

Evaluating a Physiological-based, On-demand Irrigation System for Container-grown Woody Plants with Different Water Requirements



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Introduction

Water scarcity is a growing concern as demand for clean water increases while availability is becoming largely restricted due to regulations, competition with urban and industrial water use, and contamination. Container nursery production is a high input form of agriculture and depends on irrigation because of the small volume of growing substrate and its low water holding capacity. Improving irrigation strategies is critical to managing nutrient- and pesticide-laden runoff, mitigating water shortages, and optimizing production schedules. This research evaluates physiology based and sensor driven irrigation scheduling systems for water use and plant growth of container-grown woody plants with different water needs.

Materials and Methods

Boxwood (*Buxus* 'Green Velvet') and slender deutzia (*Deutzia gracilis*) 4-inch liners were planted in 1 gallon containers filled with 85% pine bark:15% peat moss (vol:vol).

Irrigation zones were 10 square feet with 18 plants per replicate. There were three replicate zones per treatment. Plots were independently irrigated by a program based on the average soil moisture readings of three ECHO-5 probes per plot.

Irrigation regimes:

(1) Daily Water Use (DWU) - Irrigation was applied daily to replace the amount of water lost in the previous 24 hours.

(2) On-Demand (OD) - Irrigation was triggered when substrate moisture fell below either 28% volumetric water content (Boxwood) or 33% (Deutzia).

Both regimes returned to 100% container capacity after each irrigation.

Physiological measurements of two plants per plot were taken weekly with Licor 6400 at the plant's driest level prior to irrigation.

On Demand Set point

The on-demand substrate moisture set point to initiate irrigation is the volumetric water content that supports photosynthesis at 90% of the maximum rate.

Figure 1: Relationship between photosynthesis rate and substrate water content. Arrow represents the irrigation set point.

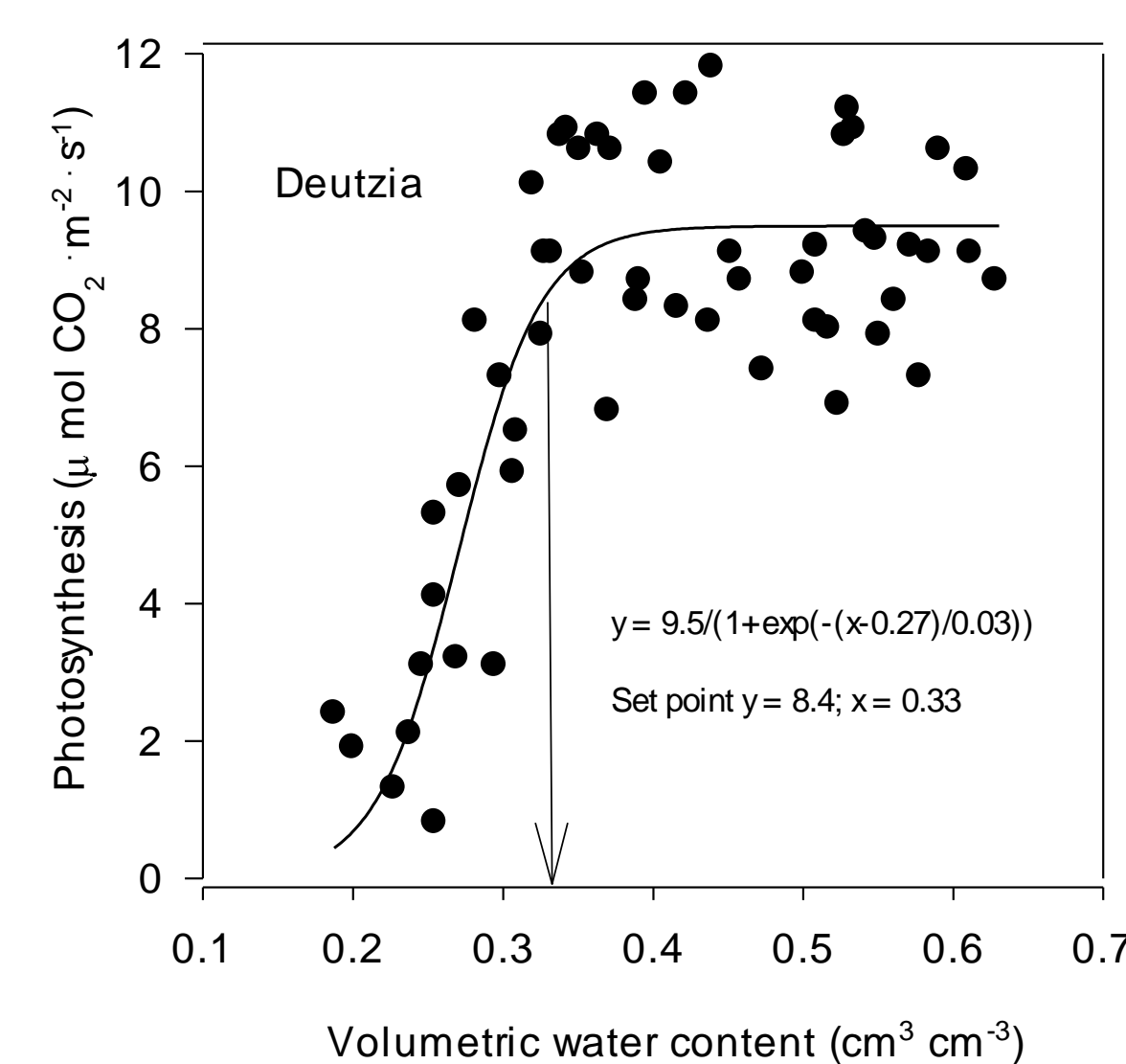
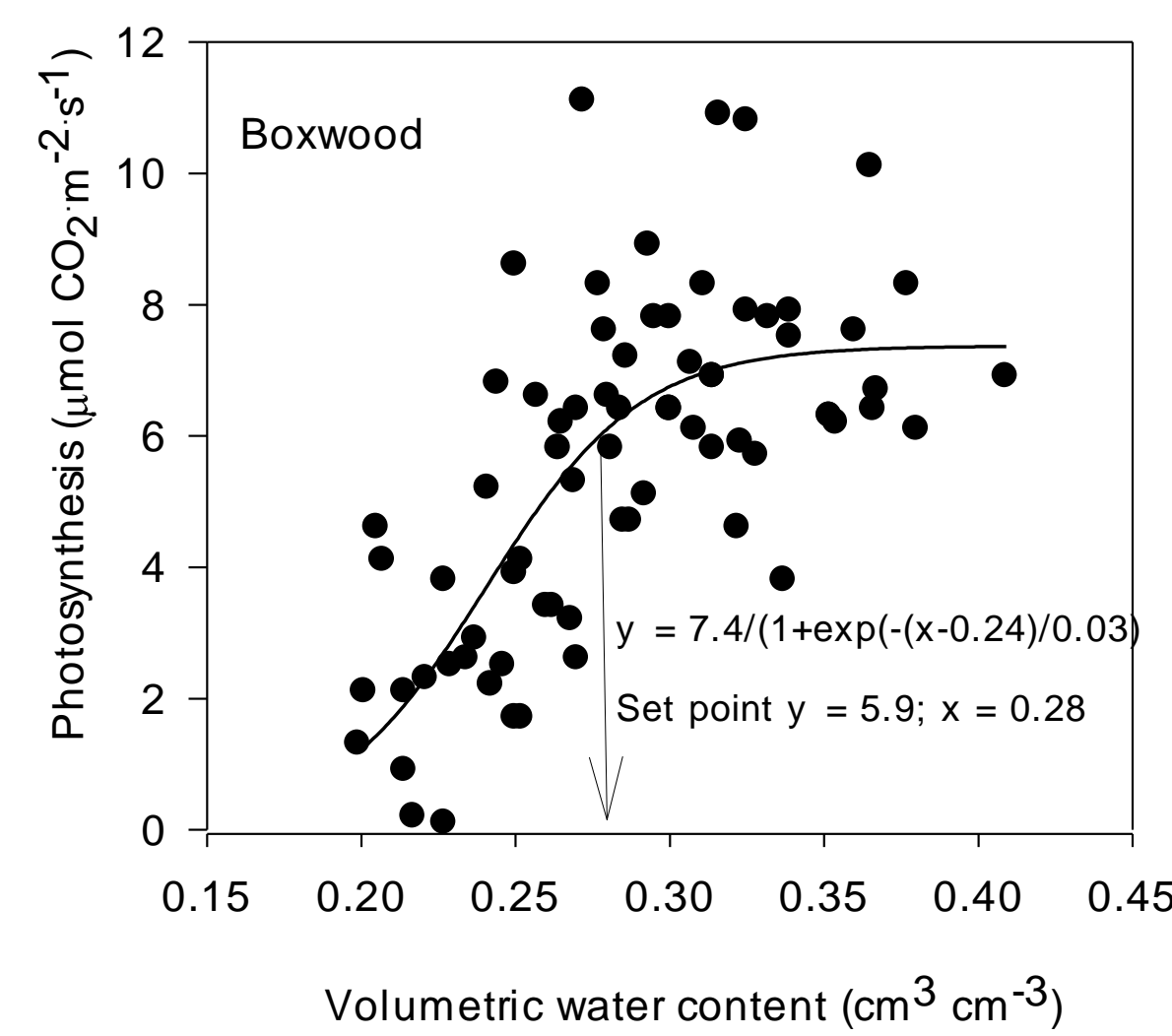
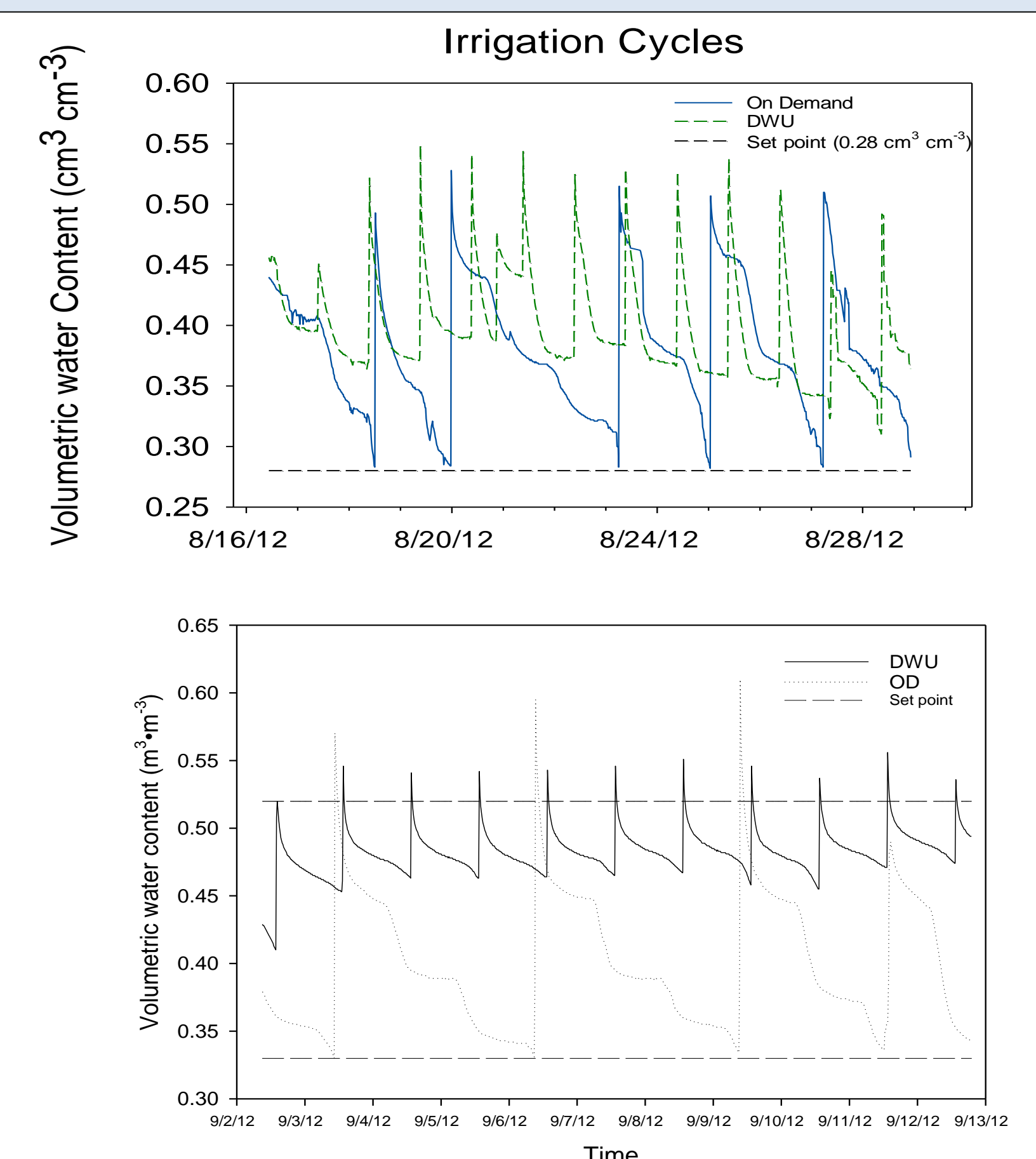


Table 1: Water use, water use efficiency, and leachate parameters of boxwood and deutzia plants

Treatments	Total irrigation applied per container (L)	Total leachate (L)	Leaching fraction (%)
Boxwood			
Daily Water Use	25.1a ^x	8.5a	33.9a
On-Demand	16.2b	3.2b	19.8b
P value	0.031	0.0426	0.0327
Deutzia			
Daily Water Use	70.9	36.8a	47.2a
On-Demand	52.1	9.1b	17.3b
P value	0.444	0.026	0.009

Figure 2. Typical irrigation cycles for two irrigation schedules: on demand and daily water use.



Results and Discussion

- There were no differences in physiological or growth measures between the two irrigation systems for either boxwood or deutzia (data not shown).
- Plants in OD were irrigated on average every 3.4 days in boxwood and 1.6 days in deutzia compared to daily irrigation event in DWU.
- Total irrigation water applied was 36% more for the DWU than the on-demand irrigation treatment for boxwood and the irrigation volume was 27% more for DWU than OD of deutzia. Water use was reduced compared to traditional overhead irrigation applications by 61% and 70%, respectively, for DWU and OD treatments.
- Since each irrigation event is inefficient, the more frequent irrigation events associated with DWU treatments would lead to greater water losses thus increasing water use and decreasing water use efficiency.

Literature Cited

- Ethan, H., S. Nambuthiri, A. Fulcher, and R. Geneve. 2014. Comparing substrate moisture-based daily water use and on demand irrigation regimes for oakleaf hydrangea grown in two container sizes. *Scientia Hort.* 179:132-139.
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