

2012 Report from Georgia for NCERA-101

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Impact Nugget

Gardenia jasminoides 'Heaven Scent' is a woody landscape shrub that is extremely difficult to grow. Over-irrigation results in root diseases and plant death, which typically causes losses of 20-80% of the crop. Using soil moisture sensors to automatically irrigate only when needed eliminated all disease and greatly reduced crop production time (from 14 to 9 months). This resulted in an economic benefit of approximately \$1/ft² for the nursery (or about \$100,000/hectare).

Unique Plant Responses

Plant water use and environmental conditions. We quantified how daily water use (DWU) of *Hydrangea macrophylla* and *Gardenia jasminoides* is affected by environmental conditions. In 2010, we used *Hydrangea macrophylla* cultivars, 'Fasan' and 'Pia'. There was little difference in DWU of the two cultivars, which ranged from 50-300 mL/plant, depending on plant age and weather conditions. In 2010, daily light integral (DLI) was the most important environmental factor affecting DWU. The combination of plant age, final leaf area, DLI, and their interactions explained 83.2 and 90.8% of day-to-day variation in DWU of 'Fasan' and 'Pia', respectively. In 2011, a follow up study was conducted using *Hydrangea macrophylla* 'Fasan' and *Gardenia jasminoides* 'Radicans'. DWU of 'Fasan' ranged from 50-200 mL/plant and DWU of 'Radicans' ranged from 50-560 mL/plant. The lower DWU of 'Fasan' in 2011 compared to 2010 was likely due to stunted growth of the hydrangeas, probably due to excessive heat after transplanting. Vapor pressure deficit (VPD) explained more of the daily fluctuations in DWU in 2011 than in 2010, suggesting that there is a complex relationship between DLI and VPD effects on DWU. Predicting DWU of the 2011 'Fasan' crop using 2010 environmental conditions and a regression model developed using the 2010 data resulted in DWU estimates that generally were 33-98% too high. This discrepancy is likely due to the differences in 'Fasan' growth in 2010 and 2011: there was more vegetative growth early in the growing season in 2010 than in 2011. Including a measure of plant size, rather than age, into predictive DWU models should improve performance and may help account for growth differences among growing seasons. Including percent canopy closure or light interception may be a simple nondestructive method to do so.

A new approach to measuring plant available water in soilless substrates. It is not clear how much of the water in soilless substrates is actually available for plant uptake. Substrate moisture release curves have been used to predict the amount of plant-available water in soilless substrates, yet there is little information about whether there are differences among species in their ability to extract water from substrates. We determined how water uptake in *Hydrangea macrophylla* and *Gardenia jasminoides* was affected by decreasing substrate volumetric water content (VWC). Growth chambers were used to provide stable environmental conditions that included continuous lighting to prevent diurnal fluctuations in water use. Water use by *H. macrophylla* 'Fasan' started to decrease at a higher VWC (0.28 m³·m⁻³) than *G. jasminoides* 'Radicans' (0.20 m³·m⁻³). Plant water uptake stopped completely at a VWC of 0.16 m³·m⁻³ in *H. macrophylla* and 0.12 m³·m⁻³ in *G. jasminoides*. The results show that *H. macrophylla* is less adept at extracting water from a drying substrate than *G. jasminoides*. However, both species extracted more water from the substrate than what traditionally has been predicted from moisture release curves alone.

Impact Statement

Wireless sensor networks have been installed in two commercial nurseries in Georgia. These sensor networks provide growers with real-time data on substrate water content and environmental conditions in their nursery. In addition, the accompanying software allows growers to automate irrigation based on substrate water content measurements. To date, this automated irrigation has resulted in significant time savings, reduced disease pressure, better plants, and, in one case, a much shorter production cycle. When sensor-controlled irrigation was used to grow a crop of *Gardenia jasminoides* 'Heaven Scent', the production period was shortened from the normal 14 months to only 9 months. In addition, no plants were lost due to root diseases, which typically results in losses of 20 – 30% of the crop (and in some cases 90%). The shorter production cycle and reduced plants losses resulted in an increase in profit of approximately \$1/ft².

Published Written Works

Refereed Journal Articles

- Astacio, M.G. and M.W. van Iersel. 2011. Concentrated exogenous abscisic acid drenches reduce root hydraulic conductance and cause wilting in tomato. *HortScience* 46:1640-1645.
- Astacio, M.G. and M.W. van Iersel. 2011. Determining the effects of abscisic acid drenches on evapotranspiration and leaf gas exchange of tomato. *HortScience* 46:1512-1517.
- Mattson, N.S. and M.W. van Iersel. 2011. Application of the 4R nutrient stewardship concept to horticultural crops: Applying nutrients at the "right time". *HortTechnology* 21:667-673.
- Kim, J, M.W. van Iersel and S.E. Burnett. 2011. Estimating daily water use of two petunia cultivars based on plant and environmental factors. *HortScience* 46:1287-1293.
- Crespo, J. M. and M.W. van Iersel. 2011. Performance of a soil moisture sensor-based landscape irrigation controller for automated irrigation of container-grown plants. *HortScience* 46:889-894.
- Kim, J. and M.W. van Iersel. 2011. Slowly-developing drought stress increases photosynthetic acclimation of *Catharanthus roseus*. *Physiologia Plantarum* 143:166-177.
- van Iersel, M.W., S. Dove and S.E. Burnett. 2011. The use of soil moisture probes for improved uniformity and irrigation control in greenhouses. *Acta Horticulturae* 893:1049-1056.

Non-Refereed Journal Articles

- Bayer, A., M. Chappell, J. Ruter, and M. van Iersel. 2011. Managing growth of *Hibiscus acetosella* by controlling substrate moisture with sensor controlled irrigation. *Proceedings of the 2011 meeting of the IPSS Southern Region meeting*.
- Kim, J., A. Malladi, and M.W. van Iersel, M.W. 2011. Abscisic acid-related gene expression and physiological responses of petunia at different substrate water contents. *Proceedings of the Plant Growth Regulation Society of America*, in press.
- Chappell, M., M. van Iersel, S. Dove, J. Ruter, P. Thomas, A. Bayer, L. O'Meara, P. Alem, R. Ferrarezi, J. Kim. 2011. Monitoring Environmental Conditions and Substrate Water Content to Increase Efficiency of Irrigation in Nurseries. *2011 Irrigation Association: Innovations in*

Irrigation Conference. (in press)

- Wells, S., M. Chappell, J. Ruter, P. Thomas, and M. van Iersel. 2011. Monitoring substrate water content in nurseries: More efficient irrigation and reducing leaching and runoff. *ASABE Paper No.* : 1111254. ASABE, St. Joseph, MI, p. 183-190.
- Pratt, T.G., M.W. van Iersel, M. Higginson, and Q. Xue. 2011. Remote sensing of soil moisture with RF polarimetry. *ASABE Paper No.* 1100017. St. Joseph, MI, p. 4948-4958.
- van Iersel, M., W. Ross, S. Dove, M. Chappell, P. Thomas, J. Ruter, and S. Wells. 2011. Substrate water content dynamics in nurseries: real-time monitoring can improve irrigation practices. *Proceedings of the SNA research conference* 56:173-179.
- Bayer, A., I. Mahbub, M. Chappell, J. Ruter, and M. van Iersel. 2011. Growth of 'Panama Red' hibiscus in response to substrate water content. *Proceedings of the SNA research conference* 56:134-138.
- Kim, J., A. Malladi, and M. van Iersel. 2011. Physiological responses of petunia to different levels of drought stress. *Proceedings of the SNA research conference* 56:46-51.
- Peter, A., P.A. Thomas, and M.W. van Iersel. 2011. Growth of petunia as affected by substrate moisture content and fertilizer rate. *Proceedings of the SNA research conference* 56:167-172.
- Soranz Ferrarezi, R. and M.W. van Iersel. 2011. Monitoring and controlling subirrigation with soil moisture sensors: a case study with hibiscus. *Proceedings of the SNA research conference* 56:187-191.
- Astacio M.G. and M. van Iersel. 2011. Unexplained wilting of tomatoes after exposure to large doses of exogenous abscisic acid (ABA). *Proceedings of the SNA research conference* 56:28-34.
- O'Meara, L., M. Chappell, and M.W. van Iersel. 2011. Water consumption of *hydrangea macrophylla* as affected by environmental factors. *Proceedings of the SNA research conference* 56:162-166.

Scientific and Outreach Oral Presentations

- van Iersel, M.W. 2011. Sustainable Greenhouse production in a changing world. Sixth JKUAT scientific, technological and industrialization conference. Jomo Kenyatta University of Agriculture and Technology, Juja, Kenya.
- Chappell, M.R., M.W. van Iersel, J. Ruter, A. Bayer, L. O'Meara, S. Dove, P. Thomas, P. Alem, and R. Ferrarezi. 2011. Monitoring environmental conditions and substrate water content to increase efficiency of irrigation in nurseries. 2011 Irrigation Show and Innovations in Irrigation Education Conference. San Diego, CA.
- Soranz Ferrarezi R., M. van Iersel, and R. Tezteslaf. 2011. Soil moisture sensors for monitoring and controlling subirrigation: a case study with hibiscus. 2011 Annual conference of the American Society for Horticultural Science. Waikoloa, HI.
- Peter A., P.A. Thomas, and M. van Iersel. 2011. Growth of petunia as affected by substrate moisture content and fertilizer rate. 2011 Annual conference of the American Society for Horticultural Science. Waikoloa, HI.
- Bayer, A. J.M. Ruter, M. Chappell, and M. van Iersel. 2011. Growth of *Hibiscus acetosella* 'Panama red' in response to sensor controlled irrigation in two outdoor nursery settings. 2011 Annual conference of the American Society for Horticultural Science. Waikoloa, HI.

- van Iersel, M. 2011. Publish or perish: trials, tribulations, and triumphs. 2011 Annual conference of the American Society for Horticultural Science. Waikoloa, HI.
- Kim, J., A. Malladi, and M. van Iersel. 2011. Gene expression and physiological responses of petunia at specific substrate water contents. 2011 Annual conference of the American Society for Horticultural Science. Waikoloa, HI.
- O'Meara, L., M. van Iersel, M. Chappell. 2011. Water consumption of *Hydrangea macrophylla* as affected by environmental factors. 2011 Annual conference of the American Society for Horticultural Science. Waikoloa, HI.
- Peter A., R. Soranz Ferrarezi, P.A. Thomas , M. van Iersel. 2011. *In situ* measurements of the electrical conductivity of substrates: the relationship between bulk EC, pore water EC, and substrate water content. 2011 Annual conference of the American Society for Horticultural Science. Waikoloa, HI.
- Thomas, P.A., M. Chappell, J.M. Ruter, S. Dove and M. van Iersel. 2011. Monitoring environmental conditions and substrate water content for more efficient irrigation in nurseries. 2011 Annual conference of the American Society for Horticultural Science. Waikaloa, HI.
- Mattos, E., R. Hunt, M. van Iersel, M. Cabrera and K.C. Das. 2011. Changes in chlorophyll fluorescence parameters in different growth stages of *Chlorella sorokiniana*. *1st International Conference on Algal Biomass, Biofuels and Bioproducts*. Saint Louis, MO.
- van Iersel, M.W. 2011. New irrigation technologies. Moving nursery producers toward sustainability. University of Florida, North Florida Research and Education Center – Quincy, FL (recorded PowerPoint).
- Kim, J., A. Malladi, and M.W. van Iersel, M.W. 2011. Abscisic acid-related gene expression and physiological responses of petunia at different substrate water contents. Annual meeting of the Plant Growth Regulation Society of America, Chicago, IL.
- van Iersel, M.W. 2011. ABA research at the University of Georgia: water use, physiology and gene expression. Valent BioSciences, Long Grove, IL.
- van Iersel, M.W. 2011. Water issues in the greenhouse industry. Annual Meeting of the National Greenhouse Manufacturers Association, Saint Louis, MO.