Panel on Propagation By Softwood Cuttings

SATURDAY AFTERNOON SESSION

December 12, 1953

The session convened at 2:00 p.m., President Wells presiding.

President Wells asked that all members of committees meet immediately at the close of the program in order to discuss membership applications and the future plan of operation for the Field Trials Committee.

PRESIDENT WELLS: This afternoon session is a continuation of the morning program, and features the propagation of deciduous shrubs by means of softwood cuttings.

The moderator of this program is Dr. John Mahlstede, of Iowa State College, Ames, Iowa. I must own that I am entirely ignorant of Dr. Mahlstede. I know nothing about him whatsoever, but his comments of the past few days and the cut of his jib is enough for me, and that is why I asked him to serve on this Committee of Field Testing. I feel quite sure that he will be able to assist us very materially in the running of this program which we adopted this morning. Without further comment, therefore, I would like to hand the meeting over to Dr. Mahlstede.

Dr. John P. Mahlstede took the chair.

CHAIRMAN MAHLSTEDE: Thank you, President Wells, ladies and gentlemen: As I see by our time schedule it is necessary that we progress fairly rapidly in order to adequately cover that phase of propagation which is concerned with the rooting of softwood cuttings of deciduous shrubs.

Dr. Mahlstede presented his paper on "Principles of Rooting Softwood Cuttings of Deciduous Shrubs." (Applause)

Principles of Rooting Softwood Cuttings of Deciduous Shrubs[1]

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A knowledge of the various physiological and anatomical conditions which exist at the time of collection and which are concerned with the process of root development, in any cutting type will, in time, result not only in increased stands, but also in the more efficient operation of the propagation end of the nursery business.

This presentation has been divided into two parts; one, which discusses the literature which may be applied to softwood cuttings in gen-

[1]Journal Paper No. *J-2457* of the Iowa Agricultural Experiment Station, Ames, Iowa. Project No. 1214.

eral, and another which summarizes this material as it is related to softwood propagation under constant mist. Each of these topics, in turn is divided into a number of sections which present the appropriate data in a logical sequence, progressing from the selection of propagating wood, through cutting preparation and rooting.

Internal Factors Governing Successful Rooting of Softwood Cuttings

Introduction

Under ideal growing conditions, the ability of a cutting to produce adventitious roots depends on the physiological and anatomical conditions that exist in the shoot. All of the various factors, which are incorporated under these two headings should be taken into consideration in the selection and preparation of the wood for propagation.

Selection of propagating wood

In selecting material for softwood cuttings, the physiological conditions of food supply and of hormone balance are of prime importance.

Food Supply

It is a well known fact that softwood cuttings, sampled at midseason from stock plants growing under poor soil fertility conditions will root slower than cuttings sampled from plants growing under good soil management practices. Preston and his co-workers (18) have found that succulent tip cuttings of azaleas selected from plants receiving a low level of nitrogen gave better rooting than cuttings taken from plants receiving a high level. This brings us to the controversial question of the carbohydrate-nitrogen relationship as it effects root production in cuttings.

Stored food is not an important factor when selecting softwood cutting material early in the season. It is apparent that by early sampling, tissues of softwood cuttings have little stored food reserve, and consequently the soluble food used in the formation of roots must come as a result of the photosynthetic activity of the cutting in the propagating bed.

In selecting softwood cutting material later in the season, it is the commercial practice to take thin wood, produced laterally on shoots, rather than vigorous leaders. It has been generally accepted that a high carbohydrate-nitrogen ratio favors root production. In this connection, Starring (20) has noted that when carbohydrates were lacking or were very low in the cutting, roots were not initiated. Brandon (2), working with the genus *Rosa,* suggests that in general, June is the most effective month for sampling softwoods of this genus, and that starch accumulation by the shoot appeared to have no relation to the ease of root initiation and development. The presence of vigorous, high nitrogen shoots is common on young plants, and consequently cuttings sampled from them do not root as well as cuttings made from thin, low nitrogen wood, produced by older plants (13).

Juvenility

Another factor immediately comes into view, inasmuch as we know, through experience, that this is not always the case. It was Gardner in 1929 (11) who noted that in general, the younger the plant, and the nearer to the perifery the cutting was taken, the better the rooting response.

Ease of propagation then, may also be attributed to the existence of the juvenile condition. O'Rourke (16) presented an excellent literature review at the first session of this Society on the importance of juvenility in propagation.

In brief, the juvenile condition is characterized not only by the morphological expressions of leaf shape, size, etc., but also by the inability of the plant or plant part to initiate flower buds, under any set of conditions.

Fritzsche (9) has reported that the juvenile stage of a plant can be fixed by stooling, and consequently the rooting capacity of the plant thereby retained.

On the other hand, Wellensiek (24) has observed that juvenile wood can be obtained from many plant species which have already taken on the mature condition. This juvenile wood which originates from sphaeroblasts, is induced by cutting back and disbudding greenhouse forced stock. These sphaeroblasts arise either from dormant or adventitious buds. The adventitious shoots which develop from these structures root readily when placed under proper conditions.

Auxins As Related to Root Initiation and Development in Softwood Cuttings

Introduction

Root formation on softwood cuttings, as a result of the application of auxin is but one of the many responses in plant tissues derived from auxin applications. Although there have been many theories forwarded as to the reason why the application of auxin to a stem cutting results in a root formation response, the hypothesis generally accepted incorporates the inclusion of an elaborate auxin balance system within the stem.

Fischnich (8) and Liabach (14) in the early 1930's discovered that indoleacetic acid, the active component in many of the commercial rooting powders, was one of the substances in the plant which was responsible for inducing adventitious roots on cuttings.

It is important to note that the movement of auxins in a cutting is generally from the apex to the base, and not from the base to the apex. In other words, the application of a rooting compound to the butt end of the cutting operates in the vicinity of application.

Species difficult to root from softwood cuttings, and which do not respond to the application of hormone powders may have factors other than a deficiency of a natural plant auxin which limits root production. The cutting, after treatment, may initiate roots, but elongation or growth of these roots may not take place because of a deficiency of some root growth hormone or a deficiency of some vitamin.

According to Went (28), a hypothetical natural plant hormone, rhizocaline, manufactured in the leaves of the cutting, results in root initiation and growth in many plant species. Van Overbeek and his co-workers (17) believe that the main function of the leaves on a cutting, as related to root initiation is to supply a source of sugars and nitrogenous compounds rather than a factor X, or Went's rhizocaline.

Cooper (6) theorizes that a factor similar to rhizocaline is equally distributed throughout the length of the stem, and subsequently is mobilized by the auxin gradient in the cutting. In other words, when a synthetic rooting hormone is applied to a cutting, the applied auxin causes rhizocaline to be accumulated at the place of highest auxin concentration at the base of the cutting. The applied auxin, in addition, causes the root inducing rhizocaline to become active. This theory is supported by the fact that the length of many cuttings is directly proportional to the number of roots produced. Thus, a longer cutting, which theoretically contains a larger amount of rhizocaline, has a greater supply available for root production than does a cutting of shorter length.

Many softwood cuttings of certain plant species, on the other hand lack the ability to initiate roots, even if treated with one of the synthetic auxins. Such a cutting, consequently, following the rhizocaline theory, is devoid of this substance.

Anatomical Considerations

Preparation of softwood cuttings

After the wood has been selected, the shoot is now ready to be sectioned. The position of the basal cut is determined by the anatomical make-up of the shoot, and the reaction of the exposed tissues to the surrounding medium.

Suberin formation

At the time the cut is made a wound stimulus causes the secretion of fatty substances into cells immediately adjacent to the cut surface. Under proper condition of aeration in the rooting medium, these substances are oxidized and a suberin layer is formed over the cut surface. Immature tissues as well as poor aeration in the rooting medium may prevent the formation of this suberin layer. Consequently, a typical damping-off reaction may develop, being caused by the ingress of fungi or bacteria into the basal portion of the cutting and subsequent development upstem.

Position of the basal cut

Chadwick (4), working with a variety of plant materials, propagated from softwood cuttings, concluded that in general, the basal cut should be made one-half inch below the node. From the nutritional standpoint, softwoods sampled at midseason have accumulated carbohydrates at the nodes and the anatomical makeup of the stem is such that positioning of the cut immediately below the leaf insertion would seem to be ideal. If preformed root initials are present, in a particular cutting type, they are usually distributed around the node at the point of leaf insertion.

Origin of adventitious roots

Although it is quite difficult to make a generalization about the specific tissue involved in the initiation of adventitious roots from stem cuttings, it is recognized that in softwood cuttings, the origin lies in the pericycle or outer phloem regions. As the stem matures, this seat of adventitious root production moves inward through the phloem to the cambium.

External Factors Governing Successful Rooting of Softwood Cuttings

Foliage and rooting

Calma and Richey (3) have shown that the amount of leaf area allowed to remain on a cutting will in part determine the extent and amount of root production. Culturally speaking, the amount of foliage allowed to remain on a cutting has in the past been determined by the environmental conditions under which it was to be grown. Water loss and excessive wilting, consequently, have been eliminated in the past by reducing the amount of leaf surface. With the advent of high humidity propagation chambers as well as constant mist systems, however, this need not be the case, in that the retention of a larger photosynthetic leaf area will not only reduce losses of benched cuttings, but may produce a more strongly rooted cutting in a shorter period of time.

The rooting medium

The importance of the rooting medium in regard to the propagation of deciduous shrubs from softwood cuttings cannot be overemphasized. The rooting medium is important from three standpoints i.e.: (a) it provides a method for holding the cuttings in place during the rooting sequence (b) it supplies water and (c) it supplies air. The first point may be satisfied by the use of almost any substance, although the regulation of the water-air ratio places a limitation on many materials such as cinders and heavy gravel.

Air-water ratio

Decker (7) has noted that 19 to 21 percent moisture (expressed as the dry weight of sand) represented a range favoring root initiation and development. In reality the air-water ratio as it exists in any rooting medium is governed by the size, as well as the porosity of the particle. Vermiculite, for example, of the grade having particle sizes ranging from two to three mm in diameter provides an excellent rooting medium provided compaction is avoided and adequate drainage provided.

It has been observed in studies concerned with the effect of size and shape of particles of the rooting media that during periods of high summer temperatures, cuttings placed in a coarse medium produced thin fiberous roots. The coarser medium contained more water and therefore the type of root system produced may be attributed to the existing air-water relationship rather than the size of the particle.

Many nurserymen know that softwood cuttings of many plants when rooted in sand produce brittle, heavy and sparsely branched roots in comparison to flexible, slender well branched roots produced by cuttings in peat moss. Long (15) concludes that low aeration as determined by the water content of the medium accounts for the finer root system produced in a peat moss medium. It is suggested that a more fibrous root system may be obtained from cuttings rooted in sand if the medium is firmed, and if short, slender cuttings are set deep in the medium.

Hydrogen ion concentration and rooting

The hydrogen ion concentration or pH of the medium as it effects rooting of different sorts has been a controversial question. It is known that callus formation is inhibited in media of low pH (below pH 4) or under conditions of high moisture. Cuttings which root profusely in peat moss (of relatively low pH) generally are those which have been sampled from shrubs belonging to the ericaceous group of plants, for instance, azalea, blueberry, and rhododendron.

In general then, the best medium to use for rooting softwood cuttings will depend on (a) the method of watering and (b) the type of plant material being propagated, as concerns acid tolerance. Root formation is based on the rapid formation of a suberin layer along the cells adjacent to the basal cut. Oxygen as well as average moisture and a slightly acid reaction of the medium are requisite to this suberization process for most sorts propagated by means of softwood cuttings.

Temperature of the rooting medium

Propagation by means of softwood cuttings is usually practiced during the summer months, and therefore, the regulation of the temperature in the medium is not an important factor. The stage of maturity of the wood selected for propagation, as well as the plant species determine the optimum temperature range favoring rooting.

Although callusing and rooting are distinct processes, callus production and rooting usually follow in sequence. As concerns temperature, Swingle (23) has noted that callusing appears to have been more active at slightly higher temperatures and lower moisture and oxygen supplies than those inducing rooting of apple.

Light as related to softwood propagation

Growth hormones in plants generally occur only in the presence of light (1). Skinner (19), working with leaf-bud cuttings of rhododendron, increased rooting by supplying an additional seven hour light period of 26 foot candles over the existing 10½ hour day. Stoutemyer and his coworkers (22) have noted that stock plants of *Gordonia axillaris*, (having evergreen foliage), given a light period of 16 hours daily (700-800 foot candles) for one month, yielded cuttings which rooted better than non-illuminated plants and with considerably less callus formation.

Stoutmyer (22) and Chadwick (5) reported that the red-orange end of the spectrum is more important in rooting cuttings than is the blue end of the spectrum.

Avery et al. (1) suggests that the fundamental principle governing these differential plant and cutting responses to light may be attributed to its effect on growth hormones as it in turn indirectly effects the synthesis of carbohydrates.

Mist Propagation

With the advent of mist propagation in greenhouses or out-of-doors, the ease of propagation of all deciduous shrubs from softwood cuttings has been greatly enhanced. However, as with any method, difficulties are encountered.

M. A. Raines in a published report presented in the *American Journal of Botany* in 1940, was to my knowledge, the first to report the use of a humidification chamber for the rooting of cuttings. Meanwhile, Gardner (10), a nurseryman from West De Pere, Wisconsin, was using mist propagation under cloth and glass during the summer of 1939 and 1940.

A portion of the following information has been compiled from work done by Stoutemyer (21), Houston and Chadwick (12), and Wells (25, 26, 27).

Constant mist installations differ from high humidity devices only in the periodicity of water application. In most controlled humidity greenhouses the water applied in an atomized spray runs only when the relative humidity of the house drops below a pre-determined point, for example 85%. Constant mist houses or outdoor frames apply atomized water continuously. In general, the effect on rooting of softwood cuttings placed in either environment is the same, provided adequate drainage exists.

Inasmuch as present emphasis is concerned with the application of constant mist spray either in sash houses or outdoor beds the discussion will be limited to this technique.

Construction

For all constant mist installations the most important single factor is that of drainage. In the construction of the beds, it is of prime importance that they be located in a full sun exposure. If raised benches are used, because of the constant application of water, it is necessary for them to be constructed of a durable building material such as transite, pecky cypress, or concrete. Adequate drainage may be supplied by either spacing holes along the groove in transite plates or by spacing pecky cypress boards and covering the space with a strip of plastic fly screening.

In the construction of ground beds, again, it is essential that good drainage be provided. This may be done by sloping the bottom of the beds to the center, making one end higher than the other, in order that the excess water, not absorbed by the soil can drain to the low end. The bed or bench may then be filled with one of several rooting media. The spacing used for a given nozzle type will depend on its height above the cuttings, available water pressure, and design of beds. Spacing will vary between 18 inches and 8 feet. If at all possible, the water should be strained or filtered before entering the main spray line which is constructed of copper tubing. Provisions for area control should be built into the system in order that men working in one part of the bed will not endanger an area previously stuck and which has been under spray application.

Media

Humidification, in general, tends to minimize the importance of a particular type of rooting medium. The salient feature must be that it permits good drainage. We have had excellent results with the use of the fine grade of perlite or volcanic ash. Wells (25) has reported good results with mixtures of sand and peat (50-50) for azaleas, and sharp river sand for a general line of deciduous trees and shrubs.

Cultural

Preparation of the cutting

The condition of the cutting wood, as previously discussed for general cold frame propagation is a matter of greatest importance in determining the response of plant material to the environment of high humidity. If cutting material from vigorous stock plants is sampled too early in the season, i.e., early May in our vicinity, the shoot is soft and immature, and subsequent placement under a high humidity environment will result in the rooting of the cutting. If the cutting is too hard, i.e., sampled late in the season, excessive callus, light rooting or immediate leaf fall often results. Cuttings of leguminous shrubs are often more difficult to propagate under mist in that they are quite sensitive to high humidity.

At Iowa State, in preliminary studies, we have found that by the application of various growth inhibitors, to stock plants, early in the season we have been able to eliminate in part this rot, which develops in cuttings sampled early in the season. We believe that this may be attributed to the effect of the chemical on hastening the maturity of the wood.

Cuttings are prepared in the usual manner, being from four to six inches in length. Longer cuttings may be made, but there is some difficulty experienced in handling, especially if they are of the slower rooting class of the larger leaved sorts. In general, as we have experienced with different media, the importance of the position of the basal cut is minimized. For most softwood species of shrubs, it is recommended that the basal cut be made immediately below the node, at a point through the leaf insertion. Cuttings are not trimmed, in that rooting, up to a certain point is directly proportional to the amount of foliage retained by the cutting. The basal cut should be clean, and the cutting should not be forced into the rooting medium, in that the damaged cells at the basal end of the cutting will not permit adequate healing, and also will serve as a medium for the growth of secondary pathogens which may ultimately cause the death of the cutting.

Handling the cutting

Of the faster rooting sorts as many as five or six batches can be rooted and transplanted during the course of one summer growing season; of the slower rooting deciduous shrubs only one or two batches can be obtained during the growing period. After rooting has taken place, cuttings propagated early in the season may be transplanted directly into protected beds. In some localities this may be impossible in that high temperatures at the time of transplanting will result in excessive wilting. If this is the case, it is necessary for the nurseryman to harden the cuttings off slowly, by gradually decreasing the amount of water applied. This can be done manually or by the installation of a time clock, which will regulate the time and amount of water applied during any one day. Studies concerned with the prevention of new growth during the rooting sequence by the application of growth inhibitors as well as the application of various anti-desiccants at the time of sticking and pulling have not proven to be commercially applicable.

Cuttings of valuable plants may be put in plant bands in a mixture of sand and peat, replaced in flats and allowed to remain under spray humidification until they have rooted through. They may then be transplanted directly into beds without danger of wilting.

Material propagated late in the season may be carried over winter in plant bands in storage cellars, or by healing-in in mulched, double sash outdoor beds.

Another method of handling this deciduous plant material propagated late in the season which seems to be working for Mr. Richard Fillmore at Shenandoah-Lakes Nursery, makes use of plastic rolls, in which the cuttings are incorporated in sphagnum moss, or vermiculite, secured in bundles, racked in boxes and stored in the cellar for early spring planting.

I realize that I have digressed in the latter part of this talk from principles to techniques. However, I feel that this method of propagating under constant mist will be the generally accepted method of increasing not only deciduous shrubs by softwood cuttings, but will be a means of propagating many other types of cuttings, throughout the season.

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. . . At the conclusion of this paper a brief summary was presented using Kodachrome slides. . . .

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CHAIRMAN MAHLSTEDE: I believe it is in order to delay the customary discussion period until after the next presentation.

Now it is my pleasure and privilege to introduce a man who has been outstanding in his field for many years. He has been described to me as one of Canada's most able propagators. He has taught at the University of Nanking, China, also at the Ontario Agricultural College at Guelph, Canada, and has been in the nursery business at Cooksville, Ontario for a number of years. It is with great pleasure that I present to you a man of the unusual blend of scientist, nurseryman, and teacher, Mr. Leslie Hancock, Cooksville, Ontario, who will speak to us on the subject of "Shrubs from Softwood Cuttings." Mr. Hancock.

Mr. Hancock presented his paper. (Applause)