

**NCERA-101: Committee on Controlled Environment Technology and Use  
2014 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 and investigating light emitting diodes for plant production. We have also been working to refine the design and further tests the basis of three filed provisional patents: 1) a wood pellet furnace exhaust gas enrichment system for greenhouses, 2) a design for a tropical greenhouse design and 3) a greenhouse design suitable for northern Canadian locations. Our work with Urban Barns is continuing and is focused on improved LED lighting system for urban agricultural hydroponic lettuce production. As well we have published a paper on a misting system to protect horticultural crops during freezing an offshoot of this research.

**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 utilization. This greenhouse heating research has resulted in the filing of a second provisional patent for the removal of particles from exhaust gas. The addition of this electrostatic and cyclone design allows for extended operation of the tradition filter. This design will allow for the exhaust gas to then be treated in the catalytic system and used to heat and provide CO<sub>2</sub> 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 with industry collaboration from Urban Barns a company specializing in urban agriculture food production (lettuce and other leafy greens). 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 the lettuce plants.

We are continuing to build and test on two different greenhouses 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. Both of these designs are being built. The tropical greenhouse was recently built in Barbados with very strong results during the misting operation. We hope to have the northern greenhouse built within the coming year.

We have published a paper outlining a simple design for a portable misting system for frost control. This system can be placed on a horticultural platform (4 ft by 4 ft) and moved to critical crops. We designed the system to be able to be placed quickly next to the crops and misting lines placed above the plant during frost events. Our research has shown that this system can protect the crops down to  $-2^{\circ}\text{C}$  for over 4 hrs.

### **Impact statement**

The biomass heating group at McGill University has been trying to identify methods to utilize both the heat from combustion and the carbon dioxide. 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 will begin testing in a commercial greenhouse in the coming months.

Light emitting diodes are slowly replacing all supplemental lighting system 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.**, Yoshiaki Kitaya, Toshio Shibuya, H. Hirai, M.G. Lefsrud. 2015. Light intensity affects on medicinal compound ajoene accumulation in hydroponically grown garlic plants. *AAAS Journal* 3(4):16-25.
2. **McCartney, L.**, M. Lefsrud. 2015. Portable Frost-protection Misting System: Trial on Tomato and Sweet Orange Crops. *Horttech* 25(3):313-321.
3. **Roy, Y.**, M. Lefsrud, **F. Filion, J. Bouchard, Q. Nguyen, L. Dion, A. Glover**. 2014. Biomass Combustion for Greenhouse Carbon Dioxide Enrichment Biomass and Bioenergy 1-14.
4. **Deram, P.**, M. Lefsrud, V. Orsat. 2014. Supplemental Lighting Orientation and Red to Blue Ratio of Light Emitting Diodes for Greenhouse Tomato Production. *HortScience* 49(4)1-5.

### **Oral Presentations**

1. **Naznin, M.T.**, V. Gravel and M. Lefsrud. 2014. Determine the Effect of Different ratios of Red and Blue LED Light on Commercial Plants Production Abstract ID# 17109. ASHS Annual Conference, Orlando, FL, July 28-31, 2014.
2. **Schwalb, M., M. T. Naznin** and M. Lefsrud. 2014. Determination of the Effect of Red and Blue ratios of LED light on Plant Photosynthesis. Abstract ID# 17110. ASHS Annual Conference, Orlando, FL, July 28-31, 2014.
3. **Rossouw, S. J.**, M. Lefsrud and V. Gravel. 2014. A novel organic substrate based on hemp- (*Cannabis sativa*), or flax (*Linum usitatissimum*) fibre for hydroponic systems. Abstract ID# 18868, ASHS Annual Conference, Orlando, FL, July 28-31, 2014.
4. **Wu, B.-S, K. Daive, M.T. Naznin**, M. Lefsrud. 2014. The Effect of Small Interval Wavelengths Using LEDs on Photosynthetic Rates of Tomato Plants. Abstract ID# 19535, ASHS Annual Conference, Orlando, FL, July 28-31, 2014.

5. Lefsrud, M. 2014. Urban Agriculture: Food Production in Non-Traditional Locations ASABE Paper 1892476. Montreal, QC, July 13-16, 2014.
6. **Roy, Y., M. Lefsrud, E. Madadian, C. Perez Lee, and L. Dion.** 2014. Biomass Combustion and Gasification for Greenhouse Carbon Dioxide Enrichment ASABE Paper 141882490. Montreal, QC, July 13-16, 2014
7. **McCartney, L., M. Lefsrud.** 2014. (NVAC) Natural ventilated augment cooling greenhouse. ASABE Paper 141868679. Montreal, QC, July 13-16, 2014
8. **McCartney, L., M. Lefsrud.** Portable frost protection orchard misting device. ASABE Paper 141904451. Montreal, QC, July 13-16, 2014
9. **Gaudet, P., S. Tawil, and M. Lefsrud.** 2014. Canadian Integrated Northern Greenhouse (CING): Designing the Outer Structure and Pivoting Hydroponic Systems. ASABE Paper 141898724. Montreal, QC, July 13-16, 2014.
10. **Naznin, M.T., M. Lefsrud.** 2014. Responses of Tomato Plantlets Cultured in vitro Under Red and Blue Light Emitting Diodes (LEDs). ASABE Paper 141898623. Montreal, QC, July 13-16, 2014.
11. **Reddy, S., B.-S. Wu, M.T. Naznin, M. Lefsrud.** 2014. LED lights on plant growth and development. ASABE Paper 141898854. Montreal, QC, July 13-16, 2014
12. **Naznin, M.T., M. Lefsrud.** 2014. Determination of the Effect of LED Irradiance on Plant Photosynthesis and Action Spectrum. ASABE Paper 141898592. Montreal, QC, July 13-16, 2014.
13. **Wu, B.-S., K. Daive, S. Reddy, M. Naznin, M. Lefsrud.** 2014. Characterization of the Photosynthesis Action Radiation of Tomato plants using LEDs with small band widths ASABE Paper 141898894. Montreal, QC, July 13-16, 2014.
14. Lefsrud, M. 2014. **Urban** Agriculture: Food Production in Non-Traditional Locations ASABE Paper 1892476. Montreal, QC, July 13-16, 2014.

#### **Other relevant accomplishments and activities.**

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