Agriculture Canada

# fruit tree propagation

PUBLICATION 1289

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*Cover*

Left. An apple tree selected for topworking.
Center. Same tree after pruning. Points are shown where grafts will be inserted.
Right. Same tree after topworking.

# contents



# AN OUTLINE OF PROPAGATION

The operations of budding and grafting serve two distinct purposes in fruit tree cultivation: the perpetuation and multiplication of any given variety, and the changing over of the fruiting area or the framework of a bearing tree from one variety to another or others. Grafting is also used to repair damaged trees.

Many kinds of trees reproduce themselves by seeds, and the parental characters are carried over to the progeny without alteration. However, most cultivated fruit trees are not only hybrids, but hybrids of such mixed ancestry that their makeup is extremely complex. Seedlings from these hybrids are variable and do not show all the parental characters. Therefore, the vegetative method of propagation is used. By vegetative reproduction any variety can be multiplied indefinitely without being changed, either by addition or removal of any individual characteristics.

The raising of a large or small number of individual trees of a particular variety is accomplished either by grafting part of a terminal growth on to a suitable stock, or by implanting a single bud taken from a tree of the variety required. If a part of the terminal growth is used, the operation is known as grafting. If a single bud is used, it is known as budding.

## ROOTSTOCKS USED IN PROPAGATING FOR NUMERICAL INCREASE

Clonal or vegetatively propagated rootstocks are increased from specially grown stools or from cuttings. Seedling rootstocks are grown from seeds. Several clonal rootstocks are used in Canada, but since no single one is satisfactory for all areas, regional recommendations should be followed. Similarly, regional recommendations for seedling stocks, those grown from seeds, should be followed.

## FRAMEWORKING

One purpose of frameworking is to change the bearing area of a tree from one variety to another. For example, you might want to grow Melba apples on trees now bearing McIntosh. All that is needed is to insert scions or buds of Melba in the framework of the McIntosh trees and, eventually, with the ultimate complete removal of all McIntosh-bearing branches, the trees will produce only Melba fruits. Similarly, a chance seedling tree that bears fruits of inferior quality but possesses other desirable characteristics such as hardiness, well-formed crotches, and disease resistance might be transformed into a profitable tree that bears fruits of any of the established varieties known to succeed in the district.

Some inherent weaknesses that exist in the trunk and base of main limbs of some commercial fruiting varieties can be avoided by frameworking. For example, the apple variety Spy has weak crotches. If Spy is budded or grafted into the framework of *Malus robusta* 5, a combination root and trunk clonal stock, the weakness is avoided.

## GATHERING SCION WOOD

Scions may be gathered any time between late fall, after the leaves have fallen, and early spring before the buds begin to swell. Only familiarity with local climatic and growing conditions can determine exactly the best time within this period. If the scions are gathered in late fall, they need exactly the correct temperature and moisture for winter storage. If they are left on the trees for early

spring gathering, they are exposed to severities of weather that may occur. When scion wood is gathered in the winter it is hard to tell whether or not it is free of injury. Therefore, in districts where winter injury often occurs, notably eastern Ontario and Quebec, it is better to gather scion wood in the fall.

Scion wood consists of terminal shoots that have developed during the current growing season. Older wood is less satisfactory. Buds should be well developed and the wood well ripened before shoots are gathered. Avoid water sprouts and spindly shoots.

Occasionally sports, which produce more highly colored fruits, are found. They may be entire trees or parts of trees. Scion wood taken from these will produce trees with more highly colored fruit than those propagated from the normal variety.

## STORING SCION WOOD

Scion wood should be stored right after it is gathered. Pack it in boxes with moist moss, peat, sawdust, forest leaves, or sand, and store the boxes in a cool, moist cellar at 1 to 2°C. The scions must be kept dormant until they are set in the stock. Also, the packing material should be no more than moist; wet material is likely to cause rotting. To prevent loss of moisture, cover the boxes with burlap or sacking, which can be sprinkled occasionally.

## BUDSTICKS

A budstick is functionally the same as scion wood, the only difference is that scion wood is gathered while it is in a dormant condition and budsticks are taken while a tree is still in leaf. Budsticks are the terminal shoots that have developed during the current growing season, and they should be taken from vigorous bearing trees, when the buds are properly matured. Bud maturity may be determined by pulling downward on a leaf in the middle of the shoot; when the bud is mature, the leaf stem will separate from the shoot cleanly and without tearing. The diameter of a budstick should be about the same as that of an ordinary pencil. Immediately after a budstick has been gathered, remove the leaves to keep moisture within the stick, and for the same reason remove the top of the shoot at the first immature bud. When trimming off the leaves, leave about 5 mm of the leaf stem for a handle when the bud is being removed from the stick and when it is later being inserted in the stock.

Keep budsticks moist. Do not let them dry out. If the budding operation cannot be done immediately after the budsticks have been gathered, wrap the sticks in damp sacking, or put their butts in water. The same precautions should be taken between the removal and insertion of one bud and the next. When budsticks are gathered for shipment, strip, top, and wrap them in moist paper toweling or newsprint, place them in a plastic bag to hold the moisture, and ship them immediately.

## RAISING SEEDLING ROOTSTOCKS

Remove seeds from fully mature fruits soon after harvesting. If a large quantity of seed is needed, the fruits can be put through a pulper, or mashed by hand pounding. When the pulp is washed in a tub of water, the flesh and skin will float to the top and the viable seeds will sink to the bottom of the tub.

Seeds may be sown in the late fall, or stored dry in bags, boxes or tins until it is time to stratify them. Experience at the Research Station in Ottawa shows that for apples and pears stratification in moist sand for 8 to 10 weeks in a

cool cellar (approximately 1 to 2°C) is satisfactory. Approximate times for other fruits are: plum, 150 days; apricot, 45 days; peach, 75 days; *Prunus tomentosa,* 75 days; Mazzard and Mahaleb cherries, 90 days.

To have different kinds of seeds ready for sowing at a given time, that is, when the land becomes workable in the spring, the stratification of each kind should begin the stated number of days before the approximate sowing time. Sand, muck, soil, or granulated peat moss may be used. Peat moss is used extensively by nurserymen. Whatever the medium used, it should be evenly moist, not wet. The simplest method of stratifying is to mix the seeds with the evenly moistened medium, which previously has been finely screened. Frequent examinations should be made by shifting the seeds and medium from one container to another. Add moisture evenly to the mass whenever it is necessary. If germination starts too early to sow seed out-of-doors, screen out the seed and mix with dry sand, then store until sowing time at a temperature close to freezing point. If metal or waterproof containers are used, there should be small holes in the bottom for drainage. The containers should be stored in a moist cellar at the temperature recommended, and, when necessary, protection against mice should be provided.

Sow seeds thinly, about 2.5 cm deep, in rows at least 1 m apart. The larger the seed, the greater the covering. Leave the seedlings in the seed rows until they are large enough to be grafted or budded, usually in the second growing season, depending on soil, climate, and other factors that influence growth. In the fall, lift roots that are to be whip-grafted and store them suitably until the grafting is done in January and February. Those to be budded are lined out in nursery rows either in the fall or early spring. They are planted 20 to 25 cm apart in rows at least 1.2 m apart. If one third to one half of the tops are removed at time of planting, the stand will be more uniform. In situations where the ground is very dry or is apt to heave badly in the winter, spring planting is recommended.

## GRAFTING WAXES

Emulsified asphalt preparations can be obtained from dealers in gardening supplies. These preparations are particularly suitable for work in the orchard and nursery as they are always ready to be applied. Follow closely the directions and precautions on the container. Brush wax can be made by using:

| | |
|---|---|
| Resin | 500 g |
| Linseed oil | 85 mL |
| Parawax | 2.5 kg |

Melt the resin and linseed oil together, pour them into the melted parawax, and mix well. Pour into a shallow pan lined with oiled paper to cool in a cake 2.5 to 5 cm thick. This makes a convenient-sized cake, which can be broken up and melted in a heater when it is needed.

## AFTERCARE OF SCIONS AND BUDS

The care of any grafted or budded tree is no less important than the proper selection of the stocks and scions used and the skill employed in the operation itself. This fact is not commonly realized and there are many losses from breakage.

Examine the budded trees in the early spring, shortly after growth starts, to determine whether the buds have taken. If they have not, use Jones budding (p. 14) or side-cleft grafting at once. As the bud itself starts to grow, remove

any competing shoots from the stock. Trim and stake the growing budshoot, when necessary, to help develop a single straight stem.

Check scions on topworked or frameworked trees soon after growth starts and recoat any cracked wax. Carefully control the new growth on topworked and frameworked trees at all times. Allow only enough growth to develop on the stocks to prevent an excess of sap from going into the scions and causing too soft and too rapid growth. As a scion develops, remove more of the growth on the stock or framework until finally all is removed. If water sprouts that appear below the grafts are allowed to grow without restriction, they will usually choke out the grafts. Prevent this by removing some of the sprouts and trimming back the others.

In cleft and bark grafting, two scions are usually inserted into the sawed-off branch stub. Do not retain more than one of the scions permanently, as a weak crotch is apt to be formed if both are left. Watch for new growth on the scion that is to be removed and keep it trimmed during the first growing season. By the end of the season the juncture of scion and stock should be healed over. At this time remove the scion level with the end of the stub. If only one scion grows, the square shoulder of the branch opposite the growing scion should be beveled towards the scion so that the branch will heal more rapidly. This also helps to prevent the bark from drying out and killing back on the side opposite the growing scion.

If the new shoots of the scion need support, tie them to strips of wood, such as a lath, until they are strong enough to support themselves. If the grafts grow too rapidly and it is uneconomical to use supports, then pinch back the new growth so that it will stouten. Train each scion as if it were an individual tree.

## PROFICIENCY

In all budding and grafting operations, proficiency and speed in using a knife are most important. Make all cuts with a positive, single, smooth-action, draw stroke. If a knife has been pushed through tissues, buds have been gouged out, or scions whittled into shape, the result will be a poor stand. Experience, practice, and a good sharp knife are essential for success.

SHIELD OR T BUDDING

Shield or T budding is the method generally used in propagating fruit trees. Shield budding is particularly well adapted to pears, plums, peaches, and apricots, which are difficult to propagate by root grafting. Even with apples, budding is more successful than root grafting. Furthermore, a large number of first-class trees, smoother in the trunk and freer of crown gall, are produced by this method. Budding may also be used to topwork young trees.

The success of shield budding depends to a great extent upon the maturity or ripeness of the buds and upon the ease with which the bark of the stock can be separated from the wood. The bark usually slips most readily when the stock is making active growth. In most parts of Canada the operation can be successfully carried out on apples throughout August, and on plums, cherries, and peaches in late July and early August.

Buds should be taken from vigorous terminal shoots of the current season's growth. The buds should be plump and well matured, therefore those at the base and the tip of the shoots should be discarded. Rootstocks should be about 10 mm in diameter at ground level when planted. Plant the rootstocks 20 to 25 cm apart in the nursery in the late fall or early spring, in rows at least 1.2 m apart.

1 Strip the leaves off the budstick immediately after it has been gathered to help hold moisture within the stick. Leave 5 to 10 mm of each leaf stem attached to the stick. This small stalk will serve as a handle when buds are removed and when they are inserted in the stock. Because only mature buds are used, cut off the top of the budstick just above the uppermost mature bud. To keep the stick from drying out, place the butt of the shoot in water.

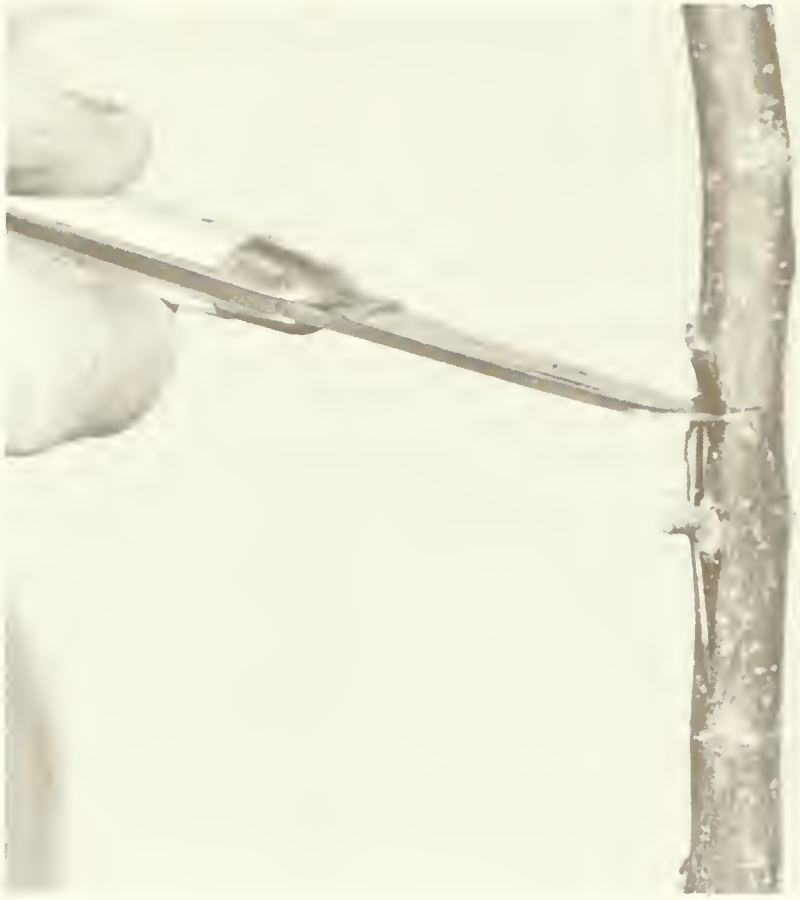
2 To prepare the rootstock for insertion of the bud, first make a horizontal cut through the bark at least 10 to 12.5 cm above ground level by pressing and slightly rocking the knife against the bark. Make the cut on the north or northeast side of the rootstock. From the center of this short horizontal cut, make a downward cut about 4 cm long. Both cuts should go right through the bark.

3 Lift the two angular bark flaps by inserting the tapered handle or blade of a budding knife beneath the bark and the wood. The bark should be lifted as far down the vertical cut as possible.

4 When the rootstock is prepared, take a budstick and insert the knife about 2 cm below a bud, and, cutting just deep enough to remove a shaving of sapwood, draw it under the bud to about 1 cm above.

5 The bud and its surrounding shield of bark about 2.5 cm long come away with a single, sweeping cut from a sharp knife. The edges of the shield are cleanly cut. The very thin piece of sapwood that lies down the center of the underside of the shield may be removed or left attached.

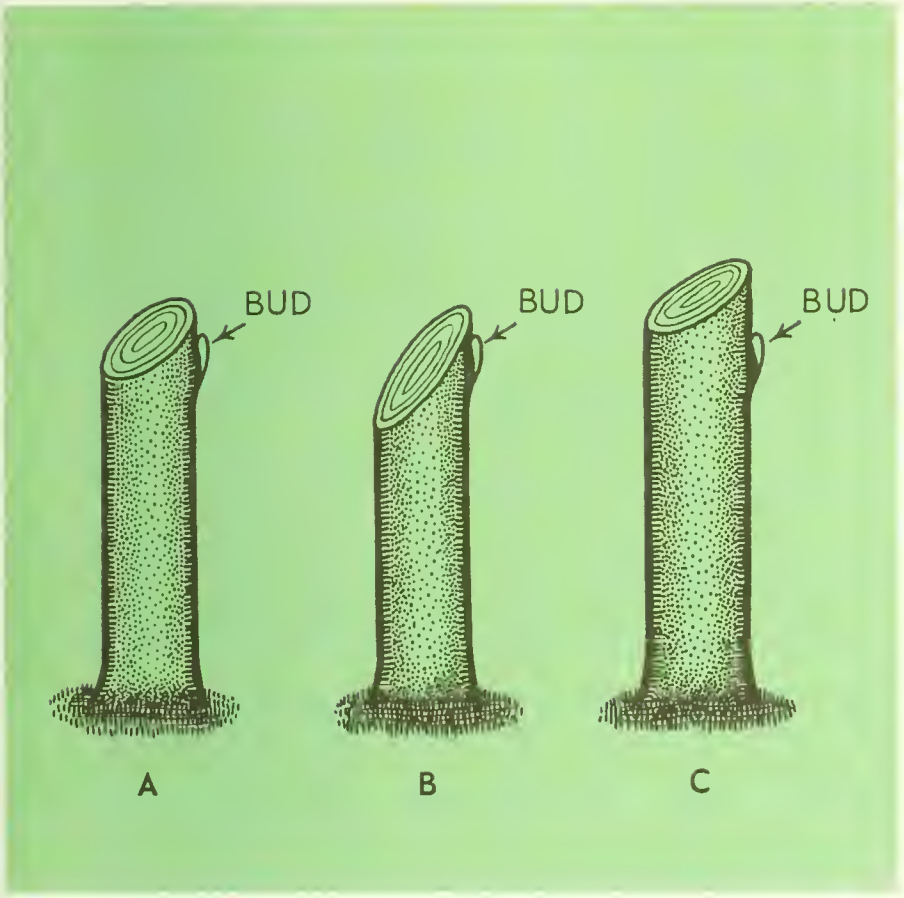
6 Holding the budshield by the short length of leaf stem, insert the lower end of the shield under the bark flaps and push it downward until the shield is completely or almost completely covered.



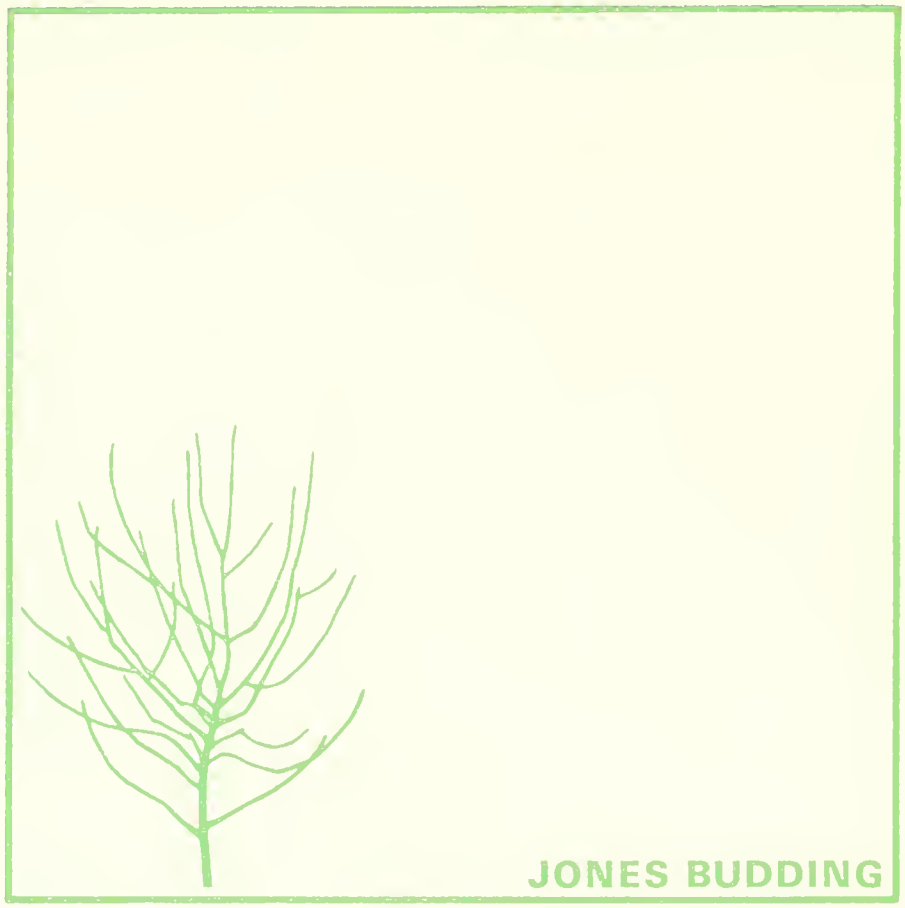
7 If the top of the shield projects above the horizontal cut in the stock, trim it off to ensure that the undersurface of the shield makes proper contact with the sapwood of the rootstock.

8 To complete the operation, bind the bark with a rubber band or raffia to keep bud and rootstock in intimate contact, and also to prevent drying out before union can take place. The bud is left exposed.

Some nurserymen prefer the approximately 4 by 3 cm plastic bud ties, which are held with an attached staple-like wire. The inserted bud is completely covered with the plastic.




9 Sometime during the following spring, as soon as the bud has taken, cut back the stem of the rootstock. *A* is the correct way of cutting back; *B* shows too steep a cut; *C* has the correct slope, but is cut too high above the bud. Some nurserymen prefer to cut back the rootstock stem to 10 or 12.5 cm above the bud. The developing shoot is tied to the stub for protection against wind breakage. The stub is cut off just above the bud when the trees are lifted from the nursery.



JONES BUDDING

While shield budding is the method generally used in the commercial fruit-growing areas of Canada, good results have been obtained with the Jones budding method, known also as dry budding and plate budding. Its use is not restricted to any particular time of the year, but it is generally used when the bark does not slip well enough to permit shield budding. It may be used in the spring when the buds are bursting or in the late summer when the bark has stopped slipping.

When budding by the Jones method in the spring, it is important to cut back the stem of the rootstock to 10 or 12 cm above the bud before the bud starts to grow. When the bud begins to swell, union of bud and stock has taken place. Cut the stub further back to just above the bud, or leave it as a support for the bud shoot, which can be tied to the stub when it has grown enough. When the latter procedure is followed, the stub should be cut off when the trees are lifted from the nursery.

Paint inserted buds with emulsified asphalt or parawax. If parawax is used, it should be no hotter than is needed to allow it to flow on the brush.

10 In the Jones method of budding, first hold the budstick with the buds pointing toward you. Starting about 10 mm below the base of the bud to be removed, push the knife through the bark in a short downward sloping cut. The knife blade should be quite flat against the stick.

11 Starting about 5 mm farther away from the bud, draw the knife under the bud just deep enough to remove a thin shaving of sapwood. When the cutting edge of the knife is about 10 mm above the bud, pull the bud off the stick, holding it between the thumb and the knife blade.

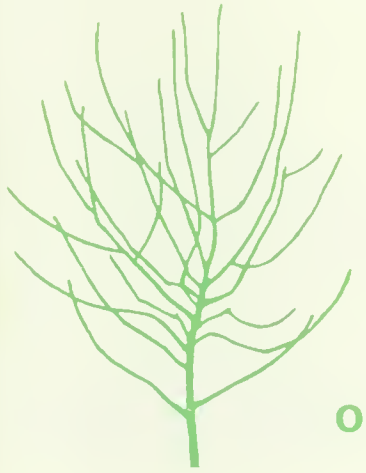
12 Still holding the bud on the blade of the knife, turn the hand so that the cutting edge is down and make a downward cut in the rootstock, through the bark and slightly into the wood. This cut should be about 3 cm long and at least 12 to 15 cm above ground level.

13 Still holding the bud on the knife, cut off about half of the bark flap produced by the preceding cut.

14 Insert the bud behind the bark flap by sliding it off the knife blade with the thumb. Push it well down so that the wedge-cut base of the shield fits snugly into the crotch formed by the back flap and the stem.

15 After the bud is properly in position, cut off the top of the bud shield just below the start of the cut in the stock, then bind as in ordinary shield budding.

16 All the steps in budding by the Jones method are shown here. From left to right: bud with the wedge at the base of the shield produced by the first and second cuts (Photos 10 and 11); bark flap after cut has been made (Photo 12); front view of bark flap after it has been trimmed (Photo 13); inserted bud; and the graft bound with a strip of rubber or raffia. Note that the bud is left exposed.



## OBLIQUE SIDE GRAFTING IN THE NURSERY

Oblique side grafting is a useful way to replace shield or T buds that have not survived the winter.

17 Make two slanting cuts at the basal end of the scion to form a tapering wedge.

18 Make an incision in the side of the cutback stock at least 12 or 15 cm from the soil.

19 Insert the two-bud scion into the side incision with the cambium in contact with the cambium of the stock on at least one side.

20 Do not tie the scion. Cover it with emulsified asphalt.

21 Both buds of a scion have developed into shoots.


In the large-scale propagation of young fruit trees, root grafting has long been a method in widespread use. The present-day tendency to favor the alternative budding method is due to the better percentage of "takes," and the lower susceptibility to crown gall of budded stocks. Furthermore, under dry growing conditions, better fruit trees are produced by budding than by root grafting. However, root grafting has one distinct advantage over budding in that it is done during the winter months when time and labor are in less demand.

One- or two-year-old clonal or seedling rootstocks, with a trunk diameter of about 10 mm at ground level, are lifted in the fall and heeled in in a cool cellar in moist sand. Grafting may be done any time during the winter, but usually it is not started until January or February. The work is best performed in a fairly cool room where the air is moist.

As only the root is needed, cut off the trunk and branches and throw them away. The whole root may be used, or it may be cut into pieces and each piece used as an individual stock. These should be somewhat larger in diameter than the scions, moderately straight, and at least 10 cm long. In the first year whole roots produce larger trees than piece roots.

Examine the stored grafts from time to time. If mold is widespread or buds are beginning to develop, repack the grafts and place them in a cooler storage.

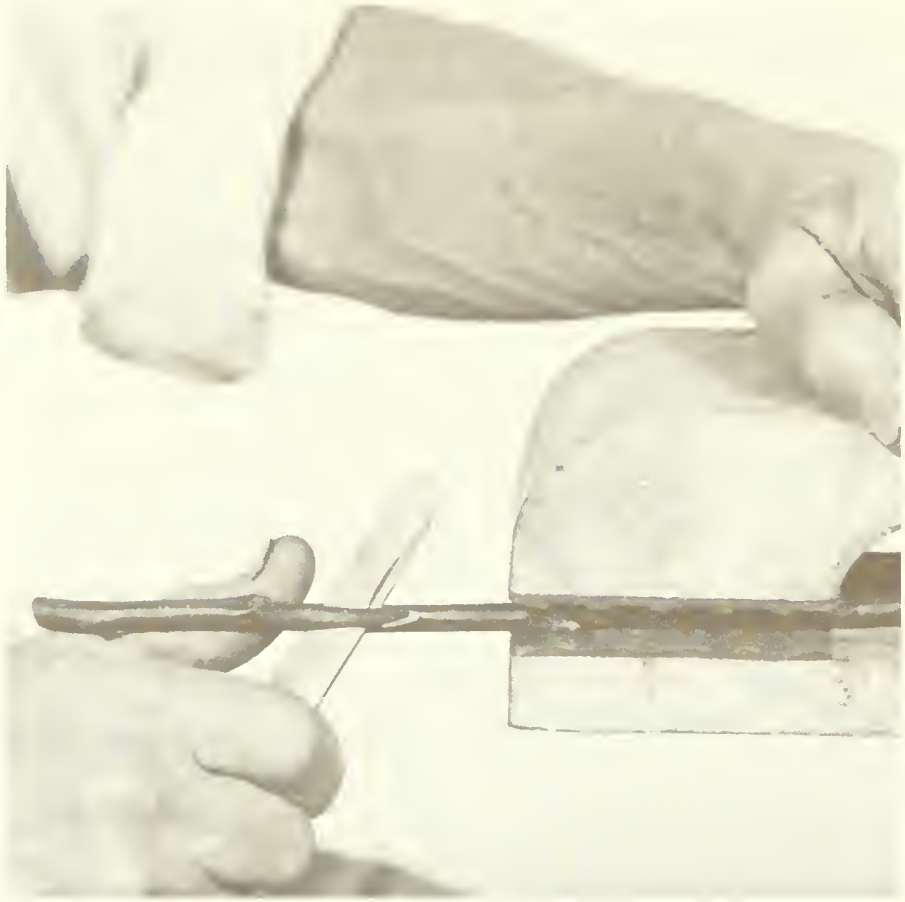
A mixture of the following is known as standard brush wax and is used to coat grafts:

| | |
|---|---|
| Resin | 2.5 kg |
| Beeswax | 500 g |
| Raw linseed oil | 115 mL |
| Lampblack or powdered charcoal | 250 g |

Slowly melt the resin, add beeswax, and when it is melted, add linseed oil. Remove the mixture from heat and slowly stir in the lampblack or charcoal. The wax is solid at normal room temperature. To use the wax, heat it until it will flow easily, and apply it with a brush. Injury to tissues may result if the wax is too hot. This wax may also be used in outdoor operations, but a portable heater should be used to keep it at the proper consistency. If a softer wax is preferred, up to 570 mL of raw linseed oil may be added. The charcoal or lampblack may be omitted.

Note: The clamp shown in the following illustrations makes the operations easier, but it is not a necessity. With practice, the cuts can be made equally well with the hands alone.

22 A typical rootstock. Two-year-old rootstocks are lifted in the fall and heeled in in sand in a cool (1 to 2°C) moist cellar. Grafting may be done any time during the winter, but it is usually done in January and February.



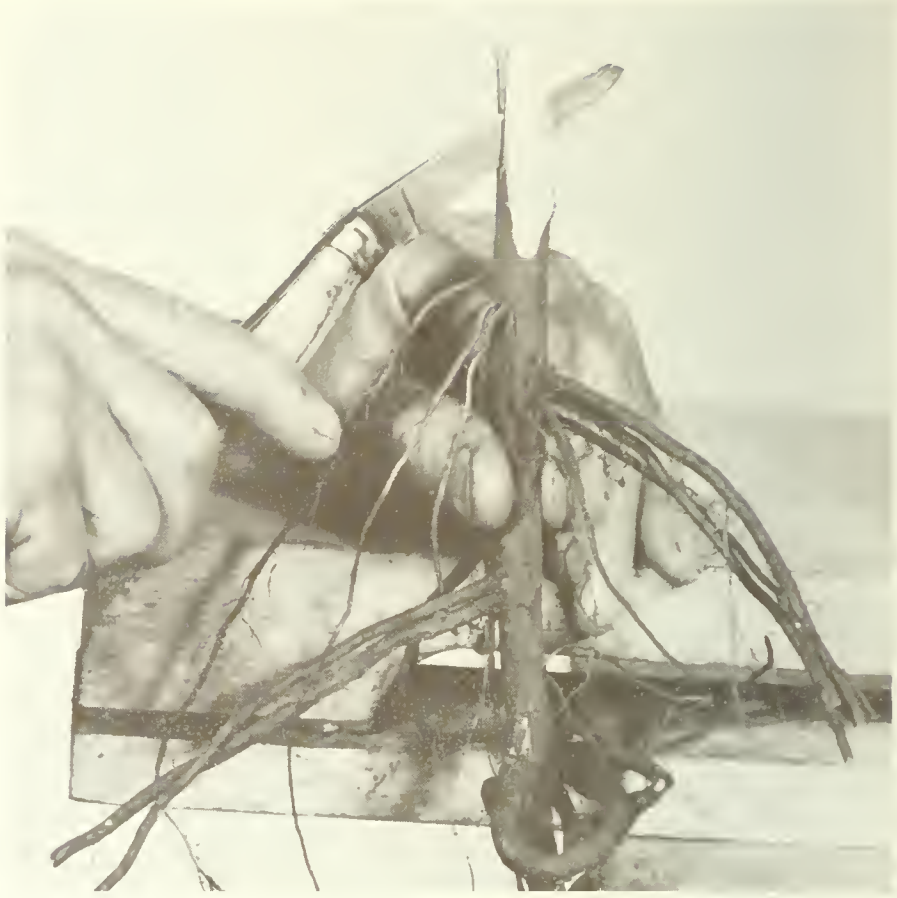
23 To prepare the scion, hold the shoot with the butt towards the operator. First, make a slanting, diagonal cut with a smooth, single, drawing sweep of the grafting knife.

24 The face of the exposed wood should be 5 to 6 cm long.

25 Make a second cut upward. Start it just above the exposed pith and end midway between the sides of the scion, just above the starting point of the first cut.

26 Cut off the longer whip so that it is level with the shorter tongue. The knife is shown holding the whip and tongue apart to expose the details of the completed cut.

27 Remove the shoot from the clamp and cut off the top just above the third bud. The result is a three-bud scion. Scions vary in length according to the spacing of the buds.

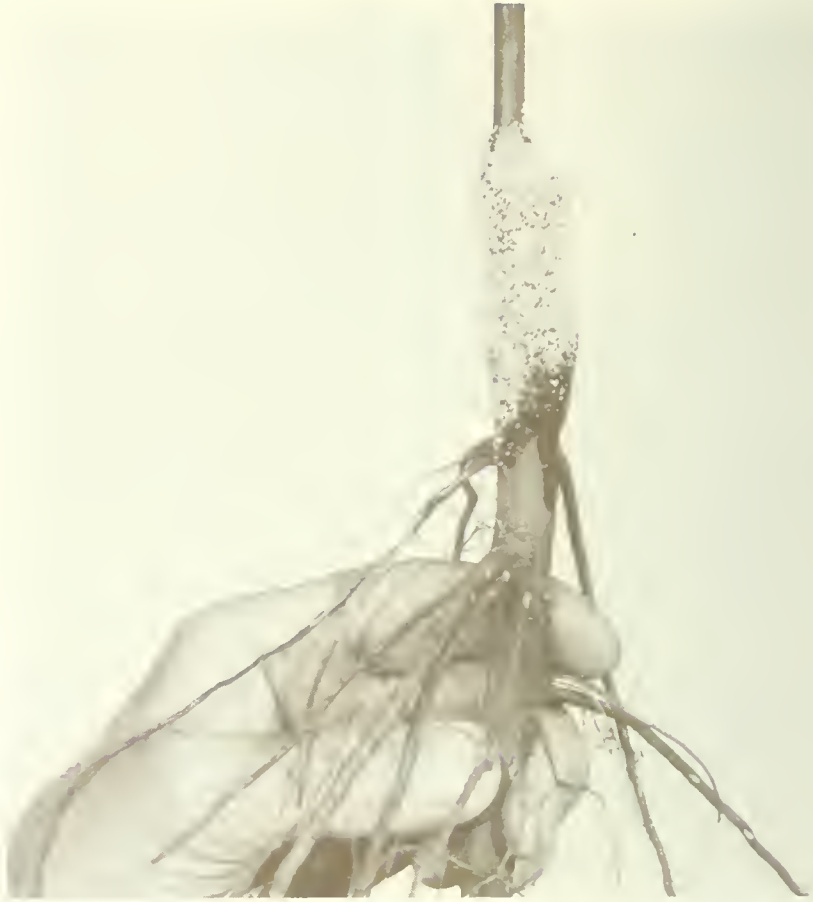


28 Cut the trunk off the rootstock just above the junction of yellow root and stem bark, and perform the same operations as in cutting the scion. The knife is shown holding the whip and tongue apart to expose the details more clearly.

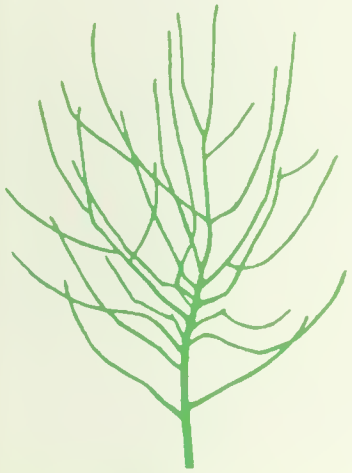
29 Insert the tapered tongue of the scion into the cleft of the rootstock, and carefully force them together to ensure tight interlocking.

30 The bark of the scion and of the stock must be flush on at least one side, for it is along the cambium layer just underneath the bark that union takes place. Wrap the graft union with rubber splicing tape.

31 Coat the whole joint and the tip of the scion with grafting wax to seal the exposed cuts and to hold the binding in place. The wax should be no hotter than is needed for application with a brush.



32 Dip the coated graft in dry sand to prevent grafted rootstocks from sticking together. Pack the grafted roots in rows between layers of damp moss. As the boxes are filled, place them in a cool (1 to 2°C), moist, and dark cellar where they will remain until spring planting time.



# FRAMEWORKING AND TOPWORKING

The object of frameworking is to retain as many as possible of the main and secondary limbs of the tree to be worked over. Topworking is used when the purpose is to replace as much as possible of the limb structure. Because the framework limbs are retained, the balance between root system and top structure is very little disturbed. The pruning wounds made in frameworking are small and they heal over more quickly than the much larger wounds that result from the removal of the large framework limbs in topworking. A further important advantage is that frameworked trees that have been grafted return to bearing and reach full production much sooner than topgrafted trees. Therefore, the greater expense of frameworking as compared with topgrafting is repaid with quicker and larger crop returns.

Changing established trees to a new variety is done by various methods such as oblique side, cleft, whip and tongue, and bark grafting.

Shield or T budding is commonly used to topwork 3- to 4-year-old trees of hardy stocks such as *Malus robusta* 5.

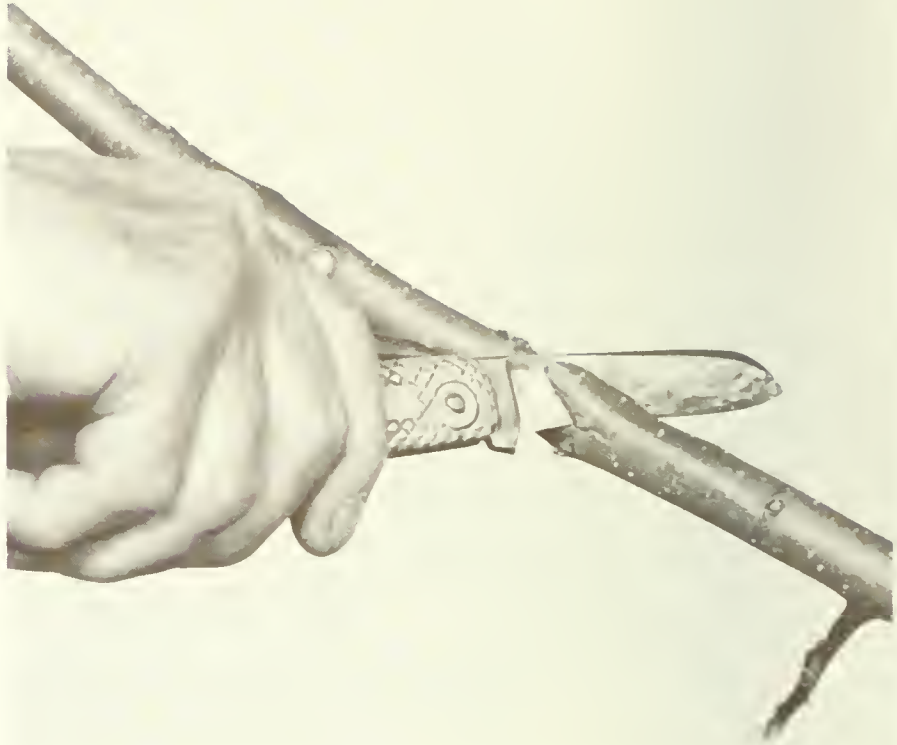
## OBLIQUE SIDE GRAFTING

Oblique side grafting is usually used for frameworking large limbs, which have thick bark. It is a simple and effective method of frameworking. The operation should be done in the spring just when the buds are beginning to swell. However, since this is a type of cleft grafting, it can be done at earlier or later periods.

Remove all lateral spurs, shoots, and branches from the framework limbs and insert scions in these limbs where lateral branches of the new variety are desired. Be sure that the cambial layer of scion and limb are in contact.

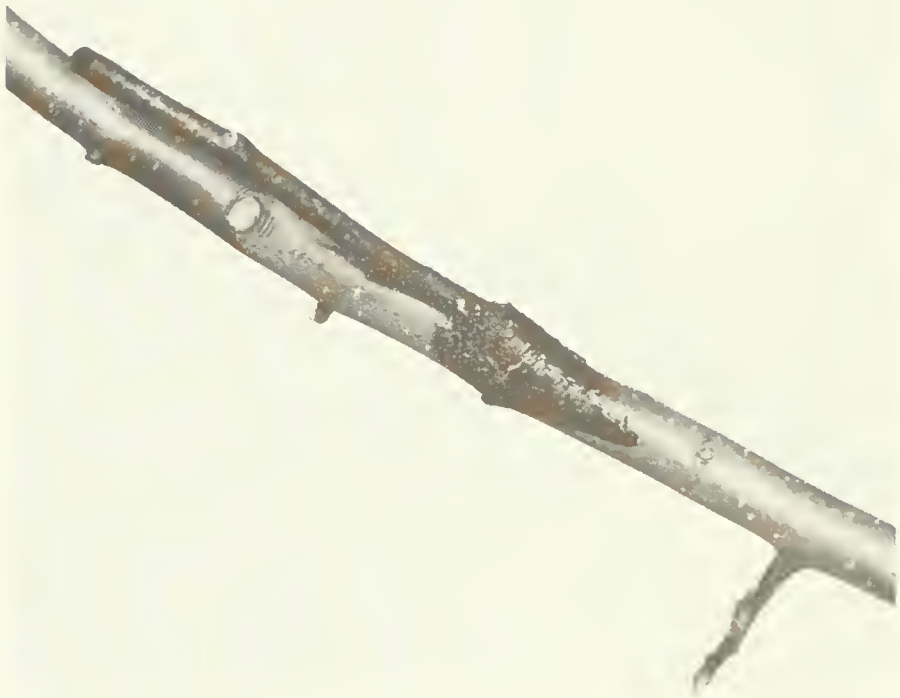
Some of the accompanying illustrations show a scion inserted into a thick branch. When grafting into a thinner and more flexible branch, the knife may be withdrawn, the cut opened by bending the branch, and the scion then inserted. When the branch is released, the cut closes and the scion is held firmly in place.

Scion wood must be dormant when the grafting is done.



33 Cut a shallow, oblique cleft, just slightly deeper than the diameter of the scion, in the framework limb at the point selected for the insertion of the scion.

34 Insert a 3-bud scion, cut as shown in Photo 17, into the cleft as the knife is withdrawn.



35 After the scion has been inserted, coat the scion and the area surrounding the cleft with emulsified asphalt or grafting wax.

## CLEFT GRAFTING

Cleft grafting has been widely used to change the bearing area of a tree of an undesirable variety to a desirable one. However, do not use this method wherever blackheart is widespread, particularly in the Prairie Provinces. The ideal time to cleft graft is in the spring, either just after the buds of the trees to be worked over begin to swell or when the buds have started to open. It is possible to carry out the operation at earlier or later periods, but the chances of success are a great deal less. Only mature 1-year-old wood is satisfactory for this type of grafting. Study the tree to be worked over and carefully select the branches that are to be grafted so that the new top will be symmetrical. It is usually unwise to completely work over the head of the tree in one year. The top branches of large trees should be grafted the first season and the lower limbs the next year. This practice avoids shading and provides feeder branches the first season to help establish the scions. Moreover "nurse" branches help to harden off the succulent growth produced on the scions. The closer to the trunk or central leader that the framework limbs can be cut off without using branches over 5 cm in diameter, the lower will be the fruiting area of the tree.

Scion wood must be dormant at the time the grafting operation is performed.

36 Remove the top of the branch that is to be grafted with a sharp, fine-toothed saw and be careful not to tear or loosen the bark. Branches to be grafted must not be larger than 5 cm in diameter.

37 The stub of the sawed-off branch is cleft 2.5 to 4 cm deep with a grafting tool or heavy knife. Sometimes a mallet is used to help insert the knife. If the branch is thick, the cleft may be held open to allow insertion of the scion either with the prong of the tool, a wooden wedge, or a screwdriver.

38 Insert the scion so that the cambium layers of scion and branch will come into contact when the cleft is closed. To be sure that this happens, give the scion a slight tilt to the side after the cleft has been closed.

39 The scion is held in place by the natural pressure of the cleft stub, but to doubly ensure contact between the cambium layers, bind the stub tightly with rubber splicing tape.

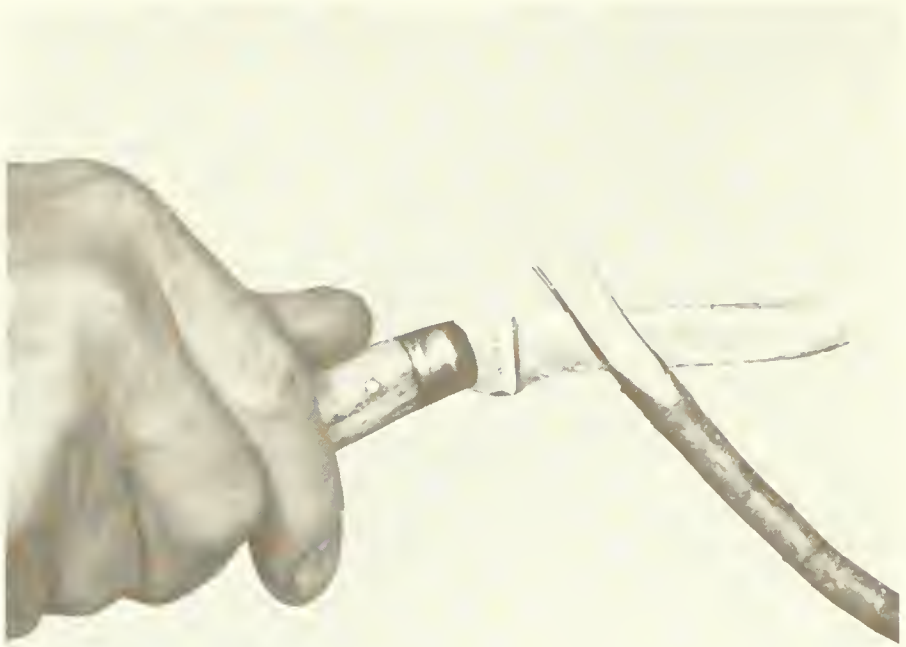
40 Coat all parts of the graft with emulsified asphalt or grafting wax to prevent drying out, and to seal the gap between the two halves of the stub from rain.

## WHIP AND TONGUE GRAFTING

The whip and tongue graft is particularly well adapted to the topworking of young trees or older trees of slower development. This method is used to replace the fruiting area of an undesirable variety, or to build a variety with desirable fruit characteristics that is subject to winter injury or disease on to the framework limbs of a variety that is resistant to these ill effects. Do not use this form of graft on branches larger than 2 cm in diameter. The best combination of scion and branch occurs when the two parts have the same diameter. This combination gives the largest possible area of contact between the cambium of the scion and that of the branch. Such contact is important because it is between the cambium layers only that union takes place. The likelihood of a successful union is increased and, provided the scion and the tree are compatible, the union is of the strongest possible kind. Often the scion and branch are not of equal diameter, and it is then necessary to make sure that the cambium of one side of the tongue of the scion is in proper contact with the cambium of one side of the branch. Never use a scion of larger diameter than that of the branch.

Topworking with whip and tongue grafts is performed in the spring when the buds begin to swell. The scions must be dormant up to the time of their insertion, therefore, only what is needed for immediate use should be taken from storage at one time.

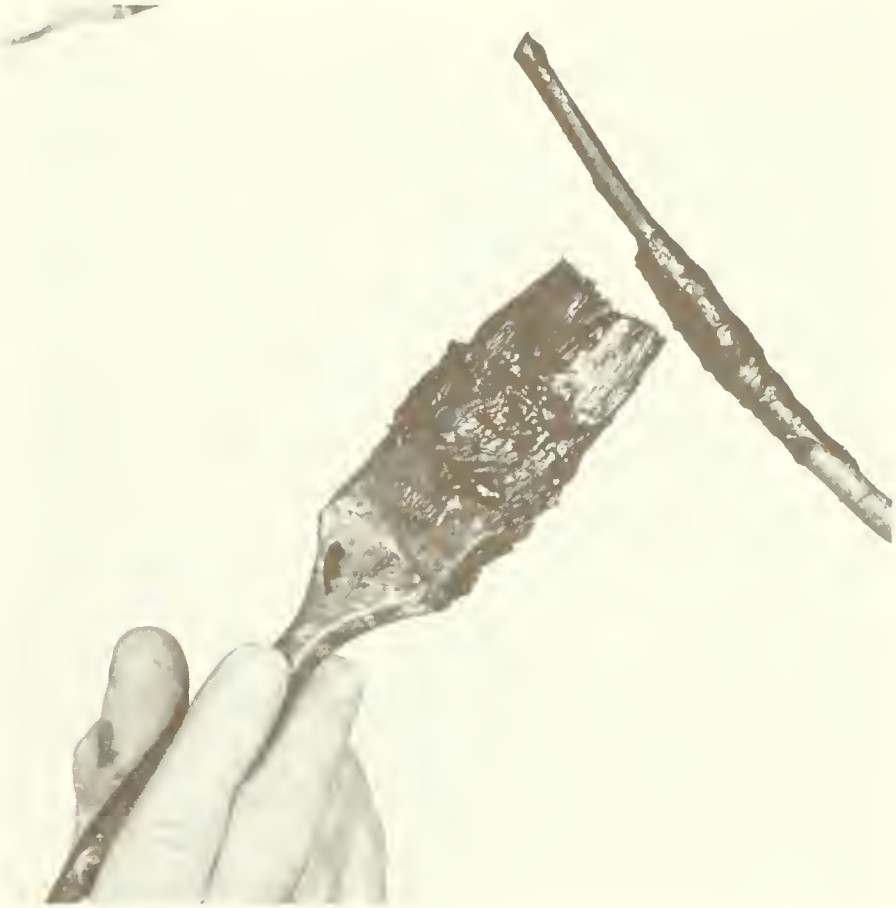
41 Grasp the branch to be grafted so that the buds face toward you and make a smooth, sweeping diagonal cut 6.5 to 7.5 cm long. The diameter of the branch at the point of cutting should never be more than 2 cm. The diameter should be about the same size as the diameter of the scion, but it must not be smaller.



42 More or less parallel to this cut, make a downward cut starting in the center of the pith and extending to almost the beginning of the first cut. To reduce the danger of splitting, make the second cut not quite parallel with the grain. Cut off the longer whip level with the tongue.

43 Take a 3- or 4-bud scion that has a diameter the same size as, or at least not larger than, the branch, and cut in exactly the same way as the branch. Insert the tongue of the scion into the cleft of the branch, and push the two together till they firmly interlock.

44 Before binding the union with rubber splicing tape make sure that the cambium layers of scion and branch are in contact on at least one side of the joint. If scion and branch are the same diameter, contact is made on both sides, but if the scion is smaller, contact is possible on only one side.



45 Coat the binding and scion tip with emulsified asphalt or grafting wax.

## BARK GRAFTING

The single-slit bark graft is in common use among fruit growers and is a simple method of topworking fruit trees. It is valuable when working over trees whose branches do not split well, since, with this method, no cleft is made in the limb. It is also used in grafting limbs that are larger than those usually cleft grafted. Bark grafting should be done only in the spring when the bark is slipping well, and the buds are beginning to swell.

Scions prepared with a shoulder at the top of the diagonal cut surface are sometimes preferred in this type of grafting, as the stub may heal over more quickly. See details of this type of scion, bark-1, and bark-2 in the section showing various scion cuts (p. 52).

Selection of the branches to be worked is the same as in cleft grafting.

The double-slit, or channel, bark graft can be used instead of the single slit with equal success. The bark on the side of the stub is prepared for the insertion of the scion in the same way as in bridge grafting.

In districts where blackheart is widespread, bark grafting is preferred to cleft grafting.

Scion wood must be dormant when the grafting operation is performed.

46 Branches to be grafted should not be more than 5 cm in diameter. Saw them off at the desired point with a sharp, fine-toothed saw. The bark must not be torn or loosened around the end of the stub, since if this happens union is less likely to be successful and the danger of infection is increased.

47 Make two lengthwise cuts through the bark on the opposite sides of the stub. They should be about 4 cm long.

48 Separate the bark from the sapwood by inserting and twisting the knife at the top of the slits.

49 Insert a 3-bud scion, with a diameter about the size of a pencil, in the slit with its cut face in contact with the white of the stub. Push it in until its lowest bud is level with the sawed-off surface.

50 After the second scion has been inserted in the opposite slit, drive one or two flat-headed brads through each scion into the wood of the stub to hold firmly in place. Wrap the grafted area with rubber splicing tape.

51 Cover the tape, end of stub, and scions with emulsified asphalt or grafting wax.


Damage to bark on the trunks of orchard trees is a common occurrence. Damaged bark may be caused by careless handling of orchard implements, chafing by wire guards, girdling by mice or rabbits, or by collar rot disease. Such injuries can usually be repaired by bridge grafting, without loss of vigor or productivity of the tree. However, when young trees have been completely girdled by mice or rabbits, replace them or saw off the trunks below the girdle and cleft graft them. If the girdled area is sufficiently above the bud or graft union that a length of uninjured trunk remains below the injury, the trunk should be sawed off just below the girdled area. Strong shoots will usually arise from the stub that is left. Keep the strongest shoot to form a new trunk, and remove all the others.

When damage occurs during the winter, paint the wounds as soon as they are discovered with a Bordeaux – linseed oil mixture or an emulsified asphalt preparation, which will prevent excessive drying out.

Do not do bridge grafting too early in the spring. The best time is when the buds begin to swell. If bridge grafting is done before the bark slips readily, much of the inner bark will remain attached to the sapwood and, if it is not scraped off, this bark will prevent satisfactory union.

Only dormant wood of the previous season's growth should be used for scions. Gather scions of vigorous hardy varieties. Since this is a form of repair grafting, it is not necessary to use scion wood of the same variety that is to be bridge grafted.

When a trunk has been injured by winter killing, allow a few branches to develop on the scion for one year only. If the top of the tree has not been affected by the injury, rub off the buds on the scions.

52 The trunk of an apple tree extensively girdled by mice during the winter is shown here. If it is left in this condition, the tree will die. It can be saved by bridge grafting. There are several ways of slitting the bark for the insertion of bridge grafts. Because of its simplicity, the single-slit method is probably the most commonly used. However, the double slit is preferred by many because the scion is so easily inserted.

Study the ways that the scions are prepared for the different slits. These are illustrated in Photos 68 and 69.

The number of scions to be used on any particular tree depends on the diameter of the tree and on the extent of the injury. Insert the scions at about 5 cm intervals around the injured area.

53 In the single-slit method, make a vertical cut through the bark both above and below the injury, in alignment. Lift the bark from the wood at the corners and insert the scion. Drive two flat-headed brads through each end of the scion to hold it firmly against the wood of the trunk.

54 In the double-slit method, hold the previously prepared scion with its ends resting upon the bark in the exact position it is to occupy. Score the bark with the knife point along the edges of the scion, remove the scion, and slit the bark through along the score marks. Lift the bark between each pair of slits, insert the scion, and nail it at each end.

55 In the inverted L, make an L-shaped cut in the bark above the injury and an inverted L in line with it in the bark below. The vertical cut in each case should be somewhat longer than the horizontal. Lift the bark and insert the scion with one edge bearing against the vertical bark edge at both top and bottom.

56 In the inverted T method, make a T-shaped cut to receive the lower end of the scion and an inverted T cut to receive the upper end. Lift the angular bark flaps, insert the scion, and nail it.

57 Cover the grafted ends of the scion and the injured area of the trunk with emulsified asphalt or grafting wax.

58 A strong trunk can be developed by bridge grafting.

INARCHING

The orchardist often has to contend with injury to the below-ground portions of orchard trees caused by pine mice. The bark may be completely eaten off the main anchor roots for several centimetres below ground level, which makes bridge grafting impracticable. Root killing is caused also by unfavorable environmental conditions during the winter months. In such cases the tree would die within a year if left in its injured state. Fortunately trees damaged in this way can be saved, and will eventually be none the worse for their injury. By inarching the tops of small seedling trees into the trunk of an injured tree, a completely new root system is provided. This is done by planting seedlings around the base of the injured tree in the very early spring, and later, by grafting the trimmed tips of these seedlings into the healthy tissue above the injury. Trees that have been injured by grass fires can be saved this way.

Inarching is best done in the spring just as soon as the bark slips easily, or when the young leaves are showing. However, the operation can be done any time before early summer when the bark is slipping.

59 Dig a hole, deep enough to hold the roots of the seedlings, around the base of the tree. Plant vigorous 1- or 2-year-old seedlings with well-developed root systems, of such hardy sorts as may be available, about 15 cm apart around the trunk and as close to it as possible. When lifting the seedlings, be careful not to damage the roots.

60 Fill the soil in around the roots and tramp it firm. Keep the seedling trunks as vertical as possible.

61 Top the seedling stem at the right level to join it to healthy bark. Starting about 5 cm below the cut end, make a diagonal cut on the side of the stem next to the trunk. Shave the edges of the cut face to expose the inner bark, as shown in the scion for the channel graft, Photo 69.

62 Hold the seedling stem vertical, press the cut face against the trunk of the tree, and score the bark along the sides of the cut face with the knife point.

63 Move the stem aside and, using the scored lines as guides, cut through the bark to the wood. One cut should exactly follow the line, the other should be made just inside. Join the two vertical cuts at the bottom by a horizontal cut. Raise the bark flap and insert the end of the seedling under it.

64 When you have fitted the cut face of the stem accurately into the channel, lower the bark flap and drive one or two flat-headed brads through the flap and the end of the seedling to hold them firmly.

65 Complete the operation by brushing emulsified asphalt over the joints and any exposed trunk wood. When the trunk has been injured only below the first main branches, rub the buds off the inarched seedlings after union has taken place.

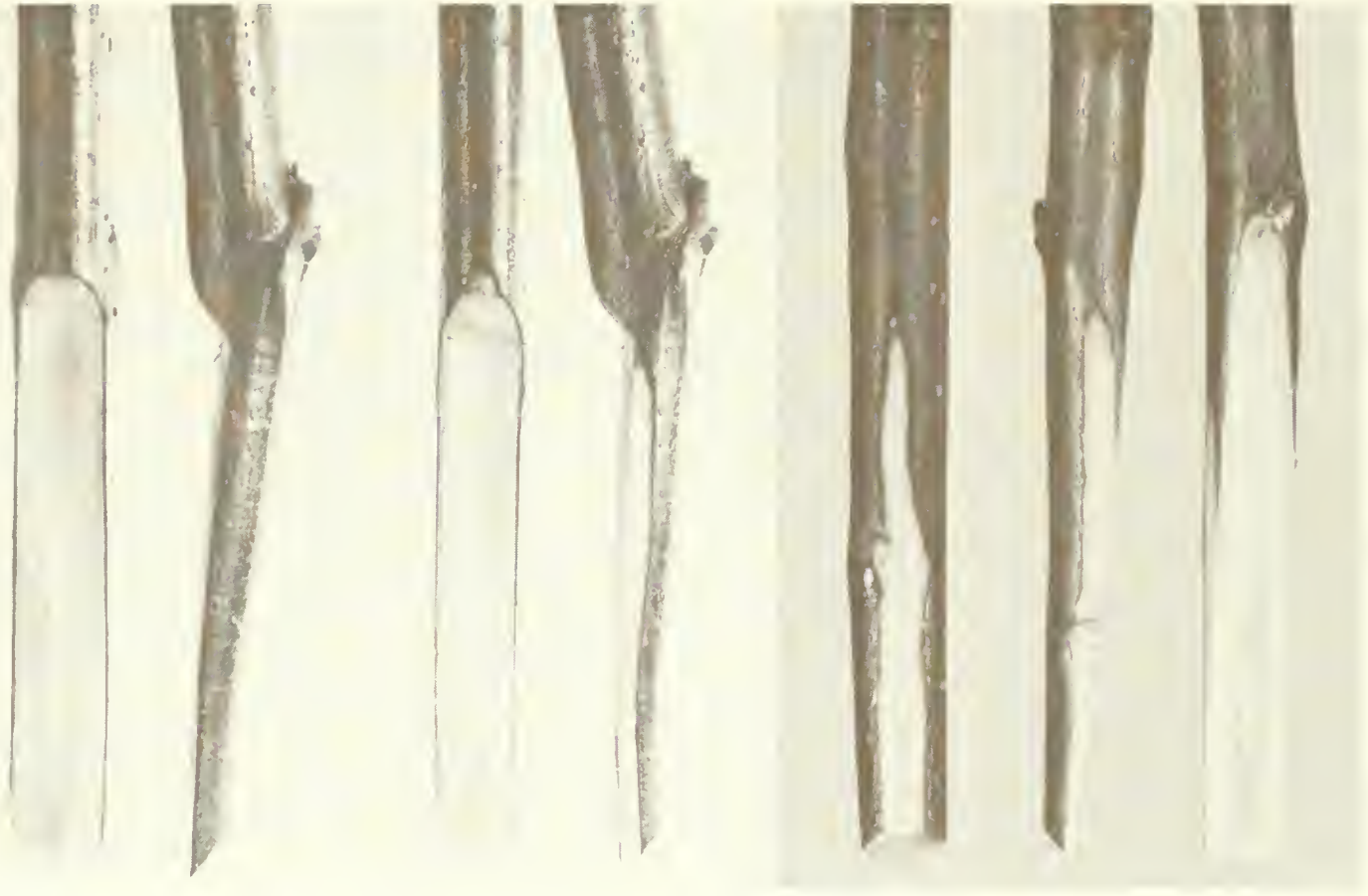
TYPES OF SCIONS

Cut faces should start level with the bud. They should be smooth in both scion and branch so that a large area of contact will be secured. In the channel and bark-2 scions, the bark is shaved off to the cambium along both edges of the cut face. In bark-1, bark-2, single-slit, and double-slit scions, the end is beveled for easy insertion. In the double-slit scion only enough bark is pared off the outer surface to expose the cambium and allow the scion to fit snugly against the under surface of bark flap.

An inexperienced person should study carefully the construction of each scion and, using Photos 66–69 as a guide, practice making the different kinds of scions before starting the actual grafting operations.

66 Cleft scions.

67 Oblique scions.



68 Left, bark-1 scions; center, bark-2 scions; and right, double-slit scions.

69 Left, channel scions; center, single-slit scions; and right, whip and tongue scions.

## TOOLS
## USED IN BUDDING AND GRAFTING

70 Fine-toothed saw with swivel blade, hammer and nails for securing scions, grafting and pruning knives, budding knife with wedge-shaped bone handle, pruning shears, tool for scraping rough bark, tool for bark lifting, and grafting tool.

## CONVERSION FACTORS

| Metric units | Approximate conversion factors | Results in: |
|---|---|---|
| **LINEAR** | | |
| millimetre (mm) | x 0.04 | inch |
| centimetre (cm) | x 0.39 | inch |
| metre (m) | x 3.28 | feet |
| kilometre (km) | x 0.62 | mile |
| **AREA** | | |
| square centimetre ($cm^2$) | x 0.15 | square inch |
| square metre ($m^2$) | x 1.2 | square yard |
| square kilometre ($km^2$) | x 0.39 | square mile |
| hectare (ha) | x 2.5 | acres |
| **VOLUME** | | |
| cubic centimetre ($cm^3$) | x 0.06 | cubic inch |
| cubic metre ($m^3$) | x 35.31 | cubic feet |
| | x 1.31 | cubic yard |
| **CAPACITY** | | |
| litre (L) | x 0.035 | cubic feet |
| hectolitre (hL) | x 22 | gallons |
| | x 2,5 | bushels |
| **WEIGHT** | | |
| gram (g) | x 0.04 | oz avdp |
| kilogram (kg) | x 2.2 | lb avdp |
| tonne (t) | x 1.1 | short ton |
| **AGRICULTURAL** | | |
| litres per hectare (L/ha) | x 0.089 | gallons per acre |
| | x 0.357 | quarts per acre |
| | x 0.71 | pints per acre |
| millilitres per hectare (mL/ha) | x 0.014 | fl. oz per acre |
| tonnes per hectare (t/ha) | x 0.45 | tons per acre |
| kilograms per hectare (kg/ha) | x 0.89 | lb per acre |
| grams per hectare (g/ha) | x 0.014 | oz avdp per acre |
| plants per hectare (plants/ha) | x 0.405 | plants per acre |