Temperature Moderating Effects of Low Tunnels Over Winter In Cool Climates – 2010

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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 (Coleman 2009) 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 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 of 2 mil perforated plastic
- **RCGH** - one layer of heavy rowcover plus one layer of 6 mil IR greenhouse film

Data Collection. Temperature data loggers (Hobo UA-002-08 or U12, Onset Computer Corporation, Pocasset MA) were placed in each tunnel and outdoors adjacent to the tunnels, to record air temperature every 2 hours. Soil temperature was also measured at 4cm depth inside and outside low tunnels. Photosynthetically-active radiation (PAR) was measured every 10 minutes over a two-week period in early spring 2012 (Watchdog 1000 Micro Station with PAR Light Quantum Sensor, Spectrum Technologies, Inc., Plainfield IL).

Research Sites. In 2010-11, low tunnels were installed in six sites, covering USDA hardiness zones 4b through 7a. In 2011-12, all studies took place at the NH Agricultural Experiment Station (Durham NH).

- **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. 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 1A), but occasionally (Fig 2B) the outdoor temperatures exceeded tunnel temperatures.

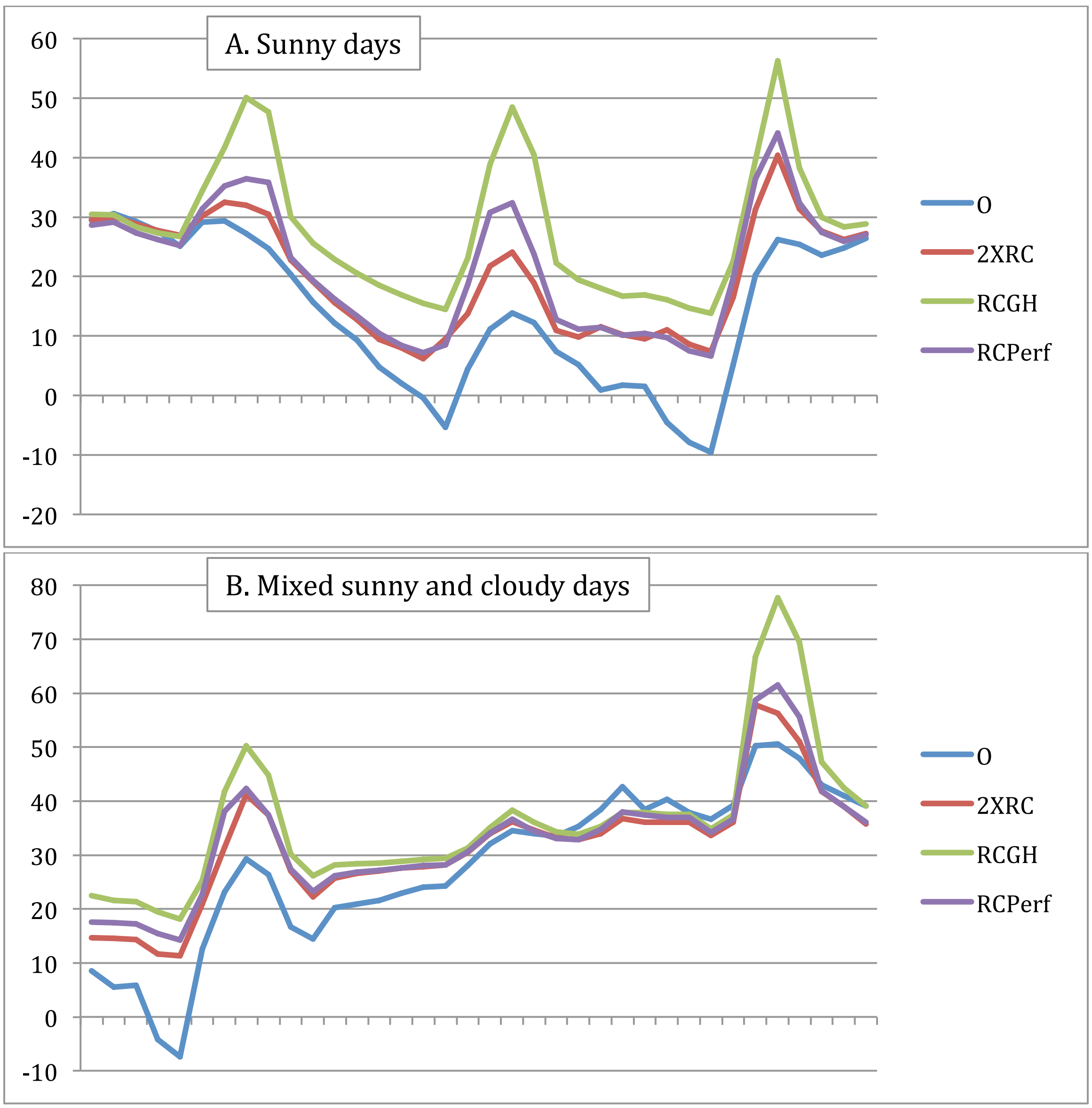


Fig 1. *Daily temperature fluctuations within low tunnels over three-day periods of sunny (Fig 1A) and mixed sunny and cloudy (Fig 1B) days in Jan. 2012 in Durham, NH.*

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

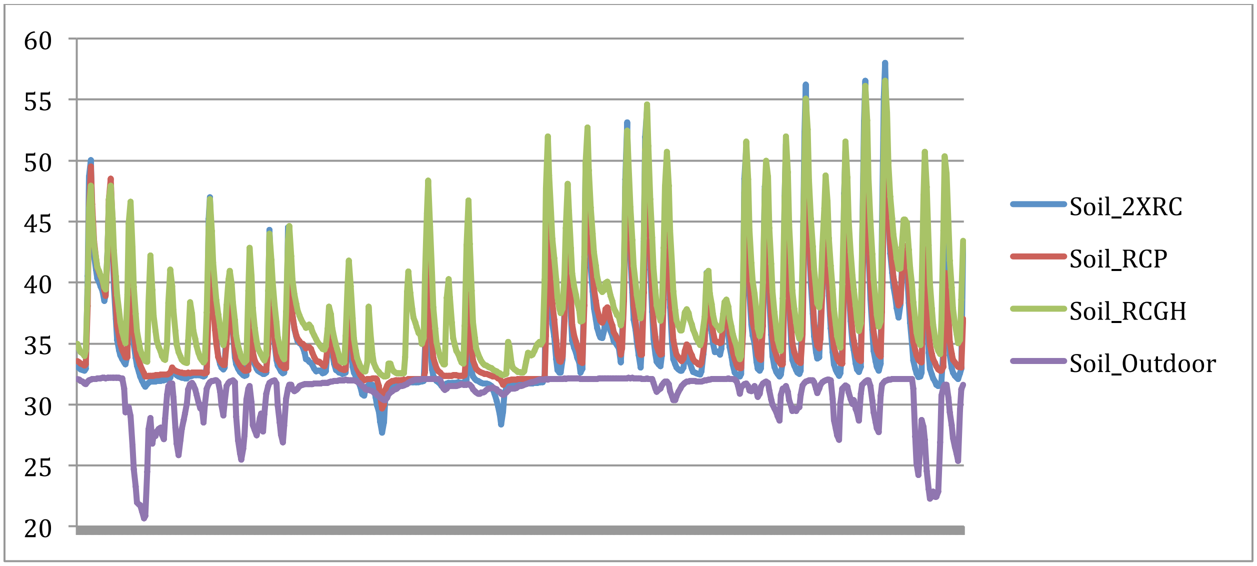
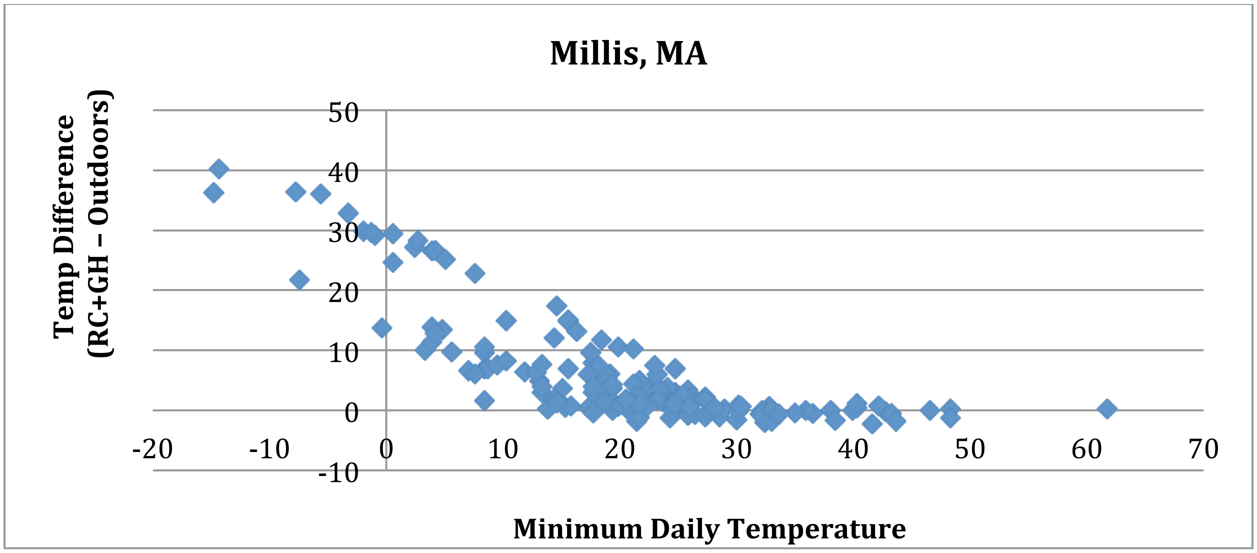


Fig 2. *Soil temperature (4cm) fluctuation in low tunnels covered with 2 layers of rowcover (2XRC), rowcover plus perforated plastic (RCP) and rowcover plus 6 mil plastic (RCGH) as compared with outdoor soil temperatures. Data shown are from Jan 1 through Feb 14, 2012.*

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

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*

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.



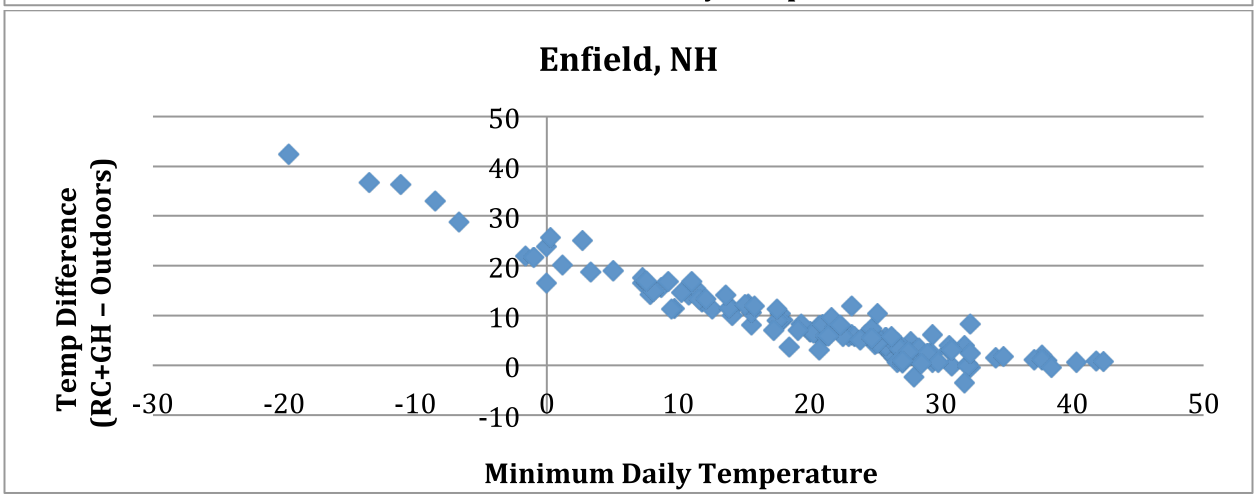


Fig 3. *The difference between minimum daily temperature (the coldest temperature measured over each 24 hour period) measured in RCGH tunnels and outdoors, plotted in relation to the minimum outdoor temperature for each day.*

5. The average photosynthetically active radiation (PAR) measured was similar under all three tunnel coverings on most sunny days (Fig 4A). On some days, such as the one shown in 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 coverings). 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.

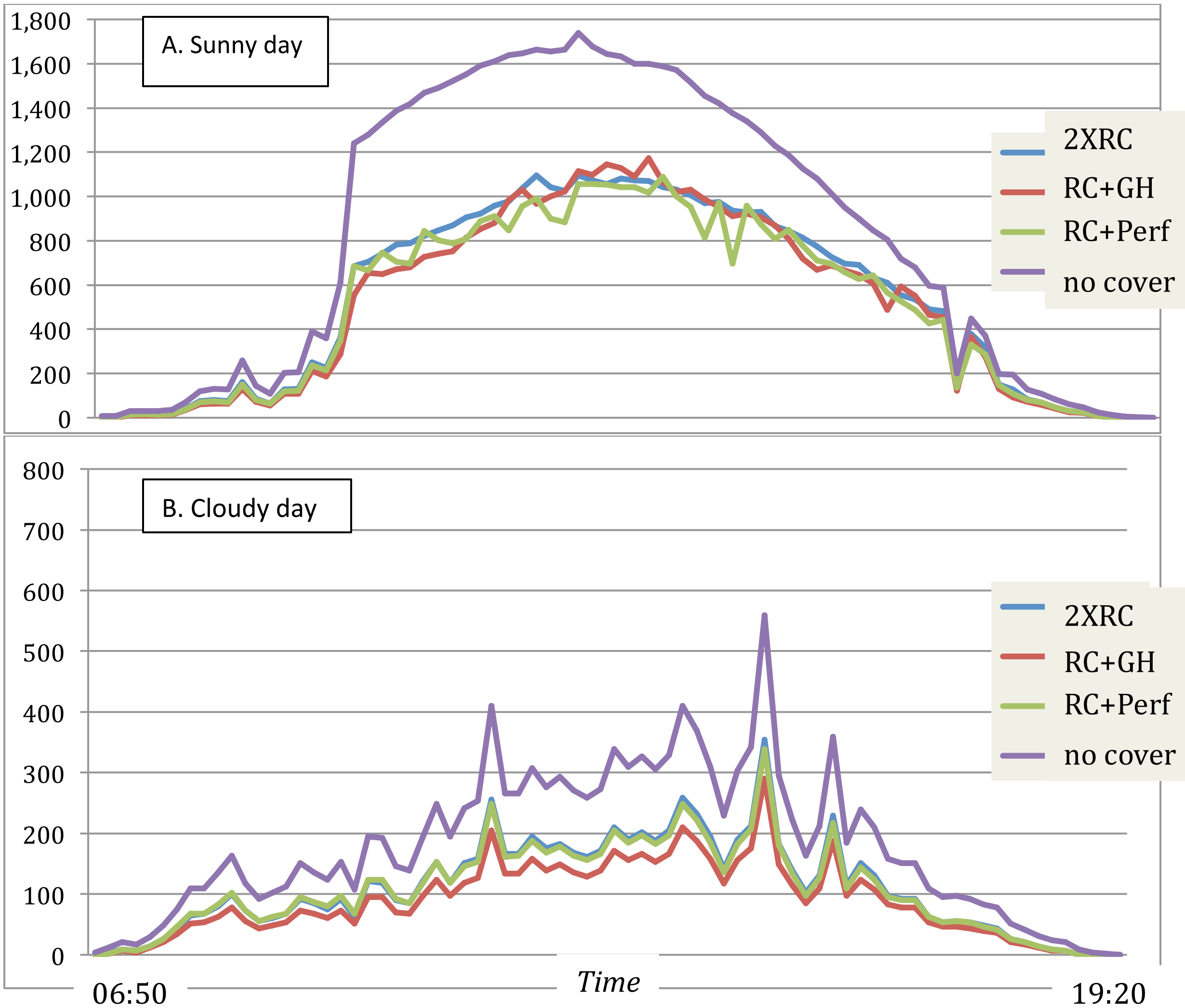


Fig 4. *Photosynthetically active radiation (PAR) transmission of three low tunnel coverings on representative sunny (A) and cloudy (B) days in March, 2012.*

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