

Measuring and Managing Soil Temperatures for Winter Growing

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We have a small, diversified, family farm which we have grown vegetables on with organic methods for 23 years in upstate New York, zone 4. We raise over 40 types of vegetables and fruits which we sell year-round at farmers' markets, and this diversity gives us our stable income. Since the early 1990's, we have done season extension and grown greens in low tunnels all winter. Starting in 2006, we have utilized high tunnels to grow a variety of greens for the ever-expanding winter farmers' markets.

We had many questions for optimizing the production of winter greens in our two Rimol high tunnels (30' x 144' and 34' x 144'); we have chosen to grow in them with as little inputs as possible, so we use a single layer of poly, no heat, and automatic roll-up curtains (we have solar electric to cover that expense). In the winter of 2009, we performed our own extensive research with 44 dataloggers to determine the best techniques of multiple parameters and also debunk myths. Three styles of tunnels were used on 3 different farms: unheated high tunnels, ground-heated high tunnels, and unheated low tunnels; the dataloggers were from Cornell Cooperative Extension and they recorded the temperature every hour from January to April. The parameters we looked at were the temperatures for: Soil, outside, in the rafters, at plant height, one foot up from the ground, and six feet up from the ground.

Our main questions revolved around the use of row covers and whether multiple layers made any difference and how the height of the rowcovers above the ground affected the temperatures. Our tunnels have no heat in them except what is produced by the sun, so every extra degree of heat helps with winter growth. We also monitored temperatures on a crop with and without Biotello black plastic.

All of these dataloggers gave an overwhelming amount of data, much of which has yet to be analyzed. However, we found answers to many of the questions we were asking at the start of this endeavor. Some of the results are below:

- 4 Dataloggers at plant height (about 2" above ground): 1 Rowcover and no hoops; 2 Rowcover with 18" Hoops; 3 Rowcover in a 2-3' Hooped area; 4 Outside temp.
Results: 5-10 degree increase in temp the closer the rowcover is to the ground; laying right on the crop is best for the night to keep the plants as warm as possible. Daytime peak temperatures were all about the same
- 3 Dataloggers measuring soil temperatures: 1 Biotello plastic under 18" hooped Swiss Chard; 2 No Biotello plastic under 18" hooped Swiss Chard; 3 Outside temp
Results: Not much difference at night, but there was a daytime advantage to warm the soil from 5 to 10 degrees which means more growth
- 4 Dataloggers measuring temperatures at Plant Height (2"): 1 Heated tunnel with rowcover at 2'; 2 Unheated tunnel under 18" hoops; 3 Unheated tunnel with 2-3' tent; 4 Outside temp
COLD NIGHT: 5 to 7 degree benefit from heat at night and 2 to 5 degrees in the daytime. Is the difference worth the cost of propane or oil? We stockpile our greens and get good yields without the heat.

YIELD DATA: In our first winter with the 30'x144' high tunnel filled with spinach, it grossed over \$16,000 which extrapolates to over \$150,000 per acre. In the 2009-2010 winter, our weekly farmers' market sales increased about \$1200 per week due to the greens out of the two high tunnels and last winter, we perfected our systems partly due to the data from the dataloggers and increased to over \$1400 per week.

This is a fast-growing business with lucrative winter markets and selling wonderful greens from high-tunnels and there is a lot more to learn to increase yields by temperature controls, rowcover specifics, venting, varieties, etc.