

Asking the plant to tell you when it needs water

March 9, 2021

Guest Speaker

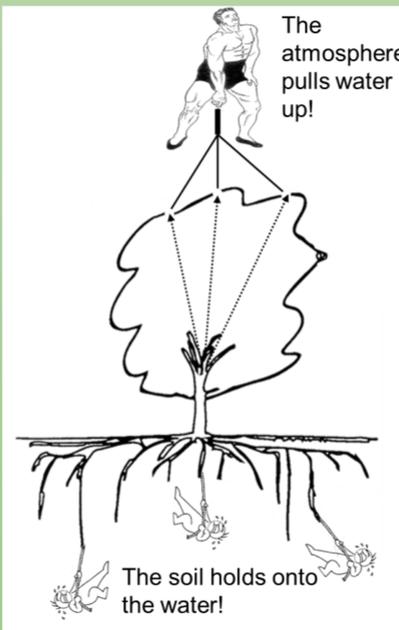
Ken “Dr. H₂O” Shackel; UC Davis Department of Plant Sciences

Plants use a lot of water—in summer a plant can lose the equivalent of its entire weight in water every day! All that water needs to be replaced from the soil, which is why we irrigate. But, the right irrigation rate depends both on what the tree is losing and what’s left in the soil. In this week’s session of our Lunchtime Seminar Series for Organic Growers, Dr. Ken Shackel explained how measuring stem water potential (SWP) allows growers to guide irrigation rates by directly “asking the tree” if it needs water.

The tree is caught in the middle of a game of Tug o’ War.

To do photosynthesis, the stomata on the leaves have to open. Since the atmosphere is drier than the leaf interior, water is pulled out by evaporation. This creates pressure throughout the tree, much higher than sucking on a straw.

If the soil is saturated, it doesn’t hold onto the water. But as the soil dries, the soil holds onto the water more and more tightly. This means a stronger suction is created in the tree as the soil dries.



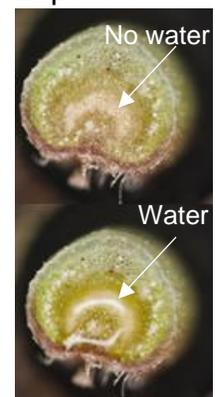
Stem water potential measures how “thirsty” the tree is.

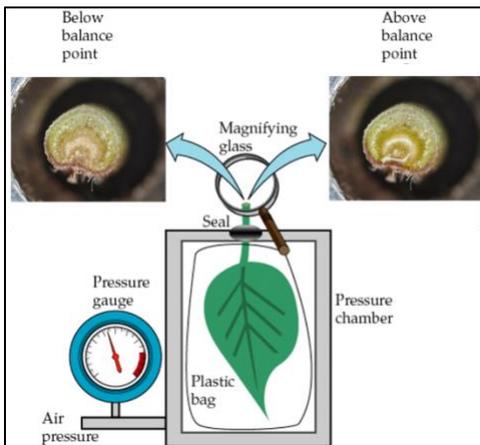
The suction in the tree (stem water potential, or SWP) will depend on the temperature and relative humidity, and on the force it takes to extract water from the soil.

The “right” SWP number will depend on the tree species. Numbers are available for several tree crops. However, with experience, a grower can get to know the SWP associated with well watered vs. water-stressed plants of any species

Stem water potential (SWP) is an important metric of how water stressed the plant feels. Measuring SWP is a lot like taking the tree’s blood pressure.

- **Put a leaf in a bag** while it still on the tree, for about ten minutes. Shielding it from the sun and air ensures that the pressure on the leaf is equal to the pressure in the tree stem.
- **Harvest the leaf and place inside a pressure chamber**, with the petiole facing outwards.
- **Measure how much pressure is needed to force water out of the leaf.** Keep applying pressure until you start to see liquid extruding from the xylem vessels.





In an irrigation block, some areas may be drier and others wetter. Growers commonly find a tree from an average performing area and use that to guide decisions for the whole block. One leaf per tree can be used. Values are evaluated in comparison to a baseline for that crop (that is, the value expected under the current temperature and humidity conditions if the soil were wet.)

A full guide to using SWP as a tool in almonds, walnuts and prunes has been published by UCANR and is available online at:

<https://ucanr.edu/datastoreFiles/391-761.pdf>

Over the years, Professor Shackel's research team has used SWP as a tool for adjusting irrigation to improve orchard yields and quality. They have found that although the evapotranspiration (ET—how much water is lost by the plant in a day) is a useful concept, there are times when it makes most sense to ask the tree what it needs.

- **How much water do young almond trees need?** In a 1-year old almond orchard near Winters, Dr. Shackel's team tried irrigating at 50% ET as well as at 100% ET, the recommended rate. Although all the trees grew well, the SWP was more negative and tree growth was smaller in the 50% treatment. However, SWP values at 100% were still below the baseline. So the team tried irrigating at 300% ET, which brought tree SWP to the baseline. The young trees responded strongly to the extra water, growing very rapidly. Irrigating young orchards at close to baseline SWP could be a good strategy for helping the trees to fill their spaces quickly.
- **When should walnut irrigation start?** Walnuts are sensitive to drought, and the trees often suffer in the period before harvest when irrigation needs to be cut off in order to dry the soil for the harvesting equipment. The SWP values suggested the problem might actually come from irrigating the trees too early, before they needed it. Researchers tested delaying irrigation until the SWP values showed that the trees were starting to become stressed. It turned out that this led to more developed and healthier roots, and less stressed trees at harvest.
- **Adjusting irrigation to synchronize almond hull split.** It's important that almond hulls split around the same time prior to harvest, to avoid insect damage and promote good drying. The timing of hull split depends on the tree water status, so this can be a problem for growers who have soil types with different capacities to supply water. The research team found that by irrigating trees in blocks with different soil types at different rates so that the SWP was equal, they could synchronize hull split between the blocks.

TAKE-HOME POINTS AND RESOURCES

Remember: It pays to think about irrigation from the plant's perspective!

- UC hosts a website with extensive information about using SWP, including
 - Map of daily baseline SWP for almonds, prunes, walnuts, and grapes
 - How-to information and videos
 - Resources for data interpretation

http://informatics.plantsciences.ucdavis.edu/Brooke_Jacobs/introduction.html
- Detailed instructions on the principles and practice for using a pressure chamber to measure SWP: http://fruitsandnuts.ucdavis.edu/pressure_chamber/
- UCANR guide to using SWP in walnuts, almonds and prunes: <https://ucanr.edu/datastoreFiles/391-761.pdf>

Questions? Stories to share? Contact Dr. Margaret Lloyd at mglloyd@ucdavis.edu

A recording of this talk is available at:

http://ccsmallfarms.ucanr.edu/Events_and_trainings/Organic_Agriculture_Seminar_Series_for_Growers/