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Influence of crop load on almond tree water status and its importance in irrigation scheduling

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In the Mediterranean area water is the main factor limiting crop production and therefore irrigation is essential to achieve economically viable yields. One of the fundamental techniques to ensure that irrigation water is managed efficiently with maximum productivity and minimum environmental impact is irrigation scheduling. The fact that the plant water status integrates atmospheric demand and soil water content conditions encourages the use of plant-based water status indicators. Some researchers have successfully scheduled irrigation in certain fruit trees by maintaining the maximum daily trunk diameter shrinkage (MDS) signal intensity at threshold values to generate (or not) water stress. However MDS not only depends on the climate and soil water content, but may be affected by tree factors such as age, size, phenological stage and fruit load. There is therefore a need to quantify the influence of these factors on MDS. The main objective of this work was to study the effects of crop load on tree water relations for scheduling purposes. We particularly focused on MDS vs VPD10-15 (mean air vapor pressure deficit during the period 10.00–15.00 h solar time) for different loads and phenological phases under non-limiting soil water conditions.

The experiment was carried out in 2011 in a 1 ha plot in SE Spain with almond trees (Prunus dulcis (Mill.) D.A. Webb cv. 'Marta'). Three crop load treatments were studied according to three crop load levels, i) T100, high crop load, characteristic crop load, ii) T50, medium crop load, in which 50% of the fruits were removed and iii) T0, practically without fruits. Fruits were manually thinned. Each treatment, randomly distributed in blocks, was run in triplicate. Plant water status was assessed from midday stem water potential (Ψs), MDS, daily trunk growth rate (TGR), leaf turgor potential Ψp, fruit water potential (Ψf), stomatal conductance (gs) and photosynthesis (Pn) and transpiration rates (E). Yield, pruning weights and reserve sugar concentration were also evaluated. Trees were drip irrigated in order to satisfy the maximum crop water requirements. Variations in MDS were compared with changes in Ψs and VPD10-15 in the three treatments at the end of fruit growth stage (stage III), kernel filling stage (stage IV) and postharvest (stage V). Our results highlighted that crop load affects almond tree water status. We observed a greater effect of crop load on MDS and TGR than on Ψs. In T0 trees, Ψs was 16% higher than in T50 and T100. MDS was 36% and 49% lower in the low (T50) and almost nil-cropping trees (T0) than in the high-cropping trees (T100). The slope of MDS vs VPD10-15 forced to the origin increased with crop load, suggesting that different relationships are needed to estimate tree water status. TGR was 33% higher in T0 than in the cropping trees. In the same way, the presence of fruits, as reflected by the source/sink relationship, increased gas exchange parameters. Also pruning weights reflected competition between fruits and shoots for photoassimilates. Nevertheless the reserve sugar concentration at the base of the main branches was unaffected by the crop load.

All this implies that it is necessary to consider the crop load in irrigation scheduling based on MDS signal intensity.