International Journal of the Physical Sciences Vol. 6(13), pp. 3134–3142, 4 July, 2011
Available online at http://www.academicjournals.org/IJPS
DOI: 10.5897/IJPS10.697
ISSN 1992 - 1950 ©2011 Academic Journals

Full Length Research Paper

Fruit physical characteristics responses of young apricot trees to different irrigation regimes and yield, quality, vegetative growth, and evapotranspiration relations

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

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

Accepted 7 March, 2011

This study was carried out to investigate effects of different irrigation regimes on fruit pomological properties of drip-irrigated young apricot trees in 2005 and 2008. Six different irrigation treatments were used: 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 not irrigated after harvest in all the years of study. The effect of different water application levels on fruit weight, fruit diameter, fruit height, seed weight, and flesh / seed ratio was found statistically insignificant. Regression analysis showed that there were significant relations among fruit yield, some quality characteristics, vegetative growth, and evapotranspiration in both 2005 and 2008. Also, the yield per tree and evapotranspiration were related with high R^2 values of 0.97 and 0.76 in 2005 and 2008, respectively. The fruit yield values showed an increasing trend depending on an increase in the tree crown volume, and trunk cross-section area in the experimental years. Fruit quality relationships were different according to the years and quality properties. In 2008, fruit weight reduced while fruit yield increased with fruit diameter and fruit height of more than about 47 and 38 mm, respectively. Thus, it was understood that yield increased, depending on the number of fruit rather than the weight of fruit.

Key words: Apricot, class a pan, drip-irrigation, evapotranspiration, fruit yield and quality, regulated deficit irrigation, vegetative growth.

Introduction

The apricot is grown in many parts of the world. Turkey is the leading producing country for both fresh and dried apricot. Total fresh and dried apricot production of Turkey in 2001 was, 500 and 120 thousand metric tons, respectively, composing a 15 to 20% fresh and 65 to 80% dried apricot production of the world (Asma ve Öztürk, 2005). The apricot is the most important stone fruit grown in the Igdir region with 1.525 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 Igdir region and is specific to the region.

In recent years, scarcity of water resources in most area of world is well known. This induces the development of studies focused on the optimization and efficiency of irrigation. Thus, the knowledge of crop response to different amounts of water is essential for planning and managing water resources, especially in areas where water supply is limited.

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

Regulated deficit irrigation (RDI) is an irrigation strategy designed to save water with a minimum impact on yield and fruit quality. This is accomplished by imposing water deficits during phonological stages when trees are relatively tolerant to water stress (non-critical periods) (Ruiz-Sanchez et al., 2000).

In fact, Regulated Deficit Irrigation (RDI) strategies are based on the beneficial effects of applying a water deficit at a certain developmental stage. Determining optimal depletion levels for fruit tree irrigation requires information on the effects of declining water supply on tree metabolic processes. Long-term experiments tend to suggest that soil water threshold levels for fruit trees should not be very different from those determined for herbaceous crops (Demirtas et al., 2008).

Furthermore, the use of irrigation methods or systems that require low labor and energy inputs has become more popular in recent years. These conditions are readily satisfied by means of drip (micro) irrigation systems. More importantly, economic and environmental reasons, such as increasing irrigation costs and decreasing sources of irrigation, have encouraged farmers to use the drip irrigation method, especially for valuable crops (Cetin et al., 2002).

Apricot trees bear large canopies, representing a great evaporative surface and show low levels of root and stem hydraulic conductivity (Alarco´n et al., 2000; Barradas et al., 2005). Apricots, like most fruit trees, are sensitive to water shortages during the early stages of fruit growth and development (bloom to pit hardening). Water stress at these times generally leads to smaller fruit at harvest (Southwick, 1993; Hanson and Proebsting, 1996). To ensure adequate fruit size when water supplies are limited, therefore, early varieties and apricots growing in early districts should not be water-stressed before harvest. Also, apricots are sensitive to severe water stress through flower bud differentiation (Southwick, 1993).

The number of fruits and their final size are dependent on the growth of other organs such as the root, shoots, and trunk. It is, therefore, important to study the growth patterns and growth rates of the various tree organs and to investigate the effect of water potential at different stages. According to various researchers (Hilgeman, 1963, 1977; Levy et al., 1978; Dasberg et al., 1981; Wiegand and Swanson, 1982), for measurements of wood growth, either the trunk or main branches may be used to compare the response of trees to different irrigation treatments at the same location. Also, the same researchers have found that measurement of the growth of the trunk may be used to compare the response of trees to different irrigation treatments in the same orchard (Kanber et al., 1999).

There are very few studies on the response of apricot to irrigation in global scale and in Turkey, which has the highest apricot production and many apricot cultivars in the world. More importantly, investigation carried out on irrigation of Salak apricot trees is nonexistence in Turkey. Therefore, it is important to investigate the efficient optimisation of the irrigation of Salak apricots.

The aim of this study was to determine the effects of different irrigation regimes on fruit pomological characteristics of apricot cv. Aprikoz (Salak) grafted on Zerdali rootstock.

MATERIALS AND METHODS

The experiment was carried out at the Soil and Water Resources Research Station, Igdir, Turkey from 2004 to 2008. The Igdir Plain is located in the Eastern Anatolia region (44°49' to 45°31' E; 39°38' to 40°03' N; altitude 850 m). The region has a semi-arid climate, with an average annual temperature of 12.1°C and an average relative humidity of 55%.The sun shines an average 6.41 h day^{-1} and the average annual rainfall is about 247.8 mm (Anon, 2009). The soil is a clay loam with 34% clay, 40% silt, and 26% sand. Average field capacity, 0.399 m^3 m^{-3} permanent wilting point, 0.217 m^3 m^{-3} ; dry bulk density, 1.27 g cm^{-3}; pH 8.04 at 0 to 120 cm soil depth. There is no shallow water table, salinity, and alkalinity. Water suitable for irrigation (pH 8.23; EC 0.275 dS m^{-1}) was obtained from a deep well in the experimental area.

The studied plant materials were Salak apricot cultivar trees (*Prunus armeniaca* L.*Salak*) grafted on Zerdali rootstocks. Salak apricot trees have very large volume of crown and are specific to Igdir region. The trees were planted in 2001, spaced 8 × 8 m apart. Treatments consisted of the application of six different water regimes: 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 not irrigated after harvest in all the years of study.

The experiment was conducted using a randomized complete block design with six irrigation treatments (S1 to S6) and three replications. Each block consisted of 36 trees and the total number of trees was 108 on the trial plot. Each plot contained one plant row with 6 trees, taking middle three trees for experimental measurements and considering the others as non-experimental guard trees.

Trees received the same fertilization treatments by using fertigation techniques. The amount of fertilizer was 0.44 kg urea (from April to July four times in a year), and 0.11 kg PO_4H_3 (from April to mid-September) applied to each tree each year. A routine pesticide program was maintained. 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 PE double-drip irrigation lateral line of 20 mm in diameter for each row. The lateral lines had online compensating emitters and the discharge rates of the emitters were 6.8 l/h at the operating pressure of 1.5 atm. The emitter spacing was chosen as 0.50 m due to soil characteristics. In addition, the control unit of the system had a vortex sand separator, sand media filters, a fertilizer tank, screen-mesh filters and pressure gauges. Also, each plot had a flow meter.

The amount of first irrigation water for all the plots was based on the moisture deficit that would be needed to bring a 0 to 120 cm layer of soil, to field capacity, and it was applied by means of the system when available water at a 120 cm depth soil profile was at 50%.

Experimental treatments were initiated one week after the first irrigation application which was in the last week of May or the first week of June, and were continued by mid September. However, the trees undergoing S6 irrigation treatment were not irrigated after harvest in the experimental years.

The amounts of irrigation water applied (I, m^3) in the irrigation treatments were determined by Class A pan evaporation using the equation given below:

$$I = A\ E_p\ k_{cp}\ P_c \quad (1)$$

Where I equals amount of irrigation water (m^3); A equals plot area (m^2), E_p equals cumulative evaporation amount measured during the preceding week ($x10^{-3}$ mm), k_{cp} equals coefficient (including crop coefficient kc, pan coefficient kp, and application efficiency Ea), P_c equals percentage of canopy cover.

The evaporation was measured from a Class A pan in the Meteorological Station of Soil and Water Resources Research Institute. The experimental plots were approximately far of 100 m from the station.

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 datalogger (Campbell Scientific, Inc. 21X). 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 via water balance equation water content (Doorenbos and Kassam, 1988):

$$ET = P + I - D - R \pm \Delta S \quad (2)$$

where P is the precipitation, I is the applied irrigation water, D is the drainage, R is the runoff, and ΔS 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:

$$ET = P + I \pm \Delta S \quad (3)$$

To determine the vegetative growth, the following measurements were done on three trees per block in the experimental years. The trunk circumference was measured with a plastic tape at harvest, and the beginning of the winter period, 30 cm above the soil line. On the same trees, the tree crown volume was estimated at harvest and the end of each growing season by measuring tree height and vertical projection of the tree canopy. Normal fruit yield could not be obtained in 2004, 2006 and 2007 due to spring frosts, so fruit yield, quality, vegetative growth and evapotranspiration data from 2005 and 2008 evaluated in this study. Fruit yields were determined as yield per tree, per unit crown volume, and per unit trunk cross-section area. Pulp hardness was determined by a penetrometer with 6 mm diameter and a piercing point. Total soluble solids (TSS) 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.

To take into account the water from rainfall and soil water as well as irrigation water, comparisons was made according to evapotranspiration rather than applied irrigation water.

Statistical analyses were carried out in order to determine the effects of different irrigation treatments on fruit pomological characteristics using TARIST version 1.0 software with the general linear mode (GLM) (Acikgoz et al., 2004). To evaluate the effect of irrigation treatment, a separate ANOVA was conducted for each year of the experiment. Year was not included as a factor in the ANOVA since irrigation amounts for the different treatments varied with season. Duncan's multiple test, an acceptable tool for the comparison of discrete data, was used to compare different irrigation programs (Yurtsever, 1984). To determine the relationships among yield, quality, vegetative growth, and evapotranspiration, values regression analysis were performed with Microsoft Excel®.

RESULTS AND DISCUSSION

Fruit pomological characteristics responses to different irrigation treatments

Fruit quality parameters studied (fruit weight, fruit diameter, fruit height, seed weight, flesh / seed ratio) are given Table 1. The final quality parameters after harvest varied from treatment to treatment and year to year. The highest fruit weight, fruit diameter and fruit height values were obtained for the S5 treatment in 2008 while the highest values were observed for the S6 treatment in 2005, which may be due to lack of water in post-harvest period of the previous year leading to the decrease in the number of fruit. Also, Torrecillas et al. (2000) reported that water stress in immediately post harvest, induces a significant decrease in fruit yield the following year, due to an increase in young fruit drop which lead to a lower final fruit set. According to the criteria of the Turkish Standards Institute, it was determined that all of the products obtained during both years were in extra class (Anon, 1981).

In the period of fruit development, and the following period, in which water stress generally leads to smaller fruit at harvest and apricots are sensitive to severe water stress through flower bud differentiation (Southwick, 1993; Torrecillas et al., 2000), the trees did not enter within a severe water stress condition in any of the irrigation treatments (including the S6 treatment) in all the experiment years (from 2004 to 2008). So, fruit quality data from the S6 were similar to those from other treatments. Even the S6 treatment showed fruit yield more than S1 and S2 treatments, receiving irrigation water more than S1 and S2 treatments in the period of fruit development of 2005.

On the other hand, in all the experiment years, trees subjected to the S6 treatment did enter within a partial water stress condition in critical period to be immediately

Table 1. Some physical characteristics of the fruits obtained in the trial years.

Treatment	Fruit weight (g)		Fruit diameter (mm)		Fruit height (mm)		Seed weight (g)		Flesh / seed ratio	
	2005	2008	2005	2008	2005	2008	2005	2008	2005	2008
S1	59,3	53,9	44.7	36.9	52.3	46.1	2.23	1.98	25.6	26.0
S2	59,5	61.0	44.9	37.8	52.0	47.3	2.24	2.21	25.7	26.6
S3	58,1	55,2	44.1	36.5	52.7	46.0	2.18	1.99	25.7	26.4
S4	57,5	59,3	44.2	37.6	52.2	46.9	2.12	2.15	26.3	26.7
S5	61,6	61,1	45.1	40.2	53.0	49.3	2.30	2.25	25.8	26.2
S6	62,3	60,9	45.7	38.2	53.6	46.8	2.25	2.29	26.8	25.5
Repl.(R)	ns	**	ns	ns	ns	ns	ns	**	ns	ns
Treat.(T)	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

(** $p \leq 0.01$, ns: non-significant according to ANOVA).

after harvest for one month in which water stress induces a significant decrease in fruit yield the following year (Torrecillas et al., 2000). In the 2005 and 2008, the S6 treatment did enter severe water stress forty and fifty day after harvest, respectively. However, the yield from the following year for the S6 treatment was not evaluated because of not being the normal yields from two consecutive years for all the treatments.

As it can be seen in Table 1, the effect of different water application levels on fruit weight, fruit diameter, fruit height, seed weight, and flesh / seed ratio was found statistically insignificant. Similar results have been reported by various researchers. Evans (2007) found that additional water supply to the soil did not affect the value of TSS, fruit flesh firmness, yield and fruit size in cherry. Similarly, Demirtas et al. (2008) stated that the effect of different water application levels on fruit weight, flesh/seed ratio, total titrable acidity, pH and inverted sugar and total sugar was found statistically insignificant while their effect on firmness was found significant in cherry.

On the other hand, Proebsting et al. (1981) stated that growth of fruit and vegetative parts was reduced by severe stress condition in bearing sweet cherry and prune trees.

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 and physical characteristics of harvested fruit were not modified by regulated deficit irrigation. Similarly, Mpelasoka et al. (2001) stated that deficit irrigation increased total soluble solids and fruit flesh firmness in Braeburn' apple. The results obtained in the present study agree with the suggestions reported by Goldhamer (1989), who has 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).

Fruit yield, quality and evapotranspiration relations

The relationships between seasonal evapotranspiration and fruit yield, and quality characteristics in the experimental years are shown in Figure 1 and Table 2. As shown in Figure 1, fruit yields per tree, fruit diameter, and fruit height increased with an increase in the evapotranspiration during both years. Regression analysis showed that there were significant quadratic relations between fruit yield, and some quality characteristics and evapotranspiration in both 2005 and 2008. Also, the yield per tree and evapotranspiration were related with high R^2 values of 0.97 and 0.76 in 2005 and 2008, respectively. Fruit diameter and fruit height were very well related with seasonal ET and it increased with seasonal ET of more than about 750 and 950 mm in both 2005 and 2008, respectively. Also, Marsh (1973) and Legaz et al. (1981) have explained that fruit size is considered to be the major fruit characteristic influenced by irrigation (Kanber et al., 1999). Similar results were obtained by Ruiz-Sanchez et al. (2000), who stated that apricot fruit growth was inhibited by deficit irrigation and compensatory fruit growth was noted when water deficits were alleviated during stage III of fruit growth, similarly to that observed in other fruits. Pulp hardness was also very well related to seasonal ET during both seasons. However, pulp hardness decreased with seasonal ET of more than about 950 mm in 2008, while it increased depending on increase in seasonal ET in 2005.

As shown in Table 2, fruit weight was poorly related to seasonal ET in 2008 (R^2=0.28), but a very good relationship was obtained in 2005 (R^2=0.75). While acidity was well related to seasonal ET, total solids soluble in water was poorly related to seasonal ET during both seasons. On the other hand, in the study done by Ben-Mechlia et al. (2000), in which ratios between total water supplied and Penman-Monteith reference evapotranspiration ([I+P] / ETo) were used for irrigation scheduling, total soluble contents of fruits increased

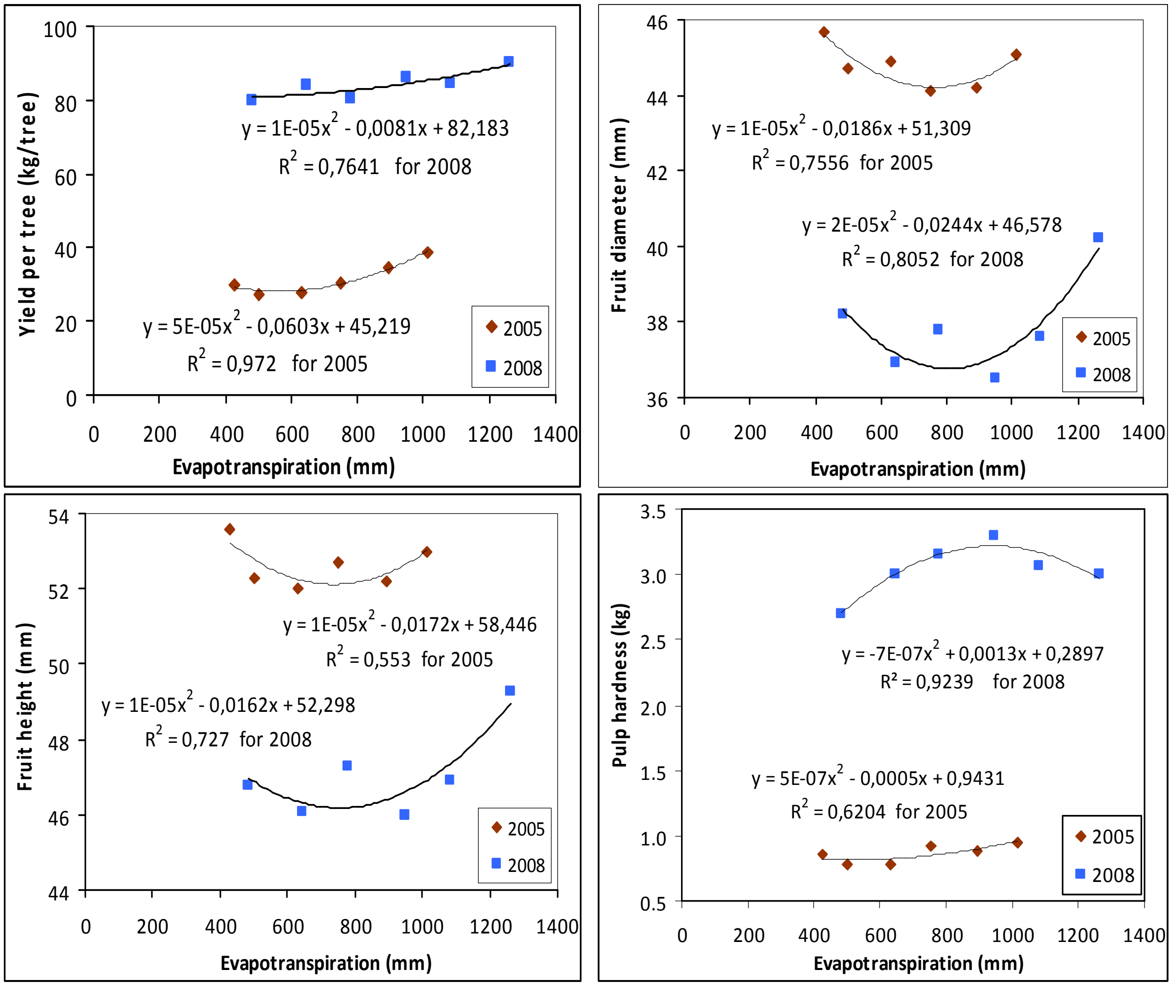

Figure 1. The relationships between seasonal evapotranspiration and fruit yield, and some quality characteristics.

Table 2. Relationships between evapotranspiration and other quality characteristics.

Related variables	Equation		R^2	
	2005	2008	2005	2008
Fruit weight vs. ET	$y = 4E\text{-}05x^2 - 0.0631x + 81.25$	$y = 2E\text{-}05x^2 - 0.04x + 73.522$	0.75	0.28
Titrable acidity vs. ET	$y = 6E\text{-}07x^2 - 0.0009x + 0.6438$	$y = -3E\text{-}08x^2 + 2E\text{-}06x + 0.5016$	0.57	0.63
Total soluble solids vs. ET	$y = -4E\text{-}06x^2 + 0.0058x + 11.563$	$y = 2E\text{-}06x^2 - 0.003x + 14.298$	0.30	0.26

linearly with decreasing ([I+P] / ETo) ratios.

Fruit yield and vegetative growth relations

The tree crown volume and trunk cross-section area were taken into account to determine the relations between yield and vegetative growth. Also, Wiegand and Swanson (1982), Levy et al. (1978), Hilgeman (1963,1977), and Dasberg et al. (1981) recorded that, for measurements of wood growth, either the trunk or main branches may be used to compare the response of trees to different irrigation treatments at the same location (Kanber et al.,1999).

During both seasons, it was found that there was a positive polynomial relationship between both the crown

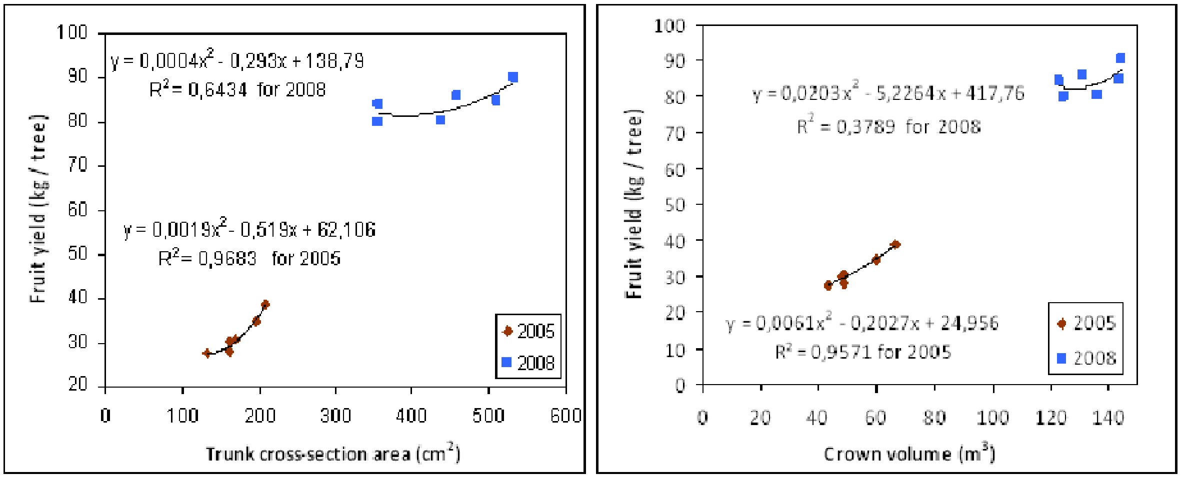

Figure 2. The relationships between vegetative growth and fruit yield.

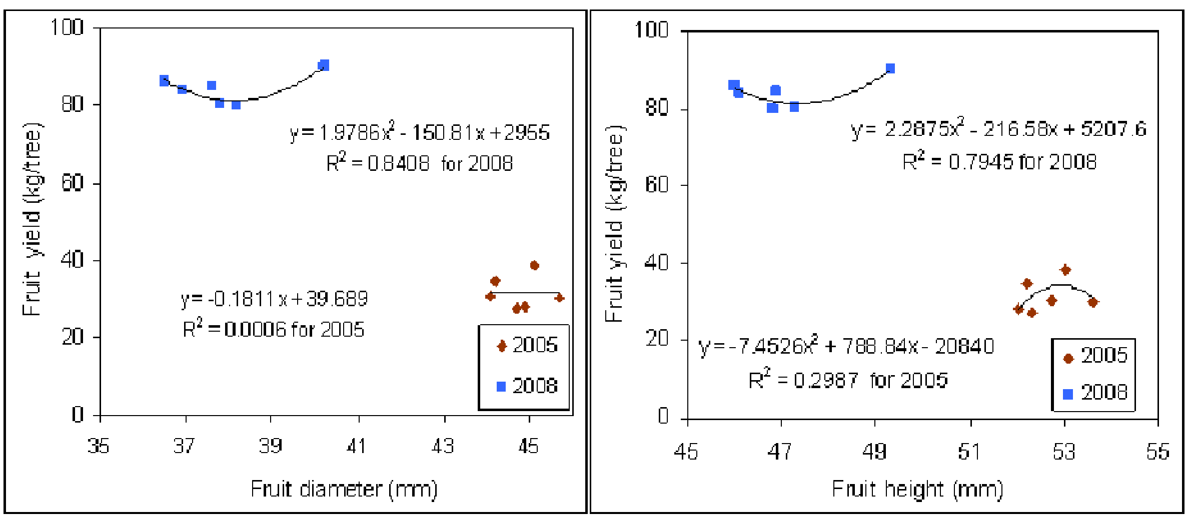

Figure 3. The relationships between fruit yield and quality characteristics.

volume and trunk cross-section area and yield. The curves showing the relationships between fruit yield and tree crown volume, and trunk cross-section area are presented in Figure 2. Accordingly, the fruit yield values showed an increasing trend depending on an increase in the tree crown volume, and trunk cross-section area in the experimental years.

Fruit yield was poorly related to crown volume in 2008 (R^2 = 0.38), but a very good relationship was obtained in 2005 (R^2 = 0.96). Also, the yield and trunk cross-section area were related with high R^2 values of 0.97 and 0.64 in 2005 and 2008, respectively. Similar findings were reported by Levy et al. (1978) who reported that there was a good correlation between canopy volume and yield. However, Kanber et al. (1999) stated that, as trees reach full size, excessive growth as a consequence of intensive irrigation can lead to decreased yield, mainly because of shading and the need for severe hedging.

Fruit yield and quality characteristics relations

Figure 3 shows that fruit yield increased non-linearly with fruit height and with fruit diameter in both 2005 and 2008. Fruit yield was poorly related to fruit height in 2005 (R^2 = 0.30), but a very good relationship was obtained in 2008 (R^2 = 0.80). Similar relationship was observed between fruit yield and fruit diameter. Also, while the yield and

Table 3. Relationships between yield and fruit weight.

Related variables	Equation		R^2	
	2005	2008	2005	2008
Yield per tree vs. fruit weight	$y = 0.7746x^2 - 92.508x + 2791.3$	$y = -0.092x^2 + 10.441x - 210.79$	0.22	0.03

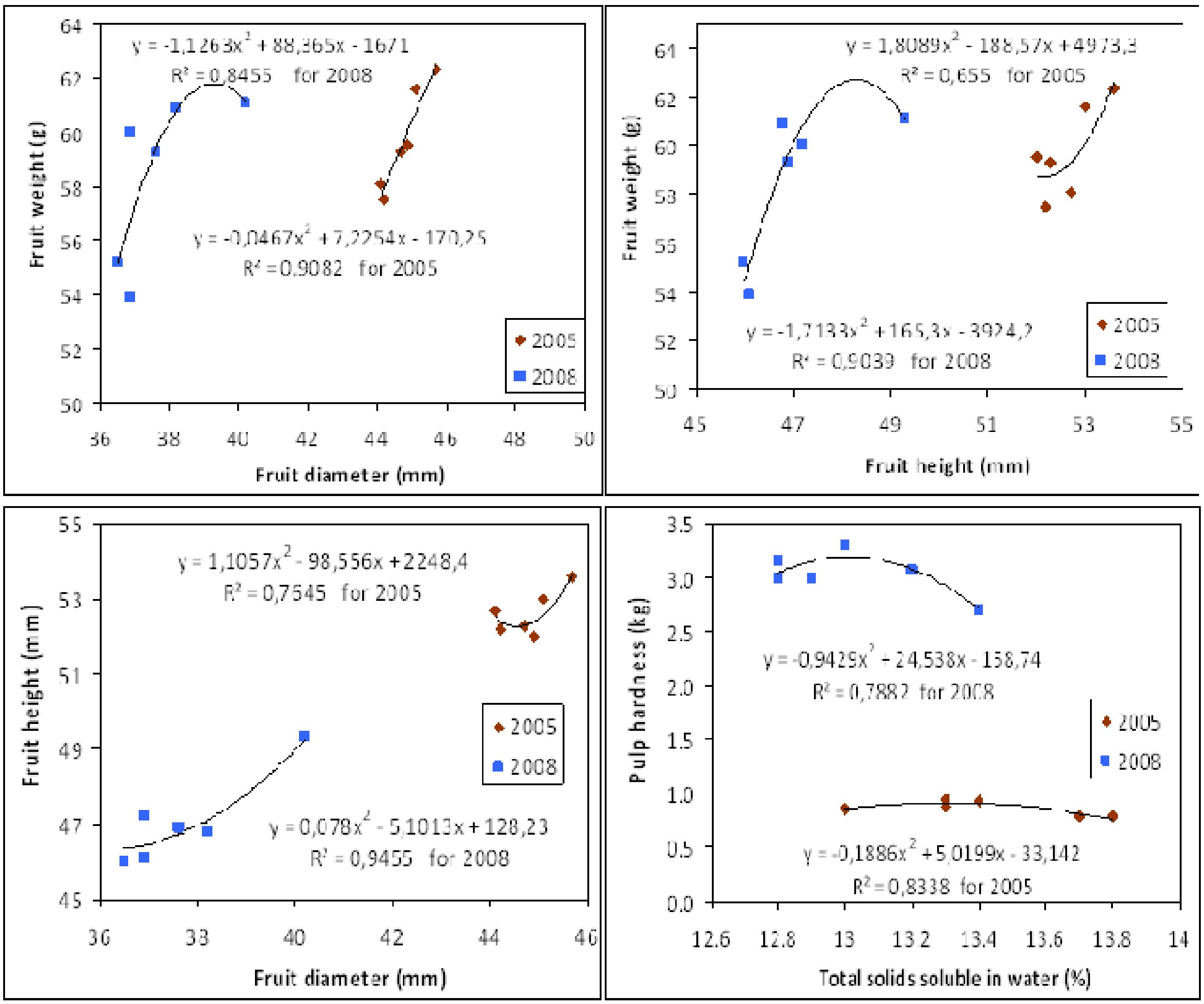

Figure 4. The relationships among fruit quality characteristics.

fruit diameter were related with high R^2 values of 0.84 in 2008, a very poor relationship was obtained in 2005. In 2008, yield increased with fruit height and fruit diameter of more than about 47 mm and 38 mm, respectively. As shown in Table 3, fruit yield was also poorly related to fruit weight in both years.

Fruit quality characteristics relations

The quadratic relationships among fruit quality characteristics for the experimental years are shown in Figure 4 and Table 4. Fruit weight and fruit height were related with high R^2 values of 0.66 and 0.90 in 2005 and

Table 4. Relationships among other fruit quality characteristics.

Related variables	Equation		R^2	
	2005	2008	2005	2008
Titrable acidity vs. TSS	$y = 0.2169x^2 - 5.8518x + 39.768$	$y = 0.2968x^2 - 7.7485x + 51.037$	0.30	0.62
pH vs Titrable acidity	$y = -1.157x + 5.4497$	$y = 0.7532x + 4.0205$	0.74	0.06
pH vs. TSS	$y = -0.0171x + 5.313$	$y = 0.1584x + 2.3217$	0.01	0.63
Titrable acidity vs. pulp hardness	$y = 0.084x + 0.2444$	$y = -0.0322x + 0.5794$	0.03	0.16

2008, respectively. Similar results were obtained between fruit diameter and fruit yield during both years. In 2008, fruit weight decreased when fruit height and fruit diameter were above about 47 mm and 38 mm, respectively. Thus, it was understood that yield increased depending on the number of fruit rather than the weight of fruit, considering the fruit yield increased with fruit height and fruit diameter of more than about 47 and 38 mm, respectively. These results are in accordance with the findings determined by Kanber et al. (1992).

Also, the fruit height and fruit diameter values were polynomially related with high R^2 values of 0.77 and 0.95 in 2005 and 2008, respectively. The pulp hardness was well related to TSS with R^2 values of 0.83 and 0.79 during both years. In 2008, it decreased with TSS for TSS below about 13%.

As shown in Table 4, titrable acidity was poorly related to TSS in 2008 (R^2 = 0.30), but a good relationship was obtained in 2005 (R^2 = 0.62). While pH was very well related to titrable acidity in 2005 (R^2 = 0.74), a poor relationship was observed in 2008 (R^2 = 0.06). On the other hand, pH was poorly related to TSS in 2005 (R^2 = 0.01), but a good relationship was obtained in 2008 (R^2 = 0.63). Titrable acidity was also poorly related to pulp hardness in both years.

Conclusion

Since the improvement of fruit quality is the main purpose of apricot production, this study was initiated to determine effects of different irrigation treatments on fruit pomological characteristics of apricot trees. The effect of different water application levels on fruit quality characteristics was found statistically insignificant. However, it was determined that fruit yield increased as long as evapotranspiration increased and effect of evapotranspiration on fruit quality characteristics was different.

It was observed that fruit weight reduced while fruit yield increased when fruit diameter and, fruit height values, were more than a certain threshold value. Furthermore, in 2008, the yield decreased as the fruit size increased up to a certain threshold size of fruit. Thus, it was understood that yield increased depending on the number of fruit rather than the weight of fruit.

In fruit development period, the amount of irrigation water applied to the S6 treatment is a regulated deficit irrigation treatment was equivalent to that of the S3 treatment and more than those of S1 and S2 treatments. Hence, fruit yield and quality values of the S6 treatment were mostly more than those of S1 and S2 treatments. However, because the evapotranspiration of the S6 treatment is less than that of S1 and S2 treatments, this situation resulted in the quadratic relations. Thus, it was observed that the declining quality values depending on evapotranspiration began to increase after a certain threshold value.

In addition, the amount of irrigation water applied to treatments was effective on vegetative growth rather than fruit yield and quality (Kaya et al., 2010 and 2011). Therefore, the relations between vegetative growth and yield was quadratic.

The relationships between evapotranspiration and fruit yield, and fruit quality properties, were analyzed in order to predict fruit yield and quality properties from observations done during both seasons. Various prediction equations were derived through regression analysis.

ACKNOWLEDGEMENTS

This present study was summarized partially from the research project supported by General Directorate of Agricultural Researches, 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.

Alarco´n JJ, Domingo R, Green SR, Sa´nchez-Blanco MJ, Rodrı´guez PA, Torrecillas A, (2000). Sap flow as an indicator of transpiration and the water status of young apricot trees. Plant Soil 227: 77–85.

Anonymous (1981). Kayısı (Apricots), Turkish Standards Institute, TS 791, Prime Ministry, TR,Ankara.

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

Anonymous (2009). Statistical data. Turkish State Meteorological

Service. (www.dmi.gov.tr)
Asma BM, Ozturk K (2005). Analysis of morphological, pomological and yield characteristics of some apricot germplasm in Turkey, Genetic Resourc. Crop Evolut., 52: 305–313.
Barradas VL, Nicolas E, Torrecillas A, Alarcon JJ (2005). Transpiration and canopy conductance in young apricot (*Prunus armenica* L.) trees subjected to different PAR levels and water stres. Agric. Water Manag., 77: 323–333.
Ben-Mechlia BN, Sahli A, Zitouna R (2000).Water relations and yield of peach trees under high evaporative demand conditions. In: Ferreira MI and Jones HG (eds.). Proc. 3rd on Irrigation Hort. Crops. Acta Hort: 537: 299-304.
Cetin O, Yıldırım O, Uygan D, Boyacı H (2002). Irrigation Scheduling of Drip-Irrigated Tomatoes Using Class A Pan Evaporation. Turk. J. Agric. For., 26: 171-178.
Dasberg S, Bielorai H, and Erner Y (1981). Partial wetting of the root zone and nitrogen effect on growht and quality of shamouti orange. Acta Hortic., 119: 103-105.
Demirtas C, Erturk U, Yazgan S, Candogan BN, Soylu A (2008). Effects of different irrigation levels on the vegetative growth, flower bud formation and fruit quality of sweet cherry in western part of Turkey. J. Food, Agric. Env., 6(2): 173 - 177.
Doorenbos J, Kassam AH (1988). Yield response to water: irrigation and drainage. FAO Paper 33, p. 193.
Evans R (2007). Irrigation Technologies Comparisons. USDA-ARSNPARL,Sidney, ww.sidney.ars.usda.gov.
Goldhamer DA (1989). Drought irrigation strategies for decidious orchards. Univ. Of California, Div. Agric. Nat. Resources. Public. No. 21453: 15.
Hanson EJ, Proebsting EL (1996). Cherry nutrient requirements and water relations. In: Webster AD and Lonney NE (eds). Cherries: Crop Physiology, Production and Uses. CAB International, pp. 243-257.
Hilgeman RH (1963).Trunk growth of valencia orange in relation to soil moisture and climate. Proc. Amer. Soc. Hort. Sci., 82: 193-198.
Hilgeman RH (1977). Response of Citrus to Water Stress In Arizona. Proc. Int. Soc. Citrus. (Orlando). 1: 70-74.
Kanber R, Köksal H, Yazar A, Ozekıcı B, Onder S (1999). Effects of different irrigation programs on fruit, trunk growth rates, quality and yield of grapefruit trees. Tr. J. Agric. For., 23: 401-411.
Kanber R, Yazar A, Köksal, H, Oguzer V (1992). Evapotranspiration of Grapefruit in the Eastern Mediterranean Region of Turkey. Sci. Hortic. 52: 53-62.
Karacali İ (2006). Conservation and Marketing of Horticulture Crops. Ege University Press, Izmir, Turkey.
Kaya S, Evren S, Dasci E, Adiguzel MC, Yilmaz H (2010.) Effects of different irrigation regimes on vegetative growth, fruit yield and quality of drip-rrigated apricot trees. Afr. J. Biotechnol., 9(36): 5902-5907.
Kaya S, Evren S, Dasci E, Adiguzel MC, Yilmaz H (2011). Evapotranspiration,irrigation water applied, and vegetative growth relations of young apricot trees under different irrigation regimes. Sci. Res. Essays, 6(4): 738-747.
Legaz F, Ilbanez DG, deBarrade D, Primo Milo E (1981). Influence of Irrigation And Fertilization on Productivity of The “Navelate” Sweet Orange. Proc. Int. Soc. Citric. (Tokyo) 2: 591-595.
Levy Y, Shalhevet J, Bielorai H (1978). Long-term effects of different irrigation regimes on grapefruit tree development and Yield. J. Am. Soc. Hortic. Sci., 103: 680-683.
Marsh, AW (1973). Irrigation. “Citrus Industry”. W Reuter (ed). Univ. of Califor. Div. Agric. Sci., 3: 230-279.
Mpelasoka BS, Behboudian MH, Mills TM (2001). Effects of deficit irrigation on fruit maturity and quality of ‘Braeburn’ apple. Sci. Hort., 90: 279-290.
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.
Proebsting EL, Middleton JE, and Mahan MO (1981). Performance of bearing cherry and prune tress under very low irrigation rates. J. Amer. Soc. Hort. Sci., 106: 243-246.
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 Hort: 537: 759-766.
Southwick S (1993). Drought Tactics for Apricots, Drought Tips, Number 92-35. University of California, Agriculture and Natural Resources, 300 Lakeside Drive, 6th Floor, Oakland, CA 94612-3560.
Torrecillas A, Domingo R, Galego R, Ruiz-Sanchez MC (2000). Apricot tree response to witholding irrigation at different phenological periods. Sci. Hort., 85(3): 201-215.
Wiegand CL, Swanson WA (1982). Citrus response to irrigation. III Tree Trunk And Canopy Growth. J. Rio Grande Walley Hortic. Soc., 35: 97-107.
Yurtsever, N (1984). Experimental Statistic Methods. Soil and Fertilizer Research Institute. General Publications No: 121, Ankara, Turkey.