Integration of Tree Density & Minimal Pruning for Efficient Almond Production

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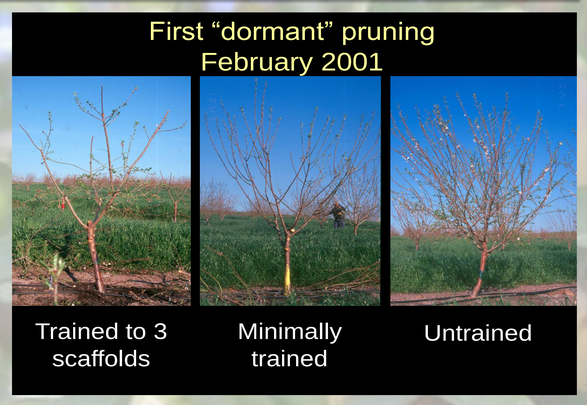
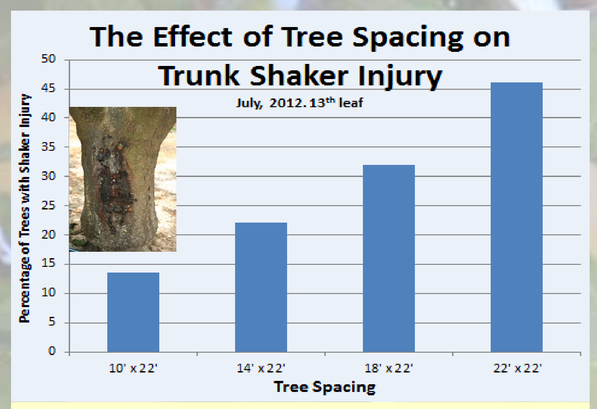
Objectives:

- 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.

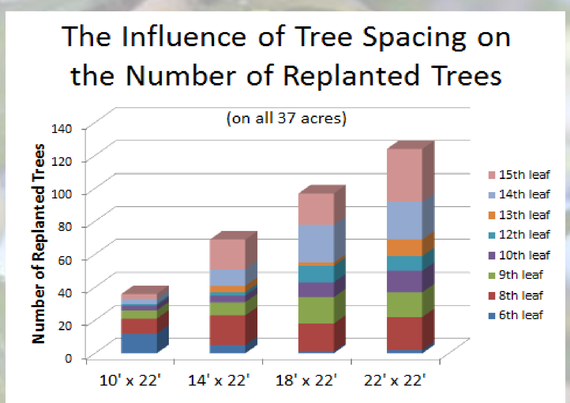
Multifactorial Trial:

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

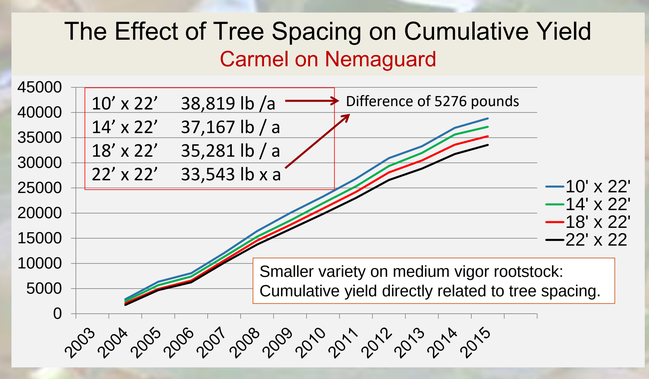


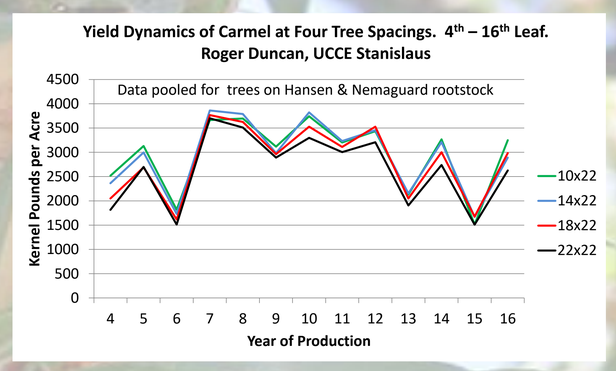


Widely spaced trees are larger, more difficult to shake and therefore more prone to shaker injury



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

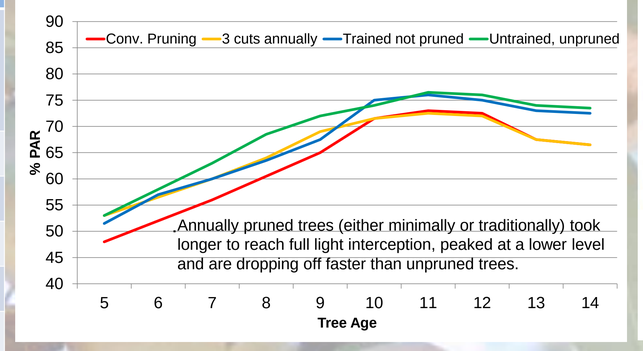
The Influence of Tree Spacing on the Time & Cost to Shake.

13th Leaf Nonpareil

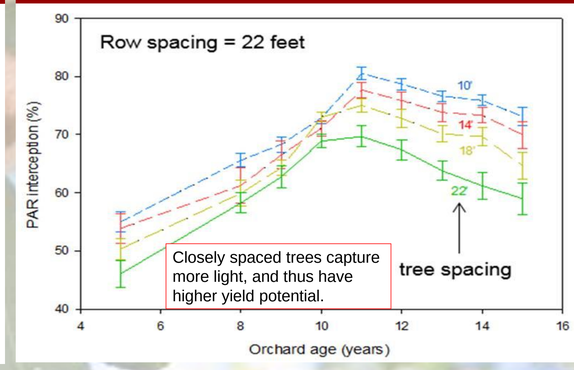
	Time (Minutes / Acre)	Cost ($ / Acre
10' x 22'	54.8	$91
14' x 22'	45.2	$75
18' x 22'	44.6	$74
22' x 22'	49.4	$82

*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 (17th Leaf) & Cumulative Yield[1]

	Nonpareil		Carmel	
	2016 Yield (lb/acre)	Cumulative	2016 Yield (lb / acre)	Cumulative
Training & Pruning				
Trained to 3 scaffolds; Annual, moderate pruning	2776 a	36,713	2779 b	34,809
Trained to 3 scaffolds; unpruned after 2nd year	2646 a	37,724	2995 ab	37,368
Trained to multiple scaffolds; Three annual pruning cuts	2572 a	35,691	2899 ab	36,670
No scaffold selection; no annual pruning	2779 a	37,945	3078 a	38,845
Tree Spacing				
10' x 22'	3019 a	37,325	3250 a	38,659
14' x 22'	2630 b	37,690	2891 b	38,123
18' x 22'	2760 b	37,440	2985 b	36,481
22' x 22'	2361 c	35,613	2626 c	34,426
Rootstock				
Hansen	3021 a	37,456	2516 b	33,843
Nemaguard	2364 b	36,577	3360 a	39,982

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

Conclusions after 17 years:

Tree Training & Pruning:

- 2016 Nonpareil yield was statistically similar for all pruning methods. Carmel trees that have been conventionally pruned each year yielded 300 pounds per acre less than untrained & unpruned trees Cumulatively, untrained & unpruned Carmel trees have accumulated over 4000 pounds more than conventional, annually pruned trees through the 17th leaf while unpruned Nonpareil has accumulated 1,232 more pounds.
- At an average price of $2.00 / pound, conventional training and pruning would have reduced net income by about $8000 per acre so far in this trial, including pruning & 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.
- Pruning has not affected kernel size.

Tree Spacing:

- In 2016 (17th leaf), trees planted ten feet apart had significantly higher yields than more widely planted trees. This was true for Nonpareil and Carmel on Hansen or Nemaguard.
- Cumulatively, there has been no yield advantage to closely planted Nonpareil, except when compared to the widest spacing (22' x 22').
- The smaller Carmel variety has benefitted more from the closer spacing.
- Closely planted trees are smaller, they have had fewer problems with scaffold breakage, are easier to shake, have fewer mummies, have suffered less trunk injury during harvest, and have had the fewest replants.
- Sunlight interception per acre has always been higher in more closely spaced trees and is decreasing more quickly in widely spaced trees. This may indicate that planting trees more closely may significantly extend the economic lifespan of an almond orchard.