SERVICE IN ACTION

COLORADO STATE UNIVERSITY EXTENSION SERVICE

Fertigation: applying fertilizers through irrigation water

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no. .512

Quick Facts

The most common nutrient applied by fertigation is nitrogen; other nutrients include phosphorus, potassium, sulfur, zinc and iron.

Anhydrous ammonia is not recommended for sprinkler systems.

Applications of phosphorous in irrigation water are subject to precipitation problems.

A tailwater recovery system should be designed for each irrigation system to recycle water and prevent downstream pollution.

The application of nutrients through irrigation systems is not new but is still in the development stages. This technique is called "fertigation," a contraction of fertilization and irrigation. Interest in this technique has resulted from the need to reduce fertilizer application costs by eliminating an operation and possibly improving efficiency of nutrient use by applications closer to the time of actual plant need.

Applications closer to the time of plant need could conceivably reduce leaching or denitrification (gaseous) losses of nitrogen and and lower the possibility of luxury uptake of nutrients by plants.

The most common nutrient applied by fertigation is nitrogen. Other nutrient elements applied less frequently include phosphorus, potassium, sulfur, zinc and iron.

A rule of thumb is that nutrients that are not absorbed by the soil (anion forms) and that move with soil water are best for sprinkler application. This may necessarily limit the list to nitrogen, sulfur and some of the chelated micronutrients (ZnEDTA, FeEDDHA, CuDTPA). Phosphorus, potassium and inorganic forms of micronutrient cations may be soluble in water; however, because of immobilization in the soil they may accumulate in the top one to two inches of the soil surface and would not be distributed throughout the root zone.

Applying Ammonia in Water

Anhydrous ammonia can be distributed in irrigation water, but it is **not** recommended for sprinkler systems. Most irrigation water in Colorado contains considerable amounts of calcium and magnesium salt. When anhydrous ammonia is injected into water, the pH of the water is raised. This causes precipitation of calcium and magnesium carbonates, which are the white, solid deposits that form on ditch banks and inside siphon tubes and gated pipe. This precipitation can be prevented by injecting into the water, ahead of the anhydrous ammonia, an inhibitor (water softener) called sodium polyphosphate that can be purchased under the trade name of "Calgon." Suggested rates of NH_3 application and amounts of inhibitor required are shown in Table 1.

Table 1: Suggested anhydrous ammonia in inhibitor rates.

Irrigation water hardness		Maximum ammonia appli./1000 gpm water	Inhibitor required per 1000 gpm water
ppm	grains/gal	lbs/hr	lbs/hr
35-120	2-7	37	0.25
120-170	7-10	37	0.38
170-425	10-25	37	0.63
425-850	25-50	28	0.75

Source: H. R. Mulliner, **Applying Anhydrous Ammonia in Irrigation Water**. *University of Nebraska NebGuide G 74-129, 174.*

Ammonia injection into ditch or siphon tube irrigation systems is somewhat less troublesome. However, siphon tubes can be encrusted with the precipitated calcium salts and are not easily cleaned. If precipitation occurs in the irrigation ditch, no particular problems are encountered.

Another major problem in applying anhydrous ammonia or free ammonia-containing solutions through sprinkler systems is the fact that

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Issued in furtherance of Cooperative Extension work in agriculture and home economics, Acts of May 8 and June 30, 1914, in cooperation with the United States Department of Agriculture, Don K. Chadwick, director of Extension Service, Colorado State University, Fort Collins, Colorado 80523. The CSU Cooperative Extension Service is dedicated to serve all people on an equal and nondiscriminatory basis.

volatilization losses of ammonia occur from the time that the ammonia-water mixture leaves the sprinkler until the ammonia reaches the soil surface. Admittedly, some of the nitrogen is present as ammonium ions but much more is in the ammonia gas form. Subsequently, as water vaporizes, ammonia also is lost to the atmosphere.

Applications of Nitrogen Solutions in Water

In irrigated agriculture, water applications of nonpressure urea-ammonium nitrate (UAN) solutions have become increasingly popular as a means of improving nitrogen use efficiency. The nitrogen sources will not cause salts to precipitate out of the irrigation water. Losses due to leaching are minimized by split or multiple nitrogen applications as compared to applications prior to seeding, particularly on sandy soils. The amount of various nitrogen fertilizer required to give 20, 30 and 40 pounds of nitrogen per acre are given in Table 2.

Table 2: Amount of various nitrogen fertilizers required to give 20, 30 and 40 pounds of nitrogen per acre.

Kind of fertilizer solutions	N	Wt/gal	Rate of N per acre, lb 20	30	40
	%	lb	gal/A	gal/A	gal/A
Urea—ammonium nitrate	28	10.65	6.7	10.0	13.4
Urea—ammonium nitrate	32	11.06	5.7	8.6	11.4

Phosphorus Application

Injection of phosphorus fertilizers into irrigation water is less common than injection of nitrogen and is not recommended on most crops. Problems related to application of phosphorus in irrigation water are at least threefold: 1) precipitation may be encountered when ammonium polyphosphate-containing liquids are injected into high calcium and magnesium water; 2) phosphorus must be applied early in the growing cycle for most crops, particularly if there is a definite phosphorus need, in order to prevent any early season reduction of yield potentials; and 3) phosphorus applied through irrigation water will remain on or near the soil surface if not incorporated by a tillage operation. The latter problem may be insignificant in the irrigation of established crops such as alfalfa and grasses.

Potassium and Sulfur Application

Application of potassium usually has involved small treatments in each of several irrigations (10 lb/A K). Usually, a nitrogen-potassium solution has been used as the potassium source. Farmers and fertilizer dealers believe that this process may improve plant absorption of potassium and result in higher yields where soil solution potassium is low due to low exchangeable potassium, leaching or heavy plant use.

Sulfur applications have been more common than applications of potassium. Injection of sulfur is quite easy and usually involves the use of ammonium thiosulfate (12% N, 26% S) or solutions of ammonium sulfate. These sulfur carriers already contain nitrogen but can be blended with nitrogen solutions quite easily. Interest in this technique has been intense in sulfur-deficient areas where sandy soils are common and where soil organic matter levels are low. Generally, potassium and sulfur should encounter no detrimental reactions in the water even if the water is quite high in soluble calcium or magnesium.

Fertilizer Meter-Injectors

There are many commercial meter-injectors on the market for injecting fertilizer solutions into sprinkler, gated pipe or siphon tube irrigation systems. Tests conducted at the University of Nebraska indicate that an ordinary tap into the irrigation piping system is all that is required to get uniform mixing of the fertilizer solution with the irrigation. To be sure of uniform mixing, the fertilizer should be injected into the system just ahead of an elbow or tree in the irrigation line. Turbulence in the water created by the pipe fittings will assure uniform mixing.

Safety devices should be an integral part of the entire injection system. Devices to automatically cut off flow into the main water discharge line, as well as to prevent back flow of chemicals or fertilizer materials into the irrigation water source, are essential.

A float box that will give a uniform flow of the fertilizer solution into the irrigation water is all that is needed for siphon tube irrigation. A good place to meter the fertilizer solution into the irrigation system is at the pump site. Usually there is a stilling basin or a structure to dissipate the energy created by the water as it comes out of the pump discharge pipe. The fertilizer can be metered into the irrigation water at this place for adequate mixing of fertilizer and irrigation water.

Tailwater Management

A tailwater recovery system should be designed for each individual irrigation system. The tailwater should be collected from the ends of the irrigated fields and be transported to a recovery pit. The reuse of tailwater can have the effect of increasing the irrigation water supply by the amount of water recovered and prevent down stream pollution. With an ever increasing emphasis on the environment, it is important that tailwater be captured and thus prevent agriculture from being the cause of pollution of soluble fertilizers to downstream rivers, lakes and reservoirs.

For More Information

For additional information relative to the injection of chemicals into irrigation water, refer to *Chemigation: recommended safety devices,* Service in Action sheet no. 2.801. More information also can be obtained from *Applying pesticides through center pivot irrigation systems,* Service in Action sheet no. 4.713.