Top and Double Working, and Bridge Grafting of Fruit Trees

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Meaning of Terms Used in Grafting and Budding

Scion.—Dormant wood of the previous season’s growth, when cut and used for grafting, is known as scion wood. It is usually cut some time during the fall or winter from unfrozen, well matured wood. One-year-old wood is preferred because experience has shown that its buds are more likely to grow successfully.

The length of the scions will depend upon the amount of growth during the past season. This may range from 10 to 12 inches or more. The size may vary from that of a lead pencil to a little larger. Scions should not be cut too long for convenience in handling and storing. They should be tied in bunches of from 25 to 50, stored in damp sand or green sawdust and placed in a cool cellar, cave, ice house, or cold storage until needed.

Water sprouts may be used if the wood shows no winter injury, is firm, well matured, and provided they do not originate below the graft. If the water sprouts used as scions come from the root below the grafting or budding union, they are usually like seedlings and are worthless or very inferior as fruit trees.

Stock.—That portion of the tree, branch or root upon which the scion is grafted is designated as the stock. With the completion of the operation of grafting or budding, that part of the tree below the point of insertion of the scion or bud is called the stock.

Buds.—Buds suitable for propagation work may be taken any time after mid-summer. They are found at the base of each leaf stalk on current season’s growth. The shoot from which the buds are cut is called the bud stick. The apple and pear are usually
propagated most successfully by scion grafting while peaches, cherries and plums succeed better by budding.

Essentials of Grafting and Budding

Success in grafting or budding depends upon the observance of the following:

1. The scion and stock must be congenial or capable of producing growth when properly united under suitable surroundings.

2. The operation must be done at the proper season of the year and under the right conditions.

3. The growing tissues (cambium) of the scion should be in close and smooth contact with the growing tissues (cambium) of the stock.

4. To prevent drying out, all wounded surfaces must be properly protected.

5. Timely attention is generally required to make the work a success.

Cambium.—The layer of live or growing tissues consisting of plant cells found between the bark of the tree or stem and the wood is called the cambium. This part possesses the power to grow and produce new cells and form new wood and bark. In all budding and grafting, it is necessary that the cambium cells of stock and scion or bud unite in order that the operation be successful. The purpose of all the operations, therefore, is to obtain the maximum contact between the cambiums of both the stock and scion.

Grafts.—When a piece of root 4 or 5 inches long and a scion 6 to 8 inches long are united by means of the whip and tongue method of grafting, the resulting product is called a graft. The work is done in January and February and the grafts are collected and tied in bundles of 25 or more. They are then placed in damp sawdust or sand and stored in a cool moist place such as a cellar, cave or ice house until early in the spring when they should be planted.
Fig. 1.—Grafting and budding tools: (1) grafting knife, (2) budding knife, (3) mallet used in cleft grafting, (4) hand shears, (5) pruning knife, (6 and 7) knives for cleft grafting.

Top Working

The orchardist employs top working to change the top of an immature or mature bearing tree to that of another variety. Certain diseases of the trunk and branches, such as collar rot and fire blight, are often combatted by means of this practice. The method is used to substitute the strong crotch structure of Minkler, Arkansas, Hibernal, Virginia Crab and others for the weak crotch structure of some standard varieties. It is also used to produce trees with hardier trunks and scaffold branches than those of the varieties that may be desired.

Cleft Graft.—The principal factors deserving consideration in cleft grafting trees are: (1) vigor, (2) type of framework, (3) age, (4) blight and disease resistance and (5) variety. Cleft or top graftage is a method often used in general practice on apples, pears and quincees. The method may also be used successfully on stone fruits, especially the cherry and plum. The entire top of trees up to about ten years of age may be sawed off and the scaffold or main branches cleft grafted at one operation. With trees older than
this, however, it is usually advisable to cleft graft no more than one-third or one-half of the top in one season. For old trees the grafts are usually unable to produce sufficient foliage in one year to carry on the plant processes. The branches which are left but which are to be grafted at another season are known as nurse branches. It is a well known fact that old apple trees will survive the grafting operation better if the limbs used are not larger than 2 to 4 inches in diameter. In from 5 to 7 years after the top grafting operation, fruit trees should develop about as much fruiting wood as ungrafted trees and may bear an average crop.

Cleft grafting work is generally most successfully accomplished just before or just after growth starts in the spring. If there is a great deal of work to do, the grower may start 4 or 5 weeks before the buds swell. The scions should be cut from well matured, dormant wood of the current season's growth during the fall or winter and stored in a cool place in damp sand or sawdust. In cleft grafting the cherry and plum, it is particularly important that the scions be kept absolutely dormant.
Preparation of the Stock. — In cleft grafting, the operation consists in sawing off the limb, leaving the stump to be grafted. The stump is split with a heavy knife and maul. The cleft or split should be made about 2 or 3 inches deep. The knife is then removed and placed in the center of the cleft in order to spread it for receiving the scions. If the stock is large, two wedge-shaped scions may be used, one in each side of the split. It is always well to use two or more scions, depending on the size of the stock, as scions are frequently broken out by the wind and other factors. If the stump is large and there is danger of the pressure crushing the scions, a wedge may be driven down into the middle of the split to hold the parts of the trunk open and lessen the pressure upon the scions. The top of the wedge is then cut off level with the stump. Where the stock or trunk is very large, it may be split both ways and four scions placed in it. In other cases the split is made to one side of the center so as to avoid splitting the heart wood.

Preparing and Inserting the Scions. — The scions should be so placed that the inner bark of one side makes an exact union with the cambium or inner bark of the stock. This is very important, as it is at this point only that any growth occurs. The scions, containing from 3 to 6 buds each, about 4 or 5 inches long and about the size of a lead pencil, are prepared by making long, sloping cuts from 1½ to 2 inches in length on both sides of the lower
ends. The wedge-shaped scions are then ready for insertion in the split or cavity made in the stock. Where the scion and stock are small and approximately the same size, the whip and tongue graft may be used more successfully than the cleft graft, in which case tying and waxing will usually give best results. If No. 18 or 20 knitting thread is used, it will not be necessary to cut the string from the whip graft as the thread is easily broken.

Recent investigations have shown that a quicker and more vigorous growth usually follows placing the strongest appearing buds directly above the matched cambium or growing layers of stock and scion. One or more of the best scion buds may generally be so placed without the loss of time or extra effort and the practice may prove helpful. It is believed that buds directly above the cambial contact of stock and scion receive more food materials,
Fig. 5.—The wrong and right way to place scions in the split when cleft grafting.
The scions may fail when not properly placed. If the bark of the stock is thicker than that of the scion, it is very important that the scion be set in far enough to allow the inner bark or cambium layers of each to match or come together. (A) scions improperly placed, as the inner bark or growing layers are not in contact, although the surfaces are flush. (B) scions properly placed, having been pushed in far enough to give the right contact between stock and scion. To give the best contact the scion should be slightly thicker on the outside than the inside.

starches and sugars, and are able to make better use of them, which results in stronger growth.

Waxing and Subsequent Treatment.—After the scions are in place, all wounded surfaces should be thoroughly and completely covered with grafting wax. If the wax is hot, 2 or 3 coats will be required. The cleft must be closely sealed to keep out air and disease and to prevent the wounds from “bleeding”. The wax should never be disturbed and new applications, if needed to keep the wounds covered should be made one or more times each growing season until the scions are well established and the wounds are healed.

Before waxing, it is usually advisable to wrap waxed tape or a heavy cord around the top of the stock near the cut surface, thus tying in the scions to prevent the stock from gaping open and destroying the contact of the growing parts. After 4 or 5 weeks, when growth should be well started, the tape or cord may be cut; otherwise, if it be very strong, it is likely to girdle the stock and prevent growth.

A paper bag is also often placed over the cleft graft and waxed surfaces and tied around the stock to lessen the evaporation of moisture from the scions and stock. In about a week or ten days, growth should start and the sacks should be removed. At the end of the first or second season if all of the scions are growing, the number should be reduced to one, because two or more growing from the same point may develop a bad crotch. Where more
Fig. 6.—An apple tree girdled by rabbits. Enough of the cambium or growing layer near the wood was left to make bridge grafting unnecessary. The wounds were painted with white lead and raw linseed oil and they were practically healed over during the following season with no apparent injury.

Fig. 7.—A girdled apple tree about 14 inches in diameter with the scions in place bridging the girdled area. Note that the rough irregular edges of the bark bordering the wound have been trimmed back evenly, and the girdled area has been painted with white lead and raw linseed oil. The wounds made in inserting the scions are covered with grafting wax which may be used to cover all wounded parts.
scions are needed, however, to heal over a large wound, they should be left for a longer period. If the scions that are to be removed are pruned rather severely each year, their growth will be greatly checked and they may be left longer without any ill effects to assist in healing over wounds.

**Danger of Injury from Top Working.**—Young hardy, vigorous varieties of apples may be more successfully cleft grafted than weaker growing sorts. Good growing trees from five to nine years old usually cleft graft or top work most successfully. Varieties susceptible to blister canker are likely to be seriously injured unless they are growing vigorously and the cut surfaces are small, carefully sterilized and kept covered with grafting wax or a good tree wound paint. If more than two or three years are required for the healing over of cut surfaces there is great danger of disease entering the grafted branches and destroying them. For this reason, it is usually advisable to confine the cleft grafting operation to limbs or branches of not more than 2½ to 3 inches in diameter. It is always dangerous to cleft graft apple trees 18 to 20 or more years old. If old trees are grafted, the cuts for the grafts should be made higher in the tree tops, in order to make use of limbs of not more than the diameter mentioned above.

**The Bark Graft Method**

It is essential in this method of grafting that the bark separate readily from the wood. Consequently, for best results it is usually advisable to do the work in the spring just as the buds are starting growth.

The limbs to be grafted are sawed off in the usual manner, leaving short stubs. There are several slightly different methods used in preparing the scions. Just as satisfactory a method as any, however, is to prepare the scions wedge shaped, as described under cleft grafting. Many, however, cut the scion with a straight splice or with a shoulder and splice.

If the bark of the stock is in the proper condition (slipping easily) the scions may be inserted without difficulty between the bark and the wood. It is usually necessary to insert 2 or more scions between the bark and wood to induce rapid healing of the stub. If the stock is large, the scions may be placed at intervals of 3 or 4 inches around the stub, to facilitate the healing of the wound. If the bark of the stock does not slip readily, a slit about ½ inch long, made at the edge of the stub will make the insertion of the scion easier. The scions should be tied firmly to the stub by means of
waxed tape or stout cord to hold them in place. Small tacks are also sometimes driven through the scions into the stock to help hold the scions firmly to the stub. All exposed or cut surfaces should be covered with grafting wax. The tape or cord should be cut after a few weeks or as soon as the scions are well established, in order to prevent girdling.

**The Notch Method of Graftage**

The "notch method" of making the cleft graft first came into prominence in the Northwest. A coarse-toothed saw is used and the desired notch is sawed out instead of split. The scions cannot be made wedge shaped, but must be whittled to fit the notch. If one side of the scion is made thinner than the other one, then the scion can be forced in tightly until the inner edges meet closely. The wedge is usually made sidewise, with the splint toward the center of the tree. Tie and wax the wounds as with other methods of graftage. The advantage claimed for this method is that it does not injure the stock badly by splitting it, and as a result it heals more quickly.

**The Side Cleft Graft Method**

The "side graft" is very good for top-working trees or grafting small branches. The scion is prepared as in the cleft graft except that the wedge is very short. The limb or stock receives a diagonal cut almost to the pith. This cut is then opened by bending the limb and the wedge shaped scion is inserted, using care to make the right contact between the two cambium layers. When the scion is in place the end of the limb is released and its spring action holds the scion in place. No tying is necessary. The original branch is then removed just above the insertion and the whole union and wound are covered with grafting wax.

**Doubling Working**

Double working is a method for reworking trees to avoid many of the troubles affecting the trunks and crowns of apple trees, as collar rot, fire blight and winter injury. Some varieties such as Grimes, are notoriously susceptible to crown troubles. The method may be used to produce straight trees instead of straggling ones or to give vigor to poor or weak growers. Pear and apple trees are most often double worked.

Trees of a known resistant variety with a good root system such as Minkler, Arkansas, Northern Spy, Virginia Crab and others are propagated in the usual manner by scion and root grafting or by
budding. The resulting trees are generally allowed to grow for 1 or 2 years. Just before growth starts early in the spring the trees may be cut off about twenty inches above ground and cleft grafted or whip grafted to Grimes or the desired variety which is being propagated. With this operation completed, the trees have been worked twice, hence the term "double worked".

Seedling stock may be budded during August or early September. The bud is inserted near the ground. If it grows the top of the tree is removed near the bud the following spring. The inserted bud is forced by keeping all growth of buds below it rubbed off. The new growth from the hardy bud may be budded to the variety desired in August of the same year. In this second operation the bud is inserted at a height of about 20 inches from the ground.

Still another method consists of allowing the hardy tree serving as the stock to grow from 3 to 5 years and form its main scaffold branches. These main branches may then be sawed off early in the spring, leaving stubs about 16 or 20 inches in length, which may be cleft grafted to the desired variety. By this method the trunk and the crotches of the scaffold branches are made up of the hardier sort. A stronger tree and one which is less likely to disease in its main stem and framework is thus produced.

**Bridge Grafting**

Bridge graftage is made use of in repairing injured tree growth. Many trees are injured by rabbits, field mice, or other animals, by the careless use of implements in the orchard and by diseases. In the treatment of such injury the bridge graft is often very valuable. Its use is not nearly as widespread as it should be.

Unless about one-fourth or one-third of the bark of bearing tree trunks has been removed down to the wood or cambium layer, bridge grafting is not usually necessary. Where rabbits have gnawed the bark of the tree trunks practically all the way round but have not peeled it to the wood except in spots here and there, bridge grafting as a rule is not needed. An application of house or barn paint (white lead and raw linseed oil) applied to the wounds only, will generally prevent drying and assist materially in healing the wounds. Trees which appear to be badly damaged by girdling will frequently heal their wounds quickly if grafting wax is used properly in covering the wounds.

If the injury occurs in winter the wounds should be protected by a coat of grafting wax to prevent drying. The grafting should be done in the spring as soon as the bark will peel freely. During
the growing season, the operation should be performed as soon as the wound is found.

Trees from 1 to 2 years old, inclusive, which have been completely girdled or the bark removed down to the wood all the way round are usually handled most successfully by cutting them off a few inches above the graft union and allowing one sprout to grow from above the union. The best time to cut the trees back is just as growth is starting in the spring. With trees from 3 to 5 years of age, it is usually advisable to saw them off near the ground and cleft graft the stub to the desired variety; while for trees 5 or more years old, bridge grafting is generally the best method to employ.

**Bridge Grafting Operations Summarized**

1. Cleanse and cut away all irregular tissue to form a straight wound on both the top and bottom of the girdle or injury. The girdled area may be painted with either white lead and raw linseed oil or grafting wax.

2. Cut a slit just beneath the bark and slightly into the wood at opposite points at the edge of both the top and bottom of the girdle.
This may be accomplished by pushing a grafting knife upward beneath the bark and then downward beneath the bark.

3. Select strong, vigorous scions of the current season’s growth. They should be a little longer than the girdle is wide. Both ends of the scions are whittled to a wedge shape, making the wedge about 1\(\frac{1}{2}\) inches long.

4. Insert the base of the scion into the lower slit.

5. With one hand holding the base of the scion in position, bend the scion until the upper end may be inserted in the upper slit. When both wedge-shaped ends of the scion have been inserted, the scion itself should be slightly arched. The spring in the arched scion will assist in holding it firmly in place.

6. Small brads or tacks may be used to fasten the ends of the scion in place.

7. Insert more scions at intervals of 1\(\frac{1}{2}\) to 2 inches until the injury is covered or the tree has been surrounded, if completely girdled.

Carefully wax the wounded tissue where the scions were inserted. Wax or paint may be used as a covering for the girdle. Rewax or paint as often as necessary to keep the cut surfaces and wounds covered.
Any kind of a fruit tree that may be propagated by grafting can usually be successfully bridge grafted. Apples and pears, however, are more often bridge grafted than other kinds of fruits. Peaches graft less readily than the fruits mentioned, but the plum and cherry should lend themselves fairly well to this method of graftage.

**Inarching or Grafting by Approach**

To cover a girdled area on the trunk below the main scaffold branches or to bridge diseased areas caused by winter cold, fire blight, collar rot or other troubles extending to the roots, inarching may prove worth while. Young seedling trees or standard trees one or two years old, of the particular species damaged, are planted as near the tree trunk as possible and in sufficient number, after spacing them 5 to 7 inches apart, to bridge the injured portion. The tops of the young trees are cut off at a height a few inches above the injury. They are then whittled to a wedge shape about 2\(\frac{1}{4}\) inches long and inserted in upward pointing slits made into healthy bark and wood 2 or 3 inches above the place to be covered. With the trees slightly bent the spring in the arched wood may assist in holding them in place. Small headed tacks or brads are often found useful in fastening the scions to the trunk. All wounded tissues should be carefully waxed and given attention from time to time for the best results as in other bridge grafting work.

**Making and Applying Grafting Wax**

Many formulae have been evolved for the making of grafting wax, most of which are good and effective. The formula which has been used for years by the Missouri College of Agriculture is as follows: Common resin 4 pounds, beeswax 2 pounds, and beef tallow 1 pound.
A harder wax may be made by using 5 pounds of resin, $2\frac{1}{2}$ pounds of beeswax and 1 pound of tallow, while a softer wax may be prepared by increasing the amount of tallow in the standard formula from 1 pound to $1\frac{1}{2}$ or 2 pounds. Melt all of the ingredients in a vessel over a slow fire, stirring thoroughly. Lump resin should be pulverized before using. When the resin, beeswax and tallow are dissolved and thoroughly mixed, remove from the fire. After the mixture has cooled somewhat and is of the right consistency for use with a brush, it is ready to apply. The wax may be stored for future use in the container in which the ingredients were melted.

Grafting wax is also frequently prepared and stored as follows: Heat over a slow fire and mix thoroughly the ingredients mentioned above. After the mixture has cooled slightly, pour it into a vessel of cold water. Grease the hands with tallow to prevent the wax sticking to them, and as soon as the wax is cool enough to handle remove it from the water and pull and work it as in preparing molasses candy. The working should be continued until the wax becomes smooth and changes to a lighter color, after which it is usually too stiff to pull readily. The wax may then be rolled into balls of suitable size and stored until desired for use. It will keep indefinitely. To use the wax after it has cooled, remelt by means of heat. Paraffin may be substituted in the same amount and used.
Charcoal wax is popular among some growers. The formula and method of preparing are as follows: Resin 5 pounds, beeswax 1 pound, powdered wood charcoal \( \frac{1}{2} \) pound, and raw linseed oil 1 gill.

Melt the beeswax and resin, add the charcoal and stir vigorously to prevent the formation of lumps. Then add the linseed oil and stir again, after which the wax is ready for use.

The application of grafting wax should leave the wounds air and water tight. Its uses may be enumerated as follows:

1. To keep out all diseases, rots, cankers, etc. and insects such as the borers which infest wounds.
2. To keep the cut surfaces moist and fresh, for if they are allowed to dry out the graft or bud cannot grow.
3. To prevent an excessive flow of sap from the wounds.

The best and most efficient method of applying grafting wax is with a brush. The wax should not be hot enough to injure the wood, but must be warm enough to run freely into crevices and cracks. A good melting pot consists of a small cup or basin inserted in the top of a kerosene burning lantern. This equipment may often be purchased from orchard supply houses. An improvised equipment may be used, however, by building a small fire in an old tin pail and suspending a small basin over the top.

Paraffin may be used instead of the grafting wax made from resin, beeswax and tallow. The following advantages are claimed for it: It requires no preparation for use other than melting, hardens quickly, is cheap and easily obtained and may be used to cover the entire scion as well as all cut or exposed surfaces. During the spring and early summer, the ordinary form known as "parawax" used for sealing jars of jelly and jam is satisfactory. In the hottest weather, paraffin of at least 60° C. melting point is required.

**Waxed Tape and String**

Waxed tape may be prepared about \( \frac{1}{2} \) inch wide, making the strips into rolls and then soaking in hot grafting wax. When the cloth is thoroughly saturated with the wax, remove the rolls and store for future use.

Waxed string is prepared by soaking in hot grafting wax the balls of twine to be used. When the twine is completely saturated with the wax the balls should be removed. After cooling, the string is ready for use or storage.