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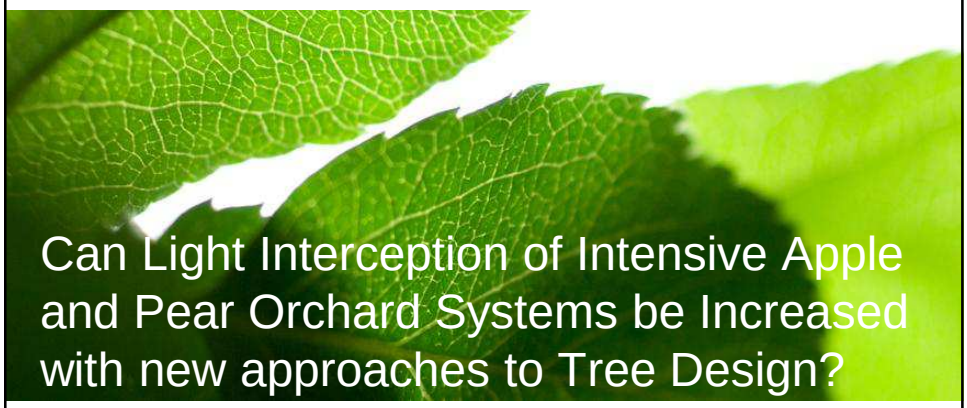

Can Light Interception of Intensive Apple and Pear Orchard Systems be Increased with new approaches to Tree Design?

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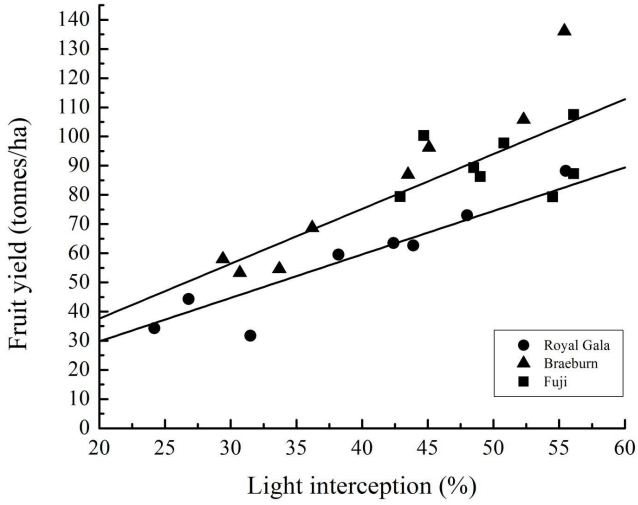
Why will this modern intensive orchard system not meet the needs of the future ?

What is the physiological limit of apple orchard productivity ?



Max. light interception is ~60%

'The theoretical yield at 90% light interception would be 169 tonnes per hectare'.

Palmer et al, 2002

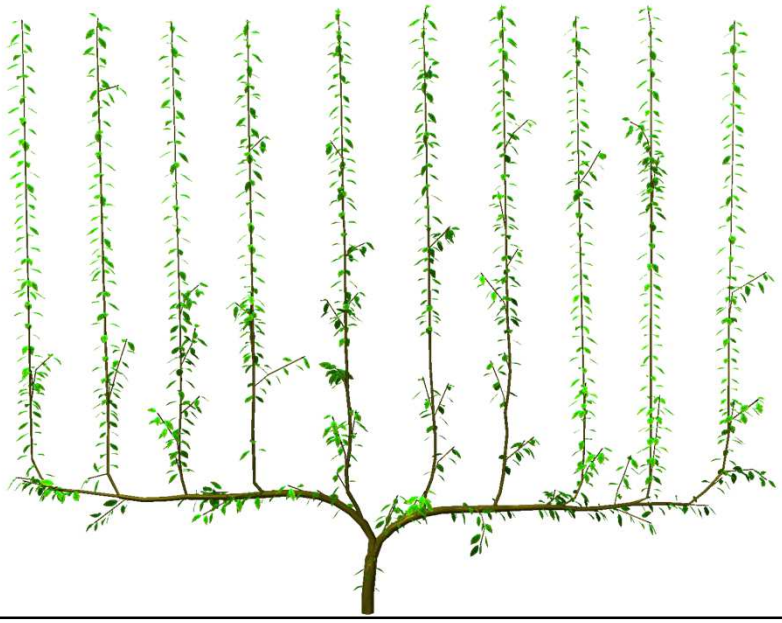
Future orchards – the systems challenges for achieving yields of 170+ t/ha

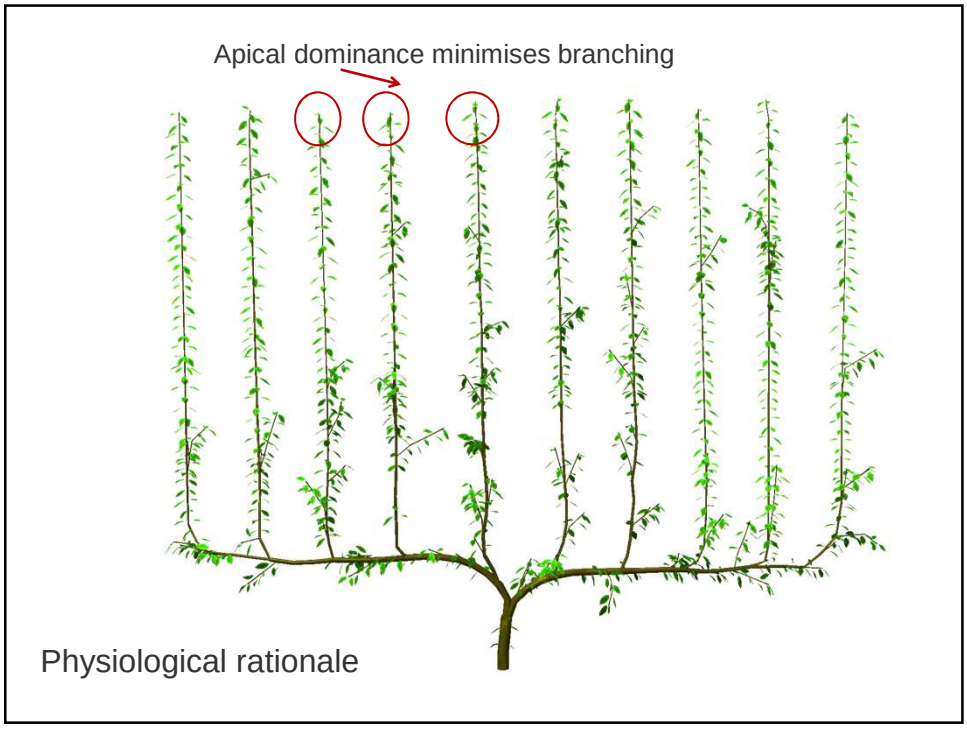
- 85+% light interception for high productivity
- High biological efficiency = high harvest index
- Simpler canopies = labour efficient, amenable to mechanisation, automation, robotics?
- Canopy designs that ensure high within-tree irradiance properties for fruit quality

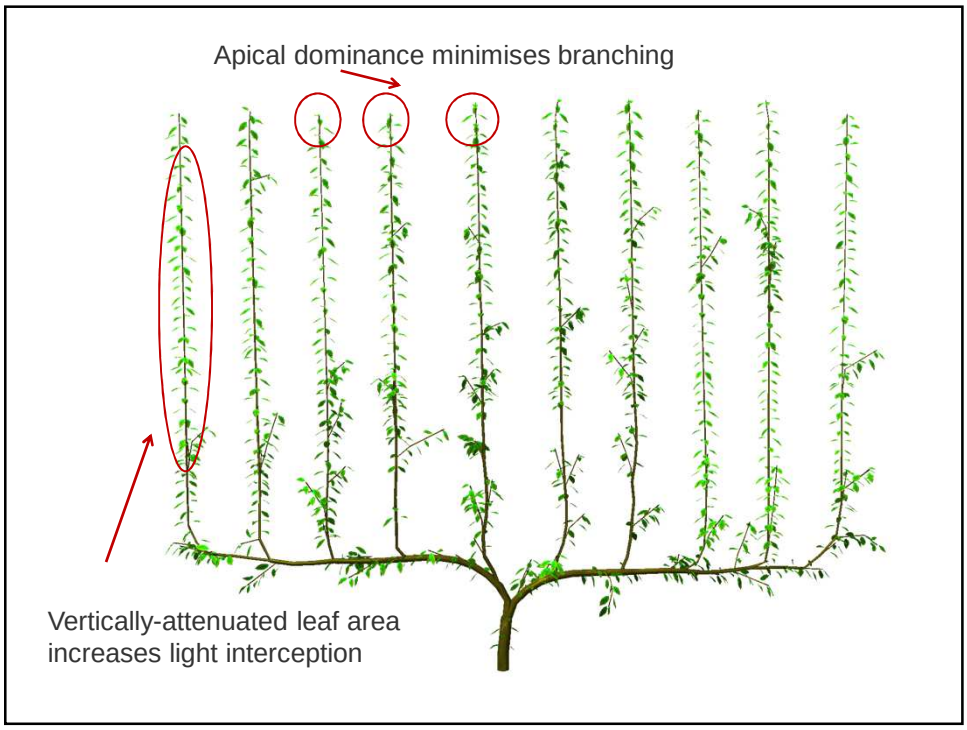
Future orchards – practical considerations

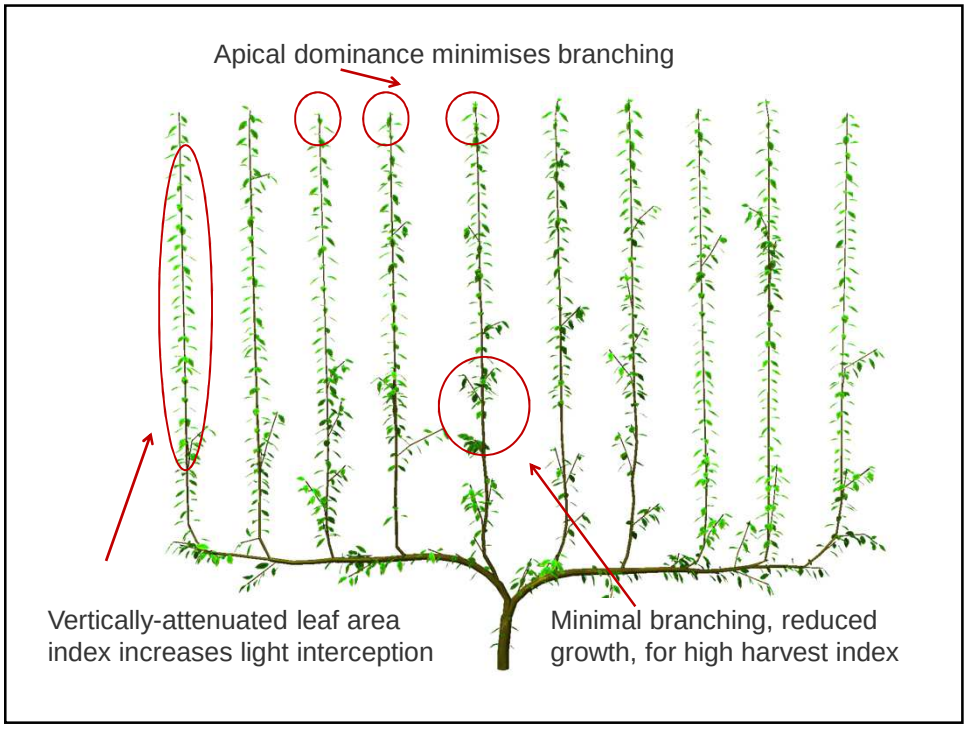
- Between-row distances must be reduced to achieve 85-90% light interception
- With closer row spacing, simpler, more planar canopies are necessary
- Simpler canopies need to be designed to be physiologically efficient for productivity AND fruit quality
- Planting systems must be economically robust
- A 'whole-system' re-design

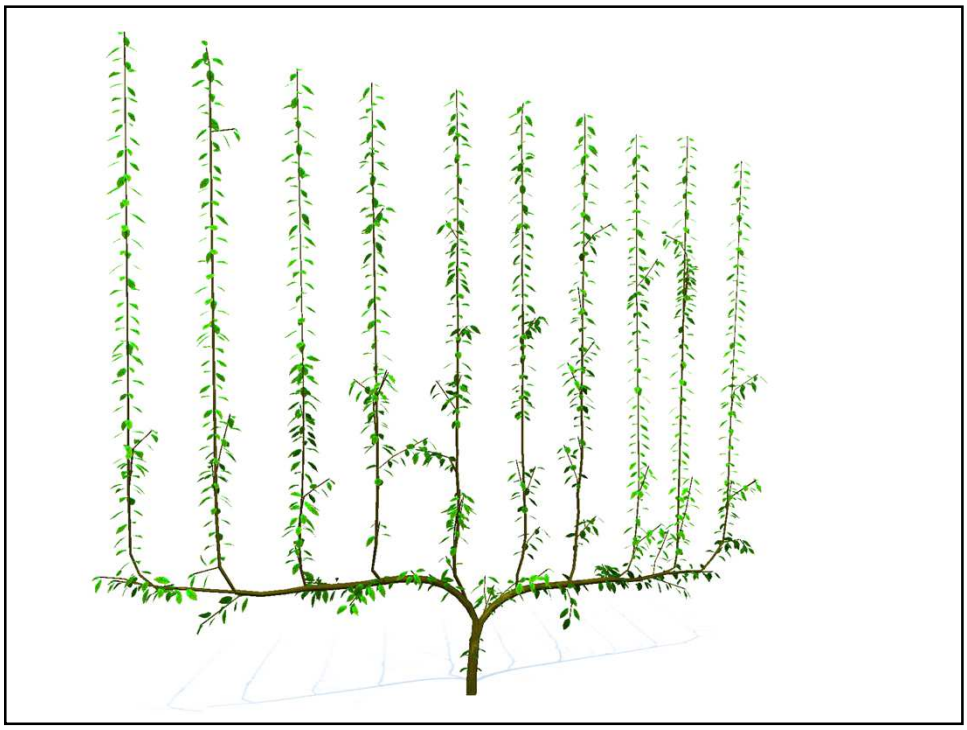
Tree prototype: planar canopy divided into multiple, minimally-branched vertical fruiting stems

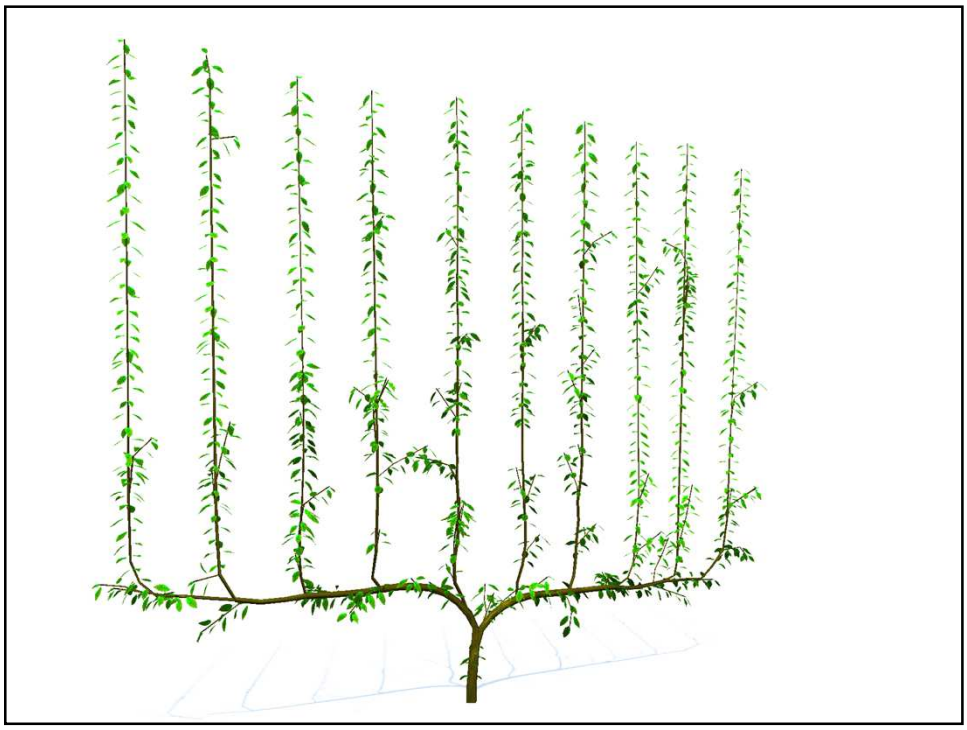



Apical dominance minimises branching
Physiological rationale


Apical dominance minimises branching
Vertically-attenuated leaf area
increases light interception


Apical dominance minimises branching
Vertically-attenuated leaf area index increases light interception
Minimal branching, reduced growth, for high harvest index





Apple ‘super orchard’ prototype - 2014

- **3m between trees, 1.5 to 2m between rows**
- **1667-2222 planted trees/ha**
- **16670 to 22220 vertical stems / ha , 30 cm apart in-row**
- **Vertical fruiting stems up to 3.5 m high**

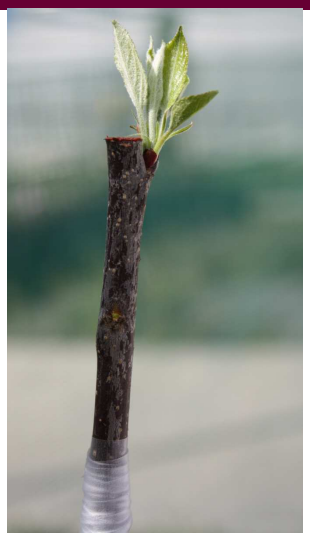
Apple ‘super orchard’ prototype – winter 2014

Systems Approach Step 1: Accelerating canopy establishment by developing purpose-designed nursery trees

Typical monoaxis nursery tree

Biaxis tree

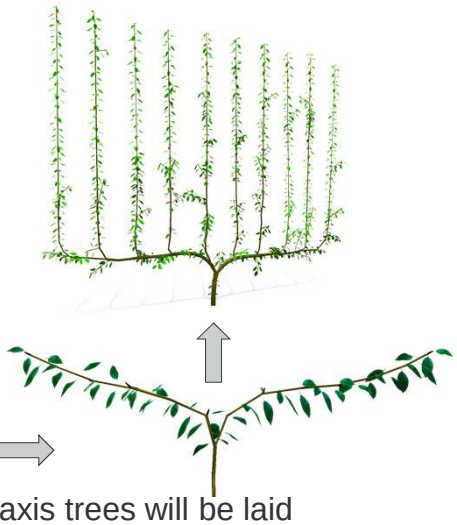
Biaxis tree established at bench graft budbreak



Monoaxis

Biaxis

Bi-axis trees from bench grafts in winter 2013, ready for planting by autumn 2014 with 3 m of primary cordon axis



Cordon of bi-axis trees will be laid down early in year one in the orchard

Bi-axis trees from bench grafts in August (winter) 2013, planting in August 2014, with 3+ m of primary cordon axis

Future orchards:– Enhancing productivity of our best current orchard systems

- » How much better can we make our current intensive orchards?
- » Advanced cropping technologies for higher productivity
- » Transitioning to precision crop load control methods

Enhancing productivity of our best performing intensive systems

Current studies from one of our commercial experimental sites:

» 'Royal Gala' on M.9, planted 2005, 3.4 x 1.25 m, 2,352 trees/ha (**11 ft something x 4 ft, 52 trees/acre**)

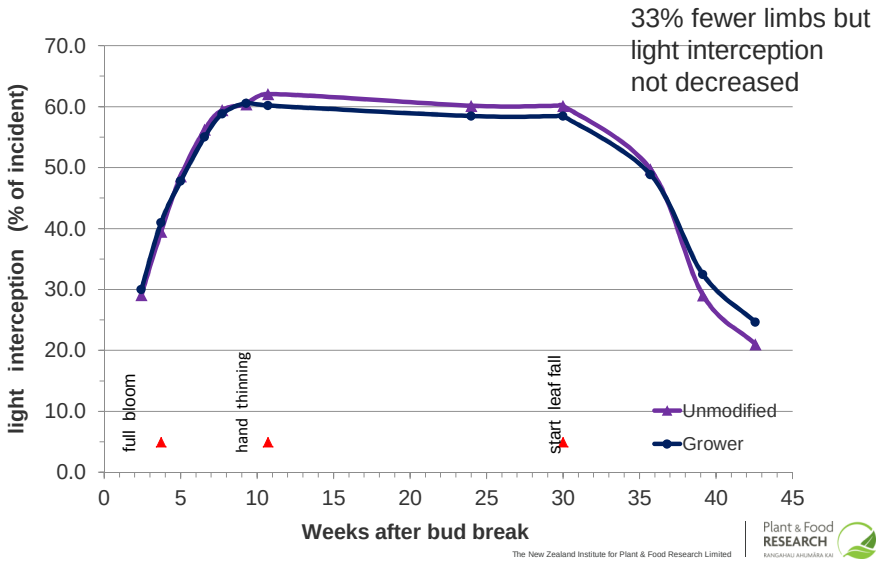
» Grower's target yield: 100 tonnes/ha (**100 bins/ acre**)

Canopy changes to enhance performance:

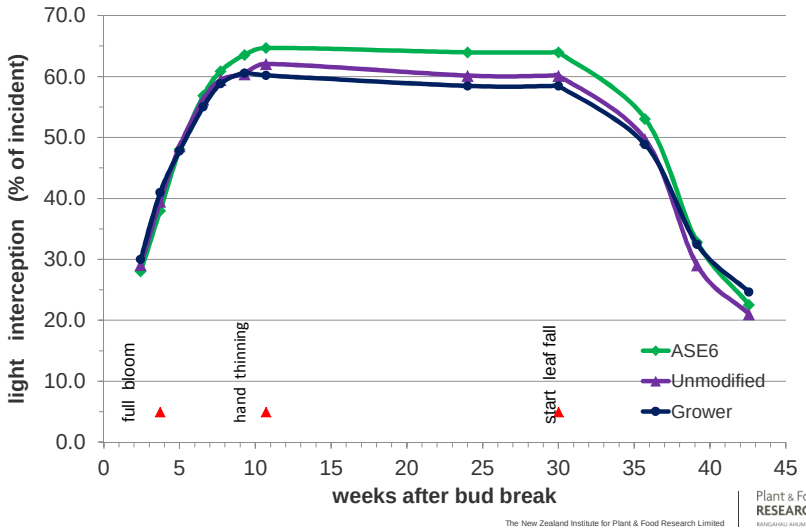
➢Reduce branch number for improved light relations: 6 limbs per vertical m of canopy

➢ Artificial spur extinction for precision crop loading, thinning and enhanced spur quality

Royal Gala/M.9: 2,352 tree/ha : Light Interception: Optimised limb number - 6 limbs per m canopy height



Royal Gala/M.9: 2,352 tree/ha Light Interception: Optimised limb number plus artificial spur extinction @ 6 buds/cm^2 bca



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Enhancing productivity of our best performing intensive systems

Royal Gala on M.9, 2,352 trees per ha

Tree type	Limbs per m tree ht (per tree)	Fruit No. per tree	Yield T/ha	Mean fruit weight (g)
Grower management	9.0 (27)	327	117	152
Optimised limb no.	5.9 (18)	325	118	154
Optimised limb no. plus ASE	5.8 (17)	321	129	170

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Light Interception: Autumn, year one

Tall Spindle: 3.0 x 1.5 m, 2,222 trees per ha
Light interception = 20.2 %

Planar Cordon: 3.0 x 1.5 m; 2,222 trees per ha
Light interception = 17.3 %

Planar Cordon: 3.0 x 2.0 m; 1,667 trees per ha
Light interception = 14.1 %

Interim conclusions

It is early days!

Ultimately, the environmental and crop physiology will inform us of the biological potential….and the practical possibilities

Yet the arithmetic looks compelling!

Cordon with 20,000 vertical fruiting stems/ha.

45 x 200g fruit per vertical stem = 180 T/ha




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