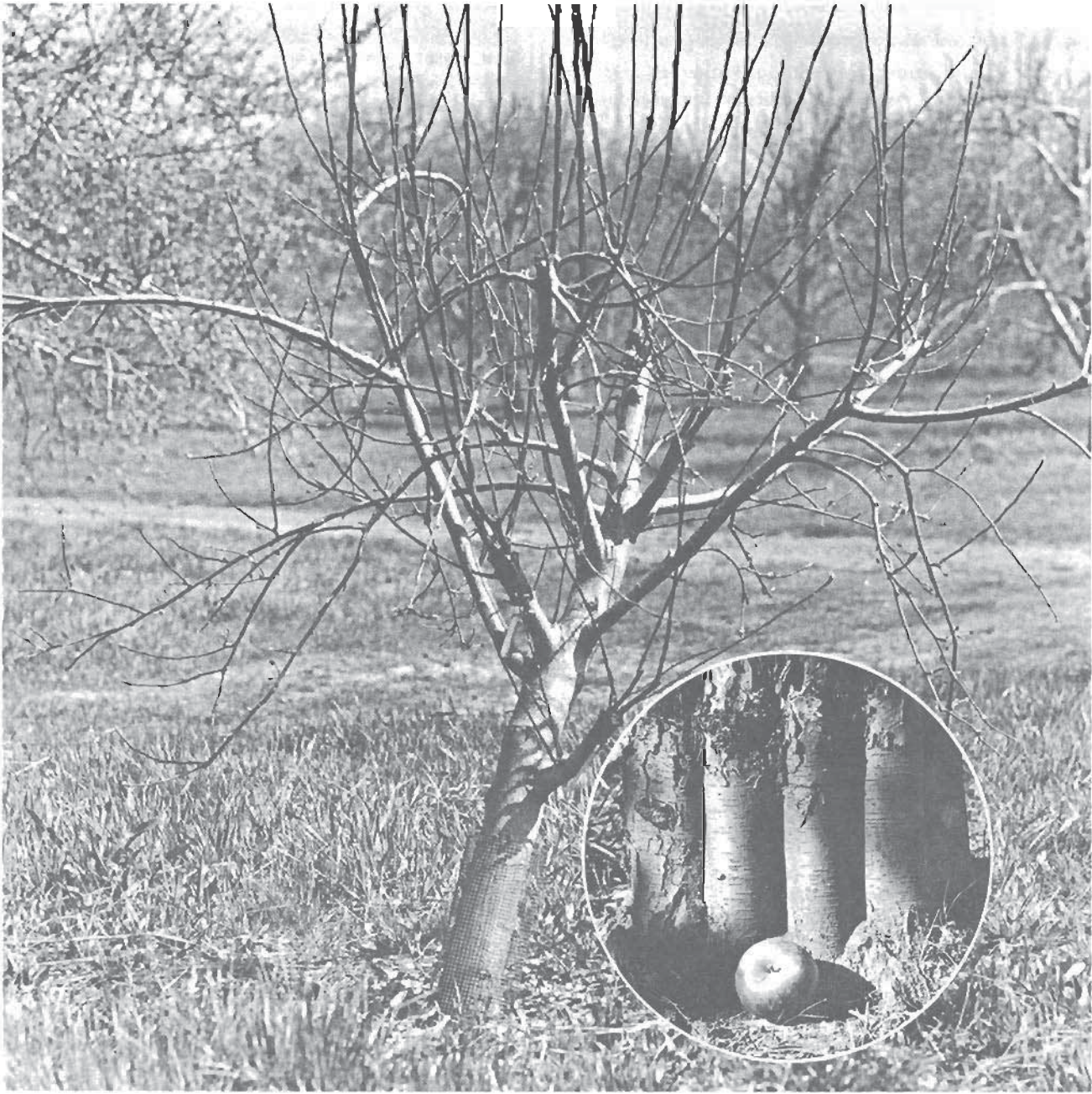


Top-Working and Bridge-Grafting Fruit Trees

by G. H. Oberly



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Top-working and bridge-grafting are often desirable or necessary practices in orchard care. By top-working you can substitute desirable varieties for undesirable ones and introduce pollinating varieties in orchards that lack proper pollination. By bridge-grafting you can repair mechanical injuries or damage caused by rodent girdling of trunk or limbs.

Essentials of Grafting

Successful grafting depends upon the following points:

Responses of commonly grown fruits to grafting

Apple, pear, and prune trees are more suited to grafting than other fruits are. Peaches and cherries are difficult to graft; they can, however, be budded satisfactorily.

Variety compatibility

The scion (the variety being introduced) must be compatible with the stock (the tree being top-worked or grafted). Most varieties of apples are compatible with each other. There are exceptions, but they are unlikely to be encountered in the common New York varieties. The closer the scion and rootstock are related, the more successful will be the graft, apple onto apple, pear onto pear, and so on.

There are a few scion-rootstock combinations which are usually incompatible, such as peach on *Prunus tomentosa* or *P. besseyi*, Bartlett pear on quince, Stanley prune on Myrobalan, and Van sweet cherry on Mahaleb. Many Myrobalan seedlings are sufficiently compatible with Stanley prune to make desirable trees while others will not support the scion for more than 3 to 5 years. In this instance, incompatibility appears to be an inheritable characteristic present in some seedlings.

Some of the adverse effects of scion-rootstock incompatibility can be avoided by using an interstem which is compatible with both the scion and the rootstock. Decline of Stanley prune does not occur if an interstem of Italian prune is placed between the scion and the Myrobalan rootstock. Similarly, the use of the pear varieties Old Home or Hardy as interstems between Bartlett pear and quince rootstock will avoid the brittle union of this combination.

Season of year

Successful grafting is dependent upon the proper season of the year. Cleft-grafts and whip-grafts are most successful when the bark is tightly joined to the wood, just before and during the early period of bud swell. Shortly before blossom, the bark begins to separate readily from the wood. When this happens, the bark may not split in the same line as the wood and thus cleft-grafting may not be satisfactory. Under these conditions the inlay-graft may give a better "take." A bridge-graft requires two inlay-grafts. Thus, for proper bridge-grafting you must wait until

the bark slips readily from the wood.

Budding is generally done in the late summer when the bark still slips easily from the wood. Usually the bud remains in the resting stage and is not forced out until the following spring.

Selection and storage of scion wood

The scion wood for all types of grafting should be collected and stored in its dormant stage prior to any bud swell or growth activity.

For top-working, select scions of well-matured wood of last season's growth (one-year wood), preferably a foot or more in length. Usually the middle portion of the shoot is the most suitable. Water sprouts make satisfactory scions if they are well matured, do not show winter injury, and are from the desired variety.

For bridge-grafting, the same type wood should be collected as for top-working. However, it should be as large as possible; the larger the better. If possible, select the scion wood from a hardy variety such as McIntosh and not a tender variety which may be damaged by low temperatures.

After the scion wood has been collected, wrap it in moist peat moss or sawdust and put the scions in a cold storage, cold cellar, or bury them in well-drained soil which is in the shade of a building. If buried in sandy soil, the scions should be well wrapped. Sandy scions soon ruin the edge of a sharp knife.

"Cambial" layer

The scion and the stock should join in a close smooth contact at the cambium layers and be held in this position until there is growth or union. It is in the cambium layer that growth in diameter or thickness takes place. Separation of the bark and wood in grafting or budding is at this layer. On small shoots, the cambium layer may be as little as 1/32 inch from the surface of the bark, while on thicker trunks it may be as deep as 1/2 inch or more.

Protection of the graft

All cut surfaces must be protected from drying out by covering them with a suitable grafting compound. Water-soluble asphalt grafting compounds which can be purchased from most garden supply centers are very satisfactory and easy to use. The water-soluble asphalt compounds have largely replaced the cold "hand-wax" materials. If a heating or grafting pot is available, a suitable melted wax can be made by melting and thoroughly mixing together:

Resin	5 pounds
Beeswax	1 pound
Powdered wood charcoal	1/2 pound
Raw linseed oil	3/4 pint

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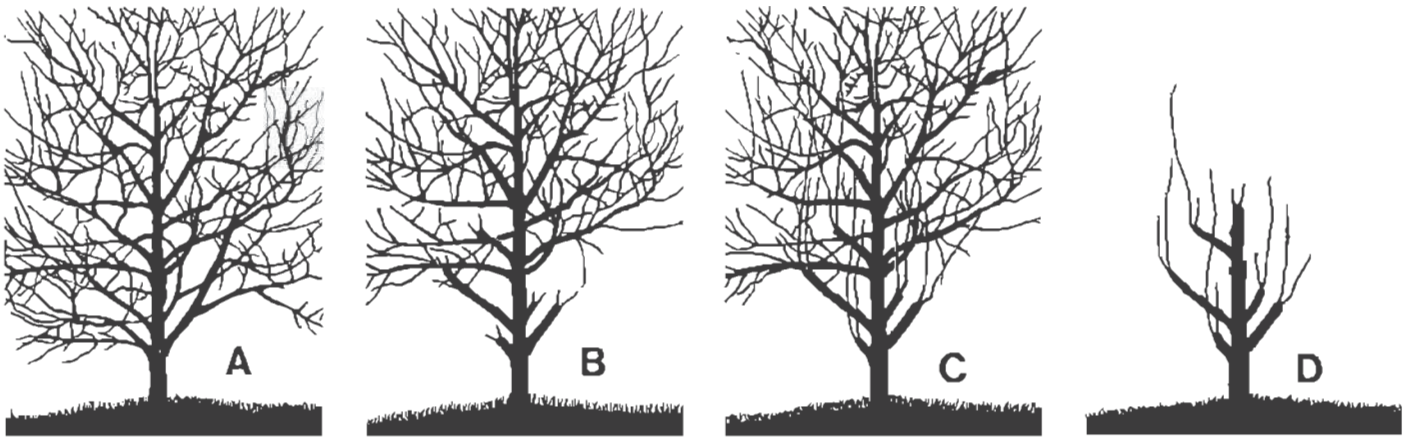


Figure 1. Top-Working: A. Tree to be top-worked; B. Scions set in 5 lower limbs; C. Growth at the end of the first year; D. One of the growing scions pruned back and scions set in other limbs to be top-worked.

Caution – The temperature of the hot waxes is important. If they are too cool to flow, it is difficult to seal the cut surfaces. If they are too hot, they may burn the tender tissues and kill the cambial cells.

Top-Working

Either the cleft-graft or the bark-graft is suitable for top-working. Cleft-grafts may be made anytime in early spring before the bark begins to peel. The best time is when the buds begin to swell. The cleft-graft is adapted to limbs from 1 to 3 inches in diameter. After the bark begins to peel, the bark and wood may not split along the same line, making it difficult to establish cambium contact between the scion and stock. The inlay- or bark-graft is more apt to be successful at this time. The inlay-graft may not form as strong a union the first year as the cleft-graft, and some support may be needed.

Stubs much under 1 inch in diameter are not suited to either the cleft- or inlay-graft. A whip-graft can be used providing the stub and the scion are approximately the same diameter. The whip-graft should also be made in early spring before cambial growth and before the bark slips easily.

Selection of limbs

Wherever possible, select stubs from 1 to 3 inches in diameter which are positioned so they will form the main scaffold limbs of the tree. Select with an eye to the future framework and bearing area of the tree. The grafts should be well distributed around the tree and as near the main trunk as the proper sized stubs allow. Usually from 6 to 10 grafted limbs per tree are sufficient.

Relatively young trees (up to about 8 years of age) may be top-worked in one operation. Two or more years may be needed to work over the tops of older mature trees, top-working about two-thirds of the branches the first year and the remainder the following year or two. Such practice will help prevent sunscald damage and

winter injury which occurs when too much of the leaf surface is removed during any one year. If young trees are completely top-worked in one operation, leave as many secondary branches as possible of the original variety for a year or two. These branches will provide shade, as well as nourishment for the tree framework and the root system.

Care after grafting

After the scions are set, all cut surfaces must be thoroughly covered with one of the grafting compounds. Inspect the grafted areas several times during the first year and rewrap them if cracks develop.

Top-worked trees generally have two or more scions set per stub or grafted area. If the stub is greater than 1½ inches in diameter and all scions grow, all but one should be heavily pruned before the second growing season. After two or three years remove the smaller grafts. If the stub diameter is less than 1½ inches and two scions grow, one can be completely removed before the second season's growth begins.

When a tree is severely headed back, as when top-working, many water sprouts will start to grow. Some of these water sprouts should be allowed to grow and provide shade for the limbs. Head back the sprouts lightly to ensure branching. Always head them back below the new grafts to prevent competition and shading of the new scions.

Bridge-Grafting

Bridge-grafting requires the use of the inlay-graft. This graft is always performed with greater speed and success after the bark begins to slip, which is shortly before bloom time. Bridge-grafts should be made as early in the spring as possible to facilitate tree recovery. However, when it is necessary to bridge-graft late in the season, some measure of success can be obtained late as one month after bloom.

In early spring before conditions are satisfactory for



Figure 2. A successful job of bridge-grafting.

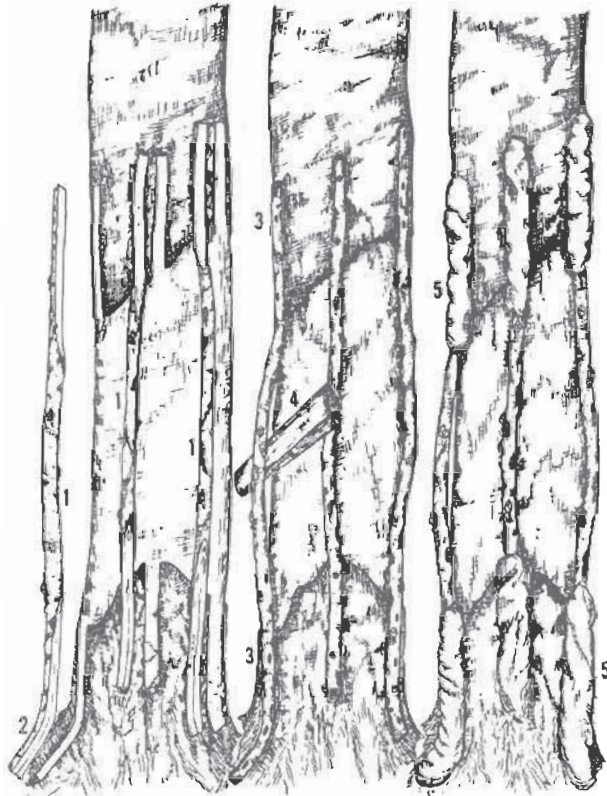


Figure 3. Bridge-Grafting: 1. Scions ready for nailing; 2. A natural crook at the base of the scion works to advantage in grafting on a root; 3. The scions are drawn into place by small wire nails (1 in. No. 18); 4. The scion is less likely to break away at the top if it is given a slight bow; 5. Wax thoroughly all cut surfaces soon after the scions are set.

setting the grafts you may: (1) inspect the areas that require bridge-grafting, (2) paint the wounded areas with a grafting compound, and (3) uncover the soil from any bark that may be needed for insertion of the inlay-graft. Uncovering the bark allows it to warm up sooner so that the bark may slip a little earlier. Also, if there are many to be made, having the damaged areas exposed will greatly speed up the grafting operation. Painting the wound may prevent the edges from drying out and dying back and is recommended for those areas which will be grafted late in the season.

Operation

Where a scion must be inserted at the curvature of a root, scion wood with a curve at the base may have some advantage. The scion should be about 4 inches longer than the space to be bridged. At about 2½ inches from each end, make a cut to the end of the scion as described under inlay-grafting. The cut ends must be in the same plane so they fit evenly against the stock without twisting when the scion is in place. On crooked trunks it may be necessary to fit the plane of the cuts to fit the curvature of the trunk.

Hold the cut surfaces of the scion against the upper and lower edges of the wound to be bridged. Trace the area beneath the scion ends and remove the bark as described under inlay-grafting. Short, thick scions cannot be bowed, so the length from the top to bottom cuts should be equal to the scion length. Longer scions can be given a slight bow (figure 3), so the distance between top and bottom cuts should be slightly less than the length of the scion. A slight bow may help keep the scions in place as the tree sways in the wind. Nail the scions in place and carefully wax all exposed areas. Scions should be inserted from 1½ to 2 inches apart over the girdled area.

Care after grafting

Inspect the grafted areas occasionally the first year and remove if necessary. Rub off any buds growing on the scions as soon as possible and replace any scions that fail to grow.

Grafting Procedures

Cleft-grafting

Equipment and supplies The equipment is a sharp knife (preferably one with a straight cutting edge), grafting chisel, mallet, grafting wax, and dormant scion wood of the desired variety.

Procedure Select a smooth place on the stock where the grain is straight and free from knots and the diameter of the wood is not more than 3 inches. Cut the limb squarely across this area.

Select scions 3 or 4 inches long with 2 to 3 buds. Make a slightly sloping cut above the top bud, with the top of the cut about ¼ inch above the bud. Make the lower cut about 1½ inches below the lowest bud. Start the bevel

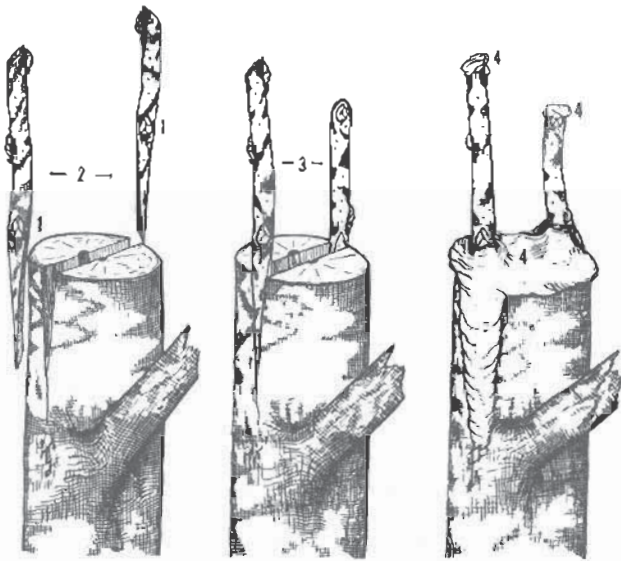


Figure 4. Cleft-Grafting: 1. Scions cut with reference to a bud at the base; 2. Scions ready for insertion; 3. Scions inserted in the cleft; 4. The completed graft with all cut surfaces waxed.

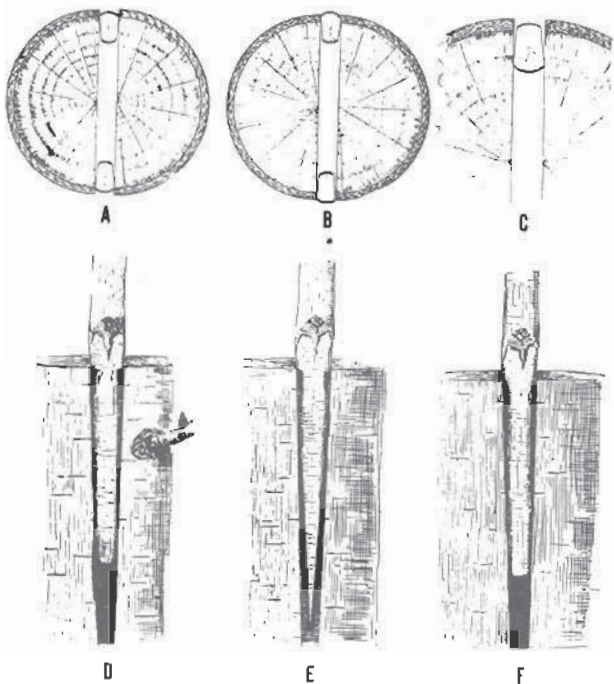


Figure 5. Why some grafts fail: A and D, grafts properly made; B, scion set too flush with stock; C, inner part of scion too thick; E, bevel of scion drawn too much to a point; F, irregular bevel surfaces, resulting in poor contact. Drawing from Michigan Agricultural Experiment Station.

cuts close to the lower bud. With two strokes of the knife, prepare the wedge-shaped scions as illustrated in figure 5. The cuts should be straight and clean, not a wavy surface. The lower bud should face the outside of the limb and this should be the thickest edge of the scion.

With the grafting chisel and mallet, split the stock from 2 to 4 inches. The orientation of the split should be such that inserted scions do not grow into one another. To hold the cleft open, remove the cutting edge and insert the wedge of the chisel. When the stub is more than 1 inch in diameter, 2 scions are usually set in the cleft.

The bark of the stock is generally much thicker than that of the scion. If the outer edge of the scion is set flush with the outer edge of the stock, the cambiums will not be in contact. Therefore, set the scion slightly deeper than the surface of the bark of the stock and at a very slight angle. By placing the scions at a slight angle, you are sure to have the cambiums in contact at some point.

Thoroughly wax all exposed surfaces, including the tip of the scion.

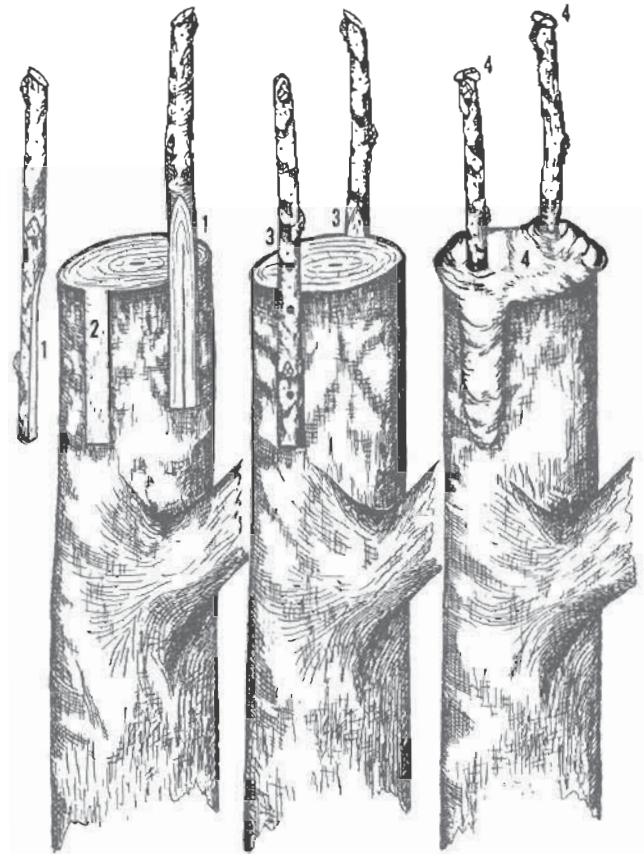


Figure 6. Inlay-Grafting: 1. Scions cut ready for nailing in; 2. Bark on stock removed, exposing cambium cells; 3. Scions nailed in place; 4. Cut surfaces thoroughly waxed.

Inlay-grafting

Equipment and supplies The equipment needed is a sharp knife, pruning saw, hammer, small wire nails ($\frac{3}{4}$ inch, No. 20 or 1 inch No. 18), grafting wax, and dormant scion

wood of the desired variety.

Procedure Cut the limbs to be grafted at places where the bark is smooth and free from knots or any irregular formations. Two scions are usually set in each stub. One may be satisfactory when the stub is less than 1 inch in diameter, and 3 or 4 may be necessary if the stub is 3 or more inches in diameter.

Cut the scion 3 or 4 inches long and be sure it has about 3 buds. Beginning about 2 inches from the lower end of the scion make an abrupt slanting cut to the center, or heart, and then straight to the lower end, leaving a smooth surface with the edges practically parallel and with 2 inches of cambium exposed on each side of the cut. Place the cut surface against a smooth portion of the stub where the scion is to be inserted and mark its outline with the point of the knife on the bark of the stock. Remove the piece of bark on the stock corresponding in size with the cut surface of the scion by following the outline through the wood with the point of the knife. If the stock has shown some growth activity, the small portion of bark should slip readily and leave a clean surface of cambium cells exposed on the face of the sapwood. If any inner bark adheres, remove it. If the bark does not remove easily, delay the grafting until it does slip free of the sapwood. Insert the scions, nail, and thoroughly wax all exposed surfaces.

Whip-grafting

Equipment and supplies The equipment needed is a sharp knife, budding bands, grafting wax, and dormant scion wood of the desired variety. (Many cut fingers result when cutting the "tongue." A first aid kit should be available or wear a heavy leather glove.)

Procedure Select a smooth place on the stock. Sever the stock with a slanting cut about 1½ inches long. Make a similar cut on the basal end of the scion. The scion should be about 3 buds in length. Make a tongue on the slanting cut of both stock and scion by placing the knife just above center and cutting across the center or heart to a depth of ½ to ¾ inches. The two tongues fit into each other. If the stock is larger than the scion, place the scion to one side of the stock, but a little inside the bark of the stock. The cambium layer of cells must be in contact. Bind the union with string or a budding band and wax. If string is used, it must be cut shortly after growth begins or it will girdle the union.

Budding

Equipment and supplies The equipment needed is a sharp budding knife, budding bands, or budding tape, and bud sticks of the current season's growth of the desired variety.

Procedure There are a number of methods of budding. The straight "T" method is satisfactory and is the only method described in this bulletin.

Whereas grafting is performed in the spring, budding is

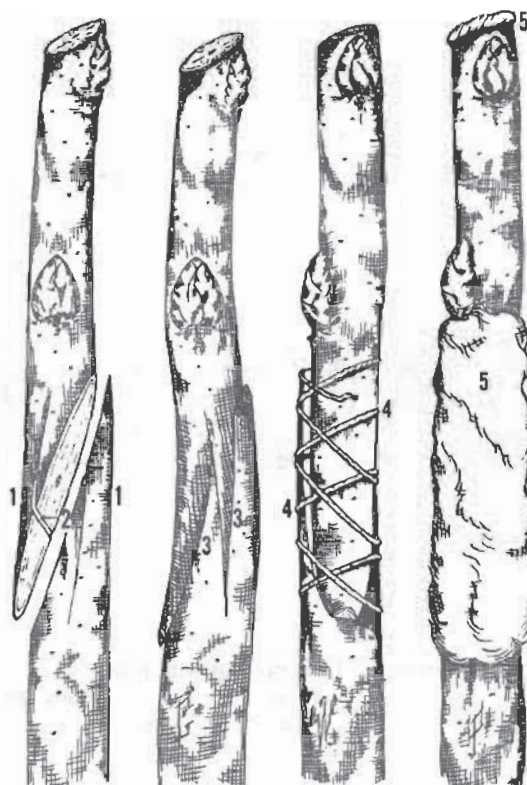


Figure 7. Whip-Grafting: 1. Scion and stock are prepared by diagonal cut from 1 to 2 inches long; 2. The tongue is made by starting the cut just above the center and drawing the knife in the direction of the long axis from ½ to ¾ of an inch and cutting across the heart; 3. It is essential that the cambium layers of stock and scion come in contact on one side; 4. Waxed string or rubber budding band is applied to hold the graft securely in place; 5. All cut surfaces are thoroughly waxed.

generally accomplished during August or early September while the bark will still slip readily at the cambium layer. The "bud stick" is obtained by taking the current season's growth from the desired variety. Immediately cut off all the leaves, leaving ½ inch of the leaf petiole to facilitate handling the buds. Make a T-shaped cut on the stock at the desired point of budding. Carefully loosen the edges of the T, making two small flaps into which the bud will be placed. The buds in the axil of the leaf petiole must be fully developed. Therefore, use the buds located on the middle of the shoot, discarding the basal and terminal buds. Cut the bud from the bud stick in a small shield. Cut from below the bud, upward to about ¼ inch above the bud; then cut the bud free with a straight cut across the top. Insert the bud into the T, making sure that the bud has not been inverted; then wrap it with a budding band or budding tape to hold it in place. It is important that the buds be wrapped fairly tightly to keep them from drying out as buds are not waxed. *Keep the bud sticks moist and out of the direct sunlight.*



Figure 8. Budding: 1. Bud sticks; 2. Budding knife; 3. Buds cut ready for insertion; 4. T-shaped incision in the stock; 5. Bud set ready for tying.

The buds will generally remain dormant until the following spring. However, sometimes they will make short growth depending upon the climatic conditions and the development of the buds. Pruning the stock to within 3 or 4 inches of the bud will also force them out. If there



Figure 9. Budding: 1. Bud tied with budding band; 2. Bud after band has been removed; 3. New growth tied to the stock to prevent being blown out; 4. Stub cut back to point of budding.

is some growth from the stock, it may be well to leave it for the first growing season as long as the desired buds make enough growth. If not, pinch off the stock growth at the tip or remove it. After a year's growth remove the stock close to the budded area.



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