Almond Board Report

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1) Pruning Trials for High Density Orchards

John Edstrom and Bill Krueger

Almond tree training and pruning practices haven't changed much for decades. Traditional concepts stressed careful selection of primary and secondary branches to develop a strong evenly spaced framework capable of supporting heavy crops. Large trees developed during the 30-40 year life span especially at wide spacings. Yearly pruning was needed on old trees to increase light into the tall canopies, stimulate growth and replace unproductive fruitwood. Considerable time, equipment and expense are required to complete this type of pruning operation.

Today, however, tree densities have increased to 100+ trees/ac, twice what they used to be and many new orchards are planted on weaker ground. Both trends result in smaller sized trees, which don't need to support such heavy weight (crop) per tree to be productive per acre. Scaffold number, position, orientation, or strength become less critical without large expansive canopies. Younger trees, typical of more tightly spaced orchards are inherently more vigorous so yearly pruning is not as critical to maintain vigor.

Shorter statured trees naturally allow more light to penetrate deeper into the canopy promoting fruit bud formation without much pruning to "open up the centers". Big cuts may not be necessary. Improvements in water management using microirrigation bring orchards into production fast (and impart vigor to older trees). Good yields are obtained in the 4th year compared to year 6 to 8 as in the past.

Many growers don't expect today's almond orchards to last longer than 20 years. Blocks will be replaced at a younger age simply to exploit new superior technology. These factors should all be considered when devising a profitable training/pruning strategy for today's high density orchards.

The **objective** of this field trial is to evaluate various tree training/pruning methods, which promote maximum early production while maintaining long-term orchard yield in tightly spaced almonds.

Four training systems were selected using 4 replicates of 33 trees on Nonpareil, Carmel, Monterey and Aldrich, microsprinkler irrigated and planted at 16'x22', 124 trees/acre:

1) **Standard Method** - Three primary limbs selected at 1st dormant pruning, secondaries selected 2nd dormant, centers kept open, limb tying/staking as necessary. Yearly traditional, moderate pruning.

2) **Unpruned** - Three Primary limbs selected at 1st dormant pruning then no additional pruning unless needed for equipment or wind damage, etc. Minimal staking as necessary.

3) **Mechanically Topped** - Same as unpruned, but, adding machine topping to remove half of prior seasons top shoot growth beginning at 2nd dormant with selective dormant thinning and topping in spring, if needed.

4) **Temporary Scaffolds** - Train limbs at 1st dormant to favor 3 permanent primary scaffolds, but also retain many other temporary branches below these on the trunk, removing only those which compete 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 quite good in this planting. This should allow a strong test for the unpruned and other methods under strong growing conditions. The north end of the planting is more vigorous than the south, providing two distinct conditions to evaluate these training methods. In the previous evaluation of the unpruned method, weak growing conditions complicated drawing meaningful conclusions.

Yield results (Table 1) show good production from all methods in this 4th leaf block. The Unpruned and Temporary methods outproduced the Standard pruned trees, while the Mechanically topped trees yielded the least. Standard pruned trees tended to be the tallest with the topped trees the shortest. (Table 2) Trunk circumference measurements showed no difference between treatments (Table 3).

Table 1.

YIELDS - LBS./ACRE

Trial	**Aldrich**	**Carmel**	**Monterey**	**Nonpareil**	**Sonora**	***Mean**
Standard	1,143	1,108	1,617	934 bc	1,133	1,185
Temporary Scaffold	-	1,587	1,690	1,122 a	1,330	1,406
Mechanically Hedged	959	1,397	1,252	838 c	895	1,060
Unpruned	1,256	1,253	1,900	1,077 ab	1,459	1,374
Mean	1,119	1,336	1,615	992	1,204	

* = Weighted Mean (considers reduced number of pollenizer trees) $P = 0.10$

Table 2.

TRUNK CIRCUMFERENCE (cm.)

	Rep 1	Rep 2	Rep 3	Rep 4	Total	Average
Nonpareil:						
Standard	34.9	42.5	38.8	44.6	160.8	NS 40.2
Temporary Scaffold	34.2	43.9	46.1	40.2	164.5	41.1
Mechanically Hedged	31.8	41.5	43.9	40.5	157.6	39.4
Unpruned	36.3	39.8	39.8	40.6	156.4	39.1

Table 3.

TREE HEIGHTS (Ft.)

Pruning System	Carmel	Monterey	Nonpareil	Sonora	Aldrich	*Mean
Standard	12.2	13.6	14.6	15.1	15.9	NS 14.2
Temporary Scaffold	13.0	12.3	14.3	13.5	-	13.4
Mechanically Topped	12.6	12.0	14.0	12.3	15.1	13.3
Unpruned	12.1	12.9	14.2	14.6	15.8	13.8
Mean	12.4	12.7	14.3	13.9	15.6	

* = Weighted Mean (considers reduced number of pollenizer trees)

Specific observations on each training method are as follows:

Temporary limb concept

This method looks promising but some of the temporary lower limbs are competing too severely with the upper permanent ones. Often these permanent scaffolds appear smaller and more spindly, compared to those on standard pruned trees. Secondary limbs also bend more and lose their upright orientation in this treatment. Nonpareil and Monterey are affected the most, while Carmel and Sonora appear to be OK. Some temporary limbs will be maintained permanently especially with Monterey as many limbs on this variety appear of equal vigor and show even developement between all primary scaffolds. However, those that are too low on the trunk are being gradually removed to facilatate shaking. Careful training of competitive branches is critical to this method but properly training work crews is difficult. Again this winter, extra effort was was made to favor the permanent primary and secondary scaffolds. Removal of strongly competing lower limbs and the vertical shoots arising from them was continued. The Aldrich variety proved too troublesome with the lower scaffold idea and this variety was eliminated from this treatment.

Unpruned Method

This method appears to have commercial potential. Within the weaker soil area, nearly all unpruned trees look acceptable. Nonpareil and Aldrich in the vigorous area appear a bit too dense in the upper canopy with more shading below but, crop load is now opening these up. Some Monterey trees appear misshapen and unbalanced but the Sonoras and Carmels look fine. Removal of twisted and rubbing limbs may be desirable. However, any cuts will likely cause sucker growth and set upthe demand for even more pruning. Trees receiving no pruning cuts 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. There was no problem with crop removal at harvest despite the dense fruitwood. As the trees enlarge this may become a problem.

Mechanically Topped

All varieties in this treatment are shorter in height than in the other methods. Aldrich benefited the most from topping with better branching forming a wider canopy. But on most varieties, excessive shoot growth resulted from the dormant topping in 1999. This dense upright growth of 3 to 8 feet was cut 1/2 during the May 2000 topping. Cutting into last year's wood deinvigorated these trees and reduced tree height. Yield loss from this unusually harsh topping was significant, some 300 lbs/ac. Regrowth of top shoots after spring topping was moderate. Future spring topping will be set to remove mainly current shoot growth and promote the desired fruitwood density in the mid canopy. The decision was made during dormant pruning 2001 not to hand prune this treatment to thin out the dense wood .

Standard Pruning

These trees are the tallest of all treatments and also exhibit the most open canopy. Primary scaffold development is good while many secondary limbs are bending out of position exaggerating the open center, especially on Nons. Maybe too many secondary limbs were left last winter. There appears to be less lower "hanger" fruitwood in this treatment. Sonoras look quite good. Dormant pruning was increased somewhat this winter on standard trees to achieve more commercial level of pruning.

Summary

At this stage of the test the better choiceis the <u>Unpruned Method</u>, where 3 primaries were selected and left unpruned since the first winter. With a few cuts to remove badly angled,twisted, and interfering branches, this system seems to be workable. The Unpruned system which was successful in the old test at Nickels for 20 years on weak soil is working here so far under much more vigorous conditions. Including another system in the test which maintained 6-8 scaffolds permanently would have been instructive,although similar grower attempts have been troublesome in the long run.

The Temporary system also shows some promise. In hindsight, we should have tied the permanent scaffolds to help maintain their dominance and avoided so much extra training of temp limbs. Yields in the next few years schould tell if theis system is economical given the expensive trsaining involved.

2. Comparison of Microirrigation Systems for Almonds

John Edstrom and Dr. Larry Schwankl

A 22 acre field demonstration site was established in 1990 to evaluate the performance of the main types of microirrigation systems: Drip, Subsurface Drip (SDI) and Microsprinklers. This site was designed for replicated evaluation of the systems while also of sufficient size for a practical field demonstration.

Four almond varieties, Nonpareil, Butte, Carmel and Monterey, are being grown with each of the following irrigation systems:

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

Subsurface drip treatments were established the first year with surface drip systems and early in the 2nd year converted to subsurface drip with the drip 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 areas were retrofitted, 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.

Results

Data for 2000 (Table1) show only a minor yield increase for micros over drip and SDI. Nonpareils produced about 200 lbs. more with micros. This advantage is similar to historical averages as seen in Table 2. However, this conclusion is complicated by the fact that the micro plots in some seasons, during some high water use periods, received more water than the drip plots. (30 inches drip versus 33 inches micro in 2000) Despite a major effort to maintain equal water rates, accomplishing timely mowing and spraying operations invariably resulted in under irrigating. Catch-up schedules favored the higher output micros resulting in more water applied to micro trees. Last season extraordinary efforts kept water equal between systems but at the cost of stressing many plots. Part of the difficulty is due to the experimental design. Our test block has micros and drip plots down the same tree rows. This causes delays in drip irrigation scheduling while middles dry down for mowing, etc. This problem clearly indicates one advantage to applying water twice per week via micros versus nearly every day or two with drip i.e. more time for cultural operations without stressing trees.

Table 1.

YIELDS - Lbs/Acre

System	Variety: Nonpareil	Butte	Carmel	Monterey	Average
Drip	1,779 cd	1,907	1,919	2,244	1,962
Drip Double	1,915 bc	1,970	1,989	2,289	2,041
Micros	2,048 b	2,329	2,114	2,499	2,247
Micros Double	1,970 bc	2,302	2,041	2,336	2,162
Micros Double 1.2	2,367 a	2,826	2,375	2,412	2,495
Drip Double 200%	1,989 bc	1,931	1,859	2,428	2,052
Subsurface Drip:					
New Geoflow Double	1,600 d	1,741	1,898	2,098	1,834
Geoflow Double	1,824 bc	1,927	2,019	2,089	1,965

P = 0.05
Fishers Protected LSD

What yield advantage micros have over drip is dependant upon the availability of more water. At equal water application amounts drip and micros have yielded the same in this test. Where micro trees received 120% of Et (treatment #5) they outproduced all other comparisons as was found last year. Given more water, microsprinklers can outperform drip systems. Our problem here is that applying more water to the restricted rootzone of drip plots causes soil saturation problems (treatment #7), while increased irrigation to micros spreads water over a much larger area avoiding saturation. Micros have the potential to outyield drip but only if more water is applied. In some areas of this test where soil limitations prevent extra water application to drip plots both systems produce equally. Careful understanding of site specific conditions are required when evaluating any irrigation system.

Table 2.

Historical Yields

YIELDS - Lbs./Acre*

System	1994	1995	1996	1997	1998	1999	2,000	Total	Average
Drip	1,050	928	2,139	2,102	2,303	2,471	1,962	12,955	1,851
Micros	1,537	939	2,404	2,208	2,470	2,310	2,247	14,115	2,016
SDI	1,234	864	2,025	1,955	2,167	2,289	1,965	12,499	1,786

*Average of all four varieties

Geoflow SDI plots continue to yield the same as surface drip and show no signs of root intrusion after 10 years in the field. The original Geoflow SDI emitters installed were not pressure compensating so resulted in poorer uniformity. The New Geoflow SDI product is PC. Trees switched to the New Geoflow this spring from plugged SDI hoses have already responded in both appearance and yield. This indicates how responsive almonds are to sufficient irrigation and how soon yield can begin to repay costs of irrigation improvements.

3. Almond/Marianna 2624 Performance

John Edstrom and Stan Cutter

Marianna plum 2624 rootstock is the most useful rootstock for Oak Root Fungus sites and has become increasingly important in the expansion of almonds onto heavier soils.

Mission, Ruby and Padre cultivars have shown excellent compatibility with M2624. Inconsistent field performance of Butte on M2624 has been common, yet Butte is the most desirable M2624 "compatible" variety. Evaluating the commercial potential of M2624 plantings however, requires closer spacings than typically used in almonds, resulting in more trees and higher investment expenses.

A test planting was established to check the productivity of four almond cultivars in a close planted hedgerow on M2624 rootstock. Butte trees were obtained as certified virus free (scion and root) to remove the virus interaction. Commercially harvestable replications were designed into the test for yield data collection. Butte, Mission, Ruby and Padre almonds were planted March, 1989, as single N/S rows at 10' x 20' spacings for 218 trees/acre.

Results

Yield and kernel size data for 2000 are presented in the following tables.

Kernel - Lbs./Acre

	Rep					
Plot	**1**	**2**	**3**	**4**	**Total**	**Mean**
Padre	2,871	2,840	2,610	2,576	10,897	A 2,724
Butte	1,703	1,941	1,880	1,689	7,212	B 1,803
Mission	2,407	2,004	2,109	2,148	8,669	B 2,167
Ruby	2,834	2,469	2,311	2,258	9,872	A 2,468

Weight - gms/Kernel

Plot	Rep 1	Rep 2	Rep 3	Rep 4	Total	Mean	
Padre	1.054	1.000	0.998	1.010	4.062	A	1.016
Butte	1.033	0.970	1.036	0.998	4.036	A	1.009
Mission	1.118	1.066	1.086	1.056	4.326	A	1.082
Ruby	1.260	1.196	1.218	1.232	4.906	B	1.227

Yields show a productive almond planting can be maintained using M2624 root. Three of the varieties Ruby, Padre and Mission produced respectable yields this year. Only Butte production was sub par. Yields in much of the district for Butte were lower this year, so the mediocre production of Butte here on M2624 this year probably isn't significant.

Noteworthy is the fact that the soil at this test location is quite shallow due to a restricting clay layer at 24-36 inches. Shoot growth has been weak in recent years especially during heavy sets. Attempts have been made to invigorate this block. Three years ago, a second drip line was added to one of the reps. This change has not resulted in any measurable difference in production. Last winter a mechanical topper (rotary saws) was used to prune one side of alternate rows to stimulate top and side shoot growth. An angled hedging cut was made on the shoulder of the canopy, positioned 2 feet from tree top center and angled 30 degrees down into the row middles. One side of all Ruby and Butte rows were cut this past winter. Next year all Padre and Mission rows will be cut. Thus, four years will be needed to complete this hedging plan.

In response to the pruning, Ruby trees produced 2-5 shoots at each saw cut, which grew 24-36 inches in length during the season. Buttes grew 3-6 shoots at each cut, which grew 24-48 inches. The mechanical pruning appears to be invigorating the Buttes and Rubys, which have been the least vigorous of the four varieties. This is particularly instructive for Ruby given its' heavy crop load this year and for Butte given the questionable compatibility on M2624.

Kernels are of high quality in all varieties with Rubys showing the larger size while all others were of similar size. The shrivel problem experienced last season with Butte was not found this year.