Innovations in Growing using Retractable Roof Greenhouses, Cold Protection, and Shade Houses

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INTRODUCTION

Most growers, given the opportunity, would prefer to grow their plants outside. Not only is the outside environment the natural environment for all plants, but it also requires less capital to grow outside than in a greenhouse structure. However, due to the fluctuation in the outdoor environment from day to day and season to season, it became obvious that some sort of structure would be required to precisely control the growing environment. As a result, growers began to build greenhouses to protect their plants from adverse outside conditions.

While inside a greenhouse, the plants are protected against adverse conditions outside. However, when outside conditions warm up and dry up, and the sun comes out, the greenhouse environment becomes too hot and too humid. During these sunny, hot conditions, most growers experience some or all of the following problems when growing in a greenhouse:

- Plant stretch
- Higher incidence of pests and disease due to higher heat and humidity
- Poor plant growth due to excessive leaf and soil temperatures
- Differences in the rate of plant growth, due to temperature variations as a result of improper ventilation
- Lack of control over crop timing, due to inability to cool the crops
- Poor plant performance after being moved to an outdoor finishing area or into a garden, due to the plant being poorly acclimated to outside light and wind conditions.

This poses a dilemma for growers. If they grow their plants outside they could be exposed to cold and rain. If they grow their plants in a greenhouse they would have to contend with the problems listed above.

Many different types of equipment were developed to help cool and ventilate the greenhouse environment in the summer, like shading systems installed inside or above the greenhouse, fog systems, gutter vents, roll-up sidewalls, etc. These different systems did help moderate the daytime greenhouse environment, but they could not create true outdoor growing conditions inside the greenhouse. The plants were still exposed to a greenhouse environment regardless of the weather outside.

Similar problems occurred with growing plants in shade houses. The plants only needed shade for 5 to 8 h per day, but they were shaded for 24 h per day. Having the shade cloth overhead 24 h per day restricted air circulation, thereby creating high temperature and humidity levels that caused poor plant quality and higher incidence of disease.

GIVE THE PLANTS WHAT THEY NEED, WHEN THEY NEED IT!

In order to maximize crop quality and quantity, it became evident that the plants need the proper growing environment, 24 h per day, regardless of the weather outside.

One solution is to have a roof covering that can protect the plants when they need protection from the outside elements, but then could be retracted when the outside environment is suitable for the plants. This way the plants are in a protected environment when they need the protection, but are in the outdoor environment when it is suitable to the plant.

There are now three types of retractable roof structures available, each providing a different level of protection when the roof is closed, namely:

- Shade houses
- Flat-roof cold-protection houses
- Greenhouses

Shade Houses. Retractable roof-shade houses can increase plant growth by 15% 30%, as compared to fixed-roof houses, simply by optimizing light levels and by properly reducing the plant leaf and soil temperatures. The retractability of the shade allows for a darker shade to be used for proper cooling during excessive light and temperature conditions, since the shade is retracted during low light conditions.

However, since black shade cloth is porous, it is very difficult to get significant cold protection or rain protection, since the rain will pass through the shade cloth. However, the shade cloth can be used to break up the larger rain droplets to create more of a mist. This type of retractable roof shade house is used primarily where shading and cooling are most important.

Cold-Protection Houses. Flat-roof cold-protection houses with a retractable roof are similar in design to a shade house, with the only difference being that a woven, white polypropylene covering is used instead of black shade cloth. This covering allows water through, but allows minimal air passage. This house is used primarily for cold protection, but can be used also for some shading in the summer for crops that are heat sensitive. This is especially beneficial for situations where soil temperatures in the pots get too high, resulting in plant stress and eventual shutdown.

This type of house is used in the south for foliage and nursery-type plants and in the north for nursery and perennial production. Since the covering is horizontal the rain does pass through the covering, so the plants will get wet when it rains. This house should not be used for rain-sensitive plants, like bedding plants, but is ideal for perennial production, especially since the automatic retraction of the roof allows for a snow cover to fall on the perennials for added insulation and protection.

With the cold protection and shade house, if proper planning is done ahead of time, the posts used for these two house designs can be used to attach a greenhouse roof at a later date.

With respect to snow, the cold protection house can be designed to hold a 7 to 10 lb ft^2 snow load when the roof is closed. For situations where greater snowfalls may occur, either supplemental heaters can be used to melt the snow, or a snow sensor can automatically retract the roof when it begins to snow.

Greenhouse with a Retractable Roof. A greenhouse with a retractable roof provides the greatest degree of protection to plants in that it can keep plants both

warm and dry, like a conventional greenhouse. The main difference is that a conventional roof vent only opens up 25% of the roof, whereas in a retractable roof greenhouse the greenhouse roof retracts 90% of the way in less than 3 min. Not only does this create a massive roof vent, but, more importantly, it allows for the plants to receive direct, unfiltered sunlight. It is becoming apparent that direct ultraviolet light is nature's most effective growth regulator and is critical to growing properly acclimated plants. With this house the crops can be exposed to outside conditions any time the outside temperatures exceed the desired minimum and it is not raining. This means for many locations the roof would be retracted 50% to 70% of the time.

These houses are essentially the same as a conventional fixed-roof greenhouse, with the exception of ventilation capacity. This means that all standard equipment that is typically used in a conventional greenhouse can be used in a retractable roof greenhouse, such as:

- Typical heating systems
- Irrigation booms
- Hanging baskets
- Additional curtain system for shading, cooling, and heat retention
- Fog systems
- Roll-up side walls or side vents for added cross ventilation.

Retractable roof-type greenhouses are ideal for bedding plants, containerized ornamentals, vegetables, tree seedlings, specialty cut flowers, or any other plant that prefers to be grown outside. A good rule of thumb is that if it is going to be sold and then planted outside it would do extremely well in this type of house.

Plant Benefits. When the roof is retracted on any of these three types of retractable roof houses:

- Plants receive outside light, temperature, and humidity levels.
- Leaves dry off quickly, due to the wind and direct sunlight.
- Plants grow more compact and are properly acclimated.
- Plants are more disease resistant, since they are grown healthier and are exposed to less stress.
- Plant growth is more uniform throughout the range, since there is no temperature differential throughout the range.

Other Benefits.

- Better temperature and humidity control will result in reduced chemical fungicide and growth regulator usage.
- Roof can be closed to help contain chemical applications
- Roof can then be retracted after applications have been completed to allow for purging.
- Growers can manage larger growing areas, since it is easier to grow plants when you have proper control over the environment.
- When plants are rain-tolerant, growers have the opportunity to conserve water by retracting the roof when it is raining.
- There is no limitation to the length of a greenhouse due to fan ventilation limitations.
- Larger greenhouse ranges can be constructed as a result, which makes it easier to monitor workers' activities.
- Eliminates the need to buy, operate, and maintain fans.

The most important benefit, however, is that the crops will be of a more consistent, higher quality and better acclimated, which is becoming a major issue with the mass merchandisers. Not only that, if the consumers enjoy higher quality plants our entire industry will benefit.

QUESTION-ANSWER SATURDAY MORNING

John LaForge: Have you seen any fog systems inside these retractable-roof houses for propagation?

Richard Vollebregt: At this point, not yet. We have only been promoting this for production ranges. As growers become more aware of it we see fog used in propagation. We have seen it in Arizona were people have flat-roof houses and they were using the fog simply for cooling whereby they would have a retractable shade to reduce the light level and then the fog system would be used to supplement the cooling of the air temperature.

Marge Sweeney: In your Mediterranean house, what was your watering system?

James Ault: Everything is being manually watered in there right now. Since we move plants around so much, trickle irrigation systems have been difficult to use. The soil mix in there is well-drained and you can have a plant that has a high water requirement next to a plant that has a low water requirement and not have problems with irrigating either one.

Ross Merker: How do you manage pest management when you have large numbers of people going through your facility?

James Ault: We have 800,000 people visit and we are open 365 days a year so that is a real concern. We have a full-time integrated pest manager and it is his job to figure this out. We do use some biocontrols. We use a lot of soap and oil that works very well under glass. We avoid including plants in our displays that have serious insect problems.

Patti Kreiber: When do you expect Volume 2?

Bruce Macdonald: It is about 25% complete.

Jim Conner: Under high wind conditions and the curtains are open, what happens to the crops?

Richard Vollebregt: The roof systems have been designed whereby they can be operated at any point in time without regard for wind. The structures, as a general rule, are designed to be exposed to 80 MPH winds when the roof is in a closed or covered position. The roof can be retracted if you want, but our philosophy is that you spent this money to buy a structure to protect these plants and you have to be able to accomplish that objective no matter what the environment is like. If you have to retract the roof to protect the structure because of 50 MPH winds, you shouldn't buy the structure. The horizontal retractable roof systems have been in operation for the last 10 years and have never had a wind-related failure. The main reason for this is that the covering is suspended below stainless steel wires that provide support in up-lift conditions that would occur in a strong wind. The retractable roofs are controlled strictly by light, temperature, or rain.