Almond Orchard and Culture Management

Project No.: **13-HORT3-Duncan/Gradziel**

Project Leader: Roger Duncan
UCCE – Stanislaus County
3800 Cornucopia Way, Suite A
Modesto, CA 95358-9492
209.585.6800
raduncan@ucdavis.edu

Project Cooperators: Franz Niederholzer, Farm Advisor, UCCE – Colusa County
David Doll, Farm Advisor, UCCE - Merced County
Andrew Ray and James Matthew Jones, Research Associates, UCCE - Merced County
Gurreet Brar, Farm Advisor, UCCE - Fresno & Madera Counties

Project Objectives:

Farm advisors conduct numerous projects addressing local issues in their counties. Many of these issues are addressed with small projects that may not require major support to conduct and complete the work. This project is designed to provide local support for county farm advisors general extension research programs related to almond production.

Interpretive Summary:

Project #1
This project evaluates whether spring foliar applications (N, N+K, N+seaweed, or seaweed concentrate, alone) can increase almond nut yield compared with untreated controls when all trees are grown under good management conditions. In 2013, the first year of this study, foliar treatments did not increase almond nut yield compared with untreated controls when all trees are grown under good management conditions.

Project #2
Project goals were a) determine the most effective rate of nitrogen for young almond trees, and b) compare effectiveness of controlled release fertilizers with conventional fertilizers. The 2013 trials were unable to support the findings of the 2012 nitrogen rate study. The varying rates of nitrogen at both locations did not outperform the control, suggesting that all of the trees in these two orchards received adequate nitrogen. Detection of nitrate-nitrogen in the water indicated that all treatments did receive nitrogen via irrigation water, and most likely compromised the experiment. This emphasizes the importance of knowing how much nitrogen is contained in irrigation water and indicates that nitrate-nitrogen in the water can vary depending on source and time of year.

Project #3
An on-farm survey of major problems in almond orchards in Fresno and Madera counties to document crop growth stages, farm operations and field was a highly educative process providing a wealth of information for research needs aimed at improving almond culture in the

Central Valley. The 2014 Almond Board farm advisor project is based on needs identified by the survey outcomes including the issues of salinity particular to various almond varieties.

Project #4
Several new insecticides that target worms have become registered for almonds in California, including newer generation pyrethroids such as Brigade, Battalion, Baythroid, Danitol, Renounce and Warrior. Additionally, there are a wide range of new reduced-risk insecticides that offer a wide range of existing and new modes of action such as Altacor, Belt, Delegate, Intrepid, Asana, Proclaim, Brigade, Athena, and Hero. Many of these products have undergone substantial testing and have been proven effective against codling moth in apples, pears and walnuts; however, until now, there is less information on their efficacy against Navel Orangeworm (NOW) on almond. 2014 replicated plot results showed moderate NOW damage and untreated nuts [2.1%] with often significant reductions in NOW damage with pesticide treatment: Altacor (Rynaxypyr) [0.9-1 %], Altacor + Asana pyrethroid (Esfenvalerate) [0.6 %], Altacor + Brigade (Bifenthrin) [0.7 %], Cyazypyr (HGW86) [1.2-1.6 %], Proclaim (Emamectin benzoate) [0.4 %], Brigade (Bifenthrin Pyrethroid) [0.5 %], Athena (Bifenthrin + Abamectin) [0.8 %], and Hero (Bifenthrin+Zeta-cypermethrin) [0.4 %], in tank-mixtures for control of NOW at hull-split in Nonpareil.

Project #1
Can Spring Foliar N+K Sprays Increase Almond Yield in the Sacramento Valley?
Franz Niederholzer
UCCE – Colusa County
P.O. Box 180
Colusa, CA 95932
530.281.2359
fjniederholzer@ucanr.edu

Project Cooperators and Personnel:
Stan Cutter, Manager, Nickels Soil Lab
Bruce Lampinen, UCCE Specialist, UC Davis
Ken Shackel, Professor, UC Davis
Holly Little, Acadian Seaplant Ltd.

Objectives:

Determine if spring foliar applications (N, N+K, N+seaweed, or seaweed concentrate, alone) can increase almond nut yield compared with untreated controls when all trees are grown under good management conditions.

Interpretive Summary:

In 2013, the first year of this study, foliar treatments did not increase almond nut yield compared with untreated controls when all trees are grown under good management conditions.

Materials and Methods:

The study was conducted in a 6th leaf planting (Aldrich, Nonpareil (NP), Fritz) at the Nickels Soil Lab near Arbuckle, CA, using only NP trees on Krymsk 86 rootstock. Treatments appear in Table 1, plus untreated controls. A total of 49 trees were used, with 7 replications of each treatment. The study was blocked by tree size, based on trunk cross-sectional area, determined prior to spraying. Each block contained one tree from each treatment. Trees were individually sprayed with a motorized backpack sprayer from Feb. 21 (20% bloom) through mid-April (**Table 1**). Leaf samples from each tree were taken on Aug. 2 and analyzed at the UC Davis Plant Sciences Department Lab. Trees were individually harvested in late August.

Results and Discussion:

Large trees produced more nuts than smaller trees (data not presented), but no treatment differences were measured in yield, leaf N, or leaf K (**Table 2**). Study trees were well fertilized with N, K, B, and Zn and carefully irrigated throughout 2013.

Table 1. Materials and timings of treatments, 2013.

Spray treatment materials & rates	Feb. 21	March 1	Mar. 15	April 19
6.9 lb N & 4 lb K_2O/a			X	X
6.5 lb N/a			X	X
4 lb K_2O/a			X	X
Seaweed Extract (2 qt/a)	X	X	X	X
Seaweed Extract (2 qt/a) + 6.9 lb N & 4 lb K_2O/a	X	X	X	X
Seaweed Extract (2 qt/a) + 6.9 lb N & 4 lb K_2O/a			X	X

Table 2. Treatment results vs. materials (all timings per **Table 1**). Results followed by the same letter are not significantly different (5% by Tukey HSD).

Treatment/spray	Yield (lbs/tree)	% Leaf N	% Leaf K
Control	20.5 a	2.52 a	2.20 a
6.9 lb N & 4 lb K_2O/a	19.1 a	2.53 a	2.14 a
6.5 lb N/a	21.5 a	2.48 a	2.29 a
4 lb K_2O/a	18.8 a	2.53 a	2.07 a
Seaweed (2 qt/a)	20.2 a	2.50 a	2.09 a
Seaweed (2 qt/a) + 6.9 lb N & 4 lb K_2O/a	19.5 a	2.52 a	2.14 a

Project #2
Fertilizing Non-Bearing Almond Trees: How Much Nitrogen?

David Doll
UCCE – Merced County
2145 Wardrobe Avenue
Merced, CA 95341-6445
209.385.7403
dadoll@ucdavis.edu

Project Cooperators and Personnel:

Andrew Ray, Research Associate, UCCE - Merced County
James Matthew Jones, Research Associate, UCCE - Merced County

Objectives:

1. Determine the most effective rate of nitrogen for young almond trees.

2. Compare effectiveness of controlled release fertilizers with conventional fertilizers.

Background:

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. With this increase use of fertilizers for non-bearing trees, there are questions in regards to what source and rate of nitrogen will provide the strongest growth response.

With the application of granular based fertilizers, there is also an interest in controlled release fertilizers for young trees. Since the root system is small and has a limited ability for nutrient uptake, controlled release fertilizers may maintain nutrients within the establish rootzone of the tree longer than conventional 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.

In 2011, two trials in Merced County tested which nitrogen source was most effective for fertilizing first leaf almond trees. The results of these studies suggested a slight benefit of using non-nitrate, NPK blend based fertilizers for young tree development. This supports the current University of California recommendation of using an NPK urea based blend for fertilizing young trees. This project will focus on what rate of urea based fertilizer is most effective.

In 2012 a trial was set up in Winton, CA to test different nitrogen rates. The results found that tree growth was maximized when three to four ounces of actual nitrogen were applied per tree. While high nitrogen application rates resulted in higher nitrogen leaf tissue concentrations, the trees did not have significantly higher seasonal growth changes. The 15 and 30 lbs per acre applications of a 120 day controlled release product were the only treatments to outperform the

control in seasonal growth, suggesting that these two treatments provided maximum uptake by the trees. Also, a single application of the 120 day controlled fertilizers performed as well as six applications of conventional fertilizer at all rates indicating that controlled release fertilizers could be economically competitive based on their labor savings.

Methods:

In 2013 trials were set up near El Nido and Winton, CA to test different rates of nitrogen on first and second leaf almonds. These trials were to repeat the experiments conducted in 2013. The El Nido trial was established in a first leaf almond orchard. Five different treatments were tested: 0, 1, 2, 4, and 6 ounces of actual N using a conventional urea-based fertilizer. There were 5 blocks of 8 trees per treatment, totaling 40 trees per treatment. Nitrogen was applied to the base of the almond tree each month starting in early April and continued for 6 months. The orchard was planted into a clay loam soil and was flood irrigated using well water.

The Winton trial was set up in a second leaf orchard almond orchard. Four different treatments were tested: 0, 4, 8, and 12 oz of actual N. There were 5 blocks of 4 trees per treatment, totaling 20 trees per treatment. The nitrogen was applied to the base each almond tree in April using a controlled release product. The orchard was located in a loamy sand soil and irrigated with solid set sprinklers using canal water from the Merced Irrigation District.

Seasonal growth of each tree was measured by taking the difference of pre-leaf out and end of year dormant caliper measurement. Water was sampled intermittently to determine the presence of nitrate-nitrogen. Levels were measured using Water Works™ test strips. The standard protocol was followed, which included dipping a test strip into a water sample for 2 seconds, waiting for one minute, then comparing to a color scale provided on the side of the bottle. The results were viewed more as qualitative (i.e. low, medium, high) versus quantitative. Water from each site was tested at four different times throughout the growing season: once at the beginning of the season, and three times during the summer.

Results and Discussion:

There were no statistically significant differences among treatments (**Figures 1 and 2**). With the exception of the first irrigation, nitrate-nitrogen was detected in irrigation water at both sites throughout the season.

The 2013 trials were unable to support the findings of the 2012 nitrogen rate study. The varying rates of nitrogen at both locations did not outperform the control, suggesting that all of the trees in these two orchards received adequate nitrogen. Detection of nitrate-nitrogen in the water indicated that all treatments did receive nitrogen via irrigation water, and most likely compromised the experiment. This emphasizes the importance of knowing how much nitrogen is contained in irrigation water and indicates that nitrate-nitrogen in the water can vary depending on source and time of year.

Once the nitrogen demand of non-bearing trees has been clearly determined, growers will be able to calculate how much additional nitrogen will be needed from fertilizer. In circumstances with high nitrates in irrigation water, such as what was observed in these 2013 studies, there may be no benefit from adding nitrogen to a non-bearing orchard.

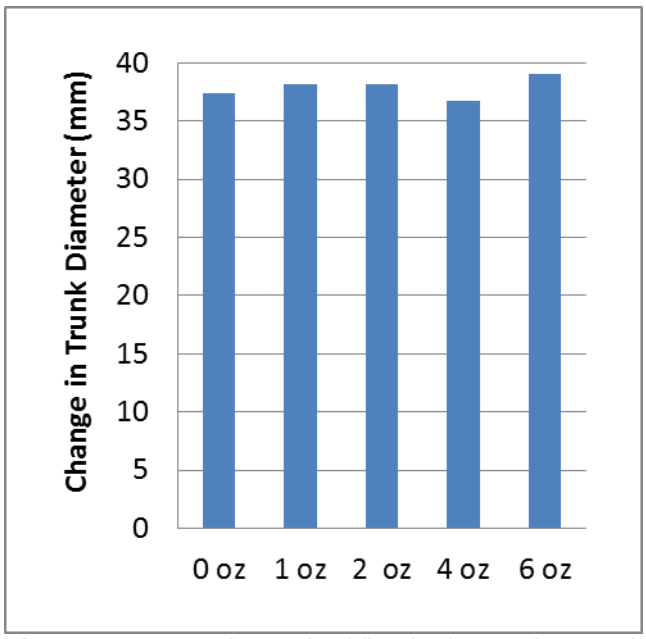

Figure 1: Seasonal growth of first leaf trees that received different rates of conventional fertilizer. None of the differences observed were statistically significant (at a p-value < .5).

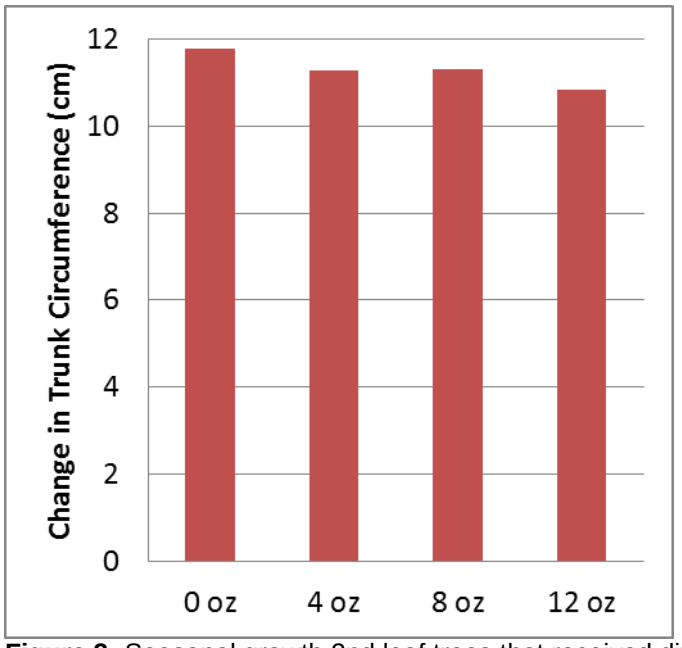

Figure 2: Seasonal growth 2nd leaf trees that received different rates of controlled release fertilizer. None of the differences observed were statistically significant (at a p-value > .5).

Project #3
Almond Field Problems Survey and Documentation: Fresno & Madera Counties
Gurreet Brar
UCCE - Fresno & Madera Counties
550 E. Shaw Ave. Suite 210
Fresno, CA, 93702
559.241.7526
gurbrar@ucanr.edu

Objectives:

1. On-farm survey of major problems in almond orchards in Fresno and Madera counties.

2. Documentation of crop growth stages, farm operations and field problems in almonds.

Background:

According to the recent Crop Report of the State of California, almonds have become the second most-valuable commodity after dairy, surpassing California's famous grape industry. University of California can be seen as a major contributor to this success story through its excellent research and extension programs. As a new farm advisor (Nut crops/Pomology), I am very keen on starting a research program that serves the needs of Fresno & Madera county almond growers. However, the foundation of a viable research program lies in feedback surveys, needs' assessment, and documentation of the field problems. I planned to initiate these efforts by conducting an extensive survey of the crop and the challenges faced by growers in the Fresno & Madera counties.

Methods:

A survey questionnaire was prepared after discussions with fellow farm advisors. The questionnaire was filled by personal contact method at the farmer's field or meetings. The survey was oriented towards documenting major issues and challenges that almond growers are facing.

For documentation of the cultural practices and issues, photographs were taken of the disease symptoms, nutrient deficiencies and other issues as well as general cultural practices throughput the season.

Results and Discussion:

Survey:

In total, responses from 71 respondents were documented in 2013. Out of these 71, 18 growers had operation size more than 500 acres, 31 between 100 - 500 and 22 growers operated less than 100 acres. Many growers provided answers to a wide variety of questions

ranging from irrigation and fertilization to pest control. The major findings based on analysis of the responses are:

- Out of 71, 15 growers (78%) had micro-irrigation systems (either micro-sprinkler or drip) while 21% used flood or furrow irrigation.
- 45 out of 71 (63%) growers said they take leaf samples each year in July to get leaf tissue nutritional analysis done.
- 63 growers out of 71 said they have hired a PCA or a consultant for pest control recommendations. All the respondents who had not hired a PCA were having operation size less than 100 acres.
- 56 respondents noted that they did scout for weeds during fall to identify weed types and then based their weed management program on the scouting results.
- Major production issues faced by the respondents are listed in Table 1 below.

Table 1: Major issues and challenges faced by almond growers in Fresno & Madera counties, 2013.

Issues reported	# of respondents	%
Salt burn	11	15
Phytophthora Root & Crown rot	3	4
Twig dieback in Monterey	3	4
Non Infectious Bud Failure	4	6
Issues with irrigation management	5	7
Training of young trees	3	4

Documentation:

Various problems were documented in photographs as observed from time to time. This collection of photos was sorted and saved digitally for later use for reference and extension purposes.

Outcomes:

The survey and documentation is an ongoing process, which continues well into 2014. This was a highly educative process providing a wealth of information for research needs aimed at improving almond culture in the Central Valley.

My 2014 Almond Board farm advisor project is based on the survey outcomes relating to the issues of salinity observed in various almond varieties. I look forward to conducting more need-based research focusing on the issues reported by the respondents.

Project #4
2013 Navel Orangeworm Efficacy Trial

Brent A. Holtz, Ph.D.
UCCE - San Joaquin County
2101 E. Earhart Ave., Ste. 200
Stockton, CA 95206
209.953-6154
baholtz@ucdavis.edu

Project Cooperators and Personnel:

Rudy S. Whitley and Cheryl S. Gartner, UCCE – San Joaquin County

Introduction:

Navel Orangeworm (*Amyelois transitella*) continues to be a major pest of harvestable almond nut meats throughout the San Joaquin and Sacramento Valleys of California. In some cases multiple insecticide sprays are applied in addition to sanitation programs to remove overwintering inoculum sources. Several new insecticides that target worms have become registered for almonds in California, with several other products in developmental stages.

One group of products includes newer generation pyrethroids such as Brigade, Battalion, Baythroid, Danitol, Renounce and Warrior. Additionally, there are a wide range of new reduced-risk insecticides that offer a wide range of existing and new modes of action such as Altacor, Belt, Delegate, Intrepid, Asana, Proclaim, Brigade, Athena, and Hero. Many of these products have undergone substantial testing and have been proven effective against codling moth in apples, pears and walnuts; however, to date there is less information on their efficacy against Navel Orangeworm (NOW) on almond. Considering the economic significance of Navel Orangeworm as a pest of almonds in California, including both the effects on percentage offgrades and aflatoxins, it is essential that we learn more about how each of these new insecticides works and might contribute to improved control in the field and in resistance management programs.

Methods:

An insecticide efficacy screening trial was conducted in 2013 at the Kearney Research & Extension Center, Parlier, CA. Products tested and rates applied were determined through consultations with members of the almond industry, chemical company product development representatives, and other colleagues within the University of California. To evaluate "sequential treatments" of Altacor (Rynaxypyr), Altacor + Asana pyrethroid (Esfenvalerate), Altacor + Brigade (Bifenthrin), Cyazypyr (HGW86), Proclaim (Emamectin benzoate), Brigade (Bifenthrin Pyrethroid), Athena (Bifenthrin + Abamectin), and Hero (Bifenthrin+Zeta-cypermethrin) in tank-mixtures for control of NOW at hull-split in California almonds.

The trial was organized as a completely randomized block design with five replications of single-tree plots; exact specifications were made after tree plots were located. Plots were sprayed at hull split with portable hand gun sprayers. Water volume was dependent on the size and density of the tree canopy. The trial was performed on the Nonpareil variety. The

first application was timed for early hull-split (July 7th) followed-by a second application one month later (August 9th). Harvest was delayed until approximately 2% worm damage was surveyed in unsprayed trees, next to the plots, by Walt Bentley, UC IPM Entomologist Emiritus. At harvest, trees were shaken and a nut sample of at least 200 nuts per tree was collected. Shelled nuts were cracked out and evaluated for Navel Orangeworm damage to the kernel. Data was analyzed by ANOVA with means separated by Fisher's Protected LSD.

Results and Discussion:

Using the methods described above, treatments of Proclaim, Hero, Brigade, and Altacor significantly reduced navel orangeworm populations when compared to an untreated control (**Table 1**).

Table 1. Nonpareil Variety-August Harvest

2013 Treatments	[a]% NOW[b]		data transformed[c]
8 Proclaim + Dyne-Amic 4.5 oz + 0.25%v/v	0.4	a	a
11 Hero EW 11.3 floz	0.4	a	a
9 Brigade WSB 18 oz + Hort oil	0.5	a	ab
3 Altacor®+Asana® XL 3.0 oz+ 9.6 floz	0.6	a	ab
4 Altacor® + Bifenthrin 3.0 oz +16.0 oz	0.7	ab	ab
10 Brigade WSB 18 oz + Hort oil+ Vigilant	0.7	ab	abc
12 Athena 19.2 fl oz + Hort oil 1 gal/ac	0.8	abc	abcd
1 Altacor® (Rynaxypyr) 3.5 oz/ac + Hort oil	0.9	abc	abcd
2 Altacor® (Rynaxypyr) 4.0 oz/ac +Hort oil	1.0	abc	abcd
7 Cyazypyr (HGW86) 20.5 floz + Onager	1.2	abc	abcd
6 Cyazypyr (HGW86) 16.9 floz + Zeal	1.5	bcd	bcd
5 Cyazypyr (HGW86) 13.5 floz + Vigilant	1.6	cd	cd
13 Untreated	2.1	d	d

[a]200 nuts were cracked out of each rep, 5 replications, 1000 nuts per treatment. Percent worm damage was determined per 1000 nuts. Data was both transformed (ArcSin(sqrt(x))[c] and not transformed[b] for analysis (one way ANOVA).