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PROPAGATION OF WOODY PLANTS BY CUTTINGS

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Of the many methods available in which woody perennials can be propagated, propagation by seed is usually the easiest and most common method used throughout the world. It is usually the least expensive method and involves less care than vegetative propagation techniques such as grafting, rooting of cuttings or layering. Many woody plants, however, are difficult to propagate by conventional seeding methods possibly because of poor seed germination or difficulties in breaking seed dormancy. For instance, highbush cranberry, Viburnum edule, seeds have a double dormancy that requires a cold stratification period for 90 days followed by a warm treatment for 60 days, and finally a second cold treatment for another 75 days. After approximately 225 days, seeds are returned to temperatures above 21 C (70 F) for germination. If seeds are sown directly into a cultivated field, germination probably will not occur until the second growing season. Highbush cranberries are much more easily propagated by cuttings rather than by seed.

Other woody plants are easily propagated by seed, but seedling growth following germination is very slow. Seeds of labrador tea (Ledum groenlandicum) usually germinate within 24 days when given the appropriate environment, but it takes 15 months to 2 years to produce a large enough plant for sale. A larger-sized plant in a much shorter production cycle can be obtained by propagating labrador tea by cuttings or layering.

Probably the most important reasons for choosing to use vegetative propagation techniques rather than seed are to maintain genetic uniformity and to ensure perpetuation of desirable horticultural characteristics. When lingonberries (Vaccinium vitis-idaea) are propagated by cuttings, the resulting plant rarely produces new rhizomes. The resulting plant is a small, rounded mound of upright stems that does not spread to form a dense ground cover. In contrast, plants grown from seed quickly form a crowded, matted ground cover. New rhizomes are produced abundantly within 1 year of seed germination. If lingonberries are used for fruit production, all plants are propagated by seed in order to maintain a ground cover growth habit. However, many nurseries, particularly those specializing in rock garden plants prefer the small mounds of stems produced by cuttings. Consequently, lingonberries grown as an ornamental must be propagated by cuttings in order to perpetuate the shrubby growth habit.

Not all species are propagated easily by stem cuttings. Some appear impossible to root, while others may exhibit root initiation only sporadically and often at very low percentages. Stem cuttings of soapberry, Shepherdia canadensis, usually become black and die within 2 weeks of sticking them into a propagation bench. Other species such as lapland rosebay (Rhododendron lapponicum), produce roots on stem cuttings, but cutting

survival during the first winter may be very low. Merely getting cuttings to initiate and develop roots is by no means the end of the story.

Not only do species differ in their rootability, but individual plants within a species can exhibit different rooting responses. These differences may be related to genetic variability among plants or possibly to differences in growing conditions such as light intensity, air temperatures and nutrient availability. Consequently, it is important to select individual plants, not only for their ornamental appeal, but also for their rooting response. These stock plants must then be grown under controlled field conditions in a cutting nursery in order to assure consistent and high-quality cutting material.

Frequently, individuals interested in vegetative propagation, particularly of Alaska native plants, use wild plants or those grown in existing ornamental landscapes as their source of cuttings. These practices should be avoided because rooting percentages and cutting survival are unpredictable and frequently very low. The source of cutting material and the environment under which stock plants are maintained can be critical to the successful rooting of cuttings. Under controlled field conditions, cuttings are more easily accessible, and it is easier to maintain young, vigorous, juvenile growth which quite often provides the best cutting material.

No less important than the source of cutting material is the stage of growth and the type of cuttings collected. Rooting potential may fluctuate widely throughout the year,and propagation success often is best at a specific time. Hardwood cuttings are collected during the dormant season, usually from September to early May in Fairbanks. The stem tissue is fully mature and leaves on deciduous species have fallen or about to do so. Cuttings usually are 6-12" in length and contain a minimum of 3 nodes or buds. Plants that produce roots easily from hardwood cuttings include snowberry (Symphoricarpos albus), honeysuckle (Lonicera sp.), and rose (Rosa acicularis).

Softwood cuttings are collected from the tips of succulent, immature stems during active growth usually in June and early July in Fairbanks. Cuttings are collected in the early morning when stems are fully turgid and are 3-5" long with 2-3 leafy nodes. Cuttings should snap off or cut very easily. Timing is critical in the collection of cuttings; the difference between success and failure being a matter of days. Cuttings taken a few days too early usually wilt and die, while those taken too late may produce no roots. Plants that root well from softwood cuttings include Beauverd spiraea (Spiraea Beauverdiana), redosier dogwood (Cornus sericea), and crowberry (Empetrum nigrum).

Semi-hardwood cuttings are collected after the first flush of new growth usually in July or August in Fairbanks. Stem tissues are maturing, and they tend to bend without breaking rather than snapping off like softwood cuttings. Cuttings generally are 6-10" long and have 2-3 leafy nodes. Some plants that produce roots easily from semi-hardwood cuttings are cinquefoil (Potentilla fruticosa), juniper (Juniperus communis) and bearberry (Arctostaphylos uva-ursi).

In addition to season, the position of the cutting on the stock plant can affect rooting potential. For instance, it has been reported frequently that cuttings taken from the basal part of the plant (the most juvenile tissue) root more easily than those from the top of the plant. Cuttings of one-year-old wood are usually preferred over two- and three-year-old wood. Cuttings taken from the basal portion of one-year-old wood often root better than terminal cuttings. A common practice with many plants such as crowberry, twinflower (Linnaea borealis), and juniper is to use one-year-old wood plus a piece of older wood at the base of the cutting. These are called heel or mallet cuttings.

After collection, semi-hardwood and hardwood cuttings may be stored, refrigerated (4-10 C; 40-50 F) for a few days until propagated. For long-term storage of hardwood cuttings, wrap cuttings in polyethylene bags or bury in moist peat and store at or slightly below freezing temperatures. Softwood cuttings should not be collected until just prior to propagation because of their perishable nature.

In many nurseries, large whips of cutting material are collected from the stock plants and brought into the headhouse or work area where they are cut to the appropriate size for propagation. Once the cuttings are made they are usually dipped into a chlorine bleach solution (one part bleach to 20 parts water) or other disinfectant. Cuttings may also be treated with a fungicide such as benomyl alone or in combination with a growth regulator. Chemical such as Indole acetic acid (IAA), indolebutyric acid (IBA), napthaleneacetic acid (NAA), napthalenacetamide (NAM) and phenoxy compounds (e.g. 2,4-D) are often used to increase rooting percentages, hasten rooting, increase root quality or improve uniformity of rooting. IAA has powerful root promoting ability but is not used commercially because it is unstable in light and is easily broken down by certain bacteria. It is also mobile within the plant and may move away from the site of application. Phenoxy compounds also are not popular because they tend to inhibit shoot formation and bud break after rooting.

Chemicals may be applied as a commercial powder that is sold at specific concentrations of growth regulator combined with talc. Commercial powders are quick, easy to use and require no special storage environment besides keeping the powder dry. Despite their popularity, it is easy to get a non-uniform coating especially if many cuttings are treated at once. Also, the powder is easily rubbed off when cuttings are stuck into the propagating medium.

The dilute solution soak method involves dissolving crystals of the growth regulator in a few drops of alcohol, then diluting in water, usually to a concentration of up to 500 ppm. Cuttings are prepared,and about 1" of the basal portion of the stem is soaked for 6-48 hours. These solutions must be refrigerated and usually lose their activity in 2-3 days. They are easily contaminated, and because of the long soak time, environmental factors such as air temperature and light influence their effectiveness in root promotion.

In the quick dip method the growth regulator is dissolved in a solvent such as ethyl, methyl or isopropyl alcohol at concentrations of 500 to

20,000 ppm. Approximately 1/2" of the base of the cutting is soaked in the solution for 5 seconds. If properly refrigerated and sealed, this solution may be used for several thousand cuttings.

The spray method is used much less frequently than the powder or liquid dip methods and involves spraying the leaves either of the stock plant or the entire cutting with aqueous solutions of IBA or NAA. If the concentration is sufficiently strong (2000-10,000 ppm), this method is successful with some species, but it wastes a lot of chemical if only the base of a cutting needs treatment in order to induce rooting.

Once cuttings are treated they are stuck either into individual flats or directly into a greenhouse bench or cold frame. Many different types of flats, wooden or plastic, will work as long as they can hold a minimum of 4" of propagating medium. They must be deep enough so that cuttings may be inserted to 1/2 their length in the medium. Flats should be strong enough to be reusable and should be capable of being surface sterilized or steam pasteurized. Flats allow easy movement of cuttings from one part of the nursery to another. Root systems usually remain undisturbed until the final planting in the field or containers. In most commercial operations, the medium is not reused.

Propagation benches may also be used as long as they have sides that are at least 4-6" high. With propagation benches, the initial investment is lower, and more plants can be propagated per square foot. The propagating medium often is reused, and both bench and medium must be steam pasteurized or fumigated chemically with substances such as methyl bromide, formaldehyde or chloropicrin. Cuttings must also be removed following rooting, and there is a greater chance of root damage with benches than with flats.

Flats or benches are then filled with an appropriate medium. Some species root quite easily in almost any propagating medium, while others may be greatly influenced by the kind of rooting medium. Not only can the percentage and rate of rooting be influenced, but also root quality and the extent of root development can also change with different media. Every nursery develops their own propagating medium. What works well in one nursery may be entirely inadequate at another because of differences in propagating techniques, species, and environmental conditions under which plants are propagated. The medium must be sufficiently firm to support cuttings in an upright position for several weeks. It must be moist but well drained since good aeration is equally as important as moisture availability in root initiation and development. It must be free of toxic substances such as high salt content and free of insects, diseases and weed seeds. Some media, because of their origin (e.g. perlite, vermiculite) are relatively sterile when purchased, while others must be able to withstand steam pasteurization or chemical fumigation. The medium must be able to retain a constant volume, either wet or dry to provide firm, dense anchorage for cuttings during rooting. If the medium is a combination of two or more substances it must be easily mixed, uniform, and relatively cheap to prepare.

Sand is one of the most widely used propagating media throughout the

United States. It is locally available and often less expensive than other media. Good quality builder's sand is a suitable medium. It usually contains weed seeds and various pathogens and should be pasteurized or fumigated between propagation cycles. It should also be noted that sand is very heavy (about 100 lb per cubic foot, dry weight), and because of this, it is often mixed with other media to decrease weight and increase moisture retention. Sand provides few, if any, nutrients to rooted cuttings, and consequently it does not provide the best medium for holding cuttings for extended periods after rooting.

Perlite is a widely used propagating medium especially in the United States and New Zealand where large natural deposits of this mineral occur. It is a white mineral of volcanic origin that is crushed and heated to 1300-1400 F. These high temperatures change the water in the rock to steam and cause the particles to expand creating a sterile, lightweight medium (weight 5-8 lb per cubic foot). Very little water is absorbed by these particles, and consequently this medium is very well drained. It may be used alone but is usually mixed with other media to increase moisture holding capacity. Like sand, little or no nutrients are available for plant utilization, thus it is not appropriate to maintain cuttings in perlite for long periods after rooting. Perlite comes in a variety of graded sizes. For propagation,a particle size of 1/16" to 1/8" is best.

Vermiculite is a mineral that resembles mica in appearance and is composed of hydrated magnesium-aluminum-iron silicate. When heated to almost 1000 F it expands 15-20 times its original volume yielding a sterile, lightweight (6-10 lb per cubic foot) medium with a high moisture holding capacity. Vermiculite in the 1/8" diameter size class often is used in combination with perlite and sand to increase moisture holding capacity and provide some nutrients to rooted cuttings. Used alone, it tends to compact with time and loses considerable volume, especially when wet.

Peat moss is often combined with sand or perlite on a 1:1 or 1:2 ratio to provide a satisfactory rooting medium for some species. Peat serves to increase water holding capacity. When used alone it is easily over watered. Another disadvantage to using peat is that it attracts fungus gnats-- a small fly whose larvae feed on decaying organic matter. In a moist propagating bench populations can increase very rapidly, and larvae feed indiscriminately on peat, young succulent roots and soft cambial tissue at the base of cuttings.

Cuttings are stuck into the appropriate medium, usually about 2 1/2" to 3" apart. All leafy cuttings root best when propagated under an intermittent mist propagation system in a greenhouse, lath house or cold frame. Nozzles are placed above or along side the plants, and a fine mist of water is applied to cuttings at specified intervals (a few seconds every minute). A mist propagation system keeps relative humidity high around the cuttings and a continuous film of water on leaves and stems. This reduces the temperature of the cuttings and prevents them from drying out before roots are formed.

Often, with small operations, an entire greenhouse cannot be devoted to propagation. In many instances, one bench in a greenhouse is covered

with a polyethylene tent that serves to increase humidity alone or in combination with a mist system. During the summer, the addition of shade cloth helps reduce water loss from cuttings and ensures greater rooting success.

A cold frame can be modified to work well as a propagating box for softwood cuttings. Frames should be raised or equipped with drainage tiles to avoid waterlogging, and they should be closed tightly to maintain high humidity. Shade cloth also helps reduce temperatures especially if a mist system is not available. It is often recommended that softwood cuttings and semi-hardwood cuttings be rooted in cold frames and allowed to remain in place until the following spring. In Fairbanks, this method works only with the most easily rooting softwood cuttings. Difficult-to-root cuttings and semi-hardwood cuttings rarely develop sufficient root systems by freeze-up, and winter survival usually is poor.

Cuttings are maintained in the propagating structure at least until secondary branch roots appear. Following rooting, cuttings must be carefully handled in order to ensure survival as they are taken from a very humid environment to a drier one. With some plants such as Prunus sp., cuttings must be removed immediately after rooting or defoliation and root deterioriation occur very rapidly. If a mist system is used, one of the most successful methods is to gradually lengthen the time between mist applications thus providing a drier environment. In cold frames, softwood cuttings may be allowed to send roots through the propagating medium into a layer of composted soil below. Cuttings may also be removed from the propagation structure immediately and potted up. The containerized stock is then held in a humid, shaded location until cuttings are hardened off.

Summary

Many woody plants can easily be grown from stem cuttings in a greenhouse, lath house or cold frame. The most important aspects for a successful program include easily available,healthy and high quality cutting material; proper selection and treatment of cuttings; providing the proper rooting environment including high humidity,warm temperatures, light and a pest free environment; and provisions for hardening off cuttings following rooting.