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AG FACTS

Culture of Grapevines in Michigan

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Grapevine culture, both commercial and home production, is expanding in Michigan. This expansion and the increase in grape types being grown have created the need for a general description of the important techniques involved in their culture.

Selection of Grape Site

Location is extremely important because the vineyard will occupy the same site for a number of years. The best sites provide maximum sunlight during the growing season and mild winter temperatures. Elevated sites are preferred because cold air drains away to surrounding low areas which reduces spring frost injury.

Mid-winter damage is a major concern. Use the following guide to evaluate a site based on its winter temperatures.

Excellent sites:

Winter temperatures drop to -5°F a maximum of 3 times or less in a period of 10 years. Winter temperatures reach -10°F not more than once in ten years. The long-term minimum temperature does not drop below -10°F. These temperature conditions are suitable for all current commercial varieties.

Good sites:

Winter temperatures reach -5°F not more than 4 times in 10 years. Winter temperatures reach -10°F no more than once in 10 years. The long-term minimum temperature does not fall below -15°F. These temperature conditions are acceptable for all current commercial varieties. However, expect tender to very tender cultivars (Table 1) to suffer severe damage at least once in 10 years and less severe damage more often.

Acceptable sites:

Winter temperatures reach -5°F every year. Winter temperatures reach -10°F a maximum of 4 times in 10 years. A long-term minimum temperature of -15°F or less occurs no more than once in 10 years. This site is generally suitable only for varieties of medium or greater hardiness.

Poor sites:

Winter temperatures reach -10°F five or more times in 10 years. Winter temperatures drop to -15°F three or more times in 10 years. Generally, this site is not considered suitable for grape production.

Slope, Aspect and Variety Selection

The choice of slope can influence vine performance. Although planting on cooler northern slopes delays early spring bud burst which reduces spring frost damage, south and southwestern facing slopes are usually most desirable. Southern slopes are warmer and promote earlier fruit ripening, which is of greatest importance in Michigan where summers are cool and growing

Table 1 Relative cold hardiness of grapevines grown in Michigan

Very Hardy	Hardy	Medium	Tender	Very Tender
Concord	Aurore	Alden	Chardonnay	Gewurztraminer
de Chaunac	Cascade	Baco Noir	Interlaken	Sauvignon blanc
Marechal Foch	Canadice	Chancellor	Suffolk Red	
	Catawba	Chambourcin	White Riesling	
	Delaware	Chelois	Pinot Noir	
	Fredonia	GW-9	Cabernet Sauvignon	
	Moore's Early	Himrod		
	New York Muscat	Lakemont		
	Niagara	Ontario		
	Vignoles	Romulus		
		S.10868		
		Seneca		
		Seyval		
		Vidal blanc		

seasons are short. Southern slopes sheltered by buildings, landscape plants or contours of topography are generally warmer, and promote earlier fruit ripening and spring bud burst.

Although prevailing winds may damage plantings on exposed western slopes, rows running east to west on a southern or northern slope, may benefit from the westerly winds because they dry the dew and rain on the foliage which helps reduce disease. However, with such an arrangement the north side of the vine is always in the shade in the fall. To avoid this problem, north and south running rows are preferred.

The increased interest in growing near-vinifera and vinifera grapes makes the selection of a suitable site crucial. In such cases, a small temperature difference between sites can mean the difference between a good harvest or a crop loss. Because varieties vary widely in their winter hardinesss (Table 1) variety selection is very important. For instance, Concord is much more winter-hardy than is White Riesling. For less hardy varieties, site selection is more critical than for more cold resistant varieties.

The number of days required to mature the crop is another important consideration. A minimum frost-free period of 165 days is required for early maturing cultivars. The frost-free season should begin early enough in the spring to protect early growing shoots and extend into the fall to produce a mature crop as well as mature vegetation. New growth that is not sufficiently mature by the end of the growing season is more susceptible to winter injury.

Drainage

Proper soil drainage is imperative for grape production. Avoid soils which are continually wet during the growing season. Roots may penetrate six feet or more in a deep, well-drained soil, but may only reach a depth of 2′ or less in a poorly-drained soil. Poorly-drained soil is slow to warm, delaying vine development and fruit maturation in the fall.

Vineyards on soils ranging from loam to clay can produce adequate yields with good management, but highest yields will be achieved if these soils are well drained. If natural drainage is poor, install a tile system before planting. This should be placed closely enough to the soil surface to remove excess soil moisture from the root zone effectively. Generally, it is not economical to purchase a less expensive site with poor drainage because the cost of improving the drainage may exceed any savings.

Selection of Vines

Vines From Nursery Stock

Selecting suitable nursery stock is critical to the success of the vineyard. Select a nursery with a reputation for providing high-quality, vigorous plants. The quantity of roots on rooted grape cuttings determines the grade and is a good guide to quality. One-year-old extra heavy and one-year-old number 1 rooted cuttings are best. Weak vines may be a lower price but will not be as vigorous or productive as those vines grown from better grades, even if the weak vines are given an additional year in the nursery. When buying grafted vines, the continual strength of the graft union is important to consider.

Propagating Your Own Vines

1. Vines from Cuttings

Reliable grape stock can be obtained by taking cuttings from grape canes. Cuttings can be taken from mature cane prunings anytime during the dormant season, but those taken early in the dormant season have less chance of winter injury to canes or buds.

The recommended cane size varies among cultivars. Generally, cuttings with one-fourth to three-eighths inch diameter and 4 to 6-inch internodes work best, but this may vary with variety. Cuttings should not exceed 10 inches in length. Cuttings from vigorous varieties, such as Concord, should have at least three nodes; less vigorous cultivars, such as Delaware, may contain more. Mark the upper and lower ends of the cutting by making the basal cut just below the lower node and perpendicular to cane direction, and the upper cut 1-2 inches above the top node at a 45° angle.

Tie the cuttings in bundles of 50 to 100. Store in a cool, moist place, such as a cellar or refrigerator (20° to 45°F), until planting time in the spring. Moist sawdust, sand and peat moss are useful materials for packing and storing the cuttings.

Cuttings can be stored in a well-drained outdoor pit if other facilities are not available. A sandy or sandy-loam soil is best for such pits, but heavier soils can be used if the pit is partially filled with sand. Cover the cuttings with at least three inches of firmly pressed sand or sandy soil and spread a mulch of 8-12 inches of straw over the top for winter protection.

Place the cuttings in a nursery row in a deep, well-drained, fertile soil as early as possible in the spring. Space rows 3-4 feet apart. Dig furrows 6-7 inches deep and 3-4 feet apart. Plant the cuttings 5 inches apart in a vertical position with the top node at the soil level. Tamp the soil firmly around the cuttings as the trench is filled.

As the season progresses, shoots will develop from the above ground

bud and roots will begin to grow from the underground nodes. Keep the new vines vigorous by controlling diseases, insects and weeds. On sandy soils, irrigation may be necessary. The young vines will be well established by fall and ready for placement in the vineyard the following spring. Start twice as many cuttings as you need to compensate for poor growth.

2. Vines from Greenhouse Cuttings

American grape cultivars may be readily rooted during late winter under greenhouse conditions. This method saves one year over the outdoor propagation technique.

Take cuttings from healthy vines in early December as described previously. Tie the cuttings in bundles, wrap in damp burlap or polyethylene bags and place in storage at 32°-33°F for approximately 30 days.

Remove the cuttings from storage in early January and place them in a suitable rooting media in the greenhouse. Vermiculite, sand, or mixtures of sand and peat work well. Before the cuttings are inserted, the lower ends may be dipped in a rooting hormone such as indolebutyric acid. This will encourage more rapid root growth. Place 3-5 inches of the media in a flat or greenhouse bench. Plant the cuttings so that the lower cut and node is pushed down almost to the bottom of the flat and the upper bud projects just above the surface. Plant the cuttings 1-2 inches apart in rows 2-3 inches apart.

Misting and bottom heat will greatly enhance rooting. Intermittent mist provides a high and constant relative humidity around the cuttings. An automatic mist system which operates once every six minutes is satisfactory. Mist is not required at night.

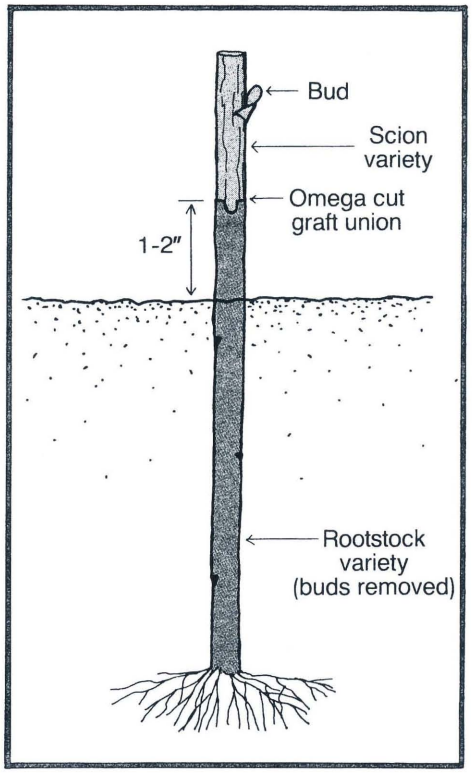
Bottom heat can be provided through a heating cable under the flats or in the bottom of a bench. Maintain day temperatures between 65°F and 70°F and night temperatures at near 60°F.

Within 4-6 weeks, the cuttings will develop roots and small leaves and can be transplanted into 4-inch pots. Use a 1:1:1 mixture of peat, sand, and soil, but sterilize the mixture with steam or chemical fumigation before using.

Once potted, place the cuttings back under the mist for another day or two to establish the roots, then place pots in a conventional greenhouse area at 70°-75°F for 2-3 weeks. The cuttings must be hardened off before they are placed in the field. To do this, maintain night temperatures at 40°-45°F and day temperatures at 65°-70°F. Water the vines regularly with weekly applications of a dilute fertilizer solution.

Regularly check cuttings in the greenhouse for insects. White fly can become a pest that may require control.

Figure 1. Grafted grapevine.



When the new shoots are 10 inches long, they are ready to set in the vineyard. Vines grown in the greenhouse are especially sensitive to frost, and should not be set in the field until all danger of frost is past. These vines will also be very susceptible to drought. Applying water, as needed, is crucial to vine survival after transplanting.

3. Vines by Grafting

A *graft* is a combination of the root system of one variety (the stock) and a top portion of another variety (the scion) to form a single plant (Figure 1).

Grafting allows a grower to grow a grape variety susceptible to some soil problem. For example, European *(vinifera)* grape cultivars are very susceptible to a root insect called phylloxera which causes galls on leaves and roots. To be grown successfully in Michigan, European varieties must be grafted on rootstocks which are phylloxera resistant. Rootstocks have also been developed which are resistant to parasitic nematodes and tolerant of high pH soils (Table 2).

Generally, American and French hybrid grapes do not require resistant rootstocks as do European cultivars. Many vineyards are established with self-rooted vines (termed *direct producers*) because phylloxera and other soil borne parasites are not as likely to trouble American grape cultivars. This is the case with Concord. Oftentimes rootstocks will impart a vigor and resistance which is especially important when replanting an old vineyard. In replant situations, even varieties which are marginally phylloxera resistant, such as Ives, Delaware and occasionally Concord, may perform better when grafted to a resistant stock.

Table 2 Beneficial Rootstocks	
Suggested Value	**Rootstocks**
Tolerant of phylloxera	C3309, C1202, 5BB, S04
Nematode resistant	C1616, Dogridge, Salt Creek, Harmony
Tolerant of drought	99 R, 110 R
Increased vigor	S04, St. George, Harmony
Greatly increased vigor	Dogridge, Salt Creek
Hasten wood maturity	41 B, 101-14 Mgt
Delay wood maturity	St. George, 110R

4. Layering

Layering is a propagation technique useful in replacing missing vines in an established vineyard. It works for all cultivars of grapes except those requiring rootstocks, but is slow to produce large numbers of plants (Figure 2).

Late winter or early spring is the best time for layering. Choose a vigorous one-year-old cane adjacent to the missing plant. Lay the cane in a shallow trench and cover a 2-3 node section with 3-4 inches of firmly pressed soil. Leave a minimum of two apical buds at the end of the cane above the soil surface. Within a few weeks, roots will develop from the covered nodes and new shoots will grow from exposed buds at the end of the cane.

Remove any shoots which may develop between the layered portion of the cane and the mother vine. The connecting cane can be cut after the new vine is well-established (two or three years). If the layered vine is to be moved, transplant after one year's growth.

Site Preparation and Vine Planting

Once the vines have been dug or received from the nursery, take care to avoid damaging or drying out the vines. Vines not planted right away should be stored in high humidity at 32°F. Areas used for storing fruit usually do not work well because the gases released by the fruit kill buds. Vines can also be stored temporarily in a shallow trench. An alternative is to heel-in vines in a sheltered area. Dig a 10-inch deep trench and place vines so that the tops are exposed. Cover the roots and tamp and press firmly. Water as needed and plant in the desired permanent location as soon as possible.

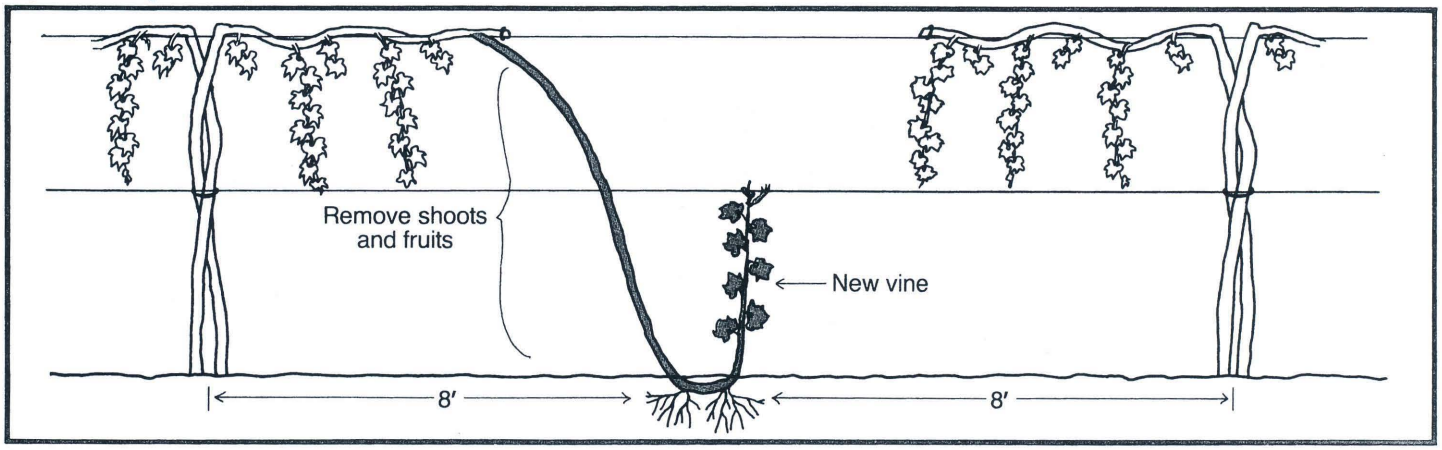
In Michigan, it is best to plant dormant grapevines in the early spring. Plant vines as early in the spring as soil can be worked, so that vines are established before the hot, dry summer weather arrives. If planting in the fall, vines must be mounded with earth to protect against frost heaving and winter damage.

Before planting, the young vines may be trained to one cane containing two buds. Some growers prefer to remove the young canes after planting so that dead buds can be identified before training. Both methods will reduce shoot number, but will increase shoot length or height in the first season.

Plant young vines in a deep furrow (10-12 inches deep) large enough to spread out the root system. Remove any broken or dead roots before planting. Spread the roots well, cover with a few inches of soil and tamp firmly. Adjust the plant so that the lowest node is at or just above the soil level. Plant grafted vines so that the graft union is 2-3 inches above the soil level.

To replace vines in an old vineyard, dig a large hole (3 feet in diameter and 2-3 feet deep) to relieve compaction and encourage a deep healthy root system. A surface

Figure 2. Grapevine layer.



application of manure as a surface mulch will help the newly planted vine become established. Vines grafted on a vigorous rootstock will often fare better as replacements and are recommended if layerage is not possible.

Establishing the lay-out plan

On sites with slight or moderate slopes, vineyards are laid out in straight rows to make training and management easier. If the land has a moderately steep slope, lay out the rows to follow the drainage grade or contour. This contour will help prevent soil erosion and make management practices easier on steeply sloping sites. Consult with a Soil Conservation Service technician in your area about such decisions.

Spacing of rows depends on the training and trellising system as well as the equipment to be used. A 9 foot spacing is generally used although a 10′-12′ spacing may be necessary for large equipment. For small home plantings, an 8′ row spacing may be most satisfactory. Spacing of vines within the row is variety dependent. An 8 foot spacing is effective for most varieties, although less vigorous varieties, such as Delaware or Catawba, may be planted closer together.

When planning a new vineyard, first decide if rows will be straight or follow the contour. For a contour planting, lay out rows at the time the contours are established. For straight rows, first establish a base line along one edge of the field to serve as the first row of grapes. Place a stake at each end of the line by measuring the desired distance away from the edge of the field. Other stakes may be placed on the base line to mark it. Establish additional rows parallel to the base line row at the desired row width.

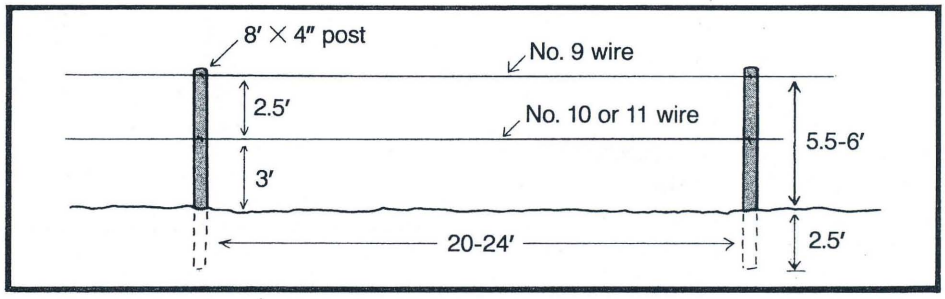
Constructing the Trellis

The trellis is a major long-term vineyard investment. It must be built to carry the heavy vines and fruit. A correctly constructed trellis will minimize sagging cordons, crooked trunks, and excessive vine damage. It is best to construct the trellis during the first growing season or before growth begins the following spring.

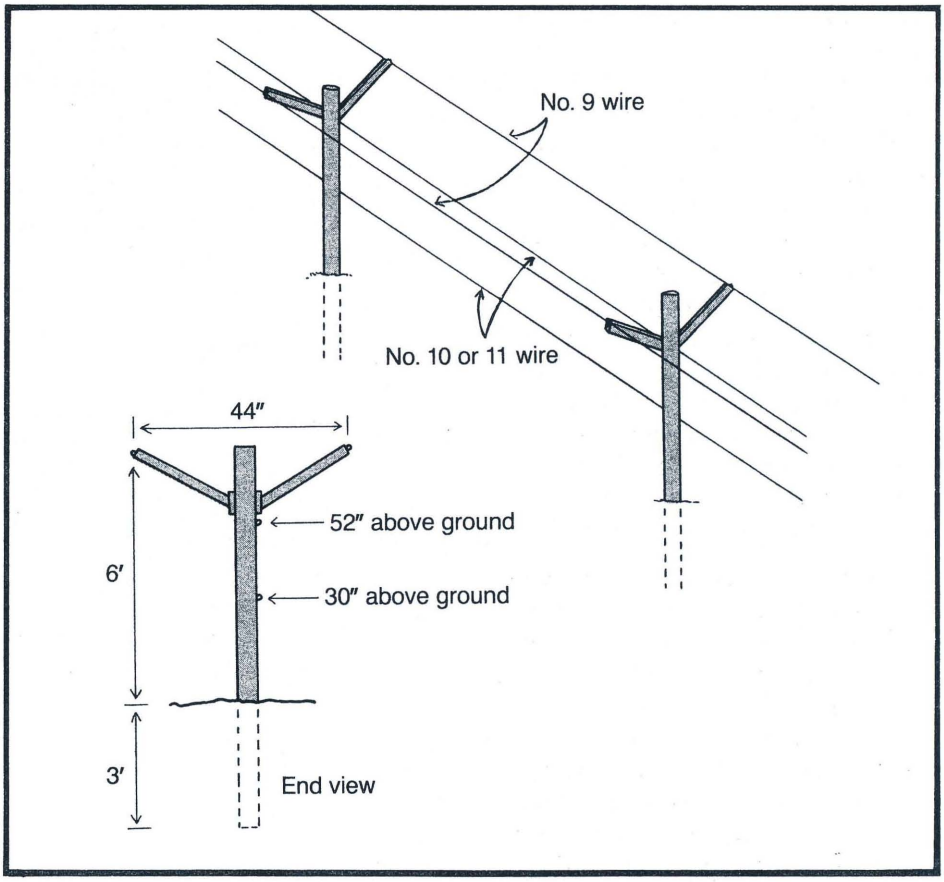
Most grape trellises are made of two or three wires, placed one above the other, and pulled tightly between posts (Figure 3-A). Although two wires are more common, some growers prefer three. Three trellis wires add strength to the trellis and make it less susceptible to wind damage. The Geneva Double Curtain trellis (Figure 3-B) is commonly used for more vigorous varieties.

There are two types of posts in a trellis system; end posts at the ends of rows and line posts spaced along the rows. End posts should be a

Figure 3. Common trellis structures used in Michigan vineyards.
A. Standard 2-wire trellis.



B. Geneva double curtain trellis.



minimum of 5 inches in diameter and 9 feet or longer in length. Well-cured cedar posts are used by many growers. Locust and white pine treated with creosote or penta-chlorophenol, or railroad ties 8½ to 9½ feet long, will also suffice.

Line posts should be 8 to 9 feet long and at least 3 inches in diameter at the top. They should be set 24 to 30 inches deep and spaced 20 to 24 feet apart in the row. Vine spacing will determine the exact spacing of the line posts. For instance, it is common practice to set three vines between two posts. If the distance between each vine is 8 feet, then the posts will be spaced 24 feet apart. Steel posts can be used as intermediates and be more durable and easier to handle. If steel posts are used as intermediates, then every third or fourth post should be wood. Using all steel posts makes the system much more susceptible to bending when the vines are fully loaded.

Set end posts at least 3 feet or more in the ground at a slight angle so that the top leans away from the vine row. Because the end posts carry much of the vine and fruit weight, they must be strengthened by one of several methods. One method is to set an extra line post a few feet from the end post on the row side. A brace of wood 3x4 inches is placed between the two posts so that the upper end rests in a notch halfway or two-thirds up on the end post, and the lower end rests against the base of the extra line post (Figure 4). A modification of the braced post system is the H-system (Figure 5-A).

End posts can also be reinforced by a brace wire running from the top of the end post to an anchor on the side opposite the row (Figure 5-B). Common anchors, include: 1) screw-in anchors; 2) a metal plate welded to a steel shank; 3) a concrete deadman attached to a steel shank or heavy wire; or 4) a buried railroad tie and old gas or oil line pipe. Install the anchor at least 36 to 48 inches away from the base of the end post. Place it at a 45° angle away from the top of the end post in the plan of the row. Run a double wire brace from the top of the end post to the anchor. Twist the wires together to tighten the brace. Additional headlands are required when using a guy wire brace, and the brace may make it more difficult to turn around the equipment at the end of the row.

Three wire sizes may be used in trellises. Number 9 is the largest and is suggested for the top wire which

Figure 4. Reinforcing end posts.

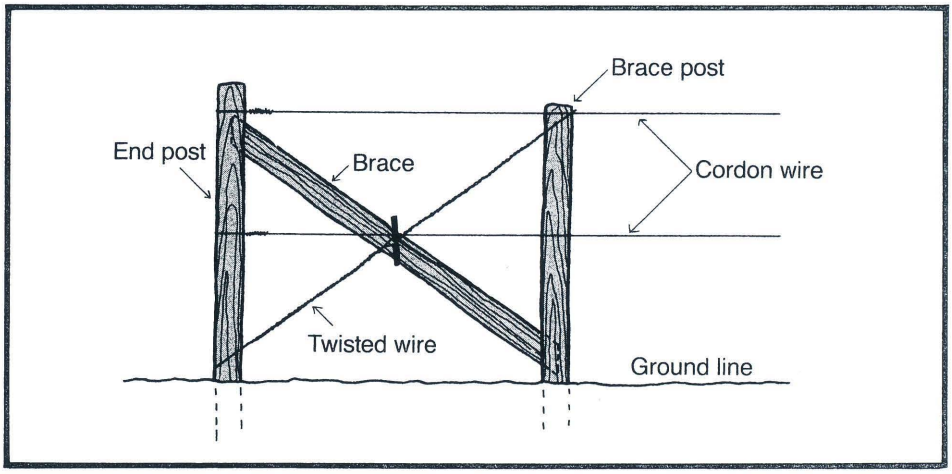
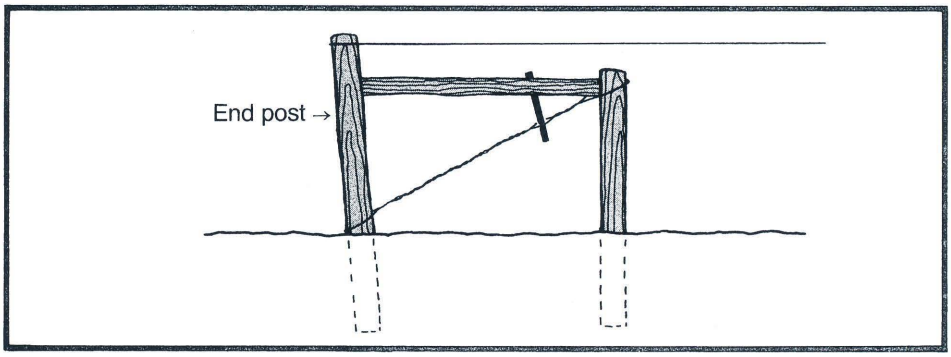
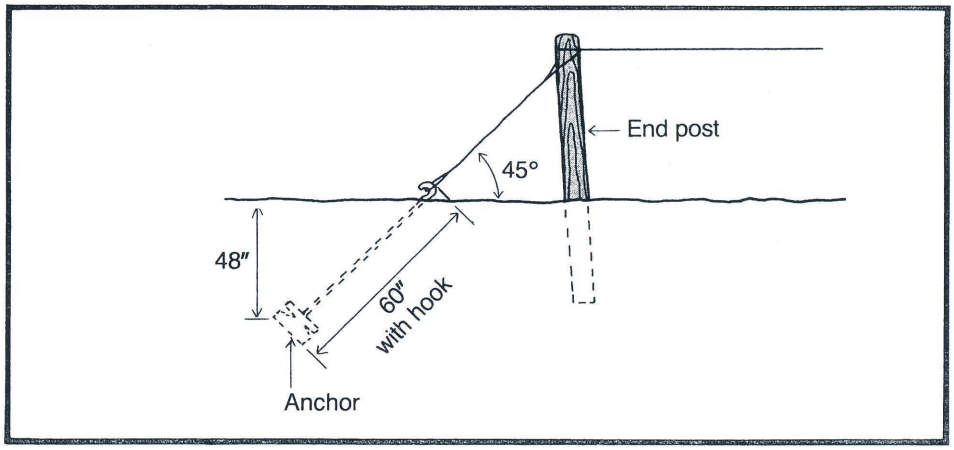


Figure 5. Common methods used to anchor vineyard row end-posts.
A. H-system.



B. Screw-auger anchor.



Unit Weight Per Length of Wire	
Wire Gauge	**ft/lb**
9	17.95
10	22.33
11	27.34
12	34.29
11 crimped	29.30

supports much of the crop. Number 10 or 11 wire is adequate for the lower wires. Galvanized wire is more durable and may prove to be the least costly over time. It is especially desirable for the lower wires because it reduces chafing injury of the young vines.

Large quantities of wire are generally sold by weight. The amount of wire needed per acre can be determined by using the following table along with row spacings and the unit weight of a wire size.

Fasten the wires to the end post by winding them around the post once or twice, and twist the end several times around the wire as it is stretched to the next post. Devices such as a crank or a cinch may simplify tightening by eliminating the removal of wires from end posts when tightening.

Use staples to hold the wire close to the line posts, but allow enough space so that the wire may be tightened. Run the top wire 5½ to 6 feet above the ground and the lower wire 2½-3 feet above the ground. If a third wire is used, place it about halfway between the upper and lower wires. Loosen the wires somewhat in the fall to provide slack so contraction during cold periods will not strain and damage the trellis. Tighten trellis wires in the spring after the vines have been pruned, but before the canes are tied to the wires.

Figure 6. Planted vine cut back to 2 nodes and subsequent first year of growth.

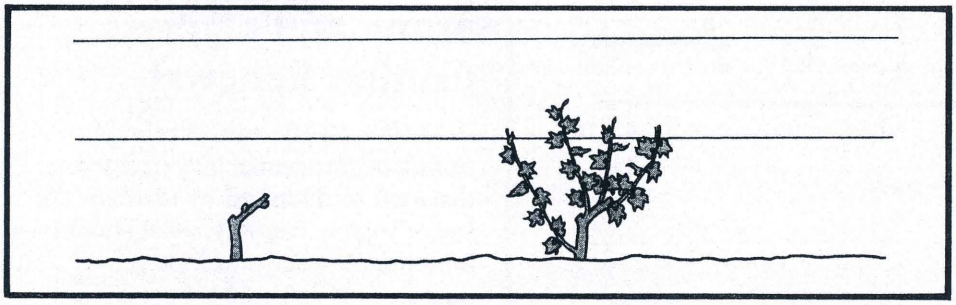


Figure 7. Pruned vine prior to second growing season and subsequent second year of growth.

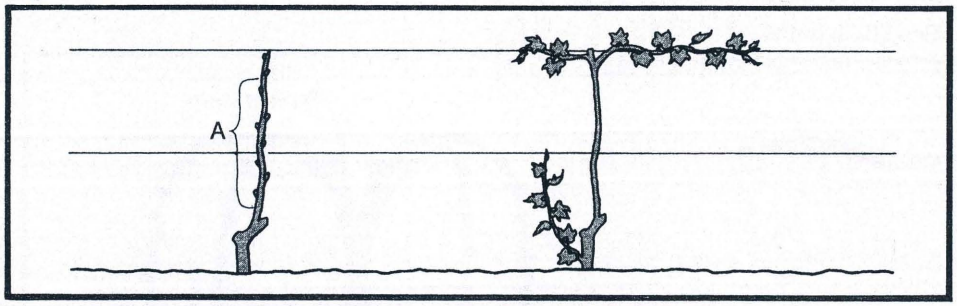
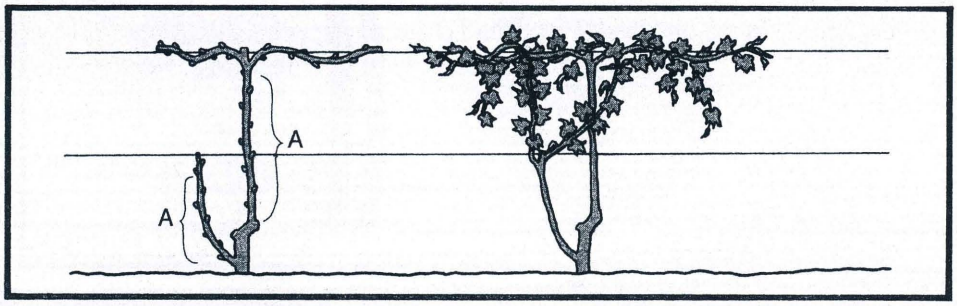


Figure 8. Pruned vine prior to third growing season and subsequent third year of growth.



Training Your Grapevines

The objective of training young grapevines is to fill the trellis as quickly as possible. This is done by limiting the number of shoots and removing all fruit until the trellis system is filled. This process will produce a large, healthy root system and two straight trunks. Prune new vines as described previously. Figure 6 shows the growth expected during the first growing season from a young vine that was transplanted and cut back to two buds. *It is crucial to remove all fruit during each of the training years.* This should be done by removing flower clusters at or prior to bloom.

Prior to the second growing season, prune away all but the most vigorous and healthy cane (Figure 7). This cane will be the first trunk. Remove all buds from the area labeled A and cut the top of the cane off leaving two healthy buds at the top. Allow a sucker to grow from the base of the vine during the growing season. This will become the second trunk.

Prior to the third growing season, tip canes on the older trunk and remove all buds from the area labeled A on the second trunk, keeping two buds at the top (Figure 8). The growth during the 3rd season should fill the trellis. Vines should be balanced pruned each year during the dormant season once the trellis is filled. (See Pruning Grapevines In Michigan, Extension Bulletin

E-1935). Figure 9 shows a typical vine trained to Hudson River umbrella that has been balanced pruned after the first year of production.

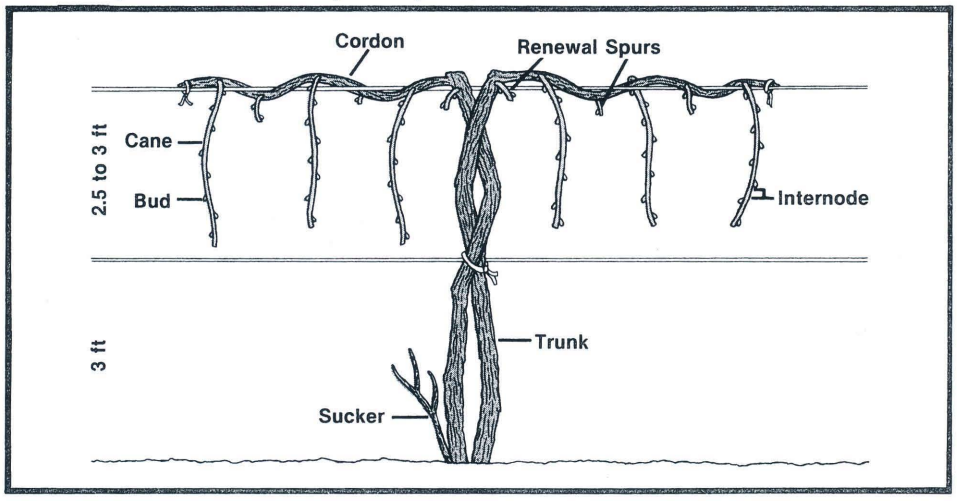
Grapevine Training Systems

The purpose of the training period is to establish the training system and fill the trellis so that leaves can efficiently trap light through photosynthesis. This maximizes fruit production and quality, and vine vigor and hardiness.

The choice of a training system depends on vine size or vigor and growth habit (see Pruning Grapevines in Michigan). Concord, the most common variety in Michigan, has large, green leaves and a willowy growth habit. Historically, Concord has been grown to either 4-arm Kniffin (4-AK) (Figure 10-A) or umbrella Kniffen (UK) (Figure 10-B). More recently there has been a shift to Hudson River umbrella (HRU) (Figure 9) and to a lesser extent Geneva double curtain (GDC) (Figure 11). Choice of training systems is less important for vines which have two pounds or less of annual cane prunings (small vine size). However, GDC should be avoided for small vines because they will not fill the trellis. Vine sizes between two and three pounds of cane prunings are best trained to HRU and those above three pounds are best trained to GDC.

Choosing a training system for varieties other than 'Concord' is more difficult. Many of the hybrid direct producers, like their *vinifera* parents, possess an upright growth habit, smaller leaves and closer internodes. Research is underway to identify the appropriate training systems for these cultivars.

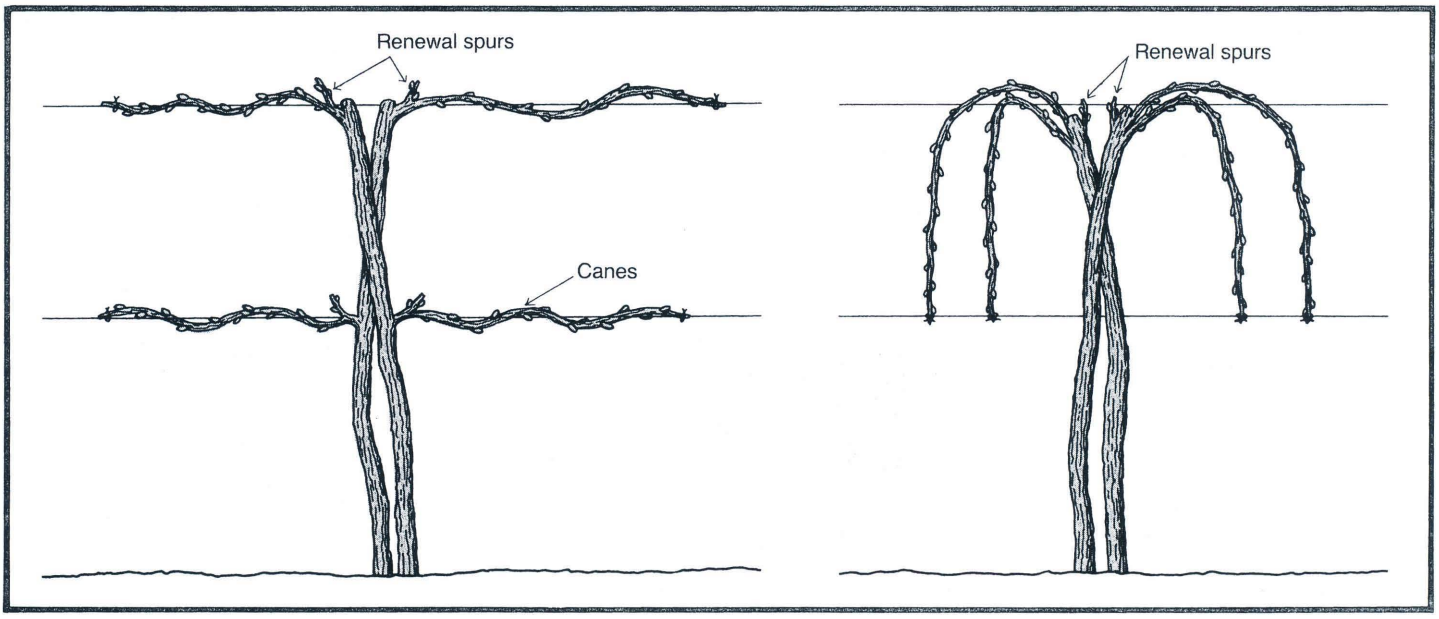
Figure 9. Mature vine balance pruned to a Hudson River umbrella system after the first year of production.



Trunk and Cordon Renewal

After 10-15 years of growth, trunks of grapevines may become diseased or damaged by machines or freeze injury. Trunk renewal should be initiated when trunks are damaged or diseased, or are 15-20 years old. This is done by training a

Figure 10. 4-Arm Kniffen (A) and Umbrella Kniffen (B) systems.



sucker to the trellis alongside the trunk to be replaced. After about two years, the old trunk is removed and the sucker fills the space.

Time trunk removal to minimize infection by *Eutypa* dieback, or apply a protective paint-fungicide mixture to prevent infection. *Eutypa* is most contagious during wet periods (rain, or melting snow).

Cordon renewal is an important step. A cordon is the older grape wood that is attached to a wire in a horizontal fashion (Figure 9) and bears the grape canes. Renewal becomes necessary when canes are not produced close to the cordon or if blank areas appear along the cordon. Cordon renewal may also be necessary to prevent the spread of a *Eutypa* dieback infection.

Cordon renewal involves the training of a vigorous cane, arising at or near the top wire where two trunks meet and cross on the wire. Canes along the cordon are removed to reduce shading within the canopy. When the new cordon fills the area, remove the old cordon.

Cover Crops

Using cover crops is recommended in vineyards. Cover crops add organic matter to the soil and prevent soil erosion by controlling run-off. Competition from cover crops slows vine growth in the fall, allowing more time for wood to mature and harden off for winter. Such crops will also use the nitrogen in the soil after the vine has stopped growing. This prevents leaching loss during the winter. Cover crops may also catch and hold snow which insulates the ground and prevents deep soil freezing. The fall growth of cover crops removes excess soil water and improves soil aeration.

In vigorous, fertile vineyards, the competition from cover crops may be beneficial in reducing vine growth. However, competition from cover crops is detrimental if vigor is low. This is particularly true on shallow soils or during dry years. These variations become important when determining the type of cover crop to be used. The expected growth and duration of the cover crop is of greater importance than the type of cover crop. Conditions of the vineyard to be considered when choosing a cover crop include vine size and vigor, soil fertility, drainage, moisture, and possible frost injury.

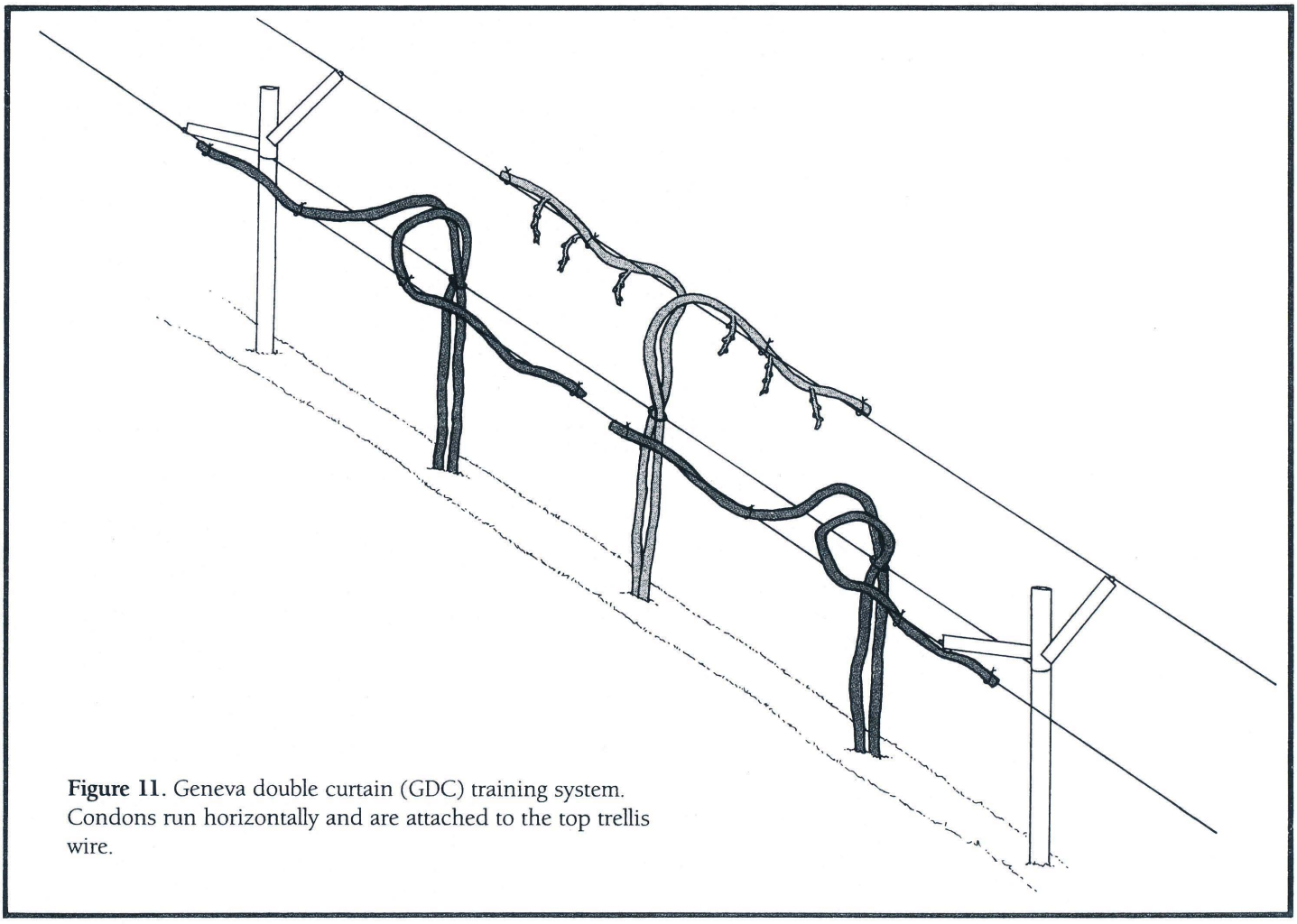


Figure 11. Geneva double curtain (GDC) training system. Condons run horizontally and are attached to the top trellis wire.

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