www.ecohcc.ipt.pt, EcoHCC14- 105

Predicted and Seasonal Dynamics of Hedgerow Olive Orchard Water use in Response to Applied Water

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Olive trees are usually irrigated in southern Portugal and given the area devoted to this perennial crop it represents a large demand on regional water resources. Several very intensive hedgerow (1700 to 2000 trees per ha) orchards have recently been established in the region to take advantage of the European Commission decision of allowing the expansion of Portuguese olive tree planting quota. With enhanced olive production and yield depending on irrigation, a precise estimation of transpiration (Ep) under non-limiting conditions is required to set up the upper limit of irrigation requirements and chart deficit irrigation water use. A distinct feature of Ep of olives is the tight coupling to the atmosphere, modulated by canopy conductance and vapour pressure deficit. For the hedgerow (cv. Arbequina) olive orchard of this study this was evaluated in 2012 by predicting daily Ep with the Penman-Monteith 'big leaf' equation coupled to the Orgaz *et al.* (2007) model of bulk daily canopy conductance (Gc) for unstressed canopies (PM-model). Dynamics of predicted Ep were compared to daily Ep field values obtained from sap velocity data from a regulated deficit irrigation (treatment A) and a sustained deficit irrigation (treatment B). Daily Ep at the stand scale (mm day^{-1}) was obtained by dividing tree transpiration by the area of tree planting $(3.75 \times 1.35m)$. Tree rows were supplied with water by a single drip irrigation line serviced by 2.3 (treatment A) and 1.6 l h^{-1} (treatment B) emitters, respectively, spaced 0.75 m apart throughout the entire length of the emitter row lines. The PM-model effectively simulated and traced out the seasonal variability of Ep, validating the model's applicability to hedgerow orchards in southern Portugal. Results show that transpiration of treatment A trees was not limited by water availability except at pit hardening, from end of June to the end of July, when the regulated deficit was applied as convenient for this low sensitive period to water stress. Conversely, tree transpiration of treatment B was limited by water availability throughout the irrigation season, from mid June to the end of September. Evolution of midday stem water potential and stomatal conductance corroborated the seasonal dynamics of Ep for both treatments, suggesting a good irrigation supply for treatment A and a sustained deficit irrigation for treatment B. A total of 296 mm of irrigation water was applied to treatment A (1st June to September 30th) for an equivalent amount of 206 mm to treatment B. Cumulative tree Ep for the same period and treatment was 320 and 185 mm, respectively, while rainfall was 29.4 mm. The 30% difference in irrigation water application resulted in stem leaf water (ψst) differences between treatments. Also from June onward, treatment B midday leaf stomatal conductance (gs) quickly declined to lower values then treatment A, never recovering and stayed rather flat and low throughout September. Results seem to indicate that the PM equation coupled to the Orgaz *et al.* (2007) model of bulk daily canopy conductance is capable of predicting irrigation requirements for unstressed olive canopies. Furthermore, in association with continuous tree sap flow velocity measurements, it can be used to set up the upper limit of irrigation requirements and chart deficit irrigation applications in hedgerow olive orchards of cv. Arbequina in southern Portugal.

Keywords
Hedgerow olive irrigation, Transpiration of cv. Arbequina, Olive transpiration model

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