The Best of Both Worlds?

Fertigation Is an Efficient Way for Many Farmers To Grow Crops

Many growers don't simply water their crops. They "fertigate" them. As the name implies, fertigation brings both nutrients and water to plants.

Fertigation has many advantages over applying water and fertilizer separately. It saves money by combining the two tasks. It allows growers to fertilize crops throughout the growing season rather than stop when the plants become too unwieldy to allow mechanized applications with conventional machinery. Finally, many crops can thrive with less fertilizer when it's applied through fertigation.

Farmers are interested not only in increasing crop yields, but also in improving water quality, according to Dale A. Bucks, ARS national program leader for water quality and management. Fertigation began with sprinkler irrigation but has advanced to surface and other irrigation systems. Surface irrigation has the added benefit of curbing both nutrient runoff and leaching into streams and groundwater. As soil scientist Floyd Adamsen of ARS's U.S. Water Conservation Laboratory in Phoenix, Arizona, points out, "With fertigation, we're trying to get the fertilizer to stay where we want it."

The main variable Adamsen and agricultural engineer Douglas J. Hunsaker studied was the timing of fertilizer injections throughout an irrigation cycle on date palms grown in borders on a sandy soil in California's Coachella Valley. They found, using bromide as a tracer and stand-in for fertilizer, that it was best to inject fertilizer during the entire irrigation process. The researchers also looked at adding bromide to irrigation water only during certain segments of the irrigation, but this was less successful. The results were similar to studies conducted on furrow irrigation systems in Arizona.

The problem with current fertigation practices for surface-irrigated fields is that the mixture isn't always distributed uniformly. Water draining off the field can carry fertilizer with it. Improved surface fertigation practices can reduce field variation to only 10-15 percent. Fertigation performance was improved by ensuring that water applications were optimized for the field and crop conditions and by precise control of fertilizer injections.

Newer, pressurized irrigation systems have less field variability of water and fertilizer than surface irrigation does. But many growers are not yet willing to replace surface irrigation with the newer systems. So many areas of the West and Southwest stick to fertigation through surface irrigation. Most wheat growers and a third of cotton growers in Arizona fertigate through surface irrigation systems, according to Steven Husman, a University of Arizona extension agent.

Sensing the Needs

You might say Jim Schepers, Dennis Francis, Mike Schlemmer, and Ariovaldo Luchiari are using a short form of remote sensing in their fertigation studies in Lincoln, Nebraska. Instead of using aerial photographs or satellite-generated images, the scientists take stock of the crop's fertilizer needs from a few feet off the ground. Their tool of choice: electronic sensors perched atop high-clearance canopy sprayers.

The sensors zap the crop with certain light wavelengths and then measure how much of that light bounces off the plant's surface. The brightness of the returning light is then assigned a numeric value.

One way the sensors check for onset of stress due to nitrogen deficiency is to zap the crop with red light, which is absorbed by chlorophyll, an important pigment. Since green, healthy plants have lots of chlorophyll in their leaves, they absorb more red light, and reflect less, than low-chlorophyll plants, such as those needing nitrogen fertilizer. Near infrared,

FLOYD ADAMSEN (K11613-1)

A fertigation system used on romaine lettuce in Coachella Valley, California. Metered chemical fertilizers are introduced through plastic tubing and injection ports at various points in the irrigation pipe. An elbow provides mixing of the injected chemical with the irrigation water, which is then distributed into multiple furrows.

a waveband not visible to humans, is sensitive to the amount of living vegetation present, so it is used to assess plant vigor.

The high-clearance sprayers use such information to fertigate with variable, rather than fixed, rates of nitrogen, saving money and reducing the risk of leaching. The sprayers' sensors can monitor the conditions of multiple plants, rows, or areas and collect reflectance readings from them at the rate of 1 to 10 per second. "This allows us to make spatial nitrogen applications that simulate variable-rate fertigation," says Schepers, research leader of ARS's Soil and Water Conservation Research Unit at Lincoln.

The sensor studies are part of a cooperative multistate project under way to evaluate this type of fertilization technology for use on corn, wheat, and—to a lesser degree—turf grass. Other ARS scientists in Fort Collins, Colorado, are applying fertilizers and pesticides using precision agriculture technologies, including variable-rate fertigation (see *Agricultural Research,* October 2000).

Schepers says the technology may eventually allow farmers to satisfy their crop's nitrogen fertilizer needs in season rather than trying to predict—before planting—what these will be. Aided by technologies such as the sensors, "Our strategy is to make sure the crop gets off to a good start, monitor its progress, and provide required nutrients as needed."

Secrets From Underground

Meanwhile, scientists are scrutinizing healthy young peach trees to find out how to fertigate for the best yields of this delicious fruit. Growers already know a lot about how to manage a mature peach orchard. But there's very little scientific information on the water and nutrient needs of a newly planted orchard.

There's ongoing interest in the care of young trees. That's because many commercial peach orchards are pulled up every 10 years or so and replaced with new varieties that have more economic potential, says plant physiologist David R. Bryla. Formerly with ARS's Water Management Research Laboratory, Parlier, California, and now with ARS in Corvallis, Oregon, Bryla leads the peach study. He expects to have final results later this year.

Earlier Parlier investigations of fertilizer and water needs of three other crops—sweet corn, cotton, and tomatoes—are attracting renewed interest. Completed by ARS scientists about a decade ago, the research demonstrated the benefits of subsurface drip systems. Through tubes buried beneath the soil, these systems bring precise amounts of water and fertilizer to the place they're needed most—plants' roots.

James E. Ayars, agricultural engineer at the water management lab, says several factors combined to boost interest in subsurface systems, including the need to prevent seepage of excess nutrients into groundwater and new, impressive improvements in subsurface drip equipment.

PEGGY GREB (K11575-1)

This high-clearance sprayer makes variable-rate nitrogen applications to corn based on sensor readings. The sensors monitor plant stresses that are frequently related to nitrogen status.

The Parlier scientists' detailed studies of crops' water use and yield with subsurface drip, as compared to surface systems, still rank as the most comprehensive of their kind.—By **David Elstein, Jan Suszkiw,** and **Marcia Wood,** ARS.

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ROBERT SHENK (K11614-1)

These Crimson Lady peach trees irrigated by subsurface drip outgrew trees irrigated by other methods during the first 3 years after planting.