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Budding and Grafting Fruit Trees

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Replaces F130 Repairing Fruit Trees by Bridge Grafting and F131 Top Working Fruit Trees

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Budding and Grafting Fruit Trees¹



Whip-and-tongue graft of Red Delicious on Malling Merton 106 about 3 weeks, following grafting.

by ROBERT F. CARLSON² and ARTHUR E. MITCHELL³

Since fruit tree varieties cannot be reproduced from seed, because of genetic variability in the seed, they have to be increased by grafting.

Many methods and techniques are used by nurserymen and orchardists in grafting fruit trees, and those in general use are described here. Furthermore, repairing injured fruit trees and top-working different varieties on established trees involve the use of several grafting methods.

Grafting is accomplished by joining together two plant parts, the *scion* and the *rootstock*.

The scion is the portion of new or one-year-old twig or stem (the previous season's or current season's growth) bearing two or more buds. From it a branch or whole tree is produced which will bear fruit according to its own kind.

The rootstock is the tree or portion of it to which the scion is attached.

If scions are grafted in the trunk or in the main branches of a tree or on the rootstock so as to eventually change the top of that tree to another variety, the operation is known as top grafting, or top working.

If a single bud instead of a scion is inserted on a stock (the root portion), the operation is known as bud grafting or budding.

¹ Replaces *Folders F-130, "Repairing Fruit Trees by Bridge Grafting,"* and *F-131, "Top Working Fruit Trees."*

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METHODS COMMONLY EMPLOYED

1. Cleft grafting — Used for top-working older established apple and pear trees. Best adapted to branches 1 to 2 inches in diameter.

2. Tongue or whip grafting — Used mostly on young apple and pear trees when the branches are relatively small (pencil size) and about the same diameter as the scion of the new variety (See cover photo).

3. Side graft — The side graft is made by bending a branch ($\frac{1}{4}$ - to 1-inch in diameter) and making a cut downward on the bias toward the center of the branch about one-inch long. The scion should be cut at the basal end with a long, slanting cut on each side, wide on one side and narrow on the other side, simulating a lop-sided chisel. The scion is inserted into the cut with thick side out by pushing downward on the branch and then releasing the branch. No tying is needed, but the graft should be covered with grafting compound. The branch is cut above the graft about 2 weeks later to encourage growth of the scion (Fig. 1).

4. Bark graft — The bark graft is a substitute for the cleft graft. The stock branch is sawed off as described for the cleft graft. The scion is shaped with a $1\frac{1}{2}$ - to 2-inch cut making a one-sided wedge. A tongue is cut on the stock similar to the one for the bridge graft. The wedge-shaped scion is inserted between the bark and the wood. A small brad can be nailed through

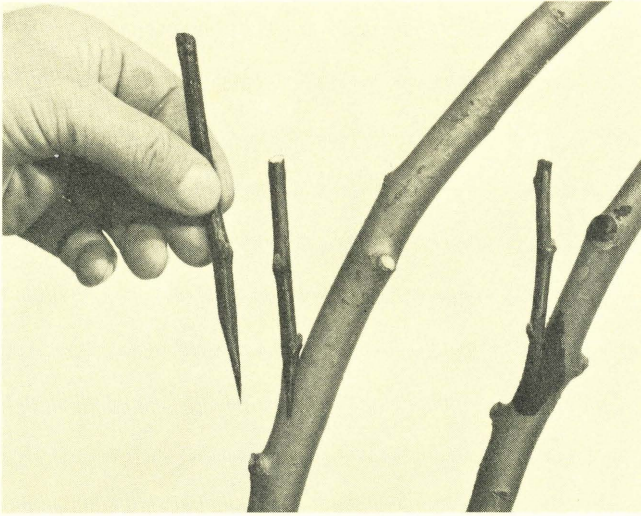


Fig. 1. Side graft made by a single cut into the side of the branch and inserting the properly cut scion. The cut surfaces should be covered with grafting compound.

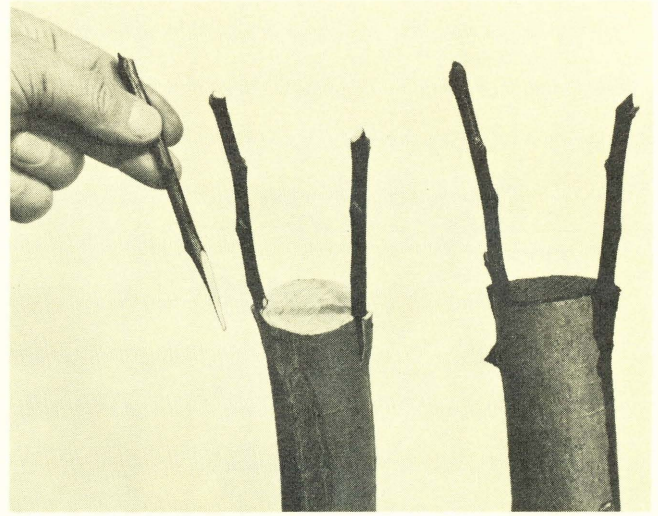


Fig. 2. The bark graft showing left, the slanted cut of the scion; middle, the inserted scions; and right, the completed covered graft.

the bark and the scion to hold it in place. All cut surfaces should be covered with grafting compound (Fig. 2).

5. Budding—Budding is the method most commonly used in the nursery to produce fruit trees. The budding is also used for top-working stone fruit (peach, cherry, plum) but may also be used on apple and pear, especially young trees. Peach, cherry and plum trees are not easily cleft grafted or whip grafted, as the grain of the wood is not straight and thus wood does not split in a straight line.

6. Spring budding—The method is the same as the budding method previously described. Spring budding is done as soon as the bark begins to slip in late April or in May. The scion wood for spring budding must be dormant and should be cut in February and held in cold storage until time to spring bud. Spring budding can be used to replace buds which failed to grow from the August budding.

LESS COMMONLY EMPLOYED METHODS

1. Chip budding—A bud 1-inch long is cut from a dormant scion and this bud is inserted in a similar cut made on the stock. For successful bud-take, this method is best when used on a stock less than $\frac{1}{2}$ -inch diameter. The bud is held in place with a rubber band or budding tape. This method is used often in the greenhouse on dormant woody plants.

2. Patch budding—This method is used during August when the bark is slipping. A square or rectangular patch ($\frac{1}{2} \times \frac{1}{2}$ inch) is removed from the stock. A similar square patch of bark with a bud in the center is removed from the scion of the desired variety and inserted on the stock where the patch was

removed. The patch is held in place with tape until the patch bud has united with the stock. This usually required 3 to 4 weeks at which time the tape is cut away.

ESSENTIALS OF SUCCESS

1. Whatever method is used, it is important that the cambium layer between the bark (phloem and outer tissue) and the wood (xylem) of the scion or the bud is brought into close contact with the cambium of the stock and that the two parts are held firmly together until they unite. Lack of cambial contact is the chief reason why many scions fail to grow.

2. The scion and stock must be closely related. Usually, different varieties of the same kind of fruit can be grafted readily, one on the other, as apple on apple or pear on pear. More distantly related plants, such as the apple and pear or plum and cherry either fail to unite or form weak short-lived unions.

3. For top-working, the tree should be healthy, vigorous and of suitable age. In general, trees of stone fruits which are over 5 years old are not successfully reworked to a new variety. Apple and pear trees of almost any age can be top-worked successfully, but it is doubtful if it is profitable to do so with trees over 10 years old.

4. The grafting or budding must be done at the proper season of the year so that the parts will unite quickly after they are joined together. The time to graft is in the spring as soon as the "bark slips." Budding is done in mid to late summer while the "bark is still slipping."

5. Use sharp tools. All cuts should be smooth, even, and without rough or ragged edges (Fig. 3).

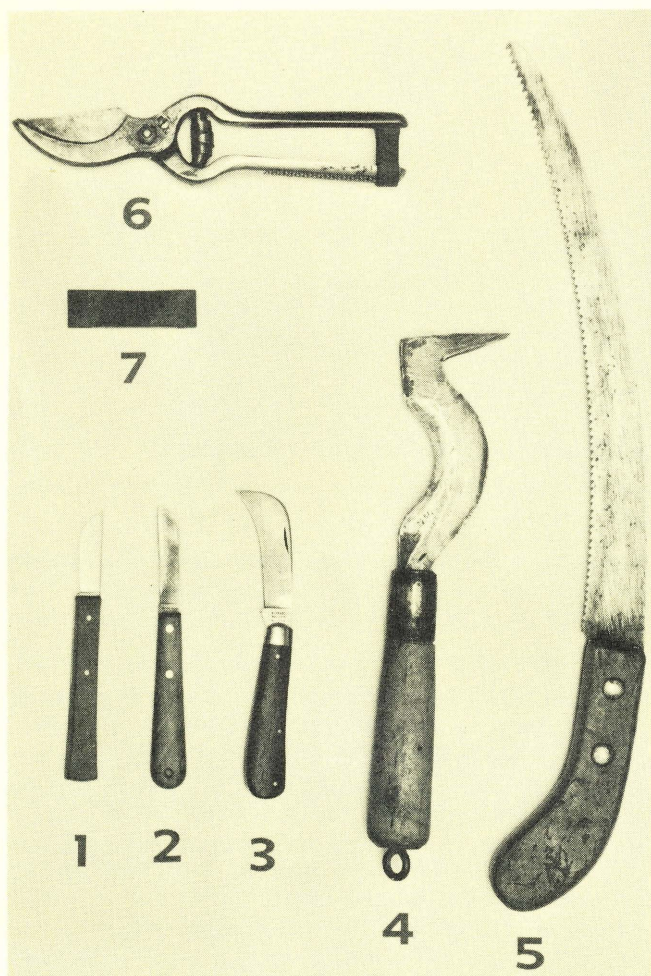


Fig. 3. Grafting tools required: (1) budding knife; (2 and 3) grafting knives; (4) cleft grafting tool; (5) fine tooth saw; (6) pruning shears; and (7) whetstone.

TOOLS AND MATERIALS NEEDED

1. Sharp knife with thin blade.
2. Sharp fine-tooth saw (for cleft-grafting only).
3. Wooden club or mallet (for cleft-grafting only).
4. Grafting tool or other implement to split stubs (for cleft-grafting only).
5. Pruning shears.
6. Asphalt grafting compound.
7. Rubber bands, or adhesive tape for tying and wrapping buds and whip grafts.

WHEN TO GRAFT AND BUD

The best time to top-work a tree by grafting is just as growth begins in the spring, when the "bark slips." Grafts may not be made successfully when the tree is dormant. Top-working may be performed as late as blossoming time provided strictly dormant scions are used.

Budding can be done at any time when the "bark will slip" readily. The usual time is late July, August or early September.

Selection and Care of Scion Wood and Bud Wood

Select scions from well-matured wood of the previous season's growth. Twigs about as thick as a lead pencil, which have made a growth of 12 inches or more during the last season, are best.

"Water sprouts" make good scions if they originate above the graft union, if the buds are well developed, and if the wood is well matured and not dried out.

Scions may be cut any time while they are dormant. It is best to collect them in late fall or during the winter and wrap them in damp cloth, sphagnum moss, or in plastic material, and store them in a cool moist place where they will remain fresh and dormant until time for grafting in the spring. *They must not be allowed to dry out.*

If scions are taken shortly before the time of grafting in the spring, make certain the scions are still dormant and free from winter injury.

Discard twigs or scion wood which show evidence of winter injury (brownish discoloration of the woody portion and bark) or of drying out.

Cleft Grafting

1. Select branches that are not more than 2 inches in diameter at the point where the graft is to be made. Make the grafts within 2 or 3 feet of the trunk, or main scaffold branches, and preferably not more than 4 to 6 feet above the ground. Otherwise, the new top of the newly reworked tree will be too high.

2. Cut off the branch to be grafted square with the grain at a point free of large knots and scars and where the grain of the wood is straight. Avoid tearing or loosening the bark at the edge of the cut. If possible, leave a small lateral branch as a "feeder" about a foot below the cut.

3. Split the stub through the center to a depth of 2 or 3 inches using a grafting tool or a heavy knife. Keep cleft cut open with a wedge in order to insert the scions.

4. Cut scion to include three buds. Shape the lower end into a wedge about 1½ inches long (Fig. 4). Start the cut at one side of the lowest bud and make the

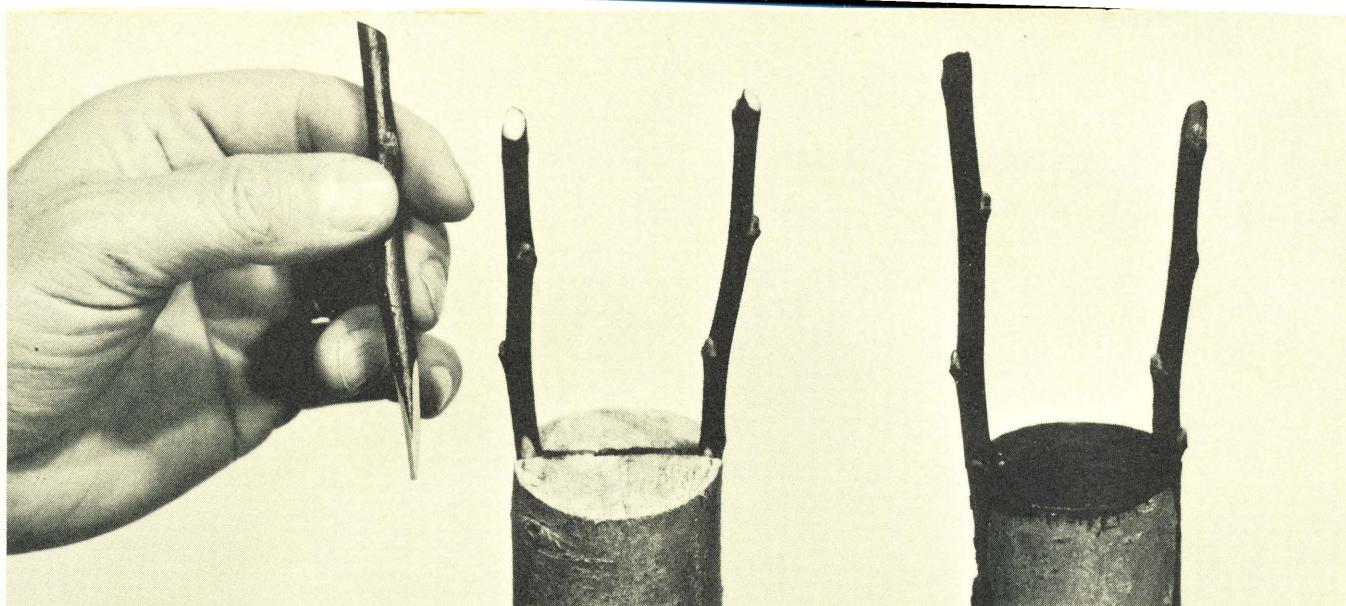


Fig. 4. Cleft graft complete (left) and covered (right). Note beveled cuts of the scion. The scion is set so that its cambium coincides and is continuous with the cambium of the stock.

inner side of the wedge slightly thinner than the outer side. Make the two bevels of the wedge continuous and uniform to insure cambial contact of stock and scion along the entire length of the beveled cuts. Cut top of scion off with a sloping cut about $\frac{1}{4}$ -inch above the upper bud.

5. Set the scion by inserting it into the edge of the cleft so that its cambium coincides and is continuous with that of the stock (Fig. 4). Since the bark of the stock is usually thicker than that of the scion, it is necessary to set the scion so that the outer edge of the woody portion (xylem) of the scion is even with outer edge of the woody portion (xylem) of the stock (Fig. 5). If the stub onto which the scion is to be grafted is less than an inch in diameter, only one scion should be used. For larger branches, two scions of equal size are used, one on each side of the cleft.

6. Remove wedge and carefully cover all cut or exposed surfaces including the top ends of the scion with grafting compound. If the grafting compound cracks, apply a second cover within one week.

7. The following spring cut back one scion to a few buds to check the growth and force the growth into the other scion. Leave both scions until the union is completely healed (2 to 4 years); then, the weaker one should be removed.

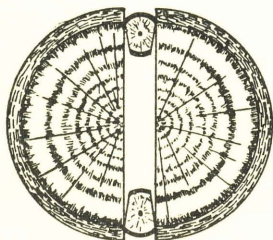


Fig. 5. Cross-section of stub and scions properly made and properly set. Note inset of scions to bring the cambium of the stock and scion in contact.

Tongue or Whip Grafting

1. Stocks for whip grafting should not be more than $\frac{1}{2}$ -inch in diameter. Best results will be obtained with smaller stocks, $\frac{1}{4}$ - to $\frac{3}{8}$ -inch in diameter and when the scion and the stock are nearly the same size. Do not use scions for whip grafting which are larger than the stocks.

2. Prepare scion by making a long sloping cut through the scion about 1 to $1\frac{1}{2}$ inches long. On the surface of this cut about $\frac{1}{3}$ the distance from the toe (the sharp end) to the heel, make a slit or tongue about $\frac{1}{2}$ -inch long (Fig. 6A and B). This is done by making a downward cut partially across the grain and in the direction of the heel. Cut the scion to about 4 inches in length and to include 3 or 4 buds.

3. Prepare stock in the same manner as that described for preparing the scion.

4. Join the stock and scion by placing the two cut surfaces together and slipping the tongue of the scion inside the tongue of the stock (Fig. 6C). If the scion is smaller than the stock, set it on one side so that the cambium areas of both the stock and the scion are in direct contact. Should the toe of either the stock or scion extend beyond the heel of the other, cut it off evenly.

5. Wrap stock and scion firmly together with a rubber band, waxed string or adhesive tape. Cover the union and binding material with grafting compound. Remove wrapping as soon as the scion has started to grow or callus to prevent girdling of the stem.

Note: Whip grafting is frequently used by nurserymen when developing new apple and pear trees using 6- to 12-inch rootstock pieces and 4-inch piece of scion wood.

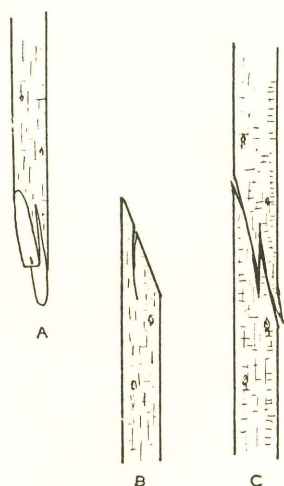


Fig. 6. Tongue or whip graft. (A) and (B), scion and stock ready for grafting; (C), scion and stock joined together and ready to be tied or wrapped.

Budding

1. Cut well-hardened shoots of the current season's growth with well-developed buds from trees of the desired variety shortly before they are used. Trim off the leaf blade leaving about $\frac{1}{2}$ -inch of each petiole as a means to handle the bud (Fig. 7A).

2. Cut bud from the budstick to include an oval or shield-shaped piece of bark and a very small amount of wood about 1 inch long (Fig. 7B). In doing this, hold bud stick upside down. Start cut about $\frac{1}{2}$ -inch below the bud and draw the knife cutting slightly into the wood to a point $\frac{1}{2}$ -inch above the bud. Remove the bud by making a cross-cut through the bark at the upper end.

3. Select a smooth place on the branch to be budded. Make a T-shaped incision in the bark by first making a cross or horizontal cut and then a vertical cut about 1 inch long (Fig. 7C). Carefully loosen bark at edges of incision along the horizontal cut with knife.

4. Insert lower edge of the bud into the loosened horizontal cut and push it down into the bark with the bud protruding from the vertical cut (Fig. 7D). If the bark of the bud extends beyond the vertical cut of the incision, cut it off evenly so that all of the bark of the bud will be covered with the bark of the stock (Fig. 7D).

5. Wrap cut area firmly above and below the bud with common string, or rubber band strips (Fig. 7E). Ten days to two weeks later, cut loose this binding material on the side opposite the bud. This prevents possible constriction and girdling.

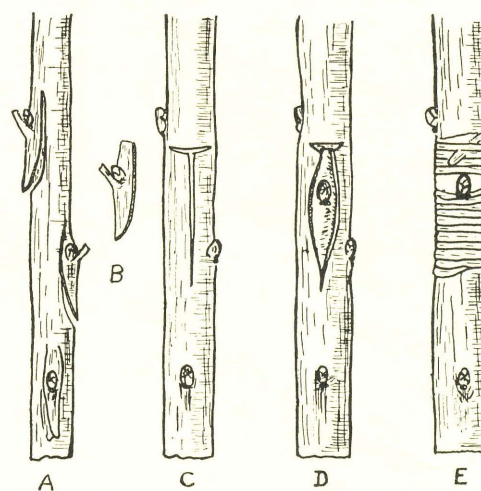


Fig. 7. Budding. (A) prepared bud stick; (B) bud removed; (C) T-shaped incision in stock; (D) bud inserted; (E) bud tied in.

6. The following spring, cut off the stock or branch just above the bud after the inserted bud starts to grow.

Note: When propagating young trees, the budding operation is done in the same manner as that described for top-working except that the buds are inserted on the main shoot of plants 12 inches above the ground-line, which are growing in the nursery row to become the rootstock portion of the new tree.

Bridge Grafting

Bridge grafting is used to "bridge over" areas, particularly those on the trunks of trees, where the bark and cambium have been severely injured or destroyed. Such damage is frequently caused; by mice and rabbits, by diseases such as fire blight, by cold injury, or by careless use of tillage implements.

The treatment given an injured tree will depend on (1) the kind of tree, (2) its age, and (3) the degree of injury.

Young fruit trees less than 1 inch in diameter which have been girdled may be cut off just below the injured area. This allows a shoot from a latent bud *above* the point of union of the root portion and the top to become the new tree.

However, young apple and pear trees between 1 and 2 inches in diameter, which have been completely girdled may best be treated by cutting or sawing them off below the injury in the spring and placing scions in the stub by cleft grafting. If badly damaged, it may be preferable to replace them with new trees. Apple and pear trees 2 inches more in diameter may be successfully repaired by bridge grafting.

Peach, cherry and plum trees which have been girdled are not usually bridge grafted successfully. If the tree is only 2 or 3 years old when injured, it may be cut off below the injury to induce the growth of a shoot from a latent bud to form a new top. When this is done, it is important that the shoot selected to renew the top *does not* originate below the original graft or bud union. Peach, cherry, and plum trees older than 3 years seldom can be saved unless enough inner bark (cambium and phloem) remains on the wood to regenerate new tissue or bark.

Unless the girdled area extends two-thirds around the trunk of the tree, bridge grafting usually is not necessary. Sometimes mice gnaw the bark entirely around the tree, but do not damage the inner bark (phloem) or cambium. In such cases, bridge grafting may not be needed if the proper attention is given before the injured tissue has dried out. Mounding with soil or covering the wound with grafting compound will give sufficient protection until new "bark" is formed.

Wounds made by tillage implements during the growing season when the bark slips readily are best treated by leaving them alone. Usually new bark will form over the injured area if the exposed surface is not touched.

If the injury occurs during the winter, the wound should be covered with grafting compound as soon as discovered to prevent drying out. This is particularly important if the exposed injured surface is large, and some time must elapse before grafting can be done in the spring.

TIME FOR BRIDGE GRAFTING

Bridge grafting should be done in spring after growth has started when the "bark slips" readily, usually in early May. Before this time it is difficult to separate the "bark" from the "wood" a procedure which is necessary to obtain good cambial contact. The grafting may be done in late May with reasonable success if *dormant* scions are available. Good scion wood long enough for bridge grafting collected well in advance of the grafting season while it is dormant and stored properly is a *must*.

Use only the more hardy and blight-resistant varieties of apples such as Oldenburg (Duchess), Fameuse (Snow), McIntosh, Delicious, Northern Spy and Wealthy for scion wood. Seckel, Kieffer and Old Home varieties are satisfactory for bridge grafting pear varieties. Suckers coming up from the base of an injured tree can be used as scions by grafting the top of the sucker into the trunk above the injury.

Use a small hammer and a No. 18 5/8- or 3/4-inch wire nail for tacking scions to the tree. Cover the area with asphalt grafting compound.

PREPARING THE TREE FOR BRIDGE GRAFTING

Remove all dead bark and, if the wound is old, any unhealthy live bark to the woody portion. Trim the bark evenly at the edges of the wound. It is not necessary to keep the bridged area short. Proper graft unions can be made more easily with the long scions than with short ones.

If the injury extends to the roots, remove soil from the base of the tree and from the larger roots until sound bark is found. If the soil is removed several days before the grafting is done, the bark on the roots will "slip" more readily.

In cases where the roots are extensively injured, young seedling trees may be planted near the base of the tree and their tops grafted or inarched to the trunk above the injured area (Fig. 8).

SETTING THE SCIONS IN BRIDGE GRAFTING

Various methods of setting the scions are employed. The methods in most common use are (1) the L-cut which is best suited to trees with thin or moderately thick bark and (2) the inlay which is generally preferred for trees with very thick bark or where the scions are set into the roots. Regardless of the method, the essential requirement is that the cambium layer of the scion be brought into close contact with the cambium layer of the tree and held in that position until the two grow together.

The scion should be made slightly longer than the distance it will cover when set in order that there will be some spring or bow in the scion when it is finally in place. The spring or bow is important to obtain better contact between the scion and the tree. Also, this allows for some swaying of the tree without disturbing the union (Fig. 9).

The scions are set right side up, as they grow in the tree, and at intervals of 3 to 4 inches around the trunk. It is usually best to set the lower end of the scion first.

The L-cut is the easiest made graft union to make. An L-shaped incision is made in the bark an inch or two above and below the edges of the wound. The "L" is inverted below the wound. Each arm of the "L" is made about 1½ inches long. Cut the scion to a rather sharp wedge as shown in Fig. 10 with a longer slope or bevel on the side to be set against the trees. Raise bark of the L-cut, insert scion and drive nails through the bark and scion to hold the scion in place.



Fig. 8. Apple tree girdled by mice and saved by planting young apple seedlings around the trunk and grafting (inarching) the tops to the trunk of the injured tree.

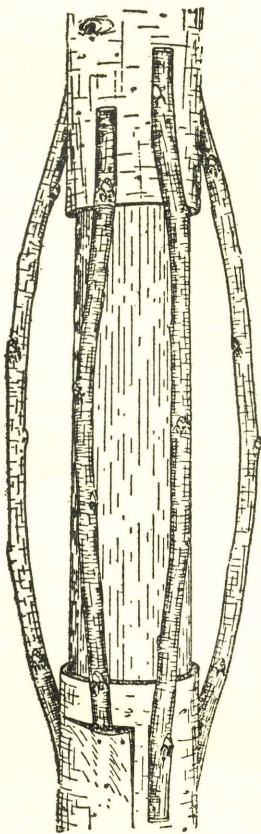


Fig. 9. Bridge graft, showing some of the many methods of setting scions. Note the bow of the scions. This is particularly important in young trees which sway most.

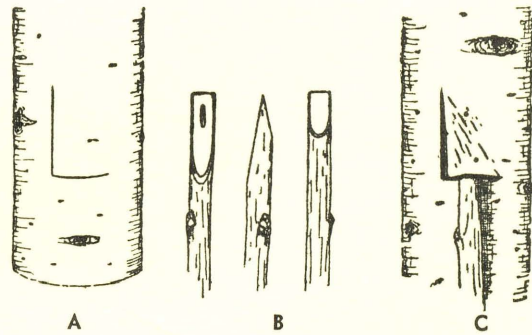


Fig. 10. The "L-cut" graft. (A) L-shaped cut in stock; (B) scion prepared with double bevel; (C) scion inserted under the bark of the "L-cut" and ready for waxing. The long bevel of the cut goes against the wood.

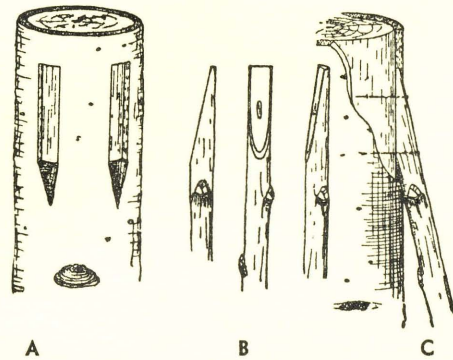


Fig. 11. The inlay graft. (A) bark removed for the insertion of scions (the notches below the slots may not be necessary); (B) scion prepared with long bevel cut; (C) scion properly set and ready to be nailed in.

The inlay graft is made by removing a small piece of bark to form a slot in which the end of the scion is inserted. The slot may be made directly on the edge, or an inch or two away from the edge of the wound as shown in Fig. 11.

Prepare scion by making a long sloping or bevel cut for a distance of 2 inches or more on the same side and at each end of the scion. This cut should extend about half-way through the scion or nearly to the pith and parallel with it leaving a flat surface at the end. Hold one end of the scion against the bark of the spot it is to occupy, trace around it. Then remove the piece of bark as outlined with the knife. Repeat operation at the other end.

Regardless of the type of graft union used, all cut or exposed surfaces should be well-covered with grafting compound as soon as the scions have been set.

Replace any soil that may have been removed from

the base of the tree. Mound slightly around the base of the tree to prevent mice from working on the newly set scions.

Prepared grafting compound may be obtained from garden and orchard supply stores or from nurserymen.

Most of the injuries of fruit trees caused by mice and rabbits can be prevented by using hardware cloth and recommended rodent control around the trees.

SELECT HEALTHY PLANT MATERIALS

In order to have healthy and productive fruit trees, the plant materials chosen for grafting and budding should be free from disease and insect injury. For example, do not bud or graft rootstocks infected with crown gall or wooly aphis, or do not top graft trees which are abnormal in growth. Similarly, the scion wood chosen should be disease-free, vigorous and free from winter injury.