

New Facilities and Equipment.

- The water cooled LEDs installed in 2012 suffered a traumatic failure when the university chilled water supply reached 180 psi. The six original units were replaced this year with nine new 9-channel (UV through to far red) water cooled LED arrays that are now decoupled from the university chilled water supply.
- Four ancient yet worthy Constant Temperature Control Ltd. walk in growth chambers were converted to Argus Controls by our greenhouse manager Ron Dutton. Switching out the T12 tubes is next on the list.
- One of our original BlueBox growth chambers was retrofitted with 7-channel (UV to far red) high intensity water cooled LEDs which provide eight 2' x 4' growing spaces in a single chamber to better evaluate plant-light interactions.
- Five PS-1000 plant photosynthesis units were delivered to a licenced marijuana producer in Ontario. These are part of an extended CESRF/UoG laboratory located in a secure licenced production facility and are capable of investigating cannabis growth, development and chemistry under controlled conditions.
- TOC-N analyzer acquired and refurbished. Applications in irrigation water research.

Unique Plant Responses.

- An undergraduate investigation on common bush bean production using LED inner canopy lighting has shown (as expected) significantly improved yields and shorter stature. This research has led to the inclusion of bush beans in our vertical farming research initiatives.
- Demonstrated altered secondary metabolite production in cannabis in response to different light spectral qualities.
- Early evidence to suggest vertical stratification of secondary metabolite production in cannabis flower buds in response to sub-canopy lighting in which the sub-canopy spectra differed from the overhead light spectra.

Accomplishment Summaries.

Technology transfer:

- Modular Farms container systems (NOT shipping containers), developed in conjunction with CESRF, continue to grow with seven units in use producing leafy greens and 10 more currently in production.
- EDEN ISS, an EU 2020 Antarctic 'greenhouse' project coordinated by the German Space Agency and involving a large consortium of European, Canadian and American partners was successfully delivered to Antarctica in December 2017. CESRF provided the hydroponics and control systems. The system will be tested over the Antarctic winter and will provide supplemental food to the overwintering staff at Germany's Neumayer III Station.

- A pilot scale seven-layer (215m²/2300 ft²) automated vertical farm is currently being tested in Toronto and will be used in our graduate program while producing romaine lettuce for local restaurants.
- Work is underway to evaluate the potential of using spectral quality to improve rooting success and manage shoot growth in *Kolanchoe* to speed production and lower the requirements for PGR's.
- A seed sterilization protocol for *Nicotiana benthamiana* is in the final stages of testing and should help improve commercial production of phyto-pharmaceuticals.

Technology advancement:

- Published the first two papers on medicinal cannabis production in North America.
- Final bench testing of a regenerative, in situ electrochemical chlorination system for recycling irrigation water. The system has shown excellent pathogen control without breaching phytotoxic thresholds for free chlorine, while negating the need for the continual addition of additional chlorine/chloride.
- Developed cumulative VPD threshold-based irrigation management protocols (an app has been developed to support implementation) that have routinely reduced water consumption in perennial nursery operations by 40-50%.

Communication:

- Tomatosphere, a free science outreach program available throughout North America, is now in its 18th year. This year's seed batch was launched on SpX-11 on Falcon rocket on June 3rd from Kennedy Space Center's Launch Complex 39A. Seeds returned to Earth on July 3rd, for a total of 30 days in space.
- Established a 3rd year (university) course in CES: Introduction to Controlled Environment Systems.

Published Written Works

Anna-Lisa Paul, Mingqi Zhou, Jordan B. Callaham, Matthew Reyes, Michael Stasiak, Alberto Riva, Agata K. Zupanska, Mike A. Dixon, Robert J. Ferl. 2017. Patterns of Arabidopsis gene expression in the face of hypobaric stress. *AoB PLANTS*. 9:4. doi:10.1093/aobpla/plx030

Deron Caplan, Mike Dixon, and Youbin Zheng. 2017. Optimal Rate of Organic Fertilizer during the Vegetative-stage for Cannabis Grown in Two Coir-based Substrates. *HortScience*. 52:1307-1312. doi:10.21273/HORTSCI11903-17

Deron Caplan, Mike Dixon, and Youbin Zheng. 2017. Optimal Rate of Organic Fertilizer during the Flowering Stage for Cannabis Grown in Two Coir-based Substrates. *HortScience*. 52:1796-1803. doi:10.21273/HORTSCI12401-17

Lanoue Jason, Leonardos Evangelos D., Ma Xiao, Grodzinski Bernard. 2017. The Effect of Spectral Quality on Daily Patterns of Gas Exchange, Biomass Gain, and Water-Use-Efficiency in Tomatoes and Lisianthus: An Assessment of Whole Plant Measurements. *Frontiers in Plant Science*. 8:1-15. DOI=10.3389/fpls.2017.01076

Sheridan, C., Depuydt, P. De Ro, M., Petit, C., Van Gysegem, E., Delaere, P. Dixon, M., Stasiak, M., Aciksoz, S. B., Frossard, E., Paradiso, R., De Pascale, S., Ventorino, V., De Meyer, T., Sas, B., Geelen, D. 2017. Microbial Community Dynamics and Response to Plant Growth-Promoting Microorganisms in the Rhizosphere of Four Common Food Crops Cultivated in Hydroponics. *Microbial Ecology*. 73:378–393. doi=10.1007/s00248-016-0855-0

Stemeroff, J. 2018. Irrigation Management Strategies for Medical Cannabis in Controlled Environments. MSc Thesis. University of Guelph. <http://hdl.handle.net/10214/12125>

Zhou Mingqi, Callaham Jordan B., Reyes Matthew, Stasiak Michael, Riva Alberto, Zupanska Agata K., Dixon Mike A., Paul Anna-Lisa, Ferl Robert J. 2017. Dissecting Low Atmospheric Pressure Stress: Transcriptome Responses to the Components of Hypobarica in Arabidopsis. *Frontiers in Plant Science*. 8:1-13 DOI=10.3389/fpls.2017.00528