Northern NY Agricultural Development Program
2011 Project Report

Project Title: Managing Fertility to Increase Yields in Vegetables Part II

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Background:
While growers realize fertility is important, most of the newer and/or smaller scale growers in NNY have a poor understanding of how to optimize fertility to enhance the performance and yield of their various crops. Whether they are using organic or conventional sources, NNY growers could increase profitability by having a more strategic approach to managing the fertility needs of their crops.

Many growers experience nutrient deficiencies by mid- season when crop needs are greatest, with the result being lower yields, and a decrease in the economic performance of their farms. There are also pH issues and uneven applications of amendments. Organic growers who rely on low analysis fertilizers such as fish emulsion need to be especially mindful of the rates to be sure their crops are receiving adequate nutrition. 'Hungry' crops are a common sight in NNY vegetable fields, and the common approaches used by growers now are costly and often insufficient. The short growing season in NNY makes it especially important for growers to keep their crops growing at full capacity all season long to get the maximum yield possible in just a few months.

In high tunnels, managing soil fertility can be challenging because the intensive crop rotations often utilized with tunnel growing beds provide few opportunities for soil building activities such as cover cropping. When long season crops like tomatoes and peppers are grown, it is difficult to provide all the nutrient requirements to the growing beds prior to planting, and as a result additional nutrients must be provided during the growing season to optimize yields. Fertigation, applying fertilizer to the growing beds through the drip irrigation system, is a very effective way to supply nutrients to the crop during the growing season.

Research Study Objective: The objective of this project was to test the efficacy of late-season fertigation on tomato and pepper yields in a high tunnel.

Methods:

Tunnel: This study was conducted in the 30' x 96' Ledgewood pipe-frame high tunnel at the Cornell Willsboro Research Farm. The tunnel was covered with a single layer of 6ml greenhouse plastic. Growing beds were 2.5' wide x 12.5' long with the long axis oriented north-south, and each bed was equipped with two drip tube lines. All growing beds received a broadcast applied 25lb/1000sqft application of North Country Organics ProGro 5-3-4 granular fertilizer prior to planting.

Tomato culture: Tomato transplants (Pineapple) were planted in the growing beds on May 1, 2012. 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 bed growing space. A total of eleven plants were grown in each of twelve beds. All tomatoes, including small and green fruits, were harvested from all the plants on August 2, 2012, prior to starting fertigation treatments. Six of the tomato beds received weekly fertigation treatments and six control beds did not. Irrigation applications on control beds were consistent with the water applications to fertigated beds. Fertigation and control treatments were applied according to a randomized complete block experimental design with six replications.

Pepper Culture: Pepper transplants were planted into the high tunnel growing beds on June 26, 2012. The planting configuration consisted of two rows of plants with 18'' between the rows and 18" between plants within a row. A total of 12 plants were grown in each bed. Three beds were planted to Lady Bell, three beds to Red2Green, two and one-half beds to Ace, and one-half bed to Cayenne. Fertigation treatments were applied to two Lady Bell, two Red2Green, and one and one-half Ace beds. The remaining beds were not fertigated and served as controls. Irrigation applications on control beds were consistent with the water applications to fertigated beds. All peppers were removed from all the pepper plants on August 2, prior to initiating fertigation treatments.

Fertigation Treatments: Ten pounds per acre nitrogen, phosphorus, and potassium (Peter's 20-20-20) were applied weekly through the drip irrigation system, starting the week of August 13, 2012.

Soil Sampling: Soil samples were collected from the control tomato beds, fertigated tomato beds, control pepper beds, and fertigated pepper beds prior to initiating the fertigation treatments in August. Soil samples were sent to Agro One (Dairy One) for analysis.

Leaf Tissue Sampling: Leaf samples were collected from control tomato plants, fertigated tomato plants, control pepper plants, and fertigated pepper plants. The first baseline set of leaf samples were collected prior to starting the fertigation treatments in August. A second set of samples were collected on September 4. All samples were sent to Waters Agricultural Laboratories for analysis.

Harvest: Tomato and pepper beds were harvested on September 10, 2012. All the fruits were harvested regardless of size or color, and harvest weights were recorded for each bed.

Grower Testing:

- As a follow up to the in-depth fertility trainings we held last March, we offered a free soil test to all attendees. 26 growers from across NNY submitted soil samples. Some had much higher levels than the grower expected, and some had much lower. During field meetings and farm visits we found and discussed signs of nutrient deficiency (photo 1) and explained why waiting until symptoms show up is too late to optimize yield.
- One high tunnel grower had a large part of his crop ruined by interior white-wall, a condition that results from potassium deficiency (photo 2). In this case the grower's soil test at the beginning of the season indicated sufficient potassium, but without regular foliar testing he wasn't able to see the deficiency develop in the plant until the fruit was damaged. A foliar test confirmed the deficiency, but it was too late to turn the situation around in time for a good harvest.

Results:

Tomato and Pepper Yields: Yields of *Pineapple* tomatoes, and *Ace* and *Red2Green* peppers were higher on growing beds receiving weekly fertigation applications of 10 lbs/acre nitrogen, 10 lbs/acre phosphorous, and 10 lbs/acre potassium, than on control beds (Figures 1&2). Average yields in the *Lady Bell* pepper beds were slightly higher on the control beds than the fertigated beds, and all *Lady Bell* pepper beds had higher mean yields than any of the *Ace* or *Red2Green* pepper beds (Figure 2).

Phosphorous and Potassium: While weekly fertigation appears to have increased yields in the tomato, and *Ace* and *Red2Green* pepper beds, leaf tissue nutrient analyses suggest that the late season fertigation applications may not have been sufficient to optimize tomato and pepper yields. Pre-fertigation leaf nutrient analyses found "sufficient" levels of phosphorous for tomatoes and peppers, and "sufficient" levels of potassium in the peppers, but tomato leaf potassium levels were "low" or "deficient" (Tables 2&3). Potassium deficiencies in the tomato plants may be explained by the larger plant size with the tomatoes, and the fact that the tomatoes had been growing in the high tunnel for two months longer than the peppers.

It is interesting that pre-fertigation tomato leaf potassium levels were "low", while the pre-fertigation soil test results found soil potassium levels to be "high" in all the growing beds (Table 1). This suggests that either the standard soil test results are not well suited to high tunnel production conditions, or our irrigation management did not enable the tomato plants to effectively access the potassium in the growing beds.

Tomato leaf tissue samples collected after three weeks of fertigation (September 4, 2012) were "low" or "deficient" in phosphorous and potassium in both fertigated and control beds (Tables 2&3). Leaf phosphorous levels in peppers were also "deficient" in both fertigated and control beds, while potassium levels were "deficient" in the control plants, but "sufficient" in the fertigated peppers. "Sufficient" potassium levels in the fertigated pepper leaves suggest a benefit from the fertigation applications.

Nitrogen: Leaf tissue nutrient analyses indicate that the fertigation applications did not supply enough nitrogen to the tomatoes. Pre-fertigation leaf nitrogen levels in all the

tomatoes were “low” (Table 4). While the tomato beds were fertilized with 25 lb/100sqft 5-3-4 at planting, the tomatoes had been growing for three months and nitrogen levels were expected to be low in the pre-fertigation samples. Tomato leaf nitrogen levels remained “low” in the fertigated plants after three fertigation applications, and were “deficient” in the control plants. The observation that the fertigated plants maintained a “low” test level and did not fall to the “deficient” level indicated that the plants benefited some from the fertigation treatments, but nitrogen levels were still less than optimal.

Pepper leaf tissue tests indicate that the fertigation applications provided adequate levels of nitrogen to the pepper plants. Pre-fertigation pepper leaf samples registered as “high’ or “sufficient”. After three fertigation applications, the fertigated pepper leaf tissue samples were “sufficient”in nitrogen, while the controls were “deficient” (Table 4).

Conclusions/Outcomes/Impacts:

Increased yields with *Pineapple* tomatoes, and *Red2Green* and *Ace* peppers indicate that the plants responded to the late season fertigation regime. Leaf tissue nutrient tests also illustrated some benefit from the fertigations, but it was clear that the weekly 10 lbs/acre nitrogen, phosphorous, and potassium fertilization rate was not enough to maintain optimum nutrient levels in either the tomatoes or peppers. Both crops would likely have benefited from a more aggressive fertigation approach. The leaf tissue testing highlighted how essential it is to regularly sample plant nutrient status, and adjust management practices accordingly to optimize yields.

Outreach:

- Summer farm visits with Stephen Reiners and Judson Reid to talk with growers about their fertility management practices and challenges, in St. Lawrence, Clinton and Essex Counties.
- Field meetings with guest speakers Stephen Reiners and Judson Reid in St. Lawrence County and Essex County in July.
- Grower discussion group meetings in December with Stephen Reiners in Watertown and Mike Davis in Keeseville to reinforce the importance of soil testing for field grown crops and plus foliar testing for tunnel grown crops.
- Articles summarizing research results will be forthcoming in regional newsletters and posted on NNY ADP website.

Next steps if results suggest continued work is needed in the areas of research, demonstration and/or education.

- 2012 was an extremely dry summer. Many growers across NNY suffered crop losses due to inadequate Irrigation. We need to convince them that the greater yield to be had with adequate irrigation will offset the initial cost of setting up irrigation.

- Many growers, especially the newer growers, are uncertain how to set up an irrigation system. They need training in how to set up and manage irrigation systems to give them confidence to make the investment of time and money.
- The soil and foliar testing done last summer showed deficiencies before symptoms were visible. While our soil testing regime provided growers with insight to their actual fertility conditions, more work is needed to encourage growers to test regularly and amend their nutrients pro-actively rather than waiting for a problem to develop before taking action.

Person(s) to contact for more information:

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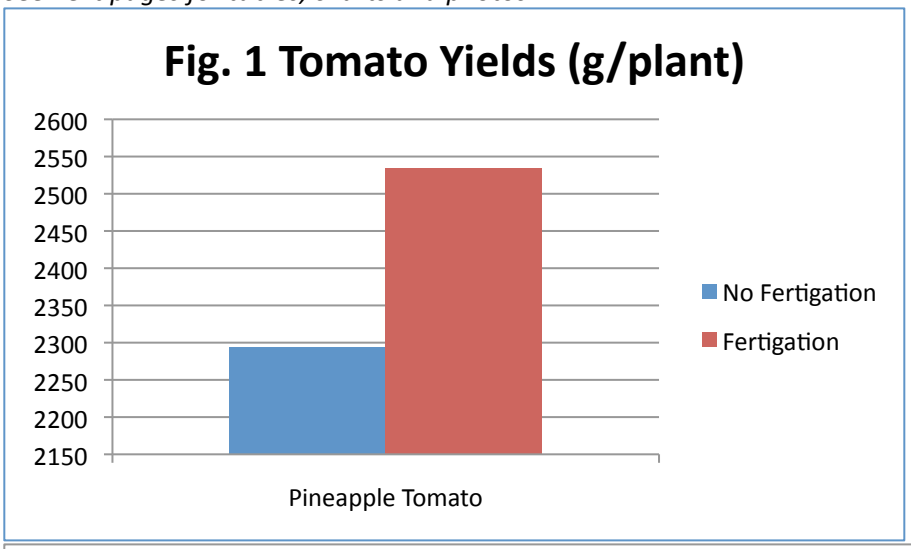
See next pages for tables, charts and photos



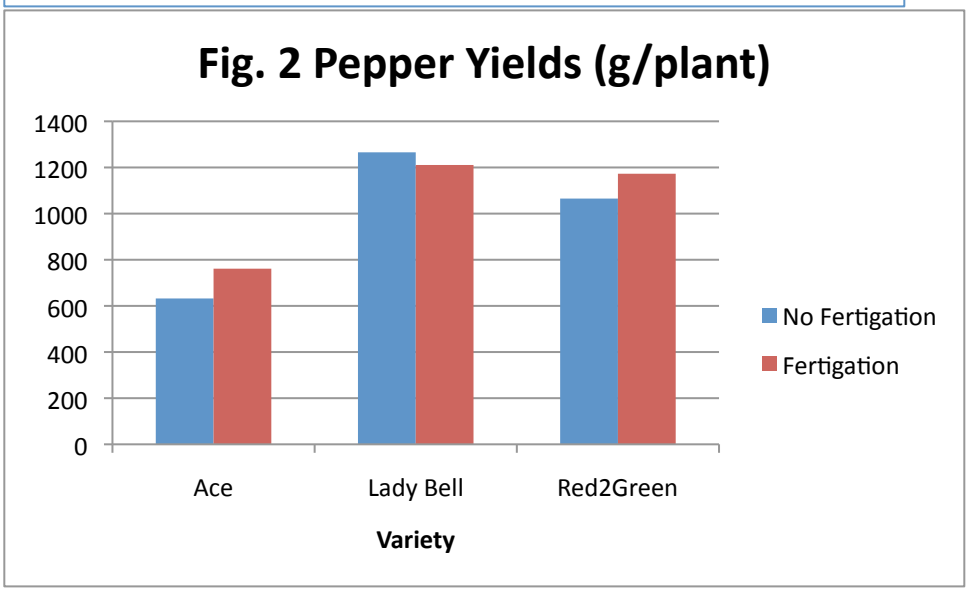


Table 1. Pre-fertigation soil sample results from the high tunnel growing beds.

Treatment Beds	Phosphorous	Potassium	Calcium	Magnesium	Soil pH
Fertigated Tomato	High	High	Optimum	Optimum	6.7
Control Tomato	High	High	Optimum	Optimum	6.5
Fertigated Pepper	High	High	High	High	7.1
Control Pepper	High	High	High	High	6.9

Table 2. Leaf Tissue Phophorous (P) Levels

Categories options: *Deficient, Low. Sufficient. High, Excessive*

Treatment Beds	Pre-fertigation P level	Post-fertigation P level
Fertigated Tomato	Sufficient	Low
Control Tomato	Sufficient	Low
Fertigated Pepper	Sufficient	Deficient
Control Pepper	Sufficient	Deficient

Table 3. Leaf Tissue Potassium (K) Levels

Categories options: *Deficient, Low. Sufficient. High, Excessive*

Treatment Beds	Pre-fertigation K level	Post-fertigation K level
Fertigated Tomato	Deficient	Deficient
Control Tomato	Low	Deficient
Fertigated Pepper	Sufficient	Sufficient
Control Pepper	Sufficient	Low

Table 4. Leaf Tissue Nitrogen (N) Levels

Categories options: *Deficient, Low. Sufficient. High, Excessive*

Treatment Beds	Pre-fertigation N level	Post-fertigation N level
Fertigated Tomato	Low	Low
Control Tomato	Low	Deficient
Fertigated Pepper	High	Sufficient
Control Pepper	Sufficient	Deficient

Photo 1. Stephen Reiners explains the symptoms of magnesium deficiencies to growers at a field meeting in Essex County (Photo by Amy Ivy)

Photo 2. These high tunnel tomatoes looked perfect on the outside but were ruined by this white-wall condition which is caused by a potassium deficiency. (Photo by Amy Ivy)