Temperature Moderating Effects of Low Tunnels Over Winter In Cool Climates

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Introduction

Low tunnels are temporary, small (4-8 ft tall, 5-10 ft wide) unheated structures with hoops made of PVC or metal conduit, covered with various materials. While low tunnels afford less winter protection than high tunnels and access is limited after snowfall, they can be erected for $0.50-$1.00 per square foot, estimated to be 5% of the cost of a 4-season greenhouse or 15-30% of the cost of an unheated high tunnel. They are easily moved, simplifying rotation of winter production areas. While many studies have been conducted on the effects of rowcovers during the temperate growing season, there is a lack of information about the effects of low tunnels on internal temperature during the cold winter months. **Our objective was to determine the winter temperature and light moderating effects of low tunnels constructed of different covering materials.**

Methods

Low tunnels. Each low tunnel was 3 ft wide, 3.5 ft high, and 40 ft long. Bows were 10 ft lengths of plastic PVC spaced 2.5 ft apart. All tunnels were placed in full sun. Three types of coverings were compared:

- **2XRC** - two layers of heavy (1.25 oz/yd^{-2}) polypropylene rowcover
- **RCP** - one layer of heavy rowcover plus one layer 2 mil perforated plastic
- **RCGH** - one layer of heavy rowcover plus one layer 6 mil IR polyethylene

Research Sites & Data Collection. In 2010-11, low tunnels were installed in six (6) sites, covering USDA hardiness zones 4b through 7a. In 2011-12, all studies took place in Durham NH at the NH Agricultural Experiment Station. Temperature data loggers (Onset Computer Corporation, Pocasset MA) were placed in each tunnel and outdoors adjacent to the tunnels, to record air temperature every 2 hours throughout the fall, winter and spring. Soil temperature was also measured at 4 cm depth inside and outside low tunnels. Photosynthetically-active radiation (PAR) was measured (Spectrum Technologies, Inc., Plainfield IL) every 10 minutes over a two-week period in early spring 2012.

- **Enfield NH (zone 4b)**
- **Meredith NH (zone 5a)**
- **Durham NH (zone 5b)**
- **S. Deerfield MA (zone 5b)**
- **Millis, MA (zone 6a)**
- **Little Compton, RI (zone 7a)**

Results

1. Soil temperatures at a depth of 4 cm fluctuated greatly, but nearly always remained above freezing in low tunnels, whereas soil temperatures outside rarely exceeded 32°F, and often dipped below 30°F and occasionally below 25°F.

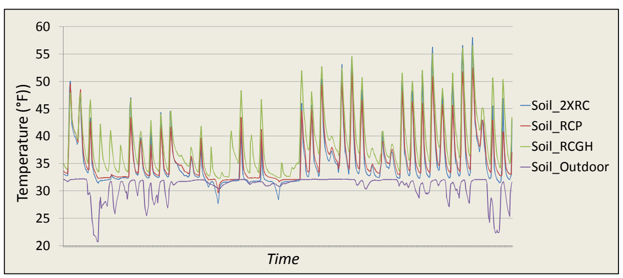

Fig 1. Soil temperature (4 cm) fluctuation in low tunnels covered with 2 layers of rowcover (2XRC), rowcover plus perforated plastic (RCP) and rowcover plus 6 mil plastic (RCGH) as compared with outdoor soil temperatures. Data are from Jan 1 through Feb 14, 2012.

2. Of the three covers tested, RCGH provided the greatest temperature gains compared with outdoor minimum temperatures. The tunnel temperatures were almost always higher than outdoor temperatures (Fig 2A), but occasionally (Fig 2B) the outdoor temperatures exceeded tunnel temperatures.

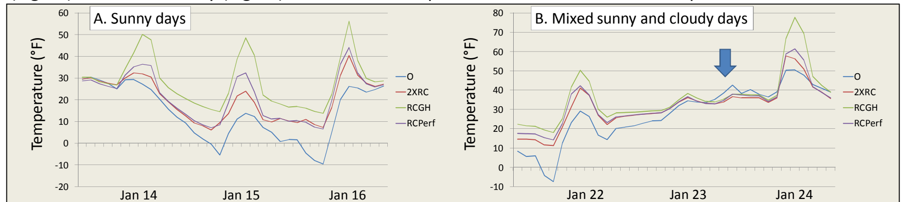

Fig 2. Daily temperature fluctuations within low tunnels over three-day periods in Jan. 2012 in Durham, NH.

3. The coldest temperatures inside the low tunnels were much warmer than the coldest winter temperatures reached outside. The winter minimum temperature in the RCGH tunnels ranged from 20 to >40°F higher than outdoor temperatures.

Table 1. Minimum winter temperatures (°F) outdoors and in experimental low tunnels in 2011-12.

Location	Outdoors	2XRC	RCP	RCGH
Durham, NH	- 11.9	- 6.7	0.3	13.4
Enfield, NH	- 19.7	13.1	14.3	22.7
Little Compton, RI	- 0.3	3.4	4.2	*
Meredith, NH	- 14.2	17.5	23.2	27.0
Millis, MA	- 14.8	24.7	27.3	21.4
S. Deerfield, MA	2.1	17.0	16.0	19.4

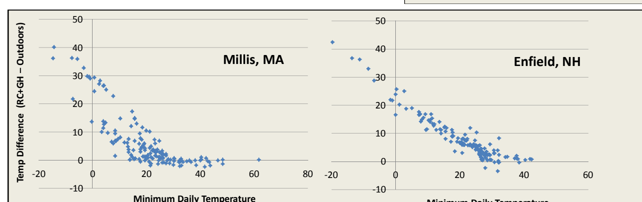

Fig 3. The difference between minimum daily temperature (the coldest temperature measured in each 24 hour period) in RCGH tunnels and outdoors, plotted in relation to the minimum outdoor temperature each day.

4. Moderating effects on minimum temperatures were greatest when the outdoor temperatures were the coldest. This trend was observed in all three low tunnel types, in all locations, and in both years of the study.

5. The average PAR measured was similar under all three tunnel coverings on most days (Fig 4A). On some days (see Fig 4B), PAR was considerably reduced under RCGH compared to the other covers (49.6% PAR transmission, as compared with 57.2% and 59% for 2XRC and RCP). This reduction in PAR transmission under RCGH appeared to be greatest on cloudy days. We hypothesize that this may be due to deflection of light by condensation.

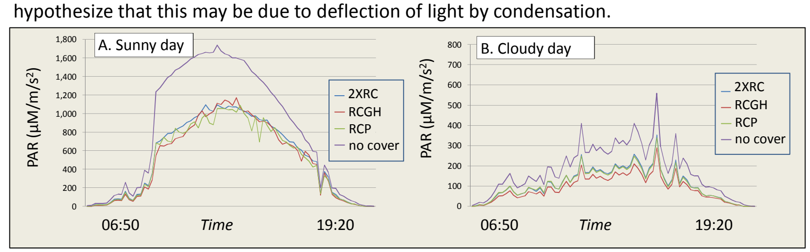

Fig 4. Photosynthetically active radiation (PAR) transmission of three low tunnel coverings on representative sunny (A) and cloudy (B) days in March, 2012.

Conclusions

Low tunnels are buffered from extreme winter cold temperatures, suggesting that they may be suitable for extending the possible range of growing marginally hardy crops. Heavy rowcover plus 6 mil polyethylene offered the greatest protection of the covers studied.

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