concentration of the active substance. Yet, when the crude extract is diluted so that inhibition of root development no longer occurs, stimulation of root initiation is greatly reduced or disappears. The same phenomenon has been found when mung bean cuttings are treated with such compounds as thiamin, ascorbic acid and arginine.

SUMMARY

From the results just presented, it is clear that needles of loblolly and slash pines contain substances which are very active in the mung bean rooting bioassay. Most of these substances appear to be very similar to, if not the same as, the rooting cofactors Hess has discovered in *Hedera* and other plants. Whether these substances will stimulate rooting in pine cuttings as well as they do in mung bean cuttings is not yet known. The quantities of these rooting cofactors appear to be as great in 22 year old flowering trees as in seedlings less than a year old.

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MR. ART LANCASTER: Thank you very much, Dr. Zimmerman. The next paper will be given by Peter Vermeulen, John Vermeulen and Son Nursery, Neshanic Station, New Jersey.

MIST PROPAGATION OF CUTTINGS INSERTED DIRECTLY INTO THE ROOTING-GROWING MEDIUM

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The subject of Mist Propagation of Cuttings Inserted Directly into the Rooting-Growing Medium is not a new one. I recall saying to this society last year that none of us have completely original thoughts. I am sure that there are many propagators who have at some time or other rooted cuttings inserted

directly into soil, peatmoss or a combination of these. We could all benefit from their experiences. I hope that you can benefit from ours which I will briefly relate this afternoon.

Leslie Hancock has twice described before this society his Burlap Cloud Method of rooting soft wood cuttings in soil (1). Harvey Templeton has given us the details of the Phytotector Method for rooting cuttings (2). C. W. M. (Charlie) Hess, Sr., talked on the subject in 1955 (3), as did Jack D. Hill (4) and Kenneth W. Reisch (5) in 1957. In 1959 I very briefly described some little work we had done that year in rooting some woody ornamentals inserted directly into peat-moss pots (6).

Rooting Media:

Before going on I wish to comment briefly on an area that may cause some confusion. Most of us are to varying degrees presumptuous. I know I tend to be so. This can be difficult, dangerous or even disastrous at times. To preclude this possibility in our discussion of rooting-growing media I wish therefore to take a moment to discuss media.

Just what is a medium? What distinction exists between a rooting medium and a growing medium? A thorough discussion would fill a greater period than we are permitted at this time and the subject has been discussed and documented frequently before. You may wish to be reminded of three publications of recent import. These are the well known "U.C. System for Producing Healthy Container—Grown Plants" edited by Kenneth F. Baker (7), "Mist Propagation of Cuttings" by Patricia Rowe-Dutton (8) and the paper of Dr. Wendell H. Camp presented at our Sixth Annual meeting in Cleveland (9). There are of course numerous others of importance which your own particular research can seek out.

At this time it would appear to me that there need be very little difference between a rooting medium and a growing medium. A rooting medium must be one that holds the cuttings in position, must provide adequate drainage and in so doing and at the same time provide for a proper oxygen-water relation during the process of root initiation. A growing medium must have all of these attributes and at the same time be capable of accepting and retaining and in turn releasing a nutrient supply of proper balance for optimum plant growth. With the materials now available all of these requisites can be met. It then seems entirely feasible to use a rooting medum as a growing medium and vice versa by merely adding the nutrients once rooting has occurred. It has always been our thinking that soil per se should be incorporated in a good, well balanced growing medium. Our thinking has not been prompted by scientific research entirely but mostly by 'green-thumb' reasoning. Dr. Camp, in his discussion of micro-organisms in soils and their action on plants (9) tends to lend validity to our thinking.

Our present rooting-growing medium therefore does contain some soil but only a very small part. It is formulated as fol-

lows: 18 parts (53%) German peat-moss, 6 parts (17½%) #1 horticultural grade perlite, 6 parts (17½%) finely shredded stryofoam, 3 parts (9%) clean fine sharp deep pit sand and 1 part (3%) soil. I must add that our soil is a Birdsboro silt-loam and that which we add to the medium has been prepared with a liberal quantity of rotted cow-manure after which it is fumigated. All of the ingredients, including sufficient Dieldrin to satisfy USDA requirements for Japanese Beetle certification. are thoroughly mixed. Other formulas may and I am sure can be used. Nutrients are added as required after rooting has occurred and after the plants have been hardened-off.

Purpose:

Our primary consideration in this endeavor was to establish a plant in the container in which it was to be grown and ultimately sold or from which it would be transplanted for growing on. We had been discouraged many times in the past by failures of quantities of excellently rooted cuttings shortly after the transplanting operation. If we could eliminate transplanting we would not only gain more plants but we would also eliminate a major production cost. Another substantial gain would be the realization of increased growth by eliminating the 'set-back' usually concurrent with transplanting. We therefore looked for a technique and a container.

Containers Used:

Based on our past experiences we were already convinced of the many attributes of peat-moss pots for growing lining out stock and so naturally used them for the bulk of our experiments. We have also used some clay pots and plastic pots and find them acceptable but with the usual limitations, chiefly the labor of removal of the pot at shipping or planting time.

A most important consideration in the use of any container is drainage. To facilitate good drainage in the peat-moss pots we punch holes in the bottoms. This is easily and effectively accomplished by using a long skewer or pointed rod which is pushed through a whole row of pots at the time they are removed from the shipping carton. Good drainage is also essential in the flat or tray the pots are placed in as well as in the mist frame into which they are set.

Peat-moss pots we have used are the 2¼″ regular, 2¼″ Polyskin, 2½″ Xtradeep or rose pot and the 3″. The 2¼″ regular and 3″ pots were unfertilized. The others are from stock and we are told that they contain some nitrates "to replace those lost in the breakdown of the wood cellulose fiber in the pot wall." We recommend and try to use only unfertilized pots which are made up for us on special order. This year, for the first time in these experiments, we used Polyskin pots which are regular thin wall peat-moss pots covered on the outside with a "skin" of polyethylene film. Our purpose in using them was to attempt to contain the roots. In a past experience with *Acer palmatum* and *Pyracantha* we achieved very good rooting only to find that

the roots persisted in growing away from the pot. At time of shipment this created quite a problem. Results have been excellent. Rooting percentages this year of *Acer palmatum Oshiobeni,* 'Bloodgood' and 'Burgundylace,' while not exceptional, are commercially acceptable at 81%, 83% and 87% respectively, with all roots in the pot and sure to go along with the plant at the time of sale or transplanting. The polyskin is easily removed at time of transplanting. Here again caution must be observed with regard to drainage. The pots are furnished by the manufacturer with holes prepunched in the polyskin. We find it necessary however to punch additional holes in the bottoms of the pots, right through the poly.

The pots are filled with the rooting-growing medium and firmed but not packed. Square pots or the newer Jiffy-strips lend themselves to quick filling since they can be placed in the flats and the medium poured over the entire flat. After firming, a straight-edge is used to level the medium even with the rim of the pots. The flats are then watered lightly and piled so as to be ready for the stickers. This operation is usually accomplished a day or so in advance but if room and time permit a week's supply can be made up at one time and covered with some polyethylene.

Selection, Preparation and Treatment of the Cuttings:

We recognize the importance of good judgment and practice in the maintenance of strong and healthy stock plants and in the selection and subsequent care of strong and healthy cuttings. Cuttings used in our experiments were not specially selected nor did they receive any care or treatment not otherwise given. When brought in from the nursery, cuttings are dipped in a solution of Malathion and Morton's Soil Drench in water and dripped dry. They are kept fluffed up, covered with polyethylene and cool. After making up, the cuttings are treated and inserted directly into the pots containing the rooting-growing medium. When a number of flats are completed they are thoroughly soaked with a solution containing Morton's Soil Drench and water. They are carried outside to the mist frames later in the day when the sun is not so high and hot.

The Mist Bed or Frame:

All of our work in these experiments has been with softwood cutting starting in June and continuing through the summer. We use outdoor mist frames without shade. The flats are set directly into the frames. Intermittent mist is supplied under pressure which we attempt to maintain at 125 lbs.. We favor low capacity nozzles because of the drainage factor and have used successfully 1.5 gallon per hour oil burner nozzles both outdoors and in our greenhouses. These have a spray angle of 90 degrees and are hollow cone nozzles. They require an adapter and a nipple as well as tapping when installed. Material costs are $1.01 per nozzle not counting the pipe. This year we used some Flora-Mist Foggers with an .020″ orifice. They

require no adapter, nipple or tapping and cost 36c. They do give 7 gallons per hour under our pressures however. A full summer's experience has shown them to be completely acceptable.

Mist is controlled by a 24 hour on-off time clock and a 30 minute repeating timer. The timer is adjusted manually according to the weather and the condition of the cuttings in any desired increments of 30 seconds.

Last summer and the one before we experienced low night temperatures in August at a time when we still had quantities of newly inserted cuttings in the frames. Medium temperatures fell below the optimum rooting level of 65 to 70 degrees. In a newer mist bed for Junipers we had installed heating cables and there we were delighted with exceptionally heavy and quick rooting in spite of the cool nights. Needless to say all of our mist beds next year will be so equipped. We find one 120′, 800 watt cable sufficient to heat 145 square feet of frame. Bear in mind that this is for Summer or early Fall operation in USDA Plant Hardiness Zone 6a. Cables are spaced 7″ from the walls and 14″ apart toward the center of the frame and are operated on 220 volts. Each section should be thermostatically controlled.

Our frames are dug out 12″ and may be considered an adaptation of the Boliver Pit Frame described by Steve O'Rourke in 1955 (10). They are lined with 6″ hollow cinder blocks. On the bottom is placed approximately 4″ of drainage material such as stone, gravel, cinders, broken pots, etc. On top of this, in the heated frames, should go 2″ of shredded styrofoam — this to prevent loss of heat to the ground. One inch of sand is placed on top of the styrofoam and the cable laid on it. Over the cable is spread evenly another 1″ of fine sand. Next comes a protective barrier of 1″ mesh braided or welded wire. In those sections which are to hold flats of cuttings, we then spread 2″ of fine sand. The flats are placed on top of this layer of sand. In those sections in which cuttings are to be inserted directly into the frame, we are more particular to use clean fine sharp deep pit sand and the depth is increased to 4″ or 5″.

We think that this frame, with a polyethylene tent cover can also be used to overwinter newly rooted plant material and at a low heating cost.

Plant Material Tested:

Following is a list of cuttings attempted this past summer. It is obvious from it that our work has been limited and that results have not all been those hoped for. They are sufficient, however, to encourage us to go forward with further experiments with additional material as well as to expand quantities on those with which we have had apparent success. Proof of the pudding was made clear to us this past year in our experience with *Prunus Kwanzan* and *Magnolia stellata* 'Royal Star.' With those inserted in the pots we achieved 98% success with *Prunus Kwanzan.* In sharp contrast however was our failure with

those inserted in sand and later transplanted to peat-moss pots. Of 1936 cuttings inserted 1195 or 60% rooted and we lost 700 in the transplanting operation leaving us with a net of only 23%. With the 'Royal Star Magnolia,' whereas we had a 93% success with the cuttings inserted directly into the rooting-growing medium, we had only a 53% net with those stuck in sand and transplanted. Our male *Ginkgo* also did much better in the pots.

Item	Date	No Stuck	Rooted	%
Acer pal. 'Bloodgood'	6/21	940	786	83
Acer pal. 'Burgundylace'	6/24	504	439	87
Acer pal. dissectum	6/19	360	96	27 *
Acer pal. dis. atropurpureum	6/21	540	93	17 *
Acer pal. Oshio-beni	6/19	504	410	81
#*Azalea* Exbury & Knaphill Hybrids:				
Balzac	7/1	25	6	24
Basilisk	7/1	61	7	11
Berry Rose	7/1	36	32	89
Cecile	7/1	108	73	68
Harvey Moon	7/1	47	27	58
Hotspur	7/1	108	70	65
J. Jennings	7/1	76	48	63
Strawberry Ice	7/1	72	41	57
White Swan	7/1	108	90	83
Cornus florida plena	7/24	150	138	95
Cornus florida rubra	7/24	200	190	95
Franklinia alatamaha	8/15	1500	1300	86
Ginkgo biloba pyramidalis	7/3	50	42	84
Ginkgo biloba fastigiata	7/3	100	93	93
Ginkgo biloba, selection #9	7/3	50	47	94
Ginkgo biloba, selection #1	7/3	150	139	93
Ginkgo biloba, selection #7	7/3	150	145	96
Magnolia stel. 'Royal Star'	7/23	200	185	93
Prunus 'Kwanzan'	6/28	500	490	98
Rhus cotinus atropurpureum	6/25	280	260	93
Rhus cotinus 'Royal Purple'	6/25	880	820	94

All **Azalea** cuttings should have been taken 1 week earlier
* Cuttings were hard

Summary:

In view of the experience mentioned we feel that there are distinct advantages and possibilities in the propagation of cuttings inserted directly into a rooting-growing medium, so much so as to make it commercially practical. The medium must be chosen and formulated with great care. Utmost attention must be given to drainage throughout all operations. The advantages apply primarily to plant material difficult to transplant but almost equally as a substantial savings in the costs of labor in transplanting operations. Where operation of misting facilities is a high cost factor different criteria must be established. As

we carry on our work at Neshanic Station we will be most willing and happy to exchange information with anyone who is interested in doing likewise.

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MR. ART LANCASTER: Thank you very much, Pete. The final paper for the first section of this afternoon's session is by J. Paul Wilms, Gwenn-Gary Nursery, Inc., Columbiana, Ohio.

PROBLEMS AND PROPAGATION PROCEDURES OF A SMALL TO MEDIUM SIZE OPERATION

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Back in 1937, when the J. P. Wilms Nursery began, budding of roses and fruit trees was the only propagation work done. At the end of the next three years, after the name had been changed to Gwenn-Gary Nursery, rooting of evergreen cuttings was begun. The nursery of 10 acres supplied most of the cutting wood which was set in either cold frames or in rented space in nearby greenhouses.

In using rented greenhouse space, several problems occurred. (1) The cuttings had to be made in advance in large quantities, and some drying out occurred before the cuttings could be set. (2) Alternating temperatures, such as when the cuttings were brought in from the cold, made up in a room at moderate temperature, and out in the cold again to be transported to the greenhouse before being set in a controlled temperature environment. (3) However, the most critical problem was the inability to oversee watering and care after the cuttings were