



Nursery & Garden Industry  
Queensland

# Disinfestation of irrigation water

*Production nurseries require a water supply that is reliable, low cost and of excellent quality. To achieve the water quality demanded by nursery production, many water sources will require some level of disinfestation.*

*Clean water for irrigation is essential for healthy, vigorous plant growth. Disinfestation of irrigation water aims to reduce the risk of bringing disease into the nursery via the irrigation water. Reticulated town water, water from deep bores and clean roof catchments are considered suitable for nursery irrigation without any disinfestation treatment, provided this water is stored carefully and not contaminated prior to use.*

*Utilising production wastewater in nurseries is an efficient and cost effective irrigation water source when managed properly. Nursery wastewater will need some form of disinfestation or treatment before the water can be reliably used for irrigation, as many disease causing organisms are easily transported in recycled irrigation water.*

*There are a number of disinfestation techniques that are recognised under industry best practice programs for use in nursery production. However, their effectiveness is influenced by the quality of the water being disinfested. The pressure on the various*



*disinfestation systems can be reduced by pre-treating the water, or water storages, before the final disinfestation treatment, greatly reducing the overall treatment costs and ensuring disinfestation success.*

*Filtration provides the essential pre-treatment for almost all irrigation water disinfestation systems. Filtration either ensures the required water quality is provided for a particular system to operate successfully, or reduces the contaminants in the water, which will ultimately reduce disinfestation costs. Filtration should be designed and installed as an integral part of the overall irrigation system based on the water source, water quality, disinfestation requirements, and the selected emitters. A water sample can quickly identify contaminants in the water, and an irrigation specialist can provide suggestions for the effective elimination of problems.*

*Disinfestation of irrigation water can be assisted through:*

- **Testing the quality and quantity of the wastewater** to be treated over a period of time prior to the selection of a disinfestation method to identify any fluctuations or changes due to seasonal variations, e.g. summer versus winter and/or as a result of production pressures, e.g. large potting/planting events
- **Managing wastewater drainage and collection systems by:**
  - installing sediment and trash traps to remove sand, gravel and rubbish from wastewater
  - establishing grass swards or seal drains to reduce clay colloids entering the wastewater storage
  - installing wetland areas to reduce nutrient loading of the wastewater.
- **Managing the wastewater storage facility by:**
  - Reducing aquatic weeds and algal growth

- locating the pump suction to avoid drawing water from the surface and bottom of the water storage
- aerating and circulating the storage to improve water quality
- adding coagulants to 'floc' clay particles.
- **Managing iron, manganese and sulfur** by:
  - treating dissolved iron with aeration, chlorination or greensand filtration
  - treating manganese with chlorination or greensand filtration
  - treating sulfur/hydrogen sulfide with aeration and circulation.
- **Pre-treating the wastewater** to suit the disinfection system selected by:
  - filtering the water to the level required by the disinfection system
  - adjusting the pH to meet disinfection requirements.

In selecting a disinfection system a number of questions should be addressed prior to selection of the system:

- What are the total costs in setting up the disinfection system?
- How much will it cost to operate the system over time?
- What supporting infrastructure is required (filtration, electricity, tanks, pumps)?
- Where in the system should the disinfection system be located?
- What is the current water volume requiring disinfection and over what time period?
- What is the capacity of the disinfection system and its ability to adapt to future requirements?
- Can the system be automated, and what levels of automation are available and required?
- Is it possible to easily monitor the system operation?
- What monitoring protocols, equipment and procedures are required, and at what cost?
- Are there alarm, bypass or emergency stop facilities incorporated into the system?
- What are the maintenance requirements of the system?
- What is the life of the system?

- Who will install and commission the system to ensure accurate and reliable operation?
- How complicated is the system to operate and troubleshoot?
- What back up and technical support is available and what are the costs?

The information gathered from the above list of questions will assist in making an informed decision on the selection of a disinfection system suitable for each specific site and provide valuable data for design engineers and irrigation professionals.

Water disinfection systems can be divided into four groups

- oxidizing chemicals, e.g. chlorine,
- physical treatments, e.g. ultra filtration (UF)
- Biological treatments, e.g. slow flow filtration
- ultraviolet light (UV).

A summary of the advantages and disadvantages of each disinfection system are given in Table 1.

When testing the effectiveness of disinfection, the type of test used depends on the type of disinfection process. Generally, oxidizing chemicals are measured using a chemical indicator to determine the amount of chemical in the water, and physical, biological, and ultraviolet light systems require direct measurement of the pathogens remaining in the water after disinfection.

When using oxidizing chemicals, once the chemical has reacted with all the nutrients, organic matter and pathogens in the water, the amount of chemical that remains can be measured, and this is used as the indicator of the effectiveness of disinfection.

The amount of chemical required to achieve effective disinfection will vary depending on the quality of the water being disinfected. Unlike plant protection chemicals, a set amount of chemical per litre isn't added, as water quality varies with

**Table 1: Advantages and disadvantages of different water disinfection treatments**

<i>Disinfection treatment</i>	<i>Advantages (when used as recommended)</i>	<i>Disadvantages</i>
<p><b>Chlorination</b> Most widely used treatment in Australia. Sodium or calcium hypochlorite can be used. (Oxidising agent)</p>	<p>Effective disinfection agent Relatively safe and non phytoxic Can be measured effectively using a DPD pool chlorine test kit Test kits are inexpensive Chlorine products are relatively inexpensive Chlorine is commercially available Equipment costs are relatively inexpensive Precipitates iron and manganese</p>	<p>Requires water pH to be monitored and adjusted (pH5 – pH7) Chlorine is rapidly used up by impurities in the water Requires regular weekly testing of residual chlorine levels Requires storage tank to achieve contact time and residual (2.5 ppm residual after a 30 minute contact time) Corrosive and requires careful handling Injection equipment requires regular maintenance Shelf life of chlorine products is limited to approximately 1 month Unsuitable for water with high iron concentrations above 0.5 ppm Does not have efficacy against all plant pathogens or life stages</p>
<p><b>Chlorine dioxide</b> Has been well tested and has a demonstrated effectiveness against a range of plant pathogens. (Oxidising agent)</p>	<p>Potent oxidant Effective in water with pH as high as 10 Requires shorter contact time (concentration of 3 ppm for 8 minutes is required for control of waterborne fungal pathogens) Residual activity is longer than chlorine Effective against a broad range of plant pathogens</p>	<p>Unstable gas that must be generated onsite Equipment is relatively expensive Requires accurate and regular testing of residual level Residual levels toxic to plants Does not have efficacy against all plant pathogens or life stages</p>
<p><b>Chloro-bromination</b> Bromine is a member of the same family as chlorine and has similar action in disinfecting water. (Oxidising agent)</p>	<p>Greater effective pH operating range than chlorine (up to pH 9) Relatively inexpensive Setup costs are moderate Testing residual levels weekly is relatively simple and inexpensive</p>	<p>Increased equipment costs when compared to chlorine (two injectors and stock tanks) pH requires monitoring and may need adjusting Requires storage tank to achieve contact time (3 ppm for 8 minutes) Does not have efficacy against all plant pathogens or life stages</p>
<p><b>Ultraviolet light</b> UV dose and effectiveness are dependent on the clarity of the water.</p>	<p>Non-chemical, non-toxic No waste products Environmentally friendly Modest operating costs</p>	<p>Water quality is critical – high quality, free of tannins Extremely high level of filtration required Difficult to monitor effectiveness Must be designed to water flow rates and water quality Maintenance is critical UV lamp output decreases with age</p>
<p><b>Slow sand filtration (SSF) (Slow flow filtration)</b> Antagonistic micro-organisms in the bio-filter attack and destroy plant pathogens.</p>	<p>No chemicals required Relatively low cost construction Low cost operation Virtually no waste products Environmentally friendly</p>	<p>Flow rates should not exceed 100L/m<sup>2</sup>/hr for best efficacy Large tanks required for high flow rates Water level maintenance in SSF is critical to effectiveness Maintenance is critical Not available 'off the shelf'</p>
<p><b>Ultra-filtration</b> This membrane filtration is used to filter pathogens from the water.</p>	<p>Removes all plant pathogens including viruses Cost effective at low flow rates Can be automated Environmentally friendly No chemicals required (small quantity of chlorine during back-wash)</p>	<p>Expensive at high flow rates Maintenance costs (membrane replacement) Wastewater from back flushing filter requires disposal</p>

seasonal variations, and consequently, so does the amount of chemical required to react with the contaminants in the water. Therefore, the residual amount of chemical must be constantly monitored, and the amount of chemical added adjusted, to take into account these variations.

The amount of chemical used in reacting with the contaminants is referred to as the chlorine demand, and the amount of chemical remaining after disinfection, the residual level. Once a certain residual level has been achieved for a minimum amount of time after disinfection (the contact time), the water is considered to be disinfected.

On-site testing is the only practical way of measuring the amount of chemical present, as the residual level continues to decline over time. Best management practice guidelines recommend the residual levels required for effective disinfection are, for chlorine - 2-3 ppm residual after 20 minutes contact time (pH also needs to be below 7.5), chloro-bromine—8 ppm after 8 minutes contact time, chlorine dioxide - 2.5 ppm after 8 minutes contact time, and for ozone - 1.4 ppm after 16 minutes contact time.

For chlorination systems, pool test kits are the cheapest option and can be used for chlorine, chloro-bromine and chlorine dioxide systems. When using these kits for testing chloro-bromine and chlorine dioxide residual levels, the reading obtained must be multiplied by 2 to convert the reading to the actual amount of chemical present. Ozone can be measured by colorimetric test kits which give a direct reading in parts per million.

Photometers give a more accurate measurement of oxidant chemical levels and remove the human error from interpreting the colour of the solution, but are significantly more expensive than pool test kits.

Physical disinfection systems either remove the pathogens by micro filtration or by using biological means (slow flow/ slow sand filtration). When using

either physical or UV disinfection, efficacy has to be tested directly by determining if any pathogens remain in the water. This can be done either by a laboratory, or on-site, using a technique called baiting, in which a prepared piece of leaf material is suspended in the water and then tested for pathogens using a Pocket Diagnostic Kit.

In addition to testing the effectiveness of disinfection by the above methods, maintenance of disinfection systems is critical in them continuing to operate at peak efficiency. Microfiltration systems require regular cleaning of the filter elements to maintain their efficiency, and slow flow filters must have the build-up that develops on the top of the sand (Schmutzdecke) regularly removed to maintain sufficient flows through the sand bed. UV tubes need to be replaced at the recommended interval and daily checks of their operation should be made, as well as regular laboratory testing of turbidity and UV transmissibility of the water. Chemical disinfection systems require regular maintenance of injection pumps to ensure their continued reliability and accuracy.

For more information on water disinfection refer to the "Nursery Industry Water Management Best Management Practice Guidelines" pp 45-48 which can be downloaded from the Australian Plant Production Standard website.

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