Nickels Soil Lab Report

Project No.: **17-HORT6-Niederholzer**

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Objectives:

1) Evaluate tree training/pruning methods for maximum early production while maintaining long-term yields in tightly spaced (16' x 22') almonds.
2) Evaluate the economics and productivity of USDA and CCOF compliant organic almond production methods suitable for the Sacramento valley region in comparison to conventional production methods.

Interpretive Summary:

No significant difference in annual or accumulated yield between unpruned (after 2nd dormant season) and conventionally pruned Non-pareil and Monterey trees has been measured since John Edstrom and Stan Cutter planted this pruning trial in 1997.

Organic production continued to be roughly 60-80% of conventional yield in a demonstration orchard planted in 2006. Maintaining adequate nitrogen nutrition in the organic orchard has become the largest economic and horticultural challenge. Multiple applications of sulfur, post petal fall, have controlled disease and mites in the orchard in the last several years, while propane burning of weeds in the tree row has maintained weed control in the organic block.

Materials and Methods:

1) A field experiment was established in 1997 to evaluate the impact of no pruning past 2nd leaf in Nonpareil, Monterey, Carmel and Aldrich trees, all on Lovell peach seedling rootstock. Due to tree loss and other factors, only Nonpareil and Monterey trees are currently measures. The trial is blocked and replicated 4x for a total of almost an acre of trees for each of the following treatments:

Standard - Three primary limbs selected at 1st dormant, tipped but long pruned, secondaries selected at 2nd dormant, centers kept open, limb tying/staking as necessary. Yearly traditional, light pruning continued.

"Unpruned" - Three primary limbs selected, tipped and left long at the 1st dormant pruning then no additional pruning unless needed to facilitate orchard operations or to remove broken limbs. Minimal staking as necessary was used.

Mechanically Topped - Same as unpruned, but with machine flat-topping to remove half of prior season's top shoot growth during the 2nd dormant season and again in spring of the 4th leaf. No additional pruning until spring, 2013, when a narrow, vertical slot (hedging) was mechanically cut – 4' at the top, 18" at the bottom between all rows of this treatment. Very little wood was removed**.**

Temporary Scaffolds - Train limbs at 1st dormant to favor 3 permanent upright primary scaffolds, temporarily retain lower less dominant branches, removing only ones competing strongly with permanent scaffolds. Retain as much wood as possible. Temporary limbs gradually removed during years 5-8 after producing some crop and adding to tree size, from then on standard pruning.

2) An organic vs conventional almond demonstration orchard is compared in a 7-acre almond planting of Nonpareil/Fritz (75/25; every 4th tree in every row is a Fritz, with rows offset so each NP has an adjacent Fritz tree) planted in 2006 at the Nickels Soil Lab near Arbuckle. The transitional trees were grown conventionally for 3 seasons and then converted to organic practices in September 2008. All trees are planted 22' across the row and 16' down the row and irrigated with subsurface drip irrigation (SDI), which was replaced in 2016 for both organic and conventional blocks. The conventional trees are managed using practices typical for almond production in the area. The organic trees are grown using practices approved for organic production by the USDA and CCOF. Certified organic pesticides and fertilizers are used. This trial is not replicated due to the limited space available. However, this side-by-side comparison is intended to be a valid case study of differing almond management systems.

Results and Discussion:

The yield results from this field trial continue to question the need for regular pruning to maintain almond production once the primary scaffolds have been selected. Both Nonpareil and Monterey showed no significant yield differences between pruning treatments in 2017 yield. Nonpareil has out-produced all other varieties cumulatively in this 19th leaf orchard (**Table 1**). Although the Unpruned and Mechanically Topped trees appear to be losing lower fruitwood each year, the total yields remain statistically the same as the Standard pruned trees. Standard pruned trees have open centers with significant light penetration into the lower canopy. The upper canopy of unpruned trees has potentially compensated for the loss of lower fruitwood. It is noteworthy to mention that this same phenomenon was observed in the original unpruned trial conducted at Nickels in the 1980-1990s. However, continuation of equal yield is uncertain and remains our primary concern.

Yield per acre was not significantly different between the pruning treatments for Non-pareil or Monterey (**Table 1**). Nonpareil kernel sizes were similar (25 ct/oz) across treatments (data not presented).

Again, as in past years, we did not see any difference between treatments for hull rot, stick-tights, or any other disease. Despite adequate irrigation water, the only summer leaf disease

found has been leaf rust seen sporadically throughout the plot in 2006 –2011, although spring, 2016 rains produced some rust in the upper canopy of much of the orchard. This site does not experience stagnant humid air conditions (max relative humidity is often < 91%) during the summer and thus far, no alternaria or scab has been found. Drying conditions in the windrows at harvest adequately dry the crop for hulling. The soil at this site is a Class II gravelly, sandy loam underlain with clay at 30-50-inch depth. Deep slip plowing, and land leveling operations have improved the profile, but, this orchard exhibits moderate vigor when compared to the strongest young almond orchards found today. This might be limiting the negative effects of shading on fruitwood longevity and ultimately yield. July leaf samples show adequate to optimal levels of leaf nutrients: Nitrogen – 2.71%, Phosphorous – 0.13%, Potassium - 2.48%, Sulfur-0.19%, Boron- 45 ppm, Calcium – 2.97%, Magnesium - 0.98%, Manganese- 94 ppm, Iron- 281 ppm, Copper- 7.0 ppm, Sodium – 0.01%, and Chloride – 0.15%.

So far, this test has consistently produced yields comparable to good production in the Arbuckle area of Colusa County. The relevance of these trial results to other growing regions is unknown, but similar tests in central and southern San Joaquin Valley vigorous orchards have supported these findings. The validation of the minimum pruning concept will require a few more years to determine the total production over the life of the orchard and to track the possible accelerated yield decline over the 20-22 year expected life span of this orchard.

Table 1. Yield by variety and pruning treatment – cumulative (cum) and 2017 harvest of pruning trial planted in 1997 on Lovell seedling peach rootstock and planted 16' x 22' (124 trees/acre). Yields were corrected downwards by 10% to account for rocks in the field weights used to calculate yield.

	Aldrich		**Carmel**		**Monterey**		**Non pareil**	
	cum	2017	*cum*	2017	*cum*	2017*	*cum*	2017*
Standard	41,758	1,542	41,591	2,661	41,320	2,269	47,337	2,743
Temp Scaffold	--	--	39,039	1973	42,202	2,590	42,633	2,939
Mech hedged	40,799	1,732	38,833	2,170	40,766	1,948	46,883	2,688
Minimum/ unpruned	38,831	1,548	36,270	1,834	46,180	2,720	49,267	2,863

*no significant difference (p≤0.05) between the treatments in the same column.

3) In 2017, organic Nonpareil yield was approximately 66% of conventional (**Table 1 and Figure 1**). Kernel size (23-24 count per oz) and quality was good to excellent for all systems.

During the eleven seasons of this trial, to date, disease management, weed control and nitrogen fertility have been the most challenging issues. Recently, nitrogen nutrition has eclipsed weed control and disease management as the largest challenge to sustainable organic production.

- Fertility: Almonds use roughly 60-70 lbs of Nitrogen (N) per 1000 lbs of kernel crop produced – the highest N use of any tree crop commonly grown in California. Maintaining orchard N status while maximizing organic production is challenging and expensive. In 2011, the nitrogen fertility program in the organic/transitional trees was modified to include more organic fertilizer. Yard waste compost was not broadcast after this year. Organic

fertilizer (4-0-2) is being applied through the irrigation system with supplemental applications of sodium nitrate. However, the organic treatment areas are N deficient, based on 2016 summer leaf N levels (**Table 1**), despite early warnings from the April leaf samples and efforts to "hold the line" on N nutrition through the summer. This drop-in leaf N level has occurred as nut production – and orchard N use – has increased. The cost of N fertility is the largest difference between conventional and organic production, costing roughly 5x/acre the amount of the conventional fertility program.

- Weed Control: While propane flaming in the tree row has been mostly effective it is slow and expensive. Sections of the organic trees received a weed cloth barrier at planting which has prevented most weed growth in the 6 ft. wide tree line but at the considerable expense of $1500/acre plus yearly repair expenses. Weeds were hard to control along the edges of the cloth where mowers couldn't operate without catching/pulling the cloth. The weed cloth was removed at the end of 2011 after annual maintenance became too expensive and time consuming to continue. The surface drip system was replaced in October 2007 with a dual line subsurface drip system, primarily to reduce weed growth, seed emergence and associated weed control costs. This has reduced propane flaming expenses significantly compared to previous seasons. Cost effective practices that widen the weed control strip may also contribute to improved tree N availability and tree N status.
- Disease control: Spring and summer disease control, especially leaf rust, has been a problem in the organic trees. Beginning in 2011, a program of one sulfur spray per month has controlled rust and suppressed spider mites, contributing to a stronger canopy at postharvest. This single practice has had the biggest impact on organic production in this demonstration block over the past four seasons (**Figure 1**). In this location, where rolling terrain aide air movement and Class II and III soils limit tree vigor, a successful organic disease management program appears to be as effective and less expensive (data not presented) than a conventional disease management program.

Table 1. 2017 Yield / Kernel Size / Leaf %N in organic, transitional and conventional orchard management blocks. Nitrogen deficient levels (<2.2 %N) appear in red font. The yield data are reduced 10% from field run data to correct for rocks.

System	2016 Nonpareil yield lbs/Ac	Kernels/oz	July leaf %N
Conventional	2217	**23**	**2.75**
Transitional	1340	**24**	**2.11**
Organic	1472	**23**	**2.14**

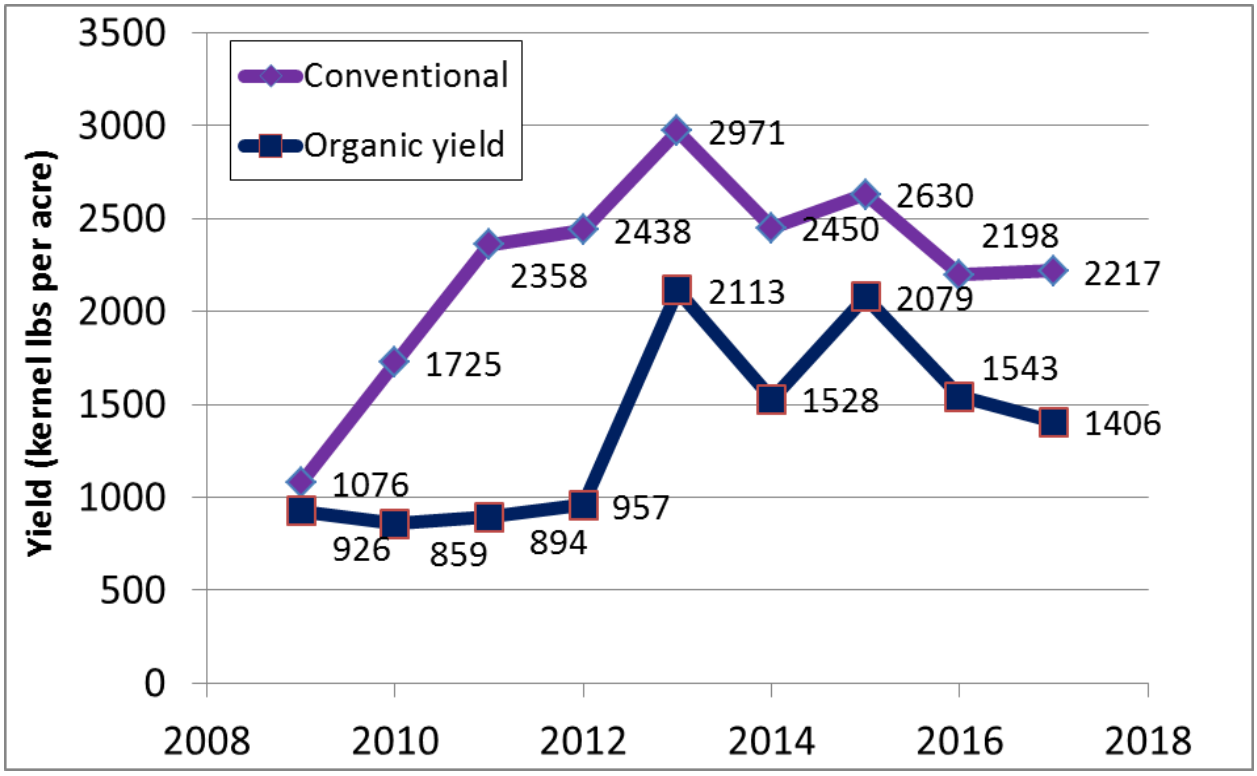

Figure 1. Nonpareil (NP) yields (kernel lbs/acre) for conventional and organic treatments planted in 2006.