

Surge Irrigation



What Is Surge Irrigation?

Surge irrigation is the intermittent application of water along a furrow to improve distribution uniformity. It works on the principle that dry soil infiltrates water faster than wet soil.

When soil is wet, the surface soil particles consolidate and form a seal. When water is re-introduced in a wet furrow, the wetting front moves quickly past the wetting zone to dry soil. At the wetting interface, dry soil slows the advance. This phenomenon allows for a faster advance through the field with less deep percolation and better application uniformity. The result is a more even distribution of water in the rooting zone from the poly-tubing to the tail ditch, and reduced nutrient loss from deep percolation near the poly-tubing.

Surge irrigation works through a program of cycle times that account for the advance of the furrow. These cycle times must be set by the user. A valve that simply moves from one set to another at a uniform or constant time interval is not surge irrigation.

Some tailwater is necessary for surge irrigation to be effective. The intermittent application reduces the tailwater volume because the water is moving as a pulse over the sealed furrow to the end of the furrow. Its velocity decreases as it moves along the furrow, so it has more time to infiltrate before it leaves the furrow. When set properly, very little tailwater leaves the furrow.

Definitions

Advance time: Time required for the wetting front to advance from the crown to the end of the furrow.

Recession time: Time for the wave front to recede from the furrow. Essentially, this is when the majority of the tailwater has stopped draining from the field.

Opportunity time: Time for water to infiltrate into the soil. The more opportunity time water has contact with the soil, the more volume is infiltrated.

Soak time: Time after the advance has completed when the remainder of the set time is used to meet the required application depth.

Application depth: The depth of irrigation applied during surge irrigation. This depth should be between 2.5 and 3.0 ac-in.

Number of cycles: The number of advance cycles (water on/water off) used to complete a surge advance program. Generally, surge advance times increase during the surge program, although some surge programs have a longer first advance than second advance before increasing.

On-time: The time water is applied to a given side.

Off-time: The time water is not applied to a given side.

Cycle-time: The time required to complete an on/off cycle (sum of on-time and off-time).

Irrigation set time: The total irrigation time, which includes advance and soak times. The set time for row crops should always be less than 40 hours. If using a CHS plan, you must add the time for each set together to calculate the irrigation set time. For example, if a surge is being used on two 24-hour sets, the total time is 48 hours, so the sets should be divided into three sets.

Computerized Hole Selection for Surge Irrigation

If you are using lay-flat irrigation pipe, as is common in Midsouth agriculture, then the surge irrigation sets **must** be planned using computerized hole selection (CHS) such as Delta Plastics Pipe Planner (www.pipeplanner.com) or PHAUCET (Pipe Hole And Uniform Crown Evaluation Tool). Computerized hole selection allows for hydraulic iteration of pressure, row length, and elevation so that each furrow receives the proportional amount of water for the row length. It also ensures uniform distribution of irrigation water across the crown of the pipe. This allows the surge valve to improve the down-furrow (top to bottom of field) distribution uniformity.

To lay out surge irrigation, two irrigation sets must be combined. For example, if an irrigation set was used to irrigate a 35-acre field or set, then it must be divided into two sets of equal size (17.5 acres) or similar size (20 and 15 acres). Combine the irrigation time for each set to get the total irrigation set time. **It is recommended not to exceed a total time of 40 hours; 24 hours is preferred.** Ideally, sets should be reduced to 24- to 30-hour total irrigation set times.

When possible, locate surge valves at risers, valves, or bonnets. It is preferable not to have any lay-flat pipe supplying irrigation water to a surge valve due to valve motion. A surge valve can be used for multiple sets in a field. For example, a 40-acre field can be divided into four 10-acre sets and the valve used for two sets at a time, then switched to the other two. Place a short piece of rigid pipe in the valve; secure with poly pipe tape to make it easier to connect pipes. Use pipe clamps to secure the lay-flat pipe to the valve between surge sets.

Anatomy of a Surge Valve

A surge valve consists of an electronic controller and an aluminum mechanized valve that diverts water from one side to the other (referred to as right and left sides). P & R Surge Systems valves have advance and soak cycle modes. The valve starts out in the advance mode and then moves into the soak mode after the advance time is reached. It continues indefinitely in the soak mode until it is shut off.

Programming the advance time in a surge valve is critical. Once you reach the soak phase in the program, you cannot go back to advance phase. Set the anticipated time of the advance phase slightly less than the actual advance time observed in the field. In many cases, surge irrigation advance time is about half the normal time.

Use CHS to plan the surge time. For example, if a CHS plan calls for a 24-hour set time, then expect a 12-hour advance. However, the advance time is highly variable, so use your experience to determine the advance; monitor the advance during the first irrigation until you know or can predict it. For example, if a 24-hour set is required to put on 2.5 ac-in application depth and you observe that the advance is halfway through the field at 9 hours, then adjust the advance time down from 24 to 18 hours.

Guidance on setting a surge valve for different soils and conditions is provided below. However, there is a no hard-and-fast rule; experiment with the valve to get the best results.

Sandy Soils

Surge valves are especially useful in sandy soils, as the challenge with these soils is minimizing deep percolation and getting water through the furrow. Set the valve as normal, but expect a longer advance time than 50 percent of the irrigation set time. Use default cycle times. Increasing the number of cycles may improve irrigation.

Silt Loams

Surge valves are especially useful in silt loams that seal. In silt loams that do not seal and infiltrate well, use the same process as for sandy soils. For silt loams that seal, you likely will need to make substantial changes to the program. In the sealing silt loams, the advance is often much less than expected. For example, for a set time of 24 hours, the advance may be completed in 6 hours. Adjust the advance time to 5 hours and increase the number of advance phases by one or two. Operate the valve in soak mode for the remainder of the irrigation set. Reduce the flow rate to increase opportunity time.

Clay Soils (Cracking)

In cracking soils, the surge valve should be used only in the advance mode. Set the advance time to the total irrigation set time. Do not operate in soak mode. Reduce the number of advance cycles to only three or four. The surge valve works in clay soil because, in the off-cycle, the soil cracks seal up and allow the advance to quickly move through the furrow on the next advance. **Table 1** lists recommended advance settings.

Table 1. Surge valve STAR Controller recommendations for clay soils.

Advance setting	Default cycles/side setting	Custom cycles/side recommendation
Input by user	Under custom tab	Use down arrow to adjust
5	4	4-1 (3) total
10	5	5-2 (3) total
15	6	6-2 (4) total
20	6	6-2 (4) total
30	6	6-2 (4) total

The number of cycles per side should equal the default setting minus two. Total cycles per side should never be less than three.

Unbalanced set sizes

Two sets of different sizes can still be surge irrigated. For example, if one set is 15 acres and another is 20 acres, the valve can be adjusted to increase the advance times for each set. In this example, the valve will divert water to the 15-acre set 43 percent of the time, and it will divert water to the 20-acre set 57 percent of the time. This setting can be input directly into the valve through a custom menu.

Operation

Surge valves operate on solar power and a battery. Check the voltage of the battery and solar panel through the custom menu (hold the button down for three seconds on a P & R). Valve controllers need to be charged and turned off in the off-season. During the season, shut them off after an irrigation event, or else they will continue to move the valve and drain the battery. The oscillation of the valve can dislodge it from the water source, so use a circle lock or horseshoe clamp to secure it. When starting irrigation, change the valve from the right or left side using the change button; this does not advance the program when done during the first advance cycle. The valve pauses before switching completely over. This setting can be changed in most valves if high flow rates cause a water hammer.

The benefits of surge irrigation are not always apparent from visual observation alone. Soil moisture

sensors or monitoring units can be useful in evaluating effectiveness and optimizing surge irrigation program settings. Surge reduces the advance time in some situations and increases it in others. Reducing the advance time results in water savings. An increased advance time typically indicates that more water has been applied to the soil; likely, fewer irrigations will be necessary, which means less total irrigation water will be needed to meet crop water demand.

Summary

Surge irrigation is the intermittent application of water in furrow irrigation to improve down-furrow efficiency and reduce deep percolation. It uses a programmed, automated valve with lay-flat pipe that is planned with set sizes. Surge irrigation must be adapted and adjusted to field conditions and soil type. Plan surge irrigation sets for a total irrigation time of 24 hours, and use CHS to determine lay-flat pipe hole-punch plans.

For More Information

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Acknowledgement: This is a joint publication with the University of Arkansas.



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Publication 3509 (POD-08-20)

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Produced by Agricultural Communications.

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Extension Service of Mississippi State University, cooperating with U.S. Department of Agriculture. Published in furtherance of Acts of Congress, May 8 and June 30, 1914. GARY B. JACKSON, Director