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THE EFFECTS OF DIFFERENT PRUNING TREATMENTS ON THE GROWTH, FRUIT QUALITY AND YIELD OF 'HACIHALILOGLU' APRICOT

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Abstract. This study was conducted in Malatya, between 1999 and 2003, and the region's most important dried apricot variety, Hacihaliloglu was used as material. In the study, the effect of 5 different combined or alone pruning treatments on the growth, fruit quality and yield characteristics were determined in comparison with non-pruned trees. Pruning treatments in different periods did not statistically affect phenological features and fruit dimensions but strongly affected total soluble solid and fruit firmness of Hacihaliloglu apricot cultivar. The highest average yield considering trunk cross-sectional area was obtained as 0.34 kg·cm^{-2} from pre-harvest summer pruning treatment and the highest share of flower bud was observed as 68.29% in pre-harvest summer+winter pruning treatment. Pruning applications significantly affected both shoot diameter and length. The highest shoot diameter and length were obtained from pre-harvest summer+winter pruning application as 8.52 mm and 77.84 cm, respectively. The highest leaf area was determined as 39.43 cm^2 in post harvest pruning treatment.

Key words: *Prunus armeniaca* L., summer pruning, winter pruning, pomological fruit features

INTRODUCTION

Apricot is grown in almost every province in Turkey except some parts of Black Sea and Eastern Anatolia where high humidity and severe winter cold take place. Due to nine different agro climatic regions found in Turkey, table, early, late and also dried apricot can be produced in these different regions. Turkey is by far the leader apricot producer in the world and it is accepted second homeland of apricot [Esitken et al. 2003;

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Ercisli 2004]. In Turkey, approximately half of the apricot production (300.000 tons) is supplied by Malatya region, the capital of apricot in the world. This region only dried apricots produces and almost all produced dried apricots from the region is exported mostly to European countries [Ercisli 2009]. The economy of this region highly belongs to dried apricot exports and approximately ten percent of apricot produced in world supplied by Malatya [Ercisli 2009]. The amount of apricot produced in Malatya is higher than some important apricot producing countries such as Italy, France and Spain and same level with Iran which is ranking 2nd biggest apricot producer [Anon 2008].

World wide well-known dried apricot cultivar, Hacihaliloglu is the main cultivar in Malatya and 75% of bearing apricot trees in Malatya belong to this cultivar. The cultivar has exceptional dried fruit quality characteristics [Guleryuz et al. 1997].

Pruning is one of the most important technical treatments applied on fruit trees. Throughout the tree's life, pruning ensures that limbs are strong enough to support fruit and that branches are properly angled to allow in sufficient sunlight for flower buds to develop and for fruit to ripen. Pruning not only considerably improves regeneration processes of damaged branches and reduces the size of tree crowns, but also reduces their excessive height [Carlson 1982; Mika 1986; Radajewska and Szklarz 2008; Szklarz and Radajewska 2009]. Pruning promotes good air flow throughout the fruit tree, which helps prevent common tree diseases. Pruning is also effect fruit external and internal quality properties such as color development, total soluble solid/acidity balance etc. [Lord and Greene 1982]. Pruning treatments can be classified according to time (winter and summer) or development stage of trees (young, middle and older stages).

Traditionally, temperate fruit trees are pruned during its dormant season, which is late winter to early spring. Pruning can also be done at the end of summer to remove new shoots or to cut back upright shoots on side branches. Summer pruning applied on temperate fruit trees is common practice by important fruit producer countries such as Italy, France, Spain etc. However it is not common in Turkey. Kuden and Kaska [1995], first time showed that summer pruning can be applied on apricot trees in Mediterranean region in Turkey. Previous studies showed that summer pruning had also positive affect on flower bud formation, to increase fruit quality, to control tree development [Miller 1982].

The aim of this study is to determine the relevant pruning time on vegetative growth, fruit quality and yield characteristics in apricot cv. Hacihaliloglu.

MATERIALS AND METHODS

The experiment conducted between 1999–2003 years by using 12 years old health Hacihaliloglu apricot trees planted in apricot orchard at the distance of 10 × 10 m between and within rows. The gobble system was applied on trees.

The cv. Hacihaliloglu is widely grown in Malatya and mature trees of the cultivar are strong and semierect-broad growing habits. The cultivar has oval, symmetrical medium size fruits and fruit surface color is orange. The fruit is less juicy, very sweet, total soluble solids and acidity approximately 26% and 0.30%. Fruit has sweet and oval kernels and flesh/seed ratio is around 14 [Guleryuz et al. 1997].

In this study, 5 different pruning treatments (combined or alone) were as follows: PH1S-Preharvest summer, PH1SW-Preharvest summer+winter, PH2S-Postharvest summer, PH2SW – Postharvest summer+winter and winter pruning were applied. These treatments were compared with unpruned trees (control).

Summer pruning were applied before and after harvest taking into account bud differentiation. The one third apex part of excess growing shoots during development period has been cut and taken away from tree. In addition, diseased, broken etc. branches have also been taken away from trees [Rom and Ferree 1985; Marini 1986; Kuden and Kaska 1995].

Phenological observation and pomological properties were determined according to Guleryuz et al. [1997]. Official AOAC [1984] method was used for total soluble solids (%) and acidity (%) analysis. Fruit firmness was determined by hand penetrometer. Skin color of fruits was measured on the cheek area of 20 fruit with a Minolta Chroma Meter CR-400 (Minolta-Konica, Japan). Chromameter was calibrated to a standard white reflective plate and used Commission Internationale de l'Eclairage (CIE) illuminant C. L* (lightness), a* (green to red) and b* (blue to yellow) values were measured [Barnalte et al. 2003]. Average fruit weight was measured on 30 random fruits per treatment by using a digital balance with a sensitivity of 0.001 g (Scaltec SPB31). Linear dimensions as length and diameter of 30 fruits per treatment were measured by using a digital calliper gauge with a sensitivity of 0.01 mm. The trunk-cross sectional area (calculated from tree diameter measured 20 cm above the graft line) and shoot growth were determined by Marini [1986]. The leaf area was determined by Demirtas [2003]. Chlorophyll and carotenoids content were determined by spectrophotometer method using mature leaves sampled from medium part in annual shoots [Strain and Svec 1966].

The experimental was established as randomized block design with 4 replicates and each replicate included 1 tree. The obtained data as % were converted to arc sinus transformation and statistical analysis was made through these values. Costat package computer program was used for statistical analysis.

RESULTS AND DISCUSSION

Phenological observations. In the study, pruning practices made in different periods was not significantly effect on phenological characteristics. First flowering dates varied between March 8 to April 4 depending on early or late warming of the air. The full blooming was observed between March 10 and April 6 and completed between 2 to 5 days depending on the air conditions. There were parallelism between early or late flowering dates and fruit harvest dates and the days from full blooming to harvest were found to be between 107 and 117 days. Ikinci [1999] found that in general flowering on trees was delayed by winter+summer pruning applied on apricot, peach and almond trees. Niran [1981] is also stated that trees pruned in May and August flowered earlier than October pruned trees.

Pomological analysis. The pruning treatments in different periods did not significantly affect pomological characteristics except TSS, fruit firmness and a color value.

Table 1. The effect of pruning treatments on pomological features of apricot fruit
Tabela 1. Wpływ zabiegu cięcia na cechy pomologiczne owoców moreli

Pruning Cięcie	Fruit width szerokość owocu mm	Fruit length długość owocu mm	Fruit weight masa owocu g	Seed weight masa pestki g	Flesh/seed ratio Stosunek masa pestki/owoc	Fruit volume Objętość owocu ml	TSS %	Acidity Kwasowość %	Fruit firmness Jędrność $kg \cdot cm^{-2}$	External color – Wybarwienie		
										L	a	b
PHlS	35.05	37.10	30.48	2.23	12.70	34.71	25.09 b	0.50	3.66 be	69.59	2.55 ab	47.48
PHlSW	34.91	36.94	32.06	2.31	12.89	33.43	25.57 ab	0.52	3.71 b	68.91	3.02 a	46.30
PH2S	34.93	37.00	31.05	2.22	12.93	32.90	25.88 a	0.47	3.32 c	67.65	3.53 a	46.41
PH2SW	35.46	37.67	31.48	2.22	13.19	33.83	24.39 c	0.48	3.83 b	70.81	-0.42 d	46.96
Winter – Zima	35.37	37.61	31.74	2.28	12.88	34.97	25.13 b	0.50	4.20 a	70.01	1.13 c	46.84
Control Kontrola	35.27	37.65	31.99	2.29	12.92	33.98	25.30 ab	0.48	3.79 b	70.04	1.17 be	46.77
$LSD_{0.01}$	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	0.83	ns – ni	0.47	ns – ni	1.65	ns – ni

ns – non significant – ni – nieistotne

According to pruning treatments, fruit weight, volume, flesh/seed ratio and acidity were varied from 30.48 to 32.06 g, 32.90 to 34.97 ml, 12.70 to 13.19 and 0.47 to 0.52%, respectively (tab. 1). Previously pruning treatments in different period in a year were found ineffective on fruit dimensions and flesh/seed ratio in peach [Marini 1985; Chitkara et al. 1991] and apple [Miller 1982] which in accordance with our results.

Pruning treatments has statistically significant effect on TSS content of fruits ($p < 0.01$). The highest TSS value was observed in PH2S treatments (25.88%), while the lowest was in PH2SW treatments (24.39%) (tab. 1). Daulta et al. [1986] reported that pruning applications had increased TSS content in peach. However, Niran [1981] and Miller [1982] reported that pruning applications had not significant effect on TSS content of fruits in both peach and apple. Cust and Ferree [1985], Miller [1987] and Christopher et al. [1989] stated that pruning applications negatively effected TSS content in peach.

The effect of pruning in different times within year was found significant on fruit firmness ($p < 0.01$). The winter pruning application gave the firmest fruits (4.20 kg·cm^{-2}), whereas the lowest values was found in PH1S treatment (tab. 1). In literature, researchers obtained different results from summer pruning on fruit firmness that applied in different times. For example Marini [1985] showed that summer pruning decreased fruit firmness similar to our results. Myers [1990] and Hussein [1988] found that summer pruning did not affect fruit firmness in peach and Miller [1987] found that summer pruning had increasing effect on fruit firmness in peach.

Pruning applications had significant effect on a color value but it was non significant on L and b color values (tab. 1). The highest a value, indicating increase of red color, was obtained in PH1S treatment (3.53) and it was the lowest as –0.42 in PH2SW treatment. It can be said that pre-harvest summer pruning treatment may have increase light penetration into crown in trees and resulted more colorful fruits. The color promotion effects of summer pruning has been reported in peach and apricot [Ikinci 1999]; Starking Delicious, Golden Delicious and Stayman apples [Barden and Marini 1984]; peach and nectarines [Day et al. 1989] and peaches [Walsh et al. 1989].

Yield. The effect of pruning on yield given both kg per tree and kg/cm^2 tree-trunk section area of cv. Hacihaliloglu has been shown in table 2.

Table 2. The effect of pruning on yield in cv. Hacihaliloglu apricot
Tabela 2. Wpływ cięcia na plon moreli odmiany Hacihaliloglu

Pruning Cięcie	Yield as per tree Plon owoców z drzewa, kg				Yield as trunk cross section unit area Wskaźnik intensywności owocowania kg·cm^{-2}			
	2000	2001	2003	average średnio	2000	2001	2001	average średnio
PH1S	135.6	138.0	155.2	142.9	0.39	0.35	0.29	0.34 a
PH1SW	102.1	172.2	180.5	151.6	0.24	0.36	0.27	0.29 ab
PH2S	101.3	143.6	153.9	132.9	0.24	0.31	0.24	0.26 b
PH2SW	103.1	154.4	139.0	132.2	0.27	0.39	0.25	0.30 ab
Winter – Zima	96.0	156.3	153.0	135.1	0.27	0.39	0.26	0.31 ab
Control – Kontrola	115.1	138.5	126.5	126.7	0.29	0.32	0.22	0.28 b
$LSD_{0.01}$				ns – ni				0.05

ns – non significant – ni – nieistotne

Due to spring frost injury, there were no data on yield in both 1999 and 2002 years. The highest yield per tree (kg) considering three year average was obtained from PH1SW as 151.6 kg while the lowest was observed in control treatment as 126.7 kg indicating approximately 25 kg yield increase and all pruning treatment increased yield even there were not statistical differences among treatments and control.

As seen in table 2, the gap between yield (as kg per tree) of PH1SW and control applications were 20.5 kg in 2000 year, this gap increased to 33.7 kg in 2001 and 54.0 kg in 2003 years, respectively (tab. 1). Previous studies confirm that the yield of pruned trees, in particular later years higher than non-pruned trees [De Jong and Day 1991; Son and Kuden 1998].

There were statistically significant differences ($p < 0.01$) among applications on yield as determined trunk cross section unit area ($kg \cdot cm^{-2}$). The highest average yield as trunk section area was determined as 0.34 $kg \cdot cm^{-2}$ in PH1S applications, the lowest was observed in PH2S as 0.26 $kg \cdot cm^{-2}$, respectively (tab. 2). Daulta et al. [1986]; Miller [1987]; Tehrani and Leuty [1987]; Chitkara et al. [1991] and Akcay [2001] found variable results on the effect of pruning on yield in different temperate fruit trees.

The effect of pruning treatments on flower and leaf bud share (%). The flower and leaf bud share were determined in the last 2 years of experiment and the effect of pruning treatments on share of flower and bud were found statistically significant ($p < 0.05$). The highest flower bud share was obtained from PH1SW applications as 68.29%, while the lowest value was observed in control treatments as 58.87%, respectively. In addition summer pruning applied before bud differentiation time had positive effect on flower bud formation (tab. 3). In parallel to this study, Day et al. [1989], Furukawa et al. [1992] and Myers [1993] reported that pruning applications on different fruit trees increased flower bud formation.

Table 3. The effect of pruning applications on the share of flower and leaf buds on shoots
Tabela 3. Wpływ zastosowania cięcia na udział pąków kwiatowych i liściowych na pędzie

Pruning Cięcie	Flower buds – Pąki kwiatowe %			Leaf buds – Pąki liściowe %		
	2002	2003	average średnio	2002	2003	average średnio
PH1S	69.97	64.64	67.31 a	30.03	35.37	32.70 b
PH1SW	69.12	67.46	68.29 a	30.88	32.54	3l.71 b
PH2S	66.95	6l.43	64.19 ab	33.05	38.57	35.81 ab
PH2SW	69.75	65.70	67.73 ab	30.25	34.30	32.28 b
Winter – Zima	67.57	58.75	63.16 ab	32.43	4l.25	36.84 ab
Control – Kontrola	61.57	56.16	58.87 b	38.43	43.85	41.14a
$LSD_{0.01}$			7.80			7.80

The effect of pruning applications on the growth. The effect of different pruning applications on shoot diameter, length and leaf area were found statistically significant ($p < 0.01$). However pruning treatments did not significantly affect trunk cross sectional area (tab. 4).

Table 4. The effect of pruning treatments on the growth of apricot trees
Tabela 4. Wpływ zabiegu cięcia na wzrost drzew moreli

Pruning Cięcie	Trunk cross sectional area growth Powierzchnia przekroju poprzecznego pnia		Growth of shoots Wzrost pędów		Leaf area Powierzchnia liścia cm^2
	cm^2	%	diameter – średnica mm	length – długość cm	
PH1S	407.3	18.8	7.90 b	70.26 bc	37.09 ab
PH1SW	502.5	18.4	8.52 a	77.84 a	37.71 ab
PH1S	484.1	18.5	7.46 c	70.69 bc	37.29 ab
PH2SW	424.7	18.2	7.86 b	72.33 abc	39.43 a
Winter – Zima	431.9	18.0	7.55 bc	75.95 ab	36.78 ab
Control – Kontrola	456.2	18.2	7.24 c	68.25 c	35.24 b
$LSD_{0.01}$	ns – ni	ns – ni	0.50	8.11	3.26

ns – non significant – ni – nieistotne

The better shoot diameter and length were obtained from PH1SW applications as 8.52 mm and 77.84 cm, while the lowest was in control applications as 7.24 mm and 68.25 cm, respectively (tab. 4). Among the all vegetative properties searched, control group trees gave the lowest values in general (tab. 4). Rom and Ferree [1985] reported that early pruning applications on peach and Marini [1985] is also stated that pruning of peach trees in June and July gave better vegetative development on trees.

Among the treatments, the biggest leaves was obtained from PH2SW applications as 39.43 cm^2, the lowest value was obtained from control as 35.24 cm^2 (tab. 4). Previous studies conducted on apple, apricot, peach and almond stressed that pruning treatments had increasing effect on leaf areas [Myers and Ferree 1984; Ikinci 1999] which supports our findings.

Pruning losts. The effect of pruning applications on the amount of pruning losts per tree were found statistically significant ($p < 0.01$).

PH2SW applications had the highest amount of pruning losts per tree as 12.58 kg and the lowest value was observed in winter pruning (2.87 kg per tree) (tab. 5). As indicated in table 5, winter+summer pruning applications had the highest amount of pruning losts.

Table 5. The effect of pruning on the weight of lost shoots from the canopy
Tabela 5. Wpływ cięcia na masę usuwanych pędów z korony drzewa

Pruning Cięcie	Pruning lost – Straty, kg					
	1999	2000	2001	2002	2003	average średnio
PHlS	5.3	4.3	3.7	5.2	9.6	5.59 c
PHlSW	12.6	14.9	10.8	9.1	13.3	12.13 a
PH2S	10.2	10.1	3.1	8.6	10.7	8.51 b
PH2SW	16.0	7.9	4.0	15.2	19.8	12.58 a
Winter – Zima	3.7	2.2	0.5	3.9	4.2	2.87 d
Control – Kontrola	2.1	2.3	0.9	2.9	3.2	2.27d
$LSD_{0.01}$						2.60

According to literature, a lot of studies conducted on this issue and the results are very variable and depend on plant specie, cultivar, pruning type and time [Kuden and Kaska 1995; Ikinci 1999; Akcay 2001; Sahin and Soylu 2001].

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WPŁYW RÓŻNYCH ZABIEGÓW CIĘCIA NA WZROST, JAKOŚĆ I PLON OWOCÓW MORELI 'HACIHALILOGLU'

Streszczenie. Badanie przeprowadzono w miejscowości Malatya w latach 1999–2003 na najważniejszej w regionie odmianie moreli do suszenia, Hacihaliloglu. W badaniu określono wpływ 5 różnych zabiegów cięcia na wzrost, jakość owoców oraz plonowanie w porównaniu z drzewami nieprzycinanymi. Zabiegi cięcia w różnych okresach nie wpłynęły w sposób istotny na cechy fenologiczne ani rozmiary owoców, natomiast wywarły silny wpływ na zawartość ekstraktu w soku oraz jędrność owoców moreli odmiany Hacihaliloglu. Najwyższy średni plon, 0,34 kg·cm^{-2} przy uwzględnieniu powierzchni przekroju poprzecznego pnia osiągnięto przy letnim przycinaniu po zbiorze owoców, a największy udział pąków – 68,29%, – zaobserwowano przy przedzbiorczym zabiegu cięcia lato+zima. Zastosowanie cięcia istotnie wpłynęło zarówno na średnicę pędów jak i ich długość. Największą średnicę i długość pędów, odpowiednio 8,52 mm i 77,84 cm, otrzymano stosując przedzbiorcze cięcie lato+zima. Największą powierzchnię liścia, 39,43 cm^2 uzyskano przy pozbiorczym zabiegu cięcia.

Słowa kluczowe: *Prunus armeniaca* L., cięcie letnie, cięcie zimowe, cechy pomologiczne owoców

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