

Canopy Management

The vine enters the new growing season trained to a particular system and pruned to a certain number of buds. Growth begins, and to a large extent, the grower now must live with the consequences of his training and pruning decisions. However, by applying the techniques of suckering, cluster thinning, shoot positioning, leaf removal, and hedging or skirting, the grower still can exert some influence over the vine's canopy, its sun exposure, shadiness, and balance between crop load and vegetative growth.

Vine canopy is the shoot system, which includes the stem, the leaves, and fruit clusters. In the viticulture world, canopy is described by its length, height, width, leaf area, number of leaf layers, and shoot density. Shoot density refers to the number of shoots per foot of row or foot of canopy. **Table 28** describes the characteristics of an ideal canopy (Dami, *et al.*, 2005).

Table 28. Characteristics of an ideal grapevine canopy*

Canopy Characteristic	Optimum Values
Shoot density	4 to 6 shoots per foot of canopy
Number of leaf layers	1 to 1.5
Number of nodes per shoot	12 to 15
Canopy gaps	40% to 50%
Cluster exposure	50% to 75%
Ratio of leaf area to fruit weight (sq inches per oz.)	44 to 53
Ratio of leaf area to fruit weight (cm ² per gram)	8 to 12
Vine size (pruning weight in lbs per ft of canopy)	0.3 to 0.4
Ratio of fruit produced (lbs) for each pound of prunings removed.	5 to 12

*From: Dami, *et al.*, 2005. **Midwest Grape Production Guide**. Ohio State University Extension Bul. 919.

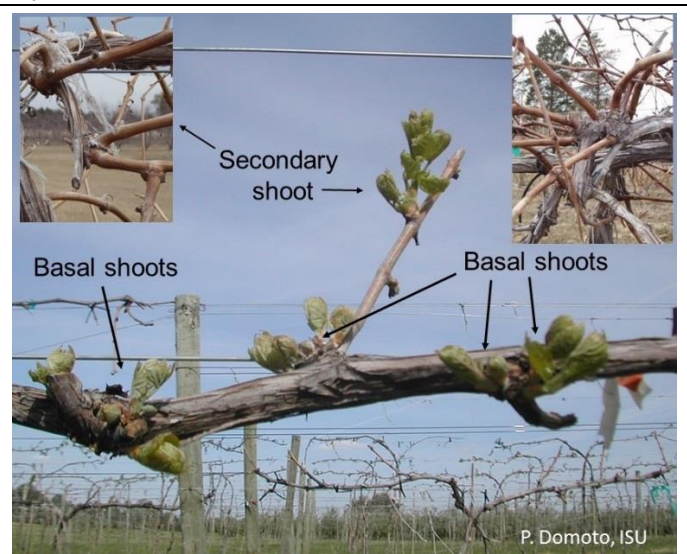
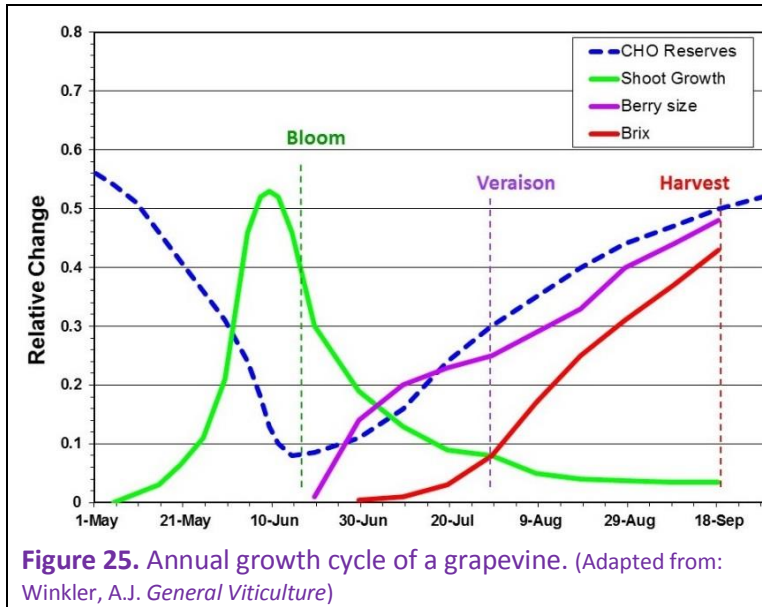
Annual Growth Cycle of a Grapevine

Annual growth cycle of a grapevine begins in the spring with bud swell and bud burst. Emerging shoots grow rapidly to just prior to bloom and then slow down during the remainder of the growing season as berries development and maturation proceed (**Figure 25**). During the early phase of shoot growth, reserve carbohydrates (CHO) stored in the roots serve as the major source of energy and proceed to decline. Following bloom, photosynthesis begins to supply sufficient CHO to promote additional shoot growth, berry development, and begins to build back up the CHO reserves in the roots. In a well-balanced grapevine, Shoots should stop growing at or near veraison when the berries begin to accumulate sugars and mature. If shoot growth continues following veraison, the grapevine is overly vigorous and additional cultural practices will need to be conducted to improve the canopy characteristics.

Canopy management practices.

There are five major canopy management practices that growers should follow throughout the growing season. Dry summers require fewer canopy management practices, wet summers require more. Some grape cultivars require all five steps; others require fewer; and certain cultivars and training systems require a repeat of some of the five steps. The Midwest Grape Production Guide (Dami, *et al.*, 2005) outlines the five canopy management steps in the order they should be addressed throughout the season.

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1. **Shoot Thinning (Suckering):** This is the removal of unwanted, adventitious shoots on the trunk, cordon, and canes/spurs.
 - **Suckers** are adventitious shoots arising near or from below the ground. These shoots are very vigorous and consume a lot of CHO reserves if not removed. It is best to snapped them off rather than cutting them off with pruning shears, which leaves basal buds that produce more suckers. Some herbicides are effective in controlling suckers when applied at the proper stage of sucker development (*See the section on **Weed Control and Vineyard Floor Management***). On grapevines produced from cuttings, suckers can be retained for trunk replacements or for a second trunk if desired, and should be trained upward. However, sucker control agents should not be used or the suckers need to be protected to avoid contact. On grafted vines, any shoots retained to replace a trunk must originate above the graft union.
 - **Water sprouts** are adventitious, non-count shoots growing on a trunk or cordon. On the cordon they are often referred to as basal shoots (**Figure 26**). On the trunk, they can be easily rubbed off when they are 1-3 inches long. If adventitious shoots on the cordon are not removed excessive shading in the canopy will occur, and on French and Northern hybrids that are productive on these shoots, over production will occur. They should be removed early in the season when they are visible and easy to identify. A basal shoot can be retained to fill a blind section along a cordon.
 - **Multiple shoot emergence from a node** can occur on some vigorous cultivars such as St. Croix, or when there has been some winter bud injury (**Figure 26**). These shoots will increase shading and lead to over production in cultivars that are productive on secondary shoots. It is best to thin the nodes to single shoots when the number of blossom clusters can be determined.
 - Any **Unfruitful shoots** on cordons should also be removed unless needed for spur renewal as they'll divert growth from growing canes. This is particularly important when adjustments in bud retention were made to compensate for primary bud injury.

Proper shoot thinning should result in shoots spaced evenly along the cordon length with a density of 4 to 6 shoots/per foot of cordon or canopy. With 8-foot vine spacing, this corresponds to 32 to 48 shoots per vine on a single curtain/high wire cordon (HWC) system, and 64 to 96 shoots per vine on a Geneva double curtain (GDC) training system. It may be necessary to thin shoots more than once, particularly if the procedure was started early in the season.

2. **Shoot Positioning:** Shoot positioning attempts to spread out the vine's growing shoots as much as possible across the available trellis, and not allowing shoots to cross over others or grow along trellis from one vine to the next. A

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good canopy should have be 1 to 1.5 leaf layers thick with 20-40% of its vertical surface area perforated by “gaps.” Shoot positioning is effective in approaching this goal and thereby enhances color development, fruit maturation, and fruit bud initiation for next season’s crop. It also improves air circulation to aid in disease prevention and improve spray penetration.

- **Combing:** This is the generic term for positioning shoots in a vertical downward position (**Figure 27**). Combing is conducted on high trellis systems such as HWC and GDC. While it’s important to reduce shading when fruit bud development starts as sunlight exposure is critical for bud fruitfulness, it’s best to wait until the shoots are firmly attached to reduce the amount of shoot breakage and make positioning easier. This is after bloom and may be mid-late June or early July in some locations. Shoot breakage is a cultivar characteristic, so start combing on cultivars least prone to breakage and finish it the cultivars that are most prone to breakage such as La Crescent. In single curtain training systems, one pass through the vineyard is usually sufficient. For GDC trained vines, at least two passes are required to make sure that no shoots are crossing over from one curtain to the other.
- **Tucking:** This is the generic term for positioning shoots upward and is used on vertical shoot positioning (VSP) training systems (**Figure 28**). Shoots are held upright by using two or three pairs of permanent or moveable catch wires, spaced 10 to 12 inches apart. Some cultivars, particularly those with few tendrils, may require extra tying with tape in order to keep the shoots upright and “tucked” in the catch wires. Shoots are tucked as they develop and may require up to three passes before bloom, and must be continued until the shoots extend over the top set of catch wires.



Figure 27. Combing high-wire cordon grapevine, before (A) and after (B).



Figure 28. Tucking shoots on grapevines trained to a mid-wire cordon with VSP.

3. **Cluster thinning:** While it’s tempting to avoid cluster-thinning altogether for quick vineyard production, it is crucial to the well-being and life span of the vineyard to thin clusters in the first year of production and possibly in future years as well. Factors that determine the need for cluster thinning include the number of shoots retained per vine or linear foot of cordon or canopy, number of clusters produced per shoot, and cluster size. Pruning, serves to minimize the need for cluster thinning, but some additional cluster thinning is sometimes needed. Some French and Northern hybrid cultivars will produce 3 or more clusters per shoot, and there is a need to do some cluster thinning to avoid over cropping. Cluster thinning is most beneficial with large-clustered cultivars such as Brianna, Edelweiss and Seyval that need to be thinned to a single cluster per shoot.

Cluster thinning can be performed either before bloom or after fruit set.

- **Pre-bloom thinning:** This consists of the removal of flower clusters and may be done at the same time as shoot thinning. The clusters are easy to see at this time and thinning can be quickly performed. The advantages

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of removing clusters this early is that berry set is improved (more berries per cluster as a result of less competition with fewer clusters) and the berries will be larger at harvest. There is also an increased yield, increased fruit flavors and sugars, and improved vine size and hardiness associated with pre-bloom cluster thinning. The disadvantage to pre-bloom thinning is that clusters tend to be tighter (as a result of the increased fruit set and larger berries), so bunch rot is a potential problem. For table-type cultivars, pre-bloom cluster thinning is preferred.

- **Post fruit set thinning:** This practice is more common and recommended for cultivars susceptible to bunch rot. Also, adjustments based on berry set can be made. This method is more time consuming because it is more difficult to see the fruit in a more developed canopy.
- **Green drop thinning:** Some cultivars will produce small, tendril-like clusters distal to the main clusters and are often referred to as “nubbins”. Other cultivars, such as Leon Millot will set clusters on the lateral shoots. In either case, these clusters lag well behind the primary clusters in their maturity. An optional practice is thin out these lagging clusters at veraison when they are easy to identify and thereby increase the uniformity of maturity.

Regardless of any cultivar characteristics, minimum cluster thinning should follow these guidelines based on post-bloom shoot length:

- Shoots less than 12 inches long, remove all the clusters.
- Shoots 12- to 24-inches long, leave one cluster per shoot.
- Shoots more than 24-inches long, leave two clusters per shoot.

Special Cases: In most vineyards, there are always some vines that fall behind in growth and production, looking several years behind the development of the other vines. These undersized vines should be heavily or completely cluster thinned. This allows the vines to recover by diverting carbohydrates to trunks and roots. This procedure should also be used with vines that have not filled their allotted trellis space.

4. **Lateral (axillary) shoot removal:** Some vigorous and very vigorous cultivars are prone to producing lateral (axillary) shoots along the primary shoots, particularly on fertile soils (**Figure 29**). These lateral shoots cause a lot of shading in both high trellis and VSP training systems. Removing these lateral shoots in the fruiting zone effectively opens up the canopy to improve air movement, spray penetration and sunlight exposure of fruit and buds near the base of the shoots. This results in better color for red wine cultivars, lower juice potassium and slower rise of the juice pH. Lateral shoot removal can be done along with pre-bloom shoot thinning, or during the post-bloom period when shoot positioning is being done.



Figure 29. Young lateral shoot (A), and lateral canes that were not removed during the growing season (B).

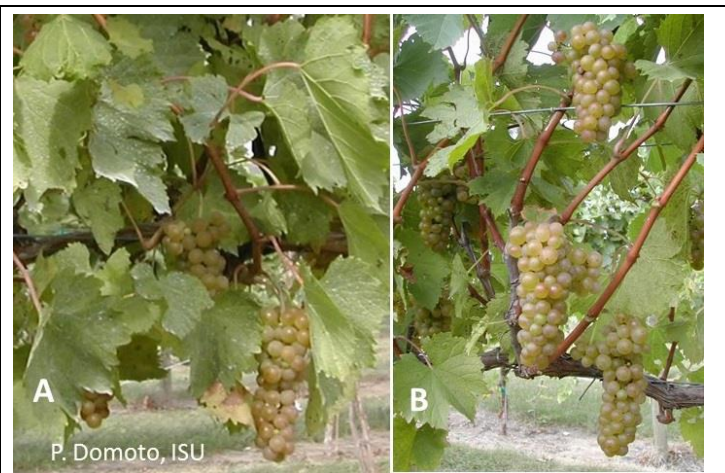


Figure 30. Before (A) and after (B) removing leaves near clusters.

5. **Leaf removal:** Leaf removal is another practice that is sometimes performed to improve the canopy environment (**Figure 30**). Leaf removal (pulling) is done on the shade side of the canopy, which is either the east side of a

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north-south row or the north side of an east-west row. One to three leaves are removed at the base of each shoot and around clusters. Leaf pulling is either minimally done or completely avoided (depending on the canopy thickness) on the sun side of a canopy in order to avoid sun burning of fruit. There is the risk that leaf pulling can result in increased bird damage because of the exposed berries. Leaf pulling is first performed after fruit set but before veraison. Avoid doing it during or after veraison as this may lead to sun burning the fruit.

6. **Hedging and Skirting:** This consists of cutting shoots that grow beyond the allocated space in a given trellis system in order to control shoot length. It is called hedging for upward shoot training, such as on a VSP system and skirting for downward shoot trained, a high-wire trellis systems.
- **Hedging:** Overly vigorous vines tend to outgrow their trellis system with shoot growing up and over the top catch wires, and then droop down over the sides of the vine (**Figure 31**). This shades the main portion of the vine canopy. Since a grapevine needs only 15 leaves per shoot to fully mature its crop, any leaves in excess of this number merely divert resources from the ripening fruit. Hedging a foot or so above the top wire or just beyond the 15th leaf and hedging the sides of the vines if needed, can create a better balance between vegetation and crop, and eliminate unnecessary shading.

Shoot hedging should be done after bloom when the shoots begin to droop over the catch wires, but before veraison, as this may result in delayed fruit maturity, and a reduction of wood maturity and winter hardiness. It may take one to three passes to complete the job. Local growers have found an ordinary hedge trimmer to be an adequate tool for grapevine hedging.

- **Skirting:** Many vines do not require skirting at all. However some vigorous cultivars will have shoot tips trailing on the ground which can interfere with traffic in row middles and results in an unkempt appearance. Many will cut the trailing shoot 12 inches from the ground. In general, a minimum of 15 leaves per shoot should be left after skirting in order to mature the fruit and wood, which is not a problem on high-wire trellis systems. Skirting is typically done when the vines are combed. Particularly when long shoots that were growing horizontally along the trellis are combed down. In a well-balanced grapevine, shoot growth should stop at veraison.



Figure 31. Shoots growing up and over the top catch wire of a VSP system (A), and a vine with shoots hedged above the top catch wire (B). Note the use of catch wire post extension to accommodate vine vigor (B).



Figure 32. View from inside the canopy of a Frontenac grapevine trained to a high-wire cordon system exhibiting good canopy gaps and cluster exposure to sunlight.

Canopy management practices of shoot positioning, lateral shoot removal, leaf removal, hedging are employed when needed to promote canopy gaps and cluster exposure to sunlight (**Figure 32**). Along with pruning, these practices and cluster thinning as needed, all function to maintain a balance between vegetative growth and fruiting and promote the production of quality fruit.

Vineyard Best Management Practices – Care of Established Vineyards

Rate your vineyard establishment practices:

Management Area: Canopy management practices	Best Practices	Minor Adjustments Needed	Concern Exists: Examine Practice	Needs Improvements: Prioritize Changes Here
Shoot thinning	Practiced early season when unwanted shoots could be easily removed.	Practiced later but before bloom when unwanted shoots were harder to remove.	Practiced after bloom when unwanted shoots were difficult to remove.	Shoot thinning was not practiced
Shoot positioning: Combing on high trellis training systems	Combed after the shoots became firmly attached, timing based on cultivar susceptibility to breakage.	Combed after the shoots became firmly attached, but cultivar susceptibility to breakage was not considered.	Combing was done before bloom.	Combing was not done.
Shoot positioning: Tucking on VSP training systems	Tucking was performed as needed, with repeated passes until shoot extended above catch wires.	Tucking was performed, but shoots often drooped over the previous catch wire when done.	Tucking was performed, but shoots would not stay upright between the catch wires.	Tucking was not performed.
Cluster thinning	Dormant pruning kept the need for cluster thinning to a minimum.	Cluster thinning was performed and required a moderate amount of time to perform.	Cluster thinning was performed and required extensive time to perform.	Cluster thinning was not performed even though the vines appeared to be over cropped.
Lateral shoot removal	Vines exhibited moderate vigor and minimum lateral shoot development occurred.	Lateral shoots were evident and removed in the fruiting zone of the vines.	Lateral shoot development was excessive and were removed in the fruiting zone of the vines.	Lateral shoots were evident, but not removed.
Leaf pulling	Vines exhibited moderate vigor with good exposure of the clusters to sunlight, not leaf pulling was required.	Lateral shoot removal was sufficient to allow good exposure of the clusters to sunlight.	Canopy was dense and leaf pulling was practiced.	Canopy was dense, but no leaf pulling was done
Hedging & skirting	Vines exhibited moderate vigor with shoots stopping growth at veraison. No hedging or skirting was required.	Vines were hedged or skirted once to contain them in their space.	Vines were vigorous and were hedged or skirted more than once to contain them in their space	Vines were vigorous, over-growing their space, but were not hedged or skirted.