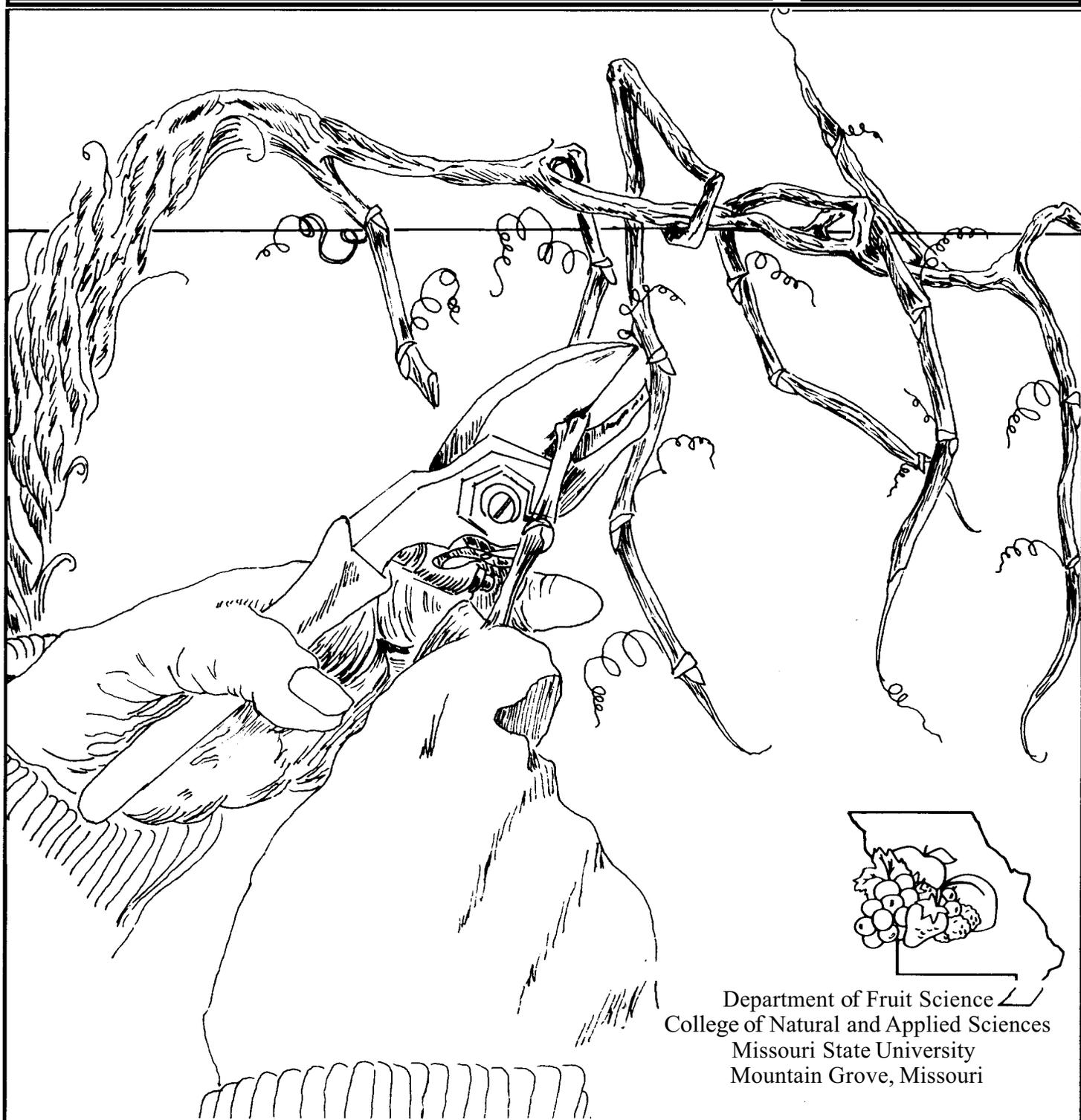


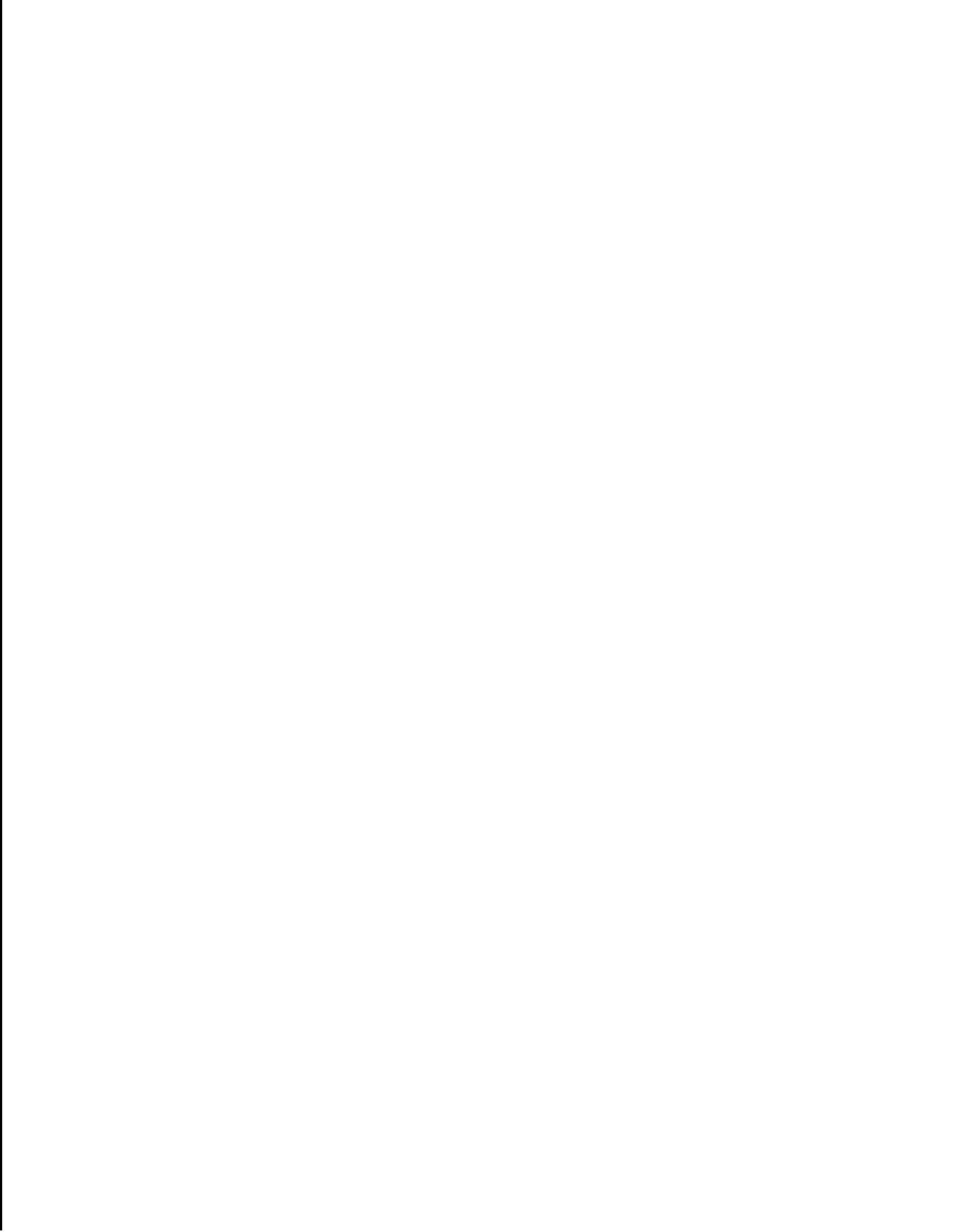
MS-14

# Training and Pruning Small Fruit Crops in Missouri

Revised April, 1989



Department of Fruit Science  
College of Natural and Applied Sciences  
Missouri State University  
Mountain Grove, Missouri



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Peter C. Andersen and Marilyn B. Odneal

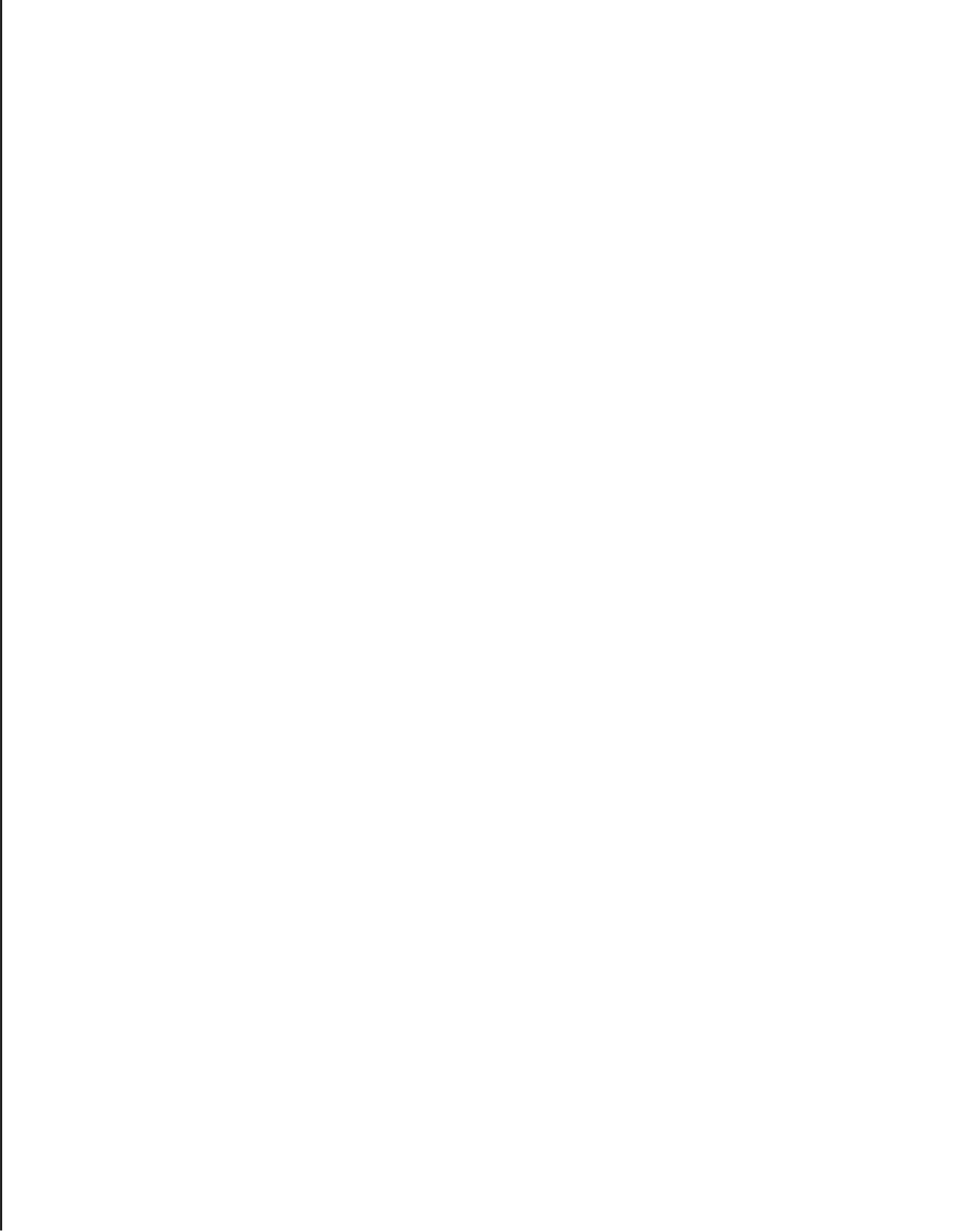
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State Fruit Experiment Station  
College of Natural and Applied Sciences  
Southwest Missouri State University  
Mountain Grove, Missouri



## INTRODUCTION

There are many good reasons to prune small fruit crops regularly. Maintenance of productive fruiting wood from year to year is just one. Increasing the plant's efficient use of sunlight and improving the air circulation around the plant parts are other important reasons. Removal of broken, dead, and diseased wood aids in preventing disease problems from occurring or spreading. A properly pruned and maintained small fruit planting will not only bear a better quality, more consistent crop, but will do so for a longer period of time.

This bulletin presents pruning methods for proper maintenance of several woody small fruit crops. Before these methods are specified, it is necessary to know how to make a proper pruning cut. All pruning cuts should be made with a sharp pruning tool. Crushed or ragged cuts invite disease problems. Stubs should never be left after cutting. Hand pruners, loppers, and pruning saws should be cleaned after every pruning session. Buildup of materials on the blades not only makes it more difficult to cut, but may also be unsanitary.

Reference is made to both thinning out and heading back pruning cuts throughout the bulletin (see Fig. 1). The heading cut is made at the tip of a branch and is sometimes referred to as tipping. The bud or lateral branch just below the heading cut will indicate the direction the headed branch will grow in the future. This cut allows for better light interception and aids in keeping the plant in bounds. The headed branch will develop more lateral or side branches and will also become stockier. This same effect is observed when you "pinch" your houseplants or garden plants.

A thinning cut is made when the entire limb or cane is removed from the plant at ground level. It is also involved when completely removing a lateral or side branch from the supporting or main branch. Thinning cuts are used to remove unproductive canes or limbs and to allow better light interception and air circulation for the plant. If the canes and limbs are too crowded, thinning will reduce the competition for nutrients and light, thus improving the fruit quality and overall thriftiness of the plant.

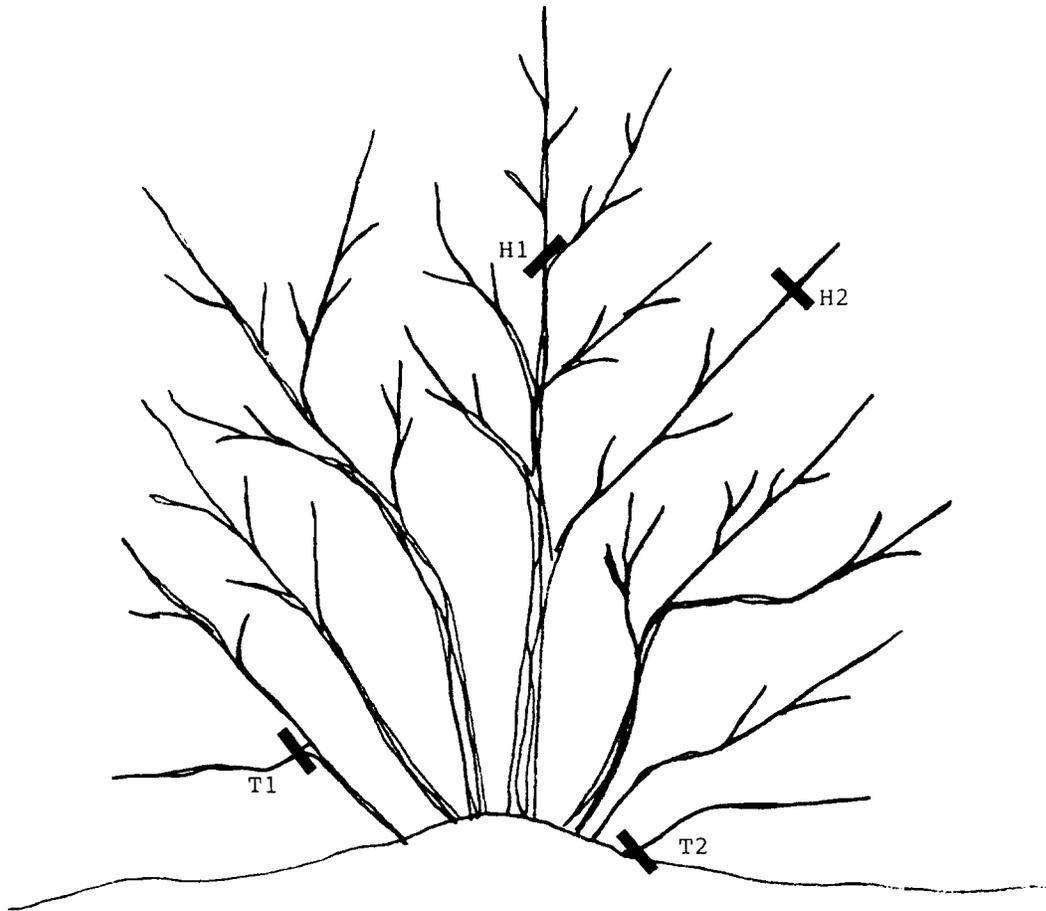


Figure 1. The pruning cuts diagrammed above are identified as follows: H1 is heading back the main limb to a lateral; H2 is heading back the main limb to a bud; T1 is thinning out a lateral from the main limb, and T2 is thinning out a limb completely.

## BLUEBERRIES

The basic goals in pruning blueberries are to promote the growth of strong new wood and to maintain consistently high production levels of large berries. Without pruning, blueberry plants produce crowded, twiggy growth which results in plants overloaded with small berries and unsatisfactory wood growth for future production.

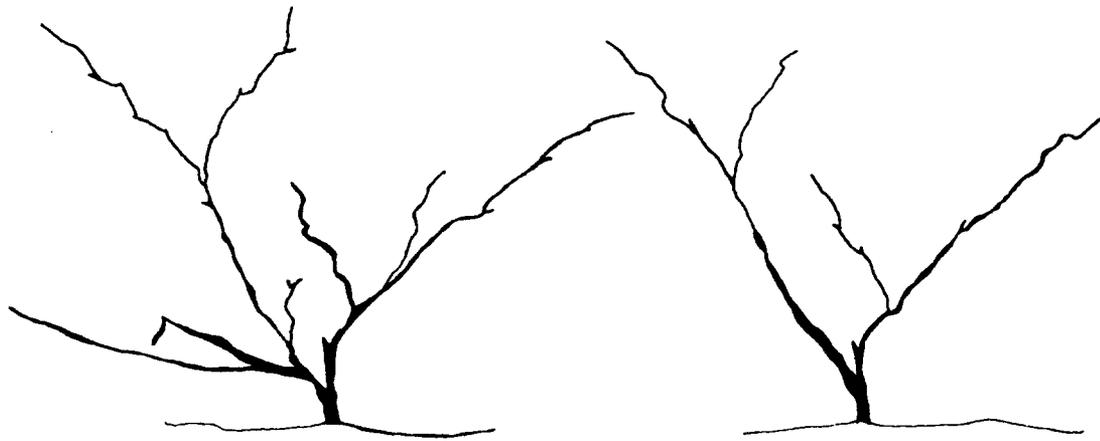
Highbush blueberries are best pruned during the late winter or early spring just before bud swell. Pruning late in the dormant season reduces the chances of freeze damage at the cut surfaces and also enables winter damaged wood to be selectively removed.

At planting, remove willowy or damaged limbs and retain only the strong shoots to begin the establishment of a strong framework (Fig. 2). Blueberry plants come into bearing sooner and produce higher yields if they are pruned lightly for the first three years. The extent of pruning during the early years consists of removing diseased limbs and heading back or thinning out willowy or low lying shoots. All flowers should be removed until blueberry plants are at least three years of age so that carbohydrates can be used for growth instead of fruit production. Weak, twiggy growth may be removed from the base of the plant.

Blueberry flowers and fruit arise from buds on one-year-old wood. Flower buds are initiated the previous summer and usually occur near the end of all new growth (Fig. 3). Therefore, a certain amount of new growth is essential for annual fruit production.

Pruning mature plants consists of removing old canes that are not producing much strong new wood and eliminating the weak twiggy growth.

First, as in the case of pruning most perennial woody plants, remove damaged or diseased limbs. Next, remove approximately 20% of the older canes each year after the fourth year to help invigorate the bush since older canes become less productive with age. In some cases older less vigorous canes may be headed to a strong lateral near the ground (Fig. 4). The majority of canes in a bush should be less than five years old. If there are many old canes present, cut the ones with the weakest growth first. Next, remove weak, twiggy growth, working from the base to the top of the plant. Remove low lying fruiting wood, because this is usually missed when picking. Remove enough growth from the plant's extremities to allow good light penetration to the center. Some cultivars such as 'Berkley', 'Colville', and 'Darrow' tend to have a spreading growth habit. These cultivars should be pruned to encourage more upright growth. Other



A. Before pruning one-year-old plant

B. After pruning one-year-old plant

Figure 2. Blueberry pruning should be light for one, two, or three-year-old plants. Pruning consists of removing or heading back willowy growth and thinning diseased, damaged, weak or low lying growth.

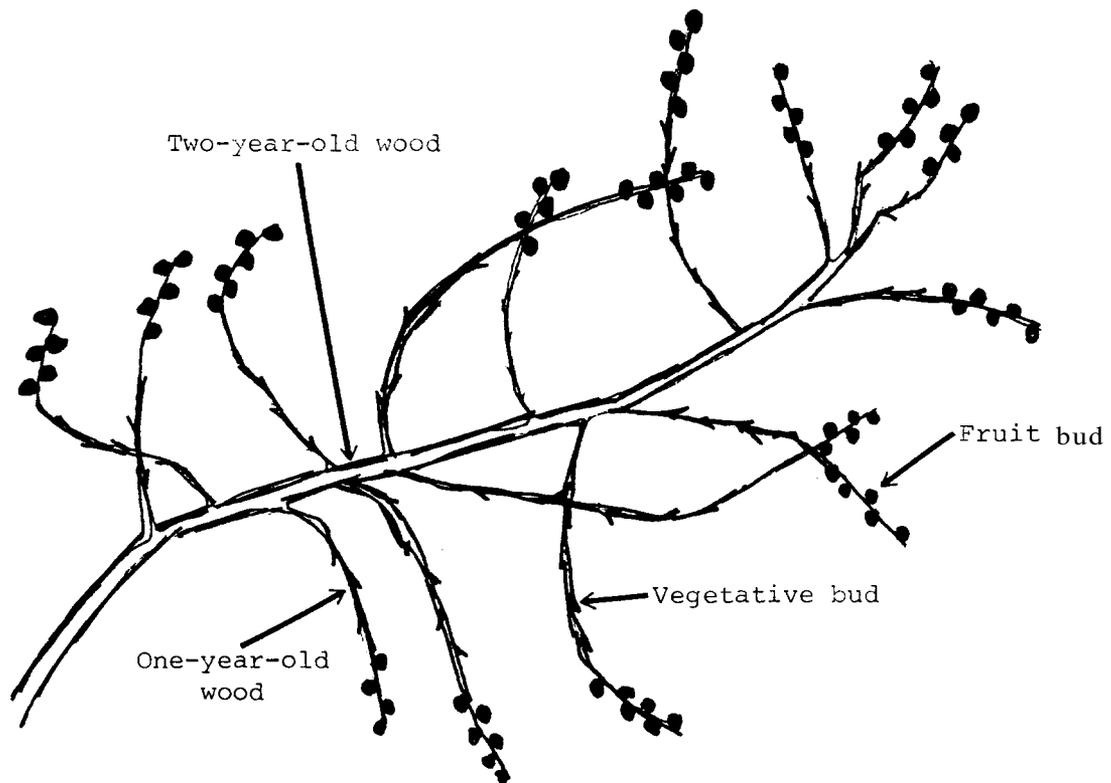
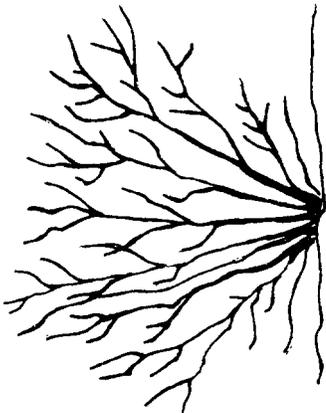
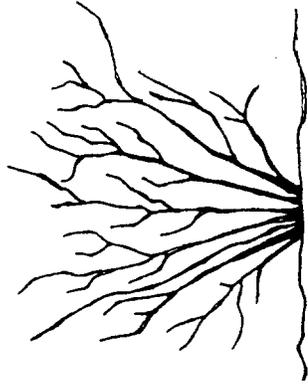


Figure 3. Flower buds of blueberry usually occur near the tips of one-year-old wood.

A Before pruning

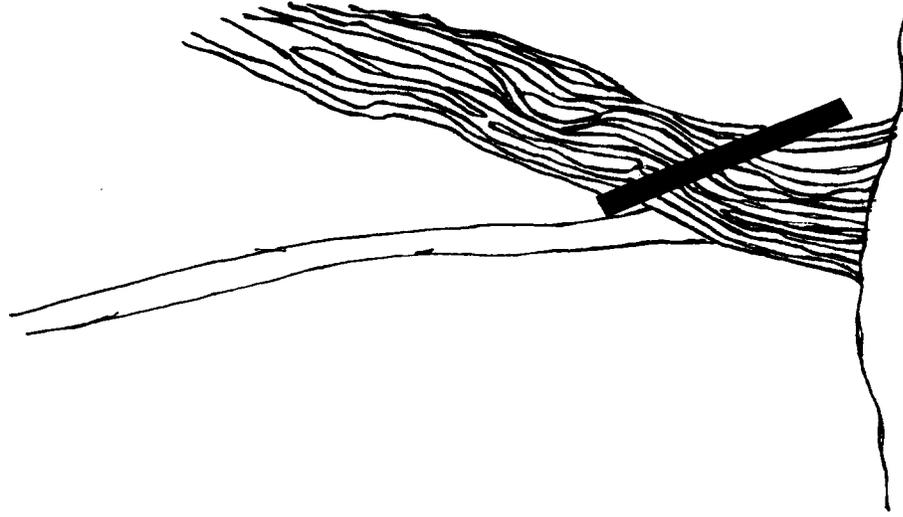
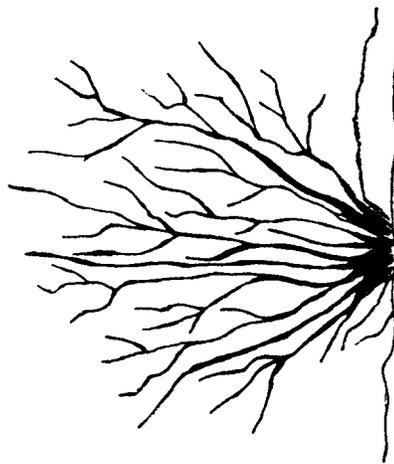


B After pruning



3rd year

5th year



C. Head back an old cane to a strong lateral near the ground.

Figure 4. Pruning a mature blueberry plant involves the removal of damaged or diseased limbs. Remove 20% of the old canes and retain only the strong, properly placed canes. Head back twiggy growth from the top and outer parts of the plant.

cultivars such as 'Bluecrop', 'Blueray', 'Collins', 'Earliblue', 'Jersey', and 'Patriot' tend to grow upright, and therefore should be pruned to encourage spreading growth.

If your plants tend to overbear and produce small berries, tip back some of the small shoots carrying a heavy load of fruit buds. Blueberry plants which have an excess number of flower buds compared to vegetative buds may experience a delay in the opening of vegetative buds, insufficient early foliage, and/or reduction in fruit size. Under these circumstances, cutting off about one-third of the fruit buds may reduce yield, but will increase the size of individual berries.

Extremely old and neglected blueberry bushes may be reinvigorated in a different manner by removing all above-ground growth. In Michigan, cutting off unproductive (1.5 tons/acre) 26-year-old highbush blueberries at the ground reinvigorated the bushes to yield 5 tons/acre after two years and 8 tons/acre after four years.

## **BRAMBLES**

Blackberries and raspberries may be distinguished by the fact that the receptacle (inner core) of the blackberry, but not the raspberry, is eaten with the fruit. There are basically three kinds of blackberries: erect, semi-erect, and trailing. Most erect blackberries have thorns, and most semi-erect and non-erect are thornless. There are three kinds of raspberries; black, purple, and red. Yellow raspberries are handled the same as reds. The vast majority of raspberries possess thorns.

The brambles are perennial in that new canes are produced each year. The canes themselves, however, are biennial in nature in that canes grow vegetatively one year (primocanes) and bear fruit and die the following year (floricanes). The only exception to this rule applies to primocane bearing raspberries such as 'Heritage', whose canes grow and bear fruit the same year.

Brambles require conscientious pruning if consistently high yields are to be attained. All brambles have to be confined to a designated in-row width (usually 1 foot) by removing primocanes arising between rows. Suckers that develop between rows should be pulled out (not cut out) during the summer. If the rows are allowed to get too wide, harvesting becomes difficult and the inside plants cannot get the care or sunlight necessary to produce high quality berries.

The primocanes and floricanes of many cultivars may have to be thinned within a row as well.

**Erect blackberries.** After planting in spring, the erect blackberries do not produce an erect hedgerow the first season, but rather relatively small, semi-erect plants. The next year, these small plants will fruit and the new primocanes will be erect. Pruning erect blackberries ('Shawnee', 'Cherokee', 'Cheyenne', 'Darrow', etc. ) during this second year entails removing a few inches of the tip of the primocanes when they reach a height of 36 to 48 inches (summer tipping) to stiffen the canes and induce lateral branching. Primocanes that form in subsequent years should be pruned in a similar manner. Pruning may be accomplished with hand or mechanical pruners. Mechanical pruners such as a sickle bar mower can be operated off the PTO of a tractor.

During the following late winter or early spring, remove weak or diseased canes. Weak canes are typically less than 1/2 inch in diameter.

These last summer's primocanes should be thinned to approximately one per 2 inches in a foot wide row. Shorten laterals to lengths of between 12 and 16 inches to promote larger fruit and facilitate harvesting since most of the fruit will be borne on these laterals ( Fig. 5 ) Remove low lying laterals. Remove floricanes anytime after fruiting through the following spring.

Training thorned erect blackberries to a trellis is usually not necessary, but a trellis about 4 feet high may be helpful under circumstances of high vigor, high winds, and/or heavy fruit load.

**Semi-erect and trailing blackberries.** Eastern thornless blackberries ( ie. Hull', 'Black Satin', 'Dirksen', 'Chester', etc. ) are semi-erect and must be grown on a trellis (Fig. 6-10). Many growers choose to construct a trellis similar to that used for grapes. A one wire system is satisfactory, but many growers prefer a two wire system for easier training and harvesting. Wires should be located about 3 and 6 feet from the ground.

The most common training systems in the Midwest are the fan system (Fig. 6) and the arm system (Fig. 7). The fan system basically entails tying the canes to the trellis in a fan-like pattern. During the summer, the primocanes are clipped 6 to 10 inches above the top wire, thereby initiating lateral branch development along the length of each cane. During the early spring, select eight to ten of the strongest canes per plant and tie them to the trellis. Remove additional canes as well as any diseased wood. Low-lying laterals

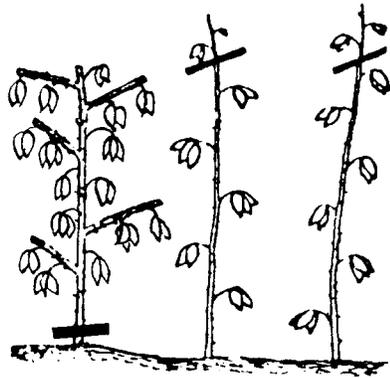
are removed; otherwise, they will bend to the ground when they bear fruit in the summer. Prune the remaining laterals to between 18 and 24 inches in length. Remove two-year-old wood (floricanes) after fruiting. This system is most practical for semi-erect varieties where there is not a lot of empty space between plants (Fig. 6). The arm system resembles the 4-arm Kniffen system for grapes (see grape section). Canes are tied to either side of both the top and bottom wires (Fig. 7), and are tipped only when they intrude on neighboring plants.

The arc system is often used both to fill in empty areas in the row and to propagate new plants by tip layering (Fig. 8). Long unbranched canes are allowed to grow 12-15 feet long. These canes are tied to the top wire and are allowed to arc gradually toward the ground where they are secured to the bottom wire about 5 feet away from the base of the plant. If the arc system is to be employed without the objective of tip layering, simply tip the canes 12-18 inches above the ground. Although this training system is not often used on a large scale, it is simple and rapid.

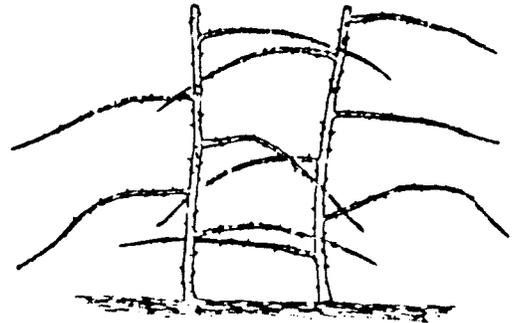
A third system often employed on the West Coast may be called the multiple cordon system (Fig. 9) which is most appropriate for the so-called trailing cultivars such as 'Boysen', 'Logan', and 'Young', which do not develop thick, upright growing canes. This system allows these cold tender cultivars, which often sustain winter injury, to escape temperature extremes. This is accomplished by allowing primocanes to grow along the ground, enabling a hay or bark chip mulch to be applied directly over them. The following spring, the mulch is removed and the canes are tied along the wires in one or both directions. The floricanes need be tipped only if they intrude on neighboring plants. After harvest, remove all floricanes. The trellis remains bare until the spring, at which time last season's primocanes are lifted from the mulch and tied to the trellis. This system would not be used with 'Hull', 'Black Satin', 'Dirksen', or 'Chester'.

The double curtain system, illustrated in Fig. 10, maximizes sunlight interception and makes harvesting more efficient. This training system, which is presently considered experimental, involves securing primocanes and floricanes to opposite sides of a "T" type trellis. The "T" bar is parallel to the ground and about 3 to 4 feet in length. The double curtain will lend itself well to U-pick operations and perhaps mechanical harvesting since the fruit need only be picked every other row middle if the order of primocanes and floricanes is such that the row middles are always flanked by canes of the same age. Vigorous cultivars such as 'Hull' or 'Black

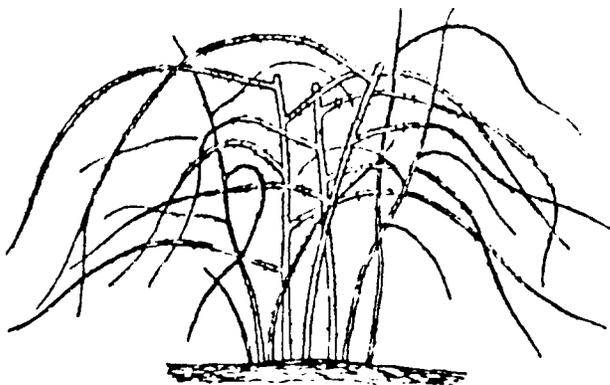
Figure 5. Pruning erect blackberry, black raspberry or purple raspberry.  
 Adapted from: Klingbeil G. C., E. K. Wade and C. Koval. 1976. Wisconsin raspberries. Wisconsin Coop. Ext. Bull. No. A 1610.



A. Remove old floricanes after harvest. Summer tip primocanes at 36 to 48 inches for blackberries. Tip a 30 to 40 inches for black or purple raspberries if supported by a trellis and 24 to 30 inches if not supported.



B. The result of summer tipping is the growth of laterals,

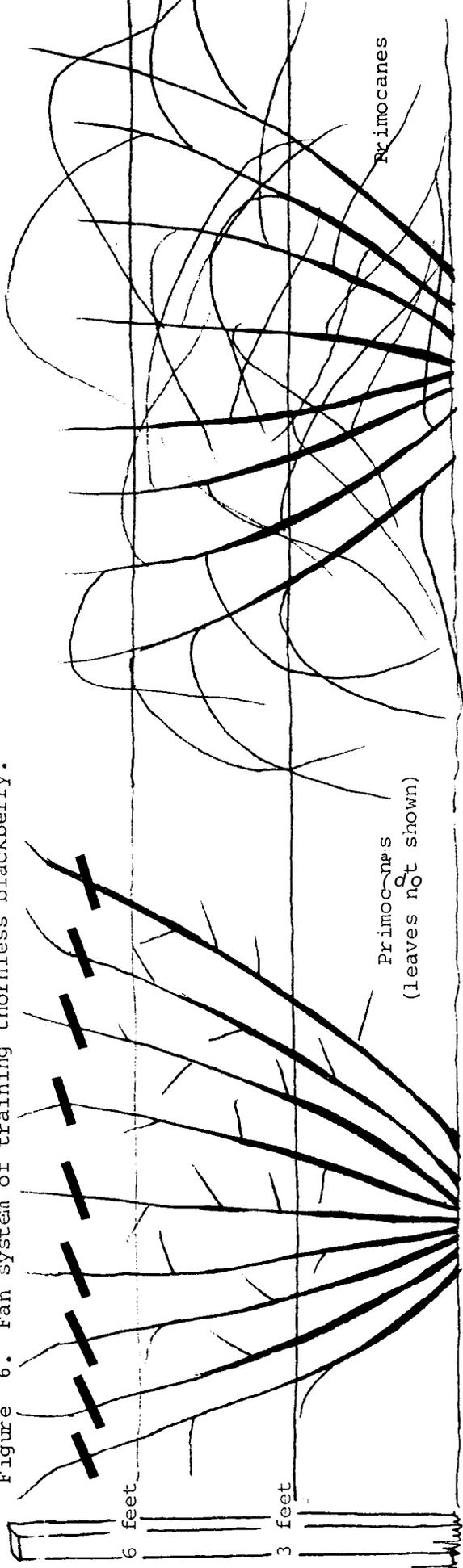


C. The appearance of blackberry or black or purple raspberry in the dormant season is depicted above.



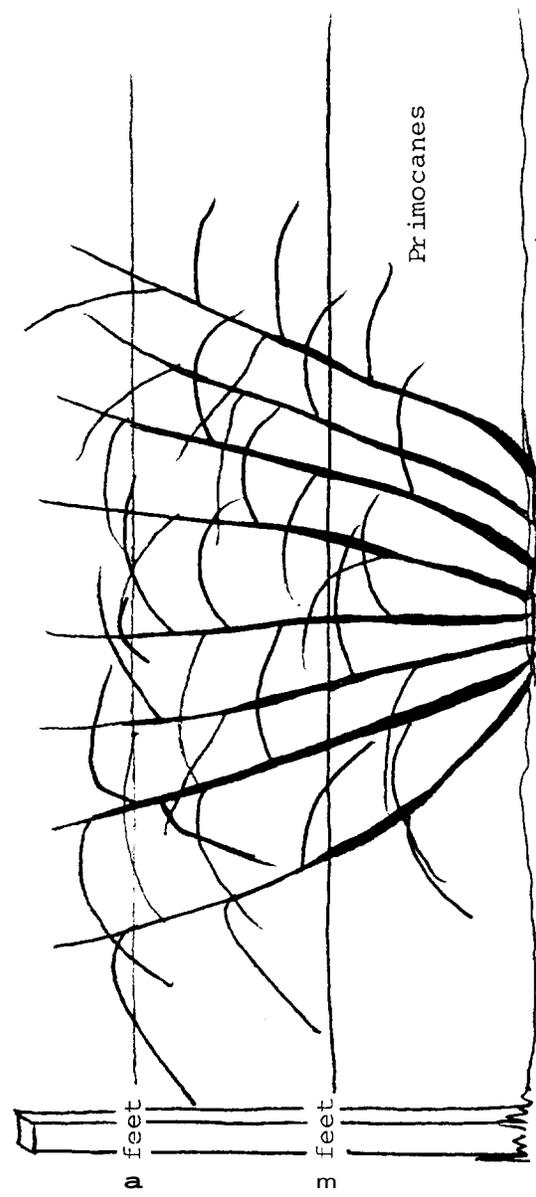
D. Thin to leave 6 healthy canes per square foot. Head blackberry laterals back to 12 to 16 inches and black and purple raspberry laterals to 7 and 12 inches, respectively.

Figure 6. Fan system of training thornless blackberry.



A. During midsummer, tip primocanes 6 to 10 inches above the top wire to induce lateral branching. Maintain 8 to 10 canes per plant.

B. Prune laterals to 18 to 24 inches and remove low lying laterals in the dormant season. Remove any weak, diseased or extra canes at this time.



C. The drawing above depicts a plant after dormant pruning. Next summer, remove the floricanes after harvest and train primocanes again as in A, B, and C.

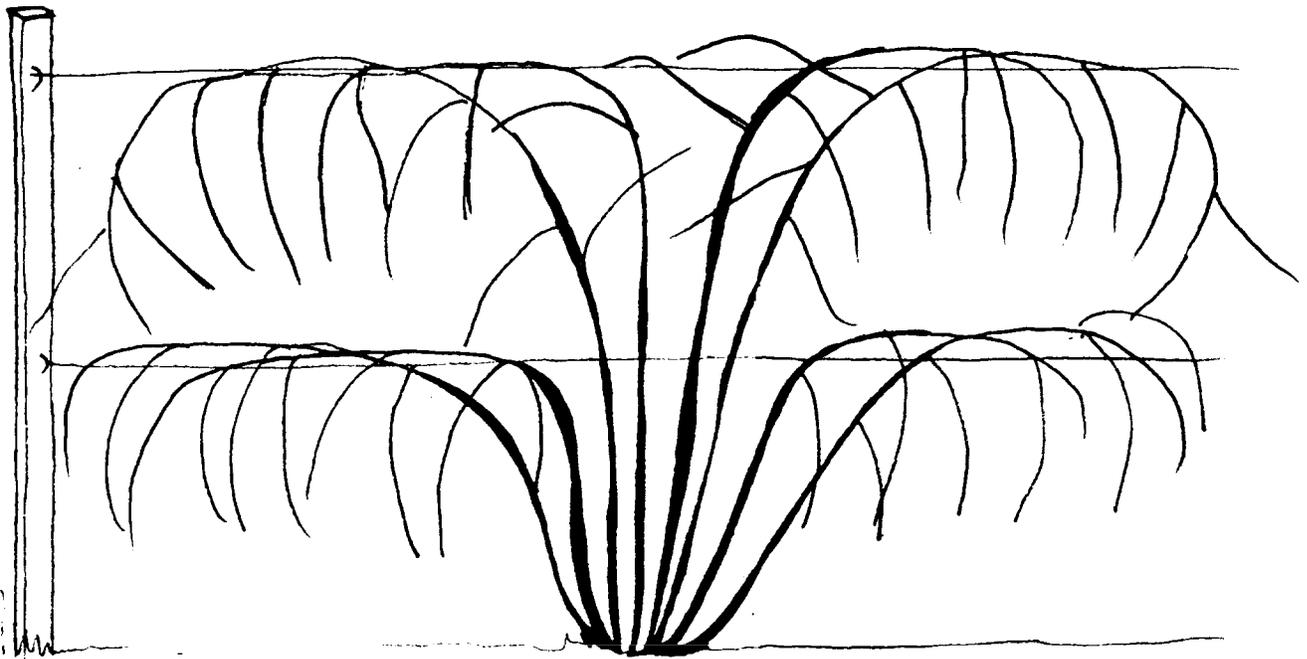


Figure 7. Arm system of training thornless blackberry. In the arm system, tip primocanes when they intrude on neighboring plants. Tie primocanes to wire as above. Tip laterals between 18 and 24 inches in the dormant season. Remove floricanes after harvest.

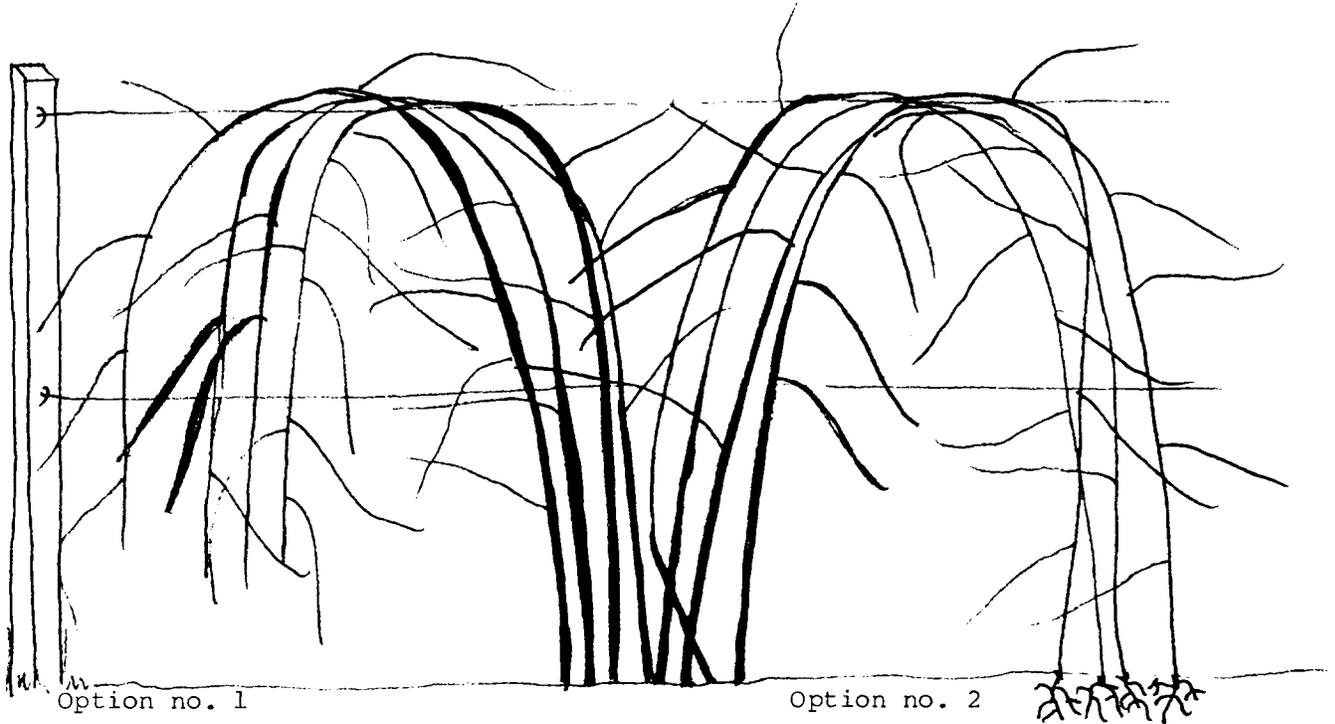
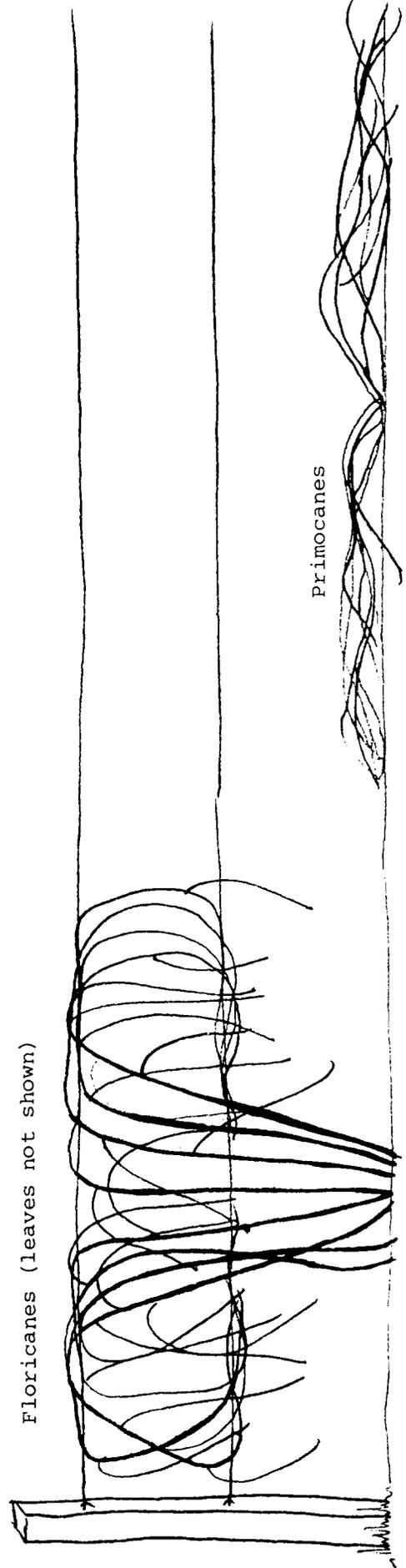


Figure 8. Arc system of training thornless blackberry. The arc system in midsummer involves either allowing the primocane tips to root at least 5 feet away from the base or tipping the primocanes 18 inches from the ground. Tip laterals between 18 and 24 inches in the dormant season. Remove floricanes after harvest.

Figure 9 Multiple cordon system of training thornless blackberry



A. In midsummer of the first year, the primocanes are allowed to grow along the ground. D. Mulch the primocanes in winter



C. Next spring, remove the mulch and train new floricanes up to the wire. Allow new primocanes to grow along the ground.

D. Remove floricanes after harvest. Mulch the primocanes in winter.

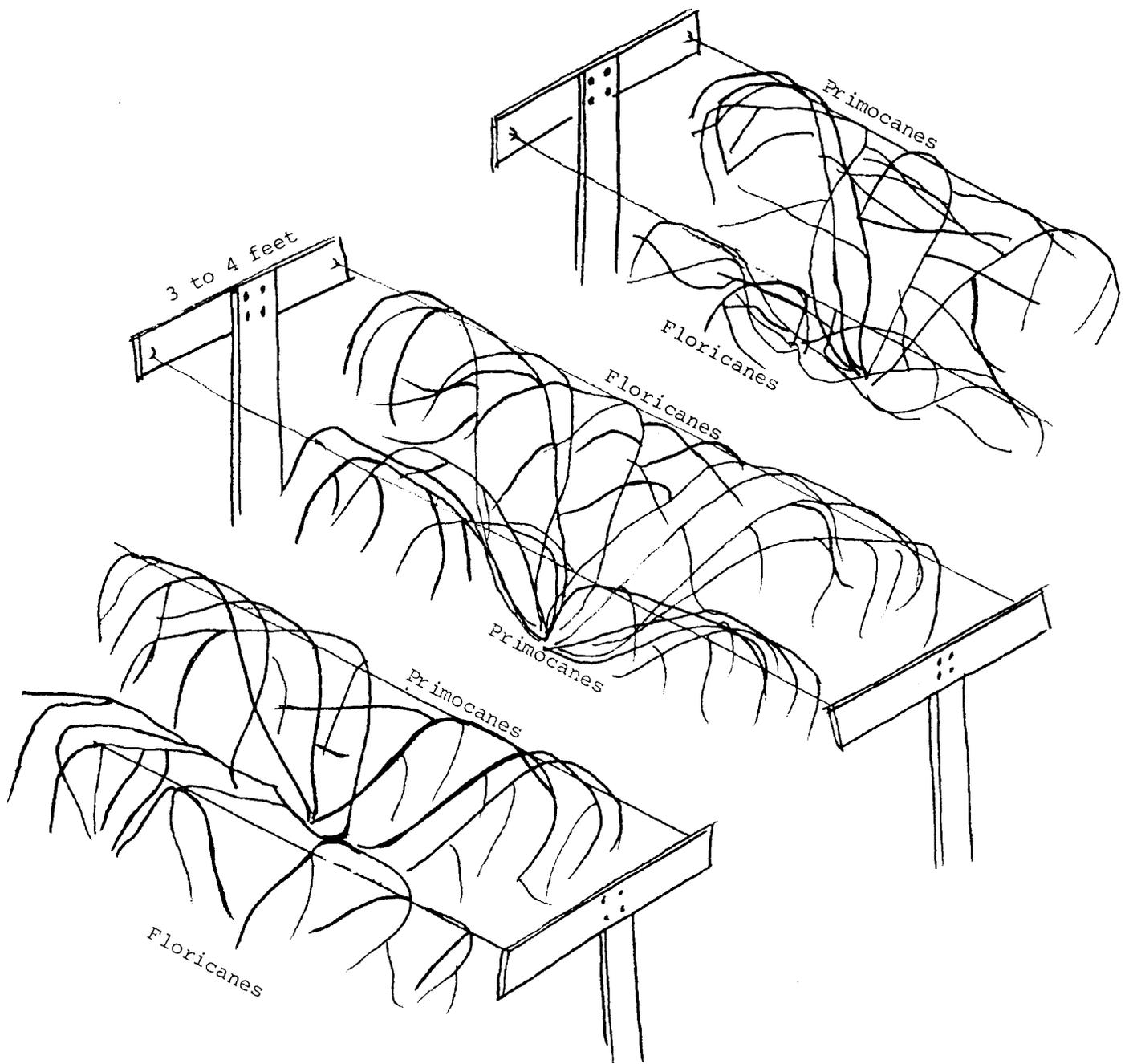


Figure 10. Double curtain system of training thornless blackberry. Primocanes are tied to one side of the trellis while the floricanes are tied to the other side. Each row middle is flanked by canes of the same age.

Satin' grown in a fertile soil would probably be best adapted to this system. Primocanes should be tipped to induce lateral branching when they reach about 9-10 feet in length. The resulting lateral branches need not be shortened, but instead they should be allowed to hang down from the top wire. By placing the top wire at 4 1/2-5 feet instead of 6 feet in height, canes can be tipped sooner, thus producing longer laterals and facilitating hand harvesting. The establishment costs may be slightly greater than the other training systems.

**Black and purple raspberries.** Pruning of black raspberry (e.g. 'Bristol', 'Jewel', 'Cumberland', 'Blackhawk', etc.) and purple raspberry (e.g. 'Royalty', 'Brandywine', etc.) is very similar to pruning erect blackberries. Generally black raspberries are managed as separate plants and purples, depending on the cultivar are managed as separate plants or as a hedgerow.

In the early summer, tip the new shoots when they are about 30 to 40 inches high if they are supported by a trellis. If they are not supported, tip them between 24 and 30 inches (Fig. 5). The following spring, side branches should be shortened to 7 and 12 inches for black and purple raspberries, respectively. Remove the old fruiting canes after harvest. During dormancy, thin the primocanes to about 6-8 per plant or 6 canes per square foot.

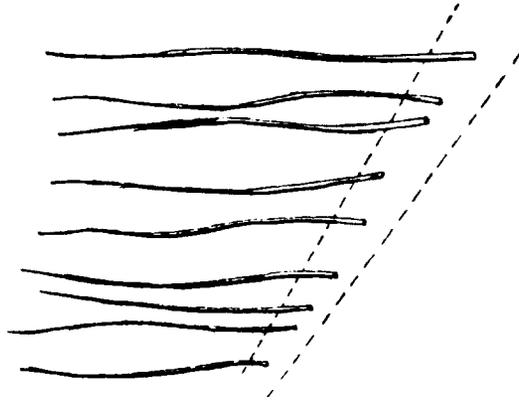
Black and purple raspberries propagate themselves by tip layering as discussed in the thornless blackberry section. This can be used to advantage if new plants are desired; however, failure to prune may result in uncontrolled tip layering, and, subsequently, a planting getting out of bounds.

**Summer bearing red raspberries.** Summer bearing red raspberries such as 'Reveille' and 'Latham' are not pruned the first year and as a result, produce long unbranched canes (Fig. 11). The following early spring they are tipped to between 4 and 6 feet in height in order to keep the canes upright with a heavy fruit load. Tipping can be toward the high end of this range if the plants are supported by a wire trellis. After the fruit is harvested on these two-year-old unbranched canes, remove them at the soil line. Summer bearing red raspberry primocanes are never summer tipped, because their response to this is unfavorable.

Figure 11 Pruning of summer bearing red raspberry. Adapted from: Klingbeil, G C , E K Koval, and C. Koval. 1976. Wisconsin raspberries. Wisconsin Coop. Ext. Bull. No. A 1610.

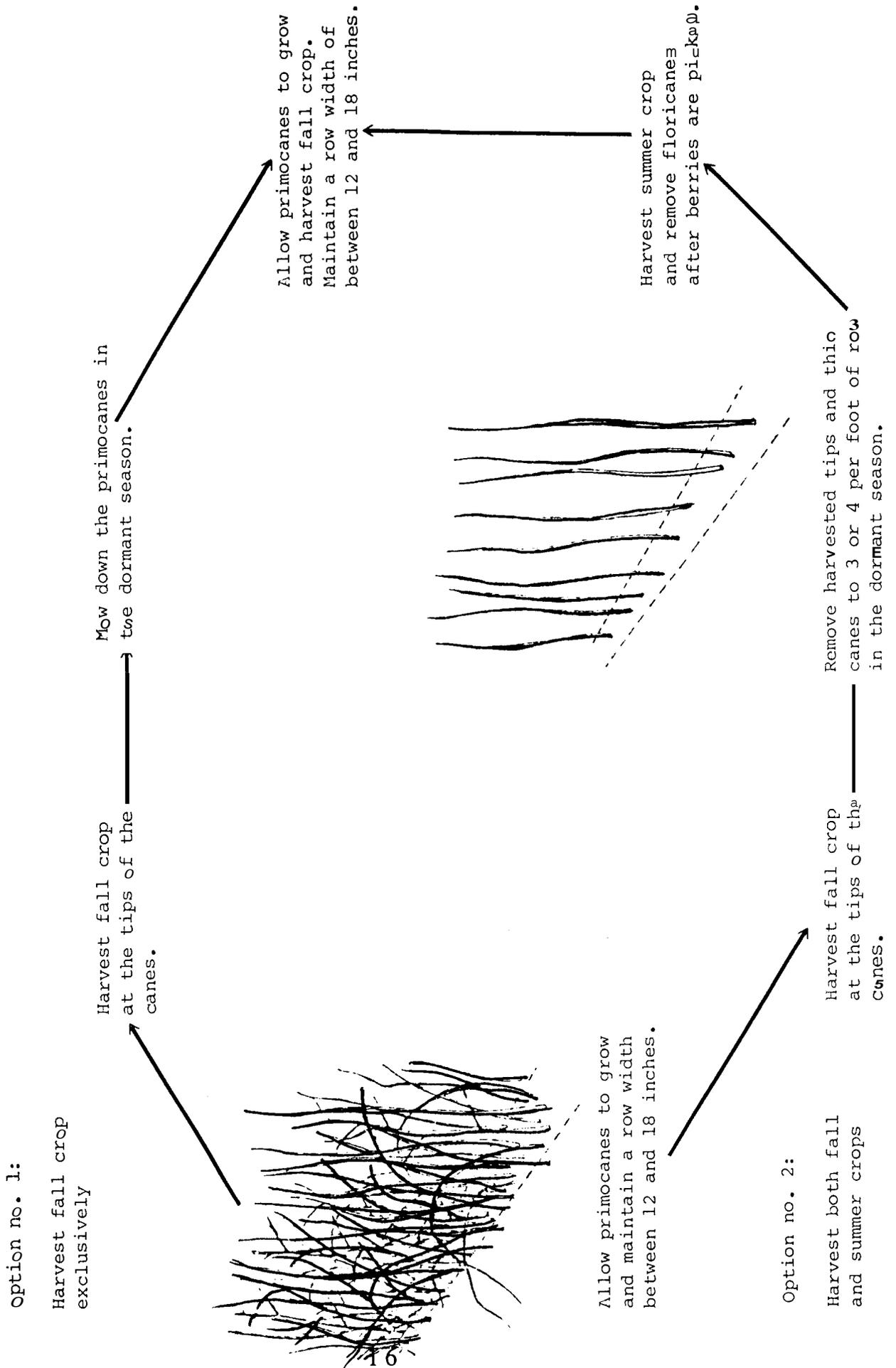


A. Summer bearing red raspberries are not pruned the first year and long, unbranched canes result.



B. In the early spring, canes are thinned to 3 or 4 per foot of row and tipped to between 4 and 6 feet. Row width is maintained at 12 to 18 inches. Primocanes may be thinned in the summer instead of the following spring but are never summer tipped. Remove floricanes after harvest.

Figure 12 Everbearing raspberry pruning specifications. Adapted from: Klingbeil, G. C., E. K. Kovalevskaya, and C. Kovalev. 1976. Wisconsin raspberries. Wisconsin Coop. Ext. Bull. No. A 1610.



**Everbearing raspberries.** The so called everbearing red raspberries such as 'Heritage', 'Fallred', 'September', and 'Southland' (also the yellow raspberry 'Fallgold') can be managed in one of two ways; 1) to produce one large, late summer-fall crop, or 2) to produce two separate crops, one in the summer and one later in the fall.

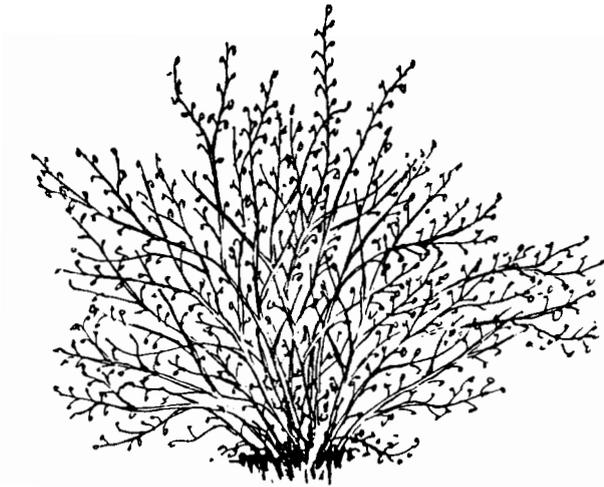
If managing for one large, late summer or fall crop, the planting is mowed to the ground in the dormant season with a bush hog (Fig. 12). This method is preferable to the two separate crop system since it is less labor intensive.

If managing for two separate crops, instead of mowing the entire planting, simply remove the tips of canes where last season's fall crop was borne. Also, prune out any diseased or damaged canes in the dormant season and thin them to 3 to 4 canes per foot of row. After harvesting the summer crop, cut out the old fruiting canes. The fall crop will be borne on the primocanes that newly emerged in the spring (Fig. 12).

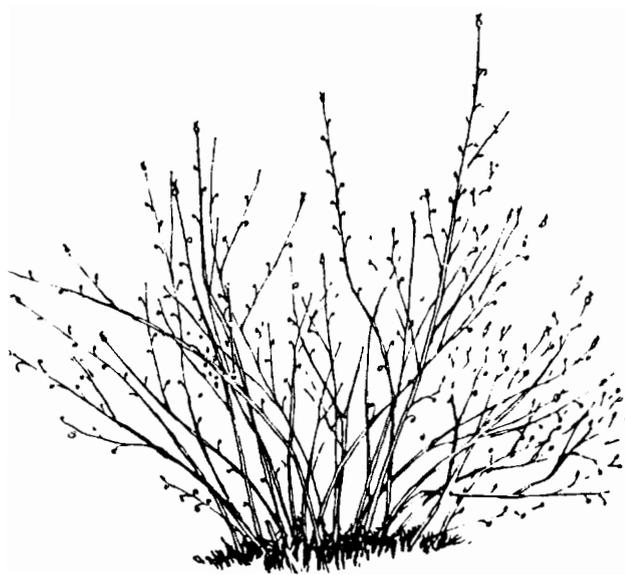
## **GOOSEBERRIES AND CURRANTS**

Gooseberries and currants are pruned to a 3 to 5 foot bush (Fig. 13). The objective of pruning is to select healthy, vigorous canes and to remove weak, diseased, or old unproductive canes. Prune when plants are dormant.

Most of the fruit of gooseberry and currant is borne on spurs arising from one, two, or three-year-old canes, although relatively little occurs on one-year-old canes of currant. Since canes older than three years are less productive, annual pruning should begin after the third year. Removing old canes will stimulate new canes to arise from the crown. Maintain a balance of one, two, and three-year-old wood. Three to five vigorous canes of each age group per plant are recommended. Remove horizontal or low lying branches. Tip canes before they approach 4 to 5 feet in height. It may be necessary to thin out the tops of gooseberries if they become too dense.



Before pruning



After pruning

Figure 13. Remove low lying and spindly growth. Remove branches that are 4 years or older. Keep a balance of 1, 2 and 3 year old canes (about 3 to 5 of each age group). If gooseberry tops become too dense, make heading back cuts in order to open it up. Maintain an overall size of 3 to 5 feet throughout the season. Illustrations from: Stang, E. J., J. Hovland, D. Mahr, and D. Boone. 1982. Growing Currants, Gooseberries and Elderberries in Wisconsin. Bull. A1960. WEX, University of Wisconsin, Madison, WI.

# GRAPES

Pruning is by far the most important cultural operation affecting vineyard productivity. Pruning has a profound influence on berry size, berry quality, yield, vine growth, vigor, and life expectancy.

Many training and pruning systems are in use worldwide with the applicable system dependent upon climate, soil, cultivar, method of harvest, and source and type of market. Desirable pruning systems maximize sunlight exposure to the foliage without interfering with cultural operations. Most of the grape acreage in Missouri is devoted to the American grape cultivars ('Concord', 'Catawba', etc.); however, there is increasing emphasis on European-American hybrids in recent years. Only the 4-arm Kniffen and the cordon systems are discussed herein. For information on other systems consult: Univ. of Missouri Columbia Extension Div. Agricultural Guide 6161, Training Systems for Missouri Vineyards.

## Grapevine Terminology

Apical - youngest portion of a vine part.

Arm - short main branches or extensions from the trunk on which canes or spurs are borne.

Basal - oldest portion of a vine part.

Bud - protuberances on a cane which actually contain the primary, secondary, and tertiary buds.

Cane - dormant woody shoots which contain buds; a shoot which has dropped its leaves in the fall.

Canopy - region occupied by the entire above-ground portion of a plant.

Cordon - arm of the trunk usually trained horizontally along a wire.

Curtain - portion of plant that is shoot-positioned.

**When to prune.** The best time to prune grapes is during March (after the coldest part of the winter but before bud swell). Pruned vines tend to be more susceptible to freezing injury than unpruned vines, so prune the tender vines later than the hardier ones. If temperatures drop considerably below freezing, canes may become brittle and break when they are tied to the wire. Vines pruned in the spring after the sap begins to flow will "bleed" sap, but the consensus is that "bleeding" is not harmful.

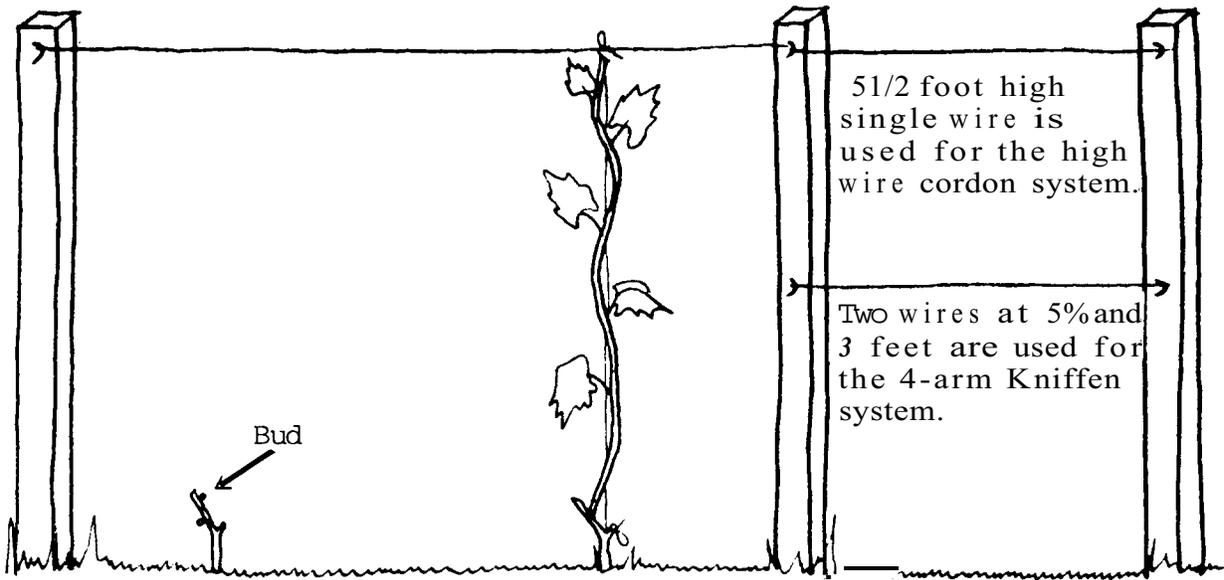
**Making the cut.** Pruning cuts should be clean and smooth since ragged or tom wood requires a longer time to heal. Canes should be cut at a slight angle to the grain. Cuts made at the end of a spur or cane should be about one inch beyond the last bud. This is a good distance of shoot to prevent the last bud from drying out without leaving too long an internode for insects or decay organisms to work on. Pruning wounds to the trunk or cordon should be kept to a minimum since they indirectly contribute to the decline in vine productivity with age.

**Tying.** Canes should be tied to the trellis wire before bud swell so that buds are not easily knocked off. Canes, when extremely cold (below 15 to -20 degrees F), are brittle and easily broken when tied to a wire.

Wrap the canes two or three times around the wire, but be careful not to twist canes excessively. Twine or commercially available grape ties may be used to firmly secure the vine to the wire. Be sure and tie the canes to the wire just before the last bud. Cut the last bud in half so that it will not grow.

**Pruning at planting.** Prune roots at planting time so that the root system will fit into the planting hole without bending. Usually 10 inches deep and 12 inches wide is satisfactory. After planting, retain the healthiest shoot and prune it to two healthy buds (Fig. 14). During the summer, tie the vertical growing shoots to the wire or a vertical stake to ensure that the vine does not flop over and grow crooked. Remove all suckers and grape clusters that happen to form the first summer. If a bilateral cordon training system is to be used, cut the shoot when it reaches the top wire to induce branching a short distance below. You may wish to retain more shoots if you are dealing with a winter tender vine.

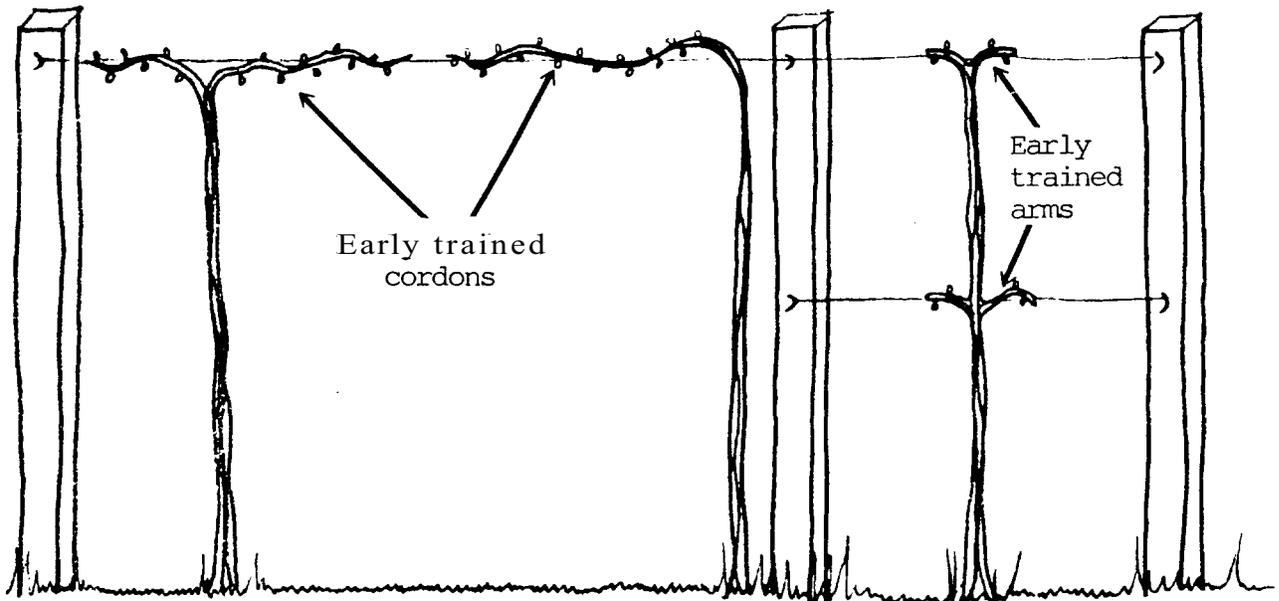
Figure 14. First year pruning and training of grape in the growing season



A. At planting, prune plant to 2 healthy buds.

B. Train plant to a straight trunk and top it when it reaches the 5½ foot wire.

Figure 15. Second year dormant season pruning and training of grape.



A. Bilateral Cordon

B. Single Cordon

C. Four-arm Kniffen

Figure 16. Third year dormant season pruning and training of grape.

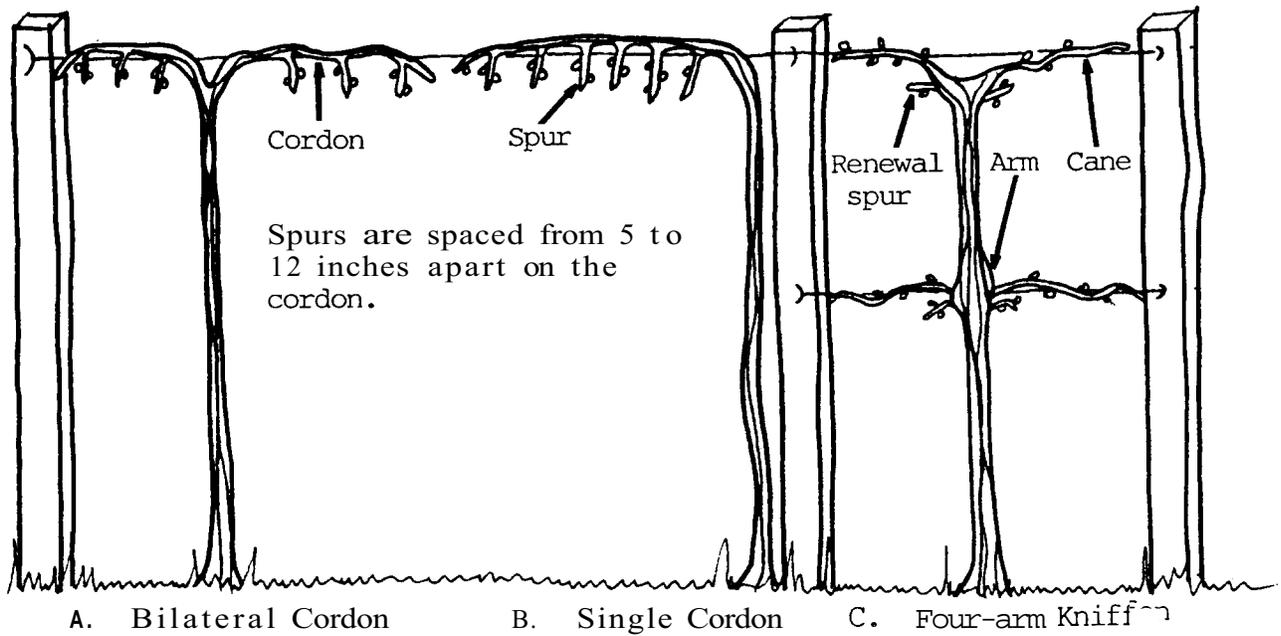
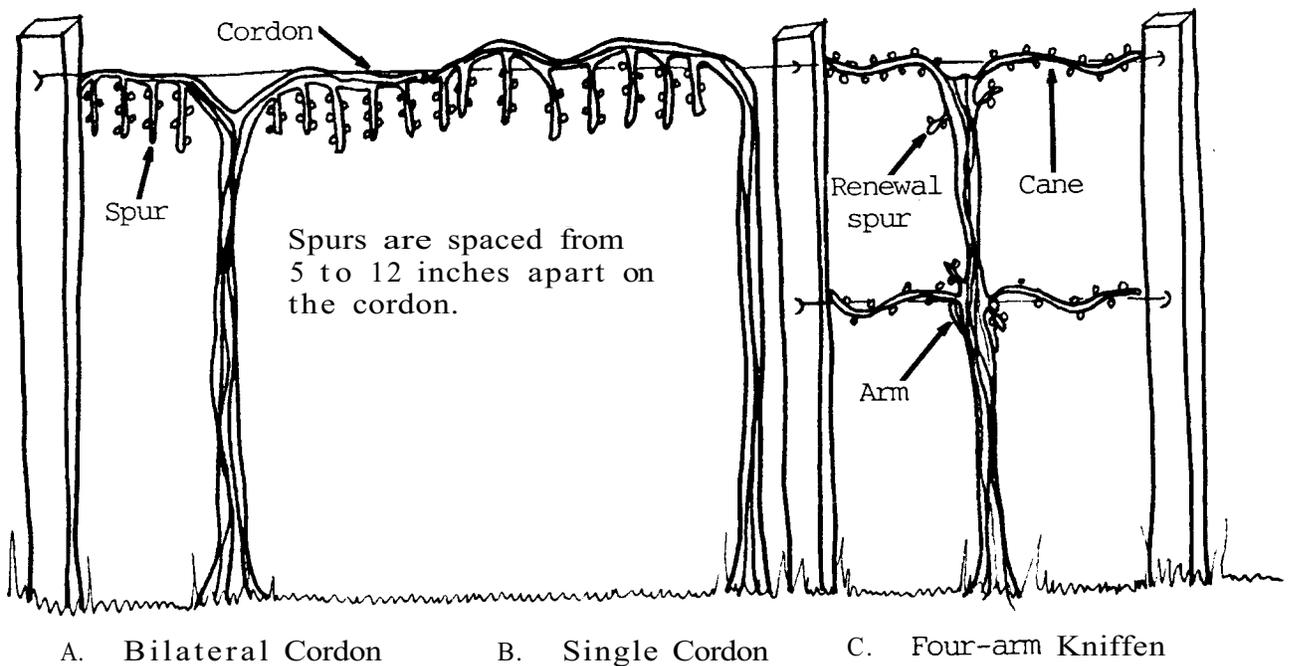


Figure 17. Fourth and subsequent year dormant season pruning and training of grape.



**Second year (dormant season) (Fig. 15).** Select a vigorous and straight cane to become the trunk. Avoid "bull" canes which are very thick. Choose a cane of about pencil diameter. Remove suckers and lateral branches which are improperly positioned. Retain laterals which are required by your particular training method. For instance, two oppositely directed laterals are retained both along the upper and lower wire for a 4-cane Kniffen-trained vine. If a cordon training system is desired, then tip the trunk at the wire as described in the preceding paragraph if you have not done so the previous season. As lateral branches form below the cut, retain the branches desirable for your system and remove all others. Remove all suckers and grape clusters that form the second year.

**Third and subsequent years (dormant season) (Figs. 16 and 17).** The basic vine structure should be formed by this time and you may wish to allow your vines to bear fruit for the first time, although the crop will be light. If, for whatever reason, your vine framework is not yet established, then treat the vine as you would during the second dormant season.

A 4-arm Kniffen trained vine should be pruned to two to five buds on each cane the third year. These buds will bear fruit and form next year's canes. Training during the fourth and subsequent years is described later under the heading Kniffen systems. If winter tender varieties are planted, one, two, and three year old replacement trunks can be maintained as insurance against winter kill. Trunk renewal in general can keep a vineyard vigorous if done approximately every 10 years.

A cordon-trained vine should possess the completed cordon by the third year. Retain only a fraction of the buds of a four-year or older vine. Approximately three to ten fruiting spurs with one or two buds on each may be left on healthy three-year-old cordon-trained vines. Thin clusters to one per shoot early in the growing season.

**Kniffen system.** The 4-arm Kniffen system is the most often used training system for American grapes in Missouri (Fig. 17), although 6-arm Kniffen system or the umbrella Kniffen are occasionally used. A 4-arm Kniffen trained vine consists of a central trunk with two one-year-old canes running in both directions along the upper (5 1/2 feet) and lower (3 feet) wires. During the dormant season, select 4 well-placed, healthy canes with at least 10-15 buds to serve as the canes. A well-placed, healthy cane has the following characteristics: 1) It

emerges from the arm near the trunk. 2) It has a similar thickness near the fifth and tenth bud (about 1/4 inch or pencil diameter). 3) It has a fairly uniform internode length (between 5 and 8 inches). For many cultivars of American grapes, the fourth bud on up to the ninth bud on a cane are most productive. The first two or three buds at the base of the cane and the last several buds near the tip are generally less fruitful in this system; therefore, canes are usually 10 to 12 buds long. Be sure to retain several renewal spurs near the trunk which will serve as next year's canes (Fig. 17).

The exact amount of wood to retain is usually determined by the weight of one-year-old pruned canes. In other words, crop size during the current year is largely dependent upon vine vigor the previous season. Balanced pruning, as it is called, takes into account vine vigor to achieve an optimum balance of crop quality and yield. Initially, the weight of pruned wood will have to be measured with a scale, but with practice, most people simply estimate pruning weight. Only canes produced in the previous season are weighed, not wood that is 2-years-old or older. Prune the vine to about **60** strong buds, then prune the remaining buds to a cultivar dependent formula. The formulas recommended by Larry Lockshin, former State Viticulturist, are listed in Table 1. For instance, a "Concord" vine with a pruning weight of 3 lb. should contain 50 buds after it is pruned. If a greater number of buds than can be accommodated on four canes are required, one may choose a 5 or 6-arm Kniffen system. However, it is preferable to select extra arms on the top wire rather than the bottom wire.

**Cordon system.** European-American grapes are usually trained to a cordon system. A single cordon trained vine has one horizontal branch on one side of the trunk (Fig. 16.) A bilateral cordon trained vine has two horizontal branches, one on each side of the main trunk (Fig. 16). The branches or cordons, as they are called, grow along the upper wire 5 1/2 or 6 feet above the ground (high wire cordon), or grow along the lower wire 2 1/2 to 3 feet above the ground (low wire cordon). Five to twelve fruiting spurs with two to five buds each are spaced approximately 4 to 12 inches apart along a cordon. The exact quantity of spurs chosen will depend largely on vine vigor and in-row spacings.

Shoots, after they become about 2 feet long, should be vertically positioned (combed) in order to prevent shoots from intertwining. Combing will improve the efficiency of cultural operations and increase light utilization. It may be advisable to renew your cordons depending upon winter damage and disease incidence. Simply train another well-positioned shoot near where the old cordons emerge,

**Table 1. Balanced pruning guide for mature Kniffen-trained grapevines.**

Cultivar	No. of buds to retain per pound pruning weight			Maximum no. of buds for plants at 8 foot spacing
	1st pound of prunings	+	Each additional pound of prunings	
Concord	30	+	10	60
Niagara, Catawba, Delaware	25	+	10	60
Most European- American types on long cane pruning*	20	+	10	40
Vinifera*	20	+	20	60

\* These types of grapes require severe de-budding after bud break to adjust the number of growing shoots to the desired amount. Flower cluster thinning may also be needed.

grow it one year, and remove the old cordon the following year. Similarly, an entire trunk can be renewed if desired.

**Geneva double curtain system.** The Geneva double curtain system is discussed in detail in the bulletin by Lockshin mentioned previously. It is depicted in Fig. 18 of this bulletin. This system maximizes sunlight interception by staggering the canopies of the plants in a row. It is applicable to those vigorous cultivars or when plants are grown in conditions of deep soil and high fertility.

**Bud and cluster thinning.** Bud thinning is often required to reduce the fruit load on European-American grape cultivars which have a tendency to overbear. Because of the possibility of winter injury or spring frosts, extra buds are often retained. The buds are easily rubbed off at bud swell; although, one may decide to remove the extra shoots if the excess is noticed after bud swell. If sufficient bud or shoot thinning was not performed, cluster thinning may be used to prevent overcropping and to improve berry quality. Thin to one cluster per shoot, choosing the cluster closest to the base or cane. Besides reducing berry quality, overcropping will also greatly weaken a vine. A cultivar-dependent maximum yield per acre should be set for each site and the number of cluster per vine should be reduced so as not to exceed the maximum.

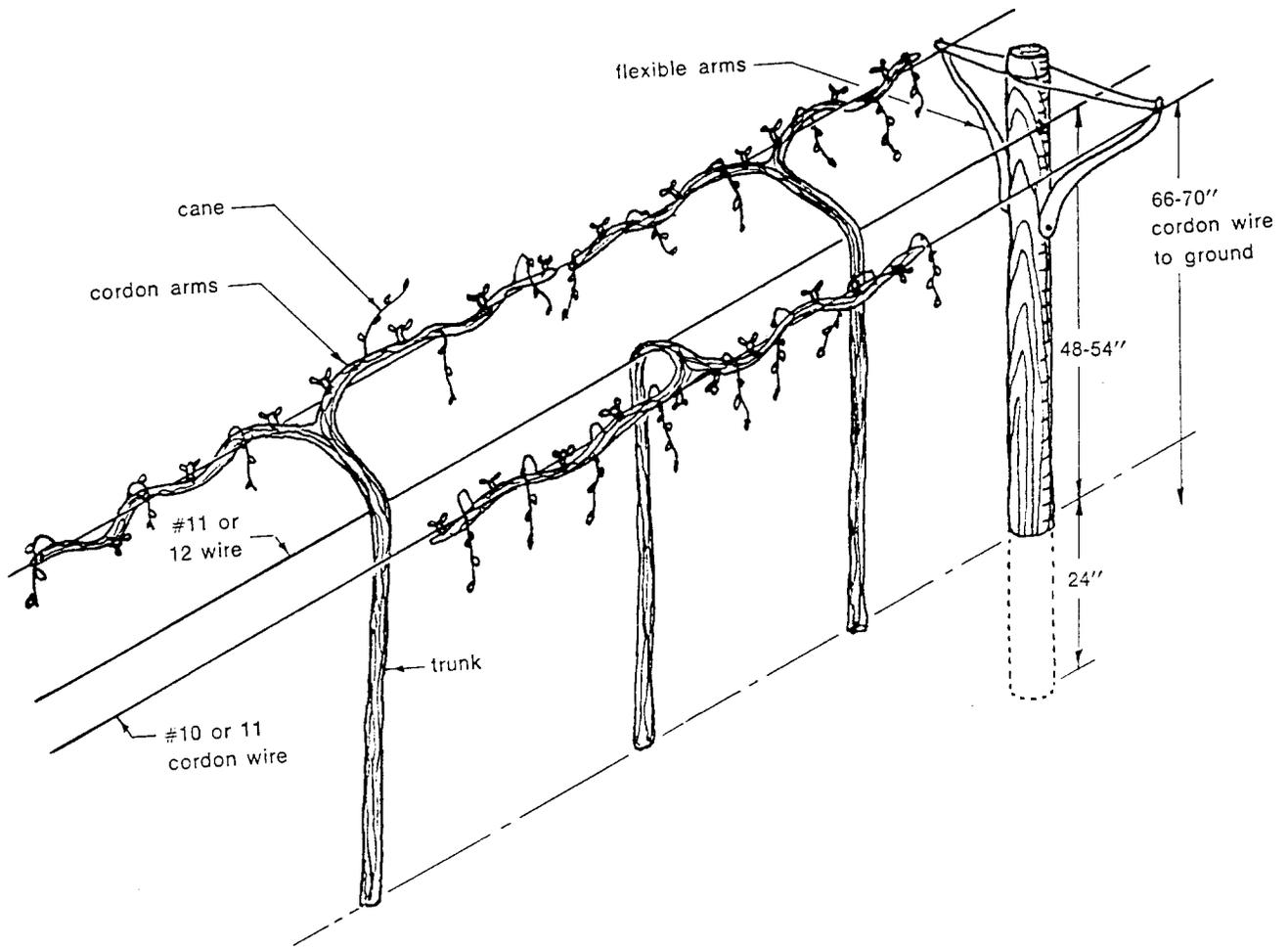


Figure 18. The Geneva Double Curtain system. Adapted from: Trellising and training grapes for production in Washington. March, 1972. Ext. Bull. 637, CES, Coll. of Ag., WSU, Pullman, WA.



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