STEPHEN AUSMUS (D340-43)

Probing Peppers' Water Needs: Middle East Meets American West

In the San Joaquin Valley of California, visiting soil scientist Ron Seligman collects data underground inside a lysimeter while visiting engineer Nedal Katbeh-Bader (left) and visiting soil and water scientist Naem Mazahrih place equipment to compare accuracy of soil-water sensors.

Crisp, crunchy bell peppers in a rainbow of bright colors add texture, flavor, and pizazz to new and traditional foods of the Middle East.

An appetizer of yellow bell peppers and sun-dried tomatoes, for example, is a "must-try" treat in some Middle Eastern restaurants. And a favorite around the world—shish-kebabs made with slices of red, green, yellow, and purple bell peppers, skewered between pungent white onion, and generously sized cubes of fresh lamb or chicken—originated from this part of our planet.

Fresh vegetables and fruits are a prized and popular part of meals in the Middle East. And some fresh produce from this sun-drenched region makes a lucrative export to European markets.

But the competition between Middle East growers and city dwellers for clean, fresh water is intense in this mostly hot and dry land. The same scenario is unfolding in many arid regions of the American West.

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Ron Seligman observes a data acquisition and control system used in a greenhouse study of nutrient and water uptake by pepper plants.

How Much Water Does a Bell Pepper Need?

The accelerating need for good-quality water has increased the thirst for knowledge of how to grow premium produce—like delicious bell peppers—with the least possible amount of water.

Like growers in the Middle East, vegetable producers working 9,000 miles away in California's famed San Joaquin Valley—one of the world's most productive agricultural regions—grow bell peppers in an often-parched environment.

Bell peppers, along with broccoli, lettuce, and onions, are relatively new crops for the west side of the San Joaquin Valley. "There's very little information about pepper plants' water use here on the west side," says James E. Ayars, an ARS agricultural engineer. He's based at ARS's San Joaquin Valley Agricultural Sciences Center at Parlier, California. Applying too little water "can stress the plants, which can lower their resistance to attack by insects or diseases," notes soil scientist Steven R. Evett. Applying too much water is not only wasteful but also "poses a risk that the excess water will seep into the underground water supply, perhaps bringing farm chemicals, salts, and toxic elements with it," he points out.

Evett works in another water-scarce venue—Bushland, in the Texas Panhandle. "Both the Bushland and Parlier labs neighbor farmlands that are heavily irrigated," he notes. ARS research on how to use the water more efficiently is, he says, vital to the future success of farms and orchards faced with declining water supplies.

Scientists monitor **pepper** plants' **water use** by measuring the change in weight of a research lysimeter—a large, in-ground, soil-filled box with pepper plants growing on top of it and a huge scale beneath it.

Pinpointing peppers' precise water needs is a focal point of a lively collaboration between Ayars, Evett, and Middle Eastern scientists Ron Seligman from Rehovet, Israel; Naem T. A. Mazahrih of Ajloun, Jordan; and Nedal A.Q. Katbeh-Bader of Hebron in the Palestinian Authority.

Agricultural engineer Thomas J. Trout, now with ARS in Colorado, participated in the pepper research while based at the Parlier laboratory.

Array of Irrigation Options Explored

The visiting scientists worked with Ayars and Trout to track plants' water use at sites that had one of three common types of irrigation systems: furrow, in which water flows down channels between crop rows; surface drip, in which water is delivered to plants a drop at a time via a network of flexible black tubing; and subsurface drip, in which the tubing is buried beneath the surface and the water is delivered directly to plant roots, where it's most needed.

Peppers received one of four different amounts of irrigation water from the furrows or tubes. These amounts ranged from replacing some, all, or more than all of the water that plants took up from the soil.

Scientists monitored the pepper plants' water use by measuring the change in weight of a research lysimeter—a large, in-ground, soil-filled box with pepper plants growing on top of it and a huge scale beneath it.

The lysimeter data is a first step toward determining what's known as a "crop coefficient" specifically for bell peppers. The region's farm advisors, irrigation specialists, and growers—who may not have the benefit of their own research lysimeter—can use the figure to calculate how much water their pepper crop used in the previous several days.

“From there,” says Evett, “you do some pretty straightforward adding and subtracting and use your answer to decide how much of that water you want to replenish, if any, and when you should do that.”

Evett’s Bushland laboratory and Texas A&M University make crop-water-use information available every day of the year for major crops grown in the Panhandle. “It’s invaluable for irrigation scheduling,” he says.

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Naem Mazahrih (left), Nedal Katbeh-Bader (kneeling) and ARS research leader Tom Trout (holding the clipboard) use a pressure chamber to check pepper plants’ water status while Ron Seligman (in the background) checks soil water content with a neutron probe.

Soil Probes Pepper the Parlier Plots

Bell pepper plants were also the crop of choice for an experiment that pinpointed the accuracy of an array of different soil-moisture sensors. Scientists, irrigation consultants, and growers lower these devices through vertical metal or plastic pipes called “access tubes” to get a real-time, underground reading of the amount of moisture in the soil profile. It’s one way to determine how much water is available to slake plants’ thirst.

If probes are “sufficiently accurate and reliable, they could be an alternative to lysimeters for tracking a crop’s water use,” says Evett. He designed and led the soil-sensor study, a segment of a 5-year investigation funded in part by the International Atomic Energy Agency. The agency promotes peaceful uses of atomic energy. One such use is the neutron probe, regarded as the gold standard for determining soil moisture. But the probe requires a license to use, Evett says.

In all, the scientists evaluated the neutron probe and four newer kinds of sensors at 36 sites throughout the amply-drip-irrigated pepper plots at Parlier.

The scientists monitored sensor readings for the entire growing season. The study spotlighted the worrisome variability in water-content estimates from the newer sensors, which matched results obtained at Bushland. Says Evett, “We also showed how many sensors of the same type you would need to get enough readings for a reasonably accurate soil-moisture estimate.” The numbers were so large that use of the newer sensors proved too costly for crop water use studies.

Research on **water-use efficiency** is **vital** to the future success of farms and orchards faced with declining **water supplies.**

A Little History

This collaboration was the brainchild of Ibrahim M. Shaqir, a Middle East and North Africa specialist with ARS’s Office of International Research Programs, Beltsville, Maryland, and manager of the project; Dale A. Bucks, a former ARS national program leader, now retired; and Charles A. Lawson, of the U.S. Department of State’s Bureau of Near Eastern Affairs, which is funding much of the work.

Plans call for the venture—begun in 2003—to continue through at least 2008, as scientists on both continents continue to learn from each other and apply what they’ve learned to other crops.—By **Marcia Wood,** ARS.

This research is part of Water Resource Management, an ARS National Program (#201) described on the World Wide Web at www.nps.ars.usda.gov.

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