

CHIP BUD GRAFTING IN WASHINGTON STATE VINEYARDS

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Grafting in perennial fruit crops has been practiced since ancient times, originating with the Chinese and Greeks. In modern-day cropping systems, grafting is often used to enhance fruit tree and vine productivity, confer disease or pest resistance, and tolerate certain soil types. As a component of grafting, rootstocks were developed to improve fruit crop quality and survivability. Rootstocks consist of the lower portion of the tree or vine below the graft union that enhances plant tolerance and/or resistance to certain soil conditions or pests.

Most of the grapes in Washington State are grown on their own roots (non-grafted) due to the limited presence of phylloxera. This aphid-like insect forms galls on roots and occasionally leaves, and can cause premature shoot defoliation, vine decline, and eventual death. Since there are no chemicals to treat phylloxera, most growers simply graft wine grape varieties onto phylloxera-resistant rootstocks.

Recently, chip bud grafting in Washington State vineyards has been used to change existing varieties to a new variety to increase economic gain, depending upon market conditions and consumer needs. This method of plant propagation also shortens the time to production of the desired new crop, using the existing variety as a rootstock. Several grape varieties at the Washington State University (WSU) Irrigated Agriculture Research and Extension Center (IAREC) in Prosser have been successfully grafted onto selected rootstocks using this technique.

Grafting Process

Grafting combines two separate plant pieces, a *scion* and a *rootstock* (Figure 1). The scion wood is the variety desired for fruit production, while the rootstock portion of the vine serves as its root system.

During the grafting process, *callus* is formed, which are undifferentiated cells that bind the scion and rootstock together. These cells differentiate into specialized cells that form a new xylem (water and nutrient pathway) and phloem (sugar

pathway) within the graft union. Several different grafting techniques can be used to produce complete grapevines or top-work varieties in the field. Bench grafting of rootstocks and scions is often used in a nursery setting (Table 1). These vines are then callused in the nursery to develop the graft union before field planting. Field grafting is used on vines designated for top-working (Table 1), and requires protection with waterproof paraffin, paint, or grafting tape. The graft union then calluses and differentiates into xylem and phloem in the field.



Figure 1.
Grafting brings two different plants
(a scion and rootstock) together.

Grapevine Grafting Techniques

Bench grafting	Omega
	Whip
Field grafting	Chip bud
	T-bud
	Cleft
	Notch
	Bark

Table 1.
Different grafting techniques used in producing
grapevines with a rootstock.

This bulletin concentrates on the chip bud grafting technique, for which considerable experience and expertise exists at WSU.





Figure 2.
Cleft grafting (A) and omega grafting (B)
are grafting techniques that can be
used on grapevines.



Figure 3.
Choose scion wood for grafting that is
12–16" in length, round, and as
straight as possible.

Chip Bud Grafting

Chip bud grafting in Washington State offers numerous benefits versus other forms of field or bench grafting (e.g., notch, cleft, omega grafts; Figure 2A and 2B) because of the region's unique climate. Eastern Washington is often very dry (less than 10" of precipitation per year), classified as a high desert environment with temperatures that warm up and cool down rapidly throughout the day. With some types of field grafting in this environment, the dark paint used to seal the wound (Figure 2A) can lead to failure of the graft union because of temperature fluctuations that cause swelling and shrinking, disrupting the cells connecting stock and scion. In western Washington, where fluctuations are not as extreme between day and night temperatures, cleft grafting may be more successful than chip bud grafting. However, the chip budding technique simply involves wrapping the bud securely to the rootstock. Chip budding is also much easier and faster than cleft or notch grafting because of the reduced surface area exposed and shorter healing time.

Since most grape varieties are grown on their own roots in Washington State, returning to the original variety to adapt to changing market demands is feasible. All this requires is removing the scion portion of the vine and retraining the original variety from suckers at the base of the vine.

In addition, chip bud grafting is more economical than replanting. While it can take up to five years to replace a vineyard, including assessing soil conditions, constructing trellis and irrigation components, and making pre-plant decisions, chip-bud-grafted vines take only two to three years to achieve full production because an established vine is used for this technique. In some cases, a reasonable crop will be produced in the year after grafting. However, it is best to not overly stress the grapevine during vascular development at the graft union and to encourage rapid shoot growth. Therefore, any crop during the year grafting is done should be removed.

There is a fairly late window of opportunity for chip bud grafting compared to other types of grafting. For example, vineyards can be chip budded successfully in late May through mid-July, compared to cleft grafting that should be completed by late May. If grafting is conducted after mid-July, the vines may not harden off properly, leaving them susceptible to winter damage.

Scion Wood Preparation

Choosing Scion Wood

Field grafting a vineyard to another desired variety requires planning at least one year in advance. Scion wood should be collected in early winter (usually November) as dormant wood cuttings. At this point in the season, most of the carbohydrates are stored as starch. Collecting scion wood early in the winter helps to minimize various fungi and bacteria that cause rots and mildews that degrade the plant material and lead to graft failure. The form of carbohydrate (starch) during early winter is less preferable for fungi and bacteria to use as a food source, which can prevent growth of these microorganisms.

Be sure to choose healthy vines for scion wood collection that have been tested virus-free. Avoid vines that show symptoms of disease, such as heavy powdery mildew infestations, and damage by frost or dehydration. Canes should be about pencil-thick (9/16–3/8" in diameter), well-lignified, round, and straight (Figure 3). However, straight canes are less important for chip budding than other types of grafting. Also choose canes where the internode length (distance between buds) is not more than 2.5". This helps to avoid the use of overly vigorous shoots (bull canes) or straggling shoots, which can indicate a nutrient deficiency, disease, or pest problem. Selecting thinner rather than thicker canes makes it easier to graft the associated buds. Cut the canes to include 4–5 buds each, for a total of 12–16" in length.

Points to Remember:

- Take scion wood cuttings in early winter.
- Be sure the cuttings are from healthy vines that have been virus-tested and do not show symptoms of disease or damage.
- Choose canes that are round, straight, and thin (pencil thickness, 9/16–3/8").
- Choose canes that include 4–5 buds (12–16" in length).

Preparing Scion Wood for Storage

Once the scion wood is cut and bundled (50–100 cuttings/bundle; Figure 3), apply a heat treatment to minimize pests and diseases. Place the wood in a water bath at 122°F (50°C) for 30 minutes to stop pathogenic fungi and minimize crown gall and certain phytoplasmas in the tissue. After the hot water treatment, rinse wood bundles in cool water to prevent tissue damage.

If wood is collected too late (e.g., early spring), these heat treatments can damage the tissue. It is better to collect scion wood in the late autumn or early winter to avoid potential tissue damage.

After scion wood is heat-treated, apply an appropriate fungicide before wrapping and storing to prevent fungal growth during storage. Soak in a 0.3–0.5% solution for up to five hours and then rinse with water. Tightly wrap moist newspaper around the scion wood and place in two heavy-duty plastic bags to ensure adequate hydration during long-term storage.

Cold storage can range from a large cold room to a simple refrigerator, as long as the temperatures stay between 32°F and 39°F (0–4°C).

Points to Remember:

- Treat scion wood for various fungal diseases, crown gall, and phytoplasmas by soaking in hot water (122°F or 50°C) for 30 minutes. Rinse with cool water.
- Treat wood with a dilute solution of fungicide (0.3–0.5%) for up to five hours. Rinse well with cool water.
- Bundle wood with moist paper or cloth and place in two heavy-duty plastic bags to minimize water loss.
- Store in a cool room or refrigerator at 32–39°F (0–4°C).

Preparing Existing Grapevines for Grafting

Between the late winter months into early spring, cut off grapevine trunks to be used as rootstocks to encourage suckers. When numerous suckers emerge, retain two, train them up to the cordon wire (using grow tubes if desired), and attach by securing with string or vinyl tape. This will become the trunk (rootstock) for the new variety.

As the suckers grow beyond the cordon wire, pinch the tip off but keep the top two leaves (Figure 4). This allows the grapevine to continue transpiring, which ensures water flow up to and through the graft union. Also at this time, remove all buds along the remainder of the sucker with a grafting knife to avoid any lateral growth after grafting (Figure 5). Lateral growth can redirect carbohydrates away from the developing graft union into new shoot growth of the rootstock, and negatively affect graft union success.

Chip Budding Scion and Rootstock

To prepare scion wood for grafting, remove from both storage containers and wrappings and soak in water for one to two days to rehydrate the tissue. Make chip buds with an initial cut approximately 1/8" from the base of the bud, and the second cut approximately 1/4" above the top of the bud (bringing the knife smoothly down to the first cut; Figure 6). The same morning as grafting is planned, cut buds from the scion wood and immediately place in a bucket of water for transfer to the vineyard. Only cut enough buds for the day of budding, as excess buds cannot be stored longer than one day.

Make cuts for the chip buds between the nodes on the rootstock (formerly suckers tied up to the cordon wire; Figure 5) in the vineyard with a grafting knife to mirror the two cuts on the scion bud. Choose buds to closely match the cut, insert, and wrap tightly with grafting tape to ensure a close connection (Figure 7). If no exact match can be found, it is better to use a bud that is too small than one that is too big. Buds that are not in intimate contact with the rootstock will dry up. It is also important to use transparent or white grafting tape to reflect excessive solar radiation. These steps should be completed quickly to avoid desiccation and graft union failure.

Research conducted at WSU Prosser IAREC indicates that grafts made high above the ground have a better chance of surviving the critical first winter. For instance, only 23% of grafts close to the ground (i.e., 11" or 28 cm) survived the 2002 "Halloween freeze" (11°F on October 31), compared to 65% of those grafted 27" or 69 cm above the ground. Higher grafts can also be trained to cordon wire more quickly than lower grafts.



Figure 4.
Leave two leaves on suckers secured to cordon wire for grafting to allow continued water movement to and through the graft union.

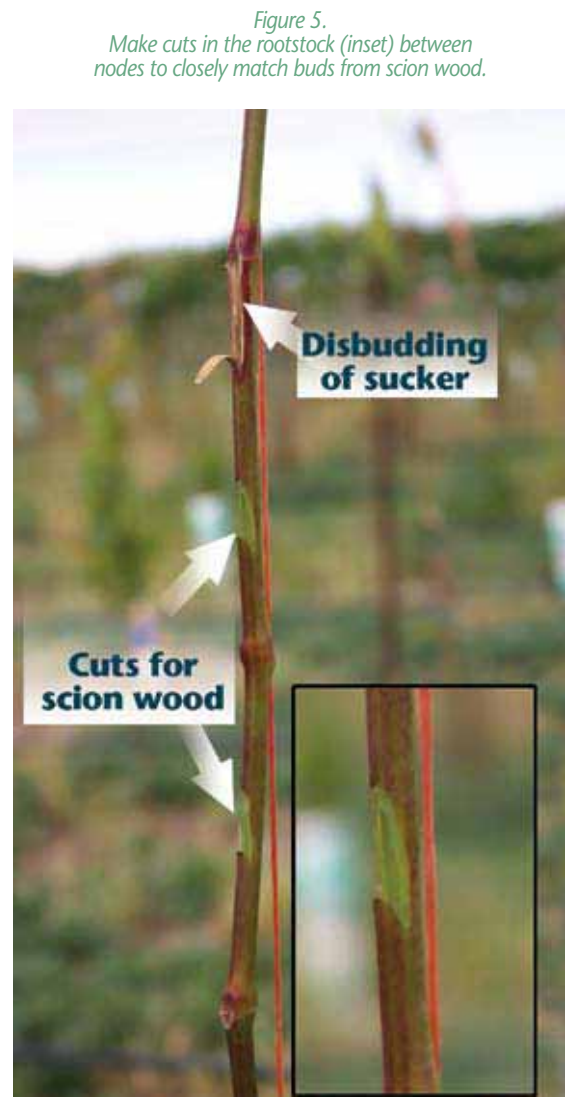


Figure 5.
Make cuts in the rootstock (inset) between nodes to closely match buds from scion wood.



Figure 6.
Cut buds (inset) off of scion wood before transfer to the field, and immediately place in a bucket of water to keep tissue hydrated.

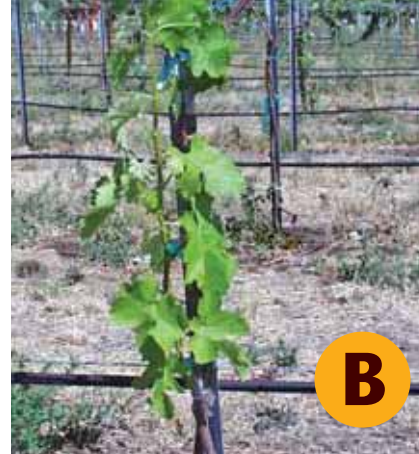


Figure 8.
A successful graft union results in a new variety and rootstock at three weeks after budding (A) and two months after grafting (B).

Following budding, water vines well to prevent water stress. New growth will emerge from the newly grafted bud approximately one to two weeks after budding (Figure 8A). However, the lateral buds in the axil of the two rootstock leaves will usually grow out more easily than the grafted bud. Such growth should be quickly removed to encourage the new scion to grow. Keep the two leaves on the rootstock until there are at least 6" of new growth from the newly grafted chip bud. After this point, the shoot portion with the two remaining leaves can be removed about 1" above the graft union. New shoot growth from the grafted bud will have developed enough to support photosynthesis and carbohydrate production for further growth (Figure 8B).

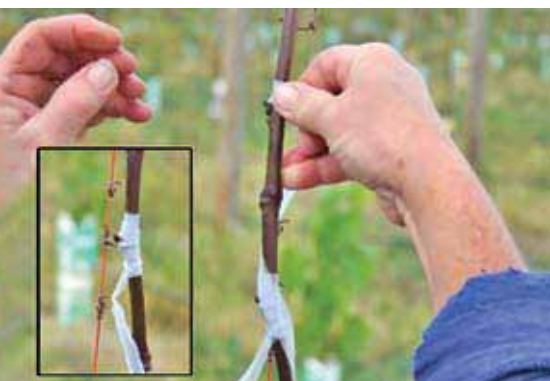


Figure 7.
Wrap buds tightly to the rootstock to ensure a proper seal between rootstock and scion, leaving the tip exposed to begin the growth process (inset).

Care for Grafted Vines

Treat newly grafted vines as young vines in the early stages of vineyard development. With the removal of a large portion of the canopy, overall vine growth is not in balance with root growth, and shoot development may be vigorous for a few years following grafting. Growth from the rootstock portion of the vine should be repeatedly removed, including laterals and suckers.

Water, fertilize, and maintain a disease and pest control program for grafted vines. Apply a similar irrigation method to that for a young vine through August, with some irrigation deficit into September and October to encourage the hardening off process. This is very important, especially the later the grafting is done in the season, because new growth is vulnerable to unseasonably low temperatures in late fall and early winter. Watch for cane maturation (browning), which is also associated with water deficit. At the end of the season, irrigate to fill up the soil profile and minimize cold injury to roots.

Encourage growth to develop the new training system, whether it requires cordons or canes. Remove fruit that sets in the year of grafting to direct all available carbohydrates into shoot growth for cordon establishment and development of the graft union to form a strong connection between rootstock and scion. A crop can be harvested in the year after grafting, with full production expected in the second or third year.

Use pesticides with care. Apply them only to plants, animals, or sites listed on the label. When mixing and applying pesticides, follow all label precautions to protect yourself and others around you. It is a violation of the law to disregard label directions. If pesticides are spilled on skin or clothing, remove clothing and wash skin thoroughly. Store pesticides in their original containers and keep them out of the reach of children, pets, and livestock.

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Points to Remember:

- Prepare vines in late winter or early spring by removing the existing trunk and cordons.
- Train two suckers to wire and secure for grafting.
- Remove all growth on the sucker, except for two leaves at the top. Disbud the remainder of the trained sucker.
- Cut sufficient scion bud wood on the morning of budding and place in a bucket of water.
- Make cuts for chip buds on rootstock (sucker) between nodes, rather than at the node.
- Match the bud size to the size of the cut on the rootstock for maximum success.
- Wrap buds tightly to the rootstock with grafting tape to avoid desiccation.
- Make sure vines are well-watered and fertilized, but reduce irrigation in early fall to encourage cold acclimation.

Summary

According to trials conducted at WSU Prosser IAREC with a 95% success rate, chip budding in Washington State vineyards can be effectively used to convert unprofitable grape varieties into a vineyard that has the potential for higher returns. If market conditions change, the original grape variety remains; the top variety only requires cutting down, and the old variety retraining from suckers. Vines need to be prepared for grafting in late winter, with completion of the grafting technique by July. Grapevines must be treated as young vines after grafting, but full production is expected in two years.