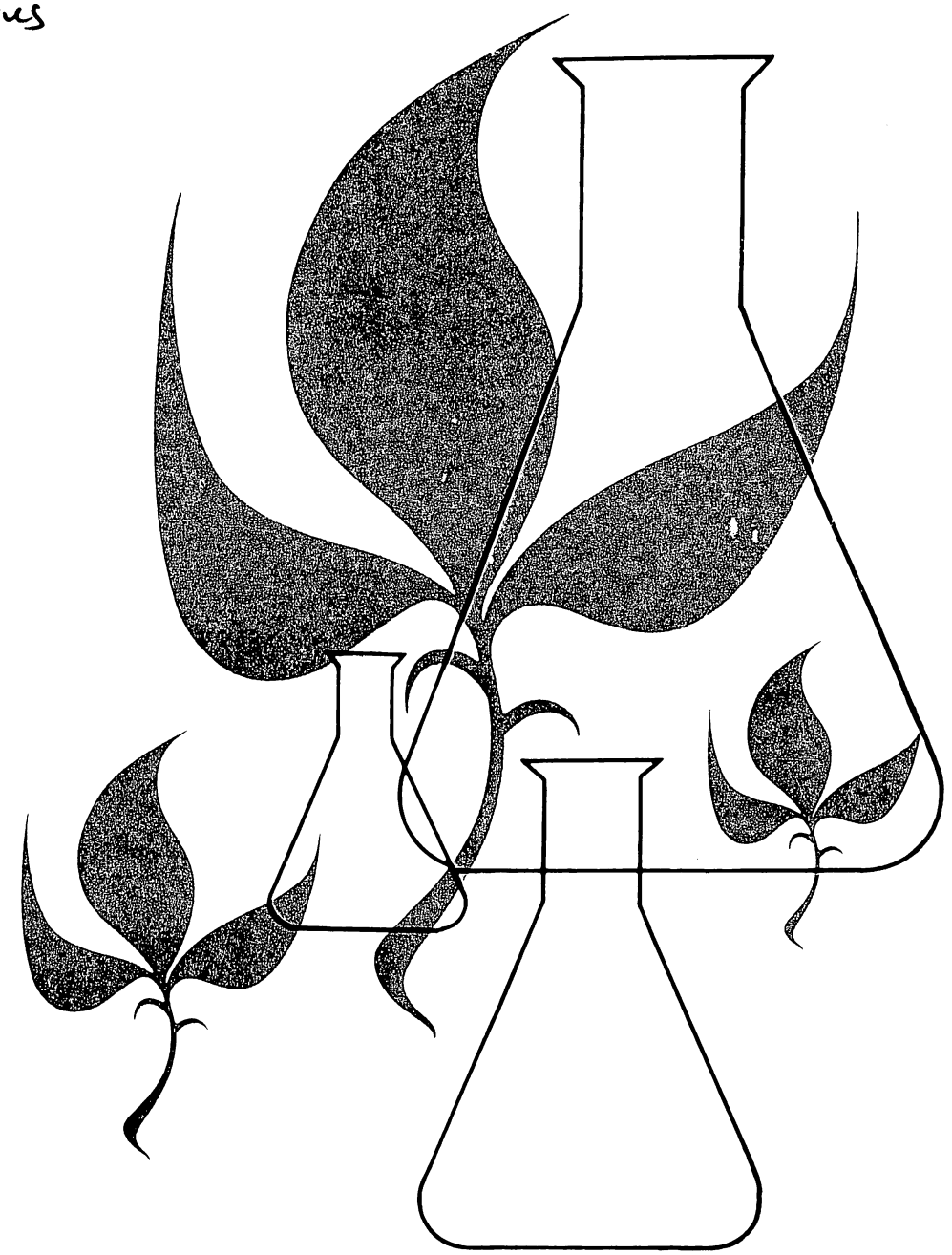
The Citrus Industry

VOLUME III

PROPAGATION, PLANTING, WEED CONTROL, SOILS, FERTILIZING, PRUNING, IRRIGATING, CLIMATE, FROST PROTECTION

= budding Citrus



Edited by
WALTER REUTHER

Revised Edition • Division of Agriculture and Natural Resources • University of California

unbranched trunk of sufficient height. With bushy-growing varieties such as sweet orange, a straight trunk may be obtained by lopping the seedling after it reaches a height of 18 to 24 inches. A strong shoot from a single vigorous bud originating below the lop is then chosen as the stem for budding and grown to the desired height.

The final suckering and trimming is done at least three weeks before budding or on the day the buds are placed in the seedlings. Pruning or sucker removal during the three-week period before budding tightens the bark, makes budding difficult, and lessens the chances for a good bud take.

The height of budding varies greatly in the different citrus areas of the world. In most cases, there are valid reasons for the height chosen. In Florida, for example, low budding at 2 to 3 inches above the soil is the standard practice. Trees so budded may be more easily banked with earth for frost protection. At the other extreme is high budding, 20 to 36 inches, which is practiced in Sicily as a preventive measure against infection of the scion with soil-borne fungi such as *Phytophthora* spp. and *Dothiorella* sp.

There are other instances where high budding is advantageous. In California, many lemon trees are propagated with buds placed at a height of 20 to 30 inches. This replaces the lemon trunk with the rootstock species and eliminates deterioration of the trunk by shell bark (decorticosis) and dry bark (siccortosis), maladies to which many lemon selections are susceptible.

Where soil-borne fungus infection is probable on susceptible scions, buds are placed high enough to take advantage of rootstock resistance to these fungi. Six to eight inches above the soil is a minimum bud height under such conditions. Many California nurserymen, in fact, consider 8 to 10 inches the minimum height for budding.

Budding the Seedling.—Perhaps the single most important step in producing a first-grade nursery tree is budwood selection. Recognition of this fact is indicated by the establishment of bud-

Fig. 1–12. Plastic tubes slipped over seedling trunk to reduce labor of suckering and produce a straight trunk.

Fig. 1–13. Aluminum-foil tubes around seedling trunks reduce suckering.

wood selection, registration, or certification programs in the major citrus areas of the world (Allen and Carpenter, 1966; Allen and Streets, 1961; Beñatena and Pujol, 1965; Mather, 1963; Anonymous, 1962; Nauer *et al.*, 1967; Norman, 1959; Rossetti *et al.*, 1963; Sleeth, 1959).

Selection of budwood.—The primary emphasis of budwood selection programs is placed on the use of virus-free budwood sources. In most cases, nucellar clones are virus-free; however, contamination by virus diseases has resulted from root grafts, careless propagation, and, in some cases, insect vectors and mechanical transmission. With the increasing use in many areas of trifoliate orange, trifoliate orange hybrids, and Rangpur lime as rootstocks, care must be taken that budsource trees are not carriers of the exocortis virus on symptomless rootstocks (Opitz, 1960). The same precautions are necessary for other virus diseases which damage only certain rootstock-scion combinations. With regard to exocortis, it is important that budding knives and pruning shears be sterilized after use on exocortis-infected plant material since this virus can be mechanically transmitted on contaminated tools (Garnsey and Jones, 1967).

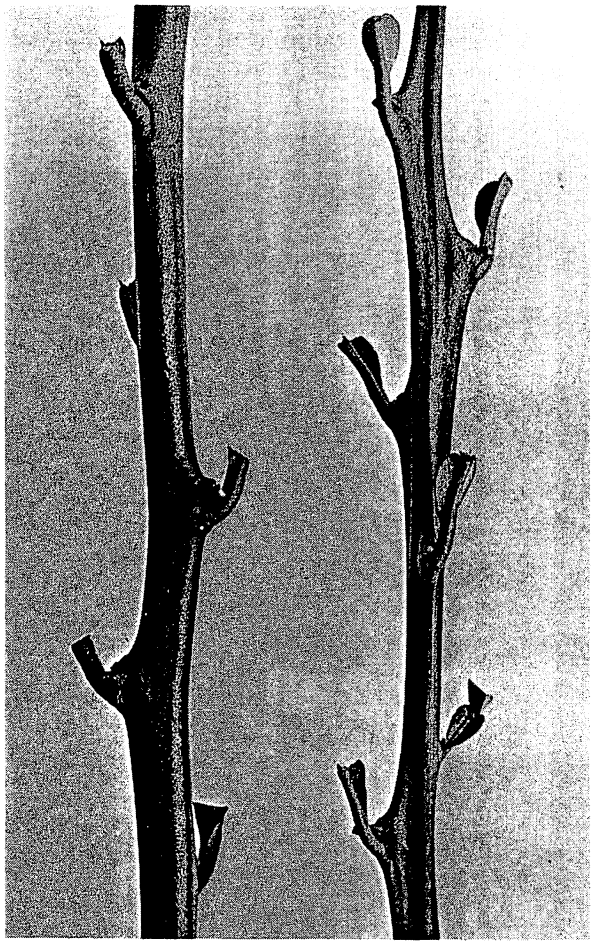


Fig. 1–14. Types of citrus budwood. *Left,* round, hardened twig is usually preferred. *Right,* angular, less-mature twig may be used.

It is also important to make certain budwood comes from trees known to be true-to-type and capable of high yields in the areas where they are to be planted. The tendency of citrus trees to produce variants is well known (Soost *et al.*, 1961). (See also vol. *II*, chap. *4*.) Every precaution should be taken to avoid the use of buds from trees or branches which show any variation from normal. Careful observation and performance records are essential in successful budwood selection.

Nurserymen express some differences of opinion as to which type of wood provides the best buds. In practice, however, there appears to be considerable latitude in the size and age of budwood that gives satisfactory results. Generally, the most satisfactory buds are obtained from budsticks taken from vigorous shoots of the next to last growth flush, or from the last flush after the growth hardens. Very often, good buds may be obtained from older growth flushes if the bark is still green. Round twigs are preferred, but budsticks cut from angular, less mature twigs have provided satisfactory buds (fig. 1–14). In fact, some Florida nurserymen prefer the angular budwood. Regardless of budwood shape, the buds should be dormant and well developed. Buds in the axils of large leaves are less apt to remain dormant in the stock. Small buds in the axils of small leaves usually start slower.

Halma (1933) compared the growth of buds from the apical and basal halves of the same budstick and from different cycles of growth developed during the same year. He found no difference in size of one-year-old Valencia orange trees produced from these buds. Halma also compared the size of year-old Valencia orange trees produced from buds cut from budsticks ranging from 3 to 11 millimeters in diameter. Again, no significant differences were found.

The satisfactory use of small buds cut from small twigs is described by Wishart (1961) in Australia. This technique, termed "microbudding," allows many more buds to be cut from a single bud-source tree and permits the use of much smaller seedling rootstocks. It also permits the use of angular budwood of small diameter.

In older bud-source trees that have matured and produced fruit for several years, the position on the tree from which budwood is taken is of little consequence. On the other hand, where young trees, particularly nucellar clones, are used for budwood sources, the position from which buds are cut influences thorniness and the age at which the tree begins to bear.

Frost (1948) demonstrated in several trials that thorny budwood from young seedling clones produced thorny nursery trees, but that if thornless budwood was selected, the progeny trees were also thornless or nearly so. He further demonstrated that trees produced from thornless budwood came into production at an earlier age. Several investigators, including Frost (1948), Cameron, Soost, and Frost (1959), and Furr (1961) have shown that on young vigorous trees, buds taken high in the tree produce progeny that are more precocious than those produced from buds taken from the basal portion of the tree.

Storage of budwood.—At the time of cutting, all leaves and thorns are clipped off the budsticks, which are then cut in convenient lengths. For the ease in handling, most nurserymen tie the sticks in small bundles and label them with the date, name, and source. At no time should budwood be allowed to dry out.

Most budwood is used within a few days after cutting. If necessary, the budsticks may be held for two or three months by placing them in damp peat moss, coarse sawdust, or vermiculite, and storing them in boxes or folded, damp, burlap sacks in a cool, dark area. Care must be taken, even for short-term storage, that the storage material be damp, not wet, as molds and fungus may develop rapidly.

A recent, successful method of storing budwood is to place the sticks in sealed polyethylene bags and hold them at refrigerated temperatures of 35° to 45° F. No moisture is added to the bags because there will be sufficient moisture in the budwood itself to maintain it in good condition. In approximately two weeks, the petiole stubs will have abscised from the budsticks. These are removed, since they may start to mold. Thereafter, visual inspection is made periodically, and any decaying budsticks are removed. Moore (1961) reports satisfactory storage for six months by this method, and some varieties have been stored for a year.

Budding process.—Citrus may be budded when the lined-out seedlings reach a suitable size and the cambium is active, causing the bark to slip. In many subtropical regions, seedlings lined out in the spring are large enough to bud in the fall. If they do not attain sufficient size by fall, they are budded the following spring. Most propagators prefer at least pencil-sized stock because smaller seedlings are too limber to handle easily and do not force continuous and vigorous bud growth. On the other hand, buds placed in seedlings larger than ½ inch in diameter at the point of budding do not "take" as readily, nor does the seedling force the bud as easily.

Fall budding in California is usually done in late September and early October, whereas in Florida late October and early November is the normal time. These months are early enough to assure sufficient cambial activity so that the bud unites with the stock, but late enough so that growth does not start. It is the opinion of many nurserymen that fall-budded seedlings tend to produce larger nursery trees and have smoother unions; however, excellent trees are produced from spring buds. Spring budding begins as soon as the bark slips and is preferred by some nurserymen since it eliminates the necessity of carrying budded trees through two winters.

In some areas, summer budding is also practiced. Summer buds however, are often more subject to winter cold damage. They do not have time to achieve adequate growth before the cold

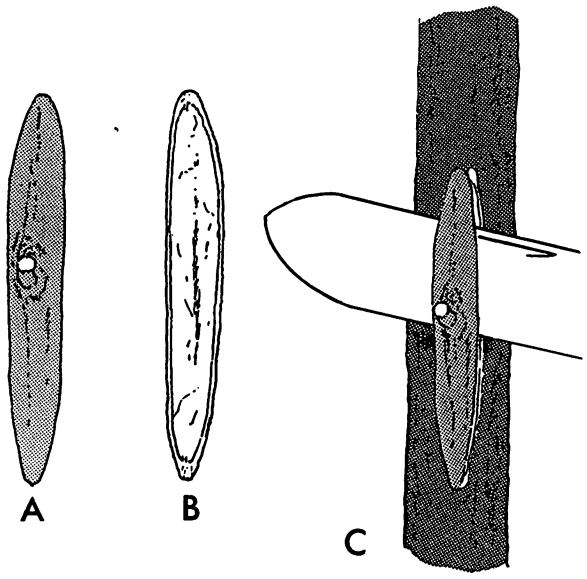


Fig. 1–15. Cutting the bud. *A*, upper side of bud; *B*, underside of bud showing bark and thin layer of wood; *C*, cutting the bud from the budstick.

weather comes and are, therefore, more tender. In areas where there is no frost, budding may be done at any time of the year when cambial activity permits bud insertion.

The most common method of budding is the shield or eye method (see figs. 1–15 and 1–16). This is also known as the T or inverted-T (⊥) method. Skilled budders use a sharp budding knife with a rounded point. With the knife, they slice a bud with a shield-shaped piece of bark from ½ to 1 inch in length from the budstick. The bud so cut generally includes a thin sliver of wood on the cut side. A sharp knife is essential in making a smooth, clean cut on the base of the bud shield. To correctly position the bud for insertion, the budstick is held upside down for T budding and right side up for inverted-T (⊥) budding (fig. 1–17, *A*).

Holding the cut bud between the thumb and knife blade, the budder makes a 1½ inch long vertical cut through the bark to the wood on the stem of the seedling. Then, with the knife blade held at an angle, he makes a horizontal cut at the upper end of the vertical cut to form a T or at the lower end to form an inverted T (⊥). This opens the bark so the bud may be inserted at the junction of the two cuts (fig. 1–17, *B*). He uses care to place the bud shield so that the bud faces upward.

Another budding method which recently has gained some popularity with Florida nurserymen is known as the "hanging bud." In this method (fig. 1–18), a section of bark, approximately the size of the bud, is cut from the seedling trunk. A "lip" is formed at the upper end of the cut to hold the bud in place. A shield bud is cut as previously described, but the top of the shield is tapered sharply by cutting off the front surface. The tapered cut is inserted under the "lip" of the stock.

Variations of the standard shield-bud method sometimes are employed under special circumstances. In cases where only angular budwood is available, successful budding may be accomplished by side budding (fig. 1–19). In this method, the bud shield is cut so that the bud or eye lies at one side of the shield. It then is in-

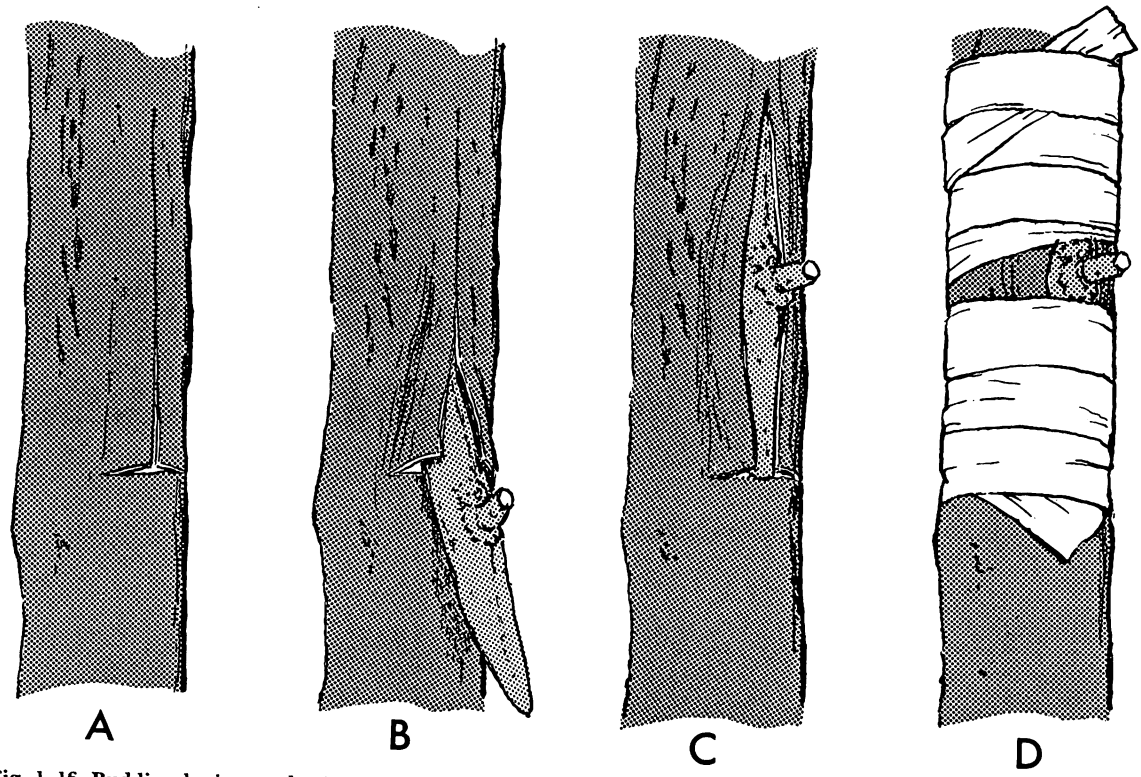


Fig. 1–16. Budding by inverted-T (⊥) method. *A*, vertical and horizontal cuts made through bark of seedling; *B*, bud partly inserted; *C*, bud completely inserted ready for wrapping; *D*, bud wrapped. Bud is left exposed in spring budding and covered in fall budding.

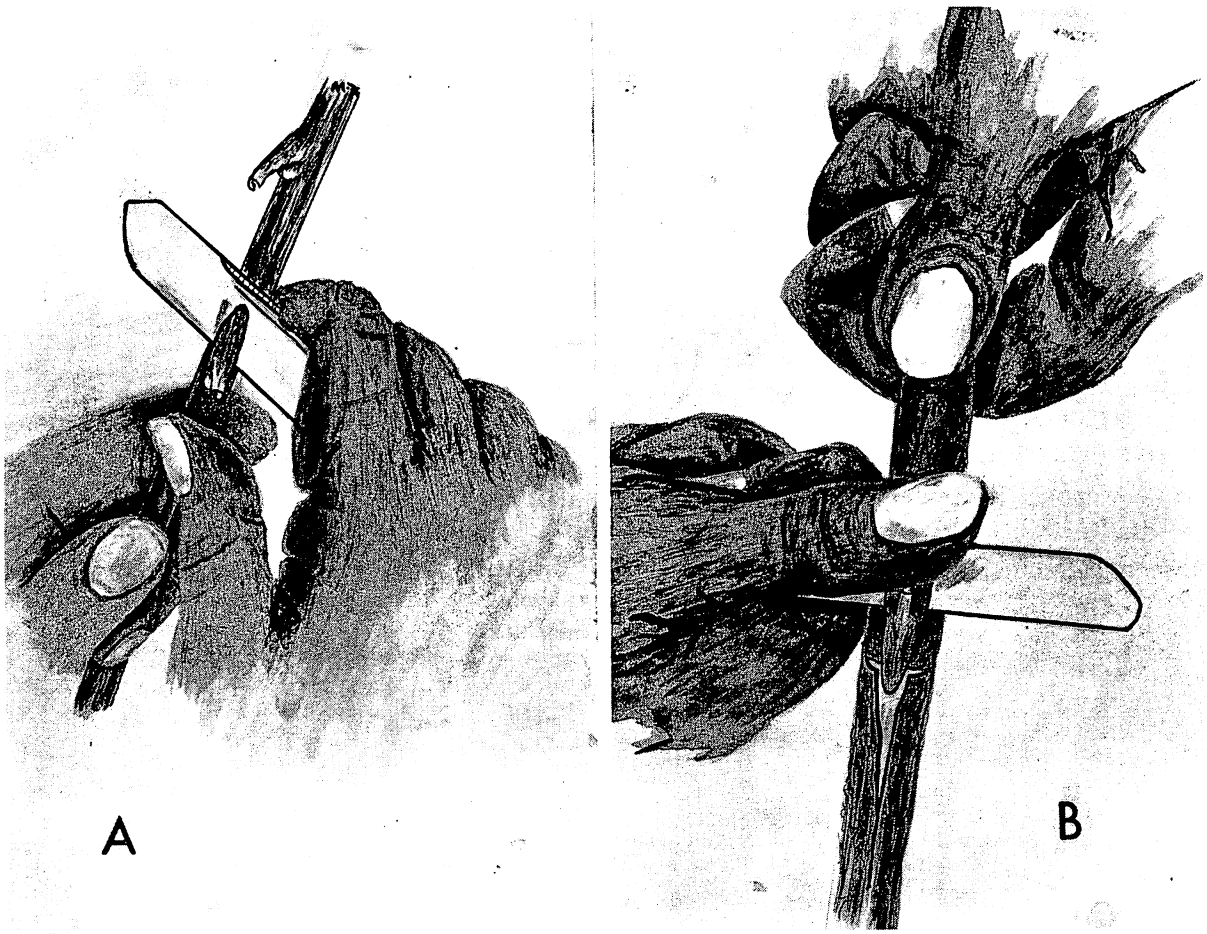


Fig. 1–17. Budding by the vertical-T method. *A*, cutting the bud with budstick held upside down; *B*, inserting the bud by pushing it down into the vertical-T cut in the seedling. Bud is wrapped as in figure 16, *D*.

serted under the bark of the stock on one side of a T or inverted-T (⊥) incision, curved incision, or angular incision.

Mention already has been made of the "microbudding" techniques described by Wishart (1961). The steps involved in this technique are essentially the same as those used for the standard shield-bud method. In cutting the microbuds, however, there are important differences. Budsticks are cut from matured wood with well-developed buds. The leaves are trimmed off, retaining a portion of the petiole (fig. 20, *A*). When cutting the buds the petiole is trimmed off flush with the bud (fig. 20, *B*) and, holding the knife flat, the buds are cut from the budstick, taking a very small sliver of wood (fig. 20, *C* and 20, *D*).

An inverted-T (⊥) cut is made on the seedling stock. The microbud is placed, bud up, under the raised flaps, and pushed firmly to the top of the ⊥ with the thumbnail or bone handle of the budding knife (fig. 20, *E* and 20, *F*). The cambium of the stock must be active so the bark slips freely. Polyvinyl chloride tape is used to tie the bud, starting at the bottom to insure a firm contact between the bud and stock. The tape must cover the bud to prevent drying. The tape is removed after ten to fourteen days for spring buds and in three weeks for autumn buds.

Wishart (1961) suggested complete removal of the stock just above the bud to force bud growth. This is done when the wrap is removed for spring buds, and in the spring following budding for autumn buds. Although the authors do not know of comparative trials with microbudding, it would seem as if bending or better, results if experience with conventional lopping the seedling would give as good, if not buds in California is any criteria (Platt, 1967).

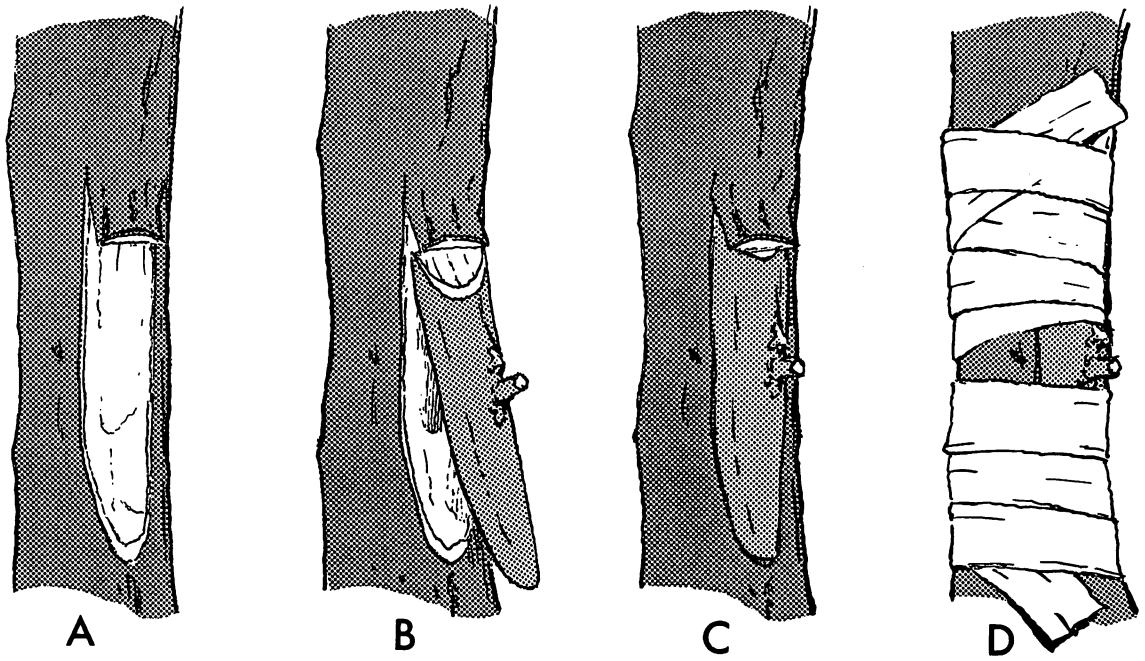


Fig. 1–18. Budding by the hanging-bud method. *A*, shows the section of bark removed from the seedling trunk with "lip" formed at upper end of cut; *B*, shield bud, with upper front surface sharply tapered to fit under "lip"; *C*, bud in place, ready for wrapping; *D*, wrapped bud.

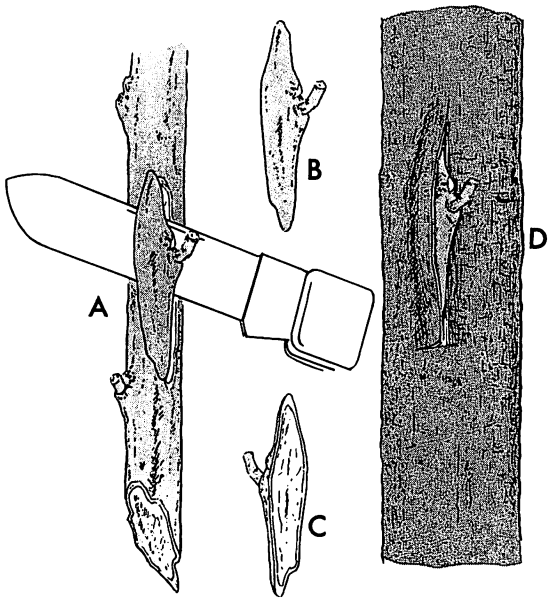
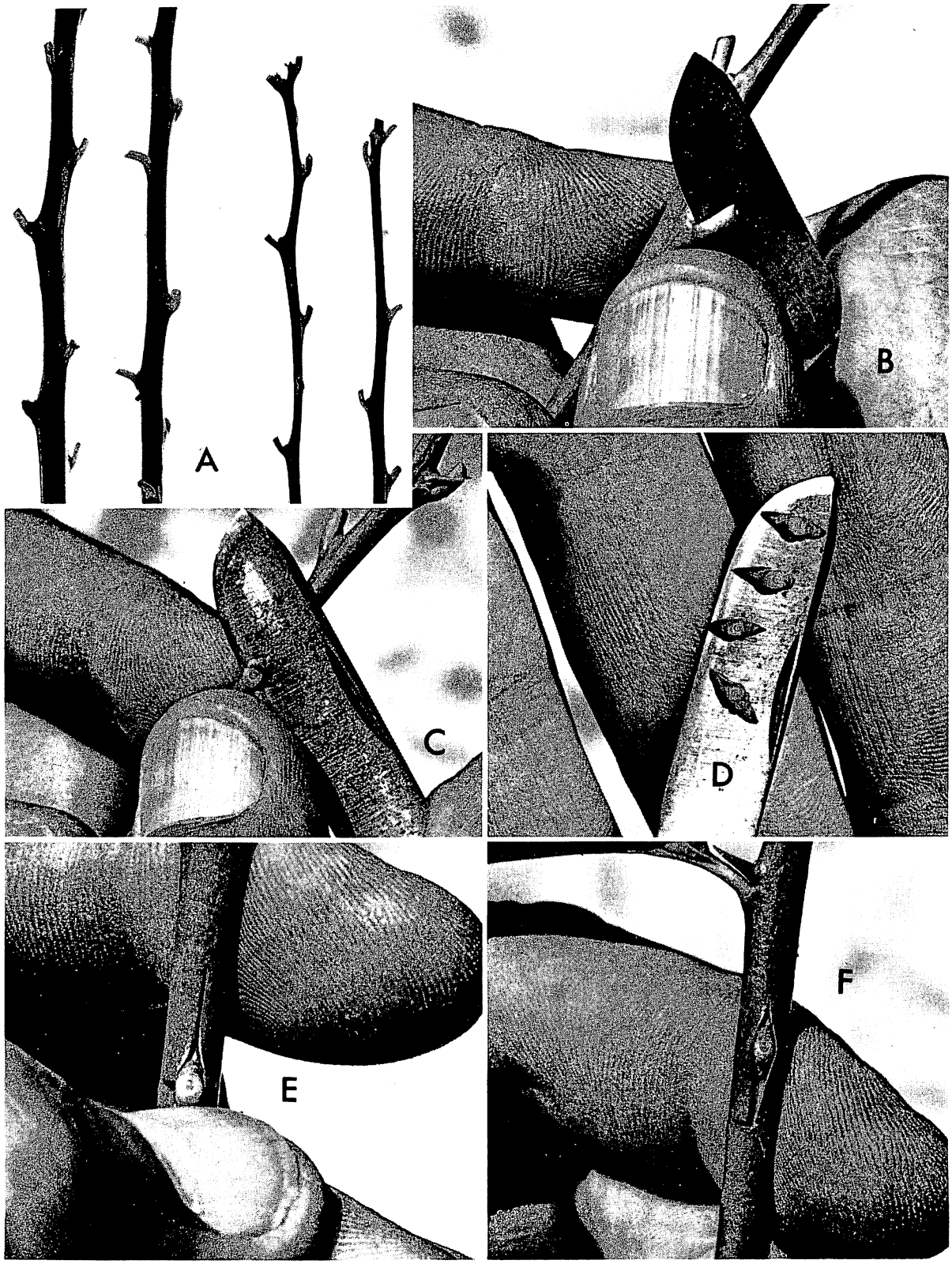


Fig. 1–19. Side-budding, a variation of shield-budding, using buds from angular wood. *A*, cutting the bud; *B*, upper side of cut bud; *C*, under side of cut bud; *D*, bud inserted under one side of inverted-T (⊥) cut in stock.

Of interest are the methods of handling microbuds described by Wishart (1961). They may be cut before budding, although not earlier than the night before, and stored in closed glass containers under refrigeration to prevent drying. When budding, up to one hundred buds may be held in the budder's mouth, larger buds under one lip, and smaller ones under the other. This keeps the buds moist and ready for use on seedlings of different size.

Some workers have questioned the advisability of leaving a wood sliver on the cut surface of the bud. Maiti, Singh, and Singh (1959) reported a significantly greater success in bud take when the wood sliver was removed. In South Australia, Botham (1957) commented that removing the wood is optional, but "gives a greater knitting surface with the stock and is useful when

Fig. 1–20 (page 21). Microbudding operation. *A*, comparison of conventional budsticks (left) and microbud budsticks (right); *B*, cutting petiole off flush with the bud; *C*, cutting the microbud; *D;* microbuds cut and ready for insertion; *E*, microbud pushed under flaps of inverted T (⊥) cut in stock; *F*, microbud pushed secure up into stock, ready for wrapping.


A
B
C
D
E
F

sap is not running well in (the) stock." In the major citrus areas, however, the wood sliver is not removed and high percentages of bud take are commonplace. In the authors' opinion, there is no advantage in removing the wood sliver.

Insertion of the bud, regardless of method, is performed carefully. All cut surfaces of the bud shield must contact the exposed surfaces of the stock. Ragged cuts increase the possibility of exposure to the air, drying out, and failure of the bud to unite properly with the stock.

For uniformity and ease of handling, most nurserymen bud all the trees at the same height and position in the row. In windy areas, buds placed on the windward side of the seedling make it easier to tie the budshoots as they grow. There is no evidence that the position of the bud in relation to the sun has any effect on bud growth.

As soon as the buds are inserted into the stock, they are tied or wrapped. Waxed cloth, rubber strips, damp raffia, or plastic tape are all suitable wrapping materials. Plastic tape (polyvinyl chloride or polyethylene) of 4 mil thickness and ½ to ⅝ inches in width has proved successful for wrapping. Its ease of handling, elasticity, and moisture-controlling properties make plastic tape a good wrapping material, and it is used by nurserymen in many areas. The wrap used in tying the bud begins at a point which forces the bud gently but firmly into and against the stock. With T incisions, this point is at the junction of the two cuts. With the hanging-bud method, the wrap starts at the bottom of the shield so as to force the bud firmly under the "lip."

Fig. 1–21. Troyer citrange seedling bent to force the bud. Seedling top is held in bent position by tying it to the seedling trunk below the bud.

Fall or dormant buds are wrapped over the eye, while spring and summer buds are wrapped to leave the eye exposed, since the buds often start growth before the wrap is removed. In areas where there is no dormant season, the eye is left exposed.

Unwrapping and forcing the bud.—Fall buds are usually unwrapped from one month to six weeks after budding, at which time they are normally well united with the stock. In Florida, the time of unwrapping is usually governed by the time of banking for frost protection, which is generally mid-November.

Spring buds unite more rapidly than fall buds and are usually ready to be unwrapped in two to three weeks.

There are two common methods of forcing the bud. One method generally practiced in California, is to lop or bend the seedling 2 or 3 inches above the bud (fig. 1–21). The other, practiced in Florida, is to cut the seedling top off just above the bud. Each method is successful in the area where it is practiced.

In California, fall buds are forced just before growth starts in the spring. In Florida, the time of forcing coincides with the removal of the earth bank. Early forcing stimulates uniform budshoot development. Spring buds are forced as soon as the wraps are removed. If there is a delay in forcing the buds, a larger percentage of "sleeper" buds, or buds which fail to grow, may result.

Lopping, as practiced in California, is accomplished by breaking or partly cutting the seedling stem 2 to 3 inches above the bud, then bending the top so it lies on the ground. This, in effect, is a "nurse" limb which provides a food-manufacturing system for the tree until the bud grows and develops enough leaves to adequately maintain the plant. Generally, a larger caliper (diameter) trunk develops faster when the tops are lopped than when they are completely removed.

In some cases, the seedling top is merely bent and tied down to force growth at the bend. This technique is much slower, and often does not force the bud as well. It has the virtue, however, of better preserving the seedling top, and with

small seedlings it can promote more bud growth. Small budded-seedling stocks grow weakly if the top is lost. If buds fail to produce a shoot within six weeks after lopping, the bend is broken or the lop shaken to make sure the "nurse" top is not too firmly attached. In some cases, "sleepers" may require forcing by cutting off the top.

Maximum benefit from lopping results when lops are allowed to remain attached throughout the spring and summer. In some cases, where bud shoots grow vigorously to a height of 30 inches or more by midsummer, the final sloping cut directly above the bud may be made at this time. In most instances, however, the stub or lop is left until the following spring, and then the final cut is made. Any cutting on nursery trees in the fall increases the sensitivity of the plant to cold injury.

Occasionally bud growth may be weak. In such cases, it can sometimes be forced by completely removing the lop. The stub, however, is left on until the following spring, since too early removal of the stub may cause the trunk to die below the bud.

Healing and callousing of the final cut may be hastened by covering it with an asphalt pruning compound. Some nurserymen have found that painting the wound with Avenarius Carbolineum eliminates or reduces fungus infection at the cut.

A slightly different technique in forcing buds is described by Nauer and Goodale (1964). Working with ⅜-inch diameter seedlings growing in gallon cans in a greenhouse, they sharply bent the seedling about 2 inches above the bud at the time of budding. The top of the seedling was placed under the can to hold it down. Results were compared with seedlings bent at the time wraps were removed three weeks after budding. Nauer and Goodale found a higher percentage of growing buds and greater average budshoot length on the seedlings bent at budding. Similar trials with seedlings in the field, however, did not show these differences.

Budling care.—To develop straight trunks and prevent possible breaking out at the union, citrus budshoots should be supported. Support is normally provided by driving a stake into the ground about an inch away from the budshoot when it reaches a length of about 6 inches (fig. 1–22). Commonly used are 4-foot lengths of 1- by 1-inch redwood, pine heartwood, or cypress, ⅜- by 1½-inch building lath, or 42-inch lengths of stiff metal rods about $\frac{3}{16}$ inch in diameter. When lath is used, the narrow side should be opposite

Fig. 1–22. Budshoots tied to stiff metal rods with raffia to assure a straight trunk and prevent the possible breaking out at the union. Three ties have been used on these budshoots.

the shoot. This allows the leaves to give some support to the stem and reduces the number of ties necessary to produce a straight trunk.

The shoot, as it grows, should be tied to the stake at intervals to insure a straight trunk (fig. 1–23). Strong, vigorously-growing budshoots require less ties than those with weak, interrupted growth. Raffia, soft twine, cloth strips, or paper- or plastic-covered wire are used. The ties are made tight enough to give adequate support to the budling and prevent wind whipping, yet loose enough to prevent compression or injury to the bark. When the trees are tied, or more often if necessary, all suckers or sprouts on the main trunk and any originating on the stock are rubbed off before they get large enough to require cutting.

Nursery trees are produced in two main forms (fig. 1–24). One is the "headed" tree in which lateral branches are induced and trained in the nursery. The other is a "whip" or "cane" tree