Colorado Flower Growers Association, Inc.

IN COOPERATION WITH COLORADO STATE UNIVERSITY
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Bulletin 190 March, 1966

Evaluation of Greenhouse Shading Compounds

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For many years, growers have been using shading techniques to lower greenhouse temperatures during summer months. Materials such as cheesecloth, louvers, interior and exterior shading compounds, and even paints have been used without actual evaluation of their effectiveness. This investigation analyzed the merits of several exterior-applied shading compounds and their relationship to heat buildup, light transmission, and general ease of application and removal.

Preparing the glass samples

Dry, commercially available shading compounds of the colors white, green, blue, and purple were mixed at approximately the rate of 1 lb./1.5 gals. of water. Liquid compounds of white were mixed at the rate of 1 gal. of concentrate per 7 gal. of water.

A transmissometer[2] with an 1100 foot-candle output was used to establish a constant light transmission factor with all colors of shading compounds. New, clean glass transmitted 91% of the incident light, the remainder being reflected or absorbed by the glass. The purple compound was used to obtain the basic transmission factor and was applied to the glass until 35% of the fluorescent light was transmitted (350 ft-c). Each of the other compounds was then applied to a new pane until 350 ft-c was transmitted.

A paint-spray gun was used to apply the compounds at a pressure of 45 psi. The compounds were sprayed on new panes of 20" x 20" greenhouse glass.

Experiment I: Heat buildup under various shading compound colors.

This investigation was conducted by spraying the inside of an 18" x 18" x 10" cardboard box with flat black paint, centering a thermocouple in the box and using the shaded panes as lids. A 250 watt G-30 GE infrared lamp was placed 6 inches above the glass and average temperatures observed at 5- and 10-minute intervals. More than 90% of the spectral distribution from this lamp is within the infrared range. Table I indicates the heat buildup in the box when infrared was applied to the glass lids covered with the several shading compounds. The yellow for this experiment was made by mixing yellow dye with the dry white compound.

[1] Part of a special problem conducted by Dennis Wolnick while a senior student in Horticulture.

[2] An instrument designed by the American Society for Testing Materials and the Society of the Plastics Industry for determining a "Diffuse light transmission factor of reinforced plastic panels."

Table I: Heat buildup in a special box when infrared energy was applied to shaded glass lids for 5- and 10-minute periods.

Shading compound colors	Time of exposure	
	5 min.	10 min.
Purple	97°F	100°
Blue	97°	101°
Green	96°	102°
Yellow	91°	92°
White	90°	91°
None	120°	No reading

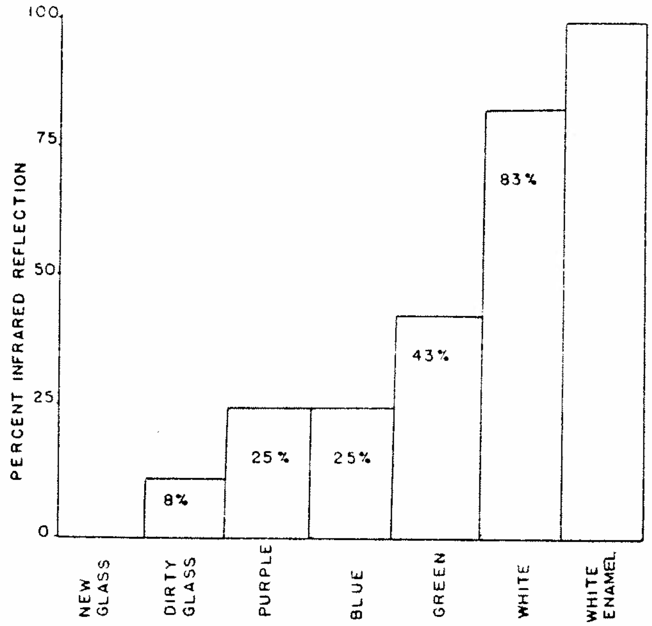

Fig. 1. The percentage of infrared reflected by various shading compounds on glass.

Experiment 2: Reflected infrared from panes shaded with different colors.

A 250 watt infrared lamp was placed approximately 8 inches and at a 60° angle above the cardboard box described in Experiment I. A Photovolt photoelectric reflection meter, model 610, was used to measure the infrared reflected by each of the panes covered with colored shading compounds. In order to measure the reflected infrared on a percentage basis, the infrared lamp was placed above new, clean glass and the meter adjusted to zero deflection. A white, enameled tray was used to reflect the same infrared and the meter adjusted to 100%.

Experiment 3: Application and removal of compounds

The same shaded panes used in Experiment I were utilized to determine the percentage of infrared reflection (Fig. 1).

Spraying--All of the compounds were applied with a paint-spray gun. It was found that a fine, spray-air mixture provided the best application. The mist spray resulted in little running, and as air was reduced the runoff increased. Clumps of unmixed compound tended to clog the sprayer and left heavy spots on the glass. Any heavy spots or runs due to spraying methods or compound decreased the usefulness of the shading compound.

Glass condition--Both liquid and dry compounds were applied to heated and unheated glass to determine differences in ease of application and coverage. The glass was heated for 30 minutes with a 250 watt infrared heat lamp, simulating sunny conditions, and then sprayed.

It was found that glass, which had been heated, dried the compound almost upon contact. The unheated glass application dried very slowly. Some manufacturers recommend that their compound be applied during early morning or late afternoon so the compound will dry slowly. The heated glass application resulted in better coverage with less material.

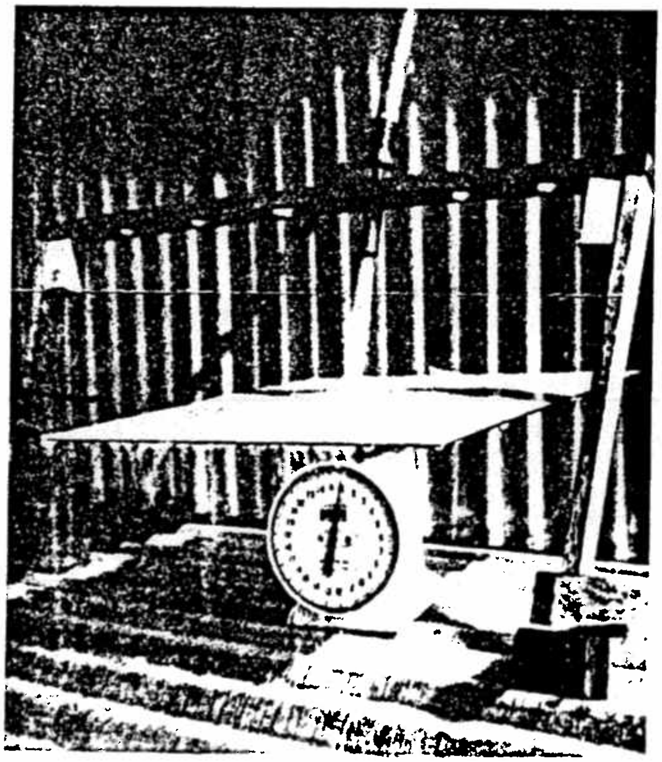

Fig. 2. Apparatus used to estimate shading compound durability.

Removal of shading compounds with water--Liquid and dry types of shading compounds that were applied to heated and unheated glass panes were used in water durability tests. Figure 2 shows the apparatus used to test the compound durability. The garden hose nozzle was placed 8 inches above and at approximately 60° angle to the glass. The water was applied to depress the scale one pound. Table II summarizes compound durability.

Table II: The durability of liquid and dry shading compounds under a forceful stream of water (see text).

Treatment	Wearing	Off
1. Liquid A unheated glass	5 min.	10 min.
2. Liquid B unheated glass	30 min.	*
3. Dry unheated glass	25 min.	*
4. Liquid A heated glass	10 min.	15 min.
5. Liquid B heated glass	30 min.	*
6. Dry heated glass	25 min.	*

*Water turned off after 40 minutes, little wearing.

A sticker, supplied by Winnandy Greenhouse Construction, Inc., was added to all of the compounds. It was noted that compounds containing the sticker gave best results when applied to unheated glass. When compounds containing sticker were applied to heated glass, unevenness and running occurred and it dried slowly.

Conclusions

Darker colors of shading compounds absorbed infrared and caused heat buildup below the glass. Lighter colors reflected more infrared; white being better than the others tested. White compounds should be used for all types of shading with the amount varied for coverage and density.

Compounds applied in a fine spray during bright sunny weather without stickers gave the best coverage. It appears that stickers are of little benefit in increasing the life of compounds and may be worthless when applied to heated glass.

The new liquid types of shading compounds appear to last equally well or better compared to dry materials, providing instructions are followed. In some cases stickers are needed. The liquid compounds are easier to prepare, can be applied through a regular greenhouse spray rig, and are time and labor saving.

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