Almond Culture and Orchard Management

Joe Connell, Farm Advisor, Butte County., Carolyn DeBuse, Farm Advisor, Solano/Yolo Counties, Elizabeth Fichtner, Farm Advisor, Tulare County, David Doll, Farm Advisor, Merced County, and Franz Niederholzer, Farm Advisor, Colusa/Sutter/Yuba Counties.

Problem and significance: This project supports Farm Advisors general extension research programs related to almond production and highlights research results addressing local issues.

The affects of delaying pruning until early spring in young almond trees

Carolyn DeBuse, UCCE Solano & Yolo Counties

Problem and Significance: The traditional pruning time for young almond trees is the dormant season after the leaves have dropped but this is also one of wettest times of year with regular fog, rain and dew. The open wound that is created by the pruning cut is vulnerable to infection from canker causing bacterial and fungal pathogens which are transferred in wet weather. The vulnerability of the cuts to infection may be reduced if pruning was done during a dry part of the year such as late fall or early spring. Previous research has shown that the late fall pruning does not reduce yield if the trees are pruned after October 15th. This trial looks at the effects of pruning young almonds in early spring compared to the dormant season.

Objective: To compare tree growth of second and third leaf almond trees pruned at three different times; dormant, after leaf bud break, during leaf expansion.

Methods:

Third year tree
- Continuing the trial from 2010 using the same trees and implementing the same treatment on each tree.
- 72 Nonpareil trees planted winter of 2008/09
- Measurements of circumference, height, and canopy size

One year tree (second leaf)
- Three varieties; Nonpareil (112 trees), Winters(56 trees), and Monterey(56 trees)
- Trees planted March 19, 2010
- Measurements of circumference, height, and canopy size

Pruning Treatments
- 3 pruning timings (replicates of 4 trees each)
  1. Dormant, February 4th
  2. Leaf bud break , March 9th
  3. During leaf expansion, April 2th

Statistics

Statistics on both years and all varieties were separately calculated due to the lack of replication of varieties within multiple blocks.

Results

A number of one year (second leaf) trees were hit by verticillium wilt and wind damage. If the trees showed severe signs of disease or had lost 2 scaffolds or more from wind damage then the tree was removed from the trial. One tree of Monterey, 4 trees of Winters, and 4 trees of Nonpareil were removed from the trial on account of severe verticillium wilt (*Verticillium dahlia)*. Eighteen trees of Monterey and 3 trees of Nonpareil were taken out of the trial due to extreme wind damage.

One year trees (second leaf)

The table shows the second leaf trees average measurements for circumference taken in the spring and the fall and the height taken in the fall for each variety with the standard error.

In the Nonpareil variety ANOVA analysis showed no significant difference in the spring circumferences but there were significant differences found in both measurements taken in fall; circumferences and height. The Duncan grouping, shown in the table as letters. Similar letters means that the groups were not found significantly different. This test shows that the late pruning timing of leaf expansion decreased the final trees size and there was also a small reduction of circumference in the bud break pruning timing.

Monterey variety part of the trial was compromised by wind damage and verticillium wilt which in turn may have influenced the results. The results from remaining undamaged trees show that the trees were unequal in circumference at the start of the trial in spring. The circumference measured in the fall was not significantly different among the treatments but the height showed significant difference using the Duncan test showing the latest pruning timing to be tallest. These results are questionable and should be repeated.

The Winters variety showed no significant differences between treatments for any of the measurements.

Third year trees

The pruning done on the trees entering their third year was minor compared to the previous year pruning. Only a little interior wood was taken out and the trees were skirted out of the way of orchard machinery. No significant differences were found in any of measurements between treatments.

2011 Almond tree growth measurements of second leaf trees after three different pruning timings: dormant, bud break, and leaf expansion

	Circumference (cm) April 2011	Circumference (cm) Oct 2011	Percent increase in circumference	Height (M) Oct 2011
Nonpareil				
Pruning 'dormant' (2/4/11)	12.57 ± 0.14 a	25.04 ± 0.22 a	99%	3.21 ± 0.04 a
Pruning 'leaf bud break' (3/9/11)	12.30 ± 0.12 a	24.34 ± 0.21 b	98%	3.12 ± 0.03 ab
Pruning 'leaf expansion' (4/2/11)	12.34 ± 0.13 a	23.64 ± 0.23 c	92%	3.08 ± 0.03 b
Monterey				
Pruning 'dormant' (2/4/11)	10.95 ± 0.47 b	24.52 ± 0.97 a	124%	2.66 ± 0.10 b
Pruning 'leaf bud break' (3/9/11)	11.94 ± 0.19 a	24.84 ± 0.44 a	108%	2.74 ± 0.05 ab
Pruning 'leaf expansion' (4/2/11)	12.14 ± 0.20 a	24.84 ± 0.35 a	105%	2.85 ± 0.03 a
Winters				
Pruning 'dormant' (2/4/11)	12.11 ± 0.18 a	24.07 ± 0.39 a	99%	2.92 ± 0.06 a
Pruning 'leaf bud break' (3/9/11)	11.92 ± 0.21 a	24.72 ± 0.32 a	107%	2.82 ± 0.03 a
Pruning 'leaf expansion' (4/2/11)	12.23 ± 0.17 a	24.33 ± 0.23 a	99%	2.97 ± 0.04 a

Figure 1. Example of first year Nonpareil trees pruning timing treatments, dormant (2/4/11), leaf bud break (3/9/11), leaf expansion (4/2/11).

2011 Almond tree growth measurements of third leaf trees after three different pruning timings: dormant, bud break, and leaf expansion

	Circumference (cm) Oct 2011	Height (M) Oct 2011
Pruning 'dormant' (2/4/11)	35.78 ± 0.42	4.37 ± 0.05
Pruning 'leaf bud break' (3/9/11)	36.90 ± 0.27	4.39 ± 0.06
Pruning 'full leaf' (4/2/11)	36.57 ± 0.35	4.43 ± 0.07

Conclusions

In last year's second leaf trial the trees did not show any significant differences between pruning timings, dormant, bud break, or leaf expansion. This year the Winters variety showed these same results but the Nonpareil showed results quite different. In the Nonpareil, significant differences were found between all three pruning treatments for circumference. The height of treatment 3, pruning at leaf expansion, was significantly shorter than the other two. The conclusion is mixed, it might be in some years pruning late has no effect on final tree size but in other years it has a detrimental effect to tree size. This size difference may disappear in following years

Soil boron fertilization: How long can it last?

Franz Niederholzer, UC Farm Advisor, Colusa/Sutter/Yuba Counties.
Cooperating personnel: Jed Walton, PCA, Big Valley Ag Services, Gridley, CA

Objectives: Compare the response (in amount and persistence) of almond flower, leaf, and hull tissues to large, one-time, soil boron (B) fertilizer applications in fall, 2008 or spring, 2009. Soil applied boron fertilizer rates ranged from 4-8 pounds actual B/acre as 20 lb Solubor®/acre or 40 lb Solubor®/acre). A fifth treatment -- 50 lb Granubor®/acre, 7 lbs actual B -- was also applied in the spring. This study is being conducted at an orchard site where the unfertilized soil has very low boron levels (≤0.05 ppm B) by saturated paste extract method.

Materials and Methods: Non-Pareil/Lovell almond trees with low B status (<50 ppm hull B at harvest, 2007) were treated with 20 or 40 lbs/acre Solubor® (20% B) on October, 2008 or late May, 2009. Granubor® (14% B) was applied at 50 lb/acre in late May, 2009. Material was applied evenly to half the distance across rows on each side of the study trees using a weed sprayer (20 gpa or hand applied with belly grinder).

Materials and Methods, cont. Soil is an Olashes sandy loam, and irrigation by hose-pull impact sprinklers. The grower applies a liquid B equivalent to 0.6 pounds of B/acre as a foliar spray each November. Flower samples were taken at full bloom (March 1, 2009, February 20-23, 2010, and February 20-21, 2011). Leaf and hull samples were taken on July 31, 2009. Hulls were sampled at harvest in 2010 and 2011. No 2011 hull data, yet.

Results and Discussion:

- **Fall timing of soil applied boron did not significantly increase flower B levels the next year (see Table 1).**
- **Spring timing of soil applied boron did increase flower B levels for at least two years (Table 1), with largest increases apparent at least one year after application.**

Table 1. 'Non-Pareil' almond flower boron concentrations (average of eight trees for each treatment) in 2009, 2010 and 2011 following soil applied boron fertilizer in fall, 2008 or spring, 2009. There is a 95% chance that data in the same column are significantly different if they do not share a letter, based on Tukey's HSD test.

Treatment	Flower Boron (ppm B) 2009	Flower Boron (ppm B) 2010	Flower Boron (ppm B) 2011
Untreated	30 a	47 a	28 a
20 lb/acre Solubor® October, 2008	36 a	52 a	39 ab
40 lb/acre Solubor® October, 2008	38 a	69 b	48 bc
20 lb/acre Solubor® May, 2009		60 ab	46 bc
40 lb/acre Solubor® May, 2009		86 c	59 c
50 lb/acre Granubor® May, 2009		90 c	56 c

Table 2. 'Non-Pareil' almond summer leaf (2009) and harvest hull boron (2009 and 2010) concentrations following soil applied boron fertilizer in fall, 2008 or spring, 2009. Lowest reading per treatment appears on the left of each column, the highest reading is on the right of each column. The average value appears in the middle in large, bold print. Treatment means followed by different letters indicate significant differences ($p \leq 0.05$) for the 2010 hull data.

Treatment	Leaf Boron (ppm) 2009	Hull Boron (ppm) 2009	Hull Boron (ppm) 2010	
Untreated	29 **33** 38	35 **41** 44	39 **50** 60	a
20 lb/acre Solubor® October, 2008	35 **41** 52	40 **65** 84	41 **59** 76	a
40 lb/acre Solubor® October, 2008	37 **42** 47	72 **104** 153	63 **108** 150	bc
20 lb/acre Solubor® May, 2009	30 **42** 55	47 **54** 61	55 **80** 100	ab
40 lb/acre Solubor® May, 2009	38 **44** 53	45 **59** 78	84 **114** 126	cd
50 lb/acre Granubor® May, 2009	41 **43** 46	60 **77** 94	120 **138** 166	d

Soil matric potential may influence respiration, and consequent root predation of Tenlined June Beetle.

Elizabeth J. Fichtner, Farm Advisor, Tulare County. Cooperators: Marshall Johnson, UC Riverside, Andrew Molinar, UC Riverside, Gabriela Ritokova, UC Davis

Background: Though Tenline June Beetle (TLJB) is an inhabitant in many orchards, it only causes damage in a fraction of infested blocks. TLJB damage is sporadic within orchards and is often associated with sand streaks, particularly during drought years.

Damage: Extensive larval feeding on roots results in tree decline and death. Additionally, wounds caused by feeding may serve as infection courts for soilborne pathogens.

Hypothesis: TLJB larval activity may be suppressed by soil saturation.

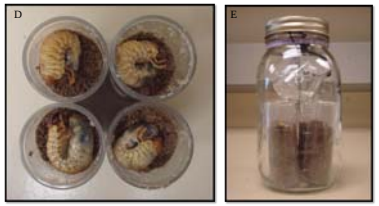
Larval feeding on roots may predispose trees to wind damage (**A**). Larvae (**B**) and pupae (**C**) may be excavated from root zone of affected trees.

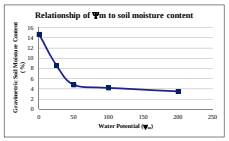
OBJECTIVE

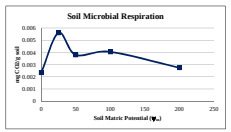
The influence of soil matric potential (Ψ_m) on larval respiration will be investigated to better understand the relationship between soil moisture and larval activity.

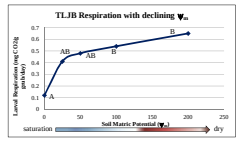
METHODS

- A 4:1 (v/v) mixture of sand and soil was equilibrated at 0, -25, -50, -100, and -100 mb Ψm using hanging water columns.
- The gravimentric soil moisture content was determined for soil at each matric ptential.
- Five replicate 1st instar larvae were individually incubated in the sand/soil mixtures (Photo D).
- The larvae-embedded sand samples were incubated in sealed jars to trap CO_2 evolution over 24 h (Photo E).
- Additional sand was incubated in absence of larvae to account for soil microbe contribution to total CO_2 evolution.
- CO_2 evolution was determined using a titration procedure.









CONCLUSIONS

Soil matric potential was negatively correlated with larval respiration, suggesting that increased soil moisture may suppress larval activity. Soil microbial activity, however, was greatest at -25 mb Ψm (just below saturation). These data represent one experimental run; therefore this experiment should be repeated and future studies designed to address larval respiration as an interaction of soil texture and matric potential.

Almond Culture and Orchard Management continued

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Problem and significance: This project supports Farm Advisors general extension research programs related to almond production and highlights research results addressing local issues.

Fertilizing First Leaf Almonds

David Doll, Farm Advisor, Merced County

Cooperating personnel: Andrew Ray, Andrew Littlejohn, Castle Farms

Introduction:
Growers have realized the benefits of increased fertilizer rates and applications to first leaf trees. These include increased vegetative growth, shorter time to first harvest, and larger crop loads on young trees. Most growers within the area have indicated that their current first leaf nutrient fertilizer programs includes the application of one ounce of nitrogen every three to four weeks applied either granularly or though irrigation water. The correct, most efficient rate for young trees is unknown.

There is also an interest in slow release fertilizers for young trees. Since the root system is small and has a limited ability for nutrient uptake, slow release fertilizers may maintain nutrients within the establishing rootzone of the tree longer than regular fertilizers. This may increase tree growth or cause a reduction in applied fertilizer due to an increase in nutrient use efficiency. These fertilizers are more expensive, and it is unknown if they are economical for young trees.

Acknowledgements: Yara North America, Inc. for donation of fertilizer

Objectives:
1. Using granular fertilizers, determine which source of nitrogen provides the greatest growth response,
2. To determine the benefit, if any, in applying a slow release nitrogen fertilizer,
3. Compare the growth effect of applying two different rates of nitrogen.

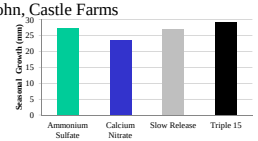
Methods: Trial one, a Delhi Sand soil, compared a single rate of ammonium sulfate, calcium nitrate, a 15-15-15 blend, and a slow release 13-5-13 blend. A total of one ounce of actual nitrogen was applied around the base of the trees once a month starting in April for a total of six applications. The slow release was applied at double the rate and three times instead of six. This was done to see if there could be a labor reduction in using slow release fertilizer types.

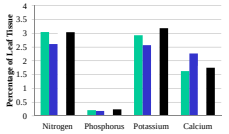
Trial two, a San Joaquin Sandy Loam soil, compared two rates of ammonium sulfate, calcium nitrate, potassium nitrate, 50/50 potassium/calcium nitrate blend, 15-15-15 blend, and a slow release 13-5-13 blend. The rates were 1.0 and 0.5 ounces of actual nitrogen applied every six weeks from May through September. Four applications were made. The slow release was applied at double the rate, but only two of the four applications.

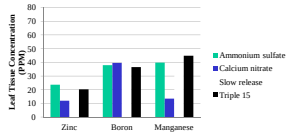
Leaves were sampled from treatments in mid-July and evaluated for differences in tissue nutrient concentration. Final growth measurements were taken in late November.

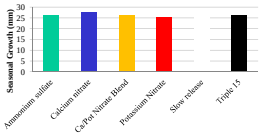
Trial	April	May	June	July	Aug	Sept	Total
Trial 1 – Sand, Regular Fert	Yes	Yes	Yes	Yes	Yes	Yes	6 ozs
Trial 1 – Sand, Slow Release	Yes	No	Yes	No	Yes	No	6 ozs
Trial 2 – Sandy Loam, Regular Fert	No	Yes	Yes	No	Yes	Yes	4 ozs
Trial 2 – Sandy Loam, Slow Release	No	Yes	No	No	Yes	No	4 ozs

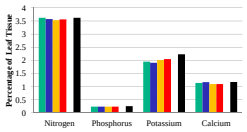
Results/Conclusions:
1. Within trial one, the application of triple 15, ammonium sulfate, and the slow release performed equally. Trees with applications of triple 15 were larger than trees fertilized with calcium nitrate (Figures 1);
2. Within trial two, there were no differences between types of fertilizer (Figure 4) or rates applied (data not shown);
3. In trial one, calcium nitrate had the lowest leaf tissue concentration of all nutrients with the exception of calcium (Figures 2, 3). Calcium nitrate had the lowest potassium levels in trial two (Figure 5);
4. The economics of using a slow release fertilizer are still unclear;
5. Soil nutrient holding capacity may explain the differences, or lack there of, between fertilizers and rates;
6. For the most part, nitrogen is nitrogen. Timing may be more important than amount applied in young tree development.

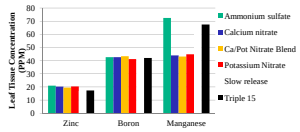












Increasing the Nonpareil Percentage: Pollenizer Arrangement & Bloom Timing

Joe Connell, UCCE Farm Advisor, Butte County Cooperating personnel: Jeff Boles, CSU Chico Farm.

Objectives:

1) **Can the Nonpareil percentage be increased with careful pollenizer placement and still maintain 1:1 planting yields?**
2) **Does an early pollenizer addition improve performance?**

Methods:

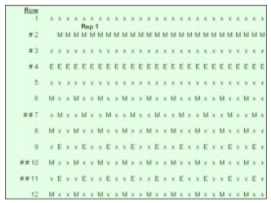
CSU Chico farm orchard, planted 2002; 18 x 21 feet, 116 trees/acre. Yield is collected from the # rows representing the three treatments. Each plot is 27 trees long and is replicated four times.

Three treatments:

- **Standard 1:1 planting, Nonpareil at 50%, an early pollenizer at 25%, and a mid pollenizer at 25%**
- **Nonpareil in every row, pollenizers every two trees down the row, Nonpareil 66%, an early pollenizer 17% and a mid pollenizer 17%**
- **Nonpareil in every row, pollenizers every two trees down the row, Nonpareil 66%, and a mid pollenizer 34%**

Plot layout

X = Nonpareil
M = mid pollenizer
E = early pollenizer



Number of Trees per Acre by Variety and % of Planting		Nonpareil	Price	Sano
Standard 1:1 Planting, 3 Varieties	Variety %	50%	25%	25%
	# Trees/acre	58	29	29
Nonpareil in Every Row, 3 Varieties	Variety %	66%	17%	17%
	# Trees/acre	76	20	20
Nonpareil in Every Row, 2 Varieties	Variety %	66%	34%	
	# Trees/acre	76	40	

Results & Discussion:

- **Yield/tree and 2011 yield/acre was not significantly different between treatments.**

Table 1. 2011 Mean Yield/Tree & Yield per Acre by # Trees/Ac per Variety.

	Nonpareil		Price		Sano		Total
	lbs/tree	lbs/acre	lbs/tree	lbs/acre	lbs/tree	lbs/acre	lbs/acre
Standard 1:1 Planting, 3 Varieties	23.2	1348	10.5	304	17.2	499	2150
Nonpareil in Every Row, 3 Varieties	22.3	1694	11.2	224	13.5	270	2188
Nonpareil in Every Row, 2 Varieties	20.4	1553	10.4	418			1971
	ns*		ns		ns		ns

*ns at bottom of column indicates no significant treatment effects at P ≤ 0.05.

- **The cumulative yield numerical trend favors the higher pollenizer % found in the Standard 1:1 planting than what was achieved with a higher percentage of Nonpareil even with careful placement of pollenizers.**

Table 2. Mean yield per acre of all varieties in each treatment.

	2005		2006		2007		2008		2009		2010	2011	2005-2011 Cumulative
	lbs/acre		lbs/acre		lbs/acre		lbs/acre		lbs/acre		lbs/acre	lbs/acre	Yield lbs/acre
Standard 1:1 Planting, 3 Varieties	547		797		2372		1752		2266	a	2061	2150	11945
Nonpareil in Every Row, 3 Varieties	493		902		2394		1689		2048	b	1978	2188	11692
Nonpareil in Every Row, 2 Varieties	481		987		2411		1462		2109	b	2095	1971	11515
	ns		ns		ns		ns				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 < 0.05.

- **An early blooming pollenizer addition enhanced Nonpareil yield numerically but not significantly.**

Table 3. Yield and Dollars per acre calculated at the variety percentage in each treatment.

			2005	2006	2007	2008	2009	2010	2011	2005-2011 Total $/ac	
Standard 1:1 Planting, 3 Varieties	Nonpareil	lbs/ac	283	476	1505	947	1318	1034	1348		
		$/ac	$ 552	$ 928	$2,935	$1,847	$2,570	$ 2,016	$2,629	$ 13,476	
	Price	lbs/ac	132	148	442	348	394	511	304		
		$/ac	$ 189	$ 212	$ 632	$ 498	$ 549	$ 731	$ 435	$ 3,245	
	Sano	lbs/ac	132	172.0	425	457	565	516	499		
		$/ac	$ 189	$ 246	$ 608	$ 654	$ 808	$ 738	$ 714	$ 3,955	
		Total	$ 929	$1,386	$4,175	$2,998	$3,927	$ 3,485	$3,777	$ 20,677	
Nonpareil in Every Row, 3 Varieties	Nonpareil	lbs/ac	328	680	1859	1193	1458	1287	1694		
		$/ac	$ 640	$1,326	$3,625	$2,326	$2,843	$ 2,510	$3,303	$ 16,573	Total Gain
	Price	lbs/ac	76	96	262	167	277	377	224		Over
		$/ac	$ 109	$ 137	$ 375	$ 267	$ 396	$ 539	$ 320	$ 2,144	7
	Sano	lbs/ac	89	126	274	310	313	314	270		Years
		$/ac	$ 127	$ 180	$ 392	$ 443	$ 448	$ 449	$ 386	$ 2,425	$ 465
		Total	$ 876	$1,643	$4,392	$3,037	$3,687	$ 3,498	$4,010	$ 21,142	
Nonpareil in Every Row, 2 Varieties	Nonpareil	lbs/ac	353	823	1842	1063	1637	1462	1553		Total
		$/ac	$ 688	$1,605	$3,592	$2,073	$3,192	$ 2,851	$3,028	$ 17,029	Gain
	Price	lbs/ac	128	164	569	398	472	633	418		Over
		$/ac	$ 183	$ 235	$ 814	$ 569	$ 675	$ 905	$ 598	$ 3,978	7
		Total	$ 871	$1,839	$4,406	$2,642	$3,867	$ 3,756	$3,626	$ 21,008	Years
											$ 331

Dollars / acre are calculated with Nonpareil valued at $1.95/lb. and Mid/Early pollinators at $1.43/lb.

- **Although "Nonpareil in Every Row" treatments have a higher Nonpareil %, the $/Ac differences are not significant since cumulative yields are lower. It is a mistake to conclude that increasing the Nonpareil percentage to 66% will result in 66% of the production having a higher value.**
- **Harvest is more difficult and costly with mixed variety rows and has the potential for mixed nut deliveries. These drawbacks are not calculated in table 3 and they are likely to erase the meager and insignificant gains accumulated over the seven years.**