

Advances in High Tunnel Covers

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While a large number of high tunnel covers are available to growers, their various characteristics can be difficult to sort out. This talk explains what the available characteristics of high tunnel covers are, and what effects they can have on plant growth and management. It should be pointed out that this is an area of current research, with a changing landscape of available covers. As part of an SCRI project, over the next few years we expect to learn much more about how tunnel covering characteristics affect raspberry and strawberry growth and their related pest complexes in high tunnels.

To understand tunnel covering characteristics, it is important to understand light, or more broadly, the radiation spectrum and what effects it has on plants, their surrounding environment, and insects and disease organisms. This presentation describes how plastic coverings can affect transmitted light and the high tunnel environment, and discusses other properties available in high tunnel coverings.

Light

Visible light

The light that we see, which includes the wavelengths that plants use for photosynthesis, is referred to as (not surprisingly) visible light. Crop plants best conduct photosynthesis utilizing wavelengths that we see as red and blue light. That is why “grow lights” and LED lights used for indoor plant culture have a purple hue to them - the color results from higher output in the wavelengths that produce the colors red and blue.

High tunnel plastic film coverings transmit the majority of the visible light reaching the tunnels, generally in the range of 85 to 95%. One interesting characteristic of some films is that the light being transmitted through the film may “come through” at a different wavelength than what originally reached the plastic, so that transmittance values of certain wavelengths are sometimes greater than 100%.

Some portion of the visible light (and also wavelengths outside of this range) striking the tunnel is diffused as it passes through the plastic. The amount of diffusion taking place varies for different plastics, and can be judged by how clearly one can see through the plastic and by the presence of shadows in the tunnel on a bright day, or more correctly the lack thereof. Plastics that diffuse a greater proportion of the light are referred to as diffuse or diffusing films. With more diffusing films, the majority of the light striking the plastic is transmitted, but it is scattered as it passes through the plastic and so is more evenly spread throughout the tunnel and plant canopy. Lower leaves receive more light instead of being shaded by upper leaves, especially with taller plants such as raspberries. Thus, total photosynthesis for the entire plant would be expected to be higher in a tunnel with a diffusing film than in a tunnel with a less diffusing film.

Ultraviolet (UV) light (aka UV radiation, and “black light”)

UV light consists of wavelengths shorter than visible ones, and is further broken down into UV-A, UV-B, and UV-C radiation, with UV-A being next in line from visible light. UV-C radiation is filtered out by our atmosphere. UV-A and UV-B wavelengths, as one can infer from sunscreen and sunglasses labels, are the ones responsible for giving us sunburn and being tough on our retinas. These wavelengths also break down plastic, so plastics used for high tunnels and greenhouses contain UV stabilizers that minimize damage to the plastic. This is one of the main characteristics that sets greenhouse films apart from plastic sheeting that one might pick up at a local hardware store, which would become brittle within about a year if used on a tunnel. Interestingly, exposure to UV wavelengths are also part of the reason why plants produce certain anti-oxidants (anthocyanins), which are some of the compounds responsible for giving fruit its color. So, growers sometimes notice that strawberries grown under coverings that block most of the UV light are paler than usual.

What is really interesting, however, is that various fungi and insects sense UV light. With fungi, UV-A radiation exposure can serve an environmental cue for sporulation. Consequently, blocking or manipulating UV-A exposure with plastic film could be a way to potentially manipulate disease pressure. Other effects of tunnels on humidity, condensation, and temperature certainly play a role in disease development, and how these factors interact remains to be seen.

Unlike humans, insects utilize UV-A wavelengths for vision and navigation. At least one species in the genus *Drosophila* (the same genus to which the infamous spotted wing drosophila belongs) use wavelengths in the blue-green and UV-A ranges to see, and “hiding” from potentially damaging UV effects is also thought to be part of the reason why SWD tends to stay on the less exposed side of leaves and fruit. The reflection of UV light from flowers, invisible to humans, causes patterns on the flowers to be visible to honey bees that aid them in locating pollen and nectar sources. Exactly how blocking UV light with plastic affects bees is unknown, though it is clear that honey bees frequently become confused in tunnels. Whether this is a UV effect, or simply an effect of them trying to orient based on sunlight is not yet known. The bottom line is that more work remains to be done to determine whether transmittance of UV radiation can be modified to aid in insect management.

Infra-red (IR) radiation and near infra-red light

Infra-red wavelengths are sensed as heat, and thus are the ones responsible for heat build-up in a tunnel. Visible light and shorter wavelengths of infra-red light enter the tunnel during the daytime and are stored as heat in the soil and plants, but then are emitted back towards the plastic as longer IR wavelengths at night. Some plastics include an additive that prevents long-wave IR radiation from passing through. These plastics are used to hold reflected heat (IR radiation) in the tunnel at night, and therefore are sold as energy-saving films. Usually they are used in more northern locations, and are recommended for use as an “inside” layer of film with another layer overtop, and the space between the two inflated with a blower.

Other films are capable of blocking IR radiation coming into the tunnel, and then have potential to keep the temperatures in the tunnel cooler than outside temperatures. Plastics intended to keep tunnel temperatures lower also diffuse light, which also helps with preventing heat build-up in

the tunnel. Berry crops are especially sensitive to high temperatures, and given our extreme temperatures as of late, these plastics may be valuable in helping in keeping the plants cool. Tunnel height and venting of course, also plays a large role, so the cooling effect may not be as great in shorter tunnels.

Other plastic film characteristics

Anti-condensate additives

These additives are intended to discourage condensation, or when it does occur, to encourage water droplets to cling to the plastic and run down the tunnel sides rather than drip onto the plants. In some cases, the anti-condensate additive is a coating on the plastic, in which case the plastic will be marked as to which side needs to be facing inside. In other cases, the additive is incorporated into the plastic, and it doesn't matter which side is facing inward. When the anti-condensate additive is incorporated into the film, the additive gradually migrates to the surface so that it is replenished over time.

Anti-dust coatings

Some plastics have an additive to repel dust and dirt, thus maintaining good light transmission.

Types of Coverings Available

The covers most frequently used on high tunnels are thin plastic films, usually 6-mil in thickness with an expected life of 4 years. Films are also available that are thinner (1-mil, 3-mil, or 4-mil), but these are intended for shorter-term use or are for use on structures other than high tunnels.

If growers want a covering with additional durability or additional insulation, there are woven materials, reinforced materials, and one product that essentially looks like bubble-wrap with very large bubbles.

Information on different brands of tunnel coverings currently available is included in the table below. This list is not intended to be an exhaustive list, but rather a listing of plastics available to growers in the northeastern U.S. along with some sources to aid growers in locating plastics that they may wish to try. No endorsement of these plastics is intended, and the omission of any tunnel covering simply means that we may not be aware of its availability. Distributors and manufacturers of any high tunnel coverings not listed are encouraged to contact the author to be added to our listing. This listing will be updated and added to our project website in the near future: www.tunnelberries.org

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<u>Plastic films</u>	<u>Manufacturer/Re-roller</u>	<u>Sources</u>
Dura-Film Super 4	AT Films Inc. (Alberta)	BFG Supply, PlastiTech, AT Films
Dura-Film Thermax	AT Films Inc. (Alberta)	BFG Supply, PlastiTech, AT Films
Dura-Film Luminance/Luminance Visqueen (U.K.)	AT Films Inc. (Alberta), BPI Visqueen (U.K.)	AT Films, BFG Supply / Haygrove High Tunnels
Flex-O-Glass 4 yr IR Clear	Warp Bros. (Chicago, IL)	BFG Supply, Hummert
Flex-O-Glass 4 yr UV Clear	Warp Bros. (Chicago, IL)	BFG Supply, Hummert
GT IR/AC	Green-Tek (Janesville, WI)	Poly-Tex, Inc., Green-Tek, Stuppy Greenhouse Manufacturers
GT 4 Clear	Green-Tek (Janesville, WI)	Poly-Tex, Inc., Green-Tek, Stuppy Greenhouse Manufacturers
K50 Clear	Klerks-Hyplast (Chester, SC)	BFG Supply, Stuppy Greenhouse Manufacturers, XS Smith/Rough Bros.
K50 IRAC	Klerks-Hyplast (Chester, SC)	BFG Supply, Stuppy Greenhouse Manufacturers, XS Smith/Rough Bros.
KoolLite Plus	Klerks-Hyplast (Chester, SC)	BFG Supply, XS Smith/Rough Bros.
Sun-Selector Suncover Clear	Ginegar (Israel)	Ledgewood Farms, A.M. Leonard
Sun-Selector Sunsaver Clear	Ginegar (Israel)	Ledgewood Farms, A.M. Leonard
Sun-Selector Sunsaver Diffused	Ginegar (Israel)	Ledgewood Farms, A.M. Leonard
Sun-Selector Suncover Diffused	Ginegar (Israel)	Ledgewood Farms, A.M. Leonard
Super Long Life AD USA	Eiffel Plastics (Italy)	Excalibur Plastics (Ontario)
Tufflite TES	Berry Plastics Corp. (Monroe, LA)	PlastiTech, Nolt's Produce Supplies, RainFlo Irrigation
Tufflite TIV	Berry Plastics Corp. (Monroe, LA)	PlastiTech, Rimol Greenhouse Systems, Nolt's Produce Supplies, Zimmerman's High Tunnels and Greenhouses, Rainflo Irrigation
Sunmaster Clear	Lumite (Georgia, USA)	FarmTek (Grower's Supply)
Sunmaster IRAC	Lumite (Georgia, USA)	FarmTek (Grower's Supply)
<u>Other covers</u>		
Solarig 140 and 172 (woven material)	Solarig, P.I.C. Plast Ltd (Israel)	Robert Marvel Plastics
Solawrap Polydress ("bubble wrap")	Global Plastic Sheeting,	Solawrap
Solexx (5 mm corrugated plastic)	Adaptive Plastics (Oregon)	Adaptive Plastics