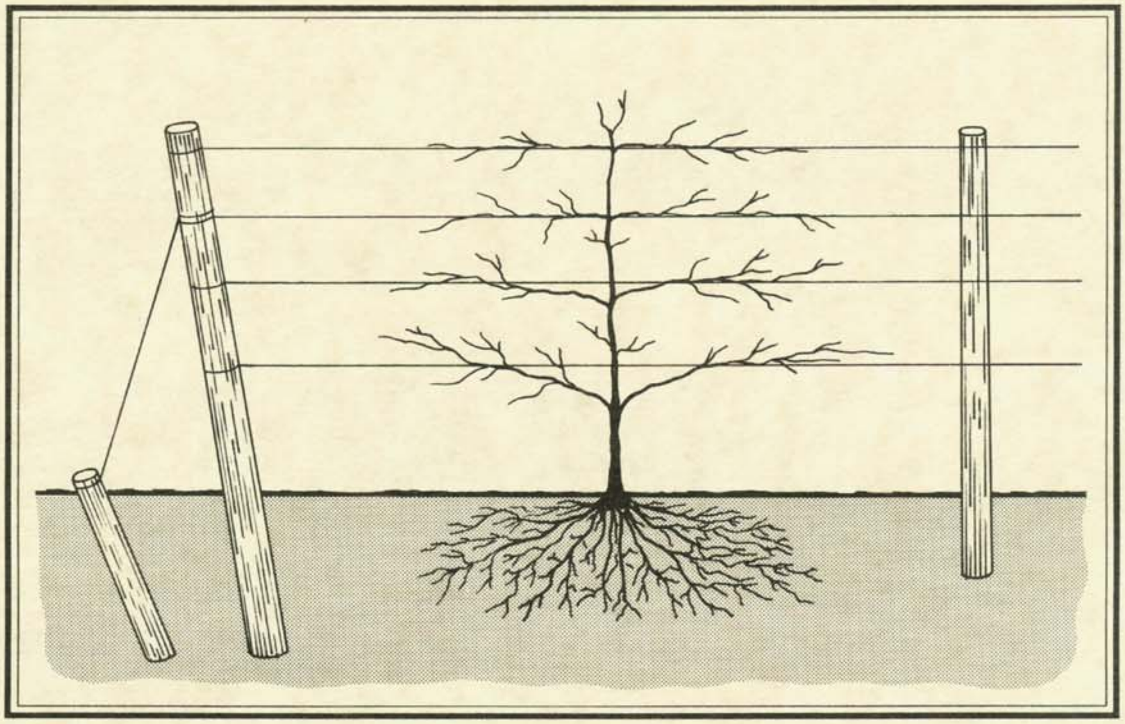
Support Systems for High-Density Orchards



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SUPPORT SYSTEMS FOR HIGH-DENSITY ORCHARDS

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INTRODUCTION

High density orchard plantings of dwarf and semi-dwarf fruit trees is a growing trend in the Pacific Northwest. Dwarf trees produce fruit faster and in less space than standard trees.

However, very dwarf trees produce crops which are too heavy to be supported by their small branch framework and must be supported. Semi-dwarf trees may require support systems with some training methods. The support system also provides greater exposure to sunlight increasing fruit yield, quality and uniformity. The small trees also make spraying, pruning and picking much easier.

Support systems for orchards can be traced back thousands of years. The Hanging Gardens of Babylon were actually supported by masonry walls.

Since the first trellises were built in the Pacific Northwest, new materials have become available. Today pressure-treated posts and galvanized high-tensile wire are available to build durable support systems at a reasonable cost.

The support system must be built to last because the support is an integral part of the planting. If the post, wire or anchors fail in a support system, the deteriorated or broken trellis can be difficult or impossible to repair. The support failure can lead to growth problems, reducing production and depreciating the entire investment.

POSTS

To maximize the life of a support system, buy posts that have been pressure treated with wood preserving chemicals. While treated wood costs slightly more, pressure-treated posts pay for themselves in greatly reduced system maintenance and extended life. When purchasing pressure-treated posts, request posts that have been treated according to the appropriate standard for ‘Ground Contact’ conditions.

There are three major chemicals used by pressure-treating plants. These are Creosote, Pentachlorophenol (PCP) and Chromated Copper Arsenate (CCA). Creosote and PCP are not soluble in water, so they are usually dissolved or diluted in a petroleum-based solvent such as light oil for pressure treatment purposes. The oil is used as a ‘carrier’ to assist in the penetration of the preservative in a spaced stack of timber when it is heated and pressurized in a large steel cylinder or ‘retort’.

Posts treated with creosote or oil-impregnated pentachlorophenol may cause damage to root stocks. One source suggests keeping tree root stocks 18 inches away from the posts at the soil line. If a volatile solvent such as naptha or ethylene dichloride is used, the solvent will be reclaimed by evaporation under vacuum and only the colorless crystals of PCP remain in the wood.

CCA on the other hand, is a combination of water-soluble salts dissolved in water and forced into the wood. They are thought to combine chemically with the wood resulting in little or no loss on subsequent contact with humidity, rain and groundwater. Ammoniacal copper arsenate (ACA) is another salt-type preservative which is used to a lesser degree than CCA. ACA, however, has been reported to cause corrosion in contact with trellis wire.

Fortunately, CCA pressure-treated posts are readily available as they are considered the best choice.

If a home treatment is to be used, for safety reasons do not use PCP. CCA is not effective in a home treatment. The best chemical for use in home treatment methods is copper naphthenate. This is the one oil-based preservative recommended for greenhouse use. Wood treated with copper naphthenate should be allowed to ‘weather’ for at least one week after treatment before placing plants near the wood. This time period apparently allows the evaporation of its petroleum-based solvents.

POST INSTALLATION

There are a number of factors to be considered in the installation of posts such as depth of set, soil type, soil moisture, and post installation method (driven or augered). By increasing the depth of set of a post by a third, the post's resistance to overturning will be doubled. Likewise, a driven post has 1 1/2 times the resistance to overturning as does one placed in an oversized hole and the earth rammed back around it. Soil types have differing effects on the post's resistance to overturning. Normally, sandy soils have less resistance than clays. Similarly, the wetter the soil, the lower the load required to overturn the post.

When hand-setting posts (in an oversized hole), always place the large end down. When driving posts, always place the small end down. Augering pilot holes 1 to 2 inches smaller in diameter than the post will facilitate driving blunt, larger diameter, and longer posts. The pilot hole can also be used to guide end posts that are to be driven at an angle.

For small diameter posts a weighted section of pipe with a cap and handles could be used to drive the posts. To facilitate the manual driving of posts a pilot hole could be formed using a soil probe through which water is forced under pressure via a sprayer pump and tank. Portable gas-powered two-man augers are also available to drill pilot holes. Post drivers that operate from a tractor's hydraulic system are the standard equipment used to install fence posts. The hydraulic post drivers are available in either three-point hitch mounts or trailer mounted. Extensions to the driving ram will be required to drive posts which are longer than nine feet. Some contractors have mounted hydraulic drivers on front-end loaders to increase the range of post lengths that can be driven.

WIRE

While high-tensile strength steel has been used in wire for many years, it has only been recently marketed in its current form for use in trellises and fences. Using high-tensile (HT) wire will increase trellis life and reduce maintenance. The main advantage of high-tensile strength steel is that it has more strength per unit cost than low-tensile strength steel. Considering the wire's physical and mechanical properties, the optimum size of the trellis wire appears to be 12 1/2 gauge (0.10 in diameter). Larger diameter wires have extra weight and higher cost per metre while smaller wires have shorter resistance to atmospheric corrosion. The wire should have a minimum tensile strength of 180,000 pounds per square inch and minimum breaking strength of 1380 pounds.

To maximize the wire's life, the wire must be galvanized. The type of galvanizing or the weight of zinc coating deposited on the wire can greatly affect its useful life. The suggested type of galvanizing for trellis wire is Class 3 or 0.80 oz. of zinc per sq. ft. of wire surface. Table 1 shows types of galvanization and Table 2 describes the approximate protection afforded by galvanization.

TABLE 1
Minimum Weights of Zinc Coating on Wire*

	Amount of galvanizing (minimum coating) (oz. of zinc per sq. ft. of wire surface)		
Wire Size (Gauge No.)	**Class 1**	**Class 2**	**Class 3**
9	.40	.60	.80
11	.30	.50	.80
12 1/2	.30	.50	.80
14 1/2	.20	.40	.60

**From ASTM subcommittee A-05.15 report dated February 7, 1977*

To fasten the wire to the post 1 3/4 in. long 9 gauge staples should be used. These staples have 50% more resistance to pull-out than 1 1/2 in. long staples. For maximum holding power, staples should have slash-cut points. Staples with single legs or diamond-shaped points are not recommended. Staples should also be galvanized.

TABLE 2
Approximate Protection Given Wire by Class 1 and Class 3 Galvanizing*

Wire size (Gauge No.)	Years till rust appears						Years after rust appears until wire reaches half strength		
Climate condition	Dry		Humid		Coastal & Industrial		Dry	Humid	Coastal & Industrial
Class	1	3	1	3	1	3			
9	15	30	8	13	3	6	50+	50+	25
11	11	30	6	13	2	6	50+	50+	16
12.5	11	30	6	13	2	6	50+	50+	12
14.5	7	23	5	10	1.5	4.5	50	20	7

**From ASTM subcommittee A-05.15 report dated February 7, 1977*

Staples should never be driven vertically into wood posts wiith both legs parallel to the wood grain. Doing so can split the post and reduce holding power. Rotating the staples off vertical to straddle the grain has greater resistance to pull-out. To maximize their holding power, staples should be driven so that their legs curve outward and not inward. Note that the slash cut points act as wedges which force the legs to curve away from the flat surfaces of the points as the staples are driven into the wood.

On rises, dips or some end posts where there is great upward or downward pressure of the trellis wires on the staple, double stapling will provide greater resistance to pull-out. Also angling the staple downward or upward against the direction of pull adds to effectiveness. **Staples must never be driven home**. This will kink and weaken the wire and damage the zinc coating.

HT wire is less ductile than the low-tensile strength wire used in the past. This characteristic makes the wire more difficult to splice. Australian Wire Industries carried out an investigation into the performance of the various knots commonly used in fencing. The most effective knots tested failed at between 60 to 66% of the HT wire's breaking strength.

To maximize the strength of the HT wire splice, mechanical devices should be used. Three commercially available mechanical splices proved to be effective in tests at British Columbia Institute of Technology (B.C.I.T.) including the Nicopress, Wirelink and the Vineline. Other manufacturers' splices may also be effective; however, be sure to buy from a reputable dealer or have the splice tested to determine its strength. More details on the B.C.I.T. tests are available from Engineering Note 316.122-1 which is available from the B.C. Ministry of Agriculture and Fisheries offices. Also available is a "Suppliers' List" for HT wire and accessories.

The HT wire, because of its mechanical properties, springs back when a wire is cut. To avoid kinks when dispensing the wire, a pay-out device such as the "spinning jenny" should be used to uncoil the wire in reverse order to the way the wire was coiled in manufacture.

One last suggestion when working with HT wire which will simplify construction and maintenance is to install the wire and then pull it only hand tight before tying it off. Use one of several 'in-line tensioners' to take the wire up to full tension of 250 lbs. These are permanently installed in the trellis wire which will allow the retensioning of wire when post movement slackens the wire. If a break should occur, the tensioner could be relaxed, the broken ends lapped and a splice installed. When the wire is pulled too tight before the tensioner is installed, it will not be possible to lap any breaks and repairs will require two splices.

These materials and methods are described in more detail in U.S. Steel's publication "How To Build Orchard and Vineyard Trellises" and is available from some trellis materials suppliers.

ANCHORS

In a trellis, the wires play the important role of carrying the weight of the fruit laden trees. These wires must be securely anchored. Inadequate anchors would appear to be the most common failure of early orchard trellises in the Okanagan.

There are several factors influencing the load on trellis wires. The strength and vigor of the rootstock as well as the method of tree training will determine the relative proportion of load carried by the tree and the wire. The weight of fruit production itself will be the most significant part of the load carried by each wire. Finally, the trellis post spacing will also affect the amount of wire sag and tension. When comparing trellises, be sure to consider all the factors affecting trellis loads including rootstock, training methods, fruit production and post spacing.

To complicate matters further, the load of each wire must be transferred to the ground. The greater the load or higher the wire, the more difficult it will be to anchor. The condition and strength of the soil will also affect the type of anchor chosen.

Until actual wire tension measurements in loaded trellises are available to determine anchor requirements, consider the following factors when selecting an anchor and comparing anchor requirements in different trellis designs:

1) Root and tree strength: how much load will they carry?

2) The tree training system: is the tree trained to the wire and is the whole tree supported or only the leader?

3) The post spacing: the greater the spacing the more sag and wire tension. With 12 1/2 ga. HT wire use post spacings of 30 to 50 ft. depending on apple and tree load.

4) Wire strength: ultimately the wire can safely carry a tension of about 1000 lbs. before it is permanently stretched. If in doubt about actual load, assume each wire carries 1000 lbs.

TABLE 3

Anchor Specifications
Diameter (inches) x Length (feet)

TRELLIS	TIE-BACK BRACE		SINGLE-SPAN BRACE (DRIVEN) *			STAY BRACE ASSEMBLY		
PostBrace	End Post	Tie-Back	End Post	Brace Post	Horizontal	End Post	Stay	Stay Block
6 ft Vertical	4"x 9'	5"x 7'	5"x 8'	4"x 9'	4"x 8'	5"x 10'	3"x 8'	5"x 2 1/2'
8 ft Vertical	4"x 12'	5"x 7'	5"x 8'	4"x 12'	4"x 10'	5"x 12'	4"x 10'	5"x 3 1/2'
10 ft Vertical	5"x 14'	5"x 8'**	6"x 8'	5"x 14'	5"x 12'	6"x 14'	5"x 12'	6"x 4'
French Axe	5"x 14'	5"x 8'**	6"x 8'	5"x 14'	5"x 12'	6"x 14'	5"x 12'	6"x 4'
Tatura	5"x 14'*	N/A	N/A	N/A	N/A	N/A	N/A	N/A

* A Single-Span Brace Assembly with augered posts has the same brace post and horizontal brace post size as the driven assembly. The end post size should be increased to the size used in the Stay Brace Assembly.

* * The Tie-Back Post must be driven 5 ft. or set in a 5 ft. deep augered hole.

N/A Brace assembly is "not appropriate" for the trellis design.

Remember that anchor failure may be difficult to repair and may cause a lot of headaches in your production system. Be sure to prevent as many problems as possible with proper anchor selection and installation.

If you have difficult soil conditions for post installation, you may wish to compare trellis designs to determine which is easiest to install successfully in your orchard. Table 3 "Anchor Specifications" provides preliminary specifications for trellis designs described later in this presentation.

There are two types of anchors that are commonly used in trellises. One is a tie-back style using a wooden post or commercially manufactured earth screws, metal plates, "ARROWHEADS" or"DUCKBILLS". The other type of anchor is a brace assembly of three posts, two vertical and one horizontal, and a diagonal brace wire.

Figure 1 depicts a tie-back post anchor. The post should be driven at a backwards angle of 2 ft. in 8 ft. and 4 ft. to 5 ft. deep. The post can then be cut off at a height of 1 ft. above the ground-line. (Post drivers cannot drive the top of the post within 1 ft. of the ground). The post at ground-line should be positioned as far back from the end post as the top wire is high. The tie-back post must be driven in undisturbed firm soils to be effective. If the loads are too great (large number of wires) or the soils are weak, a brace assembly should be used. Commercial tie-back anchors must also be placed in undisturbed soil.

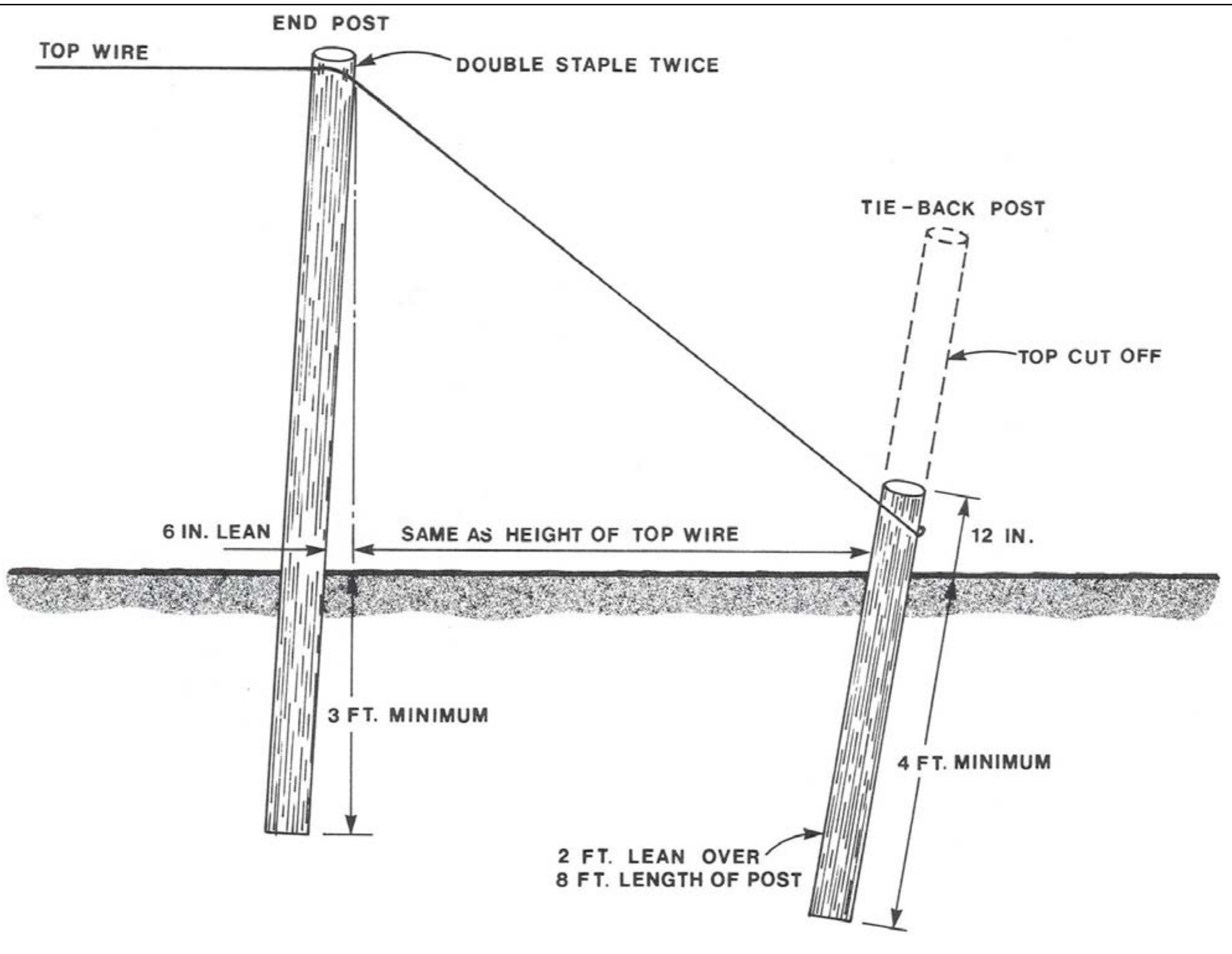

FIGURE 1 TIE-BACK ANCHOR

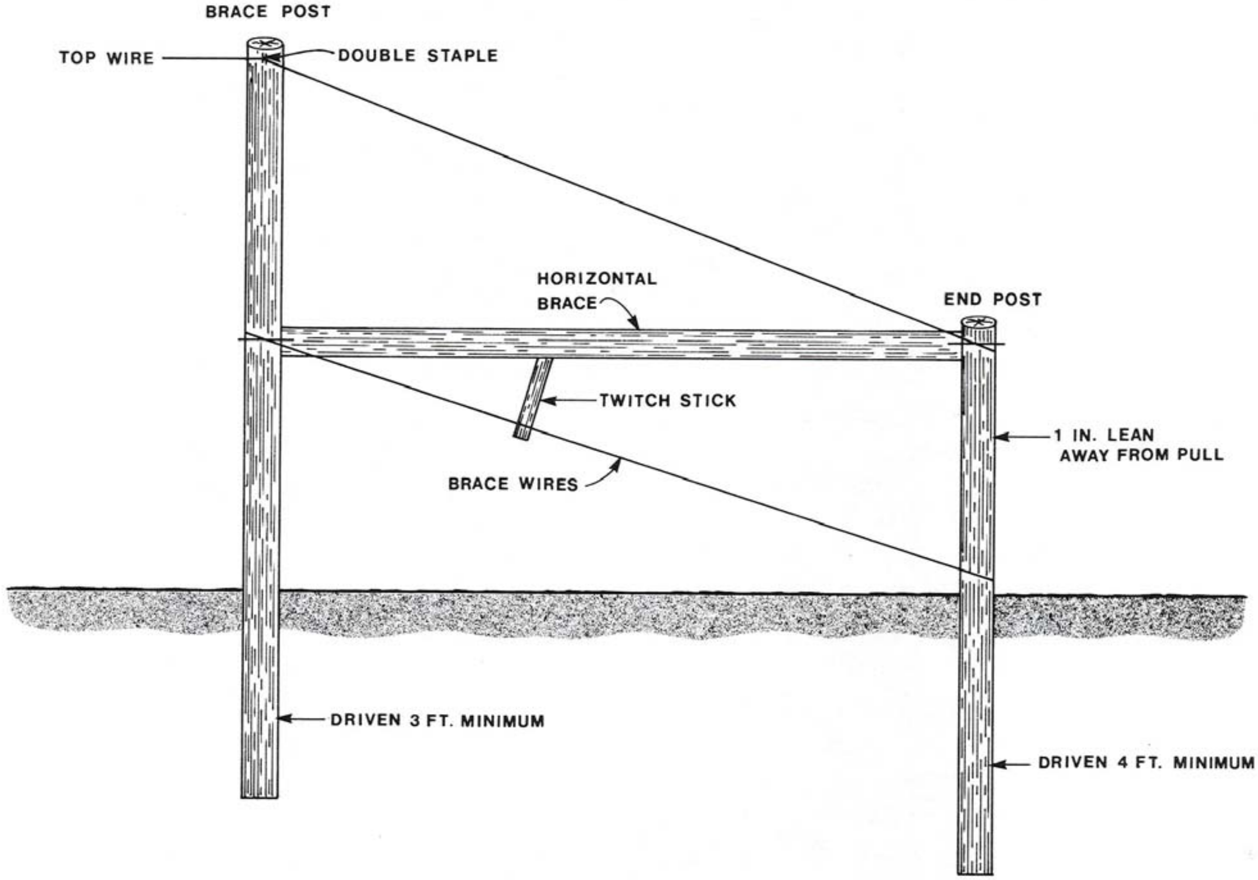

FIGURE 2 SINGLE SPAN BRACE ASSEMBLY DRIVEN END POST

A single-span brace assembly with a driven end post is shown in Figure 2. An 8 ft. end post is chosen because it can be driven by most post drivers. The size of the end post and length of horizontal brace should be increased as the height of the trellis and number of trellis wires increase. The U.S. Steel Manual "How To Build Orchard and Vineyard Trellises" describes the construction method in detail. The end post depth is critical to the strength of this brace assembly. It is worth the extra effort to pull and reinstall end posts where required to obtained the required depth. Increasing the length of the horizontal brace lowers the angle of the diagonal brace wire, reducing the lifting force on the end post and increasing the strength of the brace assembly. If the end post cannot be driven, then the brace assembly shown in Figure 3 should be used.

The end post may be placed by using a tractor-mounted auger to make a hole that is 4 in. larger than the diameter of the post and 4 ft. deep. The post is placed and centered in the hole. Pour and tamp concrete mix to a depth of 8 in; then place and tamp 22 in. of soil. Add another 8 in. of concrete mix and 10 in. of soil. To attain maximum compaction, fill and compact only small amounts of soil at a time. If soil moisture is adequate, dry pre-mixed concrete may be placed in the hole. The soil moisture will then set the concrete. Ready-mix concrete may also be used. Filling the hole completely with ready-mix concrete is not significantly stronger than the layered concrete mix and soil tamped backfill already described. A 1/2 in. dowel of re-bar should be driven through a hole augered in the bottom of the post to fix the post to the concrete. A bell shape in the bottom of the hole also helps to prevent uplift.

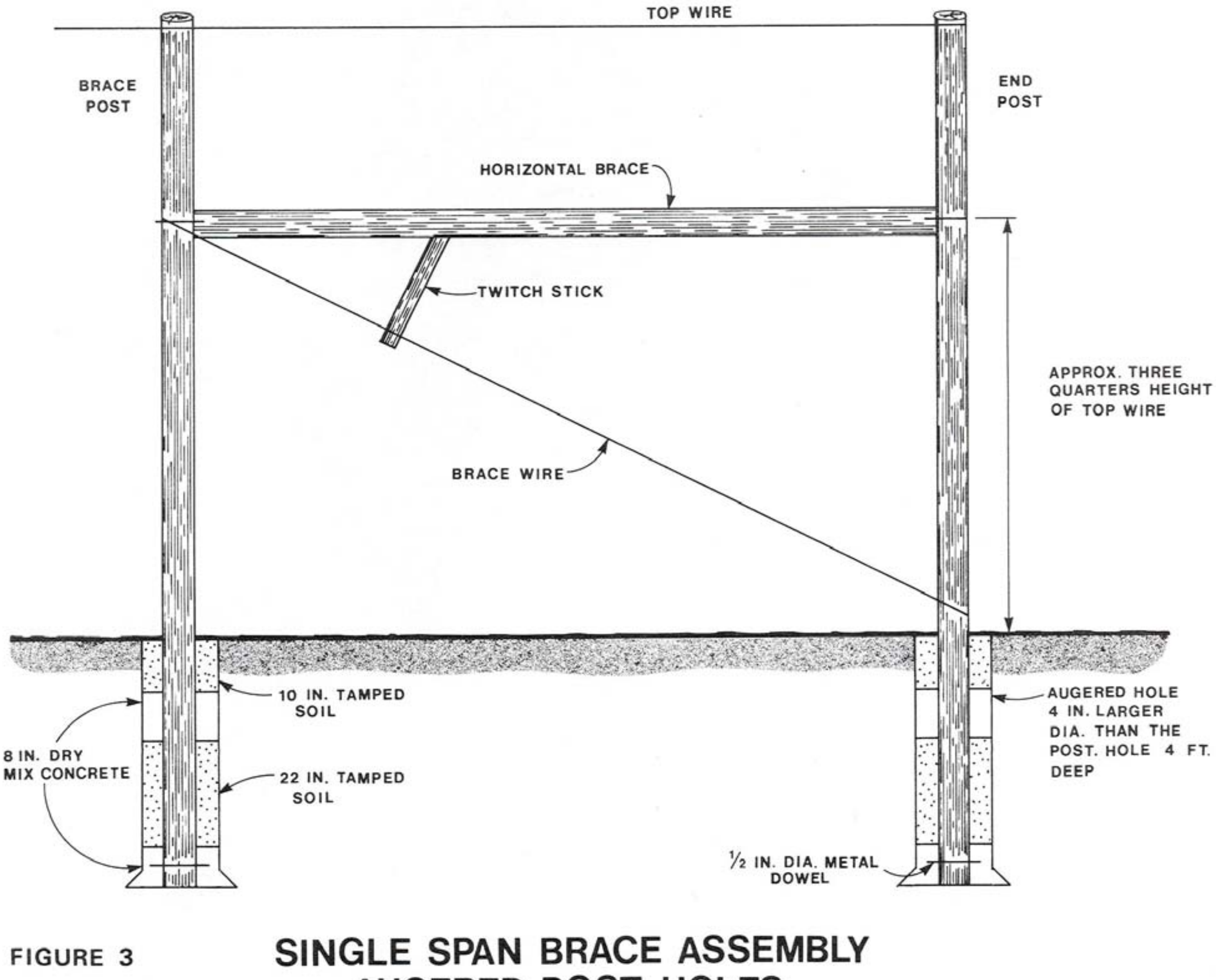

FIGURE 3 SINGLE SPAN BRACE ASSEMBLY AUGERED POST HOLES

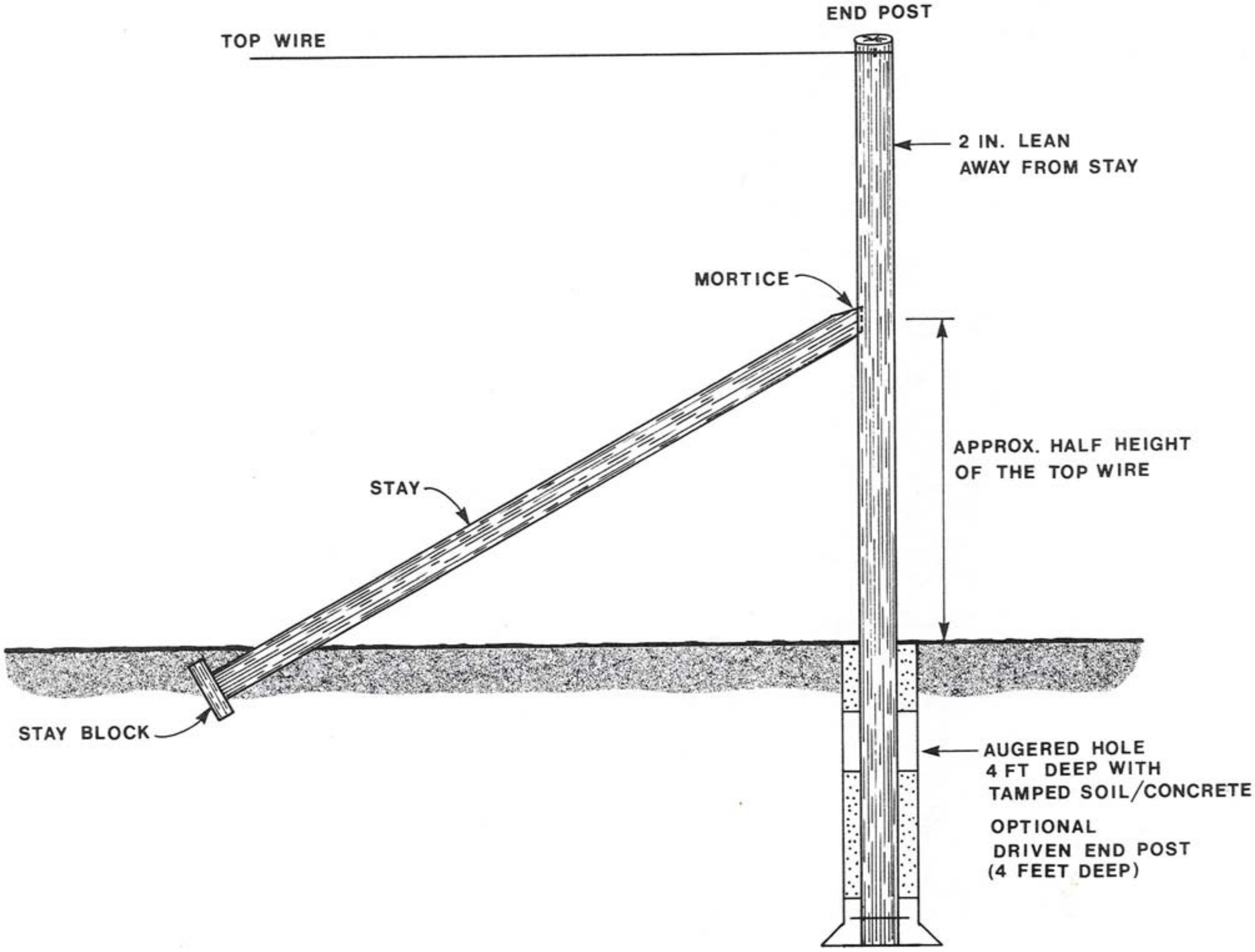

FIGURE 4 **STAY BRACE ASSEMBLY**

A "stay" brace assembly is shown in Figure 4. This brace can be used with a driven end post or an augered end post fixed in concrete. In this design the diagonal stay is placed approximately halfway between the ground and the top of the end post. The stay block requires only a shallow trench. This may be an advantage if there are too many rocks in the soil for a post hole auger.

In areas of extremely rocky soil conditions a backhoe is often used to dig the post holes. In these circumstances the posts require extra support as the soil cannot be adequately tamped in these large holes. To provide this support, thrust blocks should be placed on the appropriate sides of the post near the top and at the bottom of the hole as shown in Figure 5.

In difficult soil conditions there is also a tendency to pour concrete in dug holes to anchor the trellis. Unless the concrete anchor is supported by undisturbed soil, it is not likely to have sufficient mass to anchor the trellis wire. For example, 12 1/2 ga. HT wire has a breaking strength of approximately 1500 lbs. A 10 cu. ft. reinforced concrete block could be lifted by a single trellis wire!

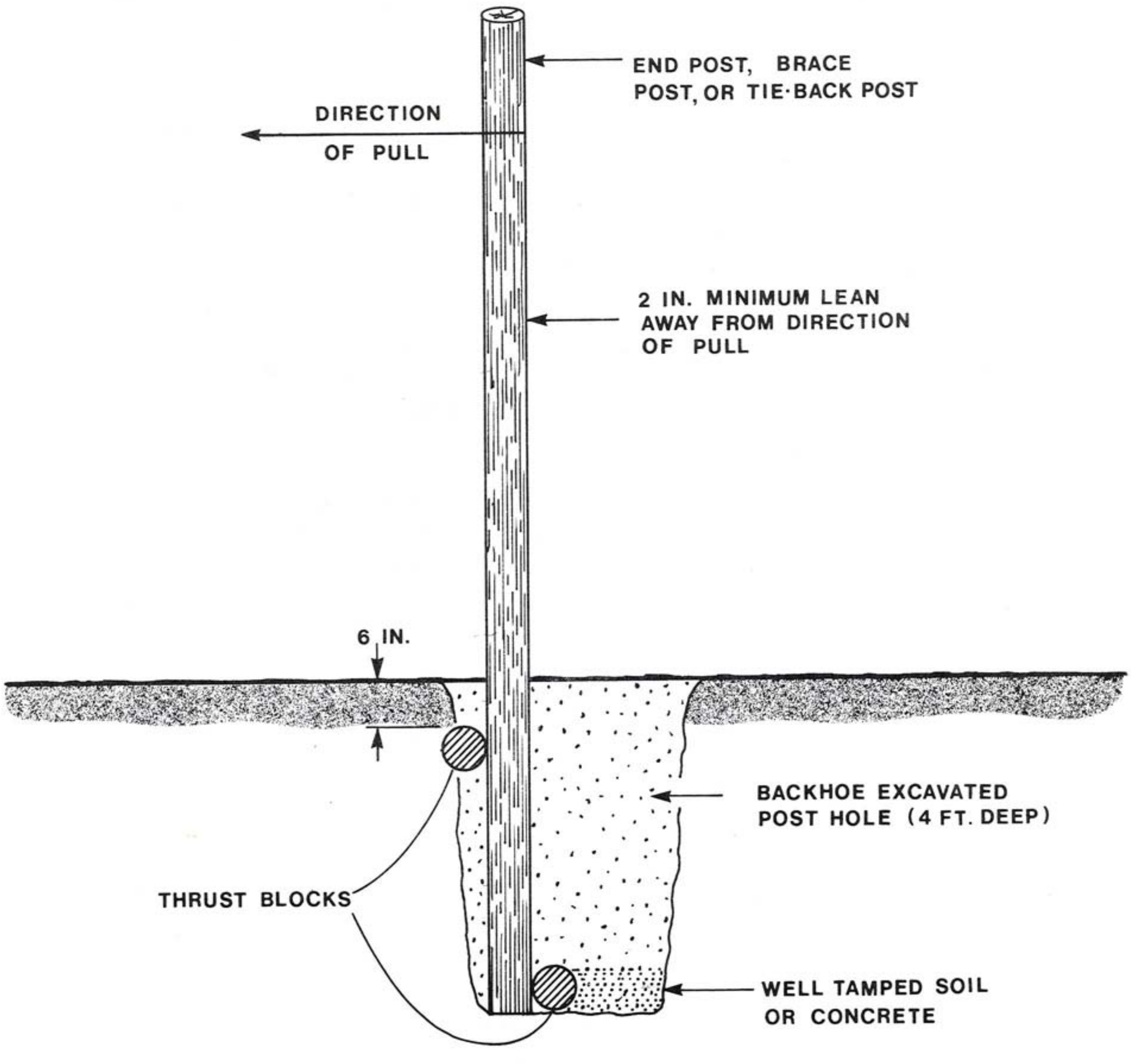

FIGURE 5

SUPPORTING POSTS PLACED IN BACKHOE DUG HOLES

SUPPORT SYSTEM DESIGNS

Numerous support systems have been used successfully for commercial tree fruit production around the world. However, for every system that has been developed, there are dozens of grower adaptations. This presents a problem when attempting to describe a given system. To avoid confusion, the support systems described herein should be considered the base models for each design.

Four support systems show potential for tree fruit production in the Pacific Northwest.

(1) Vertical Trellis
(2) Vertical (French) Axis
(3) Tatura Trellis
(4) Slender Spindle

Other systems such as the Ebro Espalier and Lincoln Canopy must be ruled out at this time due to their excessive start-up costs. In the Pacific Northwest, most apple growers are utilizing the free-standing central leader system. Over the years these trees have served growers well. However, initial dollar returns have been greatly delayed due to rootstock characteristics and the very nature of the training system. Increasing costs make it critical that new plantings come into bearing quickly.

VERTICAL TRELLIS

Vertical trellises of different heights are currently being used throughout North America with a great deal of success. Common trellis heights are 6, 8, and 10 feet. Although 4 ft. trellises are used, the necessity of using the unproven M27 rootstock eliminates it from further discussion on a commercial scale.

Due to varying load factors, all trellises do not require materials of the same stature. Table 4 outlines the requirements of each.

Trees grown on a vertical trellis can be trained in many ways. Perhaps the most popular training systems are:

(1) horizontal palmette (branches emanating at 90° from the leader and trained to the wires).
(2) oblique palmette or "Penn. State Low Trellis Hedgerow" (45°), and
(3) Van Roechoudt palmette.

TABLE 4.
Vertical Trellis Design

	Component Measures (in.)		
Materials	**6 ft.**[1]	**8 ft.**[2]	**10 ft.**[3]
End Posts - diameter	4-5	4-5	5-6
- length	108	144	168
- depth inground	36	48	48
In-line Posts - diameter	3-4	3-4	4-5
- length	96	120	144
- depth inground	24	24	24
Distance between posts (ft.)	30-50	30-50	30-50
Distance between wires			
ground to 1	24	36	36
1 to 2	24	24	24
2 to 3	24	18	24
3 to 4	-	18	18
4 to 5	-		18
Distance between trees (ft.)	6	7	8
Distance between rows (ft.)	13	14	15

1 See Fig. 6
2 See Fig. 7
3 See Fig. 8

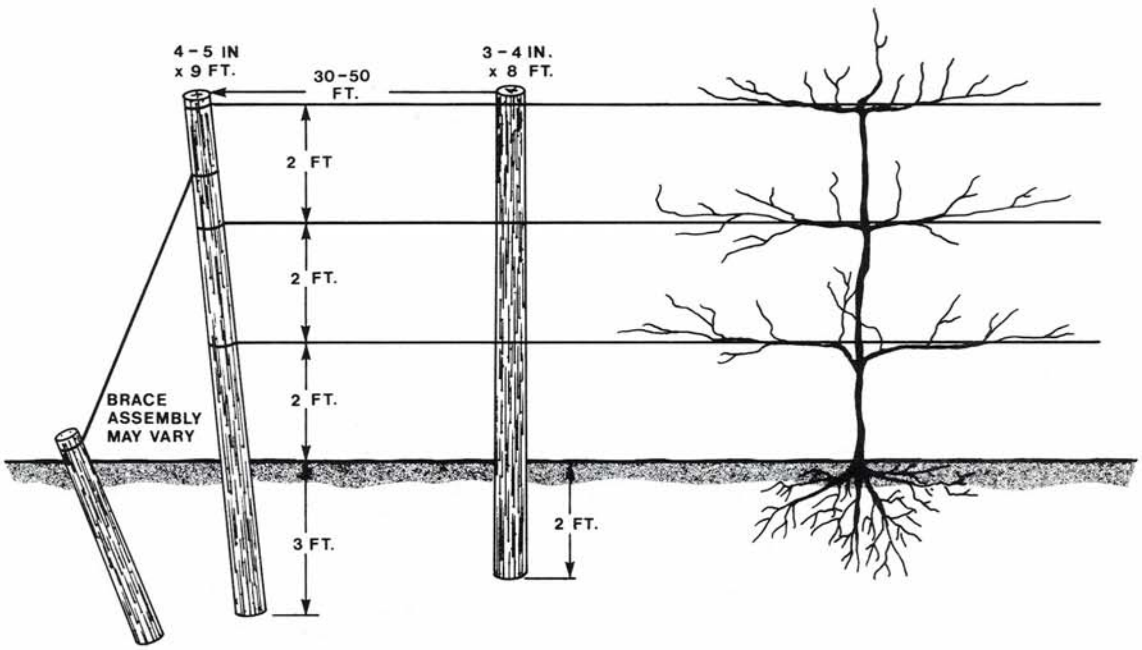

FIGURE 6

6 FT. TRELLIS

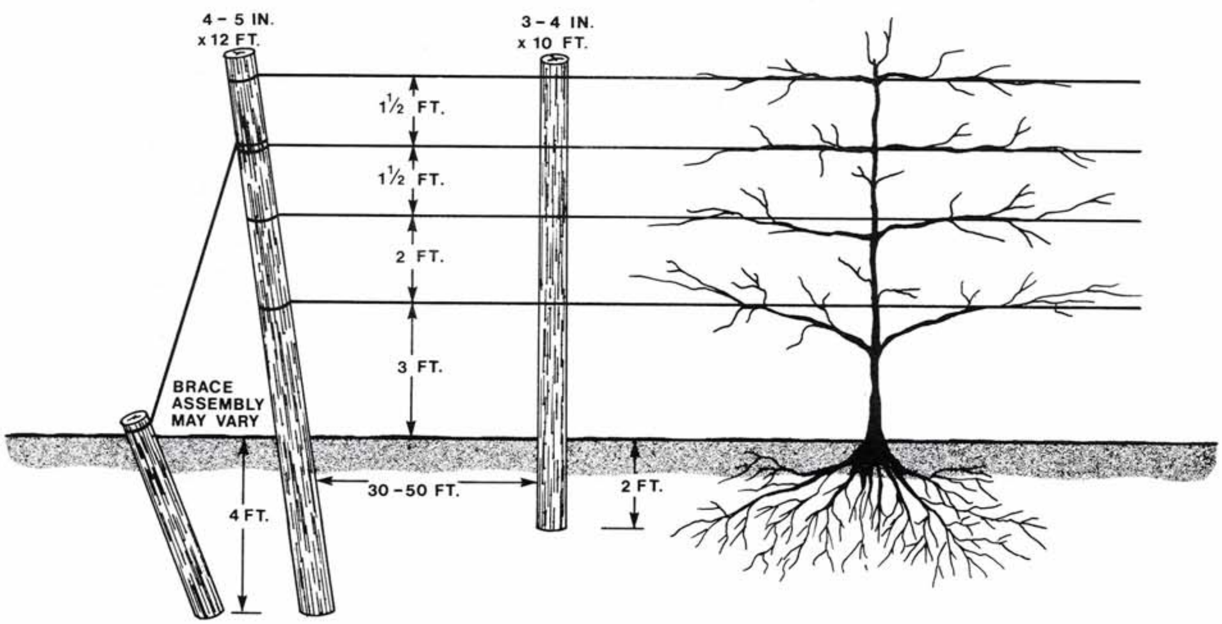

FIGURE 7

8 FT. TRELLIS

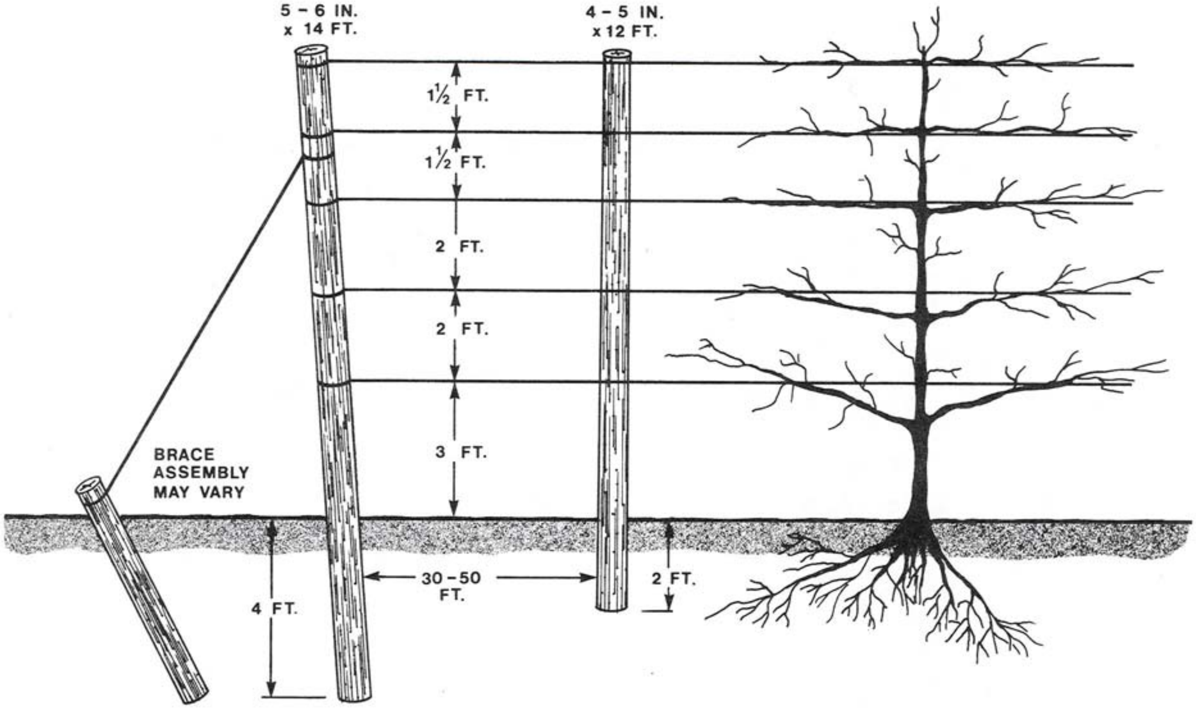

FIGURE 8 **10 FT. TRELLIS**

Many training systems have potential on a trellis, provided one principle is strictly adhered to: Vigor must be maintained in the lower scaffolds and reduced towards the top of the trellis. This point applies to all trees grown with a central leader.

It is very important to construct a sound trellis system. Anchors that pull out, poles that snap or rotate in the soil, staples that pull out, or wires that stretch with expansion and contraction can seriously harm the current season's crop as well as restrict future performance of the trees.

A vertical trellis support system can be used successfully with apples, pears, prunes, plums and peaches. With peaches, it may be difficult to justify the cost of a trellis since they bear quickly when free-standing.

VERTICAL (FRENCH) AXIS

The vertical axis support system is very similar to the 10 ft. trellis. Table 5 lists the necessary structural components.

TABLE 5.
Vertical Axis Design

Materials	**Component Measures (in.)**
End Posts –diameter	5 - 6
- length	168
- depth inground	48
In-Line Posts-diameter	4 - 5
-length	144
-depth inground	24
Distance between posts (ft)	30-50
between wires	
-ground to #1	12
-#1 to #2	53
-#2 to #3	53
Distance between trees (ft.)	4
Distance between rows (ft.)	15

The vertical axis support system lends itself nicely to grower adaptations. Post size and placement should not vary; however, from one to five wires can be used for crop support. Bamboo sticks, thin posts, wire, string and other materials have been used as leader supports. Trees trained to this system are never headed when growing properly; consequently, the leader will devigorate if allowed to flop over with fruiting. For this reason, it is important to select a leader support that will last and withstand the stresses cropping puts on it.

The vertical axis system shown in Figure 9 depicts a three wire trellis with full-length leader support at each tree, securely fastened to all three wires. This will provide the most cost effective trellis. It is not critical for the leader support to extend past the bottom wire into the ground.

At this time, apples are the only tree fruit crop considered for use with this support system.

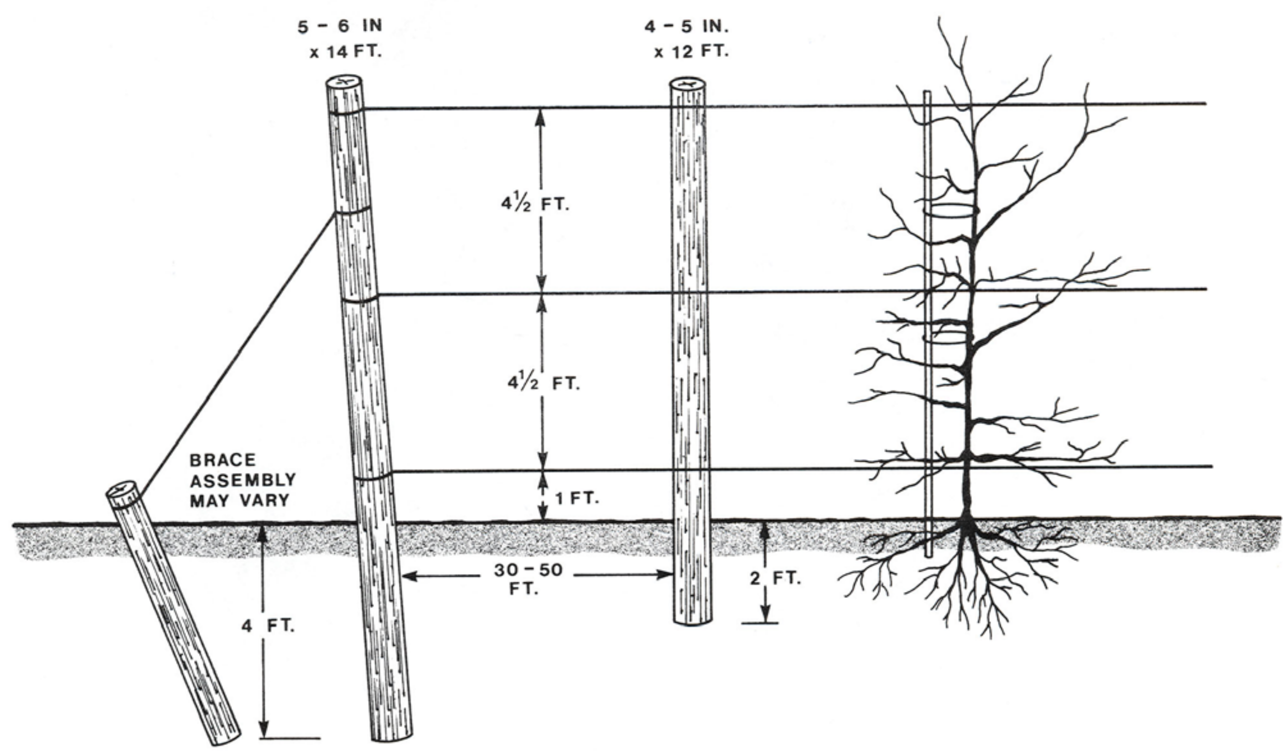

FIGURE 9 VERTICAL FRENCH AXIS

TATURA TRELLIS

An Australian system, the Tatura, was designed to increase the bearing surface of the vertical trellis system. Table 6 is a listing of the trellis specifics.

TABLE 6.
Tatura Trellis Design

Materials	Component Measures (in.)
End Posts - diameter	5-6
- length	192
- depth inground	48
In-Line Posts - diameter	4-5
- length	144
- depth in ground	24
Cross braces - diameter	3-4
- length	120
Distance between posts (ft.)	30-50
Distance between wires	
- ground to #1	36
- #1 to #2	24
- #2 to #3	24
- #3 to #4	18
- #4 to #5	18
Distance between trees (ft.)	6
Distance between row middles (ft.)	17

As seen in Figure 10 this support system utilizes crossed support posts, forming a "V" shaped trellis. Ten wires are fastened to the posts (five per side) and cross braces are affixed between the tips of all end post pairs. Cross braces are optional for in-line post pairs. The trees are headed at 24 in. to produce double leaders. The leaders are then trained to the wires on opposite sides of the trellis.

Support posts of the Tatura are pounded in at a 60° angle to the horizontal. This produces a 60° angle between the two posts as well. The juncture of the two posts (bottom of the "V") is at 18 in. above the ground in a 10 ft. Tatura trellis. The nature of the angled cropping system combined with the pull of ten wires under tension places a great deal of stress on the entire support system. Post sizes, use of cross braces and anchor durability cannot be compromised with this system if the structure is to remain intact for two decades.

The Tatura trellis is well suited to apples, pears, plums and prunes. It may also be the best support system for peaches and Asian pears where fruit movement must be kept to a minimum to reduce fruit scuffing. Cherries and apricots have been tried on the Tatura and other trellis systems with limited success. At this point, it would not be advisable to use a trellising system with cherries or apricots on any more than a trial basis.

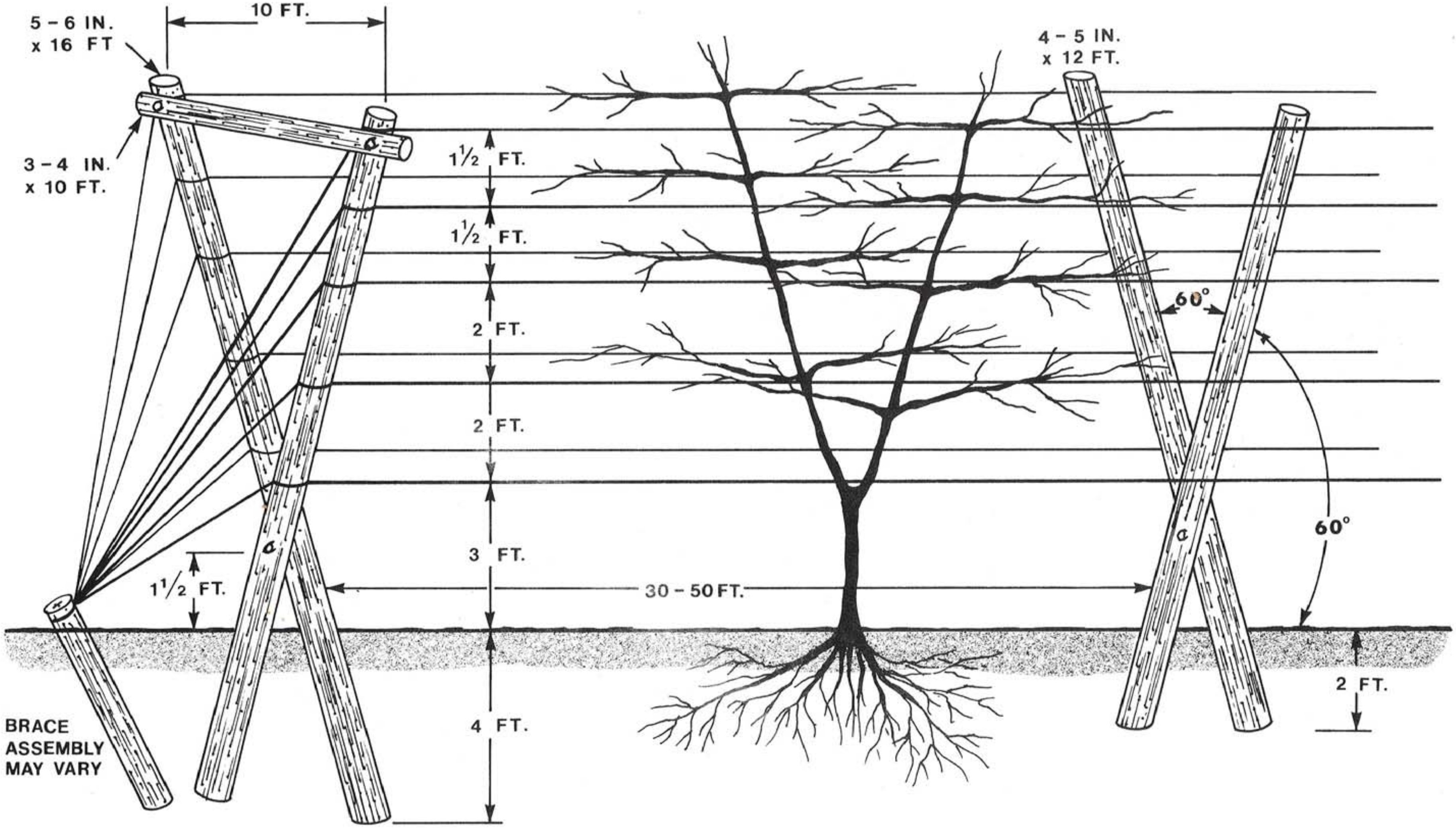

FIGURE 10

TATURA TRELLIS

SLENDER SPINDLE

Figure 11 shows the simplicity of this support system. The slender spindle does not require large support posts, anchors or wires. A slender 2 in. x 8 ft. post is pounded 2 ft. into the ground to support the leader and cropping tree. String wrapped around branches and tied down to a spike driven into the support post at ground level is used to train most limbs. The leader can be zig-zagged across the post to control leader vigor and promote lateral branching. Table 7 is a listing of slender spindle specifications.

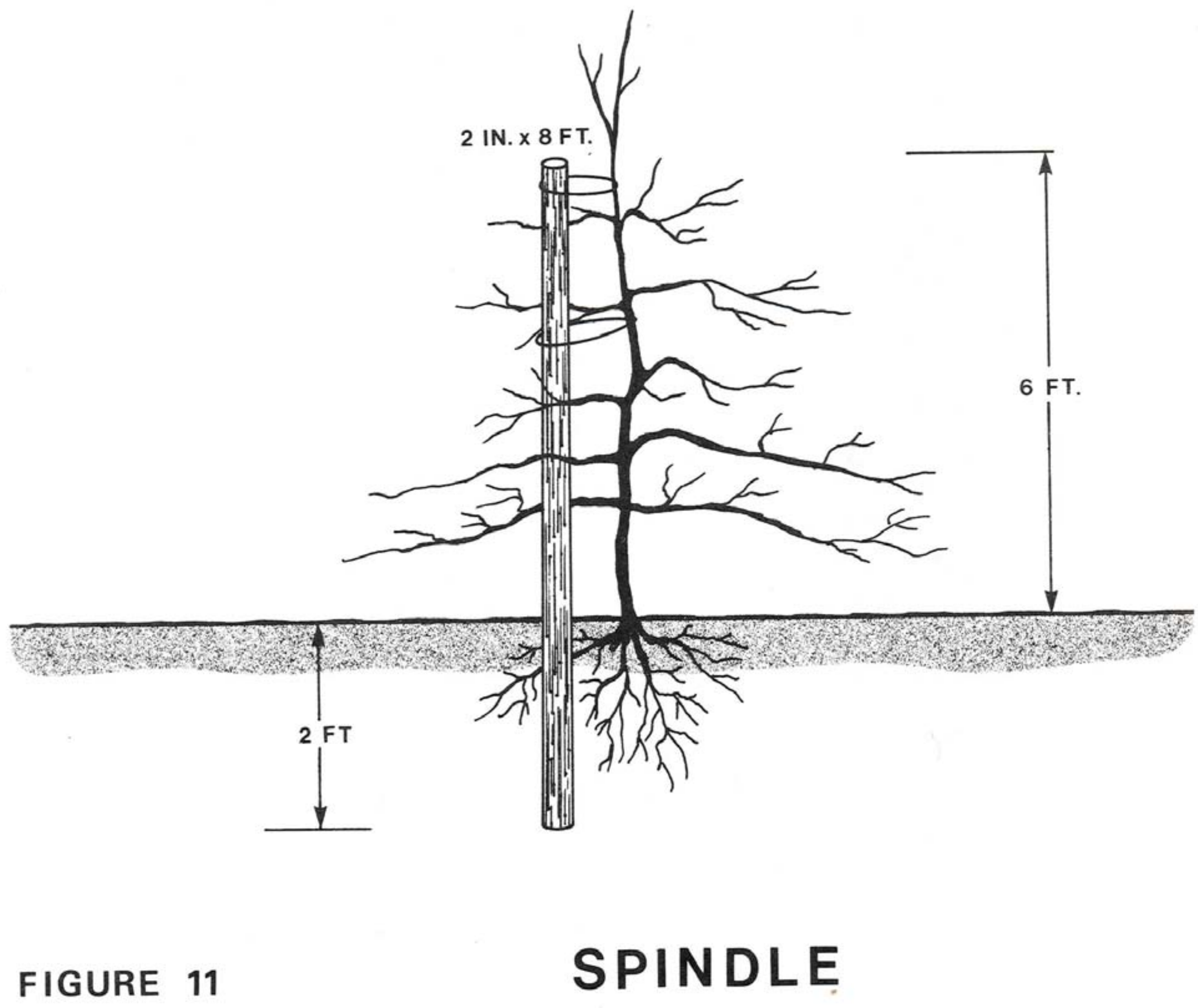

FIGURE 11

TABLE 7.
Slender Spindle Design

Materials	Component Measures (in.)
Posts - diameter	2
-length	96
-depth in ground	24
Distance between posts (ft.)	5
Distance between trees (ft.)	5
Distance between rows (ft.)	13

This system is highly intensive, therefore, it is very important that a grower starts with a very strong, feathered nursery tree to assure early, heavy cropping.

The Slender Spindle system is best suited to apples. Growth and cropping habits of other tree fruits makes this system less desirable than a trellised system.

COSTS

Tables listing the cost of the various support system designs have been prepared. These support system costs are based on recent prices for materials in British Columbia's Okanagan Valley. A summary of the material costs are:

Posts	Material Cost ($)
3 - 4 in x 8 ft.	2.30
4 - 5 in x 9 ft.	4.25
3 - 4 in x 10 ft.	3.25
4 - 5 in x 12 ft.	6.00
4 - 5 in x 14 ft.	8.00
5 - 6 in x 16 ft.	15.00
2 - 3 in x 8 ft.	1.60
Vertical Axis leader pole	.50
Anchor*	5.00
1/2 in. bolt	1.00

The same anchor cost was assumed for each trellis.

Wire

12 1/2 ga. HT wire, 3330 ft. roll	70.00
HT wire tie-off splice	1.00
HT wire 'In-line tensioner'	3.00

Installation costs are also estimated. A local contractor installs wire for $50.00 per 3330 ft. roll. Post and anchor installation have been roughly estimated as a cost charged by contractors:

6 ft. Vertical Trellis	$2.00/post or anchor
8 ft. Vertical Trellis	$2.25/post or anchor
10 ft. Vertical Trellis or Vertical Axis Trellis	$2.50/post or anchor
Slender Spindle	$1.25/post
Tatura Trellis	$7.50/"V" assembly $5.00/anchor

A uniform $6.00 per tree cost has been assumed. This combined with the above information allows for a tree and total support system cost to be projected for each design. Installation of the trees has not been included in these numbers. These costs are tabulated in Tables 8 to 13 and summarized in Table 14.

SUMMARY

If properly treated and constructed the support system will outlast the trees it is supporting. Many trellis and spindle plantings exist in North America that are twenty years old and producing large volumes of top-quality fruit.

These systems and the results they can produce are very attractive, however, the approach is much different from free-standing central leader training. Growers contemplating an intensive planting must be prepared to adopt new training and crop management ideas. Dr. Loren Tukey (Professor of Pomology, Pennsylvania State University) suggests that "success depends upon a good match between the grower and the system and method used." Any system will work if the grower is willing to spend the time and effort to make it work.

Growers considering installation of a support system can obtain further information by purchasing a copy of U. S. Steel's booklet, "How To Build Orchard and Vineyard Trellises". Happy Orcharding!

TABLE 8
Six Ft. Trellis

Row Spacing	13 ft.	
Tree Spacing	6 ft.	
Trees per Acre	558	
COSTS		**$ Per Acre**
Trees $6.00/Tree		**3,350**
Trellis Materials		
(500 ft. Spans)	Per Span	
Wire (1500 ft.)	31.50	
Splices	3.00	
Tensioners (3)	9.00	
Line Posts (11)	25.30	
End Posts (2)	9.50	
Anchors (2)	10.00	
Sub Total	**88.30**	**590**
Installation (approx.)		**360**
TOTAL		**4,300**

TABLE 9
Eight Ft. Trellis

Row Spacing	14 ft.	
Tree Spacing	7 ft.	
Trees Per Acre	444	
COSTS		**$ Per Acre**
Trees $6.00/Tree		**2,660**
Trellis Materials		
(500 ft. Spans)	Per Span	
Wire (2000 ft.)	42.00	
Splices	4.00	
Tensioners (3)	12.00	
Line Posts (11)	35.75	
End Posts (2)	12.00	
Anchors (2)	10.00	
Sub Total	**115.75**	**720**
Installation (approx.)		**410**
TOTAL		**3,790**

TABLE 10
Ten Ft. Trellis

Row Spacing	15 ft.	
Tree Spacing	8 ft.	
Trees per Acre	363	
COSTS		**$ Per Acre**
Trees $6.00/Tree		**2,180**
Trellis Materials		
(500 ft. Spans)	Per Span	
Wire (2500 ft.)	52.50	
Splices	5.00	
Tensioners (5)	15.00	
Line Posts (11)	66.00	
End Posts (2)	18.00	
Anchors (2)	10.00	
Sub Total	**166.50**	**970**
Installation (approx.)		**450**
TOTAL		**3,600**

TABLE 11
Vertical Axis

Row Spacing	15 ft.	
Tree Spacing	4 ft.	
Trees Per Acre	726	
COSTS		**$ Per Acre**
Trees $6.00/Tree		**4,360**
Trellis Materials		
(500 ft. Spans)	Per Span	
Wire (1500 ft.)	31.50	
Splices	3.00	
Tensioners (3)	9.00	
Line Posts (11)	66.00	
End Posts (2)	18.00	
Anchors (2)	10.00	
Leader Pole (125)	62.50	
Sub Total	**200.00**	**1,160**
Installation (approx.)		**360**
TOTAL		**5,880**

TABLE 12
Tatura

Row Spacing	17 ft.	
Tree Spacing	6 ft.	
Trees per Acre	427	
COSTS		**$ Per Acre**
Trees $6.00/Tree		**2,560**
Trellis Materials (500 ft. Spans)	Per Span	
Wire (5000 ft.)	105.00	
Splices	10.00	
Tensioners (10)	30.00	
Line Posts (22)	176.00	
End Posts (4)	60.00	
Cross Ties (11)	35.75	
Anchors (4)	20.00	
Sub Total	**436.75**	**2,240**
Installation (Approx)		**970**
TOTAL		**5,770**

TABLE 13
Spindle

Row Spacing	13 ft.
Tree Spacing	5 ft.
Trees Per Acre	670
COSTS	**$ Per Acre**
Trees $6.00/Tree	**4,020**
Materials (670 Posts)	**1,070**
Installation (approx.)	**840**
TOTAL	**5,930**

TABLE 14
Cost Summary
($ Per Acre)

Support System	Trees	Support Material	Support Installation	Total
Six Ft. Trellis	3,350	590	360	4,300
Eight Ft. Trellis	2,660	720	410	3,790
Ten Ft. Trellis	2,180	970	450	3,600
Vertical Axis	4,360	1,160	360	5,880
Spindle	4,020	1,070	840	5,930
Tatura	2,560	2,240	970	5,770

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