Northern NY Agricultural Development Program
2010 Project Report

Extending the Season with High Tunnels

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Background:
The use of high tunnels for production of fresh market vegetables is of keen interest to growers in the cold climate of NNY. Growers have found significant advantages from these tunnels in extending the growing season, lengthening their period of sales and income, increasing the yields of each crop, reducing pest and disease pressure due to the protection of the tunnel, and the production of a succession of crops in the same space which enables growers to maximize their profits from each tunnel.

With these advantages have come some challenges. Growers without tunnels are not confident their investment in a tunnel will repay itself, the newer tunnel growers need to learn how to train and space their crops for maximum yields, and the more experienced tunnel growers have significant nutrient deficiencies and toxicities that adversely affect their yields. In addition, many growers in the region want to use organic products which require careful management and specialized application methods.

Nutrients in the soil of rain-protected tunnels are not leached out by rainwater and can build up to high levels. Warm temperatures in the tunnel also increase the availability of nutrients, and not always at the optimum time for the crop. Some crops (tomatoes) have quite high nutrient needs, while others (greens) are more sensitive to salt accumulation and have an overall lower need for nutrients.

Every grower has a slightly different situation from the other; there is no one right way to manage crops in a tunnel. By giving our growers first hand experiences and guidance, not only will they learn and choose the methods that work best for them, they will be able to give input from their experiences to other growers.

Methods:
This project consisted of 3 approaches:

- A trial to examine the efficacy and logistical implications of grafting tomatoes for high tunnels.

- A trial to test the effect of seeding date on the productivity of three different greens produced under three different season extension systems.
- Grower to grower learning opportunities, and regular nutrient testing.

Each of these approaches will be covered individually in this report.

Tomatoes

Background

Tomatoes are one of the most popular and profitable greenhouse crops for fresh market vegetable growers, and many producers plant tomatoes in the same greenhouse or high tunnel beds year after year. Continual tomato production can result in a build-up of soil borne pathogens. One of the possible solutions for increased disease pressure in the soil is to graft desirable tomato varieties onto vigorous, disease resistant rootstock. This study was designed to examine the efficacy and logistical implications of grafting tomatoes for high tunnels.

Objectives

1. To evaluate the performance of four tomato varieties grown in a 30' x 96' high tunnel.
2. To test the effect of grafting tomato seedlings onto disease resistant rootstock on fruit yields, time to first harvest, and harvest duration.

Methods

Four indeterminate tomato varieties were selected for the 2010 study. *Trust* and *Geronimo* are commonly grown greenhouse varieties that reportedly have some resistance to leaf mold and are therefore well suited for high tunnel production. *Big Beef* and *Conestoga* are not resistant to leaf mold, but have excellent flavor and command premium fresh market prices. *Maxifort* was chosen as the rootstock variety for the grafting trials. Seeds of each market variety as well as the *Maxifort* rootstock were started in April in a germination chamber, and transplanted into 48 cell trays with an organic *Fort V* potting mix (Vermont Compost Co.) once the first true leaves had developed. Transplanted seedlings were grown on in a heated greenhouse with 60 degree minimum night-time temperatures. When stem diameters had reached 6mm, half of the plants of each variety were grafted onto the *Maxifort* rootstock using an apical "v-notch" technique. At the time of grafting, all the seedlings (grafted and non-grafted) were transplanted into 4" pots. Plants were transplanted into 4' wide greenhouse beds in June. Tomato transplants were spaced 18" apart within the row with 30" between the rows. All plants were pruned to two leaders and string trellised to an overhead wire. Water and nutrients were provided through a drip irrigation system.

Results and Discussion

Grafting Methods:

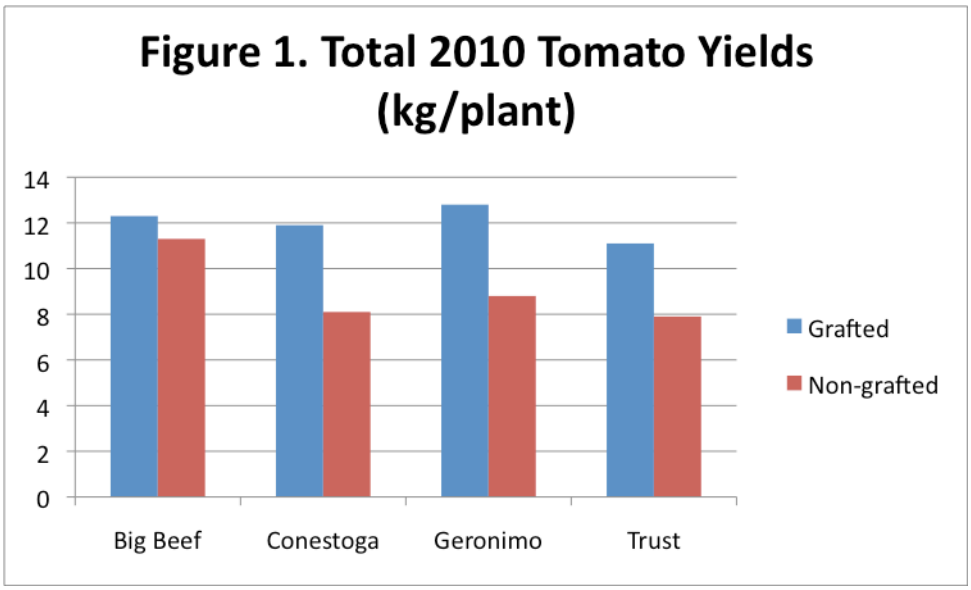
The apical v-notch grafting method has worked extremely well for us during the past two years. In 2009 we employed a top-graft method with half of our transplants, and an apical v-notch approach with the other half. The apical v-notch strategy worked much better than the top-grafts in 2009. In 2010 we used the apical v-notch method for all our transplants, and experienced a 100% success rate. As a result of the high grafting success rate (Photo 1), we ended up with more grafted than non-grafted plants in the 2010 trial (Table 1). All yield results are reported on a per plant basis.

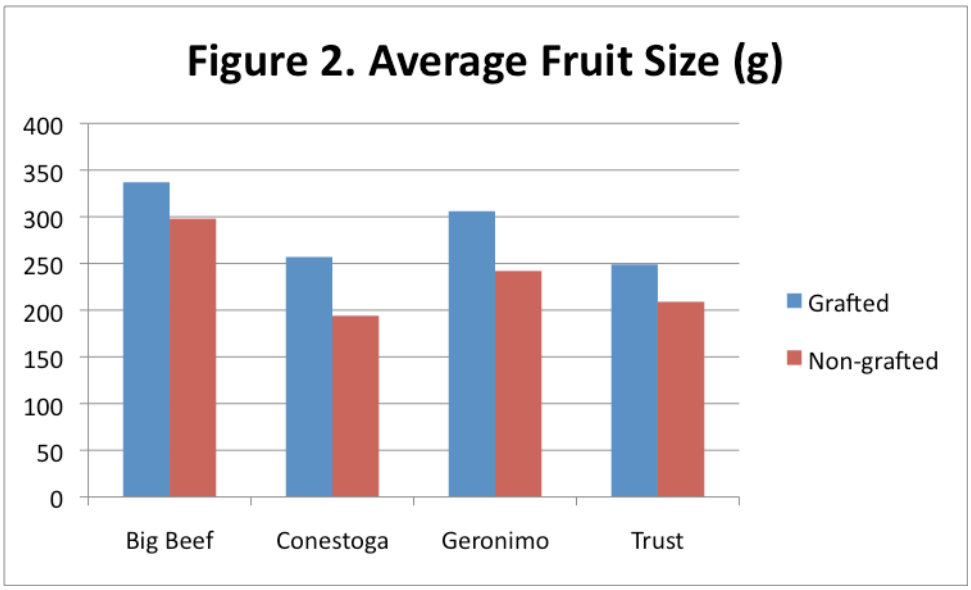
Table 1. The number of plants of each treatment included in the 2010 high tunnel tomato trial.		
Tomato Variety	**Grafted vs Non-grafted**	**Number of Plants**
Conestoga	Grafted	16
Conestoga	Non-grafted	16
Trust	Grafted	16
Trust	Non-grafted	8
Geronimo	Grafted	18
Geronimo	Non-grafted	8
Big Beef	Grafted	26
Big Beef	Non-grafted	16

Tomato Production:
Grafting the tomato seedlings onto Maxifort rootstock set the transplants back and delayed the first harvest date by one to two weeks for all four varieties (Table 2). While the harvest started earlier for the non-grafted plants, and both non-grafted and grafted plants continued to produce well into October, the grafted plants produced higher yields than non-grafted plants for all four varieties (Figure 1). Higher yields with the grafted plants were associated with both increased total fruit numbers (Table 2), and increased fruit size (Figure 2). The increased yields with grafted plants in the 2010 trial are consistent with the 2009 results, and illustrate the significant benefits that can be gained through grafting. Growers interested in harnessing the productivity of grafted tomatoes without sacrificing early season sales, should start the grafted tomato seedlings and rootstock seedlings a couple weeks earlier than non-grafted plantings.

All four tomato varieties performed well in the 2010 high tunnel trial. No leaf mold problems developed, and as a result *Big Beef* and *Conestoga* produced yields that were comparable to the two leaf mold resistant entries, *Trust* and *Geronimo*.

Table 2. First harvest date and total number of tomatoes produced per plant for each treatment.			
Tomato Variety	**Grafted vs Non-grafted**	**Date of First Harvest**	**Total Number of Tomatoes Per Plant**
Conestoga	Grafted	8/9/10	23.1
Conestoga	Non-grafted	8/2/10	19.8
Trust	Grafted	8/16/10	20.0
Trust	Non-grafted	8/2/10	15.9
Geronimo	Grafted	8/9/10	19.7
Geronimo	Non-grafted	8/4/10	16.1
Big Beef	Grafted	8/9/10	17.4
Big Beef	Non-grafted	8/2/10	18.2





Fall-Winter Greens

Background

Producing greens in high tunnels can significantly extend the marketing season for fresh market growers. Many greens can tolerate freezing temperatures, and while they don't grow much during late fall or winter, eating quality can be maintained under the protective cover of an unheated high tunnel as long as the greens are not frozen when they are harvested. In this scenario high tunnels can be used to effectively extend the harvest season for greens grown in the late summer and early fall. The 2010 fall greens study at the Cornell E.V. Baker Research Farm was designed to test the effect of seeding date on the productivity of three different greens produced under three different season extension systems.

Types of Greens

- *Regiment* Spinach
- Standard Arugula
- *Five Star* lettuce mix

Seeding Dates

- August 21, 2010
- September 5, 2010
- September 30, 2010

Season Extension Systems

- System 1: "High Tunnel" -- Greens were grown in a permanent 30' x 90' high tunnel. Low hoops were set over the greens beds and covered with an additional layer of plastic when below freezing temperatures were forecast.
- System 2: "Movable High Tunnel" -- Greens were planted into outside beds that were equipped with low hoops and a layer of plastic when below freezing temperatures were forecast. A moveable 24' x 48' high tunnel was moved over the greens beds on November 11, 2010.
- System 3: "Low Covers" -- Greens were planted into outside beds that were equipped with low hoops and a layer of plastic when below freezing temperatures were forecast. A deep layer of straw mulch was placed over these beds after the ground was consistently staying frozen throughout the day. The mulch layer was applied on December 8, 2010.

Methods

A randomized complete block design with three replications within each season extension system was employed. All growing beds were fertilized with North Country Organics Pro-Gro 5-3-4 granular fertilizer at rate of 1089 lbs/acre. Five tons/acre well composted dairy manure was also worked into the surface of the growing beds prior to seeding. Weeds were removed by hand and the beds were hand watered with a hose as needed. The first spinach, lettuce, and arugula plantings in all three systems were cut in the middle of September and allowed to regrow.

Results and Discussion

Planting Date:

Planting date had a major influence on the productivity of greens produced under all three season extension systems. Seeding the greens on August 21 allowed for two harvests of spinach, arugula, and lettuce mix (Table 3), while the two later seeding dates only allowed for one fall-winter harvest, regardless of the season extension system. A two week difference in planting date (August 21 vs September 5) reduced the number of harvests by half. On the other hand, delaying seeding an additional three weeks to September 30 still allowed for a single, somewhat smaller, harvest. Greens harvests were not quantified, but greens planted on Sept. 30 were noticeably smaller than greens planted on September 5 in all three season extension systems. These results illustrate the importance of a mid-late August planting date for optimizing fall-winter greens production in northern New York.

Season Extension System:

All three types of greens grew faster when seeded into the high tunnel beds than they did when seeded into outside beds. The greens started in the outside beds with system two (movable high tunnel) had stopped growing by the time the tunnel was moved over the beds on November 11, so they didn't look much different than the plants in the low cover system at the end of the season (December). The primary benefit of moving the tunnel over the beds in November was an extension of the harvest season through the month of December.

All the greens plantings were left to overwinter. Beds inside the permanent high tunnel and movable high tunnel (Photo 2) were covered with an additional layer of plastic draped over low hoops. The outside beds in system 3 were buried with a thick layer of mulch in December. Plant health-quality was assessed in the high tunnel beds in March. The outside beds were still covered with snow and mulch, so their fate is yet to be determined. All three plantings of spinach in both tunnels survived the winter in nice shape (Photo 4). Winter survival in the arugula and lettuce mix beds differed with planting date. In the permanent high tunnel where the greens growth was more vigorous and the plants for each planting date were larger (relative to the plants in the movable high tunnel system) going into the winter, only the last seedings (September 30) of arugula and lettuce mix (Photo 3) survived (Table 3). With the movable high tunnel system, arugula and lettuce mix plots from the last two planting dates (September 5 and September 30) survived. The observation that arugula and lettuce mix planted on August 21 did not survive the winter in either high tunnel highlights the influence of plant size and maturity on tolerance to winter conditions.

Table 3. 2010 Greens Season Extension Results

*TBD = to be determined

Season Extension System	Type of Greens	Planting Date	Number of Harvests in 2010	Spring 2011 Stand Status
System 1 High Tunnel	*Regiment* Spinach	Aug. 21	2	Green
		Sept. 5	1	Green
		Sept. 30	1	Green
	Standard Arugula	Aug. 21	2	Decomposing
		Sept. 5	1	Decomposing
		Sept. 30	1	Green
	Five Star Lettuce Mix	Aug. 21	2	Decomposing
		Sept. 5	1	Decomposing
		Sept. 30	1	Green
System 2 Movable High Tunnel	*Regiment* Spinach	Aug. 21	2	Green
		Sept. 5	1	Green
		Sept. 30	1	Green
	Standard Arugula	Aug. 21	2	Decomposing
		Sept. 5	1	Green
		Sept. 30	1	Green
	Five Star Lettuce Mix	Aug. 21	2	Decomposing
		Sept. 5	1	Green
		Sept. 30	1	Green
System 3 Low Covers	*Regiment* Spinach	Aug. 21	2	TBD*
		Sept. 5	1	TBD
		Sept. 30	1	TBD
	Standard Arugula	Aug. 21	2	TBD
		Sept. 5	1	TBD
		Sept. 30	1	TBD
	Five Star Lettuce Mix	Aug. 21	2	TBD
		Sept. 5	1	TBD
		Sept. 30	1	TBD

Grower to Grower Learning Opportunities

Regular Nutrient Testing
To show growers the value of regular nutrient testing and what can be learned our summer intern took one soil test and two foliar tests of five different growers. Judson Reid interpreted the results and made recommendations:
Essex County growers: Rob Hastings, Rivermede Farm; Adam Hainer, Juniper Hill Farm; Christine & Mike McAuliffe, Carriage House Garden Center.
Clinton County growers: Beth Spaugh, Rehoboth Homestead; Ken Campbell, Campbell's Greenhouses.

Season Extension Methods for Vegetable and Berry Growers
Held Saturday, November 13, 10-3:00 in Canton at the CCE Learning Center
Guest speakers: Judson Reid, Cathy Heidenrich, Laura McDermott, and grower Dan Kent
Audience: twelve growers considering putting up high tunnels from St. Lawrence and Jefferson Counties.

Fall Salad Greens Research Field Day
Held Tuesday, December 7, 9:00-3:00; speakers: Judson Reid, Mike Davis, host growers

We visited two growers (Juniper Hill in Westport, Rehoboth Homestead in Peru) to see their fall greens tunnel crops and learn from their experiences and the Cornell Willsboro Farm to see their trials on seeding dates of fall greens and responses to being grown under three different season extension systems. Judson Reid provided technical expertise and gave a presentation on bio-control in greenhouses as well.

Low Tunnel Approach to Season Extension Road Trip
Monday, December 13 10-3:00, Ted Blomgren's Windflower Farm, southern Washington County.
Speaker: Laura McDermott, Capital District Veg Specialist and Ted Blomgren
Eight growers from Clinton, Essex and St. Lawrence County traveled to see Ted's caterpillar tunnels and high tunnels, and to learn what methods of season extension work best for his operation.

Conclusions/Outcomes/Impacts:
Growers have data to help them decide if using grafted tomatoes or growing a crop of fall greens is feasible for their operation. They learned a variety of ways to use traditional high tunnels, rolling tunnels, moveable tunnels, and low-tech caterpillar tunnels.

Outreach: Local newspapers covered field meetings. Research data will be distributed to growers via our email list. Growers continue to meet with and mentor each other.

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