Almond Orchard Profitability & Longevity Under Differential N Fertility & Irrigation (13.HORT11A)

(Follow-up in same orchard as Brown fertility project: Development of a Nutrient Budget Approach To Fertilizer Management In Almond)

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Introduction

Competition for fresh water in California has increased dramatically over the last 30 years. Municipal and environmental water demands over this period have increased by 2 million ac-ft (MAF) per year, while water exports to agriculture have declined by nearly the same amount. Ag has made up the difference by fallowing acreage, pumping more groundwater and increasing water use efficiency.

Almonds have been one of the bright spots in this setting as worldwide markets have expanded to keep pace with higher yields due to improved irrigation and production practices (Figure 1). This has maintained price and profitability for the grower and increased acreage.

Improved varieties, planting, pruning and pollination practices have all contributed to this increase, but some of the most significant yield increases have been realized through the use of micro-irrigation, fertigation and improved understanding of the potential crop water use (ET) of almonds. UC field trials over the last 5 years have shown that almond ET can be 25% more than UC estimates published 30 years ago (Figure 2).

But increased water use and yield is often accompanied by increased disease and loss of the lower canopy due to shading. This trial attempts to understand the tradeoff, if any, in orchard longevity and profitability between pushing the orchard with maximum water use and yield compared to a more moderate N fertilizer and water budget.

Objectives

- Determine the impact of differential N fertilizer rates and conservative vs. full irrigation on long-term yield, tree health/decline and orchard longevity.
- Track nitrogen and water use efficiency (NUE and WUE) of respective treatments.
- Estimate overall profitability and final efficiency of each treatment for 18 to 24 years of orchard life given achieved yields and tree decline.

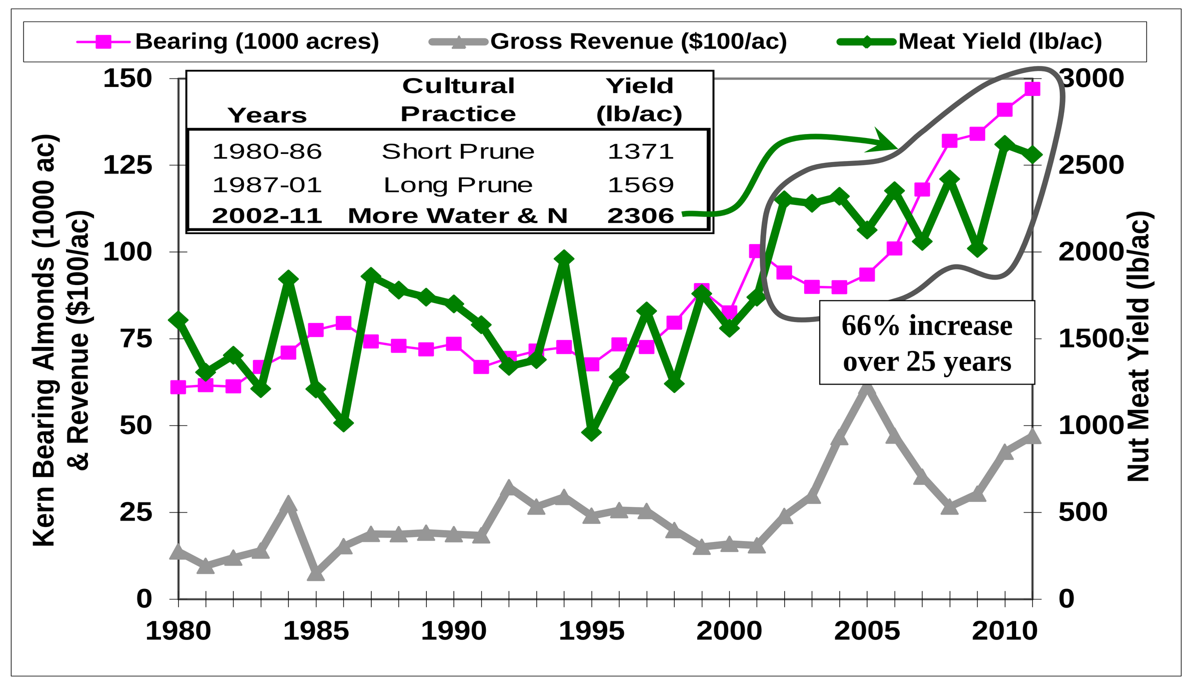

Fig 1. Changes in Kern almond acreage and yield, 1980-2011.

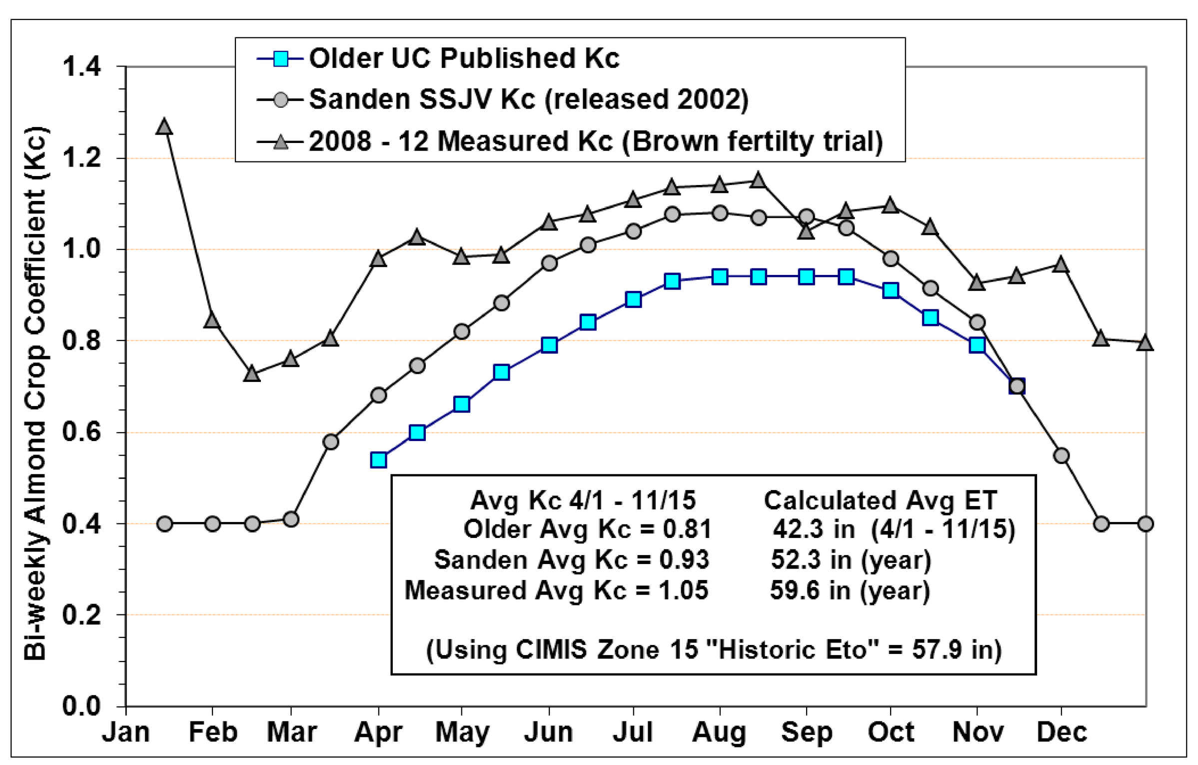

Fig. 2. Comparison of older published crop coefficients, Kc, for almonds to current practice (Sanden SSJV) and the average of actual 2008-2012 measured values from the Brown fertility trial.

Materials and Methods

Site Layout: A 9th leaf 150 acre Nonpareil/Monterey almond orchard in NW Kern County with three 51 acre sets irrigated with microsprinklers (2 Fanjets applying 1.65 in/day) was selected for this trial starting February 2008. The eastern 2 sets (uniform Milham sandy clay loam) were used for the Brown fertility trial, which had a total of 12 different fertilizer treatments. For this trial we have retained the differential N rates used in the Brown trial with 8 replicated blocks. For the last 6 years these plots have also received 200-300 lb./ac K and 60-80 lb/ac P.

As of 2013 we now have two irrigation rates: the more conservative application of 48-50 inches scheduled by Paramount and a 16% increased rate (45-58 inches) by adding two 2 gph pressure compensating drip emitters/tree.

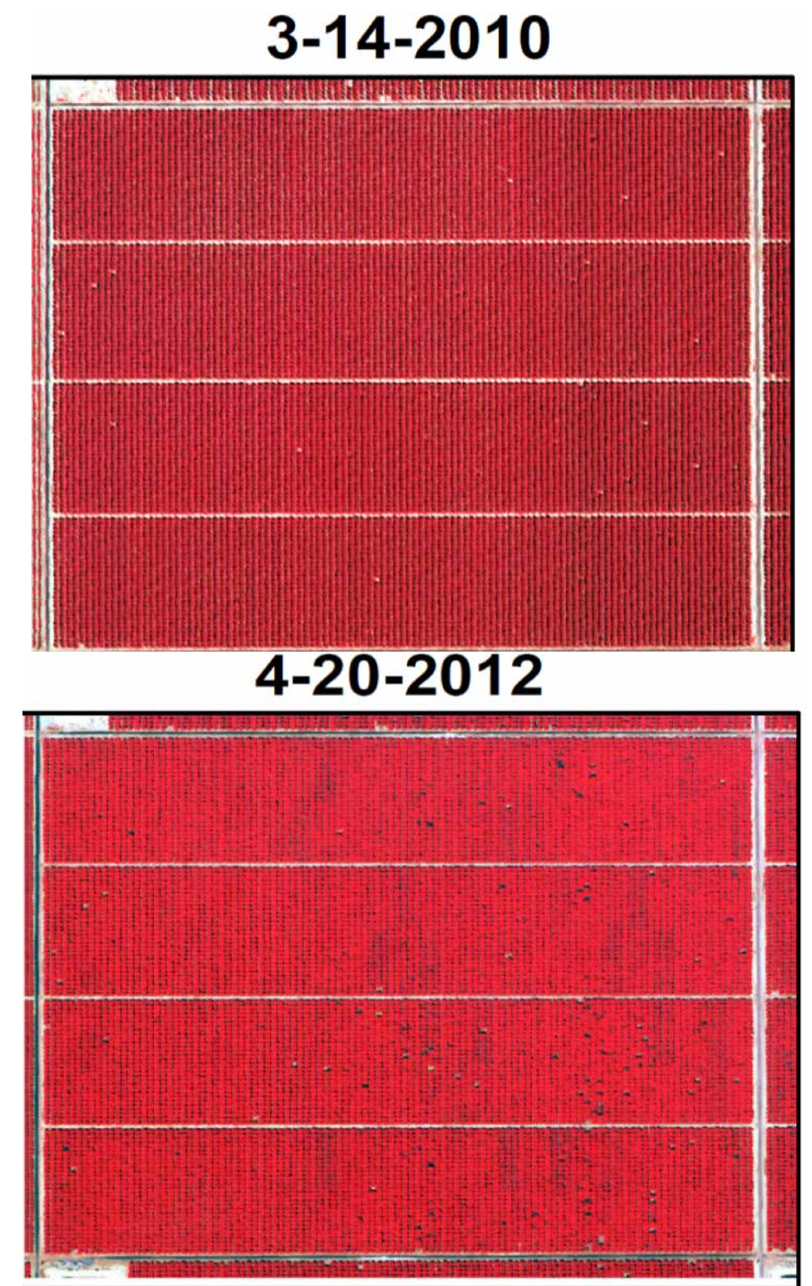

Fig. 3. Colorized normalized differential vegetative index (NDVI) comparing 2010 with 2012.

FERTILITY MANAGEMENT

Winter banded base of 125 lb/ac K as K2SO4. In-season fertigation of 75 lb/ac K as KTS. Variable rates of N (UN32) below applied with fertigation. Fertigation is done 4 times/year: 20% bloom, 30% April, 30% June, 20% post-harvest.

Treatments

Nitrogen rates

125, 200, 275

Irrigation rates

48, 56 inches (+16%)

Plot size

15 Nonpareil flanked by 15 Monterey trees either side.

Fig 4. Defoliation in Nonpareil and Monterey (10/6/11).

Fig 5. Late Nonpareil harvest with significant leaf drop, but unstressed trees with full canopy and excellent shoot/spur development for 2013 (9/6/12).

Results and Discussion

From 2009 through 2012 hull rot has been a problem, generally increasing every year. Alternaria and rust appeared starting 2011, but kernel yields increased every year from 2009-11, averaging 3,960 lb/ac/yr over this three year period for the 275 lb/ac N treatment for the plots in this study. In 2012, yields crashed to 899 lb/ac (Figure 8.a.); most likely due to carbohydrate depletion, poor bloom conditions, some frost and severe stress /defoliation starting in August 2011(Figure 4) resulting from low levels of soil moisture after attempts to control hull rot with regulated deficit irrigation during hullsplit. Some tree SWPs reached -20 bars. During 2012 there were four fungicide applications, but still significant infestations of hull rot, some rust and some alternaria accompanied by leaf drop over the season. But irrigation scheduling was done to maintain non-stress conditions in the orchard (average SWP = -8.1 bars) with a final 57.7 inch ET. The result was excellent shoot growth and full canopy (Figure 5). The concern, however, is that high levels of ET combined with high levels of N fertilizer predispose these trees not only to higher yields but also more disease and potentially early decline. This concern is partially illustrated in Figure 3 which shows a significant number of trees died and were pulled during the 2010 and 2011 seasons. This figure also illustrates the decline in tree vigor in the 125 lb/ac N fertilizer plots. Tracking the yield / ET of individual trees in this earlier trial indicated no consistent yield advantage above and ET of 52 inches.

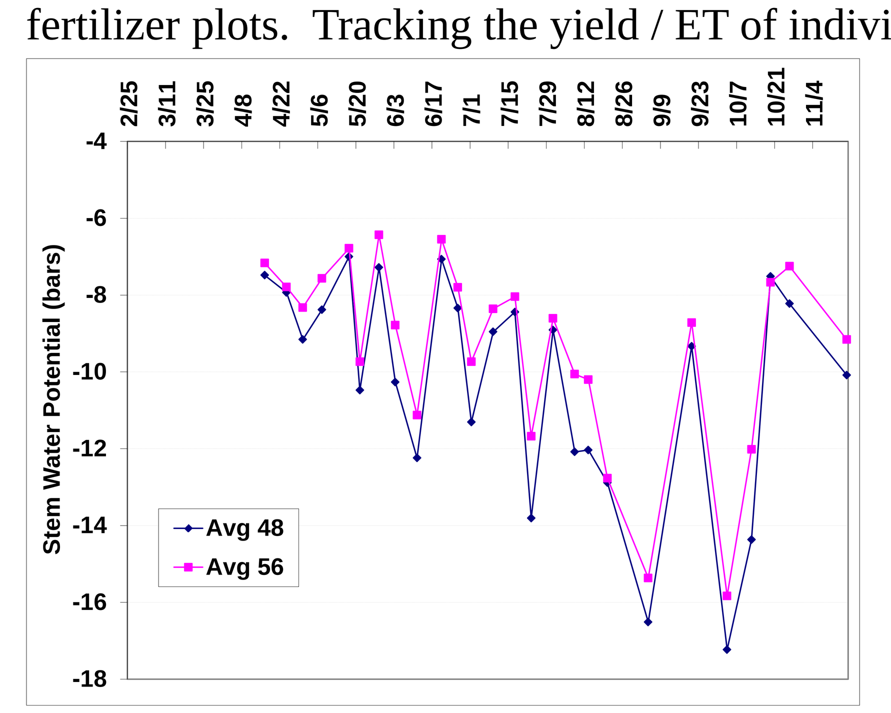

Fig 6. Stem water potential measurements (using bagged leaves) for the 2013 season .

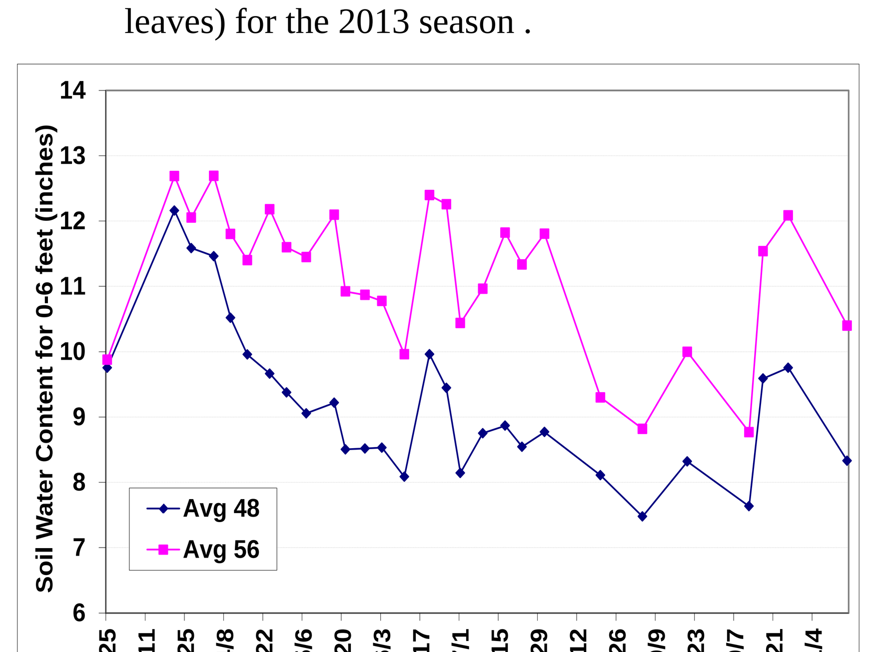

Fig. 7. Changes in rootzone volumetric water content for the 2013 season.

Very dry spring weather helped reduce disease pressure in 2013 resulting in only two fungicide sprays and much reduced hull rot. There was minimal separation in SWP between the 48 and 56 inch irrigation treatments (except for August during Nonpareil harvest (Figure 6)) despite the significant depletion of stored rootzone soil moisture in the 48 inch treatment by mid April (Figure 7). Given the similarity of SWP as an indicator of tree stress we did not expect to see an irrigation response this year, but Figure 8.b. shows that there was both a highly significant irrigation response (gain of 346 lb/ac for the 56 inch irrigation @ 3,824 lb/ac, P=0.0056) as well as the expected fertilizer N rate response (P=0.0015).

Conclusions

Orchard yield recovered significantly after the 2012 "off year". The 8 inch irrigation deficit resulted in a 10% yield loss, even though SWP measurements indicated little difference in tree stress. The "higher level" irrigation did not reduce tree health.

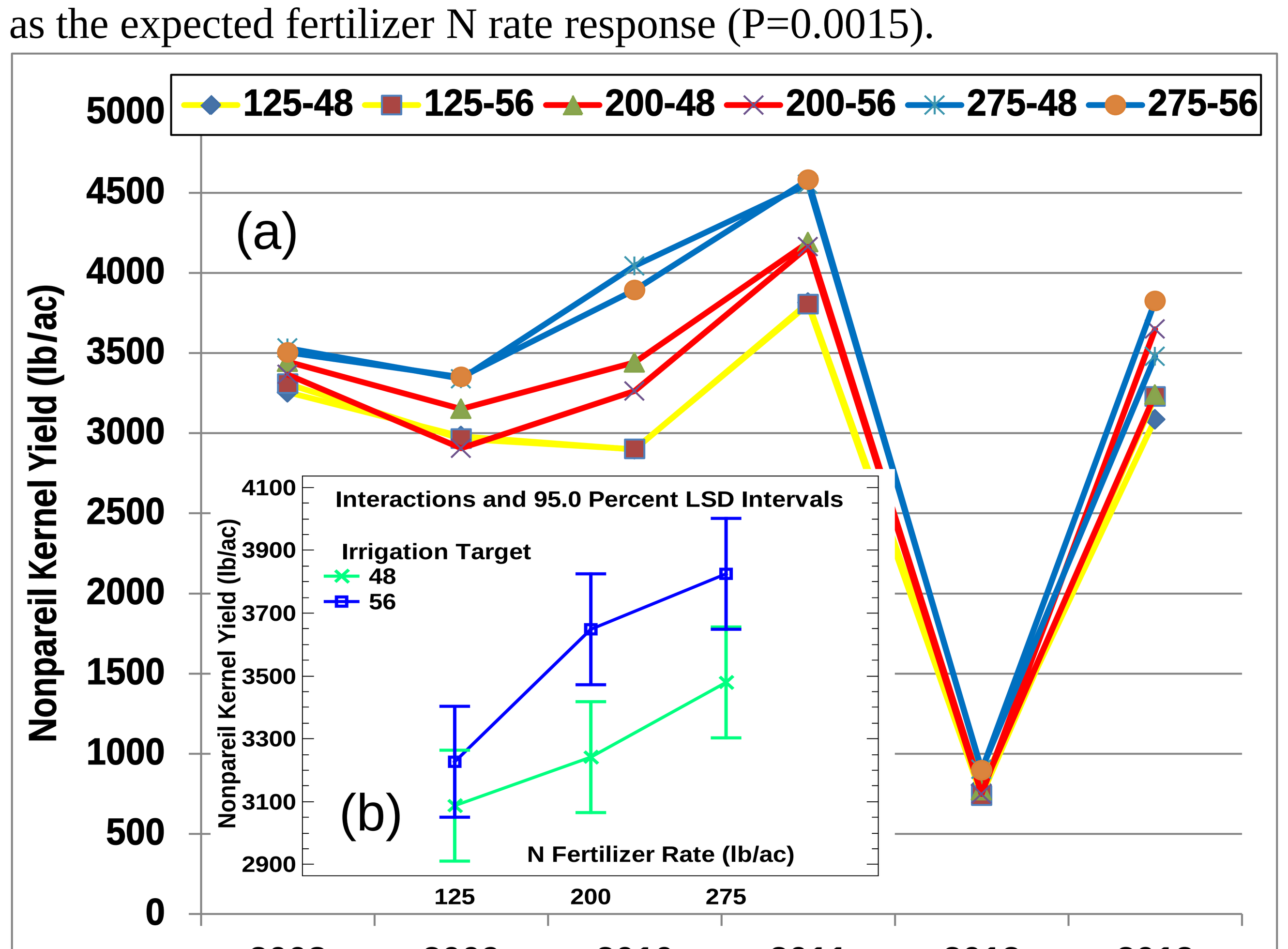

Fig. 8.a. Average kernel yield from longevity plots by fertilizer rate (2008-12) and irrigation (2013 only). 8.b. 2013 treatment yields and LSD error bars.