NCERA-101: Committee on Controlled Environment Technology and Use
2015 Station Report

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Impact Nugget

We are continuing our research in the target area of plant growth in controlled environments: focusing on identifying the potential of greenhouse heating using wood pellets, creating innovative greenhouse designs for crop production in extreme climates and investigating light emitting diodes on plant growth. We have also been working to refine the design for further testing of the basis of two filed patents: 1) a wood pellet furnace exhaust gas enrichment system for greenhouses and 2) a design for a tropical greenhouse. Our work with Urban Barns has ended but research is continuing to improve LED lighting systems for urban agricultural plant production.

Accomplishment Summaries

The Macdonald Campus of McGill University is continuing its research into controlled environments with work on the impact of biofuel heating systems with a focus on greenhouse heating using wood pellets combined with carbon dioxide enrichment. This greenhouse heating research has resulted in the filing of a second provisional patent for the removal of particulate matter from the exhaust gas, through the addition of an electrostatic and traditional cyclones that allows for extended operation of the traditional air filter. This design allows for the soot free exhaust gas to then be treated in the catalytic system and used to heat and provide CO_2 for improved production in the greenhouse. We are continuing this research and are working on design improvements to develop a commercial unit.

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 begun to add in amber LEDs to the red and blue mixture with improved production of lettuce plants.

Finally, we are continuing to build and test on two different greenhouses. More specifically, a greenhouse designed for the tropics that uses water misting to create a natural ventilation loop and a northern greenhouse that maximizes natural solar light with supplemental LED lighting. A second tropical greenhouse was completed in Barbados with very strong results during the misting operation. The northern greenhouse is still in the construction phase but we have begun to grow plants in the unit as an initial proof of concept. Full results are expected in the coming year.

Impact statement

The biomass heating group at McGill University has been trying to identify methods to utilize both the heat and carbon dioxide that result from the combustion process. A second challenge of this research has been to develop a method to remove the soot from the exhaust gas stream. We have filed a patent that describes our ability to remove the soot and allow for a cleaner exhaust gas before conversion and removal of the noxious gases with the catalytic conversion system. We are currently testing the unit and hope to begin testing in a commercial greenhouse in the coming year.

Light emitting diodes are slowly replacing all supplemental lighting systems in greenhouses, growth chambers and urban agricultural systems. Our research has been to determine the optimum wavelength of light for plant production and we have begun to alter light composition by adding amber wavelengths to the red and blue LEDs with improved production of the lettuce.

Published Works

1. Naznin, M. T., M. Lefsrud, V. Gravel, X. Hao. 2016. Different Ratios of Red and Blue LED to improve the Growth of Strawberry Plants. ISHS 8th International Symposium on Light in Horticulture. East Lansing, MI. ACTA Horticulturae 1134:125-130.
2. Both, A.J., L. Benjamin, J. Franklin, G. H. Holroyd, L. D. Incoll, M. G. Lefsrud and G. Pitkin. 2015. Guidelines for Measuring and Reporting Environmental Parameters for Experiments in Greenhouses. Plant Methods11(43):1-18

Oral Presentations

1. Lefsrud, M.G. Development of a Northern Greenhouse. Northern Farm Training Institute, Hay River, NWT, March 11-12, 2016.
2. Lefsrud, M.G. Designing for sustainable plant production systems, Dalhousie University Truro, January 8, 2016.
3. Reddy, S., M.G. Lefsrud. 2016. Effect of LED light wavelength and intensity on accumulation of phytochemicals in lettuce. Paper 162460742. ASABE Annual Meeting Orlando, FL, July 17-20, 2016.
4. McCartney, L., M.G. Lefsrud. 2016. Cubic Farming: An Overview of Intercanopy Lighting and Crop Trials. Paper 162460470. ASABE Annual Meeting Orlando, FL, July 17-20, 2016.
5. McCartney, L., M. Lefsrud. 2016. Natural ventilation augmented cooling (NVAC) greenhouse: analysis of microclimate and plant responses. ICEC/Auspheno 2016 Conference, Camberra, Australia, September 18-22, 2016.
6. McCartney, L., L. Hendry, M. Lefsrud. 2016. Natural ventilation augmented cooling greenhouse. CSA/CSHS 2016 Annual Conference Montreal, Quebec, July 24-26, 2016.
7. Gaudet, P., M.Cool and Mark Lefsrud. Food Security in Northern Canada (Food SINC) Project: Development of Northern Greenhouse and Working Prototype. CSA/CSHS 2016 Annual Conference Montreal, Quebec, July 24-26, 2016.
8. Naznin, M. T., M. Lefsrud, V. Gravel, X. Hao. 2016. Different Ratios of Red and Blue LED Light Affect on Coriander Productivity and Antioxidant Properties. ISHS Light Conference, Michigan, USA.
9. Wu, B.-S., M.G. Lefsrud. 2015. The Photosynthesis Action Radiation (PAR) Curve of Lettuce plants using Blue Narrow Spectrum LEDs. Paper 21339. ASHS Annual Meeting New Orleans, LA, August 4-7, 2015.
10. Wu, B.-S., M.T. Naznin, M. Lefsrud. 2015. LED Safety: Performance of Twelve Glasses Using 9 High-irradiance LEDs. Paper 21340. ASHS Annual Meeting New Orleans, LA, August 4-7, 2015.

11. Reddy, S., M.G. Lefsrud, B.-S. Wu. 2015. LED Light Screening Method for Better Quality and Quantity of Lettuce. Paper 21898. ASHS Annual Meeting New Orleans, LA, August 4-7, 2015.

Other relevant accomplishments and activities.

The successful results from the application of a number of grants will allow us to continue our research for the upcoming years in LED lighting for lettuce production, proteomic expression, improved exhaust cleaning technology, and also continue research on wood pellet greenhouse heating.