Quantifying Water Requirements of Hydrangea and Gardenia

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Significance to Industry: Water availability and usage is becoming an increasingly important issue for the nursery industry. Growers often encounter pathogen problems (both foliar and root-related) due to excessive overhead irrigation, which can result in decreased product salability and increased crop losses. Unfortunately, there is a lack of quantitative information regarding the water requirements of ornamental plants. In 2010, we determined the effect of plant size and environmental conditions on water use of *Hydrangea macrophylla* 'Pia' and 'Fasan'. Daily water use of both cultivars was similar and depended mainly on plant size and daily light integral (DLI, the total amount of sun light over a day). In 2011, we conducted a follow up study comparing water use of hydrangea 'Fasan' and *Gardenia jasminoides* 'Radicans'. During the summer months, water use of the gardenias was much higher than that of the hydrangeas, mainly because the gardenias grew much faster. Water use of the gardenias decreased in fall, because of the cooler weather and lower light levels, while water use of the hydrangeas remained fairly stable: the effects of the cooler weather and lower light in fall were offset by a flush of fall growth. Daily water use of the gardenias was at most 570 ml/day (20 fl. oz.) while daily water use of the hydrangeas was at most 200 ml/day (7 fl. oz). Unlike 2010, water use of the plants in the 2011 study was greatly affected by both DLI and vapor pressure deficit (VPD): overcast conditions reduced water use by as much as 60%, emphasizing the importance of adjusting irrigation based on weather conditions.

Nature of Work: Excessive irrigation can result in a wide array of economic and physiological problems in nurseries. Over-watering can increase plant susceptibility to root diseases, such as phytophthora, and can lead to eutrophication of lakes due to high levels of nitrogen and phosphorus contained in irrigation runoff. As a follow up to a 2010 study with two cultivars of *Hydrangea macrophylla*, we compared daily water use of two different species: *Hydrangea* *macrophylla* 'Fasan' and *Gardenia jasminoides* 'Radicans'. We also quantified the impact of weather conditions on the water use of these plants

Rooted cuttings were transplanted into #2 containers filled with composted pine bark medium. The plants were arranged on a custom drip irrigation system with six plants from each species placed on load cells. Light levels, temperature, and humidity were collected throughout the study. All sensors were connected to a datalogger. The datalogger used all the light measurements from one day to calculate the daily light integral (DLI) and used temperature and relative humidity data to calculate the VPD (see side bar) (Fig. 2).

Plants were weighed at midnight, establishing a base weight for the start of each day. At 10:00 pm every night, the datalogger again weighed the twelve plants on the load cells. The decrease in weight that occurred between midnight and 10 pm was the daily water use (DWU). The plants were watered daily at 10 pm for 30 minutes to bring the substrate back to container capacity. Leachate was allowed to drain for an hour and a half before the load cells weighed the plants again.

Vapor pressure deficit (VPD)

Although a term not commonly used in horticulture, VPD is much more important for plants than relative humidity. Both terms relate to the amount of water vapor in the air: relative humidity is the actual amount of water vapor in the air divided by the maximum amount of water vapor the air can hold × 100%. So at 100% relative humidity, the air is saturated with water. VPD is different: it indicates how much more water vapor the air can hold before it would be saturated. Like air pressure, VPD is expressed in pressure units, most commonly kilopascals (kPa). VPD is more important than relative humidity, because VPD is the driving force for transpiration: the higher the VPD, the more water plants use.

As is illustrated in Fig. 1, relative humidity is a poor indicator of VPD. The VPD of air with 40% humidity is much greater under warm than under cool conditions. As a rule of thumb, VPD increases with increasing temperature and decreases with increasing humidity.

After 150 days, the plants mounted on the load cells were harvested and their leaf area was measured. The effects of environmental and plant parameters on daily water use of the plants were tested using regression analysis.

Results: The daily water use of the gardenias initially increased as the plants grew rapidly following transplanting. The maximum daily water use occurred in July and August and was about 570 ml/day (20 fl. oz.). Daily water use of the gardenias decreased throughout the fall, as light levels and temperatures dropped (Fig. 2, 3). Water use of hydrangea was fairly stable throughout most of the summer and early fall (Fig. 3). Due to hot weather, the hydrangeas did not grow much until fall, explaining the fairly steady daily water use throughout summer. In fall, the growth flush of the plants did not result in increased daily water use, because light levels and temperatures were dropping at the same time, offsetting the effect of plant growth on water use.

In contrast to 2010, when DLI was the only environmental variable with a large impact on daily water use, in 2011 both DLI and VPD were important in explaining day-to-day changes in water use by plants of both species. It is not clear why VPD played an important role in 2011, but not in 2010.

A predictive water use model developed from 2010 data overestimated water requirements of the 2011 hydrangea 'Fasan' crop by about 60%. The reason for this difference is that the hydrangeas grew much more during the early part of the 2010 study than in the early part of the 2011 study. Therefore, the predictive model was developed using larger plants and overestimated water use of the smaller 2011 crop. This discrepancy emphasizes the importance of including accurate estimates of plant size into predictive water use models. Measurements of canopy light interception appear a promising approach to obtaining non-destructive estimates of canopy size.

By monitoring plant size and environmental conditions (specifically DLI and VPD), growers can more accurately determine the daily water requirements of hydrangea and irrigate their stock more efficiently. Irrigation volume and/or frequency can be adjusted based on environmental conditions and plant size, improving both economic and environmental aspects of nursery production.

Acknowledgements: We thank Sue Dove and Mike McCorkle for their help with this research. Funding was provided by USDA-NIFA-SCRI award no. 2009-51181-05768 and the Center for Applied Nursery Research.

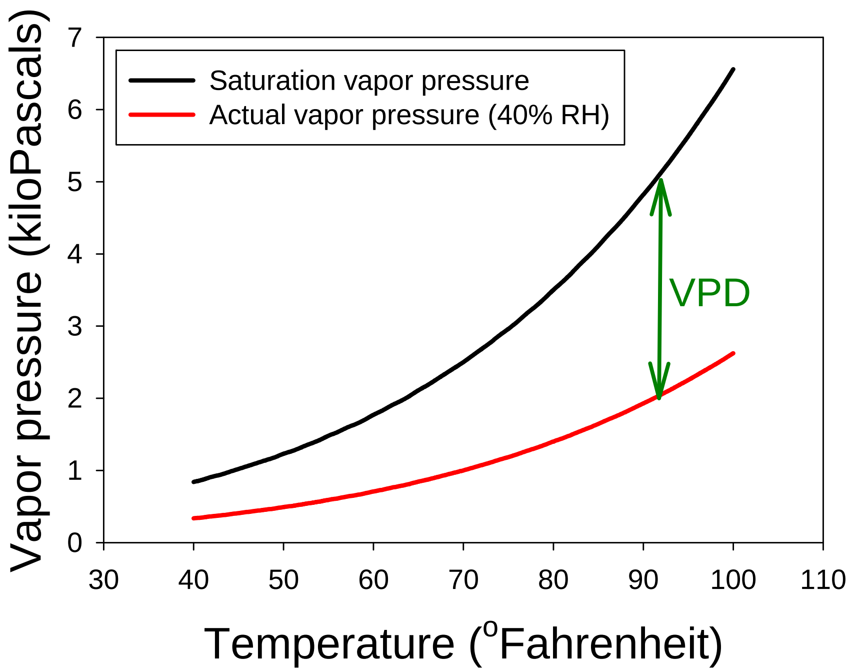

Fig. 1. Vapor pressure deficit is the difference between the actual vapor pressure of the air (red line, assuming 40% relative humidity) and the total amount of water vapor the air can hold (saturation vapor pressure (black line). Note that the vapor pressure deficit is much higher at higher temperatures, assuming 40% relative humidity.

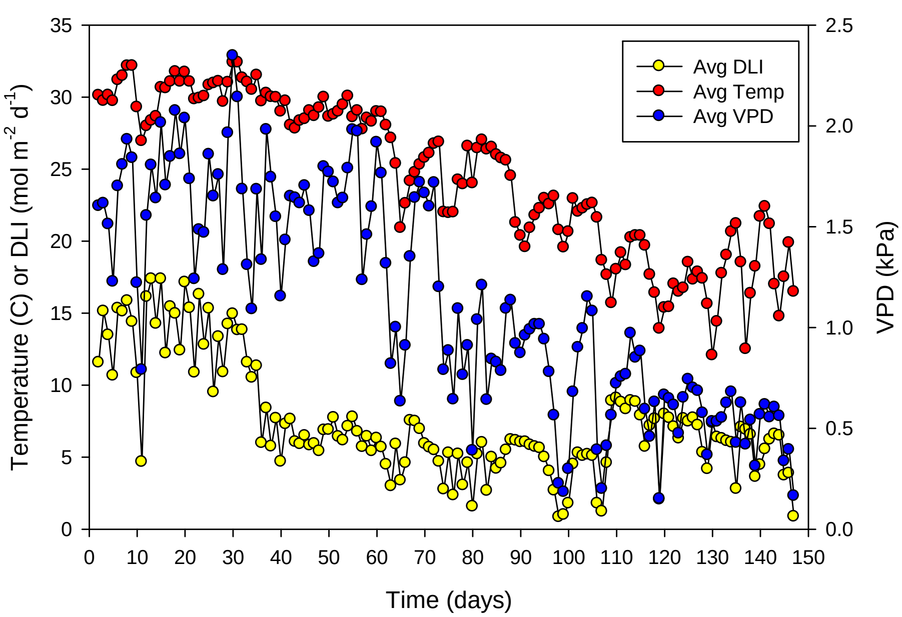

Fig. 2. Environmental conditions (daily light integral (DLI), temperature and vapor pressure deficit (VPD)) during the 2011 study.

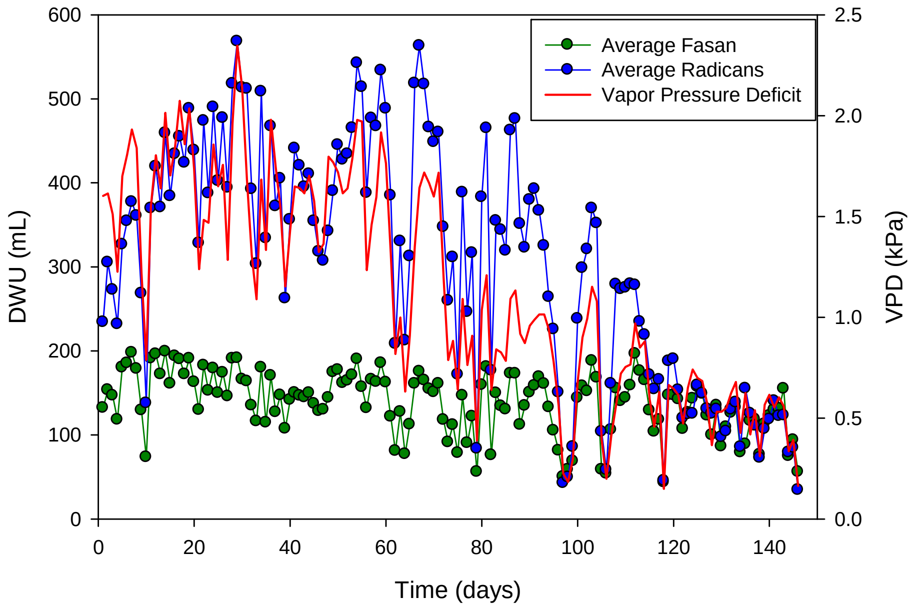

Fig. 3. Measured daily water use of gardenia 'Radicans' (blue line) and hydrangea 'Fasan' (green line). Note that the daily water use of the gardenias tracks the vapor pressure deficit (VPD): on days with a high VPD, water use is high and vice versa.

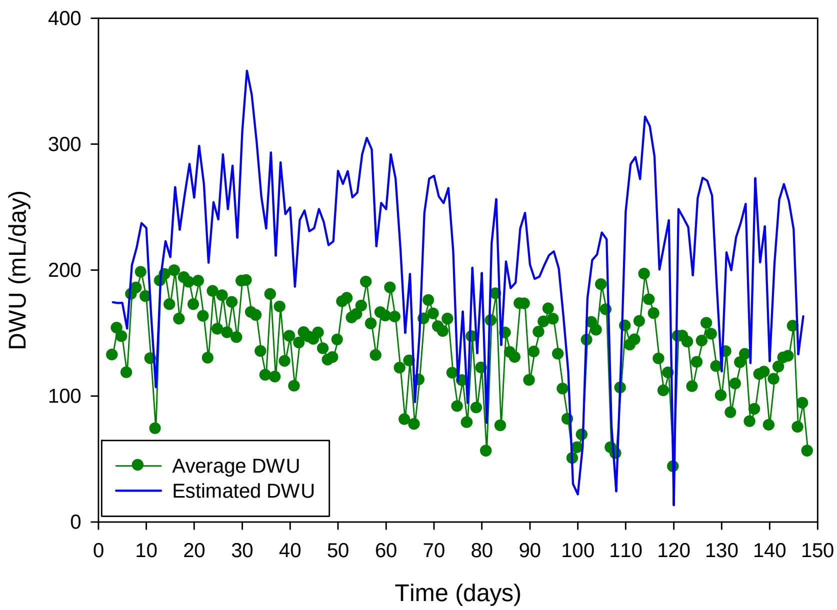

Fig. 4. Daily water use of hydrangea 'Fasan' (green line and dots) as compared to the predicted water use. Water use predictions are based on a 2010 CANR study when the hydrangeas grew much more in the early part of the study, and thus used more water. The predicted water use is about 60% higher than the actual water use, but the model was able to predict day-to-day ups and downs in water use of the plants.