Feasibility of using a Leaf Monitor to Detect Plant Water Status in Walnut Crops

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The objective of this project was to explore the feasibility of using a continuous leaf monitor developed at UC Davis to monitor plant water status in walnut crops to assist with irrigation management. The continuous leaf monitor measures the leaf temperature, ambient temperature, relative humidity, incident solar radiation, and wind speed to estimate plant water status (Figure 2a). The data from the leaf monitor can be monitored using a data acquisition system and uploaded to the web through cellular modem so that the data can be visualized through PCs or any mobile device.

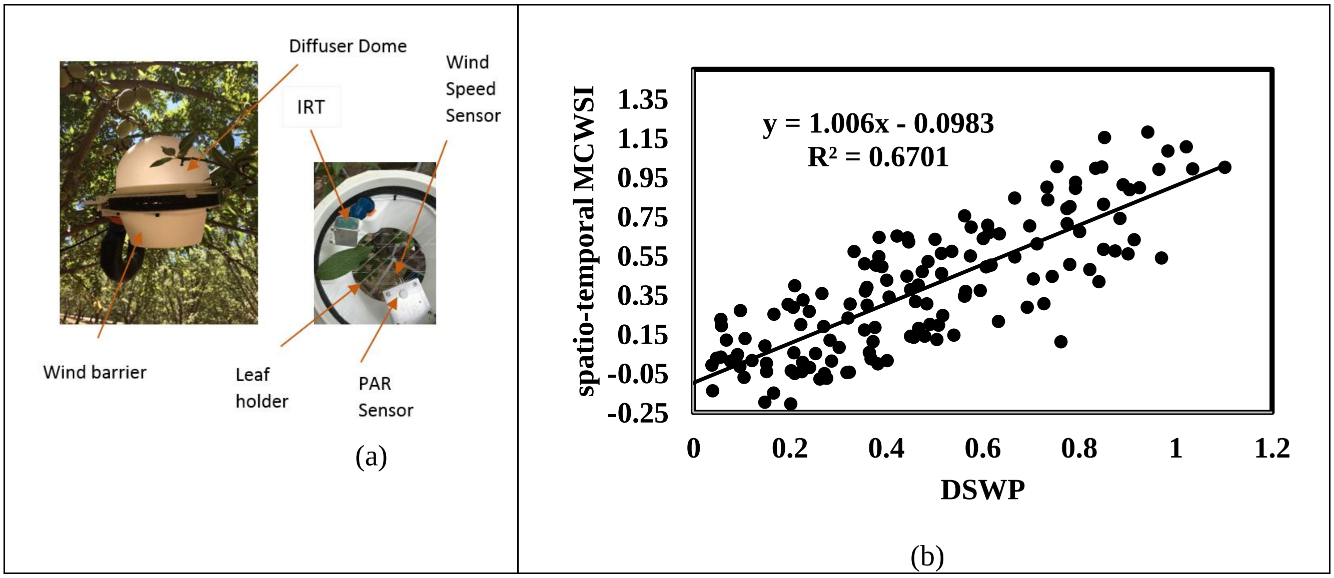

Figure 2. (a) A leaf monitor mounted on an almond tree, and (b) response of the leaf monitor to plant water stress.

Previous studies conducted by UC Davis researchers have indicated that the leaf monitor data can be used to create modified crop water stress index values (MCWSI[3]) that correlate with plant water stress as measured using a Pressure Chamber reasonably well (Figure 1b). However, estimation of this crop water stress index requires the knowledge of how the monitored leaf would have behaved under identical environmental conditions, if the tree was well-watered. Since this information is not readily available, an alternate approach that looks at the difference between the monitored leaf and air temperature (preferably dry leaf temperature under identical environmental conditions) appropriately adjusted for vapor pressure deficit, known as Comprehensive Stress Ratio (CSR), is currently being investigated.

Typical plots of leaf monitor derived CSR and pressure chamber data are shown in figures 2a and b. Figure 2a corresponds to a tree that was irrigated from the beginning of the season to avoid stress and figure 2b corresponds to a case where the first irrigation was delayed until –3 bar stress was measured. These plots exhibit similar variabilities between leaf monitor data and pressure chamber readings. We are collecting additional data this year to validate these results.

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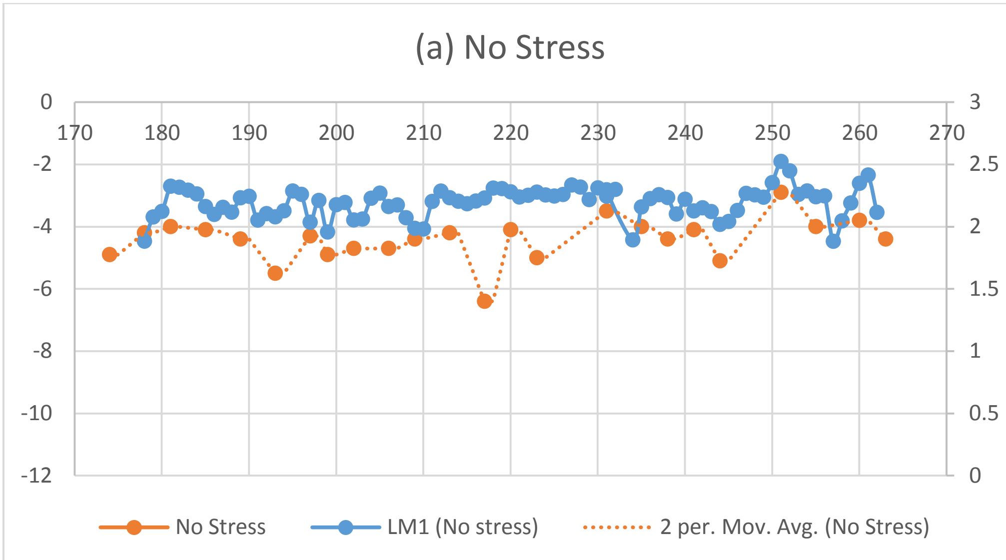
[3] $MCWSI = \frac{T_L - T_S}{T_D - T_S}$, where T_L, T_S and T_D stand for the monitored, saturated, and dry leaves. T_D can be easily obtained from a leaf with a broken stem (simulated dry leaf). However, T_S needs to be estimated using analytical or empirical approach.



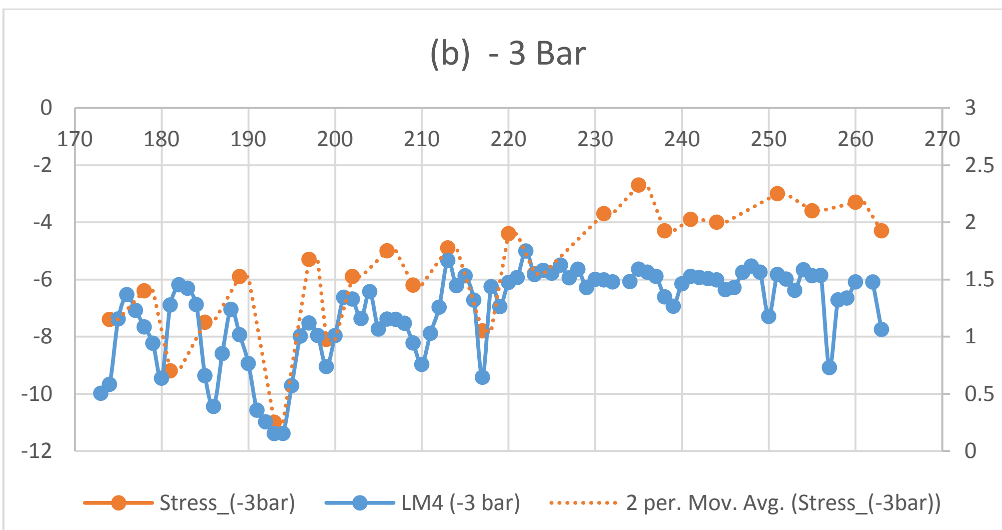


Figure 2. Variability in leaf monitor and pressure chamber data for walnut trees – (a) tree was irrigated from the beginning of the season to avoid any stress, and (b) irrigation of the tree was delayed until the onset of – 3 bar stress.