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Multispectral reflectance vegetation indices are highly sensitive to water stress in grapefruit trees

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The sensitivity to water stress of different plant water indicators (PWI) at different plot scales (leaf and aerial) was evaluated during the second fruit growth stage of grapefruit (*Citrus paradisi* cv. Star Ruby) trees growing in a commercial orchard for a sustainable irrigation scheduling. Trees were drip-irrigated and submitted to two irrigation treatments: (i) a control (CTL), irrigated at 100% of crop evapotranspiration to avoid any soil water limitations, and (ii) a non-irrigated (NI) treatment, irrigated as the control until the 104 days after full bloom (DAFB) when the irrigation was suppressed, until to reach a severe water stress level in the plants (around -2.3 MPa of stem water potential at solar midday). The plant water indicators studied were: stem water potential (SWP); leaf conductance (Lc); net photosynthesis (Pn), and several vegetation indices (VI) in the visible spectral region derived from an unmanned aerial vehicle equipped with a multispectral sensor. The measurements were made at 9, 12 and 18h (solar time) on 50 and 134 DAFB, coinciding with a fruit diameter of 20 and 70 mm, respectively. The correlation analysis between the PWI at leaf scale (SWP, Lc and Pn) and at aerial scale showed relatively poor results, with Pearson correlation coefficients (r values) around 0.6. However, SWP presented the highest r value with the normalized difference vegetation index (NVDI), green index (GI), normalized difference greenness vegetation index (NDGI) and red green ratio index (RGRI) showing the higher coefficients 0.80, 0,80, 0.85 and 0.86, respectively. In addition, a quadratic regression curve fitting was made for the SWP and aforementioned indices, obtaining values of R^2 around 0.7 in all cases; the best fit corresponded to SWP = - 4.869 + 15.765 NDGI - 14.283 $NDGI^2$ (R^2 = 0.749) to predict SWP values between -0.5 and -2.3 MPa. Results obtained show the possibility of using certain vegetation indices to be used in the detection of water stress in adult grapefruits, and thus propose a sustainable and efficient irrigation scheduling.

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