Correct Project Number: 90-I2

Project No. 91-I3 - Irrigation Cutoff and Drought Irrigation Strategy Effects on Almond

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Objectives:

1) Cutoff Experiment: To evaluate the effects of eight preharvest irrigation cutoff periods on long-term sustained almond tree productivity. Emphasis is placed on how water stress influences the plant processes that affect the yield components and tree bark damage through mechanical shaking.
2) Drought Irrigation Strategy Experiment: To evaluate irrigation management regimes for a single drought year. Assuming that 16 acre-inches/acre of water were available, four strategies that applied water at different rates and times of the year were imposed in 1989. The trees were returned to full irrigation in 1990 to assess tree recover from a single year of drought.

Interpretive Summary:

Background and Previous Findings:

Cutoff Experiment: This work is being conducted in cooperation with Paramount Farming Co. in Kern Co. Both cvs. Non Pareil and Carmel are being studied but for brevity, only Non Pareil data are reported here. Preharvest cutoff treatments range from 52 to 4 days before tree shaking. After imposing the preharvest irrigation cutoff regimes in 1989 and harvesting the trees, the six original replications were divided into two sets of three each. The first set received full postharvest irrigation and the second set received no postharvest water in 1989. In 1990 and 1991, the same preharvest cutoff regimes were followed by full postharvest irrigation in all replications.

For the first two years of this experiment, there were no significant effects of preharvest cutoff duration on total kernel yield provided that the trees received full postharvest irrigation. Hull splitting was decreased in direct relation to the cutoff duration. There was a dramatic decrease in fruit set--the evolution of flowers to nuts--as a result of the postharvest water deprivation. The greatest decrease (a 96% reduction in fruit set) occurred with the earliest preharvest irrigation cutoff (53 days before harvest that applied 21 inches of water) although significant decreases in fruit set were observed with all cutoffs of 25 days or more were followed by no postharvest water. There were no significant effects of the preharvest irrigation cutoff regimes on bloom or fruit set when full postharvest irrigation was applied. It must be emphasized that the experimental orchard has a shallow, relatively low water holding capacity soil. Thus, water stress increases rapidly when water is withheld.

Drought Strategy Experiment: This work took place in Fresno Co. and began in 1989 with the application of four regimes that each applied a total of 16 acre-inches/acre. They ranged from applying all the water early in the season (mid June cutoff) to irrigating with small amounts until the 16 inches of water ran out in late August. Total kernel yields were lower in 1989 when all the water was applied early due to smaller individual kernel size. Although the trees were returned to full irrigation (38 acre-inches/acre) in 1990, total kernel yields were quite low in the trees that received only early water in 1989. Yields in 1990 were significantly higher where water had been stretched out through late August of the previous year. Yields and nut quality were also assessed in 1991 but will not be reported here.

<u>Third Year (1991) Results</u>:

Cutoff Experiment: Yield and yield component data are shown in Table 1. In 1991, we observed lower nut loads in the earlier cutoff treatments; generally 32 days or more. It must be emphasized that this is the first time that an important yield component has been negatively impacted by the preharvest irrigation regimes. This translated into significantly lower total kernel yields for the early cutoffs. As was true in previous years, hull splitting was reduced in proportion to the duration of the preharvest cutoff. For example, with 17.5 inches of preharvest applied water (52 day cutoff) versus 31 inches for the control, there were 38% and 100% full hull split nuts at harvest, respectively. Due to the lower nut loads with the early cutoff and its compensatory effect on individual nut size, we did not observe the clear reduction in nut size in relation to cutoff duration as in previous years when nut loads were similar.

Considerable efforts were made to determine the source of the reduced nut load with the early cutoffs this year. A battery of measurements was made of fruiting characteristics on single branches in the late winter and early spring. No significant differences were found in spur density, nut density, spur length, and nuts per spur (Table 2). Only mild statistical differences were found in bloom density, fruit set, and nut per unit spur length (Table 2). We believe that the reduced nut loads were the result of less fruitwood growth and more shoot dieback with the early cutoffs. Table 3 shows that for the 1990 and 1991 seasons, the total increase in trunk cross-sectional area was inversely related to the duration of irrigation cutoff. For example, there was a 37% reduction in trunk growth relative to the control with the 52 day cutoff. Trunk growth is usually related to shoot growth. Thus, reduced vegetative growth resulted in fewer fruiting positions. Due to partial leaf defoliation of the tree canopies resulting from the early cutoffs, sunlight penetration into the interior of the tree likely enhanced shoot dieback, also reducing fruiting positions.

As in previous years, there was no increase in bark damage even though the trees were irrigated only four days before shaking. We believe that even this short time is sufficient with the shallow soil to harden the bark. Trees on deep soils that do not go into water stress as rapidly would be more subject to bark damage with late irrigation.

Webspinning spider mites were counted in May and June before the imposition of water stress in 1991. There was a direct correlation between mite abundance and the duration of the 1990 preharvest cutoff duration; the earlier the 1990 cutoff, the higher the 1991 mite population. Investigation of this phenomenon is continuing.

Overall Summary of Three Year Experiment:

Although total kernel yields were reduced in the early cutoffs this third year, there were no significant differences in average nut load or yield over the three years of this project (Table 3). This is because nut loads and yields were somewhat higher for the early cutoff treatments last year (Figure 1). Individual kernel weights tended to be less for the early cutoffs (Table 3).

The important yield components over the three years where preharvest cutoffs were followed by full postharvest irrigation in all years are shown in Figures 1-3. Decreased kernel yields with the early cutoffs (32 days or more) that occurred in year three primarily due to lower nut loads indicates that: 1) the effects of preharvest water deprivation on yields may not be observed in a spur bearing species for at least two years after the deprivation due to less shoot (fruitwood) growth, and 2) even with a shallow soil, preharvest cutoffs up to 25 days (about a 6 inch reduction in applied preharvest water) have no significant effects on total kernel yield, although hull splitting will be reduced.

Table 1. Third year (1991) yield component data for trees with different preharvest cutoff periods that received full postharvest irrigation in 1989 and 1990.

Last preharvest irrigation	Cutoff duration (days)	Cumulative preharvest applied water (inches)	Nut load (#/tree)	Mean individual kernel weight (gm)	Total kernel yield (lbs/acre)	Nut Quality: Full hull split	Nut Quality: Partial hull split	Nut Quality: Hull tight
						-- (% of	tree nut	load) --
Jun 25	52	17.5	3272a*	1.19	573a	38.3a	33.0a	29.5b
Jul 1	46	19.3	4411ab	1.36	903ab	65.7abc	10.7c	23.6ab
Jul 8	39	21.1	4364ab	1.30	854a	58.9ab	22.1b	19.0ab
Jul 15	32	22.9	4484ab	1.33	896ab	78.7bc	11.9c	9.4ab
Jul 22	25	25.6	7087cd	1.18	1281abc	87.3bc	6.4c	6.3ab
Jul 29	18	27.4	5035abc	1.15	924ab	93.3bc	3.2c	3.5ab
Aug 5	11	29.2	6847bcd	1.35	1421bc	98.5c	0.6c	1.0a
Aug 12	4	31.0	7772d	1.26	1498c	99.6c	0.0c	0.4a
				NSD				

* Numbers not followed by the same letter are significnatly different than others in the same column at the 5% confidence level using Duncan's multiple range test.

Table 2. Third year (1991) fruiting characteristics for trees with different preharvest cutoff periods that received full postharvest irrigation in 1989 and 1990.

Preharvest cutoff duration (days)	Shoot diameter 60 cm from tip (mm)	Spur density (#/60 cm)	Bloom density (#/60 cm)	Nut density (#/60 cm)	Fruit set (%)	Mean spur length (mm)	Nuts per spur (#)	Nuts per unit spur length (#/mm)
52	7.51	11.8	28.5a*	8.0	28.2bc	27.5	0.687	0.291ab
46	8.87	13.3	27.8a	8.8	31.6c	32.4	0.703	0.269ab
39	7.64	12.4	30.3a	7.4	24.5abc	34.1	0.603	0.230a
32	7.53	12.8	29.3a	7.8	26.7abc	29.2	0.660	0.288ab
25	8.76	11.7	35.7ab	10.4	29.2abc	31.7	0.887	0.365ab
18	9.26	14.3	48.4b	9.6	19.8a	25.4	0.663	0.389b
11	9.13	14.7	38.9ab	11.1	28.5bc	30.1	0.763	0.359ab
4	7.80	11.0	30.0a	9.11	30.7c	28.8	0.923	0.346ab
	NSD	NSD		NSD		NSD	NSD	

* Numbers not followed by the same letter are significnatly different than others in the same column at the 5% confidence level using Duncan's multiple range test.

Table 3. Summary of three year average values (1989-91) for trunk growth and the primary yield components for the eight preharvest cutoff durations. All cutoff regimes received full postharvest irrigation each year.

Cutoff duration (days)	Increase in trunk cross-sectional area[1/] (cm^2)	Nut load (#/tree)	Individual kernel weight (gm)	Total kernel yield (lbs/acre)
52	70.8a*	8643	1.08a	1384
46	92.7ab	9474	1.11ac	1552
39	75.9a	8652	1.13abc	1456
32	94.1ab	7872	1.18abc	1388
25	85.3ab	9526	1.15abc	1684
18	79.4ab	8340	1.13abc	1455
11	102.1ab	8368	1.24b	1574
4	112.0b	9534	1.21bc	1723
		NSD		NSD

[1/] Total for 1990 and 1991 seasons.

* Numbers not followed by the same letter are significantly different than others in the same column at the 5% confidence level using Duncan's multiple range test.

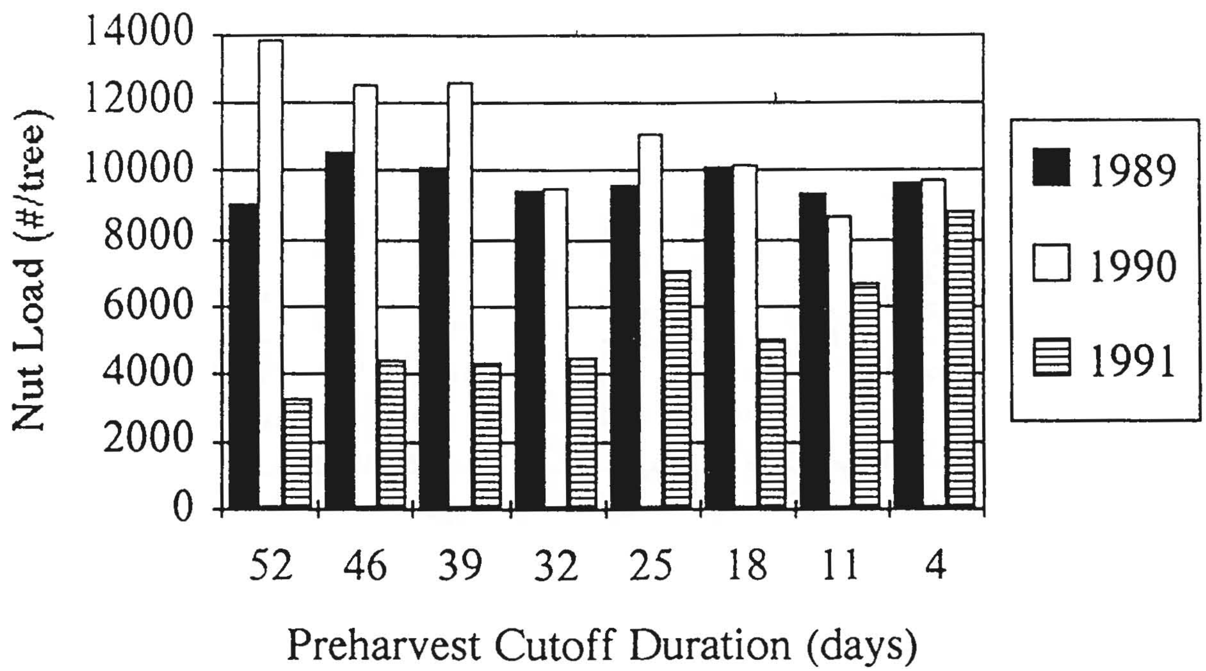

Figure 1. Tree nut load for the 8 preharvest cutoff regimes for each of the 3 experimental years. All preharvest cutoff durations received full postharvest irrigation.

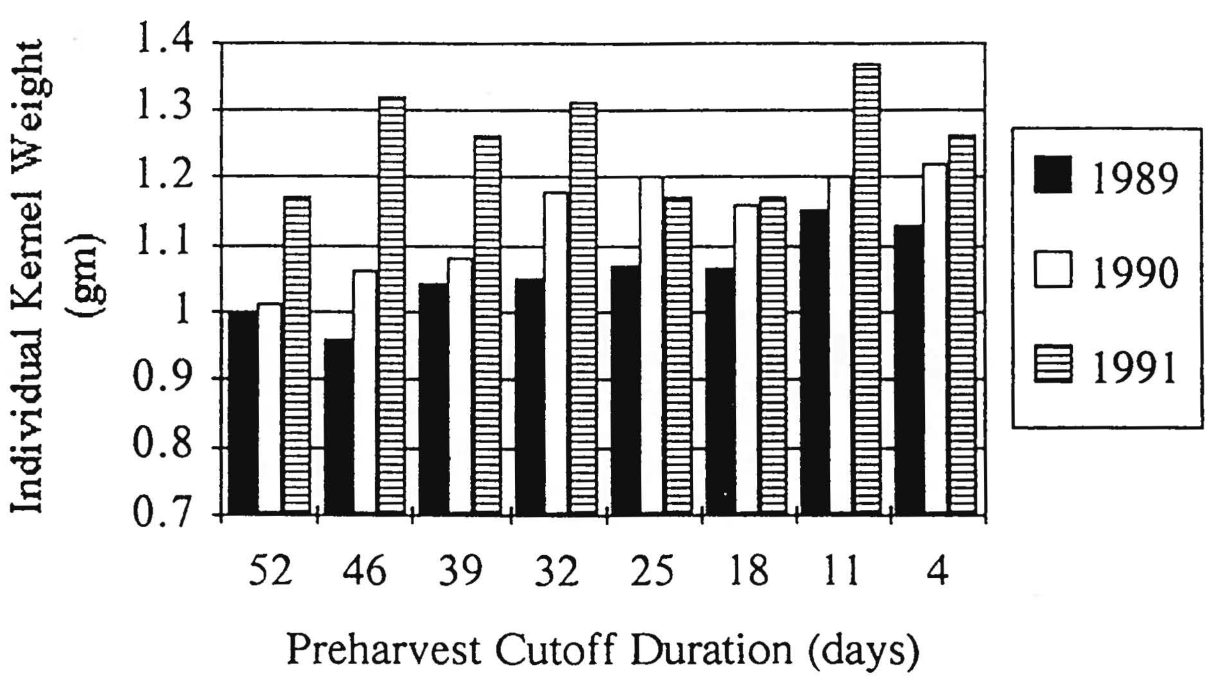

Figure 2. Individual kernel weight (field dried) for the 8 preharvest cutoff regimes for each of the 3 experimental years.

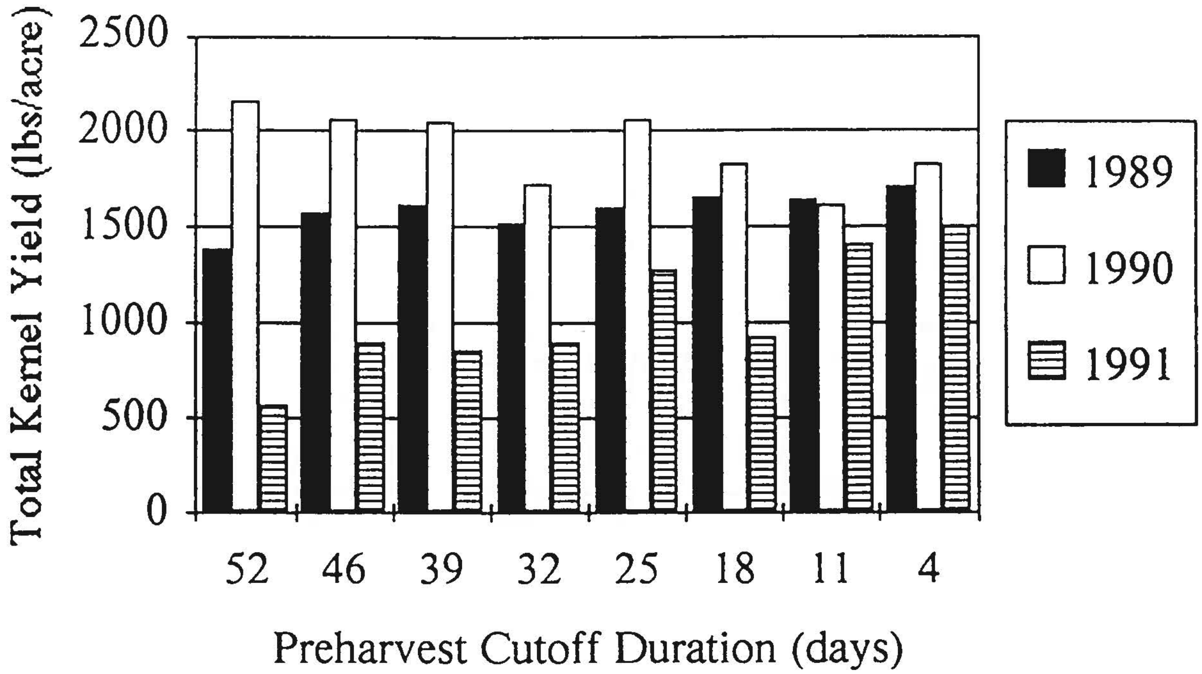

Figure 3. Total kernel yield (field dried) for the 8 preharvest cutoff regimes for each of the 3 experimental years.