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Comparison of Different Pruning Methods for Training Young Fernor Walnut Trees

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Abstract: The aim of the study is to determine the effects of minimal pruning (MP) and unpruned&unheaded (UP&UH) on young Fernor walnut cultivar trees concerning, tree growth, yield, nut quality and water use efficiency. The trees in the research orchard were planted in 2017. According to the data, a statistically significant difference was found between (MP) and (UP&UH) in terms of shoot length, canopy length, tree height, yield, kernel weight, kernel ratio and nut length. The two-year cumulative yield value was found to be 6036.28 g in (MP) and 9865.87 g in (UP&UH). The stem water potential values (GSP), (MPa) of (MP) and (UP&UH) were 7.65 and 7.50, respectively. Considering the significant difference in yield between two pruning methods, it has been observed that water use efficiency is higher in (UP&UH). If water deficiency and insufficient fertilization are combined with (UP&UH), significant losses in tree growth, yield and nut quality can occur. In this context, (UP&UH) should be considered along with other factors that will affect tree growth, yield and fruit quality.

Keywords: Pruning, Training, Yield, Fernor, Walnut.

Genç Fernor Ceviz Ağaçlarının Yetiştirilmesinde Farklı Budama Yöntemlerinin Karşılaştırılması

Öz: Çalışmanın amacı, minimum budama (MP) ve budamama&tepe vurmamanın (UP&UH) genç Fernor çeşidi ceviz ağaçlarında ağaç gelişimi, verim, meyve kalitesi ve su kullanım etkinliği üzerine etkilerini belirlemekti. Araştırma bahçesindeki ağaçlar 2017 yılında dikildi. Verilere göre (MP) ile (UP&UH) arasında sürgün uzunluğu, taç uzunluğu, ağaç yüksekliği, verim, iç ağırlığı, iç oranı ve meyve boyunda istatistiksel olarak önemli farklılık bulundu. İki yıllık kümülatif verim değeri (MP) ağaçlarında 6036,28 g, (UP&UH) ağaçlarında 9865,87 g olarak belirlendi. (MP) ve (UP&UH)'nin ortalama gün ortası gövde suyu potansiyeli değerleri (MPa) sırasıyla 7,65 ve 7,50'dır. İki budama yöntemi arasındaki verim farkı dikkate alındığında (MP) uygulamasında su kullanım etkinliğinin daha yüksek olduğu görüldü. Sulama suyu yetersizliği ve yetersiz bitki besleme&gübreleme yönetimi (MP&UH) ile birleştiğinde ağaç gelişiminde, verimde ve meyve kalitesinde önemli kayıplara neden olabilir. Bu bağlamda (MP&UH) uygulaması, ağaç gelişimi, verim ve meyve kalitesini etkileyecek diğer faktörlerle birlikte düşünülmelidir.

Anahtar Kelimeler: Budama, Şekil budaması, Verim, Fernor, Ceviz.

1.Introduction

Training and pruning of adult walnut trees serve purposes: controlling tree size balancing generative and vegetative development, enhancing nut size, promoting the formation of new fruit buds, ensuring proper light distribution within the tree, and eliminating old, dried, dead or overlapping branches. Additionally pruning aims to shape the tree suitably for harvesting and picking operations by machinery. Another objective of pruning in mature walnut trees is to stimulate strong spur development, encourage female flower formation, and facilitate the growth of large nuts. (Akça, 2014; Andersen, 1984).

In walnut varieties that bear fruit on terminal branches, pruning may delay yield. However, this effect is not seen in varieties that produce high amounts of fruit on lateral branches. Significant differences exist between varieties regarding development type, fruiting location, vigor and many other characteristics. If young fruit-bearing trees are minimally pruned, ıt can encourage sufficient shoot development to form fruit areas Conversely, heavy pruning of young trees may delay the onset of yielding.

Studies investigating the effects of different pruning methods on yield and fruit quality in walnut cultivation in Turkey are very limited (Argaç, 2021). According to our observations in walnut orchards where hard pruning is practiced in walnut cultivation, our initial results indicate that the shoots are susceptible to damage from the onset of yield is delayed, productivity is low and

increased susceptibility to *Xaj* disease.

Similar research has been conducted on Ashley, Howard and Chandler varieties (Hasey et al., 1998; DeBuse et al., 2010). However, there is no study on the Fernor variety. Fernor trees have different morphological and physiological characteristics compared to the Ashley, Howard and Chandler varieties, their responses to different pruning systems remain unknown.

Walnut growers in Türkiye prefer very hard pruning over minimal pruning. There is a common belief that minimal or no pruning is not appropriate in walnut cultivation. Growers hold belief that with hard pruning, the tree will have a more uniform shape and stronger growth. In fact, it is widely believed that if young walnut trees are not pruned, their development will stagnate, leading to decreased yield and fruit quality due to early fruit bearing. Consequently , very hard pruning is performed on young trees. When we realized that we could not change habits with rhetoric, we realized that we needed applied research results. The only way to overcome resistance to paradigm change should be persuasion with results based on research.

It has been reported that young trees of the Howard, Chandler, Tulare, Forde, Solano and Livermore varieties do not require pruning to maintain growth and achieve adequate yield. Heavy pruning is not recommended for these cultivars as it leads to reduced yields and smaller trees. Pruning may delay yield on varieties that bear fruit on terminal branches, such as Hartley and Franquette. However, this effect is not observed in cultivars that bear fruit on lateral branches (Hasey et al., 1998).

There is no research investigating the effects of different pruning methods on yield in young Fernor walnut trees. The use of hard pruning methods, especially in the Fernor variety, delays the age at which trees start yielding. In our research, we investigated the effects of pruning management on tree development, yield, nut quality and water stress in young Fernor trees. Additionally, our study aimed to provide new results against the hypothesis that pruning reduces tree growth in varieties that bear fruit on lateral branches.

2.Material and Method

2.1. Material

2.1.1. Plant Material

In 2017, an extensive walnut orchard was planted in the Northeast of Turkey, in Lüleburgaz (41°18'44.08"N & 27°17'42.64"E), with trees spaced at 8m x 4m grafted ‘Fernor’ trees onto *J. regia* L. rootstock. Fernor walnut cultivar has the characteristics of late leafing and lateral bud fruitfulness. Fernor is the most used cultivar after the Chandler variety in walnut orchards established in Turkey in recent years.

2.1.2. Soil characteristics of the orchard where the research was conducted

Physical and chemical properties of the soils of the research orchard presented in Table 1.

Table 1. Physical and chemical properties of soils
Çizelge 1. *Toprakların fiziksel ve kimyasal özellikleri*

Parametre	Results	Unite	Metod
Soil pH	7.50	%	-
Eletrical conductivity (EC)	0.04	%	Saturation
CaCO3	1.95	%	Calsimetric
Saturation	74.80	%	Saturation
Organic matter (OM)	1.49	%	Walkey-Black
(N)	0.07	ppm	Kjeldahl
P	7.07	ppm	Olsen
K	191.54	ppm	Amonium Asetat - ICP
Ca	8 014.23	ppm	Amonium Asetat- ICP
Mg	740.81	ppm	Amonium Asetat- ICP
Fe	21.11	ppm	DTPA-ICP
Cu	1.68	ppm	DTPA-ICP
Zn	0.37	ppm	DTPA-ICP
Mn	8.50	ppm	DTPA-ICP

2.1.3. Devices used to measure length and weight

Meters were used to measure trunk length, shoot length, tree height, and canopy and tree width. An electronic caliper with 0.01 mm precision was used to determine fruit sizes from pomological characteristics, and an electronic scale with 0.01 g precision was used to determine nut and kernel weight.

2.2. Method

2.2.1. Preparation practices for different pruning methods on saplings

Fernor saplings were initially over 2.00 meters high and were pruned to 50 cm upon planting. Drip irrigation was installed from the outset, and orchard management followed standard practices appropriate to the environment and the age of the plantation. Before onset of the second growing season trees were cut at 1.80 m and 5-6 scaffold branches were selected, including the leading branch. Subsequently main shoot leader and scaffold branches were pruned during in the winter training, removing either 1/3 or 2/3 of their length depending on their annual growth, typically around a meter . During the three first year’s stakes were used. The objective was to achieve 5 to 6 limbs, growing the first at 1.50 m from the soil. A minimal pruning system was applied to trial trees in 2018 and 2019 to establish a main branch system that would allow adequate light penetration (Ryugo et al., 1980). Trials of two different pruning systems started in 2020.

2.2.1.1.Minimum pruning method (MP)

In 2020 and 2021, the branches of the trees that will undergo (MP) were cut below 150 cm from the soil level, and 25% to 30% of the shoots from the previous year were cut and headed (Figure 1).

2.2.1.2.Unpruned/Unheaded training method (UP&UH)

In 2020, in (UP&UH), only narrow-angle and forked branches and branches below 150 cm on the trunk were removed. All other branches were unpruned and unheaded. Trees that were not crowned and cut under management UP&UH in 2020-2021 were released. However, during the summer pruning of these trees, only the forked branches, if any, were reduced to single branches (Figure 1).

2.2.2.Determination of the effects of pruning management on phenological, morphological, pomological and yield

In order to determine the effect of pruning management on phenological characteristics, data on bud burst time, leafing time, female flowering time, male flowering time, harvest time and leaf fall time were taken.

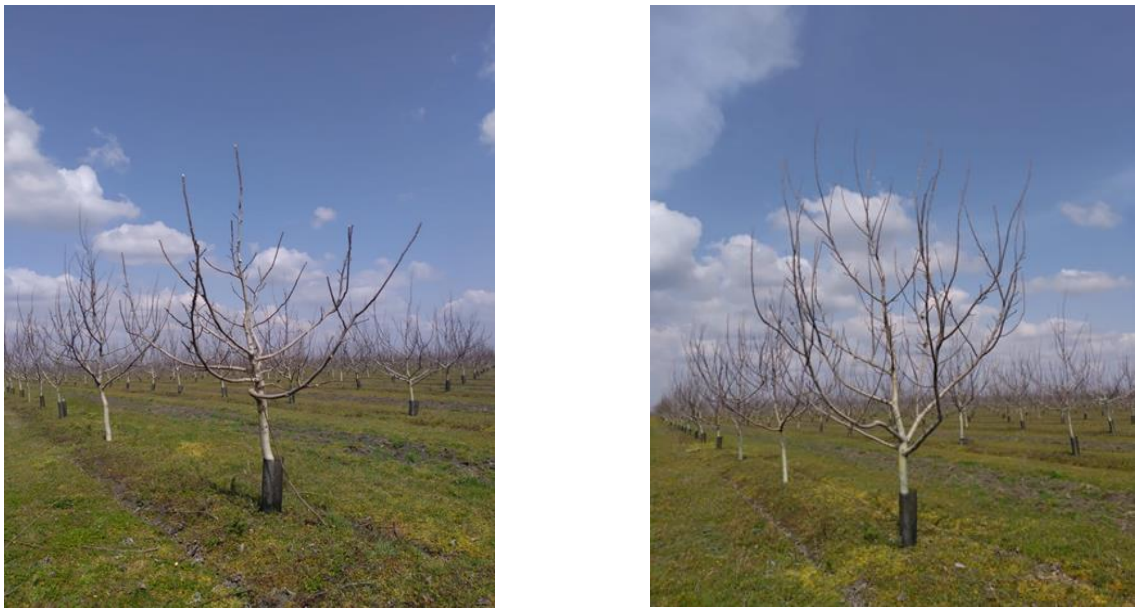

Figure 1. Crown shape of trees treated with (MP) (left) and (UP&UH) (right)
Resim 1. *(MP) (solda) ve (UP&UH) (sağda) uygulama yapılan ağaçların taç şekli*

In order to assess the act of pruning management on morphological characteristics, various parameters were examined, including tree trunk circumference, tree height, tree and canopy volume, canopy length and width.

In order to assess the act of pruning management on morphological characteristics, various parameters were examined, including tree trunk circumference, tree height, tree and canopy volume, canopy length and width.

Additionally, the yield per tree was determined to evaluate the effect of pruning methods on yield (g/tree). Tree volume (TV) and crown volume (CV) were calculated based on Equation 1 (Stehr, 2005) and Equation 2 (Argaç, 2001).

$$TV(m^3)=[(L+W)/4)^2.\pi.H]/2 \quad (1)$$

L: Crown height
W: Crown width
H: Tree height

$$CV(m^3)=\pi r^2 h/2 \quad (2)$$

h: Crown height
r: Crown width

In order to determine the effect of pruning methods on pomological characteristics, nut weight, kernel weight, kernel percentage shell thickness, nut dimensions (length, height, width) and kernel color characteristics were examined. Pomological characteristics were examined in 20 nuts randomly taken from 12 trees selected for each application.

2.2.3. Effect of pruning managements on plant water stress

Irrigation time, irrigation interval and irrigation water amount were determined using climate data obtained

from the climate station in the research orchard. Soil moisture values obtained from digital soil moisture sensors.

To directly determine the effects of two different pruning treatments on plant water stress, stem water potential (GSP) values were measured with a pressure chamber device between in June and October. Measurements were conducted on Thursdays between 12.00 and 13.30 on three trees selected from each of the trial plots. Measurements were made on leaves selected from the south side of the tree. The leaf was wrapped with foil and the measurement was taken after waiting for 10 minutes. Leaf water potential was determined using a PMS 615 model device (Fulton et al., 2001).

2.2.4. Plant nutrition and leaf macro and micro element contents

Leaf and soil analyses were conducted to determine plant nutrition management, and yield served as a basis for adjustments. A total of 150 kg of nitrogen (N), 90 kg of potassium (K), and 40 kg of phosphorus (P) were applied per hectare. Additionally foliar fertilization with combined microelements was applied throughout the season. The effects of (MP) and (UP&UH) applications on leaf macro and micro element contents were examined.

2.2.5. Evaluation of data

The experiment was set up with 3 replications and 4 trees were included in each replication. The effects of two different pruning methods on morphology, pomology and yield were analyzed in the SAS statistical program and comparisons were made with the Duncan test.

3. Results and Discussion

The aim of the research is to determine the effects of (MP) and (UP&UH) on young trees of Fernor variety on the growth vigor, yield, nut quality and water use efficiency of the trees.

3.1. Effect of pruning methods on phenological characteristics

The leafing time, the time of receptive period in female flower and the time of pollen shedding of the trees that received (MP) were observed approximately 5 days earlier than the trees that (UP&UH). Harvest time and leaf fall dates were found to be similar for two pruning managements.

3.2. Effect of pruning methods on morphological characteristics

3.2.1. Tree trunk circumference

In (MP), the average tree trunk circumference values were measured between 37.70 cm and 43.50 cm, with and the average trunk circumference value calculated as 39.61±1.69 cm. In (UP&UH), the trunk circumference ranged from 35.50 cm to 41.80 cm with the average trunk circumference recorded as 38.46±1.89 cm (Table 2).

The effect of two pruning methods on the trunk circumference was found to be insignificant (Table 1). Similar results were reported in a study on Chandler walnut variety, where the effect of training systems on trunk circumference was also found to be insignificant. Moreover, investigations on four different pruning methods in Chandler cultivar revealed that trees without pruning exhibited the highest trunk circumference (126.90), while trees subjected to minimal pruning showed the lowest trunk diameter (Aletà et al., 2006). Like our research results, the effect of minimum pruning and non-pruning management on the tree trunk environment was found to be statistically insignificant (Argaç 2021). The effects of hard pruning, minimum-low level pruning, minimum pruning and unpruned/unheaded treatments on the trunk circumference were found to be insignificant in Gillet, Forde and Tulare varieties. However, in Chandler variety, a significant difference was found between severe pruning (27.9 cm) and other pruning methods (29.7-32.0 cm). Similar to our research results, the lowest trunk circumference value was found in the Tulare variety under unpruned/unheaded methods, and the highest value was found in the Gillet variety under minimum pruning (DeBuse et al., 2010).

Table 2. Effect of different pruning methods on morphological characteristics
Çizelge 2. *Farklı budama yöntemlerinin morfolojik özellikler üzerine etkisi*

Pruning Methods	Tree trunk circumference (cm)	Tree height (m)	Tree volume (m^3)	Canopy volume (m^3)	Canopy length (m)	Canopy width (m)	Shoot length (cm)
(MP)	39,61[a]	5,50[b]	36,32[a]	18.28[a]	4,00[b]	4,17[a]	90,28[a]
(UP&UH)	38,46[a]	5,71[a]	41,12[a]	20.91[a]	4,23[a]	4,29[a]	33.32[b]

*The difference between means shown with different letters in the same column is significant (P<0.05)

3.2.2. Tree height (m)

In (MP), tree height were measured between 4,90 and 5,76 m, and the average tree height was 5,50±0.27 m. In (UP&UH), tree height varied from 5.48 m to 6.35 m, and the average tree height was 5.71±0.22 m. A significant difference (P<0.05) was found in the tree heights between (MP) and (UP&UH) (Table 2). DeBuse et al. (2010) reported that different pruning systems had no significant effect on tree height, but they noted that the highest tree height was observed in minimally pruned trees. Similarly, in our research, the height of (UP&UH) trees was found to be higher than (MP) trees, consistent with the results of Argaç (2021).

3.2.3. Tree and canopy volume (m^3)

In (MP), tree volume (m^3) varied between 24,93 and 42,66 and the average canopy volume was 36,32±6,35. In (UP&UH), the tree volume (m^3) ranged from 33,12 to 52,17 and the average tree volume was 41,12±5,12 (Table 1). In (MP), canopy volume (m^3) varied between 11.62 -23.99 and the average canopy volume 18.28±3.67. In (UP&UH), the canopy volume ranged from 13.92 m^3-26.54 $m^3$and the average canopy volume was 20.91±3.20 m^3 (Table 2).

There was no statistical difference between the tree volume and canopy volume of trees with (MP) and (UP&UH) (Table 1). Similar to our research results, Argaç (2021) stated that the effect of non-pruning and minimum pruning on the tree and canopy volume is insignificant, but the tree and canopy volume values of trees without pruning are higher than the values of trees with minimum pruning.

3.2.4. Canopy length and width (m)

In (MP), the canopy length varied between 3.40 and 4.29 m, and the average canopy length was 4.00±0.27m. In (UP&UH), the canopy length was found between 3.98 and 4.85 m, and the average canopy length was 4.23±0.23 m. A statistically significant difference was found between the canopy length of trees with (MP) and (UP&UH) (Table 2).

In (MP), the canopy width varied between 3.45 and 4.80m, and the average canopy length was 4.17±0.35m. In (UP&UH), the canopy width was found between 3.58 and 4.95 m, and the average canopy width was 4.29±0.23 m. A statistically insignificant difference was found between the canopy width of trees with (MP) and (UP&UH) (Table 2).

3.2.5. Shoot length (cm)

In (MP), the shoot length varied between 79,6.0 to 106.0 cm and the average shoot length was 90,28±7,38 cm. In (UP&UH), the shoot length varied between 20,06 to 41,06 cm and the average shoot length was 33,32±6,38 cm. A statistically significant difference was found between the shoot length of trees with (MP) and (UP&UH) (Table 2).

Dalkılıç et al., (2005) compared the effects of six different intensities of pruning on vegetative growth in eight-year-old trees of Yalova-4 and Bilecik walnut varieties. They found significant effects of different pruning severities on vegetative development. Specifically, significant effects of pruning intensities on the number of annual shoots, total shoot length, and total number of buds were observed in the Yalova variety. The effect of different pruning intensities on the number of annual shoots in the Bilecik variety was found to be insignificant.

3.2.6. Average yield (g/tree)

According to two years, average yield values per tree in (MP) varied between 1707.28g and 4329.4g. The average yield of (UP&UH) management was between 2829.62 and 7036.25. The two-year cumulative yield was found 6036.68 g in (MP) and 9865.87 g in (UP&UH). The cumulative yield of (UP&UH) was determined to be 61.18% higher than that of (MP) management (Table 3). A significant difference (P<0.05) was observed between the yield values of (MP) and (UP&UH) (Table 3).

Table 3. Effect of different pruning methods on yield (g/tree)

Çizelge 3*. Farklı budama yöntemlerinin verim üzerine etkisi (g/ağaç)*

Pruning Methods	Average Yield (g/ tree)		Cumulative y ield (g/tree)
	2021	2r022	
(MP)	1707.28 b	4329.4 b	6036,28b
(UP&UH)	2829.62 a *	7036.25 a *	9865,87a

* The difference between means shown with different letters in the same column is significant (P<0.05)

In the study comparing the yield values of Chandler trees with minimal pruning and no pruning in Bursa ecological conditions, it was reported that trees without pruning had a higher yield of 40.56% compared to trees with minimum pruning, which is consistent with our research results (Argaç 2021). Some studies have indicated that no significant difference in yield resulting from pruning walnut trees, but these results are from studies on mature trees. Observations conducted at UC Davis orchards and grower orchards in California have shown that walnut trees can grow without pruning even in the early years (Lampinen et al., 2015). The effects of

hard pruning, minimum-low level pruning, minimum pruning and no-topping-no-pruning management on yield were found to be insignificant in Tulare variety and significant in other varieties (Chandler, Gillet, Forde). The highest yield value was found in unpruned and unheaded management, consist with our research results (DeBuse et al., 2010). Olsen et al., (1990), reported that the yield value of annually pruned trees did not significantly differ from that of unpruned trees, in contrast to our research results. According to Lampinen et al., (2015), the yield of trees that are not pruned except for removing branches that get in the way of shakers or tractors has a cumulative yield similar to trees that are pruned every year for the first 7 years.

3.2.8.Effect of pruning methods on pomological characteristics

The kernel colors of the trees applied to two different pruning methods were found to be similar (Figure 2).

In (MP), average nut weight was found as 11.57±0.59 (g), kernel weight was 5.09±0.40 (g), shell thickness (mm) was 1.85±0.15, nut length (mm) was 37.12±0.53, nut height (mm) was 32.55±0.51, nut width (mm) was 31.23±0.88 in 2021 year. In (MP), average nut weight was found as 13.30±0.42 (g), kernel weight was 6.37±0.36, shell thickness (mm) was 1.58±0.09, nut length (mm) was 40.75±0.95, nut height (mm) was 34.43±0.61, nut width (mm) was 32.56±0.54 in 2022 year (Table 4).

In (UP&UH), average nut weight was 12.01±0.48 (g), kernel weight was 5.32±0.27 (g), shell thickness (mm) was 1.79±0.16, nut length (mm) was 38.11±0.81, nut height (mm) was 33.84±1.15, nut width (mm) was 32.13±1.09 in 2021 year (Table 4).

In (UP&UH), average nut weight was found as 13.44±0.43 (g), kernel weight was 6.69±0.32 (g), shell thickness (mm) was 1.64±0.1, nut length 41.15±1.02 (mm) nut height was 34.35±0.45, nut width (mm) was 32.81±0.54in 2022 year (Table 4). According to 2021 data, there was a significant difference ($P<0.05$) between pruning methods in terms of nut length and nut height values . In the 2022 data, differences were found in terms of kernel weight and kernel percentage (Table 4). However, the effect of pruning methods on other pomological characteristics was found to be insignificant.

Nuts of (MP) | Nuts of (UP&UH)

Figure 2. The nuts of (MP) and (UP&UH)
Resim 2. *Minimum budama ve budamama&tepe vurmama uygulanan ağaçların meyveleri*

Table 4. Effect of different pruning methods on pomological characteristics
Çizelge 4. *Farklı budama yöntemlerinin pomolojik özellikler üzerine etkisi*

Pruning Methods	Nut weight (g)	Kernel weight (g)	Kernel percentage (%)	Shell thickness (mm)	Nut length (mm)	Nut height (mm)	Nut width (mm)
			2021				
(MP)	11.57 a	5.09 a	43.97 a	1.85 a	37.12 b	32.55 b	31.23 a
(UP&UH)	12.01 a	5.32 a	44.28 a	1.79 a	38.11 a*	33.84 a*	32.13 a
			2022				
(MP)	13.30 a	6.37 b	47.70 b	1.58 a	40.75 a	34.43 a	32.56 a
(UP&UH)	13.44 a	6.69 a*	50.57 a*	1.64 a	41.15 a	34.35 a	32.81 a

*The difference between means shown with different letters in the same column is significant ($P<0.05$)

Argaç (2021) reported no difference between nut width, shell thickness, kernel weight and kernel percentage of trees with minimal pruning and non-pruning trees. However there was a significant difference between management practices in terms of nut weight. Conversely , Olsen et al., (1990) stated that there were losses in nut size and nut quality in unpruned walnut orchards. The inconsistency of the results regarding the effects of pruning methods on nut quality may be attributed to variations in the walnut varieties used in the research, rootstock variety combinations, irrigation, plant nutrition, disease and pest management strategies.

3.2.9.Effect of pruning methods on midday stem water potential

In order to determine the effects of pruning management on plant water stress, leaf water potential values were measured and the results are presented in Table 5. Average stem water potential values were found as 7.65 in trees with (MP), and 7.5 in trees with (UP&UH). The difference between (MP) and (UP&UH) was found to be approximately 0.15 MPa (Table 5). There was no statistically significant difference between pruning management methods in terms of seasonal midday trunk water potential values (Table 5). Lampinen et al., (2015) reported that, similar to our research results, the effect of different pruning systems on water stress was minimal. They found no significant difference in average seasonal midday trunk water potential values between pruning treatments in 2005, 2006 and 2009. In 2007, 2008 and 2010, slight differences were detected (approximately 0.05 MPa). In our study, the irrigation management of the trees subjected to two different pruning methods was similar; thus, the amount of water provided to the trial trees and the irrigation timing were consistent.

Table 5. Midday trunk water potential values (MPa) of different pruning methods

Çizelge 5. *Farklı budama yöntemlerinin gövde su potansiyeli üzerine etkisi*

Date	(MP)	((UP&UH))
July 1, 2022	7.0	7.5
July 15, 2022	7.0	6.0
August 1, 2022	8.5	8.5
August 15, 2022	7.5	7.5
September 1, 2022	6.5	6.0
September 15, 2022	10.0	10.5
October 1, 2022	7.0	7.0
October 15, 2022	7.5	7.0
Average	7.65[a]	7.5[a]*

*The difference between means shown with different letters in the same column is significant (P<0.05)

Although the yield values (gr/tree) of no-pruning management were higher, the water use efficiency values of these trees were also observed to be high. As a matter of fact, similar to our research results, Lampinen et al., (2008) reported that unpruned trees had higher yield than pruned trees with the same amount of water.

3.2.10. The content of macro and micro elements of leaf

The content of macro and micro elements of leaf in (MP) and (UP&UH) are presented in Table 6. The macro and micro element contents of the leaves of the trees to which two different pruning methods were applied were found to be similar. The nitrogen, potassium and zinc contents of the leaves were found to be insufficient, but the copper content was high (Table 6)

Table 6. The content of macro and micro elements of leaf in MP and (UP&UH)

Çizelge 6. MP and (UP&UH) *budama yöntemlerinin yaprak makro ve mikro element içerikleri*

	(MP)	(UP&UH)	Unite	Metod
N	2.19	2.3	%	Kjeldahl
P	0.16	0.15	%	Wet digestion-ICP
K	1.15	1.04	%	" "
Ca	2.2	1.76	%	" "
Mg	0.65	0.49	%	" "
Fe	95	78	ppm	" "
Cu	130	118	ppm	" "
Zn	8	9.22	ppm	" "
Mn	85	97	ppm	" "

4. Conclusion

With (UP&UH), the costs of pruning labor and collecting pruning pieces are eliminated. Moreover, the earlier and higher yield of trees in the initial years positively impacts orchard management costs. In our study, unlike others , pruning management was started after a balanced and regular main skeleton was achieved on the canopy. It is estimated that this practice will increase light penetration into the trees canopy. According to preliminary results, the results contradict the hypothesis that young walnut trees that are not pruned will experience growth stagnation, crown fruit branches dying, and tree size reduction.

For pruning management to be recommended despite its positive results, ecological conditions, plant nutrition and irrigation management must also be considered. If (UP&UH) management is combined with inadequate irrigation and suboptimal plant nutrition, significant setback in tree development, yield and nut quality may occur. Consequently , pruning management should be integrated with other factors influencing tree

development, yield and fruit quality. It should not be implemented in walnut orchards without considering integrated orchard management. Additionally, for more definitive and consistent results, the research should be continued for at least 5 more years. Final decisions should be based on the findings obtained in the subsequent years.

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