

ARS Report to the NCR-101 Committee on Controlled Environment Technology and Use
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A. Growth Facilities Planned or Installed: Construction of the new APHIS-permitted Containment Facility in Range 1 has been completed and infiltration testing will be done in mid-May 2004. Plans are underway to construct two new glass greenhouses adjacent to this facility. One will be a Citrus Quarantine Greenhouse; the other will be a Multi-Use Greenhouse. Each of these greenhouses will be 100' long x 37' wide. Several temporary plastic greenhouses have also been erected during the past three years. Two high tunnel houses (each 96' long x 21' wide) have been erected on the North Farm, one covered with UV-transmitting plastic and the other with UV-blocking plastic. The Controlled Environment Facility (CEF) at BARC was completed in 1998 and is now over 80% occupied with about 70% of the growth chambers in use. Three new growth chambers (EGC M-18) are being installed in the CEF by Environmental Growth Chambers Inc. for the Florist & Nursery Plants Research Unit. An alarm system has been installed in several of the growth chambers and is now being used by researchers to obtain 24-hour graphs of environmental conditions. ARS researchers continue to use insecticidal soaps and predatory insects in both growth chambers and greenhouses to reduce reliance on agricultural pesticides.

B. Other Facilities Planned or Installed: Several construction projects are underway or have been completed at BARC. Phase I (Bldg. 307B) and Phase II (Bldg. 307C) of the new Beltsville Human Nutrition Research Center (BHNRC) Facilities at BARC-East have been completed and personnel have moved into the new facilities. The design of the Phase III BHNRC renovation of Building 307 will be completed in September 2004. Phase III construction is expected to cost ca. \$25 million and is contingent on funds being approved by Congress. Other facilities being planned include the Poultry Production Hatchery Barns (estimated at ca. \$4 million). The design is at the 100% completion stage. Congressional funding of ca. \$3 million has been provided in the budget for constructing this facility with the remaining \$1.3 million coming from funds left over from the design stage. Plans for an Insect Quarantine Research facility have been deferred. The bulk of modernization funds for ARS in the President's budget for FY 2005 has been earmarked for modernizing facilities at the National Centers for Animal Health in Ames, IA. During the past three years, the National Agricultural Library has completely upgraded its electrical, heating, ventilation, and plumbing systems to replace the original systems that had become obsolete and posed a safety hazard. The fifth floor of the library has been converted to house the Library's extensive rare and special collections. This follows major renovations to the first floor facilities that were completed in 2000.

C. Instruments and Sensors: SPAR (soil-plant-atmosphere-research) chambers were utilized by Alternate Crops & Systems Lab. (ACSL) researchers to study the effect of water stress on maize crop photosynthesis and evapotranspiration under ambient and elevated atmospheric CO₂. A separate study was also conducted with potato (cv. Kennebec) to provide information on the influence of air temperature on foliar development and gas exchange rates of various portions of the potato canopy. Results of these studies are being used to improve knowledge gaps in mathematical crop models. Plans are still underway in the Phytonutrients Lab. to construct a ¹³C plant growth chamber to study metabolism of carotenoids in humans using carrots as the source of food. BARC continued to participate in the USDA UV-B Monitoring Program. A description of this program may be obtained at: <http://uvb.nrel.colostate.edu>. This monitoring program is managed by the Natural Resource Ecology Laboratory of Colorado State University (CSU). A suite of state-of-the-art instruments (costing ca. \$1 million) has been located on the South Farm since 1998 in close proximity to the Air Pollution facility to measure UV radiation and atmospheric optical properties. These instruments are maintained by personnel from CSU and State University of New York (SUNY) at Albany. The data for the CSU instruments are available on-line within 1 day of measurement. BARC staff (Steve Britz and Roman Mirecki, Phytonutrients Lab.) are assisting in the operation of the facility.

D. Unique Plant Responses: Cellulose diacetate (CA) has been widely used in UV-B enhancement studies and has also been used along with Aclar and Teflon in UV-B exclusion studies. In recent UV exclusion studies conducted at Beltsville, MD under solar UV, cucumber plants were found to develop marginal chlorosis under CA filters. To test the hypothesis that CA was responsible for the phytotoxic effects observed, an experiment was conducted in which CA and/or Teflon (T),

both UV-B and UV-A transmitting films, were used to cover 'Ashley' cucumber plants grown from seed in flower boxes under the following four combinations (top lay/bottom layer): CA/CA; CA/T; T/CA/ and T/T, one layer on top of the other. When CA was used as the bottom filter (CA/CA and T/CA), the plants were stunted and showed marginal chlorosis and epinasty of the cotyledons and first true leaf. However, when T was used as the bottom filter (CA/T and T/T) or the plants were grown in open air without any covering, the plants produced vigorous growth and were free of injury. These findings suggest that toxicity is caused by the CA itself rather than by solar UV radiation, possibly as a result of outgassing of a phthalate known to be used as a plasticizer in the manufacture of CA or some breakdown product (D.T. Krizek and R.M. Mirecki. 2004. *Env. Expt. Bot.* 51:33-44). An inadvertent leak of propylene glycol from a valve packing system in the SPAR chambers vaporized, causing severe toxicity to maize and soybean plants; this coolant had been presumed to be non-toxic to plants. This damage is consistent with previous reports of phytotoxicity from propylene glycol.

E. Research Grants/Cooperative/Interdisciplinary Projects: Since joining SASL in November 2000, I have completed work on our USDA grant on eastern gamagrass and am currently working on a new CRIS Project, entitled "Management of Cover Crops for Enhancement of High Value Cropping Systems." I have begun a new area of research on the use of high tunnel houses to extend the growing season for tomato production by 3-4 weeks each in the spring and fall. This work will be done in collaboration with several researchers from SASL (John Teasdale, Aref Abdul-Baki, Mark Davis, Pat Millner, Yao-Chi Lu, Dave Clark, Peter Ewashkow, Ruth Mangum), Biometrical Consulting Services (Mary Camp), FMOD (Ted Currier), other researchers at BARC in ACSL, the Produce Quality and Safety Lab, and the Food Composition Lab, and collaborators from Maryland Cooperative Extension (MCE) Carroll County (Bryan Butler), Penn State Univ. (Bill Lamont, Mike Orzolek), and Rutgers Univ. (AJ Both). We are currently setting up a joint experiment to determine the effects of different transplanting dates and the use of compost on tomato production in two high tunnel houses, one covered with UV-transmitting plastic and the other covered with a UV blocking plastic. In July, 2004, Mark Davis, John Teasdale, and I will join Bryan Butler (MCE), Jim Hanson (Univ. of Maryland), and Skip Kauffman (Accokeek Foundation) on a new SARE grant recently awarded us on "Season Extension and Cultivar Evaluations for Increasing Farmer Profitability Using High Tunnels in the Baltimore/Washington Metropolitan Marketing Area." Skip will be the PI on this grant. SASL will receive \$241,566 in new funding to conduct research on improving weed management for organic farming in cooperation with Rodale Institute and Penn State Univ. BARC is cooperating with NASA and the USDA UV-B Monitoring Program (funded by CSREES and operated out of CSU and SUNY, Albany) as indicated in C.

F. Committees and Sub-Committees Served: I continue to serve on the Editorial Board of *Environmental and Experimental Botany*. Dave Fleisher served on committees for the ASAE SE303 Committee on Environment of Plant Structures and ASAE IET210 Committee on Systems Analysis and Artificial Intelligence.

G. Workshops/Colloquia/Symposia: On 3 July 2003, I chaired a Symposium on UV Effects on Terrestrial Ecosystems at the American Society for Photobiology (ASP) Meeting in Baltimore, MD. Selected papers presented at the symposium and several invited manuscripts will be published in a Symposium-in-Print in the May 2004 (Part I) and June 2004 (Part II) issues of *Photochemistry and Photobiology*. Dr. Wei Gao (with the USDA UV Monitoring Program at Colorado State Univ.) and I will be guest editors of this Symposium-in-Print. Papers presented at the International Horticultural Congress in Toronto in August 2002 and at the 3rd Eastern Native Grass Symposium in Oct 2002 at the Univ. of North Carolina, in Chapel Hill, NC are in press. I am currently organizing a Symposium on UV Effects in Terrestrial Ecosystems to be held at the ASP Meeting in Seattle, WA on 13 July 2004. Partial funding to help defray costs for the two ASP Symposia were provided by ASP and the BA Director's Office.

H. Personnel: John Cherry was appointed Acting Director of the BNRC. David Fleisher, formerly at Rutgers Univ., joined ACSL. Dennis Gitz left ACSL for Lubbock, TX where he is in the Cropping Systems Research Lab. Bob Owens is monitoring the construction of the two new greenhouses in Range I; Bryan Bailey is the Research Program Representative for the Containment Facility. Charles Foy and Richard Thimijan serve as SASL volunteers.

I. Internet Entries/Access: Information on ARS research programs in the 35 labs and 4 institutes at BARC may be accessed at: www.ba.ars.usda.gov/research. Information on SASL may be accessed at: www.ba.ars.usda.gov/sasl/. Information on ACSL may be accessed at: <http://www.arsusda.gov/acsl/>. Information on BHNRC may be accessed at: <http://www.barc.usda.gov/bhnrc/>. Information on the Produce Quality and Safety Lab (PQSL) may be accessed at:

<http://www.barc.usda.gov/psi/pqsl/> . Information on ACSL's SPAR plant growth chambers may be accessed at: <http://soilphys.arsusda.gov/spar/HTMLfiles/RTPINDEX.htm> .Data on Realtime Plots in the SPAR chambers and in the lab's indoor plant growth cabinets may be accessed at: <http://soilphys.ars.usda.gov/spar/realtimePlots.htm> . Images of the construction of the CEF may be accessed at: http://www.ba.ars.usda.gov/sasl/krizek/cef_const.html .

J. Selected List of Recent Publications: 2002-2004

Ambumozhi, V., V.R. Reddy and Y.-C. Liu. 2003. The role of crop simulation models in agricultural research and development: A review. *Intl. Agr. Eng. J.* 12(1&2):1-18.

Baker, J.T, S.-H. Kim, D.C. Gitz, D. Timlin and V.R. Reddy. 2004. Estimating carbon dioxide leakage rates in controlled-environment chambers using nitrous oxide. *Environ. Expt. Bot.* 51:103-110

Bunce, J.A. 2002. Sensitivity of infrared water vapor analyzers to oxygen concentration and errors in stomatal conductance. *Photosyn. Res.* 71:273-276.

Bunce, J.A. 2003. Effects of water vapor pressure difference on leaf gas exchange in potato and sorghum at ambient and elevated carbon dioxide under field conditions. *Field Crops Res.* 82:37-47.

Bunce, J.A. 2003. Responses of seedling growth to daytime or continuous elevation of carbon dioxide. *Int. J. Plant Sci.* 164:377-382.

Buyer, J.S., D.P. Roberts, and E. Russek-Cohen. 2002. Soil and plant effects on microbial community structure. *Can. J. Microbiol.* 48:955-964.

Cavigelli, M.A. and S.J. Thien. 2003. Phosphorus bioavailability following incorporation of green manure crops. *Soil Sci. Soc. Am. J.* 67:1186-1194.

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.

Krizek, D.T. and R.M. Mirecki. 2004. Evidence for phytotoxic effects of cellulose acetate in UV exclusion studies. *Environ. Expt. Bot.* 51:33-43.

Lu, Y.-C., J.R. Teasdale and W.-Y. Huang. 2003. An economic and environmental tradeoff analysis of sustainable agricultural cropping systems. *J. Sustain. Agric.* 22(3):25-41.

Millner, P.D., S.F. Wright. 2002. Tools for support of ecological research on arbuscular mycorrhizal fungi. *Symbiosis* 33:101-123.

Roberts, D.P. and S.M. Lohrke. 2003. United States Department of Agriculture - Agricultural Research Service programs in biological control of plant diseases. *Pest Manage. Sci.* 59:654-664.

Timlin, D.J., Y. Pachevsky, V.R. Reddy, J.T. Baker, S.-H. Kim, C. Fraisse and A. Alva. 2002. 2DSPUD, a two-dimensional mechanistic model of potato growth and development. Presented at the Annual Meeting of the American Society of Agronomy, Crop Sciences Society of America, and Soil Science Society of America, Nov. 2002.

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.

Wang, C.Y. 2002. Alleviation of chilling injury in tropical and subtropical fruits and vegetables. In: C.J. Lee (Ed.), *Professional Frontiers in the 21st Century*. Chinese-American Prof. Assoc., Washington, D.C. pp. 501-512.

Wang, C.Y. 2002. Chilling injury and freezing injury. In: K.C. Gross, C.Y. Wang and M. Saltveit (Eds.), The Commercial Storage of Fruits, Vegetables, and Florist and Nursery Crops. An Adobe Acrobat pdf of a draft version of the forthcoming revision to the U.S. Department of Agriculture, Agriculture Handbook 66 on the website of the USDA, Agricultural Research Service, Beltsville Area <<http://www.ba.ars.usda.gov/hb66/index.html>>

Wang, S.Y., J.A. Bunce and J.L. Maas. 2003. Elevated carbon dioxide increases contents of antioxidant compounds in field-grown strawberries. *J. Agric. Food Chem.* 51:4315-4320.

Watkins, B., Y.-C. Lu, J. Teasdale. 2002. Long-term economic and environmental assessment of alternative cropping systems for the Mid-Atlantic region. *J. Sustain. Agric.* 20:61-82.

Wu, S., Y.-C. Lu, D.J. Mills, C.B. Coffman and J.R. Teasdale. 2002. Economic evaluation of alternative production systems for fresh-market tomatoes in the Mid-Atlantic region. *J. Veg. Crop Prod.* 8(1):91-107.

Zheng, Y., C.Y. Wang, S.Y. Wang, and W. Zheng. 2003. Effect of high oxygen atmospheres on blueberry phenolics, anthocyanins, and antioxidant capacity. *J. Agr. Food Chem.* 51:7162-7169.

Zhou, R., R.C. Sicher and B. Quebedeaux. 2003. Apple leaf sucrose-phosphate synthase is inhibited by sorbitol-6-phosphate. *Funct. Plant Biol.* 29:569-574.

Ziska, L.H. 2002. Sensitivity of ragweed (*Ambrosia artemisiifolia*) growth to urban ozone concentrations. *Funct. Plant Biol.* 29:1363-1367.

Ziska, L.H. 2002. Influence of rising atmospheric CO₂ since 1900 on early growth and photosynthetic response of a noxious invasive weed, Canada thistle (*Cirsium arvense*). *Funct. Plant Biol.* 29:1387-1392.

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., 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.

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 C₃ and C₄ weed with increasing CO₂. *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.

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