

Propagation by Grafting and Budding

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Grafting and budding are used to increase the number of plants of a variety which does not come true from seed and which cannot be economically reproduced by cuttage, layerage, or similar vegetative methods or where special root stocks are desirable. Varieties of the more commonly grown tree fruits such as apple, pear, peach, plum, and cherry, and a number of ornamental plants are propagated in this way.

Besides the actual manipulations of grafting and budding, careful planting, thorough cultivation, and other cultural operations are necessary to produce properly shaped tops and well developed root systems. Nurserymen with years of experience, skilled help and suitable equipment and conditions for quantity production usually can grow better plants more economically than the average fruit grower or farmer. Moreover, one or two years' time may be saved by buying plants already started. There are some growers, however, who find it desirable or who wish to produce their own trees. For them the more generally useful methods of grafting and budding are discussed here.

Terms

Grafting consists in the placing together of the parts of plants in such a way that they will unite and grow. In propagating plants, two general methods of grafting are employed, scion grafting and bud grafting or budding. A scion graft is composed of stock and scion. The stock is the plant or part of the plant upon which the grafting is done. The scion is a short section of a stem placed upon the stock. It is taken from the plant to be propagated. In budding, a bud with a small amount of adjacent bark rather than a scion is placed upon the stock. The apple is commonly propagated by scion grafting while peaches, plums, cherries, roses, and a number of other plants respond better to budding. Pears are now commonly budded.

Essentials of Grafting and Budding

Success in grafting and budding depends upon the observance of a number of points.

1. The stock and scion or bud must be congenial or capable of uniting, growing and developing a good union. Only occasionally will plants not closely related intergraft successfully. Usually

varieties of the same kind of plant will graft readily one upon the other. Distantly related plants as a rule cannot be made to grow one upon the other or the plants are short lived.

2. Between the bark and wood is a layer of special cells called the cambium. During the growing season these cells divide to form new cells from which new wood and bark are formed. In grafting and budding the parts must be so joined that their cambiums are in contact, or at least in close proximity, in order for them to knit together and grow. This is the underlying principle of all grafting operations.

3. The parts of the graft must be protected against drying.

4. The operation should be done at the proper season of the year when bud and scion wood is of the right maturity, when manipulations can be performed most skillfully and when best conditions for proper healing can be provided more easily.

5. Attention and good care subsequent to the actual grafting operations are necessary for the best results.

Selection and Care of Scion Wood

Well matured, moderately vigorous wood of the past season's growth should be chosen for scion wood. Older wood is less satisfactory and its use is not advisable unless one-year wood cannot be

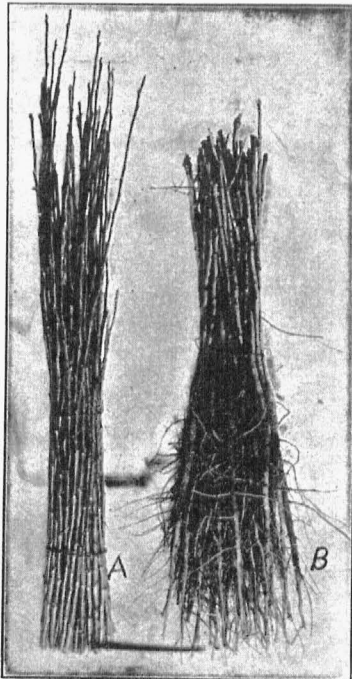


Fig. 1.—(A) A bundle of apple scion wood.
(B) Bundle of apple seedlings such as used in root and scion grafting.

obtained. Watersprouts, if not too large and if well matured with well developed buds, make good scions, but avoid using those which are large and long-jointed or which have been heavily shaded inside a densely growing tree. Good wood of apples and pears generally ranges from about 1 to 3 feet in length.

Scion wood usually is cut sometime in the late fall or early winter, tied into convenient sized bundles, carefully labeled as to variety and stored in a cool moist place. It is important that the scions be kept moist and dormant. Drying or starting of the buds greatly reduces the chances of success. Suitable conditions can be provided by packing the bundles in moist sand, sawdust or moss and placing in a cool cellar. A temperature of about 40°F is best. Green hardwood sawdust contains about the correct amount of moisture without adding water. Sand, dry sawdust and moss will need to be dampened but should not be soaked. After wetting and mixing, it should be spongy and crumbly. When too wet, the scions may rot or be severely damaged.

Where a suitable cellar or cold storage is not available, the bundles may be buried horizontally in the ground in a well drained place, covering deep enough to prevent drying out. Do not dig the pits very deep as they may collect and hold water. During the winter additional covering may be provided to protect against severe freezing.

A satisfactory and convenient method, when the scion material is close at hand, is to gather the wood as it is needed. When cut after severely cold weather, examine for any discoloration and discard all but sound wood. If it is necessary to collect frozen wood, handle carefully and thaw in a cool place.

Seedling Stock

A desirable size for seedling stock of apples, pears, cherries and plums is $3/16$ to $1/4$ inch. This is the diameter at the collar or where the top joins the root. Apple and pear seedlings are of two types—straight roots, preferred for piece root grafting—and branched roots, preferred for whole root grafting and budding. With a good grade of straight roots, from two to three grafts can be made from each seedling.

Standard apple trees are now grafted largely on domestic seedlings. Certain strains of Paradise stock are used in growing dwarf trees such as Malling IX for a very dwarfing effect and Malling II and Malling IV for semidwarfing. The common stock for pears is Bartlett which is widely congenial with other varieties. Serotina seedlings are satisfactory with Kieffer and probably other hybrid Oriental varieties of pears. The best dwarfing stock is Anjers quince grown from layers or cuttings. Sour cherries are propagated on Mahaleb and Mazzard stocks. Trials indicate the Mazzard to be superior to the Mahaleb for this section, although more difficult to produce good trees for planting. For general use the Myrobalan is the best plum stock.

The stock when received should be packed in a moist material and stored in a cool cellar. Early in the spring cherries and plums are planted in rows 3 or 4 feet apart and 6 to 8 inches apart in the row. The roots are trimmed to make planting easier and the tops cut back

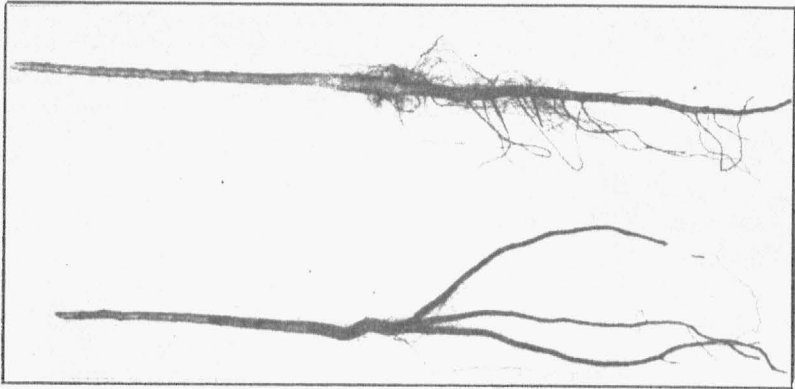


Fig. 2.—(Top) A No. 1, 3/16 inch apple seedling, straight root for piece root grafting. (Bottom) Branched apple seedling as used in whole root grafting and budding.

to 8 or 10 inches. They will be ready for budding in late summer or early fall. Apple and pear seedlings for budding are handled in a similar way. For root grafting of apples and pears, the stock is used in January and February, at which time this work is best done.

Growing Seedlings

Fruit trees are grafted and budded for the most part on seedling stock. Seedlings of apple, pear, plum and cherry are grown mostly in certain regions where soil and climate are best suited to their development. Generally it is better to purchase this stock as grown by the specialist although it is often possible to produce a very good grade at home. Seedling peach trees are grown in the field where the budding is to be done.

Some seeds will not germinate when gathered but must go through an "after ripening" process. Many kinds, including fruit and nut seeds, require cool, moist conditions for the proper internal changes to take place. These may be provided by planting in the fall or by stratification. Large seeded kinds like the peach can be satisfactorily fall sown, ridging slightly to provide better drainage and to give some protection against severe cold. Stratification consists in packing the seed in a box or other container with good drainage in alternate layers of moist sand and placing in a cool cellar or covering with a mound of soil out of doors. The more nearly the seed can be held at about 40°F, the better, for both high and low temperatures retard

the after ripening processes. Freezing of the seed which formerly was thought to be important is not necessary and may at times prove harmful.

The seed should be planted early in the spring although extremely early planting may result in many of them failing to grow. It is well as spring approaches with warm weather to examine frequently for germination and sow at the first signs of starting. Instead of placing in layers, that is stratifying, a good practice is to mix the seed with several times their volume of sand to keep them separated and prevent heating. The mixture of seed and sand can then be sown in the rows in the spring and covered with a light friable soil. Covering with sand is undesirable as it dries so rapidly that the stand may be reduced. Any crust that may form with soil can be broken by raking lightly over the rows.

It is important that seed be cleaned as soon as available of flesh or pulp to prevent fermentation and heating which destroys the vitality of the seed. Apple seed generally are obtained from the pumice of cider mills and if left long in the pile germination will be low. A convenient way to separate the seed is to mix the pumice with enough water to stir well. With a little stirring and churning of the mixture, the good seed will settle to the bottom, with the pulp and light non-viable seed floating to the top.

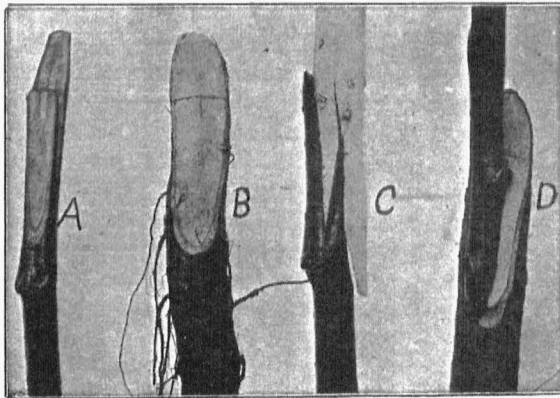


Fig. 3.—Making the whip graft. (A) Slicing cut with slit made on lower end of scion. (B) Similar cut on upper end of stock. (C) Stock and scion joined with tongue of each inserted into the cleft of the other. (D) Side view showing scion placed on one side for cambium contact, where stock is larger than scion.

Seed of some varieties grow well while others are unsatisfactory. Ben Davis, Gano, Rome, Winesap, Wealthy, Delicious and Jonathan are common apple varieties of this section which produce good stock. The two common pear varieties, Kieffer and Garber, will give suitable standard stock. Most peach stock is grown from "naturals" from the

south but if local seed is planted in excess of what is wanted, enough good trees for budding usually can be grown for one's own use especially if pits from seedling trees are used. Seed from white fleshed peaches are reported to be more reliable for growing seedling peach stock than seed from peaches with a yellow flesh. Cherry and plum pits should be purchased from seed dealers.

The period for the after ripening process varies with different plants. With apples and pears it is completed in one or two months. About three months are required for the peach and three to four months for plum and cherry. With the latter fruits, early fall planting or stratification is necessary to prepare the seed for germination the following spring. If the seed are dry at stratification time, they should be soaked in water for several days, changing the water every day. Seed that dry after stratification do not germinate well.

The apple and pear require a rather fertile soil to attain sufficient size for use after one season's growth. The cherry and plum are best planted on only moderately fertile soil to prevent too late growth in the fall. Seedlings tend to grow and hold their leaves late, and early digging is to be avoided. To remove the leaves, if still present when it is necessary to dig, place the seedlings in small piles and cover with moist soil, removing the plants after a few days when the leaves will come off.

Whip Grafting

Apple varieties are propagated commonly by grafting the scions to the roots of young seedling trees by what is called the whip or tongue method. By this method a rather tight rigid joint is obtained with a considerable contact surface. The whole root may be used to make one graft or it may be cut into sections of 3 to 4 inches to make several so-called piece-root grafts. For whole root grafting, branched roots are employed; for piece-root grafts, long straight tap roots are preferred. The No. 1 grade of the 3/16 and 1/4 inch size with a good diameter for a considerable length of the root will make the most grafts.

Making the Grafts

The scions usually are cut 4 to 6 inches in length. On the lower end a sloping cut is made about 3/4 inch long but varying somewhat with the size of the wood. The cut should be made with one stroke of the knife to give a flat, smooth, evenly sloping surface. Better results are obtained by drawing the blade across the wood rather than straight down. If a cut is faulty, make a new one. Trimming and whittling will not give tight fitting surfaces. Beginning 1/4 to 1/3 of the distance from the tip of the slope, a thin tongue about half the length of the slope is cut. The upper end of the stock is prepared in a similar way and the two parts pushed together

with the tongue of each slipping into the cleft or slit of the other. It is important that the two parts be so joined that the cambium of stock and scion are in contact on at least one side. It is not necessary that the cambium match on both sides but when stock and scion are not the same size, the difference should not be great and the stock should be the larger. Tip ends of either stock or scion, when they extend beyond the slope of the other, should be cut back to that point.

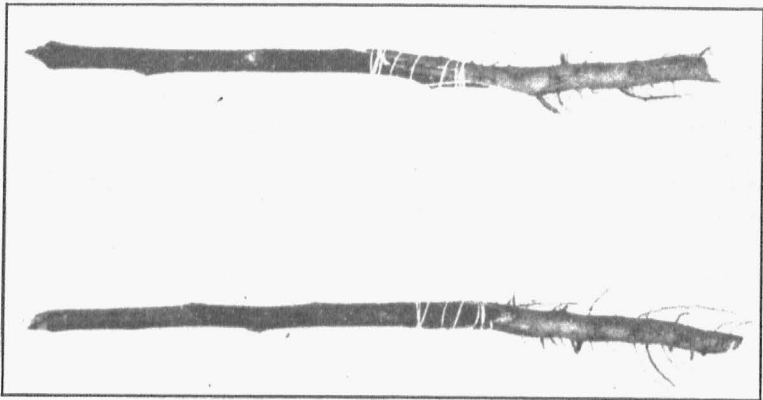


Fig. 4.—Completed piece root apple grafts showing properly trimmed stock and correct wrapping with twine.

The completed graft should be wrapped to make it more rigid and hold the parts in contact. A No. 18 or 20 knitting twine will serve the purpose and if untreated will decay rapidly without injury to the graft after growth begins. Very little twine is needed. The wrapping is begun at the upper end of the union, catching the end of the twine under the first lap, several turns are made, then with a few wide turns it is carried to the lower end where a few fairly tight turns are made, and finally the twine is brought under the flap of the scion and broken. No knotting is required. Special adhesive tape for grafting purposes also is used for wrapping grafts.

Keeping the scion wood, seedlings and completed grafts covered with wet cloths or burlap will protect them against drying while the grafting work is being done. This is especially important in a warm, dry room.

Storing and Handling Grafts

The completed grafts should be gathered into convenient sized bundles and packed in damp sand, sawdust, or moss. Store in a cool place, preferably where a temperature of 40 to 45°F can be maintained. This will permit the soft spongy healing tissue called callus to develop from the region of the cambium and at the same time is

not high enough to encourage bud development. It is important that the storage medium not be too wet. It is well to examine the grafts occasionally, and if mold appears, unpack, dry a few hours in the storage room and repack in a drier material. With the right moisture content the grafts will have a bright moist appearance, but they should not feel or appear wet.

Planting and Growing Grafts

Grafts should be planted early in the spring before the buds start. Should any activity be noticed, they should be planted at once or moved to a cooler place until planting can be done.

Fall plowing is necessary to have the ground in proper condition for early planting. It should be thoroughly disked and harrowed as in the preparation of a fine seed bed. The grafts are placed about 6 or 8 inches apart to give room for development and to use a hoe between, and in rows far enough apart for horse cultivation. They are set with only the top bud of the scion above the ground. This will place the union deep enough in the soil to keep it moist until healing is completed. The soil should be pressed firmly about the grafts taking care not to disturb the union. Many failures are due to leaving the soil loose. It is not necessary, however, to tramp or pack heavily.

A fertile soil is necessary to produce a 3 or 4 foot whip for planting after the first season's growth, or a well branched tree the second year. The first summer, all side branches should be pinched out as they start to encourage length growth of the main stem. Such whips may be dug in the fall or early the following spring to plant as one-year trees. If left in the nursery, cut them back to about 36 inches to grow side branches in positions to start the formation of a good modified leader tree. Trees too short to plant or handle properly may be cut back to a bud near the ground. The second summer a vigorous whip is produced. This is called a "cut back" tree. It has a two-year root and a one-year top.

T or Shield Budding

Peaches, cherries, and plums are propagated almost entirely by the so-called T or shield budding method. Apples and pears, roses, and a number of other ornamentals also are propagated in this way. In Missouri, budding usually is done in late summer or early fall when the bark slips easily. When the bark is tight the tissues are mutilated by prying and a very poor "take" is obtained.

Selection of Buds.—In budding, a single leaf bud with a little of the adjoining tissue is used instead of a section of a stem as in scion grafting. Buds from the present season's growth are used. Shoots of moderate growth of the current season with well developed buds are selected as a source of buds. These are called "bud sticks." It is best to cut only a day's supply at a time although they can

be held several days if kept moist and moderately cool. The best buds are from the middle portion of the shoot. Those near the base are small and weak while those near the tip are too immature. As the bud sticks are gathered the undesirable bases and tips are removed and the leaves cut off so as to leave about $\frac{1}{2}$ inch of the leaf petiole or stalk attached to the stick.

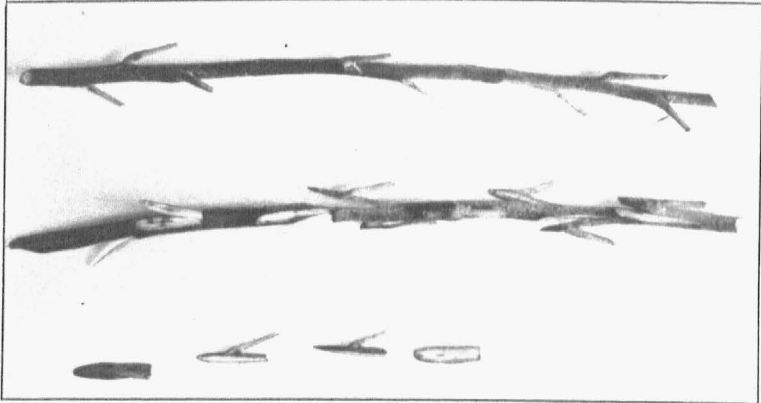


Fig. 5.—(1) Apple bud stick with base and tip removed and the leaves cut off leaving about $\frac{1}{2}$ inch of the leaf stalks. (2) Bud stick showing the method of slicing off the buds; at the right the slices have been lifted, at the left are shown the slivers of wood after the buds have been snapped off. (3) Buds removed from the bud stick and ready to place on the stock.

Budding Stocks.—Stocks for budding should have a diameter of about $\frac{1}{4}$ to $\frac{1}{2}$ inch. Small stems are difficult to handle while with large ones the bark is too thick for good work. One-year stocks of cherry, plum, apple, pear and many others generally are too small for budding and require a second season's growth. The one-year seedlings have the roots trimmed enough to facilitate planting and the tops cut back to 8 to 10 inches. The plants are set 6 to 8 inches apart in the rows. They should be ready for budding the following fall. Peach seedlings usually are large enough for budding the first year.

The Budding Operation.—With fruit trees, the buds are placed on a smooth portion of the stem a few inches above the ground and preferably on the northern or eastern side for better protection from the sun. On the trunk a vertical slit is made about 1 to $1\frac{1}{2}$ inches long. A slight curved cross cut is made near the top. If the flaps do not open enough to start the bud into place, the corners can be lifted with the point of the knife. The bud is cut from the bud stick by starting about $\frac{1}{2}$ inch below the bud and slicing off the bark fairly deep into the wood. This cut should extend to about $\frac{1}{2}$ inch above the bud. A cross cut is then made through the bark only at the upper end. By pressing firmly on the bark to either side of the bud with the thumb and forefinger the bark and bud can be snapped off the sliver of wood provided the wood is in proper condition for

budding. This gives a shield shaped piece of bark with the bud in the middle, rounded at the bottom and square across the top.

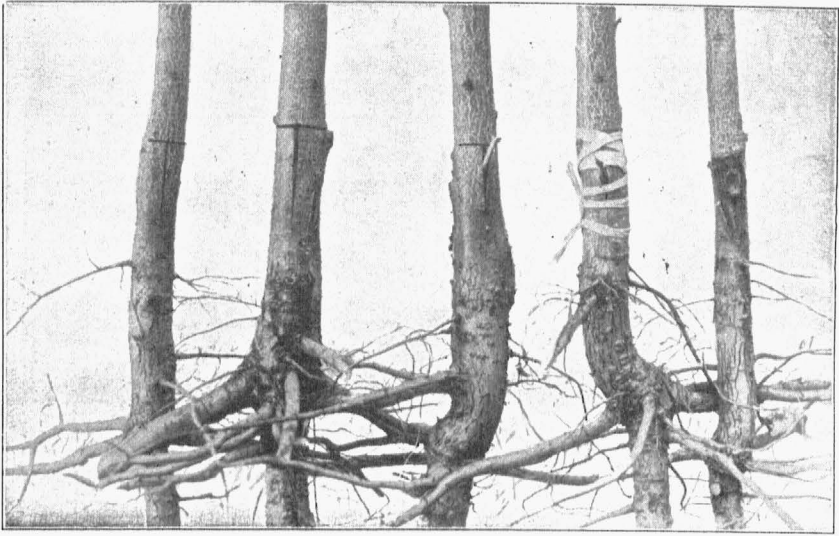


Fig. 6.—Stages in the budding of peaches. (1) T-shaped cut on 1-year seedling tree. (2) Bark slightly raised at top to receive the bud. (3) Buds inserted with leaf stem or petiole still attached. (4) Bud properly wrapped in with binding material removed. In the spring as growth starts the top of seedling tree is cut off just above the inserted bud. (5) Bud after it has "taken" and the top of seedling tree is cut off just above the inserted bud. (Budding is done on trees in the fields—these were dug in order to photograph them.)

When the bark does not slip readily on the bud stick the bud is sliced off just deep enough to obtain a small sliver of wood. The bud, bark and wood are all cut off with a cross cut about $\frac{1}{2}$ inch above the buds and the entire bud slice inserted on the stock without removing the thin sliver of wood. Whether the section of wood under the bark is or is not removed the bark must slip readily on the stock if satisfactory work is to be done.

The rounded end of the bud piece is started into the T-shaped cut on the stock and pushed down until the top of the shield is below the cross of the T. The flaps of bark are next tied down to hold the cambium of the bud piece securely against the cambium of the stock and prevent too rapid drying. Small twine may be used, although it tends to cut into the bark. Raffia soaked in water to make it soft and pliable is much used. Narrow strips of cloth will serve the purpose. Special strips of rubber are now much used by nurserymen.

Wrapping is begun below the bud, catching the end of the material under the first lap and continuing a spiral wrap until the top of the cut is reached. The end may be drawn under the last lap and pulled tight or a small diagonal slit cut back of the stock in which the binding material may be caught.

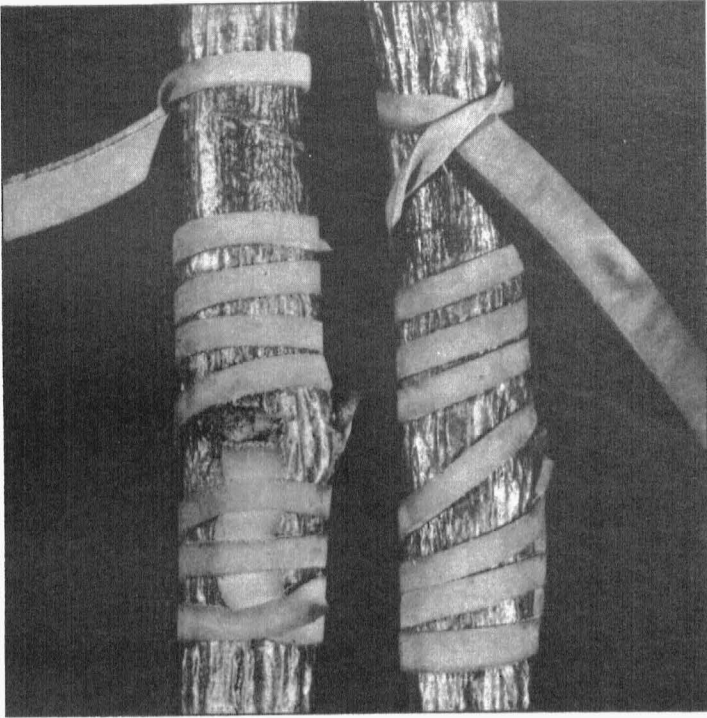


Fig. 7.—Method of wrapping in shield buds with rubber strips. At left is shown the beginning of the wrap in detail and at right the finish. (Twig is enlarged.)

Handling Budded Trees

With peaches and other rapidly growing stocks the bandages should be cut in about 10 days to 2 weeks or as soon as the buds have "taken" to prevent girdling. When the buds unite with the stock or have "taken" the stub of the leaf petiole or stem turns yellowish and will drop off clean when gently rubbed across. When the buds have not taken this short stub dries and remains firmly attached to the shield of bark carrying the bud. Many stocks are slow growing and the wrapping material is left on for several weeks. Buds inserted in August and September should remain dormant until the following spring. Before growth begins the tops are cut off just above the inserted buds. This forces the buds into growth. Suckers or sprouts coming from below the buds should be removed. With a favorable season, a tree suitable for permanent planting will be produced in one year.