ARS CSGCL Report to the NCR-101 Committee on Controlled Environment Technology and Use
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A. Personnel

The Crops Systems and Global Change Lab (CSGCL) was formed in fiscal year 2005 when the Alternate Crops and Systems Lab was divided into two different research units. The CSGCL conducts basic and applied research to discover and improve methods for planting and farming. Research impact will be on application of systems theory to complex agricultural problems, development of models and expert systems, and studies to improve the growth, yield and quality of horticultural and agronomic crops. Plant physiologist Dr. J. Michael Robinson, formerly of the Environment Quality Laboratory joined the CSGCL in 2004. Post-doctoral associate Dr. Genhua Niu left the laboratory for an assistant professorship at Texas A&M.

B. New facilities planned or installed

A concrete pad, equipped with plumbing for irrigation and electricity, was added to the Crop Systems and Global Change laboratory research facilities and will be used complement the experiments conducted in the adjacent SPAR (soil-plant-atmosphere-research) chambers. New acrylic doors and access ports were installed on six of the SPAR chambers to provide easier access to plants during experiments and decrease errors in automated gas exchange measurements.

C. New/different control systems

None.

D. Sensors and instruments

A leaf chlorophyll fluorescence head (#6400-40) was purchased to complement leaf level gas-exchange measurements using a Li-Cor 6400 meter (Li-Cor Biosciences, NE), Wescor (Wescor, UT) thermocouple psychrometers were used to measure leaf water potential, and TDR probes were used for soil water content measurements.

E. Unique plant responses

SPAR (soil-plant-atmosphere-research) chambers were utilized to study (1) interactive effects of [CO_2] and water stress on whole-plant physiology of corn and temperature responses during grain filling and (2) the effect of air temperature on potato crop photosynthesis and development under ambient and elevated [CO_2]. Reach-in growth chambers were also used to study effects of photoperiod and irradiance on branching and leaf appearance rates in potato. Differences in canopy development were observed. A modeling study on mean daily PAR values within SPAR chambers found them to be within 5% of ambient values. Models were developed to describe potato leaf appearance rates and area expansion as a function of air temperature and physiological age. A separate growth chamber study investigated the effect of CO_2 concentration and temperature during the dark period on leaf respiration, translocation and nitrate reduction in soybean leaves. This is along the lines of prior and subsequent work asking whether the CO_2 concentration during the dark is a variable of any significance to plant growth (the answer is yes, in some cases).

A research project used open top chambers, constructed from plexiglas, metal and wood, maintained within greenhouses, and supplied with low O_3 level (control) or elevated O_3 generated from pure oxygen, to examine the influence of elevated ozone on ascorbic acid (vitamin C) relations in the leaves of ozone tolerant and ozone sensitive soybean cultivars. Elevated ozone appeared to negatively influence the soybean leaf ascorbate synthesis pathway enzymes, galactose dehydrogenase and galactonolactone dehydrogenase resulting in deceases in ascorbate synthesis. This research exemplifies productive uses of greenhouse located open top chambers in assisting in determinination of the impact of elevated ozone on crop plant foliar metabolic processes.

Controlled environment chambers were used to determined the impact of the bacterial plant pathogen, *Pseudomonas syringae* pv. *tagetis,* on ascorbic acid synthesis**, or**, to determine the influence of elevated CO_2 on foliar ascorbic acid (vitamin C) level, redox status and apparent ascorbic acid synthesis. Sunflower plants were grown and infected with *Pseudomonas syringae* pv. *tagetis,* ***or*****,** young developing barley plants were exposed to elevated CO_2 for as much as 9-13 days. *P. syringae* pv *tagetis* caused a severe inhibition of ascorbate accumulation in sunflower leaves, as did elevated CO_2 in primary barley leaves.

F. Committees and sub-committees served

Dave Fleisher served as vice-chair for the NCR-101 committee.

G. Representative Publications for 2003-2005

Sicher, R.C. 2005. Interactive effects of phosphate nutrition and carbon dioxide enrichment on assimilate partitioning in barley roots. Physiol. Plant. 123: 219-226. 2005.

Bae, H. and Sicher, R.C. 2004. Changes of soluble protein expression and leaf metabolite levels in Arabidopsis thaliana grown in elevated atmospheric carbon dioxide. Field Crops Res. 90: 61-73.

Baker, J.T., S.-H. Kim, D.C. Gitz, D.J. Timlin and V.R. Reddy. 2004. A method for estimating carbon dioxide leakage rates in controlled-environment-chambers using nitrous oxide. Environmental and Experimental Botany 51:103-110.

Bunce, J. A. 2004. A comparison of the effects of carbon dioxide concentration and temperature on respiration, translocation and nitrate reduction in darkened soybean leaves. Annals of Botany 93: 665-669.

Kim, S.-H., V.R. Reddy, J.T. Baker, D.C. Gitz and D.J. Timlin. 2004. Quantification of photosynthetically active radiation inside sunlit growth chambers. Agricultural and Forest Meteorology 126: 117-127.

Robinson, J.M., , J. Lydon, C. A. Murphy, R. Rowland, and R. D. Smith. 2004. Effect of *Pseudomonas syringae* pv. *tagetis* infection on sunflower leaf photosynthetic and ascorbic acid relations. International Journal of Plant Sciences 165 (2)(March-April): 263-271.

Robinson, J.M. and R. C. Sicher. 2004. Antioxidant levels decrease in primary leaves of barley during growth at ambient and elevated carbon dioxide levels. International Journal of Plant Sciences 165 (6)(November-December): 965-972.

Ziska L.H, and George K. 2004 Rising carbon dioxide and invasive, noxious plants: potential threats and consequences. World Resource Review 16:427-447.

Ziska L.H., Morris C.F., Goins E.F. 2004. Quantitative and qualitative evaluation of selected wheat varieties released since 1903 to increasing atmospheric carbon dioxide: can yield sensitivity to carbon dioxide be a factor in wheat performance? Global Change Biology 10:1810-1819.

Bunce J. A. and Sicher, R. C. 2003. Daily irradiance and feedback inhibition of photosynthesis at elevated carbon dioxide in Brassica oleracea. Photosynthetica 41: 481-488.

Fleisher, D.H., A.J. Both, C. Moraru, L. Logendra, T. Gianfagna, T.C. Lee, H. Janes, and J. Cavazzoni. 2003. Manipulation of Tomato Fruit Quality Through Temperature Perturbations in Controlled Environments. ASAE Paper No. 34102. ASAE, St. Joseph, MI.

Ting, K.C., D.H. Fleisher, and L.F. Rodriguez. 2003. "Concurrent Science and Engineering for Phytomation Systems". J. Agric. Meteor. 59(2):93-101.

Zhou, R., Sicher, R.C., Cheng, L. and Quebedeaux, B. 2003. Regulation of apple leaf aldose-6-phosphate reductase activity by inorganic phosphate and divalent cations. Funct. Plant Biol. 30: 1037-1043.

Ziska, L.H. 2003. Evaluation of the growth response of six invasive species to past, present and future carbon dioxide concentrations. J. Expt. Bot. 54:395-404.

Ziska, L.H. 2003. Rising carbon dioxide and weed ecology. In: Weed Biology and Management, Edited by Inderjit. Kluwer Academic Publishers, The Netherlands. pp. 159-176.

Ziska, L.H. 2003. The impact of nitrogen supply on the potential response of a noxious, invasive weed, Canada thistle (*Cirsium arvense*) to recent increases in atmospheric carbon dioxide. Physiol. Plant. 119:105-112.

Ziska, L.H. 2003. Evaluation of yield loss in field sorghum from a C_3 and C_4 weed with increasing CO_2. Weed Sci. 51:914-918.

Ziska, L.H. 2003. Climate change, plant biology and public health. World Resource Review 15:271-278.

Ziska, L. H. 2003. Rising carbon dioxide: Implications for weed-crop competition. In: Rice Science: Innovations and Impact for Livelihood (eds. T.W. Mew, D.S. Brar, S. Peng, D. Daw and B. Hardy). International Rice Research Institute Press, Beijing, China. pp. 615-634.

Ziska L.H. 2003 Evaluation of the growth response of six invasive species to past, present and future carbon dioxide concentrations. Journal of Experimental Botany 54:395-404.

Ziska L.H. 2003 The impact of nitrogen supply on the potential response of a noxious, invasive weed, Canada thistle (Cirsium arvense) to recent increases in atmospheric carbon dioxide. Physiologia Plantarum 119:105-112.

Ziska, L.H., D, E, Gebhard, D.A. Frenz, S. Faulkner, B.D. Singer. 2003. Cities as harbingers of climate change: Common ragweed, urbanization, and public health. J. Allergy and Clinical Immunology 111:290-295.

H. Internet sites of interest

Information on CSGCL:**http://www.ars.usda.gov/ba/psi/csgcl**