Designing Best Management Practice Irrigation Systems

Onsite visits regularly reveal irrigation installations that do not meet nursery industry Best Management Practice (BMP) benchmarks. Irrigation supply outlets are extremely competent in the design, supply and installation of pumping and distribution systems for irrigation, but many have little experience in designing irrigation systems that meet the requirements of modern production nurseries.

The planning of a new irrigation installation is an essential part of designing an efficient irrigation system. Gathering site information, and discussing the requirements of the system with irrigation professionals, provides essential information for the system design to meet BMP benchmarks.

Deciding on a suitable irrigation system for a new growing area, or upgrading an existing production area can be simplified by following **a stepped approach**.

The first step is to conduct some background research on the current irrigation system, and the crop or crops to be produced. The following is some of the information that needs to be Identified during preliminary data collection:

- the available water flow and pressure required or generated by an existing system
- the irrigation window, or available irrigation run times
- growing media parameters such as absorption rate, Air Filled Porosity (AFP) and Water Holding Capacity (WHC)
- the crop water demand
- if multiple crops are to be grown, whether they have similar water use requirements
- the container size or sizes
- current and future access requirements for setting out new plants and selecting and removing orders
- possible future materials handling requirements such as palletisation.

This fundamental information can then be utilised in the more detailed planning of the system.

Consider information on **the growing area and the emitters** to be used:

- layout and shape of the growing area to establish feasible emitter spacings
- emitter positioning, e.g. upright or inverted, or the location of drippers
- correct sprinkler location to give Scheduling Coefficient (Sc) and Coefficient of Uniformity (Cu) values that meet minimum BMP benchmarks
- if drip emitters are to be used, what flow rates are required to match the Mean Application Rate (MAR) to the absorption rate of the growing media
- sprinkler height above the crop
- MAR for a sprinkler system required to match growing media absorption rates and crop requirements
- wind conditions
- scheduling of irrigation.

Once the above have been considered, the decision of which emitter is best suited to the situation can be made by also taking into account:

- the type of emitter
- the flow rate of the emitter
- the coverage pattern of sprinklers
- the height of the sprinkler stream so it isn't affected by shadehouse covers etc.
- the operating pressure required for the efficient operation of the emitter
- the cost and availability of the emitter

Once the characteristics of the chosen sprinkler are known, an **appropriate sprinkler spacing** can be established, subject to the dimensions of the production area, the crop, container size, access and available operating pressures and flow rates.

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The further sprinklers are spaced apart, the larger the droplet size required to cover the distance, which results in more force required to propel the droplet. This can lead to splashing of water and growing media out of the containers, compaction of the growing media, disturbance of young planted material and generally low application rates requiring long irrigation run times. Close sprinkler spacing can present many obstructions, e.g. irrigation sprinkler risers, and can be more expensive with more laterals, risers, supports, and irrigation fittings being required. However, closer sprinkler spacing can provide irrigation systems that are extremely uniform with higher application rates.

The crop requirements then need to be addressed. The plant type, the density of planting and cropping cycle are all important aspects to consider in assessing how the crop requirements will be met by the irrigation system. If the plant type is rosette or grass-like, then gentle irrigation can be suitable. However, if the planting density is high, and the plants grown have leaves capable of shedding the irrigation, then larger droplets or a stream rotator type sprinkler should be selected to more effectively penetrate the foliage. It's important to view a sprinkler in operation before making a selection, to confirm that the sprinkler operation for the selected crop type will be suitable.

The **riser height or height of the sprinkler above the crop** should be high enough to guarantee the irrigation is not intercepted by any foliage, and not excessively high causing wind to blow water off the target. Sprinklers are designed and specified to be located at specific heights above a crop to ensure the irrigation water covers the required distance. If the riser height is too low the sprinkler will not cover the area. Too high, and water will be thrown far outside the area and will be influenced more by wind

affecting the performance of the system. It's best to maintain sprinkler risers as low as possible, while still meeting BMP benchmarks for uniformity. Risers must be secured firmly to a support to achieve the best results, and small extension risers can be screwed onto existing risers if more height is required for short periods of time as the crop reaches maturity.

T**he sprinkler nozzle or dripper flow rate** determines the MAR of the system, which must be matched to the absorption rate of the growing media. However, the MAR must also be such that the system is still able to meet the requirement of applying the irrigation in the time available. The sprinkler nozzle selected also affects the droplet size produced, and consequently affects the wetted diameter/radius of the sprinkler, the ability of the droplet to penetrate foliage and how wind affected the sprinkler will be. The selection of nozzle size may also be limited by the flow and pressure available in the system.

Some sprinklers have the ability to direct the irrigation application totally to the growing area, while others can be fitted with **road guards** to prevent unwanted irrigation reaching sensitive areas. Gear driven sprinklers are available that direct water to full or part circles, but are often more expensive, operate at high pressures, and most often do not meet the other performance parameters.

Providing the wastewater can be collected and directed to storage for reuse, full circle sprinklers are most often the preferred option. Road guards direct the irrigation that would normally fall outside the irrigated area back onto the growing pads, and upset the uniformity of the application. However, these can be used to prevent irrigation spray reaching sensitive areas if required. Any method used to direct water away from non-crop areas will always negatively affect the overall uniformity of the system.

Once the requirements of the crop and growing area have been established there are many other factors that need to be taken into account when designing a system that will function as efficiently as possible. The following are other areas that should be investigated, and some of these may affect the choice of sprinkler selected in the above process.

Measure the water supply for the amount of water that's available, i.e. sustainable extraction rate. Bores holes should be tested to measure flow rates and the total quantity of water available, while the volume of surface water sources also need to be measured. For surface water storages allowances also need to be made for evaporation and seepage losses, as well as the degree of recycling available. A knowledge of the size of the catchment area of the storage, and the amount of and variation in rainfall are also required when **developing a water balance** for the system i.e. calculating water security for the business.

Water quality should be tested to establish if any problems such as clogging of the emitters may occur, and if the water is suitable for irrigating the crops being grown. Knowing the water quality available will guide decisions on water treatments required and disinfestation, as well as likely filtration requirements.

Taking some time now, to plan the size and location of future growing areas, water storages, roadways and structures will save many dollars in capital and operational costs in the future. Production nurseries traditionally continue to expand production areas over time, leading to accumulated problems of poorly sized mainlines, unsuitable pumping systems and odd shaped growing areas. Growers regularly comment they never planned to expand or grow to their current size, and if they had their time over they would certainly plan well beyond their current expectations.

Pumps or pumping systems are often located in small hot pump shelters, lacking room to upgrade, and not central to the growing areas. Many pumping locations also have insufficient room for expansion; for multiple pumps, disinfestation systems, storage tanks, and are often serviced by a limited electricity supply.

Growing areas are not always well planned and easy to irrigate. Growing areas that, due to expansion, fill in the gaps between established growing areas, are often irregular in shape, long and narrow, triangular, or some other strange shape that makes it extremely difficult to design efficient irrigation systems.

Check the **location of man-made structures** such as power lines, buildings and dams, and how these will

affect the final design.

Map the topography of the area, as the features of the site have to be taken into account to restrict pressure variations along laterals to less than 10% of the desired operating pressure. Topographical information is also essential in designing drainage systems and water storage infrastructure.

The system should be designed to **enable the irrigation schedule to be completed in the time available** (system capacity). The amount of water to be applied in a given time must be calculated on the expected highest daily/weekly/monthly water use scenario. Allowances should also be made for breakdowns and system maintenance when calculating system capacity

The **maximum irrigation required per day** is a function of crop water requirements and the total irrigated area, but the available hours of operation must also be taken into account in determining pump capacities and pipe sizes, e.g. it may be desirable to operate the system only during daylight hours to make use of on-site generated solar electricity limiting the time available to apply irrigation increasing the flow rate/hr.

There are a number of **disinfestation systems** that are recognised under Nursery Industry BMP for use in nursery production, The selection of an appropriate disinfestation system must take into account water quality parameters such as pH, capital expense and overall cost of treating water.

The required capacity of the irrigation system (system curve) should be matched to the pump curve to achieve optimal efficiency, i.e. the pump should be operating as close as possible to its Best Efficiency Point (BEP). In a new design, pump selection is the last decision to be made. Once the required flow rate and operating pressure of the system have been calculated, a pump can be selected to closely match the required system characteristics. The design flow rate of a new pump should be 10% higher than required to allow for wear over the life of the system.

The mainline should be a class above the design pressure, with thrust blocks placed at mainline and submain elbows and pipe ends. Air release, pressure release and vacuum valves should also be included where appropriate, to minimise damage and flow restrictions associated with water hammer and topography.

Installing a mainline now that is oversized for current requirements or makes allowances for future expansion is a shrewd and prudent investment, i.e. it's far easier to upgrade a pump to increase flow rates than to increase the diameter of a mainline. Mainlines are one of the most common irrigation system components that limit the ability of production nurseries to expand their growing areas. Mainlines are often too small to carry the flow and pressure required in expansion plans, contain too many restrictions such as corners and elbows, and can be inaccessible, often running under growing areas, structures, and concrete. Increasing the flow and pressure through existing mainlines to support new production areas can put the mainline under excessive strain, leading to leaks and pipe failure, as well as substantially increasing pumping and maintenance costs.

Where filtration systems are required the **filter mesh size** should be no greater than 25% of the sprinkler nozzle diameter, or 14% of a drip emitters outlet diameter. Information on available water quality will also guide the type of filtration system installed as well as consideration such as labour requirements.

Depending on the location of pipe work within the system, **water velocities within the pipes** should be between 0.6 and 2.0 metres/second. To minimise pressure losses and pumping costs, mainlines should have flow rates with velocities of between 1.0 and 1.5 metres/second.

Flushing lines or valves must be included to enable the removal of foreign matter that may accumulate or grow within the irrigation system.

Decide if the system is to be **assembled by professional personnel or using on-site labour**. Some cost savings can be made by installing the system utilising on-site labour, but this shouldn't happen at the expense of the quality of the installation, i.e. the cost savings may be outweighed by decreased efficiency of the system if not installed to specification.

A **site risk assessment** should be carried out, and relevant insurance and licensing obtained. Search for any **legal obligations,** such as water allocations, pumping licenses and restrictions on clearing remnant vegetation, and pumping from natural water courses.

Consideration needs to be given to **the capital and other outlays required**. Allow for earthworks including drainage and dam storages, survey costs, licencing costs, consultant costs, electricity supply costs, pumping systems, filtration units, disinfestation and treatment systems, mainline and delivery pipes, irrigation emitters, automation, fertigation equipment, irrigation scheduling tools, software and insurance.

Estimate the return on investment. Consider:

- the value of the crop
- pumping costs per ML of water applied
- treatment and disinfestation costs per ML of water applied
- cost of water
- energy use in all parts of the system
- maintenance costs per ML of water applied
- labour cost per ML of water applied
- leasing expenses
- interest expenses
- taxation implications.

Spending the time researching and designing the system to meet or preferably exceed accepted industry BMP benchmarks will provide a system best able to apply the required irrigation effectively and give a long service life.

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