



EM4826

Surge Flow Surface Irrigation

Surge flow is a surface irrigation technique that can save water and works well under Washington conditions. It can be defined as the intermittent application of water to furrows, rills, or borders in a series of on and off periods of constant or variable time spans. These cyclic applications, termed “hydraulic surges” (thus, surge flow), are generally applied to a field through gated pipe systems or buried pipelines with furrow risers. Surge gates can be fabricated for lined concrete ditches with ports.

Increased Flexibility

Surge flow, while not the perfect surface irrigation method, does offer increased flexibility and many advantages over traditional practices. For example, growers can often complete irrigations in the same number of hours as under conventional irrigation techniques, but waste much less water. Growers can reduce variations in advance rates from furrow to furrow, and often can increase the length of run that can be irrigated with surge flow.

Surge flow requires automation for economical operation. The commercial development of controllers and valves has led to widespread adoption of surge flow in many areas in the United States with good results. It is appropriate for any land that is, or could be, surface irrigated in Washington. Surge irrigation is more easily adapted when slopes are gradual and consistent both across and down a field.

An automated valve (electronically or pneumatically actuated) and a controller are added to a conventional application system to switch the water from one set to another at the end of a surge. The valve controller is programmed to apply water to a given area (1 set) for a time period (usually 1 to 3 hours—based on field length and soil intake rates), then the water is diverted to a second area for an equal period of time.

At the end of the second time period, the automatic valve diverts the water from the second set back to the first set. The water travels fairly quickly, with relatively little infiltration, over the already wet soil to the dry area of the furrow where most of the intake occurs during that surge. Thus, the valve alternately applies water to each of the two areas until the irrigation is completed. After water advances to the end of the field, growers can continue to surge water between sets in a cut backcycle. Since growers are pulsing water between fully advanced furrows, the rate of inflow is reduced by 50% and the corresponding tailwater also is reduced.

Surge Flow Advantages

The advantages of surge flow surface irrigation fall into three broad categories:

1. Surged water advances to the end of the field at least as rapidly as continuous flow irrigation with the same inflow rates but with a smaller volume of water, thus greatly improving the uniformity of application during the advance phase.
2. Growers can reduce tailwater and deep percolation losses and can improve application efficiencies under proper automated management.
3. Surge irrigation provides an inexpensive means of automating, managing, and accurately controlling the surface application of water to a field while reducing labor requirements.

The “surge” effect on surface irrigation is primarily due to reducing the soil intake rates and improving the hydraulic characteristics in the previously wetted portions of the furrows. This reduction occurs almost immediately after the initial dewatering of the soil surface. Lowering the infiltration rates may also allow a grower to slightly reduce

furrow inflow rates from what was previously required and reduce soil erosion or improve water penetration on steeper lands. Light, frequent irrigations are also possible with this method, which can be advantageous when “irrigating up” a crop, irrigating shallow rooted crops (such as mint), or other times when heavy water applications are not warranted.

What’s New about Surging

Surge flow is really not a new idea, as many irrigators use a similar practice by reintroducing water into a furrow or rill 12 to 48 hours after the initial irrigation to push water to the end of the run, particularly early in the spring or just after a cultivation. The new aspect is surging the water at relatively high frequencies several times a day.

Surges can be alternated between 3 or more sets; however, existing commercial hardware basically limits use to two equal sets. Thus, a field is divided into an even number of sets and irrigated two sets at a time. Uneven field shapes can be irrigated, but each set should receive equal amounts of water so that the on-farm water delivery rate remains constant. A second “delivery” pipeline is often required to supply water to a surge valve or to break a field into sets. Because different crops require different amounts of water, irrigators should design each system to cover a single crop or field rather than trying to cover several crops with the same installation.

The total time for a valve to go through one on and one off cycle is referred to as the “cycle time.” The fraction of the cycle time that the water is on is called the “duty cycle.” For example, a set with a 2-hour on time and a 2-hour off time has a cycle time of 4 hours and a duty cycle of 0.5.

Most commercial controllers automatically increase the on times of successive surges as the water travels longer and longer distances to reach the dry sections. Selection of the proper on times for a sequence of surges will optimize advance distances of each surge down the furrow and is important in maximizing efficiencies. Many controllers have preprogrammed cycle time options that will fit many field situations. The off times should probably exceed 30 minutes in most fields during water advance. The correct program for a field may change from irrigation to irrigation and from year to year. Some seasonal trial-and-error adjustments should be expected.

Increasing Efficiencies

Cutting back the furrow or rill inflow rates by 30% to 50% after water reaches the end of the field can further increase efficiencies and reduce runoff. Some valves/controllers can stop the surging and “center” the valve to split the water equally between the two sets into a cut-back mode. However, doing this requires careful management. Pipelines must be able to supply water equally to all rills at the reduced flow levels.

Another option is the use of “time-averaged” cut-back, where the valve is surged at cycle times as low as 10 to 20 minutes, and the averaged furrow flow rate is one-half of the instantaneous rate. The second cut-back option is often preferred for pipelines lying on slopes exceeding 0.1%.

Studies in Washington have shown that water can be applied more evenly by intermittent surges than by steady flow. Water under surge flow advances to the end of the field in the same elapsed clock time as continuous flow, but with half as much water. This translates into increased uniformity and water savings. Overirrigation at the top of the field is reduced. Under proper management, application efficiencies are increased and soil erosion can be less, since the water is in the furrow for less time than in the continuous flow furrow. Also, less furrow outflow means less inflow into the tailwater and less erosion of the tailwater ditch. If surge flow is poorly managed, however, the procedure can be less efficient than use of conventional flow, and more erosion can occur. Surge flow also works better than traditional surface irrigation methods when there are crop residues in the furrows.

Research in Washington

Investigations conducted from 1982-1986 on another variation of surge flow used a daily surge flow irrigation program to water sweet cherries with only one furrow per tree row. The system was set up and operated similar to a trickle or drip system. The number of surges per day was varied depending on estimated tree water use. Measured inflow and outflow volumes indicated that 80% or more of the water infiltrated the soil. The success of this project showed that it is possible to efficiently and economically automate large orchard and vineyard acreages (one furrow / plant row spaced 10 to 20 feet apart) without the relatively high cost

of a trickle system. However, water must be available daily for irrigations.

In field demonstrations conducted on hops in 1987 near Prosser, surge flow was compared with traditional surface irrigation in the same field. Based on measured in-flow and out-flow volumes, the average percentage of total water applied which infiltrated was approximately 78% (22% runoff) using surge flow, and 57% (43% runoff) using the continuous flow for all irrigations. Soil water monitoring indicated that both methods applied adequate water to fill the rootzone in all irrigations on both yards. Yield data indicated no differences in total yields or quality of hops between the surged and the continuous irrigated portions of the field.

Installation

Because the technology is new to most people, growers should try surge flow on only one or two fields to learn how it might best fit into their operation. Installation of several systems without any prior surge experience is discouraged. It takes time to train irrigators to use the new systems. Irrigators need to work with an actual system to gain confidence in programming the controllers before the full benefits are realized.

The systems are generally easy to install and operate. Existing valving is designed for gated pipe installations, but it is fairly simple to adapt valving to existing PVC or concrete pipelines with a minimum of modification. A 4-inch valve will have a capacity of about 300 gpm, 6-inch about 700 gpm, 8-inch about 1200 gpm, and 10-inch about 2000 gpm.

The same controller fits all surge valve sizes made by that manufacturer.

Costs of the automated irrigation systems on farms having existing buried pipelines with furrow risers are typically about \$150 per acre. New systems may range in cost from \$250 to \$450 per acre. Individual valves will cost from \$400 (4-inch) to \$800 (10-inch) while each controller will be about \$600 to \$800. Since a single controller can be used on several valves in a farm water rotation, per acre costs may be lower.

Information on surge flow can be obtained from your local WSU Cooperative Extension office, the Washington State University Irrigated Agriculture Research and Extension Center in Prosser, or from the Natural Resources Conservation Services. Various levels of cost sharing may be available in some areas under CFSA (Consolidated Farm Service Agency) programs.

Information on soil moisture monitoring and crop evapotranspiration from Washington's Public Agricultural Weather Stations (PAWS) and Washington Irrigation Scheduling Expert (WISE) are available on the Scientific Irrigation Scheduling (SIS): web page <http://sis.prosser.wsu.edu>

Drought advisories and other Washington State University Cooperative Extension Bulletins are available online at <http://pubs.wsu.edu> Type "drought" in the search box for downloadable files.

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