WARNER GRANT FINAL REPORT

Project Goals

Our project goals for this study included the comparison of yields between varieties of specialty crops late fall or early Winter-planted in low tunnels for Spring harvest. In addition, we wanted to compare methods of securing poly to tunnels to survive severe Winter storms and snow load but also wanted to evaluate ease of ventilation in early Spring. Other goals included to identify ways to suppress weeds in early specialty crops in low tunnels and determine if micro-irrigation was necessary for Winter to Spring production.

Project Preparation

We decided to purchase a hoop bender by mail order. Two sizes were offered and in order to gain the most square feet under plastic cover we decided to create hoops that would cover six-foot wide beds and make the beds twenty-four feet long. This would give us 144 square feet per bed. It would also allow for natural ventilation by opening just the ends.

Materials included twelve foot long treated 2x6's, ten foot long ½" metal conduit bent to make hoops, plastic ¾" pvc conduit cut to make sockets for the metal conduit, conduit straps to mount pvc conduit sockets, wiggle wire track, wiggle wire, 6-mil greenhouse plastic ten feet wide by one hundred feet long, and miscellaneous zip screws and bolts.




Raised beds were created with the 2x6's and conduit spaced three feet apart and on each end. There was a second additional conduit slightly taller mounted on each end of the bed with crimped ends and drilled to receive a bolt and wing-nut so it could swing up and down to allow for ventilation. This was also covered with plastic using pvc cylinder clips. This end vent door was simply secured to the stationary end hoop with an "S" hook to keep it from blowing open.

Soil tests were taken and the soil was amended appropriately. Attempts were made to identify specific crops and varieties for cold tolerance and vigor in cooler weather.

Controls beds beside the raised beds were prepared using #9 wire hoops with plastic secured by sand bags and plastic pins.

Planting

We planted five varieties of beets, six varieties of broccoli, six varieties of cabbage, four varieties of carrots, four varieties of onions, three varieties of peas, and three varieties of spinach in the low tunnels.

As a control method, the same varieties were planted in the field under the #9 wire hoops and covered with plastic secured with sandbags and specialty plastic large pins for securing greenhouse plastic to the ground.

Planting date was December 4th, 2013 as the first polar vortex of the winter season was rolling in.

Elimination of Mulching Trials

Since we were sowing from seed, rather than using transplants, after further consideration we began to have concerns about mulching methods. We wondered if we used straw, would it prevent the solar gain on the dark earth and if we used black plastic would it bake the soil and sterilize the seed. Because our goal was germination in colder weather, we decided not to risk complicating our germination success. So, we resigned ourselves to the idea that hand weeding would be the weed control method.

Severe Winter Weather

The winter weather for the 2013/2104 season was quite severe in terms of sustained low temepratures (-22 degrees) and snow fall (record breaking for our area). For an extended portion of the Winter the tunnels were buried under snow fall and barely visible.

The beds were checked for germination on February 2, 2014 with no visible emergence. They were checked again on March 20th and certain varieties had begun sprouting. By April 21st, 2014 the things which did sprout were on average 3" tall.

It should be noted that we had done very crude small experiments in November planting in the fall of 2009 and 2011. In these milder Winters, things sprouted about three weeks earlier and were closer to 6" tall by mid-April. It is our assumption that the colder winter and snowpack prevented the soil from warming up earlier.

Success and Failures

Seven types of vegetables were planted. Beets, carrots, and onions all germinated very well on the raised beds. However, under the wire hoop tunnels, germination was extremely poor.

Cabbages were a failure in germination. Of the six varieties, three seeds total germinated on the raised beds; none under the wire tunnels.

Spinach germinated estimated at about 20% on the raised beds and 40% under the wire tunnels in the field.

Out of six varieties of broccoli, only two came through as shining stars on the raised beds, Arcadia and Avenger. The other four were very sparse. In the field under the wire, Arcadia, Avenger and Emerald Crown sprouted.

Peas were the biggest surprise of this trial. Very few germinated on the raised bed (6 seeds). However, approximately 35% germinated in the field under wire tunnels. It is my assumption that the constant moisture needed to germinate the seeds was available in the sections of the field that sprouted, whereas the raised beds drained away needed moisture.

Harvests

The main purpose of our experiment was to fill our early CSA baskets in mid-May. We normally start the Monday after Mother's Day. This year due to cold weather, we delayed a week. June 9th we harvested the first carrots and June 16th the first beets. Again, we believe these could have matured earlier if the Spring weather had not been so cool this year compared to the average Spring temperatures. All plant yield evaluations ended July 21st. See Chart A.

Chart A-Evaluation of Crop Varieties

	Location 1	Harvest Date	Plant Count	Weight	Average Weight	Location 2	Harvest Date	Plant Count	Weight	Average Weight
	Low Tunnel	16-Jun				***Field & Wires***	16-Jun			
Beets	Kestral		60	30.36 #	.51 #	Kestral		11	6.8 #	.62 #
	Burpee Golden		10	2.59 #	.26 #	Burpees Golden		4	.375 #	.09 #

	Red Ace		56	17.74 #	.32#	Red Ace		N/A *			*Did not germinate
	Albino		4	3.06 #	.76 #	Albino		N/A *			
	Detroit Red		N/A *		0	Detroit Red		28	2.86 #	.1 #	
Carrots	Primo	9-Jun	158	12.3 #	.07 #	Primo	9-Jun	N/A *			
	Abledo		54	2.96 #	.05 #	Abledo		25	.63 #	.025 #	
	Bolero		92	9.35 #	.10 #	Bolero		43	2.09 #	.048 #	
	Mokum	23-Jun	39	5.10 #	.13 #	Mokum		N/A *			Note later harvest date
Spinach	Baker	26-May	7	3.17 #	.45 #	Baker	26-May	14	3.83 #	.27 #	Tall branching habit
	Reflect		4	1 #	.25 #	Reflect		7	1.42 #	.20 #	Tip Burn
	Tyee		7	1.6 #	.22 #	Tyee		22	5.09 #	.23 #	
Peas	Maestro	2-Jun	5	0.33 #	.066 #	Maestro	2-Jun	12	1.50 #	.125 #	Peas performed better in field
							9-Jun	15	1.92 #	.128 #	
	Bloom Time					Bloom Time					Earlier bloom in field
	14-May					7-May					
Broccoli	Avenger	30-Jun	4	4.25 #	1.06 #	Avenger	30-Jun	2	4 #	2#	
	Arcadia		1	.75 #	.75 #	Arcadia		1	.94 #	.94 #	
	Emerald Crown		N/A *			Emerald Crown		1	.25 #	.25#	
	Avenger	7-Jul	8	2 #	.25 #	Avenger	7-Jul	3	.52 #	.17 #	
	Arcadia		3	.52 #	.17 #	Arcadia		2	.94 #	.47 #	
	Emerald		N/A *			Emerald		3	.60 #	.20 #	
	Avenger	14-Jul	1	.42 #	.42 #	Avenger	14-Jul	None ready			

	Arcadia		None ready			Arcadia		4	1.05 #	.26 #
	Emerald		None ready			Emerald		8	3 #	.375 #
	Avenger	21-Jul	3	1.52 #	.50 #	Avenger	21-Jul	None ready		
	Arcadia		2	3.26 #	1.63 #	Arcadia		None ready		

Total average yield for Avenger broccoli from tunnel/field .51 # per plant

Total average yield for Arcadia broccoli from tunnel/field .57 # per plant

Total average yield for Emerald broccoli from tunnel or field .32 # per plant

Tansplant date for all broccoli from low tunnel or field & wires was 12-May

Transplants from low tunnel were planted in raised bed low tunnel

Transplants from field were planted in field

Securement of Poly to Tunnels

In our before mentioned crude experiments, securing the poly and venting the tunnels seemed to be mutually exclusive. Our location suffers consistent wind velocity in the Spring and our attempts to vent the wire tunnels usually resulted in it blowing off and the plants suffering windburn from cold temperatures. We had previously tried sandbags but it seemed that poly would eventually work itself out from under the bags in a few hours of wind drag. So, a method to resolve this issue was needed.

The low tunnels were designed with wiggle wire track and wire along the long sides to allow for convenient on, off , or a half-off position of the poly if desired. The end hoops were constructed to swing on crude bolt pivots that allowed the ends to be raised or lowered for ventilation. The wire tunnels in the field were secured with screw-in pins (into the soil) specifically designed for greenhouse poly on the windward (West) side and sand bags were used on the East sides to allow for venting without removing the pins.

We were very pleased with the function of the low tunnel venting design and did not need to remove the plastic until the end of May when temperatures began to climb. The poly of the wire tunnels in the field under the sandbags worked itself loose again and exposed the plants that did germinate (mostly peas and spinach) to cold wind chills. The wire tunnels also collapsed under the heavy snow loads and needed to be re-set in Spring when the snow melted.

Micro-Irrigation

We waited until it was evident that we needed to install micro-irrigation lines. We were hoping to reduce expense by not needing it but it became evident that temperatures under the low tunnels were climbing rapidly by mid-April and the plants were stressing due to lack of proper moisture. Each bed was out-fitted with a triple or quadruple line to keep the plants adequately irrigated. Significant plant growth was visible after the addition of micro-irrigation.

Summary

Marketable crops were harvested from this method. We were very pleased with the quality of beets, carrots and onion transplants. The two varieties of broccoli had good yields. It is evident that this method is a great way to produce early broccoli transplants. Our disappointment was that the harvest dates were later than expected due to a bitterly cold Winter and cold Spring. *However, to keep perspective, these harvests were four to six weeks ahead of the Spring planted open field harvests.*

We like the design of poly securement and will duplicate it. We learned that micro-irrigation is needed for each bed and will include it in future installments.

Forward Looking

Antique varieties of cruciferous crops and shell peas intended for fall sprouting and to over winter were identified by a seed company on the West Coast. We procured seed from them and sowed the cruciferous plants in early August. Ongoing trials this coming fall and winter will be to plant "cold hardy" cabbage, sprouting broccoli, cauliflower and Brussel sprouts transplants into a couple of the raised beds to see if they will winter over and produce in early spring, (since it appears cabbage seed has trouble sprouting with this method of fall sowing).

Contribution to Sustainable Agriculture

The method of growing on raised beds with micro-irrigation is very suitable for the management of water resources on any specialty crop farm. The experiments of late fall/ early winter sowing have yielded valuable clues to what crops or even varieties of crops are suitable for this method of farming. When our region experiences severe climate changes resulting in bitter winters and late springs, it is important to know that some crops were already sowed and are germinating under cover even when the open fields are not suitable and temperatures prohibit planting in early Spring. In our search for regional food security it is our belief that it is vital to have the knowledge that supports a year round food production system with moderate cost.
We have two high tunnels we have been experimenting with and the grant allowed us to erect low tunnels for research. It is encouraging to see that the low tunnels (which are more cost effective) may be quite useful in this early season-extension effort to bring certain local foods to early market. Even if the types of specialty crops are limited, it is still food being pumped into the local food system. With a combined system of high tunnels and

low tunnels it may be quite possible to be able to harvest decent amounts of fresh food from this region all year round without the costly input of heating the tunnels.

For example: our un-heated high tunnels in early November are filled with marketable crops of kale, beets, turnips, bok choy, Swiss chard, spinach, lettuce, and carrots. These will most likely survive the entire winter as marketable crops with the exception of bok choy (it goes to seed). Also, in the high tunnel and some of the low tunnels are experiments of sprouting broccoli (purported to sprout in Feb/March), winter hardy cabbage, cauliflower, Brussels sprouts, and peas that were fall sprouted. These were planted with the goal of filling the winter "gap" of fresh food that we find in late January-late March.

It is our belief that varieties exist that can allow us to harvest substantial fresh food (not only greens) all winter long from the un-heated high tunnels and low tunnels. These crops and varieties simply need to be identified for suitability to these methods of growing. We may have to create a hinged "lid" for low tunnels to allow ease of harvesting in mid-winter if we can identify plants that will survive and thrive under them. Each experiment tends to create more questions for us in comparison to the one or two answers we obtain. We would like to encourage others to try a couple experiments each year as well.

Thank You

We would like to thank the Warner Grant Foundation for providing us with the resources to explore these methods. We will continue to ask ourselves how we can continue to increase food production year round in Northwest Ohio and will seek ways to extend the season or ways to learn how to work with it.