.41	0.18
S4	0.14±0.03	0.18	0.08	0.31±0.05	0.40	0.26
S5	0.13±0.07	0.24	0.05	0.33±0.04	0.40	0.29
	RWR			NAR		
	Mean±SD	Max	Min	Mean±SD	Max	Min
S1	0.51±0.07	0.60	0.37	0.00026±0.000020	0.00032	0.00024
S2	0.48±0.05	0.55	0.42	0.00030±0.000010	0.00033	0.00028
S3	0.52±0.02	0.56	0.50	0.00019±0.000050	0.00024	0.00010
S4	0.53±0.06	0.63	0.44	0.00017±0.000010	0.00020	0.00016
S5	0.49±0.05	0.59	0.44	0.00018±0.000005	0.00019	0.00018
	RGR			LT		
	Mean±SD	Max	Min	Mean±SD	Max	Min
S1	0.00560±0.000002	0.0080	0.0030	0.01±0.000002	0.011	0.007
S2	0.00640±0.001200	0.0080	0.0040	0.01±0.001000	0.013	0.008
S3	0.00310±0.000100	0.0040	0.0008	0.01±0.004000	0.019	0.008
S4	0.00100±0.000200	0.0016	0.0009	0.02±0.010000	0.030	0.010
S5	0.00078±0.000200	0.0011	0.0005	0.03±0.020000	0.070	0.010

The SLA value ranged from 127.98 (S1) to 12.65 cm2 g-1 (S5) for chokeberry plants with different irrigation water quality in the soil (Table 4). The LAR value ranged from 28.54 (S2) to 3.07 cm2 g-1 (S5), and the LWR value ranged from 0.34 (S2) to 0.05 g g-1 (S5). The SWR parameter was 0.41 and 0.18 g g-1 for the S3 treatment. The RWR value ranged from 0.63 (S4) to 0.37 g g-1 (S1). The highest NAR value was obtained in the S2 (0.00033 g cm-2 day-1) treatment, and the lowest value was obtained in the S3 (0.0001 g cm-2 day-1) treatment. The highest RGR value was obtained in the 2 dS m-1 application with an average of 0.0064 day-1. LT value varied between 0.07 (S5) and 0.007 (S1).

When the growth parameters of chokeberry plants grown in peat medium with different irrigation water quality were analyzed, the SLA value varied between 134.19 (S1) and 61.33 $cm^2\ g^{-1}$ (S5) (Table 5). LAR value varied between 25.07 (S1) and 2.88 $cm^2\ g^{-1}$ (S5). The LWR value varied between 0.24 (S3) and 0.03 g g^{-1} (S5). The highest SWR value was 1.22 g g^{-1} (S5), and the lowest was 0.3 g g^{-1} (S1). The highest mean RWR value of 0.92 g g^{-1} was obtained in the S4 treatment. The highest NAR mean value was 0.00034 g $cm^{-2}\ day^{-1}$ in the control treatment. The highest RGR value was obtained in the S1 treatment (0.008 day^{-1}), and the highest LT value was obtained in the S5 treatment (0.016 day^{-1}).

Table 5. Descriptive statistics of growth parameters of chokeberry plants at different irrigation water quality in the peat medium.
Çizelge 5. Torf ortamında farklı sulama suyu kalitesinde aronya bitkilerinin büyüme parametrelerine ilişkin tanımlayıcı istatistik değerleri.

Water Quality	SLA			LAR		
	Mean±SD	Max	Min	Mean±SD	Max	Min
S1	126.61±5.340	134.19	121.51	23.74±1.08	25.07	21.91
S2	112.47±5.380	118.39	102.94	21.96±1.26	23.75	20.46
S3	90.22±13.76	104.10	70.47	17.46±2.02	19.14	13.47
S4	86.81±13.05	103.93	72.43	4.38±0.25	4.71	4.01
S5	75.79±11.21	90.55	61.33	3.65±0.61	4.69	2.88
	LWR			SWR		
	Mean±SD	Max	Min	Mean±SD	Max	Min
S1	0.18±0.009	0.20	0.17	0.48±0.15	0.66	0.3
S2	0.19±0.010	0.20	0.17	0.51v0.16	0.68	0.29
S3	0.19±0.030	0.25	0.17	0.55v0.16	0.74	0.37
S4	0.05±0.007	0.06	0.04	0.69v0.12	0.81	0.56
S5	0.04±0.008	0.05	0.03	0.79±0.27	1.22	0.54
	RWR			NAR		
	Mean±SD	Max	Min	Mean±SD	Max	Min
S1	0.87±0.45	1.36	0.43	0.00034±0.00003	0.00038	0.0003
S2	0.93±0.57	1.62	0.31	0.00026±0.00004	0.0003	0.00021
S3	0.81±0.47	1.26	0.34	0.00023±0.00003	0.00028	0.00021
S4	0.92±0.62	1.59	0.33	0.00019±0.000008	0.0002	0.00018
S5	0.74±0.40	1.22	0.35	0.00017±0.0000008	0.00018	0.00016
	RGR			LT		
	Mean±SD	Max	Min	Mean±SD	Max	Min
S1	0.00800±0.00100	0.00930	0.0065	0.0079±0.0003	0.0082	0.0074
S2	0.00570±0.00070	0.00600	0.004	0.008±0.0004	0.0097	0.0084
S3	0.00410±0.00080	0.00510	0.0029	0.011±0.001	0.014	0.009
S4	0.00083±0.00006	0.00090	0.0007	0.011±0.001	0.013	0.009
S5	0.00062±0.00010	0.00079	0.00046	0.01±0.002	0.016	0.011

The parameters examined were affected by the salt doses applied and showed differences according to the treatments (Table 4, 5). The highest mean SLA value was 100.39 (S1) in soil medium and 126.61 (S1) in peat medium. The highest average LAR value was obtained in S1 treatment with 20.95 and 23.74 values in soil and peat media, respectively. The highest LWR value was 0.23 (S2) in soil and 0.19 (S2,S3) in peat medium. The highest mean SWR values were 0.33 and 0.79 (S5) in soil and peat media, respectively. RWR values of 0.53 (S4) and 0.93 (S2) were obtained in soil and peat media, respectively. The highest mean values of NAR and RGR, which represent good growth and development of the plant, were 0.00030 (S2) and 0.0064 (S2) in soil medium, 0.00034 (S1) and 0.008 (S1) in peat medium, respectively. LT value was obtained from S5 treatment with the highest mean value of 0.03 in soil and 0.01 in peat medium. In accordance with these results, it can be said that aronia plant shows a better development in peat medium at different irrigation water quality.

Correlation analysis was performed to determine the relationships between the growth parameters of chokeberry plants. The correlation analysis results of SLA, LAR, LWR, SWR, RWR, NAR, RGR, and LT of growth parameters of chokeberry plants grown in soil environment are given in Figure 1.

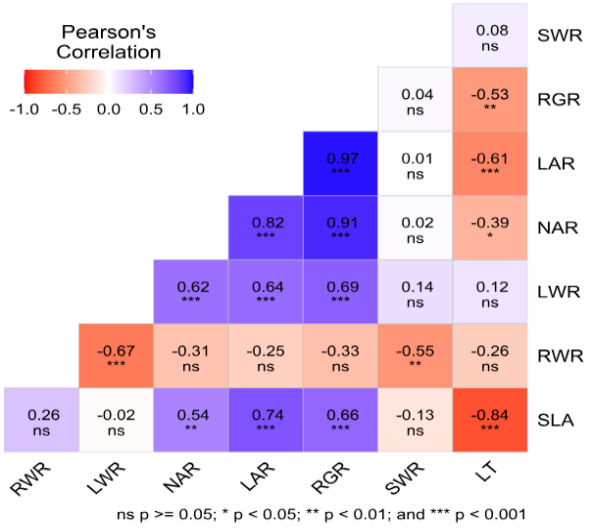

Figure 1. Results of correlation analysis of chokeberry plants in soil medium.
Şekil 1. Toprak ortamındaki aronya bitkilerinin korelasyon analizine ait sonuçlar.

According to Table 1, there is a positive relationship between LWR, LAR, and SLA. The relationship between LWR and LAR is significant at p<0.001 level. There is statistically significant relationship between LAR and SLA (p<0.001). Similarly, Öztürk and Demirsoy (2014) determined that there was a positive and statistically significant relationship between LWR, LAR, and SLA in strawberry. There was a negative and very strong relationship between LWR and RWR and a positive and insignificant relationship with SWR. There is a negative and significant relationship between LT, SLA, and LAR at p<0.001 level. Öztürk and Demirsoy (2014) found a negative and statistically significant relationship between LWR, RWS, and SWR at p<0.01 level. A positive and statistically very significant relationship was found between RGR, NAR, and LAR. Öztürk and Demirsoy (2014) similarly determined a positive and strong relationship between RGR and LAR.

The correlation of growth parameters of chokeberry plants grown in peat medium with different irrigation water quality is given in Figure 2.

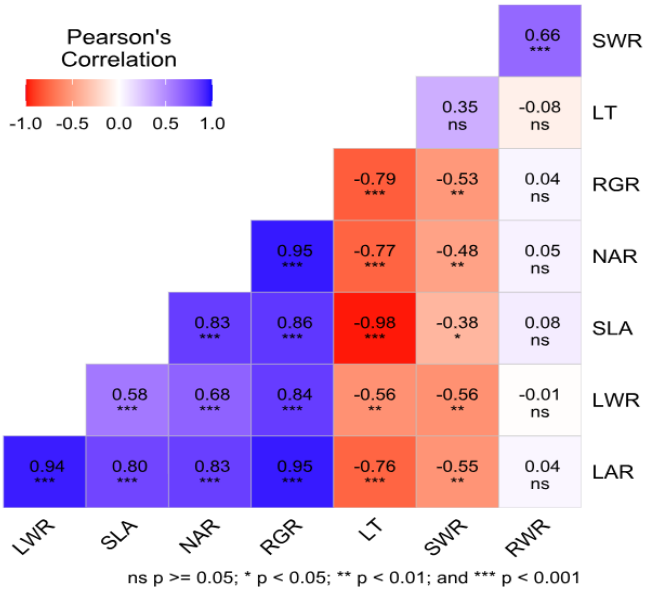

Figure 2. Results of correlation analysis of chokeberry plants in peat medium.
Şekil 2. Torf ortamındaki aronya bitkilerinin korelasyon analizine ait sonuçlar.

Correlation analysis results show us there is a positive relationship between LAR and LWR, SLA, NAR, and RGR at p<001 significance level (Figure 2). There is a negative relationship between LWR and LT, SWR (p<0.01), and RWR (ns). There is a negative and statistically very significant relationship between LT and LAR, LWR, SLA, NAR, and RGR. There is a strong positive relationship between RGR and LAR, LWR, SLA, and NAR at p<0.001 significance level. In their study, Özbakır et al. (2012) found a positive and strong relationship between SLA and LAR, RWR and LAR and SLA, and RGR and NAR. Öztürk and Demirsoy (2014) determined a positive relationship between LAR, LWR, and SLA in parallel with our study. Uzun and Kar (2004) determined a negative relationship between LT, SLA, and LAR in their study.

The differences in growth parameters of the chokeberry plant in different irrigation water quality and soil conditions according to irrigation treatments are given in Figure 3.

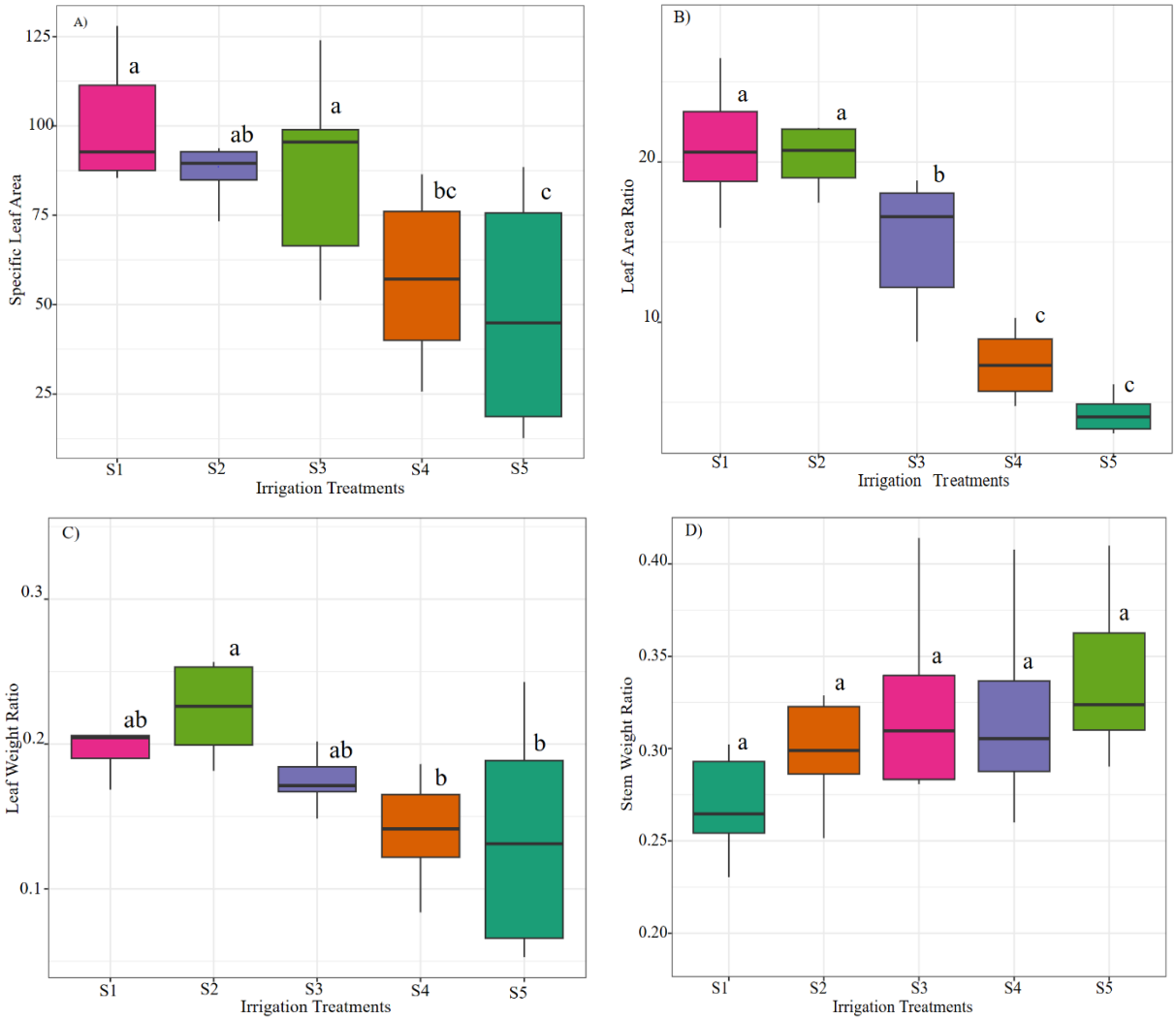

Figure 3. Response of growth parameters of chokeberry in soil medium to treatments A) Specific leaf area, B) Leaf area ratio, C) Leaf weight ratio, D) Stem weight ratio, E) Root weight ratio, F) Net assimilation ratio, G) Relative growth rate.

Şekil 3. Torf ortamında aronyanın büyüme parametrelerine tepkisi A) Oransal yaprak oranı, B) Özgül yaprak alanı, C) Oransal yaprak ağırlığı, D) Oransal gövde ağırlığı, E) Oransal kök ağırlığı, F) Net asimilasyon oranı, G) Nisbi büyüme hızı.

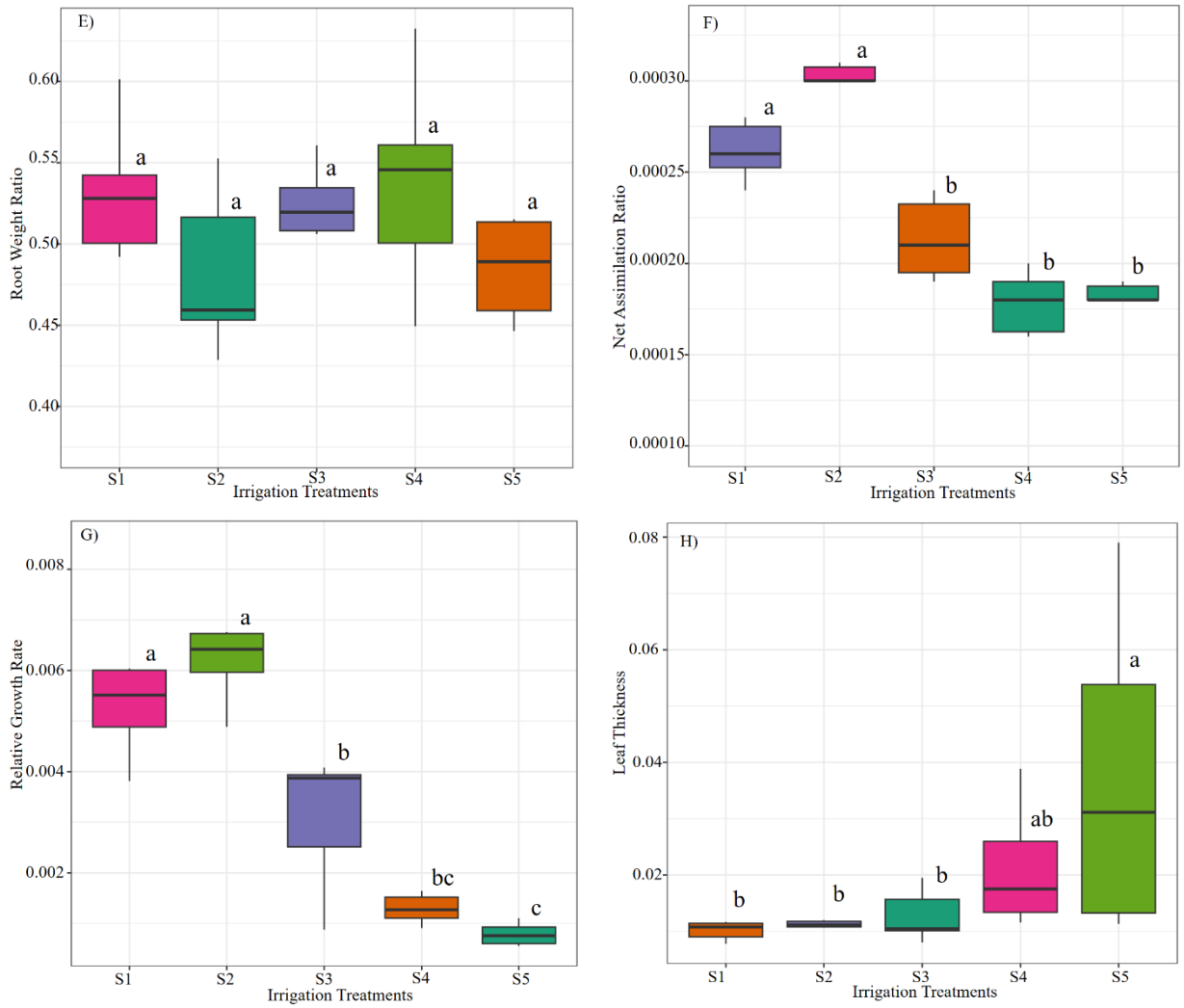

Figure 3. Continue.
Şekil 3. Devamı.

According to the SLA parameter of chokeberry plants in soil, statistical differences between the treatments can be seen (Figure 3, A). The highest SLA value was observed in S1 treatment while the lowest one was observed in S5 treatment. As irrigation water salinity increased, SLA decreased. For LAR value, control and S2 treatments were in the same the highest statistical group, while S4 and S5 treatments were in the same lowest statistical group (Figure 3, B). On the other hand, statistical differences were observed between treatments for LWR parameters, while there were no statistical differences between treatments for SWR and RWR parameters (Figure 3 C,D,E). When NAR was analyzed, control and S2 were in the same group, and S3, S4, and S5 were in the same group (Figure 3F). NAR and RGR reflect dry matter production and high yield (Thakur and Patel, 1998). When RGR and LT were analyzed, it was determined that there were statistical differences between treatments (Figure 3, G, H). Leaf thickness increased as irrigation water salinity increased.

The differences in growth parameters of chokeberry plants grown in peat medium against irrigation water of different quality are given in Figure 4.

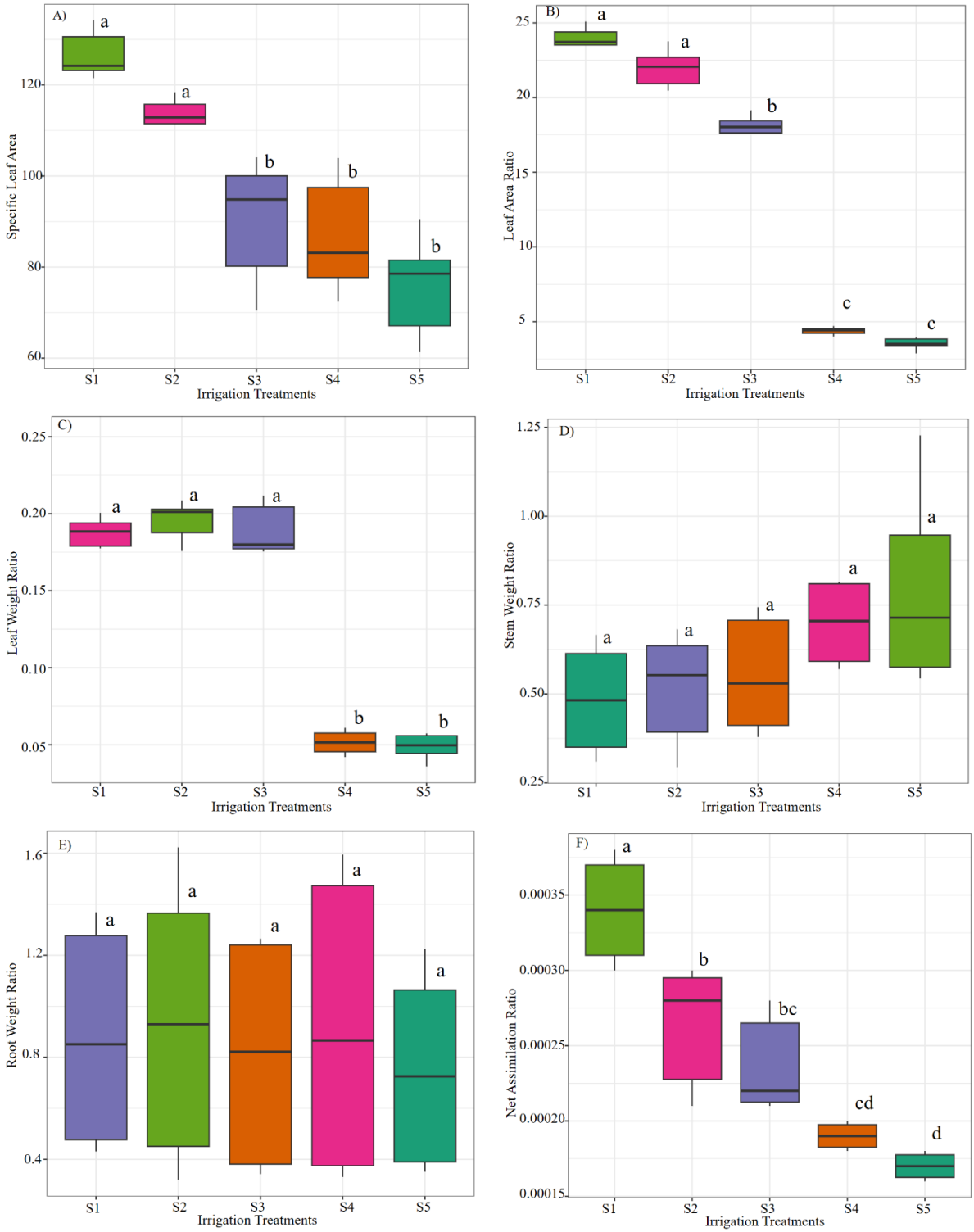

Figure 4. Response of growth parameters of chokeberry in peat medium to treatments A) Specific leaf area, B) Leaf area ratio, C) Leaf weight ratio, D) Stem weight ratio, E) Root weight ratio, F) Net assimilation ratio, G) Relative growth rate.

Şekil 4. Torf ortamında aronyanın büyüme parametrelerine tepkisi A) Oransal yaprak oranı, B) Özgül yaprak alanı, C) Oransal yaprak ağırlığı, D) Oransal gövde ağırlığı, E) Oransal kök ağırlığı, F) Net asimilasyon oranı, G) Nisbi büyüme hızı.

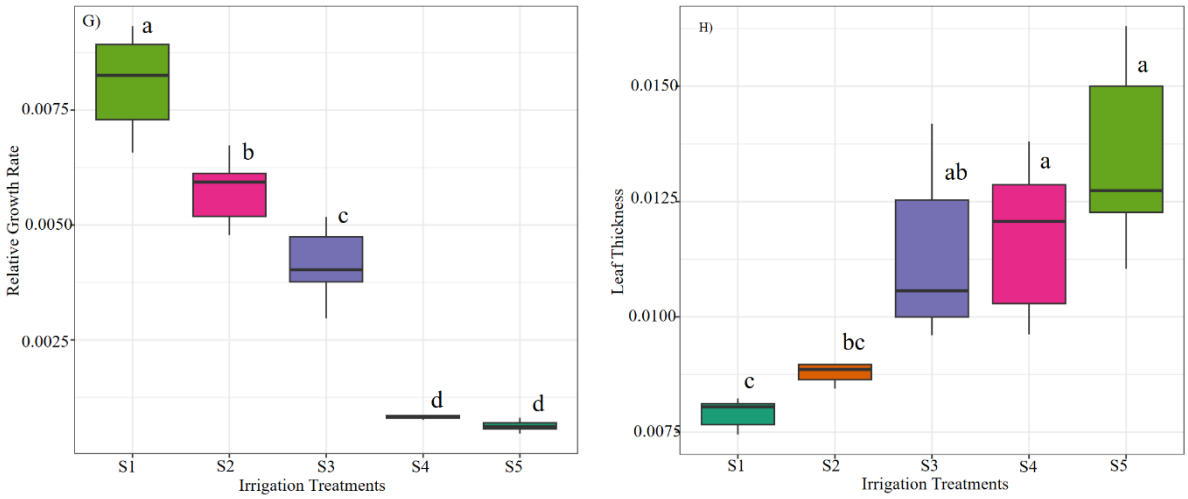

Figure 4. Continue.
Şekil 4. Devamı.

SLA parameters of chokeberry plants in peat medium showed statistical differences according to the treatments. SLA decreased as irrigation water salinity increased. This results agree with the Çırak and Esendal's (2006) results who concluded that plants reduce transpiration by decreasing leaf surface area in conditions where they cannot get water from the soil. Control and 2dS m^{-1} were in the same statistical group in SLA and LAR parameters, while control, 2 and 4 dS m^{-1} were in the same statistical group in LWR parameters. This situation can be explained by the fact that with increasing irrigation water salinity, the plants are subjected to a physiological drought and shrink the leaf surface to reduce transpiration. Ünlükara et al. (2017) evaluated the effect of greenhouse and outdoor environment on salinity tolerance of spinach and found that LAR and SLA were affected by salinity under both conditions. The decrease in leaf area per unit dry biomass due to salinity stress is consistent with this study. SWR and RWR were not statistically affected by increasing irrigation water salinity. NAR and RGR were statistically affected by irrigation water salinity, and there were differences between treatments. Studies have revealed that temperature and light affect NAR and RGR. Öztürk and Demirsoy (2014) determined that strawberry plants grown in the open field during the growth period had higher NAR values than those grown in the shade. Acock et al. (1978) and Uzun (1996) reported that NAR value increased with the increase in photosynthesis rate in intense light. As a result, it is thought that decreases in photosynthesis rate cause decreases in NAR and RGR values.

CONCLUSION

Chokeberry plants showed different development according to irrigation water quality and growing medium. In the study, an increase in irrigation water salinity caused a decrease in root, stem, leaf fresh and dry weights, and leaf area. This decrease caused differences in SLA, LAR, LWR, SWR, RWR, NAR, RGR, and LT values, which are important evaluation parameters to reveal plant development. In both peat and soil mediums, the increased electrical conductivity of the irrigation water decreased leaf, stem, root weights, and leaf areas, which caused an increase in LWR, SWR, and LT values and decreases in SLA, LAR, NAR, RGR, and LWR values. RWR value increased with increasing salinity in the peat medium, while it showed a decreasing trend in the soil medium.

The interaction between water quality and growing medium had an effect on plant growth. NAR and RGR, which are the parameters that express plant growth most strongly, were affected by the growing medium and electrical conductivity of the irrigation water. According to the results, irrigation water quality and growing medium should be considered for plant growth and quality in chokeberry cultivation. NAR and RGR parameters reached their highest values in control (0.65 dS m^{-1}) in the peat medium and 2 dS m^{-1} (S2) in the soil medium. Considering that plants with high NAR and RGR values grow faster and show good development, irrigation water with an electrical conductivity of 0.65 dS m^{-1} in peat medium and 2 dS m^{-1}

in soil medium was found suitable for optimum development. The data obtained in this study to determine the effect of irrigation water salinity and medium effect on plant growth parameters will be useful in studies to determine the effect of irrigation water quality and medium on plant growth in chokeberry plants.

CONFLICT OF INTEREST

The authors have declared no conflict of interest.

DECLARATION OF AUTHOR CONTRIBUTION

A.A. and B.C. contributed to the design and implementation of the research, to the analysis of the results, and to the writing of the manuscript.

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