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# Pruning and Training Apple Trees for Maximum Yield & Fruit Quality Tall Spindle and Vertical Axe

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# Rule 1

- Plant only high quality Trees

# What is a Quality Tree

- Caliper and height
- (Branching) Feathers
- Standard Rootstock Shank Length
- Healthy Rootsytem
- Budding or Grafting Method Used
- Pest Freeness



# Whips vs. Feathered Trees

- Whips
  - Readily available, easy to grow
  - Easy to handle and plant
  - **Additional training and pruning**
  - **Delayed bearing by at least 1 year**
  - Must be headed in nearly every situation
- Feathered Trees
  - **Yields at least one year earlier**
  - **Less training required**
  - **Much more profitable**
  - Harder to get, harder to grow
  - Can be planted at a higher density than whip of the same variety and same rootstock





These are excellent tree for a High Density Planting System but must be severely pruned for lower density planting systems!

# Tree Planting



Planting Depth

# Water and Starter Fertilizer Solutions immediately after planting!



# Early Cropping

- "The best way of restricting vegetative growth is to produce apples."
- Cropping must begin:
  - In the second year with the Tall Spindle
  - Limit cropping to 5 fruit/sq cm TCA by **HAND THINNING** before fruit bud differentiation!
  - Use return bloom sprays - NAA 3-4 X

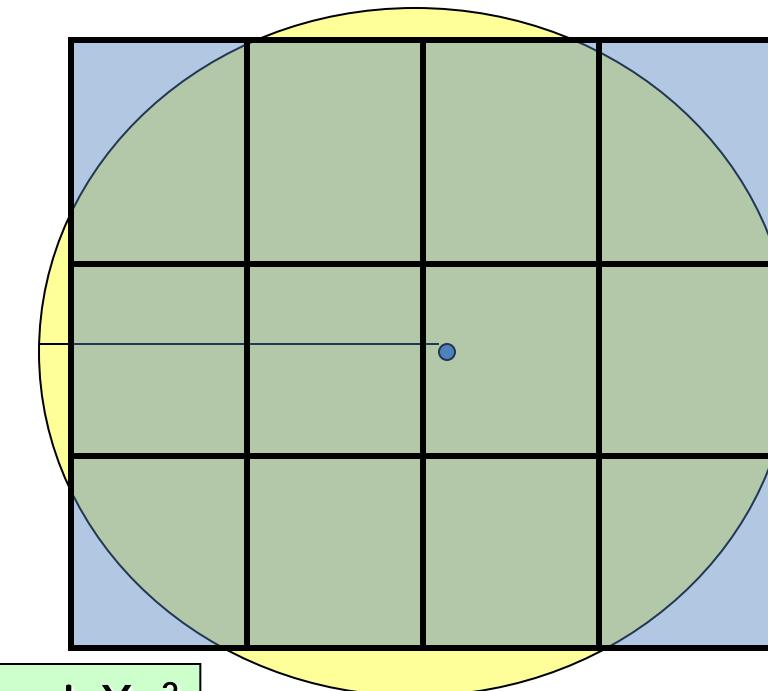
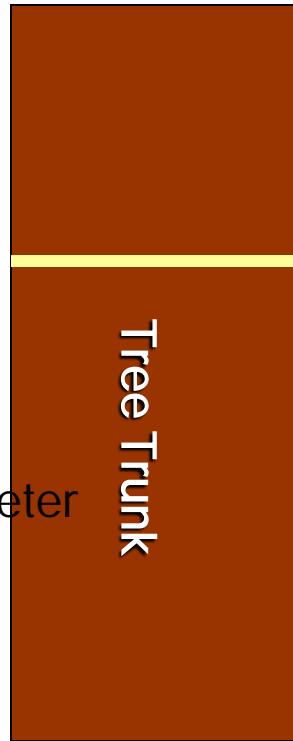
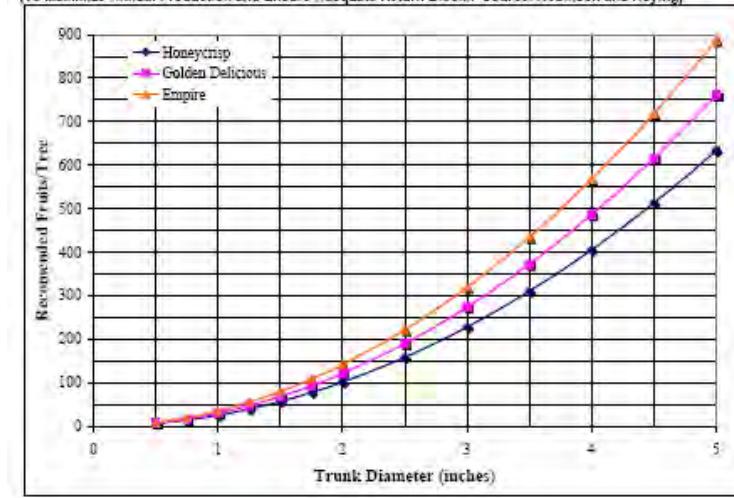


# Acceptable Crop Loads For 2<sup>nd</sup>-5<sup>th</sup> leaf trees

Fuji = 5 fruit/sq cm TCA

Gala = 8 fruit/sq cm TCA

NY Guidelines for Maximum Apple Cropload for Different Trunk Sizes  
(To Maximize Annual Production and Ensure Adequate Return Bloom. Source: Robinson and Hoying)



$$TCA = \pi \times r^2$$

# Training of 2 Similar High Density Apple Planting Systems

## Vertical Axis

- 100 trees/mu
- 1.8m X 4.2m
- Permanent bottom limbs
- Upper limbs renewable

## Tall Spindle

- 200 trees/mu
- 0.9m X 3.3m
- No permanent limbs
- All limbs renewable



Vertical Axis

# Advantages - VAXE

- Early bearing 3<sup>rd</sup> - 4<sup>th</sup> leaf
- Fast to mature bearing 5<sup>th</sup> – 6<sup>th</sup> leaf
- High mature yields of excellent quality fruit (3.5 tons/mu)
- Simple and stable one wire and stake trellis
- Plenty of room for moderate sized orchard equipment
- Lower establishment cost (tree numbers)

A close-up photograph showing several young fruit trees trained in a tall spindle system. The trunks are vertical, and branches are trained upwards and outwards at various heights. Some branches have small green buds or leaves. The ground is covered with fallen leaves and some green moss. In the background, more rows of trees and a hilly landscape are visible under a clear sky.

# Tall Spindle



# Pruning at Planting

## Vertical Axis

Tree spacing 1.5m or more

- Remove large side branches that compete with vertical tree growth using a bevel cut.
  - Remove upright, narrow angled branches.
  - Remove scaffolds that are larger than 2/3 diameter of leader.
- Head or Tip leader
- Head or Tip feathers

# Upright Scaffolds



# Essential Components

## TS and VA

## Pruning and Training

- Branch devigoration
  - 1<sup>st</sup> leaf
  - Upright scaffold branches are weakened by bending below the horizontal through bending.
  - Use branch weights, rubber bands, or tying
  - Branch bending maintains whole tree vigor, but keeps trees within allotted space, and encourages the production of fruit buds for the following growing season.



# Vertical Axis

## At Planting

- Remove excessively large feathers.



# Vertical Axis At Planting

Completely removed only  
two branches!



# Tree Training During the First Growing Season

## Vertical Axis

- Select leader and remove competitive shoots immediately below at 5-10cm growth.
- Pinch tips of side shoots in upper 1/3 of leader when shoots are 10-15cm length.
- Re-pinch side shoots in upper 1/4 of leader if shoots regrowth an additional 10-15cm length.
- Tie leader to support system.
- Tie down 4-5 lower branches to 35-40° angles before growth stops to induce flowering and reduce vigor.

# Vertical Axis

## At Planting

After 10 cm shoot growth, remove new shoots which compete with the leader.



Remove all buds  
below 60cm by  
rubbing them out.

This will redistribute  
additional growth  
into scaffold shoots  
and then leader!



# Dormant Pruning Year 2

## Vertical Axis

- Do not head leader.
- Do not head feathers
- Remove side branches that compete with leader using a bevel cut.
  - Remove narrow angled branches.
  - Remove scaffolds that are larger than 1/2 diameter of leader.



Tree at the end of the 1st year with all branches tied down shortly after planting



Tree at end of second year  
Feathers tied down in 1<sup>st</sup> year



Tree at end of second year  
Feathers left upright in 1<sup>st</sup> year.





# Re-Starting Weak Trees

## (Year 2 only)

- Vertical Axis
- Leader.
  - Prune severely down to 4 buds on 1 year wood.
- Feathers.
  - Remove all feathers and spurs using a bevel cut.
  - Leave a stub 1/2" long.



# Tree Training During the 2<sup>nd</sup> Summer

## Vertical Axis

- Pinch side shoots in upper 1/4 of leader when shoots are 4-5" long.
- Re-pinch side shoots in upper 1/4 of leader when regrowth is 4-5" long.
- Fasten leader to support system.

# Vertical Axis - Review

## Young Tree Management

- No Heading after the year of planting
- Use Pinching to slow vigorous growth near the leader
- Tie down vigorous scaffolds and remove large ones missed in previous years.





# Dormant Pruning Years 3-4

## Vertical Axis

- Do not head leader
- Remove 1-3 side branches above the bottom tier of limbs that compete with leader using a bevel cut. These would include:
  - narrow angled branches.
  - scaffolds that are larger than 1/2 diameter of leader
  - those that compete directly with the leader

# Tree Training During the 3<sup>rd</sup> and 4<sup>th</sup> Summers

## Vertical Axis

- Pinch and re-pinch side shoots in upper 1/4 of leader when shoots are 4-5" long if you can still reach them from the ground.
- Lightly summer prune to remove upright shoots that intercept sunlight and decrease fruit quality



# Dormant Pruning Year 5

## Vertical Axis

- Reduce the number of lower scaffold branches to 3-5 if necessary because of crowding. Remove those that grow directly into the tree row or tree alley.
- Remove and renew 2-3 large limbs along the main trunk for renewal.
- Do not head leader; rather replace the leader that has been bent below horizontal by crop load by cutting to a suitable upright shoot with fruit buds. This leader will likely bend and weaken by this years crop.



# Vertical Axis

## Mature Management

1. Limit tree height to 90% of between row spacing by cutting leader back to a fruitful side branch. This tree height optimizes light interception with regard to adjacent rows so that lower branches receive enough light to remain productive.
2. Remove 1-3 of the largest limbs each year in the upper portion of the tree using a bevel cut concentrating on branches more than 1 inch in diameter. Preserve all weak fruiting wood; however, long pendant fruiting branches can be shortened to prevent shading of lower fruiting branches.



# Vertical Axis Mature Management

3. Keep 3-4 permanent lower tier scaffolds that are arranged in an X pattern with respect to the row, are horizontal and are not overly vigorous. Gradually remove all other lower scaffold branches. Shorten permanent bottom tier scaffold branches to facilitate tractor movement by pruning back to a side branch.







Super Spindle  
0.6m X 3.0m  
3.0m tall



Tall Spindle  
1.0m X 3.3m  
3.3m tall



# Advantages – Tall Spindle

- Early bearing - 2<sup>nd</sup> leaf fruit
- Fast to mature bearing – 4-5<sup>th</sup> leaf possible.
- Very high mature yields of excellent quality fruit 5.2 tons/mu.
- Most profitable system tested to date.
- Simple and stable trellis - 5-Wire Trellis with 3.65 m inline posts or 3-Wire with splints
- Easily mechanized

# Tall Spindle Nursery Stock

- Highly feathered nursery trees
  - Nursery trees ideally have from 10-15 feathers, or short shoots per tree.
  - Trees with scaffolds provide bearing surface for production in the second leaf.
  - Transplant shock caused by a high top to root ration helps keep trees within this tight spacing. It also contributes to significant fruit bud differentiation the year of planting.
  - Early bearing is essential to help pay for increased tree numbers and establishment costs.





These trees will  
need almost no  
pruning

# Tall Spindle

## Density

- Higher density
  - 200 trees per mu or 3000 trees per hectare.
  - The optimum average spacing for Tall Spindle is  $0.9 \times 3.4$  m.
  - Maximum of 3.7 m between rows.
  - The maximum in-row spacing is 1.2 m.
  - Proper selection of density for any system depends on consideration of the vigor of the variety and rootstock and the soil strength



# Essential Components – TS Rootstock

- Full dwarfing rootstocks –
  - The most successful Tall Spindle orchards established to date have been on M.9 and B.9. Precocious dwarfing stocks are important since early cropping is essential.
  - The yield efficiency and precocity of the Geneva rootstock series justifies their use especially where *Erwinia amylovera* is a concern. Geneva 41, G.11, G.214, and G.935 are all appropriate rootstocks for the Tall Spindle.
  - More vigorous rootstocks than these should only be used with the weakest growing varieties such as Spur Delicious.



Gala, G.11, 2<sup>nd</sup> leaf  
2007

# General Rules for Training Tall Spindle

- Do not head leader or scaffold limbs, ever!
- Remove feathers that compete with leader using a bevel cut.
- Tie down 5-8 feathers below horizontal at planting or in July.
  - Remove narrow angled branches.
  - Remove scaffolds that are larger than 1/2 diameter of leader.
  - Remove side branches that are longer than 2'.
  - Remember "large branches create large trees"
- Remove branches larger than 3.5 cm diameter.

# Dormant Pruning Year of Planting

## Tall Spindle

Tree spacing 1.2 m or less

- Do not head leader
- Do not head feathers
- Remove side branches that compete with leader using a bevel cut.
- Remove narrow angled branches.
- Remove scaffolds that are larger than 1/2 diameter of leader.





Select a single leader shoot by removing all buds within 10cm that compete with the leader before shoots are 12cm in length

Remove all buds  
below 60cm by  
rubbing them out.

This will put  
additional growth  
into scaffold shoots  
and the leader!



# Tree Training During the First Growing Season

## Tall Spindle

- Pinch side shoots in upper 1/4 of leader when shoots are 10-15cm long.
- Re-pinch side shoots in upper 1/4 of leader when regrowth is 10-15cm long.
- Tie leader to support system.
- Tie or weight down 4-5 lower branches below horizontal in July before terminal growth stops to set branches and induce flowering.

# Dormant Pruning

## Year 2 and 3

### Tall Spindle

- Do not head leader.
- If they exist, remove 1-3 large branches that are more than  $\frac{1}{2}$  the diameter of the trunk
- Remember “Big Branches makes Large Trees”

# Tree Training During the 2<sup>nd</sup> and 3<sup>rd</sup> Growing Season

## Tall Spindle

- ❖ Pinch side shoots in upper 1/4 of leader when shoots are 10-15cm long.
- ❖ Re-pinch side shoots in upper 1/4 of leader when regrowth is 10-15cm long.
- ❖ Continue to tie leader to support system.
- ❖ Reposition weights on upright vigorous scaffolds if missed in year 1.

**The Tall Spindle has fruiting branches that remain for 3-6 years but no permanent scaffold branches**



**Mature Tall Spindle/M.9    3' x 11'   11' tall**

# Dormant Pruning Year 4 and 5

## Tall Spindle

- Limit height of tree by cutting leader to a weak fruitful side branch.
- Remove branches larger than 3.5 cm diameter.
- Simplify remaining shoots by removing all large side shoots.



# Essential Components

## TS Pruning and Training

- Minimal pruning at planting
  - The Tall Spindle system is planted in place! Very little growth needed to fill the available space, therefore very little pruning is needed.
  - Pruning is limited to only the removal of a few larger branches along the leader. Generally, those that are more than  $\frac{1}{2}$  the diameter of the leader at the insertion point are removed
  - An important objectives is to actually cause some transplant shock..





Combination of Tree weights  
and fruit

# Essential Components – TS

## Pruning and Training

- Limb renewal
  - ALL scaffolds are renewed by complete removal as they become too large for the available space and become out of balance within the tree.
  - Renewal cuts are made using the standard method of using a “bevel cut” which encourages new shoots to form as replacement fruiting limbs.
  - There are no permanent limbs within the tree.



Keep leaders  
tied up to  
support system

Cropping in the  
2<sup>nd</sup> and 3<sup>rd</sup> leaf  
will occur  
mostly along the  
leader!



# Essential Components – TS

## Yield

- Early Fruiting
  - Fruiting in the second and third leaf is essential to keep a low tree vigor level and provide income from early fruit sales.
  - Crops in the early years must also be carefully managed to prevent biennial bearing.
  - Aggressive pest management practices are essential starting in the second year since marketable crops are expected and necessary for optimum profitability.
  - This is the only system we have ever tested that achieved a cumulative production over 1000 bushels in the 1st five years, resulting in approximately a 40% increase in crop value compared to the Slender Vertical Axis system.

# Essential Components – TS Support System

- Full Support System
- 3m height
- Tall inline support posts (3.5m) and multiple wires. Training wires or small diameter stakes between wires are ideal.



# Review of the Principles for Tall Spindle

- 1) Tall Spindle - very little additional tree growth is required - NO heading of the leader or tipping of the feathers.

# Principles (cont.)

2. Grow trees to 10' tall by end of the 3<sup>rd</sup> leaf by not heading the leader.
3. Minimize pruning during the first 4 years.
  - Limit pruning to the removal of excessively vigorous side branches that compete with the leader.
  - No heading cuts.
4. Tie branches down.
  - Tall Spindle – Weight or tie vigorous branches below horizontal



# Principles (cont.)

5. Allow top of tree to bend with fruit before cutting top back.
6. Annually remove 1-2 branches if they are too large and develop replacement shoots.
  - Tall Spindle – replace and reduce branches in Tall Spindle as they reach 3.5cm in diameter.



# Mechanization for Labor Savings



Hedging Tall Spindle Plantings

# Mechanization for Labor Savings



**Platforms**

