

Modern Apple Training Systems

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The Problem: What System to Plant?

- There is great disparity of opinion on the optimum planting density.
- Some growers plant 200-300 trees/acre on semi-dwarfing rootstocks with Central Leader.
- Most growers plant 500-1000 trees/acre on dwarfing rootstocks with some version of Vertical Axis.
- A few growers plant 2000 trees/acre on dwarfing rootstocks with Super Spindle.

Viabable Orchard Systems in NY

• •System	Tree Density		Spacing	Rootstocks
	(trees/acre)	(trees/ha)	(ft.)	
•Slender Pyramid	340	840	8' x 16'	M.26, G.30,G.935
•Vertical Axis	622	1538	5' x 14'	M.9, G.41,G.11
•Slender Axis	908	2244	4' x 12'	M.9, G.41,G.11
•Tall Spindle	1320	3262	3' x 11'	M.9, G.41,G.11
•Super Spindle	2178	5382	2' x 10'	M.9, G.41,G.11

Slender Spindle/M.9



Triple Row Slender Spindle/M.9



Geneva Y-trellis/M.26





USA-Vertical Axis/G.202

V-Slender Spindle/M.9



Gala Super Spindle/M.9 (Second Leaf)





Tall Spindle/M.9
(Note high branches that
do not need to be tied up.)

Braeburn Tall Spindle/M.9 (Third Leaf)



Tall Spindle/M.9



The Geneva Planting Systems Trial

(Planted 1997)

System	Spacing
Slender Pyramid/M.7	10' X 18'
Slender Pyramid/M.26	8' X 16'
Vertical Axis/M.9	7' X 15'
Vertical Axis/M.9	6' X 14'
Slender Axis/M.9	5' X 13'
Slender Axis/M.9	4' X 12'
Tall Spindle/M.9	3' X 11'
Super Spindle	2' X 10'

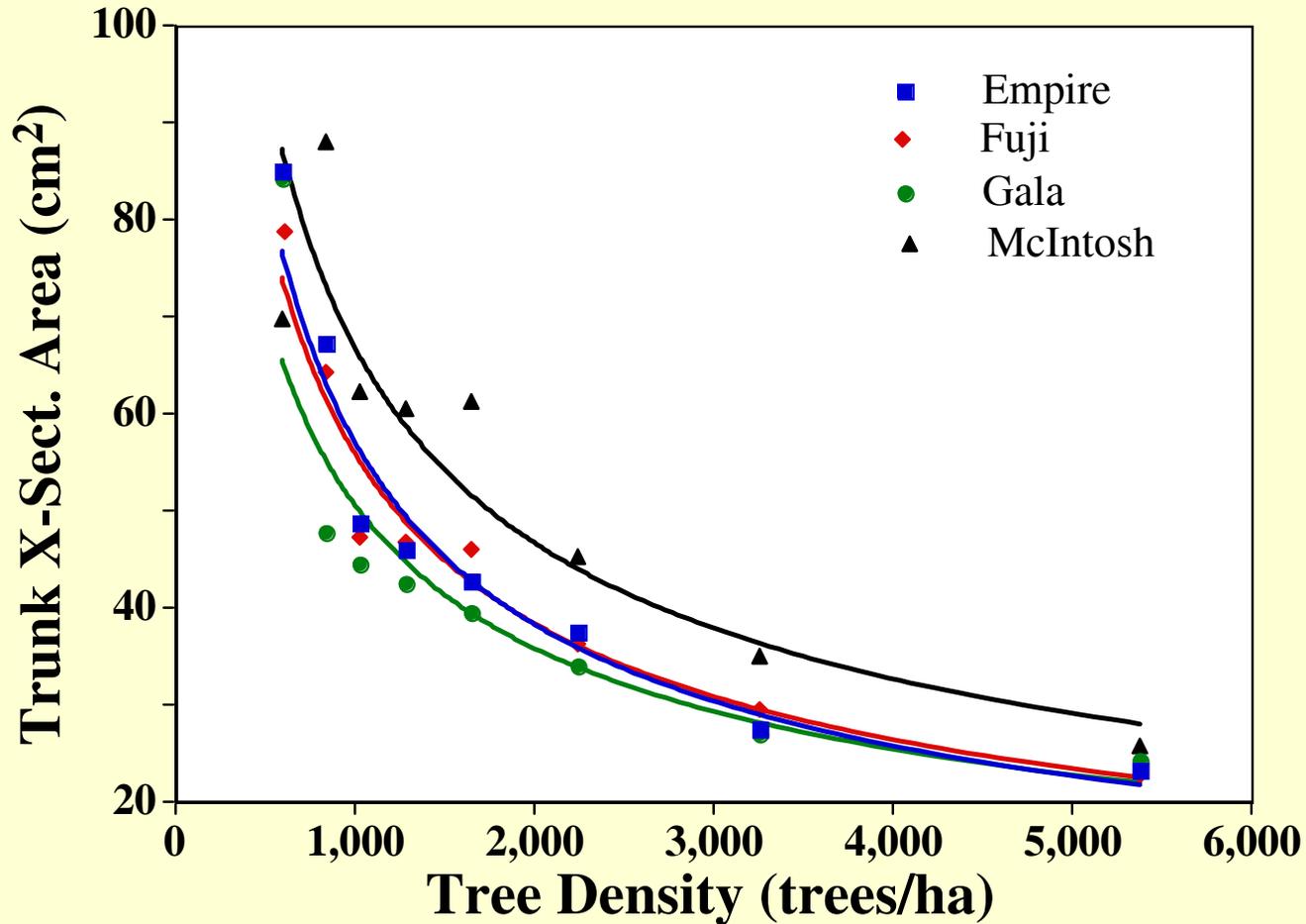


Super Spindle
0.6 x 3.1m
3m tall



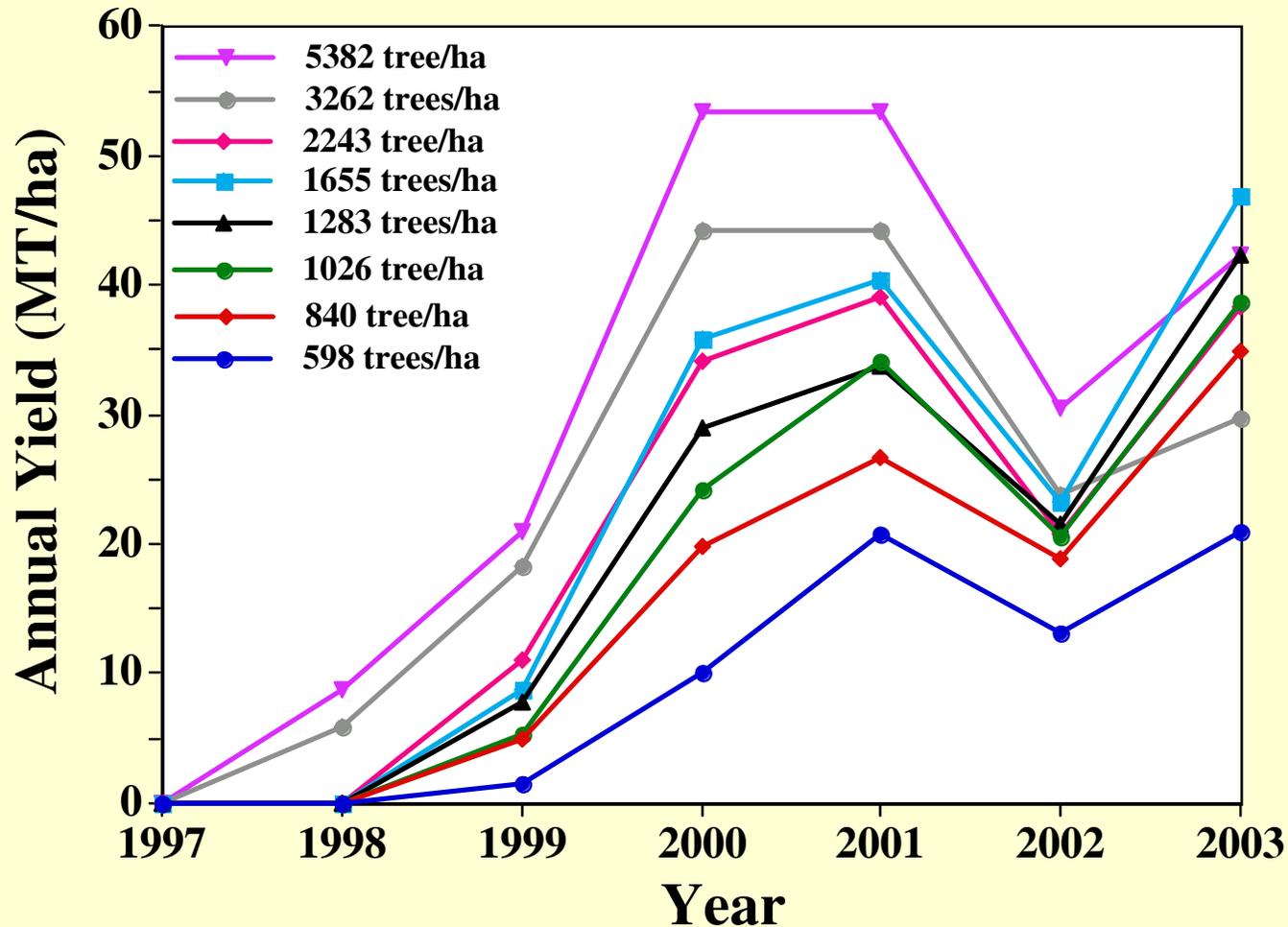
Tall Spindle
0.9 x 3.3m
3.2m tall

Effect of Tree Density on Tree Size



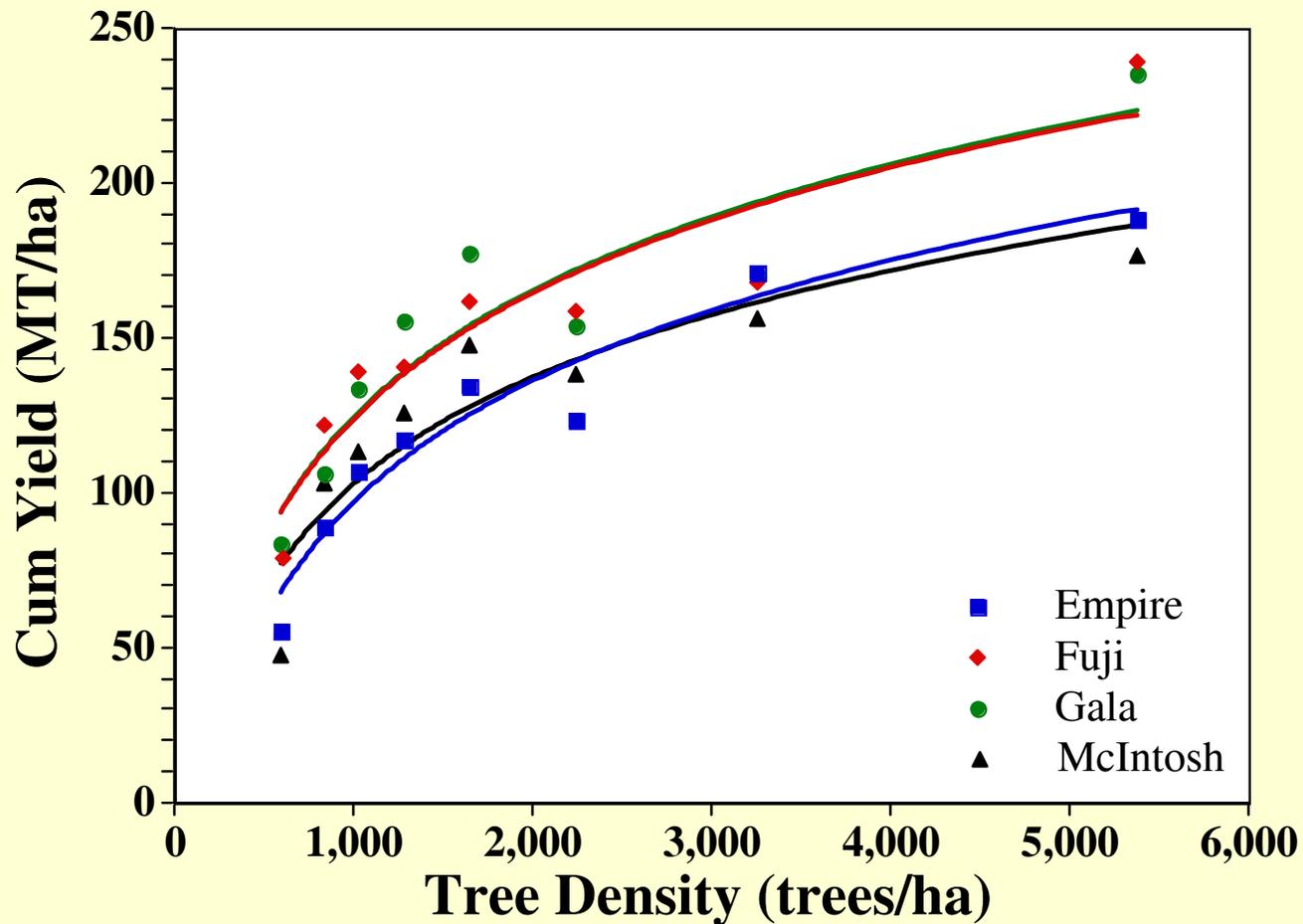
- Tree density and variety had a highly significant effect on final trunk cross-sectional area.
- Among M.9 treatments the highest planting density produced trees about 1/3 the size of the lowest planting density.

Yield Curves for 8 Orchard Systems

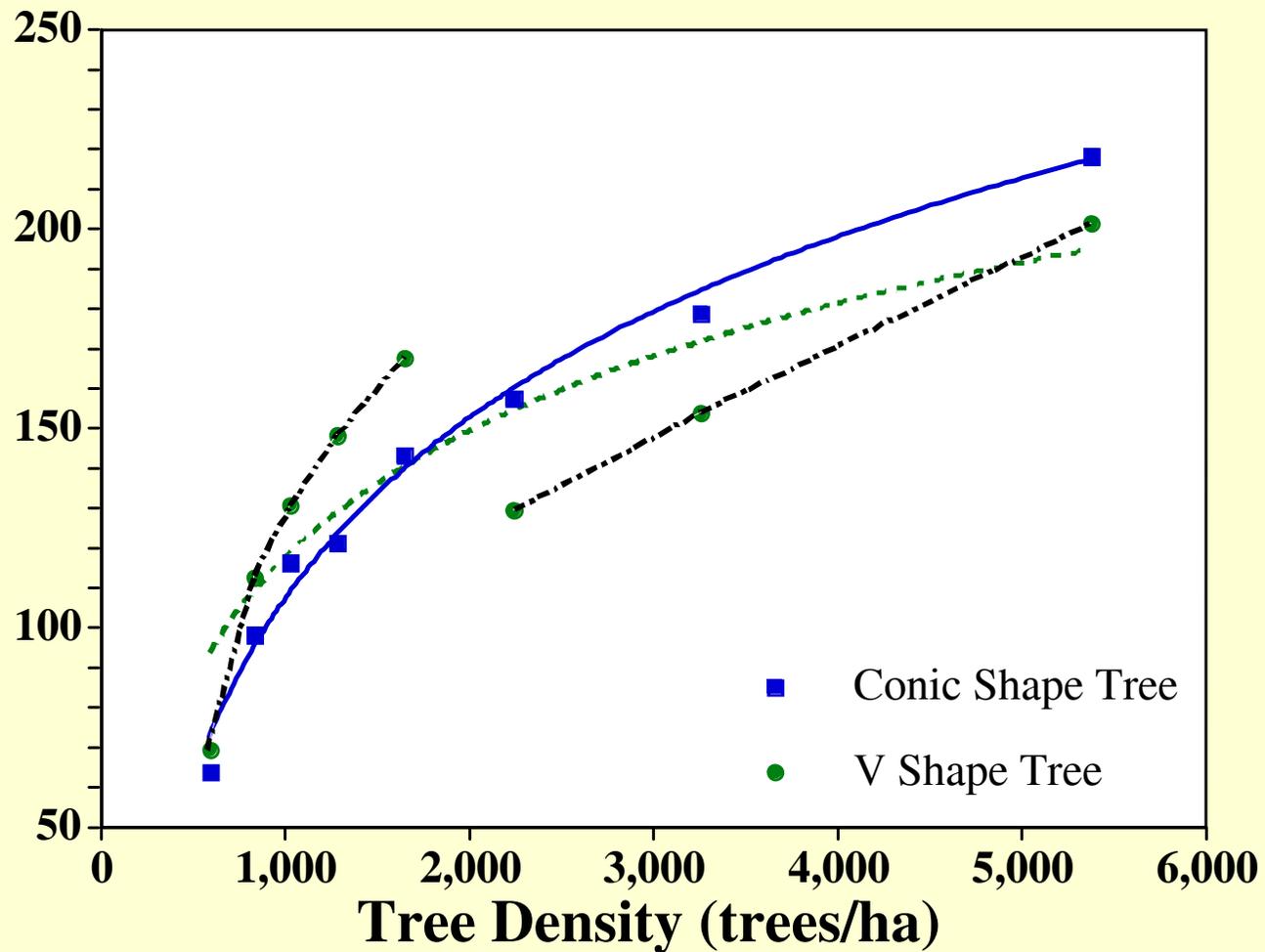


Tree density had a highly significant effect on yield per ha. The highest density system achieved 50Mt/ha on the 4th year while the lowest density system did not surpass 25 Mt/ha.

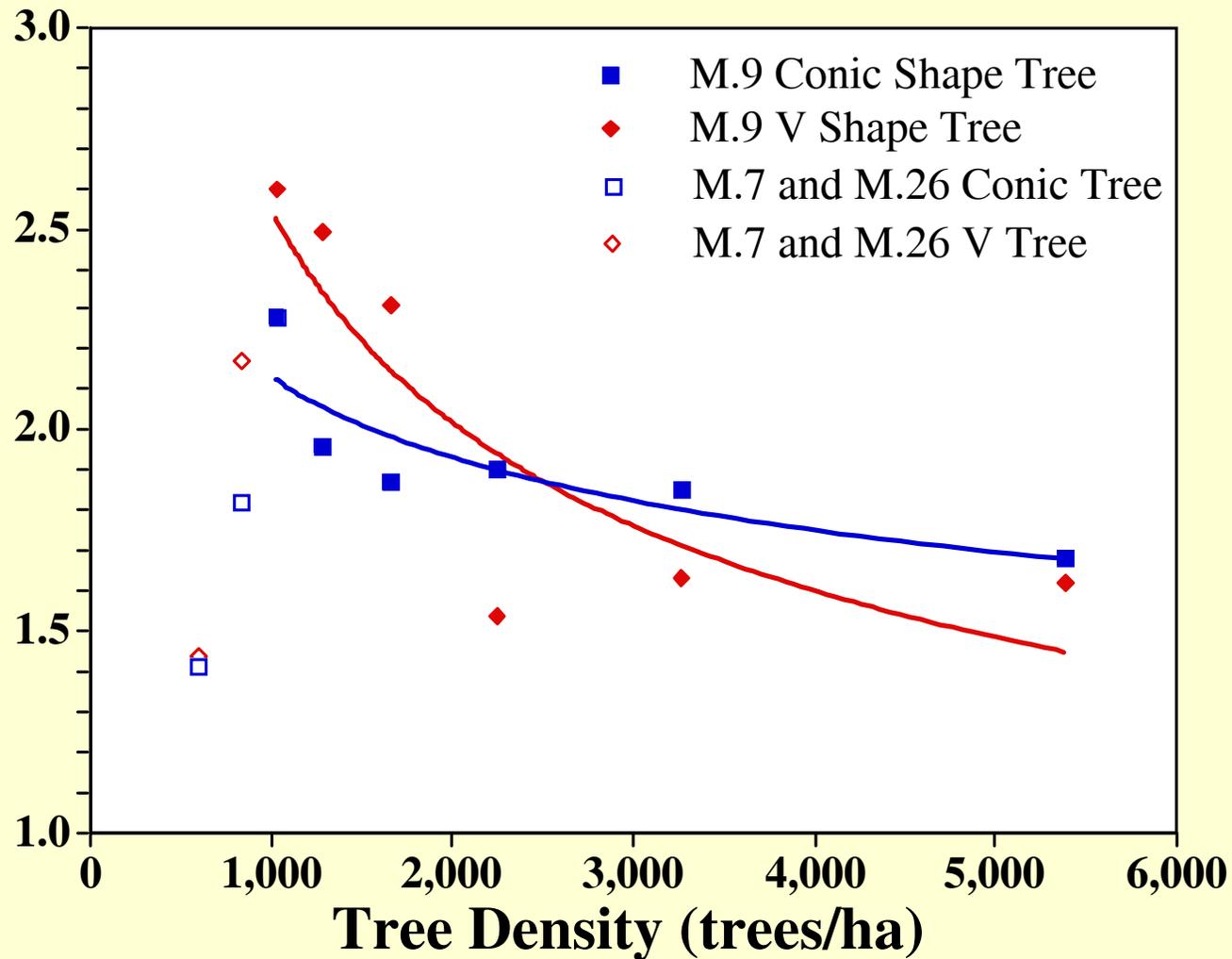
Effect of Tree Density on 7 Yr. Cumulative Yield



Tree density had a highly significant negative effect on cumulative yield per tree but a highly significant positive effect on yield per ha. The cumulative yield per ha of the highest tree density was 3X greater than the lowest density



- There was no significant effect of tree shape on yield but there was a significant interaction with tree density. At high tree densities the V shape was inferior to the conic shape while at lower tree densities the V shape was superior to the conic shape.



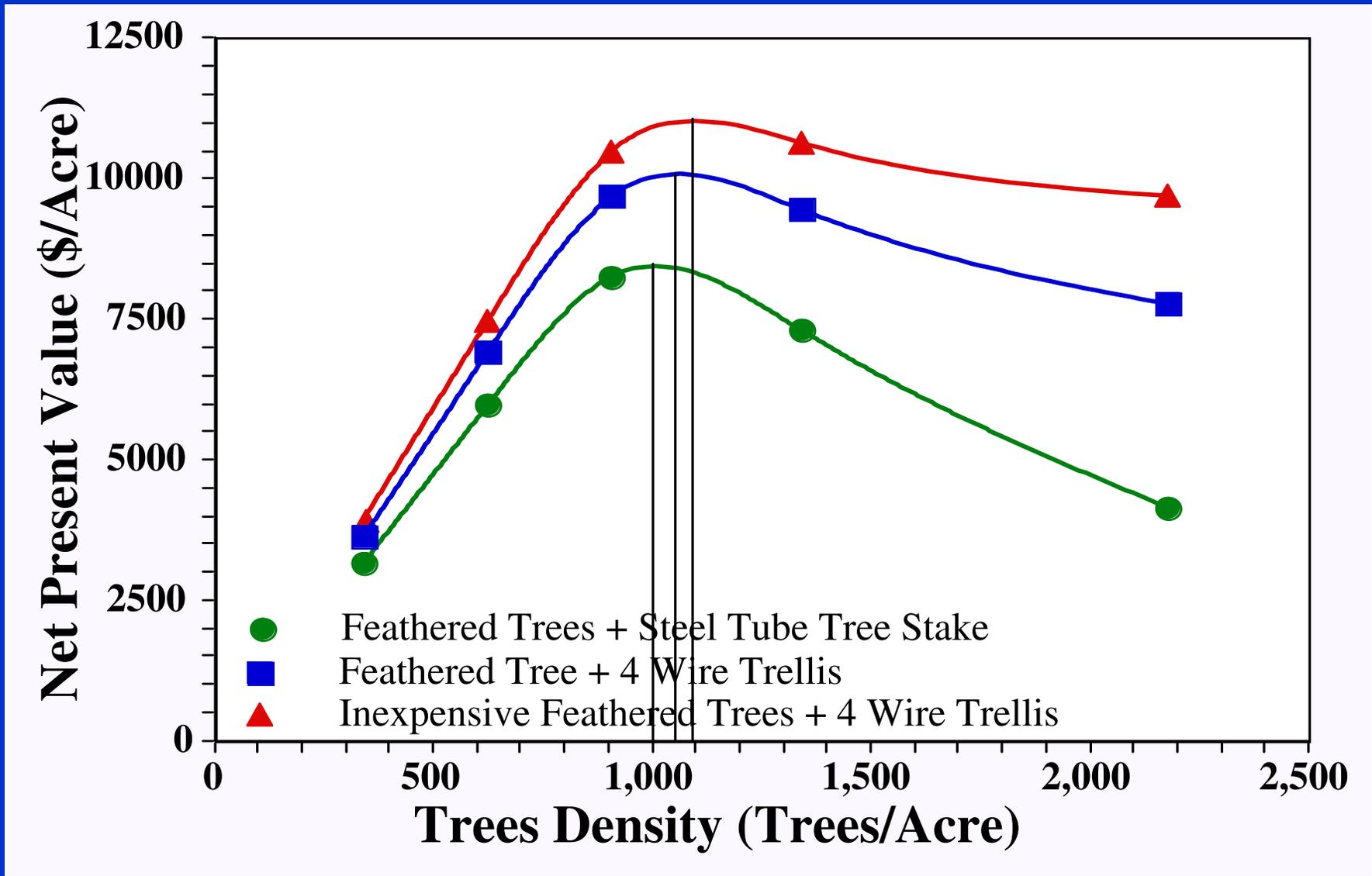
Increasing tree density had a strong negative influence on yield efficiency of M.9. The highest tree density had a similar yield efficiency as M.7.

Conclusions

- **Tree density had a strong influence on tree size, yield per hectare and light interception.**
- **The very high tree densities achieved a high yield of 50 Mt/ha by the fourth year and had a cumulative yield 3X the lowest densities.**
- **Tree shape had no effect on tree size or yield.**

Orchard System Performance in Northern NY- 2005

• Variety	System	Tree Den.	Yield/Acre (bu.)			
			2nd	3rd	4th	Cum
•McIntosh	Central Leader	218	0	1	24	25
•	Slender Pyramid	444	0	37	113	150
•	Vertical Axis	726	2	239	327	566
•	Tall Spindle	1307	13	351	771	1135
•Honeycrisp	Central Leader	218	0	1	27	28
•	Slender Pyramid	444	0	33	117	150
•	Vertical Axis	726	0.1	111	277	388
•	Tall Spindle	1307	3	132	578	713



With traditional fruit prices, profitability over 20 years increases with increasing tree density up to a density of 1,000-1,100 trees/acre.

Can you afford to replant and what density should you choose?

- **If you receive a farm gate fruit price of at least \$5.50/bu., have land or can buy land for up to \$5,000/acre, can purchase trees for a price of \$5.32, and have access to capital at 5% then you can afford to replant.**
- **The greatest profitability will be with the Slender Axis system (4' in-row spacing=908 trees/acre) or the Tall Spindle system (3' in-row spacing=1320 trees/acre)**
- **A 4 wire trellis and feathered trees are essential components of the system.**

The Tall Spindle and Slender Axis Systems

- 3-4' in-row spacing
- 10-12' between rows
- 10' tall
- no permanent branches
- highly feathered trees
- minimal pruning at planting
- feathers tied below horizontal at planting.





Tall Spindle

Rootstock Selection

- **M.9 T337 on vigorous soils or with vigorous scions, Nic29 or Pajam 2 on replant soil or with weak scions)**
- **B.9 or O.3 are alternatives.**
- **G.41 or G.11 may be better.**

Recommended Tree Type for the Tall Spindle and Slender Axis Systems

- Plant large caliper highly feathered trees (8-15 feathers).
 - Feathers should be high enough (<24") to eliminate the need to tie up feathers.



Tree Spacing of the Tall Spindle

- In-row spacing of 3' for weak growing varieties (Honeycrisp, Delicious, Empire, Macoun, Gala).
- In-row spacing of 4' for vigorous varieties and tip bearing varieties. (McIntosh, Fuji, Cortland, Jonagold, Gingergold).
- Between row spacing should be 12-13' on slopes and 10-11' on level ground.

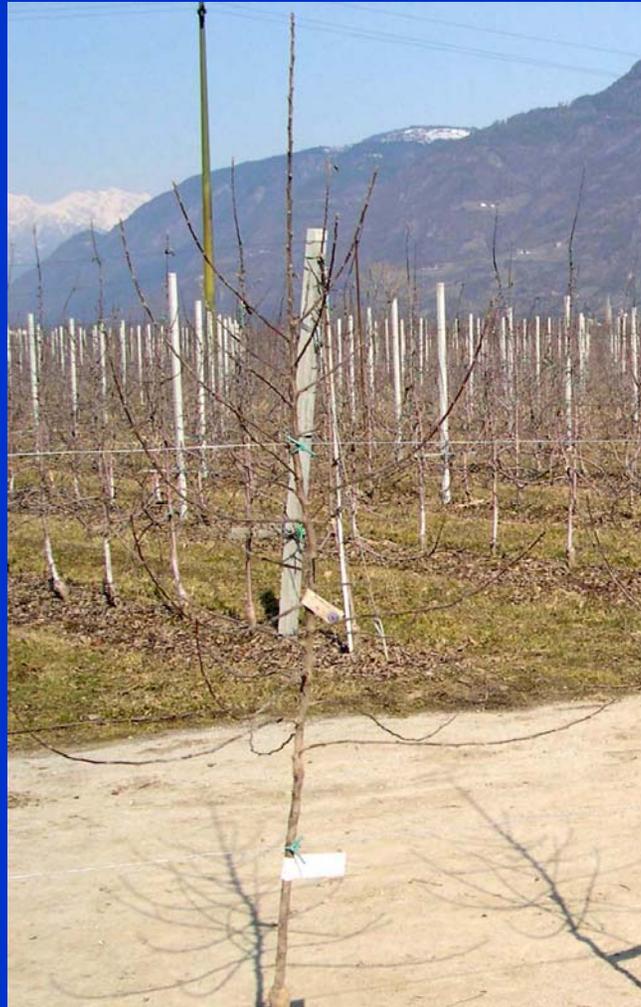
Pruning after Planting of Tall Spindle

Large caliper highly feathered trees (8-15 feathers).

- **Do not head the leader.**
- Remove all feathers below 24".
- Remove feathers that are larger than $\frac{2}{3}$ diameter of leader.
- **Do not tip the feathers.**

Medium Caliper poorly feathered trees or whips.

- Head the leader at 60".
- Remove feathers larger than $\frac{2}{3}$ diameter of leader.
- If there are less than 3 good feathers remove them using a bevel cut.
- Score above every other bud along leader from 24"-42" high.





Tree Training During the First Summer

- 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.
- Tie leader to support system.
- Tie down 4-5 lower branches below horizontal at planting or in July to induce flowering.



Pruning Year 2

- 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 $2/3$ diameter of leader.
 - Remove side branches that are longer than 2'.
- Remember "**large branches create large trees**"





Early Cropping

- **"The best way of restricting vegetative growth is to produce apples."** (Kurt Werth)
- **Cropping must begin:**
 - In the second year with the Tall Spindle system.
- **Cropping targets for the Tall Spindle**
 - Year 1 1-5 fruits
 - Year 2 20 fruits
 - Year 3 40 fruits
 - Year 4 70 fruits
 - Year 5 90 fruits

Pruning Year 3- 5

- Allow crop to bend the top.
- Limit height of tree only after top has bent by cutting leader to a weak fruitful side branch.
- Remove branches larger than 3/4 inch diameter.
- Remember **"large branches create large trees"**
- Shorten older, pendant branches to a weak side branch or spur.
- With Gala begin stubbing back pruning.



Pruning Years 6-20

- **Limit height of tree by cutting to a fruitful side branch.**
- **Annually remove 2 branches per year (limb renewal pruning).**
 - **Focus on the middle tiers of branches first then on upper branches.**
- **Remove low hanging branches.**
- **Shorten pendant branches to point of bend.**
- **Do not overprune.**



Young Tall Spindle Orchard



Gala Schniga
plant. year: 2010
plant. dist.: 3.2 x 1 m

Older Tall Spindle Orchard



Conclusions

- 1) The tall spindle or Slender Axis systems appear to be the most profitable systems.
- 2) **High tree density** gives high early yield.
- 3) **Highly feathered trees** are the key to the systems.
- 4) **Minimal pruning at planting** (No heading the leader or tipping the feathers at planting)
- 5) **Branch angle management.** Bending feathers below horizontal at planting induces early cropping and limits branch size.
- 6) **Branch caliper management.** Ruthless removal of large branches keeps trees manageable. "**Large branches create large trees**"
- 7) "**The best way of restricting vegetative growth is to produce apples.**"