

### **1. Impact Nuggets**

- The University of Arizona developed a low temperature storage method for grafted cantaloupe seedlings (up to four weeks) that would save labor requirement of grafting propagators significantly.

### **2. New Facilities and Equipment**

- Dr. Kacira is working on development of a **sensing and control lab** at CEAC to assess plant growth, quality and health. Currently a masters student is working in the project. A machine vision system has been designed, constructed and it is under operation. Machine vision system autonomously monitors textural, color, and temporal features of experimental plants to determine plant health, growth and early symptoms of stresses. The capability of the system is currently being evaluated for detection of tipburn on lettuce growing in a floating hydroponics setting.

- Prototype Lunar Greenhouse (LGH)

The LGH is now operable, instrumented, and able to demonstrate a number of potential Bioregenerative Life Support System technologies, including water recycling, atmosphere revitalization (CO<sub>2</sub>-O<sub>2</sub>) and a multi-crop cable-culture crop production system. Initial calibration studies indicated comparable biomass productivity (g/kW-h) to that of the South Pole Food Growth Chamber, with expected improvement as system leakage is reduced. For more information: [http://ag.arizona.edu/ceac/live/CEAC\\_live.htm](http://ag.arizona.edu/ceac/live/CEAC_live.htm); <http://www.youtube.com/watch?v=Z-0qJ4eZhs4>.

### **3. 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.

- The Kubota lab completed a project on low temperature storage of grafted cantaloupe seedlings, and found the optimum storage temperature (12C) for cantaloupe seedlings grafted on interspecific squash rootstock. It was also found that the cold tolerance of squash rootstock helped cantaloupe scion survive longer in storage having a suboptimal low temperature environment.

### **4. Accomplishment Summaries**

- CEAC successfully organized ISHS International Workshop on Greenhouse Environmental Control and Crop Production in Semi-Arid Regions (October 20-24, 2008). The number of participants was 160 from 22 countries. Conference proceedings was published (*Acta Horticulturae* 797) and distributed to the participants on site.

[Kubota, C. and M. Kacira. 2008. Proceedings of the international workshop on greenhouse environmental control and crop production in semi-arid regions. *Acta Horticulturae* 797.]

### **5. 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.

- Dr. Kubota works with three propagators for developing vegetable grafting capability. One of the three is a new venture company who plans to start the operation for grafting this year in Arizona.

### **6. 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* 18:460-466.

Giacomelli, G.A., 2009. Engineering Principles Impacting High Tunnel Environments. *HortTechnology* 19:1-4.

- Kacira, M., S. Sase, A. Ikeguchi, M. Ishii, G. Giacomelli, N. Sabeh. 2008. Effect of Vent Configuration and Wind Speed on Three-Dimensional Temperature Distributions in a Naturally Ventilated Multi-Span Greenhouse by Wind Tunnel Experiments. *ActaHorticulturae*, 801: 393-400.
- Kubota, C. 2008. Use of grafted seedlings for vegetable production in North America. *Acta Horticulturae* 770:21-28.
- Kubota, C., M.A. McClure, N. Kokalis-Burelle, M.G. Bausher, and E.N. Roskopf. 2008. Vegetable Grafting: History, Use, and Current Technology Status in North America. *HortScience*. 43:1664-1669.
- Lovichit, W., C. Kubota, C. Choi, and G.G. Schoonderbeek. 2008. Feasibility study for water recovery system for pad-and-fan cooled greenhouse in semiarid climate. *Acta Horticulturae* 797:315-320.
- Matsuda, R., C. Kubota, L.M. Alvarez, and G.A. Cardineau. 2008. Growth, development, and protein productivity of transgenic tomato plants expressing a *Yersinia pestis* antigen fusion protein F1-V in a greenhouse. *Acta Horticulturae* 797:381-385.
- Takakura, T., C. Kubota, S. Sase, M. Ishii, K. Takayama, H. Nishina, K. Kurata, and G.A. Giacomelli. 2009. Measurement of evapotranspiration rate in a single-span greenhouse using the energy-balance equation. *Biosystems Engineering*. 102:298-304.
- Thomson C.A., N.R. Stendell-Hollis, J.L. West, E.C. Cussler, L.M. McCune, M. Kroggel, H.J. Kim, and C. Kubota. 2008. High-lycopene consumption increases serum carotenoid levels but does not have decrease levels of oxidative stress and inflammation in healthy adults. *The Open Bioactive Compounds Journal*. 1:7-12.
- Wu, M., and C. Kubota. 2008. Effects of electrical conductivity of hydroponic nutrient solution on leaf gas exchange of five greenhouse tomato cultivars. *HortTechnology* 18:271-277.
- Wu, M., and C. Kubota. 2008. Effects of high electrical conductivity of nutrient solution and its application timing on lycopene, chlorophyll and sugar concentrations of hydroponic tomatoes during ripening. *Scientia Hort*. 116:122-129.

### **5. Scientific and Outreach Oral Presentations**

- 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.
- Kubota, C. 2008. How to grow flavorful tomatoes. Greenhouse Crop Production and Engineering Design Short Course, Tucson, AZ, January, 2008.
- Kubota, C. 2008. Transplant production: vegetable grafting. Greenhouse Crop Production and Engineering Design Short Course, Tucson, AZ, January, 2008.
- Kubota, C. and C.A. Thomson. 2008. Enhancing nutritional value of fresh tomato under controlled environments - A summary of collaborative research effort. International Symposium on Controlled Environment Agriculture, March 9-12, Cocoa Beach, Florida.
- Kubota, C., M.A. McClure, M. Olsen, and R. Tronstad. 2008. A multidisciplinary project for introducing vegetable grafting in the U.S.A. Methyl Bromide Alternatives Outreach Conference, November 11-14, Orlando, FL.
- Lovichit, W., C. Kubota, C. Choi and G.G. Schoonderbeek. 2008. A feasibility study for water recovery system for pad-and-fan cooled greenhouse in semiarid climate. International Workshop on Greenhouse Environmental Control and Crop Production in Semi-Arid Regions, October 20-24, Tucson, AZ.