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WHY PLANTS CAN BE COOLER ON A SUNNY DAY IN POLY COVERED GREENHOUSES THAN OUTSIDE OR UNDER BLACK SHADE CLOTH

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Most people think that plants inside poly covered greenhouses are hotter when it is sunny than those outside…

…because they know that air temperatures inside the greenhouse are usually warmer than those outside.

This belief is based on monitoring air temperatures, **not** surface temperatures.

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On a sunny day, plants outside are exposed to infrared radiation, which heats the leaves. The leaves would be warmer than the air temperatures, but the plants cool themselves by transpiring.

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Inside a poly covered greenhouse, the infra-red radiation hits the roof covering first, instead of the plants.

Some of the infrared radiation that hits the greenhouse roof covering is reflected, some enters the greenhouse by conduction causing air temperatures to increase, and some enters by radiation causing surface temperatures inside to increase.

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The ventilation capacity of conventional ventilation systems is usually insufficient to exhaust the hot air at the same rate as heat enters the greenhouse...

...which makes the air temperatures inside the greenhouse warmer than those outside.

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The polyethylene roofs actually prevent the heating of exposed leaves and containers by intercepting radiant heat more effectively than

- No roof or
- 50% black shade cloth.

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The following **soil temperatures** were measured at 1:00 p.m. on November 14, 2002 in Tuscon, Arizona. Conditions were sunny and the relative humidity was approximately 20%.

	Outside	Inside hoop house	Inside gutter connect	Inside retractable flat roof
Light Level (foot candles)	16000	9500	9000	8000
Air temperature C, (F)	29° C (85° F)	34° C (94° F)	32° C (90° F)	30° C (87° F)
Surface temperature C, (F)	39° C (103° F)	29° C (85° F)	30° C (87° F)	29° C (85° F)

Notice how surface temperatures were 10°C (18° F) warmer than air temperatures outside, but up to 4°C (7° F) cooler than air temperatures inside the greenhouse.

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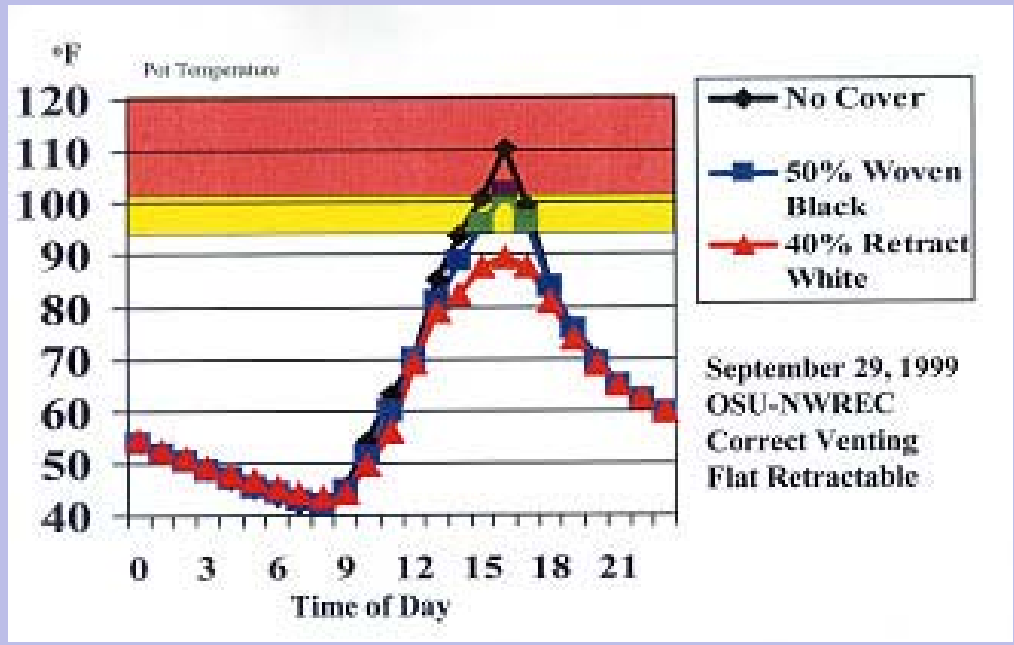
Soil temperatures in exposed containers are also cooler under a polyethylene roof than outside or under 50% black shade cloth. Data taken Oregon State University shows that crops can be cooler if under white poly roof in the summer than outside or under black shade cloth.



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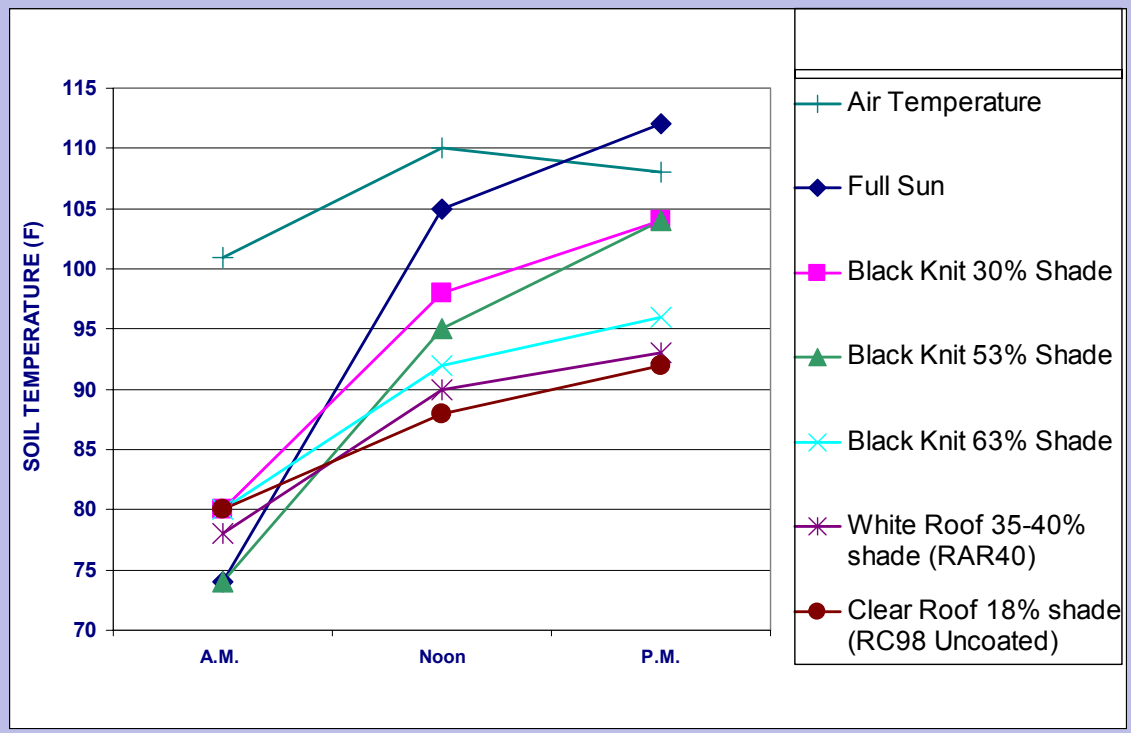
The following soil temperatures were taken in 20 L (5 gallon) pots, in Arizona.



44° C (111° F) in full sun
40° C (104° F) under 50% black shade
34° C (93° F) under white and clear poly

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What is very significant is that soil temperatures on a sunny day were around 34° C (93° F) under the white and clear roof coverings. This implies that the amount of infrared radiation being intercepted by the roof covering is more significant in minimizing the heating up of plant surfaces than light transmission or color.

This also implies when outdoor temperatures are ideal, the roof coverings actually prevent plants from warming up, even though air temperatures may feel warmer.

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The most effective way to reduce radiant heat while still maintaining cool air temperatures is to intercept the infrared radiation while maintaining a high rate of air exchange.

SUMMARY

Polyethylene roofs have a positive and negative impact on plant quality depending on the outside temperature. When outside temperatures are:

- **<15°C (59°F):** The roofs have a positive effect by trapping convective heat to keep plants warm.

- **15-30°C (59-86°F):** The roofs can have a negative effect by causing leaves to be cooler than the air, resulting in a reduction in transpiration, an increase in condensation on the leaves, and by preventing the warming up of leaf and soil temperatures.

- **> 30°C (86°F)**: The roofs have a positive effect by intercepting infrared heat to help prevent overheating of exposed leaf and pot surfaces.