

Trellis Support System for High Density Plantation – A Civil Engineering Perspective.

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Abstract:-

Modern high-density planting systems can produce huge crops on small trees, which can create significant force or leverage on the tree and graft union. Support systems must also be engineered to withstand the additional stresses caused by wind, snow and rain.

However, the system has challenges. The limited branch framework of dwarf trees provides insufficient support for the crop, and hence a support system, also known as a trellis, is necessary for supplemental support.

Keywords: - Force, loads, trellis, support, stresses, support system.

1. INTRODUCTION

The support system in today's modern orchard is an essential component. Fully dwarfing rootstocks used in the Tall Spindle and Vertical Axis planting systems induce early bearing so that the tree's trunk and limbs cannot support the full weight of the fruit (Robinson, 2003). In addition, many of the newer rootstocks have brittle graft unions, which have a tendency to snap under any type of stress induced by wind and fruit weight. A sturdy support system capable of holding more than 35 tons of fruit per acre is necessary and takes the place of the trunk and scaffolds of older systems. Support systems must also be engineered to withstand the additional stresses caused by wind, snow and rain. It is apparent that support systems must be engineered to support more than 10 times the weight of a crop load for worst case scenarios

There have been many versions of the orchard support system since the introduction of high density planting systems in the United States back in the '60's. Originally, single wooden stakes at each tree or a simple 3 or 4-wire was used. The conduit pipe was widely adapted to support Interstem systems but proved to function more as a training aide than as a pure fruit weight support system. Through years of research on the various planting systems growers realized that higher densities and a stronger support system were needed and economically viable.

High-density dwarf tree fruit production is a common practice in orchards. The spindle-type tree is grafted or budded to a dwarf rootstock. These spindle-type trees produce fruit faster and at higher densities than traditional trees. The ability to quickly implement newer varieties that better meet market demands and improve financial returns make high density production attractive. However, the system has challenges. The limited branch framework of dwarf trees provides insufficient support for the crop, and hence a support system, also known as a trellis, is necessary for supplemental support.

1.1 Benefits

High-density orchards using trellises for support are initially more expensive to implement than traditional plantings but are more efficient and profitable over their production life. A trellis provides the following advantages:

- Encourages trees to put energy into fruit production instead of producing wood.
- Provides a uniform structure for tree training, promoting uniform growth.
- Improves light interception and uniformity of fruit quality and ripening.
- Produces earlier yields, potentially within two years of planting, and higher total yields over the life of the orchard.
- Reduces Labour costs and encourages more uniform pruning, training, and thinning.

- Reduces damage to fruit and grafts by reinforcing trees against the wind.
- Facilitates the management of orchards as fruiting walls in two dimensions.

1.2 Trellises Can Fail

Trellises can fail. Figure 1 illustrates why. To be successful, a trellis must stand for the full life of the planting, typically 20 years. During this time, the capacity of the trellis system must always be greater than the load they are required to carry.

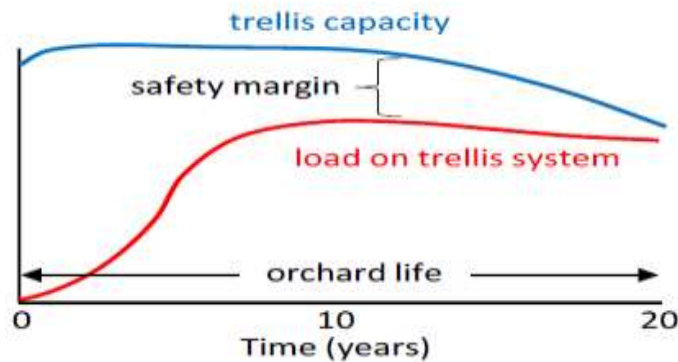


Figure 1. Evolution of trellis loads and trellis capacity over the life of the orchard.

It is important to recognize that the loads on and the capacity of a trellis change over the life of the planting.

- In the first two to three years, loads are relatively light as the planting establishes itself. At the same time, the trellis system is at its maximum strength.
- As trees grow and produce more fruit, typically from five to eight years, they exert a greater weight on the trellis and wind loads increase with greater foliage. Meanwhile, the trellis may begin to weaken due to:
 - ❖ Corrosion of wire and hardware.
 - ❖ Cyclic wind loads, weakening posts, wire, connectors, and soil.
 - ❖ Operational wear and tear.
- After eight to ten years, loads may stabilize and slightly decrease on the trellis as spindles thicken and carry a bit more load, but the trellis system will potentially lose significant load capacity as a result of advancing post rot, and corrosion and fatigue of wire and metal.

If the loads on the trellis exceed the capacity of the trellis, it will fail.

1.3 Preventing Trellis Failure

A properly functioning trellis is the product of good planning and implementation. Each support system must be uniquely designed for its site and application. It should not be assumed that the design of a support system on a neighboring orchard is adequate for the current application. At the time of planting, the materials and construction that comprise a support system are near their peak performance, but experience minimal loads. To overcome the challenges posed to support systems during their operational life and to mitigate failure, orchardists must use:

- A support system designed to provide adequate strength and resilience for its service life.
- Recommended materials that meet the design requirements of the system.
- Proper construction techniques in implementing support systems.
- Best practices in the use and maintenance of the support system over its service life.

This paper will guide producers in design and construction of trellises, the materials and methods used in their construction, and the expected costs.

“Trellises must be designed and built for the full life of the orchard (20 years) to assure success. What may appear to be an oversized support system at the time of installation may only have a small safety margin for its capacity near the end of the orchard lifespan.”

2. TRELLIS

A trellis support system relies on poles and wires to support the weight of the trees and fruit, including wind loads. Stroger poles installed at a greater depth create a stronger system. Not only is the post itself stronger but the lateral resistance to post overturning is higher because the forces acting on poles are distributed over a larger contact area. Increasing the post embedment in the soil will significantly increase the load capacity of the support system. The support system capacity is also dependent on the strength of the soil around the post.

The soil around driven poles will provide more resistance to wire and wind loads compared to a post installed in an auger borehole. Therefore, drive the poles where possible because a driven post can be 50% stronger than an augered poles.

The support poles are typically installed in a straight line. The poles at each end of the line (endpoles) will carry more load than the poles within the line of poles (line-poles). The end-poles are designed differently than the line-poles. The designs presented here consider a recommended standard for line-poles and different design options for the end-poles. The larger poles should always be selected and used for the end-poles.

3. WIRE

The Perfect trellising wire is easy to install, requires little maintenance and has a long service-life. The high strength, low elongation wire results in various advantages such as more usable wire length with the same final breaking load and a higher resilience that lasts many harvests. The advanced, zinc-aluminium coating exceeds the performance of heavy galvanised wires in both quality and lifetime. As a result, trellising wires stay tight and corrosion-free during the entire lifespan of the orchard.

4. SOIL ANCHORS/ANCHORAGES

The general types of soil anchors can be used to secure tie-back wires/ropes. The helical steel plate welded onto the end of a steel rod. The anchor should be installed strong enough into the ground. Ideally, each soil anchor should be installed in firm undisturbed soil at an inclination such that the wire rope or anchor shank to points towards the tie-back attachment location on the end port. The attachment loop should be near the ground surface after the anchor is installed.

5. PRE-STRESSED CONCRETE POLES

Pre-stressed concrete pole distinguishes itself by:

- **Elasticity:**
The elasticity is determined by the particular compound and the choice of a high quality harmonic steel strand. Those are two of the factors that leads to a higher elasticity of pre-pressed concrete.
- **Robustness:**
The pole must also ensure a good strength performance depending on the regions where they are located, orchards may be exposed to strong winds and particularly intense atmospheric events and there is the aggravating weight of snow or hail that drains on the net. These two aspects must be considered with great care and are crucial to ensure a stable and long-lasting system.

Pre-stressed cement poles are available in different sections:

- 7 x 7 cm
- 7 x 8 cm
- 9 x 9 cm
- 8 x 12 cm



Figure 2(a)



Figure 2(b)

Photos showing the assemblage of trellis support system including End-Poles and Line Poles with other accessories like wires and cables of different diameters, single and double VA-PA hooks, anchorages, anti-sinking plates, plastic caps or hoods, collars etc.



Figure 3. Installation of Anchorages at Pulwama J&K.



Figure 4. A collar is attached to the End-Pole to hold the trellis wire of 2.2mm dia. firmly

6. CONCLUSION

Trellised orchards are much more uniform, simpler to manage and easier to harvest. The future looks bright for trellis support systems.

Pre-stressed pole trellis support structure is likely to continue to be the best support system as it is well engineered to withstand the likely loads to act on it. Trellises must be designed and built for the full life of orchard to assure success.

GPS-guided, robotic and autonomous equipment can also be assisted by trellises. This future, though, will depend on strong trellis design and installation to provide the critical support needed to produce high yields and quality.

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