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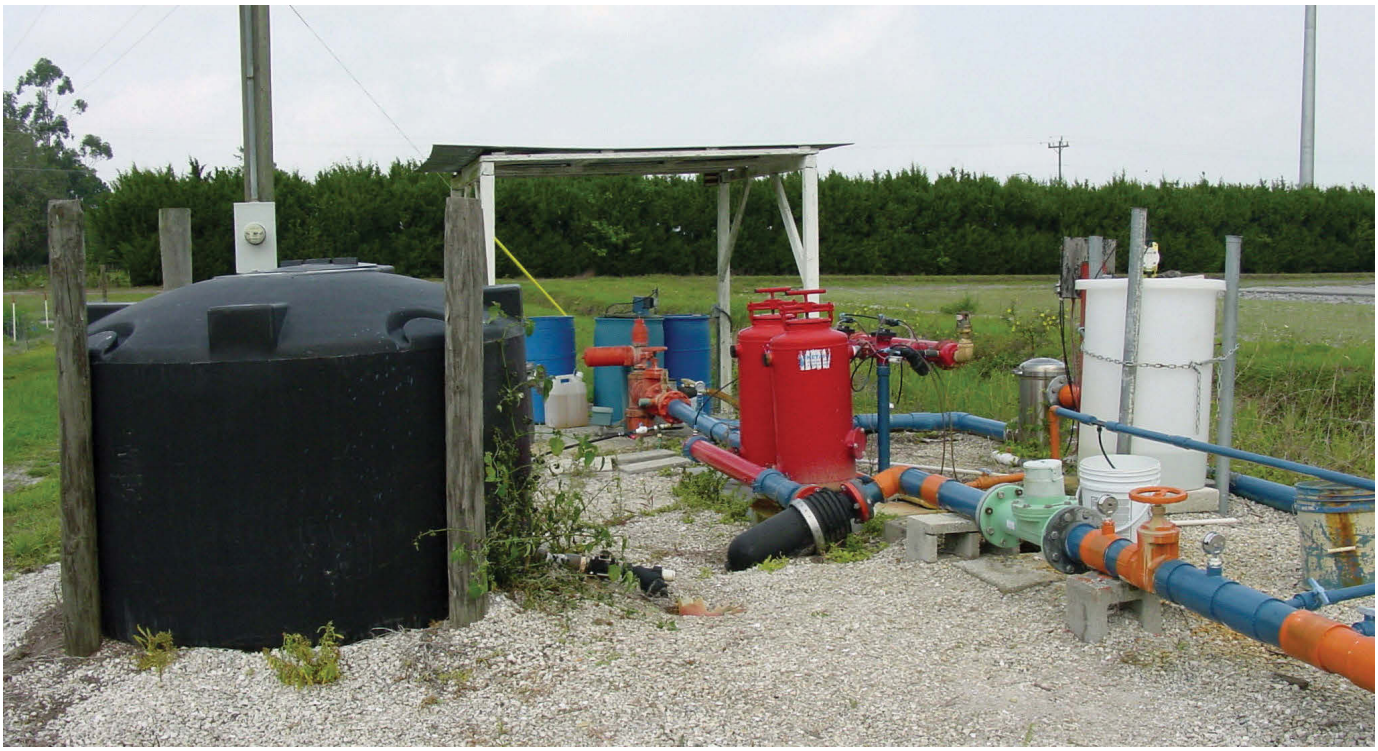

Figure 1. Fertigation system including backflow prevention devices

What you need to know about citrus fertigation

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Microirrigation is an important component of citrus production systems in Florida. For citrus trees, microirrigation is more desirable than other irrigation methods for several reasons: water conservation, fertilizer management efficiency and freeze protection. Research has shown that when properly managed, water savings with microirrigation systems can amount to as much as 80 percent compared with sub-irrigation, and 50 percent compared with overhead sprinkler irrigation.

Fertilizer applied via microirrigation (Figure 1) provides precise timing and application of water and fertilizer nutrients in citrus production. Fertilizer can be prescription-applied in small doses at times when those nutrients are needed. This capability helps growers increase fertilizer efficiency and reduce nutrient leaching by excess rainfall or excessive irrigation, potentially resulting in reduced fertilizer rates. The two most common nutrients applied to citrus through fertigation are nitrogen and potassium.

BACKFLOW PREVENTION

Florida state law requires that backflow prevention equipment be installed and maintained on irrigation systems that have fertilizer injection capability. The function of the backflow prevention device is to prevent contamination of ground or surface water by the applied chemicals. Therefore, before injecting fertilizer into any irrigation system, make sure all required backflow prevention devices are in place and working properly (see edis.ifas.ufl.edu/ch184).

PROPER TIMING

The time required for water to travel from the injection point to the farthest emitter is generally 20 to 30 minutes for most microirrigation systems. Therefore, a minimum injection time of 30 to 45 minutes is recommended. This time should be sufficient to achieve uniform distribution of nutrients throughout the irrigation distribution system. After fertigation, continue to run water for at least 30 minutes to completely flush the fertilizer from irrigation system lines and emitters to minimize clogging potential. Keep in mind that excessive flushing time can leach plant nutrients below the root zone.

FERTILIZER SOLUBILITY

Before injecting fertilizer solutions, conduct a jar test to determine compatibility of liquids and for clogging potential of the solution within irrigation system components. A sample of the fertilizer solution should be mixed with irrigation water in a jar (at the same dilution rate that is used in the irrigation system) to determine if any precipitate or milkiness occurs within one to two hours. If cloudiness does occur,

there is a chance that injection of the chemical will cause line or emitter plugging.

When urea, ammonium nitrate, calcium nitrate and potassium nitrate are dissolved, heat is absorbed from the water, resulting in a cold solution. Consequently, it may not be possible to dissolve as much fertilizer as needed to achieve the desired concentration. It is often necessary to let the mixture stand for several hours and warm to ambient temperature to allow all of the fertilizer to dissolve.

Nitrogen

Urea, ammonium nitrate, calcium nitrate, potassium nitrate, ammonium sulfate and ammonium thiosulfate are water-soluble.

Phosphorus

Most dry phosphorus fertilizers (including ammonium phosphate and superphosphates) cannot be injected into irrigation water because they have low solubility. Monoammonium phosphate, diammonium phosphate, monobasic potassium phosphate, phosphoric acid, urea phosphate, liquid ammonium polyphosphate and long-chain linear polyphosphates are water soluble. However, they still can have precipitation problems when injected into water with a high calcium concentration.

Phosphoric acid is sometimes injected into microirrigation systems. It not only provides phosphorus, but also lowers the pH of the water, which can prevent the precipitation problems previously mentioned. This practice will be effective if the pH of the fertilizer-irrigation water mixture remains low. As the pH rises due to dilution, phosphates precipitate.

One approach that is sometimes successful is to supplement the phosphoric acid injections with sulfuric or urea sulfuric acid to assure that the irrigation water pH will remain low (between a pH of 4 and 5). Phosphoric acid should only be injected when the combined calcium and magnesium concentration of the water is below 50 parts per million (ppm) and the bicarbonate level is less than 150 ppm.

Potassium

Most potassium fertilizers are water soluble, and injection of potassium through microirrigation systems has been very successful. The problem most often associated with potassium injection is solid precipitants that form in the mixing tank when potassium is mixed with other fertilizers. The potassium sources most often used in microirrigation systems are potassium chloride and potassium nitrate. Potassium phosphates should not be injected into microirrigation systems.

Calcium

Fertilizers containing calcium should be flushed from all tanks, pumps, filters and tubing prior to injecting any phosphorus, urea-ammonium nitrate or urea sulfuric fertilizer. Calcium should not be injected with any sulfate form of fertilizer because it combines to create insoluble calcium sulfate (gypsum).

Micronutrients

Several metal micronutrient forms are relatively insoluble and therefore are not used in fertigation. These include the carbonate, oxide or hydroxide forms of zinc, manganese, copper and iron. The sulfate form of copper, manganese and zinc is soluble and usually the least expensive source of micronutrients. The nitrate form appears to facilitate the uptake of micronutrients and is the most commonly used.

CRYSTALLIZATION

Solution fertilizer salt-out, crystallization or precipitation in storage tanks can be a problem during the winter. As a rule of thumb, the more complex the formulation, the greater is the tendency for salt-out.

The most important factor affecting salt-out temperature of a fertilizer solution is its concentration of nitrogen and potassium. The higher the analysis of a solution, the higher is the crystallization temperature. For example, a 10-0-10 solution fertilizer made from ammonium nitrate and potassium chloride will salt-out at about 60°, while 8-0-8 and 6-0-6 solutions made from the same sources will salt out at about 41° and 27°, respectively. Solution fertilizer suppliers can provide salt-out temperatures for specific mixtures. If prolonged temperatures below the salt-out temperature are expected, crystallization should be prevented by diluting the solution with water.

FERTIGATION SUMMARY

Fertilizer is placed in the wetted under-canopy area where feeder roots are extensive and may be applied more frequently in small amounts so that it is available when the tree needs it. Increased fertilizer application frequency can increase fertilizer efficiency and reduce leaching.

The fertigation application cost is much lower compared with dry or foliar fertilizer application. Through fertigation, it may be possible to produce comparable or better yields and quality with less fertilizer.

Microirrigation systems must be maintained properly to apply water and fertilizer uniformly. Growers must know:

- Which fertilizer formulations are best for injection
- The most appropriate fertilizer analysis for different age trees and specific stages of growth
- The amount to apply during a given fertigation event
- The timing and frequency of applications

Properly managed applications of plant nutrients through irrigation systems significantly enhance fertilizer efficiency while maintaining or increasing yield. On the other hand, poorly managed fertigation may result in substantial yield losses as well as maintenance issues with the irrigation system. Be sure that backflow prevention devices are in place and working properly.

See edis.ifas.ufl.edu/pdffiles/HS/HS130600.pdf for more detailed information.

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Common fertigation materials

- **Ammonium nitrate solution (20-0-0)** is the most widely used nitrogen source for Florida citrus.
- **Urea-ammonium nitrate solution (32-0-0)** contains the highest concentration of nitrogen of all the nitrogen solution products.
- **Calcium nitrate (15.5-0-0-19 Ca)** should not be combined with any products containing phosphates, sulfates or thiosulfates.
- **Ammonium thiosulfate (12-0-0-26)** is used as both a fertilizer and as an acidulating agent.
- **Phosphoric acid (0-54-0)** should never be mixed with any calcium fertilizer.
- **Potassium chloride (0-0-62)** or muriate of potash is the least expensive source of potassium and is the most popular potassium fertilizer applied through fertigation.
- **Potassium nitrate (13-0-46)** is expensive, but plants benefit from both the nitrogen and the potassium in the product.
- **Potassium sulfate (0-0-52)** is less soluble than potassium chloride and potassium nitrate.
- **Urea solid (46-0-0) and urea solution (23-0-0)** should never be mixed with sulfuric acid in the field.
- **Urea sulfuric acid** can also be used to acidify irrigation water (reducing plugging potential from carbonates and bicarbonates).