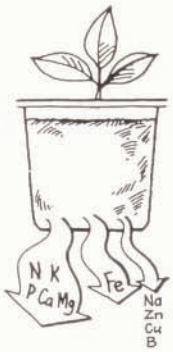
The *Nursery* Papers

ESSENTIAL INFORMATION FOR AUSTRALIAN PROFESSIONAL NURSERY OPERATORS

AN INITIATIVE OF THE NATIONAL NIDO PROJECT. ISSN:1326-1495 ISSUE NO:1996#009

Reducing nutrient leaching from pots



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Do the words ***runoff*** and ***EPA*** in close proximity make you feel slightly uneasy? Recent HRDC & HSNA funded research indicates that if sprinkler irrigation is being used without recycling then the reaction is probably justified. However, the news isn't all bad. This same research suggests that commercial as well as environmental benefits can be obtained by adopting more efficient practices.

Nutrient runoff

A typical sprinkler irrigation generates around 100,000 litres of nutrient-rich waste water per day for every hectare of productive land. This is made up of the drainage water from pots (leachate) and the water that falls between pots and onto other non-producing areas of the nursery, such as pathways, roads and buildings. Although the leachate is only 10 to 20% of the total, it contributes most of the nutrients present in the waste water.

The most effective way of reducing the volume of waste is, therefore, to ensure that more of the water from sprinklers lands in a pot (improving irrigation efficiency). Management of nutrient loads in waste water is achieved by minimising leaching.

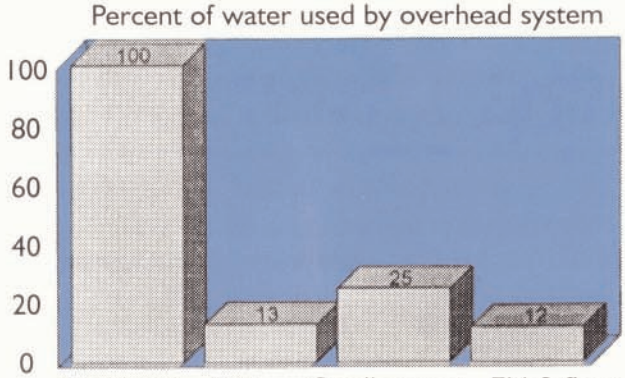

FIGURE 1. Relative water use for different types of nursery irrigation systems, after Neal and Henly (1992).

Irrigation efficiency

Overhead sprinklers apply water inefficiently. They have two major weaknesses:

1. Water is distributed to an area of bench or ground regardless of whether pots are present. Pots normally cover only 20 to 50% of the area under sprinkler irrigation which means that most of the applied water is wasted. Water savings of 75% or more can be achieved by simply replacing sprinklers with drip, capillary mat or ebb and flow systems (Fig. 1). Closer spacing of plants will improve efficiency where sprinklers are used.
2. Sprinklers often don't distribute water evenly and this leads to dry areas. Uneven application is generally dealt with by watering until the driest pots are wet. This practice means that more water than necessary is applied (up to 6-7 times). Large water savings are

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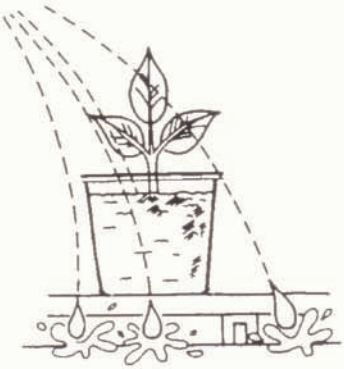
one advantage of improving water uniformity. Case studies indicate that the cost of upgrading a sprinkler system should be recovered within 3 years from savings in water rates alone.



Nutrient leaching

In Australian nurseries, irrigation rates commonly exceed the daily water use of plants (around 3-6 mm/day depending on season) by as much as 10-fold. This, combined with periods of heavy rainfall, is responsible for extensive leaching of soluble nutrients from potting mixes. Nutrient losses are generally higher in summer than in winter (around 5 times for N and P) and are always greatest in the first few weeks after potting up. The quantities of most major nutrients lost as leachate are high relative to fertiliser inputs and this reduces plant performance.

The solubility of fertilisers, the leaching fraction and the physical and chemical properties of the potting medium have major effects on the extent of leaching losses.

Fertilisers

High fertiliser rates are required to maintain rapid growth of nursery plants because of excessive leaching. Calcium, sulphur, nitrogen and potassium are leached in largest quantities. Phosphorus is relatively resistant to leaching.

Soluble inorganic fertilisers are most susceptible to leaching. They must be applied at low rates and at frequent intervals to minimise losses and to ensure supply to plants. Fertilisers such as urea and nitram added to potting mixes during preparation to compensate for N-drawdown are generally lost in the first 2 weeks of irrigation. Unless waste water is recycled, use of soluble fertilisers should be kept to a minimum where nutrient runoff is a problem.

Organic fertilisers are also rapidly leached. Under a typical summer irrigation of 25 mm a day, 82% of the K in Dynamic Lifter® (3 N : 2.5 P : 1.6 K) was leached within the first 10 weeks of the application. These fertilisers should not be considered the major nutrient source for nursery plants

Controlled release fertilisers (CRF) are most resistant to leaching. However, recommended application rates are sometimes not high enough to provide optimum growth. Because release patterns do not coincide with plant needs (Fig. 2) when fertiliser rates are increased more leaching results. Improved CRF performance can be achieved by blending products with different release characteristics and by splitting applications.

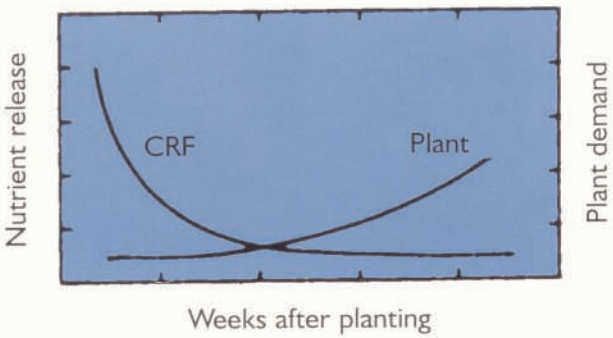


FIGURE 2. A generalised pattern of CRF nutrient release pattern and plant nutrient requirements.

Leaching fractions

The leaching fraction (LF) is the proportion of the applied water which drains from a pot following an irrigation.

As the LF increases so does the quantity of nutrients lost as leachate (Fig. 3) Some leaching is necessary to prevent salinity and a LF of 12% appears adequate. Leaching fractions of 50 to 80% are common in Australian nurseries and considerable savings in fertiliser and water appear possible if the LF can be

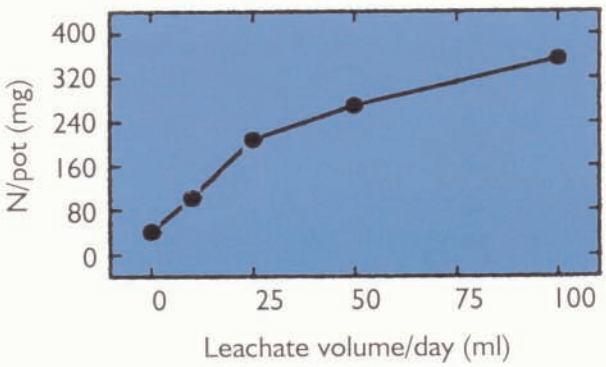


FIGURE 3. Influence of leachate volume (ml/pot) on nitrogen leached over 4 weeks from a 10cm pot with plants fertilised with a CRF at 5kg/m^3

reduced. Such reductions are only possible if the irrigation system applies water uniformly. Sprinkler systems should have a uniformity (Cu%) greater than 85% and a scheduling coefficient (Sc) less than 1.5.

High LFs generally reflect a tendency to water too often and for too long. Watering should only be done as necessary (when only 30% available water remains in the mix) and should be discontinued as soon as the mix is rewet. This can only be achieved by monitoring water use and adjusting irrigation schedules accordingly. This can be difficult with clock-based programmers.

Potting mixes nutrient holding abilities

Most organic based potting mixes have only a modest capacity to retain nutrients against leaching compared with a fertile soil. This is related to low numbers of negatively charged sites (the CEC or cation exchange capacity) which hold positively charged ions such as NH_4^{+2} (ammonium), Ca^{+2} (calcium), Mg^{+2} (magnesium) and K^{+2} (potassium).

Composting of organic materials and addition of minerals such as zeolite, and vermiculite, kaolite and kandite (clays), will increase the CEC of a potting mix. Work into the effect of using such materials is continuing, particularly in regard to zeolite.

Water retention

Potting mixes water retention abilities

Potting mixes also differ greatly in their capacity to retain water. Mixes which are slow to rewet must be irrigated for longer and this usually means higher leaching losses. Wettability can be improved to some extent with a wetting agent (Fig. 4) or by pulse watering. Applying water as a series of short pulses instead of a continuous irrigation is more effective in rewetting potting mixes. A half hour watering cycle could be changed to two 10 minute waterings spaced an hour apart. The time gap between applications allows water to be absorbed by the potting mix and minimises leaching.

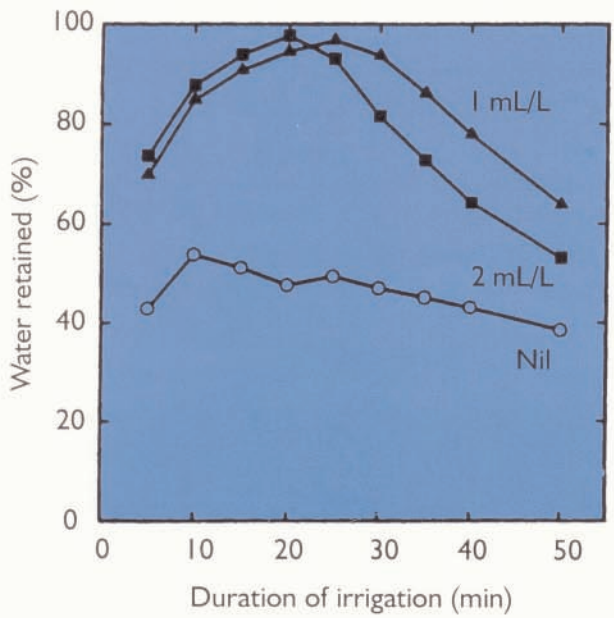


FIGURE 4. Effect of a wetting agent (Wetta Soil) on water retention of potting mix.

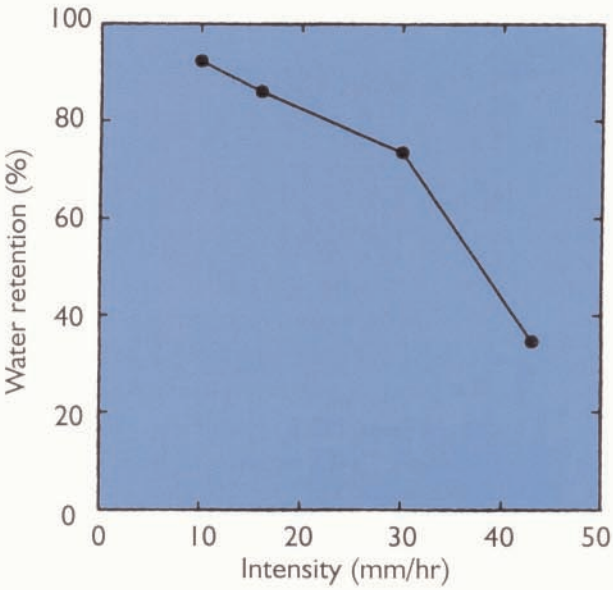


FIGURE 5. Effect of irrigation intensity on water retention by a hardwood sawdust/peat/sand potting mix.

Reducing the intensity of irrigation will increase water retention by most mixes (Fig. 5). Low intensity sprinklers set up so as to apply water at no more than 15mm/hr (mean application rate, MAR), are recommended. Appropriate sprinklers and spacings are listed in the book *"Managing water in plant nurseries"* (see Further reading). When replacing high intensity sprinklers with low intensity ones it is essential to check & adjust sprinkler operating pressure because the change over will probably result in pressure increases and possibly excessive misting.

Pulse watering and use of low intensity sprinklers save water and also reduce nutrient leaching losses.

Watering by pot weight

Excessive watering can be avoided by watering on demand. The timing of irrigation can be linked to a target pot weight. The target weight can be established by either of two ways, using portable scales (remembering that 1 litre of water weighs 1 kilogram).

a. Weighing several representative pots that are judged, by the appearance of the plants and mix, to be needing water. This point can be moist or dry depending on the growers preference. Whenever this weight is reached then water is applied.

b. Remove some established plants from the irrigation, weigh them and then allow them to wilt slightly, again record their weight. The difference in weight between a recently watered plant at 'container capacity' and a plant near 'wilting point' is an estimate of 'available water' in the pot. Aim to water the plants when between 30% and 50% of the 'available water' has been used up.

Water availability to plants can be estimated by weighing representative plants

The bottom line

Nurseries which do not take some action to minimise nutrient runoff may be in breach of State water quality guidelines. The good news is that the adoption of more environmentally sound practices can deliver considerable commercial benefits:

- savings in fertiliser (up to 30%)
- savings in water (up to 80%)
- improved plant growth and quality.

Further information on fertiliser and irrigation management is available in our book which largely covers our completed project (see suggested reading - copies can be obtained for $20 from Tropical Fruits Research Station, PO Box 72, Alstonville, NSW, 2477). A new project is investigating improved management practices in demonstration areas on three nurseries and has a research component concerned with specific aspects of water and fertiliser use.

Acknowledgements

We wish to thank the 16 nurseries who participated in the nutrient leaching survey conducted from 1992 to 1995. Bob Pearce provided much of the material and nursery space for the experimental work. Special thanks is extended to Ross Bolwell, Stan Leach and Josh Kirk who have provided space in their nurseries for the current project and to the 18 nursery operators who form the research teams.

These studies have been funded by NSW Agriculture, the Horticultural Research and Development Corporation, the NSW Horticultural Stock and Nurseries Act Committee and Scotts Australia.

Further reading

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