the same as polyethylene. The labor to put the polyethylene on is expensive and it comes at the wrong time of the year for us.

HANS HESS: How long have you used fiber glass?

ANDREWS ADAMS: We have had it on a lean-to greenhouse for 11-12 years. The fibers are starting to show. What we did this year was to put on a fiberglass refinisher. We coated the fiberglass and it keeps the dust from accumulating on the fibers. We really should have done it a little earlier. The material is available from Geiger in North Wales and is advertised in the American Nurseryman.

MODERATOR TINGA: The next talk we have is overwining container stock under plastic my Mr. Gil Nickel. He has 40 acres of containers.

OVERWINTERING CONTAINER STOCK UNDER PLASTIC

GIL NICKLE
Greenleaf Nursery Co.
Park Hill, Oklahoma

The need for cold weather protection of container grown broadleaf ornamentals became apparent at our nursery after severe losses during the winters of 1960, 1961, 1962. We are located in northeastern Oklahoma, in the Ozark Mountains. The average low temperature is 5 to 10 degrees F. below zero, and most broadleaf evergreens grown in containers, such as holly, pyracantha, euonymus, and some shrubs, are subject to varying degrees of winter damage. We felt that polyethylene covered houses offered the most promising solution to providing the needed protection, but several criteria had to be considered:

1. The houses had to be low in cost.
2. They had to be able to hold snow loads of 6″-12″.
3. They had to withstand winds in excess of 60 MPH.
4. They had to be easily erected and dismantled as we intended to put up the houses in the fall and take them down in the spring.
5. They had to do an adequate job of protecting the plants.

The structures I am going to describe are now being used for their third winter. We decided on A-frame construction because of its relative strength and simplicity. By making individual A-frame bows and joining any number of bows with stringers, a house of any desired length can be erected. The A-frame bow is constructed from two 2x6's - 19½′ long, with a 12′ 2x4 cross brace, and gussets of ⅜″ plywood, resulting in a bow 33′ wide, 11′ high, and each leg making an angle of 31 degrees with the ground. The bows are spaced 8′ apart with 2x4 stringers 16′ long, nailed at the bottom, middle and top. Diagonal braces are put at each end and, in the case of a long house (200′ or more), braces are put in the

middle. Metal stakes constructed of 1" structural pipe are driven in the ground to hold the house down. The ends are then covered and padded and the stringers inspected and rasped down, if necessary, in order to prevent tearing the plastic sheet.

The plants are bunched and stacked three high, if necessary, so that a block of spaced plants 100' wide will fit into 30', with a 18" aisle down the middle and a cross aisle every 40 feet. The stacking of the plants is very important. On the bottom layer the plants are put can to can. The second layer is can to can in one direction, but spaced the size of a can in the other direction. The top layer is spaced all the way. The result is, that for each 4 cans on the bottom layer, there are 2 cans on the second layer, and 1 can on the top layer. In the case of 1 gallon cans, this is 7 plants per square foot.

After the plants are stacked, the house is erected over them. The plastic sheets are ordered to fit the houses. During the summer the size and location of each house to be built is decided. The plastic is ordered about 10% too long to allow for adding a couple of bows, if necessary, and to allow for possible slight errors on the part of the plastic manufacturer in cutting the sheet. The sheets are all 40' wide — I don't know of any plastic company manufacturing sheets wider than 40'. When the house is completely ready to cover the plastic is rolled out beside the house and carried over and draped in place. The sheet is then nailed down with lath at one end and stretched to the other end. It is important that the weather be suitable. It is virtually impossible to handle these large sheets in winds over 15 MPH, and a completely calm day is very desirable and makes the job much easier. The temperature should be 40 degrees F. or above on a clear days, and 60 degrees F. or above on a cloudy day, or it is impossible to obtain the necessary stretch on the plastic. The plastic is stretched and nailed to the middle stringer by a crew of 5 or 6 men on each side of the house pulling against each other. Then the plastic is stretched and nailed to the bottom. The plastic should be drum tight when the job is completed in order to withstand the winter winds. The plastic is then nailed over every other bow in order to break it up into small, repairable sections. The house is then sealed along the bottom with sawdust. Shading material is applied to the houses as desired. The doors are closed anytime the temperature is expected to go below 32 degrees. In the spring, cigar shaped holes can be cut in the plastic above the middle stringer to improve ventilation.

Now, let us evaluate these overwintering houses with regard to the criteria outlined earlier. First we said the houses had to be low in cost. Here is a cost breakdown on one A-frame bow:

40 feet of 2x6 @ .10c ft.	$4.00
12 feet of 2x4 @ .06 ft.	.72

40 feet of 2x4 @ .06 ft.	2.40
2 metal stakes 2 ft. long, plus 1 ft. of strap metal, plus labor	1.00
3 sq. ft. of ⅜″ plywood @ .13c sq. ft.	.39
4 mil polyethylene, 8′x40′ @ .006c/sq. ft.	1.92
Estimated labor to build bow	.50
Estimated labor to haul bows, erect buildings, and cover with plastic	2.00
50 feet of lath @ 1.80 bundle	.45
Nails	.15
Total for 240 sq. ft. usable space	$13.53

Thus the intial cost per sq. ft. is 5.6 cents. However, if we assume that the bows will last 4 years, the lath 3 years, the stakes 10 years, and that the labor to disassemble the houses is the same as that to erect it, we come up with a prorated cost of 3.5 cents per square foot per year. When it is considered that it is possible to stack as many as 7 one-gallon plants per square foot, the cost can be as low as ½ cent per one-gallon plant, which we feel is certainly reasonable.

Next, we said the structures must hold snow loads of 6″-12″. The heaviest snow load we have had while using these houses, was 6″-8″, but this didn't seem to be very close to the structural limit.

The houses have gone through winds in excess of 60 MPH, and the only damage was a few iron stakes pulling loose, and a few rips in the plastic, which were easily repaired. If stronger winds were expected, it would be necessary to use iron stakes more often, or an entirely different means of anchoring the houses to the ground, and to lath the plastic to every bow rather than every other bow.

Next, we said that the houses must be easily erected and dismantled. It takes a 6 man crew approximately 4 hours to erect a 300′ house, if the materials are all close by. It takes 20 men about 2 hours to cover the same house.

The last criteria was that the houses had to do an adequate job of protecting the plants. I can say with no reservations, that they do an excellent job. Winter damage is practically a thing of the past for us. On a cold night the temperature inside is usually 20-30 degrees above outside temperature. In our climate the soil ball of the plants never freezes more than 1″ deep. Here are two excerpts from temperature records I kept the first winter we used the houses:

Dec. 22, 1963 — The outside temperature has not been above freezing for several days. It snowed approximately 3″ last night. At 5:30 P.M. the temperature outside was 14 degrees, inside it was 32 degrees. The low outside during the night was 7 degrees below zero, inside the low was 26 degres.

Jan. 13, 1964 — The low outside was 4 degrees, inside 26 degrees. High temperature outside was 30 degrees, inside was 56 degrees.

It is also important to note that the color of most plants overwintered inside is much superior to those left outside. This is certainly an important spring sales consideration. However, unless the houses are shaded, the plants will break dormancy 2-3 weeks before plants left outside. Also, it is necessary to water the plants once or twice a week, or even more often during a warm spell. We use #20 rainbird sprinklers, equipped with a baffle, spaced 20′ apart down the center of the house. Rodent damage in the houses can be quite severe, and it is necessary to maintain bait stations. The warm temperatures and high humidity in the houses are very conductive to insects and disease, so we spray every two weeks with Captan, and every four weeks with Sevin.

During the winter of 1964 we decided to experiment with white opaque plastic. We used two overwintering houses of the same width and length, located side by side, one covered with clear plastic and one covered with white plastic giving 40% light transmission. A maximum-minimum recording thermometer was placed in each house at identical locations in order to compare inside air temperature. Also, a continuous recording thermograph was placed in each house with the probe buried 6″ deep in a 5 gallon can to compare soil temperature. Finally, a continuous recording thermograph was placed outside to record outside temperatures. The following year, we covered approximately 1/3 of our overwintering houses with white plastic. In comparing clear plastic versus white plastic, we have some to the following conclusions:

1. The night air temperature is approximately the same in the clear and white houses. We had expected the white to be warmer at night due to reduced heat radiation. However, on a cold night a heavy layer of frost forms on the inside of the clear plastic, resulting in heat transmission approximately equivalent to the white plastic. Also the frost layer, from ⅛ to ¼″ thick, has some insulation quality.
2. The day time air temperatures are much higher in the *clear plastic houses, approximately 15-20 degrees dif*ference. The temperature in the white houses is about the same as the outside temperature during the day.
3. The soil temperature is more even in the white houses. The soil temperature in the clear houses fluctuates more, but is higher on the average.
4. The water requirements are much less in the white houses, requiring water only about every two weeks.
5. The plants stay dormant 2-3 weeks longer in the white houses, breaking dormancy about the same time as plants left outside.
6. Plant color is a little better in the white houses.
7. The clear plastic is much stronger than the white plastic. The white plastic on all the houses covered last

year failed before March 15th. This is a serious problem and forced us to abandon the use of the white plastic. However, it is possible we used an inferior grade of plastic in our tests.

I think that the advantages of the white plastic are too many to ignore, especially in the cold climates where it would be impossible to prevent the soil ball of container grown ornamentals from freezing solid without artificial heat. The white plastic would allow a slow thawing process that would probably be more benefical than quick temperature changes. However, the same result could be obtained by heavily shading clear plastic.

CORLISS INGELS: What thickness of plastic do you use?

GIL NICKEL: Four mil. We start covering October 15th.

MODERATOR TINGA: Our next paper is on the storage of budwood, scions, and rooted and unrooted cuttings. I will ask Hugh Steavenson to start.

HUGH STEAVENSON: Regrettably our good friend Darrell Holmes could not be with us today. Fortunately we have Jim Law who is the production manager of Stark Brothers who grew up in the nursery business and is working right in this very subject. So I think it is very fortunate that Jim could be here to read Darrell's paper and handle any comments.

STORAGE OF ROOTED CUTTINGS, UNROOTED CUTTINGS, SCIONS AND BUDWOOD

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I am sure that many of you, perhaps all of you, have had much experience in storing ROOTED CUTTINGS, UNROOTED CUTTINGS, SCIONS AND BUDWOOD and probably have just as good a method as we, but I will try to give you complete information on our methods.

First — ROOTED CUTTINGS:

We do not have occasion to store great quantities of rooted cuttings for any period of time, but we do store rooted cuttings of Crimson Pygmy Barberry and several varieties of Taxus. These are stuck as semi-hardwood cuttings in greenhouse propagation benches during September. We carry them in the benches until about the first of February, then dig and wrap 100 per bundle in moist sphagnum moss and two millimeter polyethylene. We tie the wrap with a rubber band. We do not put the polyethylene over the tops. In fact, the tops of the Barberry cuttings are above the polyethylene about one-half inch, and the Taxus cuttings may be from one-half inch to three inches above the poly., depending on the length of the cutting that was rooted.