THE SENSITIVITY OF PLANT WATER INDICATORS IN ALMOND TREES SUBMITTED TO SEVERE DEFICIT IRRIGATION

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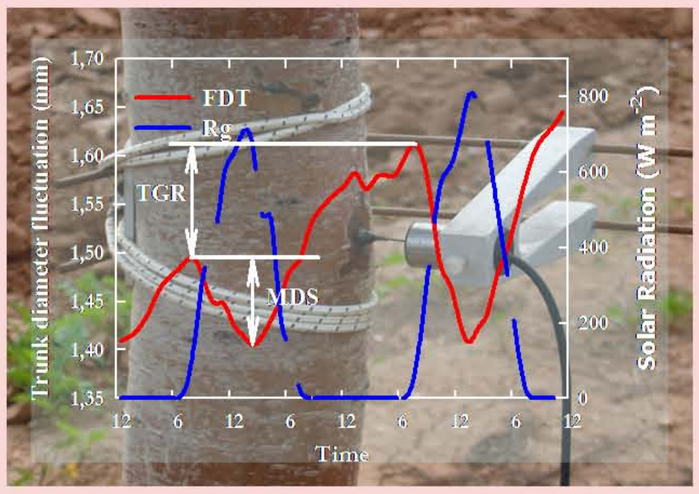
• OBJECTIVE

Compare the use of trunk diameter fluctuation measurements with discrete measurements of plant water status for detecting water stress in young almond trees exposed to a severe short term water deficit, as well as to improve the application of regulated deficit irrigation in this crop.

• MATERIAL AND METHODS

The experiment was carried out during 2003 in a 1 ha plot planted in December 1999 with 'Marta' almond trees (Prunus dulcis (Mill.) Webb) grafted on 'Mayor' rootstock. The trees were spaced 7 x 6 m apart and drip-irrigated by four pressure compensated drippers per tree, each with a flow rate of 4 L h^{-1}. The orchard is located in the province of Murcia (SE Spain), where the climate is semiarid Mediterranean.

Almond orchard. Two treatments were applied according to a randomised block statistical design, with three blocks. Trees were starved of water for 23 days, 1–23 September (T1S), while the control trees were watered daily to 120% of ETc.



Trunk diameter fluctuation (TDF) was measured with LVDTs. A single sensor per tree (six trees per treatment). The maximum daily shrinkage (MDS) was calculated as the difference in diameter between the maximum, in the morning, and the minimum, in the afternoon. Trunk growth rate (TGR) was calculated by subtracting consecutive daily maximum diameters.

Midday stem water potential (SWP) were measured several times on 12 mature leaves for each treatment (two leaves per tree on six trees per treatment), with a pressure chamber, following the recommendations of Hsiao (1990).

Leaf conductance (LC) was measured, on a similar number of leaves as SWP and sun-exposed leaves.

• RESULTS

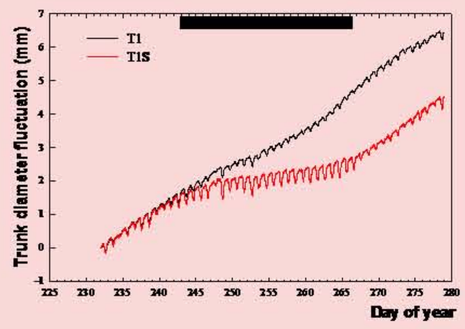


Figure 1. Trunk diameter fluctuation (mm) in almond trees for the two irrigation treatments during the experiment. The horizontal bar indicates the water stress period applied (243 – 266 day of year).

The average value for the control group during the experiment was -0.94 MPa, 280 mmol m^{-2} s^{-1}, 142 mm and 0.15 mm d^{-1} for SWP, LC, MDS and TGR, respectively (Figure 1). Whereas suppressing irrigation lead to a significant response of these indicators with values at the end of the water stress period of -2 MPa, 130 mmol m^{-2} s^{-1}, 420 mm and 0.04 mm d^{-1}.

The decrease in all indicators studied for stressed plants occurred from day 1 of the stress period (Figure 1 and 2). The relative differences between irrigation treatments (Naor and Cohen, 2003), detected these significant differences from day 4 in MDS with higher values than the others indicators (Figure 3). There are not measurements before the day 8 of stress period for SWP and LC, but our previously experience in the same crop indicates that these significant differences are reached from 3-4 day.

Relative differences between treatments (as % of the T1 treatment values) increased from the beginning of the water stress period (Figure 3). The greatest values were for MDS, reaching at the end of this period 411 %; 117.5 and 31 % for SWP, LC and TGR, respectively (Figure 4).

Three days after irrigation was restored, SWP reached similar values to those of the control treatment. LC recovery was slower than SWP (5 days) (Figure 4). MDS recovered more rapidly than LC and TGR, reaching values close to those of control plants in all the stressed treatments on day 3 of the recovery period (Figure 4).

During the recovery period the relative differences values of MDS showed a 72.8 % recovery slope, significantly higher than the other three plant indicators (24.7, 6.4 and 11 % for SWP, LC and TGR, respectively).

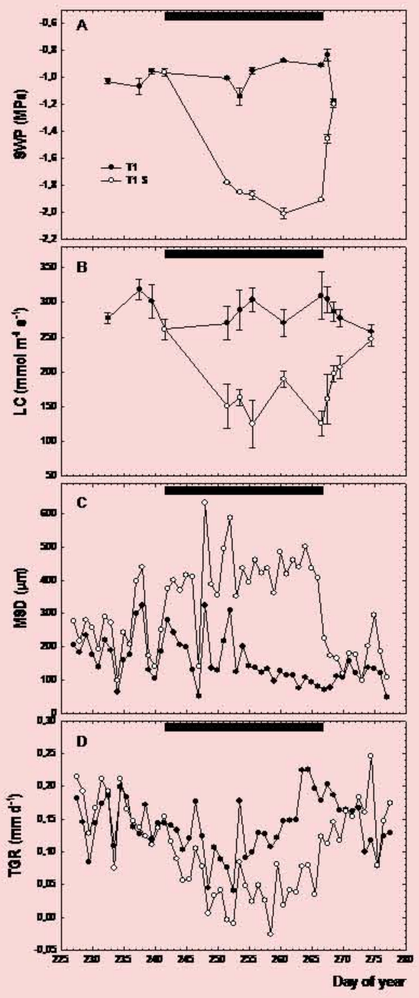


Figure 2. Mean values of stem water potential (SWP, A), leaf conductance (LC, B), maximum daily trunk shrinkage (MDS, C) and trunk growth rate (TGR, D) for the two irrigation treatments during the experiment. The horizontal bar indicates water stress period applied. Vertical bars represent S.E. of the mean.

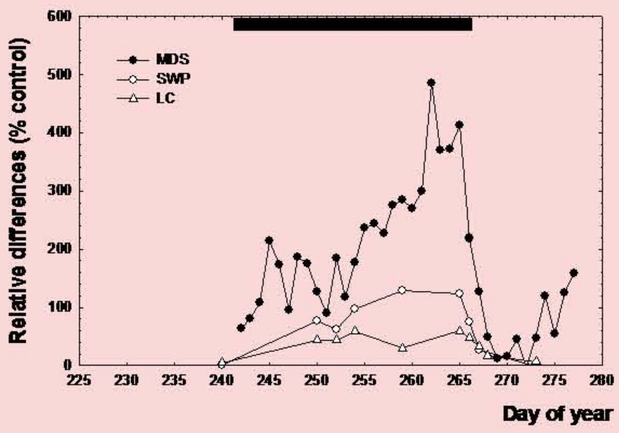


Figure 3. Relative differences between irrigation treatments (% of control group) for maximum daily shrinkage (MDS), stem water potential (SWP) and leaf conductance (LC), during the experiment. The horizontal bar indicates water stress period applied.

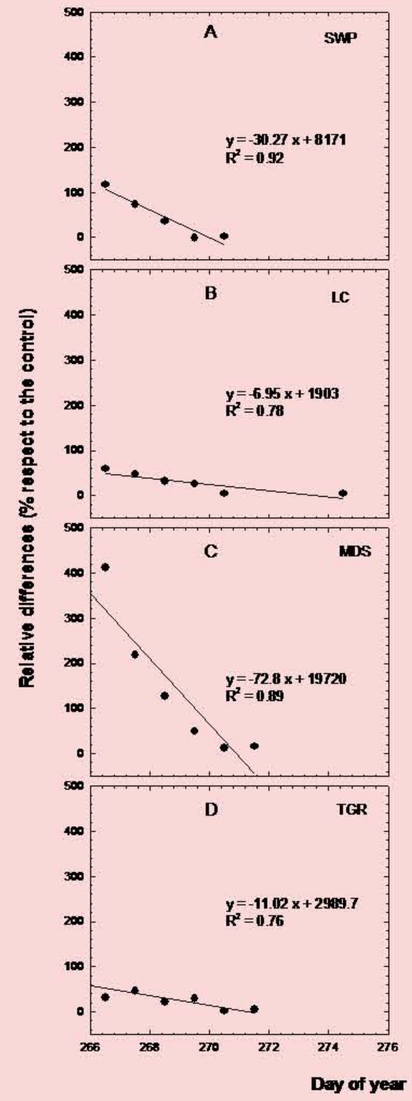


Figure 4. Relative differences between irrigation treatments (% of control group) for stem water potential (SWP, A), leaf conductance (LC, B), maximum daily trunk shrinkage (MDS, C) and trunk growth rate (TGR, D) at the end of the stress period and during the recovery period.

All this indicates that MDS shows a higher sensitivity in detecting water stress even the recovery period as fast as SWP, and could be used in the automatic scheduling of irrigation in young almond trees.

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