2010 NCERA-101 Station Report - University of Maryland

1. **Impact Nuggets**:

- By monitoring soil moisture using a commercial sensor network installed in the University of Maryland Greenhouse complex, our Greenhouse research manager has been able to more accurately monitor water use in poplar, soybean and wheat crops.
- This has enabled management to precisely schedule irrigation events, minimize waste (in the form of water and nutrient leaching), increase efficiency and increased the quality of information and research material (based on researcher feedback).
- The sensor network is remotely available at any time to greenhouse managers and researchers, by using logmein (www.logmein.com)software.

2. **New Facilities and Equipment:**

- In the Plant Sciences Building, 21 Conviron model BDR8 reach-in growth chambers, 9 Conviron model BDW36 walk-in chambers, and one Conviron chamber model BDR16, as well as a handful of critical walk-in freezers, refrigerators and tissue culture rooms have been connected to the University Department of Operations and Maintenance Campus-wide Central Control & Monitoring System (CCMS), the in-house 24 hour alarm monitoring system. This has improved notification and response time on equipment failures for these facilities, many of which are over 15 years old. Additionally, in the Research Greenhouse Complex, all eight EGC growth chambers have been connected to CCMS.
- The eight Environmental Growth Chambers at the Research Greenhouse Complex (Six model M40s and two model M240s) have been connected to the emergency back-up generator, which supports the continuing effort to have all critical controlled environment equipment on emergency power, as reported previously.
- Research Greenhouse Complex shade cloth replacement: Ranges C and D have had new shade/heat retention cloth installed. Ranges C and D represent 55% of the total square footage of the glasshouse. The remaining ranges, A and B will be similarly re-clothed later this year. Material used: Flame-retardant Revolux XLS15R with 50% shade factor.
- The Norton Brown Herbarium has moved into the Research Greenhouse Complex.

3. **Research and Outreach**:

As previously reported in 2009, Maryland is leading a Specialty Crops Research Initiative (SCRI) Grant to investigate Precision Irrigation and Nutrient Management for Nursery, Greenhouse and Green Roof Systems, using Wireless Sensor Networks.

The SCRI–MINDS project is a 5-year project funded by USDA-NIFA and brings together scientists, engineers and economists from five universities (Maryland, Carnegie Mellon, Georgia, Colorado State and Cornell) and two companies (Decagon Devices and Antir Software), to develop and deploy smart sensor networks for specialty crop growers, and provide producers with real-time information to make better irrigation decisions every day. A full first-year report of the activities of this five University and two Commercial Company effort can be accessed at http://www.smart-farms.net/progress

Impact Statements.

- A number of sensor networks were deployed in various research site and in commercial nursery and greenhouse operations in Maryland during 2010. At the University of Maryland Greenhouse research complex, there are four active 'networks', including a 20-node, 100 sensor green roof network, a weather station node, an 8-node, 40 sensor snapdragon network and a number of nodes use for daily irrigation management decisions by Greenhouse management staff
- Carnegie Mellon and Decagon Devices have developed next-generation sensor nodes which are capable of making independent irrigation decisions in the field, based on volumetric water content and other sensor data. Information from a whole suite of environmental sensors (such as temperature, relative humidity and photosynthetic photon flux density measurements) can also be monitored and transmitted from field networks for active decision making using a commercially-available software package (Datatrac, Decagon Devices, Inc.)
- New software tools which integrate this information (Vapor pressure deficit, Daily light integral, degree days) are now available in this software program. These and other predictive parameters and are being tested and integrated into more advanced predictive plant water use models.
- Good progress has been made on developing and testing a Petunia water-use model (Kim and van Iersel, UGA) and a Green roof stormwater runoff model (Starry and Lea-Cox, UM).
- Understanding the implications made of decisions made from sensor data is a key deliverable of this project, driven by the knowledge gained from our scientific teams. The challenge is to translate this new knowledge to growers, understand the value of this information for growers, to determine return on investment and the utility of this information.
- Water management in horticultural crops is very intensive and greatly affects crop quality; accurate information can help growers better manage expensive inputs and reduce labor costs. Existing sensor technology has been deployed in the commercial operations and we have already reduced water applications by up to 50%, by using information from simple soil-moisture sensor networks.

4. Publications and Presentations.

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. In: Hort. Reviews J. Janick (Ed.). J. Wiley, NJ. 38:253-297.

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 20: 509-517.

Conference proceedings

1. Lea-Cox, J. D., A. G. Ristvey, D.S. Ross and G. Kantor. 2011. Wireless Sensor Networks to Precisely Monitor Substrate Moisture and Electrical Conductivity Dynamics in a Cut-Flower Greenhouse Operation. *Acta Hort.* (In Press).
2. Lea-Cox, J. D., F. R. Arguedas-Rodriguez, A. G. Ristvey and D.S. Ross. 2011. Relating Real-time Substrate Matric Potential Measurements to Plant Water Use, for Precision Irrigation. *Acta Hort.* (In Press)

3. Lea-Cox, J.D., G.F. Kantor, W.L. Bauerle, M. van Iersel, C. Campbell, T.L. Bauerle, D.S. Ross, A.G. Ristvey, D. Parker, D. King, R. Bauer, S. M. Cohan, P. Thomas, J.M. Ruter, M. Chappell, M. Lefsky, S. Kampf and L. Bissey. 2010. A Specialty Crops Research Project: Using Wireless Sensor Networks and Crop Modeling for Precision Irrigation and Nutrient Management in Nursery, Greenhouse and Green Roof Systems. *Proc. Southern Nursery Assoc. Res. Conf.* 55:211-214.
4. Majsztrik, J., J. D. Lea-Cox, A. G. Ristvey and D. S. Ross. 2010. Modeling Water and Nutrient Runoff from Nursery and Greenhouse Operations in Maryland : Preliminary Statistics. *Proc. Southern Nursery Assoc. Res. Conf.* 55:215-220.
5. Solano, S. L., A. G. Ristvey, J. D. Lea-Cox and S. M. Cohan. 2010. Crumb Rubber as an Amendment for Extensive Green Roof Substrates: Preliminary Research Conclusions. *Proc. Southern Nursery Assoc. Res. Conf.* 55: 400-405.

Presentations

1. Lea-Cox, J.D., 2010. Water Conservation and Irrigation Management in Nursery Production Systems. ***Symposium 1 - Water Issues in the Production of Ornamental Crops in the United States.*** USDA-NIFA National Water Conference. 21-24 Feb., 2010. Hilton Head. SC. http://www.usawaterquality.org/conferences/2010/symposia.html#1
2. Lea-Cox, J.D., 2010. Implementing Wireless Sensor Networks in Intensive Horticultural Production Systems, for Precision Irrigation and Nutrient Management. Keynote Presentation. ***First International Symposium on Wireless Sensor Networks in Agriculture.*** China Agricultural University; Chinese Academy of Agricultural Sciences. 18-21 November, 2010. Beijing, China.
3. Lea-Cox, J.D., G. Kantor, W. Bauerle, M. van Iersel, C. Campbell, T. Bauerle, D. Ross, A. Ristvey, D. Parker, D. King, R. Bauer, S. Cohan, P. Thomas, J. Ruter, M. Chappell, M. Lefsky, S. Kampf, L. Bissey, T. Martin. 2010. Precision irrigation and nutrient management for nursery, greenhouse and green roof systems: Wireless sensor networks for feedback and feed-forward control. Annual Int. Meeting. American Society Agriculture & Biological Engineers. June 23rd. Pittsburgh, PA.
4. Lea-Cox, J.D., G.A. Kantor, W.L. Bauerle, M. van Iersel, C. Campbell, T. Bauerle, R. Bauer. 2010. SCRI-MINDS: Some management and communication strategies for a national coordinated agricultural project. ASHS 107th Annual Conference, Palm Springs, CA.

Abstracts

1. Lea-Cox, J.D., G.A. Kantor, W.L. Bauerle, M. van Iersel, C. Campbell, T. Bauerle, D.S. Ross, A. Ristvey, D. Parker, D. King, R. Bauer, S. Cohan, P.A. Thomas, J.M. Ruter, M. Chappell, S. Kampf, M.A. Lefsky, L. Bissey, and T. Martin. 2010. Precision irrigation and nutrient management for nursery, greenhouse and green roof systems: sensor networks for feedback and feed-forward control. *HortScience* 45(8):S86-87.
2. Lea-Cox, J.D., G.A. Kantor, W.L. Bauerle, M. van Iersel, C. Campbell, T. Bauerle, R. Bauer. 2010. SCRI-MINDS: Some management and communication strategies for a national coordinated agricultural project. *HortScience* 45(8):S202-203.
3. Lea-Cox, J.D., S. Black and D. S. Ross. 2010. Measuring Spatial and Temporal Dynamics of Drip Applications to Nursery Tree Crops. *HortScience* 45:S79-80.
4. Lea-Cox, J.D, 2010. Examining the 4R Concept of Nutrient Management. Workshop 16: Plant Nutrient Management Workshop. *HortScience* 45:S30.
5. Lea-Cox, J.D. and A.G. Ristvey, 2010. Sensing Green Roofs to Provide Continuous Data for Stormwater Modeling. In: Workshop 30. Utility of Mechanistic and Empirical Models for Basic and Applied Research in Horticultural Stress Physiology. *HortScience* 45:S46-47.

Websites

1. Lea-Cox, J.D. and C. Zhao, 2010. Smart-farms: Managing Irrigation and Nutrients via Distributed Sensing - The Specialty Crops Research Initiative Project Website http://smart-farms.net