Quote: . . . forming an equilateral triangle . . . with the endpost, wire and ground is the simplest, strongest, most stable and most effective form of anchorage.

Nuts and Bolts of Dwarf Fruit Tree Support Systems

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There are many kinds of dwarf fruit tree support systems with numerous articles written about their benefits. This paper focuses on the practical side of building a good support system. Because growers want to know which system is more difficult or costly to build, a case study is presented analyzing the overall costs on a per acre, or tree basis.

There are many support systems, each with variations. Support systems are often associated with particular orchard systems. The most popular orchard and support systems are:

- Slender Spindle; midsize support posts at each tree and nothing else (Figure 1).
- Vertical Axis; narrow support posts at each tree, each connected to a single wire (Figure 2).
- Tatura Trellis; trees supported by three wires on an angle on each side of ‘Y-shaped’ canopy (Figure 3).
- Super Spindle; trees supported by four wires one above the other, running the length of each row (Figure 4).

SUPPORT SYSTEM COMPONENTS

There are five components to consider when building a dwarf fruit tree support system, all of which are important in making sure that a tree support system will last for the life of the orchard:

- Soil
- Endposts and anchors
- Tree support posts
- In-line posts
- Wire

Soil Factor

A good dwarf fruit tree support system starts with a good soil foundation. Poor anchorage is the main cause of failures. Consider the following:

- Clay soils offer more resistance to uplift and overturning than sandy soils.
- Dry soils offer more resistance to uplift and overturning than wet soils.
- Know where your tile drains are before you start installing posts.
- The higher the mature trees and expected apple weight, the more important is good anchorage.
- Irrigation can loosen posts if too much water is applied, especially around anchor posts.
- Increasing the depth of posts in the soil by 33% increases a post’s strength by 100%.
- Undisturbed soil gives much better anchorage than soil that has been disturbed.
- Moving anchor posts because of rocks may compromise anchorage and headland space.

Endposts and Anchors

Good anchorage of endposts for vertical axe, tatura trellis and super spindle is critical to the success of all dwarf fruit tree support systems. Consider the following:

- The type and size of material is less important than the method of installation.
- Many methods are used, but the concept of forming an equilateral triangle (60^{o} angles at each corner with all sides the same length) with the endpost, wire and ground is the simplest, strongest, most stable and most effective form of anchorage (Figures 2, 3, 4 and 5).
- Start by installing the endpost, leaning toward the headland, at 60^{o} to the ground. An equilateral triangle has about 1.75:1 sloped sides (Figure 5). That is, for every 1.75' vertically, the endpost should be 1' horizontally. So, an endpost with the top 10' above ground vertically should lean about 5.75' toward the headland of the row horizontally.
- For a wire over the top of an endpost that is 10' vertically above ground, the screw anchor (Figure 5) should be about 11.5' away from the endpost.
- A triangular template with 60^{o} sides is helpful for installing endposts at the correct angle.
- Pressure-treated lumber should be used for endposts to ensure they do not rot over time.
- Endposts that are pounded in with no starting hole are 50% stronger than augered ones.
- Custom operators to pound in posts are well worth their cost.
- Put the small end of round posts down for pounded posts, large end down for augered ones.
- Steel screw anchors are quick and cheap to install with specialized installation equipment.
- Screw anchors should be installed vertically, not angled, since this disturbs less soil.

Tree Support Posts

Tree supports are the most costly component of slender spindle and vertical axis systems. Consider the following:

- Many types are used including steel angle bars, bamboo poles, pressure-treated posts and galvanized electrical conduit.
- Although bamboo poles are least expensive, they are more difficult to push into the ground than more expensive, but easier to install, steel angle bars or galvanized electrical conduit.
- Support posts must be larger in diameter and have greater strength for a slender spindle system than for a vertical axe system because there is no wire to support posts in the slender spindle system.
- Some growers install tree supports on the windward side of trees to prevent wind rub damage.
- Plant the trees about 6" from the tree support posts.

In-line Posts

In-line posts give periodic support for the wire(s) in support systems for vertical axe, tatura trellis and super spindle. Consider the following:

- They should be custom pounded for added strength.
- They are usually made from pressure-treated lumber.
- They usually range from 30 to 50' apart (10 to 15 m) depending on a number of factors, but should be closer if the trees (and apple weight) are going to be quite high at maturity or if the land is rolling, causing the wires to pull the in-line posts out of the ground.

Wire

Installing wire for vertical axe, tatura trellis and super spindle can be a time-consuming, frustrating and dangerous job. Consider the following:

- Installation is usually at least a two-person job.

- The apple weight is the main load and it affects the sag of the wire.
- Use 12.5 gauge high tensile strength wire.
- High tensile wire springs and kinks when cut, so uncoil in reverse order.
- Use an unwinding spool.
- Consider distribution of the wire from a moving platform.
- Install on the windward side of in-line posts.
- Do not drive home staples, as this puts a stress point on the wire and weakens it over time.
- Use gloves, safety glasses and be ready in case the wire breaks during tightening.

CASE STUDY

It is sometimes easier to compare costs when a case study is used (comparing "apples to apples"). In this case study, slender spindle, vertical axis, tatura trellis, and super spindle systems were compared (Table 1). Suppose a new orchard is being planted that is 5 acres in size, 500' long x 436' wide (the case study is not converted into metric to avoid confusion). Here are the assumptions:

- Between-row spacing is based on 1.3 times the mature tree height, but is not less than 11' for tractor access, and not more than 14'.
- Number of rows is based on allowing at least 14' between the last row and the side fence line on the 436' wide orchard.
- Number of trees/row is based on allowing at least 25' clear turning room at headlands beyond steel screw anchors, and planting trees between the post and screw anchors on wire systems.
- Pressure-treated wood may be more commonly available than galvanized electrical conduit for tree supports, but conduit is used in this case study.

Material Cost Assumptions

The costs of materials ($CAN) are as follows (Table 2):

- $2.65 for 2" x 8' pressure-treated wood tree supports, sharpened at one end (slender spindle).
- $1.75 for 10' hollow galvanized electrical conduit for tree supports (vertical axe).
- $0.02 for ties to attach trees to posts (slender spindle and vertical axe) or trees to wires (tatura trellis and super spindle).
- $0.08 for twisted wire clips to attach tree supports to wire (vertical axe).
- $0.02 per foot of 12.5 gauge high tensile smooth wire (vertical axe, tatura trellis, super spindle).
- $12 per 14' pressure-treated wood post anchor; 3" to 4" round, including staples (vertical axe, tatura trellis, super spindle).
- $8.50 per 10' pressure-treated wood in-line post; 3" to 4" round (vertical axe, super spindle).
- $10.25 per 12' pressure-treated wood in-line post; 3" to 4" round, including staples (tatura trellis).
- $10 per 8' pressure-treated wood cross brace, including bolts and nuts (tatura trellis).
- $9 per 4' x 3/4" x 6" plate steel screw anchor; includes tightening hardware (vertical axe, tatura trellis, super spindle).
- Trees cost $6.80 each.

Labor Cost Assumptions

The costs for labor ($CAN) are as follows (Table 2):

- Grower labor at $10/hour to install wire, tree supports, ties, wire clips, braces, etc.
- Custom post pounder at $45/hour to install post anchors, screw anchors, in-line posts.
- Labor costs include moving around orchard for installations.

- 6 minutes to install 2" pressure-treated wood support, pounded 2' deep by grower (slender spindle).
- 2 minutes to install 1/2" electrical conduit, twisted 1' deep by grower (vertical axe).
- 20 sec for grower to install tree to post ties (slender spindle or vertical axe), or tree to wire ties (tatura trellis or super spindle).
- 20 sec for grower to install twisted wire clips to attach tree supports to wire (vertical axe).
- 30 minutes/wire/row for each of two grower employees to install a 475' wire down row (vertical axe, tatura trellis, super spindle).
- 6 minutes/endpost anchor to custom pound (vertical axe, tatura trellis, super spindle).
- 4 minutes/in-line post to custom pound (vertical axe, tatura trellis, super spindle).
- 3 minutes/screw anchor to custom screw them in (vertical axe, tatura trellis, super spindle).
- 15 minutes/cross brace to drill and bolt them to anchor post (tatura trellis).
- Trees are installed with three people, a planter, and at 200 trees/hour.

Results

The cost breakdown is shown on Table 2. Some comments include:

- The least expensive system on a per acre basis is the vertical axe system because there are relatively fewer trees planted per acre.
- The most expensive system on a per acre basis is the super spindle system because there are so many trees per acre planted.
- The least expensive system on a per tree basis is the super spindle system because there are so few posts, little wire to install and so many trees.
- The most expensive system on a per tree basis is the tatura trellis system because there are so many wires and posts to install and so few trees.

CONCLUSIONS

There are many considerations to take into account when deciding which dwarf fruit tree support system to use in your orchard. All systems have their own advantages and disadvantages. Attention to little details during construction will make any system last the life of the orchard. Remember to include all costs, including your own, to get a true comparison between systems.

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Table 1. Comparison of the characteristics of 4 dwarf fruit tree systems in a 5-acre cost study.

Component	Slender Spindle	Vertical Axis	Tatura Trellis	Super Spindle
	System characteristics			
Tree spacing	5'	6'	6'	2.5'
Row spacing	12'	14'	14'	11'
Number of rows	35	30	30	38
# Trees/row	91	74	74	174
# Total trees	3185	2220	2220	6612
# Tree/acre	637	444	444	1322
Wire height	NA	8'	Top 8'; mid 6'; bot 3'	Top 8'; 6.5'; 5'; bot 3'

Table 3. Comparative total costs ($CAN) for labor and materials for 5-acre plantings of 4 dwarf fruit tree support systems.

Component	Slender Spindle	Vertical Axis	Tatura Trellis	Super Spindle
Total materials	$30,161.95	$ 23,131.80	$ 25,187.40	$52,729.56
Total labor	$4,193.58	$3,081.33	$5,318.00	$5,976.13
Total cost (5 acres)	$34,355.53	$26,213.13	$ 30,505.40	$58,705.69
Materials/tree	$ 9.47	$10.42	$11.35	$7.97
Labor/tree	$1.32	$1.39	$2.40	$0.90
Total/tree	$10.79	$11.81	$13.74	$8.88
Total/acre	$6,871.11	$5,242.63	$6,101.08	$11,741.14

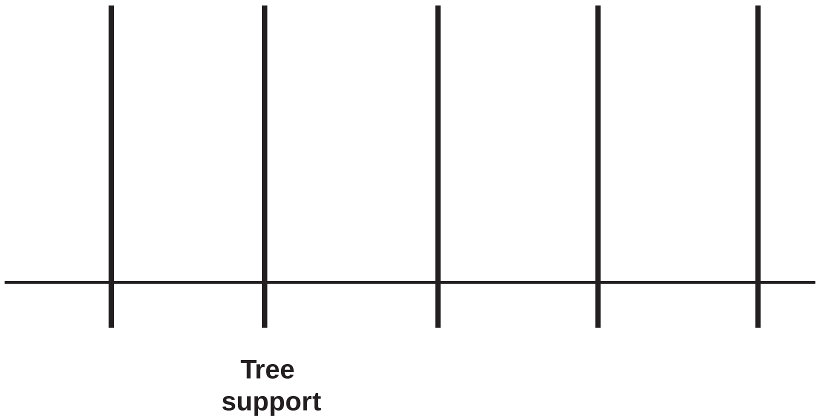

Figure 1. Side view of slender spindle system, showing midsize post supports at each tree.

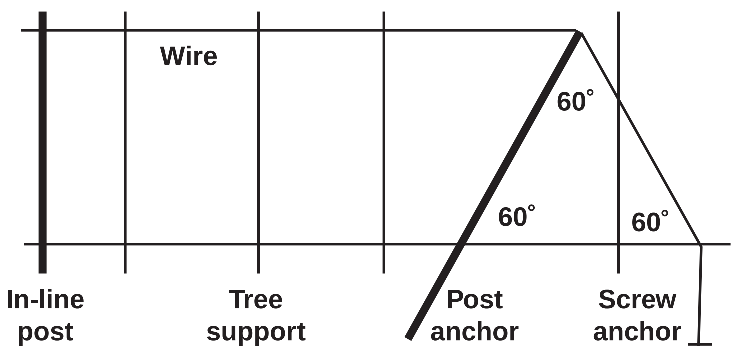

Figure 2. Side view of vertical axis system, with narrow support posts at each tree, all connected by one high tensile wire running the length of the row.

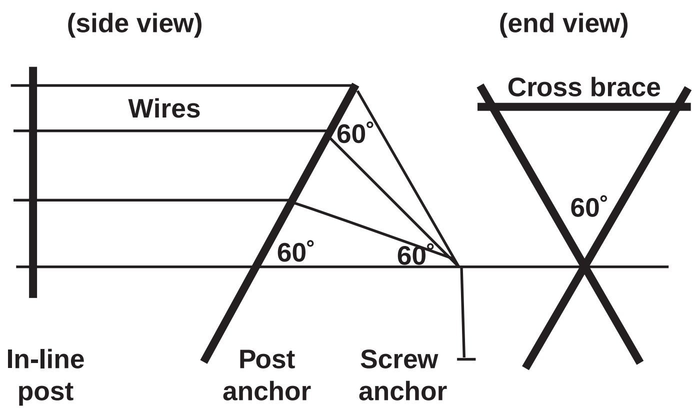

Figure 3. Side and end view of Tatura trellis system, with trees supported by three wires on each side of 'Y-shaped' tree canopy.

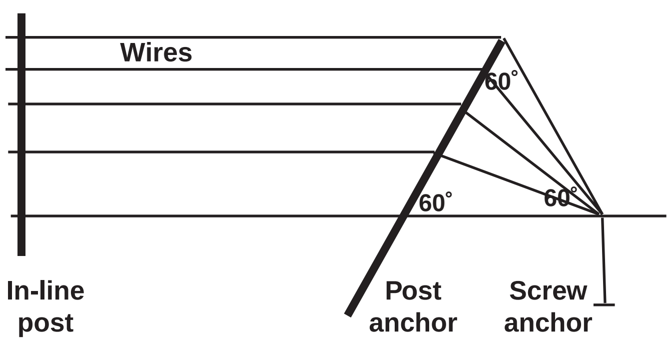

Figure 4. Side view of super spindle system, trees supported by four wires the row length.

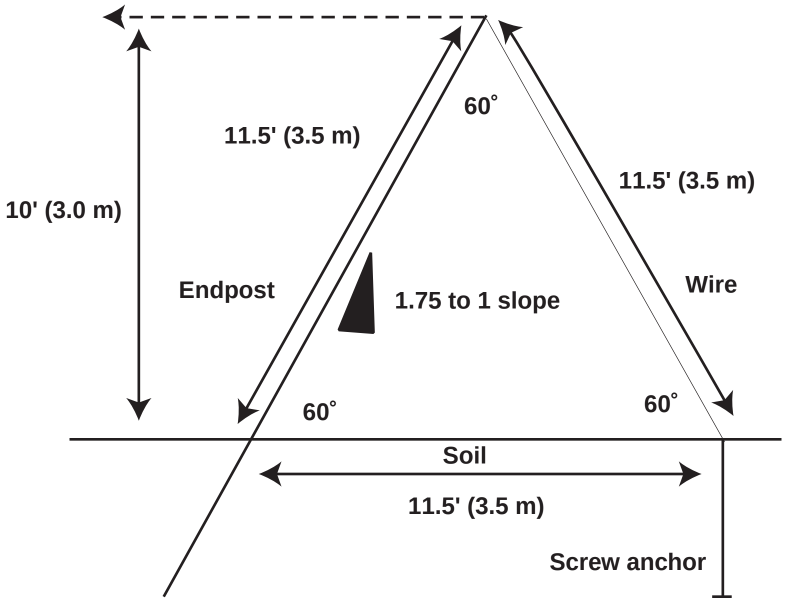

Figure 5. A stable, strong anchoring system is produced by forming an equilateral triangle between the endpost, soil and wire, with 60˚ angles between each of them.