The industry associations via the Nursery Industry Accreditation Scheme Australia, the untiring work carried out by our Industry Development Officers and the highly successful Waterworks training program, continue to raise awareness of the urgent need to improve and adopt water use standards. If we are not seen to be proactive in this area and to have improved our water use efficiency, then we can expect to be excluded from participation in any future dialogue that may take place regarding the implementation of further regulations.

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## Water in Australia: A Nursery Industry Perspective©

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### INTRODUCTION

Fresh, useable water is one of Australia's, New Zealand's, and in fact the world's most precious resources. This is a given. Water is crucial in nursery production and it is a resource that we as an industry need to be aware of and conserve. We need to be "water wise", but how do we do this without sacrificing plant quality and productivity?

### AUSTRALIAN AND NEW ZEALAND WEATHER

Australia and New Zealand have many similarities. Many of the plant species sold in the nursery industry are the same. In some areas the climates are similar but not very many. The following table shows the major climatic figures that affect plant growth for the major population centers in New Zealand and Australia and how they compare.

Table 1 shows dramatically the ratio of rainfall to evaporation and the fact that typically evaporation relative to rainfall is higher in Australia than it is in New Zealand.

### WHY SHOULD WE BE CONCERNED ABOUT WATER (ANYWAY) IN AUSTRALIA?

Australia is well known as one of the driest continents. In Victoria, where I live, we are in our 7th year of below average rainfall, and the last couple of years have seen above average summer temperatures. The cost of water is increasing in Australia, moving towards real values, but not very quickly for that used in agriculture. There is an increased demand for water both in the number of people using it and how much each person is using. This in turn leads to less water getting back into storages because of increased numbers of dams and other stored water.

Other factors, including that governments have moved away from capital investment in water storage, means that water restrictions are being enforced and becoming inhibitive for many growers. Water trading is becoming a significant issue — particularly in tough economic times.

Typically though, in Australia, we waste water in Agriculture. Less than 50% of the water used in agriculture gets to the target crop due to losses in evaporation, leakage, open channels, leaking drains, and poorly designed infrastructure.

**Table 1.** Australian and New Zealand weather data (source of raw data: Bureau of Meteorology)

| City | Mean max January temp. (°C) | Rain days | Mean annual rainfall (mm) | Evaporation (mm) | Rainfall vs. evaporation* |
|---|---|---|---|---|---|
| Wellington | 20.3 | 123 | 1246 | 1000 | 1.25 |
| Auckland | 23.8 | 131 | 1198 | 1200 | 1.00 |
| Brisbane | 25.5 | 122 | 1146 | 1518 | 0.75 |
| Darwin | 31.9 | 111 | 1702 | 2598 | 0.66 |
| Sydney | 22 | 129 | 1099 | 1796 | 0.61 |
| Melbourne | 19.8 | 147 | 654 | 1215 | 0.54 |
| Perth | 23.3 | 119 | 869 | 1742 | 0.50 |
| Christchurch | 21.2 | 84 | 635 | 1300 | 0.49 |
| Canberra | 20 | 103 | 633 | 1364 | 0.46 |
| Hobart | 17.4 | 141 | 509 | 1310 | 0.39 |
| Adelaide | 21.3 | 121 | 455 | 1853 | 0.25 |

* The rainfall versus evaporation figure is calculated to show the relationship between the different population centers in New Zealand and Australia. It is a percentage, shown as a decimal, of the amount of annual rainfall compared with the average evaporation in the same location. A figure of "1" would mean that the average rainfall would be similar to the annual evaporation.

## WATER IN THE HEADLINES

There are many implications for the community as a whole with regard to the shrinking water resources in Australia. The rural newspapers are full of stories on water-related issues. In the past couple of years I have noted increased reports on the following:

**River Murray.** One of our biggest and most important rivers. The Murray's mouth is not always flowing, it either dries up or has so little water that flows sufficient to sustain the natural environment do not occur.

**Wimmera Mallee Pipeline.** Federal and state governments are going to spend millions of dollars "piping" parts of inland Australia where traditional water transport is inefficient, e.g., open irrigation channels. In some instances less than 50% of the water from source actually makes it to where people need it. This will be a significant capital scheme.

**Water Theft.** This is also increasing. One of the regional water authorities has admitted that there has been a significant increase in prosecutions for water theft. The number of water thefts not apprehended is considered to be very high.

**Dam Builder Fined.** There have been several cases reported of farmers being prosecuted for unauthorised extensions to dams or building dams without the appropriate permits.

**Rain Seed Trials.** NSW government researchers have started rain-seeding trials to increase rain catchment in the Snowy Mountains.

**Water Bans Hit Vegetable Growers.** Growers in the Werribee region (one of the core market garden areas in Victoria) are facing water bans for the first time in many years.

## WATER USE FIGURES ACROSS INDUSTRIES IN AUSTRALIA

As an industry we do use a considerable amount of water. But is what we use really all that much compared to other industries and the value of product we produce? Table 2 provides a comparison of water use and production value for several primary industries.

**Table 2.** The amount of water (L) required to harvest $100 worth of product in several primary industries. (Compiled from a number of stories in the *Weekly Times* rural newspaper 2003/2004).

| Industry | Water (L) |
|---|---|
| Rice | 745,800 |
| Cotton | 150,000 |
| Dairy | 147,000 |
| Sugar cane | 123,900 |
| Beef | 81,200 |
| Fruit and vegetables | 37,900 |
| Wheat | 24,500 |
| Hydroponic fruit and vegetables | 500 |

In the nursery industry we can be very efficient with our water use compared to the other industries highlighted above. As an example consider the following calculation based on standard rose production at Clyde Nursery (Victoria).

**Example 1:** Drippers on standard roses at Clyde Nursery:
4 × standard roses @ $25.00 = $100.00 sale price.
4 drippers for 4 pots = 2 L of water applied per pot per irrigation cycle.
30 irrigation cycles per year: 4 plants × 2 L × 30 cycles = 240 L**.**
2 years growing before saleable = 240 L × 2 years **= 480 L to produce $100.**
That is at least as efficient as any other industry shown in Table 2.

## NURSERY INDUSTRY IS NOT PERFECT!

The nursery industry is not blameless in wasting water. Our main deficiencies include:

- Over watering — running sprinklers too long — this also leaches fertilizers and increases the potential for ground water pollution.
- Poorly designed sprinkler systems.
- Low point drainage.
- Leaking valves and fittings.
- Watering when windy or raining.
- Sprinklers operating over pressure.
- Not grouping plants with similar water needs.
- Inefficient or poorly maintained sprinklers.

## HOW THE AUSTRALIAN NURSERY INDUSTRY IS SAVING WATER

The Nursery & Garden Industry Australia (NGIA) has worked very hard to educate its members on efficient water use. It has done this in a variety of ways.

**WaterWork.** WaterWork evolved from a funded research program, which was a joint venture between Horticulture Australia Limited (HAL) and NGIA. It was carried out by Chris Rolfe. The idea was to develop an irrigation best practice program for the nursery industry. The outcome was a competency-based homestudy and workshop-based training package. WaterWork covers virtually every aspect of water use; irrigation, water management, re-cycling, treatment, drainage, and filtration. It is a 2- or 3-day course facilitated by highly qualified irrigation professionals with expertise in the nursery industry.

**Nursery Industry Accreditation Scheme, Australia (NIASA).** NIASA is a best practice scheme for all aspects of the nursery industry and provides an industry standard for water and irrigation including: scheduling, water quality, and irrigation design.

## NURSERY & GARDEN INDUSTRY VICTORIA (NGIV) WATER EDUCATION INITIATIVES.

- **Water Recycling and Treatment Workshop:** The NGIV has conducted many workshops on water issues. In particular we ran a water re-cycling and treatment workshop. This workshop brought together a group of irrigation and water traders and experts that discussed the different products and services available for the nursery industry. It also included presentations on water quality, the laws relating to water use and collection and how to reduce water use.
- **Irrigation Best Practice Bus Tours:** Nursery & Garden Industry Victoria has also run two bus tours that showcased some of the most efficient irrigators in the nursery industry. Nearly 100 people were involved in these two events. Nurseries showcased were chosen because they used excellent irrigation techniques, promoted water re-cycling and treatment, had excellent drainage systems or were planning significant improvements to their nurseries that would improve their water use.

## TRENDS IN AUSTRALIAN NURSERY IRRIGATION

**Water Recycling.** The re-use of water through recycling is becoming more commonplace. It is a significant capital cost that takes a long time to be recouped through savings given that water costs so little. Setting up a water recycling system typically involves drainage and earthworks. Some of the important considerations that have been realised lately include the use of:

- **Lined Dams.** Using high-density polyethylene plastic or rubber-type liners to line the dams. This ensures cleaner water, less weed growth, and fewer losses due to leaking.
- **Aerators.** The use of aerators in bigger dams is improving water oxygenation, de-layering dams, and is generally improving water quality. Aerators also help reduce algal and other organic loads.

- **Clean Water in.** Reducing the amount of "dirty" water being collected is simple but not often practiced. Water from dirty roads and soiled areas is diverted away from the main drainage systems. Do not collect water after large batches of potting, spraying, or the first amount of water after extended dry periods. The use of automatic pre-filtration, reed beds, collection sumps, and settlement ponds aid in cleaning up the water before storage.

**Saving Water Through Potting Media.** It is not just about applying the water more efficiently. The use of alternative potting media and components of these mixes can also reduce the amount of water that needs to be applied at any irrigation event and can increase the interval between cycles. Here are three examples:

- **Wetting Agents.** These products work to lower the natural surface tension of water allowing it to penetrate more readily though all soil types.
- **Water-holding Crystals.** Crystals capable of absorbing many times their own weight in both water and soluble mineral nutrients. These are placed in the root zone of plants, can be incorporated into either potting media or soil. Approximately 95% of absorbed water and minerals are available back to plant roots, which actually grow through the crystal.
- **Coco-Coir Peat.** This fibrous by-product of coconut processing is being increasingly used in the nursery industry. The product provides excellent aeration and water-holding capacity. The manufacturer claims that they can create the correct air porosity and wettability, trace elements, and pH/EC for any plants. This coir is available pre-mixed into potting mix or separately to mix as required. Some propagators are using the product by itself.

**Filtration, Automatic Self-Flushing.** Nurseries have been using water filters for a long time. The problem has been that as the filter is used it becomes filled with particles, which results in a loss of pressure. This reduction in pressure can become significant and sprinkler operation can suffer, as well-designed sprinkler systems operate at an optimum pressure. In Australia many growers are installing self-cleaning or self-flushing filters. These cost a bit more but ensure correct sprinkler operation over time with minimum input.

**Water Treatment Systems.** Water filtration works well but does not remove pathogens or some smaller minerals, salts, iron, and other metals. Water treatment systems can deal with these problems. These can be physical or chemical systems. The following four examples are relatively new to the nursery industry:

1) **Peat Bio-Filtration.** A nonchemical treatment system using peat as a filtration media. Water is passed through a bed of various grades of locally harvested sedge peat. The peat works to physically remove particulates and also chemically by taking out nutrients and other mineral based elements.
2) **Calcium Hypochlorite.** This system uses highly compressed calcium mixed with chlorine in canisters. The water to be treated is passed through the compressed blocks and mixes with the disinfectant. Compared to sodium hypochlorite, calcium hypochlorite

works in a greater pH range and is less susceptible to loss due to organic load. It also is safer to use from an occupational health and safety perspective and has a longer storage life.

3) **Slow Sand Filtration.** This has been used for a long time but has recently started taking a foothold in hydroponics and the nursery industry. The water is passed through a bed of various grades of sand in a water tank. Over a period of time a population of useful microbes builds up and works to "clean" water before it is physically filtered through the sand beds. Slow sand filtration is relatively cheap to build and requires little on-going maintenance.
4) **Reverse Osmosis.** This is the ultimate treatment system. It is very expensive per unit of water treated. Water is pre-filtered and then passed through porous membranes, which work to remove pathogens, disease, and minerals such as salts, iron, etc.

**Irrigation Application Devices.** Choosing the correct application method for your production system can result in significant water savings. Here are some examples of what is available.

1) **Irrigation Emitters — Low Volume.**
   **Drippers.** Using low flow, pressure regulated, and non-drip emitters.
   **Micro-Rotors.** Low flow, high uniformity of application 2 to 6 m radius/spacing.
   **Pot Sprays.** Used for larger pots to accurately apply water. Low flow and pressure required.
2) **Irrigation Emitters — Large Volume.**
   **Higher Distribution Uniformity.** Replace rotors, butterfly and impact sprinklers. Puts water out evenly across the wetted area.
   **Lower Flow Rated.** Uses less water and better matches rate of media take-up
   **Better Technology.** Newer materials and design than those previously available.
3) **Irrigation Emitters — Boom Irrigators.** Boom irrigators have long been used in agriculture. In nurseries they are gaining popularity because they provide: Higher uniformity across the wetted area; can be used for pesticides and fertiliser application; and water application rates can be matched to crops.
4) **Sub-surface Watering.** Sub-surface watering is not new but its use in the mainstream, non-hydroponics sector is working well for those that implement these techniques.
   **Capillary Watering** uses geo-textile fabrics on benches or on nursery beds. It is very effective and can reduce water use by 80%. It also can reduce foliage disease.
   **Ebb & Flow** systems utilize water being applied from underneath the pots. The water rises to wet the medium in the pot, saturates, and then is drained away. The cycle time is relative to climatic and crop factors. Ebb & flow, also known as flood and drain systems, significantly reduce water use and increase growth rates.

5) **Irrigation Scheduling.**

**Computer scheduling and operation** — based on turf and agricultural systems. Incorporate crop and environmental factors to accurately schedule irrigation systems.

**Pulse watering** — regular, shorter run times for irrigation. Aim to better match plants requirements for water. Typical run times 1–5 min for 4 to 20 times per day. Requires efficient irrigation systems, automatically operated.

**Solar irrigation initiation** — solar sensors accumulate solar radiation. At a pre-determined level, set by operator, the irrigation cycle is initiated. Cumulative solar radiation can be incorporated with most irrigation controllers.

**Weather stations** — can be utilized in irrigation scheduling. Humidity, wind speed and direction, rainfall, and a range of other factors can be monitored and measured. These, via data loggers and cables, can be utilized in calculating and initiating irrigation cycles.

**In-pot sensors** — newer technology and at a reduced size. These are new versions of older style tensiometers or newer technology sensors that measure electrical charges in the media.

6) **Irrigation Control.**

**PC Based** computer systems, replace or are used in conjunction with stand-alone irrigation controllers. Allow increased flexibility and central control. Expensive but worthwhile if the system requires it. Generally used in larger operations.

**Remote- and radio-wave controlled** solenoid valves. Reduce the need for wires and cabling where physical barriers or distance prevent this. This technology has improved significantly in recent years.

**Battery-operated controllers and solenoids** are increasing in popularity. They are more flexible and don't need expensive cabling. Ideal in isolated nurseries or where mains power is not available.

## AUSTRALIAN NURSERIES IRRIGATING WELL

There are many Australian nursery operations managing their water well. Some of these are shown as examples below:

**Clyde Plant Nursery, Clyde, Victoria**. A high quality, large production nursery growing roses, dwarf citrus, and general lines. Clyde irrigates well because:

- They use capillary watering for most plants.
- They group plants with similar water requirements.
- They use drip irrigation on larger pots.
- Everything is automatically watered.
- Irrigation systems are well maintained.

**Warner's Nurseries, Narre Warren, Victoria.** A large production nursery selling general lines into retail nurseries and the landscape trade. Specializing in larger size shrubs and trees. Warner's Nursery irrigates well because:

- Efficient micro-rotors irrigate all smaller pots.
- Larger pots irrigated by drippers and pot sprays.
- Nursery layout and design to maximize water collection and recycling.
- Irrigation control closely regulated.
- All plants automatically irrigated, even those in car parks.
- Pressure regulated solenoid valves, which are regularly checked to ensure correct operating pressure and performance.
- Good filtration.
- Various sprinklers were tried to get the layout right before building nursery.
- Good back up systems and water storage.

**Grandiflora Nurseries Propagation, Cranbourne, Victoria.** A specialist propagator in controlled environment greenhouses. Grandiflora Nursery irrigates well because:

- Pressure regulated, non-leak drippers allow exact pulse watering.
- Solar-initiated irrigation cycles.
- Efficient propagation system with excellent humidity/fogging system.
- Collected water used elsewhere on property.
- Nutrient incorporated into watering system — automatically regulated and controlled.

## WHAT SHOULD YOU DO? — AN ACTION PLAN

Every nursery business can manage and apply water better. It does not have to be expensive or reduce stock quality. Consider some or all of the following as a starting point:

- Do an irrigation audit of your nursery.
- Consider best practice for the nursery industry — get accredited or implement the irrigation component of NIASA.
- Do an irrigation improvement plan and set priorities for improvements.
- Get expert help —- but not all experts are experts in the nursery industry.
- If you are not recycling — then why not? If you are recycling, are you treating your water?
- Consider your irrigation running time and adjust.
- Think locally —- act globally!

## GOOD SOURCES OF FURTHER INFORMATION

These are some excellent sources of additional information to help you manage water in your nursery better.

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# Irrigation Systems for Soilless Media©

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## INTRODUCTION

Greenhouse irrigation and cooling technologies for intensive growing are highly specialised. With growers under increasing pressure to deliver higher quality crops, to reduce costs by shortening the growth cycle, and to be able to market it on time all around the world, an irrigation strategy must be robust and efficient in order to maintain the growers' competitiveness and profitability.

## SPRINKLER IRRIGATION

The application of sprinkler irrigation is still commonly used in many crops, particularly for germination and rooting irrigation after planting. Sprinkler irrigation must take in to account all types of structures, gable width, bed width, and whether the sprinkler will be placed in an upright position or suspended overhead in an upside down (UD) mode. In greenhouses or shade-houses in which plants are grown in small pots, sprinkler irrigation can provide a most cost-effective option. For this application, a bridgeless micro-sprinkler constructed from acid resistant materials (for chemical application) with a flat trajectory offers a good solution. There are various brands and models of micro sprinklers suitable for UD operation with a range of flow options available (Fig. 1).

**Figure 1.** Example of an upside down (UD) sprinkler with anti drain Valve and stabilizer for UD operation.

Spacing, heights, flows, and pressures are selected to provide the highest level of uniformity according to specialized sprinkler design software. The levels of uniformity are measurable and the parameters that industry recommends are:

- Christiansen's Coefficient of Uniformity (CU) = +84%
- Distribution Uniformity (DU) = +75%
- Scheduling Coefficient (SC) = < 1.2

One or all of the above measures of uniformity should be considered when designing a sprinkler system. The growers in The Netherlands for example insist on