The Importance of Uniformity and Timeliness In the Selection of Propagating Wood

DR. L. C. CHADWICK
Department of Horticulture, Ohio State University

Much has been written in the past denoting the importance of uniformity and timeliness in the selection of propagating wood and perhaps little that is new can be added at this time. However, it seems to me that the subject is of sufficient importance to warrant discussion. Those who have had an opportunity to visit the commercial nurseries at Boskoop, Holland, surely left impressed with the uniformity of the nursery stock propagated in that region.

In the commercial propagation of plants interest centers around two things primarily, (1) quantity production and (2) the quality of the plants produced. During the past few years, with the scarcity of nursery stock, emphasis seems to have been more on quantity than quality in many of our nurseries. Quality of young propagated stock and quality of larger saleable stock seems worthy of considerable emphasis in the U. S. nursery circles today. Poor quality propagating stock results in poor rooting percentages, or the rooting may be slow and the growth weak. Such slow or weak growth seldom responds to give good finished plants.

In the discussion of this subject it must be emphasized that uniformity and timeliness in the selection of propagating wood are not the only factors responsible for successful propagation. Undoubtedly there are others of equal or even greater importance, but it is my intention to limit this discussion to these factors and others closely correlated with them. What I hope to do in this discussion is to stress the importance of careful selection and if I can get you to think a little more about it, I will have accomplished my purpose.

Causes of Variability. Many causes of variability in propagation and in growth of young plants can be enumerated. Among the most important may be listed (1) lack of typical or uniform stock plants, (2) carbohydrate-nitrogen relationship, (3) morphological relationship, (4) flowering vs. vegetative wood, (5) position on the plant from which propagating wood is taken, (6) sex, and (7) prevalence of disease and insects.

Lack of Typical or Uniform Stock Plants. In the cutting of propagating wood, especially cutting wood, there has been a common tendency to select this wood from row-run plants. This tendency has developed because of the quantity of propagating wood desired and to the ease of taking. Quantity production and the saving of labor have appeared more important than high quality stock. Surely, the care and time involved in the selection of uniform propagating wood will pay dividends in the end. A plea might well be made for the establishment of stock blocks for propagating purposes, a practice quite common several years ago. In such blocks the propagator can establish true-to-name plants and varietal uniformity. Inferior plants and those not true to name can be rogued from the blocks leaving only those of exceptional quality for propagating purposes. All of us, I am sure, have noticed on many occasions the lack of uniformity in growth habit of nursery stock supposed to be of the same variety or species.

State nurserymen's associations might well aid the colleges, universities, and

experiment stations in establishing trials leading to trueness-to-name and trueness-to-type in many kinds of nursery stock.

In making the comments above I am not overlooking the possibility of developing new plants by propagating those with variable characteristics. That phase of production does not come within the realm of this discussion.

Carbohydrate-Nitrogen Relationship. Propagators have long emphasized the importance of selecting the "right condition" of propagating wood for softwood cuttings. A simple rule followed with softwood cuttings is to take the wood when it will snap and not crush when bent. The snapping or crushing actually is of no importance, but the physiological and morphological make-up of the twig is important. The snapping is a manifestation of the correct physiological-morphological conditions. It is apparent from the literature and commercial practice, that the condition of the wood may be right for successful rooting for only a short time in some plant species and varieties and extends over a considerable period with other plants, if air, moisture, and temperature are satisfactorily regulated during the rooting period. Philadelphus coronarius aureus, the Golden Philadelphus, and Syringa vulgaris, the Common Lilac, are noted examples of the "short-period" type of plant, whereas many examples, such as the privets and most narrowleaf evergreens could be cited where cuttings can be taken over a long period of time and rooted successfully.

The timeliness factor is tied up with quality production as well as quantity production. Cuttings taken at the right time root readily and continue to develop rapidly and uniformly, if other conditions are satisfactory, while cuttings taken "out-of-season" often root slowly, if at all, and the plants develop irregularly and often do not attain saleable quality. It might also be mentioned that the timeliness factor in the successful rooting of cuttings may be tied up with the period of rest in the stem tissues as well as the carbohydrate-nitrogen relationship.

It is not my intention to give here a complete review of the literature pertaining to these phases of propagation, but refer to a sufficient number to emphasize their importance.

Time of Taking Cuttings. Batson (1) (1933) working on the propagation of Camellia japonica stated that December through February were the best months for taking cuttings of this plant. Durham (7) (1933) showed that the best season for taking cuttings of some evergreens was variable. Some of these were rather specific in their requirements and others not. He stated that cuttings of Junipers and Arborvitaes would root readily when taken from mid February to mid March. He further stated that cuttings of Euonymus latifolius and Ilex opaca should be taken in the spring and those of Azalea mollis and Kalmia latifolia in October and November respectively. Several propagators would not agree on these dates since success is obtained with several species and varieties of Junipers and Arborvitaes by taking them in early winter (December to January) and handling them in the greenhouse or taking the cuttings in March and April or in August and rooting them in frames. All methods are satisfactory, depending on location and equipment available.

The variation existing between species was noted by Zimmerman and Hitchcock (30) (1933) as they found that late August was the best time to take cuttings of Ilex opaca but cuttings of Ilex cornuta could be taken and rooted successfully at any time of the year. Lindberg (13) (1952)

reported that Ilex opaca cuttings rooted nearly 100% in less than two months when taken in mid August and handled under conditions of high temperature and humidity. Cuttings taken in December rooted satisfactorily but were much slower in attaining a high percentage of rooting. It might be mentioned that while these statements are usually considered correct, cuttings of Ilex opaca taken at Ohio State University the week of November 3, 1952, and handled under conditions of high temperature and humidity are now well rooted. On the basis of this experiment and those of Ilex reported above, the time of taking American Holly cuttings may not be as critical as formerly supposed.

Farrar and Grace (9) (1941) took cuttings of Norway Spruce throughout the year but a good percentage of rooting was attained only with those taken during September and October. Stoutemyer (24) (1942) reported that the period for successful rooting of Chionanthus retusus was limited to the first week in May at Washington, D. C., Wells (28) (1949) in his series of articles on the propagation and production of hybrid Rhododendrons in the American Nurseryman recommended late June through August as the best time for taking cuttings of this plant.

At the recent International Horticultural Congress two papers were presented which emphasize the importance of the time of taking cuttings or the condition of the wood. Miss S. de Boer (4) of the Boskoop Nursery Research Station, Boskoop, Holland, in her paper entitled "Some Aspects of Propagation by Cuttings of Ornamental Trees and Shrubs" stated that one of the most important factors in propagation was the proper ripeness of the shoots used for cuttings. If the shoot is too soft it will frequently rot and if it is too hard excessive callus and few roots often results. F. E. W. Hanger (11) of the Royal Horticultural Society's Wisley Gardens stressed the importance of careful selection of propagating wood stating it was the most important factor determining uniformity of growth after rooting as well as rooting.

Carbohydrates. The importance of carbohydrates in the development of roots was emphasized by Starring (21) (1923) and Schrader (18) (1924) but Reid (17) (1926) was perhaps the first to show the relationship of the content of carbohydrates and nitrogenous compounds to the development of root and shoot growth on cuttings. Reid pointed out that a high carbohydrate content plus a fair amount or reasonable quantity of nitrogenous compounds in the tissues was best for good root and shoot production on cuttings. While Winkler (29) (1927) has shown that the correct carbohydrate content for good root production can be fairly easily determined, it is doubtful if many nurserymen will go to the trouble of making these determinations. Tukey and Green (26) (1934) have indicated the importance of selecting certain portions of long canes if the quickest and best rooting is to be obtained. Working with Rosa multiflora they pointed out that long canes showed an increasing gradient of carbohydrates and a decreasing gradient of nitrogenous compounds from tip to base. The best portions of the cane for cuttings was dependent upon the carbohydrate-nitrogen relationship of those portions. While it varied somewhat with the season, the best results with softwood cuttings were usually obtained when the cutting wood was taken from the section eight and sixteen inches back from the tip.

Rest. Rest influences to a considerable extent the rate of rooting of cuttings and it requires correct manipulation of the environmental conditions for good success. Chadwick (3) (1933) reported that cuttings of

Taxus taken in February would root in much shorter time than similar cuttings taken in November or early December. If evergreen cuttings are taken before cold temperatures have broken the rest in the buds, shoot growth, and correspendingly rooting, will take place slowly. If the cuttings are taken after the rest period is broken, the buds will become active and root growth will develop rapidly. Environmental conditions, especially temperature, must be much more closely regulated with cuttings taken after the rest period is broken.

The correct manipulation of environmental factors, especially temperature, is important in the storage of hardwood cuttings of deciduous shrubs. Best practices vary depending upon the extent of the rest in the buds when the cuttings are taken. Chadwick (2) (1931) reported that best results were obtained with hardwood cuttings if they were stored at temperatures of 65-70°F. for two to three weeks previous to storing at 40°F. for the remainder of the storage period. Such a practice can be followed, however, only if the cuttings are taken previous to the breaking of the rest in the buds. If the plants had been exposed to considerable cold temperature before the cuttings are taken, the rest will be broken and with such cuttings the warm period of storage should be eliminated, and the cuttings placed directly at the 40°F. temperature.

The references given above are adequate to show the importance of the time factor, carbohydrate supply, and rest in the successful rooting of cuttings. It may be well to emphasize again the point that while the propagator may get a fair percentage of rooting when cuttings are taken other than at the best time or wood condition, growth will often be slow and irregular and the resulting quality of the finished plant unsatisfactory. Keep the growth of rooted cuttings continuously active.

Morphological Relationships. There is little doubt that the morphological structure of the tissues influences the rate of rooting, the amount of roots produced, and the quality and uniformity of the plants produced. A few points will be mentioned in this category.

The factor of juvenility has been shown to influence the rooting ability of cuttings. Stoutemyer (23) (1937) showed its importance in the rooting of apple cuttings. Thimann and DeLisle (25) (1939), Passecker (16) (1940), and Kemp (12) (1948) have likewise noted the importance of this factor. Snow (19) (1941) reported that cuttings of Sugar Maple taken from three to five year seedlings rooted better than cuttings taken from older plants. Since O'Rourke (15) (1951) discussed this factor rather thoroughly at the Plant Propagators Society meeting last year, I do not need to dwell on it longer at this time.

The position of the basal cut was first shown to be of importance by Van der Lek (26) in 1925 when he pointed out the difference between what he termed wound roots and morphological roots. He pointed out that preformed root initials or the formation of root initials were most abundant in the first one-half inch below the node. These so-called morphological roots were stronger, more capable of supporting the cuttings and resulted, at least initially, in more uniform plants than those supported by wound roots.

Chadwick (3) (1933) classified cuttings of various plants into several groups based on the patterns displayed by the morphological roots and also emphasized their importance to successful rooting and management practices. It was further pointed out that very large calluses characteristic with cuttings of Weigela Evá Rathke could be prevented by using tip cut-

tings with the basal cut made about ¼ to ½ inch below the node. Such cuttings produced a smaller callous and rooted better than those made with the basal cut just below the node. Kemp (12) (194) points out that the basal cut should not be made through the node but at the base of the visible swelling associated with leaf insertion.

Stewart (22) (1927) suggested that cuttings of Rhododendron often root poorly because of the large pith. He suggested cutting off the tip of developing shoots, forcing side shoots which have comparatively more wood in comparison with pith and better food supply. These side shoots will root more readily than the terminals. Kemp (12) (1948) has also pointed out that with softwood cuttings in general, lateral shoots should be chosen in preference to leaders. Hanger (11) (1925) reported that Ericas have a deep seated cambium and for successful rooting, tip cuttings, ½ inch long, should be taken before cork forms and stuck three-fourths their length in the rooting medium.

Lindberg (13) (1952) stressed the importance of taking a particular type of cutting, a short tip cutting, with Hydrangea petiolaris, if good results are obtained. Such cuttings set deep root well. Undoubtedly, morphological factors are influenced here. Hanger (11) (1952) stated that plants containing abundant fibers in the wood seldom respond from cuttings and cited Fagus as an example of this condition.

Many additional references could be cited wherein the importance of anatomical and morphological factors are influential in the rooting of cuttings but those given are sufficient to denote the importance of these factors.

Flowering vs. Vegetative Wood. Whether or not the presence of flower buds retards rooting has been the subject of considerable debate. Plant physiologists infer that respiration in flower buds takes place at a higher rate than in leaf buds. If this is the case, greater amounts of stored or manufactured food in the cuttings bearing flower buds would be used leaving less for rooting. We might expect under such conditions poorer rooting and poorer growth after rooting.

O'Rourke (14) (1944) pointed out that vegetative cuttings of blueberry rooted better than cuttings bearing flower buds. DeBoer (4) (1952) reported, as an example of this phenomenon, that Rhododendron cuttings root much better if the flower buds are removed. She further reported that the removal of leaf buds reduced rooting and root growth.

It is the opinion of the writer that with many easy rooting species the selection of flowering wood for cuttings is of little importance in their rooting. With difficult to root subjects, the selection of vegetative wood for cuttings is preferred.

Position on the Plant from Which Cutting Wood is Taken. Factors associated with rooting in this category are no doubt closely aligned with those discussed in parts two and three above and perhaps the same fundamental factors are operative. However, as closely associated as they may be, I have elected to separate them for sake of discussion. A few references will be cited noting the importance of the part of the plant from which the cuttings are taken but time does not allow discussion of the reasons back of these findings.

All propagators are familiar with the fact that only cuttings of erect terminals or erect side shoots of Taxus cuspidata capitata will result in

good uniform, upright plants, even though lateral or horizontal side shoots will root as well or better than the others. DeFrance (5) (1936) reported that multiple stem cuttings of Arctostaphylos uva-ursi rooted better than single terminals. Grace (10) (1939) pointed out that cuttings of Norway Spruce taken from the lower portions of the plant rooted better (86%) than those from the upper region (48%). Deuber (6) (1924) also reported this tendency when he pointed out that he was able to obtain some rooting from lateral twigs from the lower branches of Norway Spruce but no rooting from cuttings taken from other regions. O'Rourke (14) (1944) reported that basal cuttings of blueberries rooted better than terminals.

With many of the easy rooting subjects, the position on the plant from which the cuttings are taken is of no importance. With some plants, as indicated, the position is important and for the sake of satisfactory and uniform results, cutting wood should be selected properly.

Influence of Sex. Undoubtedly, considered on the basis of successful rooting only, this factor is of minor importance. The value or importance of male or female trees for landscape use is not a part of this discussion. Only two references to the factor of sex and its influence on rooting of cuttings will be cited.

Snow (14) (1942) reported that, in general, cuttings from male trees root better than those taken from female trees. Edgerton (8) (1944) has also pointed out that cuttings of Red Maple from the upper part of the crown of male trees, or female trees producing little seed, rooted most readily.

This factor may also be tied up with the respiration rate as brought out in the discussion of flowering wood vs. vegetative wood, since it has been reported that the respiration rate of female flowers may be somewhat higher than that of male flowers.

Prevalence of Diseases and Insects. The importance of disease and insect free stock to satisfactory and uniform results is too well known to require discussion here. It may be pointed out, however, that it is not always easy to detect disease or insect infected wood when cuttings are taken. Because of infestations growth may have become stunted or sufficient fungus may be present, which under propagating conditions, develops rapidly and the cuttings are either lost, root poorly, or growth of the resulting plants become stunted. Infestations of Phytophora blight on lilacs is one example of the above.

In conclusion, the following points can be emphasized:

(1) Many factors influence the uniformity of rooting and the growth of resulting plants.

(2) Keep in mind the various factors that can affect uniformity and try to select propagating wood accordingly.

(3) Good strong rooted cuttings will give uniform plants of good quality.

(4) Propagate for quality as well as quantity.

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PRESIDENT WELLS: Do we have any questions for Dr. Chadwick?

MR. JOHN B. ROLLER (Verhalen Nursery Co., Scottsville, Tex.): Dr. Chadwick, I would like to ask you about excessive callus on *Juniperus sylvestris*. Is there some way it can be prevented.

DR. CHADWICK. I can't answer that question as it applies to *Juniperus sylvestris* since we haven't propagated it very much, but I would suggest this as a trial, that you regulate rather careful the pH of the rooting medium and carry it on the dry side. We have found with *Andorra Juniper*, which is a good example of a type often developing a large callus, that a pH of around 6.9 to 6.95 will materially reduce the size of the callus. If the pH is over 7, it will be larger and if it is below pH 6.2-6.5 it also may be larger.

PRESIDENT WELLS: Any other question?

MR. MARTIN VAN HOF (Newport, R. I.): What kind of wood do you prefer on Greek juniper?

DR. CHADWICK: I think you can root the Greek juniper rather successfully, taking the cuttings at least three different times of the year. Hardwood cuttings may be taken about this time of the year on up to the middle of February and rooted in sand or sand and peat in a greenhouse. Hardwood cuttings can be taken the latter part of March and rooted satisfactorily in outside frames. Also, semi-mature cuttings of Greek

juniper can be taken in August and rooted in outside frames. I don't think that the type of wood on Spiny Greek juniper is too important.

MR. VAN HOF: I have to disagree with you there. We have found that hardwood cuttings taken from the top of the plant won't root with us.

DR. CHADWICK: You take the cuttings, then, from side shoots, not top.

MR. VAN HOF: The bottom of the plant.

DR. CHADWICK: I haven't observed that difference in them.

MR. VAN HOF: I wonder if anyone else has.

MR. LOUIS VANDERBROOK (Manchester, Conn.): We have had exactly the same experience in Connecticut. Bottom cuttings root practically 90 per cent.

DR. CHADWICK: I am glad to have those comments.

MR. VAN HOF: Cuttings taken from the bottom of the plant. show the start of air roots. If such cuttings are stuck in sand at a temperature around 68°F., they root in about a month's time.

DR. CHADWICK: Taken at what time of year?

MR. VAN HOF: About this time of year.

MR. VANDERBROOK: We have had this experience with most types of Junipers. We have found that cuttings taken about the first of October and handled in a greenhouse give good results.

DR. CHADWICK: That comment illustrates one point I mentioned. Cuttings of several evergreens can be taken over a fairly wide period of time. With Taxus, for instance, it doesn't make too much difference when the cuttings are taken as far as the percentage of rooting is concerned. They will root much faster if taken about the 15th of February than if taken about the 15th of November, but the percentage of rooting may be no better, maybe not as good unless you manage the environmental conditions within the greenhouse very, very carefully.

PRESIDENT WELLS: Any other questions?

MR. MAURICE WILSEY (Wilsey Evergreen Nursery, Corfu, New York): I wonder if you would answer a question as to the temperature and the time of day most beneficial for taking cuttings.

DR. CHADWICK: What kind of cuttings are you referring to?

MR. WILSEY: The evergreen line—Arbor-vitae, Yew, etc

DR. CHADWICK: Are you bringing into the picture the condition of frozen wood? If you are—

MR. WILSEY (Interrupting): As to the condition of the wood and the outside temperature. If it is below freezing, would it be better to wait until it warms up?

DR. CHADWICK: We have taken cuttings of Taxus when they were frozen hard and still had good results, but we thawed the cuttings out gradually before they were made up and stuck in the rooting medium. I wouldn't advise it, however, because if the cuttings are frozen you are

going to knock off a lot of the foliage in just the manual operation of taking the cutting.

MR. WILSEY: When you obtain a large number of cuttings, what is the proper way to hold them until you can get all of them made up?

DR. CHADWICK: I would hold them in a cool place, sprinkling them down and covering them with moist burlap.

PRESIDENT WELLS: Do we have any more questions?

Thank you very much, Chad. for your talk. It was an excellent one. (Applause) I have no doubt that Chad will be on hand later on this evening if you have thought up some more questions.

We are adjourned until 8:30 this evening when we will meet in this room again.

. . . The first session recessed at 5:15 o'clock . . .

RECESSED
BUSINESS SESSION
Friday evening, December 12, 1952

The business meeting convened at 8:30 o'clock, in the Ballroom, Wade Park Manor, Cleveland, Ohio, President James S. Wells, Koster Nursery, Bridgeton, New Jersey, presiding.

PRESIDENT WELLS: Can we come to order, please?

The first purpose of the meeting tonight is to explain to you briefly what has happened since the meeting last year. Those of you who were in this city at our first meeting will perhaps remember the controversy which arose over basic principles governing our society and it was finally left to a committee of nine to try to thrash these points out.

At that meeting in Cleveland, I expressed a few ideas which met with a mixed reception, but when we got down to examining those ideas we found there wasn't such a wide difference really in our thinking; it was mainly in how to achieve what we had in mind.

What we had in mind was a society of skilled people, a society of craftsmen, a society of men, and women if any wish to join, who were skilled craftsmen in plant propagation. We felt that we needed to establish a reservoir of knowledge and, to tap that reservoir to help ourselves and other people coming on in the business.

We had the mistakes of the past to look back upon because there had been a society which had failed way back in 1932 or '33, and one of the main reasons for its failure, as I understand it, was that the people who knew finally got tired of giving information to others who didn't know and who had no intention of doing anything but extract all they could from the organization. In such an atmosphere those people who were prepared to give naturally dried up, so we felt it was necessary to establish ourselves this time in such a manner that such an atmosphere could not recur.