COLORADO FLOWER GROWERS ASSOCIATION, INC.

IN COOPERATION WITH COLORADO STATE UNIVERSITY
Richard Kingman, Executive Director
2785 N. Spear Blvd., Suite 230, Denver, Colorado 80211

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Condensate in Plastic Greenhouses

Kenneth L. Goldsberry

The combination of glass, bars and drip grooves has automatically controlled most condensate problems in glass-covered greenhouses for many decades. The laps between glass panes also allow the structures to "breathe" and thus provide air exchange that aids in condensate control.

Film and rigid plastic greehouse coverings generally form condensate on the inside during winter months and "drip" falls on crops creating or enhancing disease problems. The film plastics are generally applied so that all joints and laps are air tight. Since little air can be exchanged, especially on cold days, heavy condensate forms and tends to fall every time the structure vibrates. Rigid plastic coverings have also contributed to "drip" problems. Builders utilize wide panels and, in some instances, seal the laps with adhesives. Once again there is limited air exchange and excess condensate forms inside.

Contributing factors of increased condensate

Besides the lack of free air exchange due to tight houses, new cultural practices have aided in increasing condensate.

Rose growers utilize mist systems and try to maintain a 70% relative humidity. Many growers use automatic watering systems and some water more than once per day. Carbon dioxide, for "aerial" fertilization of plants, is often obtained by burning natural gas or propane within the greenhouse, producing a by-product of water vapor. No doubt automatic ventilation has also contributed to increased condensate—the "ole time grower" cracked vents when a house felt stuffy, but today fans are controlled by temperature.

Rosehouse Rainfall

During the summer of 1964, a greenhouse used for rose research at Colorado State University was recovered with 5 oz. arcylic modified fiberglass reinforced plastic (FRP). During the early part of the winter, heavy condensate and drip were observed. The house was controlled at 62° N and 72° D minimum temperature, 84° maximum day temperature and minimum of 70% RH during daylight hours. On February 16, 1969, official 8-inch Weather Bureau non-recording gauges with a 1:10 ratio catch tube were placed in 3 isles of the rosehouse (Fig. 1). For periods of 15 days after February 16 and March 3, the amount of rainfall was measured in the 3 locations under the slope of the roof (Fig. 2).

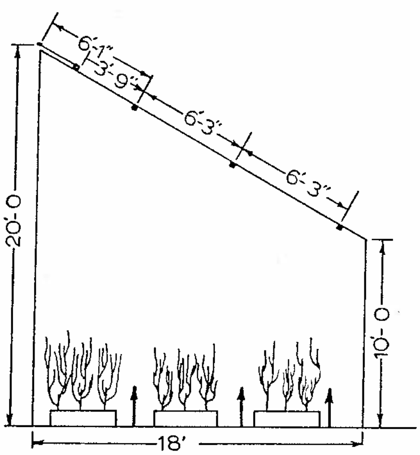

Figure 1. Side view of rose greenhouse area utilized to determine condensate drip. Arrows indicate position of rain gauges during observations.

A second study utilizing a quonset-type structure at Colorado Roses Incorporated was conducted during December 1969. The house was covered with 4 oz. fiberglass reinforced plastic. The environmental control included:

- Top vents open at least ½" when temperatures were above 40° F outside
- Vents wide open as needed during daylight
- Heat on with less than 2 inches of ventilation
- 62-64° F night temperatures
- 70-80° F day temperatures

— All but 2 houses had been sprayed with a surfactant to reduce drip
— RH = 70%

On December 17 and 23, Belfort Model 5-780 Universal Recording rain gauges were placed in three isles (Fig. 3) of a greenhouse not sprayed with a surfactant. The aforementioned environment in the total range decreased the "drip" and only the area in the center of the house yielded rainfall (Fig. 4).

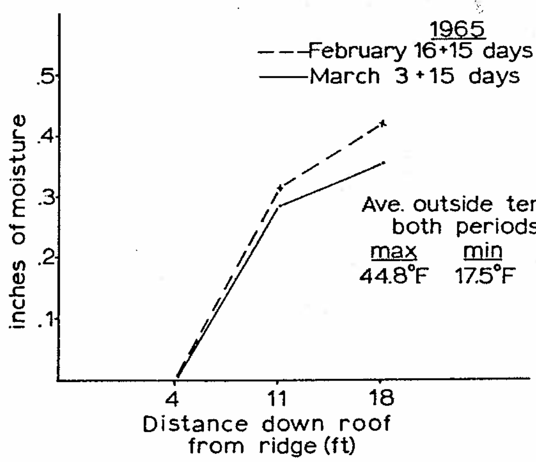

Figure 2. Moisture collected from 3 locations in a standard FRP covered rosehouse during two observation periods starting February 16 and March 3, 1965 and continuing for 15 days.

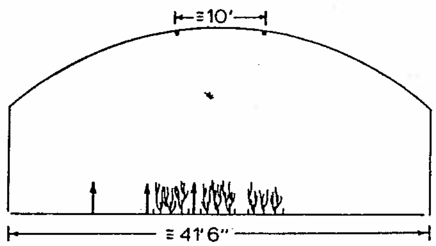

Figure 3. Side view of a quonset-shaped rosehouse used to observe condensate drip. Arrows indicate positions of rain gauges during observations.

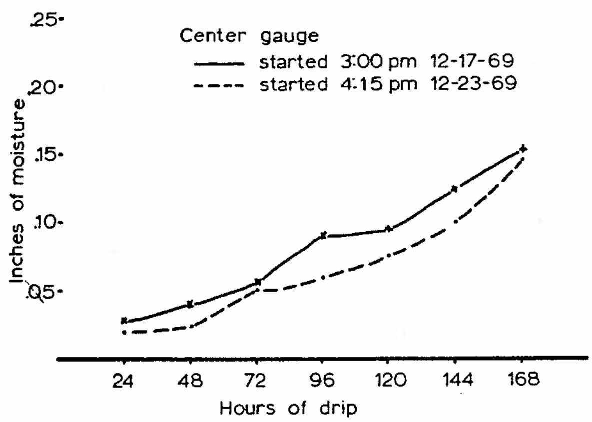

Figure 4. Moisture collected in the center of a quonset-type FRP-covered greenhouse during two observation periods of 168 hours starting December 17, 23, 1969.

Controlling condensate in plastic houses

Air exchange - In FRP covered houses the air exchange can be increased by using the narrower panels without adhesives at the joints. Circulation can also be increased by removing every third or fourth closure strip in the ridge of the house. Several automatic louver and/or tube designs can be utilized for more effective air exchange.

Double layer - Consendate in plastic film houses can be controlled by installing a second film (of less durability and cost in many cases) on the underside of purlins, rafters, etc. providing a dead air space. A film has also been successfully placed below FRP panels. In either case, the lower film can become dirty and lead to decreased light transmission and poor plant quality and yield, especially when it is left installed more than one year under FRP covers.

Coatings - Many detergents, emulsifiable spreaders and surfactants have been sprayed on the underside of plastic coverings for drip control. All of the materials utilized at CSU have benefitted only momentarily after application and did not provide indefinite control. The only proven material to date is "Sun Clear," a product of Solar Sunstill, Inc. of Setauket, L. I., New York. Colorado Roses, Inc. successfully controlled drip prior to our study in their houses.

Color - Recent studies at CSU have shown that FRP panels normally used as greenhouse covers and classed as clear, frost or super clear will always have condensate and drip under proper environmental conditions. Panels containing color pigments form condensate but not enough to drip. The color pigments absorb energy (heat) which is transferred to the surrounding resin and glass causing a rise in temperature and evaporation of moisture from the surface. The amount of heat absorption depends upon the color and its density in the panel.

Discussion

Condensate in plastic, covered greenhouses can be controlled but probably not eliminated. Drip from condensate on FRP panels tends to decrease with age and after 2-3 years little drip is observed. The decrease in drip is probably due to a change in surface tension on the under side and not the "yellowing" of the panel.

The tinting of panels for greenhouse covers has not been recommended to date. Studies are continuing to determine its effect on plant growth; the consideration of condensate control is only secondary..

No endorsement of products or equipment referred to in this paper by trade name is intended, nor is criticism implied of similar products which are not mentioned.