SURGE IRRIGATION INFORMATION

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What is Surge Irrigation?

Surge irrigation is the intermittent application of water used to improve distribution uniformity along a furrow. It works on the principle that dry soil infiltrates water faster than wet soil. When soil is wet is seals because the soil particles at the surface consolidate. When water is re-introduced in a furrow that has been wet, the wetting front moves quickly past the wetting zone to dry soil. At the wetting interface, dry soil slows the advance. This phenomena allows for a faster advance through the field with less deep percolation and better application uniformity. The end result, therefore, 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 is performed through a program of cycle times that account for the advance of the furrow, they must be set by the user. Some tail water is necessary with surge irrigation for it to be effective. The intermittent application reduces the tail water 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 and has more time to infiltrate before it leaves the furrow.

When set properly, very little tail water leaves the furrow. A valve that simply moves from one set to another at a uniform or constant time interval is not surge irrigation.

Definitions

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

Continuous Flow: Irrigation flow in a furrow that does not stop from start to finish, before the required application depth is applied

Recession time: Time for the wave front to recede from the furrow. Essentially this is when the majority of the tail water 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 advance has completed where the remainder of the set time is used to meet the required application depth.

Application depth: The depth of irrigation applied during a 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 the second before increasing.

On-time: The time water is applied to one side

Off-time: The time water is not applied to one 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, this 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 set, the total time is 48 hours and the sets should be divided into three sets.

Computerized Hole Selection for Surge Irrigation

If lay flat irrigation pipe is going to be used with surge irrigation, as is common in mid-south 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) to gain the full benefit of surge irrigation. CHS 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 provides for uniform distribution of irrigation water across the crown of the pipe (along the pipe). Thus allowing the surge valve to improve the down furrow uniformity (top to bottom of field distribution uniformity will be improved). Surge sets require higher flow rates than would generally be planned for in continuous flow irrigation sets. So proper planning the layflat pipe plan for surge is critical to success. Most likely if CHS plans been developed without surge, it will require new plans for surge irrigation. Surge sets will have twice the flowrate of a continuous flow set.

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 sub-divided into two sets of equal size (17.5 acres) or similar size (20 ac and 15 acre). The time to irrigate each set is combined for the total irrigation set time and **it is recommended not to exceed a total time of 40 hours, 24 hours is preferred**. Ideally sets should be reduced to 24-30 hour irrigation times (total irrigation set time).

When possible, locate surge valves at risers, valves, or bonnets. It is preferable not to have any lay flat pipe suppling irrigation water to a surge valves 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, ten 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 and secure with poly pipe tape, to ease pipe connection making. 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. This is referred to as right and left side. P and R surge 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 has been reached. It continues indefinitely in the soak mode until it is shut off. The most critical setting is programming the advance time correctly in a surge valve. Once you reach the soak phase in the program you cannot go back to advance phase. Set the anticipated time of the advance phase just slightly less than the actual advance time observed in the field. In many cases the time that is normally taken to advance through the field will be about half for a surge irrigation. Use a CHS plan to establish the initial advance time and total time required for irrigation (ie. the advance time plus the soak time) For example if a CHS plan calls for a 24 set time for your expected application depth, then expect a 12 hour advance. However, the advance time is highly variable and the user must determine the advance from experience. The advance should be monitored during the first irrigation until it is known or can be predicted. For example assume that a 24 hour set is required to achieve a 2.5 ac-in application depth. If it is observed that the advance is halfway through the field at 9 hours, then adjust the advance time down from 24 to 18 hours. Below is guidance in how to set a surge valve for different soils and conditions, however there is no hard fast rule and sometimes the user must experiment with the valve to obtain the best results is necessary.

Sandy Soils

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

Silt Loams

Surge valves are useful in silt loam soils, especially in fields that tend to seal. In these sealing soils, the surge valve allows for more water to be applied than can be done without surging. For silt loams that seal, it will likely be necessary to make substantial changes to the program. Essentially the valve is operated to increase the opportunity time by operating mostly in the soak phase. Often in silt loams that seal, the advance will be 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, increase the number of advance phases by +1 or +2. Operate the valve in soak mode for the remainder of the irrigation set. Reduce the flow rate to increase opportunity time or decrease the pre-set soak time. Expect irrigation set times to increase in sealed silt loams that are surge irrigated, but the result will be more effective irrigation (more applied) or fewer irrigation sets. Experience has shown that surge irrigation can often double the application depth that can be applied to a sealed silt loam.

In silt loams that do not seal, reduced infiltration is not typically a problem. Under these situations, the surge valve should be set the same as for fields with sandy soils.

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. Also reduce the number of advances so that there are only 3-4 advance cycles. The surge valve works in a 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. Recommended advance settings are shown in Table 1.

Table 1: Surge Valve Star Controller Recommendations for Clay Soils

It is recommended that the number of cycles per side equals the default setting minus two. The total cycles per side should never be less than three.

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	**5**	**6-2 (4)** total
20	**5**	**6-2 (4)** total
30	**5**	**6-2 (4)** total

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 43% of the time the valve will be diverting water to the 15 acre set and 57% of the time it will divert water to the 20 acre set. This can be input directly into the valve through a custom menu.

Operation

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

Use of soil moisture sensors or a soil moisture monitoring unit can be useful in evaluating the effectiveness and optimizing surge irrigation program settings. In some cases surge can reduce the advance time, in other situations it will increase the advance time. Reducing the advance time will result in a water savings. An increased advance time typically indicates that more water has been applied to the soil, likely indicating that fewer irrigations will be necessary, overall resulting in less total irrigation water needed to meet crop water demand. Thus the benefit of surge irrigation is not always apparent from visual observation alone.

Summary

Surge Irrigation is the intermittent application of water in furrow irrigation for the purpose of improving down furrow efficiency and reducing deep percolation. The use of a programmed automated valve is used with lay flat pipe that has been planned with set sizes Surge irrigation must be adapted and adjusted to field and soil type conditions. Plan surge irrigation sets for a total irrigation time of 24 hours and use CHS to determine lay flat pipe hole punch plans.
