NSW GOVERNMENT
Department of Primary Industries
primefact

Fertigation equipment for orchards

December 2011, Primefact 1144, First edition

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Introduction

The basic components of a fertigation system include:

- one or more tanks to dissolve dry fertiliser into water or store pre-made liquid fertiliser mixes
- a means of injecting the dissolved fertiliser into the irrigation line.

There is a wide range of fertigation equipment available. The best system is one that suits your farm size, layout, irrigation system and budget. Management skills, style and personal preferences are also important.

System configuration

The type of equipment needed and how the system is configured will depend on the irrigation system (i.e. drip or sprinkler) and how frequently fertiliser is to be supplied. These considerations are important because on most farms there are different aged trees, varieties and rootstocks that would typically be in different irrigation blocks. The system should be configured so that water and fertiliser needs can be applied to suit irrigation blocks.

Quantitative fertigation

Injecting a large amount of dissolved fertiliser during irrigation is commonly known as 'slug dose fertigation' or quantitative fertigation (i.e. a specific quantity of fertiliser is injected during the irrigation shift regardless of the irrigation volume). It is the simplest approach and requires less sophisticated equipment. It is more commonly used on medium to heavy textured soils (i.e. loams and clays) that can hold higher amounts of nutrients. On these soils, fortnightly or monthly injections are usually sufficient to maintain adequate levels of nutrients in the root zone.

Proportional fertigation

Injecting a small amount of fertiliser solution into the flow of irrigation water (usually around 1–2 L per 1,000 L of irrigation water) is referred to as proportional fertigation. This approach is better suited to light sandy soils with a low nutrient holding capacity because the soil cannot hold a large dose at one time. Proportional injection systems are commonly used in advanced fertigation programs.

Multiple in-field injection points

Multiple, small, in-field injection stations can be installed for each irrigation block or individual tree rows. These can be controlled by the simple decision of whether to add fertiliser to an in-field tank or not.

Central injection point

A central fertigation station can service a whole farm and is easier to manage because fertiliser storage and mixing occurs in one place. A central fertigation station operated daily with a low output irrigation system and a proportional injection system can have some limitations. This scenario usually requires the whole farm, or large sections of it, to be irrigated in one shift. This means all plantings will receive the same concentration of nutrients. The amount of nutrient applied is related to the amount of water applied and this makes it difficult to apply exact amounts to specific blocks or adjust fertiliser supply to different varieties (e.g. mandarins versus oranges).

Central injection stations that can irrigate at any time with a medium output irrigation system and fertigate quantitatively generally allow more flexibility to target specific fertiliser amounts to individual blocks.

Single or multi-tank systems

A single tank system (Figure 1) allows mixing of compatible fertilisers in one tank and the dissolved fertiliser is usually quantitatively injected during an irrigation shift. A single tank system is relatively inexpensive to purchase, install and house.

A multi-tank system (Figure 2) has at least two tanks and allows otherwise incompatible fertilisers to be dissolved separately and injected into the irrigation line during the same irrigation, though not necessarily at the same time. For example, nitrogen (N) (except calcium nitrate), phosphorus (P) and potassium (K) fertilisers could be dissolved in one tank and calcium (Ca) fertilisers could be dissolved in the other tank.

Figure 1. A single tank injection system based on a centrifugal pump.

Figure 2. Fully automated twin multi-tank fertigation system.

Fertigation controller

A simple fertigation controller is a power timer that independently turns a fertigation pump or a solenoid valve on and off. As the timer is not integrated with the irrigation controller, a fertigation event could be inadvertently programmed for when there is no irrigation, possibly causing pump damage.

Most modern irrigation controllers also control the injection of fertiliser solutions, allowing both proportional and quantitative fertigation. More advanced irrigation controllers also incorporate pH adjustment of the irrigation water by injecting acid ('acid trimming'). Wireless communication is possible with some controllers, allowing programming from mobile devices (i.e. smart phones) or a computer.

Injection equipment

Many types of injection equipment are available. The key selection factors are the labour required to operate the equipment, cost, accuracy and maintenance requirements.

Orchard spray tank

A conventional orchard sprayer can be used to inject fertiliser into an irrigation line. Fertiliser is added to the spray tank and dissolved by mechanical agitation or recirculation of water through the pump and back into the tank. The spray tank is connected to the intake valve of a field filter and the solution is pumped into the line during irrigation. Concentrated solutions of fertilisers might cause internal pump parts to wear faster than normal and/or corrode.

Pressure differential tank

A pressure differential tank is a sealed tank connected in parallel to an irrigation supply line. Fertiliser is placed in the tank via an opening with a lid that can be securely sealed. A partial obstruction (e.g. a valve or a filter) installed in the irrigation line causes a pressure differential that pushes some of the irrigation water into the tank.

The water dissolves the fertiliser in the tank and the pressure pushes it back into the irrigation

line. This is a very inexpensive simple system that can be semi-automated by installing a control valve on the intake side of the pressure tank.

Pressure differential tanks are often installed in the field (Figure 3) to service an irrigation block or a section of the farm. Commercial units have a volume of up to 100 L and can service up to 5 ha. Care must be taken to ensure that enough time is allowed to dissolve the fertiliser and gradually move it into the supply line. Different types of fertiliser will dissolve at different rates. Most systems require about 40–90 minutes of injection time to adequately dissolve and flush out drip lines. Fertigation delivery times can be checked using dye. When using fertilisers such as potassium nitrate or ammonium nitrate, nitrate test strips can be used to detect movement in the irrigation line.

Figure 3. An in-field pressure differential tank.

Venturi injection

The Venturi is the simplest injection method because it has no moving parts. Venturi-based injection is considered to be less accurate than other injection methods but the inaccuracies reported by users are minor (i.e. less than 5%).

The Venturi is usually installed in a bypass line. The Venturi sucks nutrient solution into the irrigation line by a pressure differential caused by forcing irrigation water into a smaller diameter pipe and then into a wider diameter pipe. There is some pressure loss, which can be overcome by installing a centrifugal booster pump in the bypass line. A booster pump also helps deliver a consistent pressure and injection rate. A gravity flow meter and valve can also be installed in the fertiliser line to provide some manual control over the injection rate.

Venturi injection systems can be configured to inject fertiliser proportionally or quantitatively. Some degree of automation can be achieved by installing a solenoid valve in the bypass line. Some farmers have built semi-automated Venturi injection systems that can be operated by an irrigation controller (Figure 4). There are many fully automated Venturi systems on the market (Figure 5) and these are becoming more popular because they are accurate and very cost-effective.

Figure 4. A do-it-yourself Venturi injection system operated by solenoid valves and an irrigation controller.

Figure 5. A fully automated multi-tank Venturi injection system.

Water pressure operated pump

These pumps are commonly used in nurseries and some in-field applications where there is no electricity. The larger pumps can service up to 5 ha. The pump is installed inline and uses the pressure of the water to inject the nutrient solution. There is a range of models with various flow capacities (i.e. 1.5–4.5 m^3/hr) and injection rates (i.e. 0.7–20 L of fertiliser solution/m^3 of water). They do not require power to operate, but annual replacement of rubber seals and valves is needed.

Single tank and centrifugal pump

This is the most common fertigation system where a tank is used to dissolve and mix the fertiliser. Most tanks are low enough so fertiliser can be manually placed in the tank from ground level. A centrifugal pump is used to inject the solution into the supply line. The pump can also be used to re-circulate water to agitate and dissolve the fertiliser. Many fertigation systems use a separate pump for this or have an impeller driven by an electric motor. Most systems inject most of the dissolved fertiliser within 30–60 minutes.

Positive displacement pumps

This includes single or multiple pistons, hose and diaphragm pumps. Piston pumps (Figure 6) can provide proportional injection, automated acid trimming and EC control. Some piston pumps develop a pipe vibration problem because the pipes are continuously flexed with each injection stroke. These pumps have several moving parts and are prone to mechanical failure, so regular inspection and servicing are required.

Figure 6. A set of six piston pumps used to run a multi-tank injection system.

Diaphragm pumps are similar to piston pumps but use a diaphragm instead of a piston. It is important to ensure the correct quality and grade of diaphragm and pump is selected to inject nutrient solutions (some are only designed for irrigation water). A variety of configurations are available from single standing units to fully automated proportional injection acid trimming units. The diaphragm needs to be maintained and replaced after a set period of use.

Hose pumps are used in the medical industry for dialysis machines and other applications, but larger versions are now available for industrial applications. Hose pumps operate by rotation of a cam that presses on a flexible rubber hose pipe.

As the cam rotates liquid is pushed through the hose. These pumps are capable of high pressures and flow rates and have a high level of accuracy. The hoses need to be replaced regularly (i.e. on an annual or biennial basis). Small and large pumps are available and can be used in an automated proportional injection system.

Centrifugal injection pump

Centrifugal injection pumps can be used in simple or fully automated fertigation systems. In simple quantitative injection systems inexpensive centrifugal pumps can be used, for which parts are generally readily available and spare pumps can be kept in case of breakdowns. There are many grades and classes of pumps to suit nearly every application (Figure 1).

In fully automated injection systems variable speed centrifugal injection pumps are used in conjunction with flow meters and a computer controller to inject the dissolved fertiliser into the bypass line.

Figure 7. A series of multi-stage centrifugal pumps used to proportionally inject in a fully automated fertigation system.

Acknowledgements

This Primefact has been produced as a part of the HAL project CT07041 'Integrated Advanced Fertigation', NPSI project DAN5027 'Knowledge and Tools to Manage Fertigation Technologies' and the CRC-IF Solutes Program. Karen Connolly and Dr Josefa Navarro (IMIDA, Spain) are thanked for their input, and the editorial input of Sandra Hardy, Jeremy Giddings and Lorraine Spohr (NSW DPI) is gratefully acknowledged.

INT11/85988