

Conclusions. From our most recent experience with mist propagation we believe the 24-hour or constant mist application is not necessary nor is it practical. The cuttings propagated under intermittent mist appear to be more vigorous and responsive after potting than those propagated in tent houses or shaded frames. We also believe that the cuttings that are stuck each day should be handled as individual units each with its own timer and solenoid valve operating from a master time clock which can be hooked to the whole system. For this purpose we intend using beds 6' x 30'.

Summary. In summary then, I have discussed with you the subject of mist propagation in open frames, a method of propagation in which I have great confidence, provided careful attention is paid to details. I have described our experiences of the past two years together with our future plan for commercial application of this method of rooting cuttings during the summer months.

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MODERATOR SNYDER: What happened to the cuttings that were hardened up in the sand? Were they fed over winter?

DR. MAHLSTEDDE: Various methods are being tried. The first year under constant mist they were taken up, rolled and wrapped in polyethylene, that is, a little moisture placed in the bottom of the polyethylene, rolled over and put in a roll and put in storage, common storage at temperature outside. It wasn't too well insulated but it is a method you can use to carry cuttings over winter and lighten your fall load and give you a little more to do in the spring if you don't have enough. It is just a method of handling.

Another method they are attempting is to put the sand on top of the soil. I think it has been described here earlier. The cuttings will root and during the rooting sequence the mist will be cut down. The roots will develop in the soil later.

MODERATOR SNYDER: The next speaker this afternoon comes to us very highly recommended. His nursery in Missouri, The Forrest Keeling Nursery, is one of the outstanding in the area and he is a very personable individual and a strong member of this Society. His topic, "Mist Propagation under Lath Shade," will be of intense interest to us all.

Mr. Hugh Steavenson presented his paper, entitled "Mist Propagation under Lath Shade". (Applause).

MIST PROPAGATION UNDER LATH SHADE

HUGH STEAVENSON

Forrest Keeling Nursery, Elsberry, Missouri

Our system of mist propagation at Forrest Keeling Nursery varies in several particulars from other mist systems I have seen or with which I am acquainted. These variations are not necessarily any better nor any worse than other adaptations. And I think "adaptation" is an appropriate word in this connection. It seems to me that almost all mist systems are adapted to an earlier propagation system or technique that happened to be in use at the nursery in question.

And this, if anything, points up the flexibility and adaptability of mist. For example, where the propagator has been using a greenhouse, he adds or adapts mist to this structure. Or he will integrate mist into his sash house operation where this type house is in use. If he has been using cold frames or hot beds he will simply remove the sash, install a mist line a few inches above the bed and raise translucent windguards around the frame to keep the mist at home.

We happened to have a convenient slat house, or shade house as we call it. With this structure it was both convenient and economical to install a set of lines and nozzles in an overhead position. The side walls of the house are 9 feet high. There was, therefore, ample height to install our lines at a 7-foot level which permits one to walk and work freely beneath.

I'll get into the simple details of our structure in a minute, but permit me to digress for a moment to say that we are enthused about the use of mist beyond the immediate problem of rooting cuttings. We do some mail order business and have been seeking a practical means of preparing conifers and broadleaf evergreens of a small finished size—say 12 to 15 in.—for shipping through the mails. Even with the revolutionary development of polyethelene for wrapping, there remains the problem of sending a bare-root evergreen to a customer with reasonable assurance that the plant will live and grow on satisfactorily. For several seasons we have followed the practice of digging such plants early in the fall; heeling them in sawdust or peat in the shade house where the plants could be syringed frequently; and thereby “re-establishing” the plant, usually with a new secondary root system, so that it would ship and transplant with far greater certainty of success.

Now it is at once apparent that mist is made to order for this method of handling plants. Mist can allay the terrific unbalance of top and root when evergreens are dug bare-root. It can obviously supply the necessary water to keep the foliage and stems turgid and fresh until the root system has recovered and is again functioning. Constant or intermittent mist can do the job more surely and economically than even the most careful and diligent syringing with a rose nozzle. So we now have considerably more area under mist in our “heel-in” shade house than we do in our propagating house. Here we use the Florida 550-A nozzle which can be spaced farther apart than the Monarch nozzle, thereby reducing the installation cost.

We also use mist over our B & B truck delivery orders as they are assembled and held awaiting shipment. We adopted this procedure for the first time this fall and we like it. We constructed a loading dock at one end of our mist heel-in house and during the hot, windy days of September we no longer had the usual “willies” when a customer was a couple of days late in picking up his load of balled evergreens, or when our delivery truck got a few days behind the balling crew. In the mist atmosphere the plants would actually take on a freshness not always apparent in the field.

Everyone who has handled container stock knows how badly a deciduous plant can wilt if the container is lifted during the flush growing period, and if, through neglect of frequent moving, roots have entered the soil beyond the container. Here again the mist-covered shipping dock is ideal to hold such plants fresh and vigorous pending shipment.

Surprisingly enough, we haven't used mist thus far to establish our freshly-potted soft wood cuttings that have been rooted under mist, and this establishment has been a difficulty with us. There are some problems here, but I would guess mist could be useful in this connection.

In discussing mist, I do not want to wander too far from propagation, *per se*, but I do want to express my opinion that as propagators and nurserymen we may well find mist has a broader and more extensive application beyond the actual cutting bed or frame. With mist we can create what might be termed a rain-forest atmosphere in situations otherwise highly forbidding to certain plants or plants in a critical condition due to root disturbance or soft foliage. Mist controlled with timing devices or suitable spacing of nozzles can be economical in use of water, and distribution of the mist over a given area within an allowable cost then becomes a matter of engineering.

Referring now to our shade house mist installation for rooting cuttings: the title given my paper by the program committee was "Mist Propagation under Lath Shade." Actually this is somewhat of a mis-nomer. We placed our mist lines in a shade house as I have indicated, but before we ever stuck a cutting in 1953, our first year of operation, Dr. Chadwick and Jim Wells came by, thank goodness, and these gentlemen suggested we should remove our overhead slats. This we did and we have never put them back. There have been times when the slats might have been beneficial—to control wind and to provide added protection when someone failed to turn the valve on at the proper hour in the morning or promptly following a couple of rainy days. But when mist is applied properly we, at our place, can only concur in the principle that a cutting covered with a film of water needs no shade protection.

Now on the basis of some of the things said this afternoon I guess I might modify that statement, yet, I don't know. Apparently in Shenandoah they got the best results out in the center of the frame where there was no side shade. In our shade house with our 9-foot sides we do get a good deal of shade from direct sun in the morning and again in the afternoon.

Our initial mist installation covered an area of shade house measuring 52' x 24'. This area was provided with three one-half inch copper lines running lengthwise of the house and fed by a 3/4 inch main running at right angles to the lines through the center of the house. This center feeding appeared to provide uniform pressure to the jets. Monarch H261 3.00.120 jets were installed at two-foot intervals along the lines and set facing downward at a 45 degree angle from the line, first to the right and then to the left. Generally, Wells' recommendations on choice of nozzle, strainer, sweat joint installation and on other points were followed.

It will be noted, however, that our lines were 7'8" apart and 3'11" from the wall. This is a wider spacing than is customarily used for this nozzle, giving each nozzle 16 sq. ft. to cover. Indeed this summer we were able to reduce the nozzles by half and still have adequate coverage.

This reduction in number of nozzles was possible because (a) the lines were at a high level—7 feet above the ground-line and because (b) air movement entering the open-topped structure created enough turbulence of the atmosphere of the house to give a fairly good dispersion to the mist droplets as they descended to the floor. Even on the quietest days this air movement factor seemed present. Incidentally, we quickly learned that wind shields were

necessary on all sides of the house and these were simply and inexpensively provided by tacking two mil polyethylene panels to the full 9 feet height of the house.

We went to some means to assure adequate drainage in this house by providing a 12-inch-deep coarse gravel floor over tile lines spaced 8 feet apart.

Now in the use of this house we made what I believe is a major departure from usual practice. We decided to stick our cuttings in flats, place the flats under mist and remove each batch to harden when rooted. Thus we proposed to use our house much as a baker would use a constant temperature oven and to be able to use the available space more fully than where cuttings are stuck in beds. This procedure proved satisfactory and we followed the same practice this year. I think I picked up from Bill Flemmer the idea of using tomato lugs for flats. These have more depth than a standard flat, which we like and they can be picked up in truckload lots from Produce Row in St. Louis for a nickle each, which we also like.

We have tried a number of varieties under mist and I will append a table which summarizes our results this past season but a few comments will suffice to point up our experiences. We are interested in propagating quite a number of broadleaf evergreens—*Ilex*, *Euonymus*, *Viburnum*, *Berberis*, *Buxus*, *Pyracantha*, *Hedra*, etc.—and as a class, the results with this group have certainly been encouraging and rewarding. We do not grow many of the usual line of flowering shrubs and haven't had occasion to work with soft woods extensively in this group, but the few we have worked with have rooted quite well. Our rooting results with coniferous evergreens, particularly junipers, have been disappointing, probably due to timing in taking wood. We can do so much better with our winter polyethylene house with this group there seems to be no reason for us to try to work out a satisfactory outdoor mist technique with conifers. Nor does mist seem to us to have a place where hardwood cuttings are satisfactory. For example, we use a good many Dwarf Blue-leaf Willow (*Salix purpurea*). This, of course, roots like a weed under mist but is difficult for us to establish after rooting. One year plants from hardwood cuttings, ready for sale as hedging, are less expensive than the production of a potted liner in this instance.

Our hormone treatments have been standard recommendations. We have not run enough checks to comment on hormone treatments of cuttings under mist. I presume each outfit finds a suitable rooting medium for its particular set of conditions, but I couldn't tell our story without mentioning our experience. We assumed our river sand would be satisfactory and we used it throughout in 1953 except for check flats of other media. Lo and behold, the darn stuff waterlogged under constant mist and where cuttings did not root promptly—as with junipers—they rotted in this sand. Fortunately, we had some check flats of vermiculite and here drainage and aeration appeared satisfactory and rotting was not a problem. We have also tried silica sand and Perelite, but with us, vermiculite has been the most satisfactory. We use the coarse house-fill grade rather than the more expensive horticultural grade and I believe this coarse grade is better. Another big advantage of vermiculite is its weight. We use women for our cutting work and sand flats are too heavy for them to pack around efficiently. The nursery profession is plagued with far too much lifting and straining at best.

I believe it has been observed over and over again in mist propagating that wood can be taken very soft with good results. Our 1954 against our 1953 experience pointed up this factor. We simply started too late in 1953. *Euonymus alata compacta* is a case in point. In 1953 we took cuttings on July 28 and rooting was virtually nil. In 1954 we took cuttings from the same stock plants on May 27 and got a 97% rooting and rooting was rapid.

I mentioned last year that we "ran out of summer" with a number of slow-rooting items. This year with our house all set in the spring this was not a problem. Second and third batches were limited to quick-rooting varieties.

We haven't used any timing devices in this summer house, although we are installing an intermittent mist system in our winter house. As I have indicated, we have been able to space our nozzles to an extent that constant mist does not use an undue amount of water. After hearing Dr. Snyder's remarks, I think we may send our intermittent mist system back and get the electronic leaf. It sounds very good. Actually, on an 8-hour day operation, and with our low pressure, our nozzles deliver only about .4 inch water per day which does not seem excessive. After the first week or so we found we could turn our mist on about 8:00 o'clock or 9:00 o'clock in the morning and turn it off at 4:30, as soon as the sun went down and when we spaced our nozzles out we were only with constant mist delivering about .4 of an inch of water per day, which does not seem excessive.

After rooting and before potting we harden the cuttings by placing the flats on a bench adjacent to the mist area. Here a slight drift of mist gives the effect of gradually removing flats from mist to no mist.

Last year the problem of a whitish precipitate forming on cuttings under mist was discussed. Our water is quite hard and this is a definite factor with us. This precipitate appears to cause no injury to the cutting but it does adhere to the leaf for months afterward. We tend to forget about it until a customer asks what is the matter with the foliage on a potted plant.

After the new foliage comes out, it covers up the white leaves. I dare say a suitable intermittent system would reduce that problem, too. Doubtless our biggest problem at present is establishing cuttings rooted under mist. Our technique needs a great deal of improvement in this direction. You will note in Table 1 that establishment was excellent in many instances, but with about a third of our subjects the losses were well above an allowable or economical figure. We were bedeviled this year by the hottest summer on record, which didn't help any, but we do feel we will have to use Roger Coggeshall's procedure of covering freshly potted plants with polyethylene sheets or else use some mist over the potted material until established. I don't think we would like to carry the cuttings over, such as has been used at Shenandoah. If we can establish them quickly we can get them out and many of them planted that same fall. I don't think we would care to carry the things over into the following spring. Unless the mist is very light, and here I think intermittent mist would come in again, however, I am afraid we would be back to our old problem of a saturated soil and root-rotting. I dare say the right use of intermittent mist would overcome that problem in establishing potted mist-rooted softwoods. I know of some others who have this same problem of establishing mist-rooted cuttings and I trust the question can be resolved in this discussion.

If I were not in the plant band business, I would be tempted to point out that we have less difficulty in establishing cuttings in cypress plant bands than we do in clay pots, but such an observation considering my commercial connection would be highly unprofessional and I will say absolutely nothing about it.

I shouldn't close without saying that we, at our nursery, have been disciples of Wells. I say Wells, but other people have also been responsible for mist spraying. We follow his articles pretty carefully not only in the use of summer mist for rooting cuttings but also in the use of John Innes Compost for potting or more properly, banding them. It seems to be all our English cousins claim. We got a little anxious to secure maximum growth and I believe burned some items by using the base at double strength. I would suggest propagators stick to John Innes No. 1 until they have tested the stronger mixtures.

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MR. STEAVENSON: I would like to take about two minutes to comment on mist versus poly. I think I am in a position to do that because as I mentioned, we have this winter house which is simply a sash type pit house, except instead of sash it is completely covered with polyethylene, tight, so we have a continuous blanket of polyethylene. We used it the first time last winter.

It is 15 x 100. It has worked out very well, but I can't see how we can get along without extra moisture in the house. We were all set to put up mist lines in his house. After Mr. Gray's comments, I thought maybe we were going off the deep end of the thing, maybe we didn't need them. When I consider the problem we had last year, I believe it is an economical way of getting the extra water into the house, which I know definitely we need, because we can't maintain anything like a saturated atmosphere in this house even during the winter without daily syringing with water, and a good deal of it.

In this tight house, I might mention, we use electric cables for bottom heat and that is all the heat there is. Temperature at night, on a cold January night, will go down pretty close to freezing, which is perfectly all right, but on a clear sunny day the temperature will pop up as high as maybe 90 degrees. Obviously, if we have no more moisture than what comes from the cuttings or media and with the same amount of moisture the relative humidity goes way down and our cuttings get very dry and we have had a problem of keeping them syringed throughout the heat of the day.

Furthermore, if the air temperature, let's say, is 80 in the house, the outside temperature is 40, much of what moisture there is in the house condenses on the poly which further removes moisture from the house and we have to have extra moisture in that poly house. We couldn't get away from it.

We didn't use it this summer, and the reason we didn't use it, it simply gets too hot. It would burn the cuttings up. Now we didn't have mist in it. Maybe when we get mist in it we can use the poly house.

The summer temperature in this particular house, without mist, would certainly burn the cuttings up, and of course, we went back to our outdoor mist without any poly largely because of temperature factor. Thank you very much. (Applause)

MODERATOR SNYDER: And now questions for Mr. Steavenson.

MR. HOOGENDOORN: Did I understand correctly that you use polyethylene on the sash house instead of sash?

MR. STEAVENSON: Yes.

MR. HOOGENDOORN: Does that keep warm enough in the winter?

MR. STEAVENSON: As I said, we use electric cables for bottom heat. That is all. During the coldest days the air temperature approached freezing. It never did freeze, but it approached freezing. Of course, during the daytime, even during a cloudy day it got warm. General rooting was pretty good.

TABLE 1. RESULTS WITH MIST PROPAGATION at FORREST KEELING NURSERY DURING SUMMER OF 1954

Variety	Date Taken	Date Banded	Number Taken	% Banded	% Established
Buxus - Carr Hardy	6/1	7/ 22	132	93%	93%
Berberis julianna	6/9	7/23	115	84%	55%
Berberis mentorensis	6/4	7/10	3,527	90%	80%
Cotoneaster r sonngar	6/5	7/26	202	65%	37%
Euonymus alata compacta	5/27	7/13-19	6,773	97%	85%
Euonymus carrieri	6/2	7/9	859	100%	100%
Euonymus fort. colorata	6/1	7/9	280	100%	100%
Euonymus fort Wild	5/25	7/9	1,505	100%	90%
Euonymus fort. vegetus	6/3	7/12	29	100%	100%
Forsythia Lynwood Gold	6/2	7/9	642	99%	(160) 25%
Hedera helix baltica	6/4	7/26	436	80%	80%
*Hedera helix bulgarian	5/27	7/20	27,210	46%	40%
	6/14-17	7/27			
**Ilex opaca	6/3	7/26	2,509	67%	57%
Ilex crenata hetzi	6/9	7/26	894	80%	30%
***Juniperus H. douglasi	6/10	7/22	1,541	36%	32%
Juniperus V. Keteleeri	6/12	8/24	3,223	18%	18%
***Kolkwitzie amabilis	6/25	8/24	650	54%	50%
Magnolia grandiflora	6/2	7/23	194	41%	(38) 20%
Magnolia soulangeana	6/25	8/24	616	68%	(267) 43%
***Metasequia glyptostr.	7/9	8/25	464	44%	40%
Prunus lavro. zabel.	6/2	7/27	54	85%	61%
Pyranantha coccinea	6/3	7/12	1,095	92%	7%
Rhus cotinus purpurea	6/2	7/26	159	40%	6%
Salix purpurea nana	5/26	7/8	5,518	100%	0%
Salix purpurea nana	7/27	8/23	6,425	96%	86%
Philadelphus - Snowfl.	6/1	7/21	921	82%	61%
***Syringa chinensis	6/7	8/23	1,303	85%	76%
***Syringa chinensis alba	6/10	7/27	935	77%	59%
Viburnum burkwoodi	5/26	7/21	1,668	77%	71%
Viburnum chanulti	6/2	7/20	843	78%	72%

(1) This figure taken at the close of the summer season when all cuttings were firmly established and growing in the plant band. John Innes Compost No. 1-1/2 was used as a potting medium on all varieties.

* Many improper cuttings were made.

** Approximately 250 cuttings died in Mist house due to improper water distribution.

*** Cuttings possibly taken too late.

MR. HOOGENDOORN: Along in March does it get too hot and burn up your cuttings then?

MR. STEAVENSON: Yes, it did get awfully hot. We used some camouflage over it, particularly on the west side. We took a spray gun and went over the house with aluminum paint and cut the light down about half. Sometimes it got pretty hot. The primary objection we had in using only electric cables for bottom heat was the fact our electric rates are very high. We thought we would use a double poly wall over the ceiling, putting poly on the outside, and we have rafters about 8 inches deep and putting a layer on the inside to cut down our heat loss because our electric bill was pretty rough during February and March.

MR. HOOGENDOORN: It seems to me you would have better control of heat in the house using sash rather than with polyethylene.

MR. STEAVENSON: What we want is a tight house so we can keep the moisture up.

MR. HOOGENDOORN: You don't want to burn your cuttings up after you get them rooted in March.

MR. STEAVENSON: Well, we didn't. It worked much better with our conifers than the outdoor mist did.

DR. MAHLSTEDDE: Does it snow down where you live? What do you do when you have heavy snow?

MR. STEAVENSON: It rolls off like it does on glass. People ask us about hail. I expect a good hail storm would tear it up. This is a 15 x 100 foot house and by getting polyethylene direct from the manufacturer in 100 foot rolls instead of buying from a fabricator, you can cover the whole thing for about \$15.00.

DR. MAHLSTEDDE: What thickness do you use?

MR. STEAVENSON: I am using two mil. Probably we should use three or four. I don't know what hail would do. There is quite a little give there. If hail did tear it up, you could get more on in a couple of hours.

MR. SHAMMARELLO: How do you get it fastened down?

MR. STEAVENSON: We have 1 x 4 stringers at intervals over this house, so we do get some shade effect from the stringers, about a third shade, and we have the edges of the poly strip. We run it vertically. Last year, we ran it horizontally. We simply make a lath and tack it down at the joint and we get a pretty tight seal.

MR. EDWARD CROSS (Haynesfield Nursery, Bristol, Tenn.): How wide?

MR. STEAVENSON: This house is 15 x 100 feet.

MODERATOR SNYDER: The last member of this afternoon's panel is in a very enviable position. He is last on the program and can, if he so desires, vary his remarks based on the comments of the previous speakers. His topic, too, is a different approach to a general subject.

Mr. Vincent K. Bailey, of J. V. Bailey Nurseries, St. Paul, Minnesota, is well qualified to discuss "Controlled Humidity in Greenhouses".

Mr. Vincent K. Bailey presented his paper, entitled, "Controlled Humidity in Greenhouses." (Applause)

CONTROLLED HUMIDITY IN GREENHOUSES

VINCENT K. BAILEY

J. V. Bailey Nurseries, St. Paul, Minnesota

The discussions you have just heard about mist propagation are an effective method of preventing loss of moisture from the softwood cuttings but there is another method which we have found very effective. I refer to controlled humidity in greenhouses as a means of keeping the cutting in good condition until rooted. We have used this method in St. Paul for the past seven years and we feel that it has some advantages.

As an introduction to our discussion of "Controlled Humidity in Greenhouses", I wish to briefly describe our physical plant. This consists of two greenhouses, one 25' x 100' built about 1938 and another 25' x 116' built in 1942. These houses are heated with hot water boilers using oil.

Our propagation is primarily for the purpose of supplying lining-out stock for our own field planting. I wish to make it plain that we are not producers on a large scale in the way that many of you are accustomed to. As you can see, these two houses are only a fraction the size of the facilities of many nurseries.

We produce one crop of deciduous greenwood cuttings and a crop of coniferous plants annually. The softwoods are stuck June 15 to July 24, and removed in October and November. About December 1st we start planting the coniferous cuttings, consisting of the following varieties:

Savins	Golden Communis	
Pfitzer	Kosteri	Globe Arborvitae
Andorra	Tamariscifolia	Golden Arborvitae
Von Ehron	Pyramidal Arborvitae	Dark Green American Arborvitae
Hetzi	Siberian Arborvitae	Compacta Erecta Arborvitae

These are removed in late May when 85% are rooted. The method we use in handling the rooted cuttings is different from those used by the majority of growers. Ninety-five to 97% of these plants go directly into the field. This is getting a little beyond our subject of propagation, but I am of the opinion that a successful propagator must see to it that the liners are easily and efficiently put into the field to be grown into finished plants of high quality.

ROOTING MEDIUM

It is our opinion that the material used is of minor importance or rather I should say that some other factors are of greater importance. We use a commercial grade of plaster's sand purchased from a building material company. We have tried several other materials and mixtures but have come back