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Scheduling irrigation to maximise efficiency

Irrigation scheduling is generally explained as 'applying the right amount of water at the right time'. Most plants use more water on hot, sunny days than cool, overcast days and different plants require different amounts of water at different stages of production. Unfortunately, many nurseries just water to keep their plants alive. This often means that the plants with the highest water use or most frequent demand dictate how the whole nursery is irrigated.

In this month's Nursery Papers, former NSW Department of Agriculture officer, creator of the Waterwork training course and renowned industry 'water guru' Chris Rolfe explains how you can manage your watering regime to better match the water requirements of your plants.

Scheduling irrigation to maximise efficiency

'Applying the right amount of water at the right time'

Irrigation scheduling is generally explained as 'applying the right amount of water at the right time'. Most plants use more water on hot, sunny days than cool, overcast days and different plants require different amounts of water at different stages of production. Unfortunately, many nurseries just water to keep their plants alive. This often means that the plants with the highest water use or most frequent demand dictate how the whole nursery is irrigated.

To add to this, many nurseries apply a simple scheduling system that sets different watering regimes for summer and winter with no regard for daily fluctuations. These daily fluctuations can vary up to 300 percent in summer while in winter, plants under low light conditions can go for days without irrigation.

These two approaches to irrigation scheduling can result in one or more of the following:

- Excessive use of water
- Excessive leaching of nutrients
- Poor plant growth
- Leaf drop, which produces a less attractive product
- Poor internode spacing and plant shape
- Excessive drainage with elevated nutrients, and
- Elevated or contaminated water tables.

All these effects will affect your bottom line because nutrients and water are interrelated. Plant growth depends on the management of nutrients, which in turn depends on the management of water.

Applying the right amount of water at the right time minimises fertiliser leaching and moisture stress.

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Getting the balance right

The whole system is driven by transpiration at one end and available water at the other. The amount of water used by a plant depends on solar radiation, temperature, wind and humidity. If there is not enough water available or it becomes too hard to extract from the potting mix, then the metabolic process starts to close down; the plant stops growing, becomes overheated and starts to wilt. If this is occurring on a regular basis, then your bottom line is being affected by poor plant growth and too many throwaways.

Plants in the open, which are exposed to full sunlight and wind, will use more water than plants under shade cloth, where solar radiation, temperature and wind are all reduced. Plants in poly or glass houses can experience higher temperatures and humidity but are exposed to less radiation and wind, so they will generally use less water than plants outside in summer. However, the opposite could be the case in winter.

In sum, what we have is a range of plants using different amounts of water throughout their growth cycle, a range of growing conditions (outdoor, shade, poly house, etc.) and daily variations in potential evapotranspiration.

So how can you manage your watering regime to better match the water requirements? Initially information is required on two fronts:
1. What is the daily evaporation at my nursery?
2. How much water do my plants use?

Measuring daily evaporation

There are many automatic weather stations now available that will calculate this figure and provide it on a daily basis.

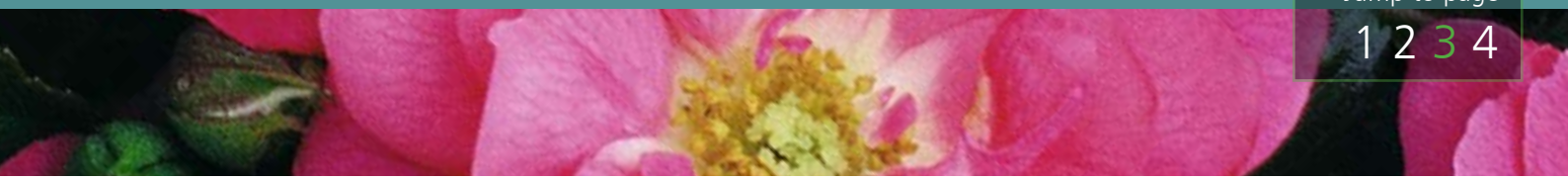
Alternatively, you could install a Class A evaporation pan and read the previous day's evaporation first thing in the morning, before setting the irrigations. It only takes about four minutes to read and set the irrigation timer if your controller has a percentage adjustment switch for each station.

For example, you might set a 5mm evaporation reading at 100 percent. On a cool day, the evaporation is only 3mm, so by changing the percentage adjustment setting to 60 percent, all blocks will get the prescribed water. If it is a hot dry day and the evaporation is 10mm, then the setting can be adjusted to 200 percent.

Plants in the open, which are exposed to full sunlight and wind, will use more water than plants under shade cloth, where solar radiation, temperature and wind are all reduced.

Many nurseries apply a simple scheduling system that sets different watering regimes for summer and winter with no regard for daily fluctuations, which can vary tremendously within seasons.

Plant growth depends on the management of nutrients, which in turn depends on the management of water



Measuring actual plant water use

Some simple measurements taken at various stages of plant development will give you a thorough understanding of the range of water requirements across your nursery.

To begin measuring the actual water use of your plants, follow these steps:

- Select the size of the container and the plant that is going to dictate the irrigation frequency for each block
- Once you are confident that the containers are at their maximum water holding capacity, weigh a representative sample of the pots (containing plants) that have received the average application rate for these blocks
- Before you next irrigate, weigh the same containers to determine the water (weight) loss.

The table below details the weight loss for a range of container sizes for each millimetre of water required to replenish the container:

Container size (mm)	Weight loss (g)
80	5
100	10
150	20
170	25
200	30
250	50
300	70

By measuring and recording a range of plants and containers in various blocks within the nursery you can start to group plants with similar water requirements and rate each structure to the evaporation readings.

For example, the following readings were recorded for a given evaporation rate of 6mm:

Is your bottom line being affected by poor plant growth and too many throwaways?

Plant type and container size	Water usage (mm)	Structure type	Crop factor
Type A – 150mm pot	4.5	Igloo	0.75
Type B – 100 mm pot	5	Open	0.83
Type C – 200 mm pot	3	Shadehouse	0.5
Type D – 100 mm pot	2.5	Shadehouse	0.42
Type E – 150 mm pot	5	Open	0.83
Type F – 150 mm pot	4	Open	0.67
Type G – 200 mm pot	6.5	Open	1.08
Type H – 150mm pot	5	Open	0.83
Type I – 150mm pot	4.5	Igloo	0.75

Next, the mean application rates and scheduling coefficients were determined for each block. Continuing the example above, the following sprinkler performances were recorded:

Structure	Mean application rate (mm/hr)	Scheduling coefficient
Igloo	8.5	1.4
Shadehouse	5.2	1.1
Open	9.6	1.2

Example

This example uses a 200mm container weighing 4,460g after rain or irrigation.

Immediately prior to the next irrigation, the container weighs 4,289g.

The water loss is 180g (4,460g – 4,280g), which is equivalent to 6mm (180 ÷30, from table above). That is, the water to be applied at the next irrigation can be taken as 6mm.

If for the same day, your evaporation reading taken from either a Class A pan or automatic weather station is 8mm, then the crop factor for this plant is 0.75. This means that this plant in this particular location in your nursery will require 75 percent of the daily evaporation reading.

Some simple measurements taken at various stages of plant development will give you a thorough understanding of the range of water requirements across your nursery.

The timing for each area can now be determined using the following formula:

$$\text{Irrigation time} = \frac{E \times C \times S \times 60}{M}$$

E = Evaporation Rate
C = Crop Factor
S = Scheduling coefficient
M = Mean Application Rate

For example, in the igloo:

$$\text{Irrigation time} = \frac{6 \times 0.75 \times 1.4 \times 60}{8.5}$$

= 44 minutes

By using this formula for the whole of our example, we can calculate the following irrigation times for 6mm of evaporation:

Plant type and container size	Irrigation timings (minutes)
Type A – 150mm pot	44
Type B – 100 mm pot	38
Type C – 200 mm pot	38
Type D – 100 mm pot	32
Type E – 150 mm pot	38
Type F – 150 mm pot	30
Type G – 200 mm pot	49
Type H – 150mm pot	38
Type I – 150mm pot	44

If these timings are set at 100 percent on the irrigation controller for a 6mm evaporation reading and the reading on a dull day is say 4mm, then the percentage dial only has to be moved to 67 percent to adjust all blocks correctly.

By checking the crop water requirements in this way every month over the growing cycle of the plants, over a number of years a picture will develop for the full range of plants grown.

Bottom line

Applying the right amount of water at the right time minimises fertiliser leaching and moisture stress so plants are produced quickly and with the right internode spacings to command top price. And all this while saving water!

Unfortunately, many nurseries just water to keep their plants alive, which often means that the plants with the highest water use or most frequent demand dictate how the whole nursery is irrigated.

Acknowledgements

Chris Rolfe needs little introduction to the nursery and garden industry. Chris is the major author of the book Managing Water in Plant Nurseries, now in its second edition, and for many years wrote a regular column in the Australian Nursery Manager.

Specialising in nursery water management issues, Chris' contributions include developing and running specially targeted one-day workshops for both production and retail nurseries as well as over 70 Waterwork workshops throughout Australia. Chris has also played an integral role in developing the new and improved Waterwork workshop, which incorporates the latest technology, updated training methods and environmental changes.

Chris has also presented numerous papers at International Plant Propagators Society and National and State Nursery & Garden Industry association conferences.

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