Climate Action Initiative
BC AGRICULTURE & FOOD

Adapting to low light/low temperature conditions using high-tunnel structures in Revelstoke, British Columbia

Research Factsheet

Farm Adaptation Innovator Program

Terra Park[1], Rob Jay[1], Andrew Perkins[2], Brian May[3] and Michael Mitsch[3]

Geographic Applicability

This study was conducted in Revelstoke and findings may be applied to other regions in British Columbia with limited light exposure and reduced temperatures.

Commodity Relevance

This study was conducted on a variety of salad greens grown under low light/low temperature conditions with different greenhouse insulation conditions. The findings may be extended to other hardy greenhouse crops.

Project Timeline

September 2015 - February 2018

[1] Owner, Terra Firma Farms, Revelstoke
[2] Professor, Faculty of Geography, SFU, Burnaby
[3] Professor, Faculty of Science, Okanagan College, Salmon Arm

Background

This demonstration project studied the viability of winter salad green production in a low-cost, high-tunnel greenhouse structure heated with compost in low light conditions without supplemental lighting over a three-year period. Many communities in the Columbia Basin and in other regions of British Columbia face similar challenges with their growing conditions as a consequence of regional climates, and potential influences of climate change, such as increased severity and frequency of winter storms, resulting in more extreme fluctuations in light intensity. Transportation of food into these communities creates a variety of attendant issues, including higher costs of transporting produce, and attendant increases in the use of petroleum fuels (and consequent emission of greenhouse gases). The project trialed seven different varieties to find a mix of cold-hardy greens that will provide a high quality mixed green salad for customers.

Study Objectives

- Determine if high-tunnel greenhouses can withstand snow load and temperature variations.
- Identify salad green varieties that may be commercially viable under low light/low temperature conditions with low-cost input.
- Compare single and double layered high-tunnel greenhouse structures for insulation/heat retention abilities and effects on plant yields.

Key Findings

- Double layered, insulated high-tunnel greenhouse is: 1-2^{o}C warmer, soil temperature is 0.72^{o}C higher, reduces PAR by 15.5 μE/m^{2}s and relative humidity by 2.1% compared to a single layer, uninsulated high-tunnel greenhouse.
- Plant viability was demonstrated from February–April with certain varieties preferring the warmer double layered, insulated greenhouse (Salanova and Pearl lettuce), others preferred higher PAR of single walled uninsulated greenhouse (Red kitten spinach, Red devil lettuce, Rainbow kale, Flamingo chard, Rouge d'hiver lettuce), while some varieties (Vates Kale, Refugio and Winter density lettuce) showed no preference.
- First year approximately 100lbs wet yield, 5% more in double layer high tunnel structure.
- Second year approximately 125lbs wet yield, 40% more in double layer high tunnel structure.
- Not all greens handled the stress of cold, low light conditions the same. Salanova Lettuces, Vates Kale and Flamingo Chard have been clear winners.

Definitions

PAR: photosynthetically active radiation; light from visible spectrum absorbed by plants

High tunnel structures: large peaked greenhouses needed for snow shedding/ removal and sunlight accession.

Design

This project was conducted on one site located in Revelstoke. One high tunnel structure had double layer plastic with air insulation while the other had only a single layer covering. Environmental conditions (air and soil temperature, relative humidity, photosynthetically active radiation (PAR), and soil moisture) were collected via automated HOBO data link. Seedlings were planted in February and representative plants collected from replicate plots in April for dry weight and leaf area analysis (2016 and 2017) and commercial wet weights recorded.

Limitations

This study was conducted on an operational farm using a low-cost/input system subject to environmental and seasonal variation in temperature and light exposure resulting in variability between production years. Results indicate all year production is not possible as productivity is very low due to poor environmental conditions.

The current processes can extend the season an extra month but the extra effort clearing snow may not be worth it. Winter is a great time for farmers to rest and rejuvenate!

Next steps

While the findings from this study provide useful information to producers, future work is required to apply these findings to the industry. Environmentally controlled experiments in the greenhouse would provide more information on specific thresholds which farmers can use as guidelines for management practices. The practice is low-cost and low-tech, making it a good fit for communities with limited skills in greenhouse production. Having product ready for the early spring markets is valuable for customer retention but more energy intensive efforts are required for year round production in cold climates with limited sunlight.

Climate Adaptation Implications

Adoption of this technology and agricultural practice may accelerate/extend growth season of salad green production in low temperature/low light regions.

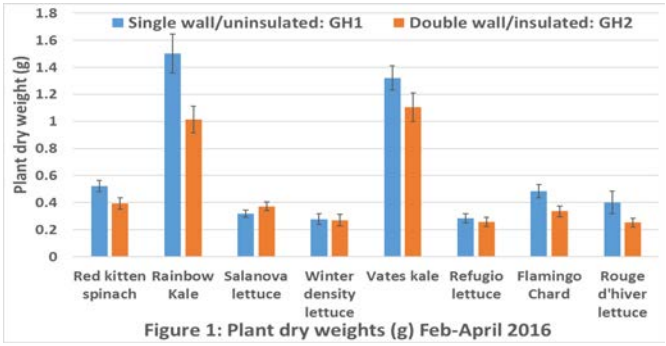

Figure 1: Plant dry weights (g) Feb-April 2016

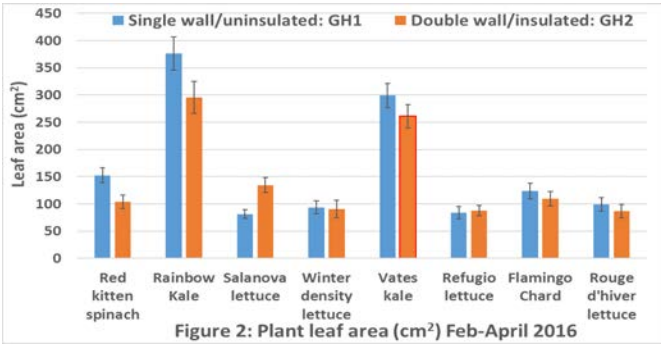

Figure 2: Plant leaf area (cm²) Feb-April 2016

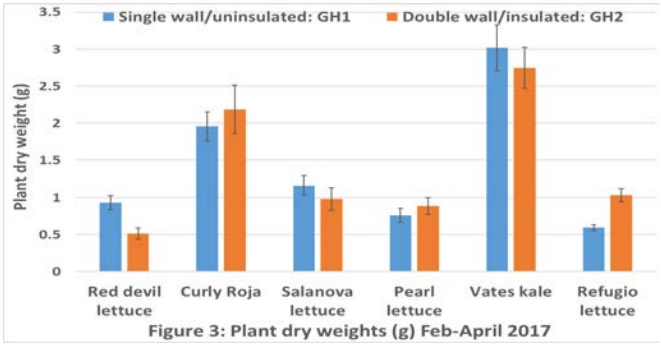

Figure 3: Plant dry weights (g) Feb-April 2017

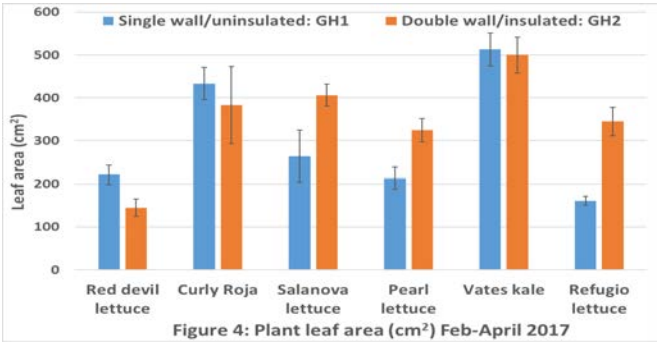

Figure 4: Plant leaf area (cm²) Feb-April 2017

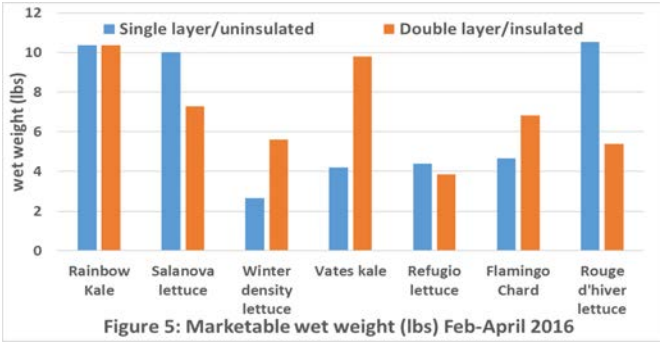

Figure 5: Marketable wet weight (lbs) Feb-April 2016

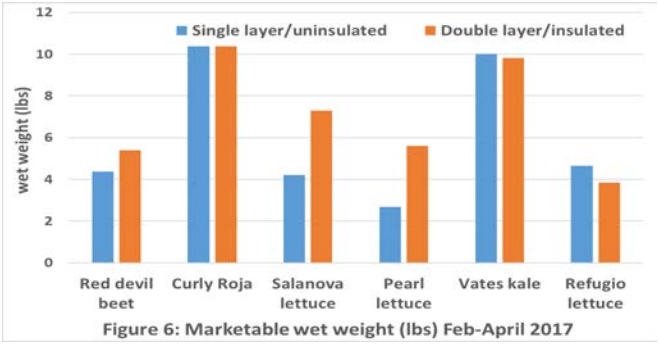

Figure 6: Marketable wet weight (lbs) Feb-April 2017

Figures 1-6: Comparison of plant growth between single layered uninsulated and double layered insulated high-tunnel greenhouse structures.

For more information related to this project and greenhouse production in general:

For more details on this project visit the Climate Action Initiative website:
https://www.bcagclimateaction.ca/faip-project/fi14/

High tunnel greenhouse environmental data from this research available at:
http://www.lowlightgreenhouses.com/index.html

B.C. greenhouse production
https://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/animals-and-crops/crop-production/greenhouse-vegetables

Commercial greenhouse production stats
https://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex1443

Greenhouse season extension
http://www.acornorganic.org/resources/library/video/season-extension-strategies-without-a-greenhouse-greenberg

Harrow Research and Development Centre
http://www.agr.gc.ca/eng/science-and-innovation/research-centres/ontario/harrow-research-and-development-centre/?id=1180624240102

The future of greenhouse production
https://www.greenhousecanada.com/inputs/crop-culture/a-look-into-the-future-3209

Funding and support for this project was provided in part by:

Growing Forward 2 · Investment Agriculture Foundation of British Columbia · ardcorp · Climate Action Initiative BC AGRICULTURE & FOOD · British Columbia · Canada