COMPREHENSIVE PROJECT REPORT
1994-95

Project No. 94-H6 - Residual Effects of Water Deficits and Irrigation Strategies on Almonds

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Objective:

Evaluate the residual effects of water deficits and irrigation strategies on almond under full water conditions.

Background:

The proper use of water in California is a major topic of discussion. Fueled by drought conditions, a suggestion often overheard is that the tree growers can easily reduce tree water use during periods of water shortage. Additionally, when the water shortage is alleviated, full irrigation could be resumed with no long-term crop effects. Such a management strategy has not been verified and is therefore essential that information be developed before adoption of such a strategy.

A recently completed project (Project No. 93-H5, Effects of Water Supply and Irrigation Strategies on Almonds) provides the ideal conditions to measure the residual effects of water deficits.

Imposed treatments included one treatment which provides water for full consumptive use (100% ET) and four treatments which provide for less than full water use (70% and 50% ET) on a seasonal basis while imposing water deficits during either midseason or postharvest. A sixth treatment (Pii or plant-indicated irrigation) utilizes leaf water potential as an indicator of plant water status for scheduling irrigations after June 15, rather than using set values of water use and static times of deficit imposition. Treatments were imposed beginning in the 1990 season and continued through the 1993 season.

Site:

After four years of imposed treatments (six), two treatments had no significant difference in yield while the other four were reduced as much as 36 percent in the 1993 season. In this current trial, the full water requirement was applied to all previous water quantity and timing treatments.

This study is conducted in cooperation with San Joaquin Delta College, using part of their teaching farm orchard located near Manteca, California. A 10-acre block of 14-year-old trees will be used as the experimental area. The orchard is planted to 50 percent Nonpareil and equal numbers of alternating rows of Peerless and Price. The soil is a sandy loam of moderate depth with ground water of excellent quality used for irrigation. Irrigation is provided by a solid set sprinkler system.

Summary of Previous Trial Results:

After four years of imposed irrigation treatments varying the amount of water and timing of its use, we found significant differences in yield, progression of hull split, hull tights and vegetative growth (weight of prunings). No differences were found in other quality parameters (Tables 1 and 2). Yield reductions are primarily a result of fewer nuts per tree as well as a small component due to decreased nut size. In high-set years, nut number is of greatest importance while in low-set years, kernel size takes on increased importance. The reduced vegetative growth occurring in the less than full water use treatments also contributes to reduced potential nut load by having less fruitwood.

One of the most encouraging treatments was the plant indicated irrigation (Pii, Treatment 6). Over the four-year duration of the experiment, this strategy has resulted in 93% of the yield of the full water treatment while using an average of 66% of the water. Of concern was the slight lack of vegetative growth observed, which may lead to a long term production decline.

This method of using a pre-dawn leaf water potential threshold of -12 bars to schedule irrigation looks promising as a strategy to minimize the effect of a reduced water supply.

Table 1.

Previous Treatment	Combined Years, 1990-93				
	Nuts/Tree x1000	Kernel Wt	Pruning Wt lbs/tree	Green Tip %	Hull Tights Wt % of Meat Yield
1 (100% use)	15.8 AB	1.28 A	38.8 A	3.3 AB	0.7 B*
2 (70% use) (postharvest deficit)	13.7 D	1.22 B	25.6 C	3.2 AB	0.3 B
3 (70% use) (midseason deficit)	14.1 CD	1.09 DE	27.1 C	4.2 A	4.8 B
4 (50% use) (midseason and postharvest deficit)	15.2 ABC	1.12 D	32.2 ABC	2.0 B	0.5 B
5 (50% use) (midseason deficit)	14.6 BCD	1.08 E	27.7 BC	4.6 A	23.1 A
6 (Pii)	16.3 A	1.17 C	34.4 AB	4.1 A	0.5 B
P-value	0.0012	0.0	0.003	0.039	0.0

* Common letters among means within columns denote no significant difference at $P \leq 0.05$.

Table 2.

Treatment	Combined Years, 1990-93			
	Percent Seasonal Use	Consumptive Water Use (in)	Average Yield (lbs of kernels/acre)	Relative Yield % of Treatment 1
1 (100% use)	100	37.4	3358 A	100
2 (70% use) (postharvest deficit)	72	26.9	2755 BC	82
3 (70% use) (midseason deficit)	66	24.7	2572 C	77
4 (50% use) (midseason and postharvest deficit)	52	19.8	2841 B	85
5 (50% use) (midseason deficit)	50	18.5	2623 C	78
6 (Pii)	66	24.7	3136 A	93
P-value			0.0054	

* Common letters among means within runs denote no significant difference at $P \leq 0.05$.

1994 Practices and Procedures:

All six previous treatments were irrigated equally to meet the full mature almond tree water requirement. An on-site CIMIS weather station was used to estimate full water use. Neutron probe measurements were used to verify adequate irrigation and to ensure adequate water storage during orchard floor harvest preparation and harvest. A measurement of 7.5 inches of water was used from soil storage, while 40.0 inches of irrigation was applied to accommodate the estimated 39 inches of total seasonal water used. All treatments were postharvest irrigated after harvest of the Price variety.

1994 Results:

Data was collected on both Nonpareil and Price varieties. This report contains only data for the earlier harvested Nonpareil variety.

Yield: Treatment 1 (previous full water treatment) yielded significantly more meats per acre than all other treatments at 3684 lbs/acre (Table 3). Treatments 2, 4 and 6 yielded nearly at about a 10 percent reduction, or 350 lbs/acre less than the previous full water treatment. Treatments 3 and 5 were similar at about a 20 percent reduction from the previous full water treatment. Treatments previously receiving full water (T1) or those not experiencing midseason water deficits out-performed those treatments with midseason water deficits and a postharvest irrigation.

The largest single factor responsible for yield differences in 1994 was nut load (nuts/tree) (Table 4). A simple regression analysis shows a good relationship with a linear

correlation coefficient of 0.87 on a R^2 of 76% (Figure 1). This supports the notion that nut load is mostly a result of increased vegetative growth. It was found that the vegetative growth, measured as prunings, was related to the nut load (Figure 2). Another factor related to yields of meats/acre is the previous year's (1993) yield (Figure 3).

Hull Split: Hull split progressed slower with the previous 1990-93 full water treatment; however, by August 25, all were hulls were fully split (Table 4).

Quality Parameters: No significant differences were found in the number of or weights of: shrivel, doubles, abortions, worms or hull tights.

Green Tip: Green tip is a physiological phenomenal resulting in a small, green-colored area inside the kernel which is easily visible when the nut is split. Previous treatments 3 and 5 (those withheld water during midseason and later supplied with a postharvest irrigation) were found to have a significantly higher percentage of green tip (Table 4).

A simple regression between yield components of kernel weight, meat yields/acre, nut load and previous water treatment resulted in the best fit with meat yield alone (Figure 1). The linear line fit (correlation coefficient) is -0.68. Forty-six percent of the increase in green tip is related to reduced yield. This data suggests that the increase in green tip is also related to the timing of previous water deficits.

Table 3.

Previous Treatment	1994 Season		
	Avg Yield lbs kernel/acre	Yield Relative to Treatment 1 (%)	Avg Kernel Mass (g)
1 (100% use)	3684 A*	100	1.22 B
2 (70% use) (postharvest deficit)	3333 B	90	1.30 AB
3 (70% use) (midseason deficit)	2961 C	80	1.27 B
4 (50% use) (midseason and postharvest deficit)	3210 B	87	1.37 A
5 (50% use) (midseason deficit)	2895 C	79	1.28 B
6 (Pii)	3331 B	90	1.36 A
P-value	0.0000		0.0142

* Common letters among means within columns denote no significant difference at $P \leq 0.05$.

Table 4.

Previous Treatment	Hull Split Percent 8/5/94	8/10/94	8/19/94	1994 Season Nut Load nuts/tree (x1000)	Prunings lbs/tree	Green Tip % of Nuts
1 (100% use)	47 B*	74 B	95 C	18.1 A	19.1 A	1.4 C
2 (70% use) (postharvest deficit)	75 A	94 A	100 A	15.5 B	13.5 B	4.8 B
3 (70% use) (midseason deficit)	79 A	94 A	100 A	14.0 C	8.1 C	7.8 A
4 (50% use) (midseason and postharvest deficit)	74 A	89 A	99 AB	14.2 C	14.4 B	3.5 BC
5 (50% use) (midseason deficit)	70 A	88 A	95 BC	13.7 C	9.0 C	6.0 AB
6 (Pii)	81 A	94 A	99 AB	14.7 BC	14.3 B	4.3 BC
P-value	0.0430	0.0033	0.0222	0.001	0.0010	0.0082

* Common letters among means within columns denote no significant difference at $P \leq 0.05$.

FIGURE 1.

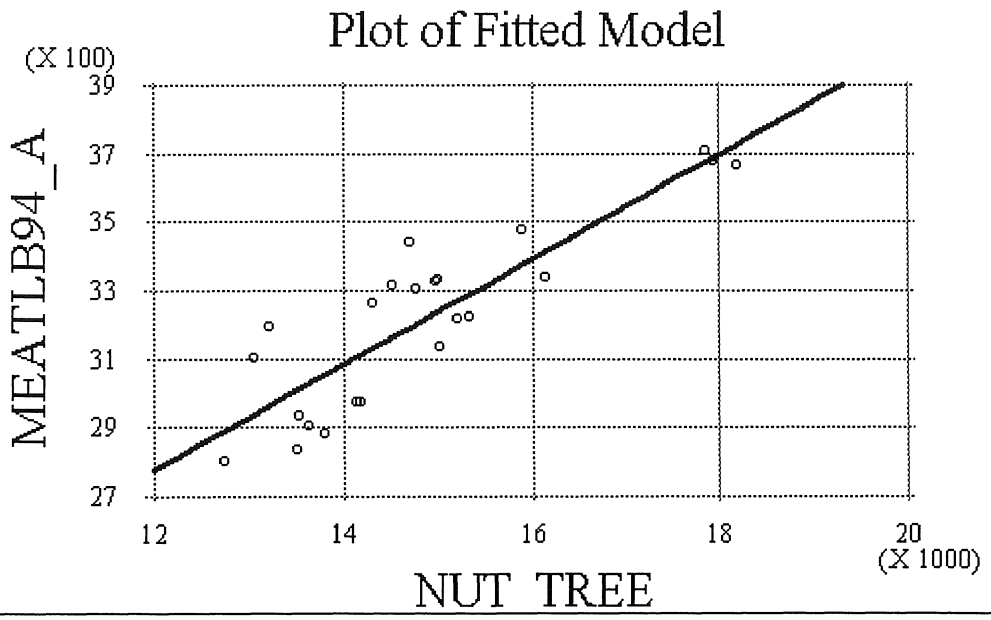

FIGURE 2.

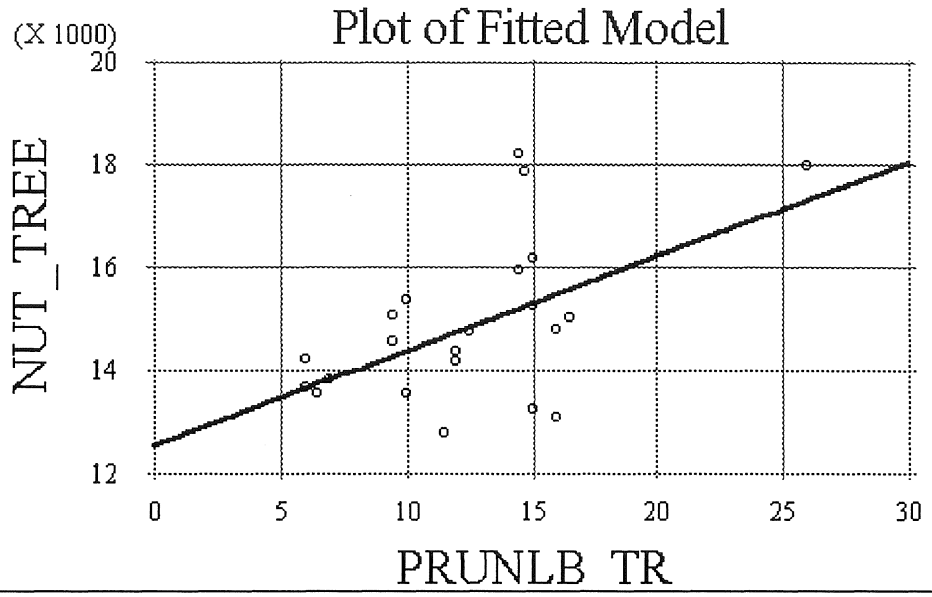

FIGURE 3.