Applying Sap Flow to Measure Almond Water Use

2015/16 15-HORT21-Gilbert

Evaluating Heat Tolerance In Almond Breeding Programs

2014/15 14-HORT21-Gilbert

Matthew E. Gilbert[1*], Heather Vice[1] and Nicolas Bambach[2]

Cooperators: T. Buckley[3], T. Gradziel[1], R. Rosecrance[4], J. Preece[5] and C. Ledbetter[5]

[1] UC Davis, Dept. of Plant Sciences, One Shields Ave. Mail Stop 1, Davis, CA 95616
(530) 572-7846 megilbert@ucdavis.edu
[2] UC Davis Dept. Land, Air and Water Resources; [3]Chico State, [4]U. Sydney, Australia; [5] USDA.

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Objectives

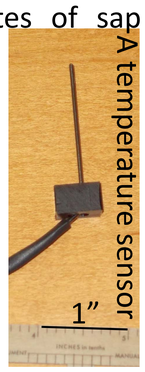
Heather Vice, a Masters student at UC Davis, will be working on this project:

- Finalizing development and testing of a new sap flow technology adapted to measure the high water flow in almonds,
- Applying the sensors to almond orchards; aiming to have three site running with many trees measured.

Why a new sensor?

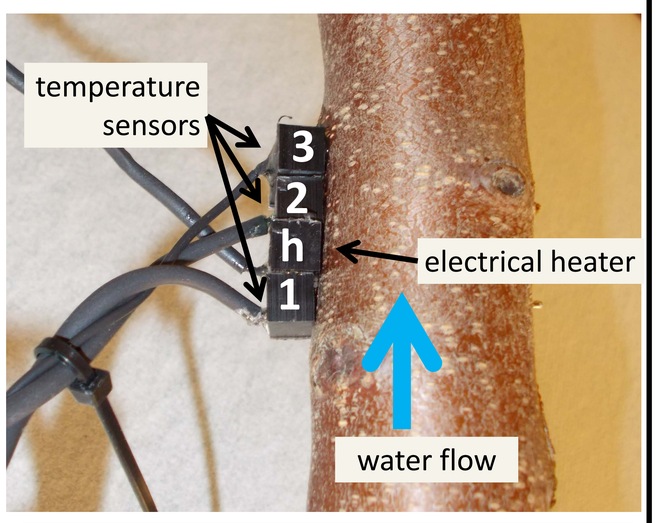
The heat ratio method of sap flow is limited by the maximum rates of sap flow possible to measure. Almonds have high rates of sap flow, and require technical and algorithmic improvement to function for almonds.

Collaboration with established U. Sydney sap flow researcher Tom Buckley is allowing us to achieve this.



How does it work?

A heater (h) and series of temperature sensors (1-3) are inserted into a trunk. The heater pulses +2°F and depending upon water flow in the trunk 1, 2 and 3 sense the pulse at different times. The inclusion of a third sensor allows the high flow rates typical of almonds to be measured.



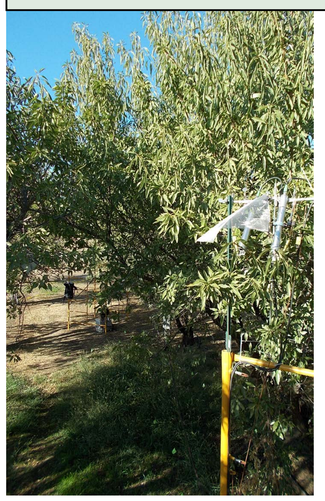
Questions to be asked

We primarily view this technology as a versatile research tool to answer questions that cannot be answered through surface renewal, the lysimeter or other technologies.

- The primary question we aim to ask this year is whether *Nonpariel* and pollinizers have different water use patterns, through a drought experiment
- Other possible questions include: impacts of saline water on almonds, deficit irrigation requirements, multisite comparisons.

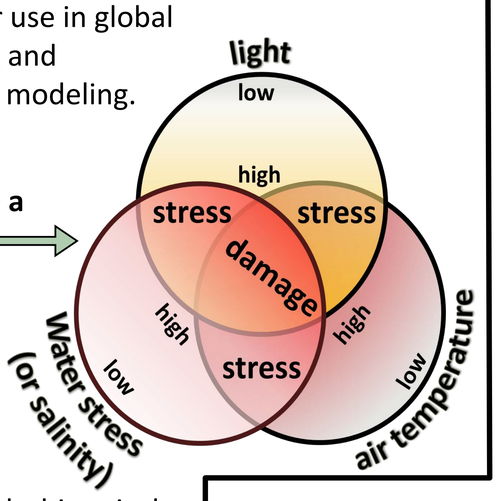
Once we have experience in applying this technology to almonds, we are happy to help with CE specialists, farm advisers etc. with this technology.

When is heat tolerance needed, and where?



Field work was performed in 2014 and 2015 in mature orchards, measuring long term photosynthetic performance in response to combinations of stresses. Almonds were well adapted to deal with heat damage, showing substantial recovery over many days. This information has led to the development, testing and deployment of a dynamic model of almond photosynthesis for use in global climate modelling and structure-function modeling.

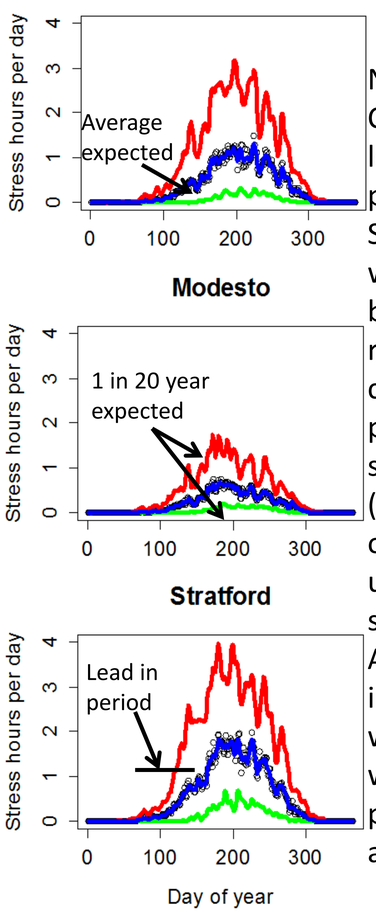
Heat damage to leaves only appears to be a problem when combined with high light *and* considerable water stress.



Based upon this information, we created a *Stress Hours* metric, similar to growing degree days, that allows a comparison of the potential for heat stress in almonds exposed to water stress.

Applying the *Stress Hours* metric to hourly historical CIMIS weather data for sites across California allowed us to comparatively determine when and how heat damage could occur. The full model is in this projects annual report:

$$Potential\ Heat\ Stress\ Index = (PAR\ index) * [1 - (1 - T_{air}\ index) * (1 - VPD\ index)]$$



Northern and Central sites had lower heat stress potential than Southern sites, as would be expected, but the high solar radiation led to considerable potential for heat stress at all sites (provided the orchard is undergoing water stress).

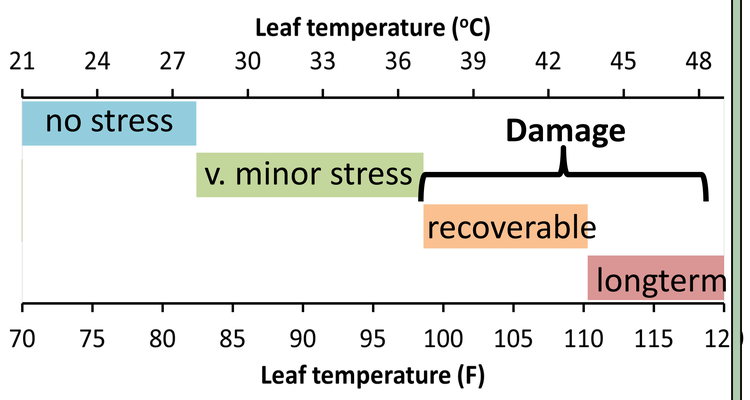
All sites had a ‘lead in’ season during which stress hours were low, potentially allowing acclimation to occur.

Objectives

- Evaluate heat tolerance of leaves among almond germplasm in breeding programs
- Evaluate how leaf heat tolerance affects photosynthetic performance

How tolerant are almonds?

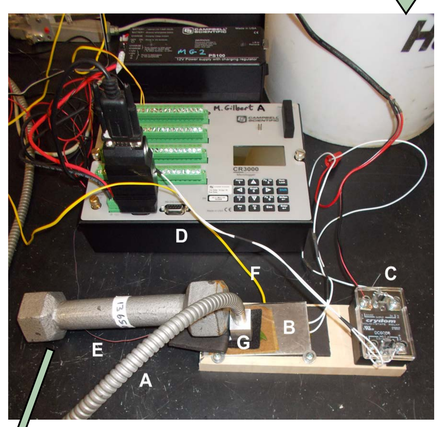
Photosynthetic measurements on leaves exposed to varying temperatures in the field show ***damage is recoverable below LEAF temperatures of 110F***.



Ranges of leaf temperatures leading to damage in *Nonpareil* almonds from field work on leaf photosynthesis recovery from combinations of high heat and light.

A protocol for screening varieties

A chlorophyll fluorometer was adapted to allow controlled heating of leaves and evaluation of the critical temperature at which damage processes start to occur.



Varieties are quite similar

Assay of diverse almond varieties in the Chico RVT and at Nickels Estate found limited variation in heat tolerance. However, the heat tolerance is high for this broad selection of germplasm – a good sign. Also there were no negative patterns associated with breeding programs .

Commercial varieties are coded as A1 to 14 and USDA and UC Davis entries are shown.