

Adaptation of Some Pistachio Cultivars to Irrigated Conditions for Southeast Region of Turkey

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Abstract

This study was carried out at the Tektok Station of GAP Soil and Water Resources and Agricultural Research Institute in Sanliurfa during 1994-2008 years to determine suitable pistachio cultivars for irrigated conditions. *Pistacia khinjuk* was used as rootstock and 14 pistachio cultivars and types were compared. They were 'Uzun' and 'Siirt' as domestic; and 'Kerman', 'Ohadi', 'Vahidi', 'Mumtaz' and 'Haciserifi' as foreign; and 'Sel 1' named as 'Tekin', 'Sel 2', 'Sel 5', 'Sel 10', 'Sel 11' named as 'Barak Yildizi', 'Sel 14' and 'Sel 15' types (selected by Pistachio Research Institute in Gaziantep). Orchards were irrigated by drip irrigation system. Yield and quality characteristics of the cultivars and types were determined for last 5 years (2004-2008 years). Phenological observations were also carried out in 2008. The higher yields were obtained from 'Mumtaz', 'Tekin' and 'Sel 5', while the lower values were from 'Barak Yildizi', 'Kerman' and 'Sel 15'. Pomological characteristics were observed to determine the nut quality. The best results were obtained from 'Mumtaz' and 'Vahidi' for 100 dry fruits weight; from 'Siirt', 'Tekin', 'Sel 2' and 'Sel 5' for split nuts; and from 'Ohadi', 'Siirt' and 'Tekin' for kernel ratio.

Regarding result of the Weighted-Rankit test; 'Tekin', 'Mumtaz' and 'Sel 5' have been determined as suitable pistachio cultivars for irrigated conditions for Southeast of Turkey.

INTRODUCTION

Pistachio grows in the appropriate microclimate of the northern and southern hemisphere between 30-45° parallel of the world. Turkey is on the gene center of pistachio in the northern hemisphere; in particular, the Southeastern Anatolia Region has an important place in the pistachio cultivation (Tekin et al., 2001). Wild pistachio species are spread to all over our country; most of them are *Pistacia terebinthus* L. and followed by *Pistacia khinjuk* Stock and *Pistacia atlantica* Desf. *P. khinjuk* is more in some parts of Southeast and Eastern Anatolia; *P. atlantica* is commonly found in the Mediterranean Sea, Central Anatolia and the Aegean Region (Bilgen, 1968 and 1973; Kaska and Bilgen, 1988). Pistachios have been grown in Turkey for over one thousand years and it has one of the largest pistachio germplasm collections in the world (Kaska, 1990).

Many pistachio cultivars are grown in several countries and have different characteristics, especially for fruit shape and the color of the kernel, which varies from light yellow to deep green. Turkey is the third largest country in the world after Iran and the United States for pistachio production. In Iran and the U.S., pistachio has been produced under suitable soil conditions and irrigation. In Turkey, however, it is produced under dry conditions and often in arid region. The major cultivars in the world are 'Mumtaz', 'Akbari', 'Ohadi' and 'Kaleghouchi' in Iran; 'Kerman' in the U.S. and 'Kirmizi', 'Uzun', 'Halebi' and 'Siirt' in Turkey (Kaska, 1995; Kafkas et al., 2006).

The Southeastern Anatolian Project (SAP, Turkish acronym GAP) is the largest irrigation and development project of Turkey covering about two million ha cultivated land. Pistachio will be produced in these areas under irrigated conditions. The aim of this

study was to determine suitable pistachio cultivars or types for irrigated conditions in Southeast of Turkey.

MATERIALS AND METHODS

This study was carried out at the Tektek Station of GAP Soil-Water Resources and Agricultural Research Institute in Sanliurfa province, Turkey (lat 37° 07' N., long 39° 15' E., altitude 530 m a.s.l.) from 1994 to 2008 years. Two standard domestic pistachio cultivars 'Uzun' and 'Siirt', and four Iranian cultivars 'Ohadi', 'Vahidi', 'Mumtaz' and 'Haciserifi' and a California cultivar 'Kerman' were studied as well as 7 pistachio types selected from Turkey 'Sel-1 named as Tekin', 'Sel-2', 'Sel-5', 'Sel-10', 'Sel-11 named as Barak Yildizi', 'Sel-14' and 'Sel-15'.

The experimental orchard was established in space of 7 m x 5 m with *Pistacia khinjuk* rootstock in 1994, and pistachio cultivars and types were budded on rootstocks in 1996 and 1997 years. Research orchard was irrigated with drip irrigation system. The cultivars and types were compared with respect to growth, start bearing age, yield, phenological and quality characteristics.

Trunk diameter was measured 10 cm above the budding point, and in this way trunk cross-sectional area was calculated. Tree habit was determined as erect, semi-erect and spreading (IPGRI, 1997). Yield was determined at the harvest as kg fruit (dry weight) / hectare and yield per cross-sectional area (CSA) as g/cm². Phenological characteristics were determined as beginning of blooming, full blooming, end of blooming, blooming period and harvest time. Quality characteristics were analyzed for 100 dry fruits weight (g), split nuts (%) and kernel ratio (%), kernel dry weight/nut dry weight x 100). Weighted-Rankit test was applied to growth, yield and quality characteristics for cultivars and types (Table 1).

The experiment was set up in a randomized block design with 3 replicates and at least 3 plants were used for each replicate. The data were analyzed by ANOVA test from the statistical package MSTAT and differences between means were separated with the Fischer's Least Significant Difference (LSD) calculated with $p \leq 0.05$.

RESULTS AND DISCUSSION

Start Bearing Age

Cultivars and types started bearing 5 to 8 years after planting. 'Uzun' and 'Barak Yildizi' started bearing at 8 years old; 'Sel 15' at 7 years old; and other cultivars and types at 5 years old.

Phenological Characteristics

The earliest type was 'Barak Yildizi' with respect to the flowering and harvest time. The harvest time of 'Barak Yildizi' was 14 August. It was ripened 18-68 days earlier than the other cultivars and types. The latest flowering was observed on 'Kerman' and 'Vahidi', and the latest harvest was done in 'Vahidi' as 20th of October (Table 2).

Yield

The highest yield per hectare was obtained from 'Mumtaz', 'Tekin' and 'Sel 5', and the lowest was from 'Sel 15', 'Kerman' and 'Barak Yildizi' (Table 3).

According to yield per cross-sectional area (CSA), the highest value was observed on 'Siirt' and 'Sel 5', and the lowest on 'Sel 15', 'Uzun' and 'Barak Yildizi' (Table 4). Yield per hectare couldn't always confirm yield per CSA, because of growth differences between the cultivars and types.

Growth

Tree growth was measured in autumn as trunk diameter. It varied from 10.62 to 18.47 cm. The largest value was obtained from 'Mumtaz' and the lowest was from 'Sel

15'. Tree habit was upright in 'Uzun' and 'Barak Yildizi'; spreading in 'Ohadi', 'Haciserifi', 'Vahidi' and 'Kerman' and, semi-upright in the others (Table 4).

Quality Characteristics

Dry pistachio fruits were evaluated with hull. The 100 dry fruits weight changed between 121.2 g and 182.6 g in 'Uzun' and 'Mumtaz' cultivars, respectively. The highest split nuts was obtained from 'Siirt', 'Tekin', 'Sel 2' and 'Sel 5', and the lowest value obtained from 'Kerman'. Kernel ratio varied between 39.4% and 46.8%. The highest kernel ratio was observed on 'Ohadi' and the lowest was on 'Vahidi' (Table 5). It was found that 'Vahidi' cultivar couldn't fill the fruits. Because of its small kernel, split nut and kernel ratio was low in this cultivar.

Pistachio trees have long been grown under dry and arid conditions in Turkey. With the Southeast Anatolian Project (GAP), irrigation has become a current issue for pistachio growing. There are a lot of pistachio cultivars and types in Turkey.

The results of our study showed that pistachio trees can start bearing early under irrigated conditions which confirmed the result of Ak et al. (2002). Arpaci et al. (1997) reported that, 'Siirt' and 'Ohadi' cultivars started bearing 6 years after budding and 'Uzun' started bearing 9 years after budding under dry conditions in Turkey.

Parfitt et al. (2005) reported that, 'Kerman', a California developed cultivar, is now the primary female cultivar commercially grown in all regions in California. Our results showed that, Kerman is not a suitable pistachio cultivar for Southeast Anatolian Region which is the main pistachio producing area in Turkey.

'Barak Yildizi' is the earliest ripen pistachio cultivar in Turkey. The fruits of 'Barak Yildizi' were small in size under dry condition (Aktug Tahtaci et al., 2007), while its fruit size and quality was satisfactory under irrigated condition.

According to the result of Weighted-Rankit test; 'Tekin', 'Mumtaz' and 'Sel 5' have been identified as suitable pistachio cultivars for irrigated conditions in Southeast of Turkey.

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Tables

Table 1. Weighted-Rankit diagram of cultivars and types grown under irrigated conditions.

Characteristic	Coefficient	Category	Category Interval	Point
Yield (kg/ha)	50	High	2.251 and above	9
		Semi-high	1.901-2.250	7
		Medium	1.551-1.900	5
		Semi-low	1.201-1.550	3
		Low	1.200 and below	1
Growth (Trunk diameter - cm)	5	High	15.1 and above	7
		Medium	12.6-15.0	5
		Low	12.5 and below	3
100 dry fruits weight (g)	15	Very high	160.1 and above	9
		High	140.1 - 160.0	7
		Medium	120.1 - 140.0	5
		Low	120.0 and below	3
Split nuts (%)	15	High	85.1 and above	9
		Medium	65.1 - 85.0	7
		Low	45.1 - 65.0	5
		Very Low	45.0 and below	3
Kernel ratio (%)	15	High	44.1 and above	9
		Medium	42.1 - 44.0	7
		Low	40.1 - 42.0	5
		Very Low	40 and below	3

Table 2. Phenological characteristics of cultivars and types grown under irrigated conditions.

Cultivars and Types	Beginning of Blooming	Full Blooming	End of Blooming	Blooming period (days)	Harvest Time
Uzun	24 March	28 March	31 March	8	1 September
Siirt	26 March	31 March	4 April	10	5 October
Ohadi	28 March	1 April	5 April	9	25 September
Tekin	26 March	30 March	5 April	11	5 October
Sel 2	26 March	30 March	5 April	11	1 October
Sel 5	25 March	29 March	4 April	11	5 October
Sel 10	25 March	29 March	2 April	9	5 September
Barak Yildizi	21 March	24 March	28 March	8	14 August
Sel 14	29 March	2 April	7 April	10	5 October
Sel 15	28 March	2 April	6 April	10	25 September
Haciserifi	29 March	3 April	7 April	10	5 October
Mumtaz	27 March	31 March	5 April	10	1 October
Vahidi	31 March	5 April	11 April	12	20 October
Kerman	3 April	6 April	11 April	9	1 October

Table 3. Yield per hectare of cultivars and types grown under irrigated conditions.

Cultivars and Types	Yield (kg) (dry weight/ha)					
	2004	2005	2006	2007	2008	Average
Uzun	990.0 df	410.7 cd	1047.4 ef	971.4 eg	1777.0 bc	1040.0 def
Siirt	1977.0 ad	1923.0 bc	2359.0 ae	1057.1 ef	1607.0 bc	1786.0 a-d
Ohadi	1793.0 ae	720.0 bd	3012.5 ab	591.4 h	2213.0 ac	1668.0 b-e
Tekin	1280.0 cf	2290.0 ab	3384.0 a	2180.0 b	2507.0 ab	2328.0 ab
Sel 2	946.7 df	1663.0 bd	2023.2 af	914.3 fg	1327.0 bc	1376.0 c-f
Sel 5	1960.0 ad	1937.0 bc	2417.1 ae	2628.6 a	1717.0 bc	2132.0 abc
Sel 10	620.0 f	1137.0 bd	2846.9 ac	1828.6 c	2573.0 ab	1802.0 a-d
Barak Yildizi	1183.0 cf	213.3 cd	1454.8 cf	237.1 i	1637.0 bc	944.0 ef
Sel 14	786.7 ef	1787.0 bd	1942.7 bf	1437.1 d	1877.0 bc	1568.0 b-e
Sel 15	942.9 df	166.7 d	933.3 f	477.1 h	760.0 c	655.2 f
Haciserifi	1590.0 bf	1437.0 bd	2716.2 ad	808.6 g	2227.0 ac	1756.0 a-d
Mumtaz	2787.0 a	3697.0 a	1441.3 df	1134.3 e	3587.0 a	2528.0 a
Vahidi	2473.0 ab	1060.0 bd	2896.1 ab	971.4 eg	1977.0 bc	1876.0 abc
Kerman	750.0 ef	386.7 cd	1495.0 cf	85.7 i	1767.0 bc	898.0 ef
LSD ($p \leq 0.05$)	921.1	1483.0	1397.0	182.2	1263.0	794.8

Letters next to numbers indicate different groups determined by LSD test ($p \leq 0.05$)

Table 4. Tree habit, trunk diameter and yield efficiency of cultivars and types grown under irrigated conditions.

Cultivars and Types	Tree habit	Trunk diameter cm	Yield per cross-sectional area g/cm ²
Uzun	Upright	14.70	21.5
Siirt	Semi-upright	11.89	56.3
Ohadi	Spreading	14.60	34.9
Tekin	Semi-upright	15.29	44.4
Sel 2	Semi-upright	11.78	44.2
Sel 5	Semi-upright	13.43	52.7
Sel 10	Semi-upright	17.20	27.1
Barak Yildizi	Upright	13.11	24.5
Sel 14	Semi-upright	15.13	30.5
Sel 15	Semi-upright	10.62	25.9
Haciserifi	Spreading	15.18	34.0
Mumtaz	Semi-upright	18.47	33.0
Vahidi	Spreading	14.17	41.6
Kerman	Spreading	11.04	32.7

Table 5. Fruit quality characteristics of cultivars and types grown under irrigated conditions averaged over five years.

Cultivars and Types	100 dry fruits weight g	Split nuts %	Kernel ratio %
Uzun	121.2 hi	70.4 cd	41.4 b-e
Siirt	146.4 de	97.8 a	44.4 ab
Ohadi	133.6 e-h	91.8 abc	46.8 a
Tekin	151.8 cd	96.4 ab	44.0 abc
Sel 2	146.0 de	97.0 ab	43.6 a-d
Sel 5	150.0 cde	96.4 ab	43.0 b-e
Sel 10	114.2 i	75.2 bcd	41.0 be
Barak Yildizi	123.6 ghi	77.0 a-d	40.2 cde
Sel 14	162.4 bc	70.6 cd	43.2 a-d
Sel 15	141.4 def	69.8 cd	43.8 a-d
Haciserifi	127.6 f-i	71.8 cd	40.6 b-e
Mumtaz	182.6 a	79.6 a-d	43.8 a-d
Vahidi	168.4 ab	32.2 e	39.4 e
Kerman	137.4 d-g	58.4 d	40.0 de
LSD ($p \leq 0.05$)	14.55	19.36	3.24

Letters next to numbers indicate different groups determined by LSD test ($p \leq 0.05$)

Table 6. Weighted-Rankit point of cultivars and types grown under irrigated conditions.

Cultivars and Types	Yield kg/ha	Trunk diameter cm	100 dry fruits weight g	Split nuts %	Kernel ratio %	Total Point
Uzun	50	25	75	105	75	330
Siirt	250	15	105	135	135	640
Ohadi	250	25	75	135	135	620
Tekin	450	35	105	135	105	830
Sel 2	150	15	105	135	105	510
Sel 5	350	25	105	135	105	720
Sel 10	250	35	45	105	75	510
Barak Yildizi	50	25	75	105	75	330
Sel 14	250	35	135	105	105	630
Sel 15	50	15	105	105	105	380
Haciserifi	250	35	75	105	75	540
Mumtaz	450	35	135	105	105	830
Vahidi	250	25	135	45	45	500
Kerman	50	15	75	75	45	260

