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VINE TRAINING SYSTEMS FOR WINEGRAPE PRODUCTION IN COOL CLIMATES



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VINE TRAINING SYSTEMS FOR WINEGRAPE PRODUCTION IN COOL CLIMATES

by

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(Graphic Illustrations by Diane Dings)

Vine training systems impact on several aspects of a vineyard operation (Zabadal, 1996). A grower should consider all the ways a training system will influence his/her new vineyard and then choose the specific training system that best fulfills the characteristics of the vineyard. A very large number of vine training systems have been devised. A complete review of all vine training systems would be neither manageable nor useful to the grower of winegrapes in a cool climate. This presentation focuses on those vine training systems for winegrape production in the eastern U.S. cool climate viticulture which have been utilized in the recent past, are used presently or are being evaluated for future use. A review of the evolution of training systems in the eastern U.S. viticulture (Zabadal et al., 1988) and those training systems suited to cool climate production of table grapes (Zabadal, 1996) have been previously presented.

The vine training systems presented below are placed in two general categories, i.e., traditional training systems which are used extensively in the commercial viticulture of the eastern U.S. or non-traditional training systems, which have had modest or no commercial experience in eastern U.S. viticulture. There is no universal training system best suited for all situations (Smart, 1996). This information will hopefully guide growers choose the best possible grapevine training system for their specific vineyard condition.

I. TRADITIONAL TRAINING SYSTEMS

1. Top-Wire Cordon - synonyms: Hudson River Umbrella (HRU); no-tie (when used only with short fruiting canes)

Description: A cordon is situated on the top wire of the trellis. It typically branches from a single or double trunk in the mid-portion of the vine space in both directions to form a bilateral cordon (Fig. 1). A variation of this training system establishes the cordon in one direction only from the trunk of the vine to the trunk of the next vine to produce an inverted "L" shape for cordons and trunk. Fruiting canes may be pruned short and left untied or pruned long and tied to a lower wire (Fig. 1).

Advantages: Adaptable to mechanized pruning; adaptable to unskilled manual pruning; adaptable to shoot positioning; places fruit on the upper portion of the trellis for sun exposure; may require little or no tying.

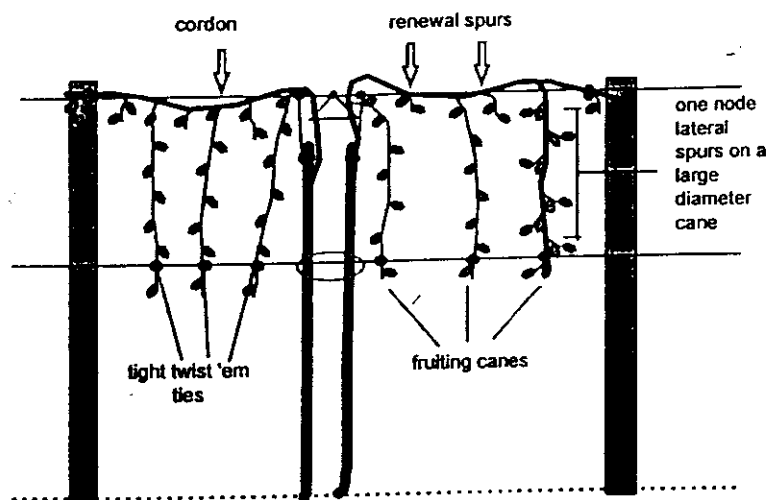


Fig. 1. The Top-Wire Cordon training system. This variation utilizes long canes tied to a lower wire for better vertical distribution of fruit and canopy.

Disadvantages: Tends to reduce vine vigor, especially when used in conjunction with shoot positioning; difficulty in establishing cordons on variety/site combinations subject to frequent winter injury; difficulty in renewing cordons after they have become embedded in the trellis wire; tissues in the cordon region may become a reservoir for diseases such as Phomopsis cane and leaf spot and powdery mildew.

2. **Mid-Wire Cordon** - synonyms; California sprawl (when shoots are not positioned); vertically shoot positioned or VSP (when shoots are shoot positioned in an upward manner).

Description: Cordons are established on a trellis wire which ranges from 30" to 42" above the ground level. Most often these cordons originate from one or two trunks in the center of the vine space and are extended bilaterally (Fig. 2). Two to three node fruiting spurs originate from the upper portion of the cordon. On rare occasion a long so-called "kicker cane" is also retained to add fruiting potential to the vine but this violates the basic structure of this training system.

Advantages: Ease of establishment; adaptable to mechanical pruning or unskilled manual pruning; no tying required.

Disadvantages: The fruiting zone becomes intensely shaded on large vines. The fruit will be highly susceptible to several diseases including Botrytis Bunch Rot unless

canopy management procedures such as leaf removal and/or shoot positioning are practiced; nodes on the fruiting spurs tend to be inferior in regard to hardiness and fruitfulness because they tend to develop in a shaded condition; the cordon may be difficult to maintain when the variety/site combination is subject to frequent winter injury; yield and fruit quality can be less for large vines in cool climates than for other training systems; difficulty in renewing cordons while keeping adequate numbers of fruiting nodes.

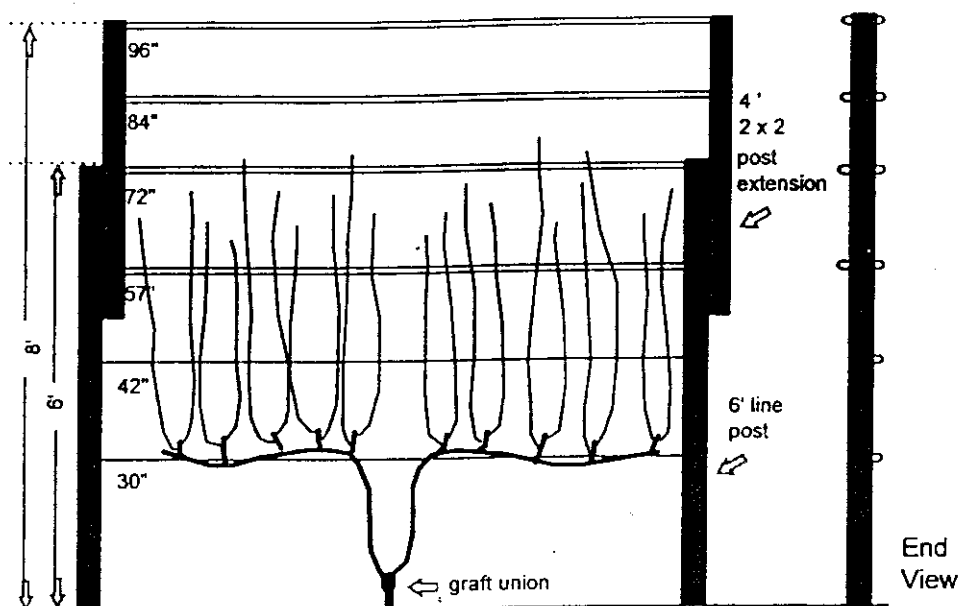


Fig. 2. The Mid-Wire Cordon training system on an 8 foot trellis.

3. Four Arm Kniffin

Description: Four long fruiting canes are utilized. Two canes are attached to each of two trellis wires. They extend bilaterally from one or more centrally located trunks (Fig. 3). These canes ideally originate just below the wire to which they will be tied. Renewal spurs are retained below the fruiting canes to serve as sources of future fruiting canes in succeeding years. The location of the two fruiting wires is variable. The original design of this training system by William Kniffin placed two fruiting canes on the top wire of the trellis and the other two fruiting canes on a wire 20" to 24" below the top wire (Fig. 3). This is the recommended variation of this training system. Some have preferred to establish the four fruiting canes on wires lower on the trellis. Another variation is a 6 arm Kniffin training system which situates 6 fruiting canes on three wires. This training system is still widely used in eastern Canadian viticulture.

Advantages: Ease of pruning to long fruiting canes; vertical distribution of fruit on the trellis; more compatible with tolerating winter injury than systems utilizing cordons.

Disadvantages: Requires annual tying of canes; not adaptable to mechanized pruning; difficulty maintaining node fruitfulness and ripening fruit on the lower fruiting wire of large vines; not compatible with systematic leaf removal or shoot positioning.

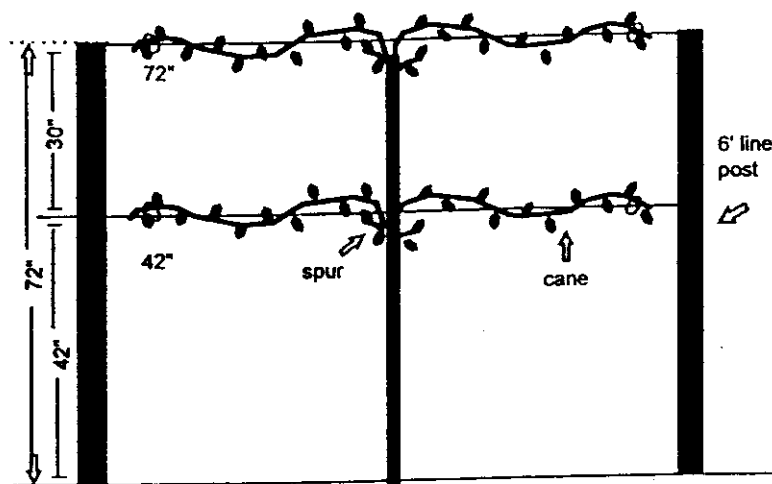


Fig. 3. Four-Arm Kniffin training system on a standard two wire trellis.

4. Modified Keuka High Renewal

Description: A variable number of long fruiting canes are utilized. They originate from one or more centrally located trunks. The head region of the vine tends to be located in the low to mid-portion of the trellis with canes extending up and out from that region (Fig. 4). Renewal spurs are retained in the head region for the development of future fruiting canes. Tying of these canes ranges from extending them relatively horizontally and tying them on a trellis wire to angling them up and attaching the end of canes to a fruiting wire higher on the trellis (Fig. 4).

Advantages: Very compatible with frequent replacement of vine parts in response to frequent winter injury.

Disadvantages: Requires annual tying of long canes; the flexible nature of this training system is difficult for inexperienced pruners to comprehend and practice; this system is not adaptable to mechanized pruning; the system is not adaptable to canopy management strategies such as leaf removal or shoot positioning.

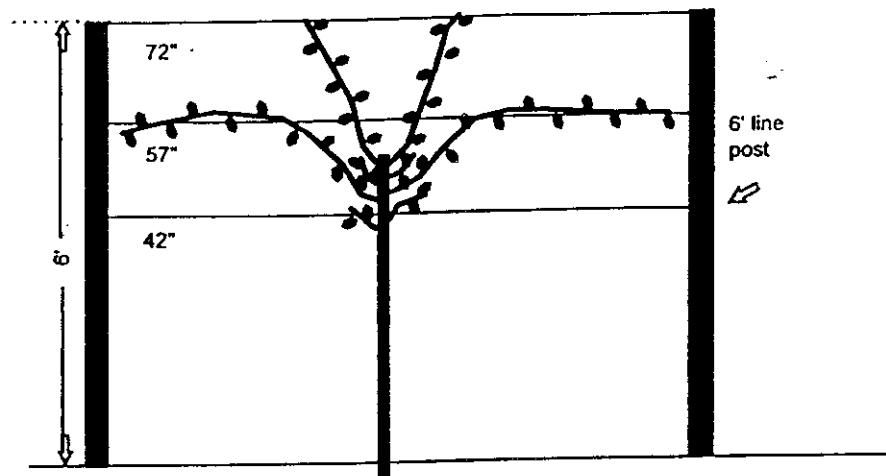


Fig. 4. A Modified Keuka High Renewal training system which utilizes long canes which originate from a central head region of the wire.

5. Umbrella Kniffin

Description: Long fruiting canes are utilized. They originate from a head region in the upper portion of the trellis. As originally conceived, these canes originated above the top wire of the trellis. Today the canes tend to originate below the top wire of the trellis (Fig. 5). It is recommended that fruiting canes originate as close to the top wire of the trellis as possible. One or more trunks are utilized. Renewal spurs are retained in the head region for future fruiting canes. Fruiting canes are tied by extending them over the top wire and then down to a lower wire on the trellis. The distance between these two wires ranges from 18" to 30" depending upon the variety and the length to which mature fruiting canes can be pruned.

Advantages: A relatively easily learned system for hand pruning; places the fruit relatively high on the trellis for exposure to sunlight; distributes fruit vertically on the trellis better than the cordon systems, which utilize short cane pruning; requires simple trellis construction with as little as two wires; can utilize very long fruiting canes to obtain highly fruitful nodes.

Disadvantages: Requires annual tying of canes; not adaptable to mechanized pruning; less adaptable to shoot positioning than cordon training systems.

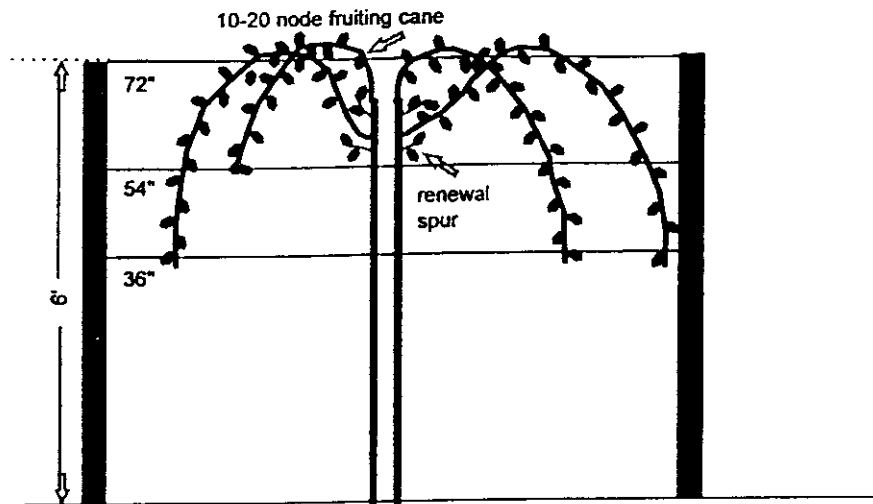


Fig. 5. The Umbrella Kniffin training system on a standard 3-wire trellis.

6. Fan Training

Description: Long fruiting canes are extended in a slanted upward and outward orientation from the base of the vine (Fig. 6). Canes may originate directly from the ground level or may originate from trunks at various heights on the trellis. Typically used with multiple trunks of different ages. Many renewal spurs are retained near the ground level just above the graft union on grafted vines as a source of future canes and/or trunks.

Advantages: Maximum flexibility to adjust to frequent winter injury due to the retention of minimal permanent vine parts; easily learned manual pruning.

Disadvantages: Requires annual tying; relatively unstructured vine is not adaptable to mechanical pruning; unstructured vine is not adaptable to canopy management strategies such as shoot positioning or leaf removal.

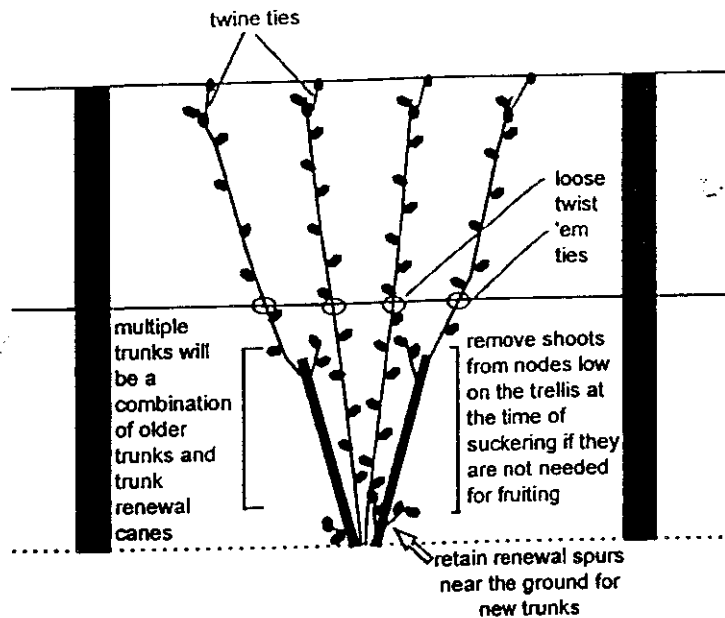


Fig. 6. The Fan training system which provides maximum flexibility in response to frequent winter injury.

II. NON-TRADITIONAL TRAINING SYSTEMS

The vine training systems presented in this section are those that have not been extensively used in eastern U.S. winegrape culture. They may be very old systems such as the European Guyot and Pendlebogan systems, they may be experimental training systems such as the modified Umbrella Kniffin or they may be relatively new, untested systems in eastern U.S. viticulture, such as the Smart-Dyson. They are presented here to acquaint growers with these options for training vines. Whenever possible, comment is made on the author's experience with these systems.

7. Scott Henry

Description - This highly innovative system divides the vine canopy vertically into upper and lower fruiting zones. Two fruiting wires are located 8" to 12" apart in the mid-portion of the trellis. Shoot growth from fruiting canes on these wires is positioned upward and downward to achieve a totally open horizontal band in the mid-portion of the trellis. Several variations of vine structure have been utilized to create this training system. These include: (a) using alternating vines with long canes to fruit the upper or lower fruiting wires (Fig. 7a); (b) using four trunks per vine, each supporting one fruiting canes. Each vine fills both the upper and lower fruiting wires within its own vine space. This is essentially a four-arm Kniffin training system that is then subjected to upward and downward positioning of shoots (Fig. 7b); (c) alternating vines on the upper and lower fruiting wire and utilizing spur pruning rather than long canes for fruiting (Fig. 7c).

Advantages: This system promotes the systematic display of a large canopy while also promoting good exposure of the fruit to sunlight. If the fruiting areas are established

with cordons and spur pruning, there is the potential for mechanizing a portion of the pruning task; hand harvest is facilitated with the systematic placement of fruit in locations that are well exposed and convenient for picking.

Disadvantages: Vines dedicated to the lower fruiting wire may produce fruit that is significantly lower in soluble solids accumulation than fruit on vines dedicated to the upper fruiting wire; vines dedicated to a lower fruiting wire may decline in vine size and be subject to significantly more winter injury than those dedicated to the upper fruiting wire; shoot positioning is required; construction of a taller than normal trellis is required for best performance of this training system.

Comment: Despite its disadvantages, the Scott Henry training system has performed well in two years of trials in Michigan. It is recommended that this system be utilized only with variations, which utilize the upper and lower fruiting wires with each vine. Spur pruning of a cordon may work well for the upper fruiting wire but it will often be necessary to use long cane pruning for the lower fruiting wire.

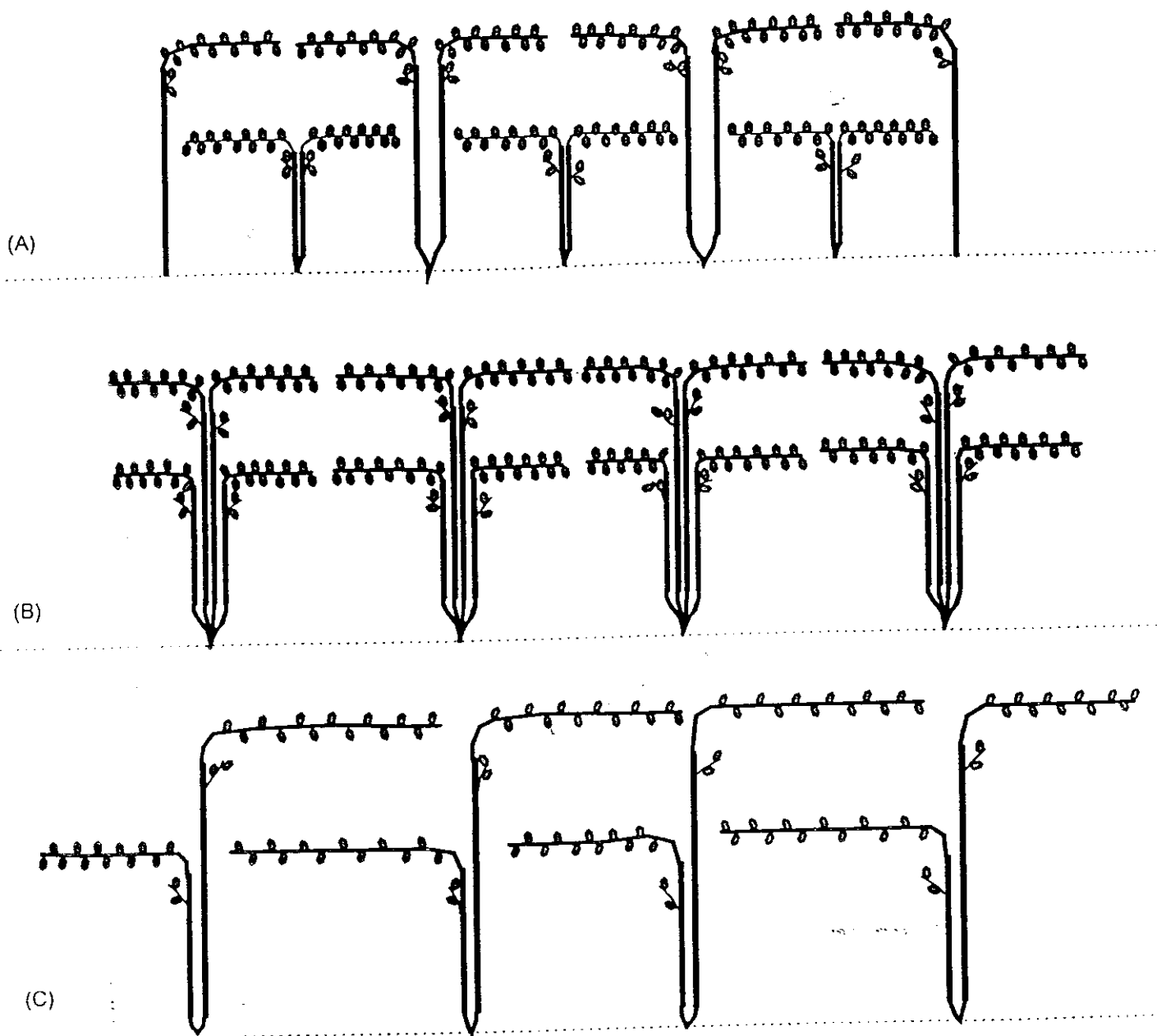


Fig. 7. Schematic views of vines utilizing Scott Henry training with (A) the traditional approach with alternating vines utilizing high and low fruiting wires, (B) a variation in which individual trunks of the same vine provide fruiting canes within the vine's own space for the upper and lower fruiting wires and (C) a variation in which individual trunks of the same vine provide fruiting canes which extend to the middle of the adjacent vine space on the upper and lower fruiting wires.

8. Pendlebogan - synonym: arched cane.

Description: This German training system utilizes long fruiting canes which are arched over one trellis wire and tied down to a lower trellis wire in the same manner as Umbrella Kniffin. However, the fruiting zone created by this training system is much lower on the trellis (Fig. 8). The higher of the two fruiting wires may be located from 12" to 30" above the ground level with the second wire located 6" to 12" below this wire. Renewal spurs are retained in the middle of the vine to promote development of fruiting canes for future years. Shoot growth is vertically positioned upward.

Advantages: Placement of the fruiting zone close to the ground for possible avoidance of winter injury with snow cover; placement of the fruiting zone near the ground to possibly enhance fruit maturity in cool climates through radiant heat from the ground surface; adaptable to vertical shoot positioning; the arching of canes creates better vertical distribution of fruit than cordon systems.

Disadvantages: Difficulty in pruning and tying vines and picking grapes close to the ground; greater susceptibility to spring freeze injury than systems which place the fruit zone higher on the trellis.

Comment: A variation of the Pendlebogan system is currently being evaluated in the Traverse City area of Michigan to determine its ability to overwinter fruiting buds under snow cover. In this instance the fruiting wires have been placed at 6" and 12" above the ground level.

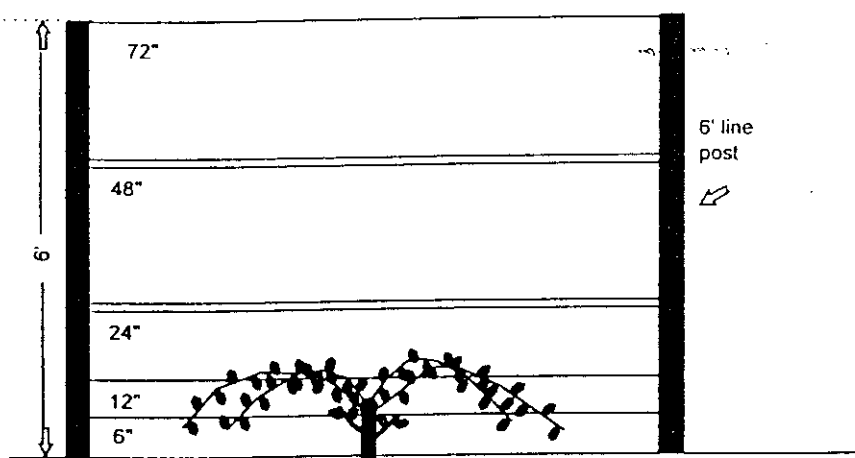


Fig. 8. A variation of the Pendlebogan training system which utilizes long fruiting canes close to the ground.

9. Modified Umbrella Kniffin

Description: Vines are grown on a trellis with an overall height of 96" with the head of the vine located just below a wire 72" above ground level (Fig. 9a). Canes are pruned relatively long to approximately 20 nodes. They are tied over the 72" wire and down to a wire 42" above ground level. Shoot growth is caught on catch wires in the upper 2 feet of the trellis (Fig. 9b). When necessary, summer pruning of shoots is performed when arching of shoot growth at the top of the trellis begins to shade the fruit zone. Preference of fruiting canes are for those that have grown up to and along the top wire of the trellis.

Advantages: The system displays a large wall of canopy while allowing good exposure of fruit to sunlight; the use of very long fruiting canes allows a large vertical distribution of fruit on the trellis; selection of fruiting canes that have matured at the top of the trellis provides nodes that have developed a high level of fruitfulness and a better than average winter hardiness; pruning is performed at a height that is comfortable.

Disadvantages: Not adaptable to mechanized pruning; requires annual tying of long canes; requires relatively long, mature fruiting canes; requires some summer shoot positioning and possibly summer pruning.

Comments: This training system has been used to produce large crops of high quality grapes for the 'Chardonnay' variety in southwest Michigan since 1992.

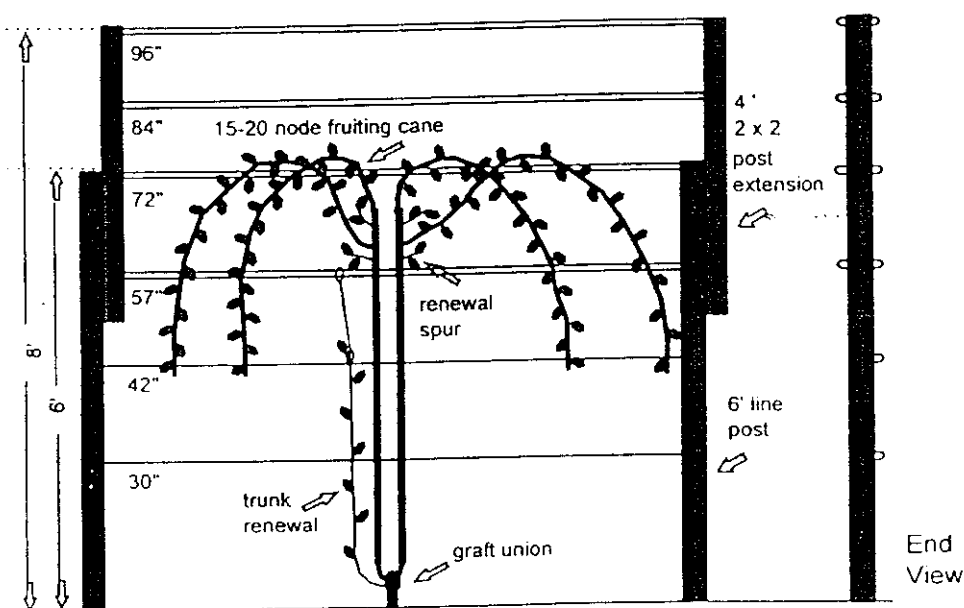


Fig 9a A modified Umbrella Kniffin training system which utilizes long fruiting canes

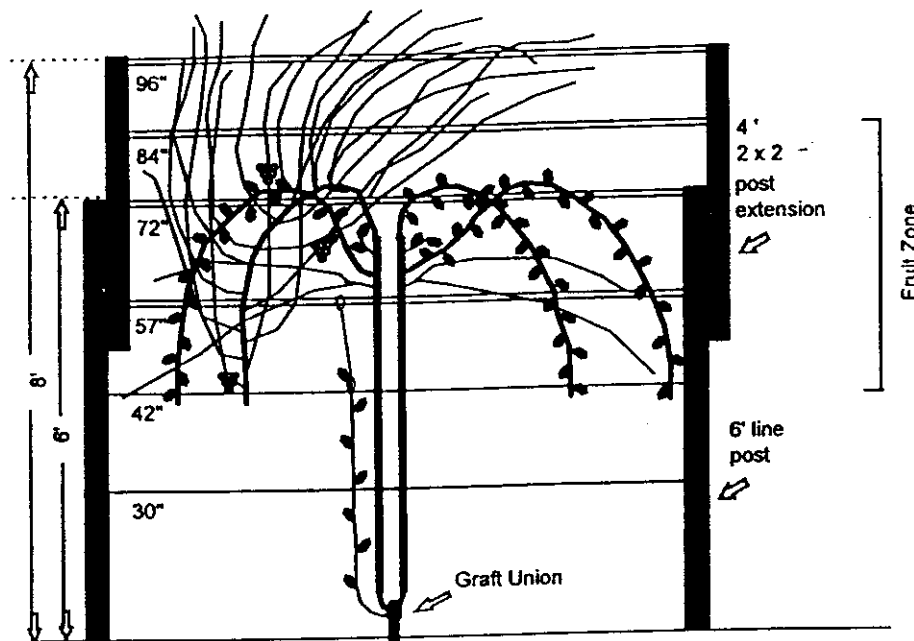


Fig. 9b. The Modified Umbrella Kniffin system showing the large vertical fruiting zone and shoot growth from a portion of the vine utilizing the top portion of this 8 foot trellis.

10. Modified Umbrella Kniffin + Mid-Wire Cordon

Description: This system is identical to the one described above with the exception that a mid-wire cordon is added to the system on a wire 30" above the ground (Fig. 10). The purpose of this cordon is to expand the vertical distribution of both the vine canopy and the fruiting zone of the vine. This system has been used with post-bloom cluster thinning to reduce the incidence and severity of Botrytis Bunch Rot when compared to either the mid-wire cordon or modified umbrella Kniffin training systems.

Advantages: A large vertical distribution of vine canopy and fruiting zone which tends to promote fruit maturity through better exposure of the fruit while decreasing susceptibility to fruit rot.

Disadvantages: Not adaptable to mechanical pruning; requires annual tying; more complex than normal trellis construction; requires post-bloom cluster thinning; requires some shoot positioning and may require some summer pruning.

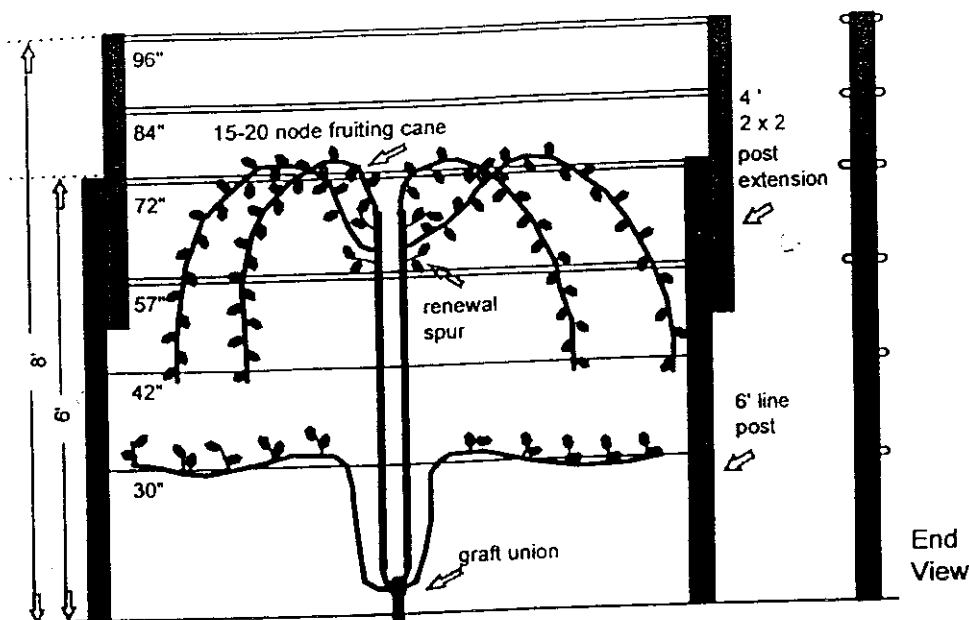


Fig. 10. A training system utilizing a combination of a Modified Umbrella Kniffin and Mid-Wire Cordon.

11. Smart-Dyson

Description: This is a mid-wire cordon training system that utilizes spur pruning on both the upper and lower sides of the cordon (Fig. 11).

Advantages: Adaptable to mechanical pruning; can utilize shoot positioning to expose fruit for ripening; less likely to develop differences in fruit maturity than with Scott Henry (Smart, 1996).

Disadvantages: Lack of commercial experience; possible difficulty in maintaining cordons where the variety/site combination results in frequent winter injury; uncertain influence on winter hardiness, node fruitfulness, development of bunch rot, etc.

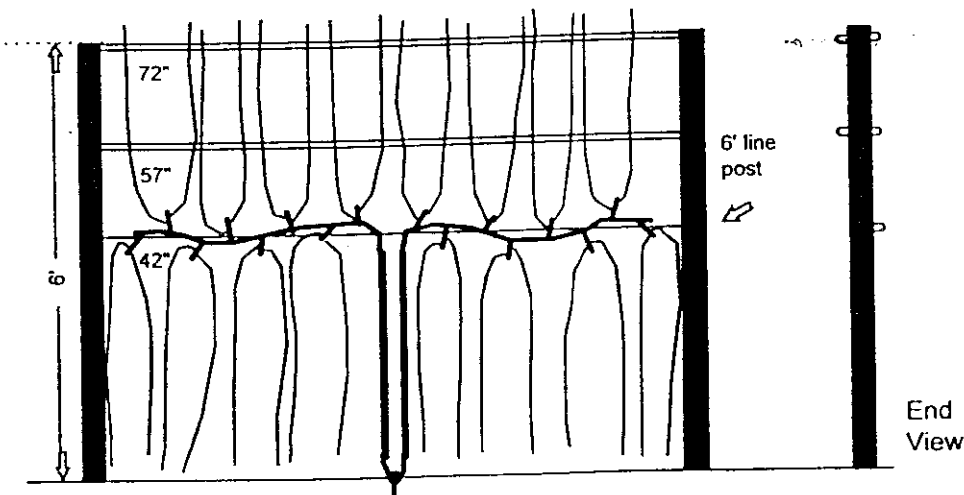


Fig. 11. The Smart-Dyson training system which has a vertically divided canopy and is shoot positioned.

12. Smart-Dyson Ballerina

Description: This is a mid-wire cordon training system. During the growing season shoots are partially positioned upward with catch wires while a portion of the shoots are positioned downward to open the fruiting zone along the cordon (Fig. 12). This is being called a vertically divided canopy (Smart, 1996).

Advantages: Improvement of the exposure of the fruiting zone when compared to the basic mid-wire cordon training system; easily converted from the mid-wire cordon training system.

Disadvantages: Possible difficulty in maintaining cordons where the variety/site combination causes frequent winter injury; little or no commercial experience in cool climate viticulture.

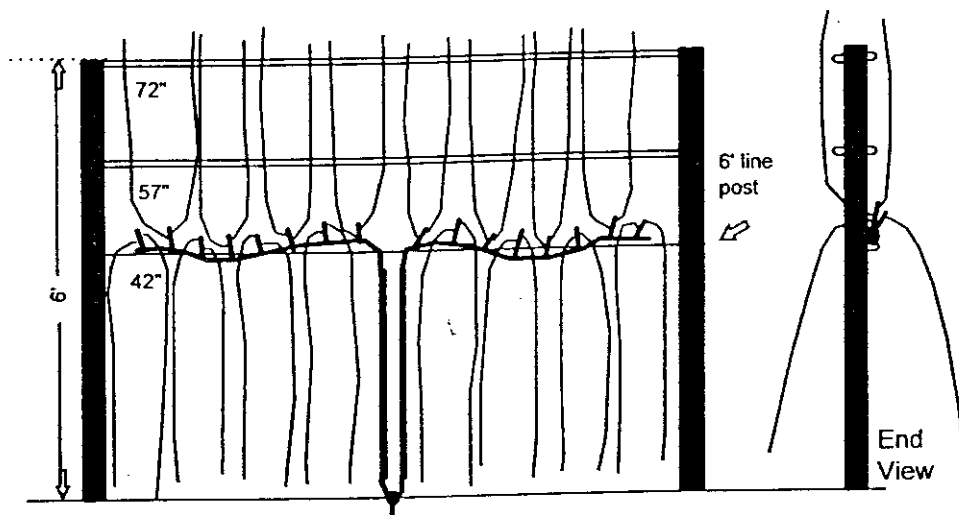


Fig. 12. The Smart-Dyson Ballerina training system. This is a Mid-Wire Cordon training system with a portion of its shoots positioned downward.

13. Low Cordon

Description: A cordon is established within 6" to 12" of the ground level. Fruiting spurs with 2 - 3 nodes are established along this cordon (Fig. 13).

Advantages: Placement of the fruiting zone relatively close to the ground affords an opportunity to utilize radiant heat from the ground level to promote ripening of fruit in a cool climate; adaptable to mechanical pruning; the low renewal area may be capable of utilizing snow cover to avoid winter injury.

Disadvantages: Difficulty in harvesting a crop that is very low to the ground; poor utilization of the vertical height of the trellis for both canopy development and fruit distribution; greater susceptibility to spring freeze injury than systems which place the fruit zone higher on the trellis.

Comments: During the unusually severe 1995-96 winter in the Traverse City, Michigan area, this training system performed well in regard to maintaining fruiting potential on vines under a snow cover.

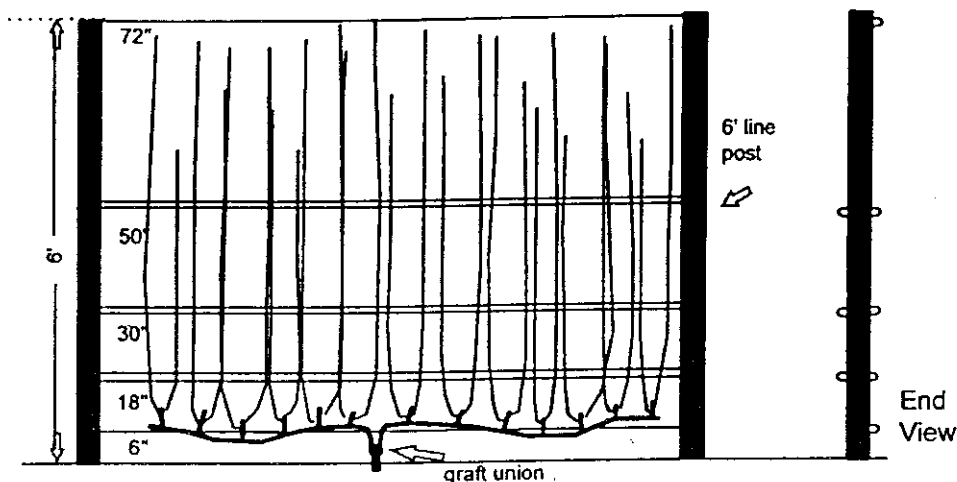


Fig. 13. A Low-Cordon training system.

14. Guyot Training System

Description: Long fruiting canes are utilized. Vines are trained to a low head 6" to 18" above ground. Canes are tied straight out a wire situated 12" to 18" above ground (Fig. 14). Renewal spurs are retained in the head of the vine to develop future fruiting canes.

Advantages: Fruit is situated relatively low to the ground where it may benefit from radiant heat off the ground surface for ripening; minimal vine structure makes it easier to cope with winter injury to vines; the use of long canes for fruiting will tend to retain more fruitful nodes than spur pruning.

Disadvantages: Difficulty in pruning low to the ground; not adaptable to mechanical pruning; possible congested fruit zone when compared to the Pendlebogan system; difficulty in harvesting fruit close to the ground; greater susceptibility to spring freeze injury than systems which place the fruit zone higher on the trellis.

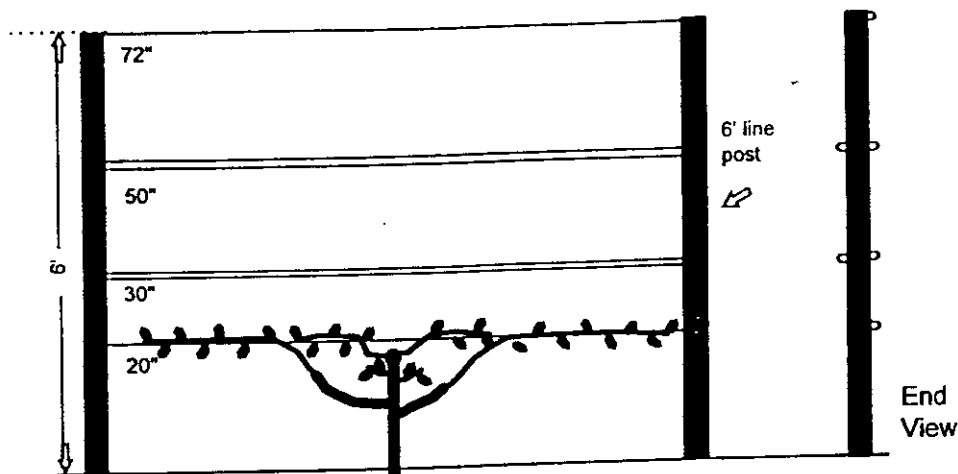


Fig. 14. The Guyot training system which utilizes long canes tied to a single wire low on the trellis.

15. Lyre - synonym: U-shaped training

Description: This horizontally divided canopy training system utilizes a three-dimensional trellis (Fig. 15). Quadrilateral cordons are established 30" above ground. Two cordons are established 30" apart or 15" off the center line of the vine row and pruned to two to three node pruning spurs. A series of catch wires is used to vertically orient shoots as they grow from these cordons.

Advantages: Excellent distribution of the grapevine canopy; desirable upward growth of all shoots; good exposure of fruit for ripening; adaptable to mechanical pruning.

Disadvantages: Complexity and cost of establishing the trellis; possible difficulty in maintaining this complex vine structure when the variety/site combination leads to frequent winter injury; necessity to perform extensive shoot positioning and possible summer pruning to ensure that the canopies will be kept divided; requires specially developed equipment for mechanical harvesting.

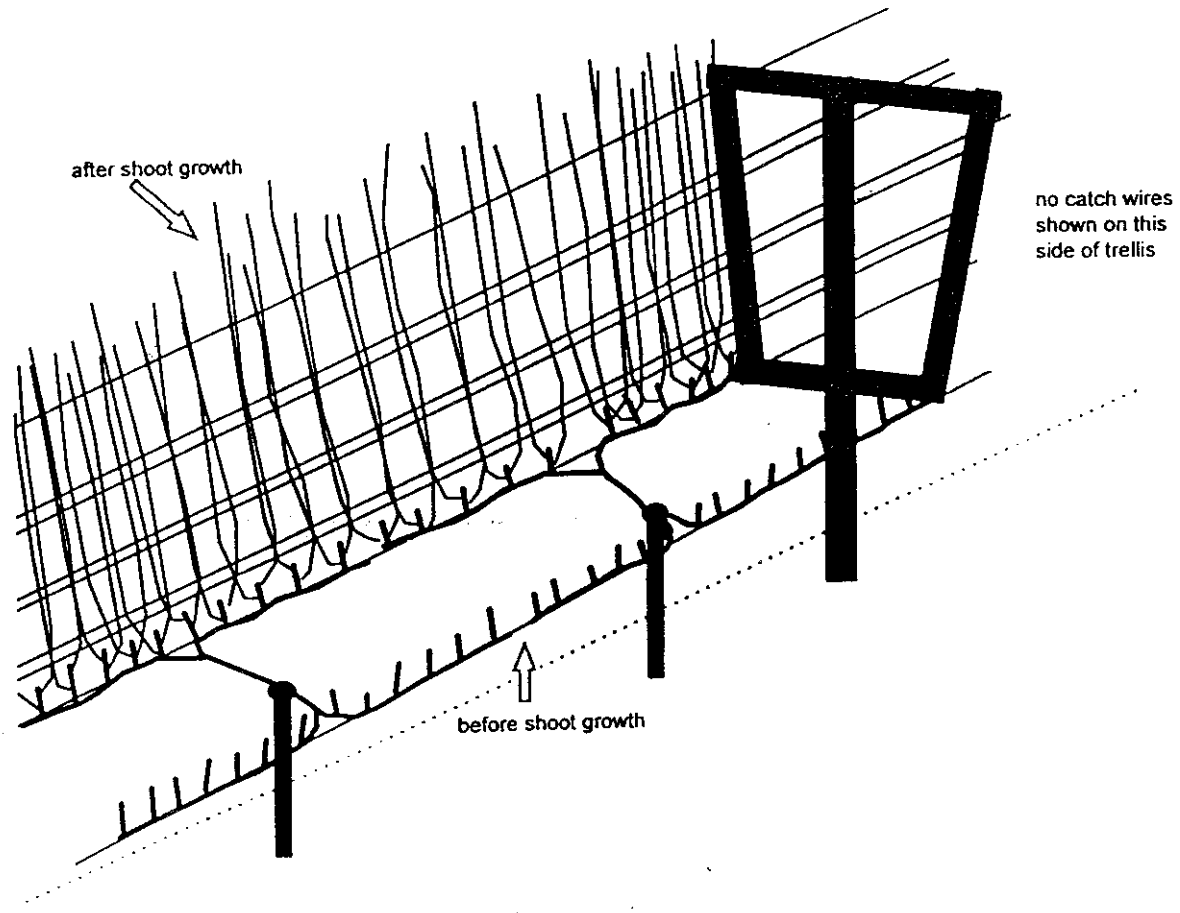


Fig. 15. The 3-dimensional Lyre training system.

16. Minimal Pruning

Description: This is not a training system per se but rather a pruning strategy. Vines may be initially trained to one of many training systems. In subsequent years the only pruning performed on the vine is that which will maintain a manageable growth form. Often this simply means undercutting the vine so that any canes trailing to the ground are removed (Fig. 16).

Advantages: High yields; reduced labor inputs; reduced cluster compactness leading to a reduced incidence of Botrytis Bunch Rot.

Disadvantages: Highly variable fruit quality in cool climates; increased susceptibility to disease problems.

Although there are numerous other vine training systems, those presented above are likely to be the principal systems used for winegrape production in the midwestern United States for the next several years. Ultimately one's choice of a vine training system will involve consideration of the climate of the vineyard, the variety being grown, the

intended use of the grape, the availability of equipment, the availability of skilled and unskilled labor, the availability of capital for building trellises and personal preference.

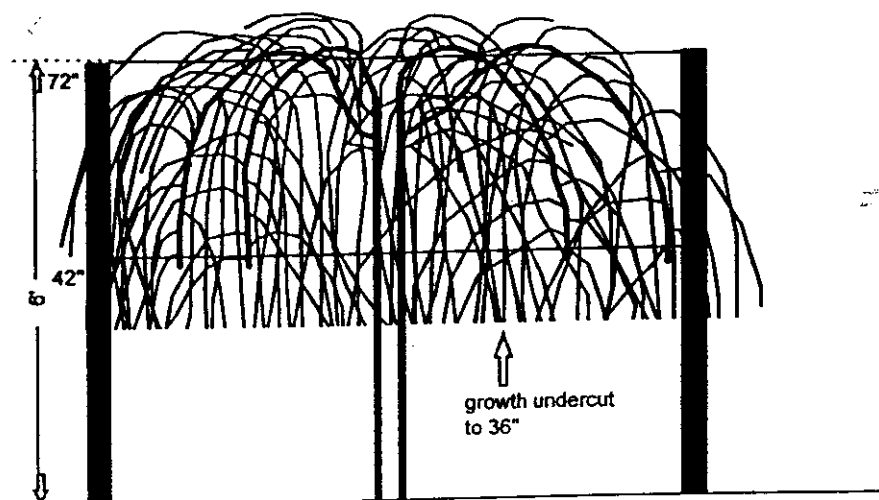


Fig. 16. Minimal pruning of a grapevine which was initially trained Umbrella Kniffin and then undercut to 36" above ground.

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