Nickels Soil Lab Projects

Project Number: **09-HORT6-Edstrom**

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I. Organic Production Systems for Almonds

Objectives:

Evaluate the economics and productivity of USDA and CCOF compliant organic almond production methods suitable for the Sacramento valley region in comparison to standard production methods.

Interpretive Summary:

For the past 4 years we have been evaluating an 8-acre almond planting of Nonpareil/Fritz (75/25) by comparing three production systems; Conventional (Conv), Transitional (Trans) and Organic (Org). The conventional trees are produced using practices typical for almond production in the area. 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 and application costs are shown in **Table 1**. Other costs common to both systems are not included.

During the four seasons of this trial, weed control and nitrogen fertility have been the most challenging issues. While propane flaming in the tree row has been effective it is slow and expensive. At this age the young trees shade only 35% of the tree line strip providing nearly full sun for weed growth. As tree canopies enlarge and create more shade, weed pressure will be dramatically reduced. 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. The longevity of the cloth will determine ultimate cost/acre. If the cloth endures for 5-6 years the cost will be comparable to current flaming expenses. However, there appears to be some advantage to tree growth and possibly yield from the weed cloth compared to propane flame weed control.

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 18 inches of rainfall 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 is a reduction in harvest time tree water stress, as this system allows full irrigation runs during harvest as shown in the photo.

The fertility levels are reflected in the tree size measurements (trunk circumference) that indicate larger tree size for the Stan/Trans compared to the smaller Org trees (**Table 2**). Canopies of the Org trees also appear thinner (**see photo**).

In general the leaf analysis results also reflect the fertilizer programs. Higher mineral content in the Stan follow the higher levels of nutrients provided by commercial nitrogen, potassium, and zinc fertilizers. For the Trans/Org, it is difficult to estimate the nutrition provided by the compost applications. Lab analysis of the compost shows 1.5% nitrogen that converts to 150 lbs N/acre (5 T x 2000lb x 0.015) applied broadcast per acre. Soil results show only 9 ppm NO_3 level in the root zone and 2.52% N in the leaves. These levels suggest a slow rate of nitrogen mineralization of the applied compost resulting in leaf level below the 2.79 % N level found in the Stan trees. The level of zinc is also low in the Org trees. Other elements are adequate. The cost of this season's organic nitrogen fertility program has been extremely high due to a mid-season nitrogen application using a fish biproduct material suitable for injection into the drip irrigation system. Hopefully, future N programs will not include this expense and rely on an upgraded compost program and higher amounts of mineralized N from past compost applications. Compost should also improve the potassium and zinc levels. Copper was applied to Org & Trans as a dormant spray, which is reflected in the 16 ppm leaf level verses 7 ppm for Stan trees that did not receive copper.

Yields for Nonpareil show a 300 lb/acre advantage using the conventional production system. Yields in general are below normal due to previous heavy pruning to rebuild scaffolds following wind damage and possibly due to the single Fritz pollinizer and high percentage Nonpareil in this unique planting design (see graphic). The high percentage Nonpareil concept was used to limit the brown rot susceptibility of the overall planting as Nonpareil shows some tolerance to *Monilinia laxa*, while the Fritz variety is highly fruitful and an excellent pollinizer for Nonpareil. Kernel size (22/oz) and quality were excellent for all three systems, virtually no worm or ant damage was found. An unusual leaf burn was noted only on the Fritz pollinizer trees that received propane weed applications combined with 2 foliar spays of wettable sulfur. Apparently, the heat from the propane applications activated the burn potential of foliar residues of sulfur and desicated lower hanging foliage. Foliage on trees above the sections with weed cloth (where no propane was applied but received sulfur) did not show leaf damage. No leaf damage was found on any Nonpareil foliage.

A significant amount of precipatation fell this season, 3.5 inches during bloom and 0.20 inch during leaf emergence. However, no significant blossom or foliage diseases resulted, except a minor amount of leaf rust late in the sesson throughout trial. We expect the disease pressure to increase substantially in future years.

SDI irrigation during harvest

Trial Planting Design
75% Nonpareil/25% Fritz

F		N		N		N
	N		N		F	
N		F		N		N
	N		N		N	

Standard 3rd leaf **Organic**

propane weed control

Table 1. Production Costs per Acre – 4th leaf.

Field Practice	Standard	$	Organic/Trans	$
NUTRITION				
-nitrogen	UAN 140 lbs N/ac	70	sodium nitrate 50lb.N/ac	100
			Phytamin 4-2-2@44 lb N/ac	400
-boron spray	Solubor @2.5lbs/ac	25		
potassium	70 lbs K2O/ac KNO3 @ 20 lbs	115		
-zinc spray	Zinc sulfate 10lb/ac	25		
-compost			5 tons/acre	125
WEED CONTROL				
herbicides	Glyphosate + Goal 3 x @ $15	45		
	Pre-emerge Matrix	45		
-propane			90 gal @ $3.50	300
			10 flamings @ .75 hr	120
-hoeing	weedeater		8 times @ 0.5hrs @ $12	48
-mowing	5 times@ $6	30	5 times @ $6	30
INSECTS				
- dormant			5 gal veg oil + 10 lb cu Nordox	25 + 35
-mites	Agrimek @12 oz	80		
-PTB	Dimilin @ 12 oz	45	Entrust @ 2.5 oz	50
-**NOW**	Asana @ 9 oz	30		
DISEASE				
-blossom	Rovrol @ 16 oz + oil	45	Wettable sulfur @ 10 lbs	22
-leaf	Pristine @ 12 oz	60	Wettable Sulfur @10 lbs	22
			Actinovate @ 12oz + ThermX @ 3oz	70
TOTAL COSTS	Includes applic costs	**$615**	Includes application costs	**$1,347**

Table 2.

System	Yield lbs/Ac	Kernels/oz	Trunk circ.cm
Standard	1,195	23	41.5
Transitional	1,217	24	40.7
Organic	841	23	39.2
Org & weed cloth	963	23	40.0

Leaf Analysis

	N %	P %	K %	Ca %	Mg %	S ppm	B ppm	Zn ppm	Mn ppm	Fe ppm	Cu ppm
STANDARD	2.79	0.14	2.45	4.00	0.95	2085	42	100*	91	298	7.4
TRANS	2.78	0.14	1.95	4.19	1.06	1970	39	18	115	265	16.2
ORGANIC	2.52	0.14	2.02	4.39	1.06	1860	41	15	98	277	16.4

II. Minimum Pruning Systems for Almonds

John Edstrom, Bill Krueger and Stan Cutter

Objectives:

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.

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.
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 production between Pruned and Unpruned trees. Nonpareil out-produced all other varieties in this 13th leaf orchard but fell short of last season's record (**Table 1**). Average yields across all varieties for 2009 and cumulative production figures for all varieties (yrs. 3-13) also show no yield reduction in the unpruned trees (**Table 2**). Kernel size continues to be equal for all pruning treatments, 22/oz. for this season. Although the Unpruned and Mechanically Topped trees appear to be losing more lower fruitwood each year, the total yields remain the same as the Standard pruned trees. Possibly the upper canopy has compensated for the loss of lower fruitwood as was seen in the prior Unpruned trial conducted at Nickels in the 1980-1990s. 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, shaker injury or any other disease. Soil moisture probe readings show that the micro-sprinkler irrigation system maintained deep soil moisture close to harvest and met Etc requirements. Despite ample water the only summer leaf disease found has been leaf rust seen sporadically throughout the plot since 2006. July leaf samples show nitrogen levels at 2.8% N while leaf potassium levels were 2.4%. This site does not experience stagnant humid air conditions during the summer and thus far, no Alternaria 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. To date, this test has produced yields comparable to the highest in the Arbuckle area; however, the relevance of these trial results to other growing regions is unknown. Similar tests in central and southern San Joaquin Valley with vigorous orchards have supported these findings. The validation of the minimum pruning concept will require a few more years to assess the peak productivity period during the typical life span of an almond orchard.

Past results have shown that 1) Minimally pruned trees and temporary scaffold trees out yield standard trees in the early years, 2) Temporary limb training is expensive and probably uneconomical, 3) Production between all treatments leveled out at the 6th year, 4) Cumulative cost savings of $ 700-1000 per acre to the 13th year are possible with minimum pruning methods, 5) Aldrich growth habit is incompatible with the temporary limb method, 6) Some minimal amount of secondary and inside branch removal may be beneficial under minimum pruning, 7) It appears that Nonpareil is most compatible with minimum pruning followed by Monterey, Aldrich and Carmel in decreasing order of compatibility, 8) No increase in disease or sticktights was found for minimum pruning, and 9) Tree height appears shorter with minimum pruning.

The central questions concerning minimum pruning are; 1) the number of primary limbs to select, 2) the necessity of heading primaries, 3) the feasibility of retaining multiple scaffolds, 4) the need for limb tying, 5) the shading of fruitwood and eventual yield decline, and 6) the range of varieties, growing conditions/vigor and tree spacings amenable to minimum pruning.

Table 1. Pruning Test Yields (Kernel lbs/acre)

	Aldrich		**Carmel**		**Monterey**		**Nonpareil**	
	cumul	***2009***	*cumul*	***2009***	*cumul*	***2009***	*cumul*	***2009***
Standard	22,863	**2,015**	21,423	**2,402**	21,117	**2,239**	23,130	**3,276**
Temp Scaffold	---	**---**	20,584	**1,830**	21,572	**2,059**	23,665	**3,436**
Mech hedged	22,900	**2,311**	22,124	**2,314**	20,650	**1,925**	22,725	**3,142**
Minimum/ Unpruned	21,032	**1,983**	18,398	**1,831**	24,980	**2,465**	24,568	**3,504**

No statistical difference between treatments

Table 2.

	AVERAGE YIELDS ALL VARIETIES 2009	CUMULATIVE (YEARS 3-12)
Standard	2,483	22,133
Temp Scaffold	2,441	21,940
Mech Hedged	2,423	22,099
Minimum/Unpruned	2,445 ns	22,244 ns