SARE grant ONE04-028, High Tunnel Tomato Variety Trial Final Report
Summary

There has been rapid expansion of greenhouse tomato production in New York State over the last 5 years. Greenhouse tomatoes capitalize on local markets and available labor. However, heating a greenhouse in upstate New York requires high-energy input and can be cost prohibitive. An alternative to a fully heated greenhouse is the hoop house or high tunnel. Unlike greenhouses, these structures have no supplemental heat or automated ventilation. High tunnels can be moved, which offers an advantage for rotating into fresh soil for tomato culture, to avoid pest and disease build-up, as well as nutrient depletion.

Until this trial, determinant, field varieties were grown in high tunnels. Due to the high yields obtained by local growers with hydroponic, indeterminate varieties in greenhouses, we decided to investigate if these varieties would perform better than determinate field types in an unheated high tunnel. A trial of 4 tomato varieties was established within an unheated high tunnel at a cooperating farm. 21 plants each of indeterminate varieties Boa, Trust, Big Beef, and determinate variety Mtn. Spring, were transplanted in a randomized complete block design with 4 replications. The indeterminate varieties were trained to a vertical trellis and single growing point, while the determinate variety was pruned for optimal production within a tomato cage.

Harvest and data collection began on July 1, 2004 and ended November 2, 2004. Yield data was recorded for each harvest using a digital scale. Total weight per block in pounds was recorded as well as number of fruit. For each variety in the trial mean weight per plant, mean fruit per plant and mean weight per fruit was calculated. Data were analyzed using Analysis of Variance (ANOVA), and treatment means were separated using Fishers Least Significant Difference.

Varieties Big Beef and Boa had significantly higher yields than Mtn. Spring and Trust as measured by mean tomato yield per plant. Big Beef and Boa also yielded significantly higher number of mean fruit per plant than Mtn. Spring. Big Beef yielded a significantly heavier mean weight per fruit than the other three varieties. These results suggest that high tunnel tomato growers could realize higher yields by adopting indeterminate varieties and trellis methods of heated greenhouses, but the trial should be repeated another season before conclusions are made.

Introduction

Hothouse tomato production has grown by over 1000% in the Finger Lakes region of New York over the last 3 years. Hothouse tomatoes are divided into fully heated and vented greenhouses and unheated hoop houses or high tunnels. High tunnel production is well suited to local farms for several reasons:

- High tunnels use no electricity.
- Soil management can be simplified.
- Generally there are less insects and diseases in unheated hoops.
- Hoops eliminate the most expensive input for local growers-heat.
With fewer inputs, the return to investment is greater, sooner. This technology is more sustainable as hoops use less non-renewable resources than heated greenhouses. Tomatoes are the most common tunnel crop.

Heated greenhouses generally out-yield hoop houses, in part due to the use of prolific, indeterminate varieties bred for the greenhouse. These varieties are disease resistant and have yields often twice that of the determinant varieties commonly used in unheated hoops. Could their high yields be achieved in the high tunnel, a less optimal environment?

**Objectives/Performance Targets**

We hoped to compare 4 tomato varieties in an unheated high tunnel by measuring yield in total weight, total number of fruit, and mean fruit weight.

We endeavored to share our information with other growers in the region.

We wanted to compare vertical to horizontal trellising.

We wanted to observe disease and insect pest trends in the high tunnel, and manage them in a sustainable manner.

**Materials and Methods**

On March 6, 2004 106 seedlings each of 4 tomato varieties were transplanted into eight 58 cell (1.53”x 2.38”) flats filled with commercial potting mix (Promix, Premier Horticulture, Quebec) at a bedding plant greenhouse in Dundee, NY. Seedlings were watered and periodically fertilized with 20-20-20 until transplanting in the high tunnel on May 1. 21 plants each of indeterminate varieties Boa, Trust, Big Beef, and determinate variety Mountain (Mtn.) Spring, were transplanted at an in-row spacing of 16” with 42” between rows in a randomized complete block design with 4 replications. Black plastic mulch and drip tape were laid prior to transplanting. Varieties Boa, Big Beef and Trust were trained to a single leader and vertically trellised as in greenhouse culture. Mtn. Spring were pruned to 4-5 leaders and supported with tomato cages. Weekly during the growing season the indeterminate varieties were trained to a vertical trellis and single growing point, while the determinate variety was pruned for optimal production within a tomato cage.

Tissue analysis was performed by the Cornell University Department of Horticulture Nutrient and Elemental Analysis Lab on tomato leaves to determine nutrition status and needs. The crop was fertilized through a 1:100 injector via irrigation drip tape. 5 lbs. soluble 20-20-20 with micronutrients (Miller’s) and 20 lbs 9-15-30 with micronutrients
were fertigated over the course of the growing season. 10 lbs magnesium sulfate (as Epsom Salts) were injected as 2 lbs doses at 5 intervals during the growing season.

Arthropod Pests and Diseases

No pesticides were used in this trial. Minor levels of white mold (*Sclerotinia sclerotiorum*), gray mold (*Botrytis cinerea*), and leaf mold (*Cladosporium fulvum*) occurred in the high tunnel. None approached economic threshold. No insect injury was detected. Rye straw was distributed on the floor to reduce dust, which contributes to two spotted spider mite (*Tetranychus urticae*) populations. No visible spider mite injury occurred. Powdery mildew (*Leveillula taurica*) appeared in late September. An interesting development was widespread late blight (*Phytophthora infestans*) in field grown tomatoes throughout the region. The disease was present in the farmer’s home garden 30 feet from the high tunnel, yet no late blight was observed within the tunnel.

Broiler chicks for personal consumption were housed in the high tunnel beginning September 7.

**Accomplishments/Results and Discussion/Milestones**

Harvest and data collection began on July 1, 2004 and ended November 2, 2004. Data presented herein covers the period from July 1 until October 12, 2004. Yield data was recorded for each harvest using a digital scale. Harvests were recorded on forty (40) separate dates. Total weight per block in pounds was recorded as well as number of fruit. For each variety in the trial mean weight per plant, mean fruit per plant and mean weight per fruit was calculated. Data were analyzed using Analysis of Variance (ANOVA), and treatment means were separated using Fishers Least Significant Difference by the Dillard lab at the New York State Agriculture Experiment Station (NYSAES).

Varieties Big Beef and Boa had significantly higher yields than Mtn. Spring and Trust as measured by mean tomato yield per plant (Table 1). Big Beef and Boa also yielded significantly higher number of mean fruit per plant than Mtn. Spring. Big Beef yielded a significantly heavier mean weight per fruit than the other three varieties.
Table 1. Mean yield per plant, mean fruit per plant and mean fruit weight of 4 tomato varieties in a grower’s high tunnel.

<table>
<thead>
<tr>
<th>Variety</th>
<th>Mean yield per plant (pounds)</th>
<th>Mean fruit per plant</th>
<th>Mean weight per fruit (pounds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Big Beef</td>
<td>21.23 a*</td>
<td>37.38 a b</td>
<td>0.57 a</td>
</tr>
<tr>
<td>Boa</td>
<td>19.41 a</td>
<td>40.86 a</td>
<td>0.47 b</td>
</tr>
<tr>
<td>Trust</td>
<td>16.49 b</td>
<td>34.54 b c</td>
<td>0.47 b</td>
</tr>
<tr>
<td>Mtn. Spring</td>
<td>16.35 b</td>
<td>33.12 c</td>
<td>0.50 b</td>
</tr>
<tr>
<td>LSD (P&lt;0.05)</td>
<td>2.12</td>
<td>4.24</td>
<td>0.03</td>
</tr>
</tbody>
</table>

*Means with different letters (grouping) differ significantly according to Fishers Protected LSD (P<0.05).

Figure 1. Yield of Four Tomato Varieties in a High Tunnel over Time.
The indeterminate varieties yielded more consistently over time than Mtn. Spring. This may be an advantage or disadvantage depending on market windows. If a grower prefers a heavy flush of fruit prior to availability of field grown tomatoes, the determinate variety may be preferable. Alternatively if the grower desires a long, sustained harvest, the indeterminate types were superior in this trial. Economic research of price trends at wholesale produce auctions is required to assist growers with this decision.

**Impacts and Contributions/Outcomes**

By implementing vertical trellising and indeterminate varieties into the participating grower’s high tunnel we demonstrated a potential increase in revenue of $4880 in a 500-plant operation. This represents a potential for $21230 of income in the improved management approach vs. $16350 in the previous style. Although it was not in the scope of this grant to measure adoption by other growers, the higher yields (with no heat or pesticides) made for excellent extension opportunities. Over 50 growers, or people interested in growing this style, were given tours and yield data at the trial site, including an attendance of 40 growers at a summer twilight meeting. A Power Point presentation will be made to over 300 growers, researchers and extension professionals in the Winter of 2005. A print summary of the project will be in the hands over 26,000 people via Small Farm Quarterly. Findings were direct mailed to the Extension database of hothouse tomato growers in the region. Judson Reid has submitted a research report to be presented at the National Agricultural Plastics Congress, March 2005.

Several growers have contacted the principal investigator expressing a willingness to cooperate on similar SARE grants in the coming seasons.

The cooperating grower, Howard Hoover, was invaluable to the success of this project. However, as a member of an Old Order Mennonite community, Mr. Hoover is reluctant to have his name featured prominently in any publicity.

**Areas Needing Additional Study**

Further research is needed to evaluate other indeterminate varieties and heirloom varieties for high tunnel production. Economic comparisons should be made between greenhouses and high tunnels including prices received during various market windows at produce auctions. Nutrient and disease management may become emerging issues in these production systems. Additional crops should be evaluated for their suitability in New York high tunnels. Efficacy of biological disease control materials is necessary. Research and extension activities of these areas will promote sustainable agriculture in the region’s farming community.