

Pruning

Pruning is defined as the removal of plant parts to regulate crop size, improve crop quality, and achieve an optimal balance between vegetative (leaf and shoot) growth and fruit production. In grapevine management, the term usually refers to the removal of parts of or even entire canes during the late dormant season, and retaining only selected buds for that season's fruiting.

A vigorous grapevine will produce hundreds of buds during the growing season. If all these buds are allowed to remain on the vine into the next growing season, most of them will grow and bear at least two clusters of fruit. This large load of fruit will not ripen well and also be demanding on the vine, resulting in weak, stunted growth. Such vines will be more susceptible to winter injury and less productive the following season. With proper pruning, there will be enough vegetative growth to properly mature the crop, mature the buds and canes so that they can withstand the winter cold, and store carbohydrate and mineral nutrient reserves in the root system to get the vines off to a good start the next growing season. Annual pruning at this level will result in a moderate crop of mature fruit year after year. A typical crop for a mature vine is 5-25 pounds of fruit per year, depending on the cultivar, vigor, and health of the vine.

There is also the danger of pruning too much. When this occurs, the vines will produce excessive vegetative growth on the few remaining buds and result in a very small crop of very shaded fruit. These vigorous shoots will continue to grow late into the growing season and not harden off well. In addition, carbohydrates manufactured through photosynthesis will be utilized for vegetative growth with less reserves being stored in the trunk and root system. The objective of pruning is to strike a balance between vegetative growth and fruiting by regulating the number of buds retained on the vines.

Formulas for Balanced Pruning

To determine the potential fruit capacity of a grapevine at pruning time, growers can use the concept of *balanced pruning*. This concept was developed for Concord grapevines, but the principle is valid for all grapes and varies in magnitude from one cultivar to another (and to an extent from growing region to growing region) (Dami, *et al.*, 2005).

Balanced Pruning Procedure (From: Dami, *et al.*, 2005. **Midwest Grape Production Guide**. Ohio State Univ. Extension Bul. 919-05):

1. Estimate the amount (weight) of one year old wood (canes) on a vine; select the fruiting canes to be retained; and remove all other one-year-old wood (leaving a margin of error).
2. Weigh the one-year-old trimmings from the vine to determine *vine size*. Weight of the one-year old wood is highly correlated to the total leaf area the vine possessed the previous season and it's potential to mature a crop. After pruning and weighing a few vines, growers will be able to make more accurate weight estimates and only periodic weighing is necessary afterward. Wood older than a year (if removed) should not be counted in the pruning weight.
3. Apply the vine size value to the pruning formula to determine the total number of buds to leave.

For example, Concord does well with the 30 +10 formula (**Table 24**). This means 30 buds are left for the first pound of trimmings plus 10 buds for each additional pound of wood removed up to 4 pounds. So, if the trimmings weigh 1 pound, leave 30 buds; if 2 pounds, leave $30 + 10 = 40$ buds; if 2.5 pounds, leave $30 + 10 + 5 = 45$ buds; and so on up to 4 pounds. This 30 + 10 formula works well for other American-type table, juice and wine cultivars. For French-American and Northern hybrid cultivars, a 20 + 10 formula or a variation is often used.

For American-type cultivars that typically produce two clusters per shoot, and whose basal and adventitious buds are not fruitful, balanced pruning usually can be achieved by weighing the wood removed at pruning time and adjusting the

bud count accordingly.

Table 24. Balanced pruning formulas.*

Lbs of 1-yr-old canes removed	Number of buds retained on the vine for fruiting	
	30 + 10 Formula	20 + 10 Formula
Less than 1	Less than 30	Less than 20
1	30	20
2	40	30
3	50	40
4 or more	60	50

* For grapevines trained to a double curtain (GDC) or split curtain system (Smart-Dyson, Scott Henry) these formula are applied to each curtain.

French and Northern hybrid cultivars are less easily dealt with because: 1) they may carry more than two clusters per fruiting shoot; 2) basal buds are often fruitful; and 3) on some cultivars, even buds arising from the trunk or other old wood are fruitful. In these circumstances, balanced pruning as applied to American-type cultivars (30 +10 formula) may result in over cropping, especially on Chancellor, Seyval and de Chaunac.

Cluster size is another factor that needs to be considered in selecting a pruning formula, particularly if cluster thinning may be necessary. Some very large clustered cultivars will need to be cluster thinned regardless, but if pruning can be used to regulate the crop load, it saves an additional labor expense. **Table 25** shows suggested pruning formulas for cultivars typically grown in northern climates.

Table 25. Suggested pruning formulas for cultivars typically grown in the upper Midwest.¹

Cultivar	Cold Hardiness	Productivity on secondary buds	Pruning Formula (maximum buds)	Need for Cluster thinning (#/shoot)
Bluebell	Very hardy	No	30 + 10 (60)	No
Brianna	Very hardy	Yes	25 + 10 (55)	Maybe (2)
Concord	Hardy	No	30 + 10 (60)	No
Edelweiss	Hardy	No	30 + 10 (60)	Maybe (1)
Esprit	Hardy	Moderate	25 + 10 (55)	Yes (1)
Frontenac	Very hardy	Yes	20 + 10 (50)	No
Frontenac blanc	Very hardy	Yes	20 + 10 (50)	No
Frontenac gris	Very hardy	Yes	20 + 10 (50)	No
Geneva Red	Very hardy	Moderate	30 + 10 (60)	No
Kay Gray	Very hardy	No	30 + 10 (60)	No
Louise Swenson	Very hardy	No	30 + 10 (60)	No
La Crescent	Very hardy	Moderate	20 + 10 (50)	No
La Crosse	Hardy	Yes	30 + 10 (60)	No
Leon Millot	Hardy	Yes	30 + 10 (60)	No
Maréchal Foch	Hardy	Moderate	30 + 10 (60)	No
Marquette	Very hardy	Moderate	30 + 10 (60)	No
Petit Ami™	Very hardy	Moderate	20 + 10 (50)	Yes (2)
Mars	Hardy	Moderate	30 + 10 (60)	Yes (1) @ bloom
Petite Pearl	Very hardy	Moderate	20 + 10 (50)?	Maybe (2)
Prairie Star	Very hardy	Moderate	30 + 10 (60)	Maybe (2)
Sabrevois	Very hardy	Moderate	20 + 10 (50)	No
St. Pepin	Hardy	No	30 + 10 (60)	No
St. Croix	Very hardy	Moderate	20 + 10 (50)	No
Swenson Red	Hardy	No	25 + 10 (55)	Maybe (1)
Swenson White	Very hardy	No	25 + 10 (55)	Maybe (1)

Adapted from: Domoto 2014b.

When practicing balanced pruning, it is not necessary to weight the pruning from each vine. For each cultivar, select some vines that are representative of the variation of vine vigor found in the planting. Prune them and weigh the trimmings. This will allow you to develop you eye for estimating amount of trimmings on a vine and allow you to make vine-to-vine adjustment on the number of buds to retain. Formulas may need to be adjusted to adapt to individual

vineyard conditions. Therefore, it's a good practice to maintain annual records of pruning weights, fruit yield and average cluster weight on 8-10 sentinel vines for each cultivar. If there is a drop in average pruning weight for a cultivar, cut back on the number of buds retained for the first pound of trimmings. If there is a steady increase in pruning weight for a cultivar over a two year period, increase the number the buds retained for the first pound of trimmings (Dami, *et al.*, 2005). Managing the vineyard to annually produce from 2.5 to 3 pounds of trimmings would be a good objective.

Because French hybrid cultivars can be so fruitful, Cornell University introduced an alternative approach to balanced pruning that uses a combination of "shoot density" and "balanced thinning". Under this approach, vines are pruned to retain 4-6 buds per foot of row or cordon and thinning of flower clusters is used to achieve consistent yields. At a density of 4-6 shoots per foot, shading and air circulation within the canopy are not a problem with 4-5 shoots per foot being optimum. As with balanced pruning more buds are retained on more vigorous vines so weighing the trimmings of some sentinel vines is still a good practice.

Growers should be particularly attuned to vine vegetative growth after veraison (when berries begin to soften, change color and mature). Research has shown that cultivars need only 15 leaves on a shoot to ripen that shoot's fruit. Shoots that are longer than this only divert the vine's energy into superfluous leaf area. The results of this superfluous vegetative growth can be excessive potassium and high pH in the must, making winemaking more difficult. Therefore, if the grower notes that the shoots are still growing actively (forming new leaves beyond 15) after veraison, the vine is excessively vigorous. The following season, the pruning formula for the vine should be adjusted to increase the crop load and decrease vegetative growth. Quite simply, more buds should be left to fruit. In fact, when in doubt about how to achieve balanced pruning for a particular cultivar, a rough rule of thumb is that the ratio of crop weight to pruning weight (for the current growing season or pruning weigh recorded the following spring) should be about 5-12 (Ravaz index). That is, for every pound of trimmings, one should have left enough buds to produce about 5-12 pounds of fruit.

Most cultivars will perform well using either cane pruning (**Figure 23A**) or spur pruning (**Figure 23B**) and some training systems employ both types of pruning. Some cultivars have a tendency to push many secondary and tertiary buds from the canes and latent buds from cordons. Short spur (2 node) pruning seems to exacerbate this problem whereas cane (6 node) pruning seems to reduce this tendency (Dami, *et al.*, 2005).

Typically, fruiting canes are described in terms of their length and number of buds or nodes: long canes (8-15 nodes), short canes (4-7 nodes), and spurs (2-5 nodes). Fruiting cane length is a function of both grape cultivar and the training system used. For example, small clustered cultivars with unfruitful basal buds and a trailing growth habit (typical of many cultivars), require pruning to long canes to maintain production. In contrast, a cultivar like Seyval, with large clusters, fruitful basal buds, and strong upright growth is well suited to spur pruning.

Regardless of how the vine is to be pruned, either to long canes, short canes or spurs, the grower must be sure to leave an "extra" four to six "renewal" spurs of 1-2 buds each to serve the purpose of producing new fruiting wood. The shoots that grow out from these renewal spurs will become next year's fruiting canes. This is practiced to aid in controlling the length of arms arising from the head or cordon of the vines. Special care should be taken during pruning to select renewal spurs that are in a good position to grow shoots with good sun exposure and with proper orientation to the trellis for the desired training system. If time permits, the flowers or clusters should be removed from the renewal shoots, so that all of their energy will go into developing next year's wood. The number of buds left on these renewal spurs should be included in the pruning bud count when practicing balanced pruning or the New York buds per linear foot approach.

Cane or Spur Pruning?



Figure 23A. Pruning Mature Vines to Canes.



Figure 23B. Pruning Mature Vines to Spurs.

Selection of Wood for Canes

Grapevines produce fruit only from one-year-old wood, called a *cane*; so long or short canes should be retained during pruning. These canes are selected based on the following criteria (Dami, *et al.*, 2005).

1. Sun Exposure: The most fruitful buds on the vine will lie on canes that received the best exposure to the sun the previous season. These are usually those that lie near the top and outside of the vine canopy and should be retained. Those canes which do not have good sun exposure should be removed.
2. Color: Cane bark should be dark and uniformly reddish-brown in color.
3. Canes should be healthy and free of disease. Canes with obvious symptoms of disease from the previous season (powdery mildew, anthracnose, black rot) should be removed and burned.
4. Size: Canes should be at least 1/4 inch in diameter (pencil size) at about the fifth and sixth buds and nearly the same thickness at the 10th bud. Large diameter (> 1/2-inch) canes, referred to as “bull canes”, (very thick, extremely vigorous shoots) should be avoided and removed, as it will likely be less hardy and less able to bear fruit than canes of more moderate growth.
5. Canes should originate from arms near the main trunk (4-cane, 6-cane and Umbrella Kniffin systems), or near the cordon (bilateral high cordon, Geneva double curtain or Vertical Shoot Positioning systems).
6. Internode length (distance between buds or nodes) should be 5 to 8 inches for Concord-type cultivars (3 to 5 inches for most French and Northern hybrid cultivars).

Care of Established Vineyards

Finally, if burying vines, care should be taken to keep only spurs and canes that lie parallel to the trellis. This will facilitate laying the vine flat on the ground for winter snow protection. If spurs or canes protrude and hold the vine away from the ground, additional covering material is needed or holes must be dug to accommodate the protruding wood.

When to Prune

Grapevines can be pruned throughout the dormant season. However, fall-pruned vines are more prone to winter injury than those left un-pruned. Growers should wait until late winter or early spring to prune so that uninjured canes can be selected for fruiting. Some cultivars are much more prone to winter injury than others, so if time is limited, growers can prune their hardiest cultivars first and the least hardy cultivars last. This will slow bud break somewhat and reduce the danger of frost damage. It also allows you to judge the survival of the buds and canes so that you can prune accordingly. On tender cultivars, it is easiest to prune in the fall before laying down the vines. The terminal portion of each shoot will not mature and those buds will not survive the winter even if covered (Dami, *et al.*, 2005).

Live buds and canes are green when cut. Pruning cuts should be made about ½ inch beyond the last bud. When lateral shoots are cut off, ½ inch should be allowed to remain beyond the bud to allow for die back at these locations. Recent studies in Michigan have shown that even with tender cultivars needing winter protection, it is good practice to leave more buds on the canes than will be needed. These extra buds, located at the ends of the canes, are the most vigorous and when they begin to grow, suppress growth of buds further back on the cane. After danger of spring frost has passed, the canes can be pruned to their final length, and the remaining buds begin to grow later than they otherwise would have. This practice is often referred to as “double pruning”. However, if a grower does not go back to final prune, the arms can become rather long or “leggy” in a few dormant seasons.

Evaluating and Adjusting for Cold Injury*

Because the cane buds are the least hardy portion of grape vines, an important practice is to assess the buds for cold injury before you begin to prune. Even if the cultivar is considered to be very hardy, the buds should be checked because injury can occur at warmer temperatures in the fall while the buds are still hardening off or in late winter following a thaw. With this knowledge, you can adjust the number of buds/nodes retained to better assure a normal crop. Cold injury to grape buds is relatively easy to distinguish. Using a sharp razor or snap blade knife, make a series of cross-sectional cuts across the buds, cutting a little deeper with each slice until the primary bud is exposed. Live buds will appear bright green, while injured buds will appear brown or black in color (**Figure 24**).

When assessing cold injury, it is important to thoroughly sample the vineyard and handle the canes properly. A proper sample should consist of at least 100 nodes collected from each cultivar. A sample of 20 5-node canes collected over an area representative of the vineyard is usually sufficient. When samples are collected following a significant freezing event, they should be brought indoors and allowed to warm for 24 to 48 hours to make the injured buds easier to see. If samples are collected several weeks after a freeze, following a period of warmer temperatures, it is not necessary to warm the samples up, and the canes can even be examined in the field.

The sampled canes should be representative of the type of wood that will be left on the vines at pruning in terms of the node position on the canes. If you typically prune back to 5- or 6-node spurs, then you want to collect a sample that is representative of that type of wood. There can be considerable difference in the extent of cold injury from the base to the tip of a cane. So keep track of the position of the buds as you cut and record the damage so you will know what part of the cane has the most damage.

*(Domoto, 2014a. *Pruning Grape Vines: Evaluating and Adjusting for Cold Injury*. Iowa State University).

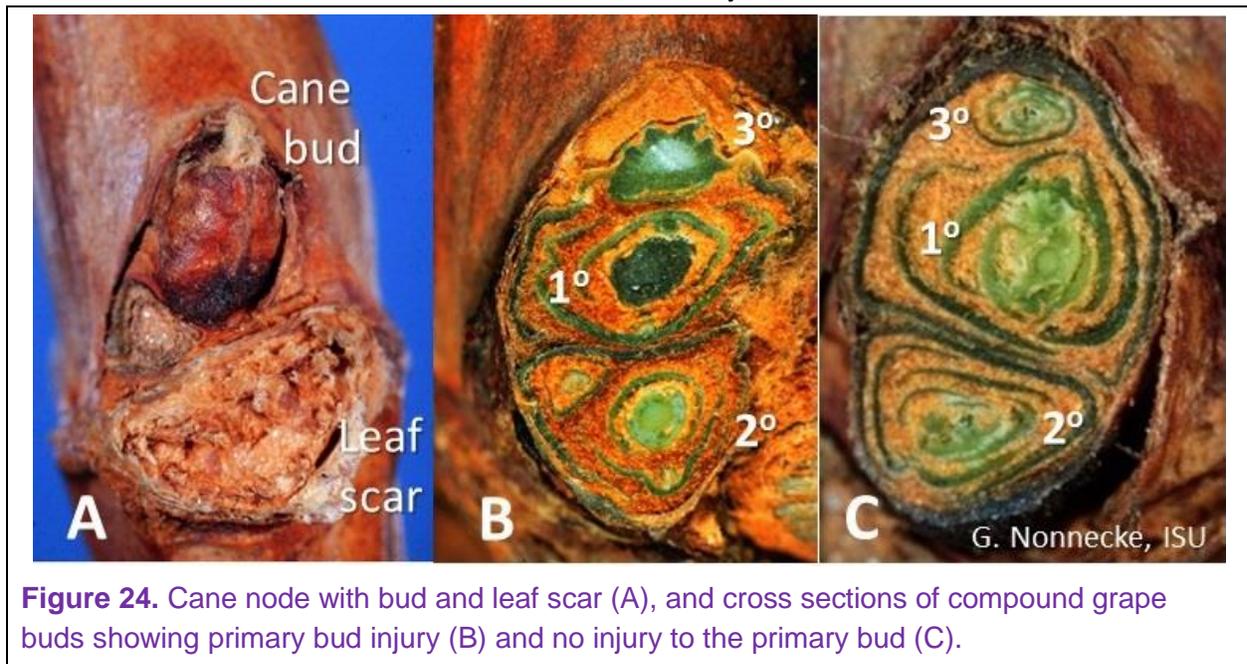


Figure 24. Cane node with bud and leaf scar (A), and cross sections of compound grape buds showing primary bud injury (B) and no injury to the primary bud (C).

Compensating for winter bud injury

For American Cultivars:

American cultivars and some Northern hybrids with strong *V. labrusca* characters are not very productive on secondary buds. By leaving more buds on the vines when winter injury to the primary buds has occurred, you can compensate for the loss of buds and minimize the potential crop reduction (**Table 26**).

Table 26. Compensating for winter primary bud injury on American cultivars in which secondary buds are not very fruitful.

% of Dead Primary Buds	Compensation ^z
Less than 15 %	Prune as normal.
15 to 50%	Adjust the pruning formula proportionally to the bud kill. <i>i.e.</i> If you experience a 30% bud kill, you will want to leave 30% more nodes than called for by the pruning formula for the cultivar. So if the pruning formula for the cultivar is 30+10 and the vine produce 2 lb of prunings, you would leave $40 + (.30 \times 40) = 40+12=52$ nodes. OR Pruning formula x (1 + % bud injury) $(30 \times 1.3) + (10 \times 1.3) = 39 + 13 = 52$ nodes. Extra nodes retained should make up for the percentage that were killed and should produce enough fruit to keep the vines in balance.
More than 50%	Do not prune , or only prune to eliminate the canes close to the ground or competing with an adjacent vine. Wait until bud break to prune these cultivars so that a more accurate assessment can be made.

^zFrom: Dami, et al., 2005. **Midwest Grape Production Guide**. Ohio State University Extension Bul. 919-05.

For French hybrid cultivars:

Many French and Northern hybrid cultivars have fruitful secondary buds. For these cultivars, the increase in number of nodes to retain may not be proportional to the percentage of damaged primary buds. There is not exact formula to determine the number of nodes to retain, but in most cases, an adjustment is necessary and depends on the cultivar's

Care of Established Vineyards

productivity from secondary buds and whether or not cluster thinning is normally practiced:

For cultivars that are not productive on secondary buds, follow the formula used for American cultivars.

For cultivars that are moderately productive on secondary buds and do not require cluster thinning, follow the Cornell model and compensate in proportion to the production loss associated with secondary buds. If the secondary buds are 60% as productive as the primary buds, then there would be a 40% reduction in potential yield and the calculated number of nodes to retain would be 40% of the calculated adjustment (**Table 27**).

Table 27. Compensating for winter primary bud injury on French and Northern hybrid cultivars having fruitful secondary buds.

% of Dead Primary Buds	Compensation ^z
Less than 20 %	Do not change normal pruning practice.
20 to 80%	<p>Increase the number of nodes retained to compensate for a 40% reduction in yield: <i>i.e.</i> If you experience a 50% bud kill, you would normally want to leave 50% more nodes than called for by the pruning formula for the cultivar. So if the pruning formula for the cultivar is 20+10 and the vine produce 2 lb of prunings, you would normally leave $30 + (.5 \times 30) = 30+15=45$ nodes. Since the potential crop reduction associated with fruiting on secondary buds is 40%, the number of buds to retain would then be $30 + .4 \times 15 = 30+6=36$ nodes.</p> <p>OR</p> <p>Pruning formula $\times (1 + (.4 \text{ yield reduction} \times \% \text{ bud injury}))$ $(20 \times 1 + (.4 \times .5)) + (10 \times 1 + (.4 \times .5)) = (20 \times 1.2) + (10 \times 1.2) = 24 + 12 = 36$ nodes. Extra nodes retained should make up for the percentage that were killed and should produce enough fruit to keep the vines in balance.</p>
More than 80%	Prune away only those nodes which will intrude into the space of adjacent vines or which will produce fruit so low that it hangs to the ground. Wait until bud break to prune these cultivars so that a more accurate assessment can be made.

^zAdapted from: Pool, R. 2000. Assessing and responding to winter cold injury of grapevine buds.

<http://www.fruit.cornell.edu/grape/pool/winterinjurybuds.html>

For cultivars that are productive on secondary buds and may or may not require cluster thinning, generally no adjustment to the number of nodes retained is needed unless the secondary buds are also injured. Then follow the procedure for French and Northern hybrids if the injury to secondary buds is greater than 33%.

For cultivars that are moderately productive on secondary buds and require cluster thinning, no adjustment in the number of nodes to retain is needed if the bud injury is less than 50% since crop load can be made up through adjustments in cluster thinning. If the bud injury is greater than 50%, use the formula for French-American hybrids and evaluate the need to cluster thin.

Vineyard Best Management Practices – Care of Established Vineyards

Rate your vineyard establishment practices:

Management Area: Pruning	Best Practices	Minor Adjustments Needed	Concern Exists: Examine Practice	Needs Improvements: Prioritize Changes Here
Assessing winter bud injury before pruning	Examined buds for injury & adjusted the number retained per vine based on the extent of injury.	Did not examine buds for injury. Left additional buds with intent to final prune after frost risk passes.	Did not examine buds for injury. Adjusted the number of buds retained based on vine vigor.	Did not examine the cane buds for injury. Pruned all vines to the same number of buds regardless of vigor.
Pruned and weighed the trimmings of some vines.	Pruned and weighed the trimmings of some vines to estimate range of buds to retain based on vigor & adjustment for bud injury.	Pruned and weighed the trimmings of some vines to estimate range of buds to retain based on vigor, but not for bud injury.	Did not prune and weigh trimmings. Left 4 to 6 buds per foot of cordon based on apparent vine vigor.	Did not prune and weigh trimmings. Pruned all vines to same number of buds regardless of vigor.
Annual records to determine if adjustments are needed.	Maintain records on sentinel vines for pruning weight, yield & average cluster weight.	Maintain records on sentinel vines for pruning weight.	Did not prune and weigh trimming. Left 4 to 6 buds per foot of cordon based on apparent vine vigor	Did not prune and weigh trimming. Pruned all vines to same number of buds regardless of vigor.