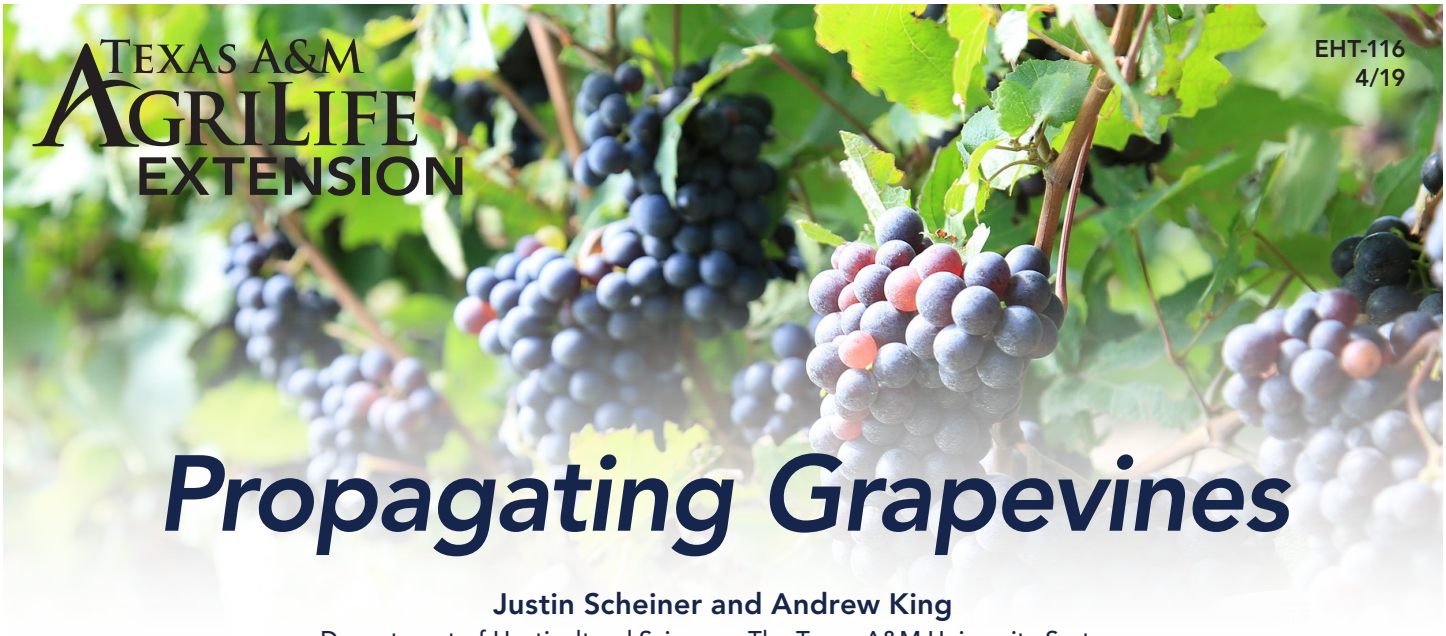

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Propagating Grapevines

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Plant propagation is the process of creating new plants. Asexual propagation is the development of a new plant from a piece of another plant. The result is a plant that is genetically identical to the mother or stock plant. Sexual propagation is the development of a new plant from a seed with genetic material from two plants. This process results in offspring that are genetically different from the mother plant and from one another. This difference is due to genetic recombination during meiosis. Although grapes can be readily grown from seed, all commercial grape cultivars are propagated asexually. This is the only way to maintain the exact characteristics of a specific grape cultivar. The mother plant's characteristics must be maintained to use the cultivar name for marketing purposes, such as on a wine label. Some of the grape cultivars grown today were developed hundreds of years ago and have been preserved through asexual propagation.

The preferred method of asexually propagating grapevines—for home or commercial use—is rooting dormant hardwood cuttings. This method is relatively easy and can be carried out on a large scale with minimal expense. This method can also be used in conjunction with bench grafting.

Dormant Hardwood Cuttings

Dormant canes are one-year-old wood that contain buds. These canes are the tissue of choice for propagating grapes. Most of the wood removed during dormant winter pruning can be used to generate new vines (Fig. 1). Dormant canes contain fully developed buds with rudimentary shoots comprised of leaf and cluster primordia and stored energy. The carbohydrates contained in the wood will fuel the growth of roots and shoots until the new grapevine has enough functioning leaves to support itself.

Figure 1. A dormant vineyard before pruning.

When selecting wood for propagation, it is generally best to avoid overly vigorous canes (bull canes) and canes that are weak and small. The most desirable wood is approximately the diameter of a no. 2 pencil or slightly larger – approximately the size of a Sharpie® marker. It is only necessary for each cutting to contain one bud for future shoot growth, but most cuttings will contain 2 to 6 buds. Sections of cane that are 12 to 16 inches can be used. For ease of determining cane orientation, the end closest to the trunk—the basal portion of the cane—can be cut flat. The other end—the distal end—can be cut at an angle (Fig. 2).

Figure 2. A bundle of dormant canes cuttings with distal ends cut at an angle and basal ends cut flat.

It is a good practice to disinfect dormant cuttings by soaking them in a hot water bath (at 115 to 125°F for approximately 5 to 10 minutes). This removes and kills some of the bacteria and fungi that could later infect the new vines. Sanitizing agents such as hydrogen peroxide may also be used for this purpose, though optimum concentrations and soaking times vary. After sanitization, the cuttings should be placed in a medium for rooting. If storing cuttings for later use, they may be placed in moist (but not wet) sawdust or sphagnum in a cooler (between 34–40°F). If stored properly, and not allowed to desiccate or become dehydrated, cuttings can remain viable for several months.

In most cases, dormant cuttings are rooted in a soilless medium such as sand, sawdust, coconut fiber or peat moss (Fig. 3). The basal end of the cuttings may be placed in position to receive more heat (from sunlight or artificially applied heat)

Figure 3. Callus box filled with coconut fiber as the rooting medium.

than the distal end. The heat stimulates root development—80°F is ideal. Initially, a whitish scab-like tissue called callus is produced at the buried basal end. Callus is a mass of unorganized or unspecialized cells that become the new roots (Fig. 4).

The goal of differentially heating the basal end of cuttings is to initiate root development before shoot development. Under controlled conditions, the cuttings can be placed in a cool room directly above a heating mat so that the basal end of the vertically-oriented canes is warmed. Exposing the buds to cooler temperatures may keep them dormant while root development takes place. In practice, it can be difficult to maintain a temperature difference between the base of the cane and the more distal buds, and it is not usually necessary unless rooting is delayed, or the type of grape is inherently slow to root. Shoots that emerge prematurely in the dark will be white in color and

Figure 4. Callused grape cuttings.

will die when exposed to bright light. However, grapes have compound buds which contain three buds, so it is not problematic if the primary or second secondary shoots that emerge from a bud die.

After cuttings have callused (usually in 3 to 5 weeks), they may be planted directly in a field nursery or in pots. The new vines are very sensitive to desiccation (dehydration) and may be misted with water intermittently until their new roots are able to support them. The above ground portion of the cuttings may also be dipped in wax (Fig. 5). The wax coating prevents dehydration but is soft and thin enough to allow shoots to emerge through it.

Figure 5. Callused grapevine cuttings after waxing.

Softwood Cuttings

The only type of grapes that are not commonly propagated from dormant cuttings are muscadines. Muscadines are usually propagated with softwood cuttings or by layering. During the growing season, softwood or herbaceous cuttings of shoots (Figs. 6–9) can be rooted using an automated mist system or other means of controlling moisture through the rooting process (2 to 4 weeks). This method tends to be costly and tedious, and newly generated vines are delicate and must be treated with care. Therefore, softwood cuttings are generally only used for grapes that are difficult to propagate from dormant cuttings or if new plants are desired during the growing season, when dormant wood is unavailable.

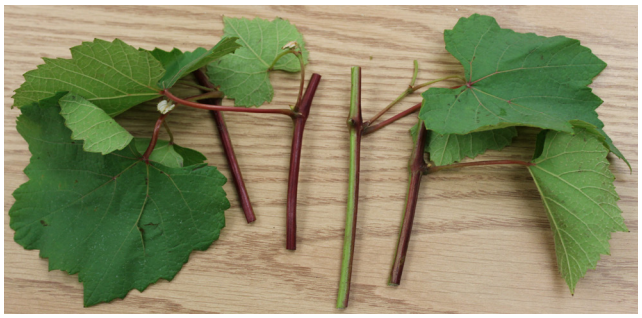

Figure 6. Softwood cuttings of grapevine shoots. Avoid shoot tips and woody cuttings taken from the base of shoots.

Figure 7. Hormone dip to increase rooting success. Liquid and powder forms may be used.

Figure 8. Cuttings placed in media and under intermittent mist to prevent desiccation until rooting.

Figure 9. Rooted cutting after 2 to 4 weeks.

Grafting

Grafting is the process of joining two plants to grow them together as a single plant. In viticulture, grafting enables grape growers to use the root system of one type of grape—referred to as the rootstock—and the shoot system of another —called the scion. Historically, grafting was the solution to the phylloxera epidemic. Rootstocks are also used for reasons such as soil adaptability, pest and disease resistance, vigor control, and drought tolerance. There are numerous grafting techniques, but grapes are most commonly bench grafted using a grafting machine (Fig. 10). Bench grafting utilizes dormant wood and may be conducted indoors versus field grafting which takes place in the vineyard or nursery.

Figure 10. Grafting machine with scion (left side) and rootstock wood (right side).

First, dormant scion and rootstock cane cuttings are collected and sanitized. The buds on the rootstock may be removed either by hand or machine in a process called disbudding (Fig. 11). This prevents any undesirable shoots from the rootstock from growing.

The rootstock and scion are then spliced together ensuring that the vascular cambium (Fig. 12) of both are at least partially aligned. The rootstock and scion become connected via callus formation at the graft union (Fig. 13).

The newly joined scion and rootstock are callused and rooted using the same techniques used for hardwood cuttings. Care must be taken to avoid

Figure 11. A disbudding machine used to remove buds from rootstock canes.

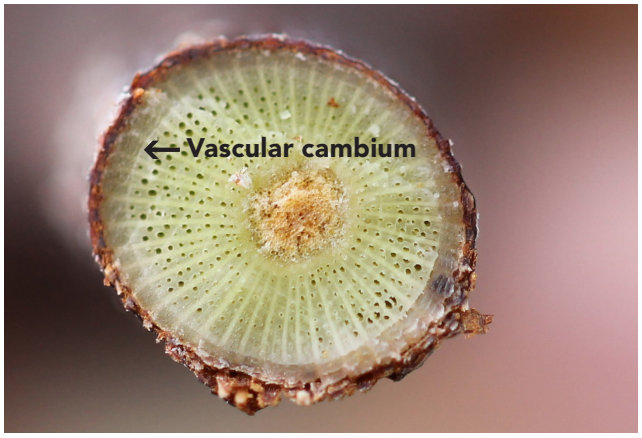

Figure 12. Cross section of a grapevine cane. The vascular cambium is the thin white layer located between the xylem and phloem tissues.

Figure 13. Omega graft immediately after grafting (left) and after callusing (right).

disturbing the graft union for at least a few months until the bridge between the rootstock and scion strengthens. Many bench grafting machines utilize an omega cut to help secure the graft.

Upon callusing, vines may be planted directly in a field nursery or in pots. Potted vines may be grown for a few months before they are sold as green grafts. They may also be grown in a field nursery for a growing season before being sold as dormant, bare root, one-year-old grafted vines (Fig. 14). The scion may be coated with wax immediately after it is removed from callusing and again after being dug from the field to protect the graft and buds (Fig. 15).

The leading cause of failure when planting dormant bare-root grapevines is desiccation. The wax coating that covers the dormant buds of bare-root vines serves as an essential layer of protection until the roots begin to grow and absorb water.

Figure 14. Green grafts approximately two months after grafting.

Figure 15. Bundles of dormant bare-root vines after one year in a field nursery.

Dormant, bare-root grapevines are often sold in bundles of 25 vines with an identification tag tied to each bundle. The bundles are typically stored in moist sawdust or newspaper to keep them hydrated.

Field Grafting

What happens when a grape grower decides that a cultivar is no longer desirable? Removing the grapevines and replanting new ones is a lot of work. It can take up to three years to produce fruit on new vines. A better option may be to graft onto the existing vines utilizing their fully developed root system. This is referred to as "top working" or "field grafting." Timing is very important when field grafting. The method chosen will dictate the timing. Common techniques used for field grafting include budding (t-budding and chip budding), and cleft and wedge grafting.

Practice is needed to become proficient in any method of field grafting, but some methods require more skill than others.

Budding

Budding is conducted in late spring and early summer when the bark is slipping. For t-budding, a capital t-shaped cut is made into the rootstock. The bark is then carefully peeled back (Fig. 16).

A bud from the scion is cut off using a shallow cut and is inserted into the bark flaps of the rootstock. The bud is then wrapped with a rubber band or budding tape to secure it and prevent desiccation. In several weeks, callus tissue forms a bridge between the rootstock and scion bud.

Chip budding is similar to t-budding except that a section or chip of wood is removed from the rootstock and the same size and shape cut is made when removing the scion bud. The bud and attached chip of wood are then fitted into the hole created in the rootstock.

Figure 16. T-budding: A t-shaped cut (top left) is made into the rootstock. Bark flaps are carefully peeled back (top right) and a dormant bud (bottom left), excised from a shoot of the scion, is inserted between the bark flaps of the rootstock (bottom right).

Wedge and Cleft Grafting

Wedge and cleft grafting are done in the spring using dormant scion canes (Fig. 17). The trunk of the rootstock is topped or cut off. A perpendicular split is then made at the top of the rootstock using a knife or cleft tool. A piece of scion cane, containing one or two buds, is cut at the base into a wedge shape and is inserted into the split of the rootstock. The graft union is then wrapped with grafting tape or rubber bands and may be covered with wax or tar to secure the union and to prevent desiccation.

Cleft grafting is similar to wedge grafting except that the scion is only aligned on one side of the rootstock which is larger in size (Fig. 18).

Tissue Culture

The most recently developed method of grapevine propagation is via tissue culture (Fig. 19). With this method, the shoot tip (or another part) of a grapevine is removed and placed on a nutrient-rich agar. Agar is usually made up of a gelatinous agent (polysaccharides from seaweed) containing essential plant nutrients in precise concentrations. Plant hormones are typically added to encourage

Figure 17. Wedge graft: The rootstock is topped and split (top left). The basal end of the scion cane is cut into a wedge shape (top right) and inserted into the split of the rootstock (bottom left). The graft is secured with grafting tape (bottom right).

Figure 18. Aligning the vascular cambium of the scion and rootstock on a cleft graft.

Figure 19. Muscadine grape in tissue culture.

shoot and root development. The excised shoot tip is able to absorb essential nutrients from the agar until roots and shoots develop. Once root and shoot growth is sufficient, the new plantlets are divided and transferred to pots.

Tissue culture is expensive and requires aseptic conditions, but hundreds of vines can be developed from a limited amount of plant material. This method may also be used in conjunction with a heat treatment to "remove" viruses from plants. Most commonly, the mother plant is grown under high heat conditions (95 to 130°F) for several days or weeks before the shoot tip (apical meristem) is extracted for propagation. The heat encourages rapid shoot elongation, and the shoot tip outgrows the mobility of the virus. The vine propagated from the "clean" shoot tip will be virus free.

Layering

Another propagation technique that is most often used on muscadines—and occasionally to fill vacant spots in a vineyard—is layering. Layering is the process of a shoot or cane of a grapevine being used to establish a new vine while attached to the mother plant. The new vine can either be produced next to the mother vine or in a container (Fig. 20). This technique is normally used in vineyards with own-rooted (no rootstock) vines. During the growing or dormant season, a section

Figure 20. Simple laying to fill an empty space in a vineyard.

Figure 21. Aerial rooting from a bunch grape cane after exposure to prolonged moisture.

of a long shoot or cane is bent into a u-shape. The bottom of the "u" is then buried. This is referred to as simple layering. If the tip of the shoot is buried or if several sections of the shoot are buried it is called serpentine layering. The buried shoot will form roots and a new vine can be established from that future shoot growth. The layered vine may be allowed to grow this way for one to two years—or longer—before pruning it from the mother plant.

Aerial layering uses a container or bag that contains soil or another medium. It may be attached to a shoot or the shoot may be situated to allow contact with the soil in the container. Over time roots form if sufficient moisture is maintained. The growing shoot can then be removed from the vine and planted (Fig. 21).

In some cases, layering may be a good option for replacing a dead or missing grapevine. New vines may become established quickly because the layered plant is initially supported by the root system of the mature mother plant. For those without an automated mist system, layering may offer the best option for muscadine propagation.

Sanitation and Pathogens

Worldwide, there are over 70 different viral pathogens known to infect grapes. Some are known to be detrimental to grapes and none are cur-

able. Because viral and bacterial pathogens live within grapevine tissue, they may be easily spread through propagation. If new plants are asexually propagated from a grapevine infected by a virus, the new vines will also be infected with the virus. This may also be true of fungi that infect the conductive tissue of grapes such as grapevine trunk diseases (GTD). In Texas alone, there are over 20 species of fungi capable of causing GTD.

When propagating grapevines, it is important to utilize clean, pathogen-free plant material. Though tissue culture is a useful tool against propagating viruses, this may be difficult for hobbyists and commercial growers alike. However, clean plant material is available for a modest fee from the Foundation Plant Services Grape Program at the University of California Davis. In response to severe problems with viruses in the 1950s, the USDA and the University of California Davis developed methods of virus testing and elimination and created an extensive collection of virus-tested grape cultivars. This clean plant material is available to grapevine nurseries as a source of mother stock plants. Testing services are also available to ensure clean plants are used for propagation. Nursery certification programs are available in some states as a means of quality assurance. Mother stock plants are regularly tested for viral and bacterial pathogens and infected plants are roged (removed). In 2010, the National Clean Plant Network was established to promote the use of pathogen-free planting stock (http://nationalcleanplantnetwork.org/).

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