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Fertigation through surge valves

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Quick Facts

Fertigation through a surge valve is a quick, efficient way to apply liquid formulations of fertilizers to a crop.

Surge irrigation and its associated fertigation, conserve water and prevent some degradation of groundwater.

Introduction

Surge irrigation has been effective in increasing the application efficiencies and in reducing deep percolation losses of irrigation water. The principle of surge irrigation is switching the water back and forth between irrigation sets by an automated valve. The valve may be set for different lengths of out-times, or times needed to advance the water through the length of run. At the end this part of the irrigation, the valve changes to shorter time lengths to switch back and forth between the sets called cutback, or soaking cycles. If correct out-times and cutback times are set, runoff (tail water) and deep percolation are minimized. This method of irrigation advances the water quicker and more efficiently through the field than if the field is continuously irrigated.

Fertigation, or adding fertilizer through irrigation water, has been a practice of sprinkler irrigators and conventional surface irrigators with some success for several years. Depending on the system and the contour of the land, the fertilizer applications may vary considerably in efficiency. If an irrigator attempts to add fertilizer through conventional surface irrigation, more runoff of the fertilizer and less uniformity of application may result than if surge fertigation is practiced. However, the irrigator must be aware that some fertilizer runoff from a field is possible even with surge fertigation.

The ability to add fertilizer through the surge valve system may be a significant advantage. Liquid nitrogen fertilizer may be added through the system during the next-to-last cutback cycle. At this point of the surge irrigation, the irrigation set should have been wetted through the entire length of run, and the soaking, or cut-back cycle should almost be complete. Reserve the last cutback cycle to flush any excess fertilizer solution out of the system and move some of the applied fertilizer into the upper portion of the soil profile. If the calculated flow rate of the liquid fertilizer is too great for the capacity of the application system, the fertigation application may be split between two or more cutback cycles as long as the last one is reserved for flushing the system and moving the fertilizer into the soil.

Table 1. Liquid Nitrogen Fertilizers

Desired Amount Of Nitrogen lbs./A	Amounts of Solution to Apply gal./A 32-0-0	28-0-0	82-0-0
10	2.8	3.3	2.4
20	5.6	6.7	4.7
30	8.5	10.0	7.0
40	11.3	13.4	9.4
50	14.1	16.7	11.7
100	28.2	33.4	23.5

1 gallon of 32-0-0 contains 3.54 lbs. of N and weighs about 11.1 lbs.
1 gallon of 28-0-0 contains 2.99 lbs. of N and weighs about 10.7 lbs.
1 gallon of 82-0-0 contains 4.25 lbs. of N and weighs about 5.2 lbs.

Phosphorus does not move readily in the soil. Therefore, if liquid phosphorus is added to a field, add the material at each cutback cycle or at the beginning of the cutback irrigations so so the phosphorus moves into the profile as much as possible. Reserve the last cutback cycle to flush the system.

Advantages to adding the fertilizer through the surge valve are many when the system is designed and installed properly:

1. The fertilizer is added rapidly and efficiently.
2. Deep percolation losses of nitrogen fertilizer are minimized.

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3. Gaseous losses of nitrogen are minimized.
4. No powered equipment is run through the field; fuel is saved.
5. The fertilizer may be added when the crop needs it.

Disadvantages:

1. Calibrate the flow rate of the liquid fertilizer, which is analogous to calibrating a fertilizer spreader.
2. Some "pitting" of the metal components of the delivery system may occur if the last cutback cycle is not saved to flush it. Ammonium in liquid fertilizer can combine with various salts from the aqueous solution that subsequently corrode metals, particularly aluminum.

There are two ways to add liquid fertilizer through the surge valve: 1.) allow it to flow by gravity through some form of a constant head metering valve at some convenient point before the surge valve, such as into an alfalfa valve or an open channel; 2.) employ a powered injector system before the valve. This is necessary when a head of water must be overcome by the fertilizer application.

Answer these questions before applying the fertilizer through the surge valve:

1. How many pounds of the fertilizer are needed per acre?
2. How many gallons of the material are needed?
3. What is the weight per gallon?
4. What is the acreage under the surge valve?
5. How long is the cutback cycle in minutes?
6. What is the application (flow) rate?

The tables show several commonly used liquid formulations of fertilizer and the gallons needed per acre to achieve the desired application rate. Table 1 covers several nitrogen compounds, and Table 2 presents the data for 10-34-0, a liquid polyphosphate formulation. Since 10-34-0 contains some nitrogen, Table 2 also presents the nitrogen amounts to add as the phosphorus is added.

The following example shows how to determine the required flow rate for 32-0-0 in an example where we want to apply 40 pounds of nitrogen per acre to a 4-acre surge set.

Table 2. Liquid Phosphorus Fertilizer

Desired Amount Of Phosphate lbs./A	Applied Amount Of Nitrogen lbs./A	Amount of Solution to Apply gal./A
10	2.9	2.6
20	5.8	5.2
30	8.8	7.7
40	11.6	10.3
50	14.5	12.9
100	29.0	25.8

1 gallon of 10-34-0 contains 2.88 lbs. of Phosphate, 1.14 lbs. of N, and weighs about 11.4 lbs.

Example 1.

lbs. of N per acre needed: ---------- 40
Acres per surge set: ---------- 4
Cutback time, minutes: ---------- 30
Material to be applied: ---------- 32-0-0

In Table 1, we find that we need about 11.3 gallons of 32-0-0 to supply 1 acre with 40 pounds of nitrogen. To obtain the amount required for 4 acres, multiply this value by 4 to equal about 45 gallons for the entire surge set. Since the surge valve irrigates half of the set at one time, 22.5 gallons is applied to 1/2 of the field in 30 minutes' time. Therefore, the flow rate is 22.5 gallons divided by 30 minutes, or 0.75 gallon per minute.

The flow rate can be set by using a marked container and a watch with second marking capabilities. By timing the flow and adjusting the discharge valve, the required flow rate can be set closely. If the applicator uses a commercial injector, the flow rate may simply be dialed in.

Excellent results have been obtained with additions of liquid formulations of ammonium polyphosphate (10-34-0) to phosphorus-loving crops such as alfalfa. An example of working with this material is:

Example 2.

lbs. of P_2O_5 per acre needed: ---------- 50
Acres per surge set: ---------- 6
Cutback time, minutes ---------- 40
Material to be applied: ---------- 10-34-0

In Table 2, about 12.9 gallons are needed to supply 1 acre with 50 pounds of phosphate. Multiply this value by 6 to obtain the total amount of 10-34-0 needed. Divide by 2, since the surge irrigation irrigates 1/2 of the surge set at one time. The amount of 10-34-0 required for 1/2 of the surge set is 38.7 gallons (round up to 39 gallons). The flow rate is 38.7 gallons divided by 40 minutes, or almost 1 gallon per minute. If a farmer applies 39 gallons of 10-34-0, it will take almost 15 pounds of N per acre.

If the material the farmer wishes to apply is not in the tables, make sure the following questions can be answered in addition to the data above:

1. What is the weight of the material per gallon?
2. What is the percent of the fertilizer unit of the material? (% x weight per gallon = lbs. of fertilizer per gallon).

A farmer may calculate the gallons of the material needed to apply per acre from these values.

Table 3. Examples

(1) Acres per Surge Set	lbs. of N Needed/	Material to be used	(2) Gallons needed per 1 acre	(1)/2x(2) = (3) Gallons Needed per 1/2 of Surge Set	(4) Minutes, Cutback Cycle	(3)/(4) Gallons/min., Flow Rate
5	30	28-0-0	10.0	25.0	50	0.5
3.5	50	32-0-0	14.1	24.5	40	0.6
6	60	32-0-0	16.9	50.7	50	1.0
4.5	20	Anhydrous Ammonia, 82-0-0	4.7	10.5	30	0.35

Following the first example, we have 5 acres under the surge valve, and we need to apply 30 lbs. of N/Acre. We'll use 28-0-0. From the table, we see that 10 gallons per acre will supply that acre with 30 lbs. of N. Then, we need to divide the "Acres per Surge Set" (1) by 2. Then, multiply this value by "Gallons Needed per 1 Acre" (2) to obtain "Gallons Needed per 1/2 of the Surge Set" (3). Since we know the time for the cutback cycle (4), we can calculate the flow rate to get the rate in "Gallons per Min." (3)/(4). The flow rate is 0.5 gallons per minute. In other words:

$$\frac{\text{lbs. fertilizer needed}}{\text{wt./gallon} \times \text{fertilizer \%/gallon}} \times \frac{\text{acres/set}}{2} + \text{min., cutback} = \text{flow rate, gpm}$$

Example 3.

An irrigator needs to add a hypothetical solution of potassium chloride through the surge valve to supply an alfalfa crop with potash (K_2O). The solution weighs 11.2 pounds per gallon and contains 28 percent potash (K_2O). How many pounds of potash are in 1 gallon of the solution? 28/100 X 11.2 = 3.14 lbs. of potash per gallon.

Additional examples are in Table 3. Follow these for practice.

Apply these principles to side-roll sprinkler systems; inject the fertilizer into the sprinkler at some point during the irrigation. Near the conclusion of the irrigation, terminate the injection of the fertilizer and flush the system with the remainder of the irrigation water.

If a surge irrigator follows the above guidelines, expect to see rapid, efficient fertilizer additions that may result in increased fertilizer use efficiencies and greater yields. Also, less nitrate nitrogen may be leached into ground and surface waters with surge fertigation than under conventional fertilized and irrigated operations.

Resources

Bausch, W.C. 1985. Chemigation: recommended safety devices. Colorado State University Cooperative Extension Service in Action No. 2.801.

Follet, R.H. 1984. Fertigation: applying fertilizers through irrigation water. Colorado State University Cooperative Extension Service in Action No. .512.

Peairs, F.B. and S.D. Pilcher. 1984. Applying pesticides through center-pivot irrigation systems. Colorado State University Cooperative Extension Service in Action No. 4.713.