Department of Primary Industries

primefact

Maintaining a drip irrigation system for perennial horticulture

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DPI Agriculture Water and Irrigation Unit

Introduction

Irrigation systems only operate well if properly maintained. This is especially important for drip irrigation, as it is difficult to detect problems before crop health problems become obvious. This Primefact outlines the maintenance procedures that all irrigators should use to gain and retain the maximum benefit from their drip irrigation system.

The most common problems with drip irrigation are:

- emitter clogging
- dripper component deterioration
- system pressure mismanagement.

Regular maintenance and monitoring is the best way to identify and avoid problems before crop health and yield suffers.

Over time, system performance will decline to some degree in all drip systems, regardless of management. However, there are ways to minimise this decline. Systems that are regularly flushed, cleaned, have adequate filtration and are well designed (including the ability to adequately flush) can maintain an acceptable level of performance over an extended period.

The three main areas of drip system maintenance described here are:

- flushing
- chlorine or hydrogen peroxide injection (oxidation)
- acid injection.

Flushing the system

Even with a good filtration system, emitter blockages can occur, and it is therefore important to regularly flush mains, submains and laterals (as well as filters). Most filtration systems are designed to stop material greater than 130 micron entering the system. Silt (2–50 micron) and clay (less than 2 micron) particles are much smaller than this and, with proper maintenance, should be allowed to completely pass through the system. However, if allowed to build up within the system, they can aggregate, with algae and bacteria causing particles to stick together as slimes, resulting in significant blockages.

It is recommended that the piped system is given a complete flush before the first irrigation of the season, several times during the season, and again at the end of the season. Monitor the water quality discharged during flushing to determine whether you are flushing sufficiently frequently. As a guide, flush three times a season when irrigating with clean water; with dirty water – after every four irrigations.

Some drip managers have installed automatic flush valves at the end of each lateral. These provide a small flush when the system is filling at the start, and emptying at the end, of each irrigation. While they reduce the labour needed to flush laterals, these valves remove material at the end of laterals only.

It is recommended that irrigators remove these flush valves at least once per season to enable the length of the lateral to receive a decent flush, as well as determining whether the valves are keeping laterals adequately clean.

Flushing procedure

It is important to flush the system in the order of water flow (that is: mains, then submains, and finally laterals).

1. Flush the mainline, while submain and lateral flush valves are closed, for at least two minutes, or until the water runs clean.
2. Close the mainline flush valve and start flushing the submains for at least two minutes or until the water runs clean.
3. Close the submains flush valve and flush the drip laterals patch by patch for at least two minutes or until the water runs clean. Often two ‘slugs’ of sediment are observed from laterals, the first being material accumulated at the end of the lateral, and the other being newly disturbed material along the length of the lateral.
4. Close the laterals in consecutive order and check that all drippers are working.

Figure 1. Flushing a lateral

A minimum flow velocity of 0.5 m/s is generally recommended for flushing lateral lines. This can be hard to achieve on long laterals or poorly designed systems. Only a few laterals should be opened and flushed together to ensure sufficient water flow and velocity is achieved. If the laterals are connected to a flushing manifold, open one at a time only.

Adequate velocity will carry particles within the pipes until the velocity slows and particles drop. It is important to understand drip systems and where this velocity decline will start and manage flushing maintenance accordingly. Most sediment will fall in the end of the dripper tube, where water travels relatively slowly. Some systems will have mains and submains that will also have slow or changing velocities when different shifts are running, so it’s important to flush with a sequence that is suitable for your design.

Table 1. Flow rates to achieve adequate flushing velocity

Pipe size (ID mm)	Flow rate required (L/min) to achieve greater than 0.5 m/s
10.2	2.5
14.0	4.6
18.0	7.6
20.8	10.2

To determine if a velocity of 0.5 m/s is being achieved when flushing individual laterals, measure the flow rate from the end of a lateral into a bucket (Figure 2). If the flow rate is less than that shown in Table 1, too many laterals have been opened or the drip system has not been designed to adequately flush the system.

If reducing the number of laterals open at one time does not improve the situation, and three-way taps on hydraulic valves are present, consider switching the valve from 'auto' to 'open' to bypass the pilot and produce greater pressures, resulting in a better scouring of the lines.

Be careful not to increase pressures in the line to levels greater than that which the pipe, fittings and pump can handle.

If flow rates are still below these recommendations, check the pressure settings at the pump or contact your irrigation designer.

Figure 2. Measuring lateral discharge rates into a bucket

Oxidation

Oxidation is carried out to reduce blockages due to organic matter. Chemicals such as chlorine and hydrogen peroxide are oxidising agents that kill bacteria, algae and other organic matter.

Chlorine

Chlorine is the most common product used for oxidation. The most common chlorine compounds are sodium hypochlorite (liquid) and calcium hypochlorite (solid). Sodium hypochlorite (usually 12.5% chlorine) is easier to use and relatively safe compared with calcium hypochlorite, which is explosive when placed in contact with ammonium fertilisers.

There are two main chlorine application methods:

- intermittent treatment.
- continuous treatment.

Intermittent treatment involves periodic sterilisation by chlorination, usually to prevent. but also to correct organic matter building up in the system. This is generally the most commonly used chlorination method. Between 10 and 15 mg/L is injected 1–4 times during the season to ensure that 0.5–2 mg/L of free chlorine is detectable at the end of the lateral furthest from the pump. A swimming pool test kit can be used to detect free chlorine. The chlorination procedure below should be used as a guide to develop a chlorination program that suits the drip irrigation system and management.

Continuous treatment involves injecting chlorine during every irrigation, and should only be used if extreme algae or bacterial problems exist. A constant injection rate is used, usually 5–10 mg/L, adjusted so that 1 mg/L of free chlorine is detectable at the end of the system. This method limits fertigation flexibility, but is sometimes used when specific problems exist in the system. Check with your designer if you are considering this method.

N.B. Chlorine concentrations of >2 mg/L can result in phytotoxicity or 'leaf burn' in some annual crops.

Chlorination procedure (intermittent treatment)

1. If the system has not been recently flushed, flush the system in the correct order. Flushing before chlorination means that the chlorine does not have to act on excess organic matter.
2. Inject chorine until it reaches the last dripper (usually 30–45 minutes).
3. Run the pump for a further 10–15 minutes.
4. Shut the system down for 2–24 hours. Managers generally choose to let the chlorine sit overnight.
5. Flush the system again after chlorination, particularly if the chlorination was to correct organic matter build-up: note the sediment discharged.
6. Consider carrying out a systems performance test following chlorination to determine if the procedure has improved system performance.

Hints for safe and successful chlorination

- **Warning!** Chlorine solutions are dangerous to human beings and animals: wear proper protection for eyes, hands and body.
- Direct contact between chlorine and fertiliser can be explosive. Do not put chlorine in a tank that has been used for fertiliser without thoroughly washing the tank. Contact between diluted chorine and fertiliser is not hazardous, but it can reduce the chlorine's efficiency.
- Chlorine can cause corrosion in pumps if left to sit in them for prolonged periods. Ensure systems are adequately flushed once chlorination is finished.
- Water travels about one metre every three seconds over whole drip systems. As a guide to determine how long it will take chlorine to reach the furthest point in the system, divide this distance in metres from the injection point by 20 to give the time in minutes.
- To check the concentration of free chlorine at the end of the lateral, use a swimming pool test kit. It is a common misconception that chlorine can be detected at the end of a lateral by smell. Often chlorine is already on fingers or clothing, and this can give a misleading impression of its presence. In addition, the smell coming from the dripper might not be free chlorine, meaning that all the chlorine has been used before reaching the end of the lateral, and injection volumes have been underestimated.
- When using chemical solutions in an irrigation system, you need a suitable backflow device to prevent reversed flow to the water supply.
- When having the system designed, consider whether chlorination is needed, including chlorinating large mains of low velocity.
- Sodium hypochlorite is often the preferred product because it is a liquid and relatively easy to handle. However, it does not store well. Purchase the product as fresh as possible, and in short-term volumes only.
- Many irrigators feel disappointed if no sediment is found when flushing after chlorination. As mentioned previously, chlorination should be viewed as a maintenance operation in most situations. Do not be concerned if little or no sediment is visible when flushing after chlorination.
- Disc and sand filters can require adding chlorine annually. See manufacturers' recommendations.

Calculating how much chlorine to inject

It is important to inject the correct amount of chlorine into a system. The system will not be adequately cleaned if too little is injected. If the rate of chlorination is repeatedly too high, low grade stainless steel, such as that existing in solenoids, can become corroded; rubber diaphragms in PC drippers can harden affecting dripper discharge; and high concentrations can affect crop and soil health.

To calculate how much chlorine (chemical) to inject, find out the:

1. system (shift) flow rate
2. concentration of chlorine in chemical to be used (% active ingredient)
3. concentration of chlorine required.

Amount of chlorine to inject:

$$= \frac{\text{Sys. flow rate (l/s)} \times \text{Req. conc. (mg/L)} \times 0.36}{\text{Active ingredient\%}}$$

Example:

Sodium hypochlorite (12.5% chlorine or 125 g/L) is to be used to chlorinate a drip system with a flow rate of 18 L/s at a concentration of 15 mg/L.

$$= \frac{18\ \text{l/s} \times 15\ \text{mg/L} \times 0.36}{12.5} = 7.8\ (\text{say } 8)\text{L/h}$$

If the tank injects 500 L/h:

- Add 7.8 L (say 8 L) sodium hypochlorite.
- Fill the tank to 500 L.
- Inject this solution for one hour.
- Determine that chlorine has reached the furthest point.
- Leave in system for more than two hours.
- Flush the system.

If a dry powder such as calcium hypochlorite is preferred (active ingredient is typically 65%), the following is required for the same flow rate;

$$= \frac{18\ \mathrm{l/s}\ \times\ 15\ \mathrm{mg/L} \times 0.36}{65} = 1.5\ \mathrm{kg/ha}$$

Hydrogen peroxide

Hydrogen peroxide is a relatively new product to Australia and its use is gaining in popularity. It is much more corrosive than chlorine and therefore safety procedures need to be followed. Unlike chorine, it is effective at high water pH and often preferred by organic farmers.

A similar method of calculating intermittent injection rates to chlorine is used. Hydrogen peroxide is available in a range of active ingredient concentrations, with 35% or 50% generally recommended. Between 30 mg/L and 50 mg/L is injected, with test strips available to detect 8–10 mg/L at the end of the system.

Example:

Hydrogen peroxide (in this example 50%) is to be used to oxidise a drip system with a flow rate of 18 L/s at a concentration of 30 mg/L.

$$= \frac{18\ \mathrm{l/s}\ \times\ 30\ \mathrm{mg/L}\ \times\ 0.36}{50} = 3.9\ (\mathrm{say}\ 4)\mathrm{L/h}$$

Acid injection

While chlorine is used to manage organic deposits in drip systems, acids can be injected to control mineral deposits. Dissolved impurities such as calcium and iron in the irrigation water can precipitate out in the drip system.

If this problem has occurred, precipitated calcium salts can appear as a white film on the inner surface of the system. You might wish to cut open a number of emitters for visual inspection.

These impurities can often be dissolved by lowering the pH of the water, usually by injecting dilute solutions of acid such as hydrochloric, sulphuric, citric or phosphoric acid. Phosphoric acid has the added benefit of adding phosphorus to the soil.

Warning! Acid should not be used if asbestos cement pipes are part of the irrigation system: acid will attack the pipe wall and release fibres from the pipe, leading to mass blockages.

Using acid can be hazardous and many irrigators are engaging qualified contractors to carryout acid injections.

Steps for injecting acid

1. Flush the mainline, all submains and laterals.
2. Determine the system flow rate in litres per hour (18 L/s from the chlorination example = 64,800 L/h).
3. Test the maximum discharge of the injector pump with the irrigation system operating (e.g. 1,000 L/h). Only use acid-resistant injector pumps. Not all plastics are acid resistant. If uncertainty exists, check with your irrigation designer.
4. Calculate the concentration of acid required to reduce the water pH to the desired level.

To determine the amount of acid needed to drop the pH, take a 1 L sample of the irrigation water. Add measured amounts of acid to this water and mix. Measure the water pH using a pH meter or test strips. Continue to add measured amounts until the desired water pH is reached – usually a pH of 2–4, depending on the nature and extent of the blockage. This process is called an acid titration. Laboratory services should be able to assist with this.

To determine if this acid concentration will be effective, place an affected emitter into this solution. The mineral deposits should dissolve in 10–15 minutes. However, heavy deposits might require a longer contact time or a repeat treatment.

Example:

If it took 2.0 mL hydrochloric acid in 1 L of irrigation water to drop the pH to the desired level:

2.0 mL in 1 L = 2.0 mL/L or 0.2% (0.002)

then the amount needed to inject into the system (0.2% of 64,800 L/h)

0.002 × 64,800 L/h = 129.6 L/h (say 130 L/h)

Adjust for injection time (e.g. 15 minutes (0.25) to reach furthest lateral)

130 L/h × 0.25 = 32.5 L (say 35 L)

If injector pump discharges 1,000 L/h, as the acid injection is to run for 15 minutes (1/4 h), fill the tank with 250 L of dilute acid solution. This means you should fill the tank with 215 L water, then add 35 L of acid (250 L total).

N.B. Always add acid to water.

5. With the irrigation system operating, start injecting acid.
6. Continue injection until the discharge at the furthest lateral has the required pH. Again, check this pH with a pH meter or test strips.
7. Adjust the injection rate if necessary and repeat Step 6.
8. Continue injecting for 10–15 minutes, then continue to irrigate for about one hour.
9. Flush the whole system.

Warning! Not all irrigation system components are resistant to low pH. Again, if uncertainty exists, check with your system designer for low pH compatibility.

In some instances, acid is also injected in subsurface drip systems to burn off roots that might have penetrated the dripline.

Acid and chlorine injection requires skill and an understanding of various occupational, health and safety (OHS) issues. Many irrigators prefer to engage a contractor to carry out these maintenance requirements.

More information

Drip Irrigation — a grapegrowers Guide, 3rd Edition NSW Agriculture 2004 ISBN 0 7347 1305 3

Acknowledgments

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