Finding Ways To Save Water in Peach Orchards

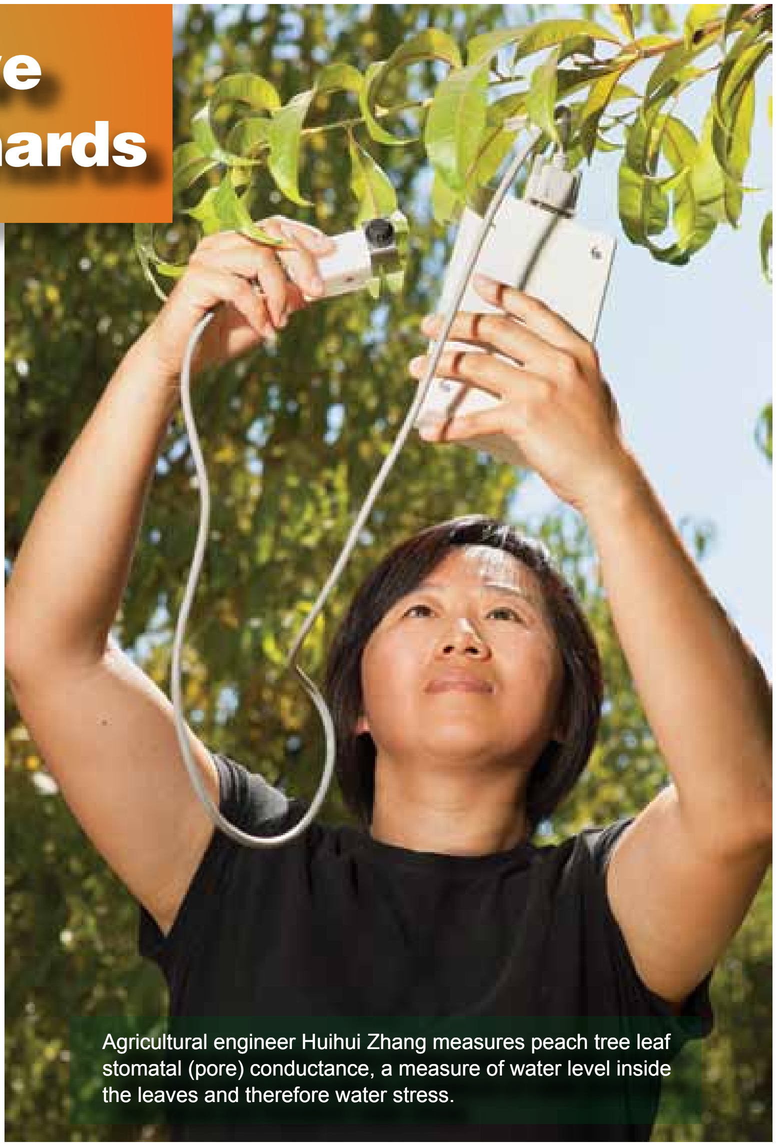
A team of Agricultural Research Service scientists in Parlier, California, is focused on helping peach growers in the San Joaquin Valley reduce the amount of water they use in ways that won't affect yield or quality.

Water is a major issue in the valley, and raising peaches there requires a lot of it. Early-season peaches are normally harvested in late May and early June, but the trees take most of their water from June through September—the time of year when temperatures and water demands are at their highest. Irrigation is the only source of water for agriculture during the summer, and while snow packs in the Sierra Nevada have traditionally been a sufficient source for peach growers, earlier snowmelts have made water even more precious. Wells drilled to supply the valley with water in recent years have had to reach deeper and deeper to bring up enough water to meet increasing demands.

Dong Wang and James E. Ayars, in the Water Management Research Unit at the San Joaquin Valley Agricultural Sciences Center, are finding ways to reduce water use in the tree's postharvest phase using two different approaches. "With peach trees, the issue is that over two-thirds of the water is applied after harvest. We're looking for ways to reduce that," says Wang, who is the unit's research leader. Their "deficit-irrigation" studies are designed to ensure continued productivity of an estimated 25,000 acres of peach orchards in the San Joaquin Valley. Deficit irrigation means supplying less water to a plant than it would normally need to stay healthy under optimal conditions. The goal is to minimize the impact on yield by using deficit irrigation during select stages of growth so that the water stress is corrected at other times of the year, such as in the winter and spring, Wang says.

In his experiments, Ayars studied the effect of deficit irrigation on a 4-acre plot of trees that produced Crimson Lady peaches, an early-harvest variety. He irrigated the trees from March to the May harvest. Then, in the postharvest phase, between June and September, he gave the trees either 25 percent of the normal amount of water, 50 percent of the normal amount, or 100 percent. He measured soil water content once a week to be sure that even with periodic rainfall, trees were given the appropriate deficit-irrigation treatments. He also followed standard commercial practices for fertilization, pruning, and fruit thinning and used three types of irrigation systems in the study: microspray, subsurface drip irrigation, and furrow, where water is distributed in shallow canal-like rows near the tress. At the end of each harvest, all defective fruit were counted and removed; and the remaining fruit were counted, weighed, and mechanically sized.

PEGGY GREB (D2683-1)



Agricultural engineer Huihui Zhang measures peach tree leaf stomatal (pore) conductance, a measure of water level inside the leaves and therefore water stress.

The results, submitted for publication in *HortScience,* show that when you reduce postharvest irrigation to 25 percent of what is normally applied, there is a negative impact on the following year's fruit yield and quality, and there are more deformities of the fruit. But the results also showed that by giving trees 50 percent less water, growers could see a 60 to 69 percent savings of postharvest water use with minimum effect on the following year's fruit quality and yield. The subsurface drip irrigation systems tended to have the lowest yields within a given year, but the differences were generally not statistically significant. The researchers also found that trees needed less pruning and maintenance because deficit irrigation slowed plant growth. "Most of the water savings we saw occurred during the hottest part of the year, when demand for water is highest, so there's a real potential for savings," says Ayars.

Deficit irrigation has been used to produce some varieties of grapes and has been studied for its potential in fruit tree and row crop production. But it has yet to be widely adopted, in part because growers need better tools to strike a balance between saving as much water as possible and keeping crops viable and healthy, Wang says. "When crops are managed under deficit irrigation, the margin of error is much smaller in terms of avoiding yield losses from any missteps in the amount of water applied or in the timing of the application," he says.

Sensing Trees' Water Needs

Wang and Jim Gartung, an ARS agricultural engineer in Parlier, are evaluating whether infrared sensors and thermal technology can help save water by determining precisely when peach growers need to irrigate their orchards. Infrared sensors go back to the 1970s and have been used to monitor the health of cotton and other crops.

Wang and Gartung installed 12 infrared temperature sensors in the same peach orchards used by Ayars. Over 2 years, they gave trees any one of four irrigation treatments: furrow or subsurface drip irrigation with or without postharvest water stress. They also measured crop yields and assessed fruit quality to compare the output of trees growing under deficit irrigation with trees growing under normal irrigation conditions.

When temperatures rise, the loss of water vapor from the leaves cools the plant. But when water loss from the leaves exceeds what the roots are taking up from the soil, the leaves' microscopic pores, called "stomata," begin to close up. Although this can conserve water in the plant, less heat is carried away by water vapor, resulting in a warmer tree, which also contributes to water stress, Wang says. "If the leaves of a tree are dry and water stressed, they will not be transpiring the way they should be, and the temperature in the tree canopy will be higher. The infrared sensor measures the temperature of the leaf canopy, which reflects the overall thermal footprint of the tree," Wang says.

They used the sensors to measure temperatures in the tree canopies and calculated a "crop water stress index" based on the differences between tree canopy temperatures and the surrounding air temperatures. Higher index numbers indicated more-stressed trees. The researchers found that midday canopy-to-air temperature differences in trees that were water stressed postharvest were in the 10˚ to 15˚F range, consistently higher than the 3˚ to 4˚F range found in the trees that were not water stressed.

How Much Pressure Can a Leaf Take?

Another way to determine whether a tree is water stressed is to measure its "stem water potential," which is the ability of the leaf to hold water. The researchers determined stem water potential of the stressed and nonstressed trees by putting their leaves in a pressure chamber and measuring the pressure required to squeeze water out of them. When the trees are water stressed, it takes more pressure to squeeze moisture from them, Wang says.

The results, published in 2010 in *Agricultural Water Management,* show that the measurements of stem water potential were consistent with data collected by the infrared sensors, which means the sensors may be an effective tool for managing deficit irrigation in peach orchards and helping growers decide when to irrigate, Wang says.

DONG WANG (D2686-1)

Infrared thermometer mounted on a pole for measuring peach tree canopy temperature under regulated deficit irrigation. Stressed leaves have a higher temperature than nonstressed leaves.

In the second phase of the project, the researchers are focused on identifying specific levels of water stress that peach trees can tolerate and teasing out relationships between that stress and canopy temperatures. They hope to develop an algorithm or formula that growers could apply to different water-stress scenarios to reduce water use year after year.

"We've proved that this is a viable approach to managing deficit irrigation in peaches. Now we want to give growers the tools they need to use it," Wang says.—By **Dennis O'Brien,** ARS.

This research is part of Water Availability and Watershed Management, an ARS national program (#211) described at www.nps.ars.usda.gov.

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Soil scientist Dong Wang examines leaves of peach trees that underwent postharvest deficit irrigation.

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