Shrubs from Softwood Cuttings

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The purpose of this paper is to describe a method of rooting many types of flowering shrubs, broad-leaved evergreens, etc. in ordinary nursery soil during the months of June and early July without the use of glass or plastic substitutes. This method of rooting softwood cuttings that has been evolved by Woodland Nurseries at Cooksville, Ontario, had its beginning in certain observations made in Nanking, China, during the years 1923-1927. As Horticulturist on the staff of the College of Agriculture, University of Nanking, I found the Chinese flower gardeners using a primitive but very effective method of rooting roses, hydrangeas, and a few other ornamentals in ordinary garden soil. During May, slightly raised beds of pulverized soil about three feet wide were constructed with a narrow rim of compacted soil sufficiently high to prevent any run off when small patches were flooded as required, much like miniature rice paddies. The propagating material used was the short side shoots (laterals) which break into growth from the older wood after the first burst of spring. These shoots were grasped firmly but gently with the thumb and forefinger and removed by a downward tearing motion, hence they were not strictly cuttings at all. After removal they were laid on flat bamboo woven containers and carried to a shady spot where the lower torn part of the old bark would be clipped away with scissors, and in the case of roses, the flower bud would be clipped away at the same time. They were then carried to the propagation bed where water would be poured on to a small area just sufficient for immediate needs. This was important because if water were poured over a larger area than necessary, the unused portion would be spoiled for insertion of the next batch. At the same time, a liberal amount of water was used in order that the shoots would stick in without injury, and the planters aimed to have all the shoots pushed into the mud before all the water had completely drained away. As planting of each batch was completed, they would be immediately shaded with large rectangular stiff mats woven from flattened reed strips. These mats had a curved form which made them very suitable for laying over bamboo rods fastened to short posts along either side of the beds. The close woven mats allowed practically no direct sunlight to pass through, so that during the hot part of the day only indirect light reached the cuttings from the sides. After the "cuttings" had been pushed into the mud, no further watering was given, apart from natural rainfall. Toward evening, about an hour before sundown, the shades were all removed and carefully stacked. The following morning, about two hours or so after sunrise, they would all be just as carefully returned to their positions on the supporting bamboo rods. This operation was not considered necessary as long as the dew remained on

the foliage. The daily covering and uncovering process was followed scrupulously for three or four weeks and the drying mud would even be starting to crack when by the appearance of the plants it was evident that rooting was taking place. As each batch appeared to be sufficiently rooted, they were taken up and transplanted into small pots, and I well remember the care that was taken to keep the little block of soil adhering to the tender roots of each young plant intact.

Alongside this native technique, I started to apply my western inspired theories of propagation. Without going into details, it is enough to say that with my youthful over-confidence plus my lack of long term experience of local conditions, the results of my efforts were far from impressive, and in the end I was forced to admit that these resourceful oriental propagators really "had something."

The outcome of all this was that since our return to Canada, I have attempted to work out, under our local conditions, the principle used so effectively by the Chinese. I had no bamboo poles and no reed mats, so used rods of 1″ x 2½″ lumber over which I draped heavy burlap. There is less summer humidity in Ontario than in Nanking and the first results were sad. The cuttings were often flattened to the ground by hot, dry, dusty winds and would not rise again. Our light sand did not puddle like the Nanking soil, and the making of an earth rim on each side of the beds proved to be impractical and time consuming. Finally, I hit on the idea of a light box frame which would keep out the wind and when sunk into the ground an inch or two, would keep the water in for the flooding operation. The burlap cover was retained as the best shading medium coming nearest to the Chinese mats. The burlap was fastened to a strip of wood nailed along one side of the frame but at first we had an uncovered one inch strip of air space along the upper edge of each side of the frame for the ventilation which I considered so necessary. During the day the burlap was made taut by slipping it over finishing nails set at fairly close intervals along the opposite side of the frame. An additional advantage of the burlap was that being light it was easy to remove and replace. After the development of this frame, our results steadily improved.

When my sons joined me in the business, production by this new method was good on the whole, but far from satisfactory for certain items. Gradually we found that frequent sprayings of the burlap during the hot part of the day gave increasingly better results, and finally we closed the air gaps, eliminating all chance of entry of outside air, except through the moisture laden burlap. Double shading of items that tended to wilt helped greatly. The extra shading was not a second layer of burlap, but ordinary 3′ x 4′ shades of builders lath, over which was tacked a square of burlap. Uncovering the frames towards evening and re-covering the following morning continued to be standard practice; in fact, we consider it an indispensable part of the technique.

Our method is now so far removed from the original Chinese practice which sparked its development, that it would be better styled the "burlap-cloud method." Emphasis must also be given to the fact that it has

been evolved to meet our own peculiar conditions and might not work at all with some other soils and subsoils along with differing climatic conditions. Our soil is a fine dust or powder, and not a true sand. Without liberal additions of humus, it tends to get very tight and lacking in aeration. We have a high water table held up by an impervious layer of clay four feet down, so we have had to drain carefully. Yet we think this high water table is one of the reasons for successful rooting. We give our results and experience only for what it is worth in the light of these qualifying conditions.

I will now describe the method in detail:

1. *Preparation of Soil:* Reasonably fertile soil that has received no fertilizer for at least one year should be used. Land should be well graded with a fall of about one foot in a hundred feet to ensure that no surface water can collect anywhere. We have sunken cross paths every sixty feet into which the water from the slightly sunken paths between the beds can drain without traversing the whole length of the field. Beds of the same widths as the frames to be used are laid out systematically and raised about two inches. Frames are then set into position in a continuous row, and some adjusting with a spade will be necessary to lower them to the level of paths between beds. Starting at one end of a series of frames, the soil is then removed from a half frame to a depth of about two inches below the lower edge of the frame and the 3′ x 6′ sieve set into position. Soil from the next six feet of frame is excavated to the same depth and passed through the sieve which will automatically give about four inches of sifted soil, and the process can be continued systematically from frame to frame. This sifted soil is levelled out with a spirit level, leaving about seven or eight inches vertically between the soil and the top of the frame. Soil should now be thrown against the outer lower edges of the frames to prevent water leaking out during planting operations. Each frame has its own burlap cover which is tacked into position along one side of the frame and securely fastened to the other side of the frame by slipping over finishing nails exposed about 1 inch.

2. *Collecting cuttings:* Something should now be said regarding the handling of the cuttings. A heavy hot hand bruises the cuttings. They should be removed lightly in small handfuls, and then we stand them upright in twelve or fourteen quart pails with about two inches of water in the bottom. We have not noticed any appreciable difference in the rooting due to the time of day they are gathered. If there is an advantage, however, it is in the evening when the shoots need not be placed in water, and can be carried to the propagation beds in a completely turgid condition. There is definitely a disadvantage in leaving the cuttings with water in the pails too long, particularly in very hot weather. In fact, leaving them in water overnight has resulted in serious losses. In my opinion, we would do well not to leave the cuttings standing in water more than one hour. Contrary to accepted practice, we do not remove any foliage, except in such cases as *Cornus florida* and the various magnolias, which have thin large leaves. Cuttings are stuck—basal leaves

and all. The air spaces made by the passage of lower leaves into the soil allows oxygen to enter, and lessens the chance of decay at the base of the cutting due to action of anaerobic bacteria.

3. *Timing:* There are two questions as regards timing. One is the time of year or date, and the other the stage of maturity of the cutting. In my opinion, the advantages are all in favor of the cuttings made early in the season. This is the reason for taking side shoots or laterals as these are the first obtainable. With the exception of *Hydrangea arborescens,* which are taken the second or third week in May, we start operations about June 1st-3rd, and would start earlier if we could. Hot weather, however, is essential, and before June 1st cold spells and even frost are possible with us. As to timing in regard to maturity, the length of a shoot gives some indication as to whether it is ready for gathering. Early shoots of Golden Mockorange should be about four inches long. Forsythias should be six inches long. An experienced propagator has to decide whether the young wood requires another two or three days of growth before gathering, or, in other cases, may consider they have grown too much and should have been gathered a day or two earlier. Because cuttings in sufficient quantity cannot be obtained at any one time, we often have as much as three or four batches of any one variety. In the case of the Golden Mockorange, all the early cuttings are of side shoots but all the later ones are made by cutting five inch tips from the strong young canes. Both root equally well with us and there is no magic as to what part of the parent plant the cuttings come from.

4. *Wounding:* In 1952 we tried wounding by making longitudinal slips through the bark near the base of some cuttings with some success. One of the most spectacular results was 100% rooting of some fifty cuttings of *Cornus florida rubra.* This year we repeated the experiment with the same variety only to lose most of them. Weather and soil conditions were not as favorable this year, but looking back, I am inclined to blame the failure on the condition of the parent plants at the time of taking the cuttings. In 1952 the plants from which the cuttings were taken had been recently moved and the shoots were short and sturdy, whereas this year cuttings were taken from plants that were well established and very hot weather had caused the growths to be long and soft.

5. *Planting the cuttings:* Water is poured on from large cans before planting, enough water to ensure complete saturation to the full depth of the sifted soil. The cuttings are pushed into the mud before the water has had time to drain away. We set cuttings close enough to get from forty to seventy-five per square foot. Any closer would give insufficient room for later growth. Cuttings are inserted to about half their length, or until their easy downward movement is stopped.

6. *Aids to rooting and disease control.* We have not used plant hormones but probably should have done so. Our greatest benefit has come from the disinfectant Tersan. At one time, batches of *Cornus elegantissima* were a complete failure but since coating the bases of the cuttings

with a light dusting of Tersan, we have had complete success. We use sulphur dust for controlling surface rots, and also Tersan. Aphis will ruin cuttings of most spiraeas unless they are sprayed with soap and Blackleaf 40, soon after inserting in the frames. Cuttings of such plants as *Viburnum Carlesii* and *Rosa hugonis* must come to the frames free of black spot or they will not root.

7. *Spraying the burlap curtains:* Water is laid on from taps centrally located throughout the length of the area reserved for the cutting beds, one tap with hose servicing 60 feet of cutting beds in either direction. At intervals of perhaps half to three-quarters of an hour, one of the planting crew sprays the burlaps carefully, making sure that each section is as uniformly moistened as possible but spraying a section no longer than is necessary to accomplish this. We consider it bad practice to drench the curtains unnecessarily and as little water as possible should drip through on to the cuttings. The idea is not to allow the burlap to get completely dry. On hot days of low humidity or very windy days, spraying may have to be done as much as eight to ten times, but on most days about six sprayings are sufficient, and on cloudy days with high humidity hardly any spraying is necessary. Also, on cloudy wet days the cuttings may remain uncovered the whole day. The worst days are when there is a hot dry wind and strong sunlight. At first sight, hand spraying would seem an expensive procedure and we have toyed with the idea of automatic spraying only to realize that such an installation would require considerable watching to be correct for all types of weather. One boy, after proper coaching, can spray a lot of burlap covered frames in about ten minutes. The hose is pulled along a central path between the propagation beds, the operator returning with the nozzle to turn off the tap when all areas are uniformly moistened.

8. *Pre-rooting care:* In fine weather all frames are uncovered about one or one and a half hours before sundown, and re-covered the following morning around 8:30 or 9:00 A.M. In wet or very cloudy weather, the burlap shades are left off. If the tips of the cuttings droop, double shading is given with 3′ x 4′ lath shades covered with burlap. When damping off or other disease or insect attacks are evident, we dust with sulphur or other standard controls, and this work is best done at a daily early morning inspection before placing the burlap shades on for the day. Different treatments are necessary for different types, and only by a daily watch is it possible to determine the correct cause for progress or failure.

9. *After rooting care of cutting beds:* Spraying is discontinued when cuttings are properly rooted and the next step is to gradually accustom them to open air growing conditions. The burlap can be left off for longer periods in morning and evening, but usually we find that rooted cuttings rapidly need more sunlight, and either we remove the burlap and lay lath shades over the frames, or else we remove the frames altogether and set up lath shading only. Sometimes, after a week or more of

partial shading, complete sunshine can be given for the rest of the season. However, there are some plants such as *Daphne cneorum* which may suffer if given full conditions too quickly and some, such as Golden Mockorange, have to be carried well into September before full sun can be allowed. Usually, by the fifteenth of September, all frames and shades will have been removed. From then until November most of the propagations grow vigorously, often too vigorously for their own good, so that we have to clip the tops of the tallest to allow all to develop uniformly.

10. *Winter protection:* As suggested above, one of the dangers comes from late fall growth, and we have lost whole batches of *Weigela* and *Viburnum* from a sudden hard ground frost. The upward thrust of frozen earth splits the soft bark at the ground line and the lesions rapidly cause the death of the whole plant. In 1952 we had a splendid lot of *Viburnum tomentosum plenum*, well rooted, and some of them a foot high. Due to such a frost, we lost all but about ten percent of them. This year we obtained another good crop, and to prevent this happening again, we lifted them during October and heeled them in a frame. Then when the first hard frost came, we had them properly protected with litter. It yet remains to be seen whether we shall be able to bring them through in good shape. Another precaution for wintering is to deepen the pathways between the beds, throwing the soil between the cuttings to raise the beds in the center. Practically all our production is wintered in this way.

Types and Varieties Grown:

We now raise over one hundred varieties of plants by this method in the following genera:

Azalea	Euonymus	Pachysandra	Sambucus
Buddleia	Forsythia	Philadelphus	Sorbaria
Ceanothus	Hydrangea	Pieris	Spiraea
Chaenomeles	Hypericum	Potentilla	Symphoricarpos
Clethra	Iberis	Prunus	Syringa
Cornus	Kerria	Pyracantha	Viburnum
Cotoneaster	Kolkwitzia	Rhodotypos	Weigela (Diervilla)
Daphne	Ligustrum	Ribes	
Deutzia	Lonicera	Rosa	

Of these, we get 100% results with easy rooting forms such as *Buddleia, Ceanothus americana, Clethra alnifolia, Deutzias, Euonymus fortunei, Forsythias, Kerria, Ligustrum, Pachysandra, Sambucus* and *Weigelas.* With care as to special needs, we can usually get 90% or more in the following: *Cornus elegantissima,* and *C. spaethi aurea, Hydrangea arborescens* and *H. paniculata, Lonicera zabeli, Philadelphus* all varieties, *Potentillas* (early batches only), *Rhodotypos, Ribes, Spiraea bumalda* varieties, *Symphoricarpos,* and *Viburnum tomentosum.* Fickle varieties which would average from 50% to 75% rooting over several years are *Daphne cneorum, Euonymus alata, Syringa persica, Viburnum tomentosum plenum.* Poor results and frequent failures are experienced with the follow-

ing: *Chaenomeles, Cotoneasters, Prunus glandulosa, Spiraea arguta* and *S. prunifolia,* and *hybrid lilacs.*

To sum up, the advantages and disadvantages of the method as we see it are as follows:

Advantages:

1. *Economic:*
   (A) The rooting of cuttings in ordinary soil not only saves considerable expense in preparation of soil medium but also eliminates the costly "potting up" stage.
   (B) Overhead cost of equipment is very low consisting of a light frame made from one inch boards, a supply of 40″ width medium heavy burlap, a large ¾″ mesh sieve and the usual garden tools. Most nurseries are already piped for water.
2. *Natural:*
   (A) Cuttings receive healthful sunlight and moisture at the right times and in the right amounts. (Moist burlap simulates cloud).
   (B) When rooted there is no check in their growth which continues uninterrupted until late Fall.

Disadvantages:

1. Danger of loss from toxic soil conditions, rots from soil bacteria or fungi difficult to completely eliminate.
2. No control over adverse weather conditions such as extreme heat, drouth, or heavy rain.

. . . At the conclusion of his paper Mr. Hancock continued the discussion by the use of slides.

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MR. HANCOCK: The basic design for the individual rooting frame is very simple. We construct a 12′ x 3′ box, using 10″ x 1″ red cedar boards. The box is carefully squared and fitted with a centrally located cross bar, also constructed of red cedar, which is used to facilitate transfer and placement. Each frame has its own curtain which is cut 8 inches longer than the unit because we find that it shrinks. The burlap is tacked in position along one side of the frame and securely fastened to the other side of the frame by slipping it over finishing nails exposed about one inch.

MR. ROSCOE FILLMORE (Fillmore's Valley Nursery, Nova Scotia, Canada): What direction do you run the beds?

MR. HANCOCK: We run them approximately north and south. With such an arrangement there is a steady movement of light from one side of the frame to the other, and therefore all cuttings get some light during the course of the day.

After the frame has been located, a 6′ x 3′ sieve is set into position. Before the soil from the adjacent six feet of frame is excavated to the same depth, we compact the floor, because we believe moisture is a very

Fig. 1. Inserting *Ribes alpinum* cuttings.

Fig. 2. A bed of cuttings of *Cornus elegantissima* showing the use of burlap.

Fig. 3. Two sixty-foot beds of golden mockorange with the frames removed.

Fig. 4. Two-year plants of *Philadelphus virginalis* (left), *Viburnum opulus nanum* (center), and *Lonicera sp.* (right).

important factor. However, it has been pointed out that on some soils and sites this might be fatal. I am giving this for what it is worth under our conditions. The soil is next passed through the sieve, automatically giving us about four inches of sifted soil. The process is then continued systematically from frame to frame.

When the soil has been sifted into the entire frame, water is poured on from a large watering can before planting, and in enough quantity to completely saturate the medium to the full depth of the sifted soil layer.

At this point I should mention that in the early phase of rooting we spray the burlap curtains about six times on the average day. You might ask why we don't have a timing device. Actually it doesn't take a boy more than five minutes to wet the burlap. The idea is not to allow the burlap to get completely dry, although it should be nearly dry by evening in order to reduce chances for the development of damping-off organisms.

MR. HOOGENDORN (Hoogendoorn Nursery, Newport, R.I.): What do you use to wet the burlap?

MR. HANCOCK: Just ordinary hose, and lots of power. With one inch hose we can do this in a very few minutes.

MR. ROSCOE FILLMORE: You are not getting drip?

MR. HANCOCK: The operators are told not to put too much water on. They spray the burlap when it begins to dry and as often as it is necessary throughout the day. They are cautioned not to put so much water on that they drench the cuttings.

MR. JACK SIEBENTHALER (The Siebenthaler Company, Dayton, Ohio): Do you feel that it would be advantageous for you to treat the burlap shading with a preservative?

MR. HANCOCK: Yes, I think it would be all right. I have been very cautious however, about using it, although I know these copper preparations do preserve the burlap. I think it would be advantageous.

MR. WILLIAM FLEMER (Princeton Nurseries, Princeton, N.J.): Of what weight is the burlap that you use?

MR. HANCOCK: I tried No. 10 ounce and it proved to be too heavy—8 ounce allowed too much light through so I figured No. 9 ounce was about right.

PRESIDENT WELLS (D. Hill Nursery, Dundee, Ill.): I would like to ask Mr. Hancock if he has ever tried plastic sheeting instead of burlap and what he thinks about the possibilities.

MR. HANCOCK: I returned to the orthodox mind recently and said the Chinese method is no good. I made up a box and put a piece of plastic over it and stuck a large batch of hydrangea in it. I said, "that is fine, this is nothing but the French bell jar." I took it off in 48 hours and the cuttings were all dead.

MR. SHAMMARELLO (South Euclid, Ohio): Do you attribute that to the heat held in the frame by the plastic?

MR. HANCOCK: I think movement of air is very vital. I quite agree with the new methods and believe the day will come for this type of work to be done mostly outside, provided you use fungicides to protect the cuttings from rot fungi.

MR. HOOGENDOORN: Do you strip the leaves from the cutting before you stick it?

MR. HANCOCK: We do not remove a piece of foliage from the cutting. We stick it directly into the mud before the water has had time to drain away, making sure that our fingers do not contract the medium. If this were allowed to happen we would block the hole, thereby giving us trouble because of poor aeration. The depth of sticking depends on the size of the cutting; for example, to a depth of one half if the cutting is short, and a third if it is longer.

As for the business of stripping the cutting; we don't even take the tails of bark off. The tails curl up and the cutting grows just the same.

(Slides were shown to demonstrate stands obtained for a number of type and varieties which were successfully propagated by this method.)

MR. HOOGENDOORN: Have you tried rooting magnolias yet?

MR. HANCOCK: I have, but I have not been successful at all—but I may yet.

MR. HOOGENDOORN: How do you make mock-orange cuttings, with a heel, as you have pictured it?

MR. HANCOCK: The boys gather them very fast, stripping them from the stock plants as rapidly as they are able, until they have a handful. They then put the cuttings in a pail of water, so that *only* the butt ends of the cuttings are wet. I will admit that you can make a mess of the stock block.

MR. HOOGENDOORN: Now, if you cut that block down in the winter you will get young growth the next year. You may have lateral shoots, or you may have straight shoots. How do you get the heels from these?

MR. HANCOCK: I don't quite understand your question, because it is possible for you to gather these cuttings judiciously. If you have a big field of viburnum, for instance, you don't need to take more than one or two cuttings from each plant. By fall, that will be beautifully healed over and it will be difficult for you to see it.

MR. HOOGENDORN: If you have a cut-back shrub it will make one straight shoot.

MR. HANCOCK: That is the Holland method to cut them back. That is your business.

MR. JACK HILL (D. Hill Nursery, Dundee, Ill.): What is your date for collecting cuttings of *Euonymus Fortunei vegeta*?

MR. HANCOCK: June. They grow fairly fast and early, and consequently we start to cut them about the third week in June.

MR. HILL: Mr. Hancock, have you ever encountered bud dormancy that precluded the growth of this plant in the first season?

MR. HANCOCK: None whatsoever.

MR. HILL: They continue to grow?

MR. HANCOCK: Except that they jump ahead. I have gathered twice as much cutting material off the next year as I put cuttings in, and I still have a bushy plant.

MR. DONALD S. McCONNELL (Port Burwell, Ontario): Have you ever dipped any of the cuttings in sulfur dust before inserting them in the frame?

MR. HANCOCK: That is a very important point, and since I belong to the Propagators Society I have to give you the whole picture. Until we found a suitable fungicide, we couldn't root cuttings in the manner I have described, on a commercial scale. The fungicide we have found most acceptable is Tersan.

PRESIDENT WELLS: Do you dip the entire cutting in Tersan?

MR. HANCOCK: I merely wet the cutting, shake it, and apply a light coat of the fungicide dust. We actually had 100% rooting the first time we attempted to root *Cornus Florida rubra.* In this procedure I slit the basal portion of the cutting, a technique that I learned from someone here the year before, and dusted that portion in order to prevent any rots from developing. We got 50 out of 50 to root. Now this year, with our technique seemingly perfected we were going to make money. We put in several hundred cuttings; we still got 50 to root.

Our poor results however can be explained. The cuttings we took the year before were taken from imported plants, which had been moved in the spring, and consequently had mostly short, hard cuttings. They went into the frame in the best possible condition. Those stock plants were then put out in the field and religiously fertilized. This year they grew very rapidly. As a result, the cuttings that we made this year were quite long and of soft, succulent wood, which resulted in a very poor stand.

DR. W. E. SNYDER (Cornell University, Ithaca, N.Y.): How many of those first 50 rooted cuttings are still living?

MR. HANCOCK: Twenty are still alive. We found that they are quite hard to overwinter and believe that one way that we might be able to handle them would be to pot them up, in order to re-root the cuttings before overwintering them in the greenhouse the first year.

MR. HOOGENDOORN: When do you remove the frames?—the spring following rooting?

MR. HANCOCK: No, as soon as they are rooted in most cases. If we want to shed the burlap, which incidentally gets rotten in about a month,

we rip it off and just lay shades over and watch the frame. As soon as the cuttings are well established the box is taken away. Of course, this invites very open conditions during the winter.

There are occasions in which we allow the frames to remain in place over winter. If this is done, it introduces the danger from melting snow, which may fill the box with ice, to give us some winter injury.

MR. HERBERT TRAUTMAN (Trautman Nurseries, Franksville, Wis.): You could raise your frames slightly in place and still furnish protection as well as drainage.

MR. HANCOCK: This is possible, in fact I have placed small blocks of wood under some frames in order to allow the water to drain out. I believe for items that root slowly it is an excellent idea to leave the frames in place for another season. I have filled a few frames with materials similar to moss, which has been used to good advantage.

QUESTION FROM THE FLOOR: After the cuttings have been rooted how do you avoid winter injury?

MR. HANCOCK: We try to avoid it by all sorts of methods. Of course, winter injury is a big danger with this method of propagation. I should have pointed out in my list of disadvantages that the cuttings may get into too much growth late in the season, especially if you don't watch them carefully. Though we use soil for growing them, we do not dare apply a lot of liquid fertilizer the first year. It is up to whoever puts them in the field to see that the cuttings go into well-prepared soil.

MR. HOOGENDOORN: Do you ever get a lot of stem splitting?

MR. HANCOCK: Our two main problems during the winter are frost heaving, and as you have mentioned, stem splitting at the base. By taking them up before the frost comes, and heeling them in, in protected frames, I think we have overcome that danger.

MR. HOOGENDOORN: Why couldn't you mulch the cuttings in place, late in the fall?

MR. HANCOCK: We also do that. In this connection we have used both leaves and shingletow. When either is used as a mulch it also is placed in the path in order to insure drainage in addition to affording protection for the first inch or two of the cutting bed proper. I have discovered that with weigela and viburnum we are particularly bothered. I lost a beautiful batch of *Viburnum tomentosum plenum* last year. This year I have already taken them up before any danger of a heavy frost.

PRESIDENT WELLS: I would like to ask Mr. Hancock to expand a little on the question of over-wintering. I would expect a very high mortality.

MR. HANCOCK: Well, Mr. President, there isn't any very high mortality. The only argument I can make to that is that we have not lost one day of growing opportunity of that plant by transferring it to a pot or other location. At one time when my good friend Bill Stemens was com-

ing to us and saying, "Why do you want to transplant that?", it gave me one idea. I didn't. The result is now, we can grow these cuttings as well as he can.

PRESIDENT WELLS: What kind of winter conditions do you have at Cooksville?

MR. HANCOCK: We get 10 degrees below zero occasionally, and we will experience some winter killing. Take *Viburnum tomentosum plenum* for instance, which is very susceptible to winter injury although it has very hardy basal buds. I think the problem can be overcome by putting on plenty of mulch. Another factor is drainage. We haven't in our whole nursery one spot where water will stand in a puddle, and I don't believe it should, in any nursery.

CHAIRMAN MAHLSTEDE: Are there any further questions you would like to direct to Mr. Hancock?

PRESIDENT WELLS: If not, Dr. Mahlstede has a few slides which we did not have a chance to see and which I think we should look at, if time permits.

CHAIRMAN MAHLSTEDE: Since we have only a short time remaining I will present a few slides showing the results of only several of the experiments being carried on at Iowa State College concerned directly with plant propagation.

. . . The summation of information presented is as follows: . . .

Pretreatment studies concerned with the application of various growth inhibitors to stock plants and cuttings, in order to hasten maturity of sofwood cutting material indicate, that under proper environmental conditions, maleic hydrazide can be used effectively. It is advisable however, not to use this chemical until further studies have been made, in that permanent injury to plants may result under certain conditions.

Use of Fermate (2 oz. per gallon of water) and Wettable Arasan (1 oz. per gallon of water) applied to stock plants before sampling softwood cuttings of *Lonicera tatarica* significantly reduced bench losses. Experimental results further indicate that a fungicide stock-plant spray, in conjunction with a solution dip, prior to insertion of the cuttings in the bench will generally result in negligible losses of cuttings propagated under high humidity and temperature conditions.

Studies concerned with the application of various growth inhibitors to a variety of plant materials, in order to inhibit terminal and lateral growth during the rooting period gave negative results. Use of maleic hydrazide, alpha cyano-beta-2,4-Dichlorophenyl Acrylic acid, and its sodium salt at concentrations of .05 and .1 percent did not significantly reduce the total amount of new growth produced by a number of softwood cutting types. In general, terminal elongation of shoots was partially inhibited by the use of the higher concentration of the growth regulator which was accompanied by the production of many axillary shoots. The one tenth percent concentration of all chemicals used no-

ticeably reduced the total number of roots produced from softwood cuttings of *Ligustrum amurense*, and *Cornus stolonifera*, as compared to the control treatment.

The effect of soil conditioners on the rooting and subsequent survival of field planted hardwood cuttings was studied. Apical, basal and combination applications of Aerotil (dry form) noticeably increased rooting and survival of fall planted hardwood cuttings of *Lonicera tatarica*. Surface and combination applications of the dry form significantly increased stands of *Ligustrum amurense*. No increase in survival was obtained from applications of Aerotil (dry and wettable forms) to cuttings of *Cornus stolonifera*. The beneficial effects derived from the use of this substance on heavy soil types may be attributed to improved aeration.

CHAIRMAN MAHLSTEDE: Now our time is gone and I want to thank you very much for bearing with us this afternoon. Especially would I like to express our gratitude, and I think I speak for the group, to Mr. Hancock, who gave us one of the most interesting presentations of the entire meeting.

The assemblage arose and applauded.

The session recessed at 4:00 p.m.

EDITOR'S NOTE: Mr. H. F. Harp of the Dominion Experimental Station, Morden, Manitoba, Canada, was unable to be present and because of the lack of time his paper was not read. However, it is included in the Proceedings as was announced at the conclusion of the panel discussion of the propagation of softwood cuttings.

Root Inducing Substances

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INTRODUCTION

It is a well known fact that stems of plants generally bend towards light. Darwin (3) was the first to demonstrate that some "stimulus" was trainsmitted from the tip to a region further down the axis of seedlings exposed to one-sided illumination. The response of the plant to this "stimulus" caused the axis to bend toward light as a result of an unequal rate of growth.

To the inquiring mind, there were many questions in connection with this phenomena which were yet unanswered. It was for Boysen Jensen (1) some years later to demonstrate that Darwin's "stimulus" was a chemical substance which moved through the tissues of the plant.

In 1928, F. W. Went, (4) working with biochemists at the University of Utrecht, described a quantitative method for determining the presence