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Effects of shading on leaf temperature, photosynthesis and water relations of two navel orange [*Citrus sinensis* (L.) Osbeck] cultivars

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We investigated diel variability of CO_2 and water vapour (H_2O) exchange and their dependency on leaf temperature on four potted 5-year-old navel orange trees [*Citrus sinensis* (L.) Osbeck] between January and February 2007 (summer season). The experimental site was an open-air laboratory on the roof of the Physics Department, University of Zimbabwe (17º46.96'S, 031º03.09'E, elevation 1450 m.a.s.l). Two of the four trees were of the *Baianinha* variety while the other two were *Navelina*. An automated dynamic chamber (cuvette) was installed sequentially on each of the four trees. The cuvette was cylindrical in form, had a stabilized Teflon film covering and was well-ventilated. Measurements of CO_2 and H_2O mixing ratio, PAR and leaf temperature were made on a selected branch of each tree typically taking ten days. Out of the ten days on each tree, three days consisted of measurements under full solar radiation, three days under a single layer plastic mesh shade net whose transmittivity was found to be 24 % of full solar radiation, and the remainder of the ten day period under a double layer net (7 % transmittivity). Leaf temperature was measured as well as branch and stem sap flow rates using the Stem Heat Balance method where sap flow sensors were attached to the branch and stem of each tree under investigation. Results showed that photosynthesis was highest when leaf temperatures were between 25 and 30 ˚C, while transpiration was also increased at such temperatures. There was less than ten percent difference between the two varieties of navel orange trees in terms of net exchange of CO_2 and H_2O. Although the shade nets were able to effectively lower leaf temperature, they also significantly lowered the levels of photosynthetic flux density to levels much less than the level at which photosynthesis saturates in citrus trees (600-700 μmol m^{-2} s^{-1}). Photosynthetic water use efficiency was found to be highest under the unshaded conditions. A SPAC model, based on Ohm's law analogy, was subsequently run on two trees to predict stem sap flow rates under different shading conditions using leaf water potential, branch sap flow and soil water potential as inputs. Model parameters for each tree were derived from the measurements on that tree. Data for the model were collected over two days for each tree: first under full solar radiation conditions then with a single layer shade net. The results showed that the model was, to a large extent, able to predict the stem sap flow. Overall, photosynthetic photon flux density was found to be a more important factor than leaf temperature in optimizing photosynthesis and water use efficiency in these varieties of navel orange trees.