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Propagation of Fruit Trees By Budding and Grafting

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Propagation methods such as budding and grafting have been used by fruit growers since ancient times. In early periods some who practiced the art endeavored to shroud it in mystery. Many were led to believe that one had to be endowed with special faculties to propagate fruits successfully. Now, however, budding and grafting of fruit trees is widely understood and the methods are so simple that anyone of average intelligence can do the work successfully through careful study and with adequate practice.

Though the nurseryman is generally able to produce better trees and plants at a lower cost, some fruit growers prefer to do the work themselves. Consequently, this circular has been prepared for those who want a good working knowledge of budding and grafting apples, pears, peaches, cherries, and plums.

Meaning of Propagation Terms

Graftage.—The term graftage includes the practices of grafting and budding. It may consist of the taking of a scion or twig from the plant to be propagated for inserting or grafting upon another plant known as the stock.

Stock.—That portion of the tree, branch or root upon which the scion is grafted or budded is designated as the stock. Also, 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 known as the stock.

Scion (also cion).—Dormant wood of the previous season's growth when cut and used for grafting is known as scion wood. It is the part placed upon the stock and is from the plant to be propagated.

Cambium Layer.—This is made up of a thin layer of cells between the bark and the sapwood. During the growing season cells are constantly dividing and forming new cells. When the bark is peeling readily in springtime the slippery substance on the sapwood and bark consists chiefly of cambium-like cells. In all grafting and budding work, the cambium layers of both stock and scion must match or come together at one or more points for growth.

Graft.—When the scion and root are united and wrapped preparatory for storage or planting, the union of stock and scion is generally known as the graft.

Buds.—Buds suitable for the different types of propagation work may be taken before growth starts for dormant budding and grafting or after growth starts when the bark will peel and slip readily for spring and summer budding. The buds are found at the base of each leaf stalk on current season's growth. A bud instead of a scion is placed upon the stock in the practice of budding.

Bud Stick.—The shoot from which the buds are cut is called the bud stick. It is produced during the current season near the ends of branches. The bud stick is selected from the variety to be propagated. The leaves are removed but a portion of the petiole or stem is left to serve as a handle for inserting the bud on the stock.

Scion and Root Grafting.—The method of uniting an apple scion on an apple root, for example, in such a manner as to cause growth under favorable conditions is known as scion and root grafting. The apple and pear are usually propagated by this method as the practice is well suited to their growth and development.

Budding.—Peaches, cherries, plums and other stone fruits are propagated generally by budding because the practice gives better results for these fruits than grafting.

Essentials of Grafting and Budding

Success in grafting or budding may depend upon the observance of the following:

1. The scion and stock must be closely related, for example, apple on apple or stone fruit on stone fruit for growth when properly united under suitable surroundings. Usually varieties of the same kind may be grafted or budded easily one upon the other.

2. The operation must be done at the proper season of the year and under the right conditions for wound healing or growth.

3. The growing tissues (cambium) of the scion should be in close and smooth contact with the growing tissues (cambium) of the stock. This is the important principle of all grafting and budding operations.

4. To prevent drying out, all wounded surfaces must be properly protected. This is essential for rapid formation of callus tissues and growth.

5. Follow-up timely inspections and care are generally required to make the work a success.

Tools Needed.—In general, special tools and equipment are not required. Good grafting and budding work may be done with a saw, sharp knife, and in some cases grafting wax may be needed to cover the unions of scions and buds with the stock.

Time for Graftage

Grafting is usually done most successfully before growth starts in the spring; yet there are some types of grafting which are best done just before or just after growth starts. It is usually necessary for best results, to keep the scions dormant. Fruit trees are generally budded during July, August and early September, although budding may be successfully accomplished from early spring until fall. For the work of budding to be most satisfactory it is usually necessary for the bark to peel easily.

Selecting Scion Wood and Its Care

Scion wood should be carefully selected and labeled. Nearly all of it is cut some time during the fall or winter from unfrozen, well matured wood of the last season's growth. One-year-old wood is preferred because experience has shown that its buds are more likely to grow successfully upon the stock than the buds from wood two or more years of age. Scions from bearing trees assure trueness-to-name of variety. Wood from young trees true to name, however, may be just as good. The length of the scion wood will depend upon the amount of growth during the past season. This may range from 10 to 20 inches or more. Scion wood should not be cut too long for convenience in handling and storing. Frozen wood or wood which has been injured by diseases or low temperature may prove worthless.

Scions and buds should be kept moist and damp. Buds beginning growth or that have become shriveled by drying are much less likely to grow. Suitable conditions may be provided by storing in clean damp sand or green sawdust or by placing in a cool cellar or cold storage. A temperature of about 35 to 40°F is best. When scions are kept in a room which is too warm they may start growth and be unfit for use; while if kept too wet they may rot or be severely injured.

Storing Scions and Buds Over Winter

Scions and buds may be carried over winter successfully by plac-

ing them in cold storage where the temperature is held at about 40°F. The wood and buds may also be stratified by packing with sand or sawdust in a flat box or other container, having good bottom drainage. They are tied in loose flat bunches in order that the packing materials may cover all parts. After labeling they are placed on layers of moist sand or sawdust about 1½ inches in depth. Alternate layers of the packing material and scions are made until the box is filled or the work is finished. The box may then be placed in cold storage, stored in a cool cellar, or outdoors in a well drained soil on the north side of a building or hedge and mounded with soil to a depth of 6 to 8 inches. A mulch of 2-3 inches of straw or other litter when stored in the soil during the winter may be helpful. As both high and low temperatures may retard later growth, the more nearly the temperature can be kept at about 40°F the better.

Scion wood which shows browning of the tissues due to winter cold or other causes should be discarded. Likewise those which are dry and shriveled are of little or no value. Tips of branches formed late in the previous season, that have poorly developed buds and show soft, immature wood are unsatisfactory. The bases of vigorous shoots are likely to have buds that will make a slow and weak growth. Keep scions moist and cool when cutting and using. Store promptly and as suggested.

Cutting and Using Scions in Spring

Scions may be cut and used successfully early in the spring immediately before or as growth starts. However, the timing and proper handling must be right because dormant scions generally grow much more rapidly and give better results than those that have started perceptibly into growth. In general, the more "growthy" the scions at time of use the less likely they are to grow. Where there is a comparatively small amount of grafting work to do, it is possible with good judgment and care to secure satisfactory growth from scions cut and used promptly at the usual time for root and scion grafting, late February or March.

Purchasing Seedling Fruit Tree Stock

Apple and pear seedling stock is often divided and listed as straight roots for piece-root grafting and branched roots for whole-root grafting and budding. A convenient and popular size for seedling stocks of apples, pears, cherries and plums is 3/16 to ¼ inch diameter. The measurement for diameter is made at the crown or where the top joins the root at or near the soil. Seedling peaches to be budded to the desired varieties are grown usually in the field or nursery row where the budding is to be done in late July, August or early September.

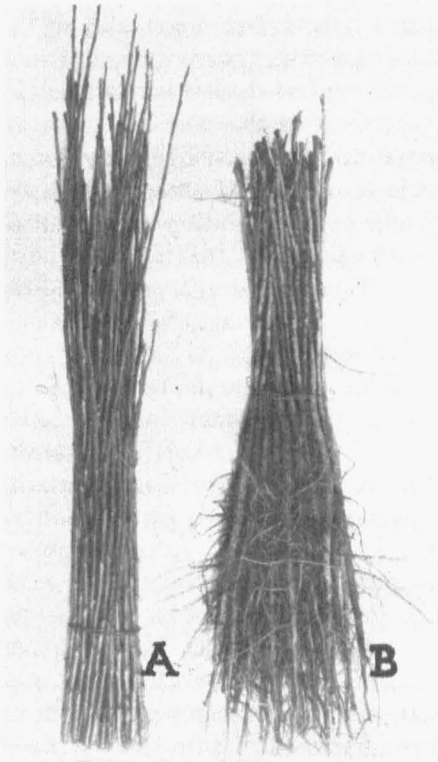


Fig. 1—(A) A bundle of apple wood. (B) A bundle of seedling apple roots for use in root and scion grafting.

From two to three grafts may be made from a good grade of apple or pear roots, while only one graft is made from the branched root which may be designated as a whole-root graft. When the seedlings are used for budding in late summer one tree only is produced from each seedling. Equally satisfactory apple and pear trees may be produced from piece-root grafting, whole-root grafting or budding.

The so-called French crab and domestic seedlings are used in propagating standard apple trees. As a dwarfing stock, perhaps, the Paradise stock is most often used. The French pear and Bartlett make up the common stock for pears. Several different dwarfing pear stocks are in general use but the Anjers quince produced from cuttings or layers is preferred by most nurserymen. Mahaleb and Mazzard stocks are used in propagating cherries. For plums the Myrobalan stock is generally considered most satisfactory.

All fruit tree stocks when received from the producer or nurseryman should be packed without delay in moist materials and placed in cold storage or a cool cellar. For root and scion grafting, the apple and pear stocks are used in January and February. If the seedling trees are to be budded, they are held in storage until early spring

when they are planted in nursery rows 3 to 4 feet apart and in the rows 6 to 8 inches apart. To facilitate planting, the roots are pruned or cut back a few inches if there is a need for shortening. After the planting operations are completed, the tops of the seedlings are cut back to stubs about 3 to 4 inches above the ground. The shoots arising from the stock should be thinned to one. This shoot is selected chiefly on the basis of vigor, straightness and location on the stub. With good growing conditions the stock should be ready for budding in late summer or early fall. Cherry, plum, apple and pear seedling stock may be handled in this manner.

Growing Peach Seedling Stock

Peach seeds or pits of about average size free from cracks and splits are selected. Some varieties of peaches produce more suitable seed for propagation than other sorts. Furthermore, it is generally known that the so-called seedling or wild peach trees may usually produce better pits for propagation purposes than named and budded varieties.

The seeds are collected in late summer and early fall. Soon after or in September or October on deep, fertile, well prepared soils the plantings may be made. The rows are spaced from 3½ to 4 feet apart and the seeds are dropped or placed in the row at distances of about 6 to 8 inches apart. For large plantings, machines similar to corn planters are used for opening the furrows dropping the seeds and covering them with soil. In general the best depth of planting for loose friable soils containing ample quantities of organic matter is about 1½ to 2 inches. The seeds are sometimes planted 4 to 5 inches deep in the fall or early winter. Early in the spring, as growth is starting, a part of the soil is removed leaving the seeds about 1½ to 2 inches beneath the soil.

Furthermore, the seeds in some sections are held over winter in cold storage, cool cellars or outdoor pits and planted in early spring. This may be particularly true toward the north. It is not necessary for the seeds to be subjected to alternate freezing and thawing before germination as formerly believed.

For the production of strong growthy seedlings, timely and thorough cultivations should follow plantings at intervals of about 12 to 14 days. It is important that plowing and hoeing should be frequent enough to keep down the growth of grass and weeds. Also, it should be continued until about the middle of July or first of August. The time of stopping cultivation practices will vary in the different sections and the amount will depend upon the need. Usually no more stirring the soil than needed to control weed growth will prove profitable.

Growing Apple Stock from Seeds

The natural method of propagating the apple is by means of apple seeds. The apple, however, like most of our cultivated fruits, does not come true from seeds. As many different varieties as there are seeds planted will generally be produced. For apples the type has not been fixed as it has in the case of many vegetable and grain crops. Moreover, experience has shown that most seedling apple varieties are inferior to standard sorts and not often is there introduced a new seedling variety of merit. As a rule, seedlings are grown only as stocks upon which to bud or graft superior or cultivated kinds.

Seedling apple and pear roots used in this country for whip and tongue grafting are often imported from France. In the United States, the Kaw River Valley just west of Kansas City is noted for its production of fine seedling apple roots used as stocks for named apple varieties. Seeds from our cultivated varieties like Jonathan, Ben Davis and Winesap may be used. The so-called French crab apple seeds are generally used in growing apple seedling roots for grafting and budding.

Apple seeds may be procured by washing the pomace obtained at cider mills. However, considerably increased pressure may crush and destroy the seeds. Also, long standing of pomace in piles may lower seed germination. The method of procuring the seed may consist of placing the pomace in a barrel or other container and adding water. In 4 or 5 days some fermentation may have taken place and by stirring the pomace vigorously the seeds may be separated. The pomace will rise to the top of the container, while the viable seeds will settle to the bottom. The pomace and water are then poured off and the seeds are collected.

The seeds are dried for a few days in the open air, after which, they may be stratified in damp sand. In a flat wooden box of convenient size is placed about 2 inches of damp sand, then a layer of seeds, and upon this, alternate layers of sand and seeds are placed until the box is filled or the work is complete. The stratified seeds should be kept moist and cool until time for planting in the early spring.

The box of seeds is sometimes buried in a well drained soil to a depth of 6 or 8 inches or placed in a cool cellar until spring. It may also be placed flat on the ground and covered with strawy manure to a depth of about a foot in order to prevent severe alternate freezing and thawing. Since the seeds begin growth early in the spring, the soil in which they are to be planted should be prepared in the fall or early winter by deep plowing. It is important that the soil be deep and rich; otherwise it will be impossible to produce straight, long

roots of the kind convenient and suitable for grafting purposes.

The apple seeds are planted from 2 to 4 inches apart in rows about $3\frac{1}{2}$ to 4 feet apart and covered with soil to a depth of $\frac{1}{4}$ to $\frac{1}{2}$ inch. When the seedlings spring up they should be given very thorough cultivations during the growing season by plowing and hoeing. In the fall after the leaves drop the little trees are dug, if large enough. When they are considered too small for use they may be allowed to grow another year before digging. For convenience in handling, the tops are shortened after digging and the trees are tied in bundles of from 25 to 50 or more. They are then packed in boxes of green sawdust, damp sand or other damp packing material and stored in a cool place. The seedling roots are used extensively for whip grafting in January and February. They are known as apple "stock" and are used in the propagation of named varieties of apples. In general, pear seeds may be handled like apple seeds in producing propagation stocks.

Handling and Making the Whip Graft

This method of grafting is frequently referred to as "whip and tongue grafting" or "root grafting", as the method employed usually has to do with grafting a scion upon a root. The whip and tongue graft is used in grafting the roots of seedling apple trees from one to two years old and $\frac{1}{2}$ to $\frac{5}{8}$ inches in diameter upon scions (current season's growth, about the size of a lead pencil). The seedling roots and scions are usually removed from storage and grafted during January or February. A cellar or basement room is generally used for this purpose, but a drier and warmer room may be used if the scions and roots are kept in their original packages and covered except when in use. Scions, roots or grafts should never be allowed to dry out. The roots may be from 14 to 18 inches long, and for grafting purposes they are frequently cut into pieces from 3 to 6 inches long, the average being about 4 inches. Each seedling root, therefore, may make from two to three grafts.

In making the graft, a sloping cut about $1\frac{1}{2}$ inches long is made on one side of the upper end of the seedling root. The same kind of sloping cut is made on the lower end of the scion. The knife is then placed on the sloping cut at a distance of about $\frac{1}{4}$ or $\frac{1}{3}$ inch from the end and a tongue is cut here on both scion and root. They are then pushed together, the tongues of each slipping into the slits made for them. To complete the graft, the scion and root are wrapped fairly tight with No. 18 or 20 knitting thread. Before tying the union or graft, however it is important to see that the inner bark of both comes together at least on one side: otherwise, the graft is not likely

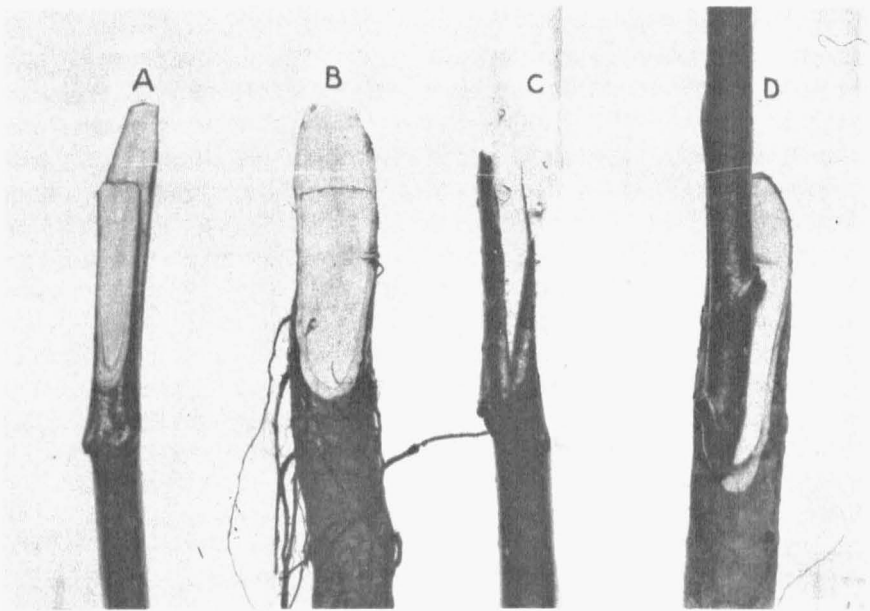


Fig. 2.—Making the whip graft. (A) Slicing cut with slit made on lower end of scion. (B) Similar cut on upper end of stock. (C) Stock and scion joined with tongues of each inserted into the cleft of the other. (D) Side view showing scion placed on one side for cambium contact as the stock is larger than the scion.

to grow. Commercial nurserymen use machines for wrapping grafts. If the scion and stock are of different diameters, care must be taken to insure the proper interlapping of the edges, at least on one side. Poor unions invite crown gall or root knot and other troubles. The weak cotton string with which the stock and scion are wrapped will decay rapidly and cause no injury when the grafts are set in the soil. The finished graft, including the scion and root, should be about $8\frac{1}{2}$ to 9 inches long.

Storing, Planting and Cultivating Grafts

The grafts should be packed in bundles of 50 to 100 each and stored in damp sand or green sawdust and placed in cold storage, a cool cellar or a callus pit until they are set in the nursery row in the spring. The soil for planting should be plowed in the fall in order that the grafts may be planted as early as possible. Prepare the ground as for a garden. The grafts may be planted either in holes made by a "dibble" or along the smooth straight edge of a furrow made by a plow. In either case, it is important to leave only the top bud of the scion above ground and to pack the soil tightly and firmly around the base of the graft.



Fig. 3—The three apple grafts at the left represent the so called whole-root graft, while the three-grafts at the right are typical for the piece-root graft.

If the young trees receive frequent shallow cultivation throughout the spring and summer, they should grow to a height of $2\frac{1}{2}$ to 3 feet or more, when they are considered large enough for transplant-

ing as "one-year-olds" any time during the late fall, early winter or the following spring. They may also be dug and stored in moist sand or green sawdust like scions or seedling apple roots. If the trees are not large enough in the fall for transplanting or if there is no ready sale, they may be left undisturbed in the nursery. The trees may be grown in the nursery row for another year and sold or transplanted as 2-year-old trees, or they may be cut back in the early spring to the original bud near the ground or just above the union of stock and scion. This usually causes a quick, vigorous growth of one or more shoots. The best shoot is selected and grown as a long straight whip. Others are promptly removed. At the end of the growing season it is called a "cut-back" with a 2-year-old root and a 1-year-old top.

Shield Budding of Seedling Stock

Shield budding is usually done any time from the latter part of July until about the middle of September. However, the time usually best suited for the work is during late July and August. The method is the same, summer or fall. The bark must be loose and easy to peel if the operation is to be rapid and successful. Also, budding is especially suitable for the stone fruits such as peaches, cherries and plums.

Selecting Buds.—A bud stick or twig of the current season's growth having several buds is selected from the variety that is to be propagated. This is done just prior to its use. The leaves are removed, leaving a portion of the petiole to serve as a handle in inserting the bud. Bud wood may be kept for several days in cool moist storage.

Doing the Budding Work.—A T-shaped cut is made preferably on the northern side of the seedling tree as close to the ground as convenient in performing the operation. The north side is suggested because less sunlight may strike this side and less drying may occur. On the budding stick the knife is inserted about $\frac{3}{8}$ inch below the base of a bud and moved upward about $\frac{1}{2}$ inch above the bud. A shield-shaped piece of bark is cut away from the budding stick, including a bud in its center. The sides of the bud are grasped between the thumb and the first finger. Pressure is applied. In so doing the bark springs or slips away from the wood leaving the bud without wood. If the bud is cut thick, it is well to spring the wood loose by pressure from both sides of the shield and remove it as suggested. However, when the shield is cut fairly broad but thin and with a minimum amount of wood, the extra step of wood removal is unnecessary.

The bud with attached bark or wood is inserted in the T-cut by



Fig. 4—Sections of apple twigs and bud sticks for use in shield budding. (1) A portion of the petiole or leaf stem remaining to facilitate the handling of the bud. (2) The methods of cutting and removing the buds. (3) The buds in different positions after removal.

carefully raising the bark from the wood slightly and pushing the rounded end of the bud downward until it fits squarely and smoothly against the wood beneath the incision of the bark. After the bud is inserted the flaps of bark are tied in place with raffia or cotton twine or held in place by a rubber band. Rubber strips used without strong tightening need not be cut. The bud piece must be held securely

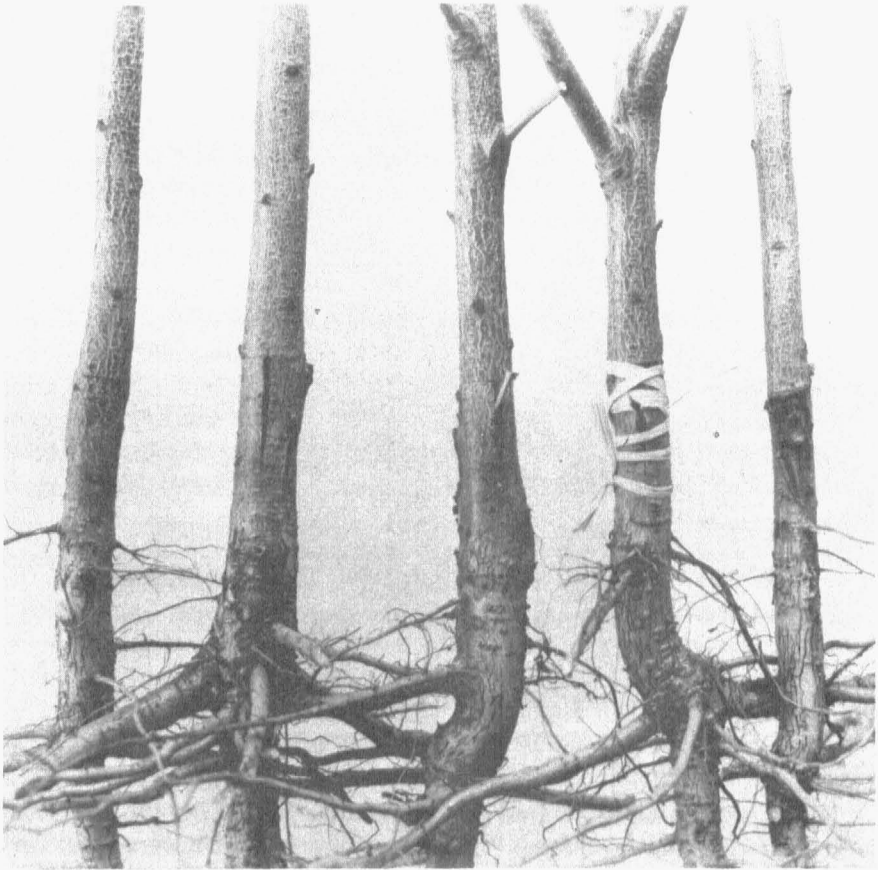


Fig. 5—One-year-old seedling peach trees, showing stages of the process of budding. (1) The T-shaped cut. Read from left to right. (2) The bark slightly raised for the insertion of the bud. (3) The bud inserted with the leaf stem or petiole of the bud still attached. (4) The bud properly wrapped with raffia. (String may also be used for wrapping). (5) The bud after growth has healed all the wounds. In the spring after growth starts the seedling trees should be cut off just above the inserted bud.

against the cambium of the stock. In about ten days or two weeks when the bud has grown tight, the string or raffia is cut on the opposite side from the bud, to prevent girdling. Where rubber bands are used, cutting is not required.

When the bark does not slip readily on the bud stick, a somewhat thinner sliver of bark and wood including a bud is removed. This is inserted on the stock as described above without removing the piece of wood under the bark and below the bud. In all instances the bark must slip readily on the stock for satisfactory results.

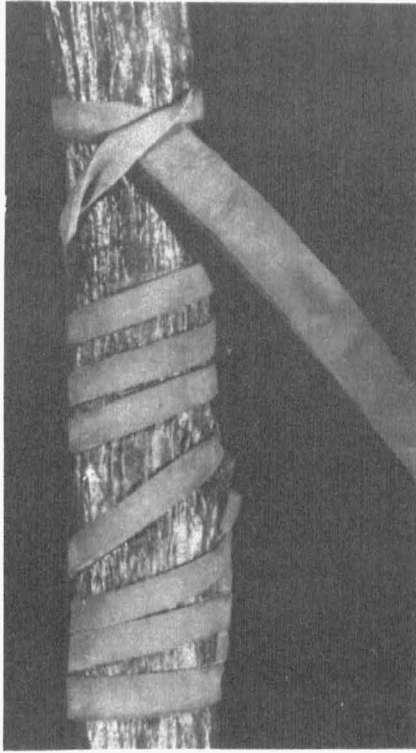


Fig. 6—The use of specially prepared rubber bands as wraps following the operation of shield budding.

The inserted bud remains dormant until spring if the work is done after the month of June. Enough growth occurs, however, for the bud to become firmly united with adjoining parts. As growth begins in early spring, the top of the stock is removed just above the bud and the sprouts which may arise below the bud on the branches and stem are carefully removed several times if needed during the growing season to stimulate and force the inserted bud into active growth.

Most of the stone fruits are propagated in this manner. They respond better to budding than grafting practices. The pome fruits (apples, pears and quinces) may be propagated by either grafting or budding. If such trees are growthy and healthy, there should be little or no material difference between budded and grafted trees in their use by the orchardist.

June Budding.—Shield budding may be done in late May or June. Then the process is known as “June budding”. The buds may be set after a very few days if they are going to grow. The tops are then

promptly removed just above the inserted bud. By the end of the growing season the top growth from the inserted bud may be a foot or more in length.

Waxing.—In general, waxing is not needed. The application of wax, however, to all cut surfaces may tend to prevent desiccation and thus make the budding practice more successful. For the amateur and where only a few buds are placed, waxing may facilitate growth.

Other Kinds of Budding.—The principal kinds of budding may be named according to the various methods of doing the work. Moreover, they apply more to top-working nut trees than to fruit trees. In addition to shield-budding, described above, there are twig or spur budding; flute, patch or veneer budding; plate budding; ring or annular budding and still other kinds. Shield budding for all purposes is a great deal more important and much more common than the other kinds of budding. In fact, the other methods are not used except in cases where shield budding does not give satisfaction.

Limits of Graftage

Propagators have generally limited graftage to plants which have a continuous growing layer (cambium) beneath the bark layer, because successful graftage depends upon the rapid growth and union of the growing layers beneath the bark of both stock and scion.

Fruits botanically related like the apple, pear and quince can usually be intergrafted or budded successfully. The process is still easier between varieties of the same species as apple upon apple. The peach is frequently budded upon the plum and likewise the plum upon the peach. In most cases the stone fruits may be interbudded and grafted without difficulty, although in some instances it is not practical, as the growth is uncertain, slow and the union between stock and scion is poor.

Trees on Their Own Roots

Trees are said to be on their own roots when they are produced from seeds, cuttings, or otherwise than from grafting or budding. In other words, such trees have roots of the same wood as their trunks. When grafted or budded trees develop roots from the scion while the stock or original root ceases to function, the trees are said to be entirely upon their own roots. This may occur when a short piece root is used in grafting and when the trees are planted fairly deep with about 2 to 3 inches of the trunk stem below the soil. In either case, if roots grow from the base of the tree trunk, the tree may be nourished mainly or entirely from its own roots.

Dwarf Fruit Trees

A fruit tree or plant of small size but of normal vigor and health is considered dwarf. Also, fruit trees which have been forced to grow slower by root and top pruning, one or both; by checking growth through growing in restricted areas; by growing on dwarf roots; and by other means in slowing up growth may be dwarfed in size.

Based upon past performances, dwarf fruit trees have not been popular with either commercial or home fruit growers. This has been true because they have not withstood unfavorable growing conditions such as cold winters, strong winds, drought and hot summers as well as standard fruit trees. Moreover, American orchardists are more or less accustomed to the use of extensive rather than intensive methods of fruit growing. It is possible that, to some extent, they may have overlooked the value of dwarf understocks.

For the home fruit gardener, dwarf fruit trees have always created considerable interest. Less difficulties are offered in handling pruning, spraying, fruit thinning and harvesting operations. The trees come into fruiting earlier and a larger number of varieties may be grown in a given area than is true with normal trees. Although shorter of life, yet dwarf trees under good care may prove satisfactory in many localities.

Renewed interest in dwarfing or semi-dwarfing understocks has been stimulated by the East Malling Research Station in England. Understocks have been separated into 16 groups, given a Malling number, propagated vegetatively, and classified as to different degrees of dwarfing. Much information is yet to be obtained regarding adaptability of varieties on different stocks, and performance in various soil types and under different climatic conditions.

Producers and investigators are generally in agreement that dwarfing understocks for both commercial orchards and home plantings are still in the experimental stage. Some believe that semi-dwarfed trees may have possibilities in some districts. Others suggest with more assurance that Malling understocks should be included for preliminary trials and observations for use in home fruit plantings, particularly. Certainly much additional information on dwarf trees will be needed before extensive plantings for home or commercial purposes are made in the colder and dryer sections of the country.