

1. New Facilities and Equipment

- Ten 4 ft x 11 ft **ebb and flow benches** (Ro-Flo series, Rough Brothers, Inc.) were installed for growing baby leaf lettuce for salad vegetable consumption study conducted in the Kubota lab at the Controlled Environment Agriculture Center (CEAC). Fifty trays of baby leaves (three selected varieties) will be produced weekly to feed total of 48 participants during 2008 and 2009.
- Four **LED lighting units** (CCS Inc, Japan) consisting of UV-A (peak wavelength: 375 nm), blue (476 nm), green (527 nm), red (660 nm), farred (735 nm) and white LEDs and the controllers were installed in the Kubota lab at Department of Plant Sciences.
- Dr. Kacira currently started his new position in University of Arizona and is working on development of a **sensing and control lab** at CEAC to assess plant growth, quality and health. The monitoring system will have machine vision system and other non-contact sensing sensors and technologies. Currently, a graduate student is working on installment of X-Y robotic camera positioning system through a motion control system.
- The Kubota lab (Plant Sciences) was registered as **BSL-1 lab** for conducting transgenic research for producing high value proteins in plant as a collaborative effort with scientists in Biodesign Institute, Arizona State University.
- Installation of six 14-ft² EGC **growth chambers** and three Arabidopsis **growth rooms** were completed in the CE room, Bio5 Institute for Collaborative Bioresearch (www.bio5.org).

2. Unique Plant Responses.

- The Kubota lab at CEAC launched new projects of re-evaluating values of farred lighting in plant production. End-of-day farred treatment, a well-known plant photomorphological response, was demonstrated in tomato rootstock seedling to control the height of grafting union. Another project is to examine efficacy of farred supplemental lighting in enhancing biomass production of baby leaf lettuce. Results obtained from both preliminary experiments addressed the need of pure and low-cost farred light source (using LEDs) for horticultural applications.

3. Accomplishment Summaries

- Arizona offered a Greenhouse Crop Production and Engineering Design Short Course on January 20-23, 2008, as a continuing professional education short course from the University of Arizona. The course programs can be viewed at <http://www.ag.arizona.edu/ceac/>. The meeting included a tour to EuroFresh Farms, Willcox, Arizona.
- The Kubota lab completed the 2.5 year study on efficacy of greenhouse tomato with high lycopene accumulation under moderate salt stress. The greenhouse study demonstrated that high EC in nutrient solution induced an overall average of 20% greater lycopene concentration on a fresh weight basis and that lycopene concentration was positively correlated to daytime mean air temperature and daily solar radiation, respectively. We also found that beta carotene, total phenolics and vitamin C increased by 20%, 17%, and 48% on a fresh weight basis when grown under high EC, primarily due to the concentration effect by reduced water content of the fruit (no significant differences in a dry weight basis). The intervention study successfully recruited 40 healthy men and women and proved that daily intake of two tomatoes with higher lycopene concentration significantly increased the plasma lycopene concentration. This research represents a unique, multidisciplinary approach to test the human biological response to consumption of a high lycopene tomato that is being produced through a cost-effective and easily adaptable greenhouse method. This collaborative research effort of plant sciences and applied nutritional sciences affords a unique opportunity to expand collaborative food-related research in the future and to develop significant partnerships within the produce industry to improve the nutritional quality of the food supply.

3. Impact Statements

- CEAC's Giacomelli group in cooperation with outside small business (Sadler Machine Co, Tempe, AZ), designed and constructed a controlled environment, hydroponic plant growth facility for producing fresh vegetables within the New Amundsen-Scott South Pole Station, Antarctica, supported by a contract from NSF, Office of Polar Programs. This facility has for 3 ½ years provided extraordinary educational and experiential opportunities for graduate students performing on-site research, station personnel managing and eating the crops, Arizona K-12 agriculture and science students through web-based distance education, demonstrating telepresence operational support experiences, and NASA scientists preparing for food production systems on Moon/Mars.

4. Published Written Works

- Buck, J.S., C. Kubota, and M. Jensen. 2008. Effect of mid-day reduction of high electrical conductivity treatment on the yield and quality of greenhouse cherry tomato HortTechnology. (In Press).
- Kacira, M, S. Sase, A. Ikeguchi, M. Ishii, G. Giacomelli and N. Sabeh. 2007. Effect of vent configuration and wind speed on three dimensional temperature distributions in a naturally ventilated multi-span greenhouse by wind tunnel experiments. ActaHorticulturae, (In Press)
- Kim, H.J., J.M. Fonseca, J.H. Choi, and C. Kubota. 2007. Effect of methyl jasmonate on phenolic compounds and carotenoids of romaine lettuce (*Lactuca sativa* L.) J. Agric. Food Chem. 55, 10366-10372.
- Kim, H-J., J.M. Fonseca, J-H. Choi, and C. Kubota. 2007. Effect of hydrogen peroxide on quality of fresh-cut tomato J. Food Sci. 72:463-467.
- Kubota, C., M.A. McClure, M.A., N. Kokalis-Burelle, M.G. Bausher, E.N. Roskopf. 2008. Vegetable grafting: history, use, and current technology status in North America. HortScience (In Press)
- Lovichit, W., C. Kubota, C. Choi, and J. Schoonderbeek. 2007. Greenhouse water recovery system for crop production in semi-arid climate. ASABE Paper No. 074012. St. Joseph, Mich.: ASABE.
- Tignor, M.E., S.B. Wilson, G.A. Giacomelli, C. Kubota, E. Fitz-Rodriguez, T.A. Irani, E.B. Rhoades, and M.J. McMahon. 2007. Multi-institutional cooperation to develop digital media for interactive greenhouse education HortTechnology 17:397-399.
- Wu, M. and C. Kubota. 2008. Effects of electrical conductivity of hydroponic nutrient solution on leaf gas exchange of five greenhouse tomato cultivars HortTechnology (In Press)
- Wu, M. and C. Kubota. 2008. Effects of high electrical conductivity of nutrient solution and its application timing on lycopene of hydroponic tomatoes during ripening Scientia Horticulturae (In Press)

5. Scientific and Outreach Oral Presentations

- Dietrich, K., Kim, H.J., Kroggel, M., Kubota, C., Fonseca, J., Wittenberg, E., and Wu, M. 2007. Post-harvest changes in antioxidant concentrations in tomato fruit grown hydroponically at different electrical conductivities . HortScience 42
- Kacira, M. 2008. Computational Fluid Dynamics (CFD) applications for greenhouse climate predictions. Computational Fluid Dynamics for Greenhouses and Biosystems Modeling Short Course, Autonomia University of Querétaro, Mexico, January 2008.
- Kacira, M. 2008. Greenhouse energy management considerations. Greenhouse Crop Production and Engineering Design Short Course, Tucson, AZ, January, 2008.
- Kroggel, M., K. Dietrich, C. Kubota and C. Thomson. 2007. Changes in concentrations of lycopene and total soluble solids of hydroponic tomato fruits as affected by greenhouse environmental conditions. HortScience 42
- Kubota, C. 2007. Vegetable grafting: History, use, and current technology status in North America. HortScience 42