NCERA-101
Committee on Controlled Environment Technology and Use
2010 Annual Station Report

State of Ohio, USA

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1. Impact Nugget: The Ohio State University team is continuing our effort in developing a decision support tool to assess the potential of energy can be harvested from a greenhouse to reduce reliance of fossil fuel for heating and cooling operations. The USDA-ARS team in Toledo, OH released Virtual Grower 2.5 software; over 8,000 copies have been distributed since the original release of the software.

2. New Facilities and Equipment. CO_2 control system was installed in the 6-chamber controlled environment facility, modeled after the 10-chamber facility in Utah State University.

3. Unique Plant Responses. Silicon alleviated copper toxicity stress in hydroponically grown zinnia plants, in part by active regulation of proteins involved in metal uptake and distribution. Switchgrass, miscanthus, and wheat straw can replace up to 20% of peat in soilless media mixes, and miscanthus and rice hulls can supply sufficient Si for zinnia to partially tolerate powdery mildew stress.

4. Accomplishment Summaries. Virtual Grower software was developed to allow a user to easily build, in software, a greenhouse that closely matched their facility so that energy simulations could be run conveniently. Virtual Grower 2.5 was released in 2009, which had plant growth simulation capabilities, as well as improved user interface, additional energy curtain options, more descriptions of air infiltration (leakage) and heating system efficiency, and real-time weather interface/predictions. These changes allow a user to see the impact that optimizing in one area (heating efficiency) may have on plant growth and scheduling. The software has enabled growers and engineers to more easily obtain energy audit information with which owners can seek funding for energy efficiency improvements. Over 8,000 copies of VG have been distributed, primarily through the website www.virtualgrower.net.

Leading Dutch researchers reported significant benefits of closed greenhouse systems including 52% heating fuel saving. The success is partly attributed to mild weather and availability of aquifers that may not be the case to other geographical regions. Before adopting the energy harvesting concept for other regions, local climate condition and specific greenhouse structure must be considered. We are continuing our effort in developing a decision support tool to assess the potential of energy that can be harvested from user specified greenhouse types and climate conditions. For example, the potential recoverable heat of a greenhouse in Wooster, Ohio can contribute up to 21%, 27% and 84% of total heating needs of the year, 2006, with 1-day, 2-day and year-round thermal storage capacities, respectively. Although improvements of the predictions models are desirable, the data processing framework established for the heat recovery strategy evaluation is valuable for the assessment of potential benefits of semi-closed/closed greenhouse.

5. Impact Statements. Virtual Grower software continues to be developed by the USDA-ARS team in Toledo, OH. The software allows a user to design greenhouses and simulate heating and plant growth for 12 greenhouse crop species. Users can optimize management strategies to save energy and improve scheduling. The decision support tool under development can be used to specify internal cooling capacity requirements for desired greenhouse closure level. Will lead to improved energy efficiency of greenhouse

production systems in Northern climates. Over 8,000 copies have been distributed, with typical, easy-to-implement savings of around 20%.

6. Published Written Works.
Refereed Journal Articles

Jeong, K.Y., B. Whipker, I. McCall, and J. Frantz. 2009. Gerbera leaf tissue nutrient sufficiency ranges by chronological age. Acta Hort. 843:183-190.

Jeong, K.Y., B. Whipker, I. McCall, C. Gunter, and J. Frantz. 2009. Characterization of nutrient disorders of gerbera hybrid 'Festival Light Eye Pink'. Acta Hort. 843:177-182.

Krug, B.A., B.E. Whipker, J. Frantz, I. McCall. 2009. Characterization of calcium and boron deficiency and the effects of temporal disruption of calcium and boron supply on pansy, petunia, and gerbera plugs. HortScience. 44:1566-1572.

Mishra, S., S. Heckathorn, J. Frantz, F. Yu, and J. Gray. 2009. Effect of boron stress on geranium grown under different non-photoinhibitory light levels. J. Amer. Soc. Hort. Sci. 134:183-193.

Pasian, C. and J.M. Frantz. 2009. Evaluating performance and stability of polyethylene terephthalate (PET) and cellulose polymer as soilless mix components. Acta Hort. 843:289-295.

Ranger, C., A.P. Singh, J.M. Frantz, L. Canas, J.C. Locke, M.E. Reding, and N. Vorsa. 2009. Influence of silicon on resistance of *Zinnia elegans* to *Myzus persicae* (Hemiptera: Aphididae). Env. Entomol. 38:129-136.

Taylor, M., P. Nelson, J. Frantz, and T. Rufty. 2010. Effect of phosphorus deficiency and high temperature on ammonium and nitrate uptake by Pelargonium. J. Plant Nut. 33:701-712.

Wee Fong Lee, Peter P. Ling, Harold M. Keener. 2009. Cooling Capacity Assessment of Semi-closed Greenhouses. In: 2010 ASABE Annual International Meeting, Paper No. 097067 ed. Reno, NV, USA: ASABE

Yu, Y., H. Zhu, J.M. Frantz, M.E. Reding, K.C. Chan, and H.E. Ozkan. 2009. Evaporation and Coverage Area of Pesticide Droplets on Hairy and Waxy Leaves. Biosystems Engineering. Vol. 104: 324-334.

Zhu, H., J.M. Frantz, C.R. Krause, L. Chen, and R.H. Zondag. 2009. Comparison of irrigation, leachate, and tree growth between soilless and coal ash based media. Acta Hort. 819:443-449.

Trade Magazine Articles

Ling, P.P. 2009. Harvesting Heat with Greenhouses. Ohio Country Journal. May issue.

Ling, P.P. 2009. Energy Saving Details. FloriBytes (IV):4. Pp 2-4.

Poster Presentations

Altland, J. and J. Frantz. 2009. Use of switchgrass as the primary potting component in nursery containers. Annual Meeting Amer. Soc. Hort. Sci., St. Louis, MO. July 25, 2009.

Blanchard, M.G., E. Runkle, and J. Frantz. 2009. Energy-efficient production of annual crops in greenhouses by manipulation of temperature and photosynthetic daily light integral. Greensys 2009. Quebec City, Canada. 6-14-2009.

Erwin, J., Runkle, E., J. Faust, J. Dole, P. Fisher, and J. Frantz. 2009. Research update for the Young Plant Initiative. Floral and Nursery Research Initiative. Cleveland, OH 10-2009.

Lee, Wee Fong, P. P. Ling, H.M. Keener. 2009. Cooling Capacity Assessment of Semi-closed Greenhouses. 2009 OARDC Annual Research Conference. Columbus, OH. April 23.

Locke, J.C., J.M. Frantz, and C.R. Krause. 2009. Evaluation of four amendments as sources of available silicon to accumulator plants grown in soilless media. Annual meeting of Amer. Phytopath. Soc. Portland, OR. 8-1-2009.

Locke, J. J. Frantz, M. Omer, J. Li, S. Leisner, and D. Sturtz. 2009. Evaluation of the use of supplemental silicon in floricultural crop production to reduce disease stress and micronutrient (Cu) toxicity and to enhance crop quality. Greensys 2009. Quebec City, Canada. 6-14-2009.

Omer, M., J. Locke, J. Frantz, C. Krause, and L. Horst. 2009. Reaction of *Calibrachoa* to infection with selected root and foliar pathogens common in greenhouse settings. Greensys 2009. Quebec City, Canada. 6-14-2009.

Rodriguez W., C. Pasian, P.P. Ling, L.A. Canas, and J. Frantz. 2009 Effects of elevated CO2 at sub optimal temperature on plant growth and development, nutrient uptake and insect behavior. 4th Annual Graduate Research Retreat. Horticulture and Crop Science, The Ohio State University. October 3rd, 2009.

7. Scientific and Outreach Oral Presentations

Andiru, G.A., C. Pasian, J. Frantz, and M. Jones. 2009. Effects of controlled release fertilizer on the post-production performance of Impatiens wallerana. Annual Meeting Amer. Soc. Hort. Sci., St. Louis, MO. July 25, 2009.

Jeong, K.Y., D. Hesterberg, P. Nelson, and J. Frantz. 2009. Predicting calcite (CaCO3) requirements of sphagnum peat moss from pH titration curves. Annual Meeting Amer. Soc. Hort. Sci., St. Louis, MO. July 25, 2009.

Frantz, J. 2009. Research updates on Virtual Grower, Silicon in Agriculture, Ornamental Plant Germplasm Center, and Nutrient Stress Detection. Young Plant Initiative. Charlotte, NC 10-2009.

Frantz, J. 2009. Decision Support tool for energy management: Virtual Grower! Keeping an eye on energy and economics. Greenhouse Crop Production & Engineering Design Short Course. Tucson, AZ. April 26-29.

Frantz, J. 2009. Update on research activities of the USDA-ARS in Toledo. Maumee Valley Growers, 11-2009.

Frantz, J. 2009. Using Virtual Grower to help manage heating costs in greenhouses. CENTS in Columbus, OH 1-2009.

Lee, Wee Fong, P.P. Ling, and H.M. Keener. 2009. Assessment of Energy Harvesting potential of Ohio Greenhouses. OFA Short Course. July 12, Columbus, Ohio.

Lee, Wee Fong, P.P. Ling, and H.M. Keener. 2009. Cooling capacity Assessment of semi-closed Greenhouses. American Floral Endowment Board of Trustees site visit. July 12, Columbus, Ohio.

Ling, P.P. 2009. Knowing Exactly When to Apply Irrigation Water. Elison Chair in International Floriculture Webinar Series. 9/15/2009.

Ling, P.P. 2009. Mechanical IPM – Humidity Management and Insect Exclusion. Greenhouse Management Workshop. Columbus, OH. 1/25.

Ling, P.P. 2009. Precision Irrigation Management. 2009 Greenhouse Crop Production & Engineering Design Short Course. Tucson, AZ. April 26-29.

Ling, P.P. 2009. Phytomonitoring Technology and Energy Management Decision Support Tool Development for Controlled Environment Plant Production University of Arizona. Tucson, AZ. April 30.

Ling, P.P. 2009. Aerial Environment Monitoring. Agricultural Technical Institute. Wooster, OH. May 6.

Ling, P.P. 2009. Hamilton County Extension Reloaded – greenhouse environmental control. Cincinnati, OH. June 3.

Ling, P.P. 2009. Extension Reloaded – 2009 OFA Short Course. OFA Short Course. July 11, Columbus, OH.

Ling, P.P. 2009. Tecnología aplicada de riego de precisión en cultivos de alto valor. International Tomato Congress, Leōn, Guanajuato, Mexico. 7/23.

Ling, P.P. 2009. Monitoreo de ambiente aéreo en cultivo de chiles en invernadero. 1st International Pepper Congress, Leōn, Guanajuato, Mexico. 7/24.

Owen, J. Jr., J. Altland, C. Scagel, H. Stoven, D. Horneck, and J. Frantz. 2009. Quantifying winter discharge of controlled release fertilizers to determine environmental impact and plant uptake. Annual Meeting Amer. Soc. Hort. Sci., St. Louis, MO. July 25, 2009.

8. **Other relevant accomplishments and activities**. None