Round Table on Mist Propagation

FRIDAY AFTERNOON SESSION

December 3, 1954

The session convened at 1:55 o'clock, President Chadwick calling the meeting to order.

PRESIDENT CHADWICK: Those of you that have attended the meetings of this organization the last two or three years certainly are aware of the fact there has been as much interest expressed in humidity and mist propagation as any one single phase of the subject. Knowing that was true, Dick Fillmore decided to give the matter of mist propagation a thorough workout on the program this year. I imagine that this session this afternoon is going to bring out more questions and comments perhaps than any session we will have the entire afternoon.

This afternoon Dr. Snyder of Cornell University is going to moderate this panel on mist propagation, and at this time I want to turn the session over to Dr. Snyder.

Dr. Snyder took the chair.

Dr. Snyder presented his paper entitled "Possibilities with Mist Propagations". (Applause)

POSSIBILITIES WITH MIST PROPAGATION

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Many standard horticultural procedures have developed as the result of years of practical experience. In more recent years, some of these standard horticultural procedures have been found to be unjustifiable on the basis of research and of practical trials, but many have been found to be completely justifiable practices.

The plant propagator has long realized that the maintenance of the turgidity of a cutting is essential for rapid and successful rooting. Thus many standard horticultural procedures are followed which are aimed to minimize the loss of water from cuttings. Some of these well known practices are:

1) Collection of the cutting wood in the early morning when the tissues are fully turgid,
2) Protection of the cutting wood from bright sunlight and from warm, dry wind
3) Covering the wood with moist burlap or, in some instances, inserting the base of the cuttings in an inch or two of water
4) Making the cuttings as rapidly as possible and inserting them in the rooting medium soon after being made
5) Thoroughly watering-in the cuttings and frequent syringing the tops until the cuttings have rooted

6) Shading the cuttings in various ways from bright sunlight
7) The use of special structure or facilities, such as double-glass, bell-jars, specially constructed cases, etc.

The excellent discussions of the use of polyethylene frames by Mr. Roger Coggeshall (2) as well as the specialized technique described by Mr. Leslie Hancock (10) at the Third Annual Meeting of this group serve to illustrate the necessity of employing these standard horticultural procedures to propagation schedules and to illustrate the highly successful adaption of special structures and methods.

In the past fifteen years, and especially since 1946, the nurseryman and the experimental plant propagator have become interested in mechanical and automatic methods of preventing or reducing transpiration—the loss of water from leaves—from cuttings in the propagation bench. Basically these new methods fall into two categories—humidification and mist. Because of certain similarities in appearance and in apparatus, these two methods frequently are confused and in some instances these two terms are considered to be synonymous. However, the humidification and mist techniques are different and should remain distinct in our thinking.

Before considering these two propagation techniques, it might be wise to briefly review the process of transpiration.

An examination of a thin section cut across the leaf shows that there is an outer layer of cells surrounding the entire leaf. This layer is known as the epidermis and in turn, it is covered on the outside by a layer of waxy material known as the cuticle. The cuticle is relatively impervious to water. Scattered throughout the epidermis are pairs of slightly different cells, called guard cells. These cells resemble elongated balloons and when filled with water, i. e. turgid, separate in the center, thereby causing an opening in the epidermis. These openings are known as stomata. When the guard cells lose water, the cells become flacid and collapse and thereby close the opening. Characteristically most plants possess guard cells and stomata on the lower surface of the leaf, however some plants have them on both surfaces, or in some cases only the upper surface.

Immediately below the upper epidermis is a row of elongated cells. These resemble the logs used in the stockades of times past and are called palisade cells. Immediately below the palisade cells is an area of cells in which there are large air spaces between the cells. It is called the spongy parenchyma because it resembles the structure of a sponge.

Water from the cells of the spongy tissue evaporates into the air spaces. As more water evaporates the air of these passages gradually becomes saturated with moisture.

If the air immediately surrounding the leaf is "drier", water vapor passes from the air spaces inside the leaf through the stomata to the outside.

Actually water vapor passes from the leaf to the outside because the water vapor pressure is greater on the inside of the leaf than on the outside. When the stomata are open, the rate of transpiration depends upon the difference in the vapor pressure inside and outside—and the greater the difference the more rapid the rate of transpiration. (In this discussion it has been assumed that there is a greater vapor pressure inside than outside, however, sometimes the reverse is true.)

Humidification can be described as any method used to increase or to maintain a given level of relative humidity in the atmosphere. As it relates to plant propagation, humidification is based on the concept that with increased relative humditiy there is an increase in the vapor pressure of the atmosphere, and consequently a decrease in the difference between the water vapor pressure inside and outside the leaf. In this manner, then, the rate of transpiration is reduced. Actually at the same temperature, a cutting will transpire more at a relative humidity of 60% than 95%. However at the same relative humidity, a cutting will transpire more at 80 degrees F. than at 60 degrees F. This is because there is a direct relationship between the water vapor pressure and the temperature. Actually a plant or a cutting can lose water through transpiration even though the atmosphere is saturated, i. e. 100% relative humidity.

In practice, humidification may be very beneficial in reducing water loss from cuttings, but it is actually not as effective as one might think at first. In the actual operation of a humidification system, the leaves of those cuttings immediately near the apparatus may actually become covered with a thin film of water, but those removed from the apparatus are not so covered.

Mist propagation involves the use of apparatus which disperses fine droplets or particles of water in such a manner that the surface of leaves and stems are covered with a thin film of water. In practice, the relative humidity of the air immediately surrounding the cuttings is markedly higher, however the important thing is that the leaf surfaces are covered with water. Water evaporates from the surface film to the atmosphere, but little or no water is lost from the leaf tissue.

The application of mist functions also to reduce the temperatures of the leaf tissues and consequently lower the vapor pressure in the air spaces and there is a reduction in the loss of water from the cells.

Our main concern, this afternoon, is neither the mechanics of transpiration nor a comparison of the relative merits of humidification and mist. Instead, we are concerned with the possibilities of the use of mist technique in various propagation procedures, specifically as related to the rooting of cuttings.

Introduction of the mist technique in scientific literature was by Raines in 1940 and 1941 (17, 18) and in the trade literature by Gardner (8) and by Fisher (6, 7) in 1941. The timing on these reports indicate a simultaneous development of the concept by these men. In a paper published in 1951, Evans (4) refers to the use of mist in 1936 by Spencer in unsuccessful attempts to root cuttings of cacao. Although some additional reports were published prior to 1946, the rapid development of the mist technique can be laid directly to the early work of O'Rourke (15, 16) at Michigan State College, of Watkins (20) at the University of Florida, and to the enthusiastic and energetic endeavors by the first president of this Society, Mr. James S. Wells (21-27). Between 1940 and 1949 there were only about eight publications concerned with mist propagation, but in the past five years the number of papers has been more than double this number.

Basically the mist technique can be described as mechanical and controlled syringing. It is simple and inexpensive to construct and the operation of the apparatus is easy. The danger lies not in the apparatus, but in the plant propagator—the way he uses the apparatus and handles the plant material after rooting has occurred.

Fundamentally the apparatus consists of water pipes to which nozzles are attached at various intervals and a shut-off valve which can be operated either manually or automatically. Mist apparatus are of two basic types:

1) the over-head system in which the pipes and nozzles are suspended over the propagation bench
2) the in-bed system in which the pipe is on or below the propagation bed and the nozzles are located on up-right pipes.

Most over-head systems have a single line of nozzles located over the center of the bed (as was shown in the first illustration), however a double line may be used in which case the lines are located along each side of the bed (13). The in-bed system is advantageous in that no support is necessary for the feeder line and because dripping of water, which may occur during periods when the nozzles are not in operation, will run down the upright pipes rather than drip onto the cuttings. Use of the in-bed system does not reduce the number of cuttings which can be placed in the propagation bed.

The type of nozzle to be used is an important consideration. An ideal nozzle for universal use may never be a reality, but important considerations for the selection of the nozzle include:

1. efficient operation at the water pressure available. Nozzles are now available which can be used effectively at low water pressure (20 lbs.) as well as at higher pressures (80 lbs. or more).
2. delivery of a small amount of water. Under most conditions, the actual amount of water necessary to maintain the film of water on the tissue is exceedingly small.
3. coverage of as large an area as possible with a uniform distribution of mist. A nozzle which would deliver a rectangular rather than a circular pattern would be ideal, but the mechanics is such that nozzles which have a rectangular pattern also have a center which is devoid of mist.
4. so constructed or have devices included which prevent clogging of the aperature. Screens and self-cleaning devices are employed in some types of nozzles. Use of copper tubing is also helpful.
5. it should be of simple operation and easy to maintain.
6. capable of being turned off individually, thereby permitting work in one part of the bench without either turning off the entire system or of getting the worker wet.
7. last, and by no means least, it should be inexpensive.

Nozzles used in mist operations are of three basic designs:

1) oil burner nozzles
2) self-cleaning nozzles
3) deflection nozzles

The oil burner nozzle was first used by nurserymen and is still in use by many nurserymen. Water is broken into fine droplets by passing through very small grooves set at an angle to each other. This nozzle delivers a small quantity of water (7 quarts to 3 gal./hour), produces an even distribution of the mist, and is inexpensive. Disadvantages are that it frequently cloggs, even though a screen is employed, the mist is easily blown away, and there is considerable dripping in the over-head system when the mist is shut off.

The self-cleaning nozzle also depends on fine grooves to form the mist. It differs from the oil burner type primarily in having a spring loaded pin which cleans the aperature each time the nozzle shuts off. Although there is less dripping with this type of nozzle than with the oil burner type, there is still enough dripping to make the nozzle unsatisfactory when used over-head. Nozzles of this type deliver about 7 quarts per hour. The main disadvantage, however, is the cost.

With the third type of nozzle, the deflection type, a fine stream of water is emitted through a relatively larger aperature. The mist is produced when the stream of water hits a flat surface. Templeton (19) uses a nozzle of this type in the "Phytotector" method of rooting cuttings. Since the aperature and the resulting stream of water are relatively larger, there is less chance of clogging. Most nozzles of this type also have a screen incorporated into the nozzle to further reduce the possibilities of clogging. The area of bench covered by the mist from the deflection type nozzle is considerably larger than that covered by the oil burner nozzle. The cost of the deflection nozzles is more than the oil burner type, but considerably less than the cost of those of the self-cleaning type.

Considering the area of coverage and consequently the number of nozzles required, the cost is about comparable for the oil-burner and the deflection types. Cost for self-cleaning nozzles would be considerably more. One disadvantage of the deflection type nozzle is the quantity of water used (six gallons per hour at 20 lbs. water pressure). If interrupted mist rather than continuous mist is used, the disadvantage of the delviery of the larger volume of water is largely avoided.

With regard to mist propagation, a question frequently raised is "How long should the mist be on?" Most of the published work about mist is concerned with the use of continuous mist, either during daylight hours or on a 24-hour basis (4, 6, 8, 15, 17, 20, 21-27) but more recently the use of interrupted mist has been advocated (5, 11, 12, 13, 19).

It will be recalled that the basic concern with mist propagation is to keep the surfaces of the leaves covered with a film of water at least during those periods when the cutting is apt to be transpiring rapidly. Consequently it would be expedient to use only enough water to maintain this film continuously, and additional water would be unnecessary. As will be discussed in the next paper, the use of excess water not only is unnecessary but actually may be harmful by lowering the temperature of the rooting medium to such a level that rooting is impaired. Under continuous mist systems, the temperature of the rooting medium may be maintained at an optimum level by the use of electric heating cable or other means of supplying bottom heat. Less practical would be the use of heated water.

If the principle of interrupted mist is acknowledged to be valid, then, the next consideration is the method of operating an interrupted system. The most obvious method is the manual operation of the mist by an individual. However this is really nothing more than an elaborate hose-syringe system and involves the judgement of the operator. It must be born in mind that serious damage can result if the leaf surfaces are allowed to become dry during the rooting period, especially on hot, sunny days. Actually if the leaves are dry for as little as ten minutes on a hot summer day, softwood cuttings may be a total loss.

The value of the mechanical mist system lies in the fact, as so often stated by Mr. Templeton, that the mechanical apparatus is a better judge of when the mist is needed than is man.

Mechanical operation of interrupted mist can be accomplished by timer mechanisms, by electric eyes (solar control), by humidistatis, by season clocks, and by electronic control.

Timer mechanisms have been described by Hess and Snyder (12) and by Langhans (13). The timer mechanism described by Hess and Snyder at the previous meeting of the Society, outlined the steps in the construction of the timer and involves a single clock mechanism with disks attached to concentric shafts. One disk operates on a 24-hour cycle and serves to regulate the daily cyclic application of mist, for example from 6 a.m. until 7 p.m. The second regulates the specific periods the mist is "on" and "off", for example 30 seconds "on" and three minutes "off". Langhan's timer control involves two separate time clocks which perform the same operations described above. These are available from commercial sources.

A solar control mechanism has been developed and is being tried by Langhans and Petersen as a means of regulating interrupted mist for the propagation and growing of florist crops. The apparatus is basically a photoelectric cell. When a given quantity of light has accumulated since the last *period of mist, the photoelectric cell control unit* activates a timer which permits a short period of mist. Whether or not this system will prove feasible remains to be seen.

Templeton (19) employes a humidistat to control the period during which the time clock controlled mist is on. Thus, if the humidity drops below a given level, the time mechanism is activated to produce the interrupted mist. When the humidity rises above this given level, the timer mechanism is turned off.

Still another method of controlling the daily beginning and ending of the interrupted mist involves a time mechanism utilizing cams which supposedly take into consideration the changes in day-length during the year. This apparatus also is available commercially.

During the past year, an electronic leaf was developed by Mr. Charles E. Hess, a graduate student at Cornell University, and was used very effectively for controlling the mist operation. The electronic leaf consists of a small rectangle of plastic about one inch long and 1/2 inch wide. Two carbon points are inserted in the plastic and a wire leads from each point to the Thyraton tube control unit. An electric current passes between the contact points when there is a film of water on the "leaf" and the control mechanism causes the solenoid valve to remain closed. However as soon as there is a break in the "leaf current", the control mechanism causes the solenoid to open and the mist starts. When sufficient moisture has collected on the "leaf" surface to enable the circuit to be completed, the solenoid again becomes closed. In actual operation it has been found that the film of water on the "leaf" surface actually dries more rapidly than does the water film on the leaves of the cuttings The "on" period for the mist varies from a minimum of three or four seconds to a maximum of about twenty seconds.

Advantages of the electronic leaf control mechanism for mist propagation include:

1) it is weather sensitive—factors which effect the rate of transpiration from cuttings also effect the evaporation of water from the electronic leaf.

2) it operates on a continuous basis—thus for outside bed propagation, the electronic leaf will operate day and night, thereby affording automatic protection on a 24 hour basis.

3) it requires a minimum of water but affords maximum protection.

4) it is relatively easily constructed (and is now available at a price less than that of many time clock controls).

Several experimental mist systems have been established in one of the greenhouses at Cornell University and recently, a comparison has been made of the operation of several methods of controlling the mist. An examination of the data in Table 1 shows that there is about ten times more water used by the time-clock controlled interrupted mist system than by the electronic leaf system, and that with the continuous mist system more than 500 times more water is used. It is also apparent that if the propagation bench is closed, the electronic system not only uses less water, about one-fourth as much, but operates significantly fewer times per hour regardless of whether the day is cloudy or not.

A course grade of sand has generally been used with the various mist systems (5, 6, 7, 9, 18, 15, 21-27), however in some instances sand and peat mixtures are employed (11, 21-27). Templeton (19) actually roots cuttings in the soil. Water-logging of the medium may be a problem if fine sand is used or if provision is not made for removal of excess water in outside beds. However, with normal soil drainage and if short intervals of mist are used, water-logging probably will not be a serious factor.

Several reports indicate, as will be illustrated later, that use of root-inducing chemicals are as beneficial to cuttings rooted under mist as to those rooted in standard ways (5, 8, 11, 21, 24, 25, 26).

Another question which is almost invariably raised concerns the problems of disease and insects in relation to mist propagation. Gardner in 1941 (8), and most authors since, have written that disease and insect problems are negligible. Langhans (13) has reported that mildew and leaf spot are not problems with Better Times roses grown under mist. However, plants with a systemic disease are apt to show signs of the disease faster under mist conditions.

Timing, or the selection of cutting wood in the best condition, is still an important factor. Gardner (8) states that the five species which failed to root under the mist the first season were successfully rooted the second. He attributed the latter success to proper timing. Wells (22, 25, 26) has also stressed timing, especially in reference to rhododendrons.

Mist propagation is not without its problems and even the most staunch advocate of the use of mist would surely caution the beginner to start slowly and to gain some experience before employing mist for the rooting of all cuttings.

One problem relates to a point raised by Mr. Ilgenfritz at the annual business meeting last year. Once the cuttings are rooted—how are they han-

TABLE 1. A Comparison of frequence of mist operation and Delivery of water for several mist systems

Measurement	Weather Condition	Continuous Mist Open Bed	Interrupted Mist: Timer Operated Open Bed 1 min on - 9 off	Interrupted Mist: Electronic Mist, Open Bed	Interrupted Mist: Electronic Mist, Closed Case
Delivery	Cloudy (700 f.c. light)	1.9	.3	.04	.01
(qts/sq ft/hr)	Sunny (5000 f.c.)	1.9	.3	.05	.02
Frequency	Cloudy (700 f.c.)	Continuous	6	5	5
(Mist Operations /hr)	Sunny (5000 f.c.)	Continuous	6	5	1

dled? Even the most novice of us recognize that cuttings under mist—regardless of whether they were rooted under glass or in open beds—cannot withstand an abrupt shift from the mist.

One procedure is to pot the cuttings and to return them to the mist bench. The potted plants are then hardened by gradually decreasing the period of exposure to mist. In some instances this has been quite satisfactory but in others the results have been most disappointing.

A simpler method is to leave the rooted cuttings in the bench under the mist until maximum rooting has been obtained. The cuttings are then hardened by a gradual decrease in the mist periods until they are capable of withstanding the more severe conditions of the greenhouse or outside planting. In most instances there is little or no harm from allowing the rooted cuttings to remain from some period under the mist. In some areas cuttings, rooted in outside beds, may be left in place over-winter, and some nurserymen are experimenting with the storage of rooted cuttings until the spring planting season. With regard to hardening the cuttings, the value of a nozzle which can be turned off can readily be appreciated.

Another problem, which apparently is rather serious with certain plants, is leaching of the cutting. It is obvious that the more water that is sprayed on the cuttings, the more leaching will occur. Evans (4) reported that with cacao cuttings under conditions of continuous mist and 33 to 100% full sunlight there was a slow breakdown of the chlorophyll resulting in a yellowish green appearance. If the cuttings were shaded so that 20% full sunlight reached the leaves, there is no destruction of the chlorophyll and rooting was not impaired. Analysis of the leaf tissue of cacao cuttings showed that leaching of nitrates and phosphates occurred primarily during the first two weeks, but that potassium was continuously leached from the tissue. Under mist conditions, the new growth of *Taxus* cuttings is also yellowish-green in appearance. The most severe leaching occurred under continuous mist, the least under the electronic leaf mist system. With *Taxus*, the discoloration appears in the new growth and occurs regardless of whether the cuttings were made in the summer or the winter.

It would hardly be appropriate to conclude this discussion without considering the responses of some plants. The list of plants which have been successfully rooted with mist propagation is constantly growing. Until the report of the Field Trial Committee is made available, the best sources of information are the references cited in this discussion.

Although generalizations are frequently dangerous, it is fairly safe to state that easily rooted plants root quicker under mist, more difficult-to-root plants also root more quickly and the strike is frequently greater under mist conditions, many difficult to root plants can be rooted with relative ease under mist, but that many "non-rooting" plants do not root with any greater success under mist than under the standard methods.

At this time, it would perhaps be wise to briefly consider some of the results obtained during the past year in experimental work. All results are based on multiple lots of cuttings and the illustrative material was selected to represent the average response.

In late January and early February, cuttings were made of a variety of narrow-leafed evergreens. The cutting wood was very hard and dormant and somewhat better results might be expected with cuttings made a month or so earlier. Representative groups were placed in open benches or under interrupted mist of the overhead type. The open bench cuttings were syringed numerous times each day and shaded from bright sunlight. The interrupted mist was operated from 8 a.m. to 6 p.m. and was controlled by a time clock. The cycles were one minute of mist and four minutes without mist. (See Table 2).

Taxus media Hicksii (165 days) represents plants in which there is little difference between the two methods. New growth of the cuttings under mist showed considerable loss of green color.

Juniprus chinensis Pfitzeriana (123 days) represents plants in which mist is of marked benefit in the rooting response—number of cuttings rooting, average number of roots, and length of roots.

Thuja occidentalis elegantissima (98 days) — another illustration of plants in which the rooting response is markedly benefited by the mist. The use of root-promoting materials show corresponding beneficial effects regardless of whether mist is used or not. (Table 3).

TABLE 2. Comparison of the Rooting of narrow-leaf Evergreens in Open-bench and under interrupted mist

Species	Number of Days	Measurement	Open Bench	Interrupted Mist
Taxus media Hicksi	98	% Rooting	1	47
		Ave. No. Roots	1.5	2.6
		Ave. Length	4.8	7.8
Juniperus chinensis pfitzeriana	123	% Rooting	99	98
		Ave. No. Roots	15.3	15.8
		Ave. Length	4.1	4.5
Thuja occidentalis elegantissima	98	% Rooting	1	41
		Ave. No. Roots	4 0	18.9
		Ave. Length	.4	2.6

TABLE 3. Percent rooting of cuttings of *Thuja occidentalis elegantissima* rooted in open-bench and under interrupted mist and treated with root-inducing chemicals. Time in bench: 98 days.

Rooting Condition	No Treatment	Talc Only	Rootone	NAA 2%	Hormodin No. 2	Geige 2%
Open Bench	1	1	11	7	4	0
Interrupted Mist	41	56	71	60	51	71

Other evergreens tested included *Juniperus chinesis Sargentii, J. horizontalis plumosa, Taxus baccata repandens, Chamaecyparis obtusa,* and *C. Lawsoniana*.

A more extensive set-up, made for the summer experimental work, included the following:

1. A wardian case
2. Constant mist (sunrise to sunset) open bench
3. Constant mist (sunrise to sunset) closed case
4. Interrupted mist—electronic leaf control.
5. Interrupted mist—time clock controlled cycles, one minute on, four minutes off
6. Outside bed—continuous mist first three weeks to interrupted mist (one minute on, 4 minutes off)

Narrow-leaf evergreens can be rooted during the summer (Table 4). Both Pfitzer's juniper and the spreading yew rooted well under mist, poorly in the wardian case. Again there was leaching of the soft new growth of the yew.

An easily rooted softwood cutting is *Forsythia intermedia spectabilis* cv. Spring Glory (Table 4). Rooting of the cuttings in the outside beds was somewhat poorer than those under glass. Temperature as recorded by maximum-minimum thermometers indicate that there were many nights during which the minimum temperature was below 60 degrees F. and a few nights below 50 degrees F. It is considered probable that the low temperature account for the reduced rooting. Based on the number and length of roots, the wardian case, the time-interrupted mist, and continuous mist open bench resulted in poor rooting. As will be discussed in the next paper, it is believed that one of the most important factors involved in this retardation is temperature.

Weigela Eva Rathke (31 days) — the rooting response was poorest in the wardian case. Best rooting occurred under conditions of continuous mist —closed case. The electronic mist—open bench was superior to either of the other open bench mist conditions. Use of root-inducing chemicals had a slight beneficial effect and tended to reduce somewhat the variation between the different mist conditions.

An interesting and significant difference between the wardian case method of rooting cuttings and the mist method is shown by *Prunus serrulata* (32 days). There is a significant difference between the two treatments in regards to the strike:—the mist treatment resulting in 87% rooting and the wardian case in only 37%. Almost half of the cuttings in the wardian case lost their leaves within the first week and subsequently died. In striking contrast no cuttings under the mist lost any leaves.

It has been the purpose of this paper to review the mechanics of the mist techniques for rooting cuttings by bringing together the various ideas and concepts of various writers on the subject and to present some hitherto unpublished work. In the paper which will follow, an examination will be made of some of the environmental factors which can account for the differences frequently encountered between standard methods of rooting cuttings and the use of mist.

TABLE 4. Comparison of the rooting of Softwood Cuttings (July, 1954) in Wardian Case and under various types of mist

Species	No. of Days	Measurement	Wardian Case	Constant Mist Closed Case	Electronic Controlled Mist	Interrupted Mist 1 min. on 4 off	Constant Mist Open Bench	Outside Mist-bed
Forsythia	21	% Rooting	97	100	100	100	97	87
		Ave. No. Roots	13.3	19.8	19.2	16.9	17.0	14.3
		Ave. Length	1.8	5.5	4.5	4.3	3.8	1.7
Weigela Eva Rathke No treatment	31	% Rooting	79	97	89	83	85	
		Ave. No. Roots	3.8	9.4	6.8	6.8	5.7	
		Ave. Length	2.4	4.9	3.4	3.5	3.5	
Hormodin 1	31	% Rooting	88	100	100	97	97	
		Ave. No. Roots	5.5	12.3	7.8	8.3	7.1	
		Ave. Length	3.6	7.4	6.1	5.5	6.3	
Prunus serrulata	32	% Rooting	37			87		
		Ave. No. Roots	6.0			8.1		
		Ave. Length	1.9			2.5		
Pfitzer's Juniper	79	% Rooting	2	80	66	94	90	
		Ave. No Roots	0.2	3.1	2.0	1.9	3.2	
Taxus	81	% Rooting	12	58	78	74	78	
		Ave. No. Roots	1.5	2.7	4.0	3 1	4.6	

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MR. SEBIAN (M. P. Sebian Nursery, Painesville, Ohio): Does the mist system reduce the temperature to any extent, say on very hot days during August and September, inside the greenhouse?

MODERATOR SNYDER: Very definitely, but let's defer a discussion of this until after Charlie Hess' talk, if you don't mind.

MR. ROGER PEASE (West Va. University, Morgantown, W. Va.): I have been interested in closed cold frame for about four years except I haven't intermittent mist. I put it on in the morning and off at night. Two things you mentioned, one of which will operate; the other I think may be dangerous. You certainly do get where you have the cuttings in there a long time, waterlogging, where the sides are enlarged. You lose cuttings from that excess water even if you have adequate drainage. Again, from that excess of water from the constant mist from morning to evening on cuttings of serrulata and rhododendrons and chestnuts, I lost a few because I got water. Secondly, if you have boxes put in at different times and you want to harden them off and put in a frame the way I have to do, you may lose very definitely the first batch because I think there would be the reason, because you are keeping it in there so long you get a root system so big and a little growth. It is in sand. You don't feed it, so it ups and dies.

MODERATOR SNYDER: That is outside. Actually, my remarks should apply primarily to material to be used in the greenhouse.

MR. CASE HOOGENDOORN (Hoogendoorn Nursery, Newport R. I.): That Weigela Eva Rathke you showed there—do you leave the tips out or leave the tips in?

MODERATOR SNYDER: Those were short cuttings taken from what we call milk soft. Actually just the tips were used.

MR. ROSCOE FILLMORE (Fillmore's Valley Nursery, Centreville, N. J.): Under the mist, the philadelphus dropped its leaves within about two weeks. They were practically defoliated, a very large percentage being rooted but there was no growth. We only used two inches of sand and the rooting would take place in the lower layer. Remember, we had a fairly good soil, so on most of the cuttings that we put in the frame, as soon as they were rooted they began to grow, but the Philadelphus of all the varieties we stuck got their foliage and failed to make any growth.

I understand that the growth of fungus is almost inhibited under the mist. It appeared to me that the tissues of the leaves were simply broken down from too much water.

MODERATOR SNYDER: I think that is quite probable.

MR. JOHN B. ROLIER (Verhalen Nursery Co., Scottsville, Texas): I ran into the same trouble with one of the viburnums under continuous mist from 6:30 a.m. to 5:30 p.m. They defoliated and had a ball of roots on them, like that. The eyes were plump but like Fillmore's plants, they started to shoot up from the bottom and never yet have they broken out on the top. Those plants were potted off the first of August. I believe Mr. Watkins in Florida advocates the cuttings should be removed from the mist when the root becomes a quarter of an inch long.

MODERATOR SNYDER: I think he does. We haven't seen any harmful effect from leaving a wide variety of cuttings under the mist with this possible exception of a leaching or yellowing of taxus.

If there are no other questions, let's go on to the second half of this topic, which Charlie and I have divided, in which an explanation will be made of why some of these differences have been encountered. Actual measurements have been made of many of the environmental factors which will substantiate or will explain these differences. Charles Hess Jr. is a graduate student at Cornell and is the holder of the Newark (N. Y.) Commercial Enterprises Fellowship in Nursery Research. His background is the nursery business and I am certain that you will enjoy his remarks.

Mr. Charles Hess Jr. presented his paper entitled "Factors Influencing Propagation under Mist." (Applause)