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

Project No.: **11-HORT5-Duncan**

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Interpretive Summary:

In this trial, we examine the interaction between planting density, rootstock performance and minimal pruning strategies, and their effects on short term and long term orchard production. The trial was established in the fall of 1999 and the orchard completed its twelfth growing season in 2011.

Varieties. 'Nonpareil', 'Carmel' and 'Sonora'. All Carmel trees were replaced early in the 2nd growing season due to widespread noninfectious bud failure (crazy top) and are therefore about one growing season behind the Nonpareil trees. Harvest data is not collected for the Sonora variety.

Rootstocks. Nemaguard, Lovell and Hansen 536. Most data is collected only for the Nemaguard and Hansen rootstocks.

Spacing. The distance between rows is constant at 22 feet throughout the trial. Down the rows, tree spacing is varied in groups of 24 trees. The four tree spacings are: 10' x 22', 14' x 22', 18' x 22' and 22' x 22'.

Pruning. Four training and pruning strategies are being imposed across all varieties, rootstocks and spacing treatments. They are:

1. **"Standard" training & pruning.** Three permanent scaffold limbs were selected during the first dormant pruning. Trees continue to receive "moderate", annual dormant pruning to keep centers open and remove crossing limbs.

2. **Standard training for 2 years, then unpruned.** Three permanent scaffolds were selected as in the "standard" treatment. Trees were pruned normally the second dormant season. These trees have been unpruned since the second dormant season except to occasionally remove limbs that interfere with cultural operations.

3. **"Minimal" training & pruning.** Shoots on Nonpareil trees were tipped twice during the first growing season to stimulate secondary branching and establish a bushy tree. At the first dormant pruning, only very vigorous shoots growing in the center of the trees were removed. Four to six scaffolds were retained to maintain a full canopy. Only a maximum of three cuts per tree is now made each dormant pruning to maintain a minimally open canopy.

4. **Untrained & unpruned.** No scaffold selection was made except to remove limbs originating too low on the trunk for shaker access. There has been no annual pruning other than to occasionally remove limbs that break or interfere with cultural operations.

Conclusions so far through the first 12 years:

- In most years, Nonpareil yields are statistically similar in conventionally pruned, minimally pruned and nonpruned trees.
- Cumulatively, unpruned Nonpareil trees have yielded 1334 pounds more than conventionally trained & pruned trees through the 12th leaf (**Table 1**).
- In most years, Carmel yields are highest in the untrained and unpruned trees.
- Cumulatively, unpruned Carmel trees have yielded 2657 pounds more than conventionally pruned trees through the 12th leaf.
- Conventional training and pruning would have reduced gross income by about $4800 per acre so far in this trial, including pruning costs and lower cumulative yield.
- Pruning tends to reduce yields more on widely spaced trees.
- Trees trained to multiple scaffolds are more prone to scaffold failure and tree blow over (young trees), especially in widely spaced trees.
- Pruning has not affected kernel size.
- Cumulative Carmel yields are significantly higher on closely planted trees but there is no obvious yield advantage to close planting of the larger Nonpareil variety.
- Unpruned trees had fewer mummies (unharvested nuts) than annually pruned trees.
- Widely spaced trees had 2.5 times more mummies per acre than closely planted trees (2010 – see **Table 2.**).
- Hansen hybrid rootstock is not well suited for the poorly drained soils of the Sierra foothills. Trees on Hansen often have smaller, yellower leaves in wet springs.
- These data indicate that annual pruning may not be necessary to improve or maintain almond yield, at least through the first half of an orchard's life. It is unknown what effect lack of pruning or higher density planting will have on the productivity of the orchard over the second half of the orchard's life.

Table 1. The Effect of Pruning, Tree Spacing and Rootstock on Current (2011) and Cumulative (Through 12th leaf) Yield (lb. per acre)				
	Nonpareil		Carmel	
	2011	Cumulative	2011	Cumulative
Training & Pruning				
Trained to 3 scaffolds; annual conventional pruning	4049 a	25,129	3006 b	22,494
Trained to 3 scaffolds; unpruned since 2nd leaf	4132 a	26,283	3079 b	24,027
Trained to multiple scaffolds; Three pruning cuts each year	3871 a	24,790	3084 b	23,772
No scaffold selection; No annual pruning	4173 a	26,463	3380 a	25,151
Tree Spacing				
10' x 22'	4032 ab	25,643	3202 a	24,888
14' x 22'	4130 ab	26,252	3232 a	24,780
18' x 22'	4205 a	25,794	3110 a	23,348
22' x 22'	3853 b	24,976	3005 a	22,429
Rootstock				
Hansen	4402 a	25,064	2929 b	22,219
Nemaguard	3710 b	26,268	3346 a	25,503

Table 2. The influence of tree spacing and pruning on overwintering mummy nuts of Nonpareil almond trees.					
	Number of mummy nuts per acre (January 2010)				
	10 x 22	14 x 22	18 x 22	22 x 22	**Average**
Standard annual pruning	4,297	9,545	12,386	10,845	**9,268**
Trained 2 years, no annual pruning	5,207	6,179	10,527	12,276	**8,547**
Minimal training, minimal pruning	5,841	7,650	15,059	13,473	**10,506**
Untrained & unpruned	3,802	5,090	7,557	9,729	**6,545**
Average	**4,787**	**7,116**	**11,382**	**11,581**	
	Number of mummy nuts per acre (February 2012)				
Standard annual pruning	4,752	8,767	6,710	9,630	**7,465**
Trained 2 years, no annual pruning	6,138	4,666	4,950	7,200	**5,739**
Minimal training, minimal pruning	5,148	9,757	6,380	15,750	**9,259**
Untrained & unpruned	6,534	7,636	6,160	13,590	**8,481**
Average	**5,643**	**7,707**	**6,050**	**11,543**	

Figure 1 indicates that there has been no significant cumulative yield difference between different tree planting densities for Nonpareil on the vigorous Hansen hybrid rootstock through the 12th leaf. **Figure 2** indicates that the smaller Carmel variety on the intermediate vigor rootstock, Nemaguard, benefits much more from closer tree spacing. Carmel at the highest density planting (10' x 22') accumulated 3804 pounds more than the widest spacing (22' x 22') which calculates to approximately $5,700 more gross income per acre.