Recycling of Water in a Seedling Nursery

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BACKGROUND

We all know that South Africa is a dry country with limited water resources. Droughts are normal. The increasing demands made on present water resources are likely to reduce future supply. Legislation restricting the use of surface and underground water resources will expand.

The country can ill afford water consumers that have no basic plan to conserve water. No industry should be without a blueprint as to how it can conserve waste water — least of all the horticultural industry. It is inevitable that the Department of Water Affairs will begin monitoring the use of water by the horticultural industry. Therefore, the industry must become more pro-active insofar as water conservation is concerned. Future legislation could be tempered if the industry is seen to save water.

We are mostly aware that we nursery operators are wasteful users of water. None more so than the seedling industry. We often do have to over-irrigate to ensure even watering. We know that we often rely on a well drained growing medium to sort out the problems of over irrigation. However we also know that we are wasteful. Many nurserymen are not able to purchase high quality regional water. In many instances raw water needs to be treated. To irrigate, reclaim, and re-use water is problematic.

The following presentation discusses the use of poor quality water and the recycling of run-off after irrigation from an existing irrigation scheme.

A PRACTICAL EXAMPLE OF RECYCLING WATER

Nurserymen have enough problems in growing plants using clean water from a reliable source such as treated water. To apply recycled water that has a potentially high level of plant pathogens is tantamount to suicide. The other major consideration is the nutrient levels from a recycled source will change. This may affect a well-tried-and-trusted fertiliser program and the resulting consequences could be damaging.

At Top Crop Nursery we recognised that we had a major problem—however, how to solve the problem has always been the million-dollar question. At Top Crop we needed to understand the magnitude of the problem. The nursery has a capacity of about 150,000 trays. If spring is dry the nursery capacity can grow to 200,000 trays. During a similar period let's assume that it is a hot, late spring day with a strong dry wind blowing. The evaporation–transpiration rate is high—maybe extremely high. The situation may require that we need to apply 3 litres of water per tray to ensure that the seedlings are kept alive. However as we may only be 50% efficient (50% of the water drains through the medium and flows to waste.) This waste is highlighted by the following simple calculations:

Water-Use Pumping Capacity. We can pump about 20,000 litres of raw water h^{-1}. Therefore, over a 24-h period we can pump $20{,}000 \times 24$ or 480,000 litres. At the same time we have a storage capacity of 1.2 million litres.

Water Use on the Hottest Days. With 200,000 trays using 3 liters of water per day a total of 600,000 litres is consumed per day.

If this were to carry on for a few weeks (the months of January, February and March 1999 required this application rate) there would be little margin for error as our maximum use would exceed our maximum input. Our storage would soon be depleted.

Potential Recyclable Water. A 50% wastage of 600,000 litres of water translates into a 300,000 litres loss. After subtracting 20% for evaporation 240,000 litres could potentially end up in a reservoir ready for recycling. This means that we have the potential to re-use 240,000 litres of water. This water contains 24 mg liter^{-1} of phosphate. Therefore, nearly 6 kg of pure phosphate is going to waste a day at this rate. This phosphorus is almost totally reclaimable.

By recycling 240,000 litres we are now only consuming 360,000 (600,000 less 240,000) litres per day. This means that we now have spare pumping capacity of 120,000 per day.

The above calculation showed that it was essential for Top Crop Nursery to look at the possibility of recycling water.

CONSIDERATIONS NEEDING TO BE ADDRESSED WHEN RECYCLING

Chemistry of the Water. There are three considerations that need to be addressed before recycled or polluted water can be used.

- Organic matter and dirt removal.
- Dissolved chemicals in the water.
- Treatment of the water to remove pathogens.

Organic Matter and Dirt Removal. The suspended organic matter must be removed prior to any treatment of the water. If a chemical such as chlorine is used it will be bound onto the organic fraction and become unavailable. The removal of pathogens is ensured only when free chlorine can be measured. If the organic fraction is high it is impossible to treat the water as the application of chemicals required, such as chlorine, to saturate organic sites will be extremely high. If treatment of the water with ultra violet light is chosen water clarity must be high to allow penetration of the UV light.

To remove the organic matter we have chosen a process known as flocculation. It is relatively inexpensive and other savings offset the added running costs. Our choice of chemical to effect flocculation is a PAC (polyvinyl aluminium chloride). Other products are available and the most efficient is alum (aluminium sulphate). We have been wary of alum as the high levels of aluminium could retard root development. However, trials are currently being done to assess the aluminium levels after flocculation using this chemical. The addition of any of the above products reduces the pH substantially and one would need to readjust the pH if too low. In our case the lowering of the pH is an advantage as our source of water has a high pH especially during the drier months. The addition of the PAC or alum helps bring the pH down.

Dissolved Chemicals. If the water quality is poor in the first instance (high in dissolved salts) it may be very costly to treat the water for irrigation. One may need to look at desalinization systems that I will not cover here. However, if the quality of the water is good enough to use for irrigation the re-use of the water after fertilisation should be no problem. The only consideration is the nutrients that were added. The stored run-off water tested at Top Crop proved to have very little nitrates or nitrites and the only chemical in large quantities is phosphorus at 24 mg $liter^{-1}$. This has proven to be an advantage as the re-use of this wastewater means that massive saving in expensive phosphorus purchases will be reduced. We fertigate with lower levels of phosphate.

Pathogens in the Water. There are many ways to sterilise water. However, one needs to find a simple economical way to ensure that all pathogens are killed. At Top Crop we chose chlorine in the form of calcium hypochlorite. The product is simple to use and even at high rates, around 3 ppm, little or no detriment to plant growth is noticed. However, taking regular measurements to assess free chlorine easily monitors the chlorine levels. A simple unit is available to measure infinitesimal levels of free chlorine. As we are treating water at a pH of about 4 the efficiency of the chlorine is enhanced.

Equipment.

Reservoir. We had to ensure that all run-off water was drained into a central reservoir. This reservoir must have sufficient capacity to store a minimum of double the maximum daily run off. The larger this reservoir the better as this will allow for collection of rainfall. A system of canals lead the water to this reservoir.

Pump. A submersible pump is floated in the reservoir. A sludge pump that can handle substantial solids was chosen. The capacity of the pump was matched to deliver 10,000 litres h^{-1}.

Injector. An injector capable of overcoming the pressure of 5 bars was installed. It needed to be able to inject about 5 litres of liquid h^{-1}. At the current rate we pump about 1.2 litres h^{-1}. This allows for about an application rate of 70 ppm of the flocculent. The pH of the floc is about 2.0 and is therefore very corrosive. The injector pump must be able to handle this.

Separator. A separator designed to handle 10,000 liters h^{-1} is necessary. This is used to remove the organic material and other solids.

A Chlorine Dispenser. This is needed to add the chlorine to the system. The type used is simple and as we buy the tablets in bulk the costs are reduced.

Tanks. Two 5000-liter tanks in line to enable sufficient contact time with the chlorine to ensure a complete kill of all pathogens.

Intermediate Reservoir. An intermediate reservoir of 250,000 liters to allow any residual chlorine to volatilise and be broken down by sunlight prior to the water being used is advisable.

SUMMARY

We have run the system since mid-February 99 during some of the hottest driest weather ever experienced. The results have been most encouraging.

Tests of the water were conducted before and after to assess pathological problems. Extremely high levels of *Escherichia coli* and *E. coliforms* were found in samples in the reservoir prior to the treatment. After the water was treated the levels were zero.

We no longer need to add acid to the system to reduce our abnormally high pH which we find can reach 9.5 in winter.

There has been no build up of chemicals. The phosphate is being managed by reducing this portion of the fertiliser. As all nutrition being applied is being controlled by the use of conductivity the same procedure reduces the phosphate applications. We have estimated that we are saving in excess of 20% of our phosphate purchases.

No water is being returned to the river and all water is being re-used.

Pumping costs to move water 600 m at a head of 80 m has been reduced. We still need to evaluate this but we know that this saving is significant.

At certain times we run for days on end from the recycling plant only. What is extremely rewarding is to see that in general the seedlings look healthier.

If anyone would like to correspond with the author on this subject please feel free to do so on topcrop@intekom.co.za or topcrop@lantic.co.za

A Germination Strategy for Seed of Verbena ×*hybrida*

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The influence of temperature on *Verbena*×*hybrida* Voss seed germination was evaluated in terms of current germination recommendations to overcome erratic and low germination.

During three experiments, nondormant seeds were exposed to continuous constant temperatures and alternating diurnal temperatures. Seeds were germinated on germination paper inside clear petri dishes, using dark temperature-controlled incubators.

Cumulative germination was modelled by the Weibull distribution function, correlating closely (R2 ≥ 0.99) to the observed germination data. No germination occurred at constant 10°C. Significantly (P ≥ 0.05) reduced germination occurred at constant 15°C and at irregular fluctuating temperatures, while 25°C was assumed as a cardinal constant temperature. Controlled fluctuations did not significantly reduce germination.

It is recommended that only hermetically sealed verbena seeds are germinated according to current germination recommendations, at any temperature regime between 28°C day and 14°C night temperatures, ensuring constant amplitudes during temperature fluctuations.

INTRODUCTION

The cultivation and utilization of bedding plants are dependent on seed germination, and the potential to germinate is economically important (Armitage, 1994; Bewley and Black, 1985 and Hartmann et al., 1997).

Verbena ×*hybrida* is a tender perennial grown commercially by all major bedding plant producers in Gauteng, indicating its economical value. Germination is erratic with total germination between 40% and 60% (Carpenter and Maekawa, 1991; Duif,