Final Report to the Almond Board – June 2005

Project Title: **Nickels Soil Lab Projects 04-JE-01**
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1. Pruning Trials for High Density Orchards

John Edstrom, Bill Krueger & Dr. Bruce Lampinen

The objective of this trial is to evaluate tree training/pruning methods for maximum early production while maintaining long-term yields in tightly spaced almonds.

In the spring of 1997 almonds on Lovell peach rootstock were planted on Marine Ave. at the Nickel's Soils Lab. The trees were spaced 16' X 22' with a north south row orientation. The soil was slipped plowed prior to planting and the trees are irrigated 2X per week with microsprinklers to meet Etc. The soil series is Arbuckle, a sandy loam with a clay layer at 25 to 60 inches. Ample amounts of nitrogen, potassium and zinc are applied monthly to maintain high leaf mineral levels. The orchard design is 1:1 with Nonpareil rows alternating with pollinator rows of Monterey, Carmel and Aldrich. Four different training systems as described below began in the first dormant season. There are four replicates of Nonpareil, three of Monterey, two of Aldrich, and two of Carmel. Beginning in the fourth leaf, yield data has been collected, summarized and, where adequate replication allowed (Nonpareil), analyzed for statistical differences.

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.

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 scheduled for gradual removal during years 5-8 after producing some crop or sooner if they threaten primaries.

Results

Overall tree vigor has been very good in this planting but not at the highest levels seen in other areas of the state. Our class II soil conditions provide a realistic evaluation of the unpruned method under local conditions where shoot vigor produces 24 inch shoots while supporting 2000 pound crops. Tree canopies have nearly closed in now after seven years, forming a dense orchard canopy, so we could expect maximum cropping in the next few years. Nonpareil production this season was about equal between all four treatments and ranged from 1761 pounds per acre for the mechanically topped treatment to approximately 2041 pounds per acre for the unpruned, standard and temporary scaffold treatments (table 1). Carmel and Aldrich yields were within this range also, while Monterey production was the highest at 2237 for the unpruned trees despite significant worm damage. These yields are substantially less than last season, which was typical for the entire district.

Table 1.

	Aldrich		Carmel		Monterey		Nonpareil	
	2004	*Accum.*	*2004*	*Accum.*	*2004*	*Accum.*	*2004*	*Accum.*
Standard	**2,003**	10,123	**1,950**	8,985	**1,834**	9,247	**1,923**	8,808
Temporary Scaffold	-	-	**2,043**	9,738	**1,845**	9,455	**1,948**	9,202
Mech Hedged	**1,657**	9,556	**2,038**	9,905	**2,103**	9,041	**1,761**	9,109
Unpruned	**1,908**	10,084	**1,981**	8,066	**2,237**	11,343	**2,041**	9,671

Accum. 4-8th leaf.

Discussion

Temporary limb concept

This particular multiple scaffold method is probably not worth the extra effort. The only yield advantage came during the 4th leaf. During the 5th & 6th harvests, production was equal to the standard pruned trees. Seventh leaf production (after the remaining temporary scaffolds were cutoff) was below the standard and unpruned trees. However, this year, yields recovered to equal the other treatments, possibly indicating that permanent limbs have now replaced fruiting wood lost during temp limb removal. We will now watch to see if these trees will outproduce the unpruned trees given the more sunlit open center canopy.

The pruning effort required to establish temporary limbs, that don't overly stunt permanent ones, is quite difficult. Aldrich growth habit was incompatible with this method and was discontinued in the 3rd winter. An alternative method of starting with 5-6 scaffolds and maintaining them until they crowd may be preferable to our temp method. However, we chose to avoid over crowded crotches (and the breakage) by positioning limbs low on the trunk for early removal. Our overall minimum pruning strategy was to develop strong crotches and rely on unthinned secondaries to produce extra fruitwood instead of maintaining extra primaries.

Some "temporary" limbs will be maintained "permanently" on Monterey, as all scaffolds developed uniform on some trees despite our extra training efforts. We will then be able to track the sustainability of 5-6 scaffolds on Monterey trees. Multiple scaffold trees planted here on a 16' x 22' spacing maybe less prone to breakage compared to the larger trees that develope on wider spacings.

Unpruned

This method continues to demonstrate commercial potential. Nearly all unpruned trees look acceptable or very good. 'Nonpareil' and 'Aldrich' did appear too dense in the upper canopy with more shading below, but the crops produced since 2002 opened the centers naturally. Of some concern is the loss of lower/interior fruitwood on unpruned 'Aldrich'. Some 'Monterey' trees are misshapen and have "mushroomed" open, but the Nonpareils and Carmels look good. Monterey continues to produce the highest yields as unpruned trees, which is surprising given its more willowy growth habit. Some thinning cuts could be made to open the trees and reduce shading. However, any cuts will likely cause sucker growth and set up the demand for even more pruning. Most unpruned trees grow more evenly without overly vigorous limbs and appear to allow enough light penetration to promote cropping. These trees are also somewhat shorter which helps promote light penetration and facilitates most orchard operations There has been no problem with crop removal at harvest despite the dense fruitwood, as the trees grow this may become a problem. Decreased light penetration over time and its impact on production is our main concern. Note, the accumulated yield for 'Carmel' appears low due to an unusually poor season (2003) for the unpruned trees. This may be an anomaly, during all other seasons the Carmel unpruned trees produced well.

Mechanically Topped

All varieties in this treatment are shorter in height than in the other methods and appear thicker and more crowded in the middle and upper canopy. Aldrich benefited some from topping with better branching forming a wider canopy, but appears too dense in the center with a noticeable loss of interior fruitwood. In general, excessive shoot growth resulted from the dormant topping in 1998. Too much was removed during that operation resulting in very vigorous growth the following spring. This dense upright growth of 3 to 8 feet was cut in half during the May 2000 topping. This resulted in cutting into some prior year's wood, de-invigorating the trees and reducing tree height. As expected, regrowth of top shoots after spring topping was only moderate. Since the forth season this treatment has received no pruning. Monterey and Nonpareil tree structure appears most negatively affected by topping. Apparently, heavy topping should be avoided or done very carefully during canopy development.

Standard

These trees are the tallest of all treatments and also exhibit a standard, "open vase" canopy. However, pruning in this treatment in the past would best be described as "minimum", as not enough wood was removed in the early years to qualify as standard pruning. This may have inflated accumulative yield figures. During the past two dormant seasons, trees in this treatment were pruned more heavily, removing more crowded and crossing limbs. This heavier pruning was reflected in reduced production compared to the unpruned and mechanically topped treatments last year. This season production is equal to the other treatments. Primary and secondary scaffold development is good, producing well balanced trees. Greater tree height resulting from standard pruning may become troublesome over time.

Summary

The "no pruning" treatment continues to look promising. After selecting three primary scaffolds, trees left unpruned for 7 years are as productive, or more, than pruned trees. To date, accumulated yields for this treatment are the highest. The trees appear well balanced with acceptable tree architecture, which should be capable of long-term high production. The impact of shading over time remains a question as well as maintaining vigor in later years. The accumulated reduction in pruning costs ($600/acre) represents a significant savings to the grower. Trees settle down more naturally, so far, without shading lower fruitwood (except Aldrich). Consistent cropping has also moderated growth. Now, after 8 seasons, many Nonpareil trees look dense, but very good and most are acceptable. Varieties like, Monterey, Carmel and Aldrich may require different methods. But this "unpruned" method continues to perform remarkably well, both in terms of production and tree framework.

The "temporary" system looks questionable. Yields don't appear to justify the extra pruning efforts. Long-term yields could reveal mature tree yield gains to this idea when compared to the possible declining yields of the "unpruned" mature trees.

2. Comparison of Microirrigation Systems for Almonds

John Edstrom, Dr. Larry Schwankl, and Stan Cutter

A 22-acre field demonstration began in 1990 to evaluate the three major types of microirrigation: Drip, Subsurface Drip (SDI) and Microsprinklers. This trial uses 36 one-half acre plots to simulate commercial conditions on four almond varieties, 'Nonpareil', 'Butte', 'Carmel' and 'Monterey'. The systems under study are:

1. Surface Drip - single hose	4 - 1 gph Netafim PC emitters/tree
2. Surface Drip - double hose	8 - 0.5 gph Bowsmith emitters/tree 4 ft. from rows
3. Microsprinkler	1 - 10 gph Bowsmith Fanjet between trees
4. Microsprinkler double	2 - 5 gph Bowsmith Fanjets around trees
5. Microsprinkler double1.2 ET	2 - 7.5 gph Bowsmith Fanjets around trees
6. Subsurface Drip - double hose	8 - 0.5 gph Geoflow emitters/tree, 4 ft. from rows
7. Surface Drip double hose150% Et	8 - 1 gph Netafim PC emitters at 4 ft.
8. Subsurface Drip double New	8 - 0.5 gph PC Geoflow emitters at 4 ft

Subsurface drip treatments were established the first year with surface hoses and early in the 2nd year converted to SDI with the tubing installed at a depth of 15 inches. Previously, Netafim Ram tubing was evaluated as SDI but became extensively plugged by almond root intrusion. All of these lines were replaced in the spring of 2000 with pressure compensating Geoflow trifluralin impregnated SDI placed at a depth of 8-10 inches directly above the abandoned Netafim hoses. This treatment is # 8 - New Geoflow double. All drip systems irrigate 5-6 times per week while micros are run 2 times per week. About 35 inches of irrigation water was applied to the 1.0 Etc treatments between March 10th and October 10th. Winter rainfall (Oct-April) was above average at 20 inches.

Results

Production was down somewhat this year with an average of 1935 pounds per acre for all plots compared to 2232 pounds per acre for 2003. Damage from navel orangeworm was high for Monterey this year reducing yields by at least 10% alone. All irrigation systems produced nearly equal yields this year except for the Double Microjet 1.2 Etc trees. Applying 120% of Etc via microjets improved yields this year over all other treatments for 'Butte' and 'Carmel'. However, this has not been a consistent result over the years, nor has it been consistent with all varieties. In contrast, when "excess" water (1.5 Etc) was applied via drip, no yield increase resulted. High irrigation rates saturated tree roots in shallow soil and in swales. When these site conditions of a restricting clay layer at 24-60 inches are combined with the limited wetted area of drip, roots can't access the additional water. Roots have better access to this moisture if applied over the larger surface area wetted by microjets which also reduces soil saturation. But, when equal amounts of irrigation water (1.0 Etc) are applied using drip, SDI or micros, no consistent yield differences have been found in the 14 years of this test. Further, no yield advantage has been found for double micros (1.0 Etc) verses single micros. Previously, soil moisture uptake measurements indicated that an advantage might be obtained from surrounding the tree canopy with wetted soil (Micro Double) verses a circular wetted area midway between trees (Micros). However, improved frost protection may be obtained by applying water directly beneath canopies verses between trees.

Evaluation of sub surface drip systems (SDI) suggests that the original deep placement of hoses at 15 inches maybe inferior to SDI installed at 8 inches (Shallow verses Deep Geoflow). This might be explained by the shallow soil at this site (24"-48"). However, the new SDI emitters are pressure compensating, the old ones are not, so a fair comparison isn't possible. Root intrusion has not been a problem with the triflurilin herbicide product (Geoflow) as was found in the standard SDI emitters (Netafim). Overall, after 14 years in the field, the yields and performance from SDI in almonds continues to be promising.

Table 2.

System	YIELDS - Lbs/Acre Variety: Nonpareil	Butte	Carmel	Monterey	Average
Drip	1,972	2,012	1,367	1,559	1,728
Drip Double	2,017	2,112	1,418	1,675	1,806
Micros	1,844	2,067	1,504	1,473	1,722
Micros Double	1,917	2,154	1,563	1,545	1,795
Micros Double 1.2 ET	2,157	2,541	1,983	1,714	2,099
Drip Double 150% ET	2,011	2,149	1,491	1,770	1,855
SDI Double:					
Shallow New Geoflow	1,944	1,958	1,355	1,491	1,687
Deep Original Geoflow	2,004	2,145	1,388	1,603	1,785

3. Deep Tillage Slip Plow Effects on Almonds

John Edstrom & Stan Cutter

This field trial is evaluating the effects of slip plow soil modification on three varieties of almonds, 'Nonpareil', 'Carmel' and 'Aldrich' planted in 1997 on 'Lovell' peach or Brights peach/almond hybrid rootstock. Prior to planting, replicated areas of this 20 ac block received a commercial slip plow operation on a 10 foot grid to a depth of 6 feet in a north/ south direction and a diagonal pass (SE-NW), the locally recommended practice. Soil conditions at this site consist of a Class II (Arbuckle series) a sandy loam topsoil to a depth of 30-60 inches which is underlain by a dense clay layer. Soil beneath this layer is similar to the topsoil, a gravelly/sandy loam . These three layers were mixed in channels by the slip plow operation.

The planting receives biweekly irrigations via dual microsprinklers, applying 36-40 inches per season. Fertilizer materials for nitrogen and potassium are injected monthly to maintain high leaf mineral levels. Foliar sprays of zinc and boron are also applied annually.

Tree size in slip-plowed and unplowed areas was determined by measuring trunk diameters 12-16 inches above ground level in addition to gathering yield and kernel size data.

Results

Tree size measurements taken this season show no difference in trunk size between trees in the two areas. Comparable measurements of tree size have been consistent now for 7 years. Yield data for 2004 also show no difference between the slip and non-slipped areas in production. Yields averaged 1860 lbs/acre in both treatments for 'Nonpareil'. Yields for this orchard and the surrounding district were abnormally low this season following exceptional production in 2003. Kernel sizes were also equivalent at 1.16 gms/kernel or 24/oz. Root excavation work done this year in back hoe pits revealed that root systems on trees in slip plowed areas grew deeper than in non-slip areas. The proportion of roots in deeper soil was minimal, however. The deeper rooting may become significant over time, but so far, no benefit has been measured.

Table 3. Slip Plow Almond Yields – 2004

lbs/acre

	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Mean
Slip Plow	1613	1625	1928	2162	2017	**1869**
No SP	1487	1376	2275	2115	2076	**1865**
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