# Nickels Soil Lab Projects

**Project No.:** **13-HORT6-Niederholzer**

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**Objectives:**

This report includes two field trial project updates from Nickels Soil Lab:

- Minimum Pruning Systems for Almonds
- Organic Production Systems for Almonds

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**Project Title:** **Minimum Pruning Systems for Almonds**

**Project Leader:** Franz Niederholzer, UCCE – Colusa/Sutter/Yuba Counties

**Project Cooperators:** John Edstrom, Stan Cutter, and Bill Krueger

**Objectives:**

The pruning trial described below was planted in 1997. The rootstock is Lovell peach seedling and the pollinators are Aldrich, Monterey, Carmel and Sonora. The objective of this trial is to evaluate tree training/pruning methods for maximum early production while maintaining long-term yields in tightly spaced (16' x 22') almonds.

**Treatments:**

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

2) **"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.

3) **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**.**

4) **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.

**Interpretive Summary:**

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. Yield results for Nonpareil and Monterey show no difference in 2013 production between Pruned and Unpruned trees. Nonpareil out-produced all other varieties in this 17th leaf orchard (**Table 1**). Kernel size continues to be equal for all pruning treatments, 24-25/oz. for this season (data not presented). Although the Unpruned and Mechanically Topped trees appear to be losing lower fruitwood each year, the total yields for Nonpareil and Monterey varieties remain statistically the same as the Standard pruned trees, while the accumulated yield trends towards higher production in Unpruned trees. (Standard pruned trees have open centers with significant light penetration into the lower canopy.) Aldrich and Carmel varieties show a trend in the opposite direction than the Nonpareil and Monterey pruning results, with slightly lower yield in Unpruned vs. pruned treatments. Possibly the upper canopy of Unpruned trees has 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 this compensatory fruiting habit is uncertain and remains our primary concern.

Again, we did not see any difference between treatments for hull rot, stick-tights, or any other disease but, shaker damage appears to be more prevalent in both the Unpruned and Mechanically Topped (also unpruned) trees. Despite ample water the only summer leaf disease found has been leaf rust seen sporadically throughout the plot since 2006. There was little rust in 2012 and 2013 following aggressive foliar disease control practices. 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 – 2.93%, Phosphorous – 0.13%, Potassium - 2.39%,

Sulfur-2340 ppm, Boron- 36.4 ppm, Calcium - 3.05%, Magnesium - 0.82%, Manganese- 102 ppm, Iron- 302 ppm, Copper- 6.5 ppm.

So far, this test has produced yields comparable to the best in the Arbuckle area. 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.

**Past results**:

- Minimally pruned trees and temporary scaffold trees out yield standard trees in the early years.
- Temporary limb training is expensive and probably uneconomical.
- Production between all treatments leveled out in the 6th year.
- Accumulated cost savings of $800 - $1,100 per acre to the 17th year are possible with minimum pruning methods.
- Aldrich growth habit is incompatible with the temporary limb method.
- Some minimal amount of secondary and inside branch removal may be beneficial under minimum pruning.
- No increase in disease or sticktights was found for minimum pruning.
- Tree height appears shorter with minimum pruning.
- There have been no problems drying crop on orchard floor.
- Lack of pruning resulted in a higher % of leaning trees.

**Table 1**. Yield by variety and pruning treatment – cumulative and 2013 harvest of pruning trial planted in 1997 on Lovell seedling peach rootstock and planted 16' x 22' (124 trees/acre).

| Pruning Treatments | **Aldrich** | | **Carmel** | | **Monterey** | | **Nonpareil** | |
|---|---|---|---|---|---|---|---|---|
| | ***accum*** | **2013** | ***accum*** | **2013** | ***accum*** | **2013*** | ***accum*** | **2013*** |
| **Standard** | 30,980 | 2,794 | 30,719 | 2,499 | 31,056 | 2,430 | 35,253 | 3,549 |
| **Temp Scaffold** | -- | -- | 29,838 | 2,278 | 32,032 | 2,703 | 30,167 | 3,788 |
| **Mech Hedged** | 30,376 | 2,428 | 29,738 | 2,091 | 31,328 | 2,485 | 34,723 | 3,378 |
| **Minimum/ Unpruned** | 28,632 | 2,493 | 27,542 | 2,299 | 35,525 | 2,664 | 37,065 | 3,608 |

*no significant difference between the treatments in the same column.

**Project Title:** **Organic Production Systems for Almonds**

**Project Leader:** Franz Niederholzer, UCCE – Colusa/Sutter/Yuba Counties

**Project Cooperators:** John Edstrom, Stan Cutter, Bill Krueger, Bob Johnson, and Bruce Lampinen

**Objectives:**

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:**

For the past 8 years we have been evaluating a 7-acre almond planting of Nonpareil/Fritz (75/25; see **Figure 1** for tree layout) by comparing three production systems; Conventional (Conv), Transitional (Trans) and Organic (Org). The Conv trees are produced using practices typical for almond production in the area. All trees are planted 22' across the row and 16' down the row and irrigated with subsurface drip irrigation (SDI). The transitional trees were grown conventionally for 3 seasons and then converted in September, 2008 to organic practices. The organic trees are grown using practices approved for organic production by the USDA and CCOF. A list of contrasting cultural practices and the associated product costs are shown in **Table 1**. Other costs common to both systems i.e irrigation, harvest, overhead etc., are not included. 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.

In 2013, the yield differences between Conv and Org Nonpareil production shrank by half of those seen in previous years (2010-2012). Nonpareil yields showed 741 lbs/acre and 976 lb/acre advantage to the Conv over the Org and Trans productions systems, respectively. Kernel size (21-24/oz) and quality were excellent to good for all three systems (**Table 2**). Worm (navel orangeworm) damage in the conventional block was <0.5% and between 2-3% in the organic. Damage in the organic was not excessive, despite only one spray applied against NOW.

During the eight seasons of this trial, organic production levels, disease management, weed control and nitrogen fertility have been the most challenging issues.

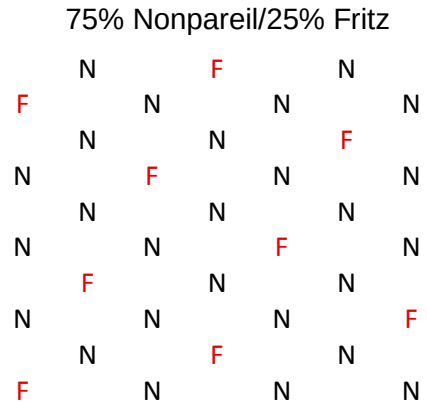
- Weed Control: While propane flaming in the tree row has been mostly effective, it is slow and expensive. Sections of the Org trees received a weed cloth barrier at planting which has prevented most weed growth in the 6 ft. wide tree line but at the considerable expense of $1500/acre plus yearly repair expenses. Weeds were hard to control along the edges of the cloth were mowers couldn't operate. The weed cloth was removed at the end of the 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. However, flaming is not effective during wet conditions and only marginally at cold temperatures. Given the average annual rainfall of 18 inches in the Arbuckle area, weed growth gets ahead of the flamer in the winter requiring hand hoeing. This should also be reduced as canopies shade the soil surface. One immediate advantage of the switch to SDI irrigation was a reduction in harvest time tree water stress by running SDI hoses during harvest without wetting the crop significantly.

- Fertility: Producing almonds use up to 70 lbs of N per 1000 lbs of kernel crop produced – the highest N use of tree crops 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 changed to include more organic fertilizer. Yard waste compost was not broadcast after this year. Instead, in 2013, 125 lb N/acre was applied through the irrigation system as 4-0-2 organic liquid fertilizer and an additional 50 lbs N as sodium nitrate. This was done in an effort to improve leaf N and canopy size. Leaf N levels remain good in both blocks (Conv and Org), but heavier crops may reduce N nutrition of the organic trees.

- Disease control: Spring and summer disease control, especially rust, has been a problem in this orchard. In 2013, bloom weather was excellent, with only 0.02 inches of rain the entire month of February. Significant precipitation did fall in March (1.03") and April (0.49"). However, no significant blossom disease was observed, and virtually no rust symptoms appeared during mid to late summer. Our aggressive program of one sulfur spray per month following petal fall may have contributed to this positive outcome. By keeping leaves on the trees into and through harvest, we hope to continue to see good yields (>2000 lbs per acre) in 2014. The role in improved yield of a single application at full bloom of a highly effective fungicide with potential for organic certification (polyoxin D; Ph-D fungicide) is being tested in 2014.

**Figure 1. Trial Planting Design**



## Organic Block – December, 2012

## Conventional Block -- December, 2012

**Table 1.** Production Costs per Acre- 8th leaf. Application costs are not included.

| Conventional | Notes | Cost/acre of trees ($) | Organic | Notes | Cost/acre of trees ($) |
|---|---|---|---|---|---|
| Nutrition | | | Nutrition | | |
| 225# N/acre as UN-32 | | 149.89 | 50# N/acre Sodium nitrate | June | 143.75 |
| 150#$K_2O$ as 0-0-12 (KCl) | | 117.19 | 125# N/acre and 62.5# $K_2O$ (4-0-2 liquid) | March (50# N) April (50#N) Oct (25#N) | 1,328.12 |
| 5#/acre zinc sulfate 35.5% | | 4.08 | Solubor (2.5#/acre) | | 3.75 |
| Solubor (2.5#/acre) | | 3.75 | | | |
| Weed Control | | | Weed Control | | |
| Chateau (12 oz/acre) | Feb 20 | 44.59 | propane | 8 flamings | 240.00 |
| Prowl H20 (8 qts/acre) | Feb 20 | 54.48 | labor for flaming | | 100.00 |
| Generic glyphosate) (1 qt/acre | Feb 20 | 2.65 | | | |
| Ammonium sulfate (AMS) (10#/100 gal) | Feb 20 | 0.92 | | | |
| Poast (24 oz/acre) | July 22 | 10.74 | | | |
| Treevix (1 oz/acre) | July 22 | 9.78 | | | |
| Mod Seed Oil (MSO) (16 oz/100 gal) | July 22 | 0.63 | | | |
| Generic glyphosate) (3 pints/acre) | Aug 5 | 7.29 | | | |
| Treevix (1 oz/acre) | Aug 5 | 17.91 | | | |
| AMS | Aug 5 | 1.34 | | | |
| mowing | 5 times | 30.00 | mowing | 5 times | 30.00 |
| Insects/Mites | | | Insects/Mites | | |
| Intrepid (16 oz/acre) | Mid May (PTB & NOW) | 33.52 | Entrust (Aug 1, 3rd gen NOW egg hatch) | 3 oz/acre | 36.56 |

| | | | | | |
|---|---|---|---|---|---|
| Onager (20 oz/acre) | mid-June | 71.62 | | | |
| Altacor (4 oz/acre) | Initial hull split (June 30) | 46.26 | | | |
| Altacor (4 oz/acre) | 2 wks after initial hull split (July 16) | 46.26 | | | |
| BifentureEC (12.8 oz/acre) | Aug 1, 3rd gen NOW egg hatch | 14.03 | | | |
| Disease | | | Disease | | |
| Vanguard (2.5 oz/acre) Tilt (4 oz/acre) | Pink, every other row | 15.71 | | | |
| Quadris Top (14 oz/acre) | Full bloom, every row | 36.99 | Ph-D fungicide * at full bloom | 6.2 oz/acre | 35.88 |
| Bravo (4 pt/acre) | 2 WAPF, every row | 21.23 | Sulfur-DF;mid-March | 20 lb/acre | 17.00 |
| ziram (8#/acre) | 4 WAPF, every row | 36.32 | Sulfur-DF; early April | 20 lb/acre | 17.00 |
| Quash (3.5 oz/acre) | Early April, every row | 31.08 | Sulfur-DF; early May | 20 lb/acre | 17.00 |
| Quadris Top (14 oz/acre) | Late June, every row | 36.99 | Sulfur-DF; late June | 20 lb/acre | 17.00 |
| **Total costs** | **Does not include application costs** | **808.26** | | **Does not include application costs** | **1986.060** |

*Ph-D Fungicide is not a certified organic fungicide, but it is exempt from tolerance and an organic label request has been submitted. All almonds grown at Nickels Soil Lab are marketed as conventional nuts, not certified organic, regardless of orchard practices.

**Table 2.** 2013 Yield / Kernel Size / Leaf %N

| System | 2012 Nonpareil yield lbs/Ac | Kernels/oz | July leaf %N |
|---|---|---|---|
| Conventional | 2971 | 26 | 2.73 |
| Transitional | 2230 | 28 | 2.38 |
| Organic | 1995 | 28 | 2.44 |

*Nonpareil (NP) yields for conventional ("Standard") and organic treatment (Transitional, Organic and Org+weed cloth are all treated as one at this time) based on field weights, 2010-2013. Planting is NP (75%) and Fritz (25%) on Lovell seedling rootstock, planted in 2006. If adjusted for rocks, etc., yield may be 10% less. Monthly sulfur applications to control leaf rust began in the summer of 2012.

**Figure 2.** Historic Yield by Production Method (2008-2014).