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Effects of regulated deficit irrigation on physiology and fruit quality in apricot trees

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Abstract

The effects of regulated deficit irrigation (RDI) were studied on 9 year-old apricot-trees (*Prunus armeniaca* L. cv. 'Búlida') grafted on 'Real Fino' rootstock. Two irrigation treatments were established. The first, a control treatment, was irrigated to fully satisfy the crop water requirements (100% ETc) and the second, a RDI treatment, was subject to water shortage during the non-critical periods of crop development, by reducing the amount of applied irrigation water to: a) 40% of ETc from flowering until the end of the first stage of fruit growth; b) 60% of ETc during the second stage of fruit growth and c) 50% and 25% of ETc during the late postharvest period (that starts 60 days after harvesting), for the first 30 days and until the end of tree defoliation, respectively. The results indicated that the apricot tree is an appropriate species to apply RDI thanks to the clear separation between their vegetative and reproductive growths and its ability to recover the fruit diameter reduction suffered during RDI application. Furthermore, some qualitative characteristics such as the level of soluble solids, fruit taste and the colour of the fruit are enhanced. These two reasons, together with irrigation water savings of 39%, emphasize the RDI strategies as a possible solution in areas with water shortages, like the south-eastern region of Spain.

Additional key words: fruit growth, photosynthesis; *Prunus armeniaca* L.; regulated deficit irrigation; stomatal conductance; water relations; water stress.

Resumen

Efectos del riego deficitario controlado sobre la fisiología y la calidad de fruto en albaricoquero

Se estudiaron los efectos de estrategias de riego deficitario controlado (RDC) sobre albaricoqueros de 9 años de edad (*Prunus armeniaca* L. cv. 'Búlida') injertados sobre patrón franco de 'Real Fino'. Para ello, se establecieron 2 tratamientos de riego, uno de riego control, que se regó satisfaciendo los requerimientos hídricos del cultivo (100% ETc) y un tratamiento de RDC, que consistió en reducir los aportes de agua con respecto a la ETc en los períodos no críticos en este cultivo: a) 40% de la ETc desde floración hasta el final de la primera fase de crecimiento del fruto; b) 60% de la ETc durante la segunda fase de crecimiento del fruto y c) 50% y 25% durante la post-cosecha final (60 días después de recolección), diferenciando 2 períodos de 30 días, el primero al 50% de la ETc, y otro hasta la caída de hojas al 25% de la ETc. Los resultados obtenidos indican que el albaricoquero es una especie adecuada para realizar estrategias de RDC, debido principalmente a la clara separación entre el crecimiento vegetativo y reproductivo y, también al efecto de crecimientos compensatorios que se producen en los frutos que han estado bajo RDC, lo cual hace que finalmente no se produzcan mermas significativas de calibre. Además, ciertas características cualitativas, como el nivel en sólidos solubles, sabor y coloración de la fruta, se ven incrementadas. Estas dos razones, junto con ahorros de agua vía riego, del 39%, conducen a que estrategias de RDC puedan suponer una clara alternativa en zonas con infradotación hídrica, como es el sureste español.

Palabras clave adicionales: conductancia estomática; crecimiento del fruto; estrés hídrico; fotosíntesis; *Prunus armeniaca* L.; relaciones hídricas; riego deficitario controlado.

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Abbreviations used: DOY (day of year), ETc (crop evapotranspiration), ETo (reference crop evapotranspiration), SSC (soluble solids content), TA (tritable acidity), TDR (time-domain-reflectometry), VPD (vapour pressure deficit).

Introduction

Apricot trees (*Prunus armeniaca* L.) are widely cultivated in Mediterranean countries, with the Murcia Region being Spain's leading apricot producer with an average annual yield in the last few years of about 85,000 tonnes of apricots, from a cultivation area of 10,500 ha (MARM, 2009); these figures represent ~66% and ~60% of the Spanish total apricot production and cultivation area of apricots, respectively. The most important cultivar of apricot in Spain is 'Búlida', which represents ~50% and ~66% of the total production of apricots in Spain and the Murcia Region, respectively (CARM, 2009).

Apricot trees are highly sensitive to drought stress at particular phenological stages, such as stage III of fruit growth and during the 2 months after harvest (early postharvest) (Torrecillas *et al.,* 2000; Pérez-Pastor *et al*., 2007, 2009). Apricot drought tolerance is mainly based on avoidance mechanisms, such as stomatal control, epinasty and limitation transpiration by reducing leaf area (Torrecillas *et al*., 1999; Ruiz-Sánchez *et al*., 2000a), together with some degree of osmotic adjustment in young apricot trees although this adjustment is not observed in adult trees (Ruiz-Sánchez *et al*., 2007).

Regulated deficit irrigation (RDI) is the practice of reducing applied water at selected phenological stages less sensitive to water deficit, thus imposing plant water stress in a controlled manner, and can be a feasible water saving practice for arid areas with a minimum impact on yield and fruit quality (Chalmers *et al.,* 1981; Goldhammer, 1989; Naor, 2006). The success of RDI strongly depends on the appropriate use of microirrigation techniques, which allows the control of soil water content (Dichio *et al*., 2007). RDI has been used successfully maintaining yield and fruit quality in many fruit species (Ebel *et al*., 1995; Girona *et al*., 2003; Buendía *et al*., 2008; López *et al*., 2008), nut species (Goldhamer *et al*., 2000; Goldhamer and Beede, 2004; Romero *et al*., 2004; Girona *et al*., 2005) citrus species (Sánchez-Blanco *et al*., 1989; Castel and Buj, 1990; Domingo *et al*., 1996; González-Altozano and Castel, 1999, 2000; Goldhamer and Salinas, 2000), wine grapes (Bravdo and Naor, 1996; McCarthy *et al*., 2002) and olives (Moriana *et al*., 2003). The most important research studies related to the application of RDI strategies in apricot trees has been done by Ruiz-Sanchez *et al*. (1999, 2000b, 2004, 2007), and Pérez-Pastor *et al.* (2004, 2007, 2009). These authors have found benefits such as higher values of total soluble solids, tritratable acidity and hue angle in apricots obtained from RDI strategies (Pérez-Pastor *et al*., 2007).

The aim of this paper was to evaluate the effect of RDI on plant-water relations, yield and fruit quality in adult apricot trees (*Prunus armeniaca* L. cv. 'Búlida'). The RDI treatment was scheduled to reduce water applications during non-critical periods, satisfying the crop water requirements during the critical periods, which corresponded to the second rapid fruit growth period (stage III) and the early postharvest period (Pérez-Pastor *et al*., 2009).

Material and methods

Experimental conditions and plant material

The experiment was performed during 2008, in a 1-ha plot of a commercial orchard, located in Mula valley, Murcia, Spain (37°55' N, 1°25' W, 360 m above sea level). The soil is a clay-loam texture and classified as a Xeric Torriorthent. It is highly calcareous, has a pH of 7.8, and a low organic matter content and cationic exchange capacity. The available water capacity is about 0.31 m^3 m^{-3}. The climate is semiarid Mediterranean with hot and dry summers; annual evaporation calculated from reference crop evapotranspiration (ET_0) and rainfall was 1,055 and 318 mm, respectively.

The plant material consisted of 9-year-old apricot trees (*Prunus armeniaca* L. cv. Búlida, on Real Fino apricot rootstock), spaced 8 × 6 m, with an average height of 3.9 m, trunk diameter of 0.19 m, and ground cover of about 65%. Trees were drip irrigated using one drip irrigation line for each row, with five emitters per tree, each with a flow rate of 4 L h^{-1}.

Crop irrigation requirements were scheduled weekly according to daily ETo, calculated using the Penman-Monteith equation (Allen *et al*., 1998), and a local crop factor based on the time of the year (Abrisqueta *et al*., 2001): 0.5 February, 0.75 March, 0.8 April, 0.9 May, 0.6 June, 0.5 July-November. The correction coefficient for ground cover was 1 according to Fereres and Goldhmaer (1990). All trees received the same quantity of nutrients through the irrigation system: 110 kg N, 62 kg P_2O_5 and 117 kg K_2O ha^{-1} $year^{-1}$. Pest control was that commonly used by growers, and no weeds were allowed to develop within the orchard.

A total of 192 trees were used in this study. The experimental design of each irrigation treatment was

4 standard experimental plots distributed randomly in blocks. The standard plot was made up of 24 trees, organized in 4 adjacent rows. The 8 central trees of the middle row were used for measurements, and the other 16 trees were guard trees.

Irrigation treatments

Two irrigation treatments were applied: (C), irrigated daily satisfying the estimated crop evapotranspiration (ETc) and RDI irrigated at 100% ETc during the critical periods (stage III of fruit growth and 2 months after harvest period) and was subjected to water shortage during the non-critical periods of crop development by reducing the amount of applied irrigation water to: a) 40% of ETc from flowering until the end of the first stage of fruit growth; b) 60% of ETc during the second stage of fruit growth and c) 50% and 25% of ETc during the late postharvest period (that starts 60 days after harvesting), for the first 30 days and until the end of tree defoliation, respectively (Fig. 1). This distribution of water applied during non-critical periods was based on studies by Torrecillas *et al*. (2000). The irrigation water was considered to be of good quality with a very low electrical conductivity (0.6 dS m^{-1}). Irrigation was controlled automatically by a head unit programmer and the amounts of water applied for each irrigation treatment were measured with in-line flowmeters placed in each standard experimental plot.

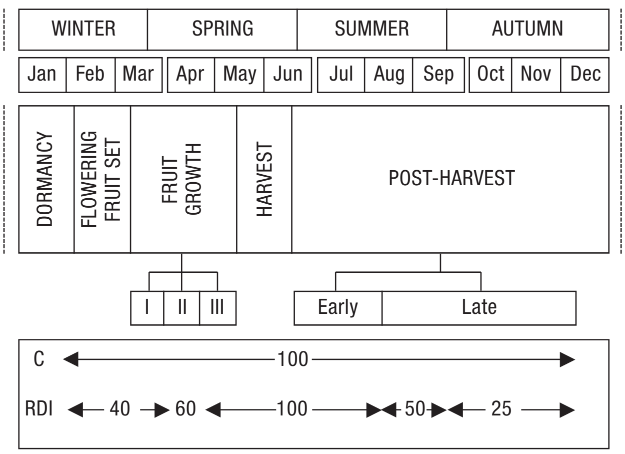

Figure 1. Percentages of crop evapotranspiration (ETc) applied in the regulated deficit irrigation (RDI) treatment during the phenological stages for 'Búlida' apricot trees during the experimental period.

Measurements

The soil volumetric water content (θ_v) of the top 0.2 m of the soil profile was measured by time-domain-reflectrometry probes (TDR) (model 1502C, Tektronix Inc., OR.), as described by Moreno *et al*. (1996). The θ_v content of the soil from 0.2 m down to a maximum depth of 1.0 m was measured every 0.1 m using a neutron probe (model 4300, Troxler Electronic Laboratories, Inc. NC.), in access tubes installed 1.0 m away from the trees and beside the emitters. Measurements using one neutron probe per each standard experimental plot (4 per treatment) were taken every 7 to 15 days in the morning, during the experimental period. Two TDR probes were used for each neutron probe.

Midday (12:00 h solar time) stem water potential (Ψ_s) was measured in one mature leaves per plant (6 trees per each experimental plot), taken close to the trunk. Leaves were enclosed in a small black plastic bag covered with aluminium foil for at least 2 h before measurements were made with a pressure chamber (Soil Moisture Equip. Corp, model 3000, Santa Barbara, CA, USA). Leaf water potential (Ψ_l) was measured in the same trees used for Ψ_s measurements, sampling one sunny mature leaves per plant. The water potential measurements were made according to Scholander *et al*. (1965) and following the recommendations of Turner (1988).

The gas exchange parameters (net photosynthesis, P_n, and stomatal conductance, g_s) were measured at solar midday, in a similar number and type of leaves, and in the same days and trees respectively, as for leaf water potential readings, using a field-portable photosynthesis system (LI-6400, Li-Cor, Lincoln, NE, USA).

Fruit growth was measured perpendicular to the fruit suture on 200 fruits in each treatment (50 fruits per experimental plot). Each sampling was carried out every 7-10 d from a fruit diameter minimum of 1 cm and sampling randomly 10 fruits in the canopy of 5 trees per experimental plot using digital callipers.

At harvest, 200 fruits in each treatment (50 fruits per experimental plot) were selected for their quality assessment. Skin and flesh colour, firmness, tritable acidity (TA), pH, and soluble solids content (SSC) were evaluated as quality indices. Colour values, on the surface (ground skin colour) and after peeling in the flesh, were measured with a Minolta chromameter (CR-300, Minolta, Ramsey, NJ) tristimulus colour analyzer calibrated with a white porcelain reference plate. The colour space coordinates L^*, a^*, and b^*, hue angle [H° = arctg

(a^*/ b^*)], and chroma (a^{*2}/ b^{*2})$^{1/2}$ were determined around the equatorial region in three different positions (with an average of nine times for each apricot). Fruit firmness was evaluated by compression test using a Lloyd instrument (model LR10K, Fareham Hants, UK) equipped with two flat plates (12 × 18 cm^2). The maximum force required to deform the fruit 5 mm at a speed of 25 mm min^{-1} was determined. TA was measured by titration of 5 mL of juice with 0.1 mol L^{-1} NaOH to pH 8.1 by an automatic titration system (AOAC, 1984). The pH values were measured using a pH-meter, and SSC was determined with an Atago N1 hand-held refractometer (Tokyo, Japan).

Statistical design and analysis

Statistical analysis was performed by weighted analysis of variance (ANOVA) using general linear model of SPSS software (version 17.0, SPSS Inc., Chicago).

Results

During the experimental period, the average values of volumetric soil water content (θ_v) from 0 to 1 m depth in C treatment was nearly constant, with values always close to field capacity (95.8% of θ_v value at field capacity) (Fig. 2a). RDI treatment presented different θ_v values (82.5% of θ_v value at field capacity) between day of year (DOY) 64 and 152 and between DOY 240 and 290, both being lower than those of C treatment (Fig. 2b). The soil moisture profile in RDI treatment was characterized by the fact that during the water deficit periods, the θ_v values beyond 600 mm were clearly below field capacity, indicating the non existence of drainage (data not shown). The amount of water applied was 574.0 mm and 352.4 mm in C and RDI treatments, respectively. The water saved in RDI treatment was 28.5% and 50% during the fruit development and late postharvest period, respectively (Fig. 2c).

Fruit growth, measured as fruit diameter, followed a double-sigmoid pattern (Fig. 3a). Fruits exposed to RDI had a lower but non-significant fruit diameter at the end of stage II of fruit development. When irrigation was restored in the RDI treatment, fruits of this treatment rapidly reached similar diameter values to those obtained in the C treatment due to a significant increase in the fruit growth rate (Fig. 3b). At harvest the fruit equatorial diameter was similar in both treatments and around 45 mm (Fig. 3a).

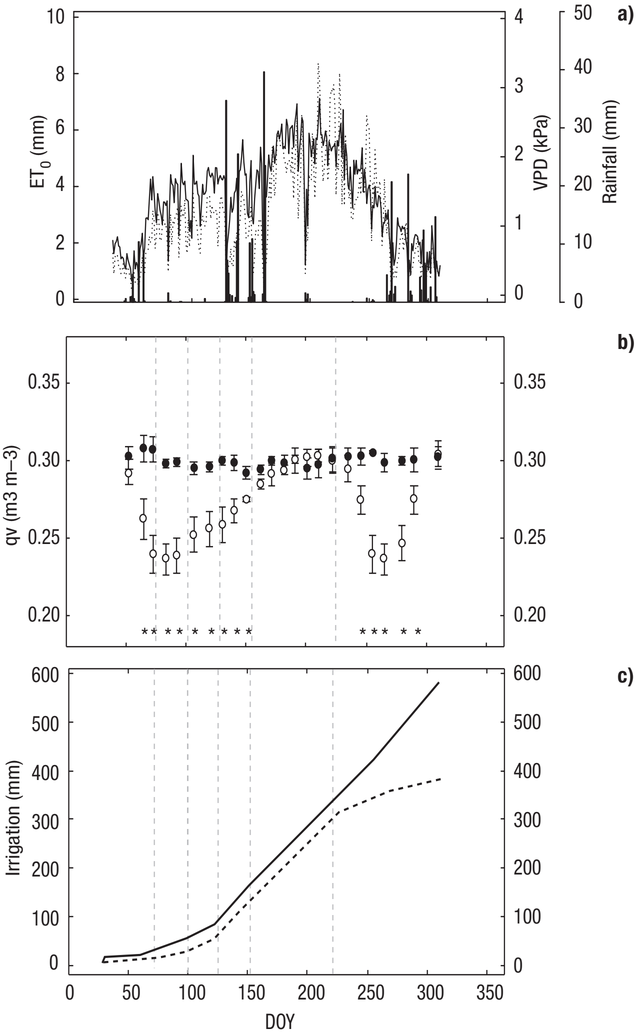

Figure 2. (a) Daily crop reference evapotranspiration (ET_0, mm) (solid line), mean air vapour pressure deficit (VPD, kPa) (dotted line) and rainfall (mm) (vertical bars); (b) soil volumetric water content (θ_v) to a depth of 1 m in the control (●) and RDI (○) irrigation treatments; (c) cumulative irrigation water applied (mm) in the control (solid line), and RDI (discontinuous line) plants along the season (DOY-day of year). The interval between vertical dotted lines from left to right represent the beginning of phases I, II and III of fruit growth, early- and late postharvest. Each value of θ_v is the mean of four measurements ± SE. Asterisks indicate statistically significant differences between treatments ($p < 0.001$).

The RDI treatment induced statically significant reductions in Ψ_s in all the stages during which the water deficit was imposed (Table 1). During the fruit development the values of Ψ_s were nearly constant in C treatment and were about –0.65 MPa. The reduction of

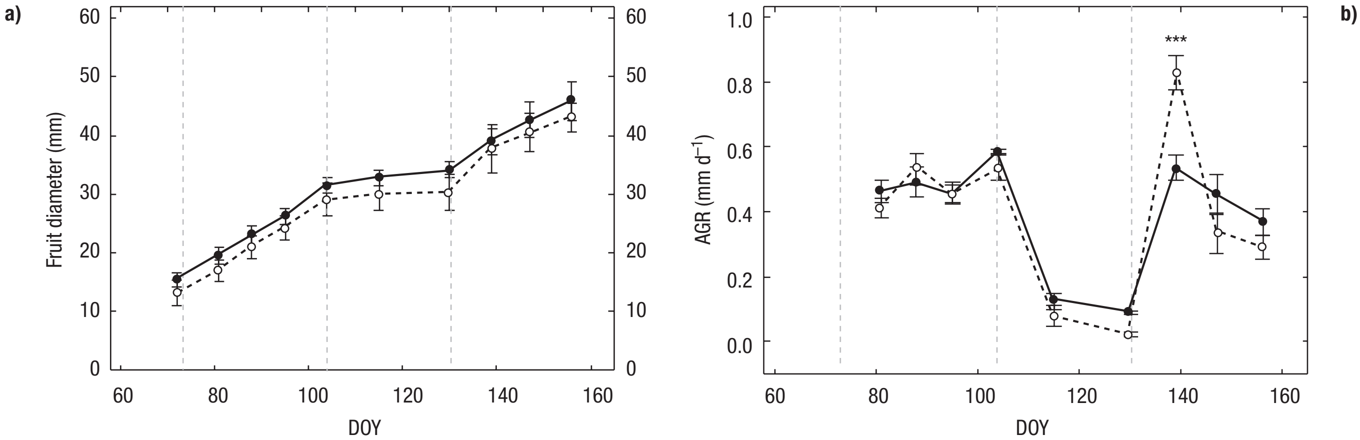

Figure 3. (a) Fruit diameter (mm) and (b) absolute fruit growth rate (AGR, mm d^{-1}) evolution in the C (solid line, ●) and RDI (discontinuous line, ○) irrigation treatments during the fruit growth period (DOY-day of year). The interval between vertical dotted lines from left to right represent the beginning of phases I, II and III of fruit growth. Each value is the mean of 200 measurements ± SE. Asterisks indicate statistically significant differences between treatments ($p < 0.001$).

Ψ_s in RDI treatment during this period was significant and about 47% respect to C plants at the end of stage II of fruit development (–0.94 MPa). During postharvest period, Ψ_s values in C plants were lower due to increased evaporative demand, reaching an average of –0.91 MPa and –1.24 MPa during early and late postharvest periods, respectively. The decrease of Ψ_s in RDI was significant and about of 26% and 18% compared to C plants during the first and second period of late postharvest respectively (–1.55 and –1.81 MPa, respectively). However, RDI treatment induced statically significant reductions in Ψ_l only during the second period of late postharvest when the water deficit was more important (25% ETc). As in the case of Ψ_s values, Ψ_l showed a decreasing tendency as vapour pressure deficit (VPD) increased in both treatments (Fig. 2a). The average values of Ψ_l for both treatments were about –1.36 MPa, –1.65 and –2.11 MPa during fruit development, early- and late-postharvest periods, respectively. Similar behaviour to that observed in Ψ_l was also shown in gas exchange parameters with a significant reduction in P_n and g_s values only being ob-

Table 1. Average values of stem (Ψ_s, MPa) and leaf (Ψ_l, MPa) water potential, net photosynthesis (P_n, µmol m^{-2} s^{-1}) and stomatal conductance (g_s, mmol m^{-2} s^{-1}) in each phenological period in the control (C) and regulated deficit irrigation (RDI) treatments

Phenological period	Ψ_s			Ψ_l			P_n			g_s		
	C		RDI	C		RDI	C		RDI	C		RDI
Stage I	–0.61	*	–0.75	–1.26	ns	–1.45	10.2	ns	8.1	144.1	ns	107.3
Stage II	–0.64	**	–0.94	–1.28	ns	–1.48	11.3	ns	9.4	167.6	ns	128.3
Stage III	–0.66	ns	–0.70	–1.36	ns	–1.52	12.3	ns	12.7	196.3	ns	193.0
Early Postharvest	–0.91	ns	–1.03	–1.65	ns	–1.66	7.6	ns	7.9	99.9	ns	78.3
Late Postharvest I	–1.23	**	–1.55	–2.11	ns	–2.12	6.2	ns	5.8	91.9	ns	72.1
Late Postharvest II	–1.25	***	–1.81	–1.98	*	–2.34	6.0	***	1.1	76.6	***	22.2

Values are the mean of 24 measurements. ns: non-significant. * $p < 0.05$. ** $p < 0.01$. *** $p < 0.001$.

Table 2. Skin and flesh fruit colour values (reflectance measurements *L**, *H*º, *C**) at harvest in the control (C) and regulated deficit irrigation (RDI) treatments

Treatment	*L**		*H*º		*C**	
	Skin	Flesh	Skin	Flesh	Skin	Flesh
C	67.1	62.6	78.8	78.6	48.1	44.7
RDI	69.2	63.9	85.3	82.9	50.6	46.6
	ns	ns	**	**	**	*

*L**: lightness factor. *H*º: Hue value. *C**: colour intensity (chroma). Values are the mean of 200 measurements. ns: non-significant. * $p < 0.05$. ** $p < 0.01$.

served at the end of the second period of late postharvest. The decrease in P_n and g_s was 82 and 72%, respectively during this second period of late postharvest RDI treatment. C plants had average values of 11.3 and 167.6 in P_n and g_s during fruit development, respectively. These values were decreased nearly by half in the postharvest period (Table 1).

The yield and fruit number per tree were similar between treatments (156.7 and 153.5 kg tree^{-1} and 2,906.7 and 3,038.4 fruits per tree^{-1} for C and RDI treatments, respectively). Irrigation treatment affected to the main quality indices of apricot fruits. The analysis of the colour values showed that the lightness factor, *L**, was similar in both treatments although slightly higher in the RDI treatment. The hue angle (*H*º) in skin and flesh was significant higher in the fruits of RDI treatment. Similar behaviour observed in *H*º was shown in the chroma (*C**), and the fruits from the RDI treatment showed significant higher values in skin and flesh than those obtained in C treatment (Table 2). Fruit firmness significantly decreased (30%) in fruits from the RDI treatment, while SSC values were increased (9%) significantly in this treatment with respect to C treatment. However, there were no statistically significant differences between treatments as regards pH and TA (Table 3).

Table 3. Fruit firmness (N), pH, soluble solid content (SSC,%), tritratable acidity (TA, g 100 mL^{-1}) and SSC/TA ratio at harvest in the control (C) and regulated deficit irrigation (RDI) treatments

Treatment	Firmness	pH	SSC	TA	SSC/TA
C	52.9	3.71	9.47	1.19	7.96
RDI	36.5	3.75	10.28	1.14	9.02
	**	ns	*	ns	*

Values are the mean of 200 measurements. ns: non-significant. * $p < 0.05$. ** $p < 0.01$.

Discussion

The amount of water applied in the C treatment maintained high values of θ_v nearest to field capacity (Fig. 2b). Similar values of θ_v were measured in the RDI treatment during periods of full irrigation, being in both treatments the drainage low (lower than 10%) (data not shown) indicating that a suitable irrigation scheduling in C treatment was applied (Abrisqueta *et al*., 2001). During the phenological periods of water deficit in the RDI treatment, θ_v decreased significantly, reaching values which provoke significant stress conditions in apricot trees (Ruiz-Sánchez *et al.,* 2000). The annual water saving achieved in RDI treatment was 39% (Fig. 2c). This amount of water is similar to that obtained from RDI strategies during the two initial years by Pérez-Pastor *et al*. (2009). Although these authors observed significant reductions in plant production for both years, in our case the yield and fruit number per tree were similar between treatments. This aspect can be explained by the highest water reductions designed by Pérez-Pastor *et al*. (2009) during the fruit development in the initial two years (75% until the end of stage II) in contrast with our experimental conditions (50%) based on the last two years designed by those authors (Fig. 1).

The water saving during fruit development did not affect fruit growth in RDI treatment, since fruits from this treatment had a slightly lower but non-significant fruit diameter at the end of stage II of fruit development (Fig. 3a). When irrigation was restored in the RDI treatment, a compensatory fruit growth was observed (Fig. 3b) which allowed the fruit to reach a similar diameter to fruits from the C treatment (Chalmers *et al.,* 1986) and at harvest apricot fruits were of «extra» size in both treatments (> 40 mm in diameter). This can be explained by the fact that fruit acts as strong sinks of photosynthates. These reserves are available when irrigation is restored, promoting higher fruit growth rates (Cohen and Goell, 1984; Mills *et al*., 1996; Torrecillas *et al*., 2000). This behaviour has been observed in other fruit trees such as lemon (Cohen and Goel, 1984), peach (Mitchell and Chalmers, 1982) and pear (Caspari *et al*., 1994). This compensatory fruit growth during a recovery period of water deficit and the relative separation between shoot and fruit growth periods in apricot plants (Torrecillas *et al*., 2000) is essential for the successful application of RDI strategies (Goldhamer, 1989), which indicates that deficit irrigation may be applied to limit shoot growth without detrimental effects on fruit growth and yield (Chalmers *et al*., 1981; Mitchell and Chalmers, 1982).

Plant water status (Ψ_s and Ψ_l) and gas exchange parameters (P_n and g_s) were affected by the RDI treatment, but not all these discontinuous water stress indicators performed in the same way. Thus, only Ψ_s reflected well the effects on plant water status of the different water restrictions even under mild levels of water deficit associated at low VPD (stage I of fruit growth) (Table 1 and Fig. 2a). For this reason, the use of Ψ_s has been adopted because of its high sensitivity to water deprivation (McCutchan and Shackel, 1992; Naor *et al*., 1995; Remorini and Massai, 2003) and its good prediction of the yield response to deficit irrigation (Naor, 2000; Intrigliolo and Castel, 2006). The remaining water stress indicators (Ψ_l, P_n and g_s) depend more on the meteorological conditions (Ruiz-Sánchez *et al*., 2004) and in our case only presented significant differences when the water reductions in RDI treatment were very high with respect to the C treatment (25% ETc).

The water deficit imposed also affected fruit quality indices. Significant differences in fruit skin and flesh colour were found. Fruits from RDI treatment showed higher values of hue angle (H^o) and chroma (C^*) (Table 2). The H^o has been described as a suitable and intuitively understandable colour index (Arias *et al*., 2000). The increase in this parameter in apricot fruits from RDI plants can be associated to a reduction in carotenoids accumulation attributed to the oxidation by exposure to light (Ruiz *et al*., 2005). This exposure to light in the fruits from RDI treatment is related to a significant reduction in the vegetative growth of the trees during fruit development (data not shown), implying a high exposure to light of fruits. Similar behaviour was observed in peach fruits under RDI (Gelly *et al*., 2003; Buendía *et al*., 2008).

One of the benefits of RDI is an improvement in fruit taste and quality (Li *et al*., 1989; Mills *et al*., 1996; Mpelasoka *et al*., 2000). Soluble solids content (SSC) and titratable acidity (TA) warrant particular attention due to their importance in fruit taste (Crisosto *et al*., 1994). In our case, SSC values were increased significantly in RDI treatment whereas TA was equal in both treatments, and therefore the SSC/TA ratio was increased significantly in RDI treatment (Table 3). This ratio affects the perception of taste (sweetness and acidity) by the consumer, thereby influencing decisions to buy again or not (Crisosto *et al*., 1997; Scandella *et al*., 1997). Thus, fruits from RDI treatment can be considered of high quality since SSC increased nearly 1º without affecting acidity (Scandella *et al*., 1997).

In conclusion, the results indicated that the apricot tree is an appropriate species to apply RDI thanks to the clear separation between their vegetative and reproductive growths and its ability to recover the fruit diameter reduction suffered during RDI application. Furthermore, some qualitative characteristics such as the level of soluble solids, fruit taste and the colour of the fruit are enhanced. These two reasons, together with irrigation water savings of 39%, emphasize the RDI strategies as a possible solution in areas with water shortage, like the south-eastern region of Spain.

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