International Scholars Journals

International Journal of Irrigation and Water Management ISSN 5423-5294 Vol. 5 (4), pp. 001-006, April, 2018. Available online at www.internationalscholarsjournals.org © International Scholars Journals

Full Length Research Paper

Effects of different irrigation regimes on vegetative growth, fruit yield and quality of drip-irrigated apricot trees

Sebahattin Kaya[1]*, Salih Evren[2], Erdal Dasci[2], M. Cemal Adiguzel[2] and Hasbi Yilmaz[3]

[1]Department of Agricultural Structures and Irrigation, Agriculture Faculty, Bingol University,12000,Bingol, Turkey.
[2]Soil and Water Resources Research Institute, 25700, Aziziye, Erzurum, Turkey.
[3]Ataturk Central Horticultural Research Institute, 77102, Yalova, Turkey.

Accepted 22 October, 2017

This study was conducted during five growing seasons from 2004 to 2008 to investigate effects of different irrigation regimes on vegetative growth, fruit yield and quality of Salak apricot trees in semi-arid climatic conditions. There were six irrigation treatments, five of which (S1, S2, S3, S4 and S5) were based on adjustment coefficients of class A pan evaporation (0.50, 0.75, 1.00, 1.25 and 1.50). The other treatment (S6) was regulated deficit irrigation treatment that was irrigated by applying 100% of class A pan evaporation until harvest, but was not irrigated after harvest. During the experimental years, the lowest values of irrigation water and evapotranspiration were obtained by S6 and S1 treatments, respectively, while the highest values were obtained for the S5 treatment. There were statistically significant vegetative growth differences among the treatments. The highest vegetative growth values were observed for the S5 and S4 treatments, while the lowest value was observed for the S6. Yields per tree and per unit crown volume did not show statistically significant differences among treatments in all the years studied, while the yield per unit trunk cross-sectional area showed statistically significant differences among treatments only in 2008. The S1 treatment showed higher yields per unit trunk cross-sectional area and per unit crown volume than other treatments, while S5 treatment showed higher yield per tree than other treatments in all the years studied. There were no statistically significant fruit quality differences among the treatments. Consequently, the S1 treatment is recommended for apricot trees under the experimental conditions.

Key words: Apricot, class A pan, evapotranspiration, water deficit, vegetative growth, fruit yield and quality.

INTRODUCTION

The apricot is grown in many parts of the world and is a popular fruit considered by many people with delightful fruits. Apricots are grown both in Central Asia with a warm summer, long and cold winter as well as in the Mediterranean climates with mild, short, dry winter and hot, dry summer (Arzani et al., 2000). According to data gathered about fruit production in 2002, the worldwide annual apricot production is 2 708 000 tons. Turkey has the highest annual production with 580 000 tons (Anon., 2003). Commercial apricot production depends on irrigation despite the fact that apricot is known to be resistant to drought and demonstrates some xeromorphic characteristics such as resistant capability to water stress at drought season and leaves fall at winter (Torrecillas et al., 1999). The benefit expected from irrigation depends on selection of irrigation method that best fits the con-ditions of climate, soil and plant. Since the soil surface is partially wetted, direct evaporation is reduced and indirectly save water by employing drip irrigation. There-fore, drip irrigation is prevalently used in watering the fruit trees grown in places in which water is scarce and expensive (Yazar et al., 1990).

There is little information on the water use and require-

---

*Corresponding author. E-mail: sebahattinkaya@yahoo.com. Tel: (90) 426 213 25 50. Fax: (90) 426 225 10 17.

Abbreviations: RDI, Regulated deficit irrigation; **ET,** evapotranspiration.

Table 1. Irrigation treatments in the study.

Treatment	Percentages of irrigation based on class A pan
S1	50
S2	75
S3	100
S4	125
S5	150
S6	100

ments of apricot trees and how water use affects the yield and root system (Mokhtar and Samir, 1999). Furthermore, it should be emphasized that water relation investigations in apricot were fragmentary or related to general biological topics, especially to stomata function and transpiration. It was also noted that the tolerance to drought is cultivar-dependent (Stankoviç et al., 1999). The design and the management schedule of irrigation and fertilization, is very important to know the critical stages of fruit development and the final quality of apricot fruit (Brunton et al., 2006).

Although a number of studies have been carried out on growing, improvement and diseases of apricot trees in Turkey, there have been few studies on the irrigation of apricots even though Turkey has the highest apricot production in the world and many apricot cultivars.

Meanwhile, In Igdır Region of Eastern Anatolia Region of Turkey, the study area, there are low seasonal rainfall amounts and scarce water resources. This area has great agricultural potential because it is a microclimate area. The apricot is the most important stone fruit grown in the region with 1525 ha dedicated to its cultivation, representing 74% of the total orchard area in the region (Anon, 1998). Salak apricot (*Prunus armeniaca L cv. Salak*) is the most often grown cultivar in the region and is specific to the region. However, investigation carried out on irrigation of Salak apricot trees is non existence in Turkey.

Furthermore, the world faces very serious global warming, which will produce a general warming and significantly increase the evaporative demand and the irrigation requirement for crops. This induces the development of studies focused on the optimization and efficiency of irrigation. It is, therefore important to investigate the efficient optimization of the irrigation of the fruit trees. This study focused on the effects of different irrigation regimes on the vegetative growth, fruit yield, and quality of Salak apricot trees.

MATERIALS AND METHODS

This study was conducted during five growing seasons from 2004 to 2008 in an apricot plot located at Soil and Water Resources Research Station, Igdır, Turkey. Plant material consisted of apricot trees (*P. armeniaca* L.cv. Salak) on zerdali rootstock spaced 8 x 8 m. The plot was planted and irrigated using the basin surface method in 2001. The Igdır region is a plain located in the Eastern Anatolia region (44° 49' - 45° 31' E; 39° 38' - 40° 03' N; 850 m a.s.l.) (Istanbulluoglu, 1989). The region has a semi-arid climate, with an average annual temperature of 12.1°C, an average relative humidity of 55%, an average sunshine of 6.41 h/ day and average annual rainfall of 247.8 mm (Anon, 2009).

A meteorology station next to the experimental plot recorded the following values in 2004, 2005 and 2006. The annual temperature averaged 11.3°C while the average relative humidity was 65.9%. Precipitation values, measured in March - October period, from 2004 to 2008 were 209, 181, 217, 223 and 108 mm, respectively. The soil at the experimental site is clay loam with 34% clay, 40% silt and 26% sand. The average field capacity is 31.4%, the permanent wilting point is 17.1%, the dry bulk density is 1.27 g/cm^3 and the pH is 8.04 at 0 - 120 cm soil depth. There is no shallow water table, salinity and alkalinity. Groundwater with C_2S_1 quality class was used as irrigation water which is also used for drinking purposes. Irrigation regimes (treatments) consist of applying different amounts of water represented by the class A pan evaporation during the previous week. Irrigation regimes are given in Table 1.

Although, the same pan coefficients were used for S3 and S6 treatments, in all the years of study, the S6 treatment was regulated deficit irrigation (RDI) treatment that was irrigated by applying 100% of class A pan evaporation until harvest, but was not irrigated after harvest. The amount of irrigation water applied was according to the considered percentages of the evaporation that occurred from class A pan. The irrigation interval for the all treatments was 7 days.

The experiment was designed as randomized complete blocks with each block containing one three-tree plot of each treatment. Every repetition consisted of 6 trees, taking middle three trees for experimental measurements and considering the others as non-experimental guard trees. All the trees in this experiment received the same fertilizer dosage. Fertilization techniques were used to provide the following fertilizer: 68 kg/ha of urea (from April to July four times in a year), 17 kg/ha PO_4H_3 (from April to mid-September). No weeds were allowed to develop within the orchard, resulting in a clean orchard floor for the duration of the experiment.

Trees were irrigated by using a double-drip irrigation line for each row, with emitters that had a flow rate of 6.8 l/h. Emitters were placed at 0.5 m intervals along lateral lines. About 35% of the soil's surface was wetted. The first irrigation was applied when available water at 120 cm depth soil profile was at 50% and increased to 100% (field capacity) for all treatments. Experimental treatments were initiated one week after the first irrigation application (in the first week of June in the initial years, in the last week of May in later years) and were continued by mid September. However, the trees undergoing S6 irrigation treatment were not irrigated after harvest in all the years of the study. The amount of irrigation water to be applied during a particular week was calculated from the daily evaporation values measured in the class A pan during the preceding week. Irrigation amounts were adjusted according to canopy size (Ruiz-Sanchez et al., 2000). The class A pan was set up according to criterions offered by Doorenbos and Pruitt (1977).

Soil water contents were determined monthly by gravimetric sampling method at 30 cm increments down to 120 cm in the profile. Furthermore, the soil water contents were checked using a neutron probe (Campbell Hydroprobe Model 503-DR) that had previously been calibrated for the site. Rainfall was measured both by a manual rain gauge and an automatic rain gauge connected to a data logger. The amount of irrigation water applied to each plot was measured by a water meter. Determination of soil water content and evapotranspiration (ET) calculations were made from the beginning of flowering until leaves began to fall off the trees. ET was calculated for each treatment through a water balance equation (Doorenbos and Kassam, 1988):

$$ET = P + I - D - R \pm S \quad (1)$$

Table 2. Irrigation water amounts applied to treatments and values of evapotranspiration determined.

Treatment	Number of irrigation	Amount of water applied (mm)	Crop water use (mm)	Number of irrigation	Amount of water applied (mm)	Crop water use (mm)	Number of irrigation	Amount of water applied (mm)	Crop water use (mm)
	2004			2005			2006		
S1	17	274	547	17	303	501	17	356	613
S2	17	392	674	17	431	630	17	504	765
S3	17	502	780	17	548	752	17	638	879
S4	17	629	903	17	696	892	17	817	1067
S5	17	755	1028	17	836	1014	17	959	1199
S6	7	208	494	7	214	428	7	276	529
	2007			2008			Mean (2004 - 2008)		
S1	17	342	647	19	453	645	17-19	346	591
S2	17	477	771	19	612	777	17-19	483	723
S3	17	603	923	19	771	948	17-19	612	856
S4	17	745	1045	19	930	1083	17-19	763	998
S5	17	875	1159	19	1089	1262	17-19	903	1132
S6	7	272	573	8	303	484	7-8	255	502

Where, P is the precipitation, I is the applied irrigation water, D is the drainage, R is the runoff, and S is the change in soil water content in that interval. All terms are expressed in millimeters of water in the crop root zone. Since there was no runoff during irrigation and the water table was at a depth of more than 3 m, capillary flow to the root zone and runoff were assumed to be negligible in the calculation of ET. On the basis of a number of soil water content measurements, drainage below 120 cm was considered to be negligible. Thus, the above equation was simplified as:

$$ET = P + I \pm S \qquad (2)$$

On three trees per block, the trunk circumference was measured annually, 30 cm above the soil line. On the same trees, the canopy shaded area was estimated as the vertical projection of the tree canopy measured across and within rows before each irrigation application. Tree crown volume was estimated by measuring the tree canopy size and tree height at the beginning of the winter period. Fruit yield and quality data were obtained for 2005, 2006 and 2008, but were not obtained for 2004 and 2007 because of spring frosts. Fruit yields were determined as yield per tree, per unit crown volume and per unit trunk cross-sectional area. Pulp hardness was determined by a penetrometer with 6 mm diameter and a piercing point. Total soluble solids were determined in unfiltered fruit juice using a hand refractometer. Titrable acidity was determined as total acidity by adding 0.1 N NaOH until the pH of fruit juice diluted with pure water was 8.1 (Karacali, 2006). All measurements were made on 9 fruits, taken at random on three trees per block.

In the present study, vegetative growth values from 2004 to 2008 and fruit yield and quality values of 2005, 2006 and 2008 were evaluated. As cultural practices and applications for 2005 and 2006 years were similar, cumulative fruit yield data and average fruit quality data from the previous years were evaluated. Since the end of the growing season of 2006, in particular, because crown width of trees have received more water completely, which covered the distance between the trees, differences of tree crown development in 2007 and 2008 were not evaluated. Statistical analysis was carried out using TARIST version 1.0 software with the general linear mode (GLM) (Acikgoz et al., 2004). The significant difference was set at $P \leq 0.01$ or $P \leq 0.05$ and determined using Duncan's multiple range test.

RESULTS AND DISCUSSION

Irrigation water applied and evapotranspiration

The total seasonal irrigation details for different irrigation treatments are given in Table 2. In all the years of the study, the S5 treatment resulted in the highest seasonal I and ET, while the lowest values were obtained for the S6 treatment. The quantity of irrigation water required and seasonal evapotranspiration increased with an increase in the pan coefficient. Since irrigation amounts were adjusted according to canopy size, depending on the tree crown development, I and ET values were observed to increase from year to year. The

Table 3. Effects of different irrigation regimes on annual increment of trunk cross-section area (cm^2/ tree).

Treatment	2004	2005	2006	2007	2008	Mean
S1	71.92 b*	68.38 ab*	75.66 bc**	72.17 cd*	68.10 bc*	71.25 bc*
S2	83.30 ab	85.11 ab	96.30 ab	89.86 bc	77.68 b	86.45 ab
S3	86.71 ab	87.07 ab	98.83 ab	99.87 ab	78.50 b	90.20 ab
S4	92.80 a	97.40 a	104.21 ab	110.30 ab	90.94 ab	99.13 a
S5	99.18 a	96.60 a	111.67 a	116.47 a	112.55 a	107.29 a
S6	74.07 b	59.26 b	58.46 c	62.73 d	44.56 c	59.82 c
Mean	84.66 ab***	82.30 b	90.85 a	91.90 a	78.72 b	85.69

* Values followed with different letters in the same column are significantly different (Duncan test, $p \leq 0.01$); ** values followed with different letters in the same column are significantly different (Duncan test, $p \leq 0.05$); *** values followed with different letters in the same row are significantly different (Duncan test, $p \leq 0.01$).

amounts of irrigation water applied for irrigation treatments were higher in 2006 than in 2007, since total evaporation from class A pan in 2006 was higher than those in 2007. Evapotranspiration values in 2004 were higher than those in 2005, since rainfall and soil water content at the beginning the season were higher in 2004 than in 2005. Similarly, evapotranspiration values of the S6 treatment in 2007 were higher than that in 2008, since rainfall was higher in the growing season of 2007 than that of 2008 (223 mm for 2007 and 108 mm for 2008). The average amount of water applied for each irrigation treatment in the experi-mental years ranged from 255 to 903 mm for the experimental treatments. Monthly ET reached its maximum levels in July for all the treat-ments except for the S6 treatment (in which ET was maximum in June) in all the years studied. The average amount of water applied to the S3 treatment (100% of Epan) was found to be 612 mm for the experimental years.

Yield data

The annual increments of trunk cross-sectional areas for different irrigation treatments are given in Table 3. The annual increments of trunk cross-sectional areas showed a difference depending on the treatment and the year. There were statistically significant differences depending on the treatment in all the years studied. The highest values were observed for the S5 treatment except for 2005 (in which highest value were found for the S4), while the lowest values were found for the S6 treatment in all the years of studied except for 2004 (in which lowest value were found for the S1). In the first two years of the experiment, S4 and S5 treatments were in the same statistical group. Annual increment in the trunk cross-sectional area showed decrease year by year at S6 treatment, since the effect of deficit water applied during the previous year also continued in later years. Similar findings were reported by Ruiz-Sanchez et al. (2000), who stated that trunk growth was reduced by continuous water deficit. Furthermore, annual increment of trunk cross-sectional area showed significant difference among the years studied. Generally, the increase in vegetative parameters showed a parallelism with increase in the water application levels. Mokhtar and Samir (1999) also reported that there was a positive relationship between water use and tree growth, yield and root length density and that more yield, higher root length and stronger trees were gotten from the treatment which got more water use. In addition, Girona et al. (1993) determined that trunk circumference of almond trees varied depending on the amount of applied water.

Annual increment of crown volume showed statistically significant differences among treatments in 2005, but there were no differences in 2004 and 2006 (Table 4). The S4 treatment showed the highest crown volume as against the S5 treatment, which might have been affected from differences in winter pruning. The S6 treatment had the lowest crown volume in 2004 and 2005, while S1 treatment had the lowest crown volume in 2006. The annual increment of crown volume did not show a statistically significant difference among the years. However, it was higher in 2006 than in other years because the water use values in 2006 were higher than those of the other years. The annual increment values of crown volume showed an increasing tendency depending on the amount of applied water in all the years studied. Mitchell et al. (1989) also suggested that vegetative growth was affected by water deficit, as indicated by the reduction in winter pruning weights (Ruiz-Sanchez et al., 2000).

Effects of different irrigation regimes on fruit yield are given in Table 5. Yield per tree and yield per unit crown volume did not show statistically significant differences among treatments in 2005 - 2006 and 2008. The S1 treatment showed higher yield per unit crown volume than other treatments, while S5 treatment showed higher yield per tree than other treatments. However, yield per unit trunk cross-sectional area showed statistically significant differences among treatments in 2008, but not in 2005 - 2006. In both 2005 - 2006 and 2008, the S1 treatment showed higher yield per unit trunk cross-sectional area than other treatments. S1 and S6 treatments were in the same statistical group in 2008. This results agree with the suggestions made by

Table 4. Effects of different irrigation regimes on annual increment of crown volume (m^3 /tree).

Treatment	2004	2005	2006	Mean
S1	30.49 a*	26.36 bc**	29.5 a*	28.78 bc**
S2	34.61 a	34.72 ab	36.8 a	35.38 ab
S3	32.2 a	33.75 ab	38.74 a	34.90 ab
S4	36.37 a	41.46 a	43.5 a	40.44 a
S5	39.31 a	35.92 ab	37.87 a	37.70 a
S6	28.35 a	21.03 c	31.77 a	27.05 c
Mean	33.56 a***	32.21 a	36.36 a	34.86

* Values followed by the same letters in columns are not significantly different (Duncan test, p ≤ 0.05); ****** values followed with different letters in the same column are significantly different (Duncan test, p ≤ 0.01); ******* values followed with the same letters in the same row are not significantly different (Duncan test, p ≤ 0.05).

Table 5. Effects of different irrigation regimes on fruit yield.

Treatment	Yield per tree (kg / tree)	Yield per unit crown volume (kg / m^3)	Yield per unit trunk cross-sectional area (kg / cm^2)
2005 - 2006			
S1	41.4 a*	0.42 a*	0.12 a*
S2	42.3 a	0.36 a	0.10 a
S3	44.2 a	0.36 a	0.10 a
S4	49.7 a	0.34 a	0.10 a
S5	52.2 a	0.36 a	0.10 a
S6	44.2 a	0.40 a	0.11 a
2008			
S1	83.9 a*	0.68 a*	0.24 a**
S2	80.5 a	0.59 a	0.18 ab
S3	86.1 a	0.66 a	0.19 ab
S4	84.7 a	0.59 a	0.17 b
S5	90.1 a	0.63 a	0.17 b
S6	80.0 a	0.66 a	0.23 a

* Values followed by the same letters in columns are not significantly different (Duncan test, *P* ≤ 0.05); ** values followed with different letters in the same column are significantly different (Duncan test, p≤ 0.01).

Goldhamer (1989), who suggested that deficit irrigation strategies may be applied in apricot trees since water deficit will affect vegetative growth without detrimental effect on fruit growth and yield (Ruiz-Sanchez et al., 2000). However, Mokhtar and Samir (1999) reported that there were significant differences among yields from water applications in different levels of available soil moisture. Fruit quality (hardness, soluble solids and acidity) values did not show statistically significant differences among treatments (Table 6). However, Ruiz-Sanchez et al. (2000) and Perez-Pastor et al. (2007) stated that higher soluble solids and acidity values were found in the deficit irrigated treatments.

Conclusion

This study was initiated to determine whether deficit irrigation strategies could be used to save irrigation water without reducing yield and quality in apricot trees. It was determined that fruit yield and quality did not increase at the same rate while tree growth significantly increased depending on the amount of water applied. Therefore, yields per unit trunk cross-sectional area and yields per unit crown volume in the treatments that received less water were higher than those in the treatments that received more water. The S1 treatment showed highest yield per unit trunk cross-sectional area and yield per unit crown volume, while the S6 treatment resulted in the lowest seasonal I and ET. The S6 treatment has not been recommended for apricot production. Because, S6 treatment (RDI) causes water stress in the critical period (immediately after harvest for one and a half months), in which water stress induces a significant decrease in fruit yield the following year (Torrecillas et al., 2000).

Thus, S1 treatment, which showed higher yield per unit

Table 6. Effects of different irrigation regimes on some fruit quality parameters.

Treatment	Pulp hardness (kg)	Titrable acidity (%)	Total solids soluble in water (%)
2005 - 2006			
S1	1.93 a*	0.40 a*	13.10 a*
S2	2.12 a	0.42 a	12.53 a
S3	2.25 a	0.45 a	12.62 a
S4	2.21 a	0.47 a	12.51 a
S5	2.10 a	0.48 a	13.10 a
S6	2.30 a	0.50 a	12.37 a
2008			
S1	3.00 a*	0.48 a*	12.8 a*
S2	3.15 a	0.50 a	12.1 a
S3	3.29 a	0.47 a	13.0 a
S4	3.07 a	0.48 a	13.2 a
S5	3.00 a	0.46 a	12.9 a
S6	2.70 a	0.50 a	13.4 a

***** Values followed by the same letters in columns are not significantly different (Duncan test, $P \leq 0.05$).

trunk cross-sectional area and yield per unit crown volume than other treatments, is recommended for apricot production in order to attain smaller values of irrigation water and evapotranspiration and to conserve water without reducing yield and quality.

ACKNOWLEDGEMENT

This present study was partially summarized from the research project supported by the General Directorate of Agricultural Research, Agriculture and Rural Services Ministry,TR.

REFERENCES

Acikgoz N, Ilker E, Gokcol A (2004). Evaluation of biological research on computer. Ege Üniv. TTUAM, 2: p. 236.

Anonymous (1998). The Igdır in 75th year of The Republic. Igdır Government,Igdır, Turkey.

Anonymous (2003). Statistical databases of FAO, (www.fao.org).

Anonymous (2009). Statistical data.Turkish State Meteorological Service. (www.dmi.gov.tr)

Arzani K, Lawes GS, Wood D (2000). The water relations of mature sundrop apricot trees in response to different vidour control techniques. Ferreira MI and Jones HG (eds). Proc. 3rd on Irrigation Hort. Crops. Acta Hortic. 537: 231-239.

Brunton JG, Rincon L, Ruiz D (2006). Growth and fruit quality of three apricot cultivars (*Prunus armeniaca* L.) under trickle irrigation and hydrogen cynamid (Dormex ®) application. ISHS Acta Hortic. 701: XII. Int. Symp. Apricot Culture Decline. pp. 697-702.

Doorenbos J, Kassam AH (1988). Yield response to water: irrigation and drainage. FAO Paper, 33: p. 193.

Doorenbos J, Pruitt WO (1977). Guidelines for prediction of crop water requirements. FAO Irrig. Drain. 2nd ed., Rome, Italy. p. 24.

Girona J, Marsal M, Cohen M, Mata M, Miravete C (1993). Physiological, growth and yield responses of Almond (*Prunus dulcis* L) to different irrigation regimes. Acta. Hortic. 335: 389-398.

Goldhamer DA (1989). Drought irrigation strategies for decidious orchards. Univ. of California, Div. Agric. Nat. Res. Publ. 21453: p. 15.

Istanbulluoglu A (1989). Comparison of irrigation methods in the cotton and sugar beet production under Igdir Plain conditions. General Directorate of Rural Services, Research Institute Directorate of Erzurum publication, Erzurum, Turkey. p. 24.

Karacali Đ (2006). Conservation and Marketing of Horticulture Crops. Ege University Press, Izmir, Turkey.

Mitchell PD, Van Den Ende B, Jerie PH, Chalmers, DJ (1989). Responses of Barlett pear to withholding irrigation, regulated deficit irrigation, and tree spacing. J. Am. Soc. Hort. Sci. 114: 15-19.

Mokhtar MH, Samir AS (1999). Water use of apricot trees. Karayiannis I (ed.). Proc. XI. Int. Symp. on Apricot Culture. Acta Hortic. 488: 547-550.

Perez-Pastor A, Ruiz- Sanchez MC, Martinez JA, Nortes PA, Artes F, Domingo R (2007). Effect of deficit irrigation on apricot fruit quality at harvest and during storage. J. Sci. Food Agric. 87(13): 2409-2415.

Ruiz-Sanchez MC, Torrecillas A, Perez-Pastor A, Domingo R (2000). Regulated deficit irrigation in apricot trees. Ferreira MI and Jones HG (eds.). Proc. 3rd on Irrigation Hort. Crops. Acta Hortic. 537: 759-766.

Stankoviç ZS, Pajevic S, Duric B, Kezserovic Z (1999). Water relation of apricot cultivars in ecological conditions of vojvodina. Karayiannis I (ed.). Proc. XI. Int. Symp. Apricot Culture. Acta Hortic. 488: 495-499.

Torrecillas A, Domingo R, Galego R, Ruiz-Sanchez MC (2000). Apricot tree response to witholding irrigation at different phenological periods. Sci. Hortic. 85(3): 201-215.

Torrecillas A, Galego R, Perez-Pastor A, Ruiz-Sanchez MC (1999). Gas exchange and water relations of young apricot plants under drought conditions. J. Agric. Sci. 132: 445-452.

Yazar A, Gencoglan C, Diker K (1990). The latest developments in irrigation systems. J. Cukurova Univ. Agric. Fac. 5(2): 61-72.