

ARS Report to NCR-101 Committee  
on Controlled Environment Technology and Use  
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**A. New Facilities or Planned:** Several construction projects are underway or are being considered for funding at the Beltsville Agricultural Research Center (BARC). These include new Beltsville Human Nutrition Research Center Facilities (Phase I - \$11.4M funded; Phase II - \$11.4M proposed), a Transgenic Animal Facility (\$3.0M), Poultry and Hatchery and Production Barns (\$1.3M), and a Level III Biocontainment Greenhouse (\$3.2M). The Biocontainment Facility is in the design phase and will contain 5000 sq ft (ca. 2500 sq ft under glass and ca. 1200 sq ft in the basement). The Controlled Environment Facility (\$5.1M) was completed and dedicated in 1998. A third chiller for propylene glycol was added in 1999. The CEF is now 75% occupied. Nearly twenty new plant growth chambers have been purchased and installed. Primary users include the Climate Stress Laboratory (26 GC), the Floral and Nursery Plants Research Unit (7 GC), the Molecular Plant Pathology Laboratory (8 GC), and the Fruit Laboratory (6 GC). Other users will include the Horticultural Crops Quality Laboratory (1 GC), the Environmental Chemistry Laboratory (2 GC) and the Soybean and Alfalfa Laboratory (2 GC). The ten new CSL growth chambers are equipped with HID lamps and CO<sub>2</sub> control. A nutrient delivery system has been installed in the CEF. Environmental conditions are being monitored with a computerized system.

**B. Instruments and Sensors:** Additional UV monitoring instrumentation has been installed on the South Farm adjacent to or within proximity of the CSL Air Pollution facility as part of the USDA (CSREES) UV Monitoring Program. These instruments are operated by Colorado State University. The data are available within 1 day of measuring @ [http://uvb.nrel.colostate.edu/UVB/home\\_page.html](http://uvb.nrel.colostate.edu/UVB/home_page.html). There are 27 instruments in the network. This includes several sensors from Yankee Environmental Systems (UV-A pyranometer, UV B-1 pyranometer, UV Multi Filter Rotating Shadow Band Radiometer (UV-MFRSR) with 7 filter/photodiode combinations, and a VIS MFRSR, with 6 filter/photodiode combinations. A state-of-the-art 1 m UV scanning radiometer has also been installed (280-410 nm, 0.1 nm FWHM spectral resolution, 0.02 nm wavelength accuracy, 0.007 nm wavelength reproducibility, and 10<sup>-10</sup> out-of-band rejection ratio). This is addition to an 18 channel UV-B scanning radiometer, which was installed in 1998. The latter instrument was obtained from the Smithsonian Environmental Research Center and was described in last years report. A device was designed and constructed to conduct automated analysis of phytonutrient samples for antioxidant capacity (i.e., oxygen radical absorption capacity, ORAC).

**C. Unique Plant Responses:** Here are some highlights of research reported by CSL staff in 1999. Evidence was obtained for the regulation of stomatal density by spectral quality. Identified reduced hydraulic conductance as a common response of plants to growth at elevated CO<sub>2</sub>, which explains why plant water relations are often not improved under these conditions. A significant increase in the proportion of photosynthate stored as starch was detected when using a modulating UV irradiation system that tracked ambient UV and added a constant percentage to ambient levels. No effect on starch was observed when a square wave treatment was used to add a fixed amount of UV in the middle of the day. Eastern gamagrass plants were found to be unusually tolerant to an acid, compact, Al-toxic soil under both greenhouse and field conditions.

**D. Research Grants/Cooperative/Interdisciplinary Projects:** Don Krizek is continuing to serve as Principal Investigator on an USDA Competitive Grant entitled: "Eastern gamagrass for forage, soil improvement, and buffer strips". Cooperative studies are being conducted in collaboration with researchers from several laboratories at Beltsville (Climate Stress, Hydrology, Environmental Chemistry, and Nutrient Conservation and Metabolism), the Natural Resources Conservation Service (NRCS), Maryland Cooperative Extension, and the University of Maryland, Department of Natural Resource Sciences and Landscape Architecture. This work involves expertise in several disciplines. Ms. Rachel Gilker, a graduate student at the Univ. of Maryland, is working with Don Krizek and Ray Weil (UMD) on her Master's degree. She spent the summer of 1999 comparing the ability of eastern gamagrass and sordan 79 plants to penetrate acid, compact soils using simulated soil profiles. She hopes to complete her MS degree in May 2000. CSL is cooperating with NASA and the USDA UV-B Monitoring Program (funded by CSREES and operated out of Colorado State University and SUNY, Albany). A suite of state-of-the-art instruments (costing ca. \$1 million ) has been installed on the South Farm to measure UV radiation and atmospheric optical properties. CSL staff are assisting in the operation of the facility and will have access to the data as part of the CSL-UMCP program to study the effects of UV radiation on plants.

**E. Committees and Sub-Committees Served:** Don Krizek continues to serve on the Editorial Boards of Environmental and Experimental Botany and Biotronics and served on the Beltsville Area Mentoring Program Committee for the past year. Elliot Herman is on the Editorial Board of the Journal of Experimental Botany. Rich Sicher is serving on the Safety Committee and on the Greenhouse Committee.

**F. Workshops/Colloquia/Symposia:** Don Krizek, Linda Chalker-Scott (Univ. Washington, Seattle, WA) and Merdelyn Cassi-Lit (Univ. Philippines, Los Banos, Laguna, PI) will co-chair a symposium entitled: "Solar UV Radiation Effects on Plants: Interactions With Abiotic and Biotic Stress Factors" at the 13<sup>th</sup> International Photobiological Congress in San Francisco on July 4, 2000. Steve Britz was invited to give an invitational presentation in Japan on his work on phytonutrients.

**G. Personnel:** New employees in CSL include: Benjamin Alsop, Robert Erdman, Michele Evancho, Ernie Goins, Shaun Faulkner, Brigitte Khan, and Emily Steiner. Recent departures include Tung Fang, Mike McMahon, Camille Pepin, Dot Rieg, Louis Rose, and Frank Turano. Ernie Goins has replaced Louis Rose as Greenhouse Manager. Steve Britz served on a 3.5 month detail to the National Program Staff working on Global Climate Change issues. Lewis Ziska, Jim Bunce, and Rich Sicher are continuing their work on CO<sub>2</sub> enhancement research. Lan Liu-Gitz is continuing her post-doctoral work on UV/blue light effects on stomatal behavior and development and production of flavonoids in soybean. Charles Foy is continuing to serve as collaborator on the gamagrass project with Don Krizek, Jerry Ritchie (Hydrology Lab), Ali Sadeghi (Environmental Chemistry Lab.), and James Reeves (Nutrient Conservation & Metabolism Lab.). Richard Thimijan is continuing to assist on the UV research program.

**H. Recent Publications:** A selected list of 1999 publications is attached (Attach. #1). Copies of these and other reprints may be obtained by requesting them from CSL.

**I. Internet Entries/Access:** Information on research programs at the Beltsville Agricultural Research Center may be accessed at the following home page: [www.barc.usda.gov](http://www.barc.usda.gov). Information on the Climate Stress Laboratory may be accessed at: <http://hydrolab.arsusda.gov/csl>. Ernie Goins will be upgrading the CSL home page and helping to develop a home page on the BARC controlled environment facility (CEF). Early photos of the new CEF may be examined at the following site: [www.barc.usda.gov/fmod/branch/modern/archive](http://www.barc.usda.gov/fmod/branch/modern/archive)

## J. Selected List of References: 1999

- Ziska, L. H., R. C. Sicher and J. A. Bunce. 1999. The impact of elevated carbon dioxide on the growth and gas exchange of three C<sub>4</sub> species differing in CO<sub>2</sub> leak rates. *Physiol. Plant.* 105:74-80. (CSL No. 526)
- Ziska, L. H. and J. A. Bunce. 1999. Effect of elevated carbon dioxide concentration at night on the growth and gas exchange of selected C<sub>4</sub> species. *Aust. J. Plant Physiol.* 26:71-77. (CSL No. 527)
- Jucker, E. M., C. D. Foy, J. C. de Paula and J. A. Centeno. 1999. Electron paramagnetic resonance studies of manganese toxicity, tolerance, and amelioration with silicon in snapbean. *J. Plant Nutr.*, 22:769-782. (CSL No. 528)
- Kurek, I., K. Aviezer, N. Erel, E. Herman and A. Breiman. 1999. The wheat peptidyl prolyl *cis-trans*-isomerase FKBP77 is heat induced and developmentally regulated. *Plant Physiol.* 119:693-703. (CSL No. 529)
- Okomoto, T., T. Minamikawa, G. Edward, V. Vakharia and E. Herman. 1999. Posttranslational removal of the carboxyl-terminal KDEL of the cysteine protease SH-EP occurs prior to maturation of the enzyme. *J. of Biol. Chem.* 274:11390-11398. (CSL No. 530)
- Slovin, J., R. S. Bandurski and J. D. Cohen. 1999. Chapter 5. Auxin. pp. 115-140. In: *Biochemistry and Molecular Biology of Plant Hormones*. P. J. J. Hooykaas, M. A. Hall and K. R. Libbenga (Eds.), Elsevier Science B.V. (CSL No. 531)
- Herman, E. M. and B. A. Larkins. 1999. Protein storage bodies and vacuoles. *The Plant Cell* 11:601-613. (CSL No. 532)
- Bunce, J. A. 1999. Leaf and root control of stomatal closure during drying in soybean. *Physiol. Plant.* 106:190-195. (CSL No. 534)
- Foy, C. D., A. M. Sadeghi, J. C. Ritchie, D.T. Krizek, J. R. Davis and W. D. Kemper. 1999. Aluminum toxicity and high bulk density: role in limiting shoot and root growth of selected aluminum indicator plants and eastern gamagrass in an acid soil. *J. Plant. Nutr.* 22:1551-1566. (CSL No. 535)
- Sicher, R. C. 1999. Photosystem-II activity is decreased by yellowing of barley primary leaves during growth in elevated carbon dioxide. *Int. J. Plant Sci.* 160:849-854. (CSL 536)
- Ziska, L. H., J. R. Teasdale and J. A. Bunce. 1999. Future atmospheric carbon dioxide may increase tolerance to glyphosate. *Weed Science* 47:608-615. (CSL 537)
- Olszyk, D. M., H. G. S. Centeno, L. H. Ziska, J. S. Kern, and R. B. Matthews. 1999. Global climate change, rice productivity and methane emissions: comparison of simulated and experimental results. *Agricultural and Forest Meteorology* 97:87-101. (CSL 538)
- Comis, D. L., Krizek, D. T. and Ritchie, J. C. 1999. Gamagrass: The Queen of Grasses: In Action at the Beltsville Agricultural Research Center. Sustainable Agriculture Fact Sheet. 2 pp.