Nursery & Garden Industry Queensland

Irrigation Scheduling in Production Nurseries

The management of irrigation in production nurseries has a direct impact on plant growth and quality. Plants require different amounts of water depending on environmental conditions, plant type and plant size. Effective irrigation scheduling can achieve significant water and energy savings.

Irrigation scheduling can be described as 'applying the right amount of water at the right time', and is a crucial tool used in water and irrigation management. Excessive irrigation can be wasteful of water, energy and labour, can leach expensive nutrients from the container, and reduce growing media aeration. Under-irrigating can stress the crop, reduce yield, reduce crop uniformity, and adversely affect plant quality.

Irrigation scheduling is about:

- identifying the optimum moisture level required in a nursery container
- determining the preferred irrigation volume to apply to the nursery containers
- applying the preferred irrigation volume at the correct time
- increasing production, yield and quality
- reducing fertiliser/nutrient leaching from containers
- reducing environmental impacts
- managing growing media salinity
- improving plant health
- saving water, energy, labour and dollars.

Irrigation scheduling

- can be accomplished manually
- is most effective when using an irrigation controller
- requires regular monitoring, manually or by sensors.

Irrigation management is a complex decision making process, that can be complicated by a lack of specific information on plant water use, inefficient irrigation systems, the various growing media blends and ingredients used, and grower time constraints. Growers are also acutely aware that any change to irrigation management practices may affect the nutrient balance and fertiliser requirement in a container. Irrigation scheduling requires a skilled operator capable of interpreting all the available data inputs and making calculated decisions.

It's difficult to effectively manage nursery irrigation without knowing how much water is applied during an irrigation event. It's important for the nursery owner/ manager to understand how much water the irrigation system applies, how quickly and how uniformly. Efficient and effective irrigation scheduling requires uniform irrigation distribution through an efficient irrigation system that is regularly checked and maintained.

To prevent increasing salinity levels in the containers and possible root and plant damage, water in excess of what is required to bring the container to capacity needs to be applied. The amount of water that runs out of the pot in relation to the water applied is know, as the leaching fraction (LF), with an LF of approximately 12% recommended to manage salinity levels without excessive water application. Poorly scheduled irrigation can provide considerably higher leaching fractions than this.

Growing media selection is vital to support an efficient irrigation system and improved irrigation scheduling. Growing media and growing media ingredients should be selected to provide optimum air filled porosity, water holding capacity, and nutrient availability during plant growth and development in the nursery environment.

The amount of water and nutrients lost from a container due to leaching will depend on the Air Filled Porosity (AFP) of the growing media and the volume of water applied. Water is held in the pore spaces between the growing media particles. This water is retained by surface tension in the micro-pores of the growing media and is accessible for later use by the plant. The larger macro-pores provide the air space or air filled porosity. The amount of water retained in a container therefore depends on the particle size and air filled porosity, i.e. the higher the AFP the lower the Water Holding Capacity (WHC) of the growing media.

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Many factors can influence the frequency and the volume of water applied, and these factors need to be considered when locating plants into irrigation areas or zones. A nursery site can often include hundreds of different plant species and varieties, at different growth stages, and all exposed to varying levels of rainfall, wind and light conditions. Plants also vary in their growth rate and water and nutrient requirements. Scheduling irrigation to a production area or zone is often dictated by the fastest growing plant species or variety, or those with the highest water requirements. Ideally plants should be grouped into irrigation zones according to their daily water use requirements.

Growers have traditionally used their practical experience and judgement to decide on irrigation schedules that have habitually been altered only two to four times a year to match seasonal changes. Modern technologies in irrigation controllers provide the ability to alter irrigation scheduling across all stations or zones, increasing or decreasing irrigation run times by a percentage at the turn of a dial, allowing a more flexible approach to irrigation scheduling and water management.

Daily fluctuations in weather conditions affecting plant water use can vary up to 300 percent in summer and, in winter, plants can sometimes go for days without irrigation. If the irrigation schedule is not adjusted to take these variations into account, water use will be excessive, leading to unnecessary leaching of nutrients, poor plant growth, leaf drop, poor internode spacing, excessive drainage, and elevated or contaminated water tables.

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 growing media, then the plant stops growing and starts to wilt. If this occurs on a regular basis, then the bottom line is being affected by poor plant growth and too many throwouts.

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 will generally use less water than plants outside in summer. However, the opposite could be the case in winter and during periods of wet weather.

To determine the optimum irrigation schedule, the daily evaporation in the nursery and the amount of water the plants are using needs to be measured. Measuring daily evaporation, automatic weather stations and weighing containers are methods that can be used to help determine the length and timing of irrigation schedules.

One basic method of irrigation scheduling relies on setting irrigation times to seasonal settings, e.g. the same application each day during the summer months and then reduced during the cooler winter periods. This method doesn't take into account daily variations in weather that occur during a season, e.g. on hot days plants will transpire for cooling and on cool days the plant will lower its respiration rate and lose less water. Nursery irrigation that is applied without taking into account these variations will most often result in the overuse of water, excessive drainage, leaching of nutrients and reduced or uneven plant growth.

Calculated irrigation scheduling, or water budgeting, can be used to determine a more precise irrigation regime. This method involves calculating or obtaining evapotranspiration rates (ET) to determine irrigation frequency and duration. ET is the term used to describe the sum of evaporation (water moving to the air from the growing media surface) and transpiration (movement of water within a plant and the subsequent loss from leaves as vapour through leaf stomata). Evapotranspiration is affected by environmental factors including sunlight, air temperature, relative humidity, and wind speed.

An evaporation pan is a relatively simple method of obtaining reliable and consistent information on evaporation that can be used to aid grower irrigation scheduling decisions. An evaporation pan can be located on site to provide a true and accurate measure

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of evaporation for that particular location and presents relatively easy access to extremely useful information. Measurements of the evaporation from an evaporation pan provide data used in calculating the level of irrigation required to recharge the soil or growing media with water lost during the previous 24 hours. Measurements to obtain the data from an evaporation pan take less than five minutes per day.

The amount of water lost to the atmosphere from a plant depends on the evaporative demand of the air, i.e. evaporation is greatest on hot, dry, windy days and much lower when the weather is cool, still and humid. Pan evaporation is a simple measure of the effect of temperature, humidity, solar radiation and wind on water loss through evaporation.

An evaporation pan is a tangible object that is used to hold water, afford visible confirmation, and provide evaporation data for a given location. There are a variety of evaporation pans in use throughout the world with many countries, including Australia, standardising on the 'Class A evaporation pan' with very specific installation practices to provide reliable and comparable results.

A 'Class A evaporation pan' has specific construction and location parameters:

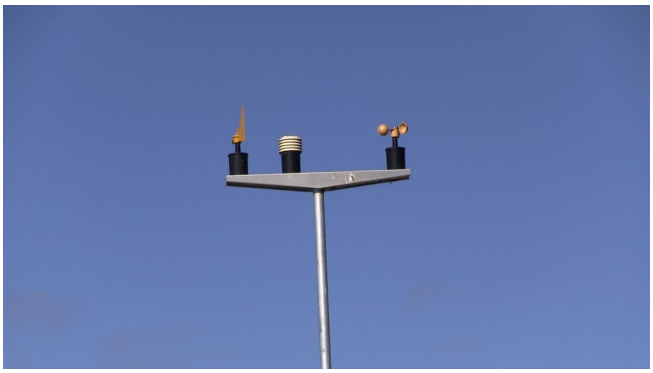
- the pan is a cylinder with a diameter of 120.7cm and depth of 25.4cm
- made from 20 gauge galvanised iron (other materials have different thermal and reflective properties providing inconsistent and incomparable results)
- filled with water to within 6cm of the pan top
- supported on a level wooden base 150mm above the ground
- located on a mown grassed area, free of tall weeds, bushes and trees
- sited to prevent any shading
- covered with wire to prevent birds and animals from gaining access.

The materials, dimensions and location are vitally important to provide evaporation results and proposed irrigation volumes that can be compared, e.g. the effect of wind and temperature on evaporation will vary with changing water depth or surface area. The evaporation data from the 'Class A evaporation pan' is normally measured daily at 9.00am to obtain details of the evaporation from the previous 24 hours. It is important that the readings and refilling of the pan occur regularly at this time or the pan holding less water will heat up more quickly and cool down faster, providing false readings.

Calculations are based on the depth of water in the pan. Evaporation will cause the water level to fall, and measuring this fall or loss from the pan will provide the evaporation data for the previous 24 hour period. To measure the amount of fall in the level, water is added to the pan and measured using a graduated measuring cylinder to refill the pan to normal, a level 6 cm from top of the pan. The amount of water added is the evaporation. Calculating this evaporation into a figure that can be used and compared is relatively simple calculating every 1.14 litres of water added to the pan equalling 1 mm of evaporation. Automated Class A evaporation pans are also available.

Evaporation data for a broad area can be accessed on a daily basis from internet sites such as the Bureau of Meteorology. Using this data can give a general indication of evaporation, but not data for specific growing areas within a nursery, e.g. shadehouses versus full sun growing areas.

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



Once the daily evaporation has been determined, the irrigation time can be adjusted by using the budgeting function on the irrigation controller, or by changing run times for each growing area. To use the budgeting function, for example, the controller could be set to apply 10 mm at the 100 percent setting. If the evaporation rate is multiplied by 10 this gives the percentage setting to set the controller to, e.g. 5 mm evaporation x 10 = 50% setting. On a cool day, the evaporation rate may only be 3 mm, so by changing the percentage adjustment setting to 30 percent, all blocks will receive the required water. If it is a hot dry day and the evaporation rate is 10 mm, then the setting is adjusted to 100 percent. This may seem an

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chore, but in reality most days in a month will be around the average evaporation rate, so in reality the settings may only need to be adjusted prior to and after a major weather event.

A more accurate approach to the irrigation scheduling of nursery stock is for the irrigation application to reflect the water lost from the container itself.

Weighing a number of representative containers from an irrigation block before and after irrigation gives a measure of plant water use, and the irrigation can then be adjusted to match plant water requirements. This method offers real time monitoring of plant water use, greatly improves water use efficiency in a nursery and after a period of weighing and monitoring containers, a nursery manager is in a position to use this data, along with his skill and experience, to schedule irrigation according to current weather conditions for more accurate and efficient irrigation scheduling.

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

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

- Select the container size and plant that is going to dictate the irrigation frequency for each block.
- Once 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 amount of water lost in millimetres can then be calculated from Table 1.

By measuring and recording the weights of a range of plants and containers in various blocks within the nursery, you can start to group plants with similar water requirements into areas. This information can also be used to schedule the irrigation, e.g. if a 100 mm pot has lost 50 g of weight this is equivalent to 5 mm of irrigation. Checking crop water requirements over the growing cycle of the plants and over a number of years will develop a picture for the full range of plants grown.

Table 1: Water loss per container size

Container size (mm)	Weight loss (g) for 1mm of water
80	5
100	10
150	20
170	25
200	30
250	50
300	70

The timing of irrigation depends on site specific conditions. Factors that need to be considered are:

- disease potential - the time foliage is wet for
- business operational requirements - other production activities such as dispatch
- system pumping capacity - how many emitters can be run efficiently at one time
- types of application systems, e.g. drip irrigation uses short pulses whereas sprinkler irrigation is usually operated for longer periods.

For more detail on irrigation scheduling refer to the Nursery Paper “Scheduling Irrigation to Maximise Efficiency” August 2006.

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