1996

G96-1305 Water Runoff from Sprinkler Irrigation: A Case Study

Norman L. Klocke
University of Nebraska - Lincoln

William L. Kranz
University of Nebraska - Lincoln, wkranz1@unl.edu

C. Dean Yonts
University of Nebraska - Lincoln, cyonts1@unl.edu

Kelly Wertz
University of Nebraska - Lincoln

G96-1305-A

NebGuide

Published by Cooperative Extension, Institute of Agriculture and Natural Resources, University of Nebraska-Lincoln

Water Runoff from Sprinkler Irrigation --A Case Study

This NebGuide illustrates the influence of soil texture, topography and irrigation system characteristics on potential runoff.

Norman L. Klocke, Extension Water Resources Engineer;
William L. Kranz, Extension Irrigation Specialist;
C. Dean Yonts, Extension Irrigation Engineer;
Kelly Wertz, Extension Educator

When water is applied to a field through a sprinkler irrigation system, it should soak into the soil where it lands rather than drain to a low spot or off the field altogether. Runoff causes non-uniformity of water application, poor irrigation efficiency and possible leaching of chemicals to the groundwater. Some systems like LEPA (Low Energy Precision Application) are designed so water does not immediately soak into the soil. However, proper LEPA designs also call for tillage practices that hold the water on the soil surface where it lands until it has time to infiltrate into the soil. Sprinkler systems should be designed for zero runoff so no water leaves the point of application.

This center pivot example has conventional tillage with no allowance for surface storage of water due to tillage. Additional background information for this case study can be found in: *Water Runoff Control Practices for Sprinkler Irrigation Systems, NebGuide G91-1043*; and *Selecting Sprinkler Packages for Center Pivots, NebGuide G88-870*.

Case Study

The base system characteristics of this example center pivot are given in *Table Ia*. Each of the table's characteristics can influence runoff potential. Soil texture and intake family, defined by the Natural Resource Conservation Service (NRCS), determine how fast water will infiltrate into the soil. In this example the field has a silt loam soil with an intake family of 0.3. Slope, or the change in elevation within the field, influences how much water will naturally puddle on the surface and later infiltrate and how easily the water will flow to a lower part of the field. In this example, the field has a moderate slope of 3-5 percent.

The characteristics of center pivot irrigation influence how intensely water is applied to the soil. In this example,

system capacity is 800 gallons per minute, system length is 1340 feet, application amount is 1 inch of water per revolution and wetted diameter of the sprinkler heads is 40 feet. The overall runoff resulting from this field system is 26 percent, which means 26 percent of the water pumped through the system did not infiltrate where it landed. The runoff moved to another part of the field or it left the field altogether. As a result, water application efficiency was reduced by 26 percent.

Each of the land surface factors and center pivot characteristics are varied individually in *Tables Ib - Ig*. These examples indicate how each factor influences overall runoff. All runoff data are reported as the percentage of applied water that did not infiltrate where landed.

Table I. Example of runoff potential from a center pivot irrigation system.

Soil Intake Family	Slope (%)	System Capacity (gpm)	System Length (ft)	App. Depth (inches)	Wetted Diameter (feet)	Runoff (%)
Table Ia. Base system characteristics.						
0.3	3-5	800	1340	1.0	40	26
Table Ib. Influence of soil intake family (soil texture) on runoff.						
0.1	3-5	800	1340	1.0	40	**44**
0.5	3-5	800	1340	1.0	40	**11**
1.0	3-5	800	1340	1.0	40	**0**
Table Ic. Influence of slope on runoff.						
0.3	**0-1**	800	1340	1.0	40	**0**
0.3	**1-3**	800	1340	1.0	40	**8**
0.3	**>5**	800	1340	1.0	40	**35**
Table Id. Influence of system capacity on runoff.						
0.3	3-5	**500**	1340	1.0	40	**14**
0.3	3-5	**700**	1340	1.0	40	**22**
0.3	3-5	**900**	1340	1.0	40	**29**
Table Ie. Influence of application amount on runoff.						
0.3	3-5	800	1340	**0.50**	40	**3**
0.3	3-5	800	1340	**0.75**	40	**16**
0.3	3-5	800	1340	**1.25**	40	**33**
Table If. Influence of wetted diameter on runoff.						
0.3	3-5	800	1340	1.0	**30**	**48**
0.3	3-5	800	1340	1.0	**60**	**15**
0.3	3-5	800	1340	1.0	**80**	**8**
Table Ig. Influence of application depth and wetted diameter on runoff.						
0.3	3-5	800	1340	**0.75**	**60**	**7**
0.3	3-5	800	1340	**0.75**	**80**	**2**

Soil texture cannot be changed in a given field. It has a tremendous impact on runoff as given in *Table Ib*. A soil in intake family 0.1 (clay, silty clay or silty clay loam) has very slow infiltration and produces 44 percent runoff.

However, a silt loam, very fine sandy loam, fine sandy loam or loamy fine sand in the 1.0 intake family can infiltrate all of the applied water from this system with no runoff.

Slope (or changes in field elevation) is usually an unchanged factor. *Table Ic* shows a field with a slope of 1-3 percent has 8 percent runoff while a slope greater than 5 percent has 35 percent runoff. The influence of land surface factors on runoff shows sprinkler packages must be designed for each field. As soils and slopes vary from field to field, sprinkler packages must be closely matched to individual field conditions. Pressure on flow regulators can compensate for slope changes within the field and keep application amount constant. However, steeper slopes will still produce more runoff than flatter slopes, even if water application is the same.

Irrigation system capacity influences application rate or intensity if other system characteristics are the same. *Table Id* shows the influence of changing system capacity on runoff. When system capacity drops to 700 gallons per minute, runoff is 22 percent. When system capacity increases to 900 gpm, runoff is 29 percent. Although not shown in Table I, runoff is greater near the outer end of the system than near the center. Outer spans have more area to water in the same amount of time, allowing less time for the water to infiltrate and increasing the potential for runoff.

Application amount of each irrigation also influences runoff. *Table Ie* shows that if the operator speeds up the pivot and puts on 0.75 inch instead of 1.0 inch, runoff is 16 percent. If the pivot is slowed to put on 1.25 inches, runoff is 33 percent. The practical limits for irrigation applications are normally 0.75-1.25 inches. Smaller applications are less efficient in delivering water to the crop; larger applications have the potential for more runoff.

Wetted diameter of the sprinkler pattern has a large influence on runoff, as shown in *Table 1f*. The wetted diameter is determined by the type of sprinkler device and operating pressure of the irrigation system. A maximum wetted diameter should be selected to produce little or no runoff. Eliminating runoff through sprinkler selection is usually more important than moving the sprinkler heads nearer or into the canopy to gain application efficiency. As shown in *Table Ig*, more than one system characteristic may need to be changed to reduce runoff to acceptable levels. Here the application amount was reduced to 0.75 inch and the wetted diameter was increased to 60 feet for an overall runoff of 7 percent. A further increase in wetted diameter to 80 feet reduced overall runoff to 2 percent of the applied water.

A computerized program, *Estimating Potential Runoff and Energy Savings from Sprinkler Package Conversions*, is available from University of Nebraska Cooperative Extension. The program calculates potential runoff from all combinations of soil types, field slope, system capacity, system length, application depth and wetted diameter. Choosing the right sprinkler package is important for least cost irrigation of a particular field. The best sprinkler device may or may not operate at the lowest pressure. The system selected needs to eliminate or minimize runoff to deliver water efficiently and uniformly to the field.

File G1305 under: IRRIGATION ENGINEERING
B-25, Irrigation Operation & Management
Issued December 1996; 1,000 printed.

Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Elbert C. Dickey, Director of Cooperative Extension, University of Nebraska, Institute of Agriculture and Natural Resources.