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## **“Exterior Shade and Cooling Curtain Systems “**

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### *Overview*

Retractable curtain systems installed above greenhouses are the most effective way to cool a greenhouse because the curtain blocks much of the infra-red radiation (heat) from the sun **before** it reaches or enters the greenhouse. By reducing the amount of heat that enters the greenhouse, a reduced air exchange is required per minute to maintain the same temperature.

This concept of preventing the heat from entering the greenhouse has proven to be very beneficial when cooling and ventilation in a greenhouse is insufficient either due to:

- humidity levels being high, making evaporative cooling less effective
- natural ventilation system being insufficient, usually due to the ventilation system being too small and/or the vents are covered with insect screening.

While the exterior curtain systems are excellent for cooling, they are not very effective at retaining heat during cold conditions.

### *Benefits of an external curtain system*

The following are the main benefits from using an exterior curtain system installed above the greenhouse.

#### **1. *Stops the heat before it gets inside of the the greenhouse***

Having the curtain above the greenhouse creates a cooling effect similar to a cloud passing by the sun since both reduce the light (**and heat**) levels before they reach and enter the greenhouse. Having an air space between the shade cloth and the roof covering reduces the transfer of heat by conduction. Reducing the heat load **before** the greenhouse helps keep the roof covering, purlins, trusses and gutter cooler.

#### **2. *Optimal light levels***

Since the curtain is retractable, a heavier shade percentage can be used to provide optimal cooling during the hot times of the day without negatively reducing light levels during times of the day where light conditions are low, or temperatures are optimal.

#### **3. *Reduces electrical costs if using fans for ventilation***

Reducing the amount of heat that actually enters the house reduces the number of fans that need to operate to maintain a certain temperature

#### 4. ***Can extend the life of the roof covering***

The life of the roof covering can be extended if it is polyethylene or polycarbonate. When the exterior curtain fabric is closed, it reduces the:

- amount of UV radiation that the roof is exposed to
- the maximum temperature that the roof covering is exposed to
- there is no abrasion to the roof covering since the curtain fabric is never in contact with the roof covering

#### **Design Considerations**

- External curtain systems are typically used in southern applications. As such, they must be designed to withstand the wind. External curtain systems should never be closed during snow since the greenhouse cooling and ventilation system should be sufficient during these conditions.
- The post extensions may impede movement of personnel along the gutters. This may complicate replacing the greenhouse poly or maintaining the greenhouse roof.
- External curtain systems generally have to be designed to cover complete greenhouse ranges due to perimeter bracing requirements.
- Since the shade fabric is high above the crop, it may be beneficial to extend the curtain system beyond the greenhouse on the south, west and possibly east walls to provide proper control when the sun has a low angle of incidence.
- The angle of incidence must be considered especially when evaluating multiple roof zones for allow for independent control of the different growing zones.

#### **What Types of Houses Work Best With Shade Above**

Virtually any type of greenhouse can accommodate a shade-above curtain system. However, house designs most suitable for installation of exterior mounted curtain systems include:

- gutter connected sawtooth
- Gutter connected poly houses with low roof profiles
- Free standing hoop houses

#### **System Design and Structural Requirements**

##### *Interior Posts*

To mount the curtain system above the greenhouse roof, a post extension is required at each gutter post which extends above the highest part of the roof. For houses covered with double poly, the curtain system height must take into consideration the height of the upper layer of poly after it is inflated. For gutter connected greenhouses that are not a sawtooth, the post extension is mounted in the gutter and attached to the internal gutter mounting bracket. The length of the extension should be such that the curtain fabric itself would never touch the roof covering, regardless of whether the curtain is retracted or closed.

##### *Sidewall Posts*

There are three sidewall post designs.

1. The sidewall posts of the greenhouse are extended either through the gutter or beside the gutter. This design would have to be incorporated in the original design of the greenhouse.

All of the sidewall posts need to be braced back with ground augers sufficient in design to withstand the pre-tensioning of the suspension wires as well as the wind loading.

2. An additional row of posts set approximately three feet from the sidewall on twelve-foot centers. These posts will have to be fairly heavy since they are long and the load at the top will be braced back with external cable bracing.
3. Freestanding structural members mounted on twelve-foot centers approximately three feet out from the sidewall posts of the greenhouse. This is a special design that requires very large structural members that are installed in large footings. This is a unique design and is typically cost prohibitive, however, can be used where the area for bracing is unavailable.

#### *Gable Posts*

The posts located at the ends of the curtains are braced with internal horizontal compression brace and a diagonal cable brace which is attached to the base of of the first post extension and the horizontal compression brace at the second post.

#### **Fabrics**

The most common fabric used to date is black shade cloth since it is long lasting and fairly economical. Fabric life of black shade on an external curtain system of 10 years is not uncommon.

However, new data is showing that a clear woven polyethylene curtain fabric could reduce the heat entry more than black shade cloth... but with a lower reduction in light levels. This is due to the fact that much of the heat load on a sunny day comes from the infra red radiation, and infra red radiation heats the first object it hits..

When a black shade cloth is used as the curtain fabric, the idea is to reduce light levels to reduce heat. Assuming a black shade cloth with a 50% shade is used, 50% of the visible light is reduced , but approximately 50% of the infra red radation still hits (and heats up) the greenhouse roof covering.

When a clear woven polyethelene curtain is used, the visible light is reduced 25%-40%, depending on the age, and amount of dirt on the covering. However, since the curtain fabric has no significant openings, virtually 100% of the infra red radiation hits the curtain fabric... not the roof covering. While the

#### **Installation**

Installation of an external curtain system is usually more difficult to install than a curtain system inside a greenhouse. The simplest and most efficient way to install an external curtain system is during the construction of the greenhouse since the curtain system can be installed before the roof covering allowing equipment that extends up to the curtain system height to be used.

When installing an exterior curtain on an existing greenhouse, sawtooth houses and houses a low profile arch are the easiest since the curtain system can usually be reached from the gutter location.