TEMPERATURE, SOLAR RADIATION AND SULFUR CAUSE YELLOWING OF PLASTIC GREENHOUSE GLAZINGS

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A general review of plastic cover problems. Sulfur vaporization in rose houses can reduce light transmission significantly.

Photodegradation

The greenhouse industry has over 30 years experience in the use of plastic greenhouse covers. The polyethylenes of the early 1950s had a useful life of three to six months, and it took a few years for people to realize the detrimental effects of ultraviolet radiation in sunlight on these plastic products. Every film product that was considered, met with some particular problem that prevented it from being the desirable "long-lasting" material. In the late 1950s and early 60s, rigid panels of polyvinyl chloride (PVC) and fiberglass reinforced plastic (FRP) were introduced to the greenhouse industry. After a few months, it was realized PVC would not withstand the ultraviolet rays provided by Mother Nature. It was the same problem that was being felt by the users of polyethylene and PVC film covers. All of the plastic glazings that were used until the early 60s tended to "yellow" and in most instances developed reduced light transmission characteristics within a few months or a year. Thus, the term "photodegradation" was introduced to the greenhouse industry. However, the various manufacturers of glazings continued to experiment with chemicals that would delay or reduce photodegradation in their products. These chemicals are still vital in the composition of the high quality plastic greenhouse glazings of today.

Thermodegradation

With the increased construction of greenhouses across the nation in the late 1960s and early 1970s, and a change toward bedding plant production by many "old" growers, greenhouse operators tended to limit the use of their facilities to late winter, spring and sometimes early summer. Upon harvesting or marketing the products, bedding plant operators would close their greenhouses and wait until winter before they began propagating and preparing for the next growing season. It soon became evident that higher than normal temperatures were contributing to color changes. The term "thermodegradation" was introduced.

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Temperatures inside a tightly closed, unvented greenhouse can exceed 110 F and often approach 130 F during hot summer months. A combination of high temperatures ("thermodegradation") and the presence of ultraviolet light that contributes to photodegradation, causes rapid and excessive yellowing and breakdown of most plastic materials.

Covers differ in their resistance to degradation

Most greenhouse operators are now well aware of the differences in the various plastic greenhouse glazings, including their resistance to yellowing and weathering. Some of the polyethylene films have high concentrations of UV inhibitors which create a yellowish-green tint in the material, but provide at least three years longevity. Most green tinted materials do continue to become somewhat brittle, and gradually darken with time, reducing the amount of light transmitted into the greenhouse. The clear poly products also darken due to photo- and thermodegradation.

A recent CSU research project utilized a PVC film from Japan. The film did not appear to change color, but its physical characteristics changed and the product had less tear resistance than when it was new.

Yellowing was quickly observed in the FRP panels of the early 60s and most of the companies incorporated UV inhibitors which reduced the rate at which yellowing occurred. The advent of Tedlar® coated FRP panels practically eliminated the yellowing of the base panel, and it has been providing up to fifteen years of useful life. There have been instances where Tedlar® delaminated. Such a condition is almost directly related to the manufacturing process.

The concept of applying a "resin rich" surface to an FRP panel has proven to add life and reduce the rate of yellowing of one company's glazing. The special coating contains UV inhibitors and other agents which are resistant to photodegradation and weathering. It must be pointed out, however, that thermodegradation can still occur and lead to yellowing of the best film or panel products. Remember, high temperatures in a closed greenhouse during summer months, can adversely affect the cover.

The structured sheet products presently available on the market, also have had problems. The polycarbonates, by themselves, tend to yellow with age and are influenced by thermal degradation like any other plastic product. There are polycarbonate structured sheets that have a special surfacing which apparently reduces photodegradation and will provide a relatively clear panel for a longer period of time.

The acrylic type structured sheets have shown their resistance to yellowing. There have been instances, however, where sudden drops in temperature and the hail have contributed to excessive cracking and, depending upon the hail size, breakage of the panels. The acrylic panels are somewhat more brittle and more easily broken due to impact, than most of the other greenhouse coverings.

Other factors that contribute to the yellowing of greenhouse glazings

It is pretty much common sense, and often very obvious, that the presence of dust and dirt on any greenhouse cover will not only reduce its light transmission characteristics, but create a visual "yellowing" of the material. In areas of the country where light conditions are less than desirable and there is little rainfall, it behooves the greenhouse operator to wash the outside of the greenhouse periodically to remove dust.

In an evaluation of FRP panels on the CSU rose research greenhouses, it was observed they had yellowed substantially after 2 years. It was noted the yellowing was due to the presence of sulfur particles created by sulfur vaporization to control powdery mildew on roses. The sulfur particles attached themselves to virtually every part of the greenhouse structure and were especially noticeable on the underside of the greenhouse glazing immediately above the vaporizer. Both covers, a Tedlar® coated FRP panel and a gel coated FRP panel, have an exterior visual appearance of yellowing (Fig. 1).

Solar energy transmitted through one sulfur coated rose-house roof (Fig. 1A) at noon on a cloudless February day, was 5 percent less than the energy received 3 ft. above the benches in an adjacent FRP covered house without sulfur vaporization, or through the corridor cover (Fig. 1B) between the two rose houses. An area above a sulfur vaporizing unit (Fig. 1C) was washed. The sulfur particles were completely removed, eliminating the yellow appearance and restoring it to a visual condition equal to the adjacent corridor cover (Fig. 1B). There was a decrease of 21%

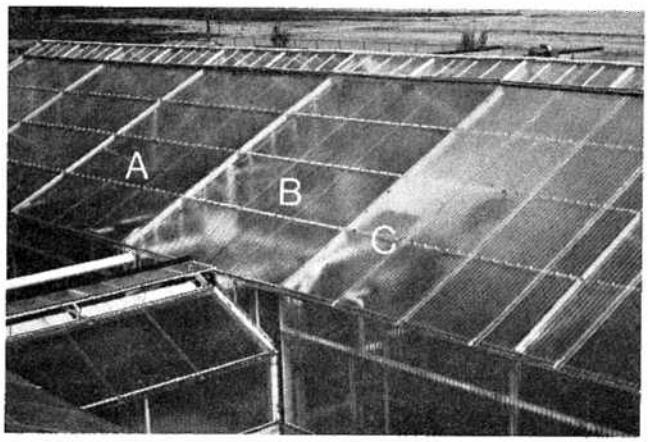

Fig. 1: Overhead visual view of the CSU rose greenhouses (A & C) compared to the corridor B. A small area just below the left "leg" of the A and immediately above the vaporizer, C, was wiped clean.

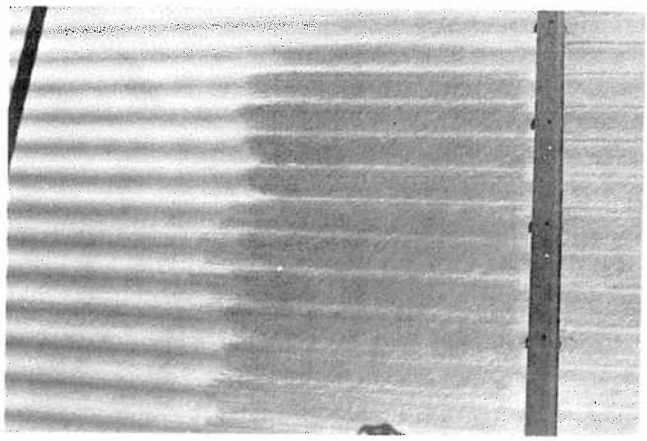

Fig. 2: Inside view of cleaned and non-cleaned area above a sulfur generator unit.

solar energy transmitted 6-in. below the most dense sulfur accumulation, compared to the washed area.

The axiom "a little is good, but a lot is better" may not be valid in regard to the vaporization of sulfur in a greenhouse. Most rose growers that use sulfur to control mildew, probably overdo it and have particles accumulating on the inside of the greenhouse covers. The question is: How many generators are needed to control mildew, and at the same time prevent excessive accumulation of sulfur particles on the underside of the rose house roof? It is recommended that all sulfur-using rose growers wipe a small roof section with a clean white rag and then view the area from the greenhouse roof. Residue on the white rag will indicate the degree of yellow particles or dirt accumulated. If an exterior difference can be visually observed, you may want to consider "hosing down" the underside of the roof during a period of low rose production.