Committee showed a colored slide of the plaque presented to Dr. F. L. Skinner for his outstanding work in the field of plant propagation.)

MODERATOR FLEMER Thank you gentlemen, we must now continue with our program Our next speaker, to continue the subject of firethorns, is Judson P Germany, Jr., of Germany's Nursery, Fort Worth, Texas, who grows *Pyracantha* on a large scale. He will speak to you on "Propagation of Pyracanthas in the Greenhouse and Mist Bench."

Mr. Germany read his prepared paper. (Applause)

PROPAGATION OF PYRACANTHA IN THE GREENHOUSE AND MIST BENCH

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INTRODUCTION

The firethorns have long been an important group of ornamental plants to commercial nurserymen in almost every section of the country. There are few plants available today which combine evergreen or semi-evergreen foliage with a showy display of white flowers in the spring, followed by a massive array of deep red or bright orange berries in the fall. While most people are attracted to firethorns because of their heavy berry production, many are discovering that they are also good subjects for training as espaliers, into tree forms and other exotic shapes. They can be used as screens, foundation plants, or in mass plantings There are dwarf forms and prostrate forms For those who appreciate variegated plants. there is at least one very interesting variegated variety

Just as the flowers and fruit of this group of plants have made them extremely popular in the past, the versatility of old varieties put to new uses and the introduction of new forms almost yearly is certain to boost their popularity to even greater heights in the years to come. Already there are available orange berried varieties which promise to extend the culture of these plants into all but the very coldest sections of the United States. The red berried varieties are still confined to the warmer sections of the country, but improved varieties are gradually moving into the northern latitudes year by year, and the time will come, no doubt, when hardy red berried varieties will be available that can be grown right alongside the orange berried kinds.

For the next few minutes I will outline the methods and describe the facilities we use at our nursery to propagate firethorns from cuttings. I believe you will find that the techniques we use are no different from those used in the average nursery for the propagation of most, common, broad-leaved evergreens.

Almost any type of propagation structure can be used for the propagation of firethorns, as they are among the easiest of plants to produce from cuttings once a few simple requirements are met and understood However, for ease of management and for almost certain results, I

would recommend the use of either a conventional greenhouse or one of the outdoor mist systems which have rapidly come into use in the past three or four years. With either of these two types of propagating structures, we can control the humidity with a minimum of effort, and, providing we do not allow the temperature to go to extremes, success is generally assured.

Since the management of these two types of propagation structures differ let us consider each one separately

GREENHOUSE PROPAGATION

First, the use of the greenhouse. A good tight greenhouse is essential in order to exercise humidity control, which as I have already mentioned is one of the most important factors we must consider if we intend to obtain a high percentage of rooted cuttings. The application of a shading compound on the glass will be necessary in order to keep the temperature from soaring too high and burning the foliage. Care must be exercised when the shading is applied, as too much shade reduces the light and lowers the temperature, both of which will retard the rooting process I have had the experience of having cuttings callus too heavily and fail to root, which I attributed to too much shade.

Now, let us consider the rooting medium. We have found that firethorns will root in practically any medium in common use today. In the greenhouse we have had good results with common brick sand, vermiculite, and perlite, and I have no doubt that any other medium you would care to use would work just as well. In short, we have come to the conclusion that the medium has little, if any, effect on the results, provided it satisfies the basic requirements of a rooting medium. It should be well drained and hold the cuttings firmly in an upright position. In our operation we generally use sand Naturally, we want a medium which is free from debris and fungus diseases, and therefore we change the sand each year. This would probably be unnecessary if we had steam sterilization equipment available

In North Texas we take the cutting wood from well ripened new growth anytime from about the first of July until around the first of December. Cuttings made in early part of the summer will be potted off and carried through the winter in a protected location, while cuttings made late in the season usually root slowly and are therefore left in the greenhouse until spring.

In making the cuttings, we use the smaller side growth, up to, perhaps, $\frac{3}{16}$ inch in diameter. Larger wood will root, although we like the cuttings to be as uniform as possible. Make the cuttings any convenient length without regard to terminals, nodes, or internodes. Strip or cut the thorns or side shoots up about halfway to facilitate sticking the cuttings. We stick the cuttings about a half-inch or so apart in the row with about two inches between rows Since firethorns usually root with a very high percentage, in a relatively short time, we consider the use of hormones or other root inducing substances as being unnecessary.

Care of the cuttings during the rooting period is much the same as with any other broad-leaved evergreen In the summertime the benches and walks must be sprayed frequently to maintain high humidity.

Temperatures will probably stay above 110 degrees during the day, and the cuttings will root rapidly Under conditions of high humidity and high temperature, most *Pyracanthas* will root in a matter of days. I have seen some cuttings root in as little as four days, but from two to three weeks is average. In the winter we take most of the shade off the glass in order to trap the heat of the sun, since the house is not heated artificially. The benches are watered only enough to prevent the medium from drying out.

When the majority of the cuttings are strongly rooted, they are removed from the bench and potted either into 2½ inch pots or directly into one gallon cans for overwintering. They are then placed in the shade. The soil mix we are now using is one that was developed at Texas A & M just recently, and consists of ⅓ soil, ⅓ peat, and ⅓ perlite. So far, this mix appears to be superior to anything we have used in the past. A light top dressing with cottonseed meal is applied soon after potting to get them off to a good start.

MIST SYSTEM PROPAGATION

The advantages of an outdoor mist system over a conventional greenhouse lie mainly in its relatively low initial cost and almost compete elimination of fungus disease troubles The principal disadvantage is the possibility of a power or water failure, in which case you are liable to have a bench full of cuttings burned beyond recovery.

Since we put our first mist bench into operation about four years ago, we have used it very sucessfully to root firethorns and many other varieties of ornamental plants. In fact, we no longer use the greenhouse for summer propagation, but rely on the mist system altogether. We now have two mist benches in operation, and they measure about 16 feet in length and about 5 feet in width. The spray nozzles we are using are the Florida type in one instance and the Monarch type in the other Both types have their advantages and disadvantages, but reasonably good results can be had with either kind, particularly with a subject such as *Pyracantha* which roots easily.

The benches must be constructed in such a way that maximum drainage is assured We achieved this by spacing the bottom boards 3 or 4 inches apart These wide spaces are covered with a strip of ¼ inch hardware cloth, and on top of this is placed a strip of galvanized screen wire. The hardware cloth supports the weight of the sand and the screen keeps the sand from sifting out the bottom. Both pieces of wire must be well tacked down with galvanized roofing tacks.

One element you have to cope with on the outside, but not in the greenhouse, is wind Although we have erected reed fencing and burlap windbreaks around our benches neither material has been entirely satisfactory. A more solid material such as plywood or masonite which would completely shut off the wind would be much better. The problem, here, of course, is that the wind increases the evaporation from the surface of the leaves, causing more water to be used than is necessary, and there is always the danger that it will blow the mist back from the edge of the bench and cause some of the cuttings to be burned.

It doesn't seem to make too much difference whether the mist is applied continuously or intermittently on *Pyracantha* cuttings. The first mist bench we put up was of the continuous misting type, and like

most everyone else, we found that a number of plants could not tolerate so much water, plus the fact that a considerable volume of water is required to keep it in operation. This led to the purchase of an "electronic leaf" water control which we employed in our second mist set up. The theory of the "electronic leaf" would seem to make it the most ideal water control available, but we have not found it entirely satisfactory in that occasionally it allowed the water to run much longer than was necessary, or even worse, it might fail to come on when it was needed, with burned cuttings as the result. Under our hot Texas sun, it takes only about 30 minutes without water to completely ruin a bench of healthy cuttings. This can become very discouraging after the second or third time it happens.

For the past two seasons we have experimented with still a third setup using flats instead of a bench and a timer to control the water in place of the electronic leaf The timer operates on a ten minute cycle, and we allow the water to run for about ten seconds This is a little too long a cycle for most plants, including *Pyracantha,* and makes it necessary to shade the cuttings. I believe that next season we will abandon this timer in favor of one with a four or five minute cycle. This seems to be about the best compromise short of a timer with multiple settings, which is an expensive piece of equipment.

The advantages of using flats in place of benches is three-fold. First since some plants root more rapidly than others, this makes it possible to remove a batch of cuttings and replace them without disturbing the adjacent varieties. *Pyracantha* will root in perhaps one third of the time required for Burford holly, for example. The second advantage is related to the hardening off process required by some plants. Some plants when rooted under mist have to be hardened off very carefully by gradually withdrawing the water over a period of several days. Cuttings made from very tender plants are usually the ones which require this treatment. Firethorns do not require any hardening off of this nature if the cuttings are made from well ripened wood. In any event, it is a simple matter to remove a flat and place it in a special mist line for the hardening off process; whereas, if you have a bench of mixed cuttings, this would be almost impossible.

The third advantage is, perhaps, a small one, but it adds to the propagators convenience and makes the equipment more flexible. This occurs when it is necessary to make up small batches of cuttings requiring different media The use of flats makes it possible to time the operations properly and get the cuttings into the proper medium without regard to the available space, as would be the case if benches were being used.

As in greenhouse propagation, the choice of a medium does not seem to have too much effect on the rooting of firethorns so long as it is well drained. We have had excellent results with brick sand, perlite, vermiculite, and a mixture of sawdust and peat. However, we almost invariably use sand because it is cheaper.

While much more succulent wood may be used in a mist system than would be possible in a greenhouse, the cuttings made from this wood also burn much easier if anythings goes wrong with the water controls. We, therefore, still prefer well ripened cutting wood for this

type of operation. Preparation of the cuttings for sticking is the same as for the greenhouse. And, again, the use of hormones or other root inducing substances is unnecessary.

When the cuttings are well rooted, they are handled in the same manner as when taken from the greenhouse. We pot them off in the soil mix I mentioned earlier, which consists of 1/3 soil, 1/3 peat, and 1/3 perlite Then we take them to the shade and topdress with cottonseed meal. After a few days in the shade, they can be moved out into the sun, or, if it is late fall, we may simply leave them in place until spring.

SUMMARY

To summarize briefly, I believe that *Pyracanthas* can be propagated with about equal success in either a conventional greenhouse or in one of the mist systems such as I have described. With either type of facility, use whatever medium you are most familiar with, as it does not seem to make too much difference when rooting firethorns. We believe that good brick sand is about as good as any. A greenhouse should be tight for humidity control, and some shading compound on the glass will be necessary in order to keep the temperature down. If you are using a mist bench, be sure that it is well drained. Be sure that your water supply and mist controls are reliable. We believe that timers are more reliable than most "electronic leaf" controls at the present time. No doubt we will see greatly improved "electronic leaf" equipment in the near future. A timer is, at best, a compromise between continuous mist and "electronic leaf" controls. The main argument against using a timer is that too much water would be applied on a very cloudy day if precautions are not taken to avoid this. Well ripened cutting wood should root in two to three weeks time under conditions of high humidity and temperature. When the cuttings are well rooted, pot them off in a well drained soil mixture, topdress with cottoneed meal or any good organic fertilizer, and keep them in the shade until top growth commences or until the following spring.

I believe that if these brief instructions are followed, anyone with a greenhouse or mist bench should be successful in the propagation of one of the nurseryman's best friends, the firethorns.

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MODERATOR FLEMER: Thank you very much, Mr. Germany. Are there any questions?

MR. JOHN B ROLLER (Scottsville, Texas): Jud, I would like to ask if you have the name of that dwarf variegated variety and also, does it fruit?

MR. GERMANY: It produces a few fruits, but not anything spectacular. I do not know the variety but I believe we may have secured that variety quite a few years ago from the Sherwood Nurseries in Corbett, Oregon. Any other questions?

MR. LOUIS SAUR (Morrow, Ohio): Have you ever tried a water filter in your electronic leaf, mist system?

MR. GERMANY: Yes, we do use a water filter Our main problem is corrosion of the electrodes. I think they will get this fault worked out in the near future.

MR JAMES WELLS: I missed your information as to the time you took your cuttings When do you start and how long do you continue?

MR. GERMANY: In our particular area we can start sometime around the first of July and continue right on until frost around the first of December, although I don't believe timing makes a lot of difference.

MODERATOR FLEMER: That is all the time we will have alloted for discussion Thanks again, Mr. Germany, for a most interesting talk.

The Agricultural Research Service of the United States Department of Agriculture is currently engaged in a most interesting project in hybridizing and breeding hardier and better forms of evergreen *Berberis* and *Mahonia*. We are fortunate in having with us, Toru Arisumi, from the Station at Worthington, Ohio, who will talk about some of the objectives and problems of the program.

Mr. Arisumi then presented his address on "Some Breeding Objectives for the Improvement of *Berberis* and *Mahonia*" (Applause)

SOME BREEDING OBJECTIVES FOR THE IMPROVEMENT OF MAHONIA AND BERBERIS

TORU ARISUMI
Ornamentals Section, Crops Research Division, Agricultural Research Service, U S Department of Agriculture

The two closely related genera of *Berberidaceae, Mahonia* and *Berberis,* comprise a large group of useful ornamental shrubs. According to Rehder (4) there are about 50 species of *Mahonia* found in North and Central America and in East and South Asia, and about 175 species of *Berberis* found mostly in East and Central Asia and South America, with a few in North America, North Africa, and Europe. Many species in these genera are susceptible to some of the rust fungi (*Puccinia graminis*) of cereals, acting as alternate hosts in the life cycles of these fungi. For this reason the cultivation and distribution of rust-susceptible barberries and mahonias are prohibited in 19 states within or near the cereal growing regions of this country Fortunately, there are about 30 species of barberries and 9 species of mahonias that are rust resistant and safe for cultivation in these states (5). This group of rust-resistant species includes many diverse and attractive types suitable for use in a breeding program.

A survey of the literature indicates the existence of many interspecific and a few intergeneric hybrids in these genera. Rehder (4) lists about 18 interspecific hybrids of *Berberis* and 2, *Mahonia* hybrids. Some of these hybrids represent crosses of quite divergent species from widely separated geographical regions. Interspecific hybrids of *Berberis* normally found in the nursery trade, such as *B stenophylla* and *B. men-*