Dormant Spur and Cane Pruning
BUNCH GRAPEVINES

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Grapevine pruning is an important and labor-intensive vineyard management task. Grapevine buds contain compressed shoots that will grow and produce a crop in the forthcoming season. Retaining fruitful buds is the primary method of manipulating shoot density and cluster number for the following season. When pruning, it's important to cut away and discard 1-year-old wood and to select and retain specific buds for the following season. The result of ineffective or incomplete dormant pruning is excessive shoot density and a congested canopy that impairs airflow and light penetration, creating a greater susceptibility to fungal disease. Failing to prune out infected tissues will increase the incidence of woodborne diseases and limit vineyard productivity over time. In the short term, ineffective dormant pruning will compromise crop quantity and quality. In the long term, it will compromise vineyard health and sustainability. This publication contains a basic discussion of commercially important pruning strategies and considerations for bunch grapes in the Eastern U.S.

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When to prune

It is necessary to prune every year. Pruning should occur later in the dormant season and before budbreak (Figure 1). The dormant season typically spans from November through March or April in the Eastern U.S.

The decision of when to start pruning often depends on vineyard acreage and available labor. Vineyards with low labor-to-acreage ratios (few hands, many acres) may start pruning in December while vineyards with high labor-to-acreage ratios (many hands, few acres) may wait until March. However, pruning in the fall is less desirable than late winter/early spring due to the increased chance of cold injury (Reynolds and Wolf, 2008). If labor is limited and pruning must begin earlier, cultivars that have greater cold hardiness or more fruitful secondary buds (e.g., several hybrids) should be pruned before those that are less cold hardy and have less fruitful secondary buds (e.g., several *Vitis vinifera* cultivars). See Dami (2007) for a table of relative cold hardiness across grape genotypes. Postpone pruning until colder temperatures are less of a threat to allow for cold injury assessment and to adjust for bud number retention. Regardless of when pruning starts, the goal should be to finish before budbreak.

Figure 1. Dormant cane pruning should be conducted between the dormant winter bud (top) and budbreak (bottom) stages. Green arrows represent cane nodes and blue arrows represent dormant buds. *Photos courtesy of Rachael White.*

What to prune

In the first two years after planting, the goal of pruning is to establish the permanent vine structures (e.g., trunks, cordons) and to shape the vine to accommodate the intended training system (Figure 2). In young vineyards, the woody canes to be retained as trunks and other permanent portions of the grapevine should be roughly 3/8 of an inch in diameter. New grape growers commonly fail to prune off enough wood in the first two years after vine establishment. When wood is less than 3/8-inch in diameter, growers should prune vines aggressively so that retained buds will produce larger shoots to develop as trunks and cordons the following year. After permanent vine structures have been established, pruning is implemented on 1-year-old (if spur pruning) and 2-year-old (if cane pruning) tissues to maintain crop yield and canopy architecture (Figure 2).

Shoots are the vegetative green tissues produced from a grapevine bud. Grapevine shoots grow and mature

Figure 2. At left, a high-wire trained 'Crimson Cabernet' vineyard in the fall of the planting year in Georgia. At right, a commercially mature, low-wire trained 'Petit Verdot' vineyard in central Virginia. Dormant pruning will establish permanent vine structures in the left photo; dormant pruning will set shoot density and crop level in the right photo. *Left photo courtesy of Bob Gilbert.*

into canes (woody tissues) over the course of a growing season. When dormant pruning, the pruner should retain the desired grapevine buds from canes. Desirable canes are between 3 to 5 feet in length, have a 1/3- to 3/8-inch diameter (slightly larger than the diameter of a pencil), and have had ample sunlight exposure in previous seasons (resulting in a brown/cinnamon color). Canes of sizes out of this range are less desirable for retention at dormant pruning. Thin, dried, dead, and hollowed-out "straw canes" should not be retained. Larger canes (commonly called "bull canes") may contain buds that produce shoots with lower cluster numbers and cold tolerance. Canes that were vigorous growers in the previous season often have fewer buds per cane length and may make it difficult to retain the desired bud number in a cordon region.

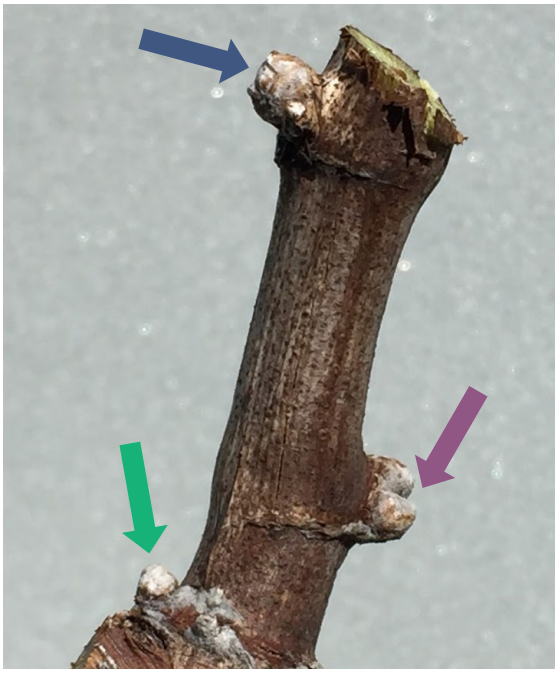

Figure 3. Noncount/basal bud (green arrow), count bud 1 (purple arrow), and count bud 2 (blue arrow) on a 1-year-old spur. The count buds are often fruitful; noncount buds are often not fruitful except in hybrid cultivars. The count buds are borne at cane nodes, the swollen sections of a cane that encompass the slimmer internode sections.

Nodes are the swollen, thick sections of shoots and canes (Figure 1). The internode is the slimmer section between nodes. Buds are located at the nodes and contain the compressed shoots which have not yet emerged (Figure 1). It is important to distinguish "count" vs. "noncount" buds when selecting buds to retain and in forecasting crop potential. Count and noncount buds can be distinguished by evaluating their position on the spur, which is the retained portion of a cane typically containing one to three buds (Figure 3). Buds are numbered in ascending order starting at the base of the cane/spur (e.g., noncount bud, count bud 1, count bud 2).

Bud fruitfulness differs amongst cultivars. Noncount, basal buds are not often fruitful on *Vitis vinifera* cultivars (e.g., 'Cabernet Sauvignon'), which means that the shoot that develops from a noncount bud is unlikely to bear clusters. Many hybrid cultivars (e.g., 'Seyval blanc') contain fruitful noncount buds, which means that the shoot developing from the noncount bud will often produce clusters. Bud fruitfulness may vary along the length of a dormant cane, depending on the cultivar. The few count buds at the basal end of a cane may be more fruitful than those more apically positioned on a cane and vice versa.

How much to retain

Because between-vine spacing is variable, determining how many buds to retain depends on the canopy length. The recommended shoot density is between three and five shoots per linear foot of canopy (Smart and Robinson, 1991; Figure 4). As count buds are anticipated to turn into fruitful shoots, the recommended count bud density to retain would parallel that target shoot density. To determine how many count buds should be retained per vine, multiply the desired shoot density per foot by the feet of canopy an individual vine should fill. For example, 25 count buds per vine should be retained at dormant pruning if five shoots per linear foot of canopy are desired on a

Figure 4. The vine pictured demonstrates the recommended shoot density of roughly four shoots per linear foot of canopy in a low, bilateral cordon-trained 'Merlot' vine with vertical shoot positioning. The vine was shoot-thinned roughly one week before the photo was taken.

vine trained to a single canopy system (e.g., low-bilateral cordon with vertical shoot positioning, or VSP). The recommended retained bud number per vine varies across popular training systems planted at different vine spacings (Table 1). Higher bud densities can be retained in systems that have single fruiting zones with canopies that are divided via shoot training (e.g., Watson and Ballerina). Such systems promote greater fruit zone space and limit cluster density relative to systems with confined canopies and fruit zones (e.g., the VSP system).

Table 1. Bud number retention per vine with various target bud densities in popular training systems (vertical shoot positioning and trailing shoot positioning) and vine spacings.

Training system example	Fruit zone number	Between-vine spacing (feet)	Retained bud number per vine (3 buds per foot of row target)	Retained bud number per vine (4 buds per foot of row target)	Retained bud number per vine (5 buds per foot of row target)
Low, bilateral cordon (VSP) -or- High, bilateral cordon (trailing)	One	4	12	16	20
		5	15	20	25
		6	18	24	30
Lyre, low bilateral cordon (VSP) -or- Geneva double curtain (trailing)	Two	4	24	32	40
		5	30	40	50
		6	36	48	60

Optimum dormant pruning weights are between 0.2 to 0.4 pounds per linear foot of cordon (Smart and Robinson, 1991). That means that a single-cordon vine should produce roughly 1 to 2 pounds of pruning weight in a well-balanced, healthy vineyard with a between-vine spacing of 5 feet. The "optimum" pruning weight will be largely determined by the interaction of several factors, including cultivar, training system, cultural practices, and growing site. Growers are encouraged to spot check vine pruning weights throughout each cultivar and block, particularly where the grower suspects that the vine size is declining and/or soil water and mineral nutrient resources are limited. Pruning weights can be taken with a field or fishing scale (Figure 5). Flag several vines and return to record their dormant cane weights and yield on a perennial basis to determine crop load and vine productivity over time. Fewer buds should be retained on vines that have reduced pruning weight and crop yield over time. Growers are encouraged to work with UGA Extension agents and specialists to determine the cause of lower vine productivity. For further information on balanced pruning and the concepts of vine balance, please see Bates (2003), Skinkis (2013), and Kliewer and Dokoozlian (2005).

Figure 5. Weighing dormant canes over several consecutive seasons in commercially mature vineyards can provide the grower with valuable insight into perennial vine health. High crop level and abiotic and biotic pests can reduce vine pruning weight over time, and pruning should be adjusted accordingly. *Photo courtesy of Rachael White.*

Pruning methods

The two pruning methods commonly used in Southeastern U.S. bunch grape vineyards are spur and cane pruning. Spur and cane pruning are associated with training method by virtue of where the fruitful, 1-year-old wood originates. The fruitful wood can originate from either a cordon or the "head region."

Spur pruning (with cordon training)

Spur pruning is commonly implemented with cordon training (Figure 6). A cordon is a horizontally trained extension of the trunk that is retained for multiple years; spurs originate along the length of a cordon. Spur pruning is implemented by cutting last year's shoots (now 1-year-old, woody canes) down to spurs. Spurs are short canes; they are called "spurs" due to their physical appearance after cutting the cane. Spurs typically contain one or two buds each in cordon-trained wine grapes but may contain two to four buds each in high wire- and Geneva double curtain-trained cultivars such as Chambourcin, Lenoir, Villard blanc, and Norton.

A good spur pruning strategy is to retain 1-year-old spurs that are positioned as close as possible to the cordon. An example of this strategy can be seen in the right photo in Figure 6; the furthest right purple arrow points to a retained spur that was lower than two other removed canes in that cordon region. Maintaining low-positioned grapevine spurs ensures that clusters are maintained in a confined fruit zone region, which promotes precision spraying, leaf removal, and harvest efficiency. Further, maintaining low-positioned spurs ensures that the amount of exposed canopy leaf area is maintained over time. It is also good practice to remove spurs that are oriented horizontally, or originating from the bottom of the cordon.

Figure 6. Pre- (left) and post- (right) spur pruning in a low, bilateral cordon system trained to vertical shoot positioning. The green arrows represent the two cordons; the purple arrows represent spurs.

Like trunks, cordons are perennial structures. However, they can have a limited productive lifespan of about seven to 10 years or less, depending on the prevalence of wood and trunk diseases and previous pruning decisions. Cordons will thus need periodic replacement throughout the lifespan of the vineyard. It is time to replace cordons when they become largely void of 1-year-old (fruitful) wood as this will reduce crop production. Figure 7 shows a cordon that is past the recommended replacement stage due to excessive "blind wood": the low number of fruitful buds could be a function of historical poor pruning decisions or woodborne disease. Vineyards characterized by a high incidence of cordons void of productive grapevine buds will have compromised crop yield and attenuated revenues.

Figure 7. A cordon with almost two feet void of spurs. This cordon is well past due for replacement, which is essentially accomplished by cane pruning.

Cane pruning (with head training)

Cane pruning is implemented with head training; canes originate from the head region of the vine (Figure 8). Cane pruning does not use cordons. Instead, new, 1-year-old canes are laid down on the fruiting wire every year. Each bud that originates along the length of the 1-year-old renewal canes has the potential to be fruitful in a similar fashion to the count buds on the abovementioned 1-year-old spurs. It might be helpful to think of a cane as a long spur that requires the support of a wire due to its length and consequent inability to support itself. The region of the vine from which the renewal cane originates is referred to the "head region," which is the region where the vertical trunk splits into horizontally positioned grapevine wood (Figure 8). The head region should start roughly 6 to 8 inches below the supporting wire so that the renewal canes are easily positioned and tied to that wire. Pruning, pulling brush, and tying canes are tasks that can be split between multiple vineyard passes when implementing cane pruning.

Figure 8. Pre- (left) and post- (right) cane pruning; arrow indicates retained cane in left photo; head region is encircled, and arrows indicate where cane should be fastened to wire with chosen tying material in right photo. These photos show a conversion of cordon training / spur pruning to head training / cane pruning to increase production in this vine. In these photos, the head region is higher than recommended due to cordon replacement; shoots emerging about 5 to 6 inches below the fruiting wire should be retained when cane pruning on a perennial basis.

Figure 9. Dormant canopies displaying the previous season's shoot growth along fruit zones of spur-pruned/cordon-trained (left) and cane-pruned/head-trained (right) vines. These vines are spaced 6 feet apart within-row. The left photo shows the even shoot growth along the cordon; the right photo shows the uneven shoot growth that is typically observed in cane-pruned vineyards at this spacing.

Choosing a pruning method

Vineyard design and variety selection can dictate appropriate pruning method. Midcane shoot growth depression and low shoot density have been observed with cane pruning, particularly in vineyards planted with more than 5 feet between vines (Figure 9; Hatch, 2015). Therefore, vineyards with between-vine spacing of greater than 5 feet are often spur pruned/cordon trained while cane pruning/head training is recommended in closer-spaced vineyards. Recent reports across several cultivars have shown that crop yield is not dramatically affected by

pruning method (Hatch, 2015; Skinkis and Gregory, 2017; White and Hickey, 2018), but cane pruning increased yield when compared to spur pruning in 'Sauvignon blanc', a cultivar with low basal bud fertility (Lockwood *et al.*, 2016). Cane pruning may thus be more appropriate for cultivars with low fertility of basal count buds, such as 'Sauvignon blanc' or 'Nebbiolo'. Several cultivars have good basal bud fertility and are thus fine candidates for spur pruning. Pruning method choice tends to be a regional phenomenon. Spur pruning is predominantly employed in the Eastern U.S., but cane pruning is increasingly adopted in vineyards with closer than 5-foot vine spacing trained to low-wire systems in that region. Cane pruning is ubiquitous in Oregon 'Pinot noir' vineyards, but spur pruning is ubiquitous in eastern Washington vineyards. The decision to implement one pruning practice over the other will depend on the perceived advantages and disadvantages of each.

Cane pruning may be thought of as having fewer, more important pruning decisions relative to spur pruning, which consists of several, less difficult pruning decisions. There are pros and cons to both pruning strategies (Table 2). For example, while cane pruning may require less shoot thinning in the spring than spur pruning (Hatch, 2015), canes must be tied to the supporting wire in the dormant period with cane pruning. Cane pruning shifts labor demand into the dormant season and therefore may be preferred over spur pruning by those who have minimal springtime labor at hand. While it takes longer to cane prune than to spur prune (Hickey, 2018), cane pruning requires fewer cuts than spur pruning. Delayed and double pruning can be easily implemented when spur pruning, perhaps providing an advantage for spring frost avoidance. A comparable strategy to maintain bud numbers and crop potential when cane pruning may be to retain three or four canes in the dormant season and cut extras off once the threat of frost has passed in the spring.

Growers admittedly have concerns about cane pruning because they are familiar with spur pruning, and the thin cane laid down as the new fruiting wood is not anticipated to produce as much crop as a thick, well-established cordon. Growers are encouraged to trial cane pruning on a small scale in their vineyard if the potential benefits pique interest. Several regional growers have already adopted cane pruning in their vineyards after learning about its merits at pruning workshops. It may be advantageous to trial cane pruning as a means of cordon replacement, particularly in situations where cordons are largely void of 1-year-old wood.

Table 2. Select pros and cons of spur and cane pruning to help grower decision for pruning method adoption.

Pruning method	Tying required	Task mechanization	Number of unwanted shoots to thin	Number of cuts required	Size of cuts	Appropriate for > 5-foot vine spacing	Suitability in cultivars with low basal bud fertility	Ability to double/delay prune
Spur	No	Easy	Many	Many	Small	Excellent	Poor	Easy
Cane	Yes	Difficult	Few	Few	Large	Fair	Excellent	Difficult

Double and delayed pruning

As the name implies, double pruning requires two vineyard passes. The order of operations when implementing double pruning on a cordon-trained vineyard is: (1) preprune to spurs with excessive bud numbers; (2) cut tendrils and pull brush from trellis; and (3) final prune with hand shears to desired spur and bud density. The first pass cuts out and removes a large portion of the tops of the 1-year-old grapevine canes from the trellis, and gas-powered hedge trimmers or tractor-mounted hedgers are often used for this step. An excessive number of buds are left after this first pass. After brush is pulled from the trellis, hand shears are used in the second pass to selectively retain the desired spurs and buds. Since brush is already pulled, the "final prune" is completed much faster with double pruning relative to standard pruning. The final pruning can therefore be implemented later in the dormant season. Final pruning later in winter enables the pruner to assess cold injury and adjust bud number accordingly, potentially after the greatest threat of winter cold injury and spring frost has passed. Delayed pruning is a modification of double pruning. Delayed pruning uses the cane apical dominance to its advantage to delay budbreak in the basal buds, which will be retained upon pruning completion. Apical buds break first while the basal buds remain dormant. Since the basal buds will be retained after final pruning, delayed pruning

has potential to reduce frost incidence in vineyards subject to spring frost. However, delayed pruning can greatly reduce crop yield and delay fruit maturation if final pruning is excessively delayed (Frioni *et al.*, 2016). Exercise caution when choosing to implement the final prune.

Challenges addressed during dormant pruning

Grapevine trunks and cordons can be infected by a suite of fungal and bacterial pathogens (Mondello *et al.*, 2017). Infection due to these pathogens results in vine decline and even vine mortality. Signs of infection include wedge-shaped cankers visible in cross sections of wood, dead wood, galls, and the collapse of vegetative growth. These infections move slowly, and in some cases, years pass between the time of infection and the occurrence of symptoms. Preventative strategies to mitigate infection of grapevines include double pruning, delayed pruning, and avoiding pruning preceding a rain event. Cane pruning or retraining a renewal shoot from the trunk are retroactive strategies to remove established infections of the grapevine cordons. For more information on grapevine trunk diseases, please see Appel and Brown (2017).

Dormant buds, canes, and perennial wood can be injured by cold temperatures. Growers can monitor cold temperatures in the vineyard and check buds and wood for injury before pruning. Retaining more buds at dormant pruning may be sufficient to compensate for moderate injury to dormant buds. More severe cold injury may require retraining vines or even replanting the vines. For more information on grapevine cold injury, please see Chien and Moyer (2014).

Pruning tools

Figure 10. Anvil (top left relative to large shears) and bypass (bottom left and right relative to large shears) hand shears are used to cut 1-year-old grapevine wood. Large shears ("loppers", in center) are used to cut through grapevine wood that is older than 2 years old.

Hand shears are necessary and sufficient to complete dormant pruning. Hand shears are used in most bunch grape vineyards throughout the world. Many manufacturers make hand shears, and some are of higher quality than others. It is highly recommended that the enterprise considers purchasing name-brand shears from reputable manufacturers. Please consult your local county Extension agent or university specialist for assistance in choosing appropriate vineyard pruning tools. High quality shears will help laborers prune more efficiently, fatigue less, and make clean cuts; moreover, the shears will last longer than cheaply made shears. High-quality hand shears can typically be found in catalogs and popular garden, orchard, and vineyard supplier websites. Hand shears come in bypass and anvil forms, with different blade angles and sizes, and with different handle sizes and setups (Figure 10). All types work well when their sharpness is maintained, but individuals tend to develop a preference for one style of hand shears over the other. Most manufacturers make replaceable hand shear blades and blade sharpeners, the latter of which is highly recommended. Larger shears (commonly called "loppers") help make larger cuts through grapevine wood (Figure 10). Large shears give the pruner leverage and strength in making large cuts. "Loppers" are necessary for cordon replacement, conversion from cordon training/spur pruning to head training/cane pruning, and for removing large amounts of dead or diseased wood that is 2-years-old or older. Mechanical pruning tools such as battery-operated pruners are increasing in popularity due to their ability to improve the efficiency of dormant pruning. Mechanical tools reduce laborer fatigue so pruning efficiency can be maintained over extended periods. Mechanical tools are thus especially worth consideration in larger (greater or equal to 10 to 15 acres)

commercial vineyards. Prepruning tools, such as gas-powered hedge trimmers, may also help dormant cane pruning efficiency in vineyards due to their ability to accomplish the first step in double pruning. It should be noted that mechanical tools are not precise and therefore should not be used to final prune to the targeted bud and spur density.

Summary

This bulletin was intended to provide both veteran and new growers an overview of commercially popular pruning strategies and a greater depth of understanding of the theory behind pruning method practice. Dormant pruning is an important vineyard management decision as it sets the crop level and canopy density before green tissues are present. Growers must take several considerations into account when choosing a pruning method, including vineyard design, cultivar, and labor force throughout the year. Some growers may choose to adopt several different pruning strategies to successfully manage their vineyard. Regardless of the pruning method, it is important to develop a plan that includes scheduling when and how each vineyard block will be pruned throughout the dormant season. Effective dormant pruning sets the stage for successful vineyard management throughout the forthcoming growing season.

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