New Insights into Irrigation Management

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Pacific Northwest potato and sugar beet farmers who irrigate their crops with sprinklers need to know a lot more than when to turn on the faucet. The region’s powdery silt loam soils don’t contain much stabilizing organic matter, and existing soil aggregates that facilitate water infiltration can be broken up during irrigation. Afterwards, the loose particles of sand, silt, and clay that remain can dry to form a solid crust that greatly limits infiltration into the soil.

This means that growers not only need to calculate how much water should be supplied during irrigation, but they also need to ensure that the kinetic energy transferred from each water droplet to the soil surface during irrigation doesn’t contribute to the breakup of the fragile soil aggregates. They also need to develop irrigation protocols that won’t saturate soils or erode valuable topsoil.

Agricultural Research Service soil scientist Gary Lehrsch has been studying sprinkler irrigation for more than a decade. He has used his findings to develop numerous irrigation guidelines to protect soil structure, maintain soil quality, sustain soil resources, and increase the odds that water delivered via sprinkler irrigation will reach the root zones of growing crops.

“Sprinkler heads on center-pivot irrigation systems can be inexpensively and easily modified to adjust the water volume applied per pass and the force with which the water droplets hit the soil surface,” Lehrsch says. He works at the ARS Northwest Irrigation and Soils Research Laboratory in Kimberly, Idaho.

In one 5-year investigation, Lehrsch and colleagues evaluated the effect of sprinkler-droplet kinetic energy on soil crust strength and aggregate stability. They irrigated sugar beet plots using a 500-foot, four-span, lateral-move sprinkler system equipped with sprinkler heads that were positioned 6 feet above the soil.

The sprinkler heads were modified so that irrigations had either low or high droplet energies. The scientists included test plots with nylon covers, which ensured that when those plots were irrigated, the energy in the droplets would be absorbed by the netting and not the soil surface.

After the sugar beets were planted, the plots were irrigated with 0.6 inches of water at an average rate of 1.5 inches per hour two to four times per week for 5 weeks after planting. The team measured surface-soil penetration resistance—which indicates the strength of the soil crust—about 4 days after the first postplant irrigation and 14 days after the last irrigation.

Water Worries

Lehrsch and colleagues found that aggregate stability decreased from 66 percent to 55 percent when the irrigation’s droplet energy increased from 0 percent (in the test plot with the nylon netting) to the lowest rate under investigation. Sugar beet seedling emergence increased 6.4 percent when droplet energy was reduced.
50 percent from the highest rate studied, an emergence increase that could raise net income for southern Idaho sugar beet growers by nearly $6.2 million every year.

“We’ve concluded that these droplet-energy restrictions should be in place until sugar beet seedlings have emerged and become established,” Lehrsch says. “After that, sprinklers can be reconfigured to apply greater water volumes—at necessarily greater levels of energy—for the rest of the growing season.”

The researchers also observed that after multiple irrigations, soil penetration resistance decreased as droplet size and energy increased, probably because the larger droplets hit the ground with enough force to loosen soil particles and erode surface soil. They saw evidence of this erosion process during late-season irrigations when sediment-laden runoff flowed from row hills into nearby furrows and basins.

Lehrsch recommends keeping crop residues on the surface to check erosion and amending soils with organic materials such as manure or whey—the liquid byproduct that was used in the study. This decrease could cause soils to become saturated more quickly, which in turn would hasten runoff and decrease irrigation efficiency.

“We now know the impact water droplet energy has on some soils, engineers can design better irrigation systems to minimize the negative effects irrigation can have on infiltration, soil structure, and crop emergence,” Lehrsch says. “With this new information, farmers can better manage their center-pivot irrigation systems to maximize infiltration and reduce runoff and irrigation-induced erosion.”

—By Ann Perry, ARS.

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