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Assessing irrigation water saving strategies in Citrus Orchard: analysis of the combined effects of timing and magnitude of soil water deficit

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Environmental policies identify resilient water saving strategies as necessary tools to cope with climate change. Regulated deficit irrigation (RDI) is a sustainable strategy for crop production in water-limited regions, because it allows the reduction of water supply at certain growth stages, without affecting significantly the crop yield.
Consequently, the knowledge of crop response to soil water deficit is important to predict the real crop water requirement under limited soil water conditions. The mathematical schematization of the crop response under RDI can allow to identify the exact irrigation timing. The threshold of soil water status below which crop transpiration decreases, represents a key parameter for the water stress functions.
The macroscopic approach, which considers the global stress indicator, estimates the parameters of empirical functions aimed to describe the plant response to soil water deficit. These parameters are based on soil (e.g. matric potential, depletion) and plant (e.g. predawn leaf or midday steam water potential, PLWP/MSWP, maximum daily trunk shrinkage, MDTS, water stress integral, WSI) measurements.
The main objective of this paper was to investigate the effects of several RDI treatments, applied during the three stages of fruit growth, on soil-plant water relations of drip irrigated mandarin trees (Clementina de Nules). Experiments were carried out in eight irrigation treatments: 1) Control, irrigated at 125% of evapotranspiration measured in a weight lysimeters, ETlys, during the whole year; 2) a deficit treatment, which received only 50% of ETlys during the whole year, and 3) six RDI treatments in which 25% and 50% of ETlys, was applied during each of the three stages of fruit growth.
The critical threshold of soil water status expressed in terms of soil water depletion and/or soil matric potential below which MSWP tendentially reduces under decreasing soil water contents, was identified. The dependency of crop water status from the climate forcing for soil water contents greater than the critical threshold was also demonstrated. Similar results were obtained when the values of MDTS were used to quantify the crop water status. Moreover, a strong relationship between WSI evaluated during the three stages of fruit growth and the corresponding amount of water applied (irrigation and precipitation) was observed in the treatments characterized by the most severe water deficit (25% ETlys). The robust relationship between the two variables ($R2 = 0.95$) confirmed that WSI represents a good indicator of the plant-water relationship and allows the prediction of the total irrigation depth to be applied to achieve a desired stress level during the fruit growth.