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Assessment of hand watering in production and retail nurseries

During 2008, Nursery & Garden Industry Australia (NGIA) commissioned the Department of Primary Industries and Fisheries, Queensland (DPI&F, Qld) to evaluate and quantify the efficiency of hand watering against other irrigation methodologies.

In this month's Nursery Paper, Dr. Rachel Poulter, DPI&F, Qld presents the results from this study.

Assessment of hand watering in production and retail nurseries

Introduction

Hand watering is a common method of irrigation in some 55% of production nurseries and 94% of retail businesses throughout Australia. This practice is perceived by some production nurseries to have several benefits such as enabling the operator to supplement fixed irrigation systems or preventing over watering in low water use areas. In the retail environment, the prevalence of hand watering is perceived to offer greater flexibility when dealing with frequent stock movement and is considered more practical that fixed overhead irrigation systems. However, despite these apparent benefits, quantifiable evidence is required to ascertain if hand watering is an efficient use of water and labour resources.

Research project examines the labour costs and water use associated with hand watering compared to calculated costs of other irrigation technologies.

Irrigation is mandatory for any form of container production. As container plants are a perishable commodity, nurseries are dependent on frequent supplemental irrigation events. Irrigation methods vary between production and retail nurseries, types of plants under production and the choice of growing media for those plants. While the nursery industry has embraced automatic irrigation systems, a large number of growers and retailers still practice hand watering as part of, or in some instances, as their entire, irrigation regime.

Hand watering is common practice in many production and retail nurseries. In some instances it is recommended as an efficient irrigation method, without full knowledge of the underlying principals and actual efficiencies of alternative methods. During 2008, DPI&F, Qld conducted an investigation into the efficiency and inefficiency of nursery irrigation practices on behalf of NGIA. This investigation surveyed a mixture of production and retail nurseries to examine the labour costs and water use associated with hand watering, compared to calculated costs of other irrigation techniques.

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Part 1: Time in motion study

Six nurseries in south east Queensland that practiced hand watering as part of their irrigation regime were selected (two production and four retail businesses). Observational data was collected at each nursery including: time spent watering; experience level of staff carrying out the hand watering; and measurement of the area irrigated. Measurements of water use were calculated based on measured flow rates or in some instances by installation of a portable water meter to the irrigation hose. These measurements then allowed determination of the water use per m² of production/plants. For ease of comparison, no additional costs such as energy consumption to run pumps or initial costs of hoses and nozzles for hand watering were included. These results are summarised in Table 1.

Nursery Identification:	Production 1	Production 2	Retail 1	Retail 2	Retail 3 [i]	Retail 4
Plant types & pot sizes	Propagation trays to 140 mm pots	Propagation trays to 140 mm pots	Mixed	Mixed	Mixed	Mixed
Irrigation system/s	Overhead and hand watering	Overhead and hand watering	Overhead sprinklers and supplementary hand watering	Overhead sprinklers and supplementary hand watering	Overhead sprinklers and hand watering	Overhead sprinklers, micro drip and hand watering
Area hand irrigated (m²)	43.8	18.95	76	50	Variable ~150	~100
No. Staff hand watering	1	1	1	1	2–3	4
Estimated minutes per day	2.6	10 [ii]	35	17.25	60	40
Experience of staff member	Experienced	Experienced	Owner and apprentice	Owner	Varied	Varied
Flow rate (L/min)	42.86	10.45	38.5	15.79	24	24
Litres applied	114.26	60.1	1347.3	272.48	2880	3840
mm applied	2.61	3.17	17.7	5.45	19.2	25.6
Irrigation rate (mm/hour)	62.31	33.1	30.4	18.95	19.2	38.4
Time (seconds) per m²	3.64	18.21	27.63	20.7	24	16
Volume (L) per m²	2.61	3.17	17.73	5.45	19.2	25.6
Labour costs (cents) per m²	2.29	11.4	17.4	13	15	10.1
Current water costs (cents) per m²	0.26	0.32	1.7	0 (bore and rainwater)	1.92	2.56
Total cost (cents) per m² per irrigation event	2.55	11.72	19.1	13	16.92	12.56

Table 1: Comparison of hand watering events in the six surveyed nurseries

[i] Nursery required by council to only irrigate between 1 and 2 pm each day, however total time spent undertaking task is dependant on customer service needs. All volumes and areas are estimated from existing stock layout at the time of visiting.
[ii] The labour component is as quoted, however water run time was reduced as the hose was stopped between areas.

Part 2: Labour and equipment costs for deferring irrigation systems

The measurements of irrigation per m² were then compared to the calculated water use for irrigating a similar area with overhead sprinkler irrigation, ebb and flow or capillary mat technologies. These results are presented in Table 2 (overleaf). These figures were derived by calculating water use per m² under best management practices (BMP) as detailed by the industry's WaterWorks program.

Observation from nurseries retrofitted with BMP systems through Nursery & Garden Industry Queensland (NGIQ) were also used as benchmark figures. The systems quoted on were professionally designed and fully installed systems (Hunt 2008). Costs were derived by comparing the time spent (labour $) and water used ($ per KL) compared to a timed irrigation system. Return on investment was derived for the irrigation system based on these figures.

The cost for installation of 'do it yourself" (DIY) overhead irrigation systems was based on designs A and B of Layout 6 in Managing Water in Plant Nurseries, (Rolfe et al. 2000). These designs were for an outdoor area; 60 m x 40 m; with mean application rates of 5.6 mm/hour and 11.2 mm/hour respectively, at an operating pressure of 200 kPa. Equipment costs were based on current retail prices for the listed components (Rolfe et al. 2000). The cost of these systems fell within the ranges quoted by a professional irrigation supplier and installer (Hunt 2008). All costs were then converted to $ per m². The cost price per m² of Ebb and Flow mat was estimated at $11.

The labour component of the cost benefit analysis was based on current wage rates as outlined in the Queensland Industrial Relations Commission 2003 Nursery Award. The rates are accordingly based on day workers over a 38 hour week with no penalty rates for overtime or additional payments for leading hands with supervisory roles.

The labour component was converted from a per irrigation event to a yearly cost per m² based on the assumption of 200 irrigation events per year, which accounts for outside areas receiving incident rainfall and the reduced water requirements during winter. A labour component is included for automated systems to account for general system maintenance and programming of 15 minutes per week plus installation.

Two options for installation are also included: either DIY based on an estimated 16 hours for two nursery workers paid at the highest level of the award; or, the quoted

labour costs from the professionally designed and fully installed systems (Hunt 2008).

The results presented in Table 2 found that hand watering can cost up to 14 times that of an installed overhead sprinkler irrigation system. Even the most expensive capillary matting system, with high initial capital costs, should provide a return on investment after two years purely from labour savings.

	Labour – production	Labour – retail	Equipment costs	Total – Production (Year 1)	Total – Retail (Year 1)	Subsequent years
Hand watering	$13.76	$27.74	$0.04	$13.80	$27.78	$13.76 (P) / $27.74 (R)
	Installation	Maintenance				
Overhead spray 5.6 mm/hr – (DIY)	$0.30	$0.12	$1.83	$2.10		$0.12
Overhead spray 11.2mm/hr – (DIY)	$0.30	$0.12	$1.94	$2.21		$0.12
Professionally installed system [iii] – MAR 5.7–8.4 mm/hr	$0.95 to $2.76	$0.12	$1.53 to $5.09	$2.61 to $7.97		$0.12
Ebb and Flow	$0.27	$0.12	$11	$11.27		$0.12
Capillary matting [iv]	$2.76	$0.24	$4.75 to $49.25	$7.75 to $52.25		$0.24

Table 2: Summary of costs for installation and maintenance of five different irrigation systems as compared to the costs associated with hand watering. The comparative costs of irrigation systems are based on average measured time per m² for hand irrigation and equipment costs for a 60 m x 40 m area converted to a m² basis.

[iii] This is based on the range of prices quoted over a number of differing locations within the nursery, from propagation, shade houses to outdoor areas.
[iv] The range of matting types varies from basic geo-textile fabric through to integrated systems with internal dripper lines or purpose built benches, hence range in price is large.

Part 3: Water use comparison

The relative importance of irrigation rate was then calculated by determining the quantity of water draining through the pots compared to the water falling between the pots at the various irrigation rates observed over this study (Table 3).

Firstly, the waste space between pots was determined through a geometrical analysis of the occupied and unoccupied space over a 10 m x 10 m area. The total area, 100 m², could then hold 5041 140 mm pots (71 across and 71 down). Using $A = \pi r^2$, the total surface area occupied by pots was 77.60 m², or 77.60% of the total area.

Secondly, the water draining through the pots was calculated as a function of the irrigation rate; for example a media with an absorption rate of 15 mm/hr, irrigated at 22 mm/hr would be draining at 7 mm/hr which equates to 32% of the applied irrigation water. A series of calculations was conducted, based on a target irrigation of 5 mm over the 100 m² area, with 140 mm pots containing media with an absorption rate of 15 mm/hour. Since water losses through drainage were calculated to occur at higher irrigation rates, a greater quantity of water was required to achieve retention of 5 mm in the pots at each irrigation event.

Finally, a comparison of the water costs per m² were determined under each scenario based on current water prices and the yearly projected bulk water costs from the Queensland Water Commission up to 2018, when all regions will be paying equal rates per megalitre of water.

The results presented in Table 3 indicate that as irrigation rate increases beyond the absorption rate of the media, more water is lost as drainage; hence a larger total application is required to ensure adequate retention of water in the growing media. As shown in Table 1 and 2, the high irrigation rates quoted here are feasible, and indeed lower than could be expected under some hand watering situations. These results suggest that high application rates result in a great deal more water loss as drainage, than occurs as direct run-off from between pots at lower application rates.

Irrigation rate (mm/hr)	Volume required to ensure 5mm is retained (Litres)	Water missing pots		Water draining through pots		Total water loss through missing pots and drainage		Yearly cost of water – current prices	Yearly cost of water – projected 2018 prices
		(Litres)	(% of original)	(Litres)	(% of original)	(Litres)	(% of original)		
12	500	112	22	0	0	112	22	$101.81	$275.50
22	950	213	22	236	25	449	47	$193.44	$523.45
40	1720	385	22	834	48	1219	71	$350.23	$947.72
50	2150	482	22	1168	54	1650	77	$437.78	$1,184.65
100	2580	578	22	1502	58	2080	81	$525.34	$1,421.58
200	5000	1120	22	3376	68	4496	90	$1,018.10	$2,755.00

Table 3: Volume of water applied or wasted when supplying 5 mm irrigation to media with an absorption rate of 15 mm/h over a 10 m x 10 m area of 140 mm pots.

Discussion

This project documents some compelling arguments against the efficiency, both economically and in the application of hand irrigation practices in the nursery industry. The presented comparative costs based on equipment and labour only illustrate that installation of an irrigation system is a cost effective alternative (based on 200 irrigation events per year). As the number of irrigation events increases, for example indoor areas requiring daily irrigation (365 days a year), the comparative cost of hand watering would almost double compared to that of an automated system.

One aspect of this cost comparison that must be highlighted is the fact that the capital cost of equipment and installation is a one-off cost, with only minor maintenance costs ensuing. However, the labour costs for hand watering will be on-going, and will increase with inflation. The cost benefit analysis of current practices provides confidence in the adoption of automated irrigation systems as well as providing decision support in terms of choosing the appropriate system for the types of plants grown and the production scale.

If the comparative water use is taken into account, the evidence for the inefficiency of hand watering is reinforced. Water consumption may seem an insignificant cost at present; however the projected costs of water show the price almost tripling over the next 10 years. Claims that hand watering allows the operator to prevent water being applied between pots is not supported as a viable argument in this study (Figure 1)

Whilst it is possible to minimise water loss with larger pot sizes and trigger nozzles to control the direction of flow, there is still significant potential for water loss. As suggested in Table 3, if the application rates from a point source (a hose) are much higher than that of a growing media, water will be lost through drainage (Figure 2).

Without the argument regarding drainage through pots, it is difficult to agree with the perception that water can be, and is, directed into pots rather than allowing water to fall in the space between pots. Taking the water consumption comparisons and factoring in the costs of wasted water, we can see that controlling the application rate of irrigation is pivotal in the control and prevention of water loss which equates to monetary loss.

Figure 1: Hand watering may results in a large volume of water missing the pot

Figure 2: Hand watering may lead to excess water lost through drainage

Conclusion

This study clearly indicates that not only is the cost of hand watering greater than that of any other irrigation system in terms of equipment and labour costs, it is also an inefficient method in terms of water use. Currently, the view of the nursery industry is that hand watering should only be relied upon as a 'fall back' for when other, more efficient systems fail, or to supplement the irrigation of higher water use plants.

Where hand irrigation is assumed to be the only viable option to maintain flexibility in the nursery layout, it is important that best management practices are adhered to. For example, nozzles which reduce flow rate and incorporate a trigger mechanism should be chosen to reduce the volume of water applied to pots and minimise water wastage between pots.

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For more information

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