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Nebraska Surge Irrigation Trials

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This NebGuide gives the results of university research on surge irrigation over a six-year period.

Surge irrigation systems are used by a number of Nebraska irrigators. A programmable surge valve is incorporated into the system to intermittently apply water to gates that are open on either side of the valve. The result, in many cases, is improved irrigation performance because of a soil sealing effect caused by the intermittent wetting. Other potential benefits include reduced runoff and enhanced labor management. Field trials and irrigator experience in Nebraska indicate that none of these benefits are guaranteed at a particular site, and that surge irrigation results vary with soil, topographic, and management characteristics.

University of Nebraska–Lincoln Extension evaluated surge irrigation over a six-year period. The tests compared continuous flow irrigation to surge irrigation on a variety of soils and field conditions in Nebraska. In all, 26 field scale tests were conducted, and the results are summarized in *Table I*. Surge irrigation was never less effective than continuous flow irrigation, when compared in terms of advance time reductions. The average reduction in the time required to advance water to the downstream end of the field using surge irrigation

Table I. Surge irrigation test results.

Trial Year	*Row Identity Soft/Hard*	*Soil Type*	*Irrigation Number*	*Advance Time Reduction (%)*
6	soft	Hastings silt loam	1st	0
1	soft	Hastings silt loam	1st	0
5	soft	Hastings silt loam	1st	23
6	soft	Hastings silt loam	2nd	0
3	soft	Hord silt loam	1st	52
3	hard	Hord silt loam	1st	0
2	soft	Hord silt loam	1st	0
2	soft	Hord silt loam	2nd	0
4	hard	Keith silt loam	1st	20
3	soft	Keith silt loam	1st	29
4	soft	Keith silt loam	1st	36
3	hard	Keith silt loam	1st	0
4	soft	Hord silt loam	1st	0
4	hard	Hord silt loam	1st	0
6	soft	Holdrege si. lo. and Butler si. cl. lo.	1st	21
6	soft	Holdrege si. lo. and Butler si. cl. lo.	2nd	19
5	soft	Tripp very fine sandy loam	1st	0
5	soft	Tripp very fine sandy loam	1st	40
6	soft	Tripp very fine sandy loam	1st	25
6	soft	Tripp very fine sandy loam	1st	50
6	soft	Tripp very fine sandy loam	1st	35
5	soft	Tripp very fine sandy loam	2nd	20
6	soft	Tripp very fine sandy loam	2nd*	0
6	soft	Tripp very fine sandy loam	2nd*	38
6	soft	Tripp very fine sandy loam	3rd	14
6	soft	Tripp very fine sandy loam	3rd	0

* Re-ditched

compared to continuous flow was approximately 17 percent with a range of 0 to 52 percent. In almost half the trials (12 of 26) no difference between surge and continuous flow advance time was detected. Most of the tests were conducted during the first irrigation, where the average advance time reduction was approximately 18 percent. Four tests were conducted during the second irrigation and two of those resulted in a significant decrease in advance time using surge irrigation. Only one in four tests on hard (wheel traffic) furrows resulted in a reduced advance time.

Soil texture and structure play an important role in the ability of surge to reduce the time required to advance water through a field. Soils with acceptable advance times due to conventional irrigation practices may not exhibit a decrease in advance times due to surge irrigation. However, soils with high intake rates may show substantial advance time reductions due to surge irrigation. With any soil, a reduction in advance time with surge flow is more likely to occur when infiltration rates are greatest. This often occurs with coarse-textured soils and during the first irrigation of the season. As with conventional irrigation practices, any difference in soil preparation, soil compaction and soil moisture content during field operations or during irrigation can affect the results of using surge irrigation.

The field trials summarized in *Table I* do not necessarily indicate the ultimate success of surge irrigation. If an irrigator is strictly interested in runoff management, reductions in advance time will not indicate the success of the system. Likewise, labor management was not considered in the trials summarized in *Table I*. It is also important to not confuse a percent change in advance time with a percent change in total pumping, application efficiency, or other indicators of irrigation system performance. For example, if the advance time changes because surge flow is used, but the irrigator allows water to flow for the same cumulative time from each gate at the same rate (same number of gates flowing at any given time) then the amount of water pumped will remain the same.

The Nebraska trials also led to recommendations for the amount and duration of advance and cutback cycles. Each cycle is an on-off sequence for one side of the valve. Advance cycles are those that begin as long as dry portions remain in the furrow. Cutback cycles are those that occur after the entire furrow length has been wetted at least once. Advance cycles become progressively longer while cutback cycles are of constant duration. The cycle durations and number of advance cycles used should be based on the soil and field characteristics. Long fields and fields with high intake soils will require more advance cycles, possibly five to six, while shorter fields with low intake soils will need fewer cycles, three to four. A rule of thumb for the number of advance cycles is to advance water a distance equal to that fraction of the number of advance cycles used during each cycle. For example, with four advance cycles water should advance one-fourth of the field distance during each cycle.

The Nebraska trials provided enough information to develop a relationship between the time required to advance water to the first advance location and the time required for subsequent cycles. The time required to move the water the desired distance for the first cycle (1/4 the field length if using four advance cycles, for example) is the first cycle on-time. For the second and subsequent on-times, multiply the factors given in *Table II* by the first cycle on-time. Following the final advance cycle, set the valve for cutback cycles. During cutback, the valve cycles the water at a shorter frequency until irrigation is complete. A cutback cycle time of 65 percent of the last on-time is recommended.

All commercially available surge valves are pre-programmed with some slight variation of the values in *Table II*. Thus, it is unlikely that individual irrigators will have to make the following calculations. The following example may be helpful to those who are unfamiliar with the expanding cycle time concept. The values in *Table II* could be used if the pre-programmed values are not performing satisfactorily. The example shows how to calculate surge cycle times for a 1,000 foot field with four advance cycles. Assume the water advances 250 feet in an average of 20 minutes. Using *Table II*, the remaining cycle times may be calculated:

Cycle Type and Number	*On-Time Factor x First Cycle On-Time*	*On-Time for Each Cycle*
Advance Cycle 1	1.0 x 20 =	20 minutes per side
Advance Cycle 2	1.9 x 20 =	38 minutes per side
Advance Cycle 3	2.6 x 20 =	52 minutes per side
Advance Cycle 4	3.1 x 20 =	62 minutes per side
Each Cutback Cycle	2.0 x 20 =	40 minutes per side

If water does not reach the end of the field by the last advance cycle, adjustments may be necessary. Options include changing the number of advance cycles or changing the number of gates opened on each side of the valve. Cycle times and the number of cycles can be adjusted for each set of conditions.

Table II. Surge irrigation on-time factors.

Cycle No.	*Fraction of Field* 4 advance surges	5 advance surges	6 advance surges	*On-Time Factor*
1	1/4	1/5	1/6	1.0
2	1/2	2/5	1/3	1.9
3	3/4	3/5	1/2	2.6
4	1	4/5	2/3	3.1
5	—	1	5/6	3.4
6	—	—	1	3.8

Cutback on-time factor is always 65 percent of the final advance cycle on-time factor.

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