Almond Culture and Orchard Management

Project No.: 06-HORT1-Connell

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Interpretive Summary:

Farm advisors conduct numerous projects addressing local issues in their counties. This project supports county farm advisors general extension research programs related to almond production. Each advisor participating in this project highlights research results from local projects in their county they feel address an important question worthy of reporting to growers at the annual almond industry conference. The individual farm advisors' projects are presented as follows.

Increasing the Nonpareil Percentage: Effects of Pollenizer Arrangement and Number of Pollenizer Varieties on Yield

Project Leaders: Joe Connell
UCCE Farm Advisor, Butte County

Jim Floyd
CSUC, and CSU Chico University Farm

Interpretive Summary:

Years ago when orchards were planted 2:1 with Nonpareil: pollenizer varieties we observed that yields were lower between the two Nonpareil rows. This was overcome in the industry by going to 1:1 plantings but the percentage of Nonpareil was reduced to 50% of the orchard. At the Nickels Estate in Arbuckle, trial work has indicated that

alternating varieties down the row provides increased production compared to having the varieties in single rows.

Objectives:

This trial is designed to see if the Nonpareil percentage can be increased with judicious placement of pollenizers while maintaining the yield advantages of the 1:1 planting. In addition, the question of whether one pollenizer variety is sufficient or if two pollenizers provide better production is also evaluated in this trial.

Materials and Methods:

The orchard used for this evaluation was planted in March 2002 at the California State University Chico farm in Butte County at a tree spacing of approximately 18 x 21 feet resulting in 116 trees per acre. Varieties included are Nonpareil, Solano, and Sano (Figure 1). The 2005 season was the 4th leaf and we conducted the first harvest in the orchard last year. Yield data was collected to compare three treatments: the standard 1:1 planting with Nonpareil at 50%, Solano at 25%, and Sano at 25%; a planting with Nonpareil in every row and pollenizers arranged every two trees down the row with pollenizer trees offset between each row, Nonpareil at 66%, Solano at 17%, and Sano at 17%; and a similar treatment with Nonpareil at 66% and Solano at 34% to compare one vs. two pollenizers.

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 Row
    1   x x x x x x x x x x x x x x x x x x x x x x x x x x x
              Rep 1
   #2     S S S S S S S S S S S S S S S S S S S S S S S S S S
   #3   x x x x x x x x x x x x x x x x x x x x x x x x x x x
   #4   N N N N N N N N N N N N N N N N N N N N N N N N N N N
    5   x x x x x x x x x x x x x x x x x x x x x x x x x x x
    6   S x x S x x S x x S x x S x x S x x S x x S x x S x x
  ##7   x S x x S x x S x x S x x S x x S x x S x x S x x S x
    8   S x x S x x S x x S x x S x x S x x S x x S x x S x x
    9   x N x x N x x N x x N x x N x x N x x N x x N x x N x
 ##10   S x x S x x S x x S x x S x x S x x S x x S x x S x x
 ##11   x N x x N x x N x x N x x N x x N x x N x x N x x N x
   12   S x x S x x S x x S x x S x x S x x S x x S x x S x x
```

Figure 1. Schematic of replicate 1 showing the plot layout. Rows marked with the # sign are yield rows representing the three treatments.

X = Nonpareil
S = Solano
N = Sano

Rows in each replicate are 27 trees long and there are four replicates in the trial. 2006 is the orchard's 5th growing season.

Results and Discussion:

Results of the first year's yield in 2005 indicated that there were no significant differences between treatments in either the yield of the individual varieties or in the total yield per acre (reported last year). In 2006 the Sano variety experienced bacterial blast during bloom due to freezing weather and the required frost protection sprinkling. Nonpareil yield was significantly greater this year in the 2:1 planting with two varieties compared to the standard 1:1 planting with 3 varieties (table 1). Both the Solano and Sano varieties showed no significant yield differences between treatments this year.

Table 1. Mean yield for each variety & total mean yield per acre of all varieties in each treatment.

	Nonpareil lbs kernel/tree	Solano lbs kernel/tree	Sano lbs kernel/tree	Total Yield lbs/acre
Standard 1:1 Planting, 3 Varieties	8.2 a	5.1	5.9	797
2:1 Planting in Every Row, 3 Varieties	8.9 ab	4.8	6.3	902
2:1 Planting in Every Row, 2 Varieties	10.8 b	4.1		987
		ns	ns	ns

* values followed by different letters are significantly different at $P < 0.05$
** ns at bottom of column indicates no significant treatment effects at $P \leq 0.05$.

The total yield in the trial averaged 895 pounds of kernel per acre in the 5th leaf. This year Chico had frost at early bloom followed by 20 inches of rain from February through May. Total yield was not significantly different between the treatments in 2006. We intend to continue this project for several more years to see if significant differences between treatments or consistent trends occur in the future.

Field Testing Bloom-Applied Fungicides for Effects on Almond Nut Set and Yield

Project Leaders: Roger Duncan
UCCE Farm Advisor, Stanislaus County

Wes Asai
Pomology Consulting, Turlock

Nathaniel Battig
UCCE, Stanislaus County

Interpretive Summary:

Fungicide sprays are routinely applied to almond orchards during the blossom period to control bloom-time diseases, including brown rot, jacket rot, anthracnose, and shot hole. Depending on weather, one to three fungicide sprays are typically applied during this period in the Northern San Joaquin Valley. However, University of Georgia researchers have recently documented detrimental effects of some fungicides on almond pollen germination and tube growth in laboratory tests (HortScience, Vol. 38(6), October 2003). Of the ten fungicides tested, eight significantly reduced pollen germination and five reduced growth of pollen tubes when subjected to 1% of the recommended field rates *in-vitro*. Two commonly used fungicides reduced pollen germination by more than 99% under laboratory conditions. Although laboratory tests are important, these results need to be validated under field conditions. In addition, new fungicides have recently been registered for use on almonds in California and should also be screened for detrimental (or positive) effects on almond yield. If some fungicides are shown to affect

nut set and yield under field conditions, growers should consider this information when planning their bloom-time disease control program.

Materials & Methods:

Commercial formulations of ten fungicides registered for brown rot control in almonds were applied to Nonpareil almond trees using a hand gun sprayer (see Table 1 below). Pollinating varieties in the test orchard were Carmel and Aldrich. Materials were applied at 10-20% Nonpareil bloom (February 15) and 60-80% bloom (February 20) in a spray volume equivalent to 200 gallons per acre. Treatments also included unsprayed trees and trees sprayed only with water. Each treatment was replicated eight times with single tree replications.

The effect on percent nut set was determined for each treatment. Prior to fungicide applications, three limbs on each tree were flagged and all blossoms on the flagged limbs were counted. In mid-June, the number of nuts on the same flagged shoots was recorded and percent set was determined. At harvest, all nuts were collected from each tree and the field weight was determined. Subsamples of each treatment were collected to calculate shelled kernel yield and determine kernel quality parameters (kernel size, % doubles, % blanks, etc.). Yield and quality parameters could not be determined in time to be published in these proceedings but will be presented at the 2006 Almond Conference.

Results:

The effect of fungicide treatments on fruit set, percent blanks and yield are shown in Table 1 below. In unsprayed trees, 20.2% of the blossoms on tagged shoots set fruit. Percent fruit set in the fungicide-treated trees ranged from 18.0% - 21.3% and was not statistically different than the unsprayed trees ($P \leq 0.05$). There also were no differences in yield per tree or in percent blanks ($P \leq 0.05$).

Table 1. The Effect of Bloom-Applied Fungicides on Nonpareil Almond Nut Set and Yield.				
Fungicide Treatment	**Rate per Acre[1]**	**% Nut Set[2]**	**% Blanks[2]**	**Yield [2] (meat lb / tree)**
Untreated	--	20.2	3.9	17.2
Water only	200 gallons	20.7	5.3	13.9
Abound SC (Syngenta)	12.8 fl oz	18.6	5.8	14.9
Captan 80 WDG (Arvesta)	3.75 lb	19.0	5.3	15.5
Elevate 50 WDG (Arvesta)	1.2 lb	21.1	3.8	18.1
Flint 50 WG (Bayer)	3.0 oz	18.5	4.8	17.0
Laredo EW (Dow Agro)	12.8 fl oz	19.8	5.8	17.8
Pristine (BASF)	12.0 oz	19.0	5.0	18.5
Rovral 4F (Bayer)	1 pint	20.4	4.8	19.1
Scala 60 SC (Bayer)	12.8 oz	21.3	5.5	16.3
Topsin-M 70 WP (Ceraxi)	1 lb	18.7	5.3	18.2
Vangard WG (Syngenta)	5.0 oz	18.0	4.4	18.6

[1]All materials applied with a hand gun sprayer in equivalent of 200 gallons per acre.
[2]Differences in fruit set, percent blanks and yield are not statistically different among treatments ($P \leq 0.05$).

Results and Discussion:

Results from this field experiment indicate that none of the fungicides affected pollen tube germination or elongation enough to affect any measured yield parameter. Recent laboratory tests conducted by UC Davis Apiculture Extension Specialist Dr. Eric Mussen showed that pollen germination and tube elongation was affected by some fungicides on excised almond flowers, but only while stigmatal surfaces were damp. Once the stigmatal surfaces dried, pollen germinated and tube elongation through the styles appeared normal. Therefore, fungicide effects on almond flower fertilization in the field, if any, may occur for a very brief period during application and may be insignificant under field conditions, especially in years with a very long bloom period like 2006.

Yield Benefits of Machine Hedging Almonds in a Marianna 2624 Hedgerow

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Interpretive Summary:

Mechanical hedging was performed over a 4- year period to invigorate this Marianna 2624 hedgerow planting. Each of the 4 varieties responded well to hedging by producing strong new shoot growth averaging 24-36 inches. Yields tended to decrease slightly (about 200 lbs per acre) during some years after hedging. Overall production has not been affected by the hedging operation.

Objectives:

Evaluate the affects of a mechanical hedging program on the productivity of four almond varieties, Butte, Padre, Mission and Ruby planted in a hedgerow design.

Materials and Methods:

A test planting was established to check the productivity of a four variety hedgerow on M2624 rootstock. Butte, Mission, Ruby and Padre almonds were planted March, 1989, under drip irrigation, in single north/south rows at a 10' x 20' spacing for 218 trees/acre.

A mechanical hedging program was initiated in 1999 to stimulate growth and fill in the canopies between rows. Alternate sides of alternate rows were cut each winter. A rotary saw topper made an angled cut 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 the first time. The next winter one side of all Padre and Mission rows were cut. Four winters were required to complete the hedging plan on both sides of every row in 2002-03. Yield data will be collected yearly for hedged and unhedged plots for the 4 varieties.

Results and Discussion:

All varieties responded well to this operation. Of special interest were Ruby and Butte, the weakest trees in this test. 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. Invigoration of the Padre and Mission was somewhat greater.

Yields this year were reduced from average due to poor bloomtime weather. Yields for 2006 were: Butte 1,992 lbs/acre on hedged trees and 2,128 lbs/ac on unhedged; for Padre 1,986 lbs/ac hedged and 1,994 lbs/ac unhedged, Mission 2,020 lbs/ac hedged and 2,114lbs/ac unhedged and Ruby 2,190 lbs/acre hedged and 2073 lbs unhedged.

Tree canopies in the unhedged rows filled in the 20-foot row spacing in 2002. Hedging actually delayed the canopy extension by stimulating more up-right growth that required two years of cropping to bend and touch in the middles. The hedging program stimulated growth, which appeared to form more fruitwood. However, now, 4 years after hedging was completed, hedging has had no affect on yield.

Mechanical Hedged Yields*

	2000	2001	2002	2003	2004	2005	2006
Hedged	**2,283**	**2,366**	**809**	**2,808**	**2,175**	**2,504**	**2,047**
Unhedged	**2,314**	**2,468**	**866**	**3,000**	**2,182**	**2,467**	**2,077**

* Average yields of Padre,Butte,Mission & Ruby

Processed-Kaolin Particle film on almond

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Interpretive Summary:

Surround, white clay like processed-Kaolin particle film, can easily be dissolved into suspension and sprayed onto trees. Several research reports have been published in the Journal American Society Horticultural Science and HortTechnology describing how this reflective film can reduce heat stress, reduce solar injury, increase leaf carbon assimilation, and reduce canopy temperatures on a number of crops in several countries (1, 2, 3).

In 2001 processed-Kaolin particle film was applied to 15 year old Nonpareil, Sonora, and Carmel almond trees in a preliminary experiment. Three in-season applications of

Kaolin appeared to result in more return bloom, nut set, and yield on Carmel trees in 2002 when compared to non-sprayed Carmel trees (4). The Carmel trees in this orchard were showing symptoms of severe bud failure. The Sonora and Nonpareil varieties appeared unaffected by the Kaolin. Record hot temperatures were experienced in the San Joaquin Valley in May 2001 and above normal temperatures at this time have been shown to worsen the severity of bud-failure on Carmel.

Objectives:

From 2002-2006 four applications of Kaolin (25 lbs/100 gallons water) were made each season to Carmel and Nonpareil trees planted in January 2002 in order to examine if Kaolin could reduce heat stress and the onset of bud failure. We also examined the effect of Kaolin on tree water status (mid day leaf stem water potential), canopy temperatures, growth (tree circumference and current season shoot growth), and yield.

Materials and Methods:

An almond orchard in Madera with 16 Carmel and Nonpareil rows was divided into a replicated design where 8 rows of each variety received four Kaolin applications each year while the 8 other rows did not.

Results and Discussion:

From 2003-2006 mid-day leaf stem water potential (SWP) measurements were performed once a month from June-September. In 2003, June and July mid day leaf SWP were significantly less on Surround treated trees when compared to non-treated trees. In August and September there was no difference between Surround and non-treated trees (5). In 2004, mid day leaf SWP of Surround treated trees were significantly less when compared to non-treated trees in June, July, and August. By September there was no difference between Surround and non-treated trees (6). In 2005, mid day leaf SWP of Surround treated trees were significantly less in July and August (7). There was no difference in SWP between Surround and non-treated trees in June, most likely due to the relatively cool temperatures experienced in June 2005. In 2006, SWP of Surround treated trees were significantly less in June and early July. But by late July and August there were no differences between Surround and non-treated trees, most likely due to the record heat wave experienced in July (figure 1).

In 2003, 2004, and 2005 surround treated trees had significantly more current season shoot growth when compared to non-treated trees. In 2002 and 2006 there were no significant differences in trunk circumference between Surround treated and untreated trees (figure 2).

In 2005 and 2006 there was a significant increase in trunk circumference in the surround treated trees that was not observed in 2003 and 2004 (figure 3). In 2004 and 2005 we counted fruit on 60 trees that received Surround and 60 control trees that had not. In 2005 we found significantly more fruit on the Surround treated trees (7). In 2006, temperatures were not significantly different between Surround treated and untreated trees, probably because of the unusually hot temperatures recorded in July. In 2005 we did not observe any bud failure on the Carmel trees in either treatment (7). In 2006 we did observed bud failure in the Carmel variety but treatment differences were not significant. In 2005 and 2006 we observed less bud failure on the Surround treated Nonpareil trees, but differences were not significant (figure 4). We will again repeat applications of Kaolin in 2007 in order to investigate the effect of Surround on heat stress and bud failure in both Carmel and Nonpareil almond varieties.

Acknowledgement:

The project would not have been possible without the cooperation of George Andrews Farms in Madera, CA and the support of the Almond Board of California.

Recent Publications:

1) Glenn, D.M., Prado, E., Erez, A., Mc Ferson, J., and Puterka, G.J. 2002. A reflective, processed-Kaolin particle film affects fruit temperature, radiation reflection, and solar injury in apple. J. Amer. Soc. Hort. Sci. 127(2):188-193.
2) Glenn, D.M., Puterka, G.J., Drake, S.R., Unruh, T.R., Knight, A.L., Baherle, P., Prado, E., and Baugher, T.A. 2001. Particle film application influences apple leaf physiology, fruit yield, and fruit quality. J. Amer. Soc. Hort. Sci. 126(2):175-181.
3) Schupp, J.R., Fallahi, E., and Chun, I.J. 2002. Effect of particle film on fruit sunburn, maturity, and quality of "Fuji" and "Honeycrisp" Apples. HortTechnology 12(1):87-90.
4) Holtz, B.A. 2002. Bud failure or crazy top–the curse of the Carmel, the effect of Surround on Carmel return bloom, hull rot on almonds and field meeting, variety update. *The Pomology Post*, Vol. 37, May, 8 pages.
5) Holtz, B.A, and Hoffman, E.W. 2003. Processed-Kaolin particle film on almond, Almond Board of California, 31st Almond Industry Conference Proceedings 35-36.
6) Holtz, B.A, and Hoffman, E.W. 2004. Processed-Kaolin particle film on almond, Almond Board of California, 32nd Almond Industry Conference Proceedings 54-63
7) Holtz, B.A., and Hoffman, E.W. 2005. Processed Kaolin particle film on almond. Almond Board of California, 33rd Almond Industry Conference Proceedings, pages 83-86.

Figure 1. Paired columns with the same date with different letters were statistically different when compared in a Student's T-test (P # 0.05).

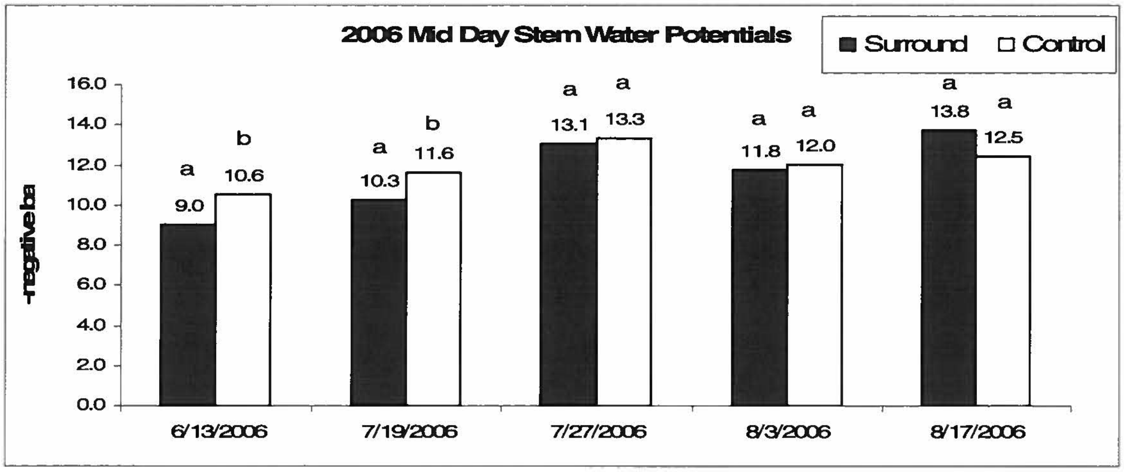


Figure 2. Paired columns with the same date with different letters were statistically different when compared in a Student's T-test (P # 0.05).

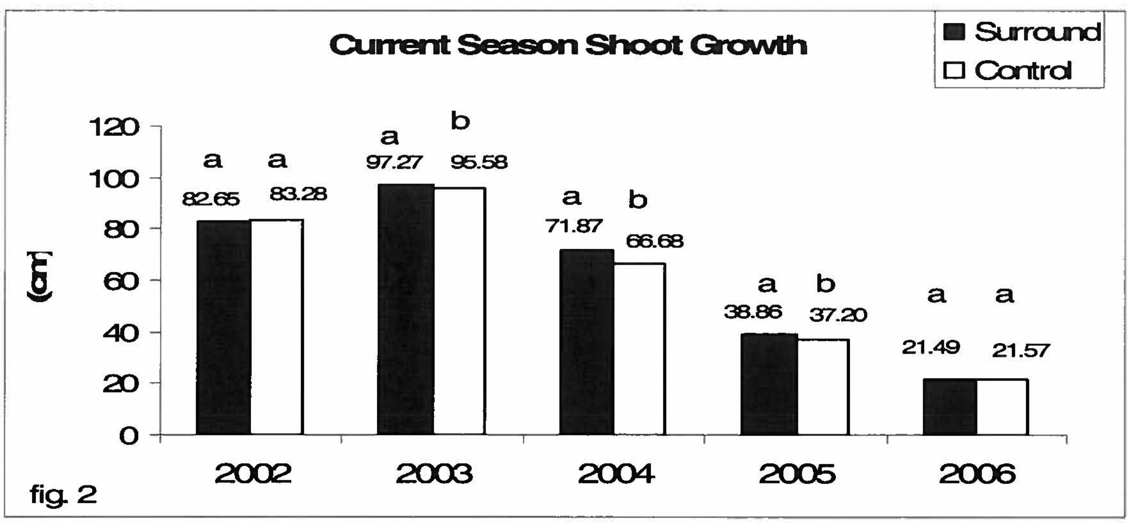


Figure 3. Paired columns with the same date with different letters were statistically different when compared in a Student's T-test (P # 0.05).

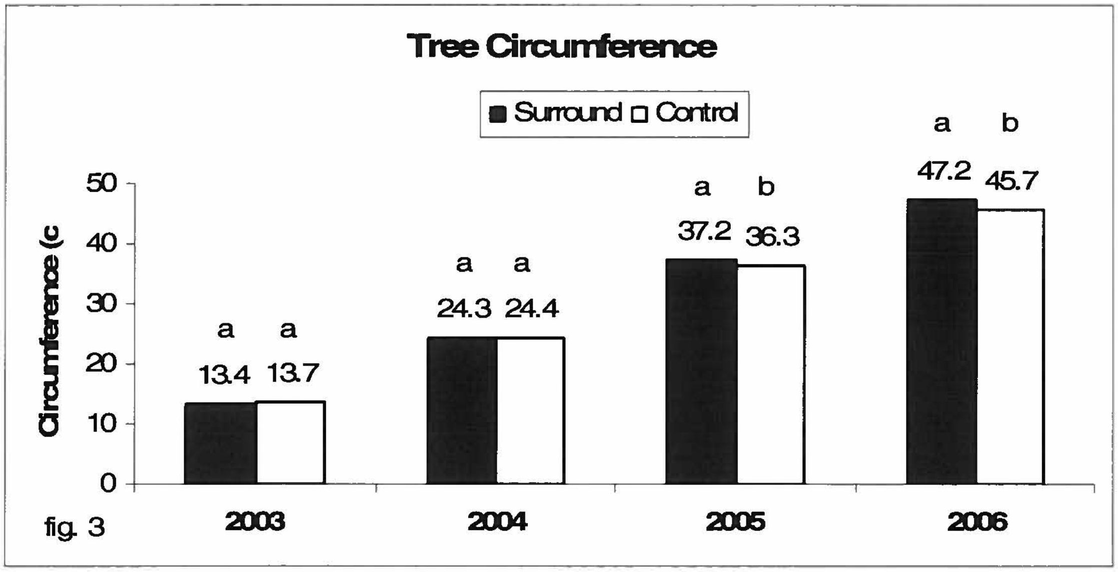
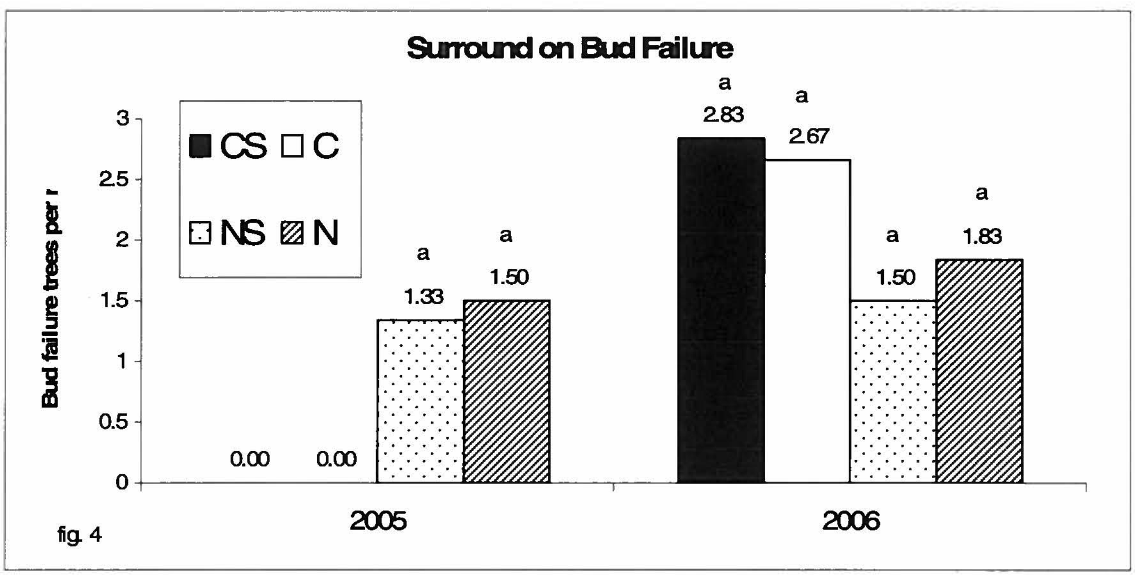


Figure 4. CS = Carmel variety with Surround, C = Carmel control without Surround, NS = Nonpareil with Surround, N = Nonpareil control. Paired columns with the same date with different letters were statistically different when compared in a Student's T-test (P # 0.05).



Does Combining Zinc and Boron in a Fall Spray Influence Bloom Nutrient Levels?

Project Leader: Franz Niederholzer
UCCE Sutter/Yuba Counties

Interpretive Summary:

As study was conducted to evaluate the affect of a boron + zinc sulfate spray, applied in November, on almond flower boron levels in March. There was a slight reduction (not statistically significant) in flower boron when zinc sulfate is mixed with boron (as Solubor), compared with results from trees sprayed with boron, boron + zinc sulfate + organic buffer, or boron + zinc sulfate + organic buffer + urea. However, contamination of the flower samples by bud scales confounds the results, and requires that the work be repeated with all bud scales eliminated from the flower samples before analysis.

Objectives:

Adequate boron (B) nutrition is required for good almond nut set and crop yield. Foliar applied boron can increase pollen tube growth, as well as reduce pollen tube bursting in lab studies using flowers sampled from the field.

Increased flower boron levels result from postharvest (late September – mid October) or pink-bud spray timings. Both of these application timings pose some challenges to almond growers. Adding boron to fungicide sprays at bloom may reduce nut set in some varieties in an orchard, as sprays applied to flowers at full bloom are reported to reduce flower set and yield (P. Brown, personal conversation), and bloom timings in a block can be such that pink bud and full bloom occur in different varieties at the same time in an orchard. On the other hand, almond growers do not regularly spray orchards within a month of harvest, and a dedicated boron spray would be expensive. Because of these potential problems with postharvest and bloom timings for boron foliar sprays, some growers add boron to the spray tank when applying zinc sulfate (36%) as a foliar fertilizer in late fall (November) just as leaves are beginning to drop. Zinc sulfate has long been recommended as a treatment for zinc (Zn) deficiency and also accelerates leaf drop – an added benefit for growers wanting to begin pruning or concerned with tree blow-over. While it has not been reported to clog sprayer nozzles and/or interfere with spray application, zinc sulfate + Solubor, a commonly used foliar boron material, produces a milky precipitate in the "jar test". No data exists, to the author's knowledge, that tests the impact of this apparent tank-mix incompatibility on efficacy of boron fertilizer.

This study evaluated the affect on flower boron concentrations following application of different combinations of zinc sulfate and Solubor in late November (just prior to leaf drop) the previous season.

Materials and Methods:

The study site was a commercial almond orchard west of Live Oak. The orchard is 50% Butte and 50% Padre, alternating each variety across the block. Trees were planted 22' x 18' on Mariana 2624 plum rootstock in 2000. Study trees were contained in a single, continuous Padre row. Experimental design was a randomized complete block design, with five blocks each containing a single-tree replicate of each treatment. There were no guard trees, but spray was directed inwards from all angles around the tree and potential for drift was minimized. Sprays were applied on November 21, 2005, using a Stihl mistblower sprayer with a spray volume equal to 100 gpa. All boron treatments were applied at 500 ppm boron. Treatment details are presented in Table 1.

Treatment affect on leaf drop was evaluated visually in the weeks following spraying. Digital photographs of each study tree were taken on November 28, December 4, December 18, and January 22. Flower samples were taken at full bloom and analyzed for N, sulfur (S), calcium (Ca), magnesium (Mg), B, zinc (Zn), copper (Cu), and manganese (Mn) concentrations. Recently opened flowers, based on stamen appearance were sampled. Bud scales were not excluded from the samples, but incidentally were included as samples were taken. Two sets of flower samples were taken from three study trees, one sample containing incidental bud scales and one sample carefully taken to avoid including bud scales in the sample. Hulls were collected just prior to harvest on September 15 and analyzed for boron content.

Results and Discussion:

Trees treated with zinc sulfate defoliated by December 4, while trees not treated with zinc held their leaves for an additional 2 weeks.

Rapid leaf loss following boron + zinc sulfate sprays did not affect flower boron levels the following spring, as flower boron levels for trees treated with boron alone or boron + zinc sulfate + buffer were not statistically different from each other.

Table 1. 'Padre' almond flower boron and nitrogen concentrations (n=5) in early March, 2006 following spray treatment on November 21, 2005. Treatments were applied at the spray volume equal to 100 gpa. There is a 95% chance that treatments are significantly different if they do not share the same letter, based on Bonferroni's multiple comparison procedure. Bud scales were not eliminated from these samples.

Treatment	Material rate/acre	Flower Boron (ppm)	Flower nitrogen (%)
Unsprayed	--	34 a	2.31 a
Zinc sulfate (36%)	20 pounds	34 a	2.32 a
Zinc sulfate + polyborate[1]	20 pounds + 2 pounds	40 ab	2.25 a
polyborate[1]	2 pounds	42 b	2.29 a
Zinc sulfate + polyborate[1] + buffer[2]	20 pounds + 2 pounds + 2 pints	42 b	2.24 a
Zinc sulfate + polyborate[1] + buffer[2] + standard urea	20 pounds + 2 pounds + 2 pints + 33 pounds	43 b	2.22 a

[1]Solubor®
[2]Trifol®

Presence of incidental bud scales in the samples increased N and B concentrations and decreased Ca concentrations in the analysis results (Table 2), regardless of fall spray treatment. Differences in N, Zn and Ca concentrations were significant at the 5% level, while differences in B were not significant at that level. Affect of bud scales on flower nutrient influenced flower nutrient concentrations of calcium, sulfur, manganese, and zinc. Bud scale presence in samples did not affect final reported values for magnesium or copper (Table 2). Hull analysis results are not yet available from the UC ANR lab.

Table 2. Affect of incidental bud scale presence in flower samples on final flower nutrient concentration on a dry weight basis. Samples where bud scales were carefully omitted from the samples are presented as " - bud scales". Samples where flowers were sampled without attention to eliminating bud scales from the sample are reported as "+ bud scales". All treatments were treated with zinc in November, 2005 and sampled at bloom in March, 2006. There is a 95% chance that the presence of bud scales caused a significant difference in nutrient concentrations when results for each nutrient do not share the same letter, based on Bonferroni's multiple comparison procedure.

	%N	**%S**	**% Ca**	**%Mg**	**ppm B**	**ppm Zn**	**ppm Mn**	**ppm Cu**
+ bud scales	2.26 a	0.11 a	0.42 a	0.15 a	42 a	147 a	50 a	11 a
- bud scales	2.63 b	0.13 b	0.18 b	0.17 a	51 a	47 b	43 b	11 a

This work must be repeated with care taken to eliminate bud scales in the flower samples. Even though bud scales didn't statistically affect ppm B in the small sample (10% of study trees), there may have been some differences that might have affected the boron results. Therefore, discussion of data in Table 1 is only speculation in light of the possible affect of bud scales on these results. These results emphasize the need for attention to detail when taking plant tissue samples.

Almond Tree Training for Catch Frame Harvester

Project Leader: Mario Viveros
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Project Cooperators: Thomas Vetsch
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Interpretive Summary:

Air quality, due to dust and PM 10 generated by almond harvest has become an environmental problem in the San Joaquin Valley. Of all agricultural activities, almond harvest produces the most dust. Two operations, the sweeping and picking up, produce 80 to 90% of the dust. One of the ways to eliminate these operations is by using a "Catch Frame" harvester. Unfortunately, trees in almond orchards have short tree trunks and low canopies which makes them unsuitable for "Catch Frame" harvesters. The intent of this project is to determine if trees can be trained with higher heads (longer tree trunks).

Objectives:

To train almond trees with different head heights.
To develop strong limb structure capable of supporting maximum crops.
To manage tree canopy suitable for Catch frame harvesters.

Materials and Methods:

A test plot was established in February 2003 in a Nonpareil-Sonora-Carmel orchard. The experiment was established in the Nonpareil variety with four treatments and eight-tree plots replicated four times. The head height was established by a heading cut at the time of tree planting. The following treatments were established: 1) trees headed at 42 inches, 2) trees headed at 52 inches, 3) trees headed at 18 inches and 4) trees headed at 18 inches. When shoots were 4 to 6 inches long, in treatments 3 and 4, the most upright shoot was selected and tied to a stake. Later on, these shoots were headed at 62 inches. All treatments except treatment three were trained using the long pruning method. Treatment three was being trained like pistachio trees: short pruned the first dormant season and topped every year at pruning time.

Results and Discussion:

All trees in treatments two, three, four and some trees in treatment one needed to be staked to develop and maintain a straight trunk.

Table 1 shows that trees that were headed at 18" and then at 62 inches have a significant reduction in trunk circumference from 2003 to 2005. The largest significant circumference has been on trees that were headed at 42 and 52 inches. Trees that were headed at 42 inches developed a bigger trunk circumference than trees headed at

52 inches. These results demonstrate that pruning dwarfs tree development. The height of trees was only significant in 2003 in trees headed 52 inches. There were no significant differences in tree heights due to heading cut in 2004 and 2005.

Table 1. Trunk circumference and tree heights from trees trained with 42", 52", 18"/62" short and 18"/62" long heads heights.

Head Heights	Trunk Circumferences (mm)			Tree Heights (ft)		
	2003	2004	2005	2003	2004	2005
42 inches	176 c	346 b	470 c	10.4 ab	12.4 a	16.27 a
52 inches	166 b	336 b	452 b	10.7 a	12.7 a	16.08 a
18"/62" short*	121 a	278 a	400 a	10.0 a	12.4 a	15.73 a
18"/62" long	226 a	287 a	414 a	9.9 a	12.2 a	15.87 a

*This treatment was pruned short in both 2003 and 2004 dormant seasons. Primary and secondary limbs were headed 36 inches in both years. Values followed by the same letter aren't significantly different from one another at p<0.05 (LSD).

Table 2 shows the amount of pruning weights per tree from 2003 to 2006. Significant amounts of wood were removed from trees headed at 42 inches in 2003. However, the amount of wood from this treatment was not significantly different from other treatments in 2004. The prunings removed in 2005 from the 18"/62" short treatment were significantly greater than any other treatment. This was due to the topping of new shoot growth 18" from the top. Significantly less wood was removed from this treatment in 2006.

Yields can be found in Table 3. There were no significant differences among treatments in both kernel weight and pounds per tree. However, there was a numerical yield increase on the 42 inch treatment. Because the orchard had 126 trees per acre, the yield was 664 pounds per acre in this treatment.

Table 2. Pruning weights from trees trained with 42", 52", 18"/62" short and 18"/62" long head heights.

Head Heights	Pruning Weights (lb)			
	2003	2004	2005	2006
42 inches	5.6 c	14.94 a	4.38 a	3.88 b
52 inches	3.5 b	9.42 a	3.25 a	1.06 ab
18"/62" short	3.3 b	11.85 a	9.97 b	0.07 a
18"/62" long	1.8 a	10.94 a	2.58 a	3.31 b

Values followed by the same letter aren't significantly different from one another at p<0.05 (LSD).

Table 3. Yields from trees trained with 42", 52", 18"/62" short and 18"/62" long head heights.

Head Heights	Yields		
	Kernel (g)	Pounds/Tree	Pounds/Acre
42 inches	1.19 a	5.27 a	664 a
52 inches	1.18 a	4.44 a	560 a
18"/62" short	1.18 a	4.01 a	505 a
18"/62" long	1.14 a	4.02 a	506 a

Values followed by the same letter aren't significantly different from one another at $p<0.05$ (LSD).