Integration of Tree Spacing, Rootstock Selection & Pruning for Efficient Almond Production

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Premise: It is necessary to fill all available space in an orchard in order to obtain maximum yields.

The sooner this is achieved, the sooner an orchard will obtain maximum yields.
Questions:

• Can we fill orchard space more quickly with closer spacings and more vigorous rootstocks?

• If so, will early crowding increase early yields but sacrifice long-term profits?

• What effect does pruning have on short-term and long-term yield in low & high density orchards?
What is the best spacing?
How many limbs do we leave in a tree?
## Effect of Various Pruning Strategies on Cumulative Nonpareil Yields

Spacing = 7’ x 22’. John Edstrom, et. al., Nickels Soils Lab.

<table>
<thead>
<tr>
<th>Pruning Strategy</th>
<th>Kernel pounds / acre through 16(^{th}) leaf</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annually pruned</td>
<td>23,117</td>
</tr>
<tr>
<td>Unpruned*</td>
<td>24,089</td>
</tr>
<tr>
<td>2 Scaffolds, annual pruning</td>
<td>24,522</td>
</tr>
<tr>
<td>Every other tree removed</td>
<td>19,206</td>
</tr>
</tbody>
</table>
Multifactorial Trial in Stanislaus County to Examine Interrelationships of Variety, Rootstock, Tree Spacing & Pruning

- 28 acres
- virgin soil
- soil deeply modified with slip plow
- planted September, 1999
- drip irrigated
- trees very vigorous (nitrogen = 3.0%)
Aerial View of Spacing / Pruning Trial
3rd-leaf. October, 2002
Multifactorial Trial

- 3 varieties
  - Nonpareil*, Carmel*, Sonora

- 3 rootstocks
  - Nemaguard*, Lovell, Hansen*

- 4 in-row spacings
  - 10’ x 22’, 14’ x 22’, 18’ x 22’ & 22’ x 22’

- 4 pruning strategies
4 training / pruning strategies

• Standard trained, standard pruned
  – 3 scaffolds, medium annual pruning to maintain open centers

• Standard trained, unpruned
  – 3 scaffolds, unpruned after second dormant season

• Minimal training & pruning
  – 4-6 scaffolds, maximum of 3 cuts each dormant pruning

• Untrained, unpruned
  – no scaffold selection, no annual pruning*
First “dormant” pruning
February 2001

Trained to 3 scaffolds
Minimally trained
Untrained
Tree Spacing:
Effect on tree size, architecture, yield, etc.
The Influence of Tree Spacing on Canopy Width (into the drive row)

6th-leaf Nonpareil (June 2005)

Tree width (ft)

<table>
<thead>
<tr>
<th>10'</th>
<th>14'</th>
<th>18'</th>
<th>22'</th>
</tr>
</thead>
<tbody>
<tr>
<td>18.5</td>
<td>19.4</td>
<td>19.9</td>
<td>21.0</td>
</tr>
</tbody>
</table>
The Influence of Tree Spacing on Tree Height
6th-leaf Nonpareil (June 2005)

Tree height not clearly influenced by tree spacing
Trees on Hansen are larger than Nemaguard, especially at wide spacings.

Tree size heavily influenced by spacing; closely planted trees are smaller.
Effect of Tree Spacing & Rootstock on Trunk Circumference. Feb. 2006

Carmel size is less influenced by planting density
Effect of Tree Spacing & Rootstock on per Tree Yield of Seventh-leaf Nonpareil. 2006

Per tree yield is directly related to tree size; Closely planted trees are smaller.
Effect of Tree Spacing & Rootstock on per Acre Yield of Seventh-leaf Nonpareil. 2006

Per acre yield is similar for all tree spacings once trees fill their space.
Effect of Tree Spacing & Rootstock on per Tree Yield of Sixth-leaf Carmel. 2006

Per tree yield is directly related to tree size; Closely planted trees are smaller.
Effect of Tree Spacing & Rootstock on per Acre Yield of Sixth-leaf Carmel. 2006

Per acre yield is still higher in tighter spacings for the smaller Carmel variety.
Tree training & pruning: Effect on structural failure, disease, yield, etc.
First “dormant” pruning
February 2001

Trained to 3 scaffolds
Minimally trained
Untrained
2nd-leaf. May, 2001

Standard trained & pruned

Untrained & unpruned

10’ x 22’
Second “dormant” pruning
March 2002

Standard trained, pruned annually
Minimally trained, minimally pruned
Untrained, unpruned
Standard trained & pruned vs. Untrained & unpruned
Standard Trained, Annually Pruned Nonpareil. 7th Leaf
Standard Trained, Unpruned five years
Untrained / unpruned Nonpareil. 7th Leaf.
Difference in shaded ground area
Spacing = 22’ x 22’

Trained, annually pruned

Untrained, unpruned
The Effect of Pruning on Scaffold Splitting 2005
The Effect of Tree Spacing on Scaffold Splitting of Almond Trees 2005

- Tree failure was most severe in widely planted (large) trees.
- No scaffold breakage in hedgerow.
The Effect of Tree Spacing on Hull Rot of Nonpareil Almond

August 23, 2005

Hull Rot Rating (0-5)
Planting density had a minimal effect on hull rot
The Effect of Pruning on Hull Rot of Nonpareil Almond

Pruning decreased hull rot

(more even hull split?)
The Influence of Training & Pruning on Yield of 7th-leaf Nonpareil Almond Trees. 2006

- Standard Trained, Standard Pruned
- Standard Trained, Unpruned 5 years
- Minimally Trained, Minimally Pruned
- Untrained, Unpruned 7 years

<table>
<thead>
<tr>
<th>Meat Pounds per Tree</th>
<th>Nemaguard</th>
<th>Hansen</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>AB</td>
<td>A</td>
</tr>
<tr>
<td>B</td>
<td>BC</td>
<td>C</td>
</tr>
<tr>
<td>C</td>
<td>AB</td>
<td></td>
</tr>
</tbody>
</table>
The Influence of Training & Pruning on Yield of 6th-leaf Carmel Almond Trees. 2006

- **Nemaguard**: Standard Trained, Standard Pruned (A), Standard Trained, Unpruned 4 years (B), Minimally Trained, Minimally Pruned (AB), Untrained, Unpruned 6 years (A)

- **Hansen**: Standard Trained, Standard Pruned (A), Standard Trained, Unpruned 4 years (B), Minimally Trained, Minimally Pruned (AB), Untrained, Unpruned 6 years (A)
We lost 63 trees due to wet 2006 spring, saturated soils.
# Rootstock Tolerance to Saturated Soil Conditions. Spring 2006

<table>
<thead>
<tr>
<th></th>
<th>Dead</th>
<th>Severely Affected</th>
<th>Mildly Affected</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nemaguard</td>
<td>6</td>
<td>3</td>
<td>14</td>
<td>23</td>
</tr>
<tr>
<td>Lovell</td>
<td>8</td>
<td>6</td>
<td>13</td>
<td>27</td>
</tr>
<tr>
<td>Hansen</td>
<td>5</td>
<td>16</td>
<td>21</td>
<td>42</td>
</tr>
</tbody>
</table>
Early Conclusions:

• High density planting may not lead to higher yields if trees are vigorous, even in the short term.

• Smaller varieties like Carmel may benefit more from higher density plantings.

• Closer spacing down the row may allow for narrower spacing between rows.

• Scaffold selection is probably less critical in closely planted orchards.
Early Conclusions Cont.:

• Pruning has not increased yield through the 7th leaf. Conventional annual pruning has actually reduced yield in most years so far.

• Pruning may be more important for equipment access and tractor driver safety than for maintaining high yields.

• The effect of high density planting on disease is unclear so far.
Early Conclusions Cont.: 

- Any yield advantage to pruning will be long term and must make up for short term losses (in yield and increased expenses).

- This trial must be monitored for many years to determine long-term effects on yield, disease, and overall profitability.
Thank you for your attention