

**NCR-101**  
*Committee on Controlled Environment Technology and Use*  
**2004-2005 Annual Station Report**

**State of Ohio, USA**

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**New facilities planned or installed**

The USDA-ARS, Greenhouse Production Research Group installed the following facilities.

1. The research greenhouse facility at the Toledo Botanical Gardens was expanded and the USDA-ARS is leasing 8,000 ft<sup>2</sup> of space including an office and restroom facility.
2. We continue to hope that our past purchase of a walk-in growth chamber, from Environmental Growth Chambers, will be installed on the University of Toledo's main campus. A room was leased from the state and renovations are expected to begin in the next 2 months.
3. A CHN analyzer was purchased from Perkin-Elmer to round out the Greenhouse Production Research Group's investment in equipment to study plant nutrition, growing media quality, and water quality for the bedding plant industry.

The Ohio State University's Wooster Campus has a 12-chamber system housed in its own building that was retrofitted for elevated CO<sub>2</sub> gas control. Lighting, temperature and relative humidity control of individual chamber is been planned.

**New/different control systems**

A prototype precision nutrient delivery system is being developed at OSU specifically for small treatment sizes required for research plots.

**Sensors and instruments**

The use of a spectroradiometer to detect nitrogen status at deficient, sufficient, and superoptimal concentrations was explored. Four diverse ornamental species (*Begonia*, *Begoniaceae x tuberhybrida*; New Guinea impatiens, *Impatiens hawkeri* Bull;

butterflybush, *Buddleja davidii*; and geranium, *Pelargonium x hortorum*) were grown in four separate studies that resulted in a range of 1.8% to 6% tissue N concentration. A first-derivative analysis of the data identified two wavebands that were strongly correlated to all species' tissue N concentration ( $r^2 \sim 0.85$ ). These wavebands did not correlate to chlorophyll peak absorbance, but rather blue, green, red, and far-red "edges" of known plant pigments.

### Unique plant responses

We investigated supplementing fertilizer solutions with silicon (Si) to New Guinea impatiens (*Impatiens hawkeri* Bull), impatiens (*Impatiens wallerana* Hook.f), marigold (*Tagetes erecta* L.), geranium (*Pelargonium × hybrida*), dianthus (*Dianthus* spp.), verbena (*Verbena × hybrida* Voss), zinnia (*Zinnia elegans* L.), poinsettia (*Euphorbia pulcherrima*), snapdragon (*Antirrhinum majus* L.), vinca (*Catharanthus* spp.), petunia (*Petunia x hybrida*), salvia (*Salvia divinorum*), and orchid (*Phalaenopsis* spp.). Using SEM, energy dispersive X-ray analysis (EDXA), and ICP analysis, Si content and location was determined. Of these 13 species, eight contained concentrations high enough to be detected with the SEM and EDXA. Over 1% of zinnia's dry weight in the leaves was silicon. Interestingly, there was no Si in stem or root sections of any of the plants. Further studies with silicon-fed zinnia revealed an enhanced ability to fight gray mold and powdery mildew.

Using our multi-chamber controlled environment system, petunia plants were grown from seed for 6 to 8 weeks after transplanting in different light and CO<sub>2</sub> environments and fed with either a low (7.1 mM N) or high (21.3 mM N) fertilizer regime. Low fertilizer-grown plants had consistently earlier and more flowers, but showed symptoms of nutrient deficiencies in the final few weeks of production at all light and CO<sub>2</sub> levels. Calcium uptake was greatly influenced by light level, Fe, P, and K were influenced by the fertilizer supply and Mg and B were inversely influenced by fertilizer supply at high light.

### Cooperative/Interdisciplinary Projects

- Biomonitoring of nutritional status of bedding plants; John Gray and Scott Heckathorn, University of Toledo, Jonathan Frantz, USDA/ARS, began April, 2004.
- Determining the factors controlling sudden pH decline in geranium production; Paul Nelson, North Carolina State University, Jonathan Frantz, USDA/ARS, began May 2004.
- The use of silicon as a beneficial nutrient in bedding plant production; Lawrence Datnoff, University of Florida, James Locke, USDA/ARS, began March 2005.
- Nutrient uptake and partitioning in petunia as influenced by environment; Peter Ling, The Ohio State University, Jonathan Frantz, USDA/ARS, began March 2005.
- Determining the fate of agrochemicals in the greenhouse; Alison Sponberg, University of Toledo and Jonathan Frantz, USDA/ARS, began May 2005.

- Susceptibility of floricultural crops to viral pathogens as a function of plant nutrition; Scott Leisner, University of Toledo, Charles Krause, USDA/ARS, began August 2005.
- Economic evaluation and technical support of new hydroponic vegetable growers using HID supplemental lighting via personal visits and interactive web-site tools at <http://www.oardc.ohio-state.edu/hydroponics/>, Ohio State University Research & Extension, Ted Short and Mary Donnell.
- Development of a State-of-the-Art Computer-Controlled Nutrient Delivery System for Container-Grown Landscape Nursery Crop Research; Dan Herms of Entomology Department, OSU, Robert Hansen of Food, Agricultural and Biological Engineering Department, and Alec Mackenzie, Argus Control Systems LTD.

### Workshops/Colloquia/Symposia

- Ling, P.P., G.A. Giacomelli, and M. Tiffany. Crop Diagnostics: Learning to use the latest tools& technology on site. 7/9/2005.
- Ling, P.P. Organizer. Greenhouse Engineering Workshop – energy management. 1/31-2/1/2006.
- Ling, P.P. and J.M. Frantz Co-organizers. NCR-101 committee on controlled environments. 4/8-11/2006.

### Committees and Sub-committees Served

- Brugger, M. Associate Editor. Transactions of the ASABE.
- Ling, P.P. Associate Editor. HortTechnology. 2003 – present.
- Ling, P.P. Member. USDA/SBIR nation review panel.

### Publications

- Buenrostro-Nava, M.T., P. P. Ling, and J.J. Finer. 2005. Development of an automated image acquisition system for monitoring gene expression and tissue growth. *Transactions of the ASAE* 48 (2):841-847.
- Canas L., D. Dyke, C. Pasian, P. Konjoian, M. Jones, and P. Ling. 2005. “Extension Reloaded” tours with commercial clientele: taking university and grower cooperation to a whole new level. OFA Bulletin. Number 890. 4 pages. OFA – an Association of Floriculture Professionals. pp. 3-6.
- Finer J.J., Beck S, Buenrostro MT, Chi Y, and Ling P. 2006. Monitoring gene expression in plant tissues Using green fluorescent protein with automated image collection and analysis. In: Plant tissue culture engineering. Eds. S. Dutta Gupta and Y. Ibaraki, Springer, The Netherlands. pp. 31-46.
- Frantz, J. M. and Bugbee, B. 2005. Acclimation to shade: photosynthesis, respiration, canopy quantum yield, and carbon use efficiency. *J. Amer. Soc. Hort. Sci.* 130:918-927.
- Frantz, J.M., D. S. Pitchay, J. C. Locke, and C. R. Krause. 2005. Actual performance versus theoretical advantages of polyacrylamide hydrogel throughout bedding plant production. *HortScience.* 40:2040-2046.

- Hansen, R.C., J.C. Christman and R.C. Derksen. 2006. Statistical evaluation of instruments designed to measure volumetric water content of soilless container media. *Applied Engineering in Agriculture*. Accepted for publication with revisions.
- Horst, L., Locke, J.C., Krause, C.R., McMahon, R.W., Madden, L.V., Hoitink, H.A. 2005. Suppression of Botrytis blight of begonia by *Trichoderma hamatum* 382 in peat and compost-amended potting mixes. *Plant Disease*. 89:1195-1200.
- Kacira, M., S. Sase, L. Okushima, and P.P. Ling. 2005. Plant response-based sensing for control strategies in sustainable greenhouse production. *J. Agric. Meteorol.* 61(1):15-22.
- Prenger, J.J., P. P. Ling, H. M. Keener, R. C. Hansen. 2005. Plant response-based irrigation control system in a greenhouse: system evaluation. *Transactions of the ASAE* 48(3):1175-1184.
- Ramalingam, N., P.P. Ling, and R. Derksen. 2005. Background reflectance compensation and its effect on multispectral leaf surface moisture assessment. *Transactions of the ASAE* 48 (1 ):375-383.
- Zhu, H., Derksen, R.C., Krause, C.R., Fox, R.D., Brazee, R.D., Ozkan, H.E. 2005. Effect of solution pH conditions on fluorescence of spray deposition tracers. *Applied Engineering in Agriculture*. 21(3):325-329.
- Zhu, H., Krause, C.R., Zondag, R.H., Brazee, R.D., Derksen, R.C., Reding, M.E., Fausey, N.R. 2005. A new system to monitor water and nutrient use efficiency in pot-in-pot nursery production systems. *Journal of Environmental Horticulture*. 23(1):47-53.

**Software and/or video presentations developed** Virtual Grower from USDA-ARS. Software is designed to calculate greenhouse costs due to energy in greenhouses that the user designs based on materials, structure, and US location.

#### **Internet sites of interest**

- Hydroponics: <http://www.oardc.ohio-state.edu/hydroponics/>
- Virtual Grower: <http://www.ars.usda.gov/Research/docs.htm?docid=11449>

#### **Announcements**

- Dr Ted Short retired officially on 10/31/2005.
- July 8-11, 2006 Columbus Ohio (USA): **OFA Short Course**. Info: <http://ofa.org/>