An Improved Heat Ratio Method Sap Flow Sensor for Providing Continuous Physiological Data for Decision Support for Almond Grower and Researchers

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PROJECT SUMMARY

Objectives:

Almond water use is difficult to measure. Previously, we have developed a new sap flow sensor that can be used to measure water use of trees in orchards. In the current project, we ask:

- Can a sap flow monitoring system provide timely feedback to inform irrigation scheduling at short time scales? We have applied the sensor under varying water use scenarios, i.e. during harvest, heat waves, wind events.
- Can we use sap flow to improve the interpretation of soil moisture and stem water potential for irrigation purposes across sites and varieties?
- Can variations in water loss at the hourly scale, estimated by combining sap flow and stem water content measurements, identify short-term patterns indicative of water stress?
- Does reduced sap flux resulting from drought stress negatively influence carbohydrate redistribution?
- Direct measurements of tree water use in the field can be used to measure canopy physiology in sufficient detail to parameterize crop models.

Background and Discussion:

Sap flow has had limited adoption by growers and applied researchers' due to high costs and the commercialized sensors have narrow ranges of operation which are unable to measure the high rates of sap flow found in almonds (>20 inches of upward movement per hour).

A collaborator (Tom Buckley) has developed an improved heat ratio sensor that can measure high sap flow rates, and thus can be used in almonds. In the last two years, we have tested these sensors on young and mature almonds at orchards including Nickels Estate, UC Davis Pomology Farm, and in the almond lysimeter at the Kearney REC.

Water use data is now available for up to two growing seasons on a selection of Nonpareil and pollinizers. In addition, an array of soil moisture sensors and a weather station were installed to provide comparable data to existing technologies. Stem water potentials were also measured weekly. These trees are also used by the Zwieniecki lab and the results by the Bailey lab for broadening their research questions.

Results include:

- Sensors have had a longevity of at least a year, with some fully functional after two years.
- The new technology allowed measurements over the entire range of sap flows for almonds, but was conditional on precise installation, suggesting that a professional perform this.
- A water stress response function was generated indicating that a stem water potential of (-)20bars indicates a loss of about 40% of plant transpiration – a clear indication of the plant stress given a particular water potential reading.
- An interesting observation has been that almond water use peaks late in the day and is partly delayed in the morning. We are investigating whether the almonds use stem/stored water during rapid stress,
- The sensors were ideal for evaluating plant stress over hours to months, showing strong concordance with soil moisture sensors, CIMIS weather, and stem water potentials. For almonds, sap flow appears to be most useful as a tool to investigate how stress events affect almonds (changing to saline irrigation water, soil flooding, deficit irrigation, testing secondary effect of agrochemicals etc).

The trials are ongoing at all the sites.

Project Cooperators and Personnel: Heather Vice (Hort. & Ag. MS student, UC Davis), Tom Buckley, University of Sydney, Franz Niederholzer, UCCE Colusa, B. Bailey, K. Shackel, M. Zwieniecki UC Davis

For More Details, Visit

- Poster location 41, Exhibit Hall A + B during the Almond Conference; or on the web (after January 2018) at Almonds.com/ResearchDatabase
- 2016 - 2017 Annual Reports (16-HORT21-Gilbert) on the web at Almonds.com/ResearchDatabase
- Related Projects: 17-PREC8-Zwieniecki; 17-PREC1-Bailey; 17-HORT31-Bailey; 17-HORT28-McElrone; 17-HORT24-Upadhyaya; 17-HORT22-Shackel