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

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Interpretive Summary:

In this trial, we examine the interaction between planting density, pruning and rootstock vigor 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; the closest spacing was 10' x 22' (198 trees per acre), and the widest spacing was 22' x 22' (90 trees per acre). There was a yield advantage to high density planting of trees on the less vigorous Nemaguard rootstock only very early in the life of the orchard. By the seventh growing season, yields were the same per acre for Nonpareil on Nemaguard at all tree spacings. We never saw any yield advantage to densely planted nonpareil on the very 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 benefited more from closer spacings. Carmel trees planted at 14' x 22' had a cumulative yield increase of about 800 pounds per acre compared to trees planted at 18' x 22' from the 4th through 7th leaf.

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 tend to have the lowest yields, especially in the Carmel variety. Trees that had no scaffold selection and are only lightly pruned when necessary for tractor driver safety tend to have the highest yields. 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 eighth-leaf in 2007. To date, there has been no yield benefit to pruning.

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 is 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. This trial must be monitored for many years to determine the effects on long-term profitability.

Materials and Methods:

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 more than one season behind the Nonpareil trees. Data are collected only for Nonpareil and Carmel.

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'.

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

“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.

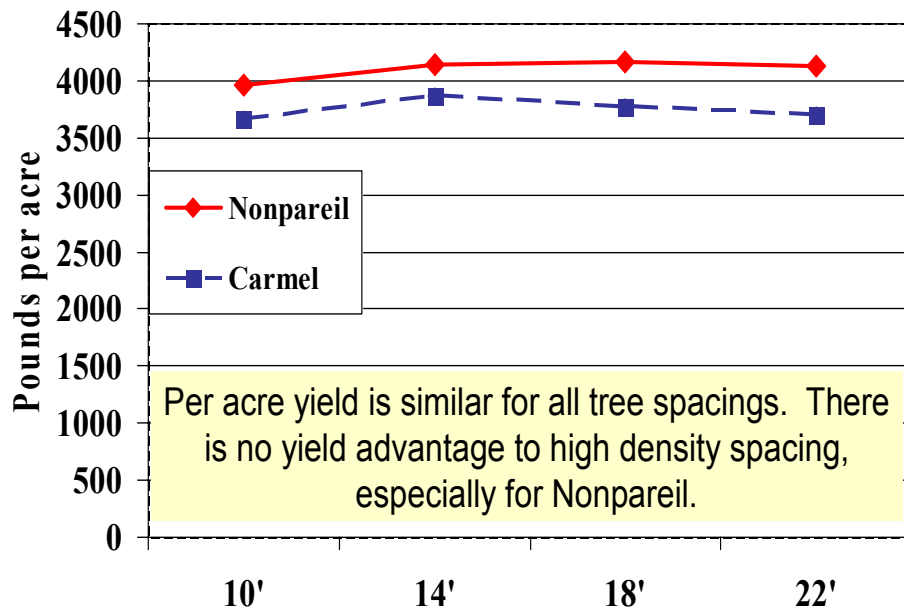
Standard Training, Then Unpruned: - Three permanent scaffolds were selected as in the “standard” treatment. Trees were pruned normally the second dormant season. These trees have been unpruned since the second dormant season except to occasionally remove limbs that interfere with cultural operations.

“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 selected 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.

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.

Results and Discussion:

Effect of Tree Spacing on per Acre Yield of Nonpareil & Carmel Almonds. 2007.

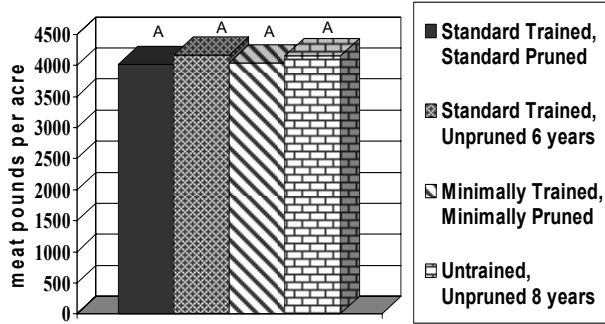


	4 th leaf	5 th leaf	6 th leaf	7 th leaf	Cumulative Yield 4 th – 7 th leaf	Cumulative Yield Difference Compared to 22 x 22
10 x 22	2518	3130	1819	3665	11,132	+ 1405
14 x 22	2363	2998	1731	3862	10,954	+ 1227
18 x 22	2049	2690	1617	3767	10,123	+ 396
22 x 22	1815	2700	1512	3700	9,727	--

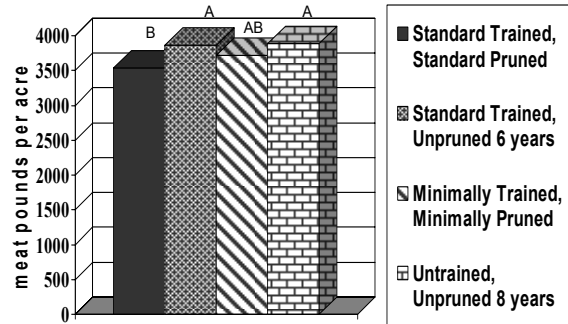
Influence of Tree Training and Pruning on Yield - Yield among all four training and pruning treatments were very similar for the Nonpareil variety. Pruning had a negative effect on yield in the Carmel variety. Unpruned Carmel trees tended to have the highest yields and trees trained to three scaffolds and have received "standard" annual pruning had the lowest yields. This is consistent with results from previous years. There was no clear effect of rootstock, pruning or tree spacing on kernel size, percent doubles or shriveled kernels in 2007. In some previous years, standard pruned trees had larger kernels than unpruned trees. 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 (Pounds per Acre) of 8th - leaf Nonpareil.					
Average of Nemaguard & Hansen Rootstocks. 2007					
	Tree Spacing Down the Row				
	10'	14'	18'	22'	Mean
Standard" training & pruning	3909	3990	4309	3873	4020
Standard training, then unpruned	3860	4151	4394	4283	4172
"Minimal" training & pruning	4026	4118	3821	4224	4047
Untrained & unpruned	4056	4290	4125	4131	4151
Mean	3963	4137	4162	4128	
Yield (Pounds per Acre) of 7th - leaf Carmel.					
Average of Nemaguard & Hansen Rootstocks. 2007					
	Tree Spacing Down the Row				
	10'	14'	18'	22'	Mean
Standard" training & pruning	3436	3692	3734	3268	3533
Standard training, then unpruned	3893	3950	3820	3774	3859
"Minimal" training & pruning	3635	3749	3665	3804	3713
Untrained & unpruned	3696	4056	3848	3953	3888
Mean	3665	3862	3767	3700	

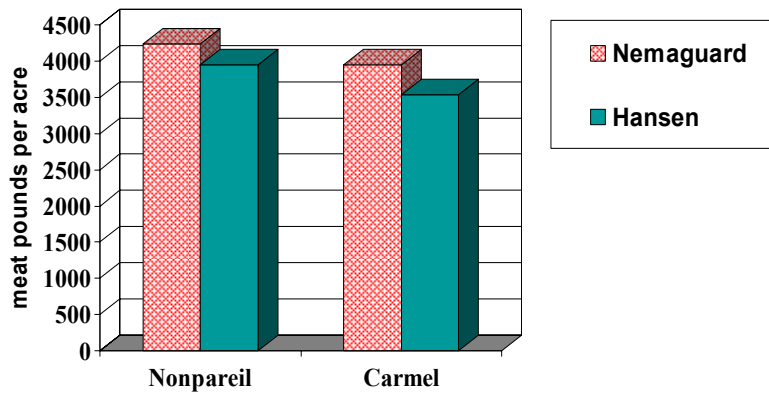
The Influence of Training & Pruning on Yield of 8th-leaf Nonpareil Almond Trees. 2007



The Influence of Training & Pruning on Yield of 8th-leaf Carmel Almond Trees. 2007



The Influence of Rootstock on Yield of Nonpareil & Carmel Almond Trees. 2007



Yield on Hansen was lower than nemaguard in 2007, possibly due to effects of wet spring in 2006.