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NF94-177 Nebraska Surge Irrigation Trials

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Nebraska Surge Irrigation Trials

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Surge irrigation is a relatively new addition to many furrow irrigation systems. 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.

The University of Nebraska evaluated surge irrigation in a series of trials from 1983 to 1989. 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 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

Table I. Surge irrigation test results.

Year	*Row Identity Soft/Hard*	*Soil Type*	*Irrigation Number*	*Advance Time Reduction (%)*
1989	soft	Hastings silt loam	1st	0
1983	soft	Hastings silt loam	1st	0
1988	soft	Hastings silt loam	1st	23
1989	soft	Hastings silt loam	2nd	0
1986	soft	Hord silt loam	1st	52
1986	hard	Hord silt loam	1st	0
1985	soft	Hord silt loam	1st	0
1985	soft	Hord silt loam	2nd	0
1987	hard	Keith silt loam	1st	20
1986	soft	Keith silt loam	1st	29

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.

1987	soft	Keith silt loam	1st	36
1986	hard	Keith silt loam	1st	0
1987	soft	Hord silt loam	1st	0
1987	hard	Hord silt loam	1st	0
1989	soft	Holdrege si. lo. and Butler si. cl. lo.	1st	21
1989	soft	Holdrege si. lo. and Butler si. cl. lo.	2nd	19
1988	soft	Tripp very fine sandy loam	1st	0
1988	soft	Tripp very fine sandy loam	1st	40
1989	soft	Tripp very fine sandy loam	1st	25
1989	soft	Tripp very fine sandy loam	1st	50
1989	soft	Tripp very fine sandy loam	1st	35
1988	soft	Tripp very fine sandy loam	2nd	20
1989	soft	Tripp very fine sandy loam	2nd*	0
1989	soft	Tripp very fine sandy loam	2nd*	38
1989	soft	Tripp very fine sandy loam	3rd	14
1989	soft	Tripp very fine sandy loam	3rd	0

* Re-ditched

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 having acceptable advance times with conventional irrigation practices may not exhibit a decrease in advance time 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 highest. 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 during each cycle a distance that is equal to that fraction of the number of advance cycles used. 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.

		Fraction of Field		
Cycle No.	*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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