1990 FINAL REPORT FOR
CALIFORNIA ALMOND BOARD

Project No. 90-S2 - Improving Almond Pruning Decisions

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Objectives: The objective of this project is to develop information to answer pruning questions with factual information. Six trials seek to provide answers to the following questions: (1) What is the best method for training temporary trees in double-planted orchards and how are those trees best removed when they crowd? (Connell) (2) What is the best method for training and pruning a high density hedgerow orchard? (Edstrom) (3) What is the best way to prune, to invigorate low vigor varieties? (Freeman, Hendricks, Beede) (4) What is the impact of alternate year pruning versus annual pruning? (Krueger) (5) Is mechanical hedging and/or topping a viable alternative? (Viveros)

Interpretive Summary: Trials designed to answer the proceeding five questions are outlined in order in the following summary. Some observations are preliminary, others report progress following a decade of work.

1. IMPROVING ALMOND PRUNING DECISIONS (Connell, Micke, Yeager)

Currently, this trial is evaluating temporary tree removal through three pruning treatments: 1) gradual removal with thinning cuts, 2) quicker removal with larger chain saw cuts, and 3) effects of keeping "temporary" trees indefinitely or possibly removing them later all at once.

Pre-treatment yields were taken in 1988. In winter 1988-89 temporary trees were lightly cut back to allow permanent trees to fill in. Pruning treatments in winter 1989-90 were applied more severe. Heavier thinning on temporary trees was done on treatment 1 and whisking back with chain saws was done on primary scaffolds of temporary trees in treatment 2. Both permanent and temporary trees in treatment 3 were thinned to remove crowded limbs in the upper canopy. Trunk circumference measurements are taken to evaluate effects of pruning on tree growth.

Treatment yields for the past three years ar shown in the following table. Yields are numerically lower as the severity of pruning increases. This was particularly evident in 1989 yields. Although the same relationship was present in 1990, even numerical differences were minimal.

In all cases, differences between treatments were not statistically significant.

'Butte' Almonds
Average meat per pounds per tree*

Treatment	1988 Pretreatment	1989 After Thinning	1990 After substantial Pruning
1. Gradual Thinning	18.8	13.8	21.9
2. Chain Saw Cuts	19.4	12.5	21.7
3. Keeping Temporaries	19.0	15.1	22.5

*Data is from treatments blocked according to 1987 pre-treatment yields.

In this experiment, failure to detect statistically significant differences between treatments is actually a desirable result. It means that the tree removal program is progressing at the appropriate rate. Permanent trees are expanding to fill the space as temporary trees are removed. 1990 yields reflect this as they are virtually the same even though there were substantial differences in the amount of pruning between the treatments.

Plans for 1990-91 are to continue the tree removal program in the orchard and to make growth and yield observations.

2. **TRAINING AND PRUNING HEDGEROW ALMONDS** (John Edstrom, Warren Micke, Jim Yeager)

Our purpose was to develop methods to train Nonpareil almonds into a hedgerow configuration and develop pruning systems capable of sustaining high yields.

Interpretive Summary

Production economics have pressed growers to increase the bearing in newly developed orchards. High density plantings can proportionately increase early yields given the increased trees planted per acre. Hedgerow systems where tree spacing is less within the row than between rows has allowed heavy early production with use of existing equipment.

Concern over the viability of almond hedgerow systems arises as the trees crowd. Limited sunlight entry into the canopy can affect fruit bud formation and may confine production to the top of the canopy. Yields may then begin to decline resulting in a hedgerow orchard with less production capacity or one with higher cultural costs than that of a standard planting.

Hedgerow research in other tree crops has shown the value of various tree training and pruning practices on maximizing early production without sacrificing mature yields.

In 1979, a Nonpareil-Price almond block, at a 1:1 ratio, was planted 7' x 22' (170 trees/acre) at the Nickels Soil Laboratory in Arbuckle, California. The following four pruning treatments were begun at the end of the first growing season.

1. **Interplanted:** Trees were trained to three scaffolds then standard pruned second through sixth years. Alternate trees were marked for removal and whisked back during seventh and eighth years to allow room for permanent trees to spread. Whisked trees removed after ninth year leaving a 14' x 22' spacing.

2. **Permanent Hedge:** Trees trained to three scaffolds and standard pruned throughout, maintaining 7' x 22' hedge.

3. **Two Scaffold Hedge:** Heavy second and third year training required to form two main scaffolds growing into the row middles. Standard pruning used fourth year on with hedge maintained.

4. **Unpruned Hedge:** Trees trained to three scaffolds then no further pruning.

Every other tree in the Interplanted hedge was whisked back two years before removal and then again one year prior to removal. This heavy pruning resulted in a 15% reduction in yield each year following whisking. After the ninth year in the orchard (1986) these alternate trees were removed reducing the yield by 30%. Today, four years after removal, yield still lags behind by 20%.

When adding together seven years of yield data, no differences were found between the three permanent hedgerow systems. However, the fourth treatment where alternate trees were removed yielded 2,600 lbs. less over the seven-year period (See Table 1).

Yields obtained for two scaffold trees were equal to yields from three scaffolds at these close spacings. This trial will be maintained to evaluate the long term effect on yields of the four training systems.

Table 1.

Hedgerow Almonds
Nonpareil - Price 1:1
1984-1990

Treatment	Accum. Yield Lbs./Acre
Interplanted	11,499
Permanent Hedge	14,746
Two Scaffold Hedge	14,673
Unpruned Hedge	13,979

1990 Yield Pounds Per Acre

Treatment	Yield Lbs./Acre
Two Scaffold Hedge	3,470
Permanent Hedge	3,334
Unpruned Hedge	3,072
Interplanted	2,631

Average Per Acre Yields 1984-1990

Treatment	Avg. Yield Lbs./Acre
Two Scaffold Hedge	2608 A
Permanent Hedge	2524 A
Unpruned Hedge	2511 A
Interplanted	1927 B

3. **BEST WAYS TO PRUNE FOR INVIGORATING LOW VIGOR TREES** (Warren Micke, Mark Freeman, Lonnie Hendricks, Robert Beede and James Yeager).

Some newer precocious varieties (such as Merced, Carmel, and Harvey) produce little new vegetative growth by the time they reach full maturity. When using the conventional pruning technique of thinning out several one to three inch diameter limbs each year, these varieties are not usually invigorated. Also it is often hard to find limbs to thin out when pruning such trees.

A plot was established during the winter of 1986-87 using 11-year-old Harvey trees that were making little or no new growth. The four pruning treatments used were 1) cutting back the entire tree to approximately six feet (dehorning), 2) moderately head back all the terminal branches on one scaffold generally 1/3 of the tree each year for a three year cycle (heading-1/3), 3) normal thinning out (control), and 4) approximately 20 small heading cuts - 1/2 to 1 inch cuts - made per tree (heading). These treatments were also randomized over three rootstocks, Nemaguard, Almond, and Lovell.

In 1987 dehorning drastically reduced production while the two heading treatments reduced yield moderately as compared to the control. However, tree vigor was improved by both heading treatments (heading-1/3 mainly increased vigor on the headed scaffold); and as expected dehorned trees responded with very [illegible] growth. In 1988 the control still had the highest yield. As compared to the control [illegible] reduced on the heading treatment by about 5%, the heading-1/3 treatment by appro[illegible] 15% and on he dehorning treatment by nearly 50%. By 1989 the heading and dehorning [illegible]ments out yielded the control by 15% and 8% respectively though these differences were not statistically significant. However, the control significantly out produced the heading-1/3 treatment by 23%. Plans are to again take production data from this plot in 1990.

In 1990, no statistical differences were noted between treatments except on almond rootstock (Table I, II, III). In that case, the "1/3 heading" yield was higher than all other treatments in contrast to 1989. We plan to obtain production data one year more.

Table I. Effect of Pruning Treatments (Nemaguard Rootstock)

	Treatment	Yield/Tree (Kernel Lbs.)	Significant Difference (Duncan Test)*
1.	DeHorn	21.848	A
2.	Head 1/3 Tree	18.889	A
3.	Thin Out	21.266	A
4.	Head	20.825	A

Table II. Effect of Pruning Treatments (Lovall Rootstock)

	Treatment	Yield/Tree (Kernel Lbs.)	Significant Difference (Duncan Test)*
1.	DeHorn	16.374	A
2.	Head 1/3 Tree	17.997	A
3.	Thin Out	16.376	A
4.	Head	17.240	A

Table III. Effect of Pruning Treatments (Almond Rootstock)

	Treatment	Yield/Tree (Kernel Lbs.)	Significant Difference (Duncan Test)*
1.	DeHorn	15.490	A
2.	Head 1/3 Tree	12.802	A
3.	Thin Out	18.278	A
4.	Head	19.624	A

*Treatments with same letter - no significant difference.

4. **ALTERNATE YEAR PRUNING OF ALMONDS** (William Krueger, Warren Micke, James Yeager, and Joe Connell)

Objectives

Annual pruning is a recommended procedure for mature almonds. Growers who prune every other year or even once every three years have been observed with no apparent deleterious effects to tree vigor or production. Alternate year pruning has been shown to be an acceptable practice with lateral bearing walnuts. This study was undertaken to compare the impact of alternate year pruning to that of annual pruning on mature almond production and kernel quality.

Procedure

A mature uniform 20 acre block of almonds planted in 1978 located in Hamilton City was selected for the trial. The planting is a 1:1 planting with 50% Nonpareil, 25% Price and 25% Peerless and 70 trees per acre. Only Nonpareil was used for the pruning treatments. The ten acres of Nonpareil were divided into a randomized complete block with four treatments and five replications. Yield data was collected one year prior to assigning the treatments to make sure that there were no significant differences due to block location. The treatments were initiated during the winter of 1987-88 and indicated: 1) annual pruning, 2) pruning in even numbered years, 3) pruning in odd numbered years, and 4) unpruned (starting in 1987). Pruning has been the same for all the pruned treatment and consisted of four, approximately 1.5 inch or larger cuts per tree or the equivalent. Average pruning weights have been collected following each pruning and have averaged between 37 and 53 pounds per tree.

Results and Discussion

After three years there have been no significant differences in yield or kernel size. However, in 1990 for the first time, yield for the unpruned trees fell below that of all other treatments. The highest yields were recorded for the alternate year pruned trees which were not pruned prior to

the 1990 crop followed by the annual pruned treatment and then the alternate year pruned trees which were pruned prior to the 1990 crop. Accumulated yields show no significant differences in yield between any of the treatments.

A number of the trees in the plot have been and are being lost to Ceratocystis or aerial phytophthora. These sick and dying trees may have a confounding effect on the results of this trial. We will continue as long as it seems worthwhile.

When yields for the non-pruned trees become significantly less than the other treatments, we will discontinue this treatment and allow those trees to be pruned. We plan to continue this study for at least one more year.

5. MECHANICAL PRUNING OF ALMONDS

Justification and Objectives

Almond growers have been experimenting with mechanical pruning of almonds for many years. However, no quantitative information has been developed from this technique. The basic questions still remain:

1. Can mechanical pruning replace traditional hand pruning techniques?
2. How are yields affected by mechanical pruning?
3. What is the impact of mechanical pruning on winter sanitation?

To answer these questions, a test plot was established in a mature almond orchard (13 years old) in 1987.

Materials and Methods

The test plot consisted of four treatments. The first three were done mechanically using a hedging machine and the fourth was done by hand. The three mechanical treatments were:

1. Perpendicular hedging
2. Angle hedging
3. Hedged and topped

The fourth treatment was pruned by hand and this became our control.

Both mechanical and hand pruning were done in 1987. The mechanically pruned treatments were hand pruned in 1989. It was done to remove limbs growing through the center of the tree. The hand pruned treatment was also pruned in 1989 to remove crossing over limbs, limbs with death fruiting spurs and limbs growing in the center of the tree.

Results

The test plot has been harvested for three years to determine the impact of mechanical pruning on yields. The results are the following:

Treatment	Yield-Meat Pounds/Acre 1988	1989	1990	Total
Control	2875	2300	2683	7858
Hedging	1840	2482	2727	7049
Angle Hedging	1590	2386	2671	6647
Hedged and Topped	945	2848	2277	6170

In 1988, the yields decrease proportionately to the amount of wood removed by the pruning. The heavier the pruning the more the yield is reduced. This is illustrated by the hedged and topped treatment where 1930 meat pounds were lost due to the severity of pruning. In 1989, there were no major significant differences among the treatments, with the exception of Hedged and Topped. This treatment significantly showed an increase in yields; however, it was not big enough to cover the 1988 yield loss. In 1990, there were no major differences among Control, Hedging and Angle Hedging. The differences are not larger than 60 pounds/acre among them. The treatment, Hedged and Topped, decreased its yield by 600 meat pounds/acre from the 1989 yields and it was the lowest yielding treatment in 1990.

Mummy counts were made in 1989 to assess the impact of these pruning treatments on winter sanitation. The results are in the following table:

Treatment	Average Mummies Per Tree
Control	120
Hedging	81
Angle Hedging	145
Hedged and Topped	69

Discussion

Three years of data show that the yields of the hand pruning treatment are superior to any of the mechanical pruning treatments. In fact, after three years, the mechanically pruned trees have not recuperated the lost yields. The total accumulated yields (meat pounds/acre) for the Control was 7,858 lbs., for the Hedging 7,049 lbs., for Angle Hedging 6,647 lbs., and for Hedged and Topped 6,170 lbs.

The only area where mechanical pruning is making an impact is on mummy counts in the winter time. Hedging and Hedged and Topped treatments gave the least number of mummies. This plot will be continued during 1990-91.