

**SWROC High Tunnels:
Extending the Season for Organic Vegetable Production
Year Two Report**

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October 2011

INTRODUCTION

High tunnels are plastic covered, low-energy use structures capable of extending the growing season earlier in the spring and later in the fall, increasing the availability and amount of locally grown food. 2011 was the second of three years of funding from The Ceres Trust to support the high tunnel research and outreach project at the University of Minnesota's Southwest Research and Outreach Center (SWROC) near Lamberton. In 2010, three new 48' x 30' high tunnels were built at the SWROC, and 2011 was their first season in production.

The objective of the high tunnel program at the SWROC is an experimental-based research and outreach program focused on extending the growing season for organic vegetable production. Current experiments center on soil and plant fertility and variety trials for Southwestern Minnesota. To conduct statistically accurate experiments we are using three high tunnels. This research will provide information for organic growers, and will be submitted for publication in peer reviewed journals. In addition, we work to collaborate with U of MN high tunnel research in other parts of the state, and with U of MN Extension Educators, as interest in organic and local food continues to expand.

DATA AND DETAILS FROM THE 2011 SEASON

Winter Durability and New Plot Plans

Construction and preparation for SWROC's three new high tunnels was completed in fall, 2010. They overwintered well and the plastic on all three supported a heavy snow-load. Minor repairs were needed in the spring, including patching some tears in the lower plastic, and fixing two of the six automatic side roll-up mechanisms. Now, with an understanding of how snow settles around the tunnels, and boxes made to fit over the side roll-up mechanisms, future spring maintenance will be easier.

An important change was made during the winter to our experimental plan. We decided to expand the trials to include three, instead of two, soil fertility treatments. We had previously planned two treatments: planting, or not, an overwintering cover crop. The new plan includes three treatments: a) an overwintering cover crop, b) a spring compost application, and c) an overwintering cover crop with spring compost application. We felt that these treatments will give us better data on whether using a cover crop in organic high tunnels has a beneficial effect on soil and plant fertility.

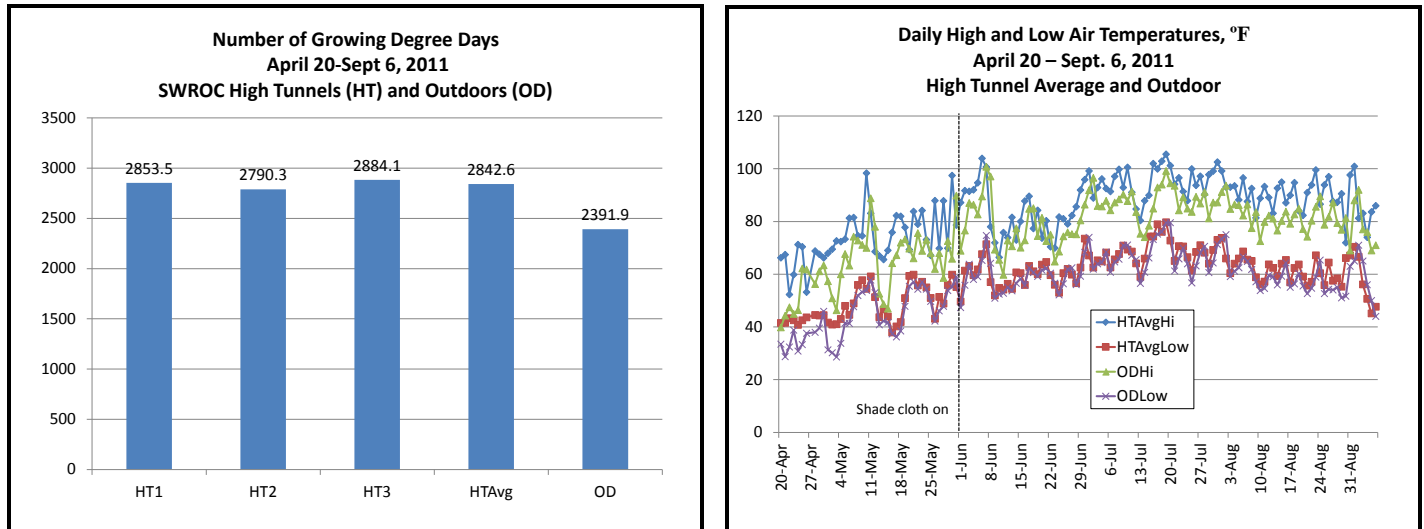
Because of this change, 2011 did not include a cover crop treatment. In fall 2010, hairy vetch had already been planted into the previously planned plots. To rectify this, in February 2011, the above-ground vetch was removed prior to soil preparation. We took soil samples and tested for differences where the cover crop had been planted, and none were found. Cover crops will be planted in the 'new' plots in fall 2011. Thus, treatments for the 2011 season were: a) a spring compost application, and b) a no compost treatment. Even without a cover crop treatment this year, we believe this is the best plan and will yield more interesting data.

Temperature and Growing Degree Days

The cool, wet spring this year near Lamberton showcased the early season benefit of high tunnels, with quality tomato harvests one to two months earlier than what local gardeners were getting outdoors.

Warm, dry weather followed in July. We used shade cloth over the high tunnels from June 1 – Sept. 13. This worked well to keep inside temperatures from getting too high. Available data from April 20-Sept 6 show an average of 450.7 more growing degree days (GDDs) in the high tunnels than outside (Figure 1). High tunnel three (HT3) was the warmest, with 2884.1 GGDs, and high tunnel two (HT2) the coolest, with 2790.3 GGDs.

Figures 1 and 2.



Average daily high and low temperatures (Figure 2) show that, as expected, daily high temperatures in the high tunnels consistently stay above outdoor temperatures. Before mid-May, the high tunnels also have the effect of keeping HT low temperatures above the outdoor lows. After this time however, low temperatures in the high tunnels are similar to the daily outdoor low temperatures. This shows that while high tunnels do accumulate more GGD units than outside, they do eventually cool down at night.

Soil Tests

Soil tests are taken each fall and spring to track soil fertility and to test for differences among treatments. In fall 2010, after the high tunnels were constructed and sand added to the bed areas, soil samples were taken on 9/8/10 from each bed. Analysis of these samples confirmed consistency of soil nutrients within each high tunnel. In the spring, after the beds were prepared and planted, soil samples were taken again on 4/29/11. In this case samples a) confirmed no difference between areas where vetch was planted or not planted in fall 2010 (see introduction); and b) were taken at three depths to compare the 2011 compost and no compost treatments.

In least squares mean comparisons of the compost and no compost treatments across all three high tunnels, Ca and Mg were not different by treatment or depth. However, total N, P, and K, were, as expected, significantly higher where compost was applied (C) than where it was not (noC): N (C=215.7 lbs/A, noC=136.6 lbs/A), P (C=87.7 ppm, noC=38.2 ppm), and K (C=380.3 ppm, noC=240.3 ppm). Comparison of the three depths across high tunnels show: for P, 0-6" was highest (100.0 ppm) and significantly different than 6-12" (45.2 ppm) and 12-24" (43.7 ppm); for K, 0-6" was highest (380.3 ppm) and

significantly different than 12-24” (250.5 ppm) but not 6-12” (299.7 ppm); and for total N, 0-6” and 12-24” were similar (198.7 and 198.0 lbs/A respectively) and both significantly different than 6-12” (132.0 lbs/A). See Table 1 for spring 2011 nutrient levels by treatment and depth. As of this writing we do not yet have analysis from the fall 2011 soil samples.

Table 1.

SWROC High Tunnels: Spring 2011 soil tests taken April 29 after beds had been prepared and planted. This is the first year of a long-term project in newly constructed high tunnels. There are two treatments this year: a spring compost application(C), and no compost(noC). A overwintering vetch cover crop will be planted this fall for a third treatment.						
Depth, in						
Total N, lbs/A	HT1-C	HT1-noC	HT2-C	HT2-noC	HT3-C	HT3-noC
0-6	229	167	173	102	298	223
6-12	150	83	184	89	143	143
12-24	271	174	267	102	228	146
P Bray, ppm						
0-6	152	51	125	42	154	76
6-12	69	31	54	35	52	30
12-24	83	28	65	19	35	32
K, ppm						
0-6	530	171	442	275	528	339
6-12	376	244	358	257	300	263
12-24	333	217	337	183	219	214
Ca, ppm						
0-6	2317	1693	2116	2626	2325	2593
6-12	2235	2240	2498	2561	2255	2496
12-24	2228	2254	2507	2372	2185	2279
Mg, ppm						
0-6	531	330	479	516	556	542
6-12	488	468	542	508	523	548
12-24	488	467	543	470	498	514

Spring Crops

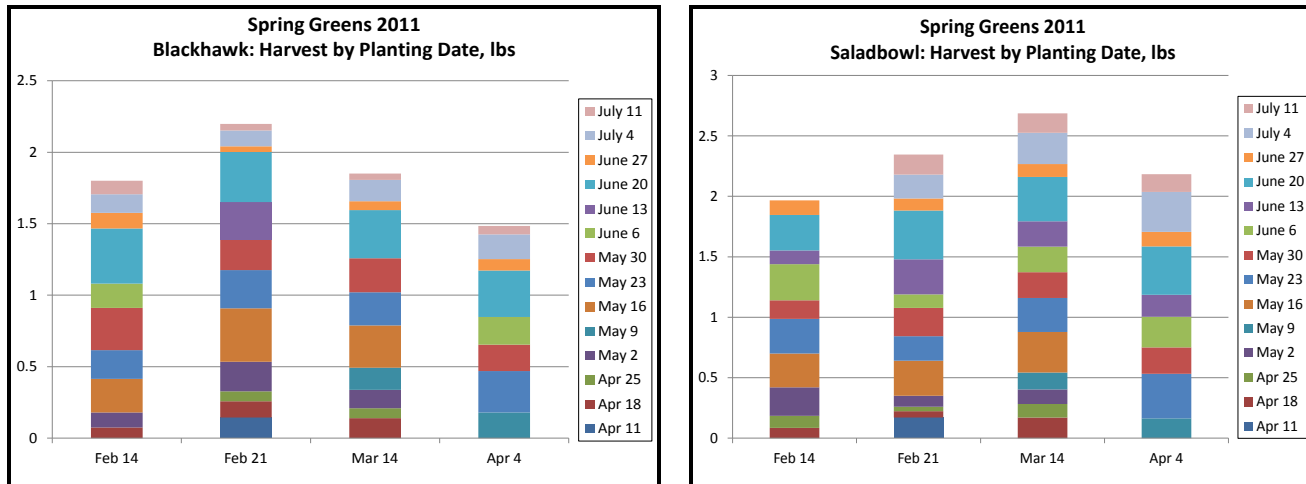
Beginning in February, spring crops were planted on four dates - Feb. 14, 21, March 14, and April 4 - in the high tunnels in compost and no compost plots. In 2011, we grew Saladbowl, a green loose-leaf lettuce, Blackhawk, a red loose-leaf lettuce, and Tyee spinach. We also planted Pink Beauty radishes, Hakurei salad turnips, and Napoli carrots on Feb. 14, and Evergreen Hardy White scallions on Feb. 24. An internal row cover was used over the spring crops until May 3.

Of the vegetables, the Hakurei turnips had high germination rates and produced beautiful and tasteful salad turnips. These were harvested from 4/21-5/5. Our radishes did not germinate or produce well, nor did the carrots. The carrots that did produce were harvested on 6/10. The scallions, after a slow start, ended up producing well, and were harvested on 6/14.

Both types of lettuce produced well and gave repeated cuttings into July. We harvested lettuce until 7/14, which was two weeks longer than in 2010. These extra two weeks may have been due to the cool spring and the use of the shade cloth this year. Our spring spinach did not germinate or produce well, and we are not sure why this occurred. There was no effect of compost vs. no compost treatment on greens production. This is not surprising as this is the first spring growing in the new location.

Figures 3 and 4 below show weekly lettuce yields from each of the four planting dates. For Blackhawk, the 2/21 seeding date gave the largest harvest, and both of the February planting dates produced until the last harvest week of July 22. For Saladbowl, the 3/24 seeding gave the largest harvest and all but the first planting on 2/14 produced until the week of July 22.

Figures 3 and 4.



Summer Crops

Summer crops of peppers, tomatoes, and cucumbers were started in the SWROC greenhouse and transplanted into beds in the high tunnels. Determinate tomatoes, indeterminate tomatoes, and peppers were transplanted on April 19, and cucumbers on April 28. The one production problem we encountered this year was bacterial wilt in the cucumbers (see below). Total harvest from our three high tunnels was: 352.4 lbs of peppers (236.5 Ace, 115.9 Lipstick), 507.9 lbs of cucumbers (233.2 Socrates, 274.7 Sweet Success), 739.8 lbs of indeterminate tomatoes (320.4 Brandy Boy, 419.5 Cobra), and 1749.3 lbs of determinate tomatoes (997.1 BHN-589, 752.2 Scarlet Red). See Table 2 below for harvest data by variety, in lbs per plant. For all four summer crops, there was no significant difference in yield between the compost and no compost treatment. This is not surprising given it is the first year in the new location.

Table 2

SWROC High Tunnels: Harvest data from 2011 season, the first season in three new high tunnels. Transplants were put in 4/19, except for cucumbers on 4/28.				
		Harvest dates	Harvest weights lbs/plant	Average fruit weight, lbs
Peppers	Ace	7/4-10/3	8.76	0.26
	Lipstick	7/11-10/3	4.29	0.15
Cucumbers*	Socrates	6/6-7/25	6.48	0.47
	Sweet Success	6/6-7/25	7.63	0.91
Indeterminate tomatoes	Brandy Boy	7/4-9/26	8.90	0.50
	Cobra	7/11-9-26	11.65	0.38
Determinate tomatoes	BHN-589	7/4-10/3	27.70	0.46
	Scarlet Red	7/11-10/3	20.90	0.49

Peppers High tunnel peppers produced well, but yield was a little lower than past years. This may have been due to the cooling effect of the shade cloth, or to a variety effect. Ace produced large, nicely shaped peppers, while Lipstick peppers were smaller. Average total yield of Lipstick was significantly lower than Ace. We liked and would recommend Ace, but due to the lower yields from Lipstick we plan to try a different variety next year. All peppers were harvested red.

Cucumbers Both cucumber varieties, Socrates and Sweet Success, began producing nice sized, nice looking fruit. Unfortunately, the cucumbers were hit by bacterial wilt, which reduced potential yields. This disease is spread by the cucumber beetle. After the problem was identified, we tried spraying with an OMRI approved insecticide (Pyganic), but the plants still died off early. Next year we will begin early to try to keep cucumber beetles off the plants. This may include covering the plants, planting a trap crop, and/or preventive spraying with approved pesticides.

Indeterminate tomatoes Two indeterminate varieties were grown this year - Cobra, a variety commonly used by northern Minnesota high tunnel growers, and Brandy Boy, an heirloom variety, which produces more heirloom-looking and tasting tomatoes. We liked and would recommend Cobra. Brandy Boy tomatoes were softer and difficult to transport, and they did not keep well for even more than a day. Using the shade cloth this year appeared to eliminate the problem of green shoulders which we experienced with our indeterminate tomatoes in the past.

Determinate tomatoes We planted two determinate tomato varieties, BHN-589 and Scarlet Red. We liked both of these varieties, which produced nice sized, firm tomatoes that kept well for short storage and transport purposes. Determinate tomatoes give a flush of produce early in the season, but will continue to produce, as we allowed them to, throughout the season.

Fall Crops

Spinach, lettuce, radishes, and carrots were seeded in the high tunnels on three fall dates, Sept 6, 12, and 19. Approximately half of these plantings will be harvested when ready, and half will be left to collect data on how long in-ground 'cold storage' is possible in our high tunnels. We hope this will lead to future trials on best types and varieties of produce to grow and store in the high tunnel for harvest into the later fall and winter.

Soil Moisture, Temperature, and Plant Tissue

As described above, there were two soil fertility treatments in the high tunnels this year: a spring incorporated compost application, and a non-composted treatment. In addition to yields, other treatment variables we are tracking are: soil nutrients (described above), soil temperature, soil moisture, and plant tissue nutrients. We have not yet received the plant tissue data. Soil moisture readings were taken, but due to problems with the data loggers early in the season, and to the die-off of the cucumber plants we did not collect quality soil moisture data this year. Next year moisture readings will be taken in a different bed, in case of further problems with the cucumbers. Soil temperatures were not significantly different across the two treatments. Vetch will be planted this fall and it will be interesting to follow these variables in the three treatments into the future.

Outreach

This year as in the past, we responded to a number of calls, emails, and visits by interested people who are thinking of or planning to put up their own high tunnels. The SWROC high tunnels were highlighted as a stop during our summer Organic Field Day tour, and were used as part of the SIREN teacher-training program. On April 7 we held our second annual Extending the Growing Season Day, with invited speakers including U of MN season extension researchers from other locations and experienced Minnesota growers. This event drew a larger than expected turnout of 104 people and was given high reviews by attendees. This year it was expanded to a full day, from a half day in 2010, due to participant feedback.

High tunnel produce was used by the SWROC kitchen for events, donated to area food shelves in seven surrounding counties, and used throughout the summer by local U of MN Extension Educators for nutrition and cooking classes. This brought much positive feedback to this project and the SWROC. Many compliments were given to the high quality of our organic and locally grown food.

CONTINUATION OF PROJECT

As described, our overwintering cover crop plots will be started this fall. In fact, the hairy vetch plots were seeded on 10/6. This completes our plans of three treatments: overwintering cover crop, spring compost application, and cover crop and compost. We are looking forward to following the long-term effect of these treatments on production and soil fertility in these organic high tunnels. We continue to see interest in this project in Southwestern Minnesota and beyond, and are committed to its continuation. The data from this project, and the experience we gain, will contribute to furthering the understanding and production of fresh, organic, low-input, locally grown produce for a longer time during the year, in Southwestern Minnesota and the Upper Midwest.

PHOTOS

High tunnels at the University of Minnesota, Southwest Research and Outreach Center near Lamberton.

