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

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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

to sand. I do not want to say that everyone should use sand but we have learned how to use it in combination with all the other factors to make for successful results.

We start with this clean sterile sand in early June at which time the benches are all cleaned and sterilized. This procedure is followed once a year. When the coniferous cuttings are stuck in December there is no sterilization or change of sand at this time.

TEMPERATURE

Summer temperatures are allowed to go as high as 100° F. These temperatures are, of course, controlled by the shading on the glass and by ventilation. It is hard to say what is the best balance of these two factors but it is my belief that the amount of light allowed has a direct effect on the vigor, and rooting time, of the resulting plant and also affects the ability of the plant to withstand transplanting. Therefore, we use only as much shading as necessary to control the temperature, using the ventilators for the balance of this temperature control. Here is the point where our automatic humidifiers demonstrate their value. We will discuss this more fully a little later on.

Winter temperatures are carried at 65° F. as a minimum. This may be a little higher than some of you use but it enables us to get the slower rooting varieties in shape to go into the field by late May. The benches have an apron of paper to help build up the sand temperature a few degrees above air temperature.

HORMONES

Rooting stimulants have been used in our work in several forms and on many varieties. I know that there is a great deal of good scientific data to prove their worth and effectiveness. I think that everyone has a different set of conditions under which the work is done. Under our conditions we may find, for instance, that Spirea Anthony Waterer roots without a hormone. This does not mean that root stimulants are valueless to other propagators or on other classes of stock. We use indolebutyric acid in solution. The following uses of hormones have been found most practical under our conditions: We have been using indolebutyric acid on our coniferous cuttings for about 8 years and find that acid used in water solution gives more uniform results than in the powder form. We use alcohol to dissolve the acid so it can be mixed with water.

On Pfitzer's Juniper we use it at the rate of 120 milligrams per quart of water leaving the plants dipped in 1/2 inch of solution for 16 hours. We find that cuttings dipped for 16 hours give more uniform rooting than when used with a stronger but shorter dip.

On Siberian arborvitae, Andorra and Savins juniper we use 80 milligrams acid per quart of water, 16 hour dip. Pyramidal and Globe arborvitae do root well without treatment, but develop a better root system when treated. On these we use 60 milligrams per quart of water for 5 to 10 hours. No treatment is given any of the deciduous items except softwoods of *Prunus* varieties.

HUMIDITY

Here was the one factor which seemed to be the most important and by the way was the hardest to know what we had. Certainly the experienced propagator could go into a house and tell whether the atmosphere is too dry or not. But even he could be off several points or more in his guess as to the relative humidity. And then, too, things might change rather fast when possibly he may not be in that house.

In 1947 we decided to take the guess work out of this very important factor in successful propagation. It was right here in the state of Ohio that I learned of the Binks system of humidity control. It looked so good that we installed it in our two houses. The cost was about $1200 broken down as follows: local plumber, labor and material - $600; electrician - $100; compressor - $500. Present day costs would be 10-20% higher and will be discussed a little later.

Briefly, the Binks system is composed of a stream of air across the end of a tube filled with water. The water is completely atomized and all of it goes into the atmosphere. Drip and wet foliage below the nozzles are completely avoided. The essential parts are:

1. A water tank with a float to maintain water level in the nozzles
2. An air compressor
3. Valves, pressure gauges and an oil extractor
4. Nozzles
5. Humidistat

We use 8 nozzles in the 25 x 100 foot house and 9 nozzles in the 25 x 116 foot house. The compressor is rated at five horsepower.

Now there are many makes of humidifiers and I have studied several of them. The Binks system seems to be well adapted to the use of greenhouse propagation. No doubt there are others just as good with which I am not familiar. But of those I have examined, the Binks system seems to fill our needs. This system may sound complicated but we have found it as near trouble proof as equipment can be. Outside of the compressor there is less machinery than under mist systems. The air compressor is the only major piece of machinery and this is a standard unit which can be purchased and serviced in any town. The entire system is very reliable and free of trouble or failure.

The only changes we have made were about two months ago when we discarded the hair type of humidistat for a new and very accurate Electronic Humidistat. The Sling Psychrometer is used to set the humidistats.

This is a relatively new type of humidistat on the market now which is extremely accurate. It is Electronic Humidistat H 7000 A, manufactured by Minneapolis Honeywell. They guarantee a variation of only 1/2 of one percent either way from the setting and will operate all the way up to 100% with the same accuracy. The cost is about $125 per unit, we have installed this new type in the greenhouse.

The system operates on the principle of the Wheatstone bridge circuit. For humidification, the relay closes the circuit when relative humidity is but a fraction of a percent lower than control point setting. A complete description of the operation can be seen in literature available.

Now that we have our controlled humidity the important question is what amount is best. Here we went to the work of researchers on the subject and adapted their findings to our conditions. At the present time we are using the following: Coniferous cuttings, 80% the first 2 or 3 weeks then reducing to 70% until rooted. Deciduous cuttings, 90% the first 2 or 3 weeks then reducing to 70% until rooted.

We think we are getting good results, at least they are better than when we left the humidity to guess. Records have been kept for many years and here are some actual figures from our 1953 records.

Total Planted	- -	203,192
Total Rooted	- -	180,656
Percent Rooted	- -	89%

The above figures are made up of the following varieties:

Cornus elegantissima
Euonymous alatus
Hydrangea paniculata Grandiflora
Ligustrum Lodense
Philadelphus aurea
Philadelphus lemoinei
Philadelphus virginalis
Physocarpus opulifolius aureus
Physocarpus opulus nana
Potentilla Gold Drop
Prunus Cistena
Prunus Tomentosa
Prunus Triloba
Ribes Alpinum
Spiraea bumalda Anthony Waterer
Spiraea bumalda Frobel
Spiraea Prunifolia
Spiraea thunbergi
Viburnum opulus
Viburnum opulus sterilis

Many of you who were at our nursery the past year have said that we are getting a high percentage rooted.

The results are due to many factors but one of the most important of the physical items is controlled humidity. Another factor of even greater importance is the human element of making decisions of what practices and procedures to follow. These are generally a composite of the thinking of several people. You will find that true in most establishments. The results that we have had in our activity are due to the composite thinking and management of several people. Clarence Seefert and Donald Nordine, who are here and most of you know, are closest to this phase of our propagation. It takes men like this to help my brother, Gordon, and myself to get results.

The cuttings are all made by hand, that is, we do not use a leaf stripper on softwoods. In 1953 when we kept a record there were 203,192 made in 991 hours or 205 per man hour. In 1949, 658 man hours were spent taking, making and planting 141,862 cuttings or 215 per man hour. I do not know how this compares with production in other organizations but it seems satisfactory to us. The time of taking in relation to maturity is important but this knowledge seems to be gained best by experience. Perhaps they can be taken a little softer with controlled humidity than otherwise and thereby get quicker rooting.

The size of the cutting is controlled in our case by availability of material. We are firmly of the opinion that a large cutting will produce a salable

plant much quicker than a small one. We, therefore, use a large one as far as material will allow. Here, again, the controlled humidity may be a factor in getting as good a stand with large cuttings as we used to with small ones. With our system of planting these rooted cuttings directly into the field the large cutting is quite an advantage. For instance, when a 10 inch cutting is used we can get 30 to 40% of 2/3' finished shrubs after 2 years in the field. Spirea Anthony Waterer gives us over 60% above 12" after 2 years in the field. Thus by using a rather large cutting we get a good quality plant at low cost.

In 1952 we built a lath house for propagation of softwood cuttings to supplement the summer work in the greenhouse. This is built of alumilath and is 50' x 50'. It was purchased from Harry Reynolds, Santa Ana, California and the cost of lath and aluminum joists was $361.97. Other material and labor came to about $350.00 making a total cost of $711.97. In 1953, 73,339 rooted cuttings of shrub were produced in this lath house. We use a Skinner humidifying nozzle with a capacity of 3 gallons of water per house on a domestic water system. It was intended to be a humidifying system but turned out to be more of a mist system. The cuttings are handled essentially the same as in the greenhouse.

As I have said before the rooted coniferous cuttings are planted, without potting, in the fields either in one foot or two foot rows. This is done late in May after danger of frost. We have saved a tremendous amount of labor since years ago we abandoned the procedure of potting. Not only the reduced costs but the quality of the liner is better due to not having been first placed in a pot. The stands obtained by this method result in 80% to 90% finished plants. In the case of the deciduous items the stands are about 90%. I wish to emphasize how easy one can be fooled by guessing at the stand of plants in the nursery row. The above percentages are actual counts.

We are so much sold on controlled humidity that we recently installed the Binks system in two refrigerated coolers, two sorting rooms and a storage cellar. The coolers are set at 98%, sorting rooms at 99% and cellar storage at 96%. The cost of this installation is as follows:

Controls (7 units)	875.00
Plumbing	1080.00
Electrical	100.00

The advantages of controlled humidity in evergreen liner sorting rooms seems to us to be very important. If the roots can in this way be protected from any chance of drying the quality of stock should be improved.

In the coolers we also are hopeful of improved quality and also to some extent eliminating the use of packing material. In the cellar storage for deciduous items we hope to eliminate the use of packing material, however it is purely experimental. This alone would pay for the investment in about three years.

The plant propagator is always alert to ways of improving the stands and improving the quality of the lining-out stock produced. We must also be alert to the economics of the business and give some thought to the cost

of production. I am firmly of the opinion that the expenditure of a few hundred dollars for the installation of "controlled humidity" in propagating houses will help to insure good crops of high quality lining-out stock.

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MODERATOR SNYDER: Thank you very much, Mr. Bailey. Now questions for Mr. Bailey.

MR. STEAVENSON: Vince, I was very much impressed with the percentages you got in taking your cuttings directly to the field. Were they in an area served by overhead sprinkling lines?

MR. BAILEY: Yes, they were.

MR: STEAVENSON: Do you grow them for two years before they go to the field?

MR. BAILEY: They are put directly into the field, directly from the greenhouse.

MR. STEAVENSON: Not for finished rooting?

MR. BAILEY: Yes.

MR. STEAVENSON: For example forty spacing?

MR. BAILEY: The rows are closer than that. We use two foot rows for all growing items such as spirea. The spirea is put in two foot rows and spaced about 10 inches apart in the row. At the end of two years, the percentages I have recited here, 60 per cent or about 12 inches, after two years.

MR. STEAVENSON: I was referring particularly to your evergreens.

MR. BAILEY: The conifers are not, of course, put in finished fields; they are put into 12-inch rows, in the case of narrow growth, such as pyramidal. Soft varieties are put in two foot rows and left there for two years and then replanted or transplanted into the balling field and spaced.

MR. STEAVENSON: Do you handle any taxus?

MR. BAILEY: No, we do not.

MR. CHARLES HESS, SR.: (Hess' Nursery, Mt. View, N. J.): Mr. Bailey, when I was at your place last summer you had the aluminum houses. How did these make out?

MR. BAILEY: Well, you refer to this aluminum lath house that I briefly described here and we have the mist system under that lath house. We got about 80 per cent rooted. I forgot the actual percent but I believe around 80 per cent, which we felt was a pretty good percent under those conditions, just a little poorer per cent than in the greenhouse. The cost of the house was less than $600.

MR. LOUIS VANDERBROOK (Vanderbrook Nurseries, Manchester, Conn.): Did I understand you planted the deciduous cuttings in the fall directly to the field?

MR. BAILEY: We plant part of them in the fall directly to the field.

QUESTION: How do you prevent freezing?

MR. BAILEY: In our country we have quite a lot of snow. That helps in that respect. I might add, in finishing the answer to that question, the smaller item such as *Ribes alpinum,* the smaller sizes of those cuttings we put in beds and we do mulch with hay.

MR. MARTIN VAN HOF (Rhode Island Nurseries, Newport, R. I.): I am duly impressed with the percentage of rooting of all your cuttings. What I can't understand is this: you said your shrubs were set right out in the field. Do you get 60 per cent stand, finished product?

MR. BAILEY: Right—60 per cent.

MR. VAN HOF: In the case of *Spirea bumalda Anthony Waterer?*

MR. BAILEY: That is right. Such things as Hydrangea P. G. I suspect we get 75 per cent salable plants. The rest are a little too small and they go back in large liners.

MR. VAN HOF: Don't you think it would be advisable to take those cuttings and set them out close together, 2 or 3 feet apart on the line and then take them up and line them out next year? They are 100 per cent salable stock then.

MR. BAILEY: Well, we do it with just one or two varieties but we feel it is more economical to put them right in the field where we can give them irrigation generally, not always. We think we are getting a little lower cost of production that way.

MR. SEBIAN: You mentioned that you get considerable snow. How does the aluminum lath hold up under heavy snow?

MR. BAILEY: As you know, the joists this firm send out with their aluminum lath are built so as to put aluminum lath on the top and one on the bottom and we take out the one on the bottom over winter so the snow load does not build up on the roof and we have had little or no trouble with snow breaking it down and wind pulling the lath out.

MR. JACK HILL (D. Hill Nursery Co., Dundee, Ill.): In an attempt to assign an absolute value to your system, would you say its inclusion in your propagating method has made practical the commercial production of plants which before that date you did not consider commercially feasible?

MR. BAILEY: From mist alone, I don't know that I could draw that conclusion because we would probably propagate those plants under some other conditions that were more commonly used several years ago. However, I do think we can make a little better profit and production a little better quality plant this way.

MR. HILL: Then the mist has brought you to a decision that because of the mist we can propagate this, and without the mist it would not be right?

MR. BAILEY: That is a correct conclusion, I would say, yes.

MR. HARVEY GRAY (Long Island Agr. & Mech. Inst., Farmingdale, L. I., N. Y.): Bill, I wonder if this is the place to defend or supplement or prepare the statements relative to the merits and values of the polyethylene tent versus the humidification by misting systems or might we put that off until another time.

MODERATOR SNYDER: I think it would be better to postpone it and consider it as a topic for the question box tonight.

I would like at this time to express appreciation to all the members of the panel this afternoon for their participation in it. I am certain that mist will be one of the subjects at this evening's session.

I will turn the program back to Dr. Chadwick.

PRESIDENT CHADWICK: Thank you, Bill, for conducting a very fine session this afternoon, and I, too, want to thank all of the members who participated in it.

We stand adjourned until 8:00 p.m. this evening.

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Plant Propagation Question Box

FRIDAY EVENING SESSION

December 3, 1954

For the second straight year, the Question Box Session proved to be an interesting and lively meeting. Dr. James R. Kamp, Department of Horticulture, University of Illinois, Urbana, Ill., moderated the session.

There was no record made of this session.