

# **Organic Production in High Tunnels**

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## **Introduction**

High Tunnels have several production characteristics that make them ideal for organic growing of vegetables and fruits. Plants grown in high tunnels are protected from rain, and constant wet foliage caused by dew, which often is the major cause of serious disease problems. Daily water needs are supplied by drip irrigation, which can prevent erratic soil moisture conditions, which are often the cause of fruit cracking. Plants are protected from high winds, which can cause micro bruises of the plant tissue and allow disease organisms to invade the plants. Since high tunnels supply plants with ideal growing conditions as compared to outside production, much of the overall stress is eliminated. Because of the increase in both growing days and heat units, producers have an excellent opportunity to use cover crops and methods to help comply with different organic recommendations and requirements.

High tunnels provide a safe haven for predatory insects to live and thrive, whether they are natural or introduced into the high tunnel system. This gives the organic high tunnel producer another major tool to control insects.

Since high tunnels utilize a very small amount of land as compared to field production, it is easily possible to change the soil texture and soil structure to provide ideal growing conditions.

In properly managed high tunnels there is little leaching of plant nutrients from the soil, which gives the high tunnel producer the opportunity to supply plant nutrient needs on a monitored consistent basis resulting in very high yields of excellent quality. This also gives the organic producer the opportunity to efficiently use organically approved soil fertility products that may be too costly or time consuming to use in outside applications.

In high tunnels, yields of individual plants can be very high; growers have many options of plant training such as staking, trellising, pruning and ground production. Different plant spacing can be utilized to help control disease and utilize light to full potential while still obtaining optimum yields.

When high tunnels are used with good management, organic producers have an excellent opportunity to produce very high quality produce at an economical cost, which will bring excellent prices at the marketplace.

### **Organic High Tunnels at the NWROC**

With the above concepts in mind, a long-term organic high tunnel demonstration and research project was started near the North West Research and Outreach Center at Crookston, Minnesota, in 2006.

The project was designed and implemented by members of the University of Minnesota High Tunnel Production Team - Terry Nennich, Carl Rosen, Jerry Wright, and Mike Klawitter. Sponsors of the project included the Northwest Minnesota Partnership, Mount Saint Benedict, Northwest Minnesota Initiative Foundation, and University of Minnesota Crookston.

The 26'x48' high tunnel was constructed in the spring of 2006. A late spring and heavy rains prevented construction of the high tunnel as early as planned. Because of lateness of construction, the production in 2006 was limited to some very late-season demonstration tomatoes, peppers, cucumbers, and fall crops.

The high tunnel was certified organic in the spring of 2007 by the Minnesota Crop Improvement Association (MCIA). The high tunnel team would like to acknowledge the efforts and cooperation of MCIA for the accomplishment.

As a comment to those considering high tunnel production, high tunnels should be constructed the fall or summer before they are planned to be put into full production. Problems that are often encountered with high tunnels built in the spring are: lateness because of adverse weather conditions; soil compaction because of construction; cool soils inside the high tunnel; and not enough time to do proper soil amending. The transplants grown for the tunnel might not be able to be transplanted in a timely manner resulting in poor plant growth, less than optional yield, and an overall less than ideal grower experience during the first year.

The natural soil that the high tunnel near Crookston was built over was very heavy clay, which was less than ideal for high tunnel production. In the late fall of 2006 and early winter of 2007, enough sand was added to the tunnel to change the soil texture from a heavy clay to a sandy clay loam. The amount of sand added was 1 cubic yard per 100 square foot of area inside the tunnel. After complete incorporation of the sand, horse manure compost was brought in and incorporated at the rate of one-half cubic yard per 100 square foot to raise the soil fertility to a very high level.

The high tunnel team reviewed much of our research at the Grand Rapids and Staples sites over the last several years and summarized the major concerns

that may need to be addressed in an organic high tunnel production system. These included enough soil fertility to supply the high production, especially Nitrogen and Potassium; disease control with a focus on tomato and cucumber leaf diseases; and general insect pest control.

To address these issues the following changes were made to focus on organic production.

1. The soil beds were raised about 1 inch from 4 to 5 inches and the widths of the beds were increased from 16 to 20 inches. This was done to allow more root accessibility to soil nutrients while still allowing a single line drip tape to water each row.
2. Enough compost was added before planting to improve soil structure and supply a high level of nutrients.
3. Additional plant nutrients were supplied by adding an organic-approved fish solution of a 4-1-1 analysis that was compatible with drip irrigation in the drip line on a weekly basis. (It is assumed that the fish concentrate also contains a high level of micro-nutrients.)
4. The in-row spacing of the variety of Sweet Success cucumbers was increased from 12 inches to 18 inches.
5. The in-row spacing of indeterminate tomatoes was increased to 24 inches.
6. Pruning of tomatoes was done to optimize air flow and yield. The christmas tree pruning method was used as an additional pruning method to reduce extra outside foliage.
7. The in-row spacing of determinant tomatoes was increased to 18 inches.
8. Plant nutrients were monitored by taking leaf samples during the growing season.
9. Soil fertility was assessed by taking soils samples at 0-6 inches, 6-12 inches, and 12-24 inches before and after the growing season. Soil tests after the growing season were taken for the tomatoes, cucumbers, onions, and lettuce.
10. Insects were monitored and controlled with natural control insects as much as possible; much of this work was conducted by Dave Wildung from the North Central Research and Outreach Center near Grand Rapids, Minnesota.
11. Organic-approved crop protectants for possible insect and disease control needs would be researched, purchased and be available for immediate use in the event of a insect or disease outbreak.

## **Results**

The above methods were used on a timely basis, as much as possible. Yields and quality of all the products grown, including tomatoes, cucumbers, lettuce, onions, and melons, were excellent.

Call it first year luck, or a successfully planned strategy, but we had minimal incidence of disease or insects. We did have a slight problem with tomato

hornworm on the outside tomato rows of the tunnel where the Sunshine and Mt. Spring were planted. This did account for a higher amount of culls in those varieties. The tomato hornworm was controlled with diatomaceous earth.

## **Yield Data and Comments**

### **Tomatoes**

All the fruits from all the plants, which consisted of 20 Cobra, 26 Sunshine, and 26 Mountain Spring plants, were weighed and evaluated for quality. All data is in pounds per plant.

<b><u>Variety</u></b>	<b><u>First harvest</u></b>	<b><u>Total yield</u></b>	<b><u>Culls</u></b>	<b><u>Marketable S/F</u></b>	<b><u>Total S/F</u></b>
Cobra	June 28	37.0	4.0	3.89	4.63
Sunshine	June 24	16.51	5.1	1.90	2.75
Mt. Spring	July 11	18.5	4.2	2.38	3.08

### **Cucumbers**

All the fruit from all 26 cucumber plants were weighed and evaluated for quality. All data is in pounds per plant.

Sweet Success	June 21	65.12	8.0	9.52	10.85
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### **Lettuce**

The lettuce used was a loose-leaf type Musculin Mix blend. Planting date was April 11, first harvest date was May 8<sup>th</sup>, and yield was .95 pound per running ft of single row for the season.

### **Onions**

Onions transplants were planted on April 16<sup>th</sup> in double rows with the between-row spacing of 8 inches and in-row spacing of 5 inches. The yellow variety of Candy was used. Onions were harvested when about 50% of the tops started to become weak and fall over. Yield was 60.2 pounds per 20ft of row. Average onion size was .627 pounds.

## **Soil Test Results**

Below is the soil test data received from Cobra tomatoes and Sweet Success cucumbers. The data below indicates that in a high tunnel system soil fertility management is of major concern. The before and after soil tests indicate that the high yields obtained extracted most of the available nutrients from the soil, leaving a nutrient challenge for the following year.

Cobra Tomatoes  
0-6 inch soil depth

	N	P	K
Before Season	335	330	1050
After Harvest	11	215	235

Cobra Tomatoes  
6-12 inch soil depth

	N	P	K
Before Season	100	150	580
After Harvest	8	80	320

Cobra Tomatoes  
12-24 inch soil depth

	N	P	K
Before Season	18	60	275
After Harvest	8	55	260

Sweet Success Cucumbers  
0-6 inch soil depth

	N	P	K
Before Season	335	330	1050
After Harvest	12	175	256

Sweet Success Cucumbers  
6-12 inch soil depth

	N	P	K
Before Season	100	150	580
After Harvest	7	69	320

Cobra Tomatoes  
12-24 inch soil depth

	N	P	K
Before Season	18	60	275
After Harvest	8	55	260

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## High Tunnels at the SWROC

Due to interest from organic growers in the region, a high tunnel research and outreach program is currently being initiated at the Southwest Research and Outreach Center (SWROC) in Lamberton, MN. In 2008, one high tunnel was constructed at SWROC, and will be managed organically throughout the growing season. The first year of this project is being funded by the SWROC and with a gift from the Cooperative Regions of Organic Producer Pools (CROPP), an organic-farmer-owned cooperative of the Organic Valley Family of Farms™ products. Start-up funds will be used to begin a program in high tunnel organic vegetable production research and demonstration, and to coordinate a symposium on high tunnels at the SWROC in Fall 2008. Future plans include the construction of additional high tunnels and the expansion of organic high tunnel research.



**High tunnel at SWROC.** Photo by C. Fernholtz.



Kelley Belina explains the high tunnel at the SWROC's Organic Field Day.



Organic Field Day participants view the high tunnel.