Northern NY Agricultural Development Program
2017-2018 Project Report

Advancing Vegetable Production in NNY 2018

Project Leader:

- Amy Ivy, Vegetable Specialist, CCE Clinton County, Eastern NY Commercial Horticulture Program, 6064 Rte 22 #5, Plattsburgh, NY 12901; 518-561-7450, cell: 518-570-5991, adi2@cornell.edu

Collaborators:

- Judson Reid, Vegetable Specialist, Cornell Vegetable Program, Penn Yan NY; jer11@cornell.edu for high tunnel projects
- Michael Davis, Manager, Cornell Willsboro Research Farm, Willsboro, NY; mhd11@cornell.edu
- Charles Bornt, Vegetable Specialist, Eastern NY Commercial Horticulture Program; Troy, NY cdb13@cornell.edu for cover crops projects

Background:

Fresh market vegetable production is on the rise throughout Northern New York as evidenced by the new Produce Auction in Franklin County and the Food Hub which recently opened in Jefferson County, along with the many farmers markets, roadside stands, shops and food coops selling locally grown produce. In past years we have addressed various topics and issues related to growing vegetables at a profit, but new information, better methods and new varieties continue to be developed.

This year the project team focused on three key areas:

1) Earliest harvest of popular crops in summer high tunnel vegetable production
2) Nitrogen update in winter spinach at different rates and its effect on yield
3) Timing cover crops to fit into vegetable production to improve soil health and quality

Earliest harvest of popular summer vegetables in high tunnels

Not only is the growing season short in Northern New York, the season for marketing fresh produce is short as well. Growers who can be the first to bring popular crops to market, even just a week before other vendors, have a distinct economic advantage. Retail and wholesale customers clamor for the first zucchini, the first snap beans, the first red pepper or tomato of the season. With weather extremes becoming more common, the protection provided by a high tunnel can have a significant impact on the timing, quality and yield of these warm season crops.

Growers wanted to know whether a high tunnel can provide an earlier harvest of these crops that are commonly grown outdoors. In addition there are new varieties of zucchini bred specifically for high tunnel/greenhouse production to overcome problems with pollination. This NNYADP project provided an opportunity to learn how these new varieties of zucchini would grow in high tunnel conditions in Northern New York.

Nitrogen uptake in winter spinach
With current nitrogen recommendations and practices ranging widely, growers question the ideal rate of nitrogen they need to grow a leafy crop like spinach in unheated high tunnels. Anecdotally, the project team has reports from farmers of applications from 200-600 lbs of N per acre in winter high tunnels. However, our previous research on nitrogen fertility in winter spinach did not show consistent differences between unfertilized plots and 130 lb applications of alfalfa-based nitrogen. This data indicating less N input may be possible represents an opportunity for organic high tunnel growers to improve in sustainable nutrient management while improving economic performance by reducing input costs. A comparison of the effect of different rates of nitrogen on a winter crop of spinach is necessary to better determine appropriate recommendations for commercial farmers.

Timing cover crops to fit into vegetable production
Vegetable production can decrease soil health because so little plant residue is returned to the soil during the usual production cycle. Most of these crops are very tillage-intensive which further deteriorates soil structure over time. It is well known that the use of cover crops can address a variety of soil issues and there are excellent resources for growers, but in many cases, seeing is believing. Growers with smaller acreage struggle to find space and justification to take fields out of production only for cover crops and to dedicate the time to fit them in between their regular crops. In addition, the newest trend is to use "multiple species" or cover crop mixes instead of mono-culture, but growers are reluctant to try them because of the cost and, in some cases, due to establishment issues. Growers are curious to see these newer mixtures first-hand in the field in Northern New York.

Methods by Project:

Earliest Harvest Methods:
We set up 4 treatments for each crop and replicated them each 4 times. Two were inside the high tunnel (unheated, 30'x96' single-layer plastic), and two were outside the high tunnel. We had planned to plant the tunnel on April 19, 2018, but the weather was too cold, so planting was delayed until April 23, 2018.

In all treatments, peppers (*Red Knight*) and zucchini (*Partenon*) were transplanted, beans (*Provider*) were direct sown, all in single rows. Peppers 12" apart in a single row, Zucchini 18" apart in a single row, Beans 1-2" apart in a single row. The zucchini variety *Partenon* is parthenocarpic, meaning it does not need pollination to set fruit.

Treatment A – inside the tunnel – planted April 23, 2018
No rowcover except on nights when the forecast was for temperatures to fall below 32°F. The first sowing of bean seeds in the tunnel failed due to cold soil and was replanted May 15.

Treatment B – inside the tunnel – planted April 23, 2018
Covered with rowcover over low hoops continuously except when temperatures inside the tunnel reached 80°F, then it was pulled back until temps dropped below 80°F. This continued until the plants began to flower in early June.

Treatment C – outside the tunnel – planted May 17, 2018
Peppers, zucchini, and beans were all grown on black plastic mulch with no rowcover.

Treatment D – outside the tunnel – planted May 17, 2018
Peppers, zucchini, and beans were all grown on black plastic mulch with rowcover left in place until June 14 (4 weeks).

Cover Crops Demonstrations Methods:

Seven different cover crops were planted in 5'x30' blocks in the sandy loam site and the clay loam site on August 2 and again on August 20. The seven crops were: 5 monostands of Niagara oats, crimson clover, Prime 360 millet, daikon radish and barley; and 2 mixes: Soil Builder Plus (annual ryegrass, triticale, crimson clover, hairy vetch, daikon radish) and Summer Feast Mix (forage brassica and Wonderleaf millet). Rates are included in appendix.

A half inch of rain fell just after the first planting creating ideal conditions for establishment. The second planting was delayed a few days due to heavy rain, followed by a month of only very light precipitation.

Nitrogen Uptake in Winter Spinach Trials Methods:

In a 22'x48' tunnel with one layer of plastic and no supplemental heat, we grew one variety of spinach, 'Space,' with two planting dates. There were 4 treatments, including the control, and 4 replications of each treatment at the two planting dates. We compared the nitrogen uptake in leaf tissue and the yield between the 4 treatments. We also tracked the soil temperature and air temperature above and below row covers.

Timing:

- First planting: Sown 8/27/18 and transplanted 9/21/18
  20 plants per 10' row, in a double row, 6" between plants
- Second planning: Sown 9/10/18 and transplanted 10/9/18 at same spacing
- Note: Each 'plant' was actually 2 seedlings. Two seeds were sown per cell, a customary practice in transplanted spinach.

Fertility:
The soil was tested by Agro-One Lab before planting, and the phosphorus and potassium levels were adjusted to the levels recommended by the test results before planting. The pH was ideal at 6.7 and the calcium was in the high range at 2743 lbs/acre so no lime was added. Organic matter was average at 3.1%. The ground was fallow for the previous 2 years with no fertilizer input.

The seeds were hot water-treated, then sown into 72 cell plug trays with Fort-Vee potting mix from Vermont Compost that contains enough fertility from the compost that no additional fertility is needed for transplant production. At transplanting the plugs were thinned so that each contained 2 seedlings which we refer to as one 'plant.'

Agro-One soil test results and Cornell Guidelines recommended 130 lbs nitrogen/acre.
We used the same N source (Pro-Booster 10-0-0 from North Country Organics) for the treatments, but at different rates:

- 200 lbs N/acre (a rate used by some experienced winter greens growers)
- 130 lbs N/acre (the soil test recommendation)
- 65 lbs N/acre (to test whether growers can reduce N inputs yet still realize yield benefits)
- Control – no nitrogen applied.

Results by Project:

Earliest Harvest Trial Results:

Research questions:

1. How much earlier is the harvest on beans and zucchini grown inside a tunnel, compared to outside?
2. How much earlier is the harvest inside the tunnel if the crop is covered with rowcover from sowing to flowering?
3. What are the yield and quality differences between the same varieties grown in an unheated high tunnel compared to grown outside?

Zucchini Trial Results

- The first harvest in the tunnel was 3 weeks before the first harvest in the field (May 23 in the tunnel, June 13 in the field).
- Rowcover in the tunnel and in the field gave slight improvement in earliness and yield, as well as protection from early cucumber beetles, but not a statistical difference.
- By early July the harvests between the inside and outside plots became similar and we concluded the project.
- Cumulative yields as of July 11 were:
    - Inside tunnel, covered 13.38 lbs/plant
    - Inside tunnel, uncovered 11.79 lbs/plant
    - Outside tunnel, covered 6.16 lbs/plant
    - Outside tunnel uncovered 4.92 lbs/plant

Green Beans Trial Results

- The biggest challenge was the poor and sporadic germination due to cold soils. Optimal soil temperature for green beans to germinate is 80°F with an optimum range of 60-85°F.
- On April 25 the soil temperatures in the high tunnel were 10-12°F warmer inside the tunnel than outside (43°F outside and 53°F and 57°F inside).
- On May 17 there was only 1-3 degrees F difference in the soil temperatures inside and outside the tunnel.

- On both dates, the soil temperatures inside the tunnel were 2 degrees warmer without the rowcover than with the rowcover. The bright white material reflects the sun while the dark soil without cover can absorb more of the sun's heat.
- The early planting in the tunnel failed due to low soil temperatures, and was replanted 3 weeks later. This resulted in a much shorter interval between the inside and outside plantings than we had planned.
- There were 3 harvests: July 11, 19 and 25. The first harvest was significantly larger from inside the tunnel than outside but the outside plots caught up in the following 2 harvests.
- The difference in total yield between the treatments was not significant so the only advantage to planting in the tunnel was the one week earlier harvest. This early harvest could provide economic value by attracting customers looking for the first green beans of the season or allowing farmers to benefit from early season wholesale premiums.
- The rowcover did not make a difference in yield or timing inside or outside the tunnel.

Red Pepper Trial Results

- The inside first harvest was 16 days earlier than the outside first harvest (July 25 and Aug 10, respectively).
- In comparing the row-covered inside peppers with the row-covered outside peppers the inside peppers yielded 51% more in weight and 97% more in numbers of fruit produced than the outside peppers, as of September 3rd when the trial was concluded.
- Plants inside the tunnel that had rowcover yielded 130% more at the first harvest than the uncovered plants, but by September 3 the difference in total yields for the season between each treatment was not statistically significant.
- There were 7 times more culls (damaged fruit from sunscald and blossom end rot) outside the tunnel than inside. The plastic covering of the tunnel and lusher plant growth inside the tunnel protected the fruit from sunburn and moderated water usage by the plants.

Nitrogen Uptake in Winter Spinach Results:

Research question: What is the optimum level of nitrogen for winter spinach production?

This project runs from fall 2018 through spring 2019 so we only have preliminary results so far. Spinach stays green but does not grow during the short days from mid-December through early February. The weather from late September through November was unseasonably cold and overcast. Winter crops like spinach can handle the cold temperatures quite well but cloudy days greatly reduce plant growth. In our 2017-2018 winter spinach trial we made 3 harvests by mid-November, 2 weeks apart, but in the fall of 2018, with the same planting dates, the harvests were 3 weeks apart. But the plants are well established and we expect robust growth to begin in late February 2019.

Harvests:

- Due to cold, cloudy conditions October-November 2018 the spinach grew slowly and only 2 harvests have been made: 10/15/18 (first planting only), 11/5/18 (both plantings).
- Harvests will resume in March when plant growth resumes as daylight lengthens. We expect robust yields then and data from those harvests will be reported once complete in late spring 2019.

Cover Crops Results:

Research questions:

1. How well does each cover crop suppress or compete with grassy, annual weeds?
2. How well do the cover crops establish on the different soil types?
3. What is the impact of planting date on cover crop establishment, weed suppression and biomass?
4. What is the average shoot biomass production for each of the cover crops on the two different soil types?

Five single crops planted: Niagara oats, crimson clover, Prime 360 millet, daikon radish, barley; and 2 mixes: Soil Builder Plus (annual ryegrass, triticale, crimson clover, hairy vetch, daikon radish) and Summer Feast Mix (forage brassica and Wonderleaf millet). Two planting dates: August 2 and 20, 2018.

- Except for crimson clover in the sandy site, the other 6 crops all did an excellent job of suppressing weeds in the early planting. In the later planting both the clover and the millet had thinner stands and more weeds than the others.
- Some crops had very different rates of establishment on the two soil types.
    - Summer Feast Mix was about half brassica and half millet on the clay site. On the sandy site, the earlier planting was 10% brassica, 90% millet for the earlier planting, but 80% brassica, 20% millet for the later planting.
- Crimson clover established poorly on the sandy site, but well on the clay site, at both planting dates.
- Millet established well in the earlier planting, but not in the later planting. It is clearly a warm season plant that thrives under warm conditions.
- There was a marked difference in growth between the 2 planting dates on both sites. The earlier plantings were clearly more robust, with the exception of crimson clover and oats on sand.
- Oats had the same biomass for both the early and late sandy planting, so planting them early was not an advantage.
- Due to heavy deer browsing on the clay loam site, we took biomass readings from only the sandy site which had deer fencing. As of early November on the clay site, deer had clipped the crimson clover and daikon radish, but ignored the forage brassica and other crops.
- Shoot biomass charts are in the appendix, but, in general, the earlier planting had significantly more biomass than the later (with the exception of oats).

Conclusions/Outcomes/Impacts:

Earliest Vegetable Harvest Trials:

Bean Trial

- Cool soil limits how early beans can be planted from seed. Consider transplants to really push the season – that would make an interesting study. No data is available for how well transplants might do under NNY conditions.

- Tunnel helped the most for the first harvest. Consider pulling beans out of the tunnel at end of June to make room for higher value crops in tunnel, like basil or cucumbers, and continuing bean production in the field.

Zucchini Trial

- The tunnel planting produced the first harvest 3 weeks before the field, but eventually field production caught up.
- Consider a small tunnel planting of early zucchini to produce those first sales then pull the plants from the tunnel once field zucchini begins to bear in late June/early July to make room for higher value crops like basil or cucumbers.

Pepper Trial

- Growing peppers in an unheated high tunnel gives an earlier harvest with fewer culls than field-grown plants.
- Based on the 2018 and 2017 trials, peppers do not thrive under cool temperatures and planting them before May 20 without supplemental heat provides no benefit.
- Rowcover provided only a minor increase in yield, and is not worth the time and cost.

Nitrogen Uptake in Winter Spinach Trials Conclusions:

This project will continue through the winter into April 2019. Conclusions will be shared through grower meetings and newsletter articles in 2019, and will be included in next year's report. Data from 2017-2018 NNYADP-funded research informed our current study. The 2017-2018 trial examined 3 nitrogen sources; alfalfa meal, urea and blood meal; each at 130 lbs N/ac. Urea and blood meal applications were split between a pre-plant fall and March 4 applications. These methods were replicated across two transplant dates: 9/20/17 and 10/6/17. Full details are available in the previous NNYADP final report posted online at www.nnyagdev.org. Data from that earlier research that has been integrated into the 2018-2019 study:

In the early planting:

- Urea had a 29% greater yield than the control
- Blood meal had a 24% greater yield than the control
- Alfalfa had a 2% lower yield than the control.

In the later planting:

- Urea had a 17% greater yield than the control
- Blood meal had an 11% greater yield than the control
- Alfalfa had a 12% lower yield than the control.

For our 2018-2019 high tunnel spinach trial there has been little difference in the yields between the treatments or in foliar nitrogen levels. The weather in October-November was unseasonably cold and cloudy which had a negative impact on plant growth and we could only take 2 harvests off the earlier planting and one off the late planting. We expect growth to resume in February when the days begin to lengthen. We appreciate NNYADP working with us as the crop cycle does not perfectly match funding and reporting cycles.

Cover Crops Demonstration Conclusions:

- Clovers in general do not establish well during summer months especially on light soil and are best used as a companion crop with grains. The crimson clover on the clay site did establish well, however, since clay soils have smaller particle size which can improve germination of crops such as clover.
- Millet is a warm season grass and performs best from June or July planting dates. It should then be followed by a fall crop to provide soil cover over the winter. Our early planting put on good growth, but once it was killed by the first frost it provided minimal soil cover. The later planting did not grow as well and provided far less biomass and soil cover into the fall.
- Oats are a cool season grass that can tolerate some frost, but then die over the winter. They establish quickly in early or late August with good weed suppression and moderate biomass production. They can be prone to rust so choosing resistant varieties might be useful.
- The variety that mixes provide can help ensure that, no matter what weather extremes occur, something will establish. In a wet season some components may thrive while in a dry season others may do better. Some, such as the brassicas, dominate in the fall, then die over winter, allowing the perennial clovers and vetches to thrive the following early spring.
- Because of variable weather every year, what worked well for a grower one year may not work as well the next. Growers need to try a variety of cover crops and timings to learn which perform the most reliably in their soils and crop cycles.
- Mixes provide some flexibility since some species in the mix may thrive under the conditions one year while others may thrive under different conditions. And in an ideal season, each of the species brings something different to the equation e.g., the deep root of the radish, the biomass of the grains, the persistence of the clovers, etc. As a result of the diversity of the mixed species, biomass production is optimized.
- August 2 is quite early for most vegetable growers to plant cover crops, but it does provide a significant difference in biomass production. As early summer vegetable crops decline (zucchini, beans, etc.), growers may choose to replace them with a cover crop as early as possible.

Outreach:

- 1/18/18 Presentation, NOFA-NY Annual Winter Conference, Saratoga Springs, NY; 30 growers in attendance.
- 3/5/18 Field Trip to experienced winter greens growers Paul and Sandy Arnold's Pleasant Valley Farm, Argyle, NY (Washington County); 29 growers and CCE staff. The Arnolds have been growing in high tunnels and selling at winter markets since 2006, and using lower tunnels since 1993. This was a unique opportunity to learn from their experience and see their tunnels in full production. Attended by 16 growers from NNY, 2 growers from Columbia County, 5 educators, 1 Essex County Soil and Water Conservation District representative, 4 youth.
- 3/24/18 Grower Meeting with Project Leader Amy Ivy, Colwell's Greenhouses, Glenfield, Lewis County; 26 growers; focus on season extension ranging from simple rowcovers to low tunnels to high tunnels.
- 7/10/18 Cornell Willsboro Research Farm open house and farm tour for the public.

- 7/31/18 Reduced Tillage in Organic Systems Field Day at the Cornell Willsboro Research Farm for 71 people.
- 10/11/18 Field meeting at the Willsboro Farm to discuss the cover crops demonstration plots. 11 growers attended and joined in a lively discussion about various cover crops strategies, timings and rotations.
- Project results were shared by Vegetable Specialist Judson Reid at CCE Jefferson Season Extension Workshop October 10, 2018 and a Franklin County workshop scheduled for March 27, 2019.
- 11/8/18 Fitting Cover Crops in Vegetable Production Systems live webinar recorded and posted for viewing any time. Speakers Amy Ivy, Michael Davis and Chuck Bornt discussed timings, mixes and rotations of various cover crops options. Link to the recording which as of mid-December 2018 has had 25 views in addition to the 16 people who attended the live webinar https://enych.cce.cornell.edu/submission.php?id=609&crumb=soil_health|soil_health
- 11/29/19 High Tunnel Vegetable Research Update live webinar recorded and posted for viewing any time. Speakers Amy Ivy, Michael Davis and Judson Reid reviewed the high tunnel trials at Willsboro over the past two years. Here is the link to the recording which as of mid-December 2018 has had 89 views in addition to the 22 people who attended the live webinar: https://enych.cce.cornell.edu/submission.php?id=612&crumb=greenhouse_and_tunnels|greenhouse_tunnels
- These 2 webinars were very well received. Many participants thanked us for holding them in this format so they did not need to travel in order to be able to interact with us, and the recordings allows growers to watch or re-watch the recordings at their convenience at no cost.

Articles, Resources and Project Results Generated and Printed:

- An article on the spinach trial, “Winter Spinach Planting Dates: What a Difference a Week Makes”, was printed in the August 15, 2018 issue of Eastern NY Commercial Horticulture Program’s Vegetable News newsletter, as growers prepared for fall planting.
- An article on the summer trials, “First to the Market”, was printed in the December 2018 Produce Pages.
- Judson Reid presented findings from the high tunnel trial at the 2019 Empire Producers Expo and included results in the official proceedings.
- Reduced Tillage Field Day Handbook posted as downloadable pdf on ENYCHP website: https://enych.cce.cornell.edu/submission.php?id=600&crumb=soil_health|soil_health
- Recordings of the two November webinars are available for viewing any time at no cost:
    - Cover Crops: https://enych.cce.cornell.edu/submission.php?id=609&crumb=soil_health|soil_health
    - High Tunnel Research Update: https://enych.cce.cornell.edu/submission.php?id=612&crumb=greenhouse_and_tunnels|greenhouse_tunnels

Next Steps:

Nitrogen uptake under cold conditions needs more study. A trend visible from 2018 is that NNY vegetable growers may be overapplying nitrogen. To this end we are currently evaluating multiple rates in our Essex County trial. Future work may include multiple nitrogen rates, application dates and sources. With the variable weather conditions common in the region, these trials need to be repeated to clarify our conclusions and recommendations to NNY growers.

Producing the earliest green beans is a goal for many growers. A trial looking at transplanted beans in the tunnel could yield interesting results.

For More Information:

- Judson Reid, Vegetable Specialist, Cornell Vegetable Program; jer11@cornell.edu for high tunnel projects. 585.313.8912
- Michael Davis, Research Associate and Manager, Cornell Willsboro Research Farm, Willsboro, NY; mhd11@cornell.edu for all farm projects. 518.963.7492
- Charles Bornt, Vegetable Specialist, Eastern NY Commercial Horticulture Program; Troy, NY; cdb13@cornell.edu for cover crops projects. 518-272-4210 x125
- Amy Ivy, Vegetable Specialist, retired as of January 4, 2019

Northern NY Agricultural Development Program

2017-2018 Project Report

Appendix: Advancing Vegetable Production in NNY 2018

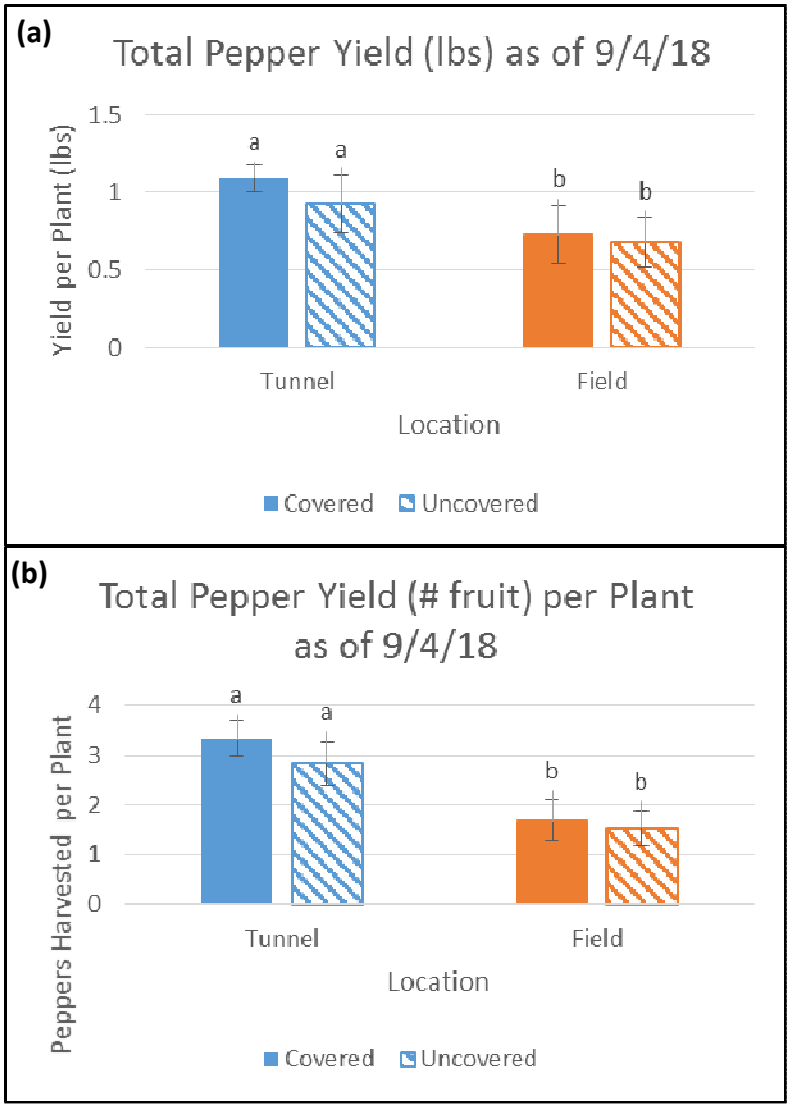


Figure 1. Pepper Yield in (a) lbs and (b) number of fruit as of 9/4/18. NNYADP Advancing Vegetable Production Project 2018, NNY.

In comparing the row-covered inside peppers with the row-covered outside peppers, the inside peppers yielded 51% more in weight and 97% more in numbers of fruit produced than the outside peppers.

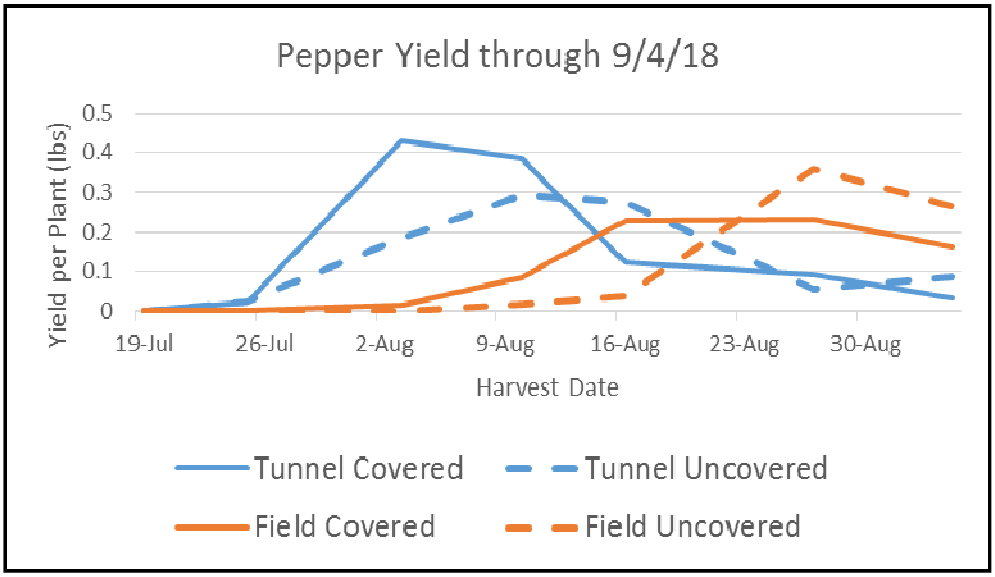


Figure 2. Pepper Yield through 9/4/18. NNYADP Advancing Vegetable Production Project 2018, NNY.

The tunnel treatments, both with and without rowcover, had a significant impact on the first harvest and yield, as well as significantly fewer culls.

The first harvest inside the tunnel was 7/25. The first harvest outside was 8/10, 16 days later.

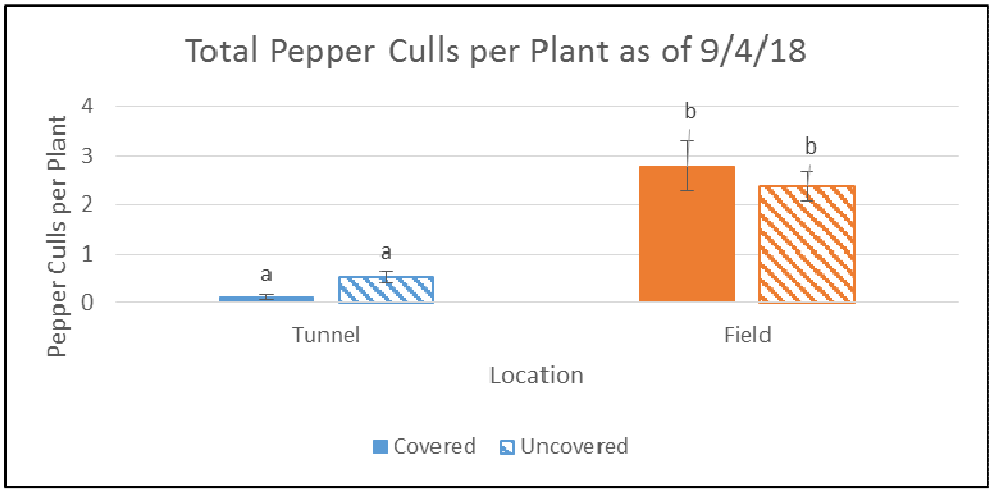
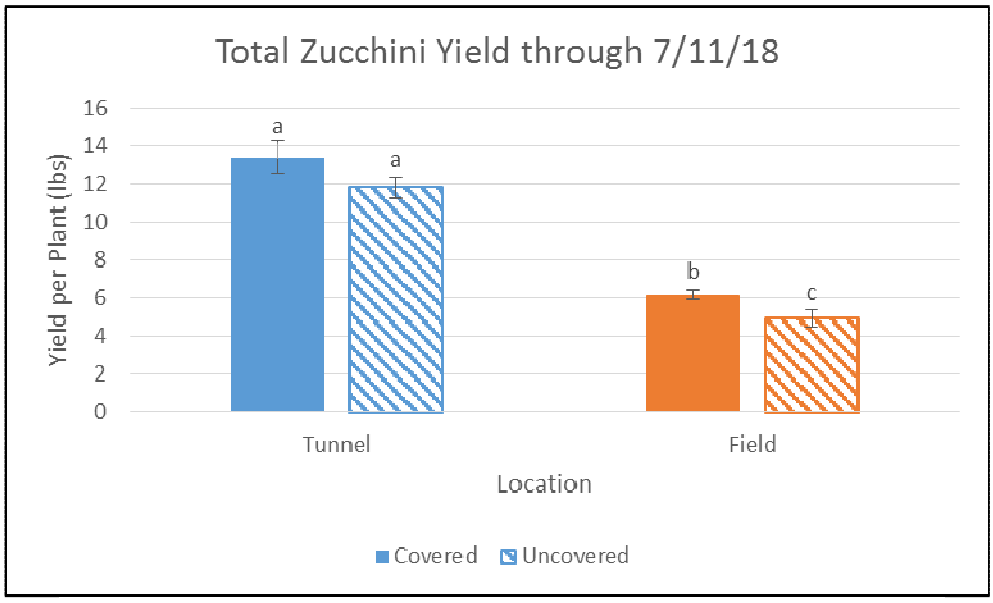


Figure 3. Total Pepper Culls per Plant as of 9/4/18. NNYADP Advancing Vegetable Production Project 2018, NNY.

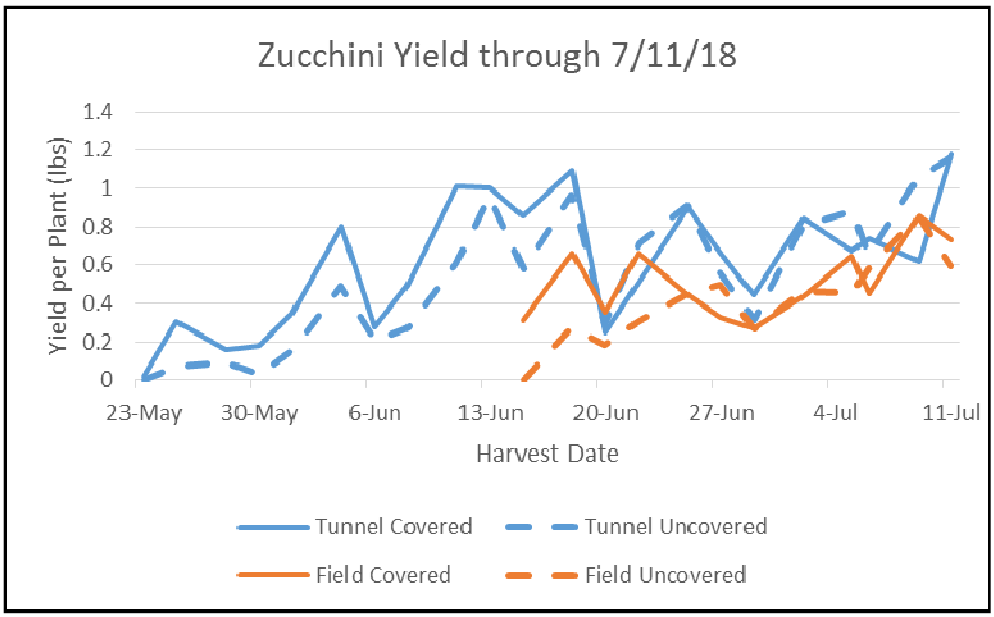
Plants grown in the field had 707% more culls (from sunscald and blossom end rot) than plants in the tunnel.



Zucchini inside the tunnel began bearing 3 weeks before plants outside the tunnel. Rowcover gave a slight improvement in yield.

Plants inside the tunnel consistently yielded more than plants outside the tunnel.

Figure 4. Total Zucchini Yield through 7/11/18. NNYADP Advancing Vegetable Production Project 2018, NNY.



Both covered and uncovered zucchini yielded statistically better than the field zucchini.

In the field, the rowcovered plants yielded statistically more than the uncovered plants.

Figure 5. Zucchini Yield through 7/11/18. NNYADP Advancing Vegetable Production Project 2018, NNY.

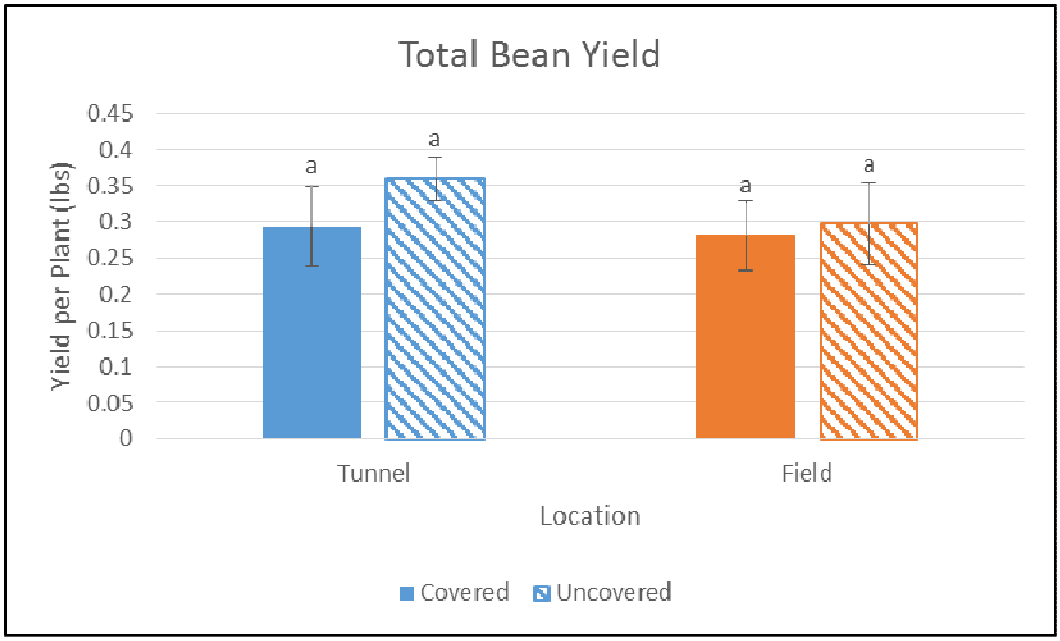


Figure 6. Total Bean Yield NNYADP Advancing Vegetable Production Project 2018, NNY.

The biggest challenge for the beans was germination in cold soils. It was sporadic and poor.

Early tunnel planting failed, replanted 3 weeks later, so shorter interval between inside

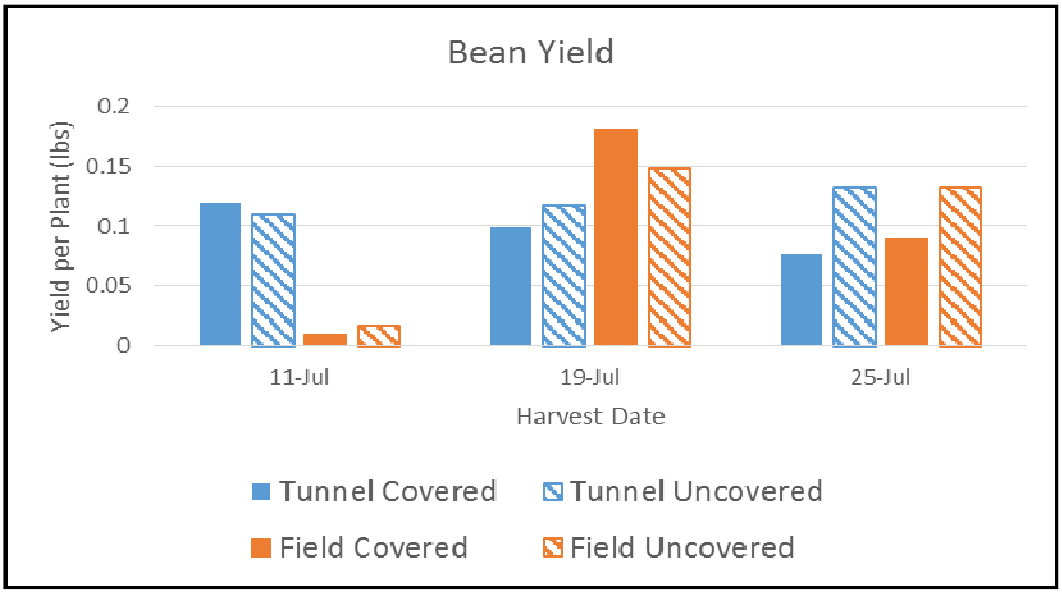


Figure 7. Bean Yield. NNYADP Advancing Vegetable Production Project 2018, NNY.

Tunnel helped the most for the first harvest, then the field plants caught up in the following 2 harvests.

As of 11/5/18 there is very little difference in the yields between the treatments or in the nitrogen levels in the leaves. The weather in October-November was unseasonably cold and gray which had a negative impact on plant growth and we could only take 2 harvests off the earlier planting and one off the late planting. But we expect growth to resume in February when the days begin to lengthen. In our 2017 trial with similar planting dates we had 3 harvests by 11/9 but the weather was warmer and sunnier that season.

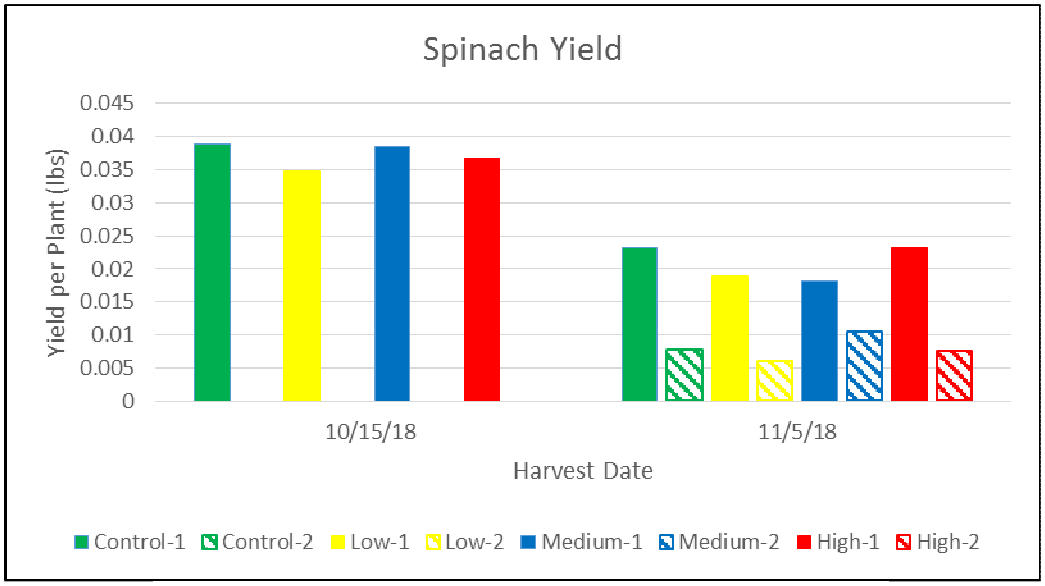


Figure 8. Spinach Yield. NNYADP Advancing Vegetable Production Project 2018, NNY.

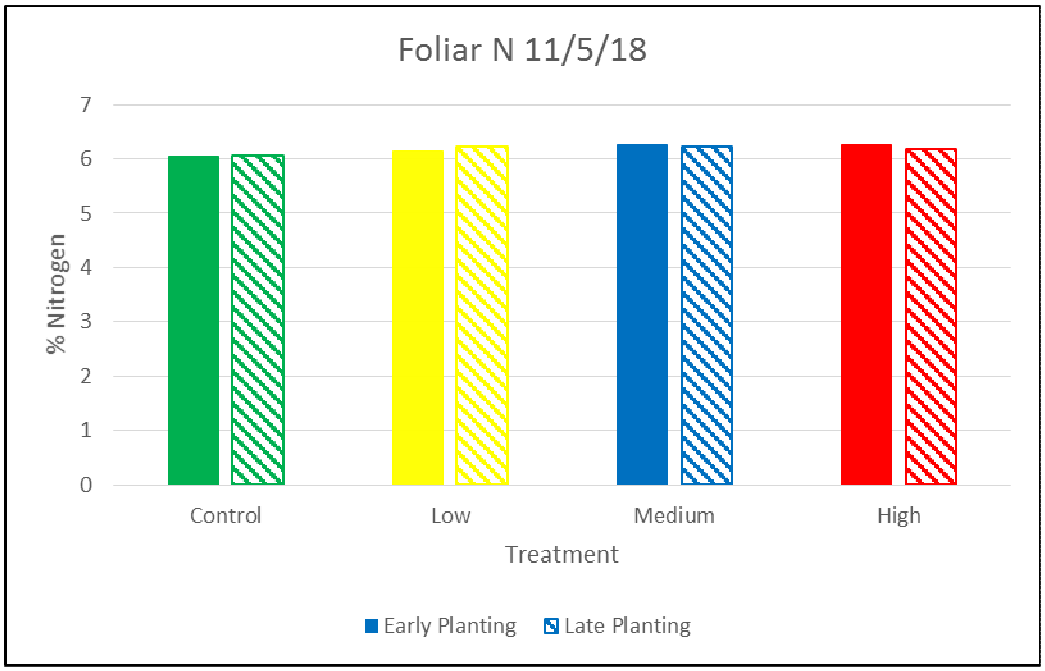


Figure 9. Foliar N 11/5/18. NNYADP Advancing Vegetable Production Project 2018, NNY.

Cover Crops plot details repeated on sandy loam site and clay loam site

Plot #	Cover Crop Plots (5x30' long)	Seeding Rate (lbs/acre)
	First planting date: August 2, 2018 **Second planting date**: August 20, 2018	
1	Soil Builder Plus Trical (triticale) 815, Crimson Clover, Hairy Vetch, Annual Ryegrass, Daikon Radish	120-140
2	Niagara Oats	60
3	Crimson Clover	10-20
4	Prime 360 Millet	10-15
5	Daikon Radish	12
6	Summer Feast Mix Wonderleaf Millet, Forage Brassica	20
7	Barley	60

With the exception of oats, the earlier cover crop planting produced more biomass than the later planting.

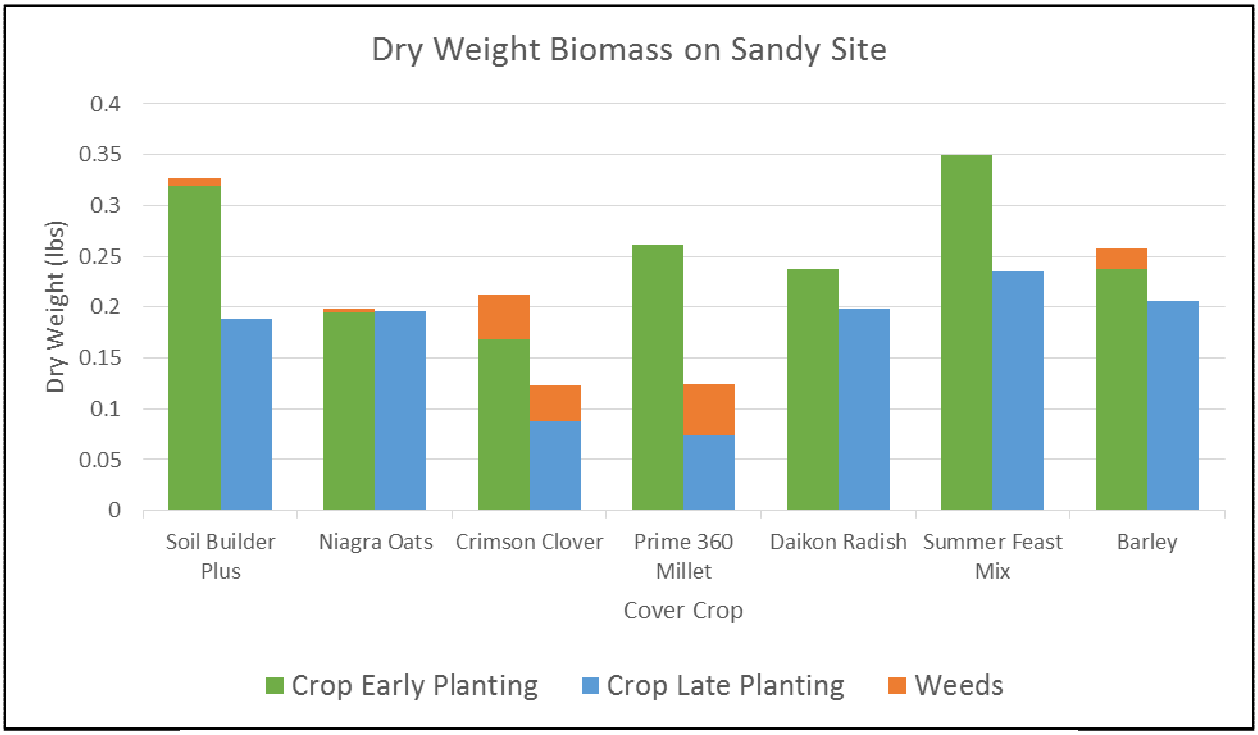


Figure 10. Dry Weight Biomass on Sandy Site. NNYADP Advancing Vegetable Production Project 2018, NNY.

Northern NY Agricultural Development Program

2017-2018 Project Report

Photos: Advancing Vegetable Production in NNY 2018

Covered and uncovered plots inside the high tunnel: zucchini, red peppers and green beans. Willsboro Research Farm, May 3, 2018. NNYADP Advancing Vegetable Production Project, 2018. Photo credit: Amy Ivy.

Tunnel plots. Willsboro Research Farm, June 25, 2018. NNYADP Advancing Vegetable Production Project, 2018. Photo credit: Amy Ivy.

Field plots: Uncovered plots on the left, covered plots on the right. Willsboro Research Farm, July 19, 2018. NNYADP Advancing Vegetable Production Project, 2018. Photo credit: Amy Ivy.

Cover crops early planting on the sandy loam site. Willsboro Research Farm, September 13, 2018. NNYADP Advancing Vegetable Production Project, 2018. Photo credit: Amy Ivy.

Grower field meeting and discussion (in the rain) of cover crops. Willsboro Research Farm, October 11, 2018. NNYADP Advancing Vegetable Production Project, 2018. Photo credit: Amy Ivy.

Demonstration and discussion at the Reduced Tillage Field Day about using a roller-crimper to terminate cover crops. Willsboro Research Farm, July 31, 2018. NNYADP Advancing Vegetable Production Project, 2018. Photo credit: Amy Ivy.

Technicians Andy Galimberti (Eastern NY Commercial Horticulture Program) and Calvin Arno (Willsboro Research Farm) just after transplanting the second planting of spinach. Willsboro Research Farm, October 9, 2018. NNYADP Advancing Vegetable Production Project, 2018. Photo credit: Amy Ivy.

Amy Ivy harvesting zucchini. Willsboro Research Farm, June 12, 2018. NNYADP Advancing Vegetable Production Project, 2018. Photo credit: Andy Galimberti.

Amy Ivy checking on the spinach trial. Willsboro Research Farm, October 9, 2018. NNYADP Advancing Vegetable Production Project, 2018. Photo credit: Andy Galimberti.