Northern NY Agricultural Development Program
2012 Project Report

Management Strategies for Winter Greens Production in NNY

Project Leader(s):

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Cooperating Producers:

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Background:

Fresh market producers commonly use their high tunnels to grow warm season crops like tomatoes, cucumbers, and peppers during the summer and fall, and cold hardy greens during the late-fall and winter. The timing of the transition between the warm season crops and winter greens is often tricky. Greens ideally need to be seeded in late August or early September to maximize winter production, but the warm season crops can continue to produce into October in the tunnel environment. As a result, growers are faced with deciding whether to cut the warm season crop harvest short and optimize winter greens production, or keep the warm season crops producing, but sacrifice winter greens yields.

Tomatoes are one of the most popular and profitable high tunnel crops for fresh market growers as early season harvests command a premium price. Two essential and interrelated questions that growers are faced with when striving for early season tomato production are – how early can tomato plants be safely transplanted into the high tunnel, and is there a way to enhance early season plant growth in the high tunnel environment? Possible strategies for enhancing the early season growing bed environment inside high tunnels include:

- Using low rowcovers over the growing bed to increase daytime and/or nighttime temperatures.
- Heating the soil in the growing bed to increase root zone temperatures (as well as air temperatures when soil heating is combined with low rowcovers).

Objective: The objective of this study is to explore the potential for low rowcovers and in-ground heat strips to enhance the initial growth of early season tomato transplants in a high tunnel.

Winter Greens
Fresh market producers commonly use their high tunnels to grow warm season crops like tomatoes, cucumbers, and peppers during the summer and fall, and cold hardy greens during the late-fall and winter. The timing of the transition between the warm season crops and winter greens is often tricky. Greens ideally need to be seeded in late August or early September to maximize winter production, but the warm season crops can continue to produce into October in the tunnel environment. As a result, growers are faced with deciding whether to cut the warm season crop harvest short and optimize winter greens production, or keep the warm season crops producing, but sacrifice winter greens yields.

Objective: The objective of this study was to try and beat the trade-off, and test strategies for establishing greens in the high tunnel late in the fall.

Strategies for enhancing late season greens establishment in the high tunnel include:

- Relying on transplants that can be started outside the tunnel, and transplanted into the tunnel in November.
- Providing low rowcovers to enhance the late-fall tunnel growing environment.
- Providing soil heat to enhance greens growth.
- Experimenting with transplanting uncommon greens (Claytonia and mache), as well as some root crops (carrots and hakuri salad turnips).

Tomato Study Methods
Location: This study was conducted in the 30' x 96' Ledgewood pipe-frame high tunnel at the Cornell Willsboro Research Farm. The tunnel is covered with a single layer of 6ml greenhouse plastic. The long axis of the tunnel is oriented east-west, while the long axis of the 2.5' x 12.5' growing beds runs 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 provides a large number of experimental treatment beds (32), and eliminates some potentially confounding issues associated with bed proximity to either the side or center of the high tunnel. All growing beds received a 25lb/1000sqft application of North Country Organics ProGro 5-3-4 granular fertilizer prior to planting, and were equipped with two drip tube lines.

Experimental Treatments:

- Growing beds with low rowcovers
- Growing beds with in-ground soil heat strips, plus low rowcovers
- Control (no low rowcovers or soil heat)

Low rowcovers: Wire support hoops were placed over the growing beds, and spaced every 4' along the length of the bed to keep the rowcovers from touching the tomato transplants. Each cover consisted of an inner layer of Agrobon AG19 rowcover, and an outer layer of 6ml greenhouse plastic. The rowcovers were only placed over the beds from 4pm in the evening until 9am the next morning. Rowcovers were pulled off the beds during the day so that the growing bed environment would not overheat.

In-ground heat strips: Experimental heating strips were supplied by Calorique Inc. and Harris Seeds (see the 2011 NNYADP High Tunnel Project Report for a detailed discussion of the electric heat strips). A single 5" wide, flat plastic electric heat strip (8 watts per linear foot) was installed at an 8" depth down the center of each heated treatment bed. An 8" wide piece of 1.5" thick rigid blue insulation was positioned an inch below the heat strips to reduce heat loss to the lower soil profile. Heat strips were on from 4pm to 9am, and turned off during the day.

Tomato culture: Pineapple tomato transplants (provided by Nelson Hoover) were planted into the growing beds on May 1, 2012, approximately three weeks before the May 20 average frost free date. Transplants were planted into two rows spaced 18" apart in each growing bed, with an 18" within-row plant spacing. Plant spacings were staggered between the two rows to optimize the use of the bed space. A total of eleven plants were grown in each bed. Nighttime rowcover and soil heat treatments were imposed for two weeks following the transplant date, and discontinued once the plants required overhead trellis strings for support.

Experimental Design: The three treatments were imposed using a randomized complete block experimental design with four replications.

Harvest: All the tomatoes were harvested on August 2, 2012. Fruits were divided into three categories: overripe, solid with red color, and green. The number and weight of the fruit in each category was tabulated for each growing bed.

Greens Study Methods

Tunnel: This study was conducted in the 30' x 96' Ledgewood pipe-frame at the Cornell Willsboro Research Farm. The high tunnel is covered with a single layer of 6ml greenhouse plastic.

Seeding: A diversity of greens, as well as some root crops, were selected for testing including: one bibb lettuce (Winter Density), one lettuce mix (All-star), one green butterhead lettuce (Nancy), one red butterhead lettuce (Skyphos), one Spinach (Tyee), one Claytonia, one mache (Vit), one salad turnip (Hakuri), and one carrot (Nelson). Seeds were planted into 36 cell trays filled with Fort V potting mix from the Vermont Compost Company. The number of seeds planted per cell for each variety is listed in Table 5. All seeds were planted on September 30, 2012. Seeds were germinated indoors at a constant 70 degree Fahrenheit temperature, and moved outdoors to a high tunnel environment after germination. Seedling trays were provided with low rowcovers to moderate nighttime temperatures, and were uncovered during the day.

Transplanting: All the starts were transplanted into the growing beds on November 11, 2012. Each growing bed received a broadcast applied 25lb/1000sqft application of North

Country Organics ProGro 5-3-4 granular fertilizer prior to planting. Growing beds were watered with a hand-held wand attached to a hose.

Low rowcover and soil heat treatments: Each entry was planted into at least one bed with a low rowcover and one uncovered control bed to evaluate the effect of rowcovers on the growth of the different crops. Additionally, some crops were planted into beds with soil heat strips plus low rowcovers to see if soil heat could increase plant growth. The 8 watt per linear foot heat strips (described in detail in the 2011 NNYADP High Tunnel Report) were turned on from 4pm to 8am, and were turned off during the day. Low rowcovers were generally left over the beds all the time. On some warm, sunny days when the high tunnel air temperature was above 60 degrees Fahrenheit, the outer plastic rowcovers were taken off during the mid-day hours, but the inner Agribon layer was left on.

The allocation of entries into the different types of growing beds is provided in Table 5. Since there were a limited number of functioning heat strips, many of the growing beds were subdivided and planted to more than one type of crop so that a greater number of entries could be tested on the soil heated beds. The heat strips developed problems with electrical shorts that tripped the high tunnel circuit breakers, and as a result the soil heating treatments were discontinued four weeks after transplanting.

Replicated trial: All-star lettuce mix and Winter Density bibb lettuce were selected for a larger replicated trial designed to test crop responses to low rowcovers with and without soil heat. The three treatments were:

- Beds with low rowcovers
- Beds with soil heat and low rowcovers
- Control beds without any soil heat or rowcover

A randomized complete block design was used with three replications.

Evaluations: All beds were visually scored for growth performance on January 14, 2013, and again on February 15, 2013. A rating system of 0-10 was used for each planting, with 10 denoting the most productive growth and 0 indicating there were either no edible plants parts or the plants were all dead.

Tomato Study Results:

There was a slight but consistent trend toward earlier tomato production with the protected growing environment treatments. Using the over-ripe fruit category as an indication of earlier fruit production, figures 1 & 2 illustrate that the beds with rowcovers produced more ripe fruit earlier than the control beds, and the beds with soil heat plus rowcovers produced more ripe fruit earlier than either the control beds or the beds with just rowcovers. This trend toward earlier fruit production with the protected growing beds is consistent with our observations during the experiment, however, the magnitude of the differences were small. No differences in overall tomato production were observed between the controls and protected plants with respect to overall tomato production by the August 2 harvest (Figures 1 & 2).

The fact that the control plant tomato production in this study was comparable to the performance of plants grown in beds with soil heat and/or low rowcovers may be explained by a number of factors. The soil heat and low rowcover treatments were only imposed during the first couple of weeks after transplanting, and they only impacted the nighttime environment. Daytime growing conditions were the same for all the treatments, and since the May 2012 weather conditions were relatively warm, the control plants were not noticeably challenged by nighttime temperatures.

Winter Greens Study Results

Weather: Willsboro experienced seasonable to mild temperatures throughout November and December of 2012, and extending into the middle of January 2013. No temperature readings below zero Fahrenheit were recorded during the first ten weeks of the experiment. A cold, high pressure cell covered the Willsboro area at the end of January and the air temperature inside the high tunnel dropped to -10 degrees Fahrenheit at 6:00am January 24, and -8 degrees Fahrenheit at 6:00am on January 25. The below zero temperatures at the end of January 2013 stressed many of the trial plants, and as a result the plot ratings for some of these crops were very different after the cold snap compared to the pre-cold snap ratings (Tables 6&7).

All-star lettuce mix: The lettuce mix starts were in the seedling trays for over five weeks prior to the transplanting date, and the plants were of harvestable size at transplanting time (November 11, 2012). As a result, a cutting was taken from all the lettuce mix trays prior to transplanting. Lettuce mix growth after transplanting was greater in the rowcover and soil-heat+rowcover beds compared to the control beds, but it was not enough to generate a second cutting by the January 14, 2013 evaluation. All-star growth really started to pick-up after January 14, particularly in the beds with low rowcovers (Table 7), such that a second cutting could have been taken at the February 15 evaluation. While growth was notably slower in the control beds, the lettuce mix was apparently not hurt by the below zero temperatures, and seemed well suited to winter production in the high tunnel.

Winter Density: Winter Density did not live up to its name in this trial. At the first evaluation on January 14, the Winter Density bibb lettuce heads in all the treatment beds looked good (Photo 1), and plants in the beds with low rowcovers had markedly increased growth relative to the controls (Table 6). The cold snap in late January, however, destroyed all the winter density heads in all the treatment beds (Table 7). Below zero temperatures proved to be a real problem for this variety, and the low rowcovers did not appear to help. If Winter Density is going to be used for high tunnel production, it should probably be harvested early in the winter, before the potential arrival of very cold temperatures.

Butterhead lettuce: Butterhead varieties are known to produce some of the finest spring lettuce. This trial tested one green butterhead, Nancy, and one red butterhead, Skyphos, to see how they would perform during the winter in a high tunnel. Both varieties surprised us with excellent growth under the low rowcovers (Tables 6&7), and decent cold tolerance in all the treatment beds. The plants had not managed to form a mature head by the second evaluation on February 15, but the heads under the low rowcovers appeared to be getting close. Higher planting densities on the growing beds would likely help optimize production of these high quality leaves. The butterheads were planted 12" apart in this trial; an 8" plant spacing might be preferable.

Spinach: Tyee spinach exhibited more growth under the low rowcovers than in the control beds, but all the spinach beds looked good, and were unfazed by the below zero temperatures.

Salad Turnips: Hakuri salad turnips have become a popular direct market crop in this area. The turnips in this study transplanted well and grew well in the early winter high tunnel environment. The plants really benefited from the low rowcovers in terms of increased growth by the January 14 evaluation (Table 6). Uncovered salad turnips were all killed by the late January cold snap, while the salad turnips under the low rowcovers were still firm and fresh. Depending on the market, salad turnips could be an option for winter production as long as low rowcovers are provided.

Claytonia: As with many of the other entries, the Claytonia plants grown under low rowcovers performed very well in this trial. At the January 14 evaluation, the covered Claytonia exhibited much more growth than the uncovered control plants (Table 6). Uncovered plants were also hit hard by the below zero temperatures, while the plants with rowcovers remained undamaged and continued to grow (Photo 2). The size of the covered plants in this trial was encouraging, and Claytonia could be a nice option for winter production depending on market demand.

Mache (corn salad): Vit corn salad is known to be very cold tolerant, and the plants in this trial were not visibly damaged by very cold temperatures. The plants, however, were not particularly productive. They were small at transplanting time and did not really grow much until after the January 14 evaluation. Growth was higher under the low rowcovers by the February 15 evaluation, but the plants were small relative to the other greens in the trial.

Carrots: The Nelson carrots were a favorite of the field mice that created some problems with this study. Almost all the carrots were destroyed shortly after transplanting.

Conclusions/Outcomes/Impacts:

Tomato Study Conclusions: Low rowcovers have been shown to significantly alter nighttime environments during the winter months, and it is likely that the low rowcovers, with or without soil heat would have a more notable impact on tomato production if the transplants had been subjected to colder nighttime temperatures the first couple weeks after transplanting. Soil heat has also been shown to moderate nighttime growing environments when coupled with low rowcovers, but it is not clear that soil heating makes economic sense given the energy costs.

Winter Greens Conclusions: This trial showed that low rowcovers can greatly enhance the quality and productivity of late-planted greens grown for winter harvests in a high tunnel. With several of the greens in this study, plants were able to thrive under the low rowcovers while uncovered counterparts were killed or greatly damaged by below zero temperatures.

Outreach:

- Farm visits with Judson Reid in Clinton and Essex Counties in late August to talk with growers on their current challenges and plans for the fall. Some have found winter greens to be a good fit in their annual production schedule while others do not.
- Few if any growers are growing winter greens on the western side of NNY so we arranged for a day-long field trip to Ken Campbell's Greenhouses in Saranac (photo 3). Twelve growers attended from Essex, Clinton, Franklin and 13 more made the trip over from St. Lawrence and Jefferson Counties. Growers saw a variety of production methods and types of tunnels and had a lively discussion as they exchanged ideas and experiences.
- Two grower discussion groups were held in December, at the Willsboro Farm to see the winter crops in production and Carriage House Garden Center, and other in Canton at the CCE Learning Farm and their teaching high tunnel. 6 growers attended the Willsboro meeting from Clinton and Essex Counties, 19 attended the Canton meeting from Franklin, St. Lawrence and Jefferson Counties.

Next steps

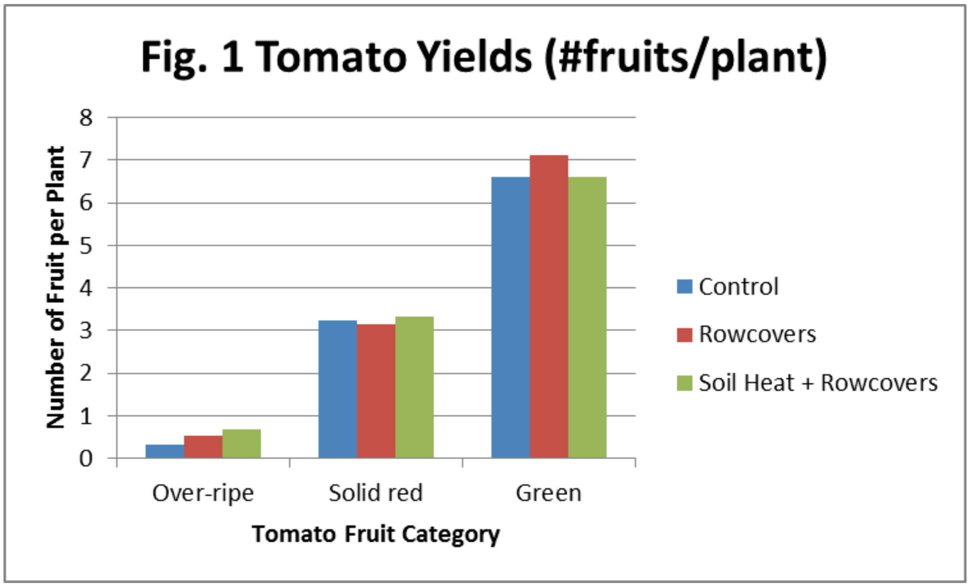
- Additional tests are needed to determine the extent to which low rowcovers, with or without soil heat, can allow for earlier tomato transplanting dates.
- All the crops, including the carrots and salad turnips, transplanted well, but the feasibility of transplanting the very high density root crops, or salad mixes remains a question. Surprising crop options that warrant a second look include the butterhead lettuces, Claytonia, and Hakuri salad turnips.

Person(s) to contact for more information

- Mike Davis, EV Baker Farm Manager – research design and coordinator at the Willsboro Farm mhd11@cornell.edu (518) 963-7492
- Ken Campbell, Campbell's Greenhouses, Saranac, NY (Clinton County) (518-293-7972)
- Michael and Christine McCauliffe, Carriage House Garden Center, Willsboro, NY (Essex County) (518-963-4330)

(See following pages for figures, tables and photos referred to in above text)

Appendix – figures, photos and data tables



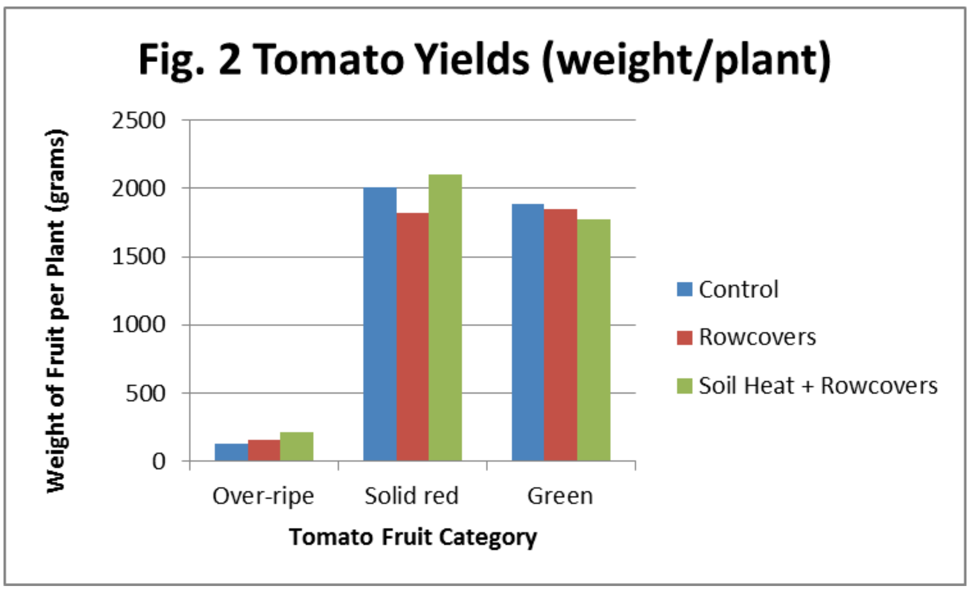


Table 5. Seeding rate for cell trays, and alloaction of entries to the high tunnel growing beds.					
					Number of
			Number of	Number of	soil heat plus
Variety	Crop Type	Seeds planted/cell	Control Beds	low rowcover beds	low rowcover beds
All-star	Lettuce mix	6 - 9	3	3	3
Winter density	Bibb lettuce	2- 3	3	3	3
Nancy	Butterhead lettuce (green)	2- 3	1	1	1
Skyhpos	Butterhead lettuce (red)	2- 3	1	1	1
Tyee	Spinach	6 - 9	3	3	1
Hakuri	Salad Turnip	2- 3	1	1	0
Claytonia	Uncommon green	6 - 9	1	1	0
Vit	Mache (corn salad)	3 - 6	1	1	0
Nelson	Carrots	6 - 9	1	1	0

Table 6. Mean plant growth-condition scores on January 14, 2013.				
	Relative scores were based on a 0 - 10 scale.			
		Treatment		
Variety	Crop Type	Control	Low rowcovers	Soil heat+rowcovers
All-star	Lettuce mix	4	10	missing
Winter density	Bibb lettuce	5.7	9.3	10
Nancy	Butterhead lettuce (green)	4	10	10
Skyhpos	Butterhead lettuce (red)	4	10	10
Tyee	Spinach	7.3	10	NA
Hakuri	Salad Turnip	8	10	NA
Claytonia	Uncommon green	6	10	NA
Vit	Mache (corn salad)	10	10	NA
Nelson	Carrots	missing	missing	NA

Table 7. Mean plant growth-condition scores recorded on February 15, 2013.				
	Relative scores were based on a 0 - 10 scale.			
		Treatment		
Variety	Crop Type	Control	Low rowcovers	Soil heat+rowcovers
All-star	Lettuce mix	4	10	missing
Winter density	Bibb lettuce	0	0.7	0.7
Nancy	Butterhead lettuce (green)	2	10	NA
Skyhpos	Butterhead lettuce (red)	2	10	NA
Tyee	Spinach	4.5	10	NA
Hakuri	Salad Turnip	0	10	NA
Claytonia	Uncommon green	2	10	NA
Vit	Mache (corn salad)	8	10	NA
Nelson	Carrots	missing	missing	NA

Photo 1. Winter Density bibb lettuce heads in the Cornell Willsboro Farm High Tunnel on January 14, 2013. (Photo by Michael H. Davis)

Photo 2. Claytonia grown under low rowcovers (near half of the left growing bed) compared to uncovered Claytonia (near half of the right growing bed) on February 15, 2013. (Photo by Michael H. Davis)

Photo 3. November 5, Ken Campbell explains to growers from across Northern NY how he grows late season lettuce in his high tunnel with no heat. (Photo by Amy Ivy).