# Trellis design and construction

## Trellis materials

Trellises consist of a system of supporting posts and wires, held tight by end assemblies (Figure 1). Most tropical tree crops are expected to have a lifetime of 20+ years, hence the trellises that support them need to be designed and constructed to last just as long.

In cyclone prone environments trellises should be strong enough to withstand cyclonic winds and support the estimated crop load. If you are considering installing trellising in a cyclone prone area it is recommended to consult the AgriFutures report 'Improving the Capacity of Primary Industries to Withstand Cyclonic Winds' available on the AgriFutures website, as this report contains detailed recommendations on trellis strength requirements and design & construction considerations for these areas (Drinnan et al., 2018).

***Figure 1. Espalier trellis mango trees, part of the Planting Systems Trial at DAF Walkamin Research Facility. These trees were planted in 2013 at a spacing of 4m between rows and 2m between trees.***



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# Posts

## Material

Various materials can be used, such as timber, concrete or steel; however, treated pine posts are best for strength, durability, price and workability. Treated pine posts such as CCA (copper, chrome, arsenic) are ideal as they are resistant to the harsh environment where most mangoes are grown. For organic growers, alkaline copper quaternary (ACQ) treated posts may be a more suitable option. The Planting Systems Trial at Walkamin Research Facility on the Atherton Tablelands, Queensland, used H4 CCA treated 150 mm diameter posts. It is recommended to over-engineer trellis infrastructure to ensure durability for the estimated lifetime of the orchard.

## Depth

Ideally, posts should be installed at least ⅓ of their height. “The force a post can resist without moving is equal to the square of its depth; therefore the depth of the posts is critical” (Drinnan et al., 2018 p52). Soil type also influences resistance so sandier soils will require deeper placement and larger diameter posts than clay soils. Preferably posts should be rammed into undisturbed soil, as this provides improved stability, over posts that have been installed in augured and backfilled holes.

## Orientation

Generally, trellises are installed in a north-south orientation to ensure the largest tree surface – the fruit wall – intercepts the most amount of sunlight possible. Site and locality characteristics should also be considered, including the slope, prevailing wind direction, shape of the block and sunlight intensity and duration. This may require the orientation to be adjusted from strictly north-south. Orchards in areas with high sunlight intensity should consider the potential implications of excess or extreme sunlight leading to sunburnt fruit and adjust row direction accordingly.

## Height

The rule of thumb is that the height of trellises should be 67 – 83% the width of the rows, to maximise sunlight interception and avoid shading. It is recommended to consider management operations when deciding on final tree height as taller trellises must be stronger to support larger crop loads and are more difficult to prune, train, spray and harvest. Workers may need to utilise ladders or elevating work platforms to access the top-most wires which brings with it WHS concerns. Shorter trellises enable closer row spacing but this may require specialised farm machinery and/or a greater capital outlay per unit area. The Planting Systems Trial at the DAF Walkamin Research Facility used 4.5m posts with 1.6m below ground and 3.2m above ground, six wires spaced every 0.5m, beginning at 0.5m above ground and the top wire at 3m. The dripper irrigation lines were fitted to the bottom-most wire. The inter-rows are 4m wide making the 3m finished height of the trees 75% the width of the rows. Ladders and elevating work platforms were necessary to undertake canopy management such as branch training and pruning on the top two wires and short picking poles were also required to reach fruit at harvest.

## Wires

It is recommended to use 2.65mm diameter high tensile galvanised wire e.g., LifeWire. Larger diameter wires can be used e.g., 3.15mm, for added strength, however, this would increase costs. The number of wires is dependent on individual trellis design. The Walkamin trial is a 6-wire trellis with wires at 0.5, 1.0, 1.5, 2.0, 2.5 and 3.0m above ground level (Figure 3). In recent trials the bottom wire has been positioned higher (eg 70-90cm from ground) to improve spray access and reduce fruit damage. Also the distance between wires was increased to 60cm. This resulted in a 5-wire trellis with wires at 0.7, 1.3, 1.9, 2.5 and 3.1m.

### Attachment

Attach wires to posts with long-life, galvanised, barbed “U” nails e.g., 40mm x 4mm. Ensure the “U” nail is installed slightly off vertical to the post wood grain to reduce the potential of splitting. Do not pre-drill holes for “U” nails, to ensure a firm fit. Trellis wires should be attached to the end assembly post, not the screw anchor.

## Trellis End Assembly

### Anchored post

The end assembly supports the tension and load placed on the trellis by the crop and wind. It is therefore critical to ensure that end assemblies are correctly installed and strong enough to support this load. Where anchored end assemblies are used in temperate industries such as viticulture, the recommendation is for end posts to be positioned at an angle of 65° to ensure the force placed upon it by the trellis wires acts to force the post into the ground (Figure 2). However, this may be difficult to achieve in a mango orchard, particularly where taller trellises may be desired, requiring longer, wider posts to support the weight of mango trees. The system installed at the Walkamin Research Facility consists of 4.8m posts with 150mm diameter erected upright at 90° with the top guide wire at a 45° angle to the screw anchors (Figure 3). The screw anchor must be positioned into undisturbed soil.

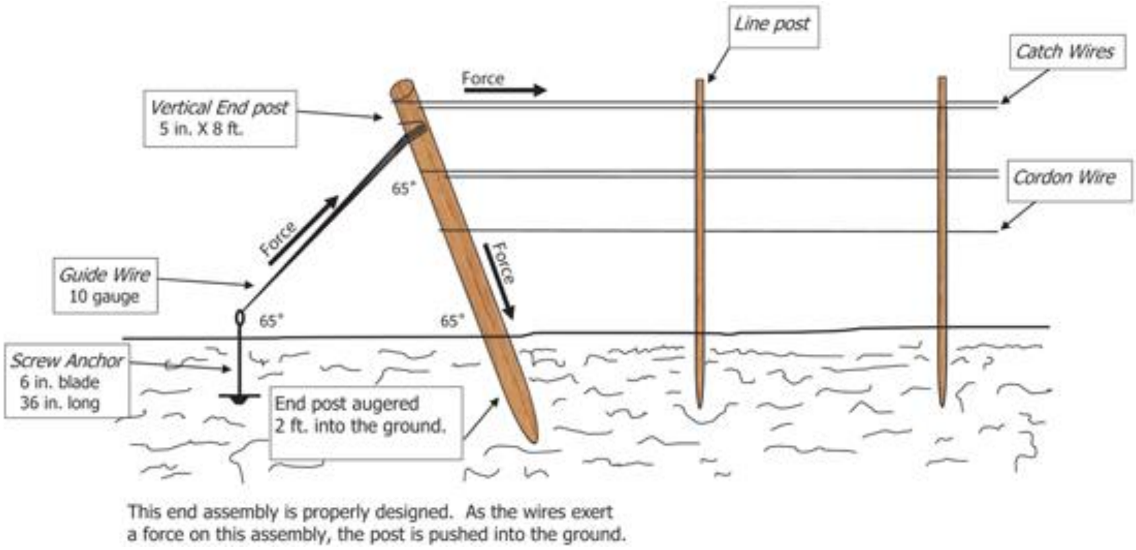


***Figure 2. Trellis end post at 65° angle as used in temperate industries***
***(Source: [https://aces.nmsu.edu/pubs/_h/H331/](https://aces.nmsu.edu/pubs/_h/H331/)).***

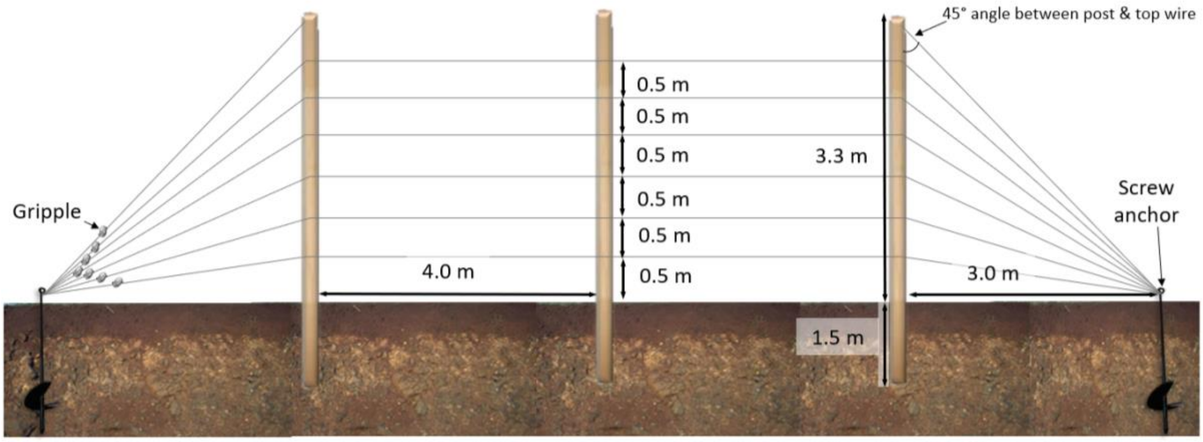


***Figure 3. Trellis assembly at 90° angle as used in mango planting systems trial at Walkamin Research Facility.***

## Trellis End Assembly

The costs for trellising were calculated for a hypothetical 1-hectare block (Table 1). The block specifications were:

1. 18 rows x 138m long, 66 trees/row
2. 4m inter-rows and 2m between trees = 1,188 trees/hectare

3. 3m tall fence-style trellises with 6 x wires per trellis spaced 0.5m apart; starting at 0.5m from the ground

***Table 1. Costs of materials and labour for one hectare of trellis infrastructure.***

| Item | Quantity per row | Quantity per ha (18 rows) | Cost ($) | Sub-Total ($) |
|---|---|---|---|---|
| 175mm x 4.8m CCA H5 Pine logs | 12 | 216 | 98.50 | 21,276 |
| 2.65mm long life, grow wire (m) 140m x 6 wires (per m) | 840 | 15,120 | 0.17 | 2,517 |
| 1360 long single plate 20mm high tensile rod anchor | 2 | 36 | 30.45 | 1,096 |
| 40mm x 4mm long-life galvanised, barbed staples (6/post) | 72 | 1296 | 0.08 | 103 |
| Medium gripple plus 2-3.25mm | 12 | 216 | 2.60 | 561 |
| Post installation (machinery and labour per hr) | 1 | 18 | 195.00 | 3,510 |
| Wire installation (labour per hr) | 6 | 18 | 25.00 | 2,700 |
| | | | **TOTAL** | **31,763** |

Note: Prices are a guide only and were current as of January 2020.

(a) (b) (c)

***Figure 4. Materials for trellis construction (a) gripples for attaching wires, (b) wire spinner and (c) example of screw anchor.***

## Key references

Drinnan, J., Wiltshire, N., Diczbalis, Y., Holden, P., and Thompson, M. (2018). Improving the capacity of primary industries to withstand cyclonic winds. AgriFutures Australia, New South Wales.