Minimizing runoff and increasing water-use efficiency of nursery crops with pulse irrigation

Marc van Iersel
Department of Horticulture - Athens
University of Georgia

Nature of Work: Water resources are increasingly scarce in Georgia, partly due to the rapid population increase in the state. Nurseries affect water resources in two distinct ways. First of all, nurseries use water for irrigation, and thus draw from water from the limited supply. Secondly, nutrient runoff from nurseries may affect the quality of groundwater or surface streams. Runoff normally occurs when too much water is applied to container-grown plants, and excess water, together with dissolved fertilizer salts, drains from the bottom of the container. If this drainage water is not collected and reused, the dissolved fertilizer may end up in ground- or surface water.

Since runoff of fertilizer occurs when excess water is supplied, total water use and fertilizer runoff are closely related issues. Application of excess water is a common irrigation practice in nurseries. Often, containers are watered till about 20-30% of the applied water has been leached from the bottom of the container. This leaching can remove excess salts from the containers, but should only be necessary if excess fertilizers are applied or if the irrigation water is high in soluble salts. Under conditions where fertilizers are managed carefully, and good quality water is available for irrigation, leaching may not be necessary.

The objective of this study was to look at irrigation practices that may reduce water use by nursery crops, while minimizing runoff at the same time. To do so, four different irrigation treatments were used:

1. Once-daily irrigation with approximately 30% leaching (control)
2. Once-daily irrigation with half the volume of treatment 1 (0.5x control)
3. Three-times per day with the same total daily volume as treatment 1 (cyclic)
4. Three times per day with half the volume of treatment 1 (0.5x cyclic)

These treatments were chosen because applying the same total amount of water in multiple, smaller applications (cyclic irrigation) may give the growing medium more time to absorb the water and allows for more uniform distribution of the water in the substrate. This in turn may reduce leaching. Applying only half of the regular amount of water also may reduce leaching and runoff, while still resulting in marketable plants.

To compare treatment effects on different species, hydrangea and abelia were used. Hydrangea is a rapid-growing crop which requires relatively much water, while abelia is drought-tolerant.

Plants were grown in 1-gallon containers filled with a bark-based growing medium with lime and slow-release fertilizer incorporated into the growing medium. Leachate from each container was collected in buckets, and the volume measured approximately every six weeks. The fertilizer concentration of the leachate was estimated from leachate EC measurements, based on the assumption that an EC of 1mS/cm equals 700 ppm fertilizer.

Results and Discussion:

Hydrangea. With hydrangea, the standard (control) irrigation practices resulted in a leaching fraction (percentage of applied water leached from the containers) of 30% (Table 1). Cyclic irrigation reduced leaching to 18%. Reducing the irrigation volume by 50% reduced the leaching fraction by another 15%, independent of whether all water was applied once daily, or at three different times. Cyclic irrigation with half the volume of the control treatment resulted in the lowest leaching fraction (3%).

Decreasing the irrigation volume by 50% resulted in an increase in the EC of the leachate. This likely happened because in the treatments that received the most water, the salts in the leachate got diluted by the large volume of water that was leached. When the amount of salts in the runoff was calculated, it was clear that decreasing the irrigation volume reduced the total amount of fertilizer leached from the containers to about 23% of that leached from containers which received the standard irrigation volume. Although cyclic irrigation reduced fertilizer leaching by approximately 18% as compared to once daily irrigation, these differences were not statistically significant.

Only the 0.5x control treatment reduced growth as compared to the control treatment. Plants in the 0.5x cyclic treatment had very similar growth to the control plants. Thus these hydrangeas were grown with only one half of the standard irrigation volume, had a very low leaching fraction (4%), and leached less than 20% of salts leached from the control treatment, without any effect on their growth. Plants in the cyclic treatments also had similar growth, and slightly more stem dry weight, as control plants, but roughly the same amount of fertilizer was leached in the cyclic and control treatments.

Abelia. As expected, cutting the irrigation volume in half reduced the leachate volume, the leachate fraction (from 40 to 20%), and the amount of fertilizer leached from the containers (by about 40%). However, cyclic irrigation did not have any effect on the amount of water or nutrients leached. Surprisingly, cyclic irrigation tended to result in leaching of more fertilizer than irrigating once daily, but these differences were not statistically significant.

The cyclic irrigation treatment resulted in the most growth, and like hydrangeas, the differences in stem dry weight were especially large. Differences in leaf dry weight were smaller, although leaf dry weight was particularly low in the 0.5x control treatment. The cyclic and 0.5x cyclic treatments resulted in similar growth, but there was much less leaching of water and nutrients in the 0.5x treatments. In general, the benefits of cyclic irrigation were less in the abelias than in the hydrangeas. This likely is due to the fact that in the abelias there was approximately 20 leaching in the 0.5x treatments, while in the hydrangeas, leaching was almost eliminated in the 0.5 cyclic treatment.

Significance to the Industry: Leaching of fertilizers and water-use can be reduced by reducing the volume of water applied to each container or by splitting up the daily irrigation into several smaller applications (cyclic irrigation). Cyclic irrigation, combined with a reduction in volume, almost eliminated leaching in hydrangeas without any detrimental effects on growth. Since reducing the irrigation volume can greatly reduce the amounts of nutrients that are leached from a container, it seems likely that less fertilizer would need to be applied. This would results in fertilizer, as well as water, savings and be a financial benefit to growers.

Table 1. The effect of irrigation method and volume on leaching, leachate EC, and total amount of nutrients leached from container-grown hydrangea (top) and abelia (bottom).

Treatment	Leachate volume	Leaching fraction	Leachate EC	Fertilizer leached	Dry weight		
					leaves	stem	total
	Liters	% of applied water	mS/cm	g	g	g	g
Hydrangea							
control	22.1 a	30 a	2.10 b	5.35 a	31.2 a	22.4 b	53.6 a
0.5x control	5.4 c	15 b	3.00 ab	1.26 b	19.8 b	17.8 b	37.6 b
cyclic	13.0 b	18 b	1.99 b	4.38 a	30.9 a	28.2 a	59.1 a
0.5x cyclic	1.6 d	4 c	3.65 a	1.01 b	29.0 ab	22.1 b	51.1 a
Abelia							
control	20.6 a	41 a	0.52 b	7.28 ab	21.2 bc	23.8 b	45.0 bc
0.5 control	6.1 b	23 b	0.88 a	4.37 c	19.7 c	20.8 b	40.5 c
cyclic	17.8 a	40 a	0.58 b	7.95 a	24.4 ab	34.2 a	58.7 a
0.5 cyclic	4.0 b	18 b	1.15 a	4.72 bc	26.6 a	29.8 ab	56.5 ab