# Northern NY Agricultural Development Program
## 2016-2017 Project Report

# Advancing Vegetable Production in NNY 2017


**Project Leader:**

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**Background:**

Fresh market vegetable production is on the rise throughout Northern NY. In past years Northern New York Agricultural Development Program-funded vegetable research has addressed various topics and issues related to growing vegetables at a profit, but new information, better methods, and new varieties continue to be developed and are of interest to regional growers.

In 2017, the project team focused on three areas of high tunnel vegetable production:

1) Increasing production and profitability of colored peppers in high tunnels
2) Extending last year's cherry tomato training and pruning trial, tracking labor and yield.
3) Assessing nitrogen availability in cold soils for late fall-winter spinach and its effect on yield.

Bell peppers, especially red, sweet peppers, can yield well in the protected conditions of a high tunnel. However, many growers planting field varieties in tunnels report varying degrees of success. New extra-productive varieties are now available specifically for protected culture. The seeds of these new varieties are significantly more expensive than traditional varieties and Northern NY growers question whether the additional cost is worth the investment. In addition the newer varieties need specific training and pruning to support their vigorous growth that requires learning new skills and additional labor inputs.

Cherry tomatoes have vigorous, indeterminate growth that vegetable farmers struggle to effectively manage with pruning and training. Growers often question the return on labor investment for these varieties. The 2016-2017 training and pruning trial was of keen interest to growers who visited the host farm at grower meetings. This additional year of data is necessary to strengthen management recommendations based on those trials.

One of the most profitable crops for cold season production is spinach that can survive northern NY winters in full-sized high tunnels without any additional heat, but the nitrogen needs of this leafy crop during the short days of winter are not well understood. In particular, organic fertilizers need warm soils in order to mineralize the nitrogen into a form plants can take up. Growers need information on how much nitrogen and in what form is needed to produce a profitable winter crop while avoiding excessive levels

## Methods and Results by Vegetable

### Red Pepper Trial Methods:

We compared a popular field variety of sweet red pepper: Red Knight with one of the new specialty red peppers: Sprinter bred for greenhouse production. Each treatment was repeated four times using a randomized block layout. Peppers were harvested as they ripened, with 60-80% red coloration.

Research questions and methods used:

1. What are the yield and timing differences in Red Knight grown inside an unheated tunnel compared to grown outside?
    a. We grew Red Knight inside and outside the high tunnel and tracked harvest dates and yields. Transplants from 4-inch pots were set out on May 25, 12 inches apart in 10-foot rows, trained using the stake-and-weave method and fertilized weekly through the drip irrigation lines.
2. What are the yield and timing differences between the varieties Red Knight and Sprinter grown in the same unheated high tunnel?
    a. We grew both varieties using the customary stake-and-weave method, fertilized weekly, and tracked harvest dates and yields until the plants were killed by cold temperatures in early November.
3. Which pruning and training method works best for Sprinter, the greenhouse variety of pepper?
    a. We used two pruning methods: the customary stake-and-weave method and the seed company's recommended double leader system. We tracked the time spent pruning and training as well as the harvest dates and yields.

### Red Pepper Trial Results:

2017 was a challenging year for vegetable growing in Northern NY. Mid-May through mid-July 2017 saw record rainfall and cold temperatures, then record high temperatures in the 90's occurred in late September. The first killing frost did not occur until October 17, a month later than usual. The peppers inside the unheated tunnel continued to bear later than expected with the last harvest on November 3. See Appendix 1.

1. Comparison of Red Knight grown inside and outside the high tunnel

- Inside peppers averaged 4.98 lbs/plant. Outside average was 2.19 lbs/plant.
- First harvest of inside peppers was Aug 23. First harvest of outside peppers was 2.5 weeks later on September 9.
- The killing frost on October 17 ended the outside harvest while the inside harvest continued through November 3.

2. Yield and timing differences between the varieties Red Knight (field variety) and Sprinter (greenhouse variety) grown in the same unheated high tunnel.
   - Red Knight yielded earlier, then tapered off, while Sprinter began yielding later and kept on yielding until killed by freezing temperatures.
     - Red Knight peak harvest ran from August 30 – September 20, 2017.
     - Sprinter peak harvest ran from September 16 – November 3, 2017.

   - Total yield of Sprinter was slightly higher but later, when market demand is less.
     - Red Knight average total yield: 4.98 lbs/plant
     - Sprinter double leader average total yield: 4.24 lbs/plant
     - Sprinter stake & weave average total yield: 5.72 lbs/plant.

3. Comparison of two pruning and training methods for Sprinter (greenhouse variety).
   The recommended double leader system compared to the simpler stake-and-weave system took twice as long to manage, and the stake-and-weave system yielded more.
     - Double leader system: 71 minutes to train avg yield: 4.24 lbs/plant
     - Stake and weave system: 38 minutes to train avg yield: 5.72 lbs/plant.

## Cherry Tomato Trial Methods:

Research questions:

1. Does the extra labor involved in strict pruning and training cherry tomatoes result in a higher yield per square foot?
2. What are the labor inputs for the 3 methods?
3. What is the return on labor for the 3 different pruning methods when yield and price data are considered?

We set up a comparison trial of three different pruning methods with one popular variety, Supersweet 100: single leader, double leader and multi-leader. We tracked the time spent pruning and training each treatment through the season.

We set out plants from 4-inch pots on May 25:

- Double and multi-leader plants were spaced 18 inches apart in the row with 5 plants per row/treatment.
- Single leader plants were spaced 12 inches apart in the row with 7 plants per row/treatment.

We harvested 3 times per week from July 20 through September 29, tracking yield and time spent pruning/training and harvesting.

In 2017 we increased the spacing between the rows by one foot to 5 feet to ensure that the multi-leader treatment was not over-growing and crowding out the single leader treatment.

We also modified our approach to the multi-leader pruning. We pruned and trained the multi-leader just like the double leader until the first harvest on July 20. From then on, we applied only minimal training of the multi-leader to keep the branches in bounds, but no more pruning, which is how many growers manage their cherry tomatoes. They start the year by pruning but often stop mid-summer when they get busy with other crops and it seems like pruning will be a waste of time. We continued pruning and training the single and double leader systems through September.

## Cherry Tomato Trial Results: Also see Appendix 2.

- **Labor**: The double leader had the most time spent on pruning and training, while the multi-leader had the most time spent harvesting, due to uncontrolled, rampant growth.

- **Yield**: The double leader had the highest average yield of 15.8 lbs/plant; the multi-leader average was 14.2 lbs/plant; and the single leader averaged 11.3 lbs/plant.

- **Net**: Using $12/hour for labor and $4/lb for gross price, the average net revenue of the double leader system was $55.31/plant; of the multi-leader system was $48.36/plant; and using the single leader system was $39.27/plant.

## Winter Spinach Trial Methods:

Research questions:

1. Do the plants fertilized with an organic form of nitrogen have a lower N content in their foliage than those fertilized with a conventional form?
2. What is the temperature range of the soil, the air under the low row cover, and the air in the center of the unheated tunnel through the winter?
3. What differences are there in the temperature of the soil in the row closest to the sidewall of the tunnel as compared to the center row of the tunnel?

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 8/25/17 and transplanted 9/20/17
  20 plants per 10'row, in a double staggered row, 6" between plants
- Second planning: Sown 9/5/17 and transplanted 10/6/17
  Due to poor germination: 10 plants per 10' row in a single row, 6" between plants
- Note: Each 'plant' was actually 2 seedlings. Two seeds were sown per cell, a customary practice in transplanted spinach. Cells with single plants were combined so that each transplant consisted of 2 seedlings.

Harvests:

- 3 in the fall: Oct-early Nov, none during WHEN with due to minimal growth
- 4 harvests in March-early May.
- Harvest dates:
  10/14/17 (first planting only), 10/28/17, 11/9/17
  3/2/18, 3/28/18, 4/13/18, 5/3/18.

Foliar samples:

- 8 in total, every 2 weeks in fall, monthly in winter, then every 2 weeks Feb 15 – April 13 when growth resumed.

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 adequate so no lime was added. The calcium level in the soil test was slightly low (1410 lbs/acre), but since pH was ideal no lime was added to increase calcium levels. Soil organic matter was slightly low at 1.7%. The ground was fallow for the previous 2 years.
The seeds were sown into Fort-Vee potting mix from Vermont Compost that contains enough fertility from the compost that no additional fertility is needed for transplant production.

Agro-One soil test results and Cornell Guidelines recommended 130 lbs nitrogen/acre
We had 4 treatments:

- Urea (46-0-0) – 65 lbs pre-plant incorporated then 65 lbs side-dressed March 4
- Blood Meal (12-0-0) – same rate at timing as urea
- Alfalfa Meal (2.5-0.5-2.0) – very slowly released so we applied all 130 lbs N pre-plant
- Control – no nitrogen applied.

From the 3 dataloggers inside the tunnel (with no supplemental heat):

- Minimum soil temperature (2" deep) outside the rowcover by the north wall for the coldest location was 22.97 degrees
- Minimum soil temperature (2" deep) under the rowcover near the center of the tunnel for the warmest location was 27.54 degrees
- Minimum air temperature (12" above the soil) in the tunnel outside the rowcover was -14.01 degrees.

Weather highlights from the NEWA weather station at the Willsboro Research Farm:

- Minimum air temperature was -15.7 degrees in December and -19.5 degrees in January
- In both December and January there were 7 days with temperatures below zero and one day in early February.

## Winter Spinach Results:

Although we had no insect or disease pressure there was patchy vole feeding during the winter months. To accommodate for lost plants our data calculations are based on average yield per plant per treatment.

**Fertility Response**

- Throughout the project the foliar samples from all treatments showed similar levels of N, regardless of the treatment, including the control that had no nitrogen added. The levels started out excessive then moved to the average range for the remainder of the trial (see Appendix for specifics in graph form)
- Alfalfa meal had a negative impact on the seedlings in the early planting. The leaves in this treatment yellowed and had lower N levels in the foliar tests. These levels evened out after the first few weeks. The later planting was not so noticeably affected.
- Foliar nitrogen levels were higher in Urea plots than the other treatments after the March 4 side dressing. These levels dropped off by mid-April.

**Yield Results**

Bar graphs in the Appendix give helpful visuals of these data results.

- The two plantings were just 2 weeks apart but had noticeable differences in yield within each treatment.
- In each treatment the later plantings yielded more than the earlier plantings.
- The lowest yields were in the alfalfa and control treatments in both the early and late plantings.
- The highest yields were in the blood meal and urea treatments in both the early and late plantings.
- 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 late 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.

## Conclusions/Outcomes/Impacts by Vegetable

### Red Pepper Trials:

1. Comparison of Red Knight grown inside and outside the high tunnel

- The inside peppers clearly benefited from the protection offered by the high tunnel, with more than double the production and a significantly earlier first harvest (2.5 weeks earlier inside than outside).
- The peak season for retail sales in Northern NY ends at Labor Day. Earliness of harvest is an important factor for peak sales and profitability.

2. Yield and timing differences between the varieties Red Knight (field variety) and Sprinter (greenhouse variety) grown in the same unheated high tunnel.

- The timing of Red Knight yields fits better into the fresh market demand
- Without additional heat Sprinter languished. It is clearly meant for heated greenhouse, long season production

3. Sprinter grown in an unheated high tunnel yields better with less pruning and training labor when trained to the stake and weave system rather than the recommended double leader system.

## Tomato Trials:

- The double leader system provided the most benefits as measured by labor efficiency, yield, and net revenue. Extrapolating these results for **a tunnel with 200 cherry tomato plants, the double leader system would bring an additional $1390 in net profit over the multi-leader system.** ($55.31-$48.36=$6.95 [net revenue gain] x200 plants=$1390)

- Because labor is the largest expense on most vegetable farms, the increased efficiency of harvesting the double leader system over the multi-leader is another important factor. Our average yield per hour of harvest is as follows: 45.1 lbs/hr for the double leader, 45.5 lbs/hr for the single leader, and 34.8 lbs/hour for the multi-leader due to the dense, tangled growth that develops when left unpruned.

## Spinach Trials:

The question of how much nitrogen to apply to winter spinach and in what form is relevant to NNY vegetable farmers as they increasingly use high tunnels for season extension.

Anecdotally, the project team has reports from farmers of applications from 200-600 lbs of N per acre in winter high tunnels. However, our research does not show consistent differences between unfertilized plots and 130 lb applications of alfalfa-based nitrogen. This may present an opportunity for organic high tunnel growers to improve in sustainable nutrient management while improving economic performance by reducing input costs.

At no time did any of the treatments, including the control with no additional N, drop below the minimum level of foliar N, although yields were higher (up to 29%) in fertilized plots.

This work does support the use of blood meal as an N source equivalent to highly soluble conventional sources such as urea. With lower foliar N levels (still within sufficiency range) and comparable yields, blood meal may offer superior fertility/yield performance than urea. Alfalfa meal, a common organic N source, decreased yields and economic performance in this trial.

The cost of these N sources varies widely depending on source and quantity purchased from as low as $2/lb of N for urea to around $15/lb N for blood meal to over $20/lb N for alfalfa.

The choice on planting date will be farm-dependent. Although we experienced greater yield in the later planting, some farms may prefer the earlier (although lower total) yield of the early planting date.

We also note that the trial includes harvest dates in April and May that may interfere with warm season crop plans. In this case, an earlier planting date for spinach may be preferred.

Our temperature data collection indicated a nearly 5-degree difference in minimum soil temperature when comparing the covered center of the tunnel to exposed edges. Given the need

for organic sources of N to mineralize, efforts to retain as much heat in the soil will be of benefit for crop uptake.

## Outreach:

**Peppers and Cherry Tomato Outreach**

**Summer Grower Field Meetings and Farm Visits in NNY**

- 7/18/17 with Judson Reid, CCE Farm, Canton; 19 growers; included visit to farm's high tunnel; plus farm visits to 3 high tunnel growers in St Lawrence County before the program
- 8/1/17 with Judson Reid, Cornell Willsboro Research Farm trials; various treatments and pruning practices demonstrated for 13 growers; plus farm visits to more than 12 high tunnel growers in Clinton and Essex counties to coach them on pruning and training tomatoes and peppers, relaying our research information.

**Winter Grower Meetings: 20-minute Talk on Trials**

- 1/19/17 – NYS Producers' Expo, Syracuse, NY; 65 growers
- 2/7/17 – ENY Winter Vegetable School, Kingston, NY; 38 growers
- 2/8/17 – ENY Winter Vegetable School, Albany, NY; 42 growers
- 3/31/17 – ENY Northern Vegetable School, Whallonsburg (Essex County); 36 growers

**IPM High Tunnel Production Train-the-Trainer Statewide Project**

- 2/23/17 webinar on training tomatoes, cucumbers and peppers: 18 CCE educators from around NYS
- 4/26/17 – 2-day in-person training, coached participants on pruning, shared resources

**Miscellaneous Grower Trainings**

- 5/3/17 – Growing Field Meeting, Montgomery County; demonstrated pruning; 30 growers
- 7/12/17 – Growing Field Meeting, Washington County; discussed pruning; 26 growers
- 10/31/17 – Putnam county grower meeting; presentation on managing tomatoes in high tunnels; 20 growers
- 3/05/18 – Vegetable farm tour, Pleasant Valley Farm, Argyle, NY: 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 – Growing Vegetables to Sell in Northern NY Workshop, Glenfield, NY: scheduled at time of report.

**Spinach 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 Co); 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.

- 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.

**Articles:**

- **Produce Pages: Pruning for Productivity (see www.nnyagdev.org: Horticultural Research: Vegetables.**
- An article on spinach trial will be printed in Summer 2018 newsletters as growers prepare for fall planting.

## Next Steps:

Many questions remain about the nitrogen needs of winter crops and nitrogen availability and mineralization in cold soils. Another year of trialing the peppers is necessary due to the unseasonably cold start in 2017. Our 2018 proposal has been accepted by the Northern New York Agricultural Development Program for funding. Thanks to the continued funding from NNYADP we will continue studying spinach yields and nutrient levels using one source of N applied at different rates in the fall-winter of '18 -'19. Future research could focus on variable rates of nitrogen, planting dates as well as understanding the decreased yield associated with alfalfa meal.

## Reports and/or articles in which results of this project have been published:

The article "Pruning for Productivity" (Appendix 3.) was printed in the January 2017 issue of Produce Pages, the Eastern NY Commercial Horticulture monthly newsletter. "Cherry Tomatoes and Sweet Red Peppers in High Tunnels" project overview article by Amy Ivy appeared in the March 2018 issue of Produce Pages, the March 2018 Cornell Vegetable Program Veg Edge newsletter, and in a Western NY county vegetable newsletter.

## For More Information:


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## APPENDIX 1: Red Pepper Trial Tables

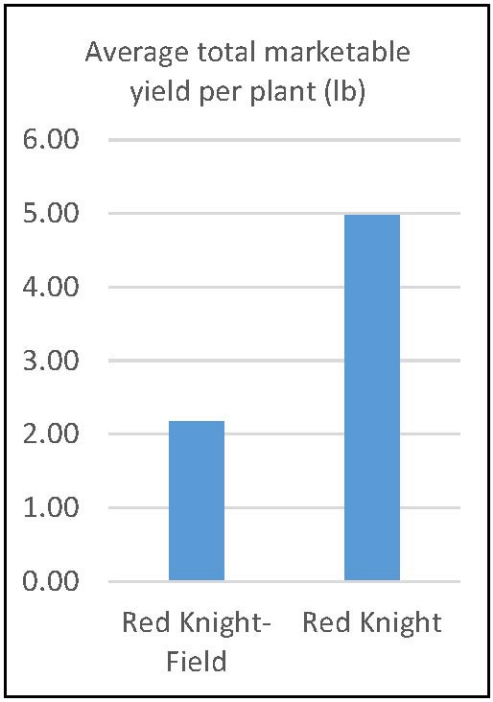



**Figure 1. Average total marketable yield per Red Knight plant (lb grown inside and outside tunnel: Greater yield inside tunnel, Red Pepper Trial, NNYADP project, 2017.**

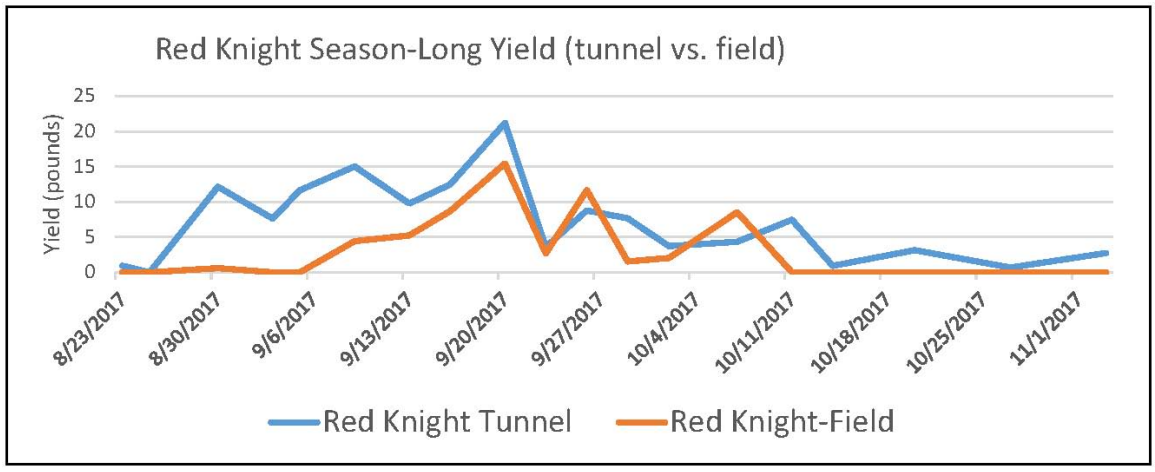
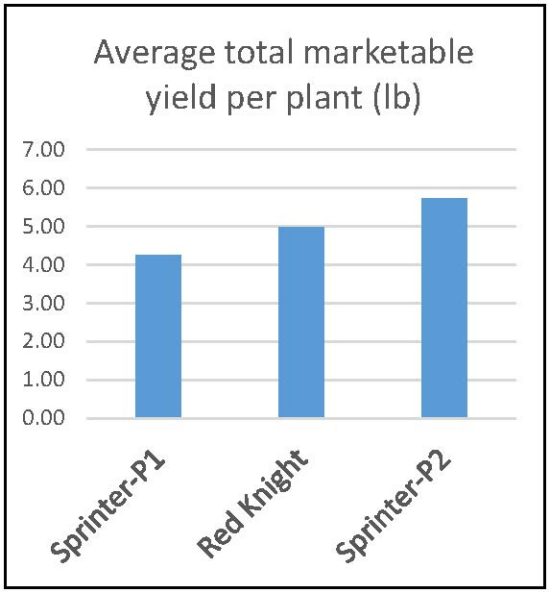



**Figure 2: Red Knight Season-Long Yield (tunnel vs. field): Earlier yield inside, Red Pepper Trial, NNYADP project, 2017.**




**Yield and Timing Differences between Red Knight (field variety) and Sprinter (greenhouse variety)**

P-1 is the double leader training method
P-2 is the stake & weave training method used on Red Knight as well

Red Knight yielded earlier then tapered off while Sprinter began yielding later then kept on yielding
Total yield on Sprinter was higher, but occurred later in season when market demand is less

**Figure 3: Average total marketable yield per plant (lb), Red Pepper Trial, NNYADP project. 2017.**

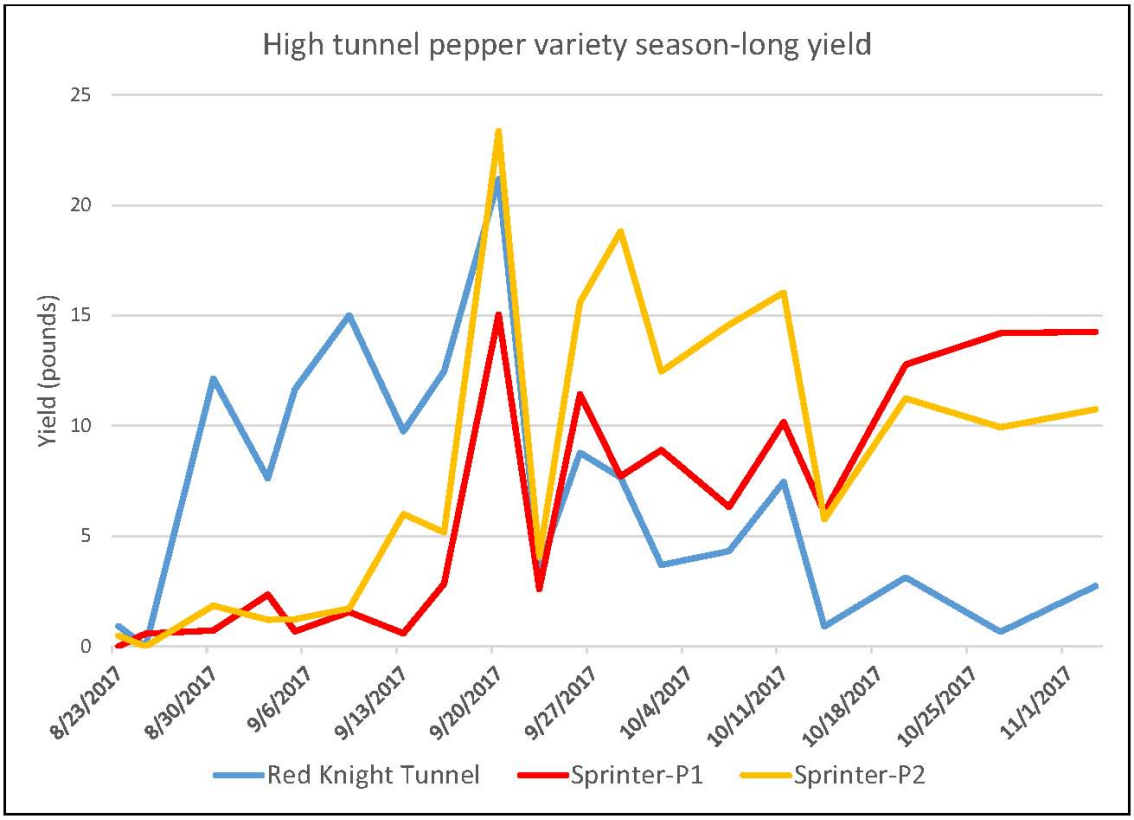
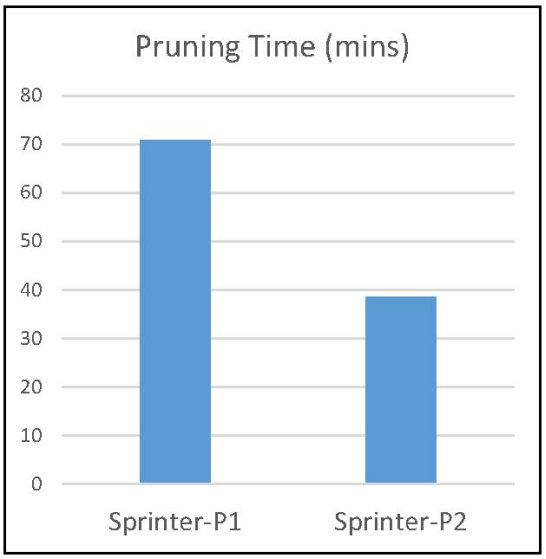



**Figure 4: High tunnel pepper variety season-long yield, Red Pepper Trial, NNYADP project. 2017.**

**Comparison of two pruning methods for Sprinter**

P-1 is the double leader training method  P-2 is the stake & weave training method

The double leader method took twice as long to manage and yielded less than the stake & weave method.



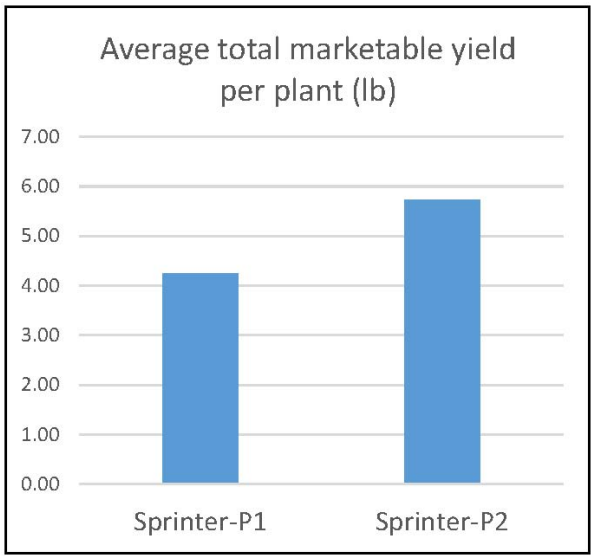




**Figure 5, left: Pruning time (mins), Red Pepper Trial, NNYADP project. 2017.**
**Figure 6, right: Average total marketable yield per plant (lb), Red Pepper Trial, NNYADP project. 2017.**

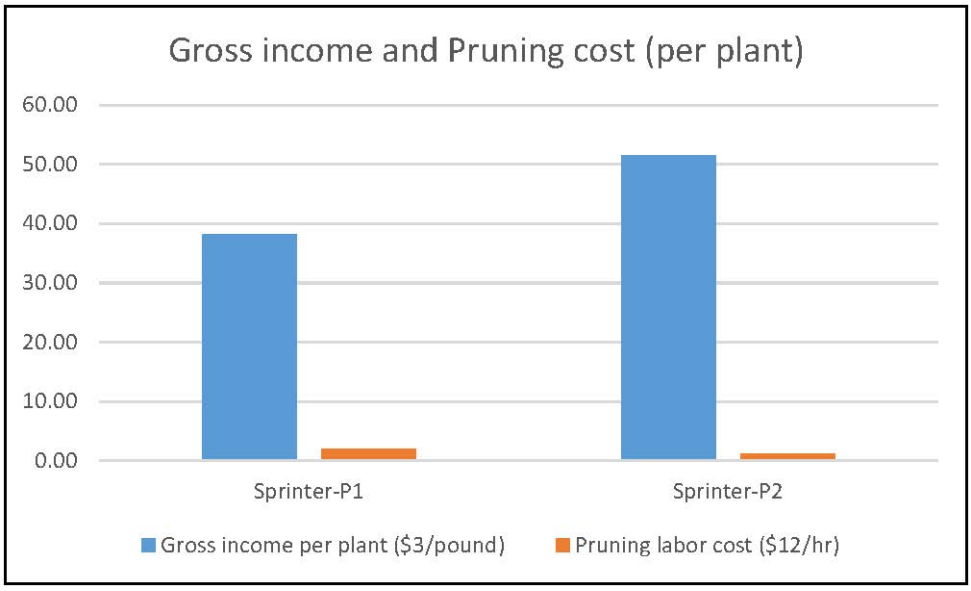



**Figure 7.  Gross income and Pruning cost (per plant), Red Pepper Trial, NNYADP project. 2017.**

## APPENDIX 2: Cherry Tomato Trial Tables

**The tables that follow indicate that the time saved in pruning less is lost in the extra time it takes to harvest the multi-leader system. The double leader system provided the most benefits as measured by yield, labor efficiency, and net revenue.**

**NOTE: Each treatment includes 4 replications and represents 40 row feet of cherry tomato crop.**

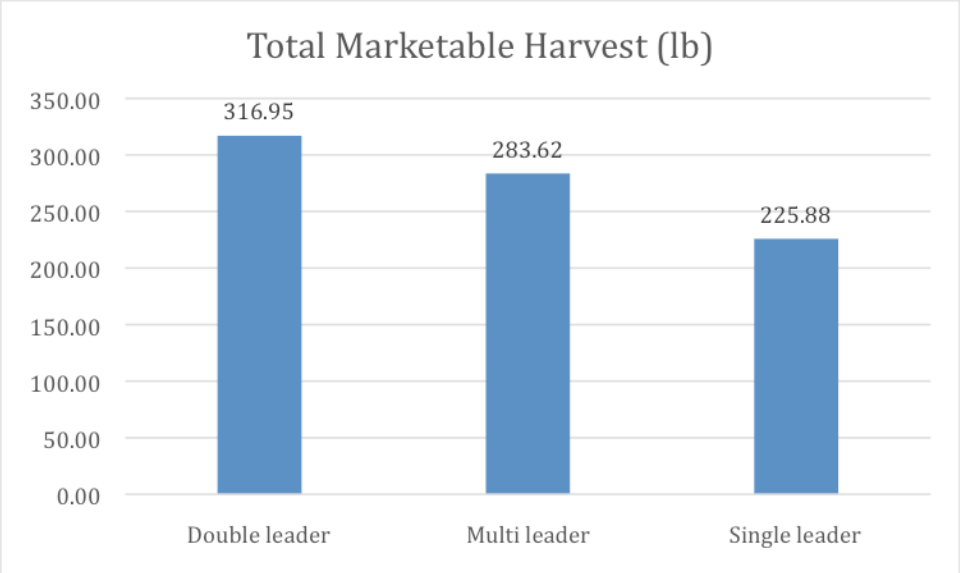



**Figure 1. Total Marketable Harvest (lb), Cherry Tomato Trial, NNYADP Project, 2017.** Double and Multi Leader treatments based on four 11' rows with 5 plants spaced 18" apart. Single Leader treatment based on four 11' rows with 7 plants spaced 12" apart. Harvest lasted from July 20 through September 29, 2017.

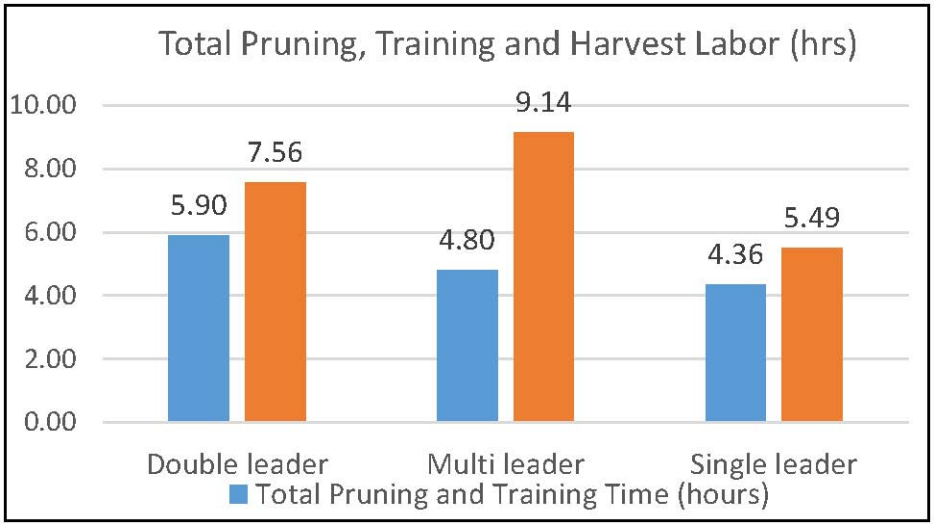



**Figure 2. Total Pruning, Training and Harvest Labor (hrs), Cherry Tomato Trial, NNYADP Project, 2017.**

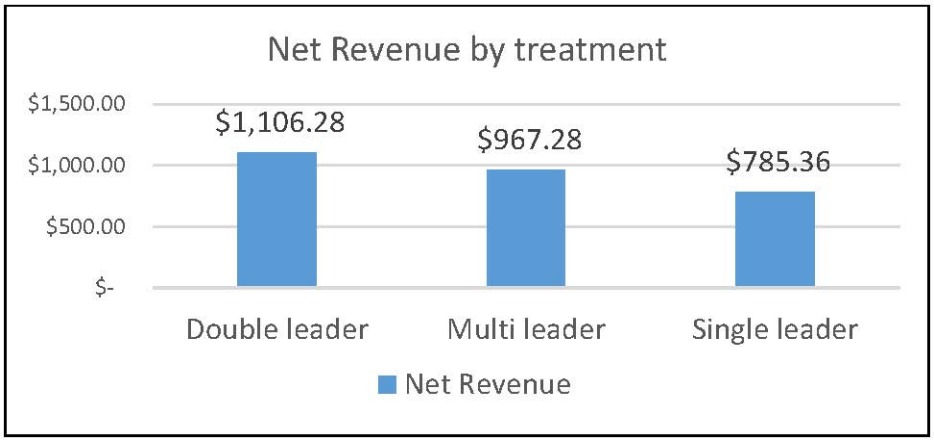



**Figure 3. Net revenue by Treatment, Cherry Tomato Trial, NNYADP Project, 2017**

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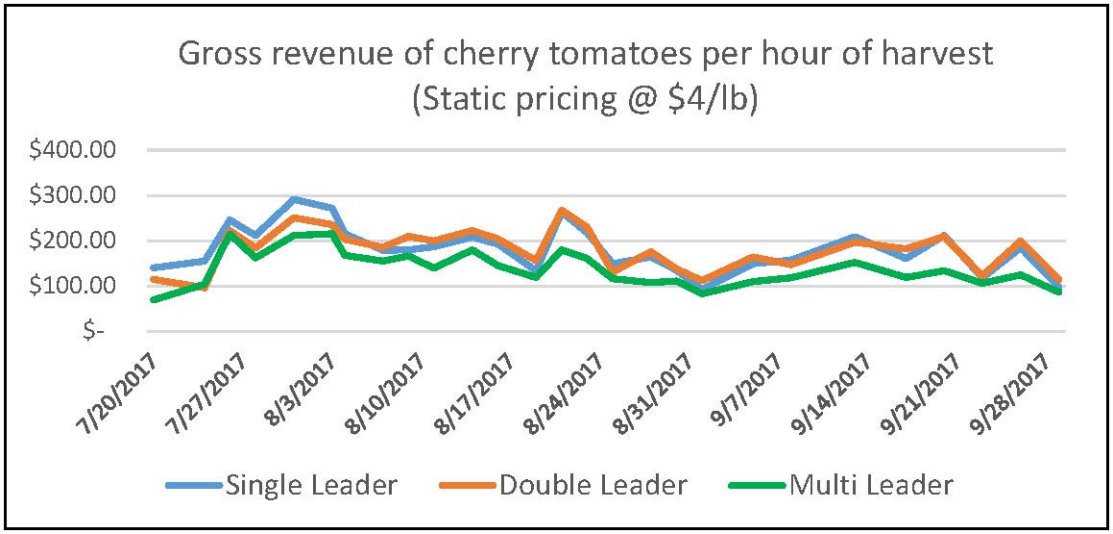
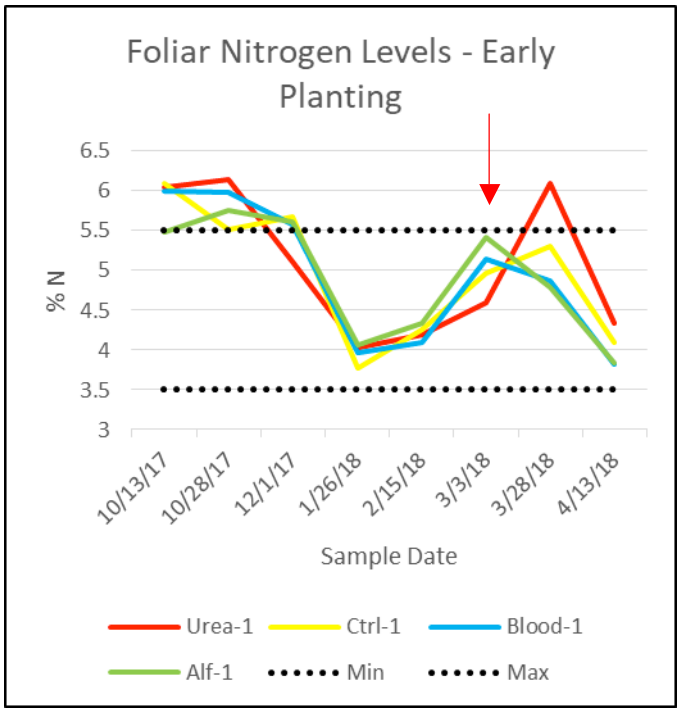


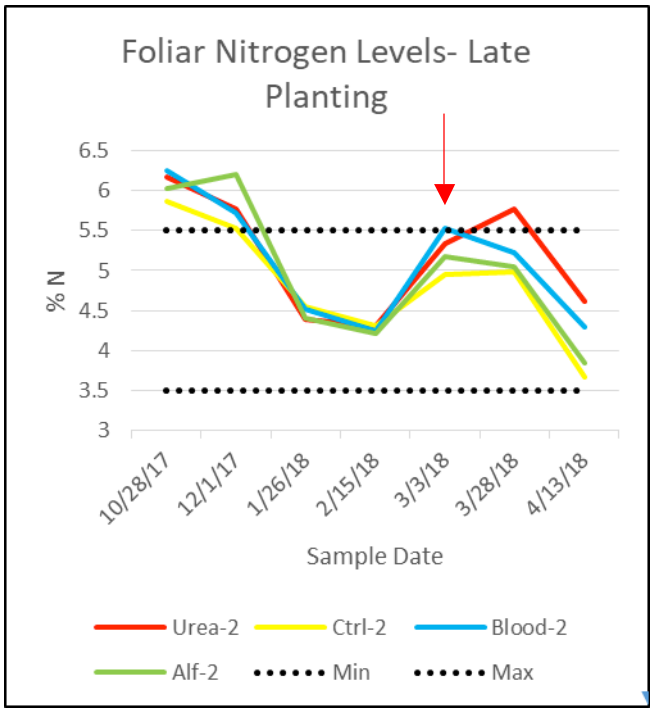

**Figure 4. Gross revenue of cherry tomatoes per hour of harvest (Static pricing @ $4/lb), Trial, Cherry Tomato Trial, NNYADP Project, 2017**

## APPENDIX 3: Spinach Trials

Key to abbreviations in charts: **Alf** – alfalfa meal, **Blood** – blood meal, **Ctrl** – Control

Early Planting was transplanted on Sept 20, 2017, Late Planting was transplanted on Oct 6, 2017 (16 days apart)




**Figures 1 and 2. Nutrient Levels Over Time in Early and Late Winter Spinach Plantings. Red downward arrows indicate when sidedressing of urea and bloodmeal occurred. Horizontal dotted lines show minimum and maximum levels of %N (nitrogen). At no time did any of the treatments, including the control with no additional N, drop below the minimum level of N. Winter Spinach Trial, NNYADP Project, 2017-2018.**

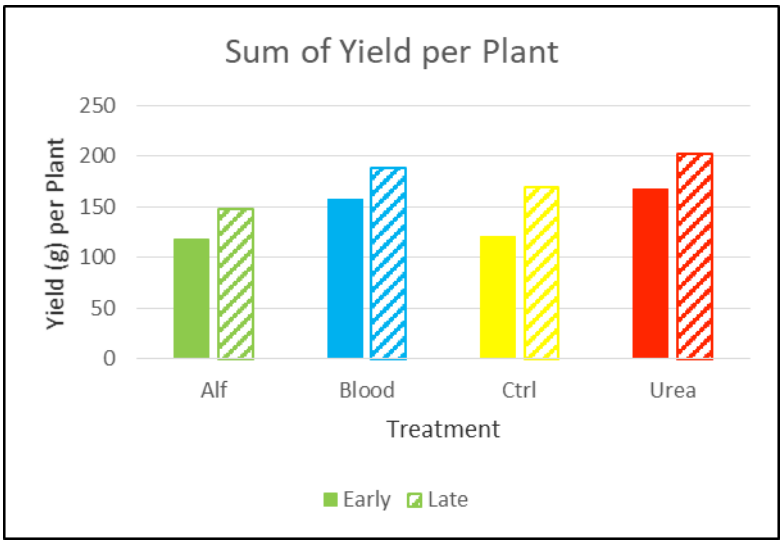



**Figure 3. Sum of Yield Per Plant. In each treatment the early planting yielded less overall than the late planting. The following chart shows when each planting peaked.The Blood Meal and Urea treatments had similar yields to each other. The Alfalfa Meal and Control had similar yields to each other. Winter Spinach Trial, NNYADP Project, 2017-2018.**

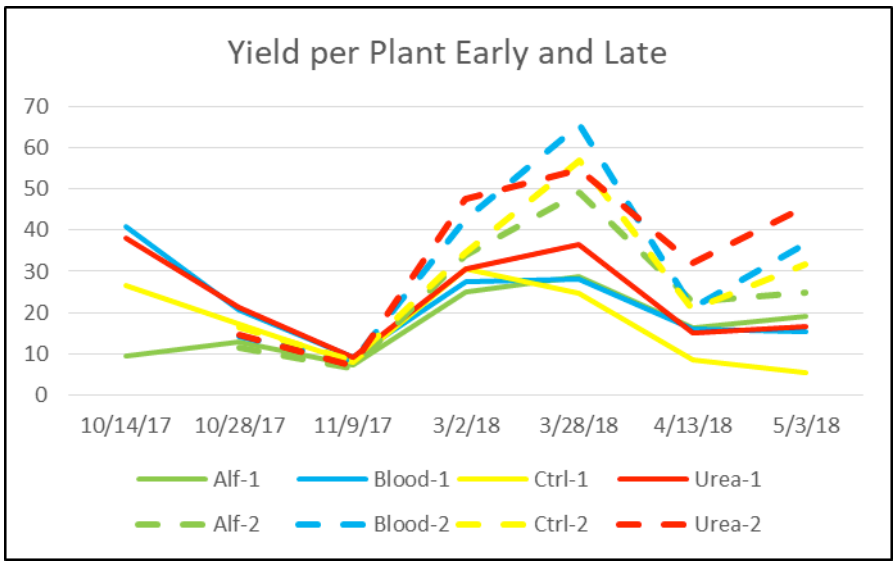



**Figure 4. Yield Per Plant. The early planting yielded in fall and late winter while the late planting peaked in March. These timings are important considerations for growers planning harvests for Nov-Dec holiday sales vs. late winter market sales. The 7 harvest dates are along X axis. Winter Spinach Trial, NNYADP Project, 2017-2018.**

**Table 1. Conditions (Temperature) Inside and Outside Tunnel, Winter Spinach Trial, NNYADP Project, 2017-2018.**

| Conditions Inside the Tunnel | | |
|---|---|---|
| Location | Min (°F) | Max (°F) |
| Soil temp 2” deep in center of tunnel, under row cover | 27.538 | 63.648 |
| Soil temp 2” deep north side of tunnel, without row cover | 22.968 | 64.888 |
| Air temp 12” above soil without row cover | -14.001 | 75.333 |
| | | |
| Conditions Outside the Tunnel | | |
| 15 days below zero from late December to early Feb<br>Dec min temp was -15.7(°F) , Jan min temp was -19.5(°F) | | |

**APPENDIX: PHOTOS: Amy Ivy**

Trial tunnel on 9/16/17
Cherry tomato trial in back
Peppers just after a harvest in front

Below: The outdoor peppers (at far left in field) were smaller and weaker than the tunnel peppers.

Photo, left: Red Knight showing the stake-and-weave training method. A stake is placed between every 2 plants, then thin twine is woven between and around stakes to hold up branches. Pepper plants are brittle and whole branches can snap off under a heavy fruit load without support.

Photo, right: Both rows are Sprinter; double leader method on left, stake-and-weave method on right, 9/2/17.

Photo, left: By November 3, 2017, the double leader Sprinters were growing well but the fruit was slow to ripen. These plants were killed by sub-freezing temperatures later that week.

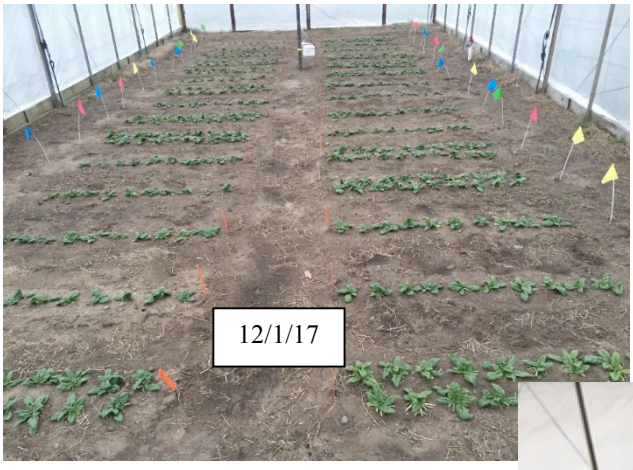
Photo right: Grower field meeting, Willsboro Research Farm: Project discussion with growers; walk through trials to see firsthand how tomatoes and peppers were responding; August 1, 2017.

Close-up of double leader system, marked by dotted yellow line. Each leader is trained to a string suspended from the high tunnel frame.



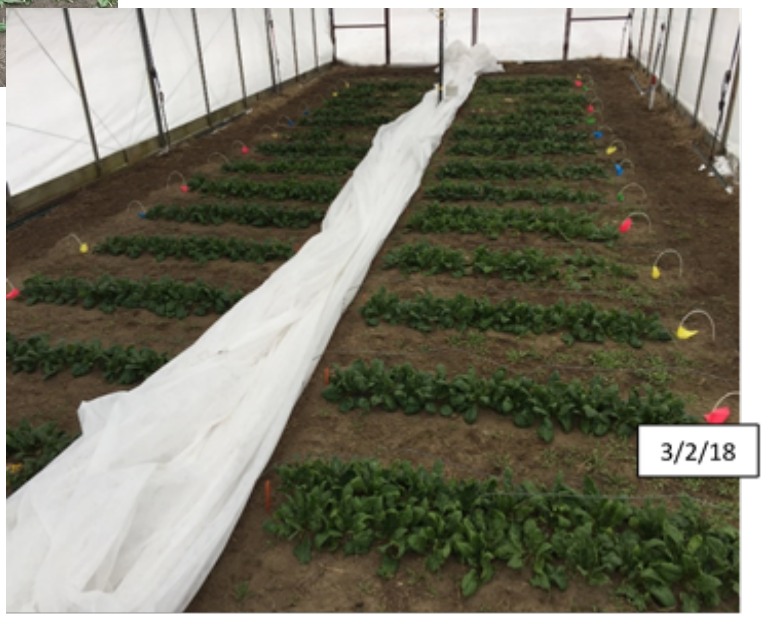
**Above: Three cherry tomato treatments:** By early September 2017 it is easy to see the dense, tangled, leafy growth of the multi-leader treatment and the more productive, easier-to-work-in double leader treatment.

Above: 10/11/17: Noticeable difference between treatments in the early planting;
L-R: Control, Alfalfa meal, Blood meal.




Left: Under the short days of winter the spinach virtually stops growing. It resumes growth in mid Feb as the days get noticeably longer.

Right: 2 layers of mid-weight rowcover were pulled over rows and held above plants by wire hoops. Here it is pulled into the center aisle for harvest.



The grower field trip to Paul and Sandy Arnold's Pleasant Valley Farm on March 5, 2018, gave NNY growers a chance to see winter tunnels in full production and ask questions of these experienced growers.

Right: Onions overwintered under a low tunnel with no heat are ready for early market sales May-June.

Left: This is the Arnold's spinach tunnel, 34x130'. Paul provided us with their winter crops seeding chart. They start spinach in successive plantings from mid Sept through mid Oct for harvest Dec through May.

Right: Paul Arnold showed the tour group his heated bench system where they start all their transplants.