2009 NCERA-101 Station Report - University of Maryland

1. Impact Nuggets:

- Based on light and plant growth research conducted at the University of Maryland, we recommended that growth chamber manufacturers use new fluorescent TL841 lamps to retrofit chambers that currently utilize T12 cool white fluorescent lamps.
- A web-based Knowledge Center for Water, Nutrient and Plant Health Management was developed to facilitate and disseminate up-to-date information about water and nutrient management strategies and tools to implement best practices in nursery and greenhouse operations. The site now has over 600 registered users. During 2009, 16,132 unique visits came from 160 countries and 49 states with 2,549 (17%) return visits from both registered and unregistered users.
- A $5.16M Specialty Crops Research Initiative Grant was awarded by USDA-NIFA to the University of Maryland in 2009, to investigate Precision Irrigation and Nutrient Management for Nursery, Greenhouse and Green Roof Systems, using Wireless Sensor Networks.

2. New Facilities and Equipment:

- Mr. Shuan Faulklner is the Growth Chamber facilities manager at the University of Maryland. He manages more than 100 growth chamber units. During 2009, usage of chamber facilities averaged 85% capacity but occasionally usage has been 100%.
- In April 2009, the Boland Trane Tracer Summit software for growth chamber facilities was upgraded to Version 17 from Version 14. This helped enormously with communication speed, allowing Mr. Faulkner to track the alarm and event logs much more efficiently.
- The University of Maryland Greenhouse monitoring and control system was upgraded to the Priva Integro system (Maximizer and Fertijet) in March 2010. System software for each was upgraded (Priva Office 3.0 to Priva Office Direct 3.0, Maximizer Version 8.0 to Version 10.0, and Integro Version 721 to 727). The host computer in the UM Greenhouse Complex was replaced to support the upgrades. The Fertijet system in the Greenhouse (Integro Specta '02) received a new microprocessor board. The Fertijet system was tested and greenhouse staff was provided some basic training on the system.

3. Research and Education Outreach:

A. New Fluorescent Lamp Testing

The University of Maryland and Conviron have been testing new T8 Fluorescent lighting for growth chambers, since the current Fluorescent T12 lamps will be phased out in the near future. T8 bulbs have a diameter of one inch, while T12 bulbs have a larger diameter of one and a half inches. T8 bulbs have a diameter of one inch, while T12 bulbs have a larger diameter of one and a half inches. Three of four BDR8 chambers at the University of Maryland were retrofitted with three different F48/T8/HO/Tri-Phosphor lamps, compared to the traditional F48/T12/VHO/Cool White source.

The three T8 lamps were:

1. F48/T8/HO/TL830 lamps with a color temperature of 3,000
2. F48/T8/HO/TL835 lamps with a color temperature of 3,500
3. F48/T8/HO/TL841 lamps with a color temperature of 4,100

A number of experiments were conducted with Apogee and Perigee dwarf wheat (from Bruce Bugbee at Utah State University). Since Conviron and other manufacturers produce growth chambers with both bare lamps or with Plexiglas barriers, we constructed a UV-transmitting barrier to compare the plant growth in the chambers. We also compared the growth and development of both varieties with and without incandescent light.

RESULTS:

- Spectral measurements of all four sources indicated that all three T8/HO lamps produced significantly greater PAR than the T12/VHO lamps at the same distance in the chambers.
- We also found that the TL830 and TL835 lamps produced significantly higher levels of both UV-B and UV-C (254nm mercury line) than either the TL841 or the Cool White lamps. Since everyone has been using Cool White lamps as the basis for plant growth in chambers for decades, we concluded that the TL841 lamps were the best replacement lamps for Cool Whites.
- There was very little difference between the growth and development of both wheat varieties under any of the four lamp conditions. The Perigee wheat was, as expected, significantly shorter that the Apogee wheat and the number of tillers was reduced, but the number leaves, flowers, heads and fresh weight were similar in all four.
- The height and fresh weight were reduced in chambers without incandescent, but none of the other parameters were significantly affected.

CONCLUSIONS:

Based on the spectral measurements and the experimental growth data, we have recommended that Conviron use the TL841 lamps to retrofit chambers that currently utilize Cool White sources.

FURTHER RESEARCH:

We are examining the production of anthocyanin and other flavonols in red leaf lettuce with the four lamp sources, with and without Plexiglas barriers, to determine if the increased levels of UV in the TL830 and TL835 lamps lead to an increase in the production of these metabolites.

A. An Online Knowledge Center for Water, Nutrient and Crop Health Management for the Nursery and Greenhouse Industry

Container-nursery and greenhouse systems differ radically from traditional agronomic-type agricultural operations in terms of water and nutrient use, and there is an acknowledged lack of up-to-date information in these knowledge areas. A web-based Knowledge Center for Water, Nutrient and Plant Health Management was developed with funding from the USDA Integrated 406 National Water Quality grant, to facilitate and disseminate up-to-date information about water and nutrient management strategies and tools to implement best practices. The primary goal of this project is to educate and increase the knowledge base of basic concepts which will improve the efficiency of use and the conservation of resources.

The project website (http://www.waternut.org) provides the general public with an overview of the project and links to the knowledge center (http://www.waternut.org/moodle/) which contains 25 in-depth modules that are open access to learners from all over world. The modules were released in July, 2008.

B. Sensor Network Research

A $5.16M Specialty Crops Research Initiative Grant was awarded by USDA-NIFA to the University of Maryland in 2009, to investigate Precision Irrigation and Nutrient Management for Nursery, Greenhouse and Green Roof Systems, using Wireless Sensor Networks. This grant, combined with an additional $5.20M in matching funding from various sources will bring together a multidisciplinary group of engineers, plant scientists, economists and extension specialists from five universities and two commercial companies. The five-year grant will develop the next generation of tools, to precisely monitor plant water use and allow for better control of irrigation water applications and increase the efficiency of water and nutrient use by commercial growers.

- Dr. John Lea-Cox from the University of Maryland is leading the project, together with Dr. Marc van Iersel at the University of Georgia, Dr. George Kantor at Carnegie Mellon University, Dr. William Bauerle at Colorado State University, Dr. Taryn Bauerle at Cornell University, Dr. Dennis King at the University of Maryland, Center for Environmental Science, with two commercial companies -- Decagon Devices, Inc. in Pullman, WA and Antir Software in Jarrettsville, MD.
- The project participants will use networks of sensors, to measure soil and substrate water in real time, to provide farmers with instantaneous management information to make better decisions, building upon experience that the various teams have gathered since 2005. Precision irrigation and plant growth management will benefit greenhouse and nursery producers, while a better understanding of the water dynamics of green roofs will provide stormwater and energy performance metrics for LEED Green Buildings.
- The research is tightly integrated with the deployment of sensor networks on a number of commercial nurseries and greenhouses throughout the US, including Raemelton Farm, Waverly Farm and Bauers Greenhouses in Maryland, Willoway Nurseries in Ohio, McCorkle Nurseries and Evergreen Nursery in Georgia and Hales and Hines Nursery in Tennessee.
- The integration of commercial partners into this project is critical for its success: it assures that the software and hardware that will be developed meets the needs of the industry. The project is designed to take advantage of the expertise of the growers and advisory board members, to ensure rapid progress towards implementation of the science into practice.
- The result will be a commercially available product for irrigation water management that is specifically designed for diverse and intensive production environments, but that also has broad applications for all high-value specialty crops, including ornamental, fruit and vegetable production.
- Full details of the project goals, the university teams and the commercial partners can be found at http://smart-farms.net

4. Impact Statements.

A. Fluorescent Lamp Testing

- Current Fluorescent T12 lamps will be phased out for growth chambers in the near future. The University of Maryland and Conviron havetested new T8 Fluorescent lighting as replacements.
- Spectral measurements of all four sources indicated that all three T8/HO lamps produced significantly greater PAR than the T12/VHO lamps at the same distance in the chambers. The TL830 and TL835 lamps produced significantly higher levels of both UV-B and UV-C (254nm mercury line) than either the TL841 or the Cool White lamps.
- Based on this and plant growth data, we recommended that new fluorescent TL841 lamps are used to retrofit chambers that currently utilize T12 cool white fluorescent lamps.

B. An Online Knowledge Center for Water, Nutrient and Crop Health Management

- The knowledge center (http://www.waternut.org/moodle/) contains 25 in-depth modules that are open access to learners from all over world.
- During 2009, 16,132 unique visits came from 160 countries and 49 states / territories with 2,549 (17%) returning visitors (both registered and unregistered users).
- Over 35,400 pages were viewed during 2009, with new visitors averaging 1.87 pages/visit; Returning visitors averaged 3.92 pages/ visit.
- There are now over 600 registered users, including over 130 Research /Extension Educators; 39 Engineers; 52 Agronomists/Consultants; 92 Grower/Manager/Farmers and 74 Graduate/Undergraduate Students. The site has over 200 registered international users.
- Nearly 60% of registered users accessed the site repeatedly during 2009, accessing an average of 9 pages per visit.

5. Published Written Works.

1. Book Chapters

1. Majsztrik, J., A. G. Ristvey and J.D. Lea-Cox. 2010. Water and Nutrient Management in the Production of Container-Grown Ornamentals. Hort. Reviews J. Janick (Ed.) J. Wiley, NJ (Accepted).
2. Lea-Cox, J.D. and D. S. Ross, 2010. Managing Water and Nutrients to Reduce Environmental Impact. In: *Nutrient Management for Floricultural Crops.* K. M. Williams and D. Merhaut (eds.). University California Press. Chapter 13. Approx 30 p. (Accepted).

2. Refereed Journal Articles

1. Lea-Cox, J. D., C. Zhao, D. S. Ross, T. E. Bilderback, J. R. Harris, S. D. Day, C. X. Hong, T. H. Yeager, R. C. Beeson Jr. ,W. L. Bauerle, A. G. Ristvey, M. Lorscheider, S. Dickinson and J. M. Ruter. 2010. A Nursery and Greenhouse Online Knowledge Center: Learning Opportunities for Sustainable Practice. HortTechnology (Accepted).
2. Lea-Cox, J. D., A. G. Ristvey, D.S. Ross and G. Kantor. 2010. Wireless Sensor Networks to Precisely Monitor Substrate Moisture and Electrical Conductivity Dynamics in a Cut-Flower Greenhouse Operation. Acta Hort. (Accepted).
3. Hong, C. X, J. D. Lea-Cox, D. S. Ross, G.W. Moorman, P.A Richardson, S.R. Ghimire and P. Kong. 2009. Containment basin water quality fluctuation and implications for crop health. *Irrigation Sci.* 27:485-496.
4. Kong, P. , G. W. Moorman, J. D. Lea-Cox, D. S. Ross, P. A. Richardson and C. X. Hong. 2009. Zoosporic tolerance to pH stress and its implications for *Phytophthora* species in aquatic ecosystems. *J. Appl. Env. Microbiology* 75: 4307-4314.

3. Poster Presentations

1. Fernandez, T., J. D. Lea-Cox, G. Zinati, C. Hong, R. Cabrera, D. Merhaut, J. Albano, M. van Iersel, T.H. Yeager and D. Buhler. 2009. NCDC 216: A New Multistate Group for Water Management and Quality for Ornamental Crop Production and Health. 106th Ann. Conf. Amer. Society Hort. Sci. National Meetings. St. Louis, MO. 24-27 July, 2009. HortScience 44:1188-1189. (Poster)

4. Popular Articles

1. Lea-Cox, J. D., G. F. Kantor and A. G. Ristvey. 2009. Wireless Water Management – Using wireless sensor networks for improved, cost-effective irrigation management in nurseries and greenhouses. *Amer. Nurseryman* Jan, 2009. pp 44-47.
2. Lea-Cox, J. D., D. S. Ross, C. Zhao, T. E. Bilderback, M. Lorscheider, T. H. Yeager, J. R. Harris, S. D. Day, C. Hong, W. L. Bauerle, R. C. Beeson, Jr., A. G. Ristvey and J. M. Ruter. 2008. An On-line Knowledge Center for Water, Nutrient, Substrate and Crop Health Management for the Nursery and Greenhouse Industry. FreeState Nursery News, Maryland Nursery and Landscape Association. August, 2008. pp. 32-36.

5. Scientific and Outreach Oral Presentations

1. Lea-Cox, J. D. 2009. The Use of Capacitance Sensors and Wireless Networks for Precision Irrigation. Natural Resource Conservation Service Irrigation Water Management Training. 29 Jan, 2009. Georgetown DE.
2. Van Iersel, M. and J. D. Lea-Cox, 2009. Sensor Technology and Wireless Sensor Networks for Precision Irrigation in Nursery and Greenhouse Operations. USDA Committee on Controlled Environment Technology and Use (NCERA-101) Workshop. 6 April, 2009. Park City, UT.
3. Lea-Cox, J. D., F. R. Arguedas-Rodriguez, A. G. Ristvey and D.S. Ross. 2009. Relating Real-time Substrate Matric Potential Measurements to Plant Water Use, for Precision Irrigation. II Int. Symp. Growing Media and Composting. 1-5 June, 2009. Charlotte, NC.
4. Arguedas-Rodriguez, F. R., J. D. Lea-Cox, A. G. Ristvey and D.S. Ross. 2009. Issues associated with real-time sensing of electrical conductivity in soilless substrates. II Int. Symp. Growing Media and Composting. 1-5 June, 2009. Charlotte, NC.
5. Lea-Cox, J. D., A. G. Ristvey, D.S. Ross and G. Kantor. 2009. Wireless Sensor Networks to Precisely Monitor Substrate Moisture and Electrical Conductivity Dynamics in a Cut-Flower Greenhouse Operation. GreenSys: High Technology for Greenhouse System Management. Int. Soc. Hort. Sci. Spec. Conf. 17 June, 2009. Quebec, Canada.
6. Lea-Cox, J. D., 2009. Using Sensor Networks for Precision Irrigation and Nutrient Management in the Nursery and Greenhouse Industry. Colloquium I – The Efficient Use of Alternative Water and Traditional Irrigation Sources in Horticulture. Symposium Presentation: 106th Ann. Conf. Amer. Society Hort. Sci. National Meetings. 25 July, 2009. St. Louis, MO. HortScience 44: 925
7. Lea-Cox, J.D. 2009. Water and Nutrient Management in Protected Agriculture – The Importance of Managing Water. Workshop 25 – Efficient Nutrient and Water Use in Protected Culture. 106th Ann. Conf. Amer. Society Hort. Sci. National Meetings. 27 July, 2009. St. Louis, MO. HortScience 44: 992
8. Lea-Cox, J. D., F. R. Arguedas-Rodriguez, A. G. Ristvey, D. S. Ross and G. F. Kantor. 2009. Real-Time Measurement of Water and Electrical Conductivity in Soilless Substrates, to Precisely Monitor and Control Irrigation and Fertigation Events. Workshop 25– Efficient Nutrient and Water Use in Protected Culture. 106th Ann. Conf. Amer. Society Hort. Sci. National Meetings. 27 July, 2009. St. Louis, MO. HortScience 44: 993
9. Lea-Cox, J. D. and F.R. Arguedas-Rodriguez, 2009. Webinar: Using Decagon Moisture Sensors for the Precision Irrigation of Soilless Substrates. Decagon Devices, Inc. 11 Sept., 2009. Pullman, WA. Registered attendance of more than 200 people in 39 countries, at 41 Universities and from numerous commercial companies. http://www.decagon.com/soil_moisture/seminars/index.php?pg=1

10. Lea-Cox, J. D., , A. G. Ristvey, F. R. Arguedas-Rodriguez, G. F. Kantor and D. S. Ross. 2009. Wireless Sensor Networks for Improved Irrigation and Production Efficiency. Int. Pl. Prop. Soc. – Eastern Region Meeting. Cleveland, OH. 16 Oct. 2009.
11. Lea-Cox, J. D. and D. S. Ross. 2009. Using Sensor Networks for Real-Time Irrigation Scheduling. *Mid-Atlantic Crop Management School.* 17 Nov., 2009. Ocean City, MD.

6. Other relevant accomplishments and activities.

1. American Society of Agricultural and Biological Engineers – Blue Ribbon Award: Educational Aids – Innovative Extension Methods or Impact Assessment Category, for "A Knowledge Center for Water, Nutrient, Substrate and Crop Health Management for the Nursery and Greenhouse Industry." ASABE International Meeting, 23 June, 2009. Reno, NV.
2. American Society for Horticultural Science Extension Materials Award: Best Website. American Society for Horticultural Science National Conference. 25 July, 2009. St. Louis, MO