

VINEYARD PROPAGATION

Paul S. Verdegaal
Farm Advisor, San Joaquin County

I. INTRODUCTION

Grapevine propagation for commercial vineyards includes the use of cuttings, rootings, benchgrafts, budding, layers and grafts. These vegetative propagation methods are used to maintain true-to-type varieties developed over many years of worldwide production. Seedlings are not used except in plant breeding programs, because each seedling is a new combination of genes with newly expressed characteristics. The aim of vine propagation is to maintain true to type varietal characteristics while producing new vines.

Vegetative replication or asexual reproduction methods must be used to conserve desired varieties. Of the propagation methods available to nursery people and to growers, the choice of a particular method often depends on several factors that include: cost, convenience, tradition, vineyard location, climate, availability of skilled labor, and grower's goals (see Table I).

Although many areas of California still make use of own-rooted ("domestic") cuttings to some degree, there is ever increasing use of resistant rootstocks ("wild root") against soil pests such as Phylloxera (*Daktulosphaira vitifoliae*) and the various plant parasitic nematodes. In addition, rootstocks are being used for vigor management of vines and improved wine quality production.

Increased problems of soil pests when replanting second or third generation vineyards and the high cost of vineyard development, encourages most growers to use resistant rootstock as opposed to own-rooted vines. The result is that the more common decision growers face today is whether to use field budding of resistant rootstock or to plant benchgrafts.

Research done in 1970 by Emeritus Lloyd Lider, Department of Viticulture and Enology, U.C. Davis, and Jim Kissler, Farm Advisor, San Joaquin County showed no difference in yield of individual vines the third year after planting either dormant benchgrafts or rootings for field budding. Although field budding can have success rates as high as benchgraft plantings, there is more of a chance for "misses." Non-uniform stands with 20% or more loss due to soil conditions, weather, or budding skills can occur with field budding. Except for the removal of budding rubbers and topping of vines for budding, there is little difference in Postplant concerns between dormant benchgrafts and field budded vines.

Since the mid 1990's, green growing benchgrafts or potted vines have become more important as the preferred method for establishing new vineyards or replacing missing vines. These

benchgrafts can be one-year-old dormants from the nursery, but more often are produced in the same year planted. These vines require more attention initially, but offer more flexibility, choice, convenience and are cost competitive.

Propagation Methods

The most common methods currently being used by the grape industry include:

- Field budding of rootstocks
- Benchgrafts (dormant or green-growing)
- Rooted cuttings (own-root)
- Field grafting or budding (mature vine conversion)
- Micropropagation
- Layers

In order to successfully establish a vineyard whatever method is chosen, some basic requirements should be followed as strictly as possible:

1. Proper vineyard design and vine spacing should account for vigor of the chosen variety, soil fertility of the site and production goals.
2. Preplant soil preparation; may include ripping, fumigation, and soil amendments. Grapes require less inputs than most other crops, but pre-plant expenditures are the most valuable investment and are more easily accomplished prior to vine establishment.
3. Vines as rootings, dormant benchgrafts or green-growing benchgrafts should be planted so that graft or bud union is a minimum of 3 to 4" above eventual soil line of row; to avoid scion rooting that can eventually outgrow the rootstock. Followed by adequate post-plant care.

With specific regard to propagation in the budding or grafting procedure five general requirements must be met to be successful:

1. There is compatibility of scion and rootstock
2. The cambiums of the scion and rootstock must be in intimate contact at some point.
3. Operation must be done at the proper time of year.
4. Cut surfaces should be covered with tape, grafting wax or a non-toxic sealant to prevent drying.
5. Proper care after budding or grafting is thorough and complete.

II. FIELD BUDDING

This is a traditional and still somewhat common method in some areas for placing a scion (fruiting variety) on a rootstock. Fall budding is then done in late August to late September of the year the rootstock is planted. Field budding can be also done in the spring of the year following rootstock planting, but success is more difficult and variable. Budwood must be kept in cold storage until needed.

Selection of Rootstock/Scionwood

- Determine what root pests are present: Phylloxera and/or what species of nematodes.
- Select rootstock adapted to soil type, scion variety and production goals.
- Use virus-free rootstocks and scion budwood. Preferably purchase certified material or observe mother vines carefully in spring and fall. If non-certified mother block is used it should be the same combination as the planned new vineyard, e.g., Zinfandel on 1103 Paulsen is planned, then try to select budwood from a mother block of Zinfandel on 1103 Paulsen. Know the history of mother vines: source, production, problems, etc.

Care of Rootstocks

- In spring, plant strong, well-developed rootings that are 16-18" long.
- Don't plant rootstock cuttings directly in field. Poor stand and weak growth can result in delays or failure.
- Allow rootstock to "warm up" 3 to 5 days if they come directly out of cold storage.
- Disbud rootstock before planting; remove all buds except top bud. This should be done at nursery before cuttings are rooted in nursery row. Trim roots slightly and dig planting holes deep enough so that roots don't curl upward.
- Plant rootstock with 4-5 inches of trunk above soil line so that scion bud is placed 3 to 4 inches above eventual soil line of vine row. This will avoid scion-rooting problems.
- Rootings can be machine planted. Vines of one row don't line up very well with neighboring rows, usually not a problem.
- After planting, cover entire rootstock with a mound of loose, moist soil. This will help keep stock moist and easy to cut at time of budding.

Budding Procedures

- Late summer remove soil away from rootstocks prior to budding.
- Hedge vines by trimming all shoots back slightly 6-8 inches or more if necessary. This makes vines more manageable by reducing shoot dominance and may encourage bud callusing by increasing new shoot growth.
- Bud in August or September as soon as mature buds of desired variety is available. Mother vines should have well lignified (hardened) canes of moderate vigor. Canes

with green patches should be avoided as budwood.

- Be sure stocks do not dry out or cease all active growth before budding. Irrigate regularly, but not excessively during season. Apply irrigation 7-10 days before budding is done.
- Hire a professional budder. Use "chip bud" method of budding (see Figure 1) Be sure budder places all buds 3 to 4 inches above soil line of vine row.
- Make sure budwood is from reported source if the budder is selecting their own wood.
- Don't allow budwood to dry out; keep bud sticks cool and moist in wet burlap or barrel of water. Select budwood the day before or same day if possible. Budwood older than 2 days should be avoided.
- Allow two to four weeks callus time for chip bud to "heal" or develop a viable union. Then resume irrigation if weather demands it.
- When vines are uncovered the following spring, make sure all budding rubbers are cut completely; or girdling can occur.
- Before topping rootstock make sure scion bud is growing or about to push. If not sure, hedge back rootstock to leave several buds, which will grow to encourage scion growth before actually topping. If scion then doesn't grow, the rootstock is still viable for another attempt within a few weeks.

III. BENCHGRAFTS

Skilled labor for budding has become more difficult to find and with high demand to replant old and non-productive vineyards or undesirable varieties, the California nursery industry has increased its use of benchgrafts. Better technology and more available expertise have made the use of benchgrafts generally more economical. Also, the quality of propagation material and the convenience of benchgrafts make them a more common choice.

There are two common types of benchgrafts and a third is becoming more available. These categories of benchgrafts include: dormant, green growing (potted), and more recently micrografting using new biotechnology techniques to rapidly propagate limited materials for green tissue grafting.

Scionwood/Rootstock Selection

- As with field budding, determine soil pests present.
- Select rootstock adapted to soil type, fruiting variety and production goals.
- Purchase certified benchgrafts or if supplying budwood to a nursery for scions, make sure mother vines are virus free. This is never a sure thing without indexing or having some experience of this budwood with the chosen rootstock.

Dormant Benchgrafts

- Purchase certified benchgrafts from nursery or be able to trace source of propagation budwood.
- Order dormant benchgrafts 12 to 18 months ahead of planting. The scarcity or demand of rootstock and scionwood increases lead-time.
- Benchgrafts should be "heeled in" (temporarily planted in light, loose soil) if planting is significantly delayed. Bundles of vines may be stored in cool shade of the north side of a building for a few days if covered and kept moist and to acclimate the vines, if warm conditions are expected.
- Plant benchgrafts in moist soil or irrigate immediately after planting to remove air pockets in soil, for better root contact. Dormant benchgrafts can be planted in late February through June. Any later is possible, but difficult due to the long storage of vines and the possibility of hot weather and dry soil conditions.
- Trim roots slightly if needed to ease planting and place in deep enough hole to avoid having roots forced upward towards the surface ("J" rooting). This can result in a shallow root system, difficulty in vine establishment and stress leading to vine decline pathogens infection.
- Prune to 1 or 2 strong buds and plant with the graft union 3 to 4" above soil level. Mound over with loose soil to prevent desiccation of union and buds.
- After 3 to 4 weeks, remove soil mound and place milk cartons to protect new shoot from desiccation and animals. Avoid this process during a very hot day.
- Loose soil, sand or sawdust in carton may help prevent cold damage to new shoot if frost is still likely.

Green-Growing Benchgrafts ("Potted Vines")

- Purchase certified material. Lead-time can be as little as 2 to 6 months. This depends on demand and availability of mother vines for both rootstock and scion.
- Sort through delivery for obvious problems with vines and for any "imported" pests that may be on vines, which you don't want to introduce. Western Grape Leaf Skeletonizer has moved with planting material; also check for Glassy Winged Sharp Shooter or Vine Mealy Bug.
- "Condition" vines before planting, 2-3 days in shade on north or east side of building. Water every day.
- Have irrigation system fully operational - emitters or spaghetti tubing close to new vine for drip system. Furrow systems can be used but require lots of attention (and shoveling).
- Plant vine root mass below surface level to prevent drying out. Some people say there is no need to slit sleeves but it is better to do so or remove vines from "pot" if possible.
- Water daily with 1 gallon per vine or 2 gallons every 1-2 days.
- Once new growth starts in about three to four weeks, water weekly or as needed.
- Plant until late August or early September. Past that point requires more care and an

“early” fall may cause weakening of vines. Planting through September is more common now. Some years may allow for fall planting of actively growing vines, but risk of vine losses is greater, with little viticultural advantage, except for tax purposes.

- After potted vines go dormant “year round” planting may be possible. Convenience of planting off schedule may be good, but there could be some vine loss under cold, wet conditions and vines don’t get an early start in the spring.

Micro-Grafting

A new technique that joins traditional bench grafting with micro-propagation biotechnology is becoming available. This process includes tissue culturing of individual nodes (“buds”) from spring shoot growth. Sufficient growth can take place in the lab so those green-growing shoots can be micro-grafted onto green-growing rootstock also grown in the lab. With hardening off in a greenhouse, vines of desired scion/rootstock combinations can be delivered to the grower one year later in late spring. The care for these would be very similar to traditional benchgrafts. Although more expensive, this may help meet demand for scions or rootstocks in limited supply.

IV. CUTTINGS

This traditional method is still used in the south San Joaquin Valley. It is also used elsewhere in California, on sites where no perennial crops have been grown and a risk of pest introduction is acceptable, or to cut costs. A first generation vineyard of own-rooted vines either as cuttings or rootings may be economically feasible, if a minimum 6 to 10 years of production is obtained before Phylloxera or nematode problems develop. A second-generation vineyard would follow this on resistant rootstock, when problems occur and they do. Resistant rootstock use is required to avoid vineyard failure and the premature need for replanting. (The following is also applicable to resistant rootstock cuttings in almost all cases being planted in a nursery row).

Making Cuttings

- Purchase wood from certified mother vines or use virus-free mother vines from a vineyard where the source/history of the original planting material is known.
- Select mature medium size canes with internodes of moderate length. Cuttings should be 10 to 16 inches long, cut flat at the bottom ¼ inch below base node. The tops are cut at an angle, 1 to 2 inches above top node.
- Cuttings should not be made from prunings that have been cut and exposed to drying more than for 4 to 5 days (7 to 10 is acceptable in wet weather). Under cool, foggy conditions prunings may last longer, but the percentage of viable buds decreases rapidly.
- Cuttings, if dry, may need to be soaked in clean water, no more than 24 to 48 hours before storage.

Storage

- Store in sand pit upside down and cover with 6 to 8 inches of sand. The area should be free of nematodes.
- Sprinkle lightly to keep soil moist, but not saturated.
- Bundles of cuttings can also be stored in sawdust or wood shavings in bags or bins. Bins can be stored in a cool shaded area. Root initiation should develop in 10 to 14 days at 80°F or 4 to 5 weeks at 60°F. Do not place vines in direct sunlight to warm up.
- Bins may be put into longer term cold storage, but require gradual warming before field planting of cuttings (2 to 3 weeks).
- Cuttings will show quicker and more uniform budbreak if they experience at least 2 to 3 weeks chilling temperature (34° to 45°F) in the field before collection and planting.
- Rooting hormone indolebutyric acid (IBA) is beneficial for only the resistant rootstocks Dogridge, Salt Creek, and 039-16. Other rootstocks and grape varieties do not require a hormone dip for good rooting.

Planting

- Planting date is not extremely important in sandy soils but the sooner after the cuttings are made the better. In heavy soils it's best to wait until mid-April when soil temperature is higher and soil moisture is not excessive.
- Plant two cuttings to a vine site, as 80-85% success rates for single cuttings are common. Double planting increases the uniformity of establishment percentage to 95% or higher.
- Plant each cutting with 1 or 2 nodes above soil line.
- Irrigate to settle soil, especially if dry. Avoid excessive soil moisture, as lack of air will slow new root growth.
- Subsequent care would include normal irrigation after shoot growth starts, weed control and small amounts of fertilizer.

V. GRAFTING

Grafting of mature vines consists of inserting a scion (a short one to two bud section of dormant cane of desired variety) onto a fully established vine that is already in production. Vines should be $\frac{3}{4}$ of an inch or greater in diameter, smaller can be successful. Field grafting ("topworking") a mature vineyard is done when another variety is desired for production, but there is no time or money available to replant; with a wait of two to three years before the first harvest. Grafted vines can produce $\frac{3}{4}$ to $1\frac{1}{2}$ tons per acre in the year of conversion. The second year these vines can produce 70 to 100% of potential. Several methods of grafting/budding can be used.

Cleft Grafting

Larger vines, one to four inches in diameter or greater, can be cleft grafted. The vines are sawed off 12 inches or lower below the trellis. At least 2 inches of smooth straight grain is needed for an even split. The trunk is split 1 to 2 inches deep. A scion of 1 to 2 buds is cut to a wedge at the bottom and inserted at a slight angle into the split (see Figure 2).

Only one scion is used for trunks 1 inch or less in diameter. Larger diameter vines need two scions. Taping or tying is not required, but sometimes done. Grafting wax or sealant is then applied to cover the exposed wound of vine and scions. The technique is more easily learned and quickly done than "side whip" grafting. Also, crown gall problems of scions being pushed off appear to be less.

Some professional grafters like the vineyard irrigated 7 to 14 days prior to grafting. Do not irrigate immediately after grafting to avoid excessive "bleeding" (sap flow) that inhibits callus formation or could even drown the new tissue. The trunk may be slashed to lessen bleeding around the scion. After the graft begins growth, suckering is needed. The amount of suckering depends on vigor of the established vine. A few suckers can divert excessive vigor or provide a "backup" if the scions fail to establish. Although quicker, more easily done and less susceptible to crown gall development, cleft grafting does leave a large wound open to many slow vine decline pathogens.

Side Whip Grafting

Begin grafting in late February. Vines are cut off 12 to 18 inches below bottom trellis wire. Remove old bark down to 4 inches below trunk cut. A shallow, gently slanting upward cut is made on the side of the trunk and a second reverse cut is made to form a tongue. Another smaller tongue cut is made at the base of the original cut. A tongue cut is also done on the scion stick of 1 to 2 buds and a slight taper cut is made on the tip of the scion (see Figure 3). The scion and trunk cuts are then matched together with the scions and trunk wrapped with tape to hold the scions in place. Grafting compound is then painted on top of trunk wound where there is no tape to seal against drying out. Irrigation practice should be the same as cleft grafting.

The trunk is then slashed with a saw to lessen "bleeding" around scion where callusing of cambiums will occur. Suckering is done as with cleft grafting. There are several other grafts used on other tree crops, which can be used on grapevines, but they require more skill and/or more time. Side whip grafting can develop crown gall, but scion wood from clean sources is not usually a problem for disease development.

T-Budding

Whether as a first choice or if late winter dormant grafting fails, T-budding can be done when the bark slips (peels away easily due to the resurgent flow of sap through the phloem) in early May through late June. If done any later, there may be insufficient shoot growth or poor wood maturity before winter.

T-budding requires the tops of the vines to be removed prior to budding. Loose old bark is stripped and a vertical cut made about $\frac{3}{4}$ to $1\frac{1}{2}$ inches long in the newer bark and an inch or two from the top of the stump. A second cut is made into the trunk at right angles to the first. These cuts can be made as a "T" or an inverted "T." The flaps of bark are pulled back and a bud shield is inserted (see Figure 4). Usually two buds are placed on vines larger than $\frac{3}{4}$ of an inch in diameter. An inverted "T" has more strength against the increasing weight of the shoot that grows from the inserted bud.

Bud shields are cut by making a downward angled cut beginning above a bud, continuing behind it and down to $\frac{3}{4}$ of an inch below the desired bud. A second downward cut just below the bud severs the bud from the stick. This shield is inserted under the bark flaps of the trunk and tape is wrapped around the bud leaving just the bud exposed for growth. No grafting compound is required. Crown gall incidence appears to be less and bleeding is not a major concern if the topping cut slants away. If buds do not heal to stock, there is no second chance until next year. Usually two buds are placed on a trunk stump.

Late in the season or by the following spring, the tape is removed to prevent girdling. This method can be quickly done and has a very high success rate. However, more skill is required and failures can't be redone until the following spring. Suckering needs to be done as needed.

Layering

Layers are used occasionally in California to replace missing vines in established vineyards. This may be economical and practical, where competition with older vines may inhibit the growth of replants, new vine care is not possible or if drip irrigation is lacking. Phylloxera and nematode problems can make this option less successful in the long term.

A long, well-developed dormant cane is selected from a vine adjacent to a missing vine site. This cane is bent down into a hole or trench dug about 12 inches deep. The tip of the cane is bent up out of the hole with several nodes extending upward and filled in with soil to cover and plant the cane in the hole. The end portion of the cane can be pruned back to 1 or 2 buds, as a new vine rooting would be. If the cane is long enough it can immediately be "trained" up the stake and topped at the desired height.

Rooting will occur from the buried nodes of the cane and will soon be functioning as a self-sufficient vine. Therefore very little care is needed. The major disadvantage to this is that the

"new vine" is not on resistant rootstock but on its own root.

Whatever method of budding, grafting or benchgraft is selected, it is very important (and a good investment) to use certified wood or at least healthy mother vines that have a traceable history. Assuming that budwood is "clean" at one site and is therefore good for your new planting is not enough. Try to get some verifiable indication, if not a guarantee as to budwood/rootstock source and history to avoid a problem that can't be remedied other than by removing vines. With the interest in clonal selections and "new" rootstocks there is more need than ever to document and maintain vine histories for the benefit of individual growers and the industry as a whole.

Grapevines are very hardy and adaptable and are relatively easy to work with in regard to vegetative propagation, but many factors can affect success. Health of the propagation wood selected, conditions under which it grew to dormancy, cultural practices that affected vine vigor, environment during dormancy before selection, storage and transit conditions for the wood, weather during propagation and the skill of the budder/grafter and finally the care of the vines after propagation. Any one of these factors can weaken a vine and cause problems, but usually vineyard propagation is very successful across a wide range of conditions. Attention to detail and maintaining good records by the grower are very important to ensure successful vineyard propagation. The investment of time and attention to avoid potential problems can repay benefits for the life of the vineyard.

February 2009

REFERENCES

- General Viticulture. A. J. Winkler, J. A. Cook, W. M. Kliever and L. A. Lider. 1976 California Press
- Biology of the Grapevine. M. G. Mullins, A. Bouquet, and L. E. Williams. 1992 Cambridge Press
- Viticulture: Volume 2. Practices. B. G. Coombes and P. R. Dry. 1992 Winetitles
- Plant Propagation: Principles and Practices. H. T. Hartman, D. E. Kester and F. T. Davies. 1990 Prentice Hall
- The Grafter's Handbook. R. J. Garner. 1990 Cassell

Table 1

COMPARISON OF THE THREE MOST COMMON PROPAGATION METHODS FOR VINEYARD ESTABLISHMENT

Field Budding vs Benchgrafting

	<u>Advantages</u>	<u>Disadvantages</u>
Field Budding of Rootings	Inexpensive and Spreads costs	Skilled art
	Established root system	Potential for 20% plus failure
	Can delay scion choice to last moment	Rootstock growth must be adequate for budding
Dormant Benchgrafts	Established root system	More expensive, initially and overall
	Minimal care	Scion and rootstock choice made at same time
	Vineyard uniformity much more likely	Long lead time in ordering
	Weak and possibly diseased plants culled in nursery	
Green-growing Benchgrafts (potted)	Cost intermediate	Irrigation <u>must</u> be available to establish; drip irrigation preferable
	Can save time over dormant	<u>More</u> postplant care needed
	Uniform stand and growth	Sensitive to wind or hot weather
	Less time in ordering	
	Weak/diseased vines more likely culled in nursery than in field	
	Availability is becoming widespread	

Figure 1 CHIP BUDDING

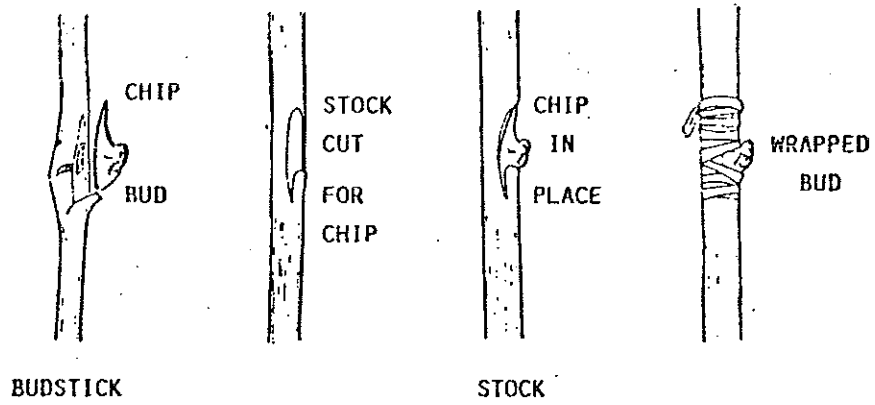


Figure 2 "T" OR SHIELD BUDDING

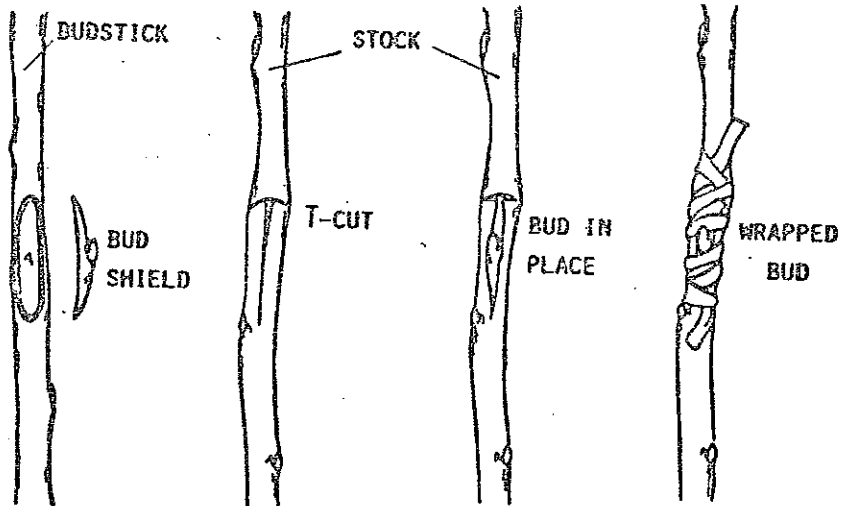


Figure 3 CLEFT GRAFT

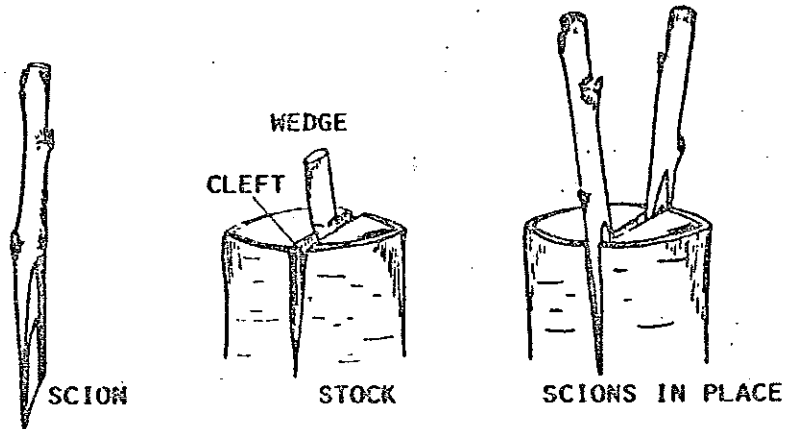


Figure 4 THE SIDE-WHIP GRAFT

