MECHANIZATION IN THE ROOTING OF CUTTINGS: 1906 to 1966

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The plant propagator is apt to take for granted many techniques of mechanization which were unknown to his predecessor sixty years ago. Continued mechanization in the propagation of plants is a necessity in today's competitive production of plants. Reduced labor costs, elimination of "human error" in judgement and accurate control of the environment of the cutting will more than pay for the costs of mechanization. Therefore, for a few moments, let us take a brief look at past and present methods of regulating the environment.

I have chosen to compare today's equipment with those described in the 10th edition of L. H. Bailey's "THE NURSERY BOOK—A Complete Guide to the Multiplication of Plants", published in 1906 (1).

First, we shall compare the aspects of the environment—atmospheric and soil—considered of importance sixty years ago and today. Second, we shall take a brief look at some of the structures used to regulate these environmental factors, then and now. Finally, we shall examine some of the methods used to regulate temperature and moisture.

Sixty years ago, Bailey discussed the importance of moisture and temperature of the air; today we not only recognize these two as important considerations, but also are concerned with the three aspects of light (intensity, quality and duration), with the carbon dioxide content of the air and with wind movement. In 1906, moisture, temperature and aeration were considered important aspects of the medium. Since that time, we recognize that three additional aspects of the medium are important—pH, nutrients and organisms. It is as true today as it was sixty years ago that the moisture and temperature relationships of both the atmosphere and the medium exert the greatest influence on the rooting of stem cuttings. And it is only natural, that as we refined our knowledge of and improved our methods to control moisture and temperature, we could then recognize the importance of other factors on the rooting of cuttings.

The structures in use sixty years ago were designed primarily to regulate moisture and temperature. Bell jars, handglasses, propagation ovens, propagation tanks, outdoor and indoor covered frames and the Forsyth cutting-pot were common structures used to regulate moisture conditions. Various methods of shading were used to reduce the heat of the sun; crude heating devices, without any means of automatic regulation, and manure were used to supply bottom heat.

The structuures in use today are also designed primarily to regulate moisture and temperature. Covered frames are

used and are an effective means for propagating a wide variety of plants. Polyethylene enclosed structures are very satisfactory. The use of intermittent mist and controlled humidification systems have made open benches and outdoor beds effective structures for many kinds of cuttings. Thermostatically-controlled heating units are used to supply a uniform bottom heat. Special structures have been devised and used to good advantage. These include the relatively simple techniques employed in Nearing's Solar Frame and Hancock's Burlay Cloud — to the more sophisticated techniques of Templeton's Phytotektor.

The maintenance of good water relations in the plant tissue is essential for the successful rooting of cuttings. There are two different ways whereby we can help to conserve the plant's water. The first is to maintain a high moisture content in the air. The second method is the application of a film of water to the foliage in order to reduce the tissue temperature. Both methods, alone or in combination, are effective and have been employed by propagators for many years. For example, the simplest way, but one which requires the utmost skill, is the frequent hand syringing of cuttings to reduce tissue temperature and wetting down of the walks and other ground areas to help maintain a high moisture content of the air. I wonder how many hours have been spent in the past sixty years in the propagation house using a watering hose.

Closed structures, such as the hand-glass, bell-jar, propagation box and covered propagation frame, were commonly used in 1906 to maintain a high atmospheric humidity in the small volume of air surrounding the cuttings. Double glass and shading furthered the effectiveness of such structures. There was, however, no good means of maintaining uniform conditions from day to day.

Covered propagation frames are in use today. One major change is the use of polyethylene film instead of glass to cover the frame.

About 25 years ago, the use of a constant level, sub-irrigation system was recommended for maintaining a uniform level of moisture in the medium. A simple float valve was used to maintain the water level. However, unrooted cuttings can absorb only limited quantities of water and the cuttings in the sub-irrigated structure need almost as much care as those just mentioned.

Controlled humidification as an aid to the vegetative propagation of plants was the title of a talk presented at the first meeting of this Society in Cleveland in 1951 (2). Dr. Chadwick described the results of his experiments in which, by the use of humidistats, he was able to maintain the relative humidity of the air at fairly uniform levels. The development of an accurate and sensitive humidistat was necessary before controlled humidification could be used.

Within a few years, the propagator's attention was di-

rected toward the use of mist applied directly to the foliage. The development of nozzles to produce a fine spray, of mechanical and electronic mechanisms to control the frequency of mist, and the use of solenoid valves to control the flow of water have made the misting of cuttings a successful technique. The use of intermittent mist results in a reduction of tissue temperatures and permits propagation with little or no shading. In the simplest terms, intermittent mist is mechanized syringing.

Let us now turn our attention to the changes during the past sixty years in the control of temperature. We are concerned with both heating and cooling of the atmosphere and with heating of the medium.

Various methods of shading and the use of manually-operated ventilators in the greenhouse were, and still are, in use to reduce air temperature. With the advent of mist, however, the necessity of using heavy shading for the cuttings has been largely eliminated. Automatic systems for the opening and closing of the ventilators are activated by thermostats. More recently washed-air cooling systems have been shown to be effective in reducing the air temperature in the greenhouse by as much as 15 to 20 degrees. Washed-air cooling systems can be controlled manually, by time clocks, or by thermostats. Refrigerated cooling systems do not appear to be economically feasible for greenhouse propagation, at least at this time, but may be used for propagation by meristem culture.

The development of efficient heating systems for buildings has resulted in better heating of the greenhouse. Accurate and sensitive thermostats, solenoid valves and greater efficiency in heat distribution systems are now available. Greenhouses can be made relatively air tight by using aluminium bar caps and by the addition of a layer of polyethylene inside the glass, thus more uniform air temperatures can be obtained.

Sixty years ago the sources of bottom heat were the sun, rotting manure, small lamps and manually-controlled hot water systems. Today, the hot water or steam systems are controlled by thermostats. Electric heating cables with thermostatic control, were first used for propagation about 35 years ago. Quite recently low voltage electric heat has been shown to have many advantages over other methods of supplying bottom heat.

At this time, I will not discuss mechanization for the control of other environmental factors we now recognize as important for successful rooting. Hopefully, other members of this panel will discuss mechanization of the treatment of cuttings with root-inducing chemicals, of the wounding of cuttings, and of handling cuttings in units rather than individually.

LITERATURE CITED

1. Bailey, L H. 1906 The Nursery Book—A Complete Guide to the Multiplication of Plants. Macmillan, 365 pp. 10th Ed.

2 Chadwick, L. C., 1951 Controlled humidification as an aid to vegetative propagation ' *Proceedings, Plant Propagators' Society*, 1 38-39

PERCY EVERETT: Again we thank you, Bill, and we also thank the Eastern Region for letting us have you occasionally. We have been fortunate to have at least four of the Eastern members with us this morning. We're going to introduce to you now a man that has, perhaps, not been so well acquainted with the Western members. It's not his first visit to California, by any means, but I think it is his first visit to one of our meetings. Vincent Bailey, of the J. V. Bailey Nurseries, St. Paul, Minnesota, is going to discuss our next subject — the mechanization problems that he has had, what they are doing now, and how they have met competition. Mr. Bailey was raised in the nursery business, which was started by his father, J. V. Bailey, in 1905. Vince was a graduate of the University of Minnesota — in horticulture — in 1929. He's been President of the American Association of Nurserymen, 1960-1961, and was President of the Eastern Region of the Plant Propagators' Society in 1964-65. He is very active in the management of the J. V. Bailey Nursery, in the production areas particularly. So now, Vince, will you come up and tell about the various means you have of meeting present day competition?

MECHANIZATION IN MODERN PROPAGATION

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Technically this subject involves the idea of the use of machines in propagation; however, I am going to deviate or take some liberties with the assigned subject. I am sure you will agree that the word propagation implies to the nurseryman and the research man not only the successful reproduction of a plant but further involves the successful establishing of this liner in a media for growing on to a useful size for distribution to the final consumer.

Webster says, "A machine is any contrivance to increase and regulate motive power, an engine, a light carriage, or vehicle." Some of the methods we, at the Bailey Nurseries, are now using do not truly involve machines, but they do involve implements which greatly improve the results and lower the labor costs. We are all interested in improving the quality of our liners, and this it as it should be. Most producers are finding that the buying public is very much interested in high quality and, what is more important, they are willing and able to pay for it.

I will confine my remarks to propagation by cuttings even though this is only a small part of the interests of this group. First, let me talk about our methods of handling hardwood