NCERA-101 Station Report from Georgia

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1. New Facilities and Equipment.

The department has added two new growth chambers for use by the recently hired Dr. Donglin Zhang. One of the chambers is a Conviron E7/2, the other one a Conviron A1000.

Dr van Iersel has recently bought a Hyprop instrument, which can be used to determine the hydraulic properties (soil/substrate moisture release curve and hydraulic conductance) of substrates commonly used in controlled environments.

2. Unique Plant Responses

Efficient irrigation can greatly speed up plant growth. We have set up a wireless sensor network in two greenhouses at McCorkle's Nurseries in Dearing, GA (a 2-acre greenhouse with a variety of crops and a 4-acre greenhouse with hydrangeas). This sensor network is capable of automatically triggering irrigation, based on a grower-determined substrate water content in the containers. With the current setup, we can control nine irrigation zones separately. We have seen dramatic impacts of automated irrigation on gardenias. McCorkle's started a new gardenia crop in June 2012, with an expected finish date of May 2013. The vast majority of the plants was ready for sale by September 2012, and all plants were finished last fall. Unfortunately, only some of the plants actually were sold in fall, due to weak market demand in fall. Nonetheless, this clearly demonstrates the potential to speed up plant production using more efficient irrigation practices. However, we do not understand the reason for this much improved growth

Oxygen concentration in the rhizosphere. Although numerous reports mention the detrimental effect of anoxic conditions in the root zone, there is little quantitative information on oxygen concentrations in the root zone of potted plants. We have started collecting data on this and how root zone oxygen is affected by substrate water content and environmental conditions. We hope that this information may help explain the much improved growth we have seen in some crops as the result of more efficient irrigation (*i.e.,* gardenia, see above).

Our initial data collection was on a petunia plant grown in a 15 cm container. Two Apogee O_2 sensors were placed in the container, one near the top and the other near the bottom of the container. O_2 concentrations were consistently higher in the top of the bottom, presumably because of easier diffusion of O_2 from the surrounding air. O_2 concentrations in both the bottom and top of the container dropped throughout most of the daytime and increased at night. Interestingly, the decrease in root zone O_2 concentrations from pre-dawn to late afternoon was well correlated with the daily light integral, suggesting that the availability of recently produced carbohydrates has a direct impact on root zone respiration.

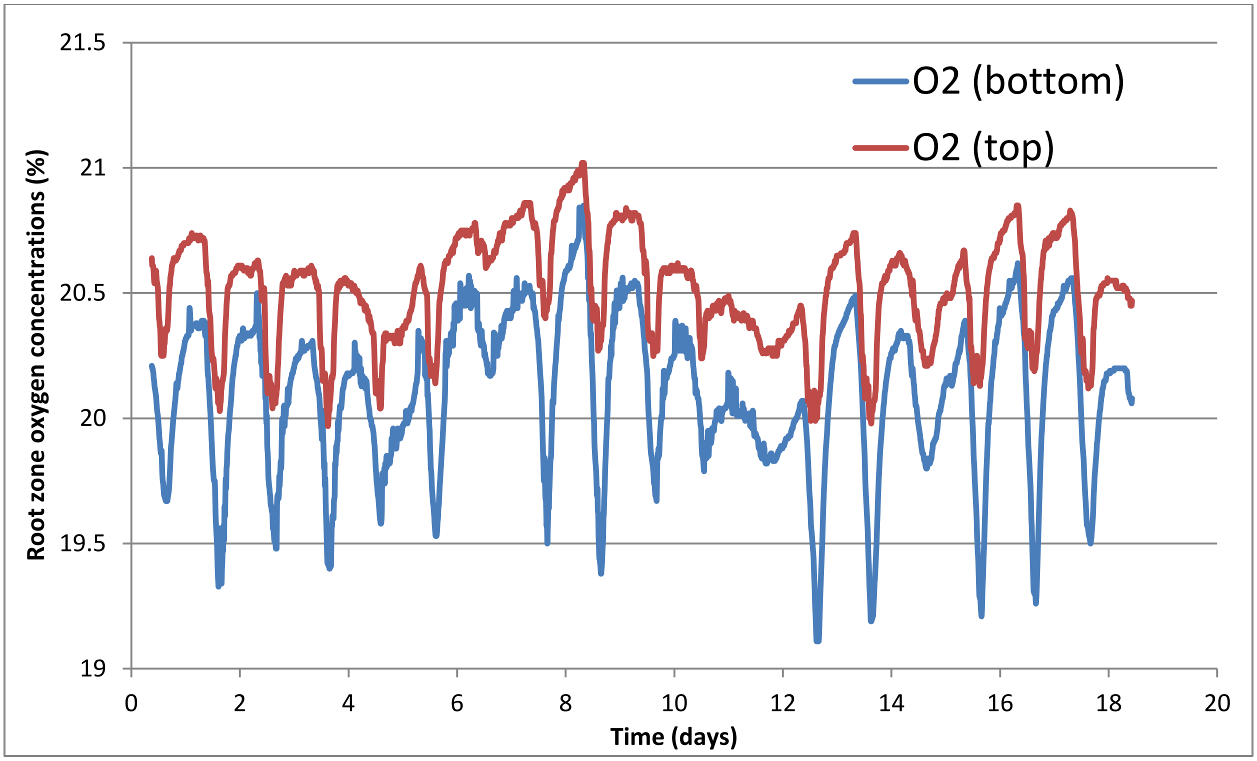

Figure 1. Fluctuations in the oxygen concentration in the root zone of a petunia in a 15-cm pot. One sensor was placed in the top part and one in the bottom part of the pot.

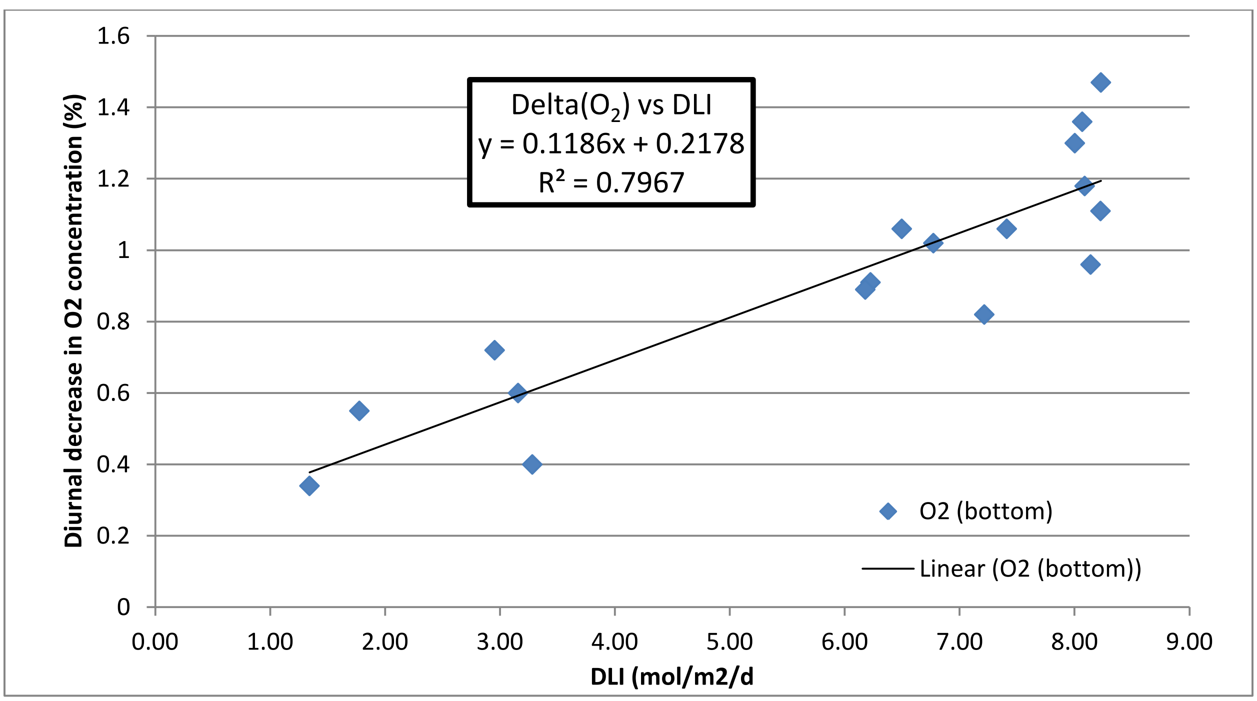

Figure 2. The relationship between the daily light integral and the decrease in root zone oxygen concentration from pre-dawn to late afternoon.

Controlling plant height with irrigation

Plant height is an important quality parameter for ornamental greenhouse crops. As part of our work on improving irrigation efficiency in greenhouses and nurseries, we have tested whether we can control plant height of poinsettias by controlling substrate water content of the crop. Final target heights of the plants were 14", 15.5" and 17", while a control treatment was included as well. Substrate water content was maintained at 0.45 $m^3 \cdot m^{-3}$, but this was reduced to 0.20 $m^3 \cdot m^{-3}$ when plants were getting too tall and increased back to 0.45 $m^3 \cdot m^{-3}$ when plant height was within the target range again. We used graphical tracking charts to determine the target height of the plants throughout the growing cycle. These data were used to decide when to decrease or increase substrate water content.

Control plants, which always had ample water, had a final height of 20". We were able to produce plants with heights of 15.5" and 17", but not 14" (see picture below for representative plants) by reducing substrate water content as needed. These results show that control of substrate water content is a feasible method for controlling plant height.

Figure 3. Representative plants at the end on the experiment. Target plant heights (from left to right) were 14", 15.5", and 17", while the plant at the right was a control plant.

3. Accomplishment Summaries.

We have tested wireless sensor networks in commercial nurseries and found that soil moisture sensors can be very effective in automatically controlling irrigation. Some crops, gardenia specifically, grow much faster and have fewer diseases problems, when soil moisture sensor-based, automated irrigation is used. We have also seen that wireless sensor networks can greatly reduce the amount of irrigation water that is used, reduce labor requirements for irrigation, and eliminate the need for routine fungicide applications. These results show the great potential for this irrigation approach in commercial nurseries.

Plant height is an important quality characteristic for ornamental plants. Greenhouse growers typically apply plant growth retardants (PGRs) to prevent their crops from getting too tall. PGR applications can be expensive, time consuming, and may stunt the crop if applied incorrectly. Therefore, we have developed a new approach to plant height control, through the use of soil moisture sensors linked to an automated irrigation system. We have shown that it is possible to control how tall plants get by increasing or decreasing the substrate water content during the production cycle. This provides a new, non-chemical, tool for height control of greenhouse crops.

4. Impact Statements.

We have tested wireless sensor networks in commercial nurseries and found that soil moisture sensors can be very effective in automatically controlling irrigation. Some crops, *e.g.* gardenia, grow much faster (4-month instead of 11-month production cycle) and have fewer diseases problems, when soil moisture sensor-based, automated irrigation is used. At the same time, fungicide applications can be eliminated, reducing the risk of runoff of agro-chemicals.

Plant height is an important quality characteristic for ornamental plants. We have shown that it is possible to control how tall plants get, by increasing or decreasing the substrate water content during the production cycle. This provides a new, non-chemical, tool for height control of greenhouse crops.

5. Published Written Works.

Wertin, T., M.A. McGuire, M. van Iersel, J. Ruter, and R. Teskey. 2012. Effects of elevated temperature and [CO2] on photosynthesis, leaf respiration and biomass accumulation of *Pinus taeda* seedlings at cool and warm sites within its current range. *Canadian Journal of Forest Research*. 42:943-957. (doi: http://dx.doi.org/10.1139/x2012-050)

Kim, J., A. Malladi, and M.W. van Iersel. 2012. Physiological and molecular responses to drought in Petunia: the importance of stress severity. *Journal of Experimental Botany* 63:6335-6345. (doi: http://dx.doi.org/10.1093/jxb/ers285)

Pennisi, S.V. and M.W. van Iersel. 2012. Quantification of carbon assimilation of plants in simulated and *in situ* interiorscapes. *HortScience* 47:468-476.

Garland, K.F., S.E. Burnett, M.E. Day, and M.W. van Iersel. 2012. Influence of substrate water content and daily light integral on photosynthesis, water use efficiency, and morphology of *Heuchera americana*. *Journal of the American Society for Horticultural Science* 137:57-62.

Chappell, M. and M. van Iersel. 2012. Sensor network deployment and implementation in commercial nurseries and greenhouses. *Proceedings of the 2012 Irrigation Show and Education Conference*. 10 p.

van Iersel, M.W. 2012. Integrating soil moisture and other sensors for precision irrigation. *Proceedings of the 2012 Irrigation Show and Education Conference*. 15 p.

Ferrarezi, R. S., M.W. van Iersel, and R. Testezlaf. 2012. Fotossíntese e crescimento de plantas de sálvia cultivadas por subirrigação em sistema semi-contínuo para medição de CO_2. Proceedings of the X Congreso Latinoamericano y del Caribe de Ingeniería Agrícola

- CLIA e XLI Congresso Brasileiro de Engenharia Agrícola - CONBEA Londrina - Paraná, Brazil. ISBN 978-85-64681-01-9.

Ferrarezi, R.S., M.W. van Iersel, and R. Testezlaf. 2012. Sensores capacitivos no monitoramento e controle da subirrigação na produção de salvia. Proceedings of the X Congreso Latinoamericano y del Caribe de Ingeniería Agrícola - CLIA e XLI Congresso Brasileiro de Engenharia Agrícola - CONBEA Londrina - Paraná, Brazil. ISBN 978-85-64681-01-9.

van Iersel, M.W. , M.R. Chappell, P.A. Thomas, J.M. Ruter and S. Wells. 2012. Wireless sensor networks for monitoring and controlling irrigation in greenhouses and nurseries. Proceedings of the X Congreso Latinoamericano y del Caribe de Ingeniería Agrícola - CLIA e XLI Congresso Brasileiro de Engenharia Agrícola - CONBEA Londrina - Paraná, Brazil. ISBN 978-85-64681-01-9.

Chappell, M., M. van Iersel, E. Lichtenberg, J. Majsztrik, P. Thomas, J. Ruter, and S. Wells. 2012. Benefits of precision irrigation of G*ardenia augusta* 'Heaven Scent'™: reducing shrinkage, shortening the cropping cycle, and economic impact. *Proceedings of the SNA research conference* 57:321-323.

Chappell, M., M. van Iersel, J. Ruter, E. Lichtenberg, J. Majsztrik and P. Thomas. 2012. Drop by Drop: Precision Irrigation Saves Significant Costs. Nursery Management 37(6):47-48.

Burnett, S.E., S. Zhen, and M. van Iersel. 2012. Water requirements of herbaceous perennial plants. *American Floral Endowment Special Research Report #533*.

Peter, A., P. Thomas, M. van Iersel, and S. Burnett. 2012. Using soil moisture sensors for poinsettia height control. *American Floral Endowment Special Research Report #532*.

Peter A., P. Thomas, M. van Iersel, and S. Burnett. 2012. Growth of petunia as affected by substrate moisture content and fertilizer rate. *American Floral Endowment Special Research Report #531*.

Burnett. S., M. van Iersel, and J. Kim. 2012. Predicting plant water uptake. *Greenhouse Grower* 29(3): 44, 46.