Guidelines for Successful Bench Grafting of Fruit Trees

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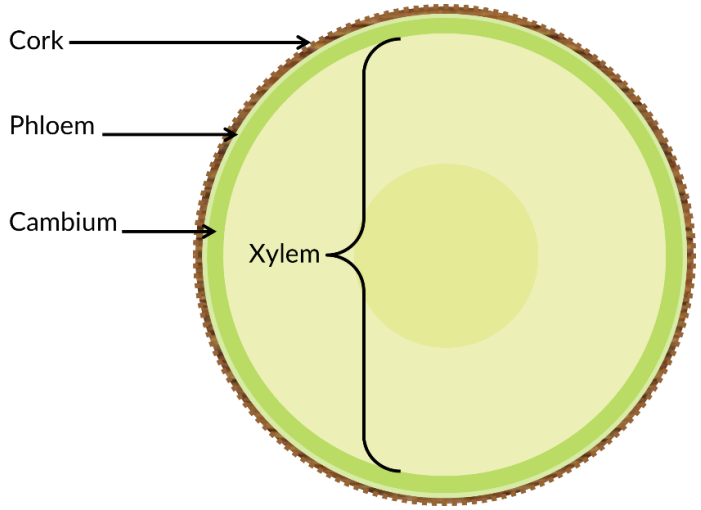
These guidelines describe fruit tree grafting techniques for use by non-commercial grafters. Grafting is a process of joining a cutting (scion) from a parent plant with a compatible rootstock to clone a plant with the identical genetic makeup as the parent plant. With fruit trees, grafting is the most common method to clone a tree of a specific variety, since seeds do not produce an identical offspring, just as an animal offspring melds characteristics of both parents. The art of grafting is reported to have begun about 2,000 years ago and still uses the same principles today. There are many different personal preferences by grafting professionals as to grafting tools and technique, but these guidelines follow generally accepted practices.

KEY GRAFTING TERMS

Scion – A short cutting from the parent tree that is grafted to the rootstock. The scion develops into an identical clone of the parent tree.
Rootstock – the short, rooted "stem" that the scion is grafted onto. The rootstock lends size, resistance, and tolerance characteristics. The size of the mature tree is determined by the type of the rootstock and by pruning techniques.
Budwood – The one-year old shoots harvested from the variety of tree to be cloned/propagated. They are the source of multiple, shorter scions, or individual buds for chip budding.
Callus: A specialized mass of cells formed by the cambium that grows to form a tissue bridge between a scion and rootstock when grafted together, or to cover a wound, such as an injury or pruning cut.

BASIC PHYSIOLOGY OF GRAFTING



- Trees have a variety of different tissues running across the diameter of their trunks and branches.

  Cambium: The green layer responsible for new growth to produce both bark and wood. Plays a critical role in successful grafting.
  Cork/**Bark**: Outer layer of protection
  Phloem: transports sugars between the leaves and the roots (up or down)
  Xylem: transports water and minerals from the roots toward the leaves (up only).

- The cambium layer of the scion piece is aligned with the cambium layer of the rootstock so they are in intimate contact with each other, then they are wrapped tightly together with grafting tape or a band to form a seal. These are two critical conditions for grafting success.
- The graft "takes" (is successful) if both cambium layers respond and form a callus bridge, joining the two pieces together. Later, the scion buds will break dormancy and grow into a new tree.

MATERIALS/TOOLS FOR GRAFTING

- Grafting knife or a razor-sharp utility knife with replaceable blades
- Sharpening stone and leather strop, if using a grafting knife
- Sanitizer (rubbing alcohol or Lysol)
- Labels and grease pen marker (a Sharpie will fade)
- Parafilm tape or rubber budding strips
- Hand pruners
- Plastic bags for scion collection
- Rootstock. Pencil-size caliper is desirable but smaller is suitable
- Scion wood (same caliper as rootstock is desired but not mandatory)
- A heavy leather glove for the hand holding the wood to be cut or split
- First aid kit

CONSIDERATONS FOR GRAFTING

- Cut 6-10" of 1 yr wood scions in Jan-Feb when the trees are dormant. Straight, vertical water sprouts are ideal. Store in a zip lock bag with a damp paper towel in ~35°F refrigerator for up to 3+ months.
- Receive the rootstock in March. Pot them into 1 gallon containers and store outside in the shade. Or store in the fridge, until ready to use.
- 2 weeks before grafting, bring the potted rootstocks inside to ~60F degrees for them to "wake up". Keep the scions in the fridge.
- In late March/early April, graft the scions (or chip buds) onto 6-18" long rootstocks. Scions with just 2-3 vegetative buds are suitable.
- Important issues:
    - A sharp knife is important for a smooth cut. Traditional grafting knives are good, but need to be periodically re-sharpened and stropped, requiring skill to get a razor-sharp edge. Grafting knives are only sharpened on one side and are flat on the other, so are “right handed” and “left handed”. Stanley-brand utility knives, or smaller “break-off” blades, also work well. Blades are razor-sharp and easy to replace.
    - Shorten the rootstock to 6-12” above the dirt level.
    - Carefully line up the cambium layers on at least one edge of the cuts to assure intimate contact between scion and rootstock cambium. Theoretically, the cambium layers only need to touch in one spot, but the greater the contact, the higher the chances for success.
    - Be sure that the scion has buds facing up when joined with the rootstock.
    - Tightly wrap the grafted area to hold it in place, maintain cambium contact and prevent drying. Rubber grafting strips are traditional and work well, but Parafilm grafting tape is a more recent development and easier to work with.
    - A common spring clothes pin can be added over the tape to further squeeze the cut faces together on the graft. They can be used on all techniques detailed here, except chip budding.
    - Seal the top cut end of the scions with thick latex paint, paraffin wax or tree-seal to prevent drying. Parafilm stretched over the top end and wrapped tightly works, too.
    - Periodically sterilizing the tools.
- Store the grafted apple/pear stock at ~60°F or more for 2-4 weeks. Callus will form, the grafts will "take", and the buds will swell/burst on the scions. Peaches and nectarines need much warmer temperatures from 70-80°F for callus formation.
- Set the containers outdoors when the danger of frost is over.

- Multiple sprouts may form from the scion. When they are >4" long, remove all but the most vigorous one. Stake the new growth for support. Remove all sprouts from the rootstock.
- If a graft does not take, a new scion can be grafted to the same rootstock, well into May. Save some scions in the refrigerator just in case.
- Fertilize gently. Use slow release, pelleted organic fertilizer that isn't too high in N, but fairly well balanced. Stop fertilizing in August, as the wood must harden off by fall.
- Transplant the containerized whips into the field during spring/summer if the trees can be consistently watered. Or, in the fall after the ground has been deeply re-wetted from fall rains. Roots will continue to develop until dormancy.
- If holding over for another season in containers, re-pot into 3-5 gallon containers to allow room for another year of root growth.

A variation on the above procedure is to store the ungrafted rootstock in a cool area packed in damp sawdust and perform the grafting in April. Then plant out the newly grafted plants directly into their permanent spot, after the last frost. Or, the grafted stock can be planted in a trench in the soil, fairly close together, to develop for another 1-3 years before planting in the permanent location.

Specific Grafting Types

WHIP AND TONGUE GRAFT

This is one of the most common methods of stick grafting, as the tongues lock the joint together for better structural integrity and cambium contact. It is ideal to have the diameters be close, but as long as the cambium layers along one edge of the two pieces are in intimate contact, there will be a high degree of success. This technique can be used if one piece is up to ~50% larger diameter than the other- just make sure the cambium layers align on one edge.

Prepare the scion 4" to 5" in length with 2-3 buds. Begin by making a sloping cut on both the scion and rootstock wood. The cut tissue should be 3-4 times longer than the diameter and both should be the same length. Make the locking tongue cut by making a receiving notch in the face of each angle cut, starting about 1/3 of the way down on the scion cut and 1/3rd of the way up on the rootstock.

The tongues of the scion and rootstock pull the pieces together and make a strong joint. Use Parafilm tape or grafting bands to bind the pieces together and add a clothes pin clamp if desired. Seal the cut end of the scion to keep it from drying out.

CLEFT GRAFT

For the novice, a **cleft graft** is easier than a whip and tongue, even if diameters are similar. It can be used for diameter differences of up to ~50%. Note that the rootstock is split down the middle and the scion has a tapered cut on opposite sides, forming a wedge with a length 3-4 times longer than the width. It is critical to align the cambium layers to get intimate contact on at least one edge. Use Parafilm tape or grafting bands to bind the pieces together and add a clothes pin clamp if desired. Seal the cut end of the scion to keep it from drying out.

MODIFIED CLEFT GRAFT

A **modified cleft graft** is good for joining pieces where the diameters are significantly different. The rootstock is split off-center and more closely matches the width of the tapered scion, leaving less gap/void to be filled by the callus. The potential for more cambium contact is better, even if the scion wedge is a bit smaller than the cleft cut. Intimate cambium contact is still essential on one edge. Use Parafilm tape or grafting bands to bind the pieces together and add a clothes pin clamp if desired. Seal the cut end of the scion to keep it from drying out.

CHIP BUD GRAFTING

Chip bud grafting uses just one bud sliced from the budwood which is then inserted into a receiving notch of the same shape in the rootstock. Chip budding is appropriate for both dormant grafting, and for summer grafting from August through early September. Rootstock with the diameter of a pencil makes cutting the receiving notch a bit easier. Budding uses less scion wood so it is economical if scion wood is limited and many trees are to be propagated.

The description below details summer chip budding, but the same principles apply when performing dormant grafting in the spring, using scion wood from the refrigerator.

Harvesting Summer Budwood

- Budwood is ready to be harvested when first year wood is sufficiently woody/lignified and will snap versus bend at a 90 deg angle — August through early Sept in the PNW.
- The budwood tree should be well watered and in good health. Sanitize pruners between varieties.
- Harvest during the cooler part of the day and have a misted plastic bag prepared to put the budwood into immediately.
- Choose straight shoots **from this year's wood** (water sprouts, new shoots). The top of the shoot may still be soft, so can be cut off. Buds in the middle of the branch are ideal.
- Snip leaves off of the budwood, but leave a ¼" piece of the petiole (the leaf stem) intact.
- Place cut budwood sticks in the misted bag. If not grafting within a few hours, store the bag in the refrigerator for up to 2 days for optimal quality.

Chip Bud Grafting Method- Applies to both Summer Grafting and Dormant Grafting

- Rootstock should be hydrated prior to budding.
- Use a sharp knife! A razor sharp blade is required both for safety and for quality of the graft union. Dull knives cause the need for excessive force which can lead to injury.
- The same cuts will be used to harvest the chip bud from the budwood and to create the receiving notch in the rootstock.
- Use Parafilm tape or budding strips to fully seal all cut surfaces and keep the bud in place. If buds start to push before the rubber strip has degraded, manually remove it. Parafilm does not need to be removed, as the bud will push right through it.
- If grafting in the dormant season (Mar-April), using Parafilm is preferred, since the bud will swell and push right through the Parafilm within a few weeks of grafting.

Rootstock, receiving notch

Any shoot growth around the budding area (2-6 inches above soil level) should be removed.

The first cut will be the lower cut and should enter at a steep angle and end roughly 1/8" - 3/16" deep. The second cut will start about 1" above the first and slice downward until it intersects the first cut and separates the bark chip. On this second cut, the blade also starts at a steep angle, but then immediately flattens out.

Bud Chip

Use the same cuts as used on the rootstock notch to cut a bud chip from the budwood.

If the bud is slightly SMALLER than the rootstock cut, in either dimension, that's fine, but a bud that's LARGER than the rootstock, cut in any dimension, is unacceptable. No part of the bud chip should overhang any bark on the rootstock.

Wrapping the Bud

Place bud chip (scion) into the receiving notch in the rootstock. Use the petiole as a hand to avoid touching or getting dirt on the inside of the bud. If the bud chip is slightly smaller than the cut in the rootstock, move to one edge to align the cambium.

Begin wrapping from the bottom and work upwards. The first wrap locks the band in place, and constant tension keeps the chip in line until complete. Use a figure eight motion of wrapping cover the area completely, leaving the petiole exposed. To finish, tie off the budding strip or firmly pull the end of the Parafilm to stretch and seal it.

The above procedures are fully detailed in this excellent YouTube video by Cloud Mountain Farm Center: Summer Chip Bud Grafting Fruit Trees - YouTube

Aftercare

- Keep the grafted tree well-watered. The callus will form, and the grafting wound will heal.
- The tree can be planted out into its permanent location or healed into soft earth in an easy to manage location, or planted in pots to grow on until success is confirmed.
- After the tree breaks dormancy, a general, balanced all-purpose fertilizer can be applied to encourage root and shoot development. Fertilizer can be reapplied twice through July, but do not fertilize after August, as all shoots should lignify and harden off before winter.
- Once the new shoots are >4” long, choose the best and cut off the scion just above it to promote a vertical whip. Remove other shoots from the scion.
- During the growing season, remove any growth coming from the rootstock.

Critical safety information:

- Some cuts are made to split the stem and necessitate that the knife be guided toward the hand holding the wood. It is essential that the knife be maneuvered in a controlled manner to eliminate excess movement should the blade slip from its intended path. These cuts are made with gentle cutting pressure and a rocking motion to split the wood grain with the knife. There are several techniques, and this video shows a good one starting at 1:50: Grafting apple trees - guide to whip and tongue grafting (bench grafting) for fruit trees - YouTube. It is strongly suggested that novices wear a heavy leather glove on the hand holding the wood until a comfort level is achieved with controlled cutting.

Fruit Tree Grafting Resources

Grafting knife or tool – Easiest blades to use are single bevel – which means there are separate right-handed and left-handed knives. There are many specialty knives, however you can usually get the job done with one basic knife. Felco makes an affordable knife. Grafting tools (brands such as Scionon) are very helpful for dormant grafting, but not as helpful with budding, and more expensive. Stanley utility knives, or similar, are suitable. *Purchase online*

Grafting tape / wax / bands – Parafilm grafting tape is easy to work with and makes a strong, waterproof seal while still being breathable. Bands give the best pressure on the cambium for a strong connection. The wax and grafting rubber bands will degrade after a few months, allowing the graft union to grow and buds to break free. *Purchase online.*

Rootstock –Raintree Nursery, Burnt Ridge Nursery, One Green World, NW Fruit (Western Washington Fruit Research Foundation) | Growing Great Fruit. Best availability typically in late winter / early spring (fruit trees). Smaller caliper rootstocks are typically more successful. Graft onto existing trees with larger calipers through top-work, etc. *Typically purchased online & shipped bareroot. May be available retail.*

Scion Wood – Collection and storage depends on type of graft being done. Make sure to collect healthy, hydrated wood that is free of pests / diseases. Scion wood is ideally roughly equal caliper to rootstock. Store in a cool, humid environment (in a moist plastic bag in refrigerator). Winter scion can be ordered online. Summer scion is typically collected and used the same day.

> **Winter scions for grafts** – Available at Burnt Ridge Nursery, NW Fruit (Western Washington Fruit Research Foundation) | Growing Great Fruit. Dormant scion wood with multiple buds are collected from dormant trees and cold stored until grafting is completed. Dormant wood can be stored into early summer to re-try failed grafts.
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> **Summer grafts** – Wood is collected by the grower early in the morning and stored only for short periods of time (ideally grafted same day) in refrigeration, with added moisture. Budding is done mid - late summer.

Sanitizer – sanitize tools regularly; sanitize between every cut or at least between varieties grafted. 70% isopropyl alcohol, or Lysol spray. Easy to find. Don't use bleach, as it corrodes the tools.

Sharpening stones, strop– grafting knives must be kept very sharp for the best results. Buy at a hardware store, or online.

Rootstock Selection Guidelines

Fruit	Rootstock	Managed Size	Stake?	Soil Tolerance	Features
Apple	M-27	4'-6'	Permanent	Needs good soil	Good for espalier
	G-41	6'-7'	Permanent	Needs good soil	Replant disease tolerant, fireblight resistance
	Bud-9	6'-7'	Permanent		Collar rot resistant
	M-9	8'-10'	Permanent	Well drained soil	Very suseptible to fire blight
	M-26	7'-12'	10 Years	Tolerates average soils	Productive
	M-106	10'-15'	3 Years	Tolerant of all but summer wet	Resistant to wooley apple aphid
	Bud-118	10'-12'	1 year	Well drained soil	Moderately resistent to fire blight
	M-111	12'-20'	1 Year	Tolerant of most soils	Resistant to wooley apple aphid and collar rot
Pear	Provence Quince	8'-12'	3 Years	Tolerant of most soils	Not compatible with all varieties (all Asians, some Euros)
	OHF-87	10'-12'	3 Years	Tolerant of most soils	Good for high density
	OHF-333	12'-15'	1 Year	Tolerant of most soils	
Cherry	Gisela 5	8'-10'	Permanent	Needs good soil	Good for UFO
	Krymsk 5	10'-12'	3 years	Needs good soil	Good for UFO
	Krymsk 6	10'-12'	1 year	Some tolerance of wet	Not compatible with tart cherries
	Mazzard	12'-20'	1 Year	Tolerant of wet and heavy	
Plum, Peach, Apricot	Krymsk 1	8'-10'	3 Years	Not drought tolerant	No suckering
Japanese Plum, Peach	Controller 6	10'-15'	Permanent	Well drained soil	
Plum, Peach, Apricot	St. Julian A	10'-15'	1 Year	Prefers well drained	
Plum, Peach	Nemaguard			Prefers well drained	Highly resistant to root-knot nematode
Plum, Peach, Almond	Lovell	12'-15'	1 year	Tolerant of wetter soil	
Plum, Peach, Apricot	Krymsk 86	12'-15'	1 Year	Tolerant of wet and heavy soil	

Reference videos and links

Whip and tongue grafting for similar diameters- winter/spring: Grafting apple trees - guide to whip and tongue grafting (bench grafting) for fruit trees - YouTube

Standard and modified cleft graft for different diameters: Grafting Fruit Trees | Modified Cleft Graft | Best option for different diameter scion and rootstock - YouTube

Production whip/tongue grafting, 2 people, 12-15 sec. per graft: Winter Grafting of Apples, Poland, 2014 - YouTube

Chip bud in winter/spring: Chip Budding Grafting Technique with Dr. Evans - YouTube

T-bud w/ Parafilm: T budding apple - YouTube

Grafting lessons 1-11, quite comprehensive. SkillCult playlist: GRAFTING LESSON #1, The Possbilities, Grafting = Freedom! (and it's fun) - YouTube

Chip bud in July/August- Cloud Mountain Farm Center: Summer Chip Bud Grafting Fruit Trees - YouTube

Chip Bud, summer, long but informative: Easy Summer Chip Bud Grafting W/ Mark Albert, Fruit Tree Graft Demonstration - YouTube

Another great grafting resource: NW Fruit research station (Mt. Vernon, WA)

A special thanks to my friends at Cloud Mountain Farm Center (now closed), for allowing me to use their material. September, 2025