NCERA-101: Committee on Controlled Environment Technology and Use
2010 Station Report

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Impact Nugget

We have been researching in two target areas with the first focusing on identifying the potential of greenhouse heating using wood pellets and the second investigating light emitting diodes for plant production. Projects were completed in both areas with the construction and testing of a wood pellet gasifier and a full scale LED supplemental lighting experiment on hydroponic lettuce.

Accomplishment Summaries

The Macdonald Campus of McGill University is researching into controlled environments with work on the impact of biofuel heating systems with a research focus on greenhouse heating using wood pellets with carbon dioxide utilization. The greenhouse heating research is in the early stages with the instillation of a gasifier furnace (GEK) and gas monitoring equipment. The first year of testing was on the quality of the gas (both syngas and exhaust gas) from the gasifier unit and possible use as a carbon dioxide enrichment system in a greenhouse. We are continuing this research with the installation of a wood pellet furnace to provide heat in the greenhouse and begin enrichment testing. The enrichment test will be completed on lettuce and tomato plants using both the wood heating system and a propane enrichment system.

The research on light emitting diodes is continuing with a experiment to compare supplemental lighting using high pressure sodium (HPS) bulb and light emitting diodes (LED lighting Systems, Terrebonne, QC) on a commercial operation using a floating tray hydroponic Boston head lettuce system (HydroSerre Mirabel, Mirabel, QC). The lettuce was grown over two growing periods for 30 days using 18hr of supplemental lighting (71.3moles m^{-2} for HPS and 35.8moles m^{-2} for LED over four weeks). After normalizing to remove the impact of sunlight, the biomass produced by the supplemental lighting was 0.47g/mol/m^2 and 0.20g/mol/m^2 for first and second HPS light treatment replications and 0.45g/mol/m^2 and 0.14g/mol/m^2 for the first and second LED light treatment replications. A nutrient deficiency occurred in the second time replication for all plants, reducing the plant size. Statistically, no different was observed between the LED or HPS supplemental light grown lettuce plants (fresh or dry mass).

Impact statement

Biomass heating at McGill University has been trying to identify methods to use both the heat from the combustion process and also use the carbon dioxide. A major challenge of this work is the numerous gases that are produced during the combustion process (CO, ethylene, SOx, NOx, and particulates) and remove these gases before injection into the greenhouse. Through the use

of a gasifier we significantly reduced the production of these gases to levels acceptable for direct injection into the greenhouse. Scale-up testing of the gasifier will be completed to empirically support this conclusion.

Light emitting diodes have a strong potential to replace all supplemental lighting system in greenhouses and growth chambers. Our research was able to show that supplemental lighting with a LED array and a HPS lighting system resulted in statistically identical plant production was accomplished with 33% less electrical usage.

The research being performed in our laboratory shows that reduced energy systems can be implemented both in the form of heating systems and lighting systems without impacting the quality or production of the plants. Using a wood heating gasifier can reduce the heating costs and carbon dioxide enrichment cost for a greenhouse, specifically in the Quebec and Northeast US region. Likewise, the LED technology is very encouraging by reducing electricity costs but not impacting the final crop yields.

Published Works

- Lefsrud, M. G., J. C. Sorochan, D. A. Kopsell and J. S. McElroy. 2010. Species, Nitrogen, and Season Influence Pigment Concentrations in Turfgrass. HortScience 45(4):650-653.
- Lizotte, P.L., P. Savoie, M. Lefsrud. 2010. Corn Stover Fractions as a Function of Hybrid, Maturity, and Site. ASABE Paper 1009207. June 20-23, 2009. Pittsburgh, PA.
- Dion, L.M., M. Lefsrud. 2010. Generating usable and safe CO2 for of greenhouses from the exhaust gas of a biomass heating system. CIGR Paper 101227, XVII World Congress of CIGR, Quebec City, Canada, June 13-17.
- Lizotte, P.L., P. Savoie, M. Lefsrud, J. Senecal-Smith. 2010. Corn Stover Fractions as a Function of Hybrid, Maturity, Location and Year. CIGR Paper 100098, 17th World Congress of CIGR, June 13-17, 2010, Quebec City, Canada.
- Biomass heating for improved greenhouse efficiency. Quebec Farmers' Advocate. May 2010.

Oral Presentations

- Light: The Importance of Wavelength for Plants. Gairdner High School Lecture Series – Montreal, QC, October 22, 2010.
- Biofuels: Next Generation Challenges. Ninth Annual Brace Research Day – Keynote Speaker. McGill University. April 12, 2010.
- Alternative Energy Sources. McGill University – Engineers without Borders. March 25, 2010.
- Biomass Production: Design and Environmental Control using Proteomics. University of Alberta. March 18, 2010.
- Biomass Heating and Carbon Dioxide Capture. Canada-Brazil Biofuels Workshop. Ottawa, ON, March 13, 2010.
- Gagné, J., M. Lefsrud. 2010. Spectral distribution and absorbance of light irradiance (photon flux density) in leaves of tomato (*Solanum lycopersicum)*, lettuce (*Lactuca sativa*) and petunia (*Petunia hybrida)* plants in controlled environment, soilless culture systems. Forum recherche et innovation serriculture 2010 Quebec City, QC.

- Fulleringer, M., M. Lefsrud. 2010. Spectral distribution and absorbance of light irradiance (photon flux density) in leaves of tomato (*Solanum lycopersicum)*, lettuce (*Lactuca sativa*) and petunia (*Petunia hybrida)* plants in controlled environment, soilless culture systems. Forum recherche et innovation serriculture 2010, Quebec City, QC.
- Huang E. and M. Lefsrud. 2010. The analysis of yeast proteome during the course of ethanol fermentation. Montreal Post-ASMS Mass Spectrometry Symposium, Pointe-Claire, QC. Sept 23, 2010.
- Sivagnanam K. and M. Lefsrud. 2010. Proteome studies of *Clostridium acetobutylicum* from butanol fermentation by mass spectrometry approach. Montreal Post-ASMS Mass Spectrometry Symposium, Pointe-Claire, QC. Sept 23, 2010.
- Fulleringer, M., M. Lefsrud. 2010. Greenhouse cultivation: reducing resource consumption while maintaining optimal yields. USRA Poster Presentation, McGill University, QC.
- Huang E. and M. Lefsrud. 2010. The analysis of yeast proteome during the course of ethanol fermentation. ASMS conference proceedings, Salt Lake City, UT. May 23-27, 2010.
- Sivagnanam K. and M. Lefsrud. 2010. Proteome studies of *Clostridium acetobutylicum* from butanol fermentation by mass spectrometry approach. ASMS conference proceedings, Salt Lake City, UT. May 23-27, 2010.

Other relevant accomplishments and activities.

A major announcement from this year was a collaborative project between General Electric, Savoura (a tomato production company) and McGill University to investigate the impact of LEDs for horticultural lighting systems in greenhouses. This research is in the early stages and will be reported in later station reports.

From the successful application of a number of grants we are continuing our research for the upcoming year in LED lighting of tomato, proteomic expression and measurement of Arabidopsis, and continued research on wood pellet greenhouse heating.