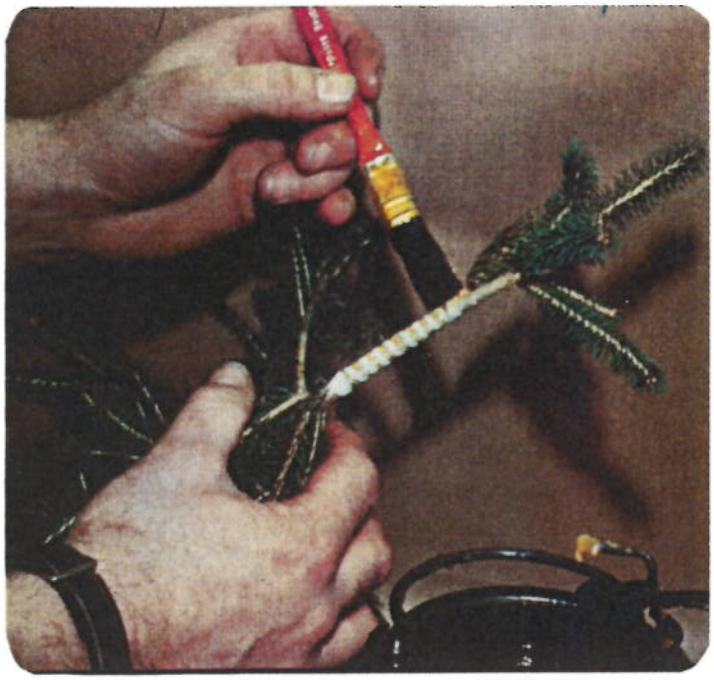
M - X - 117
ISSN 0704-769X



MANUAL FOR GREENHOUSE GRAFTING OF CONIFERS IN THE MARITIMES

by
R. D. HALLETT
R. F. SMITH
and
T. W. BURNS

MARITIMES
CANADIAN FORESTRY SERVICE

MARITIMES FOREST RESEARCH CENTRE

The Maritimes Forest Research Centre (MFRC) is one of six regional establishments of the Canadian Forestry Service, within Environment Canada. The Centre conducts a program of work directed toward the solution of major forestry problems and the development of more effective forest management techniques for use in the Maritime Provinces.

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Cover photographs:

Top: Waxing a white spruce graft.

Bottom: Clonal seed orchard, Lawrencetown, Nova Scotia.

Insert: Black spruce ramet bearing cones.

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R.D. Hallett, R.F. Smith, and T.W. Burns

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Information Report M-X-117

Canadian Forestry Service
Environment Canada

1981

Contents

ABSTRACT

Procedures are outlined for winter greenhouse grafting of spruce, larch, and pine. Sections are included on the production of root stocks, grafting techniques, and care of grafts. Four grafting techniques are described: side-veneer, pocket, cleft, and whip-and-tongue.

RESUME

Ce rapport explique les procédures à suivre pour le greffage en serre l'hiver de l'épinette, du mélèze et du pin. On y inclus des sections sur la production de porte-greffes, les techniques de greffage, et le soin des greffes. Quatre techniques de greffage y sont décrites.

INTRODUCTION

Grafting is used in tree improvement programs to reproduce exactly, the genetic material (genotypes) of selected trees. In addition to being genetic "photocopies", grafts usually retain the physiological age of the original tree (ortet) and are thus capable of flowering at an earlier age than are seedlings. This is beneficial when establishing seed orchards of species such as red spruce (Picea rubens Sarg.) white pine (Pinus strobus L.) and Norway spruce (Picea abies (L.) Karst.) which do not normally flower at an early age.

In the Maritimes, expanding reforestation programs have resulted in an increased tree improvement effort. Grafting, which is an integral part of this effort, is both costly and time consuming. It involves tree selection, scion collection, production of rootstock, the grafting itself, and finally the care and maintenance of the grafts. Costs may be as high as $600 to $700 to produce 20 to 30 successful grafts per selection. The utmost care must be taken to ensure the greatest possible success.

The publications "Greenhouse grafting of spruce and hard pine" by Holst et al. (1956) and "The Grafters Handbook" by Garner (1946) have been used extensively. However a recent manual specific to grafting forest tree species is not available.

This report provides working guidelines for the production of greenhouse grafts in spruce, (Picea spp.) larch, (Larix spp.) and pine (Pinus spp.) and is based on our experience. It includes sections on greenhouse and nursery culture which are specific to the production of rootstocks and the care of grafted plants. For more information on greenhouse culture the reader is referred to container production manuals such as those by Carlson (1979) and Tinus and McDonald (1979). For bareroot nursery soil management practices, the manual by Armson and Sadreika (1979) is suggested. A comprehensive treatise on seed orchards by Faulkner (1975) is also useful reading.

PRODUCTION OF ROOTSTOCK

The production of rootstock must be planned in advance. Time is required to grow seedlings and to raise the potted rootstock. Extra stock is needed in both phases to allow for culling.

Seedling Quality

Healthy seedlings of good form are required for potting. They can be bareroot or container stock. Clear wood is essential for successful grafting, if knots are present a clean cut is difficult. Spruce seedlings should have long leaders with large diameters at both the time of potting and grafting. This should permit a choice between terminal or internode positions to match the scions to be grafted.

It is advisable to have some variation in seedling size as it is inevitable that the scions will not be uniform.

Choice of Pot

Usually, pots should not be smaller than 10 cm (4 in.) in diameter for black spruce (Picea mariana (Mill.) B.S.P.) and larch. Certain species such as red pine (Pinus resinosa Ait.) or Norway spruce, which produce heavy growth (i.e., potentially large scions), require larger stock. However, increasing pot size reduces greenhouse capacity but it is necessary to choose a size suitable for growth of the required size of stock.

Soft, durable, plastic pots with several drainage holes are recommen-

ded. Fibre pots tend to break down so are difficult to handle in the greenhouse. Clay pots lose too much water under outdoor conditions, making it difficult to maintain adequate moisture for good growth. Also, clay and hard plastic pots break too easily after weathering.

Potting Medium

Moisture and aeration properties of the medium are most important to facilitate handling in the rootstock production phase and for tending after grafting. Coarse soil mixes are recommended because they facilitate drainage and aeration, yet have sufficient organic matter or absorbing material (e.g., vermiculite) to hold an adequate supply of both available water and nutrients. A recommended overall mix easily reproduced is composed as follows: 2 parts peat, 1 vermiculite, 1 aggregate (crushed rock) and 1 composted loam, by volume.

Coarse, sphagnum peat moss has been used successfully although difficulties can be experienced in regulating soil water. Wide variations in soil moisture can occur, as peat may dry out in summer and be very hard to rewet: in winter when less water is required, water-logging can occur. For these reasons, a soil mix is suggested.

Mineral soil mixes should not be used. They are difficult to handle because of weight, compaction, and reduced available water.

Potting

Potting is important because of its effect on seedling quality and root form. For a winter grafting program, seedlings potted in the spring will have strong root systems by fall. Mortality or poor growth caused by improper potting or handling can be recognized and stock can be culled before the grafting season. Seedlings can be potted in the summer, but it will be more difficult to recognize subsequent potential losses. Root systems may be less "pot-bound", but there will be greater losses from potting and grafting stress. Pot-bound rootstock should not be used, thus rootstock should not be kept more than one season before grafting.

The roots should fit into the pot without curling, bending, or bunching. Root-pruning may be necessary. The roots should be well distributed in the pot and moist soil medium packed around them. This can be done by hand, with fingers extended in order to achieve a natural placement of roots.

Tending Pots

The seedlings should be watered and fertilized immediately after potting with a plant starter solution such as 10-52-10. The rate of application may vary from 1 to 2 kg/500 L per 50 - 100 m^2 of pots (1 kg/500 L = ca. 1 Tbsp/5 L). They should then be moved to a shaded area (about 50% shade) where the potted stock can remain most of the summer. Shaded plants are easy to care for and grow well.

Maximum quality of rootstock is desired, so optimal growing conditions should be maintained. Seedlings must not be submitted to moisture stress, hence the moisture content of the soil media should be held near field capacity.

During the growing season, application of a soluble fertilizer such as 20-20-20 is suggested (1 to 2 kg/500 L per 50 - 100 m^2 of pots). Occasionally, this may be amended with ammonium nitrate (0.25 to 0.5 kg/500 L per 50 - 100 m^2 of pots). Care must be taken to avoid fertilizer salt injury. Concentrated fertilizer solutions must be washed from foliage immediately following application. Salt levels should be monitored regularly to avoid toxic

accumulations. The soils should be leached when the salts reach 50 x 10^{-5} μ mohs/cm^2.

A good pest prevention program should be implemented to prevent insect damage. Root aphids are a problem with rootstock, particularly with white spruce (Picea glauca (Moench) Voss). The use of soil applied pesticides such as lindane (0.25 to 0.5 kg active ingredient (ai)/500 L per 100 m^2 of pots) should prevent the build-up of high populations. They are difficult to control in the greenhouse.

Foliage diseases usually are not a problem. Root rots may occur, particularly in cold and wet periods during spring and fall. Root deterioration can result from prolonged saturation of the soil, excessive drying, or soil salts.

Rootstocks of spruce and larch should be pruned during the summer to provide a section of clear wood on which to graft. This is easily done by removing the buds, foliage, and branches as they develop at the desired grafting location.

Overwintering

When assembling rootstock for overwintering, poor seedlings should be culled.

A well-drained, protected location is required to overwinter the rootstock. It is almost impossible to transfer potted rootstock that is 'frozen-in' without causing severe damage. The rootstock should be placed on pallets in a protected area such as a cold frame, lath house, or a forest stand, to facilitate transfer to the greenhouse. Poles can be used to keep the pallets off the ground as a further insurance against freezing in. Snow cover is ideal to protect the rootstock from winter drying and root injury from severe freezing. Artificial cover is essential if snowfall is unreliable. Reducing the exposure of border pots with boughs, straw, or lath fencing is suggested (Fig. 1).

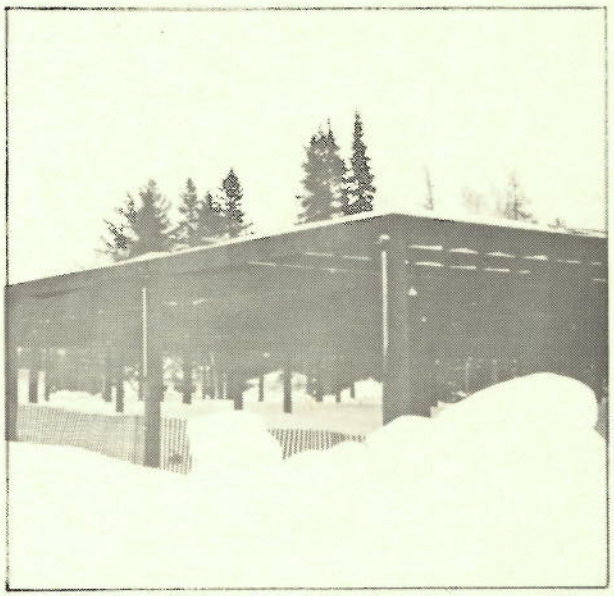

Fig. 1. Pole frame shade area for container stock.

SCION COLLECTION

Scion collection must be coordinated with grafting to ensure the scions are grafted fresh. Only the best possible quality of scions should be collected, properly transported and stored to ensure that this material is not damaged.

Scion Quality

1. Only current-year growth should be used. Older wood in white spruce, for instance, generally results in a low take in grafting (Holst et al. 1956). White spruce and tamarack scions are often very small because of budworm damage or reduced vigor in older trees. In such instances, intact branch ends should be collected. This permits selection of the best available scion material at the time of grafting and reduces drying out of the scions.

2. Scions should be 8-15 cm (3-5 inches) in length, and 3-6 mm (1/8-1/4 inch) in diameter (Fig. 2).

3. Each scion MUST have at least ONE full intact bud, preferably terminal.

4. The scions should be as free as possible, from insect or other damage and, for pines and spruces, have a full complement of needles.

It is important that the scions meet these criteria as closely as possible. For instance, the use of small scions both increases the difficulty in working with the material and reduces considerably, the chance of success.

Fig. 2. Scions of A. White pine, B. Tamarack, C. White spruce, and D. Norway spruce.

Position in Crown

Scions should be collected from the upper one-third of the crown where the best growth is usually found. If taken lower, the grafts are more likely to maintain the growth habits of lateral branches ("topophysis"), thus producing poorly formed trees. Also, scions from the upper crown will eventually produce both male and female flowers, whereas those from the lower crown will tend to produce male flowers only (Rauter 1977).

Time of Collection

In the Maritimes grafting is usually done using dormant scions collected between January and March. This is after the buds have had their dormancy requirements satisfied, but before growth commences in the spring.

Method of Collection

1. **Shooting:** Rifles may be used for for scion collection. Single branches may be shot off with a .22 or similar calibre rifle. However, it is often very difficult to bring down single branches in dense stands, as they easily get caught in adjacent crowns. A 12-gauge shotgun using rifled slugs has been used in New Brunswick to shoot off the entire top of the tree. High powered rifles should not be used near habitation.
2. **Climbing:** Several methods of tree climbing have been tested that are both safe and effective. Presently, climbing is used extensively in Nova Scotia. The various techniques are discussed in detail by Yeatman and Nieman (1978). Climbing should only be performed by fully trained personnel using properly designed and tested safety equipment.
3. **Felling:** When the tree from which the scions are to be collected is in an area soon to be cut or when the tree is almost certain to blow down, (e.g., a solitary tree standing

in a clearcut), it is best to fell the tree. The entire crown can then be examined and the best scions obtained. This method precludes the possibility of making subsequent collections from the same tree, and hence should be used with discretion.

Storage and Transportation

The scions keep best when packed in snow inside plastic bags during collection, transportation, and storage. The bag should be identified with a tag inside and another outside, both marked with waterproof ink, giving species, tree number, agency, date collected, and any other relevant information. Care should be taken to prevent the snow from melting. The scions will deteriorate if left in water more than a few minutes. If the snow melts, the water must be drained off immediately and new snow added. If snow is not available, moist (not wet) sphagnum moss can be used. Place the bags in a freezer or a snowbank. NEVER ALLOW THE SCIONS TO DRY OUT OR COME TO ROOM TEMPERATURE.

It is necessary to keep the time between collecting and grafting to a minimum. We have found a direct correlation between length of storage and grafting success. The scions should be shipped within a week after collection, to the location where the grafting will be done. If being transported by car, a picnic cooler packed with ice or snow serves well to prevent thawing (if melting occurs, the plug can be pulled for drainage.)

PREPARATIONS FOR GRAFTING

Rootstocks

For winter grafting, the rootstocks must remain outside until their cold requirement is fulfilled (about the end of December). Rootstock moved inside should be thawed gradually in a cool, humid, and shaded location.

After the stock has thawed, fertilize lightly with water-soluble plant starter fertilizer (1 - 2 kg/500 L per 50 m^2 of pots). Several species of insects on the stock can be controlled at this stage with insecticides. First, drench the soil with a chemical such as lindane (0.25 to 0.5 kg a.i/500 L per 100 m^2 of pots), which has residual action for soil-borne insects. Then apply a dormant oil spray to the foliage (dormant oil can burn the foliage of white pine).

Spruce and larch rootstocks are ready to graft immediately after they have thawed. Grafting should be done before the buds flush. If the rootstock is of poor quality, it may be advisable to delay grafting until until root activity is seen or budswelling occurs. In this way, it is possible to cull dead and dying rootstocks. Root activity may not be a reliable criterion, because it often does not occur before bud flush in a greenhouse situation of forced growth.

Grafting materials

1. **Knives:** Each grafter should have a set of three knives. A typical set is shown in Fig. 3.

a) **Grafting knife** - This knife is beveled on ONE SIDE only, facilitating a straight cut. It must be extremely sharp, as a dull blade will damage cambial cells adjacent to the cut.

b) **Curved blade knife** - This is used for cutting or stripping needles and buds from scions and rootstock, and removing small branches from the rootstock.

c) **Budding knife** - This is used for pocket grafting to make the cut and lift the bark flap.

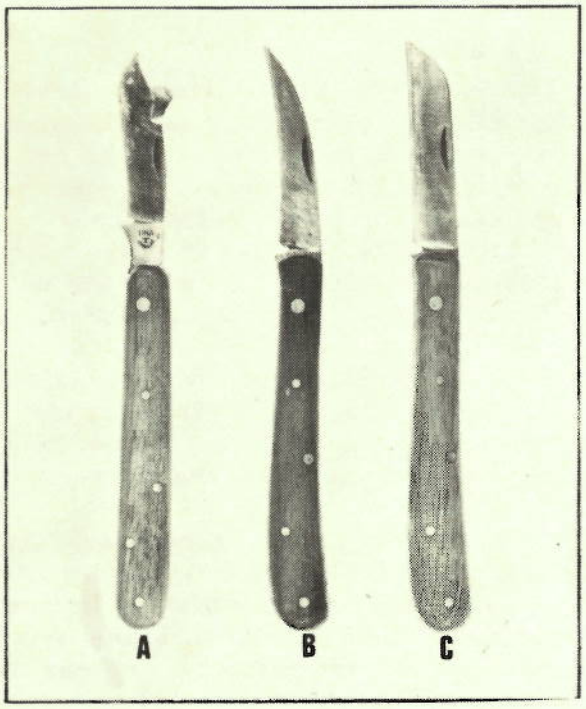

Fig. 3. A. budding, B. pruning and C. grafting knives.

2. **Sharpening Stones:** A combination of stones is useful:

a) A soft stone for initial sharpening,

b) A hard stone or strop for finishing, and

c) A stone with a rounded side to sharpen curved blades.

3. **Grafting bands:** Rubber strips are required to hold the scion to the rootstock. Several companies supply a thin banding material in various lengths and widths for grafting. Bands 5 mm wide by 10 - 15 cm long are satisfactory. Wide elastic bands can be used also.

4. **Wax or grafting compound:** For spruce and larch the exposed edges of the completed graft are usually covered with a wax or grafting compound to prevent dessication.

5. **Hot plate:** This is probably the easiest method of maintaining wax at the desired temperature. Any variable temperature heating element will suffice.

6. **Brush:** A soft camel-hair brush should be used to apply the wax.

7. **Tags:** Various types of plastic tags are available and should be used to ensure that the identity of the graft is retained.

8. **Alcohol:** When grafting, knives become covered with resin and they can be easily cleaned with alcohol.

9. **Hand pruners:** These are essential for the removal of larger branches at the time of grafting, and for subsequent pruning in the greenhouse and nursery. Several types are available (Fig. 4.):

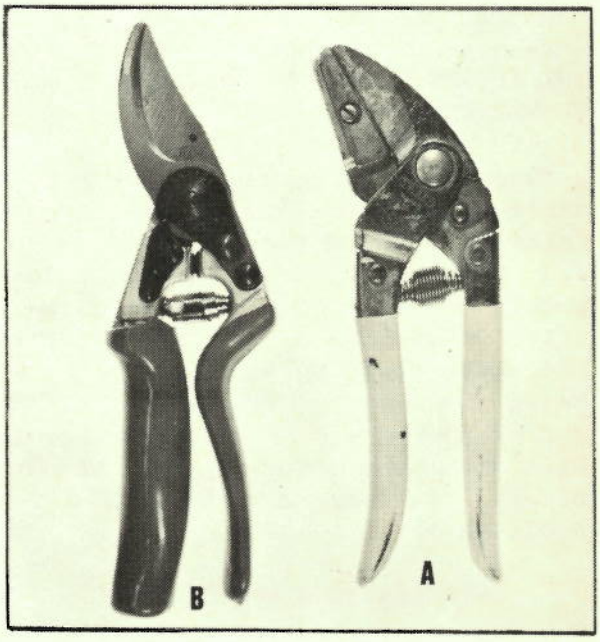

Fig. 4. Handpruners. A. anvil pruners and B. side cutters.

a) **Anvil cutters:** These consist of a cutting blade which is forced down on an 'anvil'.

b) **Side cutters:** These have two cutting blades, one shearing by the other. Closer cuts can be made with these than with anvil cutters.

Record Systems

Good records are essential - the identity of a graft must never be lost. "If in doubt, throw it out!" Some information should be recorded: tree and graft identification numbers are essential, and other data such as the dates of scion collection and grafting, graftor, etc, can prove useful in later evaluation.

GRAFTING PROCEDURES

All grafting materials should be ready before bringing the rootstock into the workroom. If wax is used, more than 1 h will be required to bring it to the desired temperature. For expediency, an automatic timer on a hot plate can be used. Note that it should be set at a temperature sufficient only to bring the wax to its melting point, a temperature comfortable to touch. HEATING WAX TOO QUICKLY OR TO A HIGH TEMPERATURE WILL RUIN ITS COATING PROPERTIES. HOT WAX CAN DAMAGE STEM TISSUE.

The scions should be brought from the freezer or snowbank when everything else is ready. Complete thawing is unnecessary. At the time of grafting, scions should be kept moist, but NOT soaked in water which would result in the scions becoming soft and difficult to use. The best method is to place them in a beaker filled with snow. Wrapping them in a damp towel will also do.

There are several grafting methods which can be used. The principle one described here is the side-veneer graft. It is relatively easy and has proven successful for conifers when the diameter of the scions matches that of the rootstock. Procedures for the pocket, cleft, and whip-and-tongue grafts are given in lesser detail later.

Side Veneer Graft

The procedures are as follow:

1. Select a scion and rootstock of appropriate sizes for matching cuts (Fig. 5). The choice of grafting point will depend on the best match between the diameter of the scion and that of the rootstock (differences in bark thickness must be considered). Spruce is usually high grafted i.e., on the terminal or first internode. Heavy cuts are not recommended on the leaders of spruce rootstocks because the leader may die and with it, the scion. The base of the leader is the best position. At least one whorl of supporting branches is left below the grafting location. Larch and pine, are usually grafted low on the rootstock resulting in a sturdy graft which is less susceptible to breakage.

Fig. 5. Section of root stock matched with scion.

2. At the desired point for grafting, cut needles, buds, and branches from the stem of the rootstock that would obstruct placement of the scion. Pruning the rootstock may not be necessary, except to facilitate grafting.

3. Trim needles and buds from the base of the scion for about two-thirds of its length. Needles may be cut or scraped from the scion depending on their condition (Fig. 6). There MUST be at least one intact bud remaining on the scion. If buds or needles on the scion prevent flush mounting, remove them.

4. Find a convenient way to hold the scion flat for cutting. This is best done on a flat board (Fig. 7) although cutting can be done on a

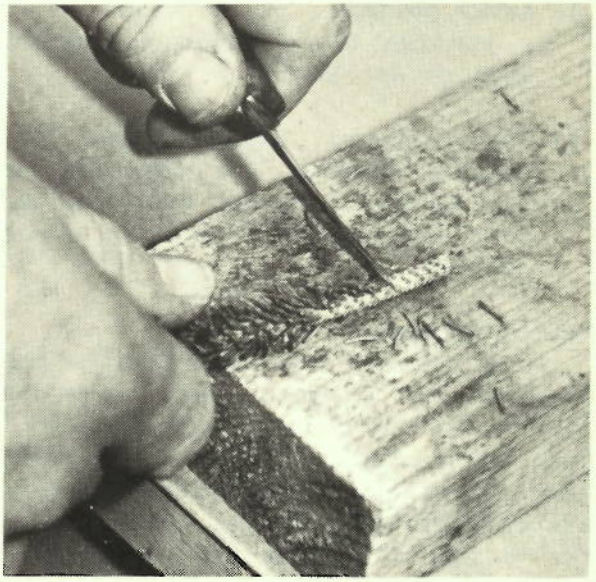

Fig. 6. Scrape or cut needles from scion.

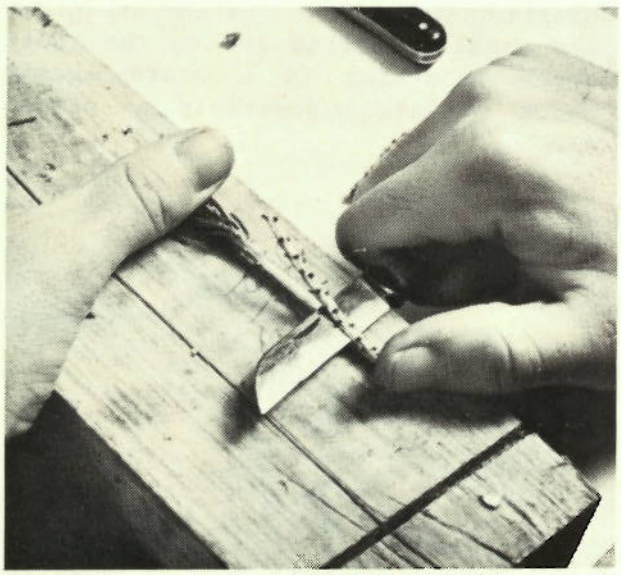

Fig. 7. Making veneer cut on scion.

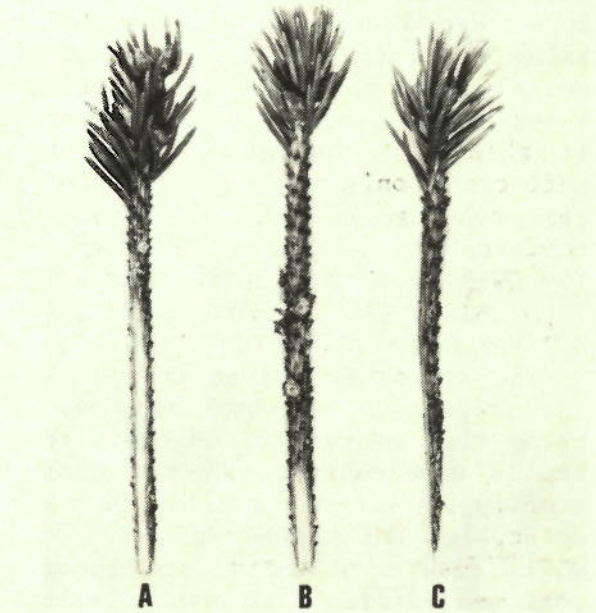

Fig. 8. Prepare scion showing A. veneer cut, B. carrot cut, and C. side view of cuts.

knee or palm of one hand. Start the cut at a gradual angle to the bark and make a smooth continuing veneer cut along the length of the scion. Sharp angles are hard to match and predispose the graft to breakage. This cut will vary from 3 to 6 to 8 cm in length for small, medium and large scions. The cut MUST be done in one motion and on one plane (don't whittle or rotate the scion as the cut is made). The cut should not be too deep (one-third way through scion or less). Cut the scion to the desired length with a diagonal cut (length 2 to 3 times diameter of scion) from the back side (carrot cut) (Fig. 8).

5. Make a matching veneer cut on the rootstock so that the exposed cambium on both surfaces will meet perfectly (Fig. 9). Then cut off the resulting strip of bark BUT BE SURE TO LEAVE A SHORT FLAP OF BARK AT THE BASE to match the carrot cut on the scion. The success of the side veneer graft depends on this bark flap (Fig.10). NOTE: When cutting the rootstock, hold the prepared scion parallel to the stem of the seedling so you can judge the cut (Fig. 11). FRESHLY CUT SURFACES SHOULD BE KEPT CLEAN AND NOT TOUCHED WITH FINGERS.

Fig. 9. Matched cuts on scion and rootstock.

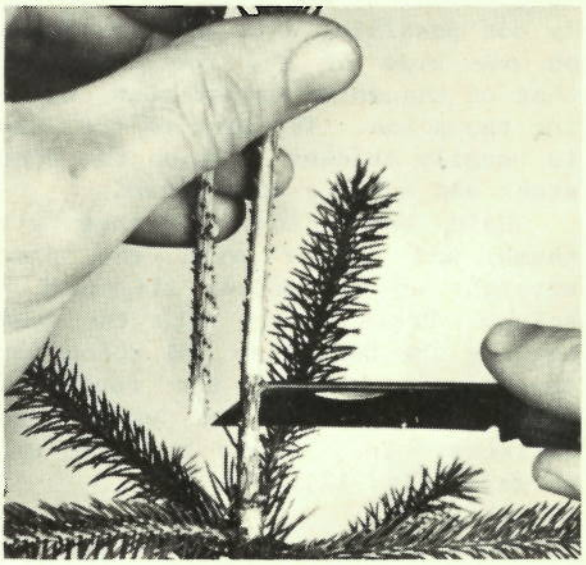

Fig. 10. Bark flap prepared to match "carrot cut".

Fig. 11. Making veneer cut on rootstock while holding prepared scion for comparison.

6. Insert the scion into the bark flap so the cambium layers of the rootstock and scion match. If this is not possible, line up the cambium on one side of the rootstock with that of the scion rather than centering the scion. The bark of the scion is usually thicker than on the rootstock and must be considered.

Hold the scion in place with thumb and finger with the thumb straight up for proper alignment of scion. Press firmly with the thumb holding the bark flap and scion, and the finger holding the rootstock. Then examine the two veneer cut surfaces. They should be flush with no gaps (Fig. 12).

7. Hold the end of a band with the finger at the back side, wrap the band around the rootstock so that it crosses and holds itself. The next wrap should catch the bark flap and scion to hold the base secure so that the thumb and finger may be released. Continue wrapping to just above the top of the veneer cuts. Rotate the band in the fingers while wrapping so it will lie flat on the bark. To tie at the top, first make two wraps at the top junction of the cuts, then while holding the stem between the fingers, wrap the band around your finger and pull the end through the loop and release (Fig. 13).

8. Make certain that the top and bottom are held firmly as these tend to be stress points and difficult to hold. Be sure the band is uniformly tight at all points. Do not wrap too tightly as strangulation may occur.

9. Wax the exposed edges of the cut, especially the top and base. It is not necessary to wax the entire circumference. Any scars or wounds left by removal of interfering branches should be covered. Waxing helps prevent desiccation and possibly reduces infection entering through the exposed surfaces (Fig. 14). It is not necessary to wax white pine grafts because of the heavy resin flow.

10. Put an identification tag on the completed graft (Fig. 15).

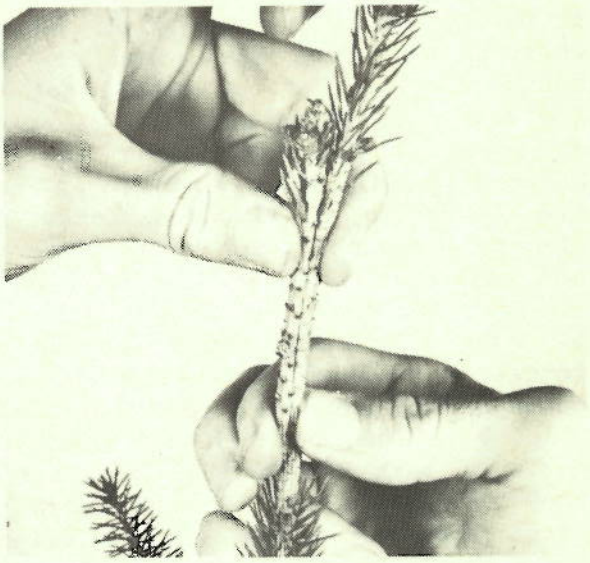

Fig. 12. Placing the scion on the rootstock so the surfaces meet flush.

Fig. 13A. Band wrapped around root-stock to hold itself.

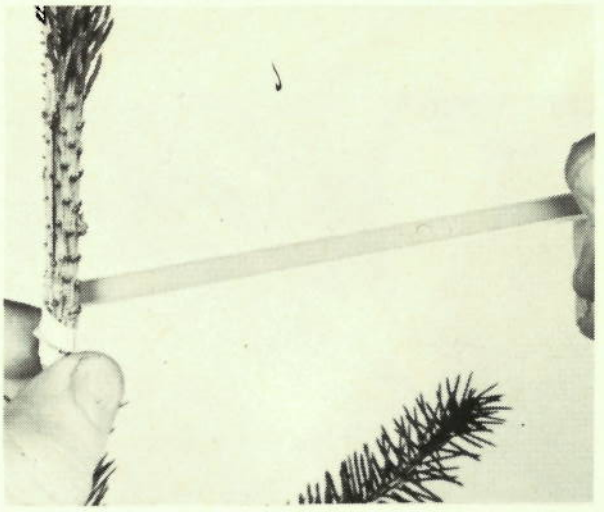

Fig. 13B. Scion held by bark flap.

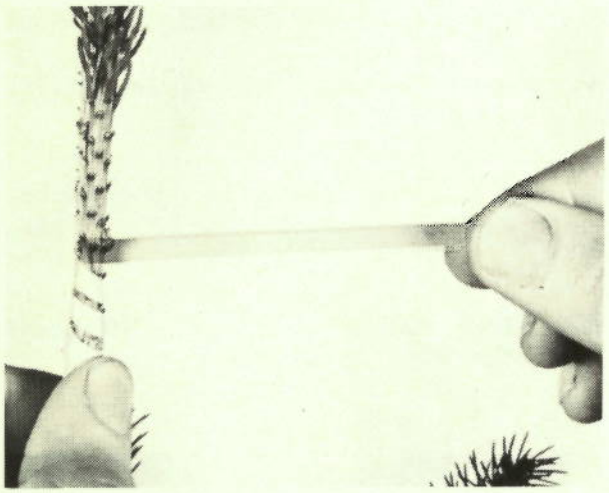

Fig. 13C. Band wrapped uniformly.

Fig. 13D. Loop band over finger.

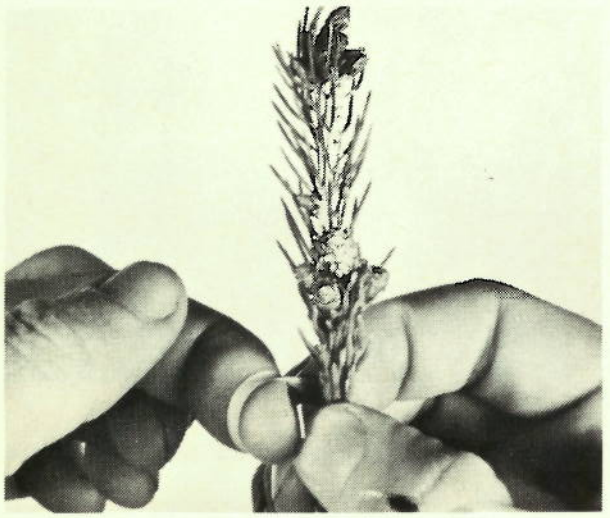

Fig. 13E. Start band through loop using thumb.

Fig. 13F. Push band through loop and pull tight with fingers.

Fig. 14. Waxing the graft.

Fig. 15. The completed veneer graft.

Pocket Graft

Scions too small for the side-veneer graft can be successfully grafted by use of the pocket graft. This is particularly useful for collections made from older or insect damaged spruce and larch trees.

1. Remove needles and buds from both scion and rootstock as for the side-veneer graft.

2. Make two non-parallel cuts forming a slender wedge tapering to one line at the base (Fig. 16).

3. Make a shallow pocket on the rootstock. For this, a cut is made at an angle through the bark and cambium and matching the length of the scion cut. At the top, a second cut is made, at right angles to the first (Fig. 17). Both of these cuts are made with the budding knife which is held near the blade tip to gauge the depth of cut.

4. Open the flap of bark using the "horn" of the budding knife to make the "pocket" (Fig. 18).

5. Insert the scion into the pocket to match the cambium surfaces (Fig. 19).

6. Wrap and wax as for the side veneer graft (Fig. 20).

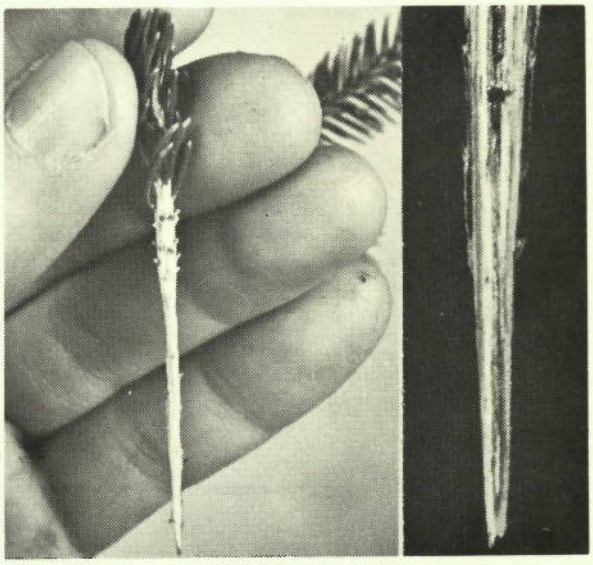

Fig. 16. A prepared pocket scion.

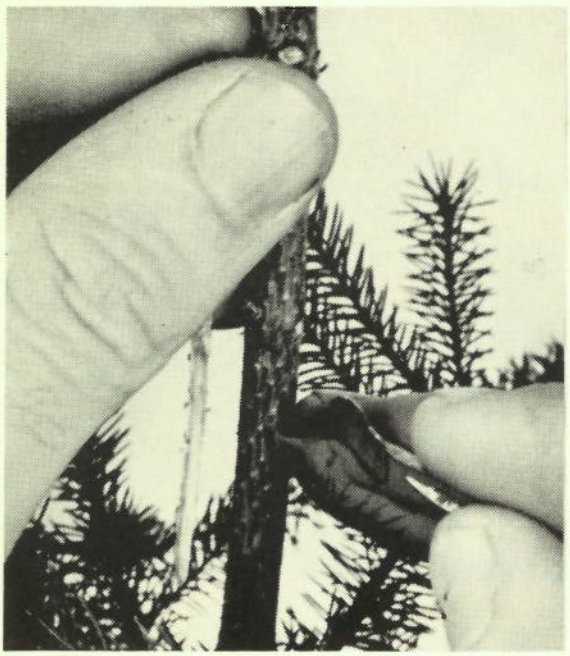

Fig. 17. Cutting the rootstock.

Fig. 18. Opening the pocket.

Fig. 19. Scion inserted in pocket.

Fig. 20. The completed pocket graft.

Cleft Graft

Another grafting technique quite simple to use is the cleft graft. Nienstaedt et al. (1958) characterized it as a useful technique for soft tissue grafting, but they noted that such grafts do not initially form strong unions when mature scions are used.

1. Remove the needles and buds from the rootstock and scion.

2. Make two cuts on opposite sides of the scion, converging at the base to form a wedge (Fig. 21).

3. Decapitate the leader of the rootstock leaving a stub. Cut the stub down the center to a length matching that on the scion (Fig. 21).

4. Insert the scion wedge matching the four cambium surfaces if possible (Fig. 22).

5. Wrap and wax as for the side-veneer graft (Fig. 23).

Fig. 21. The scion "wedge" and prepared stub.

Fig. 22. Wedge joined to stub.

Fig. 23. The completed cleft graft.

Whip-and-tongue graft

The whip and tongue graft is a more difficult procedure but can result in a strong graft. This is one of the most common hardwood grafting methods but has not been used extensively for conifers (Nienstaedt et al. 1958).

1. Remove the needles and buds from the scion and rootstock as usual.

2. Make a diagonal cut 1-2 cm in length. Cut a slit at about one-third the length of this diagonal cut, thus forming a tongue (Fig. 24).

3. Decapitate the leader of the rootstock with a diagonal cut similar to that of the scion. Cut a slit into the "whip", forming a corresponding tongue (Fig. 25).

4. Match the scion to the whip so the tongues lock and the cambium surfaces meet (Fig. 26).

5. Wrap and wax as for the side veneer graft (Fig. 27).

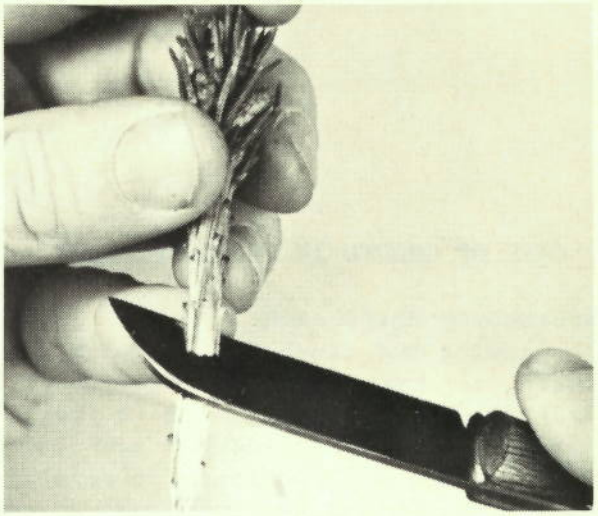

Fig. 24. The prepared scion.

Fig. 25. The prepared scion and whip.

Fig. 26. The scion and whip matched.

Fig. 27. The completed whip-and-tongue graft.

CARE OF GRAFTS IN THE GREENHOUSE

Greenhouse Environment

Slowing bud flush will benefit the union of the scion and rootstock. Grafts should be kept in a cool, (13-18°C), humid (+80% RH) and partially shaded environment for several weeks (3-5) until growth begins on the buds of the scion (Fig. 28). Soil temperature should also be monitored and not permitted to drop below 13°C. It is not advisable to place grafts in with routine greenhouse materials at this time.

After growth begins on the scions, the grafts can be gradually conditioned to normal greenhouse conditions of sunlight, heat and humidity. Movable shades are particularly useful in the grafting greenhouse to avoid unnecessary reduction of light.

Fertilizing

Fertilizing grafts is not advisable during the initial greenhouse phase. After one season in the pot, most media has weathered sufficiently to supply nutrients for growth. Furthermore, the use of fertilizer can impair the graft union by causing the rootstock to grow too rapidly, producing excessive callus which may block or force the scion from the rootstock. Eight to ten weeks after grafting, vigorous grafts can be fertilized lightly.

Watering

An adequate water supply is essential. If the rootstock experiences water stress, the scion suffers first. Until the grafts are placed in normal greenhouse conditions, care must be taken to avoid overwatering.

Fig. 28. Buds flushing on scion.

Pruning

For spruce, lateral buds on the rootstock above the graft union should be nipped as they flush (Fig. 29). Any flowers on the scion should also be removed. Note that where large or vigorous rootstock of any species is used, it will be necessary to prune some branches and remove some buds as they develop.

Pruning should be done periodically as required to control the growth of the rootstock. This is done to slow callus formation on the rootstock, allow scion development to keep up, and so maximize scion growth. Note that excessive pruning at one time can result in loss of rootstock vigor and adversely affect the developing graft.

For vigorous grafts of larch or pine, all branches may be removed prior to outplanting in the spring. For the spruces it is generally desirable to retain some branches on the rootstock through the second growing season.

Fig. 29. Buds developing on the leader of the rootstock (left) are nipped (right) as they develop.

Protection

In a greenhouse environment several factors can adversely affect grafting success. Insects or diseases can quickly result in unnecessary losses. Pesticides and fertilizers must be carefully administered because they can burn foliage. Also excesses or deficiencies of heat, relative humidity, and water must be avoided.

Removal of Grafting Bands

Normally the bands are not removed in the greenhouse. The graft union remains brittle for months and will break easily. If bands and wax are removed too soon the graft may shear off either by drying too rapidly, or because of excessive callus formation by the rootstock. Some bands may seem too tight as evidenced by severe swelling between the laps of bands. Usually this indicates that the rootstock is growing too rapidly (if too tight, replace).

We recommend leaving the bands on throughout the first growing season and winter.

CARE OF GRAFTS IN THE NURSERY

Outplanting to the Nursery

Grafts are usually moved from the greenhouse to a shelterhouse after the danger of severe frost is over. Transplanting is done after a period of acclimatization.

Great care should be exercised in the handling and transplanting of grafts because the graft unions are fragile. Transplant them without breaking the rootball excessively - a couple of cuts made vertically down the side of the rootball will effectively prune spiralling roots. If roots are coiled at the bottom of the pot, they should be pruned. Pruning and careful placement of the roots during planting will reduce deformation often associated with potted rootstock.

WATER and SHADE the grafts immediately after transplanting. Shade frames should remain over spruce and larch until the grafts seem rigid and able to withstand exposure (early-August). Regular irrigations should be made throughout the summer. Normal planting depth is used for grafts made high on the rootstock. Pine and larch are grafted low, so deep planting to contact the graft union encourages its rooting. This is beneficial for both stability and prevention of mortality from graft incompatibility[1] (Fowler, 1967).

The grafts can be fertilized with granular fertilizers after transplanting. One application of 1 kg/30 m^2 of 10+10+10 should be sufficient for the season and, in subsequent years, two applications will suffice - early May and late June.

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[1] Graft incompatibility: The failure to form or maintain a union between grafted scion and rootstock.

Pruning Shoots and Roots

We noted earlier that the branches of the rootstock are gradually removed as the graft develops. For larch and pine, it is usually possible to remove all branches during the first summer. For the native spruces, the grafts develop much more slowly and complete removal of rootstock branches may require two to three years (Fig. 30). If pruning is not conducted as required, the potential growth of the graft will not be realized (Fig. 31). Pruning wounds should be covered with a tree wound dressing.

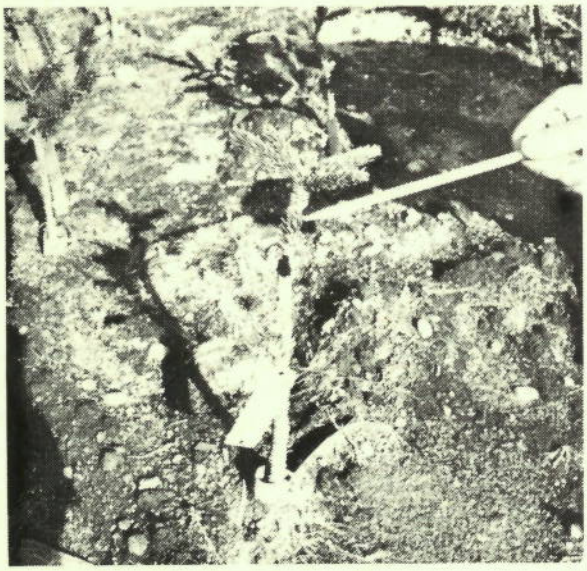

Fig. 30. Two-year-old white spruce graft.

The leader is left intact on spruce until spring of the following year. When removing the part of the rootstock above the graft union, make a close cut just to the cambia at the top of the graft union (Fig. 32). DO NOT LEAVE A STUB. A close cut reduces the time for the wound to callus over thus strengthening the graft.

Fig. 31. White spruce graft over topped by rootstock.

Grafted stock which remains in the nursery more than one year must be rootpruned to encourage development of a fibrous root system and reduce deformities. We use two approaches: with a spade (a) prune around one-half of the circumference in spring, the other half in summer, and (b) cut the rootball vertically on a radial from the stem.

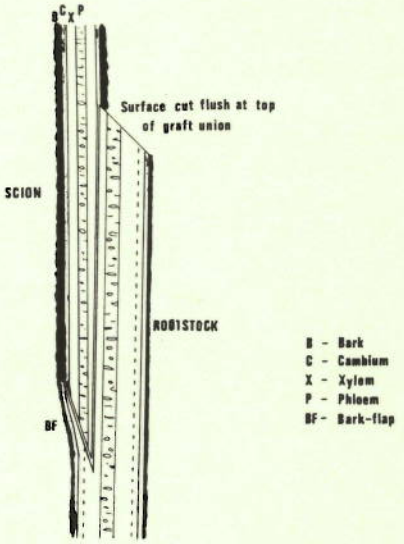

Fig. 32. Diagram showing close cut at top of graft union.

Weed Control

Weeds can be reduced in nursery fields by cultivation and fallow before use. Weed control is essential and can be accomplished quite readily after planting by hand weeding, hoeing, and mulching. A mulch of peat, weathered sawdust, or bark will also contribute to soil fertility and reduce frost-heaving. However, the potential of weed control with herbicides should be considered.

Several approaches can be used:

a) preplanting use of partial sterilants such as trifluralin (Treflan^{R})*;

b) at time of planting, use of a soil active herbicide such as DCPA (dacthal) will achieve a measure of control even at low rates;

c) end-of-season use of glyphosate (Roundup^{R}) or pronamide (Kerb^{R}) will control overwintering weeds without leaving harmful residues;

d) and in succeeding years, spring applications of herbicide combinations such as DCPA and simazine (Princep^{R}) for seasonal control of both grasses and broadleaved weeds.

Mapping

It is critical that graft identity be maintained. Therefore, it is beneficial to organize the outplanting of the grafts such that each clone is planted separately and mapped accordingly. Before winter, the plastic identification tag used in the greenhouse should be replaced with a permanent metal tag.

Overwintering

We noted earlier that the leader on spruce can be left intact until spring of the following year to resist breakage by snow. Graft unions remain weak the first and second winters and to help prevent breakage the grafts should be covered with lath shades in late fall (Fig. 33). Grafts in a top position should be rewrapped and then seedling tied to a stake to further reduce breakage (Fig. 34). This extra care, of two-year grafts, will be beneficial because snow breakage is very prevalent on veneer grafts.

Fig. 33. Grafts covered with lath shades.

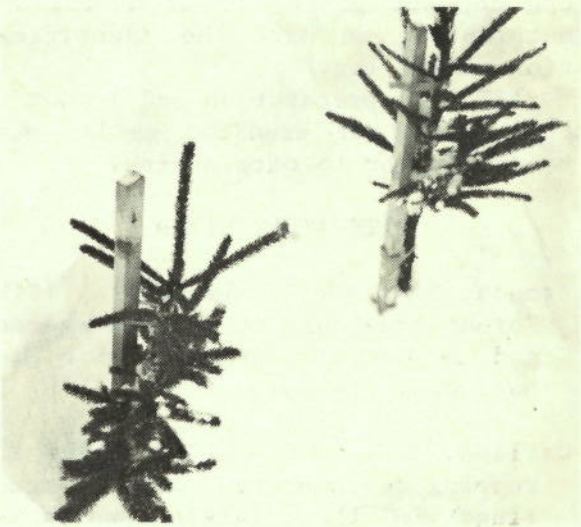

Fig. 34. Grafts retied and seedlings tied to a stake.

*Trade names are used for identification only and do necessarily mean endorsement of the product.

Shipment for Field Planting

Once the graft unions are sound and the grafts have reached an acceptable size, they should be outplanted. Some will be ready in 1.5 years, whereas others require 2 or more years before field planting is possible.

Early lifting and immediate planting to the orchard or breeding garden is recommended. Lifting should be done before the grafts flush, this must be coordinated with the phenology of the species. Larch, for instance, should be dug as soon as the ground thaws, whereas red spruce can be left in the ground longer because it is among the latest to flush.

When lifting, as much soil as practical should be left on the rootball. The roots and shoots can be pruned as required for handling. The size and fragility of grafts dictates individual handling: keep them in an upright position. Heavy white plastic bags or double-wall bags with reflective exterior and waterproof liner are excellent for shipping. AVOID PROLONGED EXPOSURE OF THE BAGS TO SUN AND WIND. Although there is a permanent metal tag on each graft, it is useful for outplanting to mark the identification on the bag.

All site preparation and layout at the orchard or breeding garden must be done prior to outplanting.

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EQUIPMENT SUPPLIERS

The following is a list of suppliers from whom the Maritimes Forest Research Centre has purchased grafting materials. It is not meant to provide special endorsement of any of these suppliers' products. The list is undoubtedly incomplete.

Supplier	Address	Supplies
Ball-Superior Ltd.	1155 Birchview Drive Mississauga, Ontario L5H 3E1	Horticultural supplies and equipment
Canadian Forestry Equipment Ltd.	170 Industrial Blvd. St. Eustache Montreal, Quebec J7R 4K3	Knives
Canlab	10 Morris Dr., Suite 12 Burnside Industrial Park Dartmouth, Nova Scotia	Hot plates
Dilmont Inc.	121 Bates St. Montreal, Quebec	Wax
Fisher Scientific Co. Ltd.	21 Gurholt Drive Dartmouth Industrial Park Dartmouth, Nova Scotia	Hot plates
C.F. Frensch Ltd.	Box 67 Grimsby, Ontario L3M 4G1	Tags, bands, knives
Halifax Seed Co. Ltd.	644 Rothesay Ave. Box 2021 Saint John, New Brunswick E2L 3T5	Pots
Horti Craft	90 Bessemer Rd. London, Ontario N6E 1R1	Tags, stakes, etc.
Jack Von Klaveren Ltd.	P.O. Box 910 St. Catherines, Ontario L2R 6Z4	Horticultural supplies and equipment
Kord Products Ltd.	390 Orenda Rd. Bramalea, Ontario L6T 1G8	Pots
Plant Products Co. Ltd.	314 Orenda Rd. Bramalea, Ontario L6T 3E1	Horticultural supplies and equipment