FACTORS INFLUENCING PROPAGATION UNDER MIST

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At this point I feel we are faced with a problem. Almost every report concerning mist propagation reveals outstanding results, results far and above those obtained from other methods of propagating cuttings. Just what can account for these results? Let us start when we first make a cutting and trace the events which follow and see if we can find some of the reasons why mist propagation can be expected to give outstanding results.

The first factor to consider is that when we make a cutting, the most important thing we leave behind is the water supply. Almost all of the water the cutting uses during the propagation period must come through the small cut area on the base of the cutting; a very small area when compared with the extensive root system that supplied the twig before it was cut.

If we are so concerned with the water supply, just where does the loss of water take place ? The great bulk of the water used by the cutting is lost through the leaves. On the under side of a leaf there are thousands of small holes, sometimes referred to as "breathing pores". These pores are the doorways to cavities within the leaf where gas exchange takes place, similar to our lungs. All the cells lining the cavity are covered by a film of water. This film is maintained by water which diffuses from within the cell. The cell water is replaced by water from small veins. The demand for water is passed from the small veins to the larger veins, from the leaf to the stem, and eventually to the roots. But a cutting has no roots. If the rate of water loss from the leaves of a cutting is not cut down from what it was on the parent plant, water will be lost at a rate greater than it can be replaced. As more and more water is drawn from the cells, a point is reached where the cells start to collapse, and the leaf wilts. The point to be made here is that the most important job of the propagator is to control water loss.

There are two basic ways in which water loss can be controlled. The first, is to build up the water vapor in the air so that it approaches the water vapor content within the cavities of the leaf. Then there is a tendency for the water to enter the leaves as fast as it goes out. This method is the one that is in general use today, double glass and polyethylene tents are examples.

The second way water loss can be controlled is to cool the leaf. In so doing we decrease the activity of the water vapor within the leaf and actually decrease the amount of water lost.. Mist is an example of this method. Of course by using mist, besides cooling the leaf, we also increase the amount of water vapor in the air, and as a result utilize both of the fundamental methods of controlling water loss from cuttings. Thus one of the advantages of mist over other methods of propagation is that it provides positive control of water loss.

The cooling effect of mist was mentioned in relation to the control of water loss. It also influences the rooting results in another very important way. It should be realized that the temperature difference is large, amounting to a 15 to 20 degreess F. difference between cuttings propagated under double glass and mist. This difference is created largely by the cooling effect of the mist but also by the fact that the temperature in the confined air under double glass tends to build up. Without heavy shading and some ventilation the temperature under double glass would reach a point where the cuttings burn up. Continued exposure of the cuttings to the high temperatures under double glass results in the respiration or the rate of utilization of reserve carbohydrates being more than double the rate of respiration under mist.

It was mentioned that shading is necessary when propagating under double glass. This brings out another great difference between mist and double glass propagation. Light is essential for photosynthesis or the manufacture of food. The cuttings under double glass must be shaded to keep the temperature within reasonable limits and are exposed to low light intensity. Because of the low light intensity the cuttings are not able to manufacture foods at the normal rate. The cuttings under mist, however, are exposed to full light intensity and are therefore able to manufacture food at a fast rate.

Cuttings under double glass can be compared to a candle burning at both ends—they are utilizing reserve carbohydrates at a fast rate because of the high temperatures, yet they cannot manufacture food at a high rate because of the low light intensity.

Cuttings under mist however, do not utilize food at a high rate because of the lower temperature and are able to manufacture foods because they are exposed to full light intensity. Figure 1 expresses this same idea. Here the cuttings are represented by storage tanks with two valves, an inlet valve controlled by light intensity and an outlet valve controlled by temperature. The

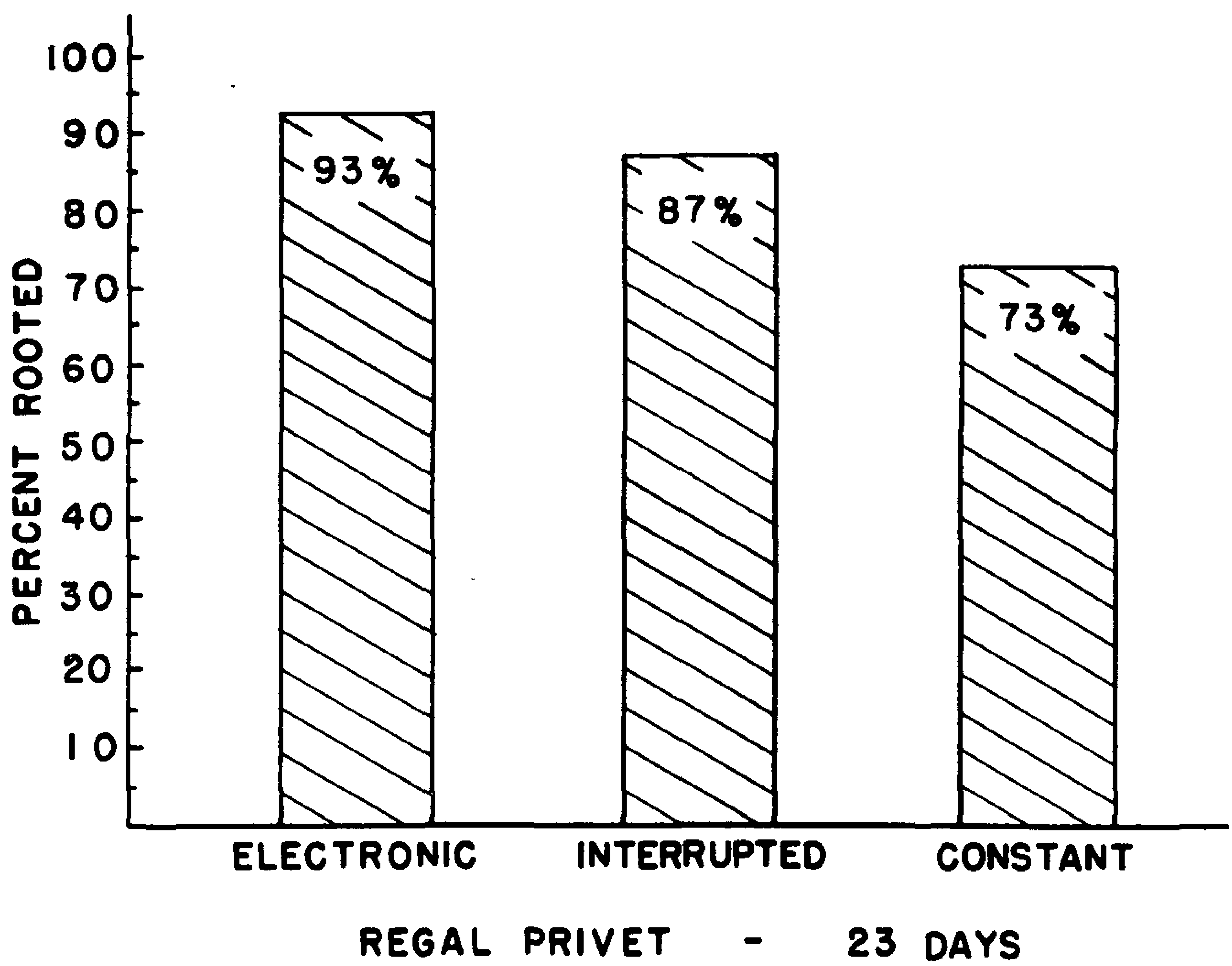

Figure 1—Effect of electronic, interrupted, and constant mist upon rooting results as represented by Regal Privet.

tanks store reserve food. You will notice that the tank on the left represents the cutting under double glass. Notice that the inlet valve of food manufacture is nearly closed because of the low light intensity. The outlet valve, however,, controlled by temperature, is wide open. Thus very little reserve food is accumulated. The tank on the right represents a cutting under mist. The inlet valve of food manufacture is wide open due to the full light intensity and the outlet valve is nearly closed due to the lower temperature. Thus a large amount of reserve foods have accumulated in the cuttings under mist. If we consider that these foods are utilized in the rooting process you can see that the rooting potential of a cutting under mist is much greater than a cutting under double glass. Not only is the larger amount of reserve foods important in the rooting process but they play an important part in the rerooting and establishment of the cutting after it is removed from the propagating bench. In brief, some of the reasons mist can be expected to give good rooting results are that it utilizes both fundamentals involved in controlling water loss—cooling the tissue and increasing the water vapor in the surrounding atmosphere, by cooling the tissue it decreases the rate of respiration, and by permitting propagation under high light intensity provides maximum photosynthesis or food manufacture.

Next, consider the comparison between interrupted and constant mist. Figure 2 will show that better rooting was obtained under interrupted mist and best rooting was obtained under electronically controlled mist—a form of interrupted mist. Figure 3 will show the main reason for these differences in rooting response. The horizontal line on the graph represents the op-

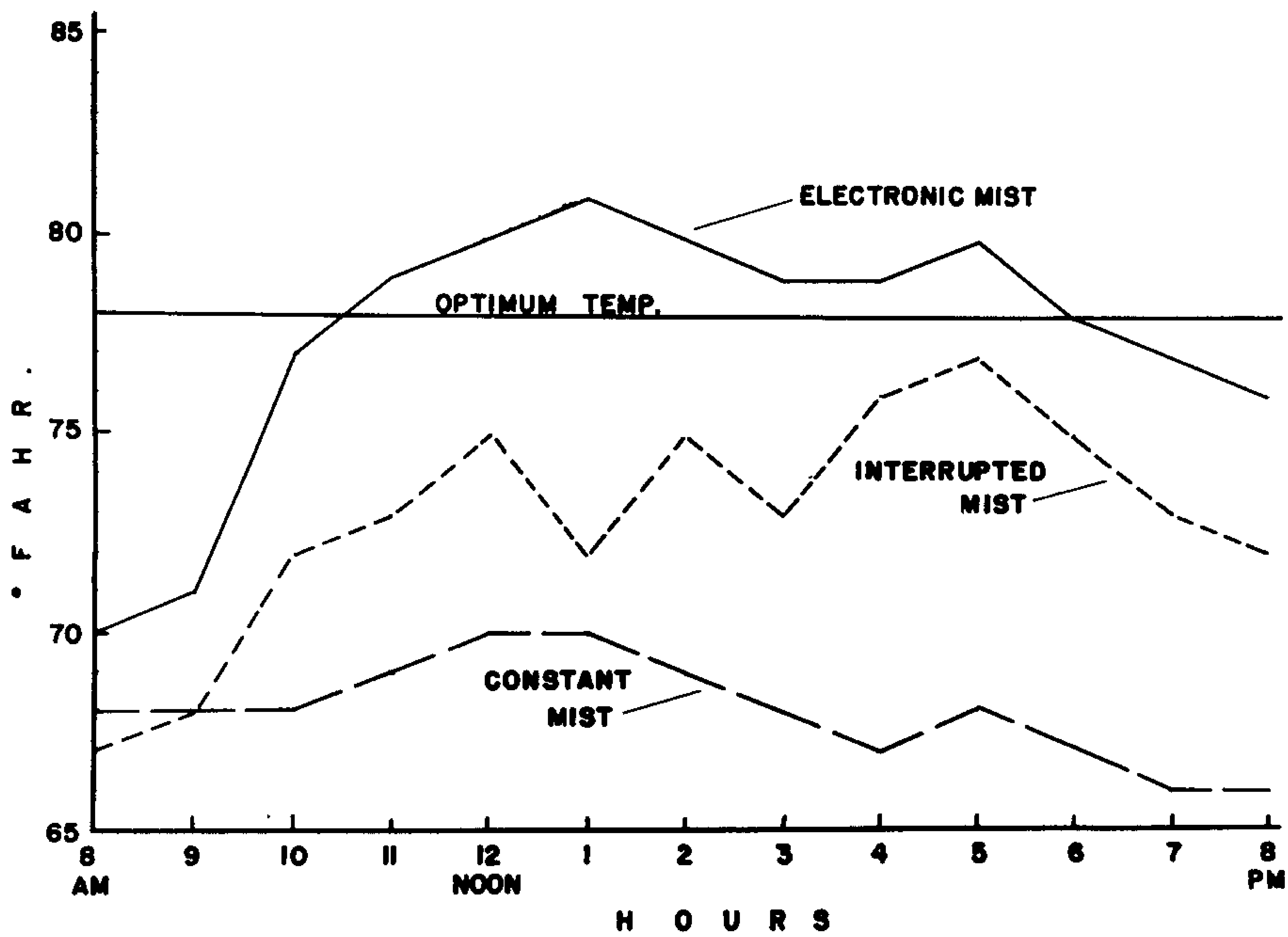

Figure 2—Temperature of cutting tissue in rooting medium compared to optimum rooting temperature.

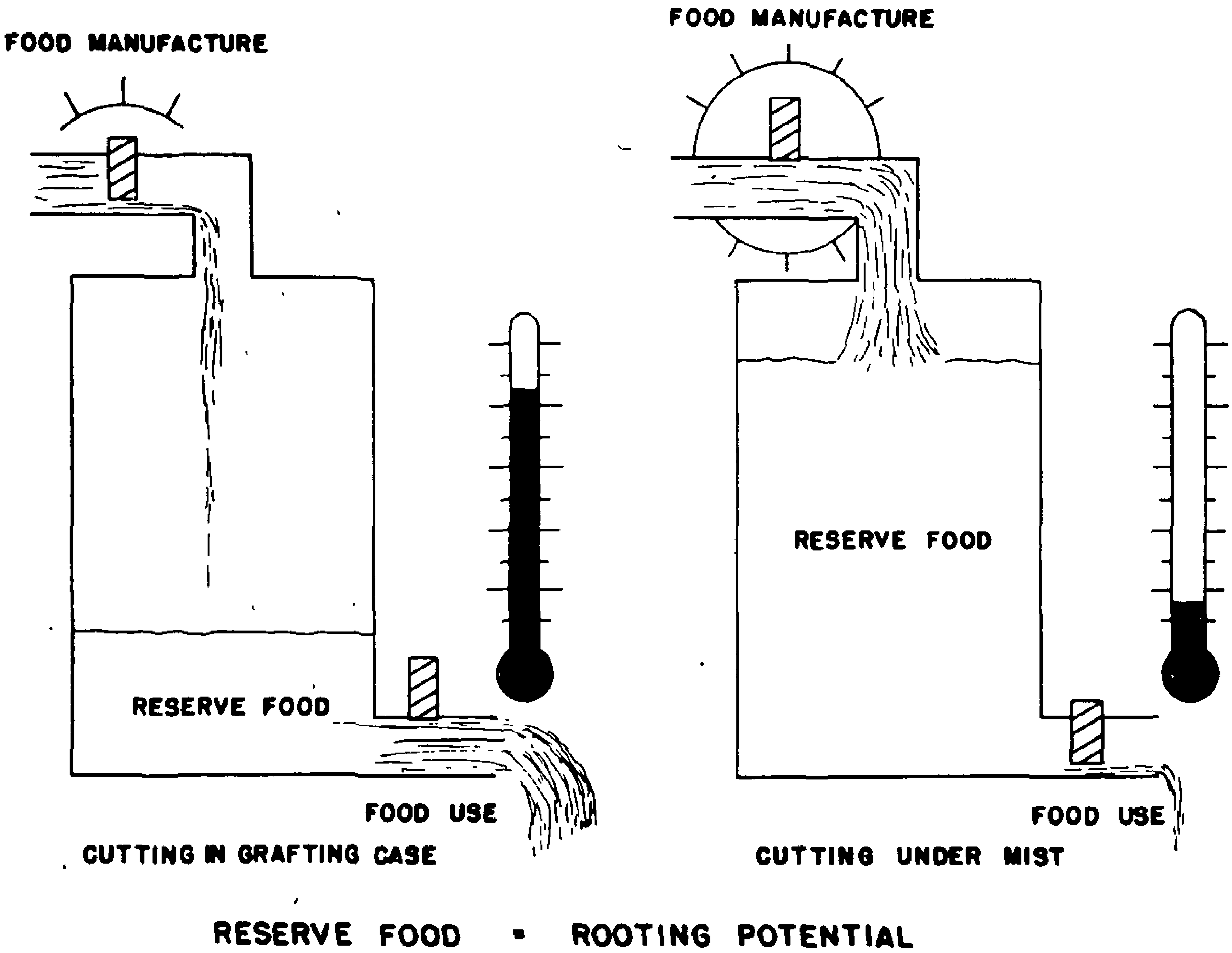

Figure 3—Diagramatic comparison of cuttings propagated in grafting case and under mist.

timum temperature for rooting the majority of ornamentals. Constant mist falls far below this optimum because the excessive amount of mist that was applied reduced the temperature of the medium to a point where the rooting response was actually inhibited. Since less mist was applied under the interrupted mist, the temperature of the medium approaches the optimum for rooting. The temperature of the medium under electronic mist was always near or above the optimum because just enough mist was applied to maintain a film of water on the foliage of the cuttings. There was no "excess misting" leading to low medium temperatures.

There are several other advantages in using interrupted mist. The problem of leaching is decreased. Since less water is applied with interrupted mist, there is less possibility for the nutrients to be leached from the cutting. Along the same lines, the problem of foliar breakdown should be controlled by use of interrupted mist. Draniage and displacement of oxygen from the medium are other potential problems which are largely eliminated through the use of interrupted mist.

Another important advantage of using interrupted mist is the ease in which cuttings may be hardened off during the rooting period so that no time is lost in handling the cuttings once they are rooted. When the cuttings are first stuck frequent, short intervals of mist are applied. After three to seven days conditioning period the number of intervals is decreased by 1/3. As the cuttings begin to root the number of mist intervals is decreased by another third and one or two days before potting or shutting off the mist system the number of applications are decreased to a minimum application of the control apparatus. By following this procedure, the process of hardening off is essentially completed at the time of potting.

In closing I would like to offer a three point plan to utilize the mist technique most efficiently.

1. *Use soft cuttings*—the cool temperatures of the mist cuts down the water loss and food use and therefore makes it possible to use very succulent cuttings, cuttings which have greater cell activity and thus greater rooting potential.
2. *Use interrupted mist*—interrupted mist approaches the optimum rooting condition of cool top foliage and warm rooting medium.
3. *Use a light shade in the summer*—a light shade consisting of a single layer of cheesecloth permits the use of less mist and thereby decreases the possibility of over misting and cooling the medium and does not cut down the rate of photosynthesis.

Once again use soft cuttings, interrupted mist, and a light shade in the summer.

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MR. SHAMMARELLO (South Euclid, O.): Would light burlap be too heavy in place of the cheesecloth?

MR. HESS: Yes, I think that it would be. It would probably reduce the light intensity below the optimum level for maximum food manufacture.

MR. SEBIAN: Should the extremely soft condition of the cuttings apply to azaleas too?

MR. HESS: I have not had any experience with azaleas. The American holly is definitely an exception to the softwood cutting. Holly should be taken when the leaves begin to become a dark green. I think that others may respond in a similar manner to holly.

MR. ROLLER: How long does it take to harden the cuttings in the bed by cutting down on the mist?

MR. HESS: Give the maximum amount of mist for the first four or five days after inserting the cuttings. Then reduce the amount of mist about 1/3 for the next four or five days, and another 1/3 after that period. By the time the cuttings are rooted, they will be receiving mist only occasionally. Three or four days before they are to be removed, stop the mist, except for an occasional squirting.

MR. ROLLER: Last summer we removed the cuttings without reducing the mist and we did not lose a plant.

MR. HESS: That is very good. Most people have had trouble if the cuttings are not harden-off some before removal.

MR. HANCOCK (Woodland Nurseries, Cookesville, Ontario.): What is the difference between my method and the use of mist plus light shade in regards to light and moisture?

MR. HESS: I believe that you will have to allow more light through and probably use a little more moisture.

MODERATOR SNYDER: May I suggest in deference to the other three speakers we let them present their discussions; then you can direct questions to whichever one you want.

Mr. Ward, of Lake's Shenandoah Nursery, Shenandoah, Iowa, was unable to be with us this afternoon. While it is not the general policy to have papers read, we feel his paper is of sufficient interest on the subject that it should be included.

We are very glad that Dr. Mahlstede of Iowa State College has agreed to read the paper because he is familiar with the work on which this paper is based. Therefore we will have someone to question in connection with the report of Mr. Ward.

Mr. Ward's paper, entitled "Mist Propagation in Open Frames", was read by Dr. Mahlstede. (Applause)

MIST PROPAGATION IN OPEN FRAMES

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INTRODUCTION

Members of the Plant Propagators Society, Ladies and Gentlemen. I was very happy when several members suggested to Mr. Fillmore that I present the topic "Mist Propagation in Open Frames", a method of propagation with which we have had two years experience. Since we were dissatisfied with the old closed case or tent house method of propagation it was quite natural for us to attempt to root cuttings during the summer under the new mist technique. At the Shenandoah Nurseries we began investigations in 1953 with a mist bed 6 x 15 feet, expanding those facilities to a bed 6 x 105 feet during the 1954 propagating season. With very few exceptions, we have consistently obtained better results with mist propagation than with our frame method under shaded sash. With two years experience behind us the management has expressed the desire that we expand our mist propagation setup to take care of the largest part of the summer propagation schedule dealing with the rooting of deciduous shrubs and selected types of evergreens.

I will speak briefly about the method by which we make the cuttings for mist propagation, the method of hormone application, and the spacing in the bed. Then with your permission I would like to describe the units which we have used during the 1953 and 1954 test as well as the mechanics of applying water, hardening-off the cuttings after rooting and a few of the problems we have encountered with each unit.

GENERAL CONSIDERATIONS

Making the cutting. Cutting material is collected from stock plants in the field. These are selected about the same time as we would ordinarily collect cuttings for the old method of propagation which is based on the deve-