



A Step-by-Step Approach to Pruning Carlos Muscadine Grapevines

The Carlos muscadine is the top cultivar selected by growers and homeowners for muscadine production in the Southeast. Carlos requires annual pruning in winter to maintain healthy fruit-bearing wood. A single healthy Carlos vine can produce up to 15 pounds of one-year-old wood annually! Removing most of this one-year wood each winter when vines are dormant helps to regulate crop size and especially fruit quality. In fact, no other operation has more influence on the production of top-quality fruit than annual pruning. Regrettably, many growers and homeowners are unsure about “how much to prune off.” In their fear of doing the wrong thing, they often prune too little (Figure 1) or too much (Figure

2). This review presents the key steps involved in pruning a mature Carlos vine for maximum production of top-quality fruit.

A New Approach

A new method called *balanced pruning* offers a holistic approach to pruning muscadine grapes. With the balanced approach, you consider the vine’s actual size and fruit-bearing capacity **before** you start pruning. Traditionally, most growers and homeowners have used a *recipe approach* to muscadine pruning in which all vines in a vineyard block or backyard are pruned or shaped the same without considering important differences in vine size. It is rather surprising how much variability in



Figure 1. Too little dormant pruning! On this vine there are well over 40-50 buds/ft of cordon (permanent arm). Actually, this photo shows a vine that was mechanically hedged and no additional wood was removed from inside the 12” x 12” box.



Figure 2. Too much dormant pruning! On this spur-pruned Carlos vine an average of 10 buds/ft were retained. Our research experience with pruning severity levels in Carlos (a vigorous cultivar) has shown that more buds need to be retained for top yields.

Table 1. Variability in vine size based on weight of cane prunings from Supreme vines, Kings Mountain, N.C., February 2012 (180 buds retained per vine)

Plot	Replication	Control treatment 4	Weight of cane prunings (lb)
31	8	4 (180 buds)	6.125
18	5	4 (180 buds)	4.750
2	1	4 (180 buds)	8.375
6	2	4 (180 buds)	8.687
27	7	4 (180 buds)	5.750
12	3	4 (180 buds)	7.125

Table 2. Suggested pruning formulas for balanced pruning of selected bunch grapes

Variety	Pruning Formula*
Cabernet sauvignon	20 + 20
Cabernet franc	20 + 20
Chardonnay	20 + 20
Seyval	5 + 10
Niagara	40 + 10

individual vine vigor occurs within a block of the same cultivar. For example, we implemented a long-term pruning study at a Kings Mountain, N.C., muscadine vineyard planted in 2008. The vines were four years old when we began the study in February 2012, and we observed remarkable differences in the weight of canes pruned from Supreme vines—a very popular black muscadine for fresh marketing. All of the control vines in this study were pruned to retain the same number of buds (180 buds/vine). As summarized in Table 1, the cane prunings for these individual vines varied from a low weight of 5.75 lb/vine to more than 8.5 lb/vine. Should a vine with 5.75 lb of cane prunings be pruned identically to a vine with nearly 50 percent more cane prunings? If we take the advice of Professor Emeritus Ronald Lane of the University of Georgia, “more wood can be left on a strong growing vine at pruning time than a weak growing one” (Basiouny and Himelrick, 2001).

Dr. Lane continues his advice in a chapter on muscadine pruning in *Muscadine Grapes* (Basiouny and Himelrick, 2001): “An attempt should be made to obtain a balance between fruit production and vegetative growth. The excess new

wood must be pruned off each year to leave the desirable number of buds from which the next season’s crop will be developed.” But in North Carolina and other southeastern states where muscadines are grown, we don’t know exactly how much wood we should remove in dormant pruning to bring about this desirable balance. The balanced approach used by growers of bunch grapes could be a solution.

Table 2 presents the formulas used by growers for balanced pruning of selected bunch grape varieties. For a balanced pruned Niagara vine with 6 lb of cane prunings, for example, you would need to leave 40 buds for the first pound of prunings. Then, for every pound thereafter, an additional 10 buds are retained. Thus, a total of 90 buds would be retained on a 6-lb Niagara vine:

$$(1\text{st lb} = 40\text{ buds}) + (5\text{ lb} \times 10\text{ buds/lb}) = 90\text{ buds}$$

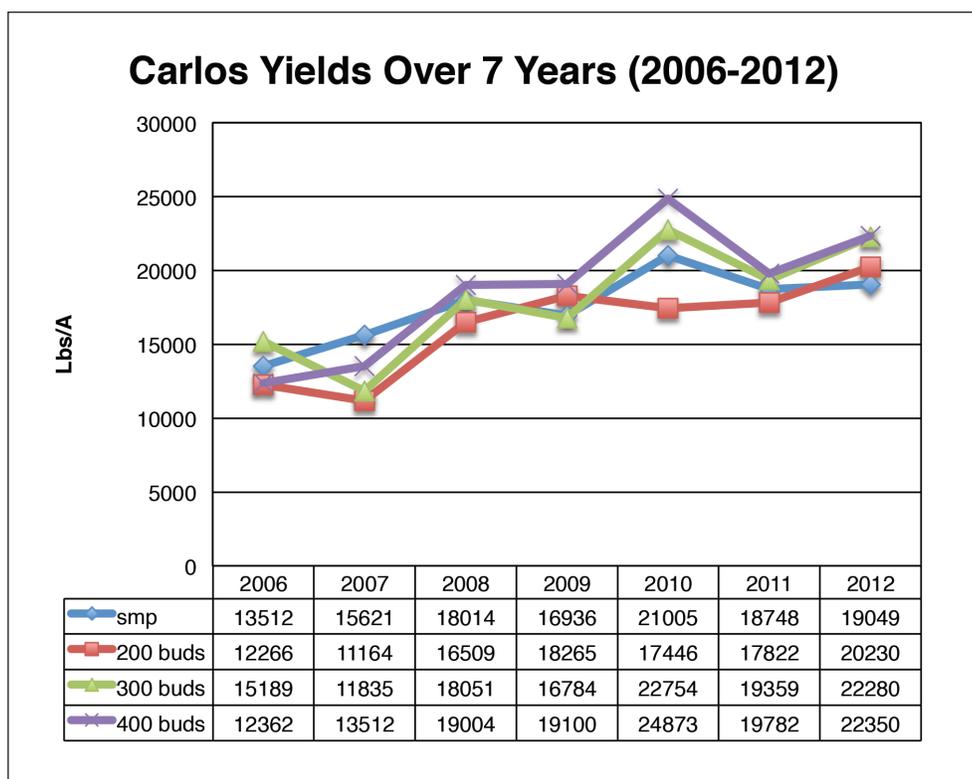


Figure 3. Comparison of yields (lb/acre) in relationship to pruning (buds retained per vine) at an NC coastal plain muscadine vineyard, 2006–2012

Balanced pruning strives to balance the vine's size with its capacity to carry out vegetative and reproductive growth. This approach is based on two concepts: (1) A vine's capacity for vegetative growth and fruit production is a function of its size. (2) The vine's size is determined by the extent of growth of roots, shoots, and perennial wood (Poling, 2007). Because the growth of roots and other perennial wood cannot be conveniently measured, vine size is best estimated by weighing the one-year-old wood (canes) removed at rough pruning when the vine is dormant.

Balanced pruning could prevent losses in yield that translate into reduced income. In a research project started in 2006 in an NC coastal plain vineyard in Duplin County, we are seeing the effects of under-cropping in Carlos vines that have been pruned each winter for the last seven years to 200 buds/vine (20 ft in-row spacing) or 100 buds/arm (10 ft). The data show that leaving only 200 buds/vine reduced the yield potential of these 10-year-old vines compared to Carlos vines pruned to 300 or 400 buds/vine (Figure 3). Following a recipe of pruning every vine to 200 buds caused a needless loss in yield of about 2,000 lb/acre (1 ton). On a 40-acre commercial Carlos vineyard, that loss would translate into a \$20,000 reduction in gross revenue

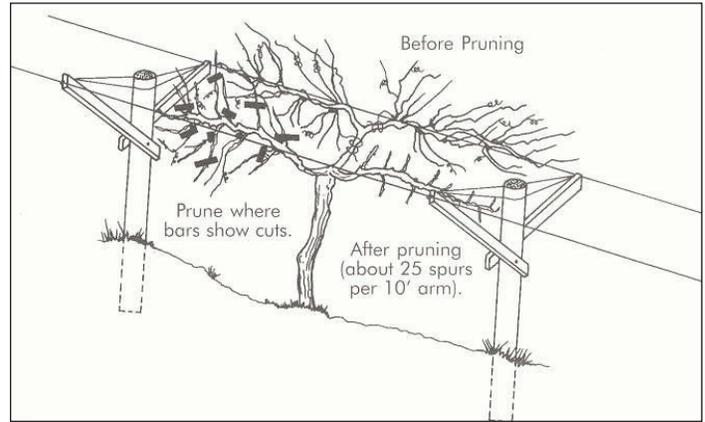


Figure 4. This illustration from NC Cooperative Extension's *Muscadine Grape Production Guide for North Carolina* (Poling et al., 2004) shows 11 fruiting spurs on the 10-ft cordon arm (not 25 as stated).

in 2012, assuming a processing grape price of \$500/ton. This problem could have been avoided by leaving another 100 buds/vine. Note that the 300-bud vines produced more than 22,000 lb of muscadines in 2012.

Our seven years of research with Carlos pruning severity has clearly established that we are undercropping



Figure 5. A healthy Carlos vine before pruning



Figure 6. A well-pruned Carlos vine



Figure 7. Carlos vine pruned to 300 buds per vine (15 buds/ft cordon)



Figure 8. Carlos vine pruned to 400 buds per vine (20 buds/ft cordon), similar to Figure 6

the vines by retaining only 200 buds/vine (100 buds/10-ft arm). Imagine the yield reduction that would occur if we followed the recommendations made in the *Muscadine Grape Production Guide for North Carolina* (AG-94). This extension guide (Poling et al., 2004) states that growers should leave 25 spurs per 10-ft arm (about 4.8 inches apart). If each fruiting spur is about 4 inches and has three buds (see Figure 7), then this approach would retain only 150 buds/vine (about 7.5 buds/ft of cordon) on a vine trained to a single-wire trellis with 20 ft in-row vine spacing.

How Many Buds Should You Retain?

As yet, we have not fully determined how many buds should be retained on a mature Carlos vine such as the one in Figure 5. But in cooperation with the vineyard manager at the Duplin County location in North Carolina, we have learned that we can improve vine productivity and maintain adequate vegetative growth by leaving between 15 to 25 buds/ft of cordon at dormant pruning. The exact number to retain within this range depends on each vine's size. Figure 5 depicts a very vigorous 10-year-old Carlos vine (from our research vineyard) that will probably produce about 16 lb of cane prunings (that's about three times as much as the four-year-old Supreme vines observed in the test vineyard in western North Carolina). The Carlos vine in Figure 5 has the potential to produce nearly 100 lb of fruit/vine on vines spaced 20 ft apart in the trellis row (single-wire trellis system). The grower in Figure 6 is holding the vine's cordon (permanent arm), and you can see lighter-colored shortened canes or *fruiting spurs* that are uniformly distributed on the horizontal cordon. In this

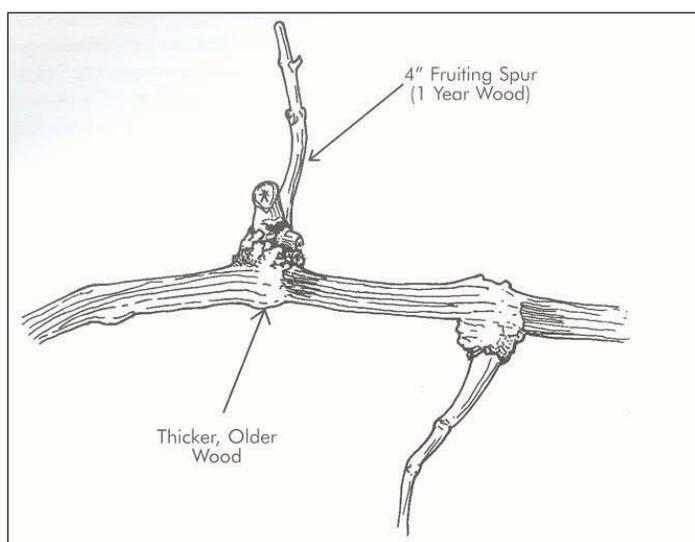


Figure 10. Typically, growers will try to select healthy fruiting spurs about every 5–6 inches along the cordon. The individual spurs are pruned to 4–7 inches. If spurs exceed 7 inches, they are technically called *canes*. On a 4-inch spur you will find two to three buds.

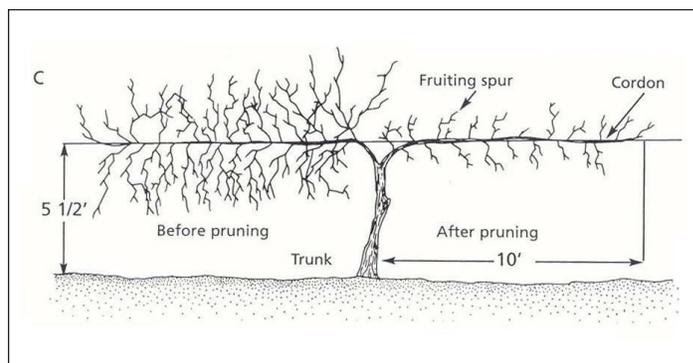


Figure 9. Muscadine vine structure—before (left) and after (right) pruning.

case, the grower is leaving about 30 fruit spurs/10-ft arm (about 4 inches apart), and the individual spurs have six to seven buds. Figure 7 shows a close-up of vines that have been pruned to 300 buds/vine (15 buds/ft) and 400 buds/vine (20 buds/ft).

Critical Points: Muscadine Vine Structure and Fruiting Habit

Before pruning a mature Carlos muscadine vine, it is helpful to understand a grapevine's parts and fruiting habits.

Vine structure. The trunk is the vine's permanent stem (Figure 9). It forms a connecting link and pipeline between the roots and the arms. The trunk supports the bearing wood of the vine at the desired height from the ground. The trunk's continued health is essential to a long life for the entire vine. The trunk divides into arms, which are permanent arms in muscadines. By definition, a permanent horizontal arm supporting fruiting wood is referred



Figure 11. Close-up of a muscadine bud. A new shoot will emerge from this bud in the spring.



Figure 12. New shoots have emerged in the the spring (May). Small fruit clusters have developed at the base of the shoot.

to as a *cordon*. The vertical one-wire trellis shown in Figure 9 has two permanent arms (cordons) that each span 10 ft.

Fruiting habit. New shoots will develop in the spring from small *fruit buds* that are found on the one-year-old fruiting spurs (Figure 10). You can see a close-up view of a single dormant bud in Figure 11. This bud has the potential to produce a new shoot in the spring. In fact, all of the buds on one-year wood have the potential to produce fruitful shoots. Muscadine grapes are borne in a few clusters near the base of the current season's shoots (Figure 12).

The one-year wood can be distinguished from two-year and older wood by the presence of buds such as those on the vertical cane shown in Figure 13. The buds in this photo (note they are alternating) are called *count buds*, and



Figure 13. A one-year cane before it has been shortened into a fruiting spur. In this case, if the cane is shortened to about 7 inches, four "count buds" will remain (for shoot and fruit development during the growing season). At the junction of the one-year cane and two-year wood (horizontal), a *base bud* occurs (relatively small). In muscadines, the base buds can be fruitful. In seasons of late spring frost (like the Easter freeze of 2007), base buds can produce a partial crop if the shoots emerging from the count buds sustain freeze injury.

these are the buds to include when counting buds. **The less visible base buds at the junction of the one-year and two-year wood are not included in bud counts.**

When pruning older vines, you must be careful to distinguish one-year fruiting wood from wood that is



Figure 14. This is a seven-year-old Carlos vine, and in this telescopic view of the cordon you can see evidence of branched structures called "bearers" that are attached to the permanent arm (cordon). The only wood on these bearers that is fruitful is the one-year wood, such as the vertical fruit spur in the center-right.



Figure 15. In this older muscadine the fruit bearing one-yr wood has been allowed to move farther and farther from the cordon each year. It is better to periodically "renew" the cordon by thinning out old bearers, and allowing new spurs to develop from shoots that grow from latent buds in the cordon.

over a year old. Figure 14 shows branched structures called *bearers* that are attached to the permanent arm (cordon). The only fruitful wood on these bearers is the one-year wood, such as the vertical fruit spur in the center-right of Figure 14. In addition to having fruitful buds (Figure 11), the one-year wood is brighter in color, and it will not be as thick in diameter as the darker older wood. An important pruning rule is that **all wood over one year old and not necessary to maintain the vine's framework should be removed. In addition, do not allow spurs to develop near the head of the vine in the V-junction area.**

Five Steps to Balanced Pruning of Carlos Muscadine Vines

1. Complete an initial rough pruning. For pruning older muscadines with bearers up to 2 inches in diameter, long-handled loppers capable of cutting large stems are essential. Smaller one-handed pruners are needed for making all other pruning cuts. It is well worth the money to invest in a good sharp pair of hand pruners as muscadine wood is very hard to cut compared to bunch grape wood. Good pruning shears will make a big difference in reducing hand and muscle fatigue. Make flush cuts to avoid leaving stubs. Don't worry about "bleeding" from pruning cuts. In commercial vineyards, standard operating procedure in muscadine pruning includes using a tractor-mounted sickle bar (Figure 16) for the initial rough pruning of the vineyard to an approximate 12-inch by 12-inch box. Homeowners can use hand-held hedgers to achieve the same result. This rough pruning dramatically reduces the amount of time required to prune a mature muscadine vine (Figure 17). A large vine like the one shown in Figure 17 will require up to 60 minutes to prune by one-handed pruning shears, and this time can be more than cut in half by first mechanically rough pruning to an approximate 12- inch by 12-inch box.

2. Follow up with hand pruning.

(a) *When to hand prune.* Rough pruning is often done in commercial vineyards in early winter, and

follow-up hand pruning occurs anytime in January or early February. If your vines are located where frosts often occur in early spring, consider delaying the final pruning until there is less risk of an early April frost (a strategy called *double-pruning*). This delay strategy, however, is not practical in large commercial vineyards. Most growers attempt to complete all dormant-season pruning before the end of February. While more sap bleeding is observed when pruning occurs closer to March, the bleeding will not harm the vines. But keep in mind that buds become more swollen in March, and swollen buds and young shoots are very susceptible to breakage.

(b) *How much to prune.* Through research and experience, we have learned that mature Carlos vines grown in a single-wire trellis with spur pruning need to have **at least 10 count buds retained per foot of cordon** and possibly more. The amount to prune depends on the vine's size. The best way to estimate the size of the vine is by weighing its one-year wood removed at the initial rough pruning (do not weigh wood older than one year). Remember that we will be taking off 80 to 90 percent of the one-year wood at dormant pruning, so don't be shy about proceeding with the rough pruning (Step 1). The number of viable count buds inside the 12-inch by 12-inch box on a mature Carlos vine (spaced 20 ft in-the-row) can easily approach 750–1,000 buds per 10-ft arm.

Returning to Dr. Lane's advice, "to obtain a balance between fruit production and vegetative growth," we have come up with a balanced pruning formula for Carlos vines of $120 + 20$. To save time in calculating the number of buds to retain, refer to Table 3. For example, if the weight of a Carlos vine's one-year cane prunings is around 5 lb, you should leave 200 buds. If the weight of the prunings on a Carlos vine is closer to 15 lb/vine, leave around 400 buds, or 200 buds per 10-ft arm. We will continue to investigate the best formula for balanced pruning of Carlos. It may be advisable in colder winter areas, such as the NC piedmont, to adopt a more conservative formula, such as $100 + 20$. The $100 + 15$ formula appears to have promise for



Figure 16. Tractor-mounted sickle bar



Figure 17. Unpruned muscadine vine

Table 3. Proposed pruning formulas for balanced pruning of Carlos muscadine grapes

Formula	Pounds of cane prunings per vine										
	5	6	7	8	9	10	11	12	13	14	15
120 + 20	200	220	240	260	280	300	320	340	360	380	400
110 + 20	190	210	230	250	270	290	310	330	350	370	390
100 + 20	180	200	220	240	260	280	300	320	340	360	380

avoiding the adverse effects of over- or under-cropping Supreme muscadine vines. Using the formulas in Table 3 allows you to break away from traditional recipe pruning of muscadines—where each vine is pruned the same **despite** significant differences in vine size within the same vineyard. Balanced pruning can help commercial growers and homeowners avoid the nasty effects of over- or under-cropping.

3. Determine spur distribution and number. You are almost finished! After you have completed the rough pruning (Step 1) and determined vine size by weighing the one-year cane prunings, you have an idea about the number of count buds to retain when hand pruning (Step 2). Now you must decide how to distribute the count buds up and down the cordon. Take another look at Figure 10. Typically, growers will try to select healthy fruiting spurs about every 5–6 inches along the cordon. The individual spurs are then pruned to 4–7 inches. If spurs exceed 7 inches, they are technically called *canes*. We do not recommend cane pruning for Carlos, so try to think about shortening all canes to 7 inches or less. On a 4-inch spur, you should see two or three good count buds. Consider that spurs are spaced an average of 5 inches apart (24 per 10-ft arm) and that each fruiting spur is about 4 inches long and has three buds. This would yield only 144 total retained buds/vine (72 per 10-ft arm). But if the vine has 5 lb of cane prunings, you need to leave at least 200 buds. The best way to resolve the bud count discrepancy is to lengthen individual spurs, increase the number of spurs on the cordon, or both. If you increase the average number of spurs on a 10-ft arm to 30, for example, then you are pretty

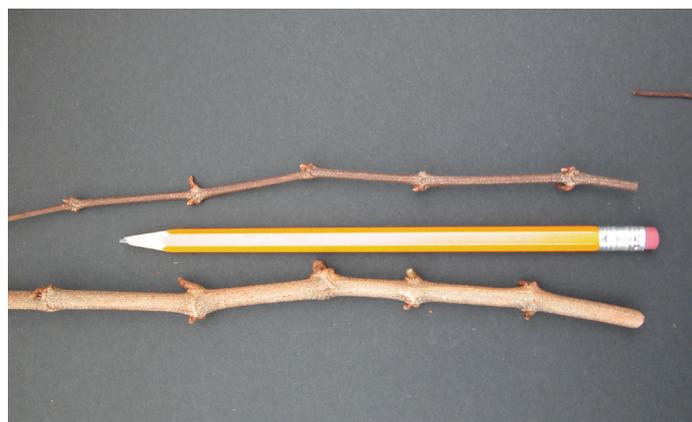


Figure 18. Be selective. Try to retain one-year wood that is close to the diameter of a pencil and remove thinner canes with smaller count buds (which are less fruitful).

close to leaving a total of 100 buds/arm (30 spurs × 3 count buds = 90). If you simply prune ten of the healthier spurs to four buds (not three), you will reach 100 buds per arm.

4. Select quality one-year fruiting wood. An important characteristic of one-year wood on Carlos is that it is brighter in color than unfruitful older wood, but you may also notice that not all one-year wood looks the same (Figure 18). So be selective in your pruning. The goal is twofold: Retain one-year wood that is close to the diameter of a pencil (notice the fatter buds), and prune out thinner, less fruitful one-year wood.

5. Renew the cordon. Spur pruning is part of a training system that makes muscadines relatively easy to prune and manage. Serious problems can occur, however, if the



Figure 19. Renewal of the cordon



Figure 20. An older cordon needing replacement

grower is not conscious of the need to continually renew the cordon with new spurs. Periodically renew the cordon by thinning out old bearers and allowing new spurs to develop from shoots that grow from latent buds in the cordon. Figure 19 shows a 10-year-old Carlos vine with multiple fruiting laterals that have developed directly from the cordon. Older cordons with wide gaps in spur positions (Figure 20) may have to be completely replaced. See the *Muscadine Grape Production Guide for North Carolina* (AG-94) for details (Poling et al., 2003).

Summary

By following the steps outlined in this review, you can expertly prune mature muscadine vines using balanced pruning. Though balanced pruning is still an experimental approach, our research and experience with a Carlos pruning severity study in Duplin County, NC, has confirmed that retaining at least 15 count buds/ft of cordon (300 buds/vine, or 150 buds/10 ft. arm) increases muscadine yield. When Carlos is pruned to 10 count buds/ft of cordon or less (the NC *Muscadine Grape Production Guide* suggests only about 70 buds/arm), needless under-cropping is the result. At this time, we cannot confirm that over-cropping will occur in healthy Carlos vines if more than 15 buds are retained per foot of cordon. It is suggested that you try a $120 + 20$ balanced pruning formula for healthy Carlos vines (Table 2). Using this formula, 400 buds would be retained on a large Carlos vine producing 15 lb of annual wood. But for a Carlos vine producing only 7 lb of annual wood, 240 buds would

be retained. Long-term benefits accrue by keeping the one-year fruiting wood close to the cordon. Periodically renew the cordon by thinning out old bearers. Be careful to select (and retain) one-year wood that is close to the diameter of a pencil, and prune out thinner, less fruitful one-year wood. By completing an initial rough pruning with hedging equipment, you can reduce your total pruning time per vine by at least half.

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Prepared by

E. Barclay Poling

*Professor Emeritus, Department of Horticultural Science
NC State University*

NC STATE UNIVERSITY

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