Nutrient Dosing

TAKE THESE GUIDELINES INTO CONSIDERATION WHEN APPLYING FERTILIZERS THROUGH IRRIGATION SYSTEMS.

By David Flood

The first step to nutrient dosing is knowing your water. Liquid feeding programs always begin with the water. If it isn't suitable for horticulture, you can't produce a quality crop. While there are a number of things that can be done to improve the quality of your source water such as blending it with captured rainwater and specific chemical and filtering treatments, they all increase the cost and complexity of irrigation and nutrient dosing. Before beginning a liquid feeding program, have your source water tested by a lab that specializes in irrigation water quality analysis.

Things You Need to Know

- You need enough knowledge to support your application methods — less if using commercial blends, more if you are preparing fertilizer recipes from scratch.
- You need to establish feeding targets — the optimum nutrient levels that are required by your crop at various phases of growth.
- You need some understanding of fertilizer formulations, ratios and elemental concentrations (ppm, millimoles/litre, etc.).
- You need a basic understanding of both EC (electrical conductivity) and pH as they relate to plant nutrient status and water quality.
- You need good quality on-site equipment for measuring the EC and pH of your irrigation water and growing media. Periodic lab tests may be needed as well depending on your crop and your growing methods.
- You need to understand fertilizer compatibility issues, particularly if you are blending fertilizers in concentrated form. Most common fertilizer materials are compatible at dilute strength; however, some will combine as insoluble precipitates when concentrated at anything greater than about 20 times the feeding strength. pH can also play a role in some precipitate reactions.

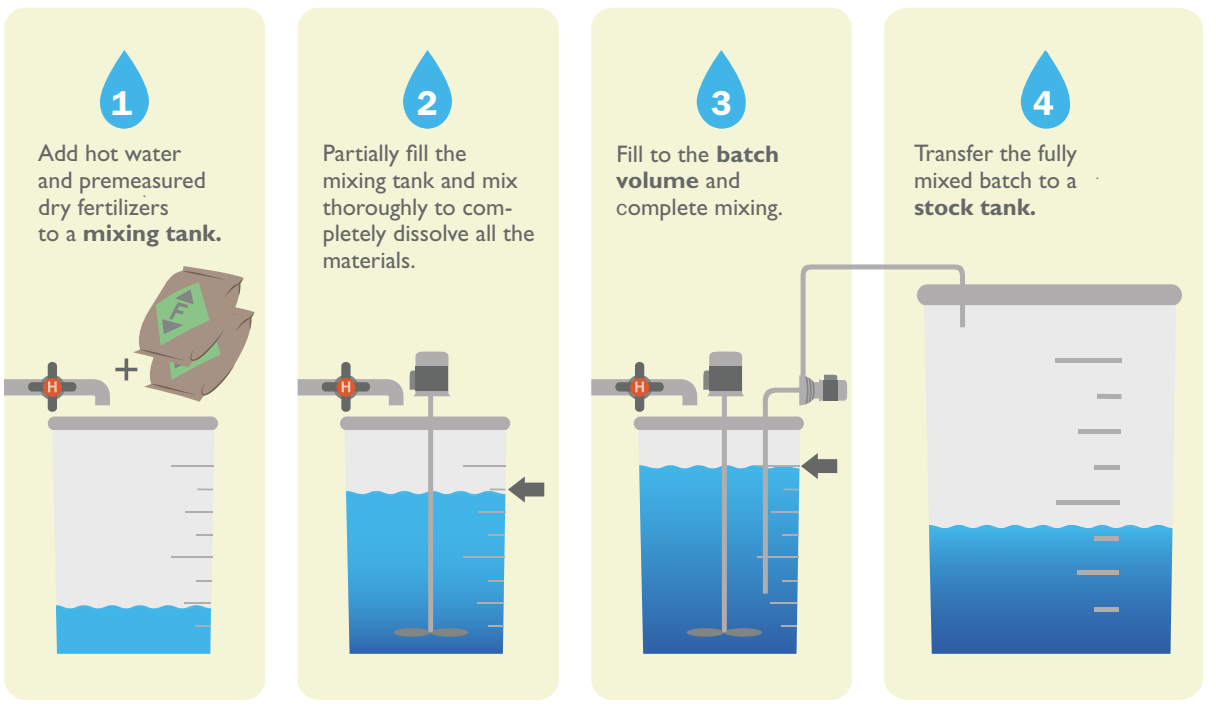
Basic Requirements for Nutrient Dosing

1. Uniform application. No matter how accurately you prepare your feed solutions you won't achieve consistent fertility in the root zone unless your irrigation system can apply uniform quantities of feed solution throughout the crop.

2. Mixing accuracy and consistency. You need reliable, safe and repeatable methods for dissolving, diluting and mixing concentrated fertilizer ingredients. Your crop depends on it!

3. Equipment. There are options available for all types of applications and situations. Basically, you need a method for dissolving and diluting dry or liquid fertilizer concentrates to their 'feed strength' and some way of getting those materials into your irrigation system.

Mixing Tip: Use a batch-mixing tank and then transfer the resulting mixture to your stock tanks. While you can dissolve fertilizers directly into in a stock tank during a period of no crop feeding, you run the risk of introducing debris, fertilizer scums and contaminants (particles best left in the batch mixing tank that can plug up your injection system or filters).



Dosing Methods

There are two ways to supply fertilizers through your irrigation system: dilute tanks and in-line injection.

Dilute Tank Control (Batch Method). With this method, fertilizers are premixed at the final feed strength concentration for the crop and stored in a tank or reservoir until used. This is the simplest, safest and potentially most accurate way to achieve the final dilution strength. Since the mixing process is completely separated from distribution, the dilute solution can be removed from the tank at practically any flow rate without ever affecting the concentration accuracy. As an added bonus, the volume of ready-made feed solution acts as a safety reserve in case you run out of chemicals or have problems with your primary water supply. Dilute tank batches can be prepared by hand or the process can be fully automated.

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Despite these positive features dilute tanks are not as popular as in-line injection systems, particularly for larger operations. Large, costly storage tanks are required and only one fertilizer formulation and concentration is available at a time (unless you have more than one dilute tank). It is generally only practical to adjust the fertilizer strength and formulation when refilling a tank. A re-pressurizing irrigation pump is also required to deliver the tank contents to the irrigation system.

In-line Injection (Continuous Methods). In-line injection equipment can range from simple mechanical injectors driven by water flow to fully automated nutrient control systems. Pressurized in-line systems preserve the pressure and flow characteristics of the water supply system, eliminating the need for a re-pressurizing pump. Atmospheric injection systems blend the fertilizer and water in a non-pressurized tank and require a re-pressurizing pump.

In-line injection is generally more popular than dilute tank systems since they do not require large holding tanks and they offer more flexibility. With in-line systems, concentrated stock solutions

A typical A/B in-line injection system using two stock tanks.

are continuously injected into the water stream as irrigation events are underway. Mixing usually occurs in the downstream section of the irrigation pipe or in a small mixing tank depending on the injector design. Injection volumes are based on system flow rates, EC/pH sensor feedback or a combination of the two.

When automated injection controls are used, it is possible to rapidly change the dilute solution concentration by adding more or less stock materials relative to the water flow. This is useful if you need to adjust the feed strength throughout the day to match growing conditions or to change the feed recipes or nutrient concentration for different crops. In some instances the actual fertilizer formulation can be changed by either switching to different sets of stock tanks or employing a 'single-element' dosing design where the individual fertilizer constituents are separated into several stock tanks. This enables an in-line injection system to operate in a multiplexing capacity, where you can simply 'dial-in' different feed recipes on the same irrigation system (although only one at a time).

In-line injection systems do have some weaknesses compared to dilute tank systems. Unless the injection system is well designed, tuned and managed, low buffer volumes and poor blending can result in dosing accuracy errors and poor final

product uniformity. These problems can become more pronounced at high turndown rates (low flow) relative to the design flow rate.

So Which Proportioning Method is Best?

Whether you select dilute tank feeding or an in-line injection system there are a range of options for automating the process or keeping things manual. Generally, you should use the simplest method that will work for you. While automated dosing systems offer many management and productivity features, including reduced fertilizer and water runoff, and better crop quality, they do so at higher cost and complexity, and a need for greater operator vigilance.

Consider simpler dosing equipment if:

• You can feed everything with a single dilute tank or a single stock tank injector.

• The dilute feed composition and strength (EC) does not change often.

• The pH of your water does not need frequent adjustment.

• You do not recirculate your irrigation drain water.

Consider some form of automated monitoring and control if:

• You can benefit from integrated irrigation scheduling and nutrient dosing.

• You need to inject multiple stock solutions to produce a single dilute feed.

• You need to supply more than one nutrient formulation on the same irrigation system (different crop requirements).

• You'd like the ability to vary the feeding strength (EC) without having to prepare new stock solutions.

• You need to regularly adjust or change the pH due to changing source water chemistry or different crop requirements

• You are recirculating your irrigation drain water

• You require safety monitoring, alarms and a continuous record of your nutrient dosing activities.

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Automated Controls

Some automated systems deal only with managing the nutrient dosing equipment while others are capable of integrating irrigation scheduling and nutrient dosing activities. This makes

A single-element nutrient dosing system.

sense from a management perspective since you generally want to optimize water management and nutrient levels. This process of managing both is often referred to as 'fertigation'. When fertigation control is also integrated with your environmental control system it can be easier to monitor and manage everything from a single interface.

Monitoring and Controls

Fertigation systems and equipment vary with each application. A recirculating flood floor system needs significantly different equipment than an outdoor nursery with overhead sprinklers. The selected control system should be capable of adapting to the design and operation of the overall facility. This may include controls and monitoring for:

- Tank levels
- EC (electrical conductivity)
- pH
- Acid/base dosing equipment
- Water temperature
- Soil moisture levels
- Leaching rates (overdrain)
- Nutrient dosing equipment
- Pump controls
- Irrigation zone valves
- Line purging
- Recirculation management
- Water treatment equipment (filters, pasteurizers, ozone, UV, etc.) g

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