10 2009-10 NCERA-101 Station Report - Crop Systems and Global Change Laboratory (CSGCL)*

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Impact Nugget: Multiple experiments were conducted in growth chambers on effects of elevated atmospheric carbon dioxide concentration (CO2), nutrition, and water stress for several crops and varieties. A new technique for measuring leaf mesophyll conductance to CO2 in controlled environments was developed.

New Facilities and Equipment:
-Six Environment Growth Chamber (EGC, Chagrin Falls, OH) reach-in chambers, located in the Controlled Environment Facility (CEF) were upgraded with TC2 controllers.

-A 15 ton chiller (#CGA180B4H0AA, Boland Trane, MD) was purchased and installed as a replacement for an existing unit. The chiller is part of a system used to provide temperature control for Soil-Plant-Atmosphere Research (SPAR) chambers.

-A non-dispersive infrared nitrous oxide analyzer (NDIR N2O 600L, California Analytics, CA) was purchased. The unit is to be used for measuring air leakage rates from growth chambers.

-Sensors and measuring equipment purchased include a datalogger (CR1000, Campbell Scientific, UT), quantum sensor (Li-COR Biosciences, NE), and leaf porometer (SC-1, Decagon Devices, UT).

Unique Plant Responses:
-Significant interactions between phosphorous nutrition and CO2 enrichment were not observed for a C3 crop (potato).

Accomplishments:
-The CSGCL lab evaluated the response of corn and potato to CO2 enrichment and nutrient and water stress using SPAR (soil-plant-atmosphere research) chambers. Corn production was not significantly influenced by CO2 or nitrogen levels but was reduced by water stress. Potato yield, leaf area, and total biomass significantly increased in response to phosphorus at levels less than 0.41 grams of phosphorus per pot. Plants responded positively to CO2 enrichment at all levels of the phosphorous treatment, but no interaction effects were observed.

-Rice plants were exposed to long- and short-term CO2 treatments at different growth stages and under different levels of nitrogen fertilizer in CEF growth chambers. The study found that nitrogen uptake capacity was reduced in response to long-term CO2 enrichment, the extent of which depended on growth stage.

-In conjunction with the USDA-ARS Rice Research Center and Cornell University, controlled environment studies were conducted on the transfer of genetics between wild and cultivated rice varieties. Research findings indicated that weedy rice lines have a stronger response to rising CO2 concentration than cultivated ones.

Impact Statement:

-A new technique to estimate the conductance of mesophyll to CO2 in plant leaves in controlled environment chambers was introduced and tested. The method is an improvement over existing approaches and combines a mathematical model with measurements of leaf level photosynthesis. Researchers can use this approach to get more accurate data from their controlled environment experiments.

Published Written Works:

Bae, H., Kim, S., Sicher, Jr., R.C., Kim, M.S., Strem, M.D., Bailey, B.A., Melnick, R. 2009. The beneficial endophyte, Trichoderma hamatum, isolate DIS 219B promotes growth and delays the onset of the drought response in Theobroma cacao. Journal of Experimental Botany. 60:3279-3295.

Bunce, J.A. 2009. Use of the response of photosynthesis to oxygen to estimate mesophyll conductance to carbon dioxide in water-stressed soybean leaves. Plant, Cell and Environment 32: 875-881.

Fleisher, D.H., D.J. Timlin, Y. Yang, and V.R. Reddy. 2010. Simulation of potato gas exchange rates using SPUDSIM. Agr. and For. Met., 150: 432-442.

Fleisher, D.H., D.J. Timlin, Y. Yang, V.R. Reddy, and K.R. Reddy. 2009. Uniformity of Soil-Plant-Atmosphere-Research Chambers. Transactions of the ASABE, 52: 1-11.

George, K., L.H. Ziska, J.A. Bunce, B. Quebedeaux, J.L. Horn, J. Wolf, and J.R. Teasdale. 2009. Macroclimate associated with urbanization increases the rate of secondary succession from fallow soil. Oecologia, 159: 637-647.

Sage, R.F., H.A. Coiner, D.A. Way, G.B. Runion, S.A. Torbert III, R.C. Sicher, and L.H. Ziska. 2009. Kudzu [Pueraria Montana (Lour.) Merr. Var lobatal]: a new source of carbohydrate for bioethanal production. Biomass and Bioenergy, 33: 57-61.

Shillito, R., D. Timlin, D. Fleisher, V.R. Reddy, and B. Quebedeaux. 2009. Yield response of potato to spatially patterned nitrogen application. Agr., Eco., and Envr., 129: 107-116.

Shimono, H., and Bunce, J.A. 2009. Acclimation of nitrogen uptake capacity of rice to elevated atmospheric CO2 concentration. Annals of Botany 103: 87-94.

Timlin, D.J., Yang, Y., Kim, S., Bunce, J.A., Anapalli, S., Fleisher, D.H., Quebedeaux, B., Reddy, V. 2009. Simulation of the effects of limited water on photosynthesis and transpiration in field crops: Can we advance our modeling approaches? In: Ahuja, L.R., Reddy, V.R., Saseendran, S.A., & Yu, Qiang, editors. Response of Crops to Limited Water: Understanding and Modeling Water Stress Effects on Plant Growth Processes: Vol. 1. Advances in Modeling Agricultural Systems. Madison, WI. American Society of Agronomy. p.105-143.

Yang, Y., D.J. Timlin, D.H. Fleisher, S-H Kim, B. Quebedeaux, and V.R. Reddy. 2009. Simulating leaf area of corn plants at contrasting water status. Agr. and Forest Met., 149: 1161-1167.

Yang, Y., S-H Kim, D.J. Timlin, D.H. Fleisher, B. Quebedeaux, and V.R. Reddy. 2009. Simulating canopy transpiration and photosynthesis of corn plants under contrasting water regimes using a coupled model. Transactions of the ASABE, 52: 1011-1024.

Ziska, L.H., Tomecek, M., and D.R. Gealy 2010. Competitive interactions between cultivated and red rice as a function of recent and projected increases in atmospheric carbon dioxide. Agronomy Journal 102:118-123.

Ziska, L., G. Runion, M. Tomecek, S. Prior, H. Torbert, and R. Sicher. 2009. An evaluation of cassava, sweet potato and field corn as potential carbohydrate sources for bioethanal production in Alabama and Maryland. Biomass and Bioenergy, 33: 1503-1508.

Scientific and Outreach Oral Presentations:

Bunce, J.A. 2009. Regional implications of climatic change on U.S. agriculture. Natural Resources Conservation Service Workshop, Avalon, NJ, October 14-16.

Chun, J.A., Y. Yang, D. Timlin, D. Fleisher, and V.R. Reddy. 2009. Interaction of air temperature and nitrogen supply on root growth and nitrogen uptake by corn. ASA-CSSA-SSSA International Meeting, Pittsburgh, PA, November 1-5.

Fleisher, D.H., D. Timlin, K.R. Reddy, V.R. Reddy, Y. Yang, and S-H Kim. 2009. Effects of CO2 and temperature on crops: Lessons from growth chambers. ASA-CSSA-SSSA International Meeting, Pittsburgh, PA, November 1-5.

Fleisher, D.H., D. Timlin, Y. Yang, J.A. Chun, and V.R. Reddy. 2009. Modeling carbon and leaf area allocation in plant canopies via optimization. ASA-CSSA-SSSA International Meeting, Pittsburgh, PA, November 1-5.

Timlin, D.J., D. Fleisher, S-H Kim, Y. Yang, and V.R. Reddy. 2009. Simulation of individual leaf size and canopy development: approaches to carbon allocation and growth. Biological System simulation Group Conference, Athens, GA, May 11-13

Timlin, D.J., Y. Pachepsky, D. Fleisher, and R. Shillito. 2009. Scale as the common language for soil variations revealed with geophysics, biophysics, and remote sensing. ASA-CSSA-SSSA International Meeting, Pittsburgh, PA, November 1-5.

Reddy, V.R., D. Timlin, D.H. Fleisher, V. Anbumozhi, K.R. Reddy, and Y. Yang. 2009. Monitoring the vulnerability and adaptation planning for food security. Regional Workshop on Mainstreaming Climate Change Adaptation into Developmental Planning, Tokyo Japan, April 14-17.

Yang, Y., D.J. Timlin, D. Fleisher, S. Lokhande, B. Quebedeaux, and V.R. Reddy. 2009. Simulating nitrogen uptake and distribution in maize. Biological System simulation Group Conference, Athens, GA, May 11-13

Ziska, L.H. 2009. Global climate change and weed biology and management. ASA-CSSA-SSSA International Meeting, Pittsburgh, PA, November 1-5.

Ziska, L.H. 2009. Global climate change and weed biology: the rest of the story. Department of Biological Sciences Seminar Series, Purdue University, IN, November 18.

Other Relevant Accomplishments and Activities:

-Richard Sicher and David Fleisher were awarded USDA-ARS 2010 headquarters funded post-doctoral research associate positions for their respective research programs.