Heating Plastic Greenhouses

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This is a progress report of the work on heating plastic greenhouses. The results are from one season only. A more complete report will be released upon completion of this study.

With the advent of many plastic greenhouses, horticulturists are being asked questions regarding costs and methods of heating such units. This study was initiated in an attempt to find the answers to some of the problems connected with heating plastic greenhouses.

Two identical greenhouses 18 x 40 feet were used in this study. Each house had an exposed surface area of 1710 square feet. Identical oil fired, hot-air furnaces were installed in the houses and each furnace had a 151,000 B.T.U. output capacity (1.35 gallons per hour burner). No. 2 fuel oil (140,000 B.T.U.'s per gallon) was burned.

A 275 gallon supply tank was placed in each greenhouse. To facilitate measurements, a one-half inch plastic tube was attached in a vertical position to the outlet line and a calibration scale was mounted behind this tube. Measurements could be made directly from the outside of the tank.

Both houses were covered with polyvinyl chloride (Bakelite KDAA 2817) .004 inch thick. In one house a .002 inch polyethylene inner layer was installed. Therefore, the only difference between the houses was that one was a single layer house and the other had an inner layer. Approximately a two-inch air space existed between the two layers.

Both furnaces were thermostatically controlled and during the course of this test period, a constant 60° F temperature was maintained. Each night, the fuel consumption from 8 pm until 8 am was measured and the difference between outside and inside temperatures were calculated.

As might be expected, it took considerably more fuel to heat the single layer house than it did the house with two layers (Table 1). Heating the single layer house resulted

Table 1. A comparison of fuel used to heat two plastic greenhouses (40′ x 18′). The fuel consumption was measured from 8 pm to 8 am starting April 2 and terminating May 8, 1959. The inside temperature was 60°F.

	Single layer	*Double layer*
Average hourly difference (inside temperature versus outside temperature)	17.5° F	17.5° F
Total gallons of fuel used	132.9	80.8
Average gallons of fuel/day	5.5	3.4

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in about forty per cent higher fuel cost.

Conclusions

On the basis of the data computed from these experiments, it appears that a saving in the neighborhood of 40 percent on fuel costs can be had if an inner layer is properly installed. An advantage that has not been brought out heretofore, is the fact that when an inner layer is used on a plastic greenhouse, the problem of drip from the inner surface of the greenhouse is almost eliminated. Even though it has been reported that an inner layer will theoretically reduce the amount of visible light coming into the greenhouse, by actual measurements under greenhouse conditions, more usable light will reach the plants through two layers than if one layer is employed because of the absence of the moisture film which acts as a definite light barrier.

The formula proposed by Gray to be used for calculating heat costs in greenhouses is as follows: $H=KA(T_2-T_1)$ where H equals heat in B.T.U.'s per hour; K equals a constant; A equals surface area exposed; T_2 equals inside temperature; T_1 equals outside temperature. Gray suggests a value for "K" of 1.13 for glass houses. The evidence from this work indicates a K of 1.724 for single layer plastic house and 1.048 for a double layer house. Generally, most growers have found single layer houses difficult to heat and feel that double layer houses heat much easier than glass.

Looking at this from a more practical level, it would take about 332 gallons of oil ($49.80) to heat for a 60 day period in a single house as against 202 gallons ($30.30) for a double layer (40′ x 18′) house assuming the same temperature differences, a 60° F night temperature and the average fuel consumed per day in Table 1.

Therefore, using the formula $H=KA(T_2-T_1)$, a single layer house would require—

17,240 B.T.U.'s per hour/10° difference/1000 ft.^{2} of exposed surface area.

and a double layer house—

10,480 B.T.U.'s per hour/10° difference/1000 ft.^{2} of exposed surface area.

When using two layers, it is imperative that both layers be secured very well to the framework. Any air leaks along the joints will nullify some of the effects of the second layer.

The air space between the layers is apparently very important. At the present time, it appears that this space should be not less than one inch and not over two inches. If space less than one inch is used, the layers frequently come together and the insulation value is lost. Where spaces greater than two inches have been used, air currents are frequently set up and this reduces the insulation value. Excellent results have been consistently obtained on the Cornell panel houses with approximately 1⅛ inches of air space.

Work on the infra-red heaters, which many of you saw last short course, has progressed very slowly. Mechanical difficulties prevented proper comparisons. This work will be continued this winter.