Seasonal dynamics and operational monitoring of hedgerow olive tree transpiration in response to applied water

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In 2012, we used sap flow measurements to assess the seasonal dynamics of daily plant transpiration (ETc) in a high-density olive orchard (Olea europaea L., cv. 'Arbequina') with a well-watered (HI) control treatment A to supply 100% of the crop water needs, and a moderately (MI) watered treatment B that replaced 70% of crop needs. To assure that treatment A was well-watered, we compared field daily ETc values against ETc obtained with the Penman-Monteith (PM) combination equation incorporating the Orgaz et al. (2007) bulk daily canopy conductance (gc) model, validated for our non-limiting conditions. We then tested the hypothesis of indirectly monitoring olive ETc from readily available vegetation index (VI) and ground-based plant water stress indicator. In the process we used the FAO56 dual crop coefficient (Kc) approach. For the HI olive trees we defined Kcb as the basal transpiration coefficient, and we related Kcb to remotely sensed Soil Adjusted Vegetation Index (SAVI) through a Kcb-SAVI functional relationship. For the MI treatment, we defined the actual transpiration ETc as the product of Kcb and the stress reduction coefficient Ks obtained as the ratio of actual to crop ETc, and we correlated Ks with MI midday stem water potential (ψst) values through a Ks-ψ functional relationship. Operational monitoring of ETc was then implemented with the ETc = Kcb(SAVI)Ks(y)ETo relationship stemmed from the FAO56 approach and validated taking as inputs collected SAVI and yst data reporting to year 2011. Low validation error (6%) and high goodness-of-fit of prediction were observed (R2 = 0.94, RSME = 0.2 mm day-1, P = 0.0015), allowing to consider that under field conditions it is possible to predict ETc values for our hedgerow olive orchards if SAVI and water potential (ψst) values are known.

Keywords: SAVI, stem water potential, sap flow, vegetation index, Arbequina, Alentejo