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The Performance of Persimmon *(Diospyros kaki* Thunb.) Cultivars Under Mediterranean Coastal Conditions in Hatay, Turkey

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Abstract

The cultivation of persimmon has been increasing rapidly in the Mediterranean region recently. We investigated the performance, phenological and pomological characteristics of ten persimmon (*Diospyros kaki* Thunb.) cultivars ('Amankaki', 'Eylül', 'Fuyu', 'Hachiya', 'Hana Fuyu', 'Harbiye', 'Jiro', 'Kaki Tipo', 'O'Gosho', and 'Vainiglia') during 2001 to 2007 in the Mediterranean climate in Dörtyol, Hatay, Turkey. 'Jiro', 'Fuyu', 'O'Gosho', 'Hachiya' and 'Eylül' had small canopy volume. Fruit maturity occurred in the first week of October for 'Amankaki', 'Eylül' and 'Hachiya', which all matured earlier than other cultivars. The highest cumulative yields were obtained from 'Vainiglia' and 'Amankaki'. The mean fruit weight varied from 251 g for 'Hana Fuyu' to 87 g for 'Eylül'. 'Eylül' and 'Hachiya' had red skin, while that of 'Vainiglia', 'Kaki Tipo' and 'Harbiye' was yellow. The results demonstrate that regional ecological conditions are appropriate for the cultivation of persimmon. The yield of 'Vainiglia', 'Jiro', 'Amankaki' and 'Fuyu' was high and regular; 'Eylül' and 'Hachiya' had the most colorful fruit. We recommend 'Vainiglia', 'Jiro', 'Amankaki' and 'Fuyu' for commercial growing in the region.

Persimmon belongs to the genus *Diospyros* (family Ebenaceae). Around 400 species grow in ecological conditions ranging from tropical to more temperate climates (36, 47). The species *Diospyros lotus* L., *Diospyros virginiana* L., and *Diospyros oleifera* Cheng have been used as rootstocks in several countries. These species are also utilized in medicine, pharmacy and in the cosmetic industry as a source of tannins (2, 14, 19, 21). *Diospyros kaki* Thunb., which originated in China and is the only commercial species, includes cultivars whose fruits are consumed fresh or processed (4, 21, 41).

Persimmons are deciduous trees that can be monoecious or dioecious and produce fruits parthenocarpically or via pollination. The fruit is generally oblong-conical with a wide variation in size, shape and color. Fruit may be yellow, orange or red when ripe. In the northern hemisphere, fruit is normally harvested from late September to early December for the fresh market or drying. The fruits taste sweet; however, many cultivars have an astringent taste until they are fully ripe (32). *D. kaki* is classified into four types depending on the relationship between astringency, presence of seeds and flesh color. They are pollination-constant non-astringent (PCNA), pollination-variant non-astringent (PVNA), pollination-variant astringent (PVA) and pollination-constant astringent (PCA) (48). The PCNA group is not astringent either with or without seeds. PVNA group is not astringent at harvest if the fruit has seeds. PCA group is always astringent. PVA group is astringent also if pollinated. They are non-astringent only around the seeds and have dark tannin spots (38).

Worldwide persimmon production is approximately 3 million MT. China, Korea and Japan account for 90% of total production; minor producers include Italy, Israel, Turkey, New Zealand and Spain (12). In Turkey, the major production areas are the Mediterranean, Black Sea and Aegean regions, where total production has reached 18,000 MT, about 80% of which comes from the Mediterranean region. Hatay in the Mediterranean region

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produces about 27% of Turkey's total production (39).

Currently, local cultivars dominate production in Hatay. The introduction of cultivars that are more productive, earlier to mature, PCNA, edible when firm, seedless, easy to ship and store and with red skin may increase demand in both domestic and export markets. Cultivar trials have been carried out previously (32, 40, 45), but not in the Hatay region. Because ecological conditions significantly affect horticultural performance (18, 28, 29), it is important to determine yield and fruit quality in each region (41). We investigated several local and foreign persimmon cultivars, with the aim of determining the most appropriate cultivars for the Hatay region, which has a typical Mediterranean climate.

Materials and Methods

This study was conducted at the Citrus and Subtropical Fruits Research Station of Mustafa Kemal University, Hatay, Turkey from 2001 to 2007. The persimmon orchard is located in the Dörtyol district of Hatay, Turkey in the eastern Mediterranean region (36° 09' E, 36° 51' N, 9 m elevation), where the mean annual temperature is 19.1°C, mean rainfall is 1026 mm, and soils are generally sandy and alkaline (pH 7.8). The introduced cultivars 'Amankaki', 'Kaki Tipo' and 'Vainiglia' (PVNA), 'Fuyu', 'Hana Fuyu', 'Jiro' and 'O'Gosho' (PCNA) 'Hachiya' (PCA) were used, as well as the local cultivars 'Harbiye' (PVNA) and 'Eylül' (PCA). 'Amankaki', 'Jiro' and 'Kaki Tipo' were introduced from Italy; 'Hachiya', 'Hana Fuyu' and 'O'Gosho' from France; and 'Fuyu' and 'Vainiglia' from Pakistan (40), by the Horticulture Department, Çukurova University Adana, Turkey where we obtained scion wood. All cultivars were grafted on *D. lotus* seedling rootstocks at 25-30 cm above the soil line. One-year-old budded trees were planted at a spacing of 5 x 6 m in September 1997. A randomized complete block design was used, with six single-tree replicates of each cultivar. Trees were trained with the open center (vase) system and pruned lightly. No flower or fruit thinning was done. Weeds were controlled by tillage. Irrigation started in May and continued until September with total of 800-900 mm of water via drip irrigation. The trees were fertilized with 500 g N per tree (2/3 of it at the end of February and 1/3 at the end of May), 300 g P per tree (in December) and 400 g K per tree (by the end of January). The trees showed no signs of nutrient deficiency. There were no incidences of diseases and pests except for Mediterranean fruit flies, *Ceratitis capitata* (Wiedemann), which were controlled via bait sprays.

Flowering was monitored from the beginning of blossoming until fruit set. "Beginning of bloom" was the stage where 5% of flowers were open, "full bloom" was when 70% of the flowers were open, and "end of bloom" was the stage where 70% of the flowers had dropped their petals.

Fruits were harvested at minimum maturity based on skin color change from green to orange or reddish-orange in 'Hachiya' and 'Eylül' or to yellowish-green or yellow in 'Fuyu' and similar non-astringent cultivars (10). Two harvests were performed. Fruits of each cultivar were collected and separately weighed so that the yield per tree (kg) could be calculated as the sum of two harvests. The seven-year cumulative yield was obtained as the sum of yield between 2001 and 2007. An alternate bearing index (ABI) was calculated between the years 2001 to 2007, using the following expression (27):

$$ABI = \frac{1}{n-1} \times \left\{ \frac{|a_2 - a_1|}{a_2 + a_1} + \frac{|a_3 - a_2|}{a_3 + a_2} + \cdots \frac{|a_n - a_{n-1}|}{a_n + a_{n-1}} \right\}$$

where n = number of years, and a1, a2, ..., an-1, an = yields of the corresponding years. An ABI value close to zero represents the most regular bearing. Trunk diameter and canopy volume were measured after harvest during dormancy but before pruning. The trunks were marked 10 cm above the graft union and measurements were done at the same place each year. Tree trunk cross-sectional (TCSA) area was calculated assuming a circular trunk. Final canopy volume (CV) was measured before pruning

and calculated from canopy height and spread, considering the canopy as a prolate spheroid shape and applying the formula:

$$CV = 4/3\ \pi ab^2$$

where a is the major axis length/2, and b is the minor axis length/2 (43).

At the second harvest, pomological analyses were performed on 20 fruits per tree for each cultivar immediately after harvest. The fruit weight, length and width were measured. Fruit length measurement was from calyx to fruit apex. Fruit width measurement was the largest equatorial length. Fruit flesh firmness was measured on two opposite sides of each fruit at the equatorial region, after the removal of a 1 mm thick disk of skin from each side of the fruit and the force in kg required to insert an Effegi penetrometer (Model FT 327 Wagner Instruments, Greenwich, USA) fitted with an 8 mm diameter probe was recorded and expressed in Newtons (N). Skin and flesh color were measured with a Minolta Chroma Meter CR-300 (Osaka, Japan), using the CIE L*a*b* color space. From these values, hue angle was calculated as, $h° = \tan^{-1}(b^*/a^*)$ and chroma as, $C = (a^{*2} + b^{*2})^{1/2}$. Color values for each fruit were computed as means of two measurements taken from both sides at the equatorial region of the fruit (1). Total soluble solids (TSS) content and titratable acidity (TA) were assessed on juice obtained from 20 fruits per replicate. TSS content was determined with a refractometer (Atago Model ATC-1E, Bellevue, USA), and TA by titration of 5 ml of fruit juice with 0.1 N NaOH to pH 8.1 (expressed as g malic acid per 100 mL juice).

An ANOVA for all variables was performed using the GLM procedure of SAS (34). Mean separation was performed by Tukey's HSD test at $p<0.05$, using SAS's GLM procedure, and considering both cultivar and year effects as random.

Results and Discussion

Flowering started in the 3rd week of April in early cultivars such as 'Eylül', 'Hachiya' and 'Hana Fuyu' (Fig. 1). The time between the beginning and the end of flowering was generally about 2 weeks, but up to 3 weeks for 'Eylül', 'Hachiya', 'Hana Fuyu', 'Kaki Tipo' and 'Vainiglia'. The cultivars tested in this study displayed similar flowering characteristics as the same cultivars in Antalya (31), which is in the south of Turkey and has similar ecological conditions as Hatay. However, compared to Samsun (3) and Yalova (37), which are in northern Turkey and have colder

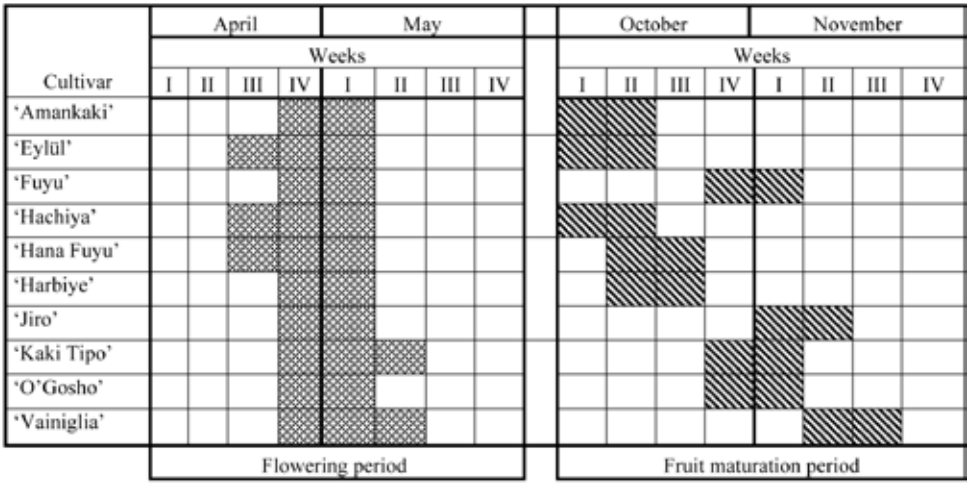

Figure 1. Bloom and harvest periods of 10 persimmon cultivars in Hatay, Turkey (mean of 5 years, 2003, 2007).

temperatures in spring, the beginning of the flowering was earlier and the duration of the flowering period was shorter in Hatay. Our observations on flowering times and duration are in agreement with controlled temperature studies by George et al. (16) who found that the time period between budbreak and flowering and the length of the flowering period were increased three fold with decreasing day/night temperature (range 32/27°C to 17/12°C). Differences in the duration of flowering were also in agreement with the findings of George et al. (18), who suggested that cultivars may have flowering times that vary by 1 to 2 weeks.

There was a 35 to 40 day difference in maturation from early to late cultivars. Earlier fruit maturation was observed in 'Amankaki', 'Eylül' and 'Hachiya', which matured in the first week of October. In contrast, the latest maturation was observed in 'Jiro' and 'Vainiglia', which ripened the first week of November and the second week of November, respectively (Fig. 1). Similar results were obtained in the regions of Antalya (31) and Yalova (37), but maturity in this study was earlier than at Samsun (3). Our results for late-maturing cultivars are also supported by studies carried out by Collins et al. (8), Sato and Yamada (35) and Wen (42). 'Kaki Tipo' and 'O'Gosho' were mid-season cultivars and 'Jiro' was intermediate- to late-maturing, in agreement with the classification of Yonemori et al. (46). Factors such as ecological conditions, growing techniques (pruning, planting density, growth regulators etc.) and cultivar affect fruit maturity (6, 18, 29).

'Amankaki', 'Jiro', 'Hana Fuyu' and 'O'Gosho' were the most precocious cultivars, with high early yields (Table 1). Persimmon producers prefer cultivars with a short juvenility period, high yield and superior quality. In this respect we suggest that cultivars such as 'Amankaki', 'Jiro' and 'Hana Fuyu' may be advantageous. Tangu et al. (37) who studied in Yalova (Turkey), also observed that cultivars start to bear at different times after planting. On mature trees, 'Vainiglia' yielded the most. The highest cumulative yields were also greatest for 'Vainiglia' and 'Amankaki' (Table 1). Yield differences among cultivars were also reported in Australia (15) and Florida (26). In Australia 'Fuyu' is more productive than Izu (17), while Collins et al. (8) described 'Fuyu' as being medium to high in yield. Under Antalya (Turkey) conditions, 'Fuyu' is moderately productive (31). In the Adana (Turkey) region, the lowest yielding cultivar was 'Hachiya' (44), as also found in this study. 'O'Gosho', 'Harbiye', 'Eylül', 'Kaki Tipo' and 'Hachiya' had the lowest cumulative yield, significantly lower than all other cultivars, possibly due to alternate bearing. The most regular bearing cultivars, as estimated by ABI, were 'Amankaki', 'Jiro', 'Vainiglia' and 'Fuyu';'O'Gosho' and 'Hana Fuyu' did not bear regularly (Table 1). Tangu et al. (37) reported that 'Fuyu', 'Amankaki' and 'Jiro' were regular bearing in Yalova, Turkey, and 'Jiro' was also regular bearing in Japan (35). Our results of irregular bearing in 'O'Gosho' and 'Hana Fuyu' confirm similar observations made in southern Turkey (44). Miller (25) and Collins and George (9) have suggested that regular fruit yield is dependent on ecological factors and cultural practices (irrigation, fertilization, use of pollinizer cultivars, fruit thinning etc.). No thinning was done in the present study.

'Vainiglia' had a trunk diameter 60-70% larger than 'Fuyu', 'O'Gosho' and 'Eylül' (Table 1). Canopy volume was largest for 'Hana Fuyu', followed by 'Harbiye' and 'Vainiglia'. 'Jiro', 'Fuyu' and 'O'Gosho' had the smallest canopies. The tree vigor of 'Fuyu', 'O'Gosho', 'Eylül' and 'Jiro' was low, based on canopy volume or TCSA. 'Fuyu' had lower values in respect to both the diameter of the tree trunk and the canopy volume. This could be explained by Bellini's (4) suggestion that this cultivar displays a complete or partial incompatibility with *D. lotus* rootstock. 'Harbiye' which is widely cultivated in the southern region of Turkey, formed trees with large canopies, perhaps because of its better adaptation to the local environment. Recently, it has been recommended that planting distances of persimmon trees should be closer in order to increase the yield per unit area

Table 1. The annual and cumulative yields, alternate bearing index (ABI), tree trunk cross-sectional area, yield per unit trunk cross-sectional area, canopy volume and yield per unit canopy volume of persimmon cultivars tested in Dörtyol-Hatay, Turkey (2001 through 2007).

Cultivar	Yield (kg per tree)							Cumulative yield (kg/tree)	Alternate bearing index (ABI) (2001-2007)	Tree trunk cross sectional area 2007 (cm^2)	Yield / trunk cross sectional area (kg/cm^2)	Canopy volume 2007 (m^3)	Yield / canopy volume 2007 (cm^3)
	2001	2002	2003	2004	2005	2006	2007						
Amankaki	3.0 ab	9.0 a	14.6 a	33.3 ab	38.0 a	21.8 b	26.3 b	146.0 a	1.1 d	103.6 ab	1.4 b	6.3 a-c	23.4 a
Eylül	1.0 cd	3.0 cd	3.2 d	12.8 d	9.3 de	5.9 d	11.6 de	46.7 d	1.4 a-c	47.8 d	1.0 b-d	5.8 bc	8.1 bc
Fuyu	1.8 bc	2.0 cd	9.0 bc	22.4 c	23.8 bc	21.1 b	23.5 bc	103.5 bc	1.2 cd	40.7 d	2.5 a	5.3 c	19.6 a
Hachiya	0.8 cd	1.2 d	2.4 d	4.9 e	8.7 e	13.5 c	18.8 c	50.2 d	1.4 a-c	62.7 cd	0.8 b-d	5.6 bc	9.0 bc
Hana Fuyu	2.6 ab	10.0 a	13.0 ab	36.4 a	8.8 e	10.3 cd	6.9 ef	88.0 c	1.6 a	95.2 ab	0.9 b-d	8.2 a	10.7 b
Harbiye	0.6 cd	1.5 d	1.3 d	6.9 de	10.3 de	7.5 d	11.9 d	40.0 d	1.4 a-c	94.0 ab	0.4 d	8.1 a	4.9 c
Jiro	4.0 a	7.8 ab	14.1 ab	33.5 ab	17.7 cd	19.7 b	21.1 c	117.9 b	1.1 d	83.3 bc	1.4 b	5.1 c	23.1 a
Kaki Tipo	0.4 d	1.0 d	2.8 d	9.9 de	10.0 de	10.2 cd	13.7 d	47.9 d	1.3 b-d	81.7 bc	0.6 cd	6.6 a-c	7.2 bc
O'Gosho	2.8 ab	3.4 cd	3.0 d	5.0 e	12.0 de	6.5 d	2.1 f	34.8 d	1.5 ab	41.5 d	0.8 b-d	5.4 c	6.5 bc
Vainiglia	1.8 bc	4.4 c	6.4 cd	28.4 bc	29.3 ab	41.3 a	36.3 a	147.9 a	1.1 d	119.3 a	1.2 bc	7.7 ab	19.2 a
$MSD^{z}_{0.05}$	1.4	2.5	5.2	6.7	8.8	4.6	4.8	19.8	0.2	26.4	0.6	2.2	5.5

[z]Mean separations were conducted by Tukey HSD test and MSD represents Minimum Significant Difference.

(13). In this respect we recommend that the cultivars 'Jiro', 'Fuyu', 'O'Gosho', 'Hachiya' and 'Eylül', which displayed weak growth, may be better suited to high density plantings in the Hatay region. Yield per unit TCSA was highest in 'Fuyu' and lowest in 'Harbiye'. Yield per unit of canopy volume was higher in 'Amankaki', 'Jiro', 'Fuyu' and 'Vainiglia' than other cultivars (Table 1).

The heaviest fruits were obtained from 'Hana Fuyu' followed by 'Vainiglia' and 'Hachiya' (Table 2), and the smallest from 'Eylül'. Miller (25) recorded fruit weights between 99 g and 249 g in Florida, while Kim and Ko (20) found a range from 44 to 302 g in Korea. In Australia, the weight of 'Fuyu' averaged 182 g (8), and in Thailand about 151 g (22). 'Fuyu' produced fruits that weighed 138 g in Antalya, Turkey (31), whilst in Adana, average fruit weight for this cultivar was 166 g (44). Differences in average fruit weight for a given cultivar are probably attributable to climatic and management factors in the studies (9, 18, 23). 'Hana Fuyu' and 'Harbiye' had greater fruit width and 'Hachiya' had greater fruit length, compared to other cultivars, in the present study.

'O'Gosho' ranked highest for flesh firmness, while 'Eylül' and 'Amankaki' had softer fruit at their minimum maturity (Table 2). In persimmon fruits, firmness should be above 22 N for minimizing postharvest loss and maintaining marketable fruit quality during shelf life (5, 10, 33). In our study all cultivars met this criterion. Among PVNA and PCNA cultivars, the highest TSS content occurred in 'Amankaki' and 'Harbiye' and lowest in 'Jiro' and 'O'Gosho'. PCNA cultivars did not reach the 18-20% TSS considered optimum (10), but still met the export requirement of 14% TSS (17). Elsewhere in Turkey, 'Fuyu' and 'Hachiya' had 18.5% and 23.5% of TSS, respectively (31). Mowat et al. (29) indicated that TSS content of 'Fuyu' was lower in New Zealand (13.2%) than in Australia (15.7%), and that TSS was negatively correlated with temperature. The titratable acidity content of the cultivars ranged from 0.11% for 'Hana Fuyu' to 0.29% for 'Hachiya'. In PVNA cultivars, the soluble tannins disappear after pollination if enough seeds (usually four or five) form (21). Therefore, the number of seeds is important for the PVNA cultivars such as 'Amankaki', 'Vainiglia', 'Kaki Tipo' and

Table 2. Fruit weight, fruit width, fruit length, fruit flesh firmness, total soluble solids (TSS), titratable acidity and seed number per fruit of persimmon cultivars tested between 2003 and 2007 in Dörtyol-Hatay (average of 5 years).

Cultivar	Weight (g)	Width (mm)	Length (mm)	Flesh firmness	TSS %	Titratable acidity (%)	Seed No. per fruit
Amankaki	128.1 d	67.3 cd	44.3 e	39.3 de	19.2 ab	0.23 a-c	0.0 c
Eylül	87.4 e	56.9 e	50.1 cd	35.8 e	21.4 a	0.25 ab	0.5 bc
Fuyu	123.9 d	65.9 d	47.5 de	64.2 a-c	14.9 cd	0.15 b-d	1.8 a
Hachiya	222.9 ab	73.8 ab	76.2 a	48.9 c-e	21.3 a	0.29 a	0.1 c
Hana Fuyu	251.0 a	79.7 a	64.0 b	58.6 a-c	14.9 cd	0.11 d	1.8 a
Harbiye	218.3 b	78.4 a	65.1 b	53.4 b-d	18.9 ab	0.21 a-c	0.3 c
Jiro	138.7 d	72.0 bc	48.6 cd	67.2 ab	14.5 d	0.13 cd	0.4 bc
Kaki Tipo	215.1 b	75.6 ab	67.3 b	51.9 b-e	17.3 b-d	0.14 cd	0.7 bc
O'Gosho	174.4 c	73.9 ab	51.8 c	73.3 a	14.7 d	0.13 cd	0.3 c
Vainiglia	234.7 ab	75.1 ab	65.0 b	58.6 a-c	17.9 bc	0.14 cd	1.1 b
$MSD^{z}_{0.05}$	31.5	6.0	4.2	17.1	3.0	0.10	0.7

[z]Mean separations were conducted by Tukey HSD test and MSD represents Minimum Significant Difference.

Table 3. The fruit skin color and flesh color (L*, chroma and hue values) of persimmon cultivars tested between 2004 and 2007 in Dörtyol-Hatay (average of 4 years).

Cultivar	Skin color			Flesh color		
	L*	Chroma	Hue	L*	Chroma	Hue
Amankaki	63.0 ab	67.4 b	70.2 ab	58.7 b-d	52.5 bc	77.7 b-d
Eylül	57.7 c	66.8 b	54.0 d	54.3 de	54.8 ab	71.4 e
Fuyu	57.6 c	60.5 c	68.5 bc	51.2 e	42.5 d	77.1 b-d
Hachiya	56.3 c	66.1 b	54.3 d	62.3 a-c	57.6 a	75.0 c-e
Hana Fuyu	59.6 bc	68.3 b	68.2 bc	57.3 c-e	49.3 c	75.2 c-e
Harbiye	67.1 a	75.9 a	72.9 a	68.8 a	49.1 c	82.5 a
Jiro	61.0 bc	59.1 c	64.8 c	57.1 c-e	51.3 bc	73.3 de
O'Gosho	58.7 bc	67.0 b	66.0 bc	61.4 a-d	50.2 c	79.1 ab
Kaki Tipo	67.2 a	73.7 a	73.8 a	65.0 ab	48.4 c	81.1 ab
Vainiglia	67.1 a	74.9 a	73.8 a	63.7 a-c	50.9 bc	81.3 a
$MSD^{z}_{0.05}$	5.2	3.6	4.2	7.4	4.3	4.7

[z]Mean separations were conducted by Tukey's HSD test and MSD represents Minimum Significant Difference.

'Harbiye'. Here these cultivars had insufficient seeds (Table 2), so pollinizer cultivars along with bee hives should be included in persimmon orchards with PVNA types.

In persimmon fruits, minimum maturity is based on skin color change from green to orange, reddish-orange ('Hachiya'), yellowish-green, or yellow ('Fuyu', 'California Fuyu', 'Jiro'), depending on cultivar (10). The highest L* value (a measure of the brightness of the color) was obtained for both the fruit skin and fruit flesh of 'Kaki Tipo' and 'Harbiye' (Table 3). In previous reports, the L* value for 'Fuyu' was 60.6 (24) or 65.0 (7), and that for 'Hachiya' was 63.4 (11). Our L* values were lower than those reported by others. 'Eylül' and 'Hachiya' were a deep orange (lower hue values) while 'Kaki Tipo', 'Vainiglia' and 'Harbiye' had light orange fruits, i.e. paler or brighter than other cultivars. 'Eylül', 'Hachiya' and 'Hana Fuyu' and 'Jiro' fruits had more orange flesh color (lower hue values) than 'Vainiglia' and 'Harbiye'. 'Jiro' and 'Fuyu' formed the darkest fruits. The chroma values for fruit skin color and flesh color were not in parallel in some cultivars, possibly because fruit flesh color can change significantly, depending on pollination. The hue value we obtained for 'Fuyu' was similar to that obtained by Mowat (30) in New Zealand, but somewhat lower than those reported by Lyon et al. (24) and Cia et al. (7). On the other hand Sato and Yamada (35) reported that 'Fuyu' and 'Jiro' fruits were reddish-orange. The differences observed in this study and others are suggested to be attributable to climatic conditions (illumination, temperature differences between day and night, etc.) and cultural practices (pruning, irrigation, fertilization etc.) (9, 18, 30).

Recently, there has been an increase in the number of commercial persimmon orchards in the Mediterranean region of Turkey. We anticipate additional increases in persimmon production with the introduction of the standard cultivars that are in demand in domestic and export markets. We suggest that the ecological conditions in the region are appropriate to obtain early and high yields and good fruit quality. According to our results, 'Amankaki', 'Eylül' and 'Hachiya' with early fruit maturity, 'Vainiglia', 'Jiro', 'Amankaki' and 'Fuyu' with high regular yield and 'Eylül' and 'Hachiya' with dark skin color, are the most desirable. We recommend 'Vainiglia', 'Jiro', 'Amankaki' and 'Fuyu' for commercial production in Hatay, because consumers prefer and demand PCNA and PVNA types.

Literature Cited

1. Abbott, J.A. 1999. Quality measurement of fruits and vegetables. Postharvest Biology Techn. 15:207-225.
2. Ahn, H.S., T. I. Jeon, J. Y. Lee, S. G. Hwang, Y. Lim and D. K. Park. 2002. Antioxidative activity of persimmon and grape seed extract: in vitro and in vivo. Nutrition Research 22:1265-1273.
3. Akbulut, M., N. Kaplan, I. Macit and A. Koç. 2004. Persimmon (*Diospyros kaki* L.) selection II in the Black-Sea Region of Turkey. Pp. 32-40. In: Turkish first national persimmon growing and marketing symposium, 25-26 November 2004, Unye-Ordu, Turkey.
4. Bellini, E. 2002. Cultural practices for persimmon production. First Mediterranean symposium on persimmon, 23-24 November, 2001, Faenza, Italy, 51:39-52.
5. Ben-Arie, R. 1995. Commercial quality of 'Fuyu' persimmon. Postharvest Biol. Techn.14:311-317.
6. Chijiwa, H., K. Hayashi and K. Ushijima. 2003. Effect of ethychlozate on fruit maturity in Nishimura-Wase persimmon (*Diospyros kaki* L.). Acta Hort. 601:105-111.
7. Cia, P., E.A. Benato, J.M.M. Sigrist, C. Sarantopoulos, L.M. Oliveira and M. Padula. 2006. Modified atmosphere packaging for extending the storage life of Fuyu persimmon. Postharvest Biology Techn. 42:228–234.
8. Collins, R.J., A.P. George and R.J. Nissen. 1995. Extending the marketing season of non-astringent persimmons grown in sub-tropical Australia. Acta Hort. 409:75-84.
9. Collins, R.J. and A.P. George. 1997. Managing crop load on non-astringent persimmon grown in the sub-tropics. Acta Hort. 436:251-260.
10. Crisosto, C.H., E.J. Mitcham and A.A. Kader. 2006. Persimmon, recommendations for maintaining postharvest quality. Postharvest Technology Research and Information Center. Online at Http://postharvest.ucdavis.edu/Produce/ProduceFacts/Fruit/ Persimmon.shtml. 3 pp. <<Accessed 27 Jan. 2009>>
11. Çelik, A. and S. Ercişli. 2007. Persimmon cv. Hachiya (*Diospyros kaki* Thunb.) fruit: some physical, chemical and nutritional properties. Int. J. of Food Sci. and Nutr. 1-8.
12. FAOSTAT, 2006. FAO Statistics Division. Online at: http://faostat.fao.org <<Accessed December 2006>>.
13. Fumuro, M., K. Ueda and H. Okisima. 1997. Early cropping and labor saving by high density planting and root zone restriction of Japanese persimmon. Acta Hort. 436:275-283.
14. Gali, H.U., E.M. Perchellet, D.S. Klish, J.M. Johnson and J.P. Perchellet. 1992. Hydrolyzable tannins: potent inhibitors of hydroperoxide production and tumor promotion in mouse skin treated with 12-O-tetradecanoylphobol-13-acetate in vivo. Int. J. Cancer 51:425-432.
15. George, A.P. and R.J. Nissen. 1982. Yield, growth and fruit quality of the persimmon (*Diospyros kaki* L.) in South-East Queenland. Queenland J. Agric. Animal Sci. 39:149-158.
16. George, A.P., R.J. Nissen and R.J. Collins. 1994. Effects of temperature and pollination on growth, flowering and fruit set of the non-astringent persimmon cultivar Fuyu under controlled temperatures. J. Hort. Sci. 69:225-230.
17. George, A., R. Collins and R. Nissen. 1994. Growth, yield and fruit quality of two non-astringent persimmon (*Diospyros kaki*) cultivars, Izu and Fuyu, in subtropical Australia. Aust. J. Exp. Agric. 34:267-275.
18. George, A.P., A.D. Mowat, R.J. Collins and M. Morley-Bunker. 1997. The pattern and control of reproductive development in non-astringent persimmon (*Diospyros kaki* L.): a review. Scientia Hort. 70:93-122.
19. Gorinstein, S., M. Zemser, M. Weisz, S. Halevy, J. Deutsch, K. Tilus, D. Feintuch, N. Guerra, M. Fishman and E. Bartnikowska. 1994. Fluorometric analyses of phenolics in persimmons. Biosci. Biotechnol Biochem. 58:1087-1092.
20. Kim, T.C. and K.C. Ko. 1997. Classification of persimmon (*Diospyros kaki* Thunb.) cultivars on the basis of horticultural traits. Acta Hort. 436:77-84.
21. Kitagawa, H. and P.G. Glucina. 1984. Persimmon culture in New Zealand. New Zealand Department of Scientific and Industrial Research, DSIR Information Series No: 159. Wellington, New Zealand, 74 pp.
22. Krisanapook, K., K. Sillapapetch, L. Phavaphutanon and K. Jutamanee. 2004. Improvement of fruit set and fruit qualities in persimmon 'Fuyu' using pollination. Acta Hort. 662:119-123.
23. Lee, Y.M., H. Park and Y.J. Lee. 1998. Effects of pollinizer on fruit drop and quality of 'Fuyu' persimmon. J. Korean Soc. Hort. Sci. 39:533-536.
24. Lyon, B.G., S.D. Senter and J.A. Payne. 1992. Quality characteristics of oriental persimmons (*Diospyros kaki* L. cv. Fuyu) grown in the Southeastern United States. J. Food Sci. 57:693-695.
25. Miller, E.P. 1984. Oriental persimmons (*Diospyros kaki* L.).in Florida. Proc. Florida State Hort. Society 97:340-344.

26. Miller, E.P. 1989. Performance of non-astringent persimmons (*Diospyros kaki* L.) in Florida. Proc. Florida State Hort. Society 102:199-202.
27. Monselise, S.P. and E.E. Goldschmidt. 1982. Alternate bearing in fruit trees. Hort. Reviews 4:128-166.
28. Mowat, A.D., A.P. George and R.J. Collins. 1995. Cultivation of persimmon (*Diospyros kaki* L.) under tropical conditions. Acta Hort. 409:141-151.
29. Mowat, A.D., A.P. George and R.J. Collins. 1997. Macro-climatic effects on fruit development and maturity of non-astringent persimmon (*Diospyros kaki* L. cv. Fuyu). Acta Hort. 436:195-202.
30. Mowat, A.D. 2003. Fruit development patterns of persimmon grown under a cool climate. Acta Hort. 601:113-119.
31. Onur, S. 1995. Adaptation of persimmon cultivars. Derim 12:8-18.
32. Onur, C. and S. Onur. 1995. Persimmon (*Diospyros kaki*) selection from Black Sea Region of Turkey. Pp. 587-590. In: Turkish Second National Hort. Cong., 3-6 October 1995, Adana, Turkey.
33. Salvador, A., L. Arnal, A. Monterde and J. Cuquerella. 2004. Reduction of chilling injury symptoms in persimmon fruit cv. Rojo Brillante by 1-MCP. Postharvest Biol. Techn. 33:285-291.
34. SAS, 1990. SAS users guide; SAS/STAT, version 6. SAS Institute Inc., Cary, N.C.
35. Sato, A. and M. Yamada. 2003. Leading persimmon cultivars for commercial production and breeding targets in Japan. Acta Hort. 601:25-29.
36. Sponberg, S.A. 1977. Ebenaceae hardy in temperate North America. J. Arnold Arboretum 58:146-160.
37. Tangu, N.A., B. Erenoğlu and E.Yalçınkaya. 2004. The adaptation of persimmon cultivars in Marmara Region ecological conditions. Pp. 41-45. In: Turkish first national persimmon growing and marketing symposium, 25-26 November 2004, Unye-Ordu, Turkey.
38. Testoni A., 2002. Post-harvest and processing of persimmon fruit. Pp. 53-66. In: E. Bellini and E. Giordani (eds.). First Mediterranean symposium on persimmon (Options Méditerranéennes: Série A. Séminaires Méditerranéens vol. 51), CIHEAM-IAMZ, Zaragoza, Spain.
39. TURKSTAT, 2006. Agricultural structure: production, price, value. Turkish Statistical Institute, Ankara, Turkey. 530 pp.
40. Tuzcu, Ö. and M. Şeker. 1997. The situation of persimmon (*Diospyros kaki* L.) cultivation and germplasm resources in Turkey. Acta Hort. 441:107-114.
41. Tuzcu, Ö. and B. Yıldırım. 2000. Cultivation of persimmon (*Diospyros kaki* L.). Tübitak, Türkiye Tarımsal Araştırma Projesi Yayınları, Adana, 24 pp.
42. Wen, I.C. 2003. Evaluation and breeding of persimmon in Taiwan. Acta Hort. 601:233-237.
43. Westwood, M.N. 1993. Temperate-zone pomology, physiology and culture, 3rd ed. Timber Press, Portland, Oregon.
44. Yeşiloğlu, T., Ö. Tuzcu, B. Yıldırım, M. Kamiloğlu-Uysal and M. Incesu. 2004. The determination of fruit characteristics of some important persimmon (*Diospyros kaki* L.) varieties in Adana ecological conditions. Pp. 60-68. In: Turkish first national persimmon growing and marketing symposium, 25-26 November 2004, Unye-Ordu, Turkey.
45. Yıldız, E. 2005. Breeding of persimmon of Hatay province via selection method. M.Sc. Thesis, Universty of Mustafa Kemal, Institute of Natural Science, Hatay, Turkey. 302 pp.
46. Yonemori, K., E. Bellini and E. Giordani. 1997. II miglioramento genetico del kaki. Pp. 99-128. In: Atti II Simposio Intemazionale su "Stato dell" Arte e Prostettive del Miglioramento Genetico dei Fruttiferi (Melo Ciliegio, Kaki e Castagno)", Bellini, E. (ed.), Faenza (Italy), 10 October 1997.
47. Yonemori, K., A. Sugiura and M. Yamada. 2000. Persimmon genetics and breeding. Plant Breeding Rev. 19:191-225.
48. Yonemori, K., A. Ikegami, S. Kanzaki and A. Sugiura. 2003. Unique features of tannin cells in fruit of pollination constant non-astringent persimmons. Acta Hort. 601:31-35.