Growing Grapes in Indiana

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Grapes are the most widely grown commercial fruit crop in the world, and also one of the most popular fruit crops for home production. Though grapes are adapted to a wide range of climates, the best production occurs in regions that meet certain specific climatic conditions. Successful production of grapes in Indiana depends on matching adapted cultivars (cultivated varieties) with good sites and following good cultural practices. Indiana's climate is suitable for production of high-quality juice, wine, and table grapes and there are many cultivars with adequate winter hardiness to survive in all regions of the state. However, cold winters and hot, humid summers can make grape growing a challenge.

The Grape Plant

The grape is a woody perennial vine that can live for many years with proper care. Grape flowers and fruit are borne only on new shoots that arise from dormant buds formed on the previous season's growth. As a shoot matures and drops its leaves, it is known as a "cane". It is from canes that the next year's fruiting wood is selected at pruning time.

Grape buds are classified as compound buds because they contain a primary bud and one to four separate, smaller buds. When growth starts in the spring, the primary, or central bud breaks dormancy and produces the fruiting shoot. Low mid-winter temperatures may cause death of primary buds, and spring frosts may occasionally kill the tender primary shoots during early stages of growth. If this happens one of the smaller buds usually develops into a shoot. These shoots are usually less vigorous and produce fewer, smaller fruit clusters. However, as these shoots grow, new compound buds are formed which will provide potential for a full crop the following season.

Flower clusters develop on shoots at nodes opposite a leaf. At nodes where fruit clusters are not formed, a tendril will develop. The number of clusters that develop per shoot is a genetically controlled characteristic of the cultivar that is not influenced much by the environment. The number of berries per cluster, however, is greatly influenced by the health and vigor of the vine, the environment during bloom, and other factors. Proper care of vines is necessary to meet full fruiting potential.

Site Selection

Climate

The major limiting factors to grape production in Indiana are cold temperature injury from winter cold and spring frosts, and diseases brought on by hot, humid weather and frequent rainfall during the growing season. Selection of a site with a desirable climate helps reduce the occurrence of these problems. The best sites for grapes are those with full sun exposure, mild winter temperatures, freedom from frost, and good soil drainage. Cultivar selection is also important in determining the suitability of a given site. Cultivars differ significantly in their ability to withstand cold and disease, so some are better suited for production in certain parts of the state than others.

Two important considerations in site selection are minimum winter temperatures and freedom from frost. Mid-winter minimum temperatures range from 0 to -5°F along the Ohio River Valley to -15 to -20°F in the northwest and north central regions. (See Figure 1.) Cultivar selection is often dictated by the minimum temperature expected for an area. Very hardy cultivars are capable of withstanding -15°F with little injury, while tender cultivars will suffer significant injury at temperatures slightly below zero. (See Table 1.) It is important to note that preconditioning of the vine, its state of acclimation, and the rate and amount of temperature change can dramatically affect the amount of cold injury sustained.

Freedom from frost events is another important characteristic of vineyard sites. Frost-free sites are usually areas with gentle slopes which are elevated above surrounding areas. Cold air drains from elevated sites to lower areas, which reduces the risks of damaging frost at the elevated sites. Elevated sites also have better air drainage throughout the growing season, which promotes rapid drying of foliage following dew or rain. Rapid drying of foliage greatly reduces disease incidence.

Length of the growing season is another important factor for grape production. It is determined by the dates of first and last frosts of the year. Length of the growing season (frost-free days) ranges from 190-200 days in the south

to 150-160 in the north. (See Figure 2.) In general, a frost-free period of at least 150 days is essential (even for early ripening cultivars), and 180 days or more is preferred. The length of the growing season is often extended within a region in urban areas and on sites near large bodies of water. There may be fewer problems with production of late ripening cultivars in these situations.

Soils

Grapes are adapted to a wide range of soil types, but perform best when they have healthy, well-developed root systems. Soil conditions favorable to root growth include good aeration, loose texture, moderate fertility, and good internal and surface drainage. Proper soil drainage cannot be over- emphasized as a necessity for successful grape growing. Soils that are consistently wet during the growing season due to an impervious subsoil, high water table, or other drainage problem should be avoided. Root growth in poorly drained soils is usually limited to the top 2 feet or less, whereas in deep, well-drained soils roots may penetrate 6 feet or more. When root growth is restricted because of poor drainage, plant growth and fruit yields are generally low and vine survival is limited to a few years.

Cultivar Selection

Selection of the proper cultivar is a major step toward successful grape production. There are dozens of cultivars available, and the choice of which to grow can be a difficult decision. Cultivar selection should be based on the relative cold hardiness, disease resistance, and the intended use of the fruit. (See Table 1.).

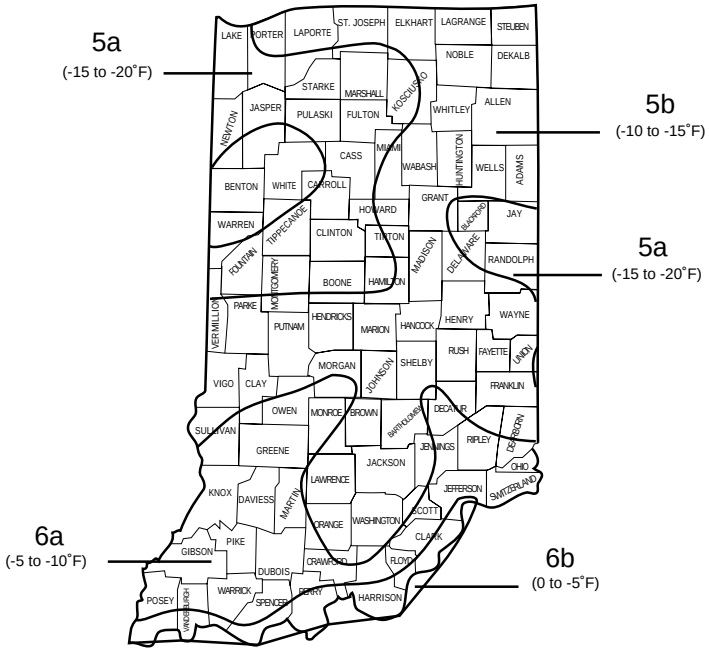

Figure 1. USDA Plant Hardiness zone map for Indiana. Average annual minimum temperatures.

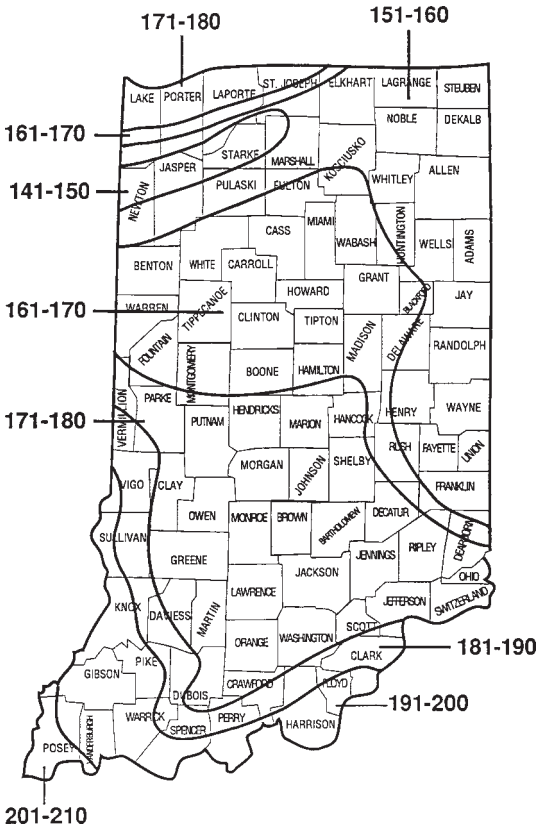

Figure 2. Average length of frost-free season in days.

Grape cultivars fall into one of three groups: American, French-American hybrids, and European. Within each group are types suited for juice, wine, or fresh consumption. American and French-American hybrid cultivars are suitable for production in Indiana. The European types generally lack the necessary cold hardiness to be successfully grown in Indiana except on the very best sites. Table 1 lists the best adapted cultivars for Indiana, their relative cold hardiness, and disease susceptibility. For home production it is best to select cultivars with adequate cold hardiness and at least moderate resistance to the common diseases black rot, powdery mildew and downy mildew. For commercial production market demand may be the most important factor.

Vineyard Establishment

Site Preparation

Thorough preparation of the planting site is essential to minimize weed problems and to increase the organic matter content of the soil. This should be done a year prior to planting. Problem weeds should be controlled with herbicides prior to soil preparation. Green manure crops such as rye add organic matter and help reduce weed problems.

Table 1. Grape cultivars for Indiana.

Cultivar	Color[1]	Principle Use[2]	Approx. Season	Cold Hardiness[3]	Relative Disease Susceptibility[4] BR[5]	DM	PM	Bot	CG
American									
Concord	B	J-W-T	Late	1	++	+	++	+	+
Catawba	R	J-W	Late	1	+++	+++	++	+	+
Delaware	R	J-W-T	Midseason	2	++	+++	++	+	+
Niagara	W	J-W-T	Late Midseason	2	+++	+++	++	+	++
Steuben	B	J-W-T	Late	1	++	+	+	+	+
St. Pepin	W	J-W	Midseason	1	+	++	++	+	+
French-American Hybrids									
Cayuga White	W	W	Midseason	3	+	++	+	+	++
Chambourcin (JS 26-205)	B	W	Late	4	+++	+	+++	+	++
Chancellor (Seibel 7053)	B	W	Early Midseason	2	+	+++	+++	+	+++
DeChaunac (Seibel 9549)	B	W	Midseason	2	+	++	++	+	++
Leon Millot (Kuhlman 194-2)	B	W	Early	1	+++	++	+++	++	+
Marechal Foch (Kuhlman 188-2)	B	W	Early	1	++	+	++	+	+
Seyval Blanc (S.V. 5-276)	W	W	Early Midseason	3	++	++	+++	+++	++
Vidal Blanc (Vidal 256)	W	W	Late Midseason	4	+	++	+++	+	++
Vignoles (Ravat 51)	W	W	Midseason	2	+	++	+++	+++	++
European									
Cabernet Franc	B	W	Late	4	+++	+++	+++	+	+++
Cabernet Sauvignon	B	W	Late	5	+++	+++	+++	+	+++
Chardonnay	W	W	Midseason	4	++	+++	+++	+++	+++
White Riesling	W	W	Late	4	+++	+++	+++	+++	+++
Seedless Table									
Canadice	R	J-T	Very Early	4	+++	++	+	++	++
Himrod	W	J-T	Very Early	4	++	+	++	+	+
Mars	B	J-T	Early	1	+	+	+	+	+
Reliance	R	J-T	Early Midseason	1	+++	++	+	++	+
Vanessa	R	T	Midseason	3	+++	++	++	+	+

[1] Fruit color: W = White; B = Black or Blue; R = Red.

[2] Cold hardiness rating: 1 = Very hardy; 2 = Hardy, 3 = Moderately hardy; 4 = Tender; 5 = Very tender.

[3] T = Table or dessert quality; W = Wine; J = Juice.

[4] Disease susceptibility is rated as follows: + = slightly susceptible, ++ = moderately susceptible, +++ = highly susceptible.

[5] BR = Black rot; DM = Downy Mildew; PM = Powdery Mildew; Bot = Botrytis Fruit Rot; CG = Crown Gall.

Soil testing will provide information on fertility and liming needs for the first-year vineyard. If the soil pH is below 5.5, apply agricultural limestone to raise the pH to a more desirable level (5.5-6.5). Lime applications should be made the year before planting, and the limestone should be incorporated deeply into the soil. Other nutrients, especially potassium, should be applied during site preparation if the soil test show a deficiency.

Avoid poorly drained soils for grape production. If the soil has only fair internal drainage and drainage tile is not installed, it may be advantageous to sub-soil (chisel plow) to a depth of 24 inches and establish a ridge upon which the vines will be planted by mounding the soil from the edges of the row to the middle. The ridge should be 8 to 12 inches high and about 2 feet wide. This will provide improved surface and internal drainage and allow deeper rooting of the vines. It also prevents ponding of water at the base of vines which can lead to disease problems.

Vineyard Layout

Grapevines are generally planted in straight rows running in a North-South direction for maximum sunlight interception. However, sites on sloping land may require contour

planting or straight rows across the slope regardless of compass direction. In some areas it may be advantageous to orient rows parallel to the prevailing wind to aid in disease control. Row spacing depends on the training system and the equipment to be used in the vineyard. Nine to ten feet between rows is commonly used, but may need to be increased to 11 or 12 feet to accommodate larger equipment or on sites with steep slopes. Row spacings less than 9 feet may be adequate for small home plantings but is not practical for commercial plantings. Spacing between vines within the rows is usually 8 feet, but may be closer for cultivars with low vigor. At maturity the vines should completely fill the trellis space without competing with each other for sunlight.

Planting

Grapevines should be planted in early spring after the date of the last hard freeze has past. Vines are usually purchased as dormant bare-root plants and should be stored in a cool, moist place, preferably cold storage, until planted. Soak the roots in water for 24 hours prior to planting to prevent the root system from drying out during the handling and planting process. Prune off broken and damaged roots and shorten excessively long roots for convenience when planting.

The planting hole should be large enough to accommodate the root system with ease. Excessive pruning of the root system is not advised; however, it is better to prune a few roots rather than stuff the roots into a small planting hole. Spread the roots, cover with soil, and tamp well. If soil moisture is low, water the plants in after planting and as needed until the plants have developed a root system large enough to support themselves during dry periods. Own-rooted plants should be set to a depth where the lowest shoot of the dormant plant is just above the soil level. For grafted vines, the graft union should be at least 2 to 3 inches above the soil level to prevent scion rooting.

Vine Training

It is important to properly train vines during the first few years of growth to establish a vine form that will be easy to manage. After planting, but before growth begins, the top of the dormant plant should be pruned back to a single cane with two to five buds. After growth starts all but the best two to four shoots should be removed. One or more of these shoots will become the trunks. Support should be provided for new shoots to keep them off the ground. This will greatly reduce disease problems and provide full sun exposure for maximum growth. The trellis should be established soon after planting to provide this support. String can be tied from a side shoot of the vine to the wires and the new shoots wrapped around the string. Never tie around the main trunk of the plant, because the trunk will expand during the first growing season and can be girdled by the string. A stake can be driven next to each plant and the shoots tied to the stake instead of using string, especially if the trellis is not established in the first year. Figure 3 illustrates the proper pruning and training of vines from planting through the fourth and subsequent years.

Trellising

Grapevines require some kind of support for ease of management. This can vary from a simple wire trellis to an elaborate arbor. Vine support serves two purposes: 1, to hold the vine up where it can be managed and cared for efficiently, and 2, to expose a greater portion of the foliage to full sunlight, which promotes the production of highly fruitful buds. Trellis design features such as number and placement of wires is dictated by the type of training system used. All training systems require a strong trellis assembly to support the weight of fruit and vines.

Training Systems

Grapevines are trained onto the trellis in a variety of ways. The most efficient methods provide well spaced, even distribution of fruiting wood along the trellis and promote full sun exposure for clusters and basal nodes. Common training methods are described in Figures 4 through 7. The best cane pruning system is the Umbrella Kniffin system. (See Figure 4.) Popular spur pruning systems are Bilateral Cordon and Geneva Double Curtain. (See Figures 5 and 6.) Cold tender vines, such as European (*Vitis vinifera*) cultivars can be successfully cultured in Indiana if some provision is made for protecting the vines from cold temperatures. One of the simplest methods is to train the vines so that the renewal zone is close to the ground. (See Figure 7.) The graft union and renewal zone must be covered with soil, straw or other protective mulch through the winter to protect the vines from winter injury. Two to four fruiting canes can also be selected and buried to provide fruiting production the following season.

Weed Control

It is important to provide good weed control during the first year or two of vineyard establishment. Young grapevines do not compete well with grasses and other weeds, and weed growth can lead to increased disease problems. Plastic and biodegradable mulches, as well as organic mulches such as grass clippings or composted leaves, can also be used to control weed growth. Mechanical weed control such as shallow cultivation is also an option. For larger plantings the use of herbicides may be necessary. Consult ID-169, *Commercial Small Fruit and Grape Spray Guide*, for information on suitable herbicides.

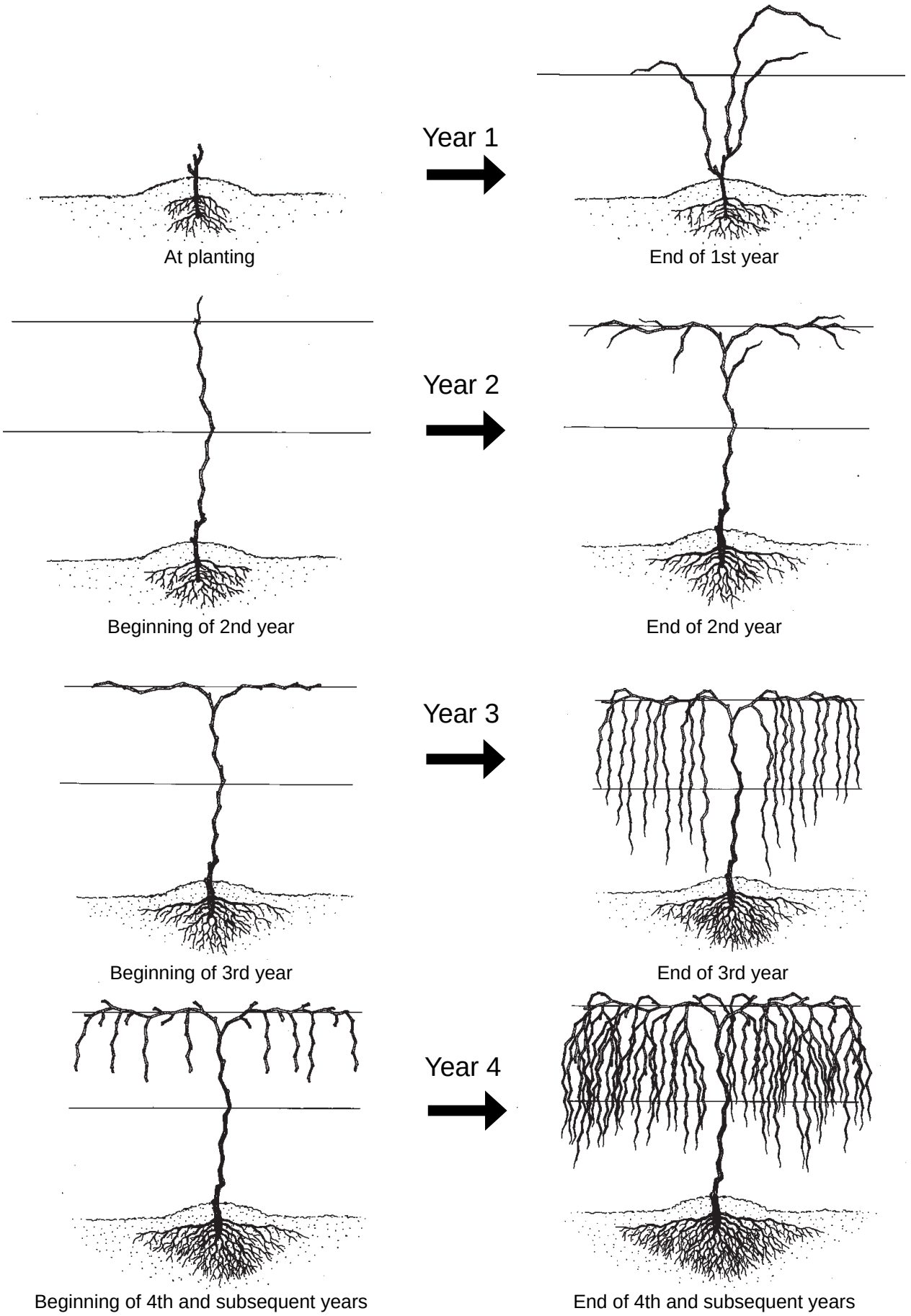

Figure 3. Pruning and training a grapevine from planting through the fourth and subsequent years.

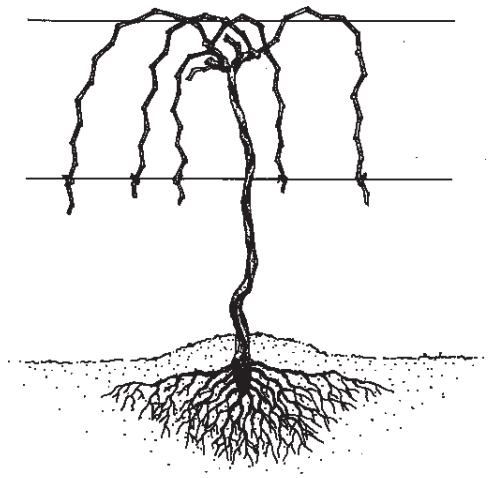

Figure 4. Umbrella kniffin training system.

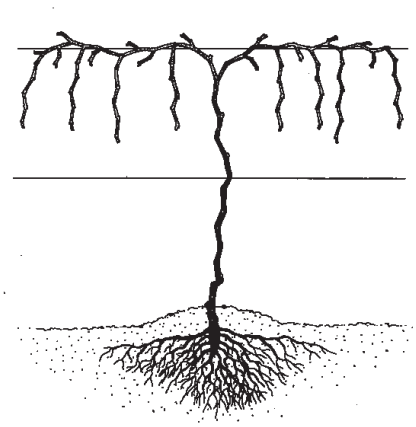

Figure 5. Bi-lateral cordon training system.

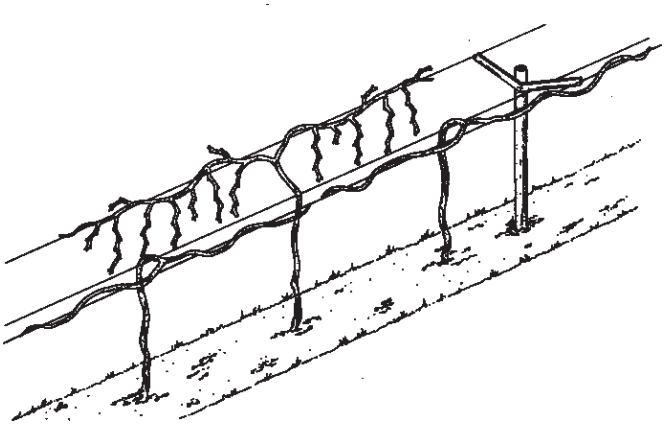

Figure 6. Geneva double curtain training system.

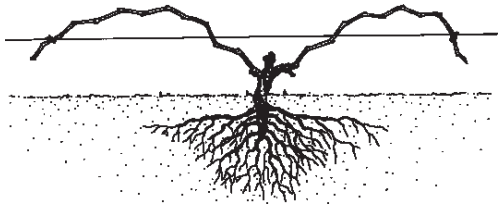

Figure 7. Training system for cold-tender cultivars.

Vineyard Management

Pruning

Pruning is the most important cultural practice in the management of grapevines. It is done to select fruiting wood, maintain vine shape and form, and regulate the number of buds retained per vine. Grapevines require annual pruning to remain productive and manageable. Pruning can be done anytime during the dormant season; however, it is best to delay pruning until late winter or early spring because pruned vines are more susceptible to cold injury than unpruned vines. In addition, delayed pruning allows for adjustments in bud number in the event of winter injury. It is important to assess bud survival before final pruning, especially on cold tender cultivars.

There are two basic types of pruning: cane pruning and spur pruning. These differ only in the length of the fruiting wood that is retained and the method of training used to effectively display the fruiting wood. Balanced pruning is used regardless of the type of pruning and training system.

Balanced Pruning

An average mature grapevine will have 200 to 300 buds capable of producing fruit. If all buds were retained the result would be a large crop that would not ripen properly, reduced vine vigor, and poor cane maturation. To avoid this situation researchers have developed a method of pruning to balance the fruit productivity and vegetative growth which will give maximum yields without reducing vine vigor or wood maturity. This procedure is called “balanced pruning”. The number of buds retained is balanced to match the vigor of the vine. The term used to describe vine vigor is “vine size”, which is determined as the weight of one-year-old cane prunings.

To balance prune a grapevine, estimate the vine size, then prune the vine, leaving enough extra buds to provide a margin of error, usually 70 to 100 buds total. Next, weigh the one-year-old cane prunings with a small spring scale. Then use the pruning formula to determine the number of buds to retain per vine (See Table 2). For 'Concord' vines the pruning formula is 30+10. This means that a vine that produces three pounds of cane prunings would require 30 buds for the first pound of prunings plus ten buds for each additional pound for a total of 50 buds. After determining the appropriate number of buds to retain, prune the extra buds off, taking care to space the fruiting buds evenly along the trellis.

Pruning formulas have been developed for many cultivars based on their productivity. Some cultivars, especially French hybrids, are highly fruitful. Balanced pruning alone will not adequately balance the crop load and vegetative growth. On these cultivars cluster thinning and shoot removal may be required. Cluster thinning is the removal of all but one cluster per shoot. The basal cluster is usually the largest and should be retained. Shoot removal involves removing shoots that occur from secondary buds on count nodes and basal buds from wood older than one year. Neither of these bud types are very fruitful.

Pest Control

Diseases

Disease control is necessary to maintain healthy leaves and protect the fruit from rots. Most diseases of grapes are caused by fungi which thrive in hot, humid conditions. The most common diseases are Black rot, Downy mildew, and Powdery mildew. Many factors affect the amount of disease that can occur, such as site selection, vine vigor and canopy density, cultivar susceptibility and other factors. Most cultivars are susceptible to some or all of the major diseases of grapes. A few cultivars are only slightly susceptible to the major disease and can be produced with little or no pesticide use. Normally, however, some pesticide use is necessary to produce good quality fruit. Refer to Table 1 for specifics on cultivar susceptibility. Responsible pesticide use requires a knowledge of pest identity and biology. Growers should scout their planting carefully and seek help in identifying problems. Most fungicides registered for use on grapes are effective against only certain diseases. Correct identification of disease problems is necessary for effective and responsible disease control. Contact your county office of the Purdue University Cooperative Extension Service, and ask for ID-169, *Commercial Small Fruit and Grape Spray Guide* or ID-146, *Controlling Pests in Home Fruit Plantings* for specific recommendations on disease and insect control.

Insects

There are relatively few insect pests of grapes. One of the most common is the Japanese Beetle. The adult insects emerge each year in June and July and feed on grape foliage. The damage can be severe if uncontrolled, especially on young or weak plants. Another important insect pest is the Grape Flea Beetle. These beetles emerge early in the spring and feed on developing grape buds. If left uncontrolled these pests can completely destroy all primary buds and cause considerable loss of fruit production. Other insect pests include the grape berry moth, grape phylloxera, grape root borer and European red mites. Insecticides should only be used if an insect infestation is present and the amount of damage is severe enough to warrant the cost of chemical control.

Herbicide Injury

Injury from 2,4-D herbicide is frequently confused with disease or insect injury. Most cultivated grapes are highly susceptible to injury by this herbicide and related compounds. These herbicides are used in a variety of forms on many different crops and non-crop situations. Because of their extreme volatility, many 2,4-D compounds can injure vines at great distances from the point of application. The use of these compounds in field crop production, especially reduced tillage situations, may limit the production of grapes in certain areas. You should inform your neighbors of your intentions to grow grapes and diplomatically request that they avoid using 2,4-D or related compounds, or that they use only the low-volatile formulations and make applications with equipment designed to reduce drift. Timing of application can also have an impact. Grapes are most sensitive to injury during the early part of their growing season when the shoots and leaves are expanding rapidly. Later in the season, when the growth rate has slowed, vines are less sensitive. Wind direction and speed during 2,4-D application can also greatly effect the amount of drift and subsequent injury to grapevines and other sensitive plants.

Symptoms of 2,4-D symptoms are easily distinguished. The youngest terminal growth at the time of exposure will be stunted, misshapen and have thick veins that tend to run parallel to each other rather than branching as in normal leaves. Growth will be stunted for several weeks following injury. Severely injured vines may die or not recover for two or more years.

Table 2. Suggested pruning formulas for various grape cultivars on single curtain training systems.

Grape Cultivar	No. buds for 1st pound of prunings	No buds for each additional pound	Maximum No. buds
Concord	30	10	60-70
Catawba	25	10	40-50
Delaware	25	10	40-50
Niagara	25	10	60-70
Steuben	30	10	60-70
French-American Hybrids: **All require removal of non-count shoots and some require additional cluster thinning.**			
Small-clustered cultivars			
Foch	20	10	50-60
Leon Millot	20	10	50-60
Baco Noir	20	10	50-60
Vignoles	15	15	60-70
Medium-clustered cultivars			
Vidal	15	5	30-40
Chelois	10	10	30-40
Large-clustered cultivars which usually require cluster thinning to one cluster per shoot.			
Chambourcin	15	15	30-40
Chancellor	20	10	30-40
DeChaunac	20	5	30-40
Seyval	20	10	30-40
Villard blanc	20	10	30-40
European (*Vinifera*) cultivars: **All require pre-bloom cluster thinning and/or shoot girdling to increase cluster size.**			
	20	20	40
Seedless table grape cultivars: **All require pre-bloom cluster thinning and/or shoot girdling to increase cluster size.**			
Canadice	30	10	50
Himrod	30	10	50
Mars	30	10	60-70
Reliance	30	10	50
Vanessa	30	10	50

Illustrations by M. L. Hayden.

For more information on the subject discussed in this publication, consult your local office of the Purdue University Cooperative Extension Service.