NCERA-101: Committee on Controlled Environment Technology and Use
2019 Station Report

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Impact Nugget

Research is continuing in the areas of plant growth in controlled environments: focusing on plant substrate, greenhouse heating using wood pellets, creating innovative greenhouse designs for crop production in extreme climates and investigating light emitting diodes on plant growth. We are continuing our research on: 1) a soot particle removal and wood pellet furnace exhaust gas enrichment system for greenhouses 2) growing plants in porous concrete 3) a design for a northern greenhouse and 4) work on plant growth using LEDs. Our large announcement is the results of using LEDs with a peak wavelength of 595 nm have resulted in an increase of yield of almost 50% over any other single wavelength LED we have tested.

Accomplishment Summaries

The Macdonald Campus of McGill University is researching means to use biomass for heat and carbon dioxide enrichment in controlled environments with a focus on greenhouses. The system combines an electrostatic chamber and a cyclone section that allow for extended operation of the traditional air filter. The electrostatic chamber has been very successful with removal of soot occurring for over 7 days with removal efficiency remaining above 85%, with peak removal at 97%. We have patented the technology and are looking for industrial partners to allow this technology to reach the marketplace.

We are continuing our light emitting diode research. This project is to determine the proper wavelengths and ratios of light emitting diodes to maximize production. This research is ongoing, but we have tested amber (peak at 595 nm) LEDs to the red and blue mixture with improved production. We have tested Arabidopsis, tomato, and lettuce plants with over 50% increase in the yield when using amber light directly. We are continuing this research.

We have continued to develop a cooling systems for a greenhouse called the NVAC. Testing is ongoing with Sprung Structures in Calgary to commercialize this technology, with testing continuing at site.

The design of a northern greenhouse is continuing with further testing and improvements required. We have successfully grown a crop of lettuce and had fruit set on tomato plants inside the unit. We are continuing our collaboration with northern partners and have completed a research project using chicken manure as a fertilizer source for a hydroponic lettuce production facility.

We have been testing a porous concrete for plant growth. We tested the porous concrete using different concentrations of Hoagland's solution with the slag based porous concrete. The double Hoagland treatment porous concrete had similar dry mass values as the rockwool treatment. This research has been patented and we are attempting commercial scaling of the technology.

Impact statement

The Biomass Production Laboratory at McGill University has shown that plant growth growth using LED light from 595 nm is very beneficial for plant growth with both fresh and dry mass over 50% higher than any other single LED wavelength we have tested. We are working with our industry partners to improve on this result and add in other wavelength to improve the lighting system further.

Published Works

1. **Routray, W.,** V. Orsat, M. Lefsrud. 2018. Effect of post-harvest LED application on phenolic and antioxidant components of blueberry leaves. Chem Engineering 2(56):1-9.
2. **Parrine Sant'Ana, D.V**., **B.S**. **Wu**, B. Muhamma, K. Rivera, D. Pappin, X. Zhao, M. Lefsrud. 2018. Proteome modifications on tomato under extreme high light induced-stress. Proteome Science 16(20):1-15.
3. **McCartney, L.,** M. Lefsrud. 2018. Field Trials of the Natural Ventilation Augmented Cooling (NVAC) Greenhouse. Biosystems Engineering. 174:159-172.
4. **McCartney, L.,** V. Orsat, M. Lefsrud. 2018. An experimental study of the cooling performance and airflow patterns in a model Natural Ventilation Augmented Cooling (NVAC) greenhouse. Biosystems Engineering 174:173-189.
5. **Parrine Sant'Ana, D.V.,** M. Lefsrud. 2018. Tomato proteomics: tomato as a model to crop proteomics. Scientia Horticulturae 239:224-233.
6. **McCartney, L.,** M. Lefsrud. 2018. Protected Agriculture in Extreme Environments: A Review of Controlled Environment Agriculture in Tropical, Arid, Polar and Urban Locations. Applied Engineering in Agriculture 34(1):1-21
7. **Wu, B.S.,** M. Lefsrud. 2018. Photobiology Eye Safety for Horticultural LED Lighting: Transmittance Performance of Eyewear Protection Using High-Irradiant Monochromatic LEDs. Journal of Occupational and Environmental Hygiene. 15(2): 133-142

Oral Presentations

1. Lefsrud, M., 2018. Using Space Based Controlled Environment Plant Growth Technology for Earth Based Production. Invited Speaker Seminar – Oakland University, School of Engineering and Computer Science. Rochester, MI. August 1, 2018.
2. Lefsrud, M., 2018. Keynote: Using Space Based Controlled Environment Plant Growth Technology for Earth Based Production. Current and future ways to closed life support systems. Joint Agrospace-Melissa Workshop. Rome May 16-18, 2018.
3. Lefsrud, M., 2018. Atelier: Efficacite Energetique et Production en Serres En Milieu Urbain. UQAM May 22, 2018.
4. Lefsrud, M., 2018. Controlled Environment Agriculture in Northern Canada. Quebec Farmers Association, Kuujjuaq, QC, February 8, 2018
5. Lefsrud, M., 2018. LED Grow Lights, Agricultural Equipment Technology Conference (AETC), Louisville, Kentucky, February 12-14, 2018.

Other relevant accomplishments and activities.

Nothing to report.