Northern NY Agricultural Development Program
2011 Project Report

Project Title: Management Strategies for Fall/Winter Greens Production in NNY

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Cooperating Producers:
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Background:
Many Northern New York vegetable growers are interested in expanding their production through the winter to meet the demand for a year round supply of locally grown produce. Field production of storage crops is an important part of this expansion, but consumers want more than root and storage crops. They want fresh salad greens in the winter. While mustards and Asian greens are extremely hardy and can be grown in NNY winter, there is greater demand for spinach and lettuce-based salad mixes. Local consumers are willing to pay up to $12/pound for this product and higher end, locally operated restaurants are also clamoring for local salad greens year round.

Without any heat, spinach can be grown and harvested most of the winter in NNY, except for January and early February. If we add minimal additional heat, spinach can be harvested all winter. Lettuce is more cold sensitive and winter production could potentially be greatly increased with additional heat, but energy inputs are expensive and often cut into the profitability of the crop. The key question is – can we develop a system for heating the lettuce-growing environment inside the high tunnel that will increase both winter lettuce production and profitability?

Product development programs at *Harris Seeds* and *Calorique Inc*. are proposing that growers could use heating strips (manufactured by *Calorique Inc*. primarily for

residential in-floor radiant electric heating systems) to warm high tunnel growing beds. These heating strips, which have not been commercially released yet, require very low wattage per linear foot, and might provide an economical way to enhance winter lettuce production. The objective of this study was to test the use of electric heat strips to warm the growing bed soil, and thereby increase lettuce growth rates during the winter months in northern New York.

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Methods:

Calorique Inc. provided the project with two types of heating strips, one that used 8 watts per linear foot of strip and one that used 15 watts per linear foot of strip. Each strip is composed of a four to five inch wide flat strip of plastic in which a grid of heating elements is embedded. The flat plastic strips come in rolls that can be cut to the desired length, but the manufacturer cautions that a single strip should not exceed 55' in length. Differential heating along the length of a strip starts to be a problem if it is more than 55' long. Heat strips for the experimental growing beds were 13' – 14' long. One of the cut ends was sealed with a waterproof vinyl mastic tape. On the other end of the strip, metal electrical connectors were crimped onto the strip and attached to a power cord-plug. All metal connectors were covered with protective plastic clips and the openings were sealed with silicone caulk to eliminate moisture.

A single heat strip was installed in the middle of each heated treatment growing bed according to the manufacturer recommendations. To install the heat strips, an 8 inch wide, 10 inch deep trench was dug down the middle of the bed, and an 8 inch wide piece of 1.5" thick rigid blue insulation was placed in the bottom of the trench. The heat strip was then laid on top of the insulation and covered with 8 to 9 inches of soil. The vinyl mastic tape sealed end was buried in the growing bed, while the end with the connectors and plug extended above the soil surface. Heat strip plugs were connected to thermostats that were plugged into electrical outlets. Separate electrical outlets were installed for each heated growing bed.

To reduce heat losses from the growing bed environment, low wire hoops were set along the beds containing heat strips,as well as some beds without heat strips, and covered with an inner layer of *Agribon AG19* rowcover, and an outer layer of 6ml greenhouse plastic.

This study was conducted in the 30' x 96' *Ledgewood* pipe-frame high tunnel at the Cornell Willsboro Research Farm. The long axis of the tunnel is oriented east-west, while the long axis of the 2.5' x 12.5' growing beds ran north-south. The growing beds are located to the north and south of a central isle that runs the length of the high tunnel, and each bed extends from the center isle to the sideboard of the high tunnel. This bed configuration was employed because it provides a large number of experimental treatment beds (32) while eliminating potentially confounding issues associated with bed proximity to either the side or center of the high tunnel.

Experimental treatments included:
Two types of lettuce

- *Black Seeded Simpson* head lettuce

- *Five Star* lettuce mix from *Johnny's Selected Seeds*

Four growing bed environments

- 8 watt/ft heat strips + low rowcovers
- 15 watt/ft heat strips + low rowcovers
- Low rowcovers without any heat strips in the growing bed
- Control (no heat strips or low rowcover)

Each type of lettuce was combined with each of the growing bed environments for a total of eight treatments. A randomized complete block experimental design was used with four replications. All growing beds received a 25 lb/1000sqft application of North Country Organics ProGro 5-3-4 granular fertilizer prior to planting. Growing beds were hand watered with a hose and wand as needed. Weeds were hand pulled.

An *Onset Hobo* weather station tracked soil and air temperatures in the following locations: soil temperature (1.5" depth) in an 8 watt heat strip bed with low rowcovers, soil temperature (1.5" depth) in an unheated bed with a low rowcovers, soil temperature (1.5" depth) in a control bed (no heat and no rowcovers), air temperature (8" above soil surface) over an 8 watt heat strip bed with low rowcovers, and air temperature (8" above soil surface) over a control bed.

Black Seeded Simpson seeds were started indoors under grow lights at the *Carriage House Garden Center* on January 1, 2012, and were transplanted into the Willsboro Farm high tunnel treatment beds on February 6, 2012 (Photo 1). Head lettuce plants were planted three rows per bed with 12" between the rows and 12" between plants within the row. The center row was planted at a 6" staggered offset from the outer rows. *Five Star* lettuce mix was direct seeded into the beds with a four-row pinpoint seeder (seeds were placed in every other hopper, so two rows were seeded per pass) on February 8, 2012. Lettuce mix rows were spaced 4" apart with six rows per bed.

Heat strips were switched on every night from 4:00pm to 9:00am, and turned off during the middle of the day. Low row covers were in place every night and on cloudy days, but were removed on sunny days to allow the plants to receive more sunlight and prevent overheating.

Lettuce was harvested from all the treatment beds on March 30, 2012 (Photo 2). Each half of each treatment bed was sampled separately in order to quantify production differences between the half of the bed nearest the tunnel sidewalls and the half of the bed nearest the middle of the tunnel. Additionally, center rows and edge rows in each half of the bed were sampled separately, so there were a total of four sampling zones in each growing bed: center row(s) of the interior half, edge rows of the interior half, center row(s) of the outer half, and edge rows of the outer half. A total of three *Black Seeded Simpson* heads were harvested and individually weighed from each of the four sampling areas on the transplanted head lettuce treatment beds. On direct seeded treatment beds, 30 cm sections of *Five Star* lettuce mix were cut (at ground level) and weighed from each of the four sampling zones. Prior to cutting, lettuce height measurements were taken for all lettuce plants and mixed lettuce stands.

Results:

Heat Strip Installation Method

Placing the heat strips directly on top of the 1.5" thick rigid blue insulation turned out to be bad idea because heat became trapped between the insulation and the plastic strip to such an extent that the insulation and parts of the heat strips melted (Photo 3). Melted heat strips then shorted out when they were turned on and caused the GFI electrical breakers to trip, and the beds to go unheated. The problem was discovered in the growing beds with 15 watt heating strips on February 7, the day after the head lettuce was transplanted into the beds. As a result the 15 watt treatments were discontinued, and only the 8 watt heat strips were turned on for the remainder of the study. No problems with the 8 watt heat strips were noted during the experiment. However, after the study was completed, an examination of the 8 watt heat strips did find some pockets of melted insulation.

Growing Bed Temperature Ranges

A plot of the temperatures recorded every five seconds from 2/10/2012 to 2/13/2012 (Graph 1) illustrates the benefits of the low rowcovers and the in-ground heat strips. It was notable that on nights when the outdoor temperature dropped into the teens (2/11/2012) and single digits (2/12/2012), the soil temperature at 1.5" depth in the heat strip + low rowcovers bed never dropped below 40 degrees Fahrenheit, and the air temperature never dropped below 32 degree Fahrenheit. In contrast, the air temperature 8" above the uncovered and unheated control bed dropped into the low teens during the night of 2/12/2012.

Lettuce Production Responses

Lettuce production responses to the growing bed environment treatments were consistent for the transplanted *Black Seeded Simpson* lettuce and the direct seeded *Five Star* lettuce mix. Lettuce yields were much higher in both the growing beds equipped with heat strips + low rowcovers, and unheated beds with low rowcovers, than in the unheated and uncovered control beds (Figure 1), illustrating that the low rowcovers had a major influence on lettuce production. Mean lettuce yields in the heat strip + low rowcovers beds were consistently higher than the yields in the unheated beds with low rowcovers. The production difference between the heat strip + low rowcover beds and the unheated beds with low rowcovers was entirely due to increased lettuce growth in the center row(s) of the beds that were positioned directly over the buried heat strips (Figures 2 &3). Lettuce growth in the edge rows of the heat strip + low rowcovers beds was no different than the lettuce growth in unheated beds with low rowcovers, indicating that the 8 watt per linear foot heat strips in our installation configuration did not noticeably impact lettuce growth across the entire growing bed surface.

The proximity of the lettuce plants to the high tunnel exterior also greatly influenced growth. For all three growing bed treatments, lettuce production was higher on the half of the bed furthest away from the high tunnel sides (Figures 4 & 5).

Lettuce Mix Germination Rates

On heated beds with low rowcovers, direct seeded *Five Star* lettuce mix emerged three days ahead of the unheated beds with low rowcovers, and eight days ahead of the unheated and uncovered controls (Table 1). For direct seeded lettuce the days to germination and emergence is critical for maximizing the productivity of the high tunnel, and accelerated germination rates could be a significant benefit of the heat strip technology.

Conclusions/Outcomes/Impacts:

While the heat strips provided a modest boost to lettuce production in the high tunnel, it is not clear that the heat strips make economic sense, and several problems with the heat strips need to be resolved. The narrow heat strips used in this study only increased lettuce growth in the middle of the growing beds and did not impact growth over entire growing bed surface. *Calorique Inc*. does manufacture a wider (11") strip that pulls 11 watts per linear foot and should enhance lettuce growth across a wider section of the growing bed. A higher watt heat strip may also be more effective at maintaining optimal nighttime soil temperatures than the 8 watt strips. The 8 watt strips in this study kept nighttime soil temperatures above 40 degrees Fahrenheit, but was not able to maintain soil temperatures in a more preferable 60-65 degree range on cold nights. The wider 11 watt heat strips should be evaluated in future tests.

Heat strips should never be installed next to or on top of an insulating material that could trap heat. It is possible that the melting problems could be resolved by separating the bottom insulation from the heat strip with 2" to 4" of soil; alternative installation configurations also require further testing.

Low rowcovers were the big winners in this experiment as they markedly increased germination rates and lettuce production over the uncovered control beds, and no additional energy inputs were required. In future studies it would be interesting to examine how the combination of *Agribon AG19* and 6ml greenhouse plastic compares to other types of rowcover or rowcover combinations.

NNY market growers continue to look for innovative ways to extend the growing season and extend their sales season. There is keen interest in seeing a variety of tunnel structure options from inexpensive, simple structures to more elaborate, higher tech structures.

NRCS has funded at least 8 new high tunnels in NNY this year alone. Growers appreciate the opportunities we provide to visit various structures in use and to talk with those growers to learn from their experience. Ultimately, each grower needs to decide which system will best suit his or her own needs and interests. There is no single answer to this question.

Outreach:

We held two day-long programs on winter crops production:

- In Madrid (St. Lawrence County) with 10 growers in attendance (from Jefferson and St. Lawrence Counties)
    - Speakers were Judson Reid, Cornell Vegetable Specialist; Jan van der Heide, Bejo Seeds; and Amy Ivy, CCE Clinton County
    - Topics included new winter storage crops and varieties, a discussion of different types of season extension structures, winter crops production and an update on garlic production and current pests.
    - Of the 10 growers attending, 5 had been growing more than 5 seasons and 3 growers had various types of season extending structures. In the evaluations growers commented on new winter vegetables they intend to try as a result of attending this meeting: more root vegetables, colored carrots, parsley root, celeriac
- In Willsboro (Essex County) with 18 growers in attendance (from Clinton, Essex and Franklin Counties)
    - Speakers were Mike Davis, Judson Reid, Laura McDermott and growers Adam Hainer and Mike McCauliffe
    - Started at EV Baker Research Farm – viewed and discussed heat tape trial then compared 3 types of season extension structures: high tunnel, lower tunnel and caterpillar tunnel, pros and cons; followed by classroom discussion of winter crops production, pest control in winter greens, and cost and construction comparisons of the different types of structures. Ended with a visit to Carriage House Garden Center to see their 2 tunnels in greens production and 2 more tunnels getting ready for tomato and pepper production.
    - NRCS has funded at least 8 new high tunnels this year and several recipients attended this program to learn about different structure and crops options. Of the 18 growers attending, 6 had been growing for 2 seasons or less and 5 had been growing for 5 seasons or more.
    - In the program evaluations participants commented on getting new ideas for winter crops, tunnel within a tunnel options for cold protection, and took home ideas for the temporary caterpillar-type tunnels we demonstrated. The Willsboro farm has 3 different style tunnels that participants could compare, and growers in the group who had used each type commented on the pros and cons of each.

In the coming months we will post more information on Cornell's High Tunnel website and the NNY ADP website for grower access.

Next steps:

To follow up on the progress made so far we need to offer more field trips to other farms using various season extending structures. In addition, growers need more information on costs, estimated time for return on investment, training in using enterprise budgets that are currently available on Cornell's High Tunnel website

(http://www.hort.cornell.edu/hightunnel/) , and diversified market options to extend their sales season throughout the year.
We also need more variety trials and enterprise budgets for various high tunnel crops, tailored to NNY markets and seasons.

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Tables and Figures

Table 1. Days to emergence for direct seeded *Five Star* lettuce mix	
GROWING BED TREATMENT	DAYS TO EMERGENCE
Heat Strip + Low Rowcovers	5
Low Rowcovers	8
Control (no heat or rowcover)	13