

Cooperative Extension
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Colorado State University

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To: Certain Area Farmers
Re: Service in Action

The enclosed (following) Service in Action sheet contains some information on applying liquid fertilizer with irrigation water. We have worked with farmers in the Grand Valley to study this method of fertilizer application.

Liquid nitrogen fertilizer (UAN, 32%N) was added through a surge valve during the next-to-last cutback cycle. At this point of the irrigation, the set was wetted through the entire length of run, and percolation into the soil profile was minimized. The last cutback cycle was used to flush the system clear of the fertilizer and to move the fertilizer further into the root zone.

Corn yields were increased by 12% by use of surge fertigation when compared to a conventional irrigation and fertilization treatment. In addition, residual nitrogen in the upper 2 feet of the profile was increased by 14% at the end of the season. Soil samples showed uniform distribution of the nitrogen through the length of the run. The fertigation system increased N efficiency, reduced nitrate contributions to groundwater, and increased yields.

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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.

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 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.
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 the 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.

Example 1. -----lbs. of N per acre needed: ----- 40 Acres per surge set: ----- 4 Cutback time, minutes: -----

In Table 1, we find that we need about 11.3 gallons of 32-0-0 to supply one acre with 40 pounds of nitrogen. To obtain the amount required for four acres, simply multiply this value by four 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 are applied to one-half 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.

Table 1. Liquid Nitrogen Fertilizers	Desired Amount	Amount of Solution to Apply	Of Nitrogen	gal./A	lbs./A	32-0-0
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The flow rate can be set by using a marked container and a watch with second marking capabilities. By time 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 P2O5 per acre needed: ----- 50 Acres per surge set: ----- 6 Cutback time, minutes: -----

In Table 2, about 12.9 gallons are needed to supply 1 acre with 50 pounds of phosphate. Multiply this value by six to obtain the total amount of 10-34-0 needed. Divide by two since the surge irrigation irrigates one-half of the surge set at one time. The amount of 10-34-0 required 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 lbs. of N per acre.

Table 2. Liquid Phosphorus FertilizerDesired Amount Applied Amount Amount Of Of Phosphate Of Nitrogen Solution to Apply lbs./A

If the material the farmer wishes to apply is not in the tables, make sure the following questions are 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.

Example 3.-----An irrigator needs to add a hypothetical solution of potassium chloride through the surge valve

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

Table 3. Examples (1) /2x(2)=(3) (1)

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 .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.