# NCERA-101 Station Report 2015 – The University of Arizona

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Reporting period: July 1, 2014 to June 30, 2015

## 1. New Facilities and Equipment (including sensors, instruments, and control systems purchased/installed)

- Fei Jia (PhD candidate) and Kacira designed and built two multi-wavelength in-line optical density sensor system for real-time monitoring of microalgae concentration and health, and for control applications in Photobioreactors and raceway systems. Research showed that the sensor unit was capable of monitoring the dynamics and physiological change of the microalgae culture in real-time without any sample preparation for the measurements. A provisional patent application has been filed for the sensor unit.
- A 9.1 x 22m single-bay Quonset Greenhouse was renovated to include side-by-side production comparison of inorganic and organic nutritional regimes in collaboration with Sonoran Hydroponics Co., AgateBiosciences and WISErg Co., Dr. Stacy Tollefson, lead scientist, Drs. G. Giacomelli, Merle Jensen and Murat Kacira supporting.

## 2. Unique Plant Responses

- As part of a new project in Kubota team, we found that Iceberg lettuce seedlings grown under electric lighting (12 mol $m^{-2}$ $d^{-1}$, DLI; 20°C temperature) exhibited high tolerance to abiotic environmental stress and could be directly transferred to outdoor under high radiation (~2,000 µmol $m^{-2}$ $s^{-1}$) and high temperature (>35°C) without acclimatization process. The stand establishment when planted in September 2014 in Yuma Arizona was also 100%. This was unexpectedly high tolerance and further study is planned to find the key factors making them highly tolerant.
- Phytotoxicity caused by unknown VOC was observed for brassica species when grown inside a growth room "Veggie Box" (a commercially available leafy crop production system equipped with multi-tiered hydroponic growing system). Possible causal VOCs include the refrigerant (R410A) used for the split-type A/C unit but phototoxicity of R410A is not known. Further investigation is needed to validate the effect on sensitive plant species (such as kale).

## 3. Accomplishment Summaries

- The initial 3 years of vegetable grafting project funded by USDA SCRI program were completed in 2014 and the multi-state project team received 2 more years of funded extension to continuously work to introduce this sustainable horticultural technology. More US growers are

now experiencing use of grafted plants in various production systems including controlled environment and several new commercial grafting nurseries are now in operation (including one who uses vertical growing facilities with electric lighting).

- As part of USDA SCRILED project, LED Symposium was held at UA CEAC on Feb 20. The one-day symposium was delivered for both onsite and online participants (160 in total). Organizing members are Drs. Kubota (UA), Hernandez (UA), Mitchell (Purdue), Runkle (MSU), Both (Rutgers) and Lopez (Purdue). The symposium presentations can be viewed at http://leds.hrt.msu.edu/meeting/.
- UA CEAC organized the 14th Greenhouse Crop Production and Engineering Design Short Course (March 22-27, 2015) with 60 participants.
- UA CEAC organized the 6th Intensive Greenhouse Tomato Production Short Course. (January 5-9, 2015) [P. Rorabaugh, G. Giacomelli] with 24 participants.]
- UA CEAC organized the first workshop "The Realities of Growing Plants Indoors" with approximately 60 participants in July 20-23, 2014.
- Online non-credit professional course 'Greenhouse Plant Physiology and Technology' was offered in 2014 (9 weeks, 45 enrollment).
- Three graduate students (3 MS and 1 PhD) were graduated with degrees with focus on Controlled Environment Agriculture. [Hesley, Li, Whalen, Tollefson]

## 4. Impact Statements

- Kubota team (Eguchi, Hernández, and Kubota) developed an effective lighting regimen of relatively high B:R (red)-PF ratio (50:50 to and 75:25) during the photoperiod followed by small dose of EOD-FR lighting (1 mmol $m^{-2}$ per application) to reduce the incidence of intumescence without causing undesirable stem extension. The details of the outcome will be presented in ISHS International Symposium on Light in Horticulture held in Michigan in 2016.
- Kubota has been in discussion with Dr. Toyoki Kozai, the president of Japan Plant Factory Association, who had been promoting high containment (as low air exchange as 0.01 $h^{-1}$) for resource use efficiency. New facilities must be recommended to have an emergency ventilation system for any contained production systems to avoid possible VOC issues.

## 5. Published Written Works

### *Books/Book Chapters*

Kubota, C. 2015. Grafting with vegetable plants. P.329-339. In: (C.A. Beyl and R.N. Trigiano eds.) Plant propagation concepts and laboratory exercises, 2nd edition. CRC Press, Boca Raton, FL.

Kubota, C. 2015. Growth, development, transpiration and translocation as affected by abiotic environmental factors, In: (T. Kozai, G. Niu, eds.) Plant Factories, 1st Ed. An Indoor Vertical Farming System for Efficient Quality Food Production. Elsevier (in press)

### *Refereed Journal Articles*

Hernández, R. and C. Kubota. 2015. Physiological responses of cucumber seedlings under different blue and red photon flux ratios using LEDs. Environ. Exp. Bot. (In Press)

Hernández, R. and C. Kubota. 2015. Physiological, morphological, and energy-use efficiency comparisons of LED and HPS supplemental lighting for cucumber transplant production. HortScience. 50:351-357.

Hernández, R. and C. Kubota. 2014. Growth and morphological response of cucumber seedlings to supplemental red and blue photon flux ratios under varied solar daily light integrals. Scientia Horticulturae 173:92-99

Story, D. and M. Kacira. 2015. Design and implementation of a computer vision-guided greenhouse crop diagnostics system. Journal of Machine Vision Applications, March 2015, 1432-1769. DOI 10.1007/s00138-015-0670-5

Tollefson, S., G. Curlango-Rivera, D.A. Huskey, T. Pew, G. Giacomelli and M. C. Hawes. 2014 Altered carbon delivery from roots: rapid, sustained inhibition of border cell dispersal in response to compost water extracts. Plant and Soil, doi: 10.1007/s11104-014-2350-z, Springer International Publishing, Dec. 2014.

### *Refereed Conference Proceedings Articles*

Giacomelli, G., M. Kacira, R. Furfaro, R.L. Patterson and P. Sadler. 2014. Plant Production, Energy Balance and Monitoring-Control-Telepresence in a Recirculating Hydroponic Vegetable Crop Production System: Prototype Lunar Greenhouse, ACTA Horticulturae IHC 2014 New Technologies in Protected Cropping Symposium in Australia in 2014.

### *Other Creative Works*

The LGH-OTM (Lunar Greenhouse – Outreach and Teaching Module) was installed and operated within a display at the Upper Habitat of the Biospsher2 facility in Oracle, Arizona (November 2014 – June 2015)