Relationship between Leaf Water Potential and Gas Exchange Activity at Different Phenological Stages and Fruit Loads in Peach Trees

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ABSTRACT. Relationships between midday (Ψ_{md}) and predawn (Ψ_{pd}) leaf water potential, stomatal conductance (g_s), and net CO_2 assimilation rate (A) were determined at different fruit growth stages and for 2 years with different fruit loads in a 'Sudanell' peach [*Prunus persica* (L.) Batsch] plot subjected to two regulated deficit irrigation (RDI) strategies plus a control irrigation treatment. A postharvest RDI (PRDI) treatment was irrigated at 0.35 of the control after harvest. The second treatment (SPRDI) applied RDI during Stage II, the lag phase of the fruit growth curve, at 0.5 of the control and postharvest at 0.35 of the control. The control treatment and the PRDI and SPRDI when not receiving RDI were irrigated at 100% of a modified Penman crop water use calculation (ET_c) in 1994, a full crop year, and 80% in 1995, a year of nearly zero crop. In 1995, with 80% of the 1994 irrigation rate and no crop, the Ψ_{md} was higher, probably because of the lower crop load, while Ψ_{pd} was lower, probably because less water was applied to the soil. The relationship of g_s and A with Ψ_{md} during Stage II was steeper than during postharvest. Low Ψ_{md} was not indicative of a depression in g_s and A in Stage III. Osmotic leaf water potential at turgor loss (Ψ_{π}^0) as derived from pressure-volume curves was more negative during Stage III and postharvest (about -2.9 MPa) than in Stage II (about -2.7 MPa). The Ψ_{md} measurements together with Ψ_{π}^0 determinations seemed to be more useful to characterize peach tree water status than Ψ_{pd} under soil water deficits because of their better relationship to midday stomatal closure.

Regulated deficit irrigation (RDI) was originally applied to control excessive vegetative growth by reducing irrigation during Stage II of fruit growth (Chalmers et al., 1981). Subsequently, RDI experiments have focused on saving water during pre- and postharvest periods (Boland et al., 1993; Girona et al., 1993; Johnson et al., 1992). If RDI is to be successful, reliable monitoring of plant water status during the deficit irrigation period is needed. The measurement technique should be an inexpensive and simple indicator of plant water status.

Environmental changes are sensed primarily by leaves (Dickson and Isebrands, 1991), and leaf water potential has been the most commonly used plant water status indicator (Jones, 1990). Particular potentials are usually associated with specific degrees of water stress (Bradford and Hsiao, 1982). Nevertheless, use of leaf water potential (Ψ) has been questioned during the last decade because stomatal closure can moderate Ψ decreases as water stress develops, diminishing the differences between watered and unwatered plants (Garnier and Berger, 1985). Parameters such as leaf conductance (Davies and Zhang, 1991) and stem water potential (Garnier and Berger, 1985; McCutchan and Shackel, 1992) have been proposed as more useful indicators of plant water stress. Despite the above limitations, Ψ is probably the most commonly used plant-based technique for assessing the influence of irrigation treatments on tree water status. With respect to irrigation monitoring, the use of stomatal conductance is limited due to diurnal

atmospheric influences (Schulze and Hall, 1982; Tan and Buttery, 1986), feedback photosynthetic responses (Schulze, 1986), and large sampling errors (Jones and Cumming, 1974; cited by Jones 1990). Although plant water stress and its subsequent influence on vegetative growth and gas exchange activity is the cumulative result of plant, atmospheric, and soil water factors, only the latter are usually contemplated for practical irrigation management. Plant water stress, as it affects photosynthetic and growth processes, varies widely at a constant soil moisture level as is evident from its diurnal cycle. Therefore, a measure of plant water status during the day, when stress develops, is needed to manage water applications during RDI.

The aim of this work is to study the implications of specific values of Ψ in peach trees in relation to leaf gas exchange data. This objective is outlined in the following points: What are the influences of water stress on the relationship between leaf water status at midday and gas exchange activity and how can this relationship change with different developmental conditions? How is this relationship modified by the presence or absence of fruit? and under which conditions can Ψ measured at midday be a sensitive indicator of plant water stress?

Material and Methods

EXPERIMENTAL ORCHARD. The experiment was conducted during 1994 and 1995 in a 0.7-ha peach plot located in a commercial orchard in Lleida, Spain (41.38 N, 0.35 E). The soil is Typic Xerothent, 50 cm loam soil profile. The average annual rainfall was 277 mm with no precipitation during the growth period. In 1994 there was almost no precipitation during the entire spring and summer. Maximum summer temperatures are about 35 °C and midday relative humidities are about 30%. The trees were heavily cropped in 1994 with a fresh fruit mass yield efficiency (FFMYE) on a trunk cross-sectional area (TCSA) basis of 0.9 kg·cm⁻². In 1995, an April freeze eliminated most of the crop (FFMYE = 0.036 kg·cm⁻²).

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Table 1. Applied irrigation as percentage of evapotranspiration (ET_c) during 1994 and 1995 for each stage of fruit development and irrigation treatment.

Year	Treatment	Percent			
		Stage I	Stage II	Stage III	Postharvest
1994	Control	100	100	100	100
	SPRDI ²	100	50	100	35
	PRDI ³	100	100	100	35
1995	Control	80	80	80	80
	SPRDI	80	40	80	28
	PRDI	80	80	80	28

²SPRDI = Stage II and postharvest regulated deficit irrigation treatment.

³PRDI = postharvest regulated deficit irrigation treatment.

EXPERIMENTAL DESIGN. A total of 352 five-year old trees on peach seedling rootstock and 'Sudanel' scion (medium-late maturing peach) was used. Tree spacing was 5×3 m and the trees were pruned to a vase system. The plot was oriented North-South. A randomized complete-block design with four blocks was originally established, but, due to a different soil characteristics in one of the blocks, all the sampling effort was concentrated in the remaining three complete blocks. Each block consisted of three adjacent tree rows with ten trees in each row. The center two trees of the middle row were used for physiological measurements, whereas the center eight of the middle row were used to measure vegetative and production parameters. Four leaves (two per tree) were measured in each replication-block for gas exchange and Ψ .

An automated drip irrigation system with four compensating emitters ($4 \text{ L} \cdot \text{h}^{-1}$) per tree was used with water meters in each replication to monitor applied irrigation water. Surface soil wetted was about 35% of the shaded area. The plot was managed using commercial practices with a mowed cover crop strip between rows. The trees were thinned in late May to a commercially acceptable level (430 fruit/tree). Fruit was harvested three times between 3 to 15 Aug.

TREATMENTS. Three irrigation treatments discussed in this manuscript include a control and two RDI regimes: a postharvest RDI (PRDI) treatment and a second treatment (SPRDI), which applied RDI during Stage II, the lag phase of the fruit growth curve. The control treatment was fully irrigated using crop evapotranspiration (ET_c) calculated from a modified Penman-determined reference crop water use (ET_0) (Doorenbos and Pruitt, 1977), with estimated crop coefficients (K_c) adapted from Goldhamer and Snyder (1989) and modified in situ based on plant water status ($ET_c = ET_0 \times K_c$). Initial K_{c1} (rapid growth) = 0.25, K_{c2} (midseason) = 1 (with a maximum $K_{c2} = 1.05$ during rapid fruit growth), and K_{c3} (late season) = 0.55. Trees leafed out on 20 Mar., full leaf growth was completed by 15 June, harvest was finished by 15 Aug., and the end of season was on 5 Nov. Irrigation began at flowering (first week of March). During 1994, SPRDI trees were irrigated at 50% ET_c during fruit growth Stage II, PRDI and SPRDI were irrigated at 35% ET_c during postharvest (Table 1). Due to lower fruit load in 1995, the control was irrigated at 80% ET_c throughout the season. In 1995, trees of the RDI regime during Stage II of fruit growth and postharvest were irrigated at 50% and 35% of the control, respectively (Table 1).

MEASUREMENTS. Meteorological data for the Penman equation were collected at the nearest automated weather station (19 km from the study plot). This station is part of the Catalan network of weather stations (Generalitat de Catalunya, 1994).

Predawn (Ψ_{pd}) and midday (Ψ_{md}) Ψ (1200 HR) were measured weekly on four leaves per replication using the pressure chamber (model 3005; Soil Moisture Equipment Corp., Santa Barbara,

Calif.) technique (Scholander et al., 1965) as modified by Turner and Long (1980). Sampled leaves were fully mature, well exposed and dew free. Stomatal conductance to H_2O (g_s) and net CO_2 assimilation rate (A) were determined using a portable infrared gas analysis (IRGA) system (model ADC LCA-2; Analytical Development Co. Ltd., Hoddesdon, Herts, U.K.). Gas exchange calculations were made according to the equations given by von

Fig. 1. Seasonal patterns of 1994 (A) predawn leaf water potential (Ψ_{pd}) and (B) midday leaf water potential (Ψ_{md}), in peach in response to irrigation treatments. Each point represents the mean $\pm$ SE ($n = 12$). (*) Significant treatment differences when comparing the control to Stage II and postharvest regulated deficit irrigation treatment. (□) Significant treatment differences when comparing the control to postharvest regulated deficit irrigation treatment ($P < 0.05$, LSD).

Table 2. Average predawn (Ψ_{pd}) and midday (Ψ_{md}) leaf water potential in different stages of fruit growth development and irrigation treatments. Comparison between 1994 and 1995.

Parameter (MPa)	Stage	Treatment	Year		LSD
			1994	1995	
Ψ_{pd}	Stage II	Control	-0.36	-0.29	NS
		SPRDI ²	-0.56	-0.87	0.095
	Stage III	Control	-0.42	-0.51	0.002
		SPRDI	-0.36	-0.58	0.001
Ψ_{md}	Stage II	Control	-1.48	-1.35	0.035
		SPRDI	-2.18	-1.75	0.007
	Stage III	Control	-1.80	-1.61	0.001
		SPRDI	-1.72	-1.62	0.025

²SPRDI = Stage II and postharvest regulated deficit irrigation treatment.

Caemmerer and Farquhar (1981). Measurements were taken weekly at midday (four leaves per replication per treatment) using different leaves for gas exchange and Ψ . During 1995, the same leaf was used to measure gas exchange and Ψ_{md} . Sample frequency was lower in 1995 with two sampled days during Stage II and four during Stage III. All readings were taken on sunny days.

PRESSURE-VOLUME CURVES. Leaves were sampled at 0600 HR with the same criteria as described for gas exchange measurements. The cut end of the petioles were immediately placed under water (4 °C) and allowed to rehydrate for 24 h in darkness. Pressure-release curves were generated using the free transpiration dehydration method (Hinckley et al., 1980) and by means of a pressure chamber using a transformation type II (Tyree and Richter, 1981). Each curve was developed using data from 6 to 12 leaves as per Augé (1991). Pressure in the chamber was increased at a rate not higher than 0.02 MPa·s⁻¹ (Kikuta et al., 1985). Pressure-volume curves were corrected for oversaturation by calculating the turgid fresh mass from the linear regression between sample fresh mass and leaf water potential at points clearly above that of turgor loss (Kubiske and Abrams, 1990). Points with Ψ_l higher than -0.08 MPa were excluded from this regression. The turgor loss point was determined by graphical analysis with the aid of a sequentially fitted regression that maximized the linear correlation coefficient. The parameters obtained from each curve were Osmotic water potential at full turgor (Ψ_{π}^{100}), osmotic water potential at the turgor loss point (Ψ_{π}^0), and average cell wall elasticity (ϵ_m) estimated as the slope of the regression line for turgor potential vs. relative water content (Warren Wilson, 1967).

Results

In 1994, Ψ_{pd} and Ψ_{md} in SPRDI declined progressively during Stage II and postharvest. In PRDI, Ψ_{pd} diminished only during postharvest (Fig. 1 A and B). The lowest values occurred at the end of both periods. During Stage III, Ψ_{pd} was generally invariant with time but Ψ_{md} mostly declined (Fig. 1 A and B). In 1995, Ψ_{pd} for the control treatment was significantly lower than in 1994 during Stage III, probably due to less applied water in 1995 (Table 2). Average atmospheric conditions for the sampled days did not differ substantially between years, air temperature in 1994 and 1995 was 33.4 ± 0.48 and 32.9 ± 1.45 (°C ± SE), respectively, and air vapor-pressure deficit in 1994 and 1995 was 3.14 ± 0.10 and 3.04 ± 0.11 (kPa ± SE), respectively. For SPRDI, differences in Ψ_{pd} relative to the control were greater at the end of Stage II than during Stage III (Table 2). The Ψ_{md} values were significantly more negative in 1994 than in 1995 during Stage III and Stage II for all treatments (Table 2). The relationship between Ψ_{pd} and Ψ_{md} for each RDI regime was curvilinear (Fig. 2). However, their shape

changed in the different periods of time. Nonetheless, the relation between Ψ_{pd} and Ψ_{md} was clear and significant.

Seasonal patterns of midday A and g_s were similar to Ψ_{md} , with decreases in A and g_s during the deficit irrigation periods. These decreases were greater during postharvest than in Stage II (Fig. 3 A and B). However, A and g_s were unchanged at the end of Stage III even though Ψ_{md} was significantly lower at this time than in the rest of Stage III (Fig. 3 A and B). There was a clear distinction between Ψ_{md} influence on A and g_s in the different phenological Stages during 1994 (Fig. 4). The A values decreased with Ψ_{md} during Stage II and postharvest, whereas there was no clear relationship during Stage III (Fig. 4 A and B). The postharvest A vs. Ψ_{md} relationship showed a clear plateau, but, below Ψ_{md} of -2.2 to -2.4 MPa, A values declined until they approached zero (Fig. 4C). The g_s vs. Ψ_{md} relationships were similar to those of A vs. Ψ_{md} except during Stage II deficit irrigation where g_s declined more rapidly with Ψ_{md} than A (Fig. 4 D-F). During Stages II and III of 1995, the A vs. Ψ_{md} and g_s vs. Ψ_{md} relationships were similar to 1994, but A showed lower rates throughout the Ψ_{md} range of values. In 1995, g_s response was similar during Stage II and had lower values during Stage III (Fig. 4 A, B, D, and E).

From Stage II to Stage III, Ψ_{π}^{100} and Ψ_{π}^0 decreased and followed constant values during postharvest (Fig. 5 A and B). There were no consistent differences in Ψ_{π}^{100} between irrigation treatments. In

Fig. 2. Relationship between predawn (Ψ_{pd}) and midday (Ψ_{md}) leaf water potential for a single controlled day in different stages: Stage II-94 = day 164; Stage II-95 = day 170; postharvest-94 = day 250. Each point is the mean of four leaves per replication per treatment.

Fig. 3. Seasonal patterns of 1994 (A) midday net CO₂ assimilation rate; (B) midday stomatal conductance, in peach in response to irrigation treatments. Each point represents the mean $\pm$ SE ($n = 12$). (*)Significant treatment differences when comparing the control to Stage II and postharvest regulated deficit irrigation treatment. (□)Significant treatment differences when comparing the control to postharvest regulated deficit irrigation treatment ($P < 0.05$, LSD).

contrast, Ψ_{π}^0 averaged -2.7 MPa at the end of Stage II, Stage III and postharvest values were 0.2 MPa lower (Fig. 5A). The e_m values tended to be lower from spring to postharvest and were not influenced by the irrigation regime (Fig. 5C).

Discussion

These data support the observation that Ψ_{pd} is a sensitive indicator of soil water stress in peach orchards (Girona et al., 1993; Olien and Flore, 1990). Comparisons of Ψ_{pd} to Ψ_{md} during Stage II for irrigation treatment effects indicated that both became significant at the same time after the initial water deprivation (Fig. 1 A and B) but, in the postharvest period, Ψ_{pd} became significant sooner, whereas Ψ_{md} did not reflect differences between irrigation treatments after 2 weeks for SPRDI and 1 week for PRDI (Fig. 1 A and B). Therefore, Ψ_{pd} was more sensitive to irrigation treatments during postharvest. Perhaps the stress preconditioning in the SPRDI treatment during Stage II was the cause of this 2-week delay in water stress development during postharvest. A similar delay in SPRDI compared to PRDI can be observed for g_s and A (Fig. 3 A and B). Comparing experimental years, Ψ_{pd} responded to

the 20% reduction in applied water for the control and SPRDI treatments during 1995 Stage III (Table 2).

During Stage II, Ψ_{md} was well correlated with Ψ_{pd} (Fig. 2). Nevertheless, the last day of stage III (day 214) coincided with a general drop in Ψ_{md} , while Ψ_{pd} values for the same day remained constant (Fig. 1 A and B). This occurred even though evaporative demand for day 214 was similar to conditions exhibited on other days of measurement during Stage III (Fig. 6). 'Sudanel' peaches have an extraordinarily high fruit growth rate at the final end of Stage III, doubling in fruit fresh mass in the last 2 weeks of expansive growth. This contrasts with other late maturing cultivars such as 'Cal Red' in which fresh mass increased by only 40% in the last 2 weeks of Stage III (Girona, 1994). Since fruit sink strength can be related to relative fruit growth rate (Grossman and DeJong, 1994), this suggests that the late Stage III drop in Ψ_{md} could be due to a high fruit sink demand. Chalmers et al. (1983) reported substantial effects of rapid fruit growth on Ψ and g_s , and Ziska et al. (1989) found important increases in g_s during Stage III of fruit growth in *Prunus salicina* L. In peach, DeJong (1986b) found that the presence of fruit in the last stage of fruit growth induced a 15% higher A rate and that this increase was related to an increase in g_s . Thus, during the short period of high reproductive sink strength, A, in our study, could be maintained by decreased sensitivity of g_s to leaf water status. In fact, g_s values in the Ψ_{md} range of -2.2 to -2.5 MPa were 63% higher during Stage III than in Stage II (Table 3). For the same Ψ_{md} range, A was 32% greater during Stage III than Stage II (Table 3).

Moreover, Ψ_{md} failed to indicate the higher irrigation applied in 1994 for the control (Table 2). In contrast, more negative values were found during this high fruit load year, suggesting that fruit reduces Ψ_{md} values (Blanco et al., 1995; Chalmers et al., 1983; DeJong, 1986a) (Table 2). Atmospheric-related effects on Ψ_{md} differences between both years are unlikely since average temperature and atmospheric vapor-pressure deficit during Stage III were similar between years (Fig. 6).

The lack of A limitation related to Ψ_{md} decrease in Stage III was presumably due to decreases in Ψ_{md} being related to the fruit sink effect rather than soil water deprivation. At postharvest, when there were no fruit and reductions in water were again imposed, A was affected by decreases in Ψ_{md} (Fig. 4C). The Ψ_{md} influences exhibited in 1994 during Stage III were surprisingly repeated again in 1995 with minimal fruit load (Fig. 4B). This suggests that lack of a relationship between A and Ψ_{md} in Stage III is perhaps not entirely due to a fruit sink effect, but to the absence of root signals when the source of water stress is related to soil drying. There is increasing evidence of direct stomatal responses to xylem concentrations of abscisic acid (ABA), which is independent of Ψ_1 until a specific Ψ_1 level is achieved (Davies and Zhang, 1991; Tardieu et al., 1996), even though there are no reports that show this for peach. The relationship between g_s and Ψ_{md} followed similar patterns to A vs. Ψ_{md} : high sensitivity of g_s to Ψ_{md} during Stage II, lower sensitivity during postharvest, and insensitivity during Stage III (Fig. 4 D–F). Thus, Ψ_{md} would influence g_s only if water stress was due to soil water deprivation. Lack of root signals in experiments with detached leaves could also explain stomatal responses to Ψ_1 only when near the turgor loss point (Andersen and Brodbeck, 1988; Yoon and Richter, 1990). Decreases in g_s during Stage II were already evident at Ψ_{md} values of -1.5 MPa, which is clearly above the turgor loss point during this stage ($\Psi_{\pi}^0 = -2.7$ MPa) (Figs. 4D and 5A).

In contrast to Stage II, postharvest g_s and A decreases related to Ψ_{md} were only apparent at values of Ψ_{md} lower than -2.2 MPa. This indicates a lower g_s and A sensitivity to Ψ_1 in postharvest than in

Fig. 4. Relationships between midday net CO₂ assimilation rate vs. midday leaf water potential (A/Ψ_{md}) in Stage II (A), Stage III (B), postharvest (C), and stomatal conductance vs. midday leaf water potential (g_s/Ψ_{md}) in Stage II (D), Stage III (E), and postharvest (F) in 2 years; (●) 1995, (○) 1994. All points in each stage and year were collected on 1 d (last day of each stage) with tree-to-tree differences giving the range of values on that day. (Stage II-1994 = day 164; Stage II-1995 = day 170; Stage III-94 = day 215; Stage III-1995 = day 214; postharvest-1994 = day 235).

Stage II. The maximum A (A_{max}) values during postharvest were clearly lower than in Stage II (Fig. 4 A and C). This could be related to a leaf age effect (Andersen and Brodbeck, 1988) but, perhaps more likely the cause is a photosynthetic limitation resulting from high air temperatures during that period. Tan and Buttery (1986) reported 26 °C as an optimum temperature at photosynthetically active radiation (PAR) levels of 444 $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$. Girona et al. (1993), reported a sharp decrease in A between leaf temperatures of 32 and 36 °C. Average midday air temperatures during July and August were 34.8 and 35.1 °C, respectively, compared to 25.5 °C in May.

Stomatal action could also be evaluated by analyzing the Ψ_{pd}/Ψ_{md} relationship. Under high Ψ_{pd} values the relationship between both parameters is somewhat linear, but a curved part appears

below certain more negative values in Ψ_{pd} (Fig. 2). The reason for the curvature initiation is due in part to progressive stomatal closure, thereby limiting the rhythm of Ψ_{md} decreases with Ψ_{pd} decline. Interestingly, this curvature began at more negative values in Ψ_{md} during postharvest than Stage II, and even at higher levels during Stage II in 1995 with minimal fruit load (Fig. 2). This indicates higher control of water loss during Stage II than postharvest, which seems consistent with the different phenological sensitivity of g_s to Ψ_{md} (higher during Stage II and lower during postharvest), as mentioned before.

Differential leaf gas exchange sensitivity to Ψ_{md} between stages may be due in part to the influence of the different environmental factors (VPD, temperature, PAR) between Stage II and postharvest. Leaf ontogeny between Stage II and postharvest may also have been different. In fact, Ψ_{π}^0 , Ψ_{π}^{100} and ϵ_m were lower during postharvest and Stage III than in Stage II (Fig. 5 A-C). This resulted in a decreased sensitivity of leaf turgor pressure (Ψ_p) to Ψ_{md} (Ψ_p was derived from pressure-volume curves) (Fig. 7). When a linear model was applied to the Ψ_p vs. Ψ_{md} relationship, the slope in

Stage II ($\Psi_p = 1.86 - 0.716 \times \Psi_{md}$) was significantly steeper than the slope during postharvest ($\Psi_p = 1.74 - 0.596 \Psi_{md}$). This decrease in turgor sensitivity corresponded to lower stomatal response to Ψ_{md} at near turgor loss levels during postharvest. Turgor loss from water release curves during postharvest occurred at about -3.0 MPa, which approached the field Ψ_{md} levels -2.9 MPa (Fig. 4F) associated with proximal stomatal closure (g_s approaches 0). Stressed treatments at this time exhibited a general leaf wilting and, for the more interior leaves of the tree, leaf yellowing and shedding. During Stage II there was no leaf shedding and only incipient leaf wilting was evident on the most stressed day of this stage (day 164).

Mature peach leaves exhibited no consistent effect of water stress on Ψ_{π}^{100} , which seems to confirm the lack of osmotic adjustment reported by others (Young et al., 1982; Steinberg et al. 1989).

In summary, soil water deprivation in Stage II and postharvest consistently induced decreases in Ψ_{md} during cloudless days, which were related to low g_s and A rates. However, in Stage III under full irrigation, decreases in Ψ_{md} may be more indicative of fruit sink strength. The Ψ_{md} values lower than Ψ_{π}^0 give a threshold level that should not be exceeded for a long period if depression in A rates and loss of photosynthetic surface area are to be avoided.

Fig. 5. Seasonal patterns of (A) osmotic leaf potential at turgor loss point (Ψ_{π}^0); (B) osmotic potential at full turgor (Ψ_{π}^{100}); (C) average cell wall elasticity (ϵ_m) in peach in response to irrigation treatments. (●)Control, (□)Spring and postharvest regulated deficit irrigation treatment. Each point is obtained by the contribution of six to twelve leaves. The solid line represents the best fit second degree polynomial for all points.

From this, under a deficit irrigation period of an RDI strategy in peach, Ψ_{md} together with Ψ_{π}^0 determinations seem to be more useful than Ψ_{pd} to regulate plant water stress; this could be useful in effectively correcting excessive stress when scheduling deficit irrigation. During postharvest, differences between treatments were detected in Ψ_{pd} while gas exchange differences were not apparent. During postharvest, a wider range of nonstressful conditions was exhibited based on soil water stress, leading to Ψ_{pd} overestimating drought stress. This study shows that, if moderate water stress is used to partially inhibit vegetative growth of peach trees during Stage II, reductions in leaf carbon assimilation can be expected depending on the Ψ_{md} level reached.

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Fig. 6. Mean air temperature (A) and vapor pressure deficit (B) measured for the dates and times that correspond to seasonal measurements of gas exchange and Ψ_{md} in 1994 (solid lines) and 1995 (dashed lines).

Table 3. Average stomatal conductance (g_s) and CO_2 assimilation rate (A) at a 2.2 to 2.5 (–MPa) midday leaf water potential (Ψ_{md}) range at different stages in 1994: Stage III and postharvest compared with Stage II.

Parameter	Stage II	Stage III	P	Postharvest	P
$g_{s(2.2-2.5)}$ ($\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$)	0.114	0.307	0.0001 ^z	0.170	0.0147 ^y
$A_{(2.2-2.5)}$ ($\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$)	5.58	8.00	0.0059	5.34	0.6931

^zProbability level of the LSD contrast between Stage II and Stage III.

^yProbability level of the LSD contrast between Stage II and postharvest.

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Fig. 7. Relationship between turgor leaf water potential and leaf water potential in two different stages of 1994 in peach. (■)Postharvest, (○)Stage II. Each fitted line is obtained by the contribution of two pressure-volume curves belonging to two different days of each corresponding stage.