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Quantifying the Effects of Canopy Cover and Cover Crop Species on Water Use Partitioning in Micro-Sprinkler Irrigated Orchards in South Africa

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Abstract : South Africa is a dry country and yet it is ranked as the 8th largest exporter of fresh apples (Malus Domestica) globally. Prime apple producing regions are in the Eastern and Western Cape Provinces of the country where all the fruit is grown under irrigation. Climate change models predict increasingly drier future conditions in these regions and the frequency and severity of droughts is expected to increase. For the sustainability and growth of the fruit industry it is important to minimize non-beneficial water losses from the orchard floor. The aims of this study were firstly to compare the water use of cover crop species used in South African orchards for which there is currently no information. The second aim was to investigate how orchard water use (evapotranspiration) was partitioned into beneficial (tree transpiration) and non-beneficial (orchard floor evaporation) water uses for micro-sprinkler irrigated orchards with different canopy covers. This information is important in order to explore opportunities to minimize non-beneficial water losses. Six cover crop species (four exotic and two indigenous) were grown in 2 L pots in a greenhouse. Cover crop transpiration was measured using the gravimetric method on clear days. To establish how water use was partitioned in orchards, evapotranspiration (ET) was measured using an open path eddy covariance system, while tree transpiration was measured hourly throughout the season (October to June) on six trees per orchard using the heat ratio sap flow method. On selected clear days, soil evaporation was measured hourly from sunrise to sunset using six micro-lysimeters situated at different wet/dry and sun/shade positions on the orchard floor. Transpiration of cover crops was measured using miniature (2 mm Ø) stem heat balance sap flow gauges. The greenhouse study showed that exotic cover crops had significantly higher ($p < 0.01$) average transpiration rates (~3.7 L/m2/d) than the indigenous species (~ 2.2 L/m^2/d). In young non-bearing orchards, orchard floor evaporative fluxes accounted for more than 60% of orchard ET while this ranged from 10 to 30% in mature orchards with a high canopy cover. While exotic cover crops are preferred by most farmers, this study shows that they use larger quantities of water than indigenous species. This in turn contributes to a larger orchard floor evaporation flux. In young orchards non-beneficial losses can be minimized by adopting drip or short range micro-sprinkler methods that reduce the wetted soil fraction thereby conserving water.

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