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

Project No.: **08-HORT5-Duncan**

Project Leader: Roger Duncan
Farm Advisor
University of California Cooperative Extension, Stanislaus County
3800 Cornucopia Way, #A
Modesto, CA 95358
(209) 525-6800
raduncan@ucdavis.edu

Project Cooperators: Bruce Lampinen, Pomology Specialist, University of California, Davis;
Robert Longstreth, grower

Objectives:

In this trial, we examine the interaction between planting density, rootstock vigor and pruning and their effects on short term and long term orchard profitability. In the fall of 1999, Nonpareil, Carmel and Sonora almond trees on Nemaguard or Hansen rootstocks were planted at four spacings; 10' x 22' (198 trees per acre), 14' x 22' (141 trees per acre), 18' x 22' (110 trees per acre) and 22' x 22' (90 trees per acre).

Varieties

'Nonpareil', 'Carmel' and 'Sonora'. All Carmel trees were replaced in the spring of 2001 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 are 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'.

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, 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 interfere with cultural operations.

Interpretive Summary:

Tree density vs. yield

High density Nonpareil trees on Nemaguard rootstock had higher per acre yields during the first few years, but by the 7th growing season, yields were similar at all tree spacings. There was never a clear yield advantage to high density planting of Nonpareil on the highly vigorous Hansen rootstock. However, trees planted more closely are smaller, have had the fewest problems with scaffold breakage and have not had more disease problems to date.

The smaller Carmel variety has benefited more from closer spacing than Nonpareil. Carmel trees on Nemaguard planted at 14' x 22' had a cumulative yield increase of about 800 pounds per acre compared to trees planted at 18' x 22' and more than 1200 pounds per acre more than trees planted 22' x 22' from the 4th through 7th leaf. 2008 yields for the Carmel variety could not be processed in time to be included in this report.

Pruning vs. yield

Within the various planting arrangements, we have implemented four different pruning strategies. Trees that were trained to three primary scaffolds and have been pruned "conventionally" every year had the lowest cumulative yields during the "development" years of the orchard (through 7th leaf). Pruning has been especially yield reducing in the Carmel variety. For the last two years (8th & 9th leaf), yields have been similar for all pruning treatments for the Nonpareil variety but unpruned Carmel trees still tend to out-yield conventionally pruned Carmel trees. Trees that had no scaffold selection and are only lightly pruned when necessary for tractor driver safety, tend to have the highest yields overall. Untrained or minimally trained trees were more susceptible to blow over and scaffold failure during the development years. A good compromise appears to be to train the trees during the first two years (to reduce scaffold splitting and safety pruning in later years) and then abandon pruning in later years.

We have now completed the ninth growing season in 2008. To date, there has been no yield benefit to pruning. Trees that were initially trained to three scaffolds but have not been pruned since the second-leaf look very acceptable, have not had scaffold breakage problems, have not created problems for equipment operators and are not overly dense. Time will tell how lack of pruning will affect long-term production.

Yield vs. Rootstock

During the development years, yields were highest for both varieties on the vigorous Hansen rootstock. In the seventh-leaf (2006), yields were similar for Hansen and Nemaguard. In 2007 (eighth-leaf), yields were significantly lower for trees on Hansen compared to trees on Nemaguard. It is unclear if the lower yields of the Hansen rootstock were a result of the very wet spring in 2006 (trees on Hansen were affected more than trees on Nemaguard) or whether it is due to some other factor. Nonpareil yields were generally higher on the Hansen rootstock again in 2008.

Kernel Size

In most years, we have not seen effects on kernel size from pruning, tree density or rootstock. In the 6th-leaf, kernels were smaller on unpruned trees. In 2008, kernel size tended to be smaller on closer planted trees but was not influenced by pruning or rootstock.

Yield (Kernel Pounds per Acre) of 9th - leaf Nonpareil.
Average of Nemaguard & Hansen Rootstocks. 2008

	Tree Spacing Down the Row				
	10' x 22'	14' x 22'	18' x 22'	22' x 22'	Mean
"Standard" training & pruning	3866	4090	4356	3516	3957
Standard training, then unpruned	3729	3911	3812	3935	3847
"Minimal" training & pruning annually	3758	3696	3767	3858	3770
Untrained & unpruned	4259	4313	3836	4035	4111
Mean	3903	4003	3943	3836	

The Influence of Tree Density and Pruning on Kernel weight
(grams / 100 meats) of Nonpareil. 2008.

	10' x 22'	14' x 22'	18' x 22'	22' x 22'	Mean
"Standard" training & pruning	102.6	106.4	107.4	109.2	106.4
Standard training, then unpruned	99.5	105.7	102.7	108.4	104.1
"Minimal" training & pruning annually	105.4	105.1	107.4	113.0	107.8
Untrained & unpruned	101.2	105.6	104.2	112.2	105.8
Mean	102.2	105.7	105.4	110.7	

The Influence of Tree Density and Pruning on Cumulative Yield of Nonpareil and Carmel Almond (pounds per acre)

Nonpareil							
	2003 4th leaf	2004 5th leaf	2005 6th leaf	2006 7th leaf	2007 8th leaf	2008 9th leaf	**Cumulative**
"Standard" training & pruning	2112	2321	No Data	3108	4020	3957	**15,518**
Standard training, then unpruned	2336	2460		3547	4172	3847	**16,362**
"Minimal" training & pruning	2475	2348		2947	4047	3770	**15,587**
Untrained & unpruned	2420	2413		3371	4151	4111	**16,466**
10' x 22'	2358	2487	No Data	3061	3963	3903	**15,772**
14' x 22'	2624	2489		2900	4137	4003	**16,153**
18' x 22'	2100	2352		3047	4162	3943	**15,604**
22' x 22'	2243	2213		2911	4128	3836	**15,331**

Carmel							
	2003	2004 4th leaf	2005 5thleaf	2006 6thleaf	2007 7thleaf	2008 8th leaf	**Cumulative**
"Standard" training & pruning	no data	2046	2818	1524	3533	no data in time for report	**9,921**
Standard training, then unpruned		1991	3088	1854	3859		**10,792**
"Minimal" training & pruning		2322	3088	1820	3713		**10,943**
Untrained & unpruned		2384	3358	1962	3888		**11,592**
10' x 22'		2518	3130	1819	3665		**11,132**
14' x 22'		2363	2998	1731	3862		**10,954**
18' x 22'		2049	2690	1617	3767		**10,123**
22' x 22'		1815	2700	1512	3700		**9,727**