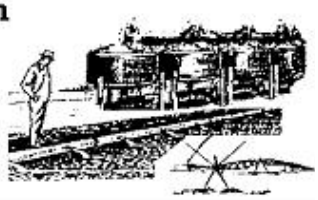
University of California Cooperative Extension
KERN SOIL AND WATER
JUNE 2011



Kern County • 1031 S. Mt. Vernon Ave • Bakersfield CA 93307 • Telephone: (661) 868-6218

UC Cooperative Extension Almond Field Meeting – June 16, 2011

Almond Irrigation, Nutrition for High Yields & Stewardship

Paramount Farming Co. Belridge Ranch 3360B (½ mile north of office)

Co-sponsored by Paramount Farming Company and the Almond Board of California

Increasing almond yields have been a bright spot in California agriculture in recent years. A 2,400 lb/ac kernel yield was a goldmine 20 years ago, but now is just the Kern County average and just barely pays the bills. In recent years, we've all heard of the occasional 4,000 to 5,000 lb/ac yield. Canopy density research by Bruce Lampinen has shown that almonds do indeed have this potential. In addition to optimizing yields and production efficiency, the almond industry is striving to meet the highest environmental standards and land stewardship for a sustainable future.

What does it take to make all this happen? Since February 2008 an intensive, 12 treatment fertility/irrigation trial coupled with other research projects has been conducted in western Kern County to try and answer that question. With a multitude of research personnel from UC Davis to NASA to Kern we have been tracking nitrogen and water use efficiency, spring to fall nutrient critical tissue levels, the need for potassium and the use of multi-spectral aerial imagery for remote reconnaissance of water and nutrient status. We don't have all the answers yet, but we do have consistent 3,600 to 4,300 lb/ac kernel yields for the optimal fertility treatments. Come see what we've found out to date and enjoy lunch. *(For lunch RSVP to Debye Hunter, contact information on page 2).*

AGENDA

8:00-8:20 SIGN-IN *(3 HOURS CCA CREDITS APPLIED FOR)*

INTRODUCTION: PROJECT CONCEPT & DESIGN; FIELD DAY ORIENTATION

8:20-8:40 **CONCEPT, ALMOND FERTILITY MANAGEMENT, ENVIRONMENTAL STEWARDSHIP & FUTURE REGULATIONS—***Patrick Brown, Pomology UC Davis*

ACKNOWLEDGEMENT OF COOPERATORS AND FUNDING SOURCES

BREAKOUT SESSION TOPICS: 8:40-11:30 (The below sessions will be repeated every 20 minutes at individual shade tents to allow for smaller groups of growers to interact with researchers. Break will be 10:00-10:30.)

1. Nutrient budgets, fertilizer materials and rate responses—*Patrick Brown, Saiful Muhammad, UCD*
2. Early season sampling and new critical values—*Brown, Sebastian Saa Silva, UCD*
3. Nitrogen management & fate: Greenhouse gases, root distribution and irrigation impacts—*Dave Smart, Daniel Schellenberg, Andres Olivos, UCD*
4. Almond water use (ET) and plant stress guidelines—*Blake Sanden (Kern UCCE), Ken Shackel, UCD*
5. Spur development, light and canopy potential—*Bruce Lampinen, UCCE Davis*
6. Remote sensing and spectral imagery as future tools—*Mike Whiting, Susan Ustin, UCD*
7. Learn to use the pressure chamber, hands on exercise—*Peggy Schrader, Kern UCCE*

COOPERATORS & INDUSTRY SUPPORTER DISPLAYS: 8:40-12:30

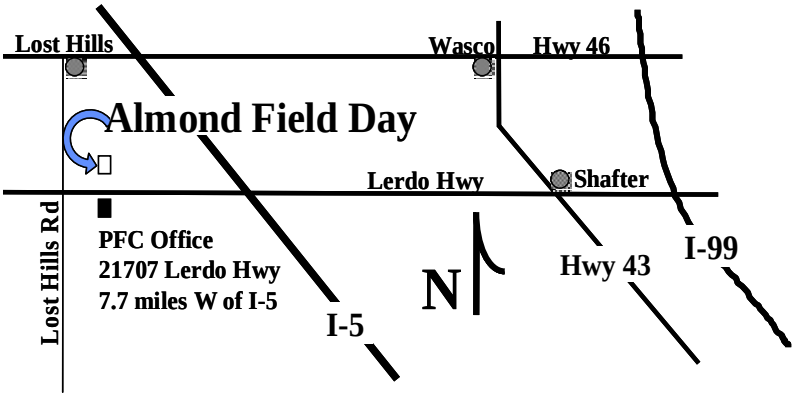
Paramount Farming is the grower cooperator on this comprehensive project, with the Almond Board of California along with many other agencies providing research funding. We have generous support from the following companies, who will have staff and information available: **Fertilizer Companies:** Yara, Great Salt Lake Minerals, Tessenderlo-Kerley, Compass, Haifa, Mosaic, SQM, Potassium Nitrate Association. **Equipment/Service providers:** PureSense, Grundfos Pumps, Bowsmith, Toro Irrigation, Irrometer, Britz, Soil Technologies Inc.

BBQ LUNCH: 11:30-12:30

The Paramount Farming BBQ brigade, led by Brigadier Burger Flipper Rob Baker, is providing lunch.
RSVP Debye Hunter, Almond Board of California: 209-343-3230 or e-mail dhunter@almondboard.com.

NEW CONTINUOUS FERTIGATION TRIAL, FANJETS & DOUBLE-LINE DRIP: 12:30-1:15

This is a special session for those hardy souls wanting to stay after lunch to preview a new "spoon-feed" trial comparing continuous fertigation with the more conventional 4 times/year injection in both microsprinkler and double-line drip irrigation. This trial will also provide the first field data on tissue critical levels and water use in Monterey. We will discuss fertigation/irrigation systems and filter station management options.



Blake Sanden
Irrigation & Agronomy Advisor
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ALMOND IRRIGATION & FERTILITY: what are the concerns, what do we know?

THE BIG PICTURE: Crop irrigation and fertility management are two sides of the same coin when it comes to California agriculture. On the one side is the necessity of not limiting sufficient water and nutrients so that the crop can achieve the most profitable yield – for most situations, that translates to maximum yield. On the other side are the environmental concerns over nitrate contamination of groundwater and air quality impacts of ammonia and nitrous oxide blow off from fertilizers – usually driven by guess what, irrigation. So the one side says push the water and fertilizers, while the other dictates caution, possible "deficit" water and N applications and potential regulatory actions. Also, the incidence of phytophthora, alternaria and hull rot in almonds is often reduced by deficit nitrogen and water. Every almond farmer in California is familiar with this debate. The Almond Board is committed in a big way to advancing our understanding of this issue through its current **Almond Sustainability Program**. We all want to be good stewards of the resources that Providence has placed in our hands.

The multiple collaborative trials to be discussed at this field day are trying to address these factors and document not only outstanding almond production yield potential, but understand individual tree variability in the orchard and what it takes to achieve maximum profitability, efficiency and sustainability. Two identical trials are being run under microsprinklers and double-line drip. Read on for some select findings thus far.

ALMOND WATER USE, EVAPOTRANSPIRATION (ET): Optimal irrigation of almonds in the southern San Joaquin Valley requires an investment in time, monitoring and skill above most other regions in California. This is mainly due to insufficient winter rain to completely recharge the soil profile and flush salts out of the rootzone. In combination with our long season from March 1 to the end of November, the tree not only has the opportunity for long-season carbohydrate production, but also extended periods of stress from excess salts or lack of water.

The original crop coefficient (Kc)/ET curve for almonds was most likely developed in the Sacramento Valley sometime in the 1960s to 1970s and used as the "standard" for almond ET for the last 40 years. We don't have the original data or details on how these numbers were determined. These numbers don't even show water use starting until April 1st for a "no cover crop orchard" with a micro system and depending on which climate zone in the Central Valley you chose would put you between 39 to 43 inches of ET. Many almond irrigation trials have been conducted over the last 30 years in California where the Control treatment has been assumed to represent "non-stressed" or "100% evapotranspiration (ET)" conditions. The maximum applied water for these trials rarely exceeded 45 inches even in the southern San Joaquin Valley, and maximum yields were low by today's standard. (The 2002-2008 Spur Dynamics Trial by Bruce Lampinen was the exception both in higher levels of applied water and achieved yield. However, precise tree ET was not calculated.)

Production scheduling work I did from 1988 to 1992 plus 10 more years of irrigation and soil moisture monitoring demonstrations in almonds confirmed my suspicions that almond ET was significantly higher than these old values. In 2002 I published my own set of almond Kc's and a "normal year" ET schedule that put almond water use in the southern SJV at 52 inches. For the current trial we can measure weekly almond ET by soil moisture depletion plus applied water, and hourly ET using more precise, large area meteorological measurements (eddy covariance and surface renewal). Kc values for almond ET are then calculated by dividing this measured ET by a nearby CIMIS station (1.6 miles west) estimate of standard potential ET (equivalent to a well-watered pasture).

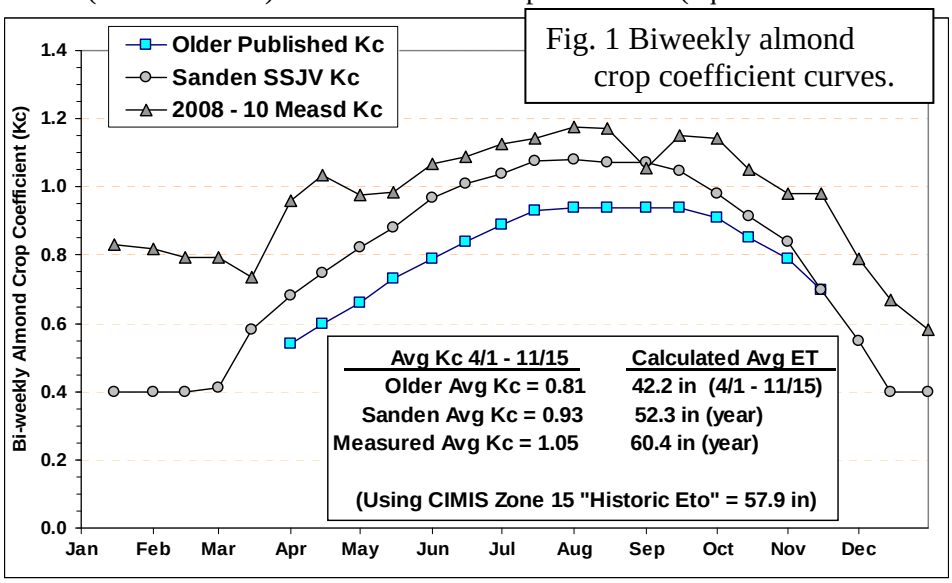

Fig. 1 Biweekly almond crop coefficient curves.

Figure 1 (left) compares these 3 almond Kc curves on a biweekly basis. The lower one is the old UC almond curve from the 1960s, with a Kern County "normal year" ET of 42 inches with a peak Kc of 0.95. The next curve is the Sanden model estimate from irrigation monitoring demonstrations in more than 50 almond blocks over 12 years at 52 inches and a peak Kc of 1.08. The top curve is not as smooth because it uses the actual measured average Kc values from March 2008 through December 2010, for a final "normal year" ET of 60 inches and a peak Kc of 1.19. The orchard is irrigated with 2, A-40 Bowsmith Fanjets per tree (21x24 foot spacing) planted as alternating Nonpareil and Monterey. Note the dip in the Kc value for the end of August. This was orchard stress due to dry down for the Monterey harvest. The actual 2009 ET in this orchard was 61.5 inches and 54.9 inches in 2010. **(NOTE: This is not a recommendation that almonds require 60 inches of water for maximum yield, but rather the fact that this is indeed the true potential ET of these trees. As long as salt is not a problem, our best current estimate would be around 50 to 54 inches of in-season irrigation would be sufficient if you start with the rootzone fully recharged during the winter.)**

HULL ROT, TREE STRESS AND DEFICIT IRRIGATION: No hull rot was observed in 2008, but was significant in 2009 and 2010. To try and reduce this problem in 2010 we maintained a -14 to -16 bar tree stem water potential (SWP, using the pressure chamber and bagged leaves) during hull split, but did not see any significant reduction in hull rot (very difficult to accurately measure). We did see a 6-inch reduction in ET for 2010 compared to 2009 and some defoliation and higher than desirable tree stress (-18 to -20 bars) around both Nonpareil and Monterey harvests. Yields in 2010 were still excellent and the stress around harvest does not appear to have reduced the 2011 crop – stay tuned next year. Some of our data indicates that actual almond ET may not decrease until several days after the beginning of stress, but will require some additional testing over the next two years for confirmation.

SALINITY UNDER MICROSPRINKLERS vs. DOUBLE-LINE DRIP: At the start of this trial peak rootzone salinity was at the 3 to 4 foot depth – averaging 3.5 dS/m EC at this depth. After 3 years of CA Aqueduct water under microsprinklers and around 52 to 56 inches of irrigation in-season, salts moved slightly to concentrate in the 4 to 5 foot depth – and increased to 5.3 dS/m. Under double-line drip, with less surface evaporation, the high salt zone has moved to the 6 to 8 foot depth – increasing to 4.4 dS/m and 3.9 dS/m EC at the 8 to 9 foot depth. Virtually no salts or water have been leached beyond a depth of 9 feet. Average salinity in the top 3 foot of rootzone is less than the recommended threshold of 1.5 dS/m.

FERTILITY, TISSUE CRITICAL LEVELS, YIELD / ET INTERACTION: There are four objectives here: 1) Improve leaf sampling protocols and our knowledge of tissue "critical levels" over the entire season to develop early season thresholds for more timely fertilizer application decisions. 2) Determine the yield and plant tissue response to various rates and sources of N (UAN32, CAN17 @ 125, 200, 275 and 350 lb/ac) and K fertilizer (K_2SO_4, KTS, KCl @ 100, 200 and 300 lb/ac). 3) Determine the impact of different N fertilizer materials and rates on air quality/nitrous oxide production. **4) Determine the impact, if any, of N rate and individual tree yield on crop ET.** You'll have to come to the field day for answers from other researchers working on the first three objectives, but at this time I can say that the release of April almond "critical values" is looking good.

2010 Treatment (N-K lb/ac)	Cumulative Neutron Probe ET (in)		Neutron Probe Tree Kernal Yield (lb/ac)		Whole Plot Kernal Yield (lb/ac)	
	Drip	Fanjet	Drip	Fanjet	Drip	Fanjet
125-200	56.8 a	55.5 a	3565 a	3280 a	3320 a	3108 a
200-200	57.0 a	54.4 a	3779 ab	3591 ab	3397 a	3294 ab
275-200	56.6 a	55.0 a	4266 bc	3914 bc	3974 b	3679 bc
275-300	57.5 a	55.1 a	4069 cd	3804 bc	4143 b	3502 abc
350-200	56.4 a	55.0 a	4717 d	4165 c	4252 b	3923 c
AVERAGE	**56.9**	**55.0**	**4079**	**3751**	**3817**	**3501**
LSD 0.05	*3.7*	*3.3*	*457*	*415*	*431*	*528*

The table at the left describes the results from 40 different neutron probe site trees (20 in the micro-sprinkler set and 20 in the double-line drip set) for UAN32 treatments. There is no difference in individual tree ET due to N. The 125 lb/ac N rate produced a significantly lower kernel yield compared to the 350 lb/ac N rate with the 275 lb N rate trending lower but not statistically significant. We attempt to irrigate all trees with the same amount of water, but irrigation system and tree vigor non-uniformity produced annual individual tree ET estimates of 51 to 63 inches. There was absolutely no correlation of tree yield with tree ET above 51 inches of almond ET. Finally, neutron probe tree yields were about 200 to 500 lb/ac higher than "whole plot" (15 trees/plot) yields – probably due to the fact that no "weak" trees are used for neutron probe monitoring while there is generally one or two weak/barked trees in a plot.

SEE YOU JUNE 16th!