Integration of Tree Density & Minimal Pruning for Efficient Almond Production

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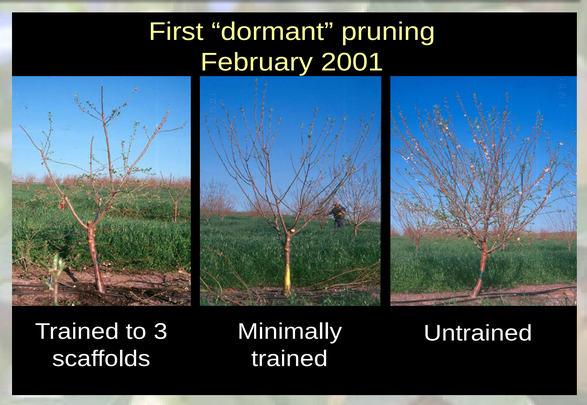
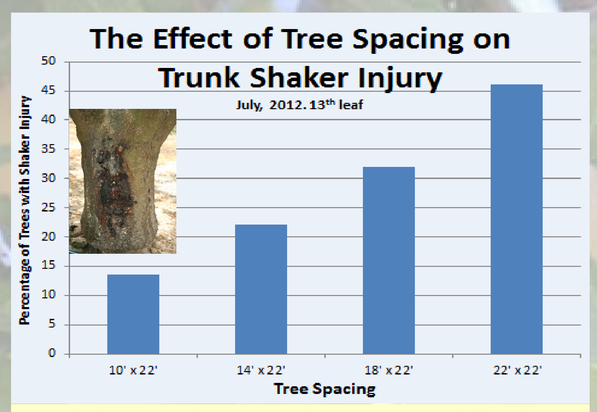
Objectives:

- Test if almond trees need to be pruned annually to maintain light permeation throughout the canopy, sustain bud fruitfulness, renew fruitwood, control tree size (height) and maintain the productive lifespan of an orchard.
- Determine the optimal orchard spacing for large trees (Nonpareil variety on hybrid rootstock) vs. smaller trees (Carmel variety on nemaguard rootstock).
- Monitor long term effects on yield, orchard longevity and profitability.

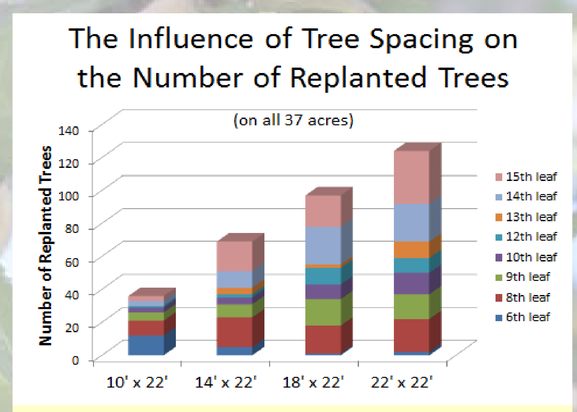
Multifactorial Trial:

- 2 Varieties
  - Nonpareil & Carmel
- 2 Rootstocks
  - Nemaguard & Hansen
- 4 Tree spacings
  - 22'x22, 18'x22', 14'x22', 10'x22'
- 4 Pruning strategies

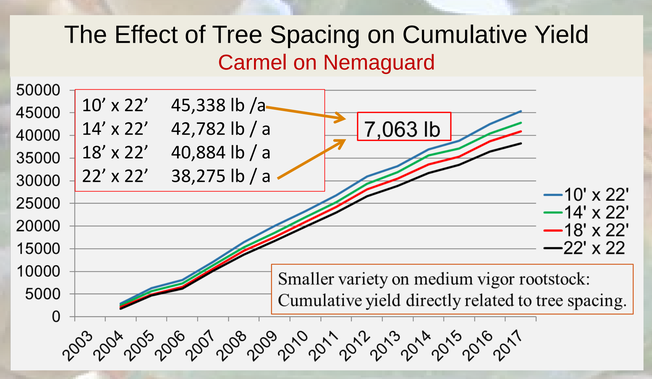


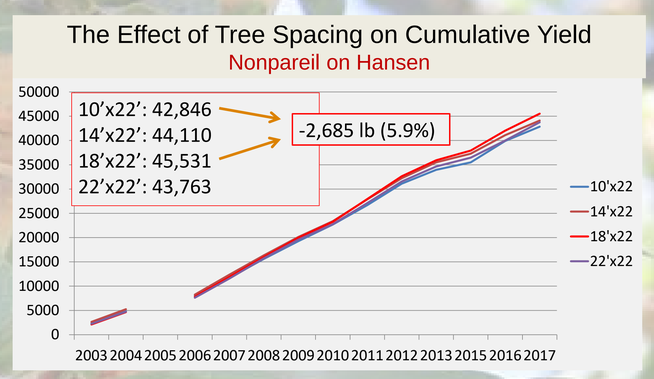


Widely spaced trees are larger, more difficult to shake and therefore more prone to shaker injury



The closer trees are planted, the less likely they will fail due to scaffold failure or shaker damage





Pruning Strategies:

1. Standard trained, standard pruned
   - 3 scaffolds, annual moderate pruning
2. Standard trained, then unpruned
   - Trained with 3 scaffolds and open centers
   - Unpruned after 2nd dormant season
3. Minimal training & pruning
   - Trained with 4-6 scaffolds & open centers
   - Maximum of three pruning cuts annually
4. Untrained, unpruned
   - No scaffold selection, no annual pruning

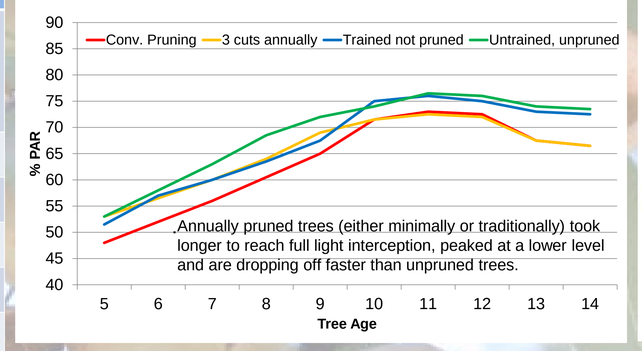
The Influence of Tree Spacing on the Time & Cost to Shake.

13th Leaf Nonpareil

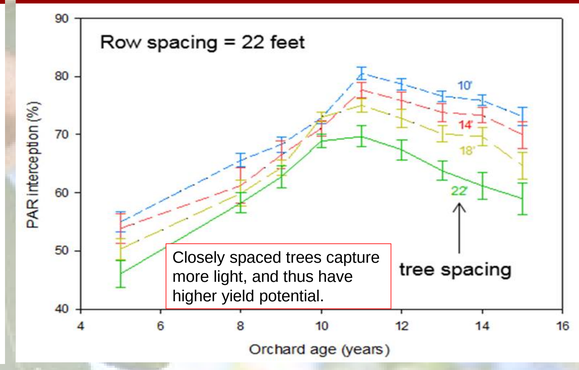
	Time (Minutes / Acre)	Cost ($ / Acre
10' x 22'	54.8	$91
14' x 22'	45.2	$75
18' x 22'	44.6	$74
22' x 22'	49.4	$82

*Shaker cost calculated at $100 / hour

Light Interception Dynamics of Different Pruning Methods



Light Interception Dynamics of Differently Spaced Trees



The Effects of Pruning, Tree Spacing & Rootstock on Current (18th Leaf) & Cumulative Yield[1]

	Nonpareil		Carmel	
	2017 Yield (lb/acre)	Cumulative	2017 Yield (lb / acre)	Cumulative
Training & Pruning				
Trained to 3 scaffolds; Annual, moderate pruning	2671 a	39,383	1583 a	36,391
Trained to 3 scaffolds; unpruned after 2nd year	2557 ab	40,277	1583 a	38,947
Trained to multiple scaffolds; Three annual pruning cuts	2384 b	38,073	1521 a	38,189
No scaffold selection; no annual pruning	2554 ab	40,498	1635 a	40,474
Tree Spacing				
10' x 22'	2515 ab	39,840	1660 a	40,310
14' x 22'	2549 ab	40,239	1467 a	39,590
18' x 22'	2901 a	40,341	1708 a	38,189
22' x 22'	2200 b	37,813	1487 a	35,913
Rootstock				
Hansen	2030 a	39,486	1332 b	35,175
Nemaguard	3052 b	39,629	1839 a	41,821

[1]Data followed by the same letters are statistically similar.

Conclusions after 18 years:

Tree Spacing:

- Any yield advantage to tight in-row spacing is highly dependent on inherent tree vigor.
  - Lower vigor trees (small varieties, less vigorous rootstocks, poor soil) will benefit most from tight spacing.
  - Vigorous trees may not have a significant yield increase if planted at high density. However, the risk of yield loss due to overly dense planting is low.
- There are advantages to tighter spacing other than yield.
  - Trees planted closer together are smaller. This results in less need for training & pruning, less tree structural failure, easier harvest, less trunk injury, fewer mummies and perhaps a longer lasting orchard.
- It appears that planting trees too far apart is a greater risk than planting too closely.

Tree Training & Pruning:

- Pruning has not increased or sustained yield. Pruning either has no effect or (more likely) reduces yield in the short term and long term.
- Less vigorous trees are negatively impacted by pruning more than vigorous trees.
- At current almond prices and labor costs, conventional training and annual pruning would have reduced net income by $7,500 - $14,000 per acre so far in this trial, including pruning, stacking & shredding costs plus lower cumulative yield.
- Annual pruning has not maintained canopy light interception longer than unpruned trees
- Trees trained to multiple scaffolds (or not trained) have been more prone to scaffold failure, especially in widely spaced trees.
- Sometimes pruning is needed for safety, equipment access, removing broken or diseased limbs, etc. but the reason to prune should justify the expense and yield loss.
- The best strategy appears to train the tree to be structurally strong during the first 1-2 years and then only if necessary for safety or equipment access thereafter.