



Nursery & Garden Industry
Queensland

Fertigation in Production Nurseries

Fertigation is the application of dissolved fertilisers through an irrigation system and can be a useful way of controlling plant growth. Fertigation is a simple and effective management tool which is relatively inexpensive to set up and operate. It can be used in conjunction with a pre-planting fertiliser program, or can be used to apply the entire nutritional requirements of a crop. For longer term crops (4-6 months) fertigation can be used to supplement the original pre-plant fertiliser.

Whether fertigation is an appropriate system for a nursery depends in part on the type of irrigation system used. Overhead irrigation systems produce more runoff due to the amount of water that falls between the containers. This results in larger amounts of runoff containing considerable amounts of dissolved nutrients. Mobile booms using light application nozzles, pulsed drip systems, and bottom watering systems such as ebb and flow, troughs and flood floors with recycled wastewater are ideally suited to fertigation.

Designing a fertigation program needs to take into account the:

- Quantity of fertiliser applied
- Duration of the application
- Proportions of fertilisers used in the mixture
- Starting and finishing time of the fertilising period.

Fertigation can be delivered continuously or intermittently on a weekly or fortnightly basis with fortnightly being the maximum recommended interval. The frequency of application and plant requirements determine the type of injection equipment and the concentration of fertiliser to be applied. Regardless of the system used, injection rates need to be accurate and easily adjusted.

There are **four ways of applying fertigation**:

1. In a continuous application system, fertiliser is applied at a constant rate from the start of the irrigation to the finish, which results in the total amount being injected regardless of the water discharge rate.

2. A three stage application is where the irrigation starts without fertiliser. Once the crop is wet (10-20% of the irrigation time) the injection phase begins, which then stops before the irrigation cycle is completed, allowing the system to be flushed out during the remainder of the irrigation cycle (10% of the irrigation period).

3. Proportional application injects the fertigation in proportion to the water discharge rate, e.g., one litre of fertiliser solution to 1000 litres of irrigation water. This allows for increased fertigation during periods of high water demand when most nutrients are required, and also allows for differences in water flow to different growing areas while providing the same concentration of fertigation to all areas.

4. In quantitative applications the nutrient solution is applied as a specified amount to each irrigation block, e.g., 20 litres to block A, 40 litres to block B. This method is suited to automated systems and allows accurate placement of nutrients.

Proportional fertigation— the amount of fertigation injected is the same per litre of irrigation water regardless of the flow rate.

Quantitative fertigation— a specific amount of fertiliser is applied to a given area.



There are two broad injection system types:

- **Centralised injection systems** near the pump with distribution of nutrients to each block.
- **Injectors at each block** to apply fertigation for the crop at each injection point.

The two main types of injection pumps used are pressure differential venturi systems and pump injection using either electric or hydraulically driven pumps.

Pressure differential venturi systems can be installed as a by-pass or in-line system. The venturi causes a rapid increase in the speed of the water passing through the pipe, thus reducing the pressure in the pipe and creating a partial vacuum which then causes the fertiliser solution to be drawn into the irrigation line. The injection rate is dependant on the inlet and differential pressures, and the flow rate in the mainline. The pressure differential created by the venturi is between 5% and 75% according to the injection mode, with injection rates between 7 and 2,000 litres/hour possible. There are also automated venturi systems available that automatically adjust pH and electrical conductivity (EC) via sensor control.

Venturi injection systems are simple, low cost systems, with no moving parts. They are easy to install, require little maintenance, and have low labour requirements. In situations where flow rates do not vary greatly injection rates can be accurately controlled with these systems. However, where a specific quantity of fertigation needs to be applied venturis can be difficult to manage. A pressure loss in the mainline up to 30% is required for the systems to operate, and this may not be practical for some irrigation systems.

Pump injection is the most common method of injecting fertiliser solutions in nursery fertigation, with systems being powered by electric motors, impeller-driven power units or water-driven hydraulic motors.

Electric injection pumps include a range of different pump types such as single piston, multiple piston, diaphragm, gear and roller pumps, with the injection rate being regulated by:

- The distance the drive shaft travels in and out

- Pulley diameter
- Variable speed motors
- Electrical impulses from a water meter.

Electric injection pumps are simple and effective and relatively easy to install and maintain. They are able to apply fertigation either proportionally or quantitatively, are less likely to cause pressure loss in the main line, are suitable for high head systems and can be automated. However, these pumps have to develop more pressure than the mainline pressure and need an electric power source to operate.

Hydraulic injection pumps use the flow and pressure of the irrigation water to operate a hydraulic motor that pumps the fertiliser solution into the system. The amount of fertiliser solution pumped is proportional to the flow rate in the mainline as the injector automatically compensates for any change in pressure or flow. Dosages can be adjusted by setting a percentage adjustment on the units. As the injection rate per pulse is known, the exact application of nutrients can be readily calculated. For high injection rates, two or more units can be operated in parallel.

Hydraulic injection pumps are simple to operate, install and maintain. They can inject fertiliser either proportionally or quantitatively, are easy to adjust, result in no pressure loss in the irrigation system, are easy to automate, and have low labour requirements. However, they can be sensitive to air pockets in irrigation lines, and some units need continuous water discharge to operate the piston or diaphragm. Hydraulic pumps require a minimum line pressure, and on some units the spent drive water is discharged from the system.

Fertigation tanks need to hold enough water to dissolve all the fertiliser required for a fertigation cycle. Containers and fittings should be made of, or be lined with, materials that will not react with the concentrated fertiliser solution. Poly tanks are ideal. Untreated galvanised iron tanks may result in zinc toxicity in the crop. The tank should be designed to allow undissolved impurities to be drained out.

Regular monitoring and preventative maintenance of the system every 24-48 hours of operation will improve reliability. Inspect hoses, valves, pumps, motors, tanks and other injection equipment for leaks. Check oil levels in motors, pumps and gearboxes, and monitor pumps for unusual noises, vibrations and bearing temperatures. Ensure the manufacturer's maintenance recommendations are followed including diaphragm and valve replacement. Flush the pump and tank after every use, and clean filters, strainers, and screens regularly.

Fertigation can cause increased algal growth (biofilm) in pipes, and on the surfaces of growing media causing problems with infiltration. Increased biofilm growth on benches and floors can also be a safety hazard. To reduce biofilm problems and increases in electrical conductivity (EC) in water storages and water released into the environment, nutrient loads in drainage water need to be managed. Leaching of growing stock may be necessary when using drip irrigation to reduce the build-up of EC in the growing media.

Flushing the irrigation system may be necessary to reduce the amount of biofilm in the pipework. Monthly flushing with chlorine will reduce, but not eliminate this problem. To flush the system, sufficient sodium hypochlorite is injected to give a free chlorine level of between 10 and 20 ppm (mg/L) in the irrigation water immediately after injection. The water pH must be less than 6.5 to ensure high levels of effective chlorine. The chlorine is injected after any filters, and free chlorine levels are tested at lateral outlets where a residual reading is required to ensure sufficient chlorine has been injected to react with all of the biofilm. The system is flushed with clean water after chlorination and before the next irrigation.

Fertigation can be **used in conjunction with Controlled Release Fertiliser (CRF)** to supply ongoing requirements of nitrogen, potassium and possibly sulfur. Fertigation can also be used as **the entire source of nutrients** for the crop. The EC limits are generally 1.5 dS/m for continuous feeding, and 2.0 dS/m for intermittent feeding. When designing fertigation programmes the EC of the irrigation water needs to be included to ensure these levels

Crop	N	P	K	Ca	Mg	S	Fe	Mn	Zn	B	Cu	Mo
Foliage	150	30	200	120	30	30	1.0	0.5	0.2	0.2	0.03	0.03
Shrub/tree	200	50	200	150	30	50	1.5	0.5	0.2	0.2	0.05	0.03
Orchid	60	30	100	70	20	70	0.5	0.7	0.2	0.2	0.03	0.03
Flowering	200	50	250	150	30	40	1.5	0.3	0.2	0.3	0.05	0.05
Anthurium	100	30	200	70	24	50	1.0	0.2	0.2	0.2	0.03	0.05

Table 1: Feeding solutions for low N-drawdown soil-less growing media (mg/L or ppm).

are not exceeded. For longer growing periods (4-6 months) trace elements may also need to be added.

Factors to be considered in determining the concentration of the fertigation stock solution are:

- Is there CRF in the growing media?
- Is the fertiliser being applied continuously or intermittently?
- What is the frequency of the applications?
- What time of the year is it?
- What is the rate of growth of the plants?
- How much nitrogen could the growing media draw down?
- What percentage of irrigation is leached through the containers?
- How much has rainfall reduced irrigation requirements?

The fertilisers used for fertigation must be completely water soluble and not contain insoluble fillers or components, while still being economical to use. The **solubility** of different fertilisers can be found in reference books or from fertiliser suppliers. Sodium, chloride, ammonium, organic nitrogen and elements not required for plant growth should be minimised. The fertiliser must not react with other components in the same mix to produce insoluble salts, and should not significantly alter the pH of the irrigation water.

Consideration also needs to be given to the **fertiliser analysis**, i.e., elemental percentages and impurities. This information can be found on the fertiliser container and allows the calculation of how much fertiliser should be used to provide the required nutrients, and how each product will increase the EC of the irrigation water. The label also specifies the type and amount of impurities that may affect some plants.

Nitrate will leach from the container if too much water is applied. Recommended sources for nitrate are calcium nitrate, potassium nitrate and urea. If using urea only use low biuret products to reduce toxicity problems. Urea does not affect EC, but plant roots react to it in the same way as a salt. If the solution contains urea, increase the measured EC by 1.5 dS/m for each gram of urea added per litre.

The application of **phosphorous** through fertigation depends on the pH, calcium and magnesium content of the irrigation water. Phosphorous is usually applied pre-plant, but where it is used in a fertigation programme it can be applied as mono potassium phosphate or mono ammonium phosphate.

As **potassium** is more readily exhausted than many other nutrients it can be applied by repeated small or continuous applications through the irrigation system. Potassium content in leaves can be almost twice as high when applied with frequent fertigation. Potassium can be applied as potassium nitrate, mono potassium phosphate, potassium sulfate and potassium chloride (not in large doses or on chloride sensitive plants).

Magnesium - magnesium sulfate.

Calcium - The pH needs to be below 6.5 to prevent scaling on pipes and do not mix with fertilisers containing sulfates. Calcium nitrate is the most commonly used form. Calcium chloride should be used with caution due to its chloride levels.

Sulfur - Add sulfur if water contains less than 15 ppm sulfur. Magnesium sulfate and potassium sulfate are used for magnesium supply.

Iron - Recommended sources are iron EDTA and Iron EPTA. By using different chelating agents the iron can be protected in solutions at a higher pH level.

Manganese - Manganese sulfate and manganese chelate.

Boron - Boric acid and sodium borate (Borax).

Zinc - Zinc sulfate and zinc chelate.

Copper - Copper sulfate and copper chelate.

Molybdenum - Ammonium molybdate and sodium molybdate.

Good agitation makes it easier to dissolve the fertiliser, but some are harder to dissolve than others, reducing the water temperature and slowing the process even more. Hot water at 65 °C may be used to overcome this.

Excessive residue left after dissolving the fertiliser may be due to:

- The concentration of fertilisers being too high and not all the nutrients dissolving.
- Fertilisers containing calcium and iron mixed with fertilisers containing phosphorus or sulfur reacting and creating insoluble compounds. These elements should be applied separately. Using chelated iron can help to reduce these reactions.
- Phosphates in hard water forming scale and blocking drippers.

Fertigation errors can be damaging to crops and therefore the strength of the diluted solution should be checked with an EC meter before application.

Monitoring fertiliser levels needs to be done to enable the adjustment of the amount of fertigation being applied. This can be done by regularly testing leachate for EC and nitrate.

Nursery owners should seek professional advice if they are uncertain about how much fertiliser a plant needs, or if they require any assistance in calculating fertiliser requirements or maintaining equipment.

Further information can be found in the **Waterwork workshop resources** and '**Managing Water in Plant Nurseries**'.

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