PLASTIC FILM GREENHOUSES

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Two types of plastic greenhouses have been developed in the last few years. One type is made from relatively rigid, corrugated strips of plastic which is reinforced with fiber glass fibers. The cost of this material has been equal to or greater than glass thus far. The second type employs a polyethylene film and is probably the cheapest of all types to construct. The remainder of this article will deal with the second type of plastic greenhouses.

Emmert (1) of the University of Kentucky experimented with this type of structure and publicized it in numerous magazine articles. Blueprints of his greehhouse design are available from the Agricultural Engineering Department, University of Kentucky. Thomas and Hafen (2) of Purdue University also experimented with plastic film greenhouses and presented a plan which differed slightly from that of Emmert.

The question soon arose as to how the plastic would withstand the sub-zero temperatures and the heavy snow fall of our northern area. In order to obtain the answer to the preceding question, an 18 x 20 foot structure was erected on our campus in the fall of 1955. In addition, the University cooperated in the construction of an 18 x 80 foot structure which was erected by a commercial grower (Wm. Lindig) close to our campus. The same plastic film was used in each house, although structural details varied slightly.

In the University construction structure all side posts were embedded in concrete, and wooden parts of the structure near the ground line were treated with copper naphthanate wood preservative. Wooden rafters, two by two inches, were spaced two feet apart on centers. The sill at the ground line and all other sills and side posts were of two by four-inch stock. Corners were of four by four-inch material. Side ventilators one and one-half by three and two-thirds feet were placed at eight-foot intervals on centers. A regular sized door opened on one end and one by two-foot vents were placed in each end just under the ridge.

Emmert (1) and Thomas and Hafen (2) suggested the use of two layers of plastic with a two-inch air space between. They recommended that the outside layer be of 0.0002-inch plastic film and the inside layer, of 0.0015 film. The Minnesota experimental greenhouses were constructed with an outside layer of 0.004-inch film and an inside layer of 0.002-inch film as suggested by the company furnishing the material. It was thought that the heavier film had a better chance of withstanding the heavy snow load. The plastic was applied by starting at the bottom plate on one side and proceeding over the top to the bottom plate on the other side. In this manner all edges were held in place by the lath batten which was nailed over the plastic along each rafter and side post.

The commercial grower's house differed from the University house in that he used iron pipe side posts for greater strength, used old house storm sash for side vents, fastened the plastic to a one by twelve-inch board placed around the base of the structure and added two rows of two by four wooden columns as a safety factor.

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The University structure was heated with a non-electric gas burning heated while Mr. Lingig's house was heated with a steam pipe attached to his regular heating plant. The University house was heated until December 1, 1955, and after April 1, 1956. Mr. Lindig's house was heated until Christmas, 1955, and after March 1, 1956.

According to official Weather Bureau records taken at International Airport in Minneapolis, the winter of 1955-56 (November through April) averaged almost 5° F. below average with sub-zero temperatures in all months except April. The low for the winter was -21° F. in December, 1955. There was a total fall of 42.7 inches of snow and sleet with a maximum of 12 inches on the ground at any one time.

Winter Damage

The plastic on both houses withstood the winter conditions very well. Mr. Lindig noted some breakage of the film in the side wall when ice sliding off his standard greenhouse contacted the film. Regular greenhouse glass might also have been broken by such an ice slide. The University structure was located in an open field where it was exposed to high winds. Several rips developed in the plastic in April, but all of these started where the plastic pulled out from under the lath batten in strong winds, or where a sharp surface cut the plastic.

Few if any of these tears would have developed if the nails holding the lath batten had been nailed at three-inch, rather than twelve-inch, intervals where the batten covered the edge of the plastic film. It would also be advisable to wrap the film around the sash bar and fasten it on the side to lessen the possibility of the wind pulling out the plastic. At the time of this writing approximately eighty per cent of the plastic still appears to be in good condition. The ability of this same plastic to withstand another winter is not known, however.

Snow and ice seemed to slide off the plastic house quicker than it did off conventional greenhouses. It is necessary, however, when securing the lath batten along the top margin of the side walls, to place it below the edge so that the batten does not interfere with the sliding of the snow and ice.

Heating and Condensation

The absence of the many small openings, such as those between overlapped glass in a standard greenhouse, reduces the number of air changes in the plastic greenhouse. As a result the heating cost should be less. The gas heater used in the University structure was more than adequate, even when the outside temperature dipped below zero. The lack of air exchange in the plastic house created a condensation problem, however, especially in the spring and fall when days were warm and the nights were cool. Leaving one of the end vents open in the University greenhouse decreased the condensation problem appreciably. This procedure was not adequate in the large commercial house and condensation remained a problem until a ridge vent was installed. The condensation presented a problem for several reasons: first, the high humidity increased the possibility of the incidence of disease; second, ornamental plants may become too soft and third, the moisture on the inside of the plastic reduced the light intensity in the greenhouse. The lack of air circulation in the plastic house also resulted in higher temperatures during the warm season of the year.

Light Intensity

Light intensity in the plastic houses was approximately ten per cent less than in conventional greenhouses. A few sample readings are provided in Table 1.

Plant Growth

Crops grown in the plastic greenhouses included the following bedding plants: Ageratum, Alyssum, Aster, balsam, Celosia, Delphinium, Dianthus, forget-me-not, geranium, Lobelia, marigold, Petunia, Salvia, snapdragon, tomato, Verbena and Zinnia. Other crops included potted Chrysanthemums, Cyclamen, Vinca and poinsettia stock plants. The Chrysanthemum and Cyclamen plants were not flowered in the plastic house.

Plant growth was very good in all instances.

Discussion

According to the observations of the past year, the plastic film greenhouse appears to have a place in the greenhouse picture in Minnesota. It will not replace standard greenhouses, but will probably supplement standard greenhouses in particular situations. The cost of the plastic film greenhouses will vary with the grade of materials used and the modifications included in the structure, but in all instances the cost will be a fraction of that of a standard greenhouse. It would seem that the plastic-covered structure would be most helpful to persons starting in business with limited capital, and to persons wishing additional greenhouse space for a limited number of years. The standard greenhouse would still seem to be the best investment, in most instances, for a long-range enterprise. The thinner weights of plastic suggested by Emmert (1) for Kentucky were not tested, so no conclusion can be drawn as to which weight of plastic is most practical in Minnesota.

Table 1. Light intensities in foot candles in plastic and in standard greenhouses.

Date	Time	Sky	Plastic Greenhouse	Standard Greenhouse	Outdoors
Sept. 27, 1955	11:00 A. M.	Cloudy	1,000 f. c.	1,100 f. c.	
Sept. 28, 1955	3:30 P. M.	Clear	3,500	4,200	
Oct. 5, 1955	2:30 P. M.	Cloudy	400	450	
Oct. 18, 1955	10:30 A. M.	Clear	4,000	5,000	8,000 f. c.
April 10, 1956	8:30 A. M.	Clear	2,500*	3,500*	6,000
	12:00 Noon	Clear	5,000*	6,750	8,500
	3:30 P. M.	Clear	3,750	5,000	7,750
April 13, 1956	12:00 Noon	Cloudy	1,500*	1,900	2,500
May 21, 1956	10:00 A. M.	Clear	5,500	6,000	8,100
	2:30 P. M.	Clear	5,600	6,100	8,500

*Condensation on glass or plastic.

Literature Cited

1. Emmert, E. M. 1954. Low cost plastic greenhouses--mimeographed. Agr. Exp. Sta., Uni. of Kentucky.
2. Thomas, M. O. and Leslie Hafen. Plastic greenhouses--mimeographed. Dept. of Hort., Purdue University.