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Making The Most Of IRRIGATION

Irrigation Runoff Control Strategies

H. Hansen and W. Trimmer

More than 4.5 million acres in the Pacific Northwest are irrigated with electric-powered sprinkler systems. Center pivots are used on about 1.25 million acres. Irrigation runoff can be a problem on many of these sprinkler-irrigated fields.

Understanding soil infiltration rates

The rate at which a soil can absorb or take in water is called the infiltration rate. The rate at which a sprinkler system applies water is called the application rate. If the application rate is higher than the soil's infiltration rate, some of the applied irrigation water will collect on the surface, creating a potential for runoff. If there is a path downhill, the water will not stand, but will form a runoff stream carrying water away from where it was applied.

Although the stream may not leave the field boundary, it can create a problem since the water no longer will be where it can effectively provide crop water needs. Runoff water is wasted water. It also wastes energy, wastes topsoil, and can be a pollutant by carrying off sediments, fertilizer, and pesticides.

Properly designed fixed-set or fixed-spacing sprinkler systems apply water at a rate low enough to allow all the water to infiltrate into the soil without runoff. The infiltration rate of a soil is determined by several factors. One of the most important is soil texture. Approximate ranges of infiltration rates for various soil textures or types are listed in Table 1.

Table 1.—*Typical infiltration rates (in inches) for common soil.*

Coarse sand	¾–2 per hour
Fine sand	½–1 per hour
Fine sandy loam	⅓–¾ per hour
Silt loam	¼–4/10 per hour
Clay loam	1/10–¼ per hour

[a]To obtain more information on specific soils, contact your county office of the OSU Extension Service or your local USDA Natural Resources Conservation Service office.

Other factors that affect infiltration rate are soil surface conditions, soil layering or depth, tillage practices, crops, soil compaction, and soil moisture content before irrigating.

Sprinkler equipment

If a runoff problem exists, it could be caused by improper sprinkler system design, by a mistaken assumption that the soil has a higher infiltration rate than it actually has, or by poor management techniques. Changes in the system and/or management sometimes can be made to alleviate these problems.

The application rate of a system is determined by the discharge rate from individual sprinklers and the sprinkler spacing. Figure 1 shows the application rate of irrigation systems using various-sized sprinklers at commonly used fixed spacings.

Prepared originally for the Bonneville Power Administration by Hugh J. Hansen, Extension agricultural engineer emeritus, and Walter L. Trimmer, former Extension irrigation specialist; Oregon State University.

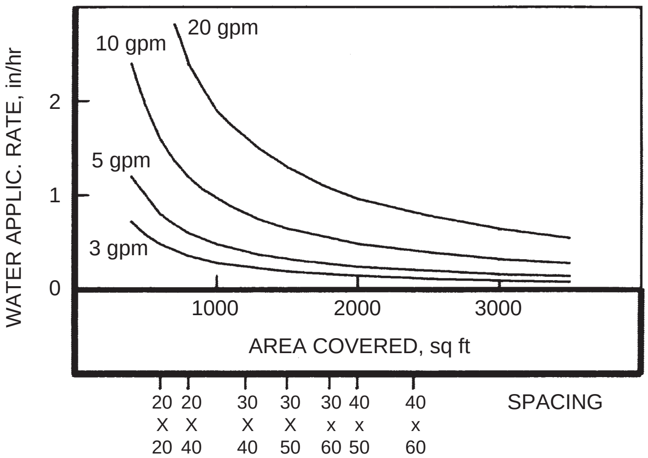

Figure 1.—*Application rate of a sprinkler irrigation system is established by sprinkler size and fixed spacings.*

It usually is not practical to increase the sprinkler spacings since this affects the application uniformity. The other choice is to use sprinklers with lower application rates, longer set times, and more laterals.

Moving sprinklers—center pivots, linear moves, and big guns—are somewhat more complex to analyze. The average application rate of a center pivot is not constant but gradually increases from the pivot point to the outer end of the pivot. The maximum application rates almost always are higher than the basic infiltration rates of most soils as shown in Table 1. Moving sprinkler systems take advantage of a soil's initially high infiltration rate, Figure 2. Moving irrigation systems can apply more water during this early phase without runoff.

Runoff is a greater problem under low-pressure center-pivot systems because of the reduced wetted diameter created by either spray heads or low-pressure impact sprinklers as compared to high-pressure impact sprinklers. Figure 2 shows the infiltration rate of an Arrowsmith sandy loam and the application rate of a typical center pivot experimentally equipped with various types of sprinkler packages. Low-pressure sprinkler heads and spray nozzles increase the application rate, and the cross-hatched areas represent potential runoff.

Design practices that can reduce the runoff problems under center pivot systems that have been converted to low-pressure packages include:

- Reducing design flow capacity of system to the minimum required to meet crop water needs
- Utilizing pressure regulators at each sprinkler in fields with large (greater than 30 feet) elevation differences
- Installing spray sprinklers on booms to increase wetted area covered
- Increasing traveling speed of pivot or moving sprinkler to reduce the amount of water applied on a given area during a given period of time

Corrective management techniques

If changing hardware to match water application rates with soil infiltration rate is not feasible, there are other management techniques that may help reduce runoff and soil erosion problems.

First, avoid irrigating bare soil. Water drops break down the soil surface and form a thin layer of fine particles on the surface. This layer then acts as a barrier to infiltration. If possible, wait until the crop has grown enough to cover the soil or use tillage practices that leave crop residue on the surface to shield the soil from water droplet impact.

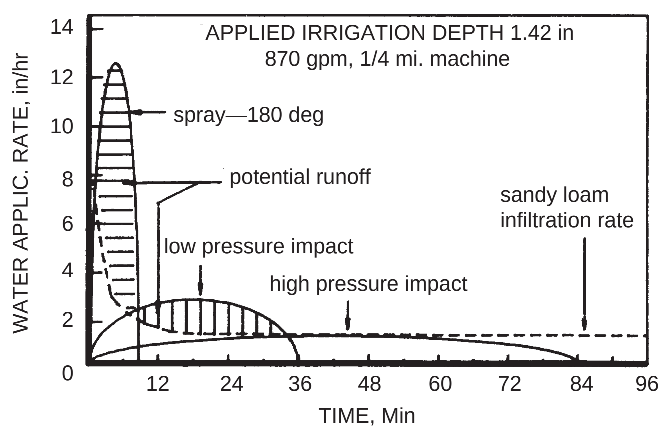

Figure 2.—*Application rates for three types of sprinkler packages showing how rates exceeding soil infiltration rate lead to potential runoff as represented by cross-hatched areas.*

Take advantage of surface storage to help hold water in place until it can soak in. This is an effective means of reducing or preventing runoff and associated soil erosion. Surface storage can be created with such practices as leaving the surface rough after tillage operations, conservation tillage, reservoir tillage, and growing perennial crops such as alfalfa or grass.

Leaving clods to create a rough soil surface will provide some surface storage for water, allowing it to soak into the soil. This is the easiest and lowest cost management practice to reduce runoff.

Waterways and contour strips

On extremely loose soil or steep slopes, it is advisable to farm on the contour or plant contoured strips of permanent vegetation to help control runoff and erosion. Rolling or sloping lands may need waterways to handle runoff that cannot be prevented. Such waterways should have a cover crop such as grass to hold soil in place as water drains away.

Conservation tillage

Conservation tillage is any soil management practice that leaves the soil surface resistant to erosion and capable of holding moisture where it hits the soil. Conservation tillage strives to maintain crop residues on the soil surface at all times. This residue reduces soil compaction from water impact, holds moisture, keeps the infiltration rate high, and reduces soil erosion and water runoff. Common conservation tillage methods include “minimum tillage,” “no-till or no-tillage planting,” “zero tillage,” “stubble mulch,” “mulch-till,” “reduced tillage,” “till-plant,” and “chemical tillage.”

Reservoir tillage

Reservoirs or basins created with specialized commercially available tillage machines will catch and hold water in place until it can infiltrate into the soil. Reservoirs or basins should be in place throughout the entire irrigation season.

Two basic methods commonly are used to construct reservoirs. One method is pitting—punching holes or depressions 6 to 10 inches in diameter, 6 to 8 inches deep, and spaced about 2 feet on center into the soil (Figure 3).

The other method—dammer diking—builds up small earthen dams or dikes with a tillage tool that scrapes and carries loose soil down the furrow. The tool trips at preset intervals, creating small dams in the furrows. Soil dams or dikes are prone to washing away, especially on steep slopes.

University of Idaho studies show that proper reservoir or basin tillage can practically eliminate runoff on slopes up to 7 percent and drastically reduce it on steeper slopes with silt loam and coarser textured soils.

Surfactants

Surfactants may be effective under certain conditions to enhance soil infiltration rates and help reduce runoff. Surfactants are most effective on nonwettable soils or soils that repel water. Such soils may have highly dehydrated organic matter such as grass thatch, field-burning ash, or be poorly drained with an organic fraction containing high fatty acid content. Water does not bead up on wettable soil; therefore, unless beading is present, a surfactant or wetting agent would be an unnecessary expense.

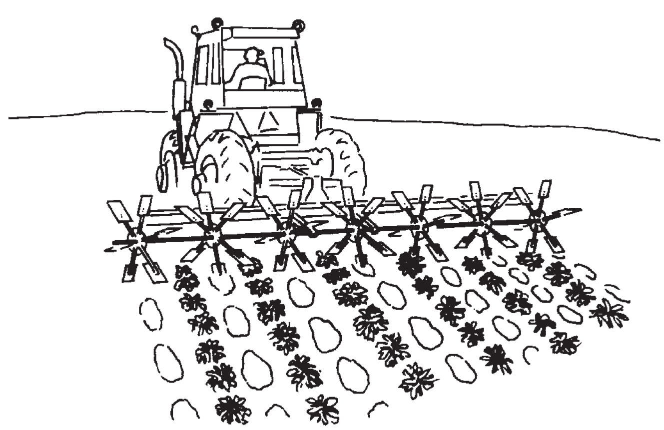

Figure 3.—*Reservoir tillage creates basins or pits to hold water in place, allowing it to infiltrate the soil, thus preventing runoff.*

Summary

Runoff problems are best controlled by:

- Sprinkler equipment designs that match water application rate to soil infiltration rate
- Management practices that reduce potential runoff
- Tillage practices that leave the soil surface with a high infiltration rate and rough enough to prevent quick runoff
- Reservoir or basin tillage practices that provide numerous small water reservoirs on the soil to pond and hold water until the soil can absorb it

Controlling runoff with these practices improves irrigation water management and irrigation efficiency. This offers the potential for a reduction in the amount of water required to be pumped and, in turn, reduced pumping energy costs.

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