Climate & Agriculture Initiative BC

Greenhouse Innovations for Market Garden Extension

Farm Adaptation Innovator Program | **RESEARCH SUMMARY** | June 2020 to March 2021

Geographic Applicability

- RESEARCH SITES: Quesnel & Prince George
- APPLICABILITY: Northern & central interior of BC

Specifications

- GREENHOUSE: Polycarbonate 5 Wall 16mm, R-value 3, heated (Prince George) and unheated (Quesnel)
- MINIDOME: 2"x2"lumber, PEX pipe, covered with translucent 5/16" bubble wrap
- LIGHTS: Two 45W LED tubes every four square feet, 50 cm above soil

Commodity Relevance

- Horticultural producers

Practice Benefits

- Extended growing season
- Resilience to variable temperatures
- Agriculture diversification

Project Lead

- College of New Caledonia – Applied Research and Innovation

Project Overview

A TEN-MONTH APPLIED RESEARCH project demonstrated how the use of minidomes and supplemental LED lighting within existing greenhouses, alone and in combination, can extend the growing season in north central BC.

Growing an additional late summer / early fall salad vegetable crop can significantly improve the overall productivity and profitability for market garden operations facing climate-change driven production uncertainties. The greenhouse trials were designed with Cariboo market gardeners to meet local needs for practical methods for season extension.

Trials took place at the College of New Caledonia's greenhouse facilities in Quesnel and Prince George with a full set of all treatments implemented at each site.

Salad vegetable crops (lettuce and scallions) were seeded on two dates (in late August and mid-September) using three treatments and a control. Two minidome treatments provided a greenhouse within a greenhouse — one was set up with supplemental lighting and one without. A third treatment had supplemental lighting and no dome. The control was undomed with natural ambient light only.

Project results show that plants grown in the treatments with supplemental LED lights, with and without a minidome, produced larger and heavier heads when compared to plants exposed to only natural light.

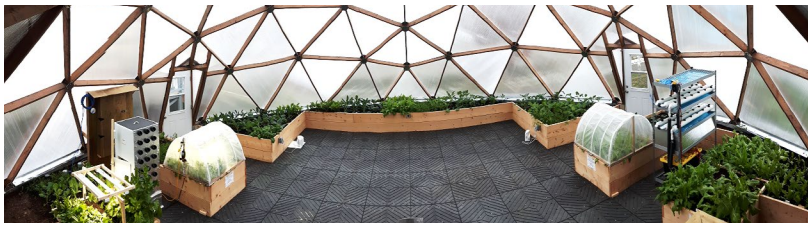

FIGURE 1 Interior of Prince George greenhouse plots in late October

Key Findings

FIGURE 2 Early and late sown plants in the trial plots in mid-October

For a passively heated greenhouse, minidomes with LED extended the growing season, but supplemental lighting alone performed equally well.

For a passively heated greenhouse, the average plant weight at harvest in the treatment with only LED was comparable to that of a minidome plus LED. Greenhouse monthly temperature averages for September, October and November were 16°C, 10°C and 4°C respectively, with only two sub-zero days. In such a scenario, the data suggests that the addition of supplemental lighting alone is sufficient for lettuce to reach market standards.

However, in the heated greenhouse in Prince George, where the monthly average temperatures from September to December were kept at around 15°C, the plants inside the minidome with supplemental lighting were heavier and reached maturity more quickly than any other treatment.

Minidomes with no supplemental lighting do not retain extra heat.

Over the 3-month trials, the air and soil temperatures recorded inside the minidome without LED were equivalent to the ones in the control, where no minidome or supplemental lighting was used. For this study, the minidomes were covered with one layer of 5/16" bubble wrap. Even though no gaps were left for air to escape, the lack of temperature gain inside the minidomes with no LED, in comparison to the greenhouse temperature, indicates that a translucent material with better insulating properties is needed.

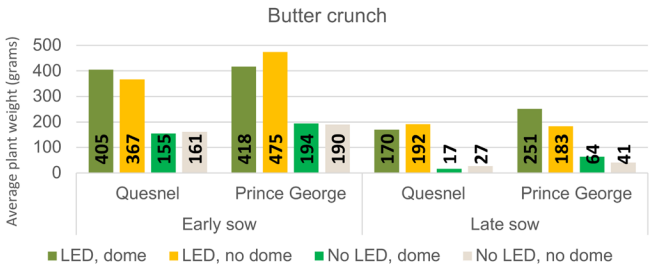

FIGURE 3 Buttercrunch lettuce harvest weights by treatment, sowing dates and sites

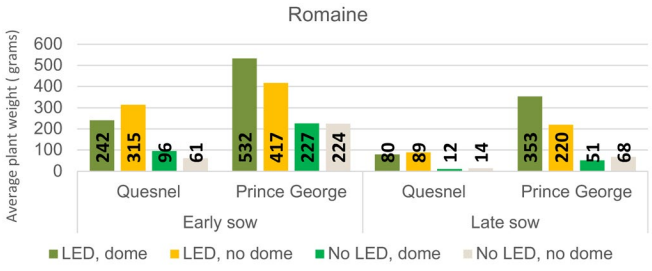

FIGURE 4 Romaine lettuce harvest weights by treatment, sowing dates and sites

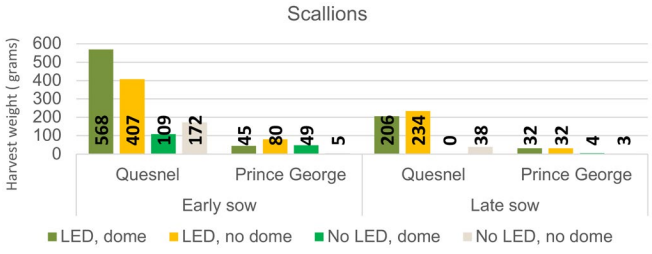

FIGURE 5 Scallion harvest weights by treatment, sowing dates and sites

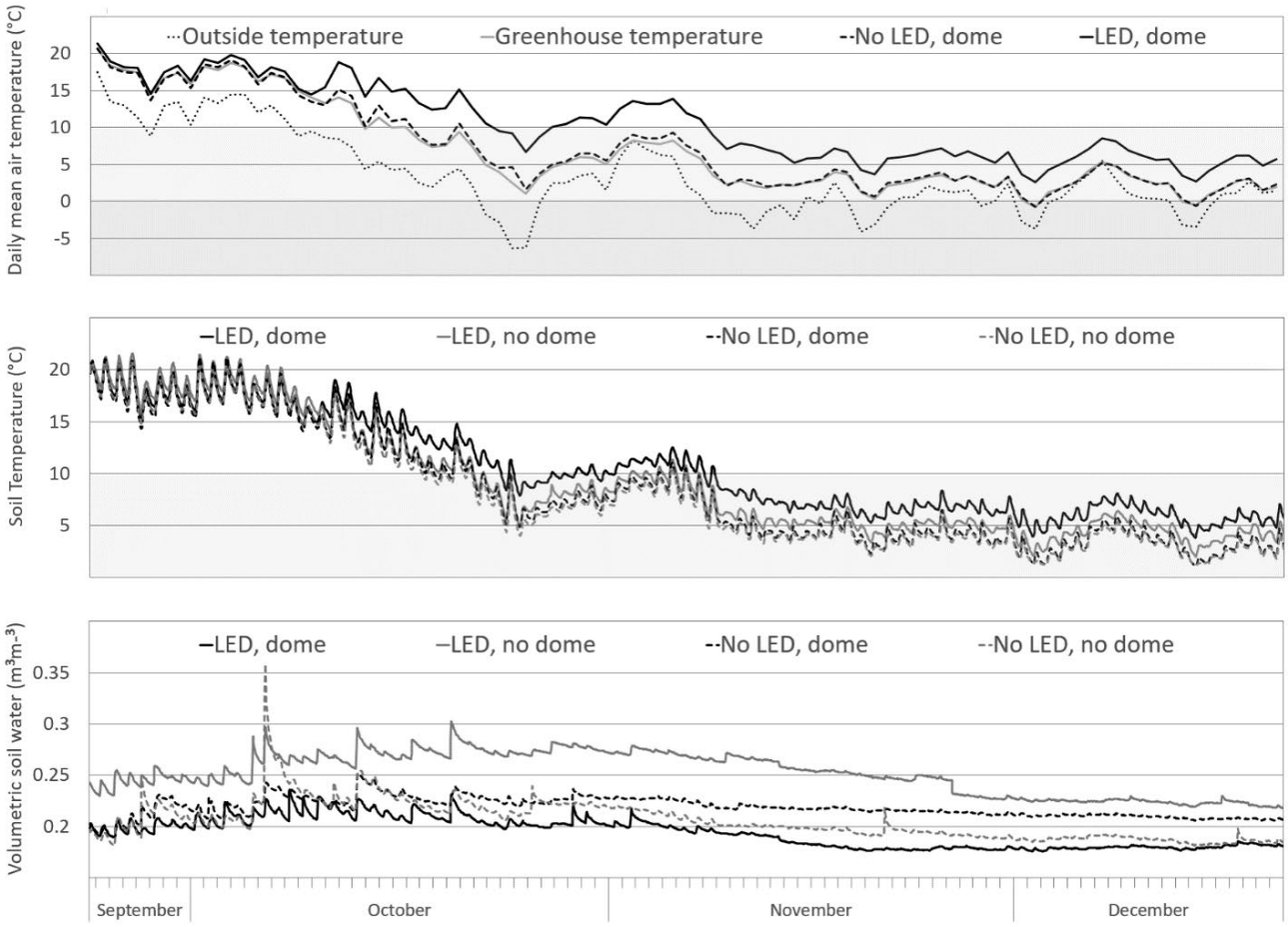

FIGURE 6 Air temperature, soil temperature, and soil volumetric water content from mid-September to December 20, 2020 at the Quesnel study site

Minidomes require ventilation and accurate watering to prevent high air humidity and related plant diseases, especially when supplemental lighting is added.

In both sites the minidomes were completely lowered only when the average greenhouse and outside temperature dropped to 14°C and 10°C, respectively. In Prince George, once the minidomes were completely lowered, the recorded daily air humidity inside the minidomes was constantly above 90%. Such high humidity, combined with a lack of ventilation, led to leaf rotting near the soil, chlorosis, and tip-burns in some plants. The same problems were found in the Quesnel site, and in both cases, they were more pronounced in the treatments with supplemental lights.

Supplemental lighting promotes a warmer environment for plants inside the minidomes.

The addition of LED lights into the minidomes had the double effect of supplying the plants with extra light and heat. The estimated efficiency of the LED lights used in the trials was 40%, causing about 60% of the input power to be lost as heat. In the passively heated greenhouse in Quesnel, this extra source of heat raised the temperature by an average of 4°C over the greenhouse temperature from October to December. The energy bill for 16 hours of full light per day was calculated at $8.50 per month.

Research Methods

The study was conducted from September to December in a passively heated greenhouse in Quesnel and a heated greenhouse in Prince George. Both greenhouses are covered with five wall polycarbonate panels, 16 mm, and R-value of 3. At the Quesnel site the trials were conducted in four 8′ by 2′ in-ground treatment plots. At the Prince George site the trials were completed in four 4′ by 4′ raised beds.

A full set of all treatments was installed at each site: (1) LED light, with dome, (2) LED light, no dome, (3) no LED light, with dome, and (4) no LED light, no dome. Each of the growing areas was divided into two zones: early sown and late sown.

Scallions (green onions), Paris Island romaine lettuce, and Buttercrunch butter lettuce were trialled. Seeds were sown at early and late intervals. The "early" scallions were sown in flats on August 1 and then transplanted. The "late" scallions were direct seeded on August 31. Both lettuce varieties were direct seeded on August 27 for the "early" sowing and September 11 for the "late" sowing. Full-spectrum LED lights were placed 50 cm above the soil surface. The soil was amended with well-rotted manure at the beginning of the study and all treatments were watered as needed. Domes were left raised until the second week of October and then remained lowered until the final harvest.

The early sown lettuce and scallions were harvested and measured by mid-November, with the late sown plants harvested one month later in mid-December. Data measurements included total weight, average height and average diameter of scallion bulbs and lettuce heads for each treatment. Ambient air temperature and humidity measurement—inside the domes, within the greenhouse, and outside—were recorded daily. Energy consumption of the LED lights was also monitored.

Research Team

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Further Information

- This research was conducted under the **Farm Adaptation Innovator Program (FAIP)**. To learn more about this program, visit *www.ClimateAgricultureBC.ca* .
- Detailed results are available in the full project report, ***Greenhouse Innovations for Cariboo Market Garden Season Extension*** (2021), available at *www.ClimateAgricultureBC.ca* .

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Farmer's Market Quesnel, BC

Canadian Agricultural Partnership

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