

Almond Board of California
Annual Report
December 1992

Project No.: 92-BF1 - Almond Culture and Orchard Management

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Objectives: The project supports several small projects conducted by almond Farm Advisors including: 1) Determine if low boron is causing the lack of crop and a general "bull" look in Padre. 2) Evaluation of alternative methods of potassium application. 3) Compare almond tree growth, production, and hull rot under three drip irrigation management systems in Yolo/Solano Counties. 4) Compare almond irrigation management systems in Colusa County. 5) Continue research on sustainable agriculture in Merced County. 6) In Kern County determine the impact of almond trunk damage on yield, kernel size, hull split and worm damage. 7) Variety sensitivities to herbicides. 8) Improve water penetration using surface tillage. 9) Leafhopper damage to almonds.

Procedures, Results and Discussion:

SEE ATTACHED

Almond Board funded project in Stanislaus County

Wesley K. Asai
Pomology Farm Advisor
Stanislaus County

Project Title: Boron Nutrition Effects on Productivity of The Padre Variety of Almond

Problem and Objective: In this project, a mature bearing 'Padre' orchard had consistently been yielding poorly, and had exhibited symptoms similar to the "Bull" problem in Mission. Symptoms included blind wood, large dark green foliage, few nuts that had rough looking hulls, and premature leaf yellowing and defoliation from the lower interior portion of the tree. The boron leaf levels in this orchard was very low (19 ppm). "Bull Padre" had not been previously reported in the literature or by observations from Dale Kester.

Joe Connell reported seeing a similar problem with the 'Butte' variety which was corrected by applications of boron. We attempted to correct the 'Padre' problem with foliar and soil applications of boron.

Results and Discussion: After fall and spring foliar and soil applications of boron (Solubor) there was a significant increase in percent flower set between the treatments versus the untreated checks (Ck = 2.62; soil = 5.32; foliar = 4.53), although all of the sets were low by comparison to typical percent sets for almonds.

At harvest, yield measurements showed the same trend as did the percent set (Ck = 2632 lbs/A; soil = 2735 lbs/A; foliar = 2838 lbs/A) however due to the variability in the plot, this was not a statistically significant difference.

It appears that boron nutrition is related to the "Bull" symptoms we are seeing in the 'Padre' variety, but results from this data are still somewhat inconclusive and require additional data.

Evaluation of Alternative Methods of Potassium Application

Joseph Connell, U.C. Farm Advisor in Butte County

Cooperators: R. Meyer, R. Nottelmann, K. Uriu, W. Micke.

Background: Potassium deficiency is a common problem in northern California almond orchards. The recommendation for correction of this problem has traditionally been a mass dose application of potassium sulfate (2000 lbs/acre) once every four years placed in a band on each side of every tree row. Since this is costly, growers would prefer to spread out the expense of correcting this deficiency while maintaining potassium at adequate levels.

Methods: A field trial was established in March 1986 using a randomized complete block design with eight, 5 tree replicates. I compared an annual every other middle potassium band application at a rate of 12.5 pounds of potassium sulfate per tree space with a standard mass dose application of two 12.5 pound bands per tree in each row applied once every four years. Leaf analysis was used to examine leaf potassium levels on the side of the trees close to the treated middle compared to levels on the side away from the treated band in the middle treatment. Leaf potassium levels of the every other middle potassium treatment were compared to levels found in trees receiving the standard treatment. Movement of potassium into the soil profile below the treatments was quantified in 1991 with soil analysis. A second plot including an untreated check was started in 1989.

Results: After five years, field work in the initial plot is complete. The percent leaf potassium remained as high in the every other middle treatment as it did following a standard mass dose potassium application. Interestingly, leaf analysis of the west side of trees in both treatments was always numerically higher in percent potassium than was leaf analysis from the east side. Statistical analysis of leaf potassium levels has shown no significant differences between the standard mass dose potassium application and the every other middle treatment (Table 1, Figure 1).

Soil analysis used to measure potassium in the profile from two sites below the standard mass dose and the every other middle potassium treatment is complete. In the standard plots, soil potassium levels were elevated in the top 36 inches of the soil profile in a narrow zone (Figure 2). The every other middle treatment that received four annual applications of potassium at the same rate per band as the standard mass dose had higher potassium levels in the soil profile in a broader zone. Potassium levels were elevated in the top 18 inches of the soil profile (Figure 3).

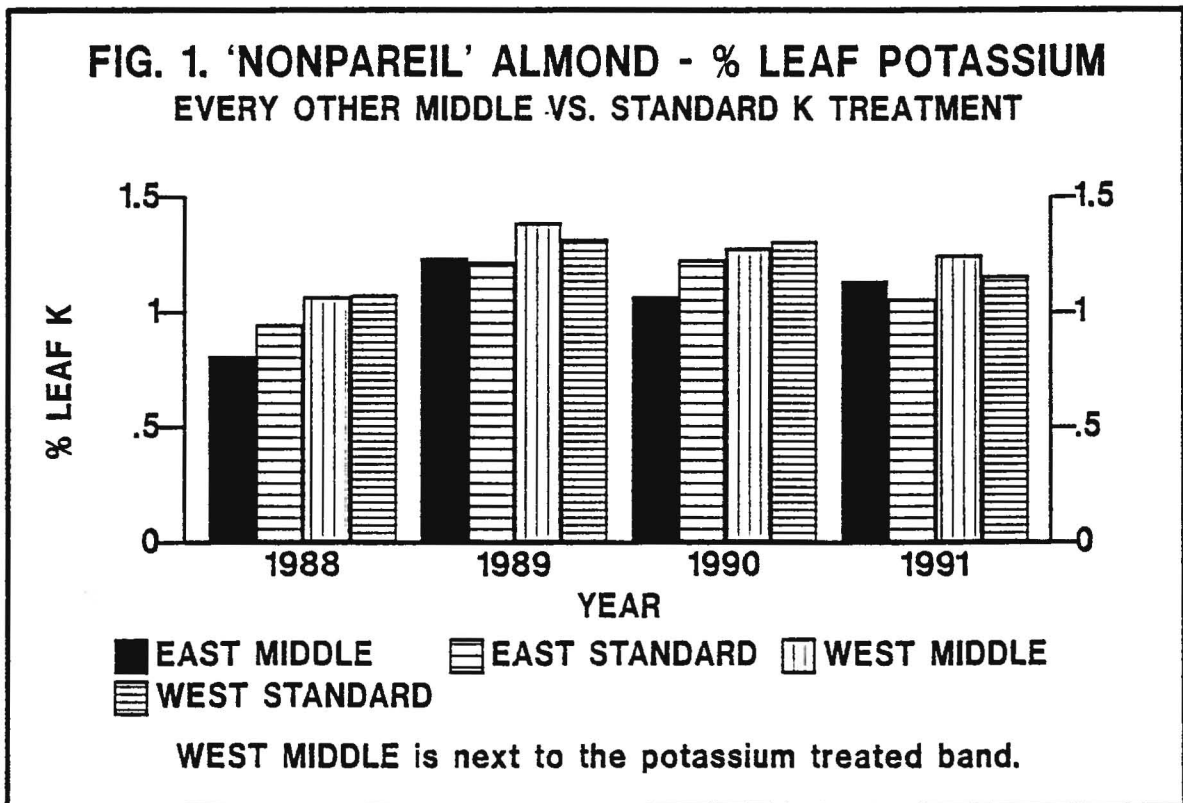
In a second trial, begun in 1989, leaf potassium levels have not shown statistically significant differences between the every other

middle treatment and an untreated check (Table 2). I intend to try and confirm the results obtained in the first trial. Additional soil sampling and analysis will be done to further document the movement of potassium into the profile under each treatment.

Conclusions: Results of the first trial suggest that applying potassium sulfate annually in every other orchard middle can maintain potassium leaf levels as well as the standard mass dose once every four years. The advantage is that the cost to maintain potassium levels can be incorporated into an annual budget and a large capital outlay once every four years can be avoided.

We believe that if annual potassium applications are substituted for a mass dose it's important that the annual band be placed in the same location every year. In this way, each annual application adds to previous applications and there is less need to overwhelm the soils ability to fix potassium.

The location of the potassium treated band is not critical. This study looked at a band in every other middle as a means of reducing application costs as well as spreading out material costs. A band in every middle, or the standard two bands per tree row should also maintain potassium levels if lower rates are used annually as long as each annual band application is made in the same place.



**TABLE 1. 'NONPAREIL' ALMOND - % LEAF POTASSIUM
EVERY OTHER MIDDLE VS. STANDARD K TREATMENT**

	1988	1989	1990	1991
EAST MIDDLE	.81	1.24	1.07	1.14
EAST STANDARD	.95	1.22	1.23	1.06
WEST MIDDLE	1.07	1.39	1.28	1.25
WEST STANDARD	1.08	1.32	1.31	1.16

WEST MIDDLE is next to the potassium treated band.

**TABLE 2. 'NONPAREIL' ALMOND - % LEAF POTASSIUM
EVERY OTHER MIDDLE K TREATMENT VS. CHECK**

	1990	1991	1992
EVERY OTHER MIDDLE SOUTH	1.26	1.25	1.25
CHECK SOUTH	1.25	1.30	1.21
EVERY OTHER MIDDLE NORTH	1.22	1.13	1.17
CHECK NORTH	1.33	1.43	1.21

EVERY OTHER MIDDLE NORTH is next to treated band.

FIGURE 2. PROFILE OF STANDARD PLOT 21 - PPM POTASSIUM

ESTIMATED BAND CENTER

		C-----18"-----+-----18"-----+				
		A	B	C	D	E
	1	256	366	271	225	216
	2	205	578	213	206	215
	3	173	660	200	182	220
DEPTH &	4	155	485	183	169	149
SAMPLE						
LOCATION	5	123	242	265	100	133
	6	85	103	110	81	80
	7	74	47	59	69	56

FIGURE 3. PROFILE OF MIDDLES PLOT 33 - PPM POTASSIUM

ESTIMATED BAND CENTER

		C-----18"-----+-----18"-----+				
		A	B	C	D	E
	1	182	207	1335	506	241
	2	183	208	982	211	203
	3	150	168	317	374	174
DEPTH &	4	165	183	159	182	177
SAMPLE						
LOCATION	5	133	126	130	123	158
	6	132	116	122	116	126
	7	129	105	131	107	89

COMPARISON OF ALMOND TREE GROWTH, PRODUCTION AND HULL ROT UNDER VARIOUS DRIP IRRIGATION MANAGEMENT

Wilbur Reil, Yolo/Solano Farm Advisor

Objectives

Farmers continue to strive to improve irrigation efficiency because of both the increasing cost of water and power and the continued drought where only limited amounts of water might be available. Drip irrigation is increasingly becoming popular. Most drip systems use single hoses with 4 to 6 point sources for water emission. This limited wetted area could possibly limit growth and tree performance. Also, buried drip irrigation systems are now being suggested and limitedly used with perhaps even higher efficiency. This trial is designed to compare two types of drip irrigation systems (above ground and buried) in a 5-year old almond orchard. Hull rot has also become a problem in this same orchard so water management will also be evaluated during July-August.

Plans and Procedures

Three irrigation systems have been installed in a 5 year-old almond orchard on the Nonpareil rows (every other row). The systems are (1) above ground drip of a single hose designed to apply 100% ET until first hull split then be reduced to 50% ET until after harvest; (2) buried drip with a hose buried on each side of the tree 5 feet from the tree row and 12 inches deep to apply the same amount of water as treatment 1; and (3) an above ground drip to apply the same water as 1 and 2 until early hull split, then apply twice the water or 100% ET of the other two systems. Counts were made at harvest on the number of nuts remaining on trees after harvest and the number of dead shoots per tree killed by hull rot.

Results

Data for 1992 was primarily to get the system up and running and to obtain preliminary hull rot data. While treatment 1 and 2 are applying the same amount of water the buried drip system has no surface moisture and no evaporation, therefore, more of the water is available to the tree than in treatment 1 and it is estimated at approximately 60 to 65% ET rather than 50%.

Evaluation of Nonpareil Almonds Under Three Irrigation Management Systems

The same quantity of water was applied to trees until June 29 (early hull split) when different rates were then applied. Hull rot and mummy nuts per tree were counted August 14. Five trees were chosen at random in each of the three treatments for counting.

	<u>Drip Irrigation System</u>		
	<u>Surface</u>	<u>Buried</u>	<u>Surface</u>
Estimated water applied as % ET			
April - June 28	100	100	100
June 29 - August	50	60-65	100
Nuts per tree remaining after shaking	282	205	683
Shoots per tree killed by hull rot	0	1.8	12.2

Conclusion

These data suggest reduced moisture in the tree throughout the hull split period may reduce the incidence of hull rot and improve nut removal at harvest. When comparing the buried drip to the above ground drip system a slight though not significant increase of hull rot occurred in the buried drip compared to the above ground drip at the reduced water whereas both treatments were superior to the 100 ET treatment. Even though the soil surface was completely dry under the trees irrigated with buried drip the increase in hull rot suggests that humidity may not affect hull rot, whereas, the moisture status within the tree itself may be the cause. Trees under adequate or luxurious moisture status such as the 100% ET during hull split had a much higher amount of hull rot. While the soil surface was wet around individual drippers in this system it was run only the same length of time as the other two systems with twice the number of emitters. The surface was wet approximately the same length of time as the 50% ET treatment.

The much higher number of nuts left on the tree after shaking in the system receiving 100% ET throughout hull split also suggests that nut abscission may be enhanced by some stress during the maturation process. Some moisture is needed to stimulate hull split but perhaps intermediate or approximately 50% ET may provide sufficient moisture for proper hull split while enhancing nut removal. Additional monitoring is planned for 1993.

COMPARISON OF LOW VOLUME IRRIGATION SYSTEMS FOR ALMONDS

(John Edstrom, Larry Schwankl)

Water use efficiency in California orchards has become a critical issue. Reduced supplies resulting from the drought and the politics of water distribution are forcing agriculture to better utilize this resource. Adoption of low volume irrigation systems can result in considerable water savings. Low volume systems exhibit the highest use efficiency ratings of all irrigation systems by applying water uniformly and allowing precise control over the timing and amounts applied. The three primary types of low volume systems are: surface drip, subsurface drip, and micro-sprinklers. However, little research-based information is available to compare these systems for almonds.

A 22 acre field plot was established in 1990 to evaluate the merits of these systems for almonds. This large plot will allow simulation of commercial production conditions and allow practical field demonstration for growers. Various tree growth, yield and quality parameters will be measured, in addition to system evaluations for water use, emission uniformities, maintenance and operational characteristics.

Four almond varieties, Nonpareil, Butte, Carmel and Monterey, are being grown with one of four irrigation schemes:

- 1) *surface drip* - single hose
- 2) *microjet* - one per tree
- 3) *subsurface drip* - single hose 2' from trunk
- 4) *subsurface drip* - double hose 4', each side of trunk

Subsurface plots were established the 1st year with surface drip hoses. Early the 2nd growing season, subsurface hoses were installed to a depth of 15".

Progress: After three years of operation, only minor differences in tree response are apparent between the three systems, with a slight increase in tree size resulting from the micro-sprinkler treatment. No problems have yet emerged with the Subsurface Drip system. However, during the transition phase between Surface Drip and Subsurface Drip, the plot trees (supplied with water via buried hoses 4' from the trunk) stopped growing mid-season. Growth resumed and sustained the following year (3rd), comparable to other treatments.

Sustainable Almond Production Practices. Lonnie Hendricks, U.C. Farm Advisor in Merced County.

PROCEDURES:

A comparison of orchard management practices including covercropping and insecticide spraying has continued for five years. The project began with two orchards, GA which has never been sprayed and RA which was sprayed conventionally until 1990. The project was expanded in 1989 to include the TT orchard which was heavily sprayed until 1991 when covercropping began and only Bt sprays were used thereafter. In 1991 two more orchards were included. PC was converted to organic in 1991, and HB has not been sprayed for many years.

RESULTS:

Total reject levels due to worms have remained low in the unsprayed, certified organic orchard (GA) after long-term vetch covercropping and sanitation. In the RA orchard the native cover has been well managed by alternate mowing, and insecticide spraying has been eliminated since 1990. This orchard maintains a low worm reject level. The TT orchard has reduced rejects with better winter sanitation, but the covercrop has done poorly due to residues of herbicide used pre-harvest. The PC certified organic orchard has converted from sprayed, clean floor to unsprayed, vetch cover with *Goniozus* releases for NOW control. The rejects are acceptable, but higher than desirable during the first two years of conversion. The HB orchard has not been sprayed for many years, and is not winter cleaned. *Goniozus* was introduced here many years ago. Rejects continue in a moderate range each year.

Mummy nut numbers were much higher in the RA orchard in 1992 as compared to 1991, but reject levels were only slightly higher in 1992. This indicates that a good supply of beneficials are resident in this orchard. *Goniozus* was recovered from the nuts in the PC, GA, and HB orchards, with high levels in HB. Scale levels were monitored in all orchards. No scale increases are being seen in these orchards.

CONCLUSIONS:

- 1) Winter sanitation is extremely important in conventionally sprayed orchards, but much less so, or not at all important in unsprayed orchards with established *Goniozus* and ample beneficials in a well managed orchard floor covercrop.
- 2) Well managed covercrops promote large populations of general beneficials and greatly aid pest control.
- 3) The unsprayed, covercropped orchards have not had mite or scale problems requiring treatment. General feeders and specific predators and parasites have held these pests to non-economic levels.
- 4) Orchards converting away from spraying conventional pesticides usually can control worms by using Bt sprays, growing covercrops, releasing *Goniozus* wasps, and by winter sanitation and prompt harvest.

Table 1. Almond Kernel Damage Due To Worms.

REJECTS DUE TO WORMS					
ORCHARD/CULTURE	1988 TOTAL	1989 TOTAL	1990 TOTAL	1991 TOTAL	1992 TOTAL
GA:VETCH/NO SPRAY	2.8	1.1	0.4	0.2	1.8
RA:NATIVE/NO SPRAY	2.7 ^a	1.8 ^a	2.9	0.6	1.6
TT:NATIVE/Bt 91+92	-	9.5 ^b	6.5 ^b	0.4	4.3
PC:VETCH/Bt+Goniozus	-	-	-	3.9	3.9
HB:NATIVE/NO SPRAY		-	-	2.5	2.8
a: RA dormant spray 1988 and 1989 only. b: TT annual dormant plus hullsplit 1989 and 1990.					

Table 2. Mummy Nuts Per Tree At Bloom

<u>ORCHARD OPERATOR</u>	<u>DATE 1991</u>	<u>AVE NUTS/TREE (PER 50 TREES)</u>	<u>DATE 1992</u>	<u>NUTS/TREE (AVE 10 TREES)</u>
GA	2/19	22.8	2/21	2.8
RA	2/19	8.0	2/21	77.2
TT	2/19	7.4	2/21	4.6
PC	2/21	1.4	2/21	1.5
HB	2/12	236.0	2/21	26.6

EFFECT OF TREE TRUNK DAMAGE ON HULLSPLIT, KERNEL WEIGHT AND YIELDS

By

Mario Viveros

U.C. Cooperative Extension, Kern County

Situation: There is need to develop information on the effect of trunk damage on hullsplit, kernel weight and yields.

Method: Test plots were established to measure the effect of trunk damage on hullsplit, kernel weight and yields. One test plot was established in Arvin in 1991 and a second one in Shafter in 1992, with the following percentages of trunk damage:

	ARVIN 1991	SHAFTER 1992
1.	Control	Control
2.	5-25%	5-30%
3.	26-50%	31-61%
4.	51-70%	>61%
5.	>70%	

Results: The data from the 1991 test plot shows that there is no differences in kernel weight between control and 5-25%, 26-50%, and 51-70% trunk damage. However, there was significant lower kernel weight when the trunk damage was larger than 70%

Hullsplit appears to be more sensitive to trunk damage than kernel weight. Maximum hullsplit was a week earlier than the control on trees that had a 5-25% and 26-50% trunk damage. Trees that had a trunk damage of 51-70% and more than 70% showed a maximum hullsplit three weeks before the control. The earliest hullsplit showed on trees that had a damage more than 26%.

The data from the 1992 test plot shows similar patterns. Kernel weight doesn't decrease until trunk damage is more than 61%. In this test plot, hullsplit is more sensitive to trunk damage than kernel weight. Damaged trunk trees showed earlier hullsplit then the control. Maximum hullsplit occurred one week earlier on those trees that showed 5-30% trunk damage, two weeks earlier on those trees were damaged 31-60% and three weeks earlier on those trees that were damaged more than 61%.

We didn't take yield data from these test plots because of the many conflicts with other experiments.

Conclusion: Kernel weight is not as sensitive as hullsplit; to have a reduction in kernel weight, the tree trunk must be damaged more than 61%. On-the-other-hand, hullsplit is very sensitive to trunk damage. Hullsplit will advance one week with a 5-25% trunk damage. This can be important in the timing of a hullsplit spray. If an orchard has too much trunk damage, it will be almost impossible to time a hullsplit spray for NOW control.

IMPROVING WATER PENETRATION USING SURFACE TILLAGE

R. P. BUCHNER¹ AND W. F. RICHARDSON²

Abstract

Surface tillage using an angular tine shatter aerator to improve water penetration was evaluated on two orchard soils in Tehama County during the 1992 growing season. Preliminary results, after one year of research, show a very slight, although not statistically different, improvement in the depth of water penetration in treated plots. Treatments improved the depth of wetting 0.4 to 1.7 inches.

After one year of evaluation shatter tine aeration did not result in a commercially advantageous improvement in the depth of soil wetting. Additional work is required to verify these preliminary results.

Introduction

Reduced soil water intake can be caused by several factors, however, orchard floor soil compaction and surface sealing, due to orchard traffic are major contributors to poor water intake. Surface tillage to break compaction in a potential way to improve water penetration.

Methods

Two distinctly different Tehama County orchards were selected. Orchard 1 was a sprinkler irrigated mature almond orchard growing in a Columbia silt loam. Orchard 2 was a surface irrigated mature walnut orchard growing in a Zamora silt loam. Both orchards had a history of water penetration problems. Experiments were conducted in 1992 to compare surface tillage using an angular tine shatter aerator to the standard orchard practice of non-tillage. The two treatments were replicated four times, in both orchards, using a randomized complete block design. Within several days following irrigation, depth of water penetration was evaluated using a soil sample tube. Ten representative locations were sampled throughout each plot. Depth of water penetration for each plot is reported as the average of 10 sample locations.

Results

Preliminary results, after one year of research, show a very slight, although not statistically different, improvement in the depth of wetting where soils were treated with the angular tine shatter aerator (Table 1.).

¹ Pomology Farm Advisor, Tehama County

² Soil and Water Farm Advisor, Tehama County

Table 1. Depth of water penetration (inches) following irrigation in cultivated versus non-cultivated soil treatments. Each number is an average of 10 samples.

Date	ORCHARD 1			ORCHARD 2		
	<u>Cultivated</u>	<u>Control</u>	<u>Difference</u>	<u>Cultivated</u>	<u>Control</u>	<u>Difference</u>
7/1	12.6a*	11.9a	+0.7			
7/15	8.1a	6.7a	+1.4			
7/20				8.8a	7.1a	+1.7
7/28	6.8a	6.0a	+0.8			
8/7				9.5a	8.3a	+1.2
8/20				8.1a	7.7a	+0.4
9/28				10.5a	10.1a	+0.4

*Numbers followed by the same letter are not significantly different at the 5% level using Duncan's mean separation.

Shatter tine tillage improved the depth of wetting 0.4 to 1.7 inches.

Conclusions

After one year of evaluation, shatter tine aeration did not produce a commercially advantageous improvement in the depth of soil wetting. Additional work is required to verify results.