PENN STATE HIGH TUNNEL PLASTIC STUDY 2007-08

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High tunnels are simple greenhouses covered with a single layer of polyethylene plastic, in which crops are typically grown in the ground rather than on benches. To determine if the properties of the plastic covering has an influence on temperatures in the tunnel, and the productivity of the crops growing inside, the following study was conducted in two growing seasons at Penn State University.

MATERIALS AND METHODS:

Detailed data were collected on colored peppers and sunflowers grown in four high tunnels at the Penn State High Tunnel Research and Education Facility, Rock Springs, PA. The tunnels measured 17 ft. wide, 36 ft. long and 9 ft. high, and their construction is described by Lamont et al. (2002) and at the Penn State website (http://plasticulture.cas.psu.edu/Design_construction.pdf). In 2006, four varieties of bell peppers and single-cut sunflowers were grown; 'King Arthur', 'Gourmet', 'Early Sunsation' and 'Blue Jay' bell peppers and 'Sunrich Orange', 'Sunbright Supreme', 'Procut Yellow Lite' and 'Procut Lemon' sunflowers. These crops were tested under four different 6 mil greenhouse grade plastics that covered the tops of our high tunnels. They were Tufflite Control, Luminance, Dupont IR and Tufflite IR. In 2007 the same crops were grown and two of the '06 plastics were replaced. Solaroof and Smartlite Red replaced the DuPont IR and Luminance materials, while the Tufflite and Tufflite IR-covered high tunnels remained with the same covering as in 2006. Soil and air temperature and irradiance data were collected using 'Hobo' weather stations (www.Onsetcomp.com) in each tunnel and one outside.

Each tunnel contained 4 beds 30 ft. long, on which peppers were planted with a 1 ft in-row spacing, and sunflowers spaced 4 in. apart. There were a total of 16 pepper plants and 40 sunflower plants per row. In 2006, peppers and sunflowers were planted on May 10, June 2 and June 23 to stagger the plantings. In 2007, peppers were transplanted on June 8, and sunflowers on June 8 and July 10. Peppers were harvested periodically as the reached mature size and color, while sunflowers were measured and cut when the flowers were just opening.

RESULTS AND DISCUSSION:

Pepper yields appeared to respond to the tunnel plastic treatments (Graphs 1 and 2). In both years, peppers growing in the Tufflite Control film-covered house had higher yields than those in the Tufflite-IR house. Since the film stayed in place on these two tunnels over the two years, it is difficult to know if this yield difference is due to a characteristic of the film, or to some other properties of the two tunnels. Among the other cover materials, Luminance in 2006 and Solaroof in 2007 appeared to perform better than Dupont IR and Smartlite Red, respectively, but again the unreplicated nature of that comparison make firm conclusions difficult to make. Yield differences among the four pepper varieties were not consistent in either year. Fruit sizes were

greater for King Arthur and Early Sunsation than the other two varieties in 2006, and King Arthur had largest fruit in 2007.

The performance of the sunflower varieties showed very little change with tunnel cover material in either year (Graphs 3 and 4). Sunrich Orange and Sunbright Supreme were tallest in 2006, and Sunrich Orange had the longest stems in 2007.

High temperatures in the high tunnels covered by different films showed very similar trends in both years (Graphs 5 to 7), rising above outside temperatures, but showing little difference among the film treatments. Since all the films except the Tufflite Control had IR blocking compound added, these results indicate that such compounds do not increase the overheating problem that can adversely affect plant growth if tunnel ventilation is not practiced in a timely manner.

In both years of the study, during the fall months, typically when it was full sun during the day and the temperature dropped considerably at night, the internal high tunnel temperature dropped below that of the ambient temperature, as shown in Graphs 6 and 7. This behavior has been reported in other study locations of this project as well. The main knowledge gained from this observation is that, on clear, cold nights, an extra layer of protection (ie floating row cover) may be necessary to maintain a higher internal night time temperature compared to ambient. On some, but not all nights, the IR blocking materials provided extra protection by way of retaining heat inside the high tunnel at night. Graph 7 is an example of such a cooling event, occurring right after sundown, which makes timing of row cover application very important. The IR plastics do not prevent this cooling from occurring, however they decrease the effect by 2 or 3 degrees F.

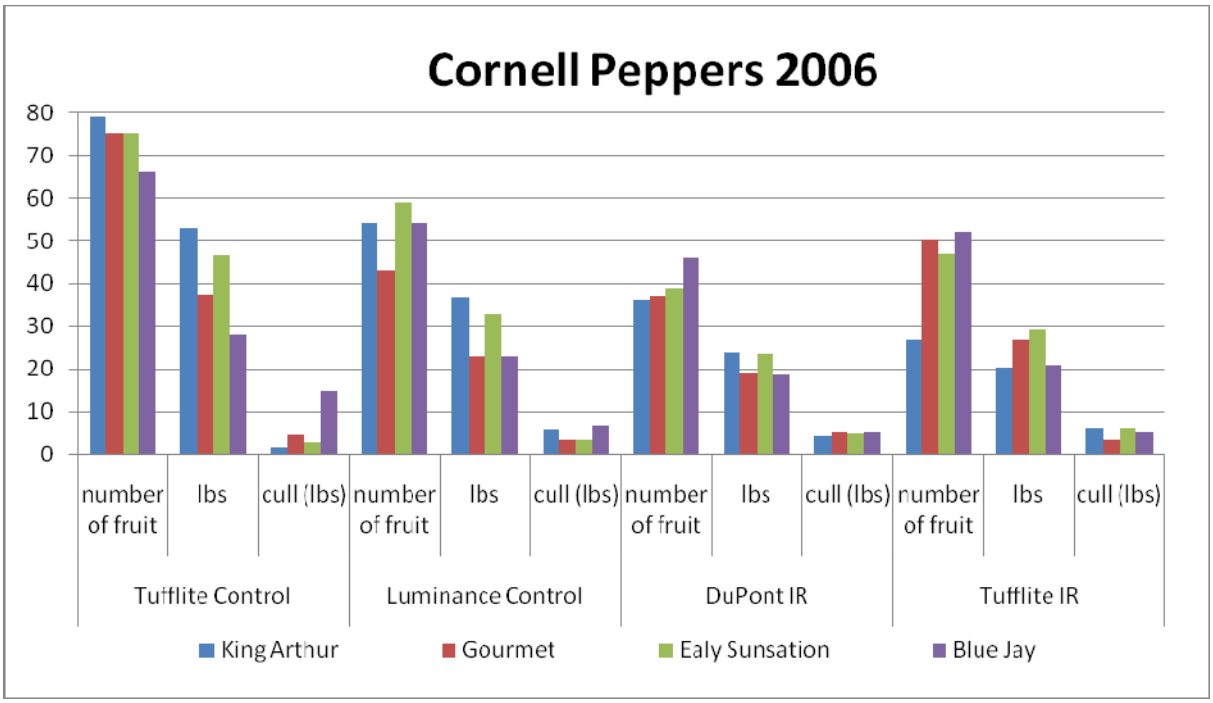
Graphs 8 and 9 show examples of the photosynthetically active radiation (PAR) readings of the tunnels covered with the different high tunnel covering plastic films. All films reduced irradiance in the tunnel, with some cover materials having a significantly greater shading effect, namely the Dupont IR and Smartlite Red films. Since both these films have a distinct red color, they may also have affected spectral distribution of the light, but this was not checked.

CONCLUSIONS:

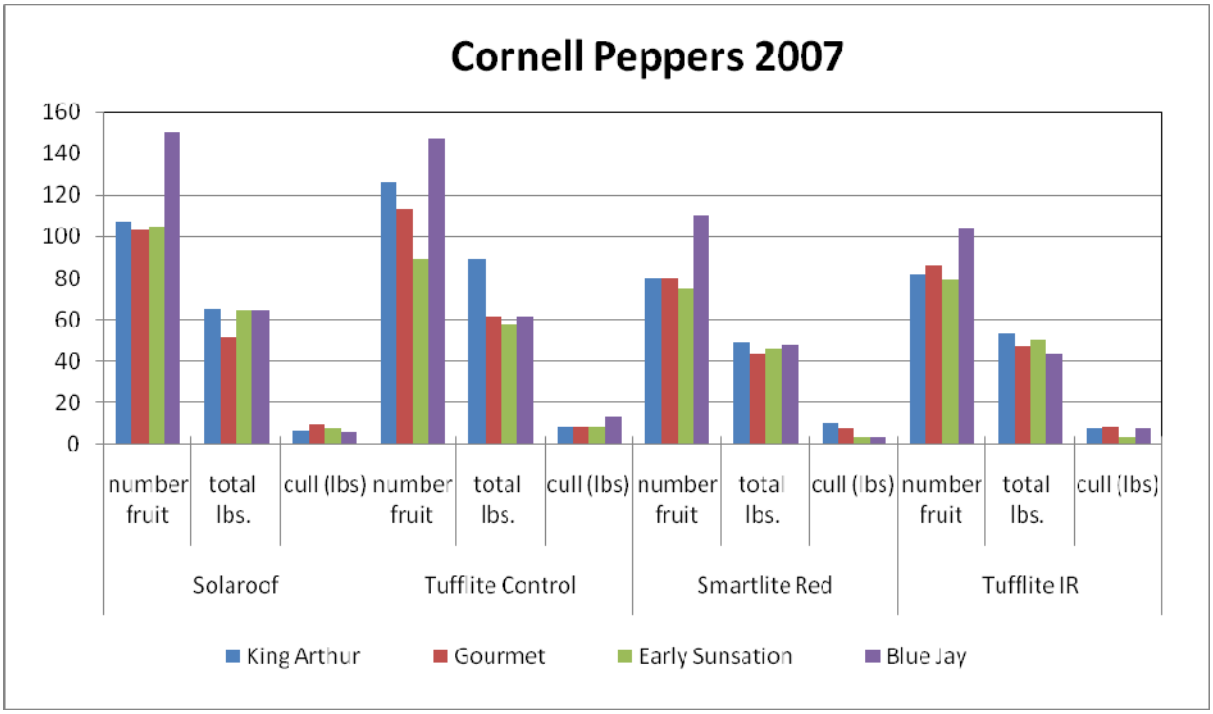
Based on the data we collected over 2 years, it appears that there may be little advantage of using these specific treated polyethylene film covers on high tunnels for horticultural crop production. In both study years the Tufflite control plastic produced more consistent and higher pepper yields than its counterpart material that had IR blocker added. Sunflower performance was not altered by the cover materials used. Graphs 5 and 6 illustrate that although IR blocking films may occasionally raise night temperatures by 0.5 - 3 degrees (F) in tunnels covered, the trend does not seem to be consistent over time. This same temperature increase can also be accomplished under ‘control’ plastic with the use of floating row cover or thermal blankets placed over the crop in the late afternoon or early evening. This will trap heat and maintain a higher temp inside the tunnel throughout the night (see associated study at Cornell). The gain of a few degrees did not outweigh the reduced yield over time in the IR plastic materials tested in 2006 and 2007.

Additionally, IR materials are commonly priced higher than conventional coverings.

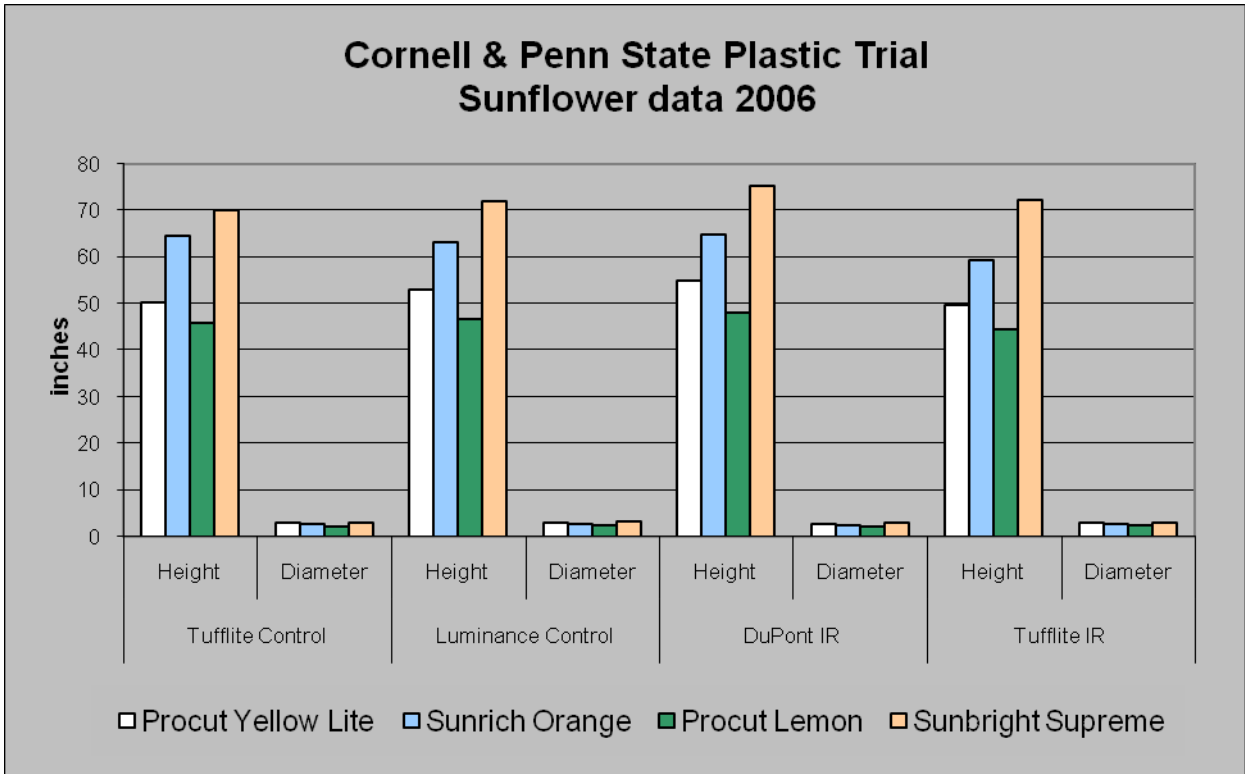
Graph 1:



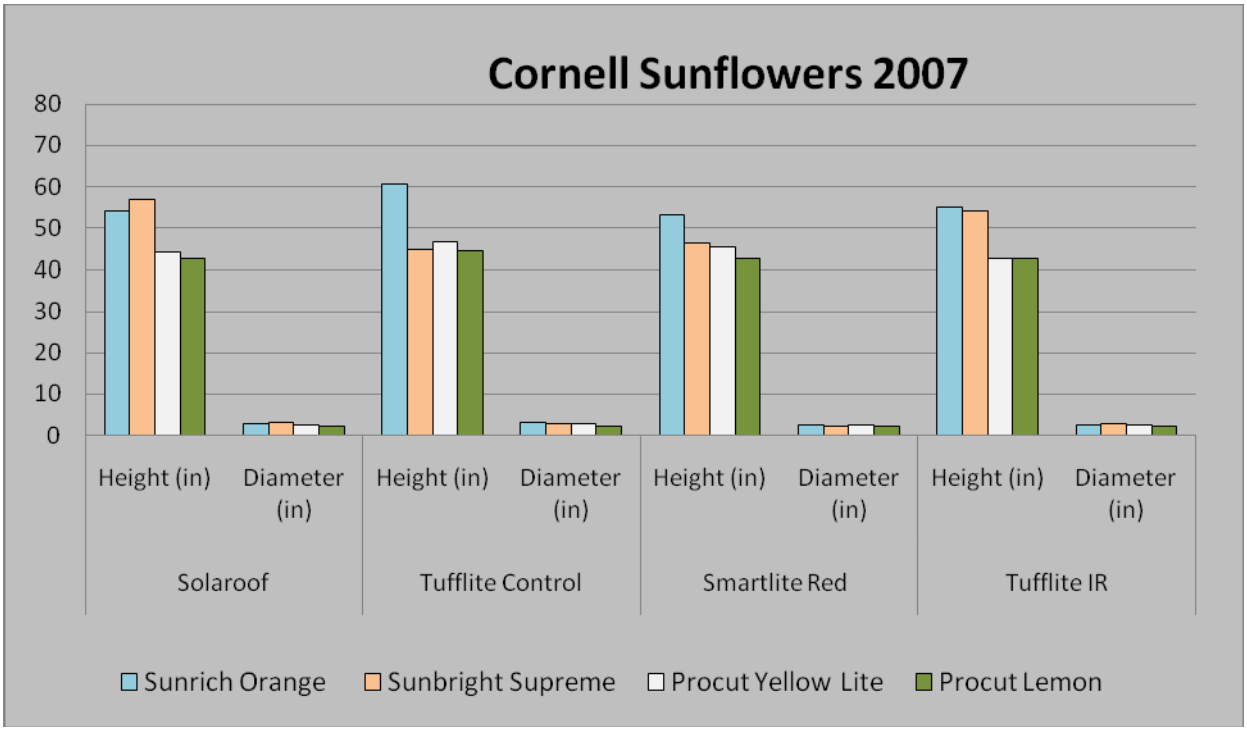
Graph 2:



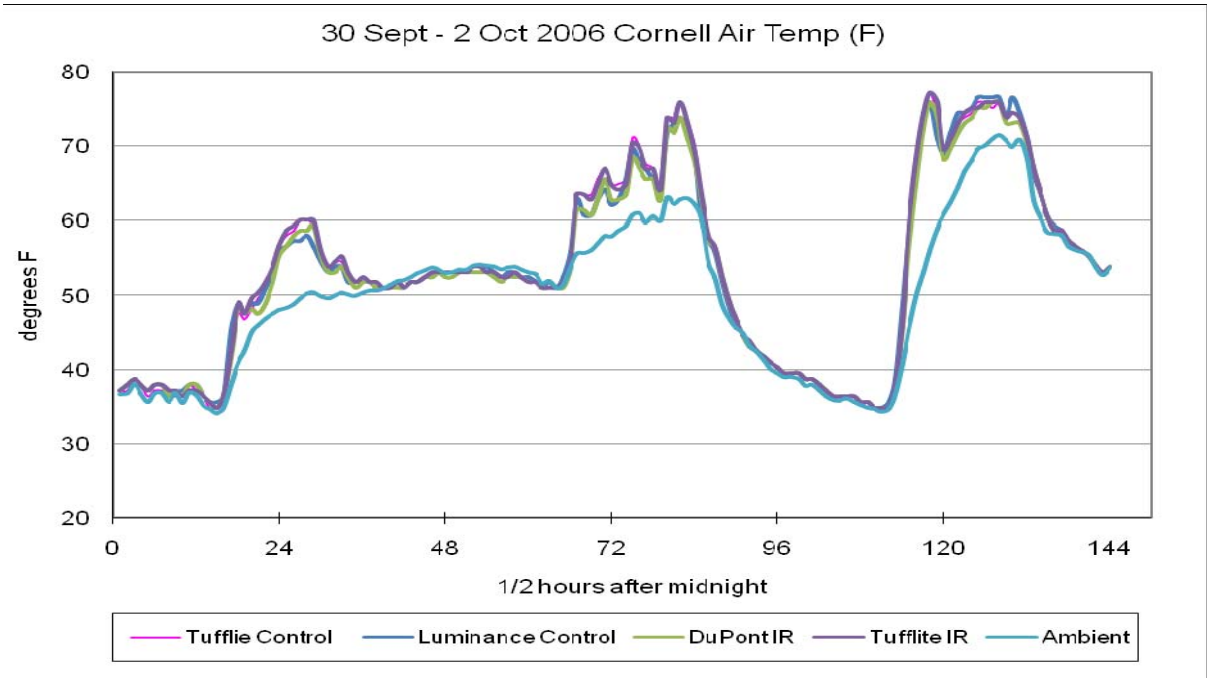
Graph 3:



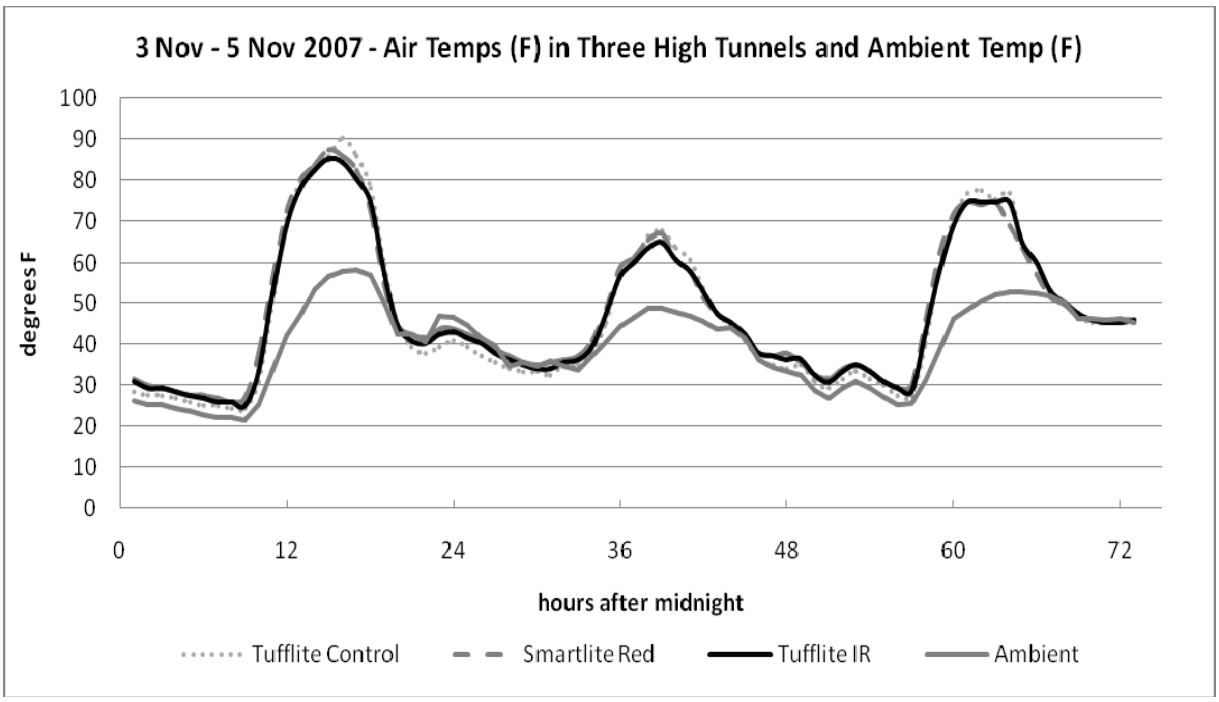
Graph 4:



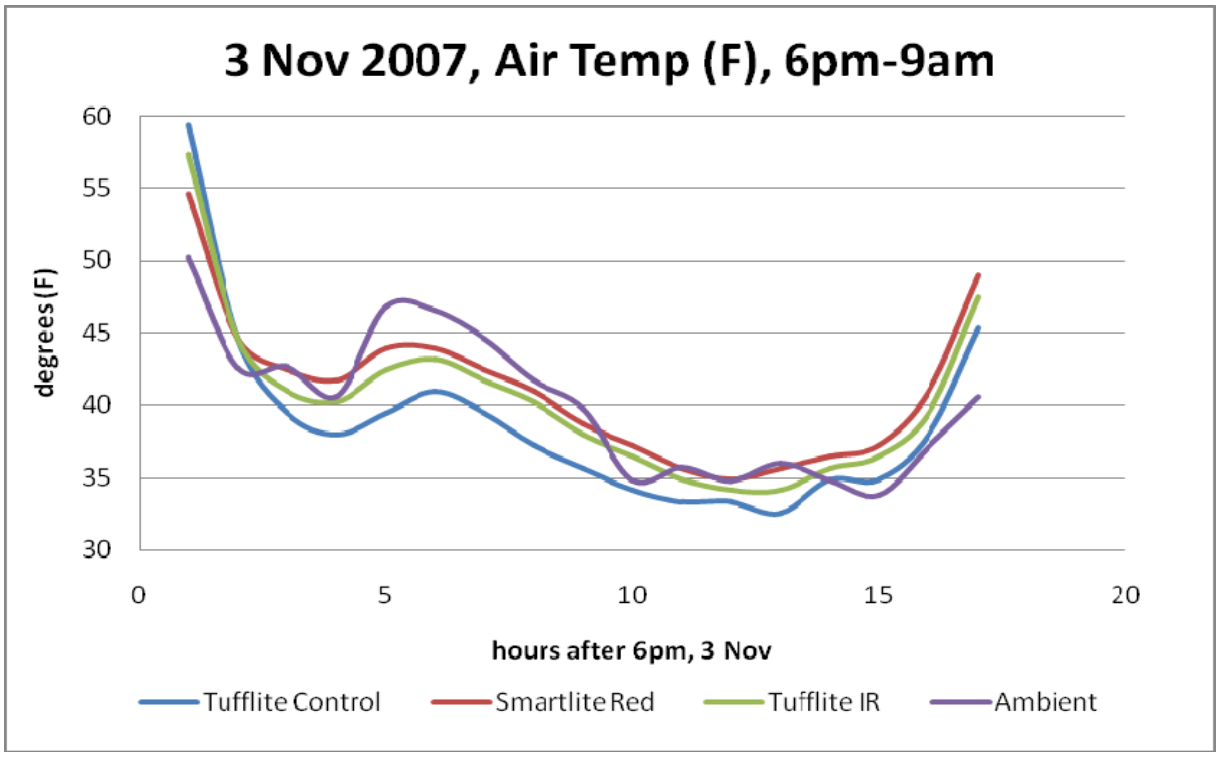
Graph 5:

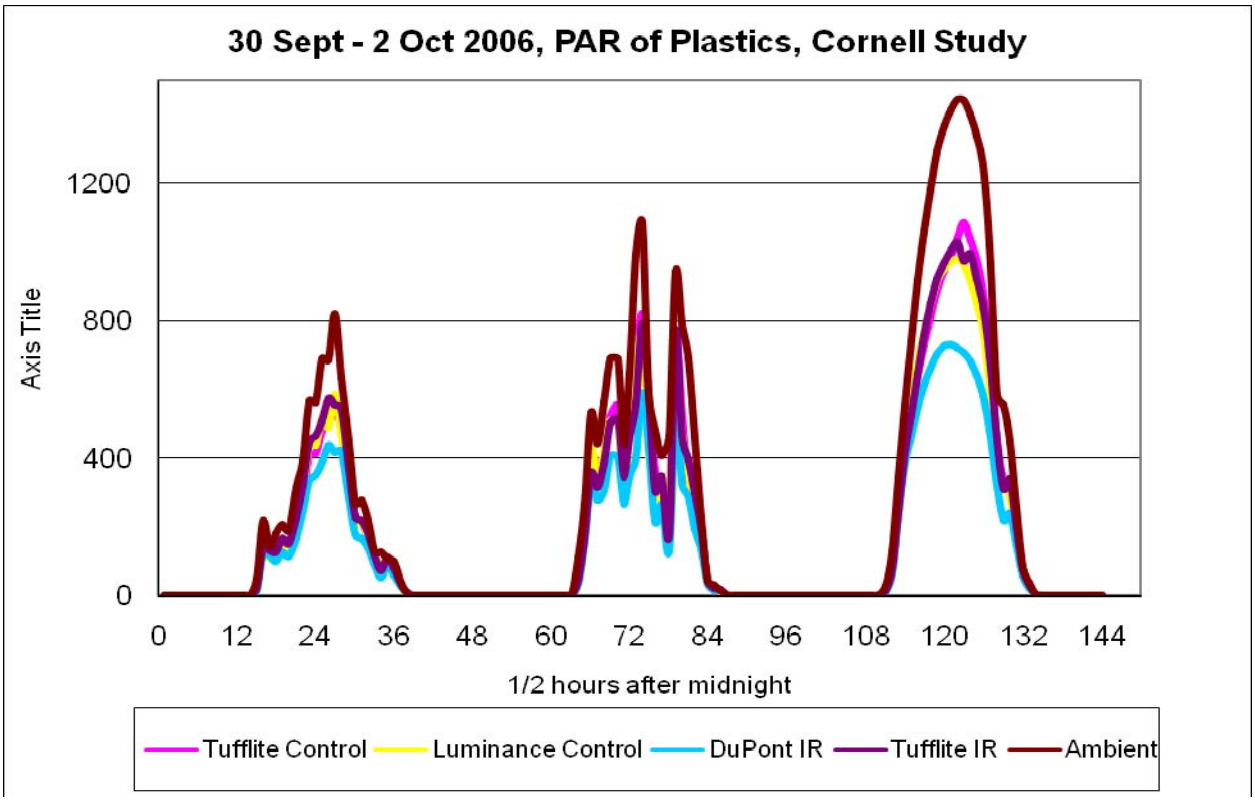


Graph 6:

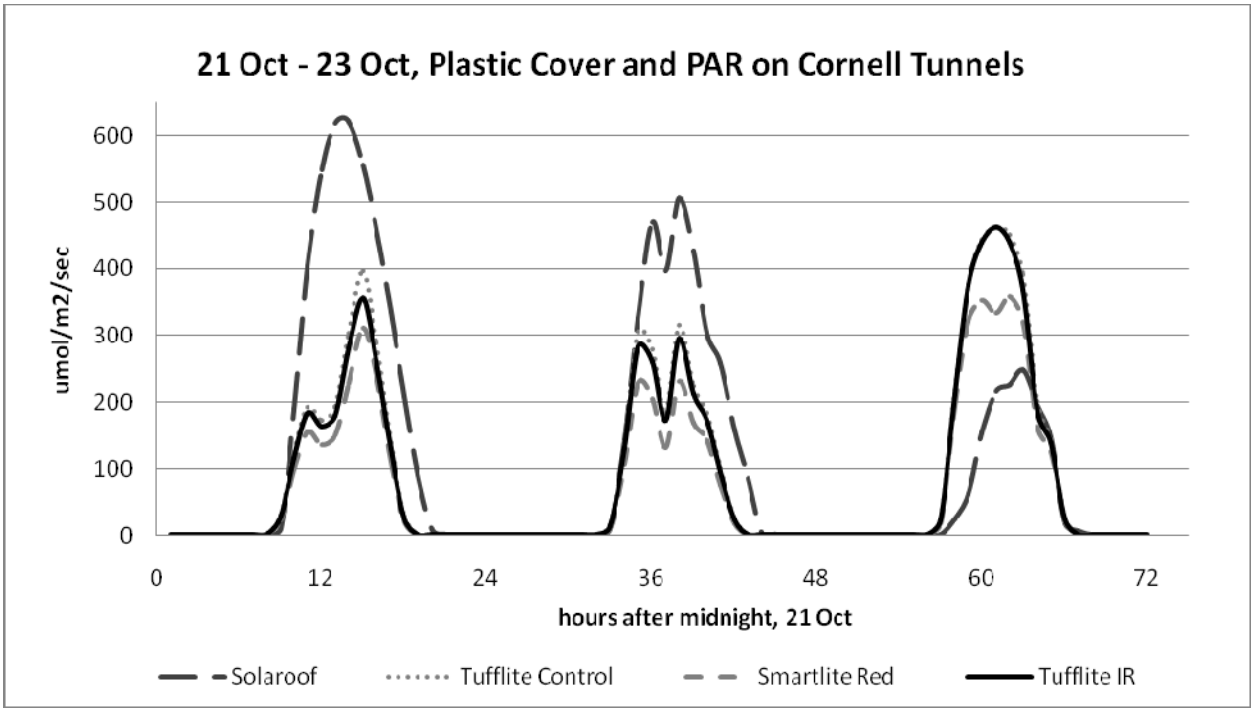

3 Nov - 5 Nov 2007 - Air Temps (F) in Three High Tunnels and Ambient Temp (F)
degrees F
100
90
80
70
60
50
40
30
20
10
0
0
12
24
36
48
60
72
hours after midnight
Tufflite Control
Smartlite Red
Tufflite IR
Ambient

Graph 7:


3 Nov 2007, Air Temp (F), 6pm-9am
degrees (F)
60
55
50
45
40
35
30
0
5
10
15
20
hours after 6pm, 3 Nov
Tufflite Control
Smartlite Red
Tufflite IR
Ambient



Graph 9: (Note;2007)



Literature cited: Lamont, W.J. et al. 2002. Design and construction of the Penn State high tunnel. HortTech. 12:447-453.