

18. Rehder, A. 1895. Veredlung der blutbuchen. *Moller's Deut. Gart.-Zeit.* X:138-139.
19. Sheat, W. 1948. Propagation of trees, shrubs and conifers. MacMillan & Co., Ltd. 479 p.
20. Temple, F. L. 1890. Some practices in grafting. *Gardens and Forest.* iii: 170.
21. Trobchen, A. 1898. Veredlung der linden und blutbuchen. *Moller's Deut. Gart.-Zeit.* XIII:276.
22. Wyman, D. 1951. *Trees for American gardens.* The MacMillan Company New York. 376 p.

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MODERATOR CREECH: I think what we should do next is to hear from Mr. Crawford of the Willis Nursery Company, Ottawa, Kansas, on his method of propagating the Buisman elm and, after that, I would like to discuss my own observations on root cuttings and on air layering Mr. Crawford.

MR. HAROLD CRAWFORD (Willis Nursery Company, Ottawa, Kansas) presented his paper, entitled: "The Propagation of the Buisman Elm." (Applause).

THE PROPAGATION OF THE BUISMAN ELM

HAROLD CRAWFORD

Willis Nursery Co., Ottawa, Kansas

Members of the Propagators Society and visitors: I don't have a lot of scientific information to give you this afternoon in regard to percentages and data of that kind. What I can give here this afternoon is merely our own personal experience in the propagation of this tree.

As you know, the Buisman elm, and I am referring to the same thing sometimes called the Boisman elm, was introduced from Europe, I think in the early twenties. It was used there as a tree resistant to the Dutch elm and they later discovered it is also resistant to phloem necrosis.

The only way that we can propagate this tree and maintain the resistant qualities is, of course, vegetatively. There are several ways that have been tried with more or less success, such as budding, grafting, top cuttings, hardwood cuttings, and root cuttings. Our own experience has been confined principally to that of root cuttings and softwood cuttings in the greenhouse.

We have been very unsuccessful in taking the wood cuttings from plants in the field, and therefore, we have had to resort primarily to the use of root stocks.

After we get our root cuttings established, we have been quite successful in propagating from softwood shoots developing from these roots.

Of course, the limiting factor on the propagation of this tree is your stock plants. It is a little slow in building up a stock. You have to dig the trees and chop up the roots, and therefore you eliminate that tree. It took several years to produce that tree in the first place. I think we were one of the first nurseries to receive stock from the U.S.D.A. and it has taken us all this time to build up a stock suitable for quantity production.

We prefer a two-year tree as a source of roots. We have used older trees and we have used roots from one year trees. The difficulty of using a one-year tree is that you get so few roots of suitable size, whereas, with a two-year tree you get roots of the size that we like to use, and that is about a lead pencil size. Some of the earlier papers recommended using roots of three-quarter to an inch in diameter. We do not like to use a root that large, not that it will not root readily, but it leaves rather a rough plant and requires a larger pot after it is established, but we have used a lot of roots as small as one-half the size of a lead pencil. They are slower and do not give as nice a plant.

We prefer to use a section approximately an inch and a half to two inches in length. Here again, some of the early information conflicts. I think they recommended using lengths as long as 2 to 4 inches, but that is not necessary.

We dig the trees to get the roots in November in our area, which is very close to Kansas City. By that time, the tree is completely dormant but the root system is still pliable and in good condition. We have never tried taking root pieces from the tree and leave the tree established. We dig the tree in its entirety so that we get the maximum number of roots.

Don't throw away roots that are injured by spades or forks when you are digging. We find that a piece of root can be quite badly mangled and will still develop adventitious buds and produce a suitable plant. After all, this little piece of root we are using actually becomes a very small portion of the finished plant so that you do not have to be careful about how it looks or the condition it is in.

I was talking with one of your members here last night about the propagation of the Buisman Elm and he said he had some difficulty in storing the roots. We never attempt to store the roots. I don't mean to say they cannot be stored successfully and then used later, but we try to cut up the roots and put them in the rooting media the same day.

Really, it is quite a simple thing to root this tree from piece roots. I think the most important factor to keep in mind is that the portion of the root nearest the parent tree must be set upright. If you get them upside down you are going to have a very spurious cutting and they will develop buds at the bottom which very seldom reach the top. A callus develops on the top which amounts to nothing. We do that occasionally and after we discover our error and turn them over.

I think there has been some work done on this with layering the roots horizontally and Dr. Creech was telling me today he had rooted some in that manner. I don't know that it makes too much difference which method you use as long as you get the end result. We pot our plants, so obviously, the horizontal root would not be desirable.

I think an important factor in the propagation is light. We like to use practically full sunlight on our roots. You see, we are trying to do two things with this little piece of root. We are trying to grow roots on the bottom of it and new shoots from the top. With our softwood cuttings we already have our tops established and only have to establish roots. With this little piece of root, we have to grow feeder roots and tops and to get the quickest action from the callus for the development of tops you need light.

I think it makes very little difference the type of media you put them in. We use perlite almost exclusively in our propagation. The roots, after placed in the media, callus very quickly — within 10 days or two weeks. This callus very quickly starts turning green around the cambium layer of the root, and from this green callus develops shoots which make the top of the plant. Now we get this action ordinarily sooner than we get the root action. Judging from the tops you will think it is ready to pot up, yet you may have practically no root action.

We got the idea why not go ahead and pot them up if we had the tops developed. We didn't get too good results from that practice, so now we leave the plants in the media until we have both tops and roots. There is no difficulty in transplanting from the media to the pots. We just take the cuttings out of the propagating house, pot them up and put them into a finishing house.

After becoming established in pots and placed in a cool house the plants grow quite rapidly up to 6 to 8 inches. Now you will have a whole ring of shoots coming from this piece root. Obviously, we only need one stem for a tree, so we remove these tops, down to two leaders. We leave the extra one there in case one gets broken off. Then we take the top cuttings, put them back in the media and root them. We attempted to propagate from softwood cuttings from plants in the field, and so far we have had 100 per cent failure from that method, and yet, we got almost 100 per cent strike on top cuttings from plants grown in the greenhouse. Of course, that is true in a good many other plants also.

We like the plants developed from the top softwood cuttings better than those from the root cutting. We have a little smoother, nicer-looking plant. It is obvious they are propagated a month to six weeks after the root cuttings are put in, but by the time we take them from the greenhouse in the spring they have caught up.

We carry our plants in pots until time to go to the field. If we have the time, we try to take them out from the greenhouse and harden them off in cold frames outdoors. Here in this part of the country and farther east, I know you are able to take stock directly from the greenhouse to the fields. Our growing conditions are at times quite rugged and at planting time we have warm winds; quite often it is dry. For that reason we pot most of our stock and also try to harden it off rather than take it directly from the greenhouse.

I was a bit amused last night at some of the explanations that were made of temperatures of 109, which you enjoyed in Illinois last summer. We experienced temperatures of 118 degrees last summer with a wind of 20 to 30 miles an hour, along with relative humidity of about 25 per cent. Those are rugged growing conditions.

Incidentally, the Buisman elm planted from pots in the field without water survived and did very well. We didn't get an enormous growth but we did get growth and high survival, which is an interesting sidelight on the use of the tree.

I failed to mention or discuss in any detail the other methods of propagation. I think the Cole Nursery has had some experience on budding. With us, that is not too satisfactory. They are budded on *Ulmus parvifolia* or *U. pumila*. We get too much over-growing of the bud and not too high a stem. I think Mr. Cole told me they were not satisfied with their budding method, either.

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MR. CRAWFORD: If there are any questions, I will be glad to answer them.

MR. RALPH M. FISHER (Manchester, Conn.): Do you find you get dwarf trees from the juvenile growth? They dwarfed on me.

MR. CRAWFORD: I think the oldest tree we have is about seven years old. We left a few alone just to see what they would do.

MR. FISHER: The trees I dig up are four inches through and dig the whole tree. Some have long roots and I usually cut them about two foot long from the tree, a ball about two foot and plant them back in.

MR. CRAWFORD: You dig the tree?

MR. FISHER: I dig the whole tree by the root and follow them on. You get an enormous number of root cuttings, as you say, all sizes. If you do it every year, they are more or less uniform and about pencil size when grown in a good moist soil.

MR. CRAWFORD: What we would like to do is get our stock plants built up to the point where we can use our regular digger and still get enough roots from it. Spade digging is expensive.

MR. JACK SIEBENTHALER (The Siebenthaler Co., Dayton, Ohio): Have you ever had occasion to observe any results that might have occurred if you just dug the trees and left a few of the roots? Incidentally, phlox propagation was mentioned yesterday. Would that give you any change of reproduction?

MR. CRAWFORD: We have not. We have been so greedy to get all the roots for propagation that we haven't knowingly left anything. I do know with *Zelkova* that you will get sucker shoots that way. On the Buisman elm, I don't know.

MR. C. MAHLSTEDE (South Euclid, Ohio): Do you cover the root cuttings or leave the tops exposed?

MR. CRAWFORD: If the entire root is covered, you will get rotting of the root. We leave them exposed a quarter to a half inch. They will rot if you cover them with material even as light as perlite.

MR. WILLIAM COLE (Cole Nursery Co., Painesville, Ohio): We have two things a little different in the way of handling. In the first place,

bringing those plants in early and sticking them gave us a little more growth, and we gave a heavy mulch with manure and put ours directly into pots, the cuttings root about the same as yours do, but we saved that one operation. Again, we left the top of the cuttings sticking out. We found it was easy to rub the suckers off if they were just barely at the surface. We didn't think of saving them for cuttings.

MR. CRAWFORD: The only reason for leaving the tops is for additional propagation. You might as well rub them off if you have an ample supply.

MR. ROSCOE A. FILLMORE (Centreville, Nova Scotia): What is the medium?

MR. CRAWFORD: Perlite. That is an expanded aluminum, I believe it is, that they use for light-weight plastic. It is pure white.

MR. FILLMORE: Would that be better than vermiculite?

MR. CRAWFORD: With us it was the one available and we knew how to handle it. We get better results from using perlite than vermiculite or a combination of vermiculite and sand. You may not agree with me on this, but again, we get better results and we use it exclusively even on soft-wood cuttings.

MR. CASE HOOGENDOORN (Hoogendoorn Nurseries, Newport, R. I.): Do you use glass over your propagating bed when you insert those roots or use an open bench?

MR. CRAWFORD: Open bench. Our propagating greenhouses are the small, two-bench style house, 10 feet wide and seven feet high.

MR. STUART H. NELSON (Central Experiment Farms, Ottawa, Canada): Have you ever tried leaf-bud cuttings?

MR. CRAWFORD: No.

MR. NELSON: The Oulette L'Assumption Experimental Farm has been working on the Dutch elm disease and has had considerable success with leaf-bud cuttings on the species. I don't remember the report in full but leaf-bud cuttings were used in the greenhouse, with some shading.

MR. CRAWFORD: Ray Keen has told me of that work. I want to try it next year on some of the hybrid elms but on the Buisman elm I see no reason going to that work because the other way is so simple.

MR. MAHLSTEDDE: By budding or grafting a Buisman elm, would it still be immune to Dutch elm disease?

MR. CRAWFORD: Yes, if you have a root system you are sure is immune. The American elm root would be out. We don't like the root system of the Chinese elm. In our part of the country it makes too shallow a root system. You can't grow anything under the trees and they tend to blow over badly in moist areas.

MR. WM. FLEMER III (Princeton Nurseries, Princeton, N. J.): What shape do you think the Buisman elm would ultimately make: similar to the Chinese or to the American?

MR. CRAWFORD: A broad pyramidal type, more on the order of the Chinese than the American elm. In the East it will probably not be as tall and quite a bit smaller. I think it will not be as archy a tree as the eastern elm. When you compare it with the American elm you should know what section of the country a person is from. They vary from New England with high branches, to central Kansas where we have some elm trees that grow almost flat, spreading out 30 to 50 feet and not over 20 or 25 feet tall.

MR. WILLIAM COLE: Ed Scanlon grew some of these on chinensis roots. I would like to know what results he got. Did you plant some out?

MR. ED SCANLON (Olmsted Falls, Ohio): Yes, when we got those trees started we wanted to get some kind of fast. I figured I hadn't much time left, so we tried to graft them on four different understocks to determine the compatibility, since nobody knew anything about it. We worked on *Zelkova*, Chinese, Scotch, and English, and we got the best results from the Scotch, because they became reestablished better, faster and with a higher percentage.

Of course, the Chinese has such a clumsy root system that we had quite a bit of loss on those, so I think the first batch of them we planted here were on Scotch. They didn't come along so good. As a matter of fact, they all kind of stood still. I think it was for two or three years, and then all of a sudden they got going.

On another batch we put on Chinese, we planted deep, with the idea they would establish their own roots and, of course, somebody brought up the question of whether on Scotch or English you have the understock susceptible to Dutch elm disease. Of course, the top is resistant. Of course, if it gets down that far you haven't any tree anyway, so it might as well kill it. There is no danger of infection that low because we know an infection in Dutch elm starts at the top as I believe it does in phloem necrosis also.

Another thing, we had quite a bit of success in budding on Chinese, but because of the poor quality of the Chinese stock, I am going to put it on Scotch hereafter.

Now the *Zelkova* understock didn't work too good because it was a little too slow for the top. They were not compatible but we got some beautiful trees out of it, and I think we have about three or four streets of them here. Some of them have been in as long as three or four years, I believe, and they are doing quite well.

Another thing I would like to suggest with regard to the form of the tree, now on the basis of the fact that this is a variety or a selection of *Ulmus carpinifolia*, we have a beautiful specimen. That is a broad-leaf pyramidal tree with a central leader and in no way resembles the American elm from an arching standpoint at all. As a matter of fact, I would say it is rather a buxom heatley elm, a little larger at the base. I think it is a very beautiful tree and from the standpoint of the form I like it for a street tree. It has a much more practical form from a maintenance standpoint and also lacks a heavy overhead or top, which of course we found out in the last three months definitely is not a very desirable thing for most street trees.

MR. CRAWFORD: I think there is a difference of opinion on the ultimate shape of the tree, based on different localities. The same variety of

tree grown in Kansas would take a different shape than one growing in the New England states.

MODERATOR CREECH: Thank you, Mr. Crawford.

I want to talk on root cuttings just a little further, some of the basic facts we know about them.

Dr. Creech read from the article entitled "Root Cuttings" by John L. Creech, *The National Horticultural Magazine*, 33:21-24, 1954. (Applause).

PROPAGATING PLANTS BY ROOT CUTTINGS

JOHN L. CREECH

U. S. Plant Introduction Station, Glenn Dale, Md.

Cuttings can be made from the roots of a number of species that are difficult to root from stem cuttings. This method is quite frequently applied to the woody legumes but to a lesser extent in other plant groups. According to Priestly and Swingle (4), root cuttings tend to produce adventive shoots more readily than adventive roots just as stem cuttings are prone to regenerate roots, seemingly as if each were trying to replace that portion of the plant which was missing. In addition, the adventive shoots formed on root cuttings are more likely to be found at the upper (proximal) end of the cuttings than at the lower (distal). Thus, the most successful root cuttings will be those obtained as close as possible to the base of the plant. This proximity to the base of the parent plant might also be expressed in terms of the diameter of the root cuttings. Kvarazkhelia (3) reported in a study of the vegetative propagation of the tea plant that when he separated the root cuttings into thick (over 2 cm.), medium (1 cm.), and thin (less than 1 cm.) pieces, the thick cuttings gave the best results and the thin ones the poorest, namely 52-73%, 37-45%, and 9.5-18% respectively. This has also been observed at the Glenn Dale Plant Introduction Garden with *Cyrilla racemiflora* when cutting were separated into two groups, one-half inch or over and less than one-half inch. In addition to a higher percentage of rooting, the thick cuttings also produced more vigorous shoots than the small roots.

As a supplement to growing the plants derived from root cuttings, it may be desirable to use some of the newly developed shoots as softwood cuttings. This may seem a roundabout means of obtaining softwood cuttings but results show that these cuttings will often root better than similar cuttings taken from stems. Toole (5) took softwood cuttings of *Albizia julibrissin* both from root pieces and stem pieces. Those shoots originating from roots rooted 100% in twenty days while the ones obtained from stems failed completely.

Root cuttings should be made either in the fall or during the winter months. Hoblyn and Palmer (2) reported that root cuttings of plum grew much better when planted in December through February than if set in April. In the propagation of the Beach Plum (*Prunus maritima*), Graves (1) used roots of lead-pencil size collected in the fall. These were cut into lengths of 3-4 inches and buried outdoors at a depth of 2-3 inches with the cuttings laid