A HISTORY OF MIST PROPAGATION

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It is probably very appropriate that we pause to reflect on the historical development, the theoretical aspects, and the commercial applications of the use of mist in plant propagation and to consider what the future may contribute to the further development of this technique.

It has been a herculean task to condense into a 10-minute talk the 29 year history of mist propagation and at the same time to recognize the contributions made by more than 100 different scientists and nurserymen who have authored over 300 articles and papers on this subject.

First, let us define what is meant by "mist propagation". By "mist propagation", we mean the mechanical spraying of water to maintain a film of water on the leaves and stems of cuttings. As evaporation occurs from this film of water, the temperature of the leaf tissue is reduced below that of the surrounding air and transpiration is markedly reduced. With mist, cuttings can be maintained in a turgid condition even though they are exposed to full sunlight. That this mist spraying, as well as the evaporation of water from the films on the leaf surfaces, may increase the relative humidity of the surrounding air is an important consideration, but it is not the primary objective of misting.

Apparently the first use of mist for the propagation of cuttings was by G. E. L. Spencer in 1936. Evans (9), in an article on the investigations of the propagation of cacao, published in 1951, refers to a private communication from Spencer which stated that he had used mist, although unsuccessfully, in tests on the rooting of cacao cuttings. The first written report of the successful use of mist for rooting was by Professor M. A. Rains of Howard University (24, 25). At the 1940 meeting of the American Association for the Advancement of Science, Professor Rains reported that a moist chamber with facilities for subjecting relatively large leafy cuttings to a spray of water was successful in permitting the regeneration of the root system.

In 1941, E. J. Gardner (13), a nurseryman from Wisconsin, reported in the *American Nurseryman*, that the use of a continuous mist resulted in the successful rooting of 56 of 61 varieties of softwood cuttings tried in 1939 and of all 133 varieties tried in 1940. The same year (1941), G. M. Fisher (10) reported in the *Florist Review* on the use of continuous mist for the rooting of several florist crops. Two years later, in 1943, Fisher (11) also wrote in the *American Nurseryman* of his successful use of mist for the rooting of conifer cuttings.

There is no indication from the evidence available that Spencer, Rains, Fisher or Gardner were in touch with one another; thus it seems probable that the origin of the use of mist

sprays for the rooting of cuttings was developed independently by these four individuals.

Between 1942 and 1945 Pridham (23), Stoutemyer (32), Gossard (15), and Cochran (4) reported preliminary results of the use of mist for such divers kinds of plants as rhododendrons, vacciniums, chaenomeles, symplococos, pecan and peach in the *Proceedings of the American Society for Horticultural Sciences.* Stahel (30) described the use of mist in the ICTA propagation frame for cuttings of *Hevea* and other tropical trees, and Dijkman (6) used mist for the rooting of mango cuttings. In 1949, O'Rourke (22) described a method of inserting nozzles in a water line beneath the ridgepole of a small sash-type greenhouse. Brentz and Swingle (2) told of the successful use of mist for rooting elm cuttings in the *American Nurseryman* in 1950 and, at the 1951 meeting of the Holly Society of America, Diehl (5) described his success with the use of mist for rooting holly cuttings.

The intense interest in mist for the propagation of tropical and subtropical plants is attested to by the work of Evans in Trinidad and by the several reports included in the Annual Reviews of the Florida Experiment Station.

The numerous articles by Wells in the *American Nurseryman* starting in 1951 about humidification (39, 40), and later about mist (41, 42, 43), contributed greatly both to the interest and application of this technique.

At the 1953 meeting of this Society, Templeton (33) described his "Phytotektor" method for the propagation of cuttings in which he combined a humidistat and a timing mechanism to give an intermittent rather than continuous mist. He stated that he was unable to use constant mist because of drainage problems and he further questioned the necessity of continuous misting. It was also at this meeting that he described the "little aluminum painted can" which was to become the "electronic leaf" control device. Also at the same meeting, Hess and Snyder (17) described a simple and inexpensive timing mechanism for regulating intermittent mist.

The interest in the use of mist for propagation was sufficiently great that at the 1954 annual meeting of this society, an entire session was devoted to mist propagation. At this meeting Snyder (28) reviewed the literature on the subject and described and compared methods of applying mist. Hess (16) presented basic information which explained how and why mist was beneficial. Ward (37) and Steavenson (31) told of their practical experiences with mist propagation. As a result of these discussions, the numerous advantages of intermittent mist over constant mist was recognized.

The following year, 1955, Floor (12), Hess and Snyder (18), and Snyder and Hess (29) presented papers on mist propagation at the 14th International Horticultural Congress in Holland which brought the mist technique to the attention of horticulturists and nurserymen in many parts of the world.

Problems of handling mist-propagated softwood cuttings

following rooting and of over-wintering these cuttings were discussed at the 1955 meeting of the Plant Propagators' Society. Templeton (34) described in detail the electronic leaf and the equipment which he had developed to "check" on the proper functioning of the leaf. During the next two or three years several variations of equipment to control intermittent mist were described. These will undoubtedly be discussed in detail later this morning.

From 1956 onward. numerous articles were written for both the scientific and trade journals which described methods of using mist for rooting cuttings with the facilities, schedules and species used in nurseries throughout the United States, Canada, the tropics, Europe, New Zealand and Australia.

Almost from the beginning, the reduction or actual elimination of problems of disease and insects was noted. Likewise the effects of mist on the leaching of minerals and other materials from the foliage was recognized. Evans (9) reported that nitrogen and phosphorus were leached during the first two weeks and that potassium was leached continuously from cuttings. More recently detailed studies of this problem were discussed by Tukey (34) and Good and Tukey (14) at meetings of this society. The use of nutrients in the mist has been described by Vanderbrook (36), Tukey (35), Good and Tukey (14) and Morton and Boodley (21).

The first and only complete review of the subject of mist propagation of cuttings was written by Patricia Rowe-Dutton in 1959 (25). The bibliography for this review contains 160 references.

Plant propagators on the West Coast recognized the importance of mist by including it as a major topic at the first annual meeting of the Western Region in 1960.

With the exception of a few reports, the use of mist for grafting has not been reported to be beneficial (3, 7, 8, 20, 26). Less spectacular than results obtained with cuttings, but nonethe-less important results have been recorded for the use of mist in the germination of seeds (1, 19, 38). The germination of annuals is not only more uniform but also more rapid under mist conditions.

The development and application of mist techniques for the propagation of plants has been a cooperative effort by horticulturalists and nurserymen. We can all be proud of the role played by this society in this effort.

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MODERATOR HESS: Our next speaker is unquestionably one of the greatest innovators in the nursery industry, whether it be to create a complete mist system we have come to know as the "Phytotecktor" or ways of advertising the sale of a nursery. Harvey has made a tremendous contribution to our Society and also is a recipient of the Society's Award of Merit. Harvey will talk to us about the mechanics of misting.

MIST SYSTEMS AND THEIR CONTROLS

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The first requirement of a mist system is that it distribute the water as evenly as possible over the bed area. There are several reasons for this requirement. The next speakers will discuss some of the reasons for not wanting too much water in any one spot — such as leaching of nutrients from the cuttings, water-logging of the rooting medium, etc. One reason they may not bother to mention is that the cuttings will dry out and die in any spot that does not get enough water.

Even reasonably good distribution of the water is difficult to arrange. Really uniform distribution is practically impossible. There are so many different things that must be taken into account — water pressure, nozzle spacing, nozzle height over the cuttings, type and capacity of nozzle, air movement, and a long list of other things. The difficulty is complicated by the fact that nozzles throw circular patterns of water. There is no way to arrange them so they just cover a square. There will always be a lot of overlap of the circular patterns so that the overlapped areas get more water than the rest. If the misting time is reduced to decrease the amount of water in those parts of the bed, other parts will not get enough water.

The best that can be done is a compromise. One must try various combinations of nozzles, spacing, water pressure, size of beds, etc. until the best compromise is reached. Then all these conditions *must* remain constant. Changing only one thing may throw the whole arrangement out of adjustment.