

Agricultural Water Management

Estimating the water requirements of high yielding and young apple orchards in the winter rainfall areas of South Africa using a dual source evapotranspiration model

Dzikiti S. et al.

Council for Scientific and Industrial Research

Pretoria, 0001, South Africa

Email: SDzikiti@csir.co.za

Abstract

Exceptionally high yielding ($> 100 \text{ t ha}^{-1}$) apple orchards (*Malus domestica* Borkh.) are becoming common in South Africa and elsewhere in the world. However, no accurate quantitative information currently exists on the water requirements of these orchards. Information is also sparse on the water use of young apple orchards. This paucity of data may cause inaccurate irrigation scheduling and water allocation decisions, leading to inefficient use of often limited water resources. The aim of this study was therefore to investigate the dynamics of water use in eight apple orchards in South Africa planted to Golden Delicious and the red cultivars i.e. Cripps' Pink, Cripps' Red and Rosy Glow in order to understand how canopy cover and crop load influence orchard water use. Four of the orchards were young (3–4 years after planting) and non-bearing, while the other four were mature high yielding orchards. Transpiration was monitored using sap flow sensors while orchard evapotranspiration (ET) was measured during selected periods using eddy covariance systems. Scaling up of ET to seasonal water use was done using a modified Shuttleworth and Wallace model that incorporated variable canopy and soil surface resistances. This model provided reasonable estimates in both mature and young orchards. The average yield in the two mature 'Cripps' Pink' was $\sim 110 \text{ t ha}^{-1}$ compared to $\sim 88 \text{ t ha}^{-1}$ in the 'Golden Delicious' orchards. However, average transpiration (Oct-Jun) was $\sim 638 \text{ mm}$ for the 'Cripps' Pink' and $\sim 778 \text{ mm}$ in the 'Golden Delicious' orchards. The peak leaf area index was ~ 2.6 and ~ 3.3 for the mature 'Cripps' Pink and 'Golden Delicious' orchards. So, canopy cover rather than crop load was the main driver of orchard water use. Transpiration by the young orchards ranged from 130 to 270 mm. The predicted seasonal total ET varied from ~ 900 to 1100 mm in the mature orchards and it was $\sim 500 \text{ mm}$ in the young orchards. Orchard floor evaporation accounted for ~ 18 to 36% of ET in mature orchards depending on canopy cover and this increased to more than 60% in young orchards.