COMPREHENSIVE PROJECT REPORT
1992-93

Project No. 92-H4 - Effects of Water Supply and Irrigation Strategies on Almonds

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Objectives: (1) Determine the relationship between seasonal consumptive water use and the growth, yield and quality of almonds. (2) Evaluate irrigation strategies to maximize plant performance given limited water supply on a short term and sustained basis. (3) Further define crop coefficients (K_c) to be used for advanced irrigation scheduling techniques.

Interpretive Summary

California almond orchards are highly dependent on adequate irrigation for production of acceptable and consistent yields of a quality crop. Quantity and proper timing of irrigation water is of paramount importance in regards not only to yield and quality, but to orchard longevity, disease suppression, and insect damage control. From a grower's perspective, enhanced irrigation management can also reduce energy use and optimize available water use. These incentives have been reemphasized by drought conditions in the mid-1970's and over the past few years.

Recent reports of studies concerning grapes and other deciduous trees indicate that providing less than full consumptive water use can have minimal impact on sustained production and quality. For deficit irrigation to be successful, however, a deficit irrigation strategy must be defined which can provide water during the sensitive vegetative and reproductive growth stages. This project directly addresses this topic.

Determining the relationship between consumptive water use and almond performance on a sustained basis requires imposition and evaluation of treatments over more than one season. This study is being conducted in cooperation with San Joaquin Delta College, using part of their teaching farm orchard near Manteca, California. The soil is a sandy loam irrigated by a solid set full cover sprinkler system able to irrigate individual plots. Our study area consists of a 10-acre block of 12-year-old trees, arranged in alternating rows of three varieties -- Peerless, Price, and Nonpareil. All measurements are made on the Nonpareil and Price cultivars.

Imposed treatments include 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 primarily 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 throughout the entire season, 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 1992 season.

Review of 1990 Results

As a result of the first year of treatments, no significant differences in yield or other measured quality parameters was observed. Hull split, however, progressed at a slower rate, ultimately resulting in significantly more hull tights in Treatment 3 (50% ET) and Treatment 5 (70% ET)--both treatments with stress occurring midseason--when compared to their postharvest stress counter-parts (Treatment 2 and Treatment 4).

Review of 1991 Results

The full water use treatment (Treatment 1) produced a significantly greater yield than those of other treatments with the single exception of the plant indicated irrigation treatment (Treatment 6) which also exhibited a high yield. Fifty percent hull tights resulted in Treatment 5 (midseason deficit) while all other strategies resulted in less than 1.5%.

While spreading the deficit over both midseason and postharvest (Treatment 4, 50% ET), the same volume of water was seen as a preferred strategy when compared to midseason deficit only. Hull tights were avoided in Treatments 2 and 3 by the virtue of irrigation near the beginning of hull split. No significant differences were found in other measured quality parameters or pruning weights. No significant difference in bloom or set was found.

1992 Results

Again, as in 1991, the full water use treatment (Treatment 1) and the plant indicated irrigation treatment (Treatment 6) produced significantly higher yields than all other treatments (Table 1.)

No significant differences were found in other quality parameters of the 1992 harvest. Incidence of worms, mold, ant damage, shrivels, and doubles were similar throughout all treatments.

Yields were down in 1992 in comparison with 1990 and 1991, as were those of the entire industry. Yields were reduced with less than full water use treatment with the exception of Treatment 6. The lack of differences between the reduced ET strategies may be a result of the warm spring and moderate preharvest conditions, culminating in an early harvest and minimizing the physiological ramifications of reduced water supply. These conditions may also explain the lack of hull tights in any of the treatments (Table 2). As evidence, pre-dawn leaf measurements at beginning of hull split were only -12 bars when compared to 1991 of -20.5.

Table 1.

Treatment	Percent Seasonal Use	Consumptive Water Use (in)	Average Yield (lbs of kernels/acre)	Relative Yield (% of Treatment 1) 1992	1991 + 1992
	1992				
1 (100% use)	100	38.6	2,586 A *	100	100
2 (70% use) (postharvest deficit)	70.3	27.1	2,180 B	84	81
3 (70% use) (midseason deficit)	59.8	23.1	2,060 B	80	64
4 (50% use) (midseason and postharvest deficit)	51.6	19.9	1,880 B	73	74
5 (50% use) (midseason deficit)	42.0	16.4	2,053 B	79	77
6 (Pii)	67.4	26.0	2,495 A	96	93
P-value			0.10		
C.V.			17.8%		

* Common letters among means within runs denote no significant difference at $P \leq 0.10$.

Table 2.

Treatment	1992 Hull Splits (%) 7/7	7/14	7/20	7/28	Hull Tights %	Pruning Wt #/acre
1 (100% use)	18.3	36.7 B	60.0 B**	100	0	2117 A
2 (70% use) (postharvest deficit)	21.3	73.8 AB	96.2 A	100	0.13	907 B
3 (70% use) (midseason deficit)	27.5	73.8 AB	93.8 A	100	0	775 B
4 (50% use) (midseason and postharvest deficit)	16.3	86.3 A	98.8 A	100	0	624 B
5 (50% use) (midseason deficit)	6.3	51.3 AB	77.5 AB	100	0	756 B
6 (Pii)	7.5	62.5 AB	80.0 AB	100	0	1606 A
P-value	n.s.	0.03	0.035	n.s.	n.s.	
C.V.		34.6%	9.5%			

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

Bloom and set were measured in both 1991 and 1992 as flowers or set per 60 cm branch (Figures 1 and 2). Significant differences were not found in either year, neither was the percent of bloom that set significantly affected by treatment (Figure 3) The 1992 set was significantly reduced from that of 1991 measured as set count or percent of bloom set.

Pruning weights were measured in 1991 and 1992. No significant differences were found in 1991, although they were significant in 1992 with the full water treatment (Treatment 1) exceeding all other treatments (Table 2).

Summary

After three years of imposed irrigation strategies, we find significant differences in yield, progression of hull split, hull tights and vegetative growth (pruning weights). No differences were found in other quality parameters. Yield differences are a result of less nuts per tree as well as decreased nut numbers. 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 nut load by the virtue of having less fruitwood.

One of the most encouraging treatments is the plant indicated irrigation (Pii, Treatment 6). Over the three-year duration of the experiment, this strategy has resulted in 95% of the yield of the full water treatment while using an average of 66% of the water. Of concern is the slight lack of vegetative growth observed in 1992, 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 tool to follow an irrigation strategy to minimize the effect of a reduced water supply.

Figure 1. **Bloom Counts**

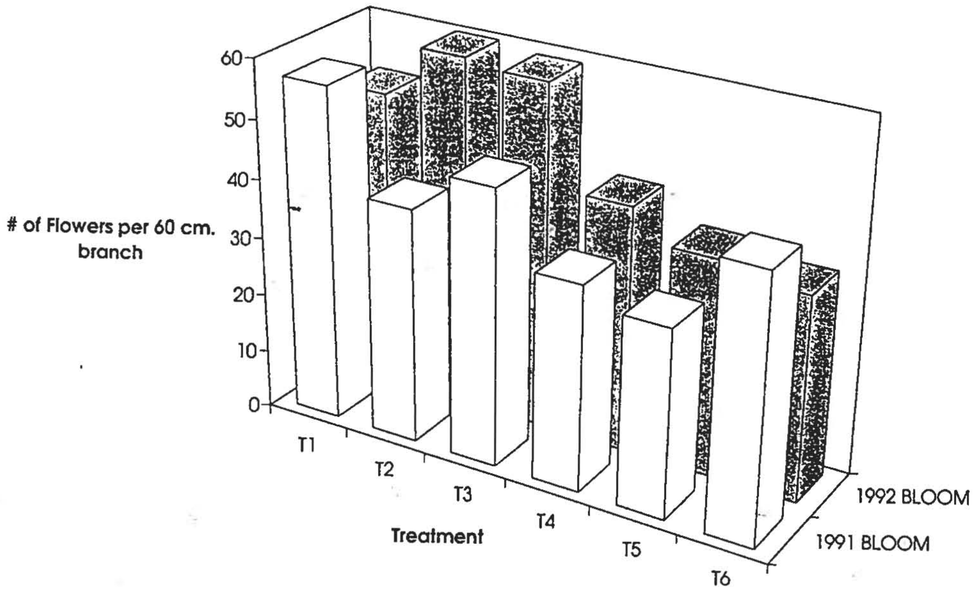

Figure 2. **Set Counts**

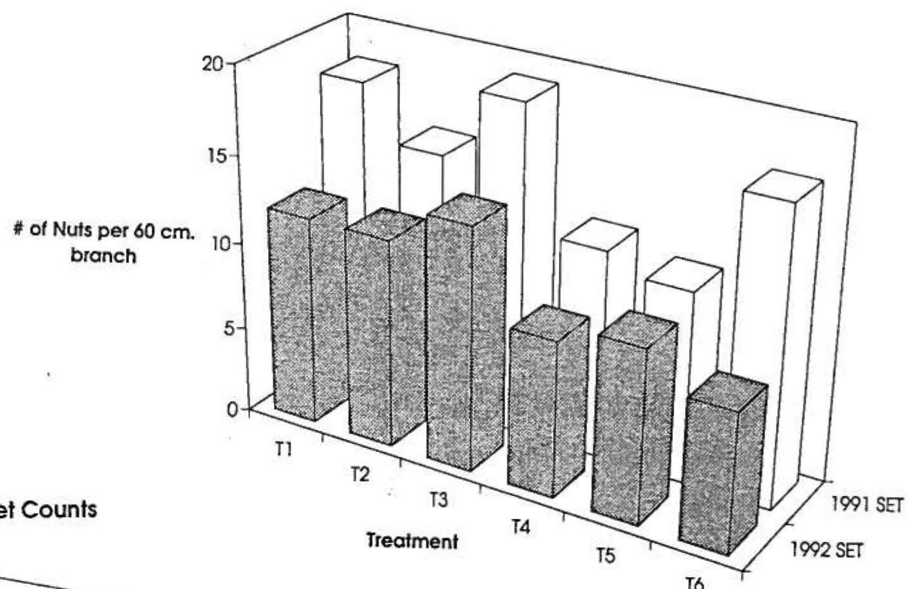

Figure 3. **% Set Counts**