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The Importance of Suitable Sources of Irrigation Water to Nursery Businesses

Poor quality water can have potential impacts to plant health and product quality when used in the production, maintenance and detailing of plants for sale. A source of high quality irrigation water at an affordable price is critical to the successful production and maintenance of plants. Consideration should be given not only of the irrigation water applied directly to the plants, but also to the overall production and irrigation systems in place. In this month's Nursery Paper, NGINA Industry Development Officer, Michael Danelon seeks to raise awareness of the importance of identifying your water source and managing irrigation water, along with covering some simple testing parameters and information resources.

Irrigation Water Quality Evolves Subject to Input Sources

Water moves continually through a cycle of evaporation and transpiration (evapotranspiration), condensation, precipitation and runoff with the water then usually reaching the sea. In a nursery situation it is the exposure of water to nutrients, pesticides, soil and organic matter and how plants selectively remove elements/compounds from it before leachate passes through the plants rootzone modifying the net water quality for either reuse or disposal.

Not unlike the water cycle, production nurseries and Garden Centres obtain water from a range of different sources due to their location and accessibility to water (influenced by legal-licencing requirements or climatic conditions) where water may be generated from rainfall or extracted from local sources (creek, river, aquifer) or provided by a water authority such as the town supply.

Greater attention needs to be paid to sustainable irrigation water quality in nurseries. Interpretive and remedial information to guide the owner/manager can be found in a few texts. Industry examples include "Managing Water in Plant Nurseries"[2], "Nursery Industry Water Management Best Practice Guidelines"[3] and the "Water Management Toolbox"[4].

As more businesses recycle or reuse their drainage water, actively sampling, recording and acting on analytical test results is an essential task, which will assist businesses in achieving good plant development in both the immediate and long term time frames.

Knowing the water quality limitations of your nursery is an essential first step in choosing an irrigation system and water management plan that best meets your water and plant health needs within budget constraints. Commence by undertaking a comprehensive study (at least over 12 months) of the water quality in your nursery to determine its limitations. These may include pH, Electrical Conductivity/salinity (EC) water turbidity, slime growth and iron content.

Irrigation water comes from a diverse range of sources

By far the most suitable water for high quality nursery irrigation is water from a town supply, which has been treated to remove suspended solids, colour, odour and pathogenic bacteria – however in many instances it is uneconomic and can be unreliable during droughts and water restrictions.

Irrigation water can be obtained from a range of different sources: surface (i.e. creek, river, dams, and rainwater harvesting), groundwater (spring/aquifers) and reticulated (treated sewage effluent) which may contain impurities and substances derived from the natural environment and the wastes of human activity. The geology and location of the aquifer of underground water supplies will often greatly influence its quality.

Town water supplies

Although generally free from suspended solids and treated to control plant pathogens, it is generally expensive and usually restricted during drought periods and likely to be a growing cost to utilise.

The pH of town water can often be too high for general plant production, > 7.5 and for disinfestation via hypochlorous acid formed from either sodium or calcium hypochlorite chlorination addition(5). It may also be too high when mixing certain pesticides where alkaline hydrolysis may occur.

Rivers and creeks

The quantity and type of impurities in streams, creeks and rivers can vary widely from the flowing watercourse depending on the size and condition of the surrounding catchment. In many locations there are conditions governing the accessibility, entitlements, allocations and trading of this water for extraction under commercial use. Every nursery needs to be

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aware of their legal requirements under the National Water Reform Process and Management of Water. For links to state legislations go to: ***http://www.water.gov.au/WaterAvailability/Watermanagement/index.aspx?Menu=Level1_3_4***

There is no certainty of the water quality generated from adjoining properties where you have no control over the exposure of the water to certain chemicals and physical environments. In catchments with urban or other agricultural activity, streams may contain large quantities of organic and suspended matter which can promote biological issues in storage or the irrigation system if not removed by appropriate management and filtration.

During flooding or heavy rain, water courses are likely to contain large quantities of suspended clay. If the stream has a lot of algae, this may result in masses of algae mixing with the clay and remaining in suspension (turbid). In low flow conditions chemical pollutants may become concentrated making the water quality unsuitable for irrigation.

Storages – fresh and/or recycled systems

The quality of water in storages is influenced by the physical, chemical and biological characteristics of that storage. These characteristics are a function of how and what the water was exposed to before entering the storage so it is critical to review the environment the water is subjected to within your nursery and surrounding areas.

Collecting water off an adjoining open bare earth paddock may deposit significant soil/clay particles which can reduce the storage capacity through the deposition of soil particles. It may also introduce colloidal clay particles held in suspension fouling the irrigation system. The possible effectiveness of ultra violet water disinfestation is also impacted on, as this relies on water with a low total soluble solids (turbidity) reading (6).

The other issue to consider is, once a contaminant enters the storage it may be difficult or impossible to remove it – especially if it is a herbicide.

Storages where water becomes both organically and nutrient enriched (eutrophication) are subject to seasonal changes, leading to increasing domination by aquatic weeds. In increasing light levels of spring and summer, the upper layer of the water can be heated reducing oxygen supplies to the water storage below. The extent of the heating and insulation capacity will vary subject to the water depth and climatic conditions causing layers of water with different temperature and oxygen supplies (stratification) and potential suspended clay particles or floating organic matter near the surface.

Where a water storage becomes stratified, the unmixed bottom water layer in a eutrophic storage may contain dissolved iron and manganese. Bacterial activity on the bottom of the storage uses oxygen resulting in iron and manganese present being dissolved and the production of hydrogen sulphide, which is often noted through its rotten egg gas smell.

It is not uncommon to have pH readings in the top half metre of 9 to 10. For water disinfestation, chlorine dioxide may not be affected up to pH levels > 10(6) but the alkaline pH may be unsuitable for acid loving crops if the water and rootzone environment is not managed.

Algal blooms often occur in the warmer, mixed surface layer, of fertile storages, in early spring and late summer. This is particularly exacerbated when storages are relatively small and shallow as the water surface can heat up and cool down rapidly with changing climatic conditions.

Normally the best quality water is found near the mid-depth between the top and bottom layers. However, as pumping and evaporation lower the storage, there may be a need to pump both layers and deal with their

The potential effect of herbicides which inadvertently enter a water storage may take time to be seen in abnormal plant growth and longer to recover subject to the mode of action.

Consider how runoff generated within a nursery is dealt with. In this instance no clear drainage plan allows runoff to flow over roads and paths which is either lost due to evaporation and seepage or to collect sediment.

Crop pruning and surplus potting mix are not ideal additions to any water storage. Consider use of sediment traps and physical removal of plant pruning in the nursery.

Management of the recirculated water storage to restrict potential for weed growth is paramount to reducing organic matter and weed seeds which can deprive oxygen levels and facilitate production of hydrogen sulphide.

corresponding impurities (hydrogen sulphide and algal blooms) via improving the aeration of the water source.

Recycled drainage water – most pertinent within a storage

How well a nursery collects their drainage water and what is collected in it is critical to the long term composition of the irrigation water contained in storages. High levels of carbonates and nitrates can produce stone-like precipitants and encourage algae and organic slimes to form in the water storage and irrigation systems.

Without appropriate removal of organic matter from the drainage water (screens/ sediment traps) this can contribute to oxygen depletion of the water creating an environment for bacterial, fungal and viral plant pathogenic microorganisms.

Recycled water from production areas will contain some or all of the following:

- surplus soluble nutrients
- degraded products of nutrients
- floating pine bark, sawdust, shavings and peat moss from potting mixes
- pesticides and fungicides
- humic acid
- leached material

These could affect water quality by:

- changing the pH
- increasing the hardness salts (principally calcium)
- adding organic matter and
- development of biological organisms (bacteria, green algae, aquatic crustacean larvae, small aquatic organisms, nymphs and adult water fleas and mites.

The effects of changed water quality are:

- scale formation in pumps, filters, valves, sprinklers and drippers
- clogging irrigation equipment
- biological growth of bacterial slimes
- growth and transmission of plant pathogens
- cross inoculation of bacteria, fungus and virus that may affect nursery staff.

Bores, wells and spear points

Water obtained from bores, wells and spear points is usually low in organic matter but may be contain fine sands.

High concentrations of iron and manganese are often present and these can become troublesome if not treated to remove from the irrigation water. Some bores which are poorly oxygenated may contain hydrogen sulphide, which may have high concentrations of sulphates and carbonates leading to possible blockages of irrigation.

Treated Effluent

The use of effluent from sewerage treatment plants for nursery irrigation can provide a source of water; however it may cause severe operational problems with filters and emitters due to growth of microorganisms. The quality of water from effluent ponds varies greatly and at times the EC level may exceed limits of the plant material and potting mixes.

Water Testing

Good quality water for nursery production contains adequate but not excessive concentrations of inorganic ions and compounds in the correct ratios, while maintaining low levels of suspended solids and bacteria.

Whether fertigating or relying on fertilisers placed within or applied topically to the growing media, the nutritional program needs to be designed in conjunction with water analysis data and a long term focus.

It is difficult to establish how much each of the various substances in water contributes to the clogging of irrigation equipment. However, it can be generally stated that clogging problems due to the occurrence of impurities in irrigation water become more acute if the water is high in the following:

- Suspended particles of organic or inorganic matter
- Precipitate-forming elements, such as iron, manganese, calcium and magnesium
- Bacteria that secrete slime which causes the suspension to accumulate or which acts chemically and causes the accumulation of sulphides and insoluble compounds of heavy metals.

Plant growth and nutrient uptake will depend on the chemical cocktail that is available in the container, some of which will be supplied by the irrigation water.

Water testing criteria

Biological - bacteria and algae

Physical - turbidity, light penetration, colour and suspended solids

Chemical - pH, Electrical conductivity, nutrients (nitrogen, potassium and phosphorous, inorganic ions and compounds and organic ions and compounds.

The number of criteria to test is determined in part on the water source, the product being grown and need for disinfestation. If water is being recycled or liquid fertiliser is being used, more frequent chemical monitoring is required to maintain the correct nutrient balance and unclogged irrigation equipment.

An easy way to monitor basic water quality is to regularly measure the EC and pH on a monthly basis to look for trends and indications of possible chemical problems.

Assessing water quality criteria is necessary for any nursery that is or soon will be recycling or treating runoff water. For the others it is good practice to better understand the nursery's water quality.

Measuring EC is relatively easy and done using testing meters to determine the amount of dissolved salts present.

Plants vary in their salinity tolerance (type, age/stage of development, growing environment and growing media) so there is no definite reading which should be adhered to. Readers are directed to the NGIA Nursery Paper Water quality and nursery crop nutrition 2002/11(7).

pH is a measure of the water's acidity or alkalinity with the pH scale being logarithmic which means that water of pH 5 is ten times more acidic than water of pH 6. A reading of 7 is neutral, less than 7 is acid, and more is alkaline.

Most water used for nursery irrigation should be between 5.5 and 7. Water between these levels will:

- maintain nutrient balance
- prevent scale formation in irrigation equipment
- provide effective chemical disinfestation

pH is one factor to use when determining potential clogging hazard of water.

If pH is:

- less than 7 it is a MINOR HAZARD
- between 7 and 8 it is a MODERATE HAZARD
- over 8 it is a SEVERE HAZARD

The information above is a guide to raise the awareness of the importance of identifying your water source, some simple testing parameters and managing your irrigation water for long term benefits.

It should guide the reader to more specific information referenced below and encourage industry participants to attend the industry specific "Waterwork" for containerised nurseries which are delivered by the State and Territory Nursery and Garden Industry Associations.

The water cycle is an evolving platform and the impact of how you manage the water cycle in your business today can influence the profitability tomorrow!

References and further reading

1. Managing Water in Plant Nurseries, NSW Agriculture 2000, 2nd Edition 2010
2. Nursery Industry Water Management Best Practice Guidelines, NGIA 2010, http://www.ngia.com.au/Section?Action=View&Section_id=556
3. Water Management Toolbox, NGIAhttp://www.ngia.com.au/Section?Action=View&Section_id=557
4. Water disinfestation – Chloro-bromination and ozone systems get the thumbs up! NGIA Nursery Papers 1997 #8
5. Using ultra violet radiation and chlorine dioxide to control fungal plant pathogens in water, NGIA Nursery Papers 1996 #5
6. Water quality and nursery crop nutrition, NGIA Nursery Papers 2002 #11

Drainage works do not need to elaborate, just effective in collecting runoff, retarding speed and removing sediments before directing to a water storage (courteous Engalls Nursery)

Portable pH and EC meters are a convenient way to monitor basic chemical properties of irrigation water in the field looking for changes in water quality.

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