WALNUT ORCHARD RECOVERY FOLLOWING A SINGLE DROUGHT YEAR

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ABSTRACT

To evaluate the effects of limited water supplies on production, a one year drought was simulated in 1989 on mature conventionally spaced cv. Chico walnuts. Controlled deficit irrigation (CDI), an irrigation strategy that imposes water deprivation during stages of the season when the trees are considered most tolerant of water stress, was used to apply 16 acre-inches/acre (hereafter referred to as inches). CDI yield in 1989 was not significantly different than the fully irrigated (41 inches) control. Individual nut weight was slightly lower and vegatative growth was much less. In 1990, the old CDI trees were returned to full irrigation but the yield was reduced by about 80% relative to the control. This was due to fewer fruiting positions presumably caused by less shoot growth the previous year. Shoot growth in 1990 in the old CDI trees was greater than the control. Production levels in the old CDI trees returned to normal in 1991. This indicates that 'Chico' walnut trees have the potential for a quick recovery from water-stress related yield losses. It must be emphasized that this was facilitated by the absence of any secondary problems such as diseases or pests that can infest a water stressed orchard.

OBJECTIVES

To evaluate the short and long term production effects of a CDI strategy applied during a simulated drought year in 1989. A CDI regime was developed based on our previous work and applied only 16 inches of water in 1989 vs. about 42 inches for fully irrigated trees. Production was also evaluated after the old CDI trees were returned to full irrigation in 1990 and 1991 .

PROCEDURES

Under drought conditions, some irrigation districts have plans to drastically cut water deliveries to growers; the figure of 16 inches of water is one commonly proposed. Thus, this project was designed to evaluate a strategy that best applied this limited amount of water. A block of cv. Chico trees (22 x 22 ft spacing) planted in early 1982 at the Kearney Ag. Center and grown under full irrigation was used for this work. Our previous work showed that tree growth, nut expansion, and stomatal conductance peaked early in the season although was significant overlap in these processes. A CDI regime was designed to apply relatively large amounts of water in the spring and progressively less as the

season advanced. The 1989 CDI regime was based on applying certain percentages of estimated ETc (Table 1).

A randomized complete block design was used with three replications of three treatments, which included two sets of the CDI treatment. The original plan was to stress trees for both one and two years followed by a return to full irrigation. However, crop load variability was such that the second set of CDI trees could not be used in any comparison with the nonstressed trees. This resulted in simulating only a one year drought and the second set of CDI trees was used for a test of heavy vs. no pruning following a drought year. The results of that experiment are reported in the paper, "Effects of Post-Drought Year Pruning on the Recovery of Walnut" contained herein.

Each experimental plot contained eight trees and was isolated with respect to irrigation treatments by heavy wall polyethylene sheeting that was installed to a depth of 4 ft midway between trees. Water was applied using circular microsprinklers positioned in the tree rows 5.5 ft from the tree (2 per tree). Orchard water use (ETc) was estimated from reference crop water use (ETo) and previously determined crop coefficients (Kc). Since we have evidence that conventionally spaced trees have somewhat higher Kc's than hedgerow trees and we didn't want water stress in 1990 and 1991, the hedgerow Kc's were increased by 10%.

In early 1990, selective 50% heading cuts of one year old whips (shoots) were made on the 100% ETc trees. The old CDI trees were similarly pruned although only about 1/3 as much wood was removed due to less shoot growth in 1989. No thinning cuts were made.

The orchard was harvested in mid September with a commercial shaker and individual tree weights were determined. Composite nut samples for each plot were taken, dried, and analyzed by Diamond Walnut Growers, Inc. for nut component weights (shell and kernel), size (commercial classifications), and quality.

RESULTS AND DISCUSSION

Applied Water

Following the simulated drought year in 1989 where 16 inches were applied to the CDI trees, 48.7 and 42.5 inches were applied in the recovery years of 1990 and 1991, respectively, to the entire block including the 1989 CDI plots.

Plant Water Status

Predawn leaf water potentials were generally in the -2.0 to -3.0 bar range during the four measurement days in 1991. Based on previous work, this confirms that the trees were not under water stress due to inadequate irrigation this season.

Nut Yield and Fruit Load

Marketable nut yields and fruit loads in 1991 were modestly higher for the 1989 CDI trees when compared with the fully irrigated (100% ETc) 1989 trees (Table 2). However, the increases were not statistically significantly different at the 5% confidence level using Duncan's Multiple Range Test.
Apparently the relatively high rate of vegetative growth attained by the old CDI trees in 1990 (and reported in last year's paper) was sufficient to result in slightly more fruiting positions in 1991 relative to the control. Shoot growth is important since fruit is borne on the previous year's wood.

The somewhat heavier yield of the 1989 CDI trees resulted in a slightly lower individual nut weight that was again not statistically significant (Table 2). Commercial nut size characterization showed a narrow shift toward smaller sizes for the old CDI trees but no statistically significant differences occurred (Table 3). There was no difference in kernel percentage.

Nut Quality

There were no statistically significant differences between the 1989 CDI trees and the control (Table 4).

SUMMARY OF THE THREE YEAR EXPERIMENT

Effects of the single drought year (1989) CDI strategy on yields for that and the following two seasons are shown in Figure 1. In 1989, there were no significant yield differences even though only 16 inches of water were applied using the CDI compared with 41 for the 100% ETc trees. The small 1989 yield decrease that did occur was due to a somewhat lighter nut (Figure 3).

Yields of the old CDI trees were about 80% lower than the control the following season (1990) even though the trees were returned to full irrigation (48.7 inches). This illustrates the carryover effects of tree-water stress on subsequent production. The yield loss was due primarily to a drastic decrease in nut load (Figure 2). This presumably was a consequence of less shoot growth in 1989 reducing the number of fruiting positions in 1990.

The return to full production and excellent nut quality this season (1991) of the 1989 drought trees indicates that 'Chico' walnut trees have the potential for a quick recovery from water-stress related yield losses. It must be emphasized that this was facilitated by the absence of any secondary problems such as diseases or pests that can infest a water stressed orchard.

Since the goal of CDI is to save water by the regulated application of water stress while limiting the negative effects on production, the 1989 CDI regime used in this work cannot be consider successful except as a drought year strategy. It must be

noted that our other research suggests that the application of only 16 inches of water (about 40% of normal) for a single season using CDI would result in less severe production losses in pistachio, almond, and prune than those observed in this work in 1990. Thus, walnut does not appear to be a good candidate for using CDI to conserve water in other than serious drought years.

Table 1. Controlled deficit irrigation (CDI) strategy used to apply 16 inches of water for the 1989 simulated drought year.

Period	Applied (% ETc)
through March 15	0
March 16-April 30	85
May 1-May 15	75
May 16-May 31	65
June 1-June 30	50
July 1-September 7 (harvest)	25
Postharvest	0

Table 2. Second recovery year (1991) harvest and fruit load related data.

Treatment	Yield dry in-shell[1/] (lbs/acre)	Fruit load (nuts/tree)	Individual nut weight (gm/nut)	% Kernel
1989 100% ET_c (41 inches)	7033	4100	8.6	47.9
1989 CDI (16 inches)	7758	5018	7.8	49.5
	NSD	NSD	NSD	NSD

[1/] 8% water content by weight.

NSD indicates no significant differences in the column.

Table 3. Second recovery year (1991) commercial nut size categories.

Treatment	Jumbo	Large	Medium	Baby	PeeWee
	% by #				
1989 100 ET (41 inches)	5.9	14.6	36.4	34.4	11.6
1989 CDI (16 inches)	4.2	8.9	21.7	29.1	31.0
	NSD	NSD	NSD	NSD	NSD

NSD indicates no significant differences in the column.

Table 4. Second recovery year (1991) commercial harvest quality parameters.

Treatment	Edible yield[1/]	Large sound[1/]	Off-grade[2/]	Internal damage[3/]	Insect damage[1/] (% by #)	RLI #1[4/]
	% by weight					
1989 100% ETc (41 inches)	47.2	19.9	0.5	0.3	0	38.7
1989 CDI (16 inches)	48.7	14.0	1.1	1.1	0	38.3
	NSD	NSD	NSD	NSD	NSD	NSD

1/ of tree nut load.
2/ of kernels.
3/ of large externally sound nuts.
4/ Reflective Light Index. The higher the RLI, the lighter the kernel color.

NSD indicates no significant differences in the column.

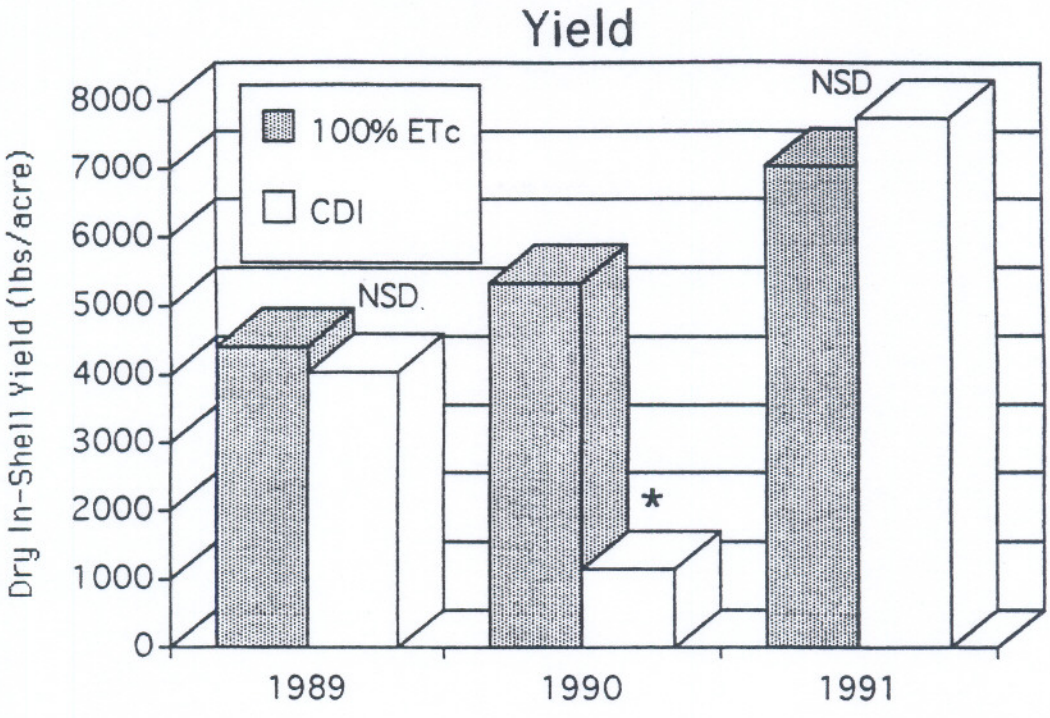

Figure 1. Nut yields for the 1989 CDI and the following two seasons of full irrigation. An asterisk indicates significant difference at the 5% confidence level between the CDI and the 100% ETc trees for a given year. NSD indicates no significant difference.

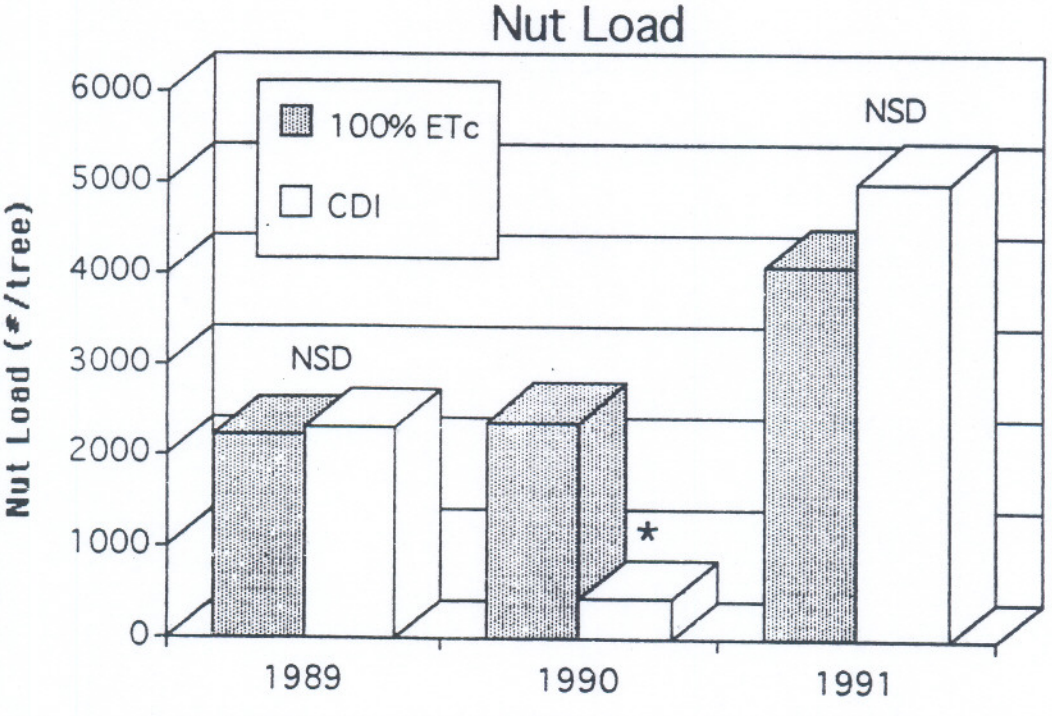

Figure 2. Nut loads for the 1989 CDI and the following two seasons of full irrigation. An asterisk indicates significant difference at the 5% confidence level between the CDI and the 100% ETc trees for a given year. NSD indicates no significant difference.

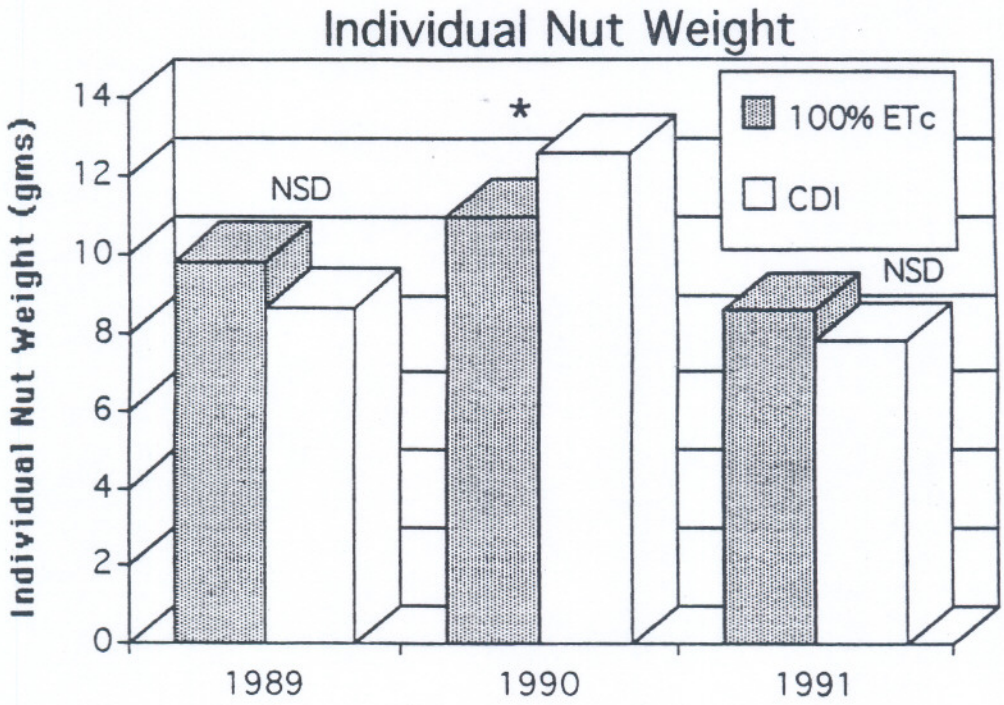

Figure 3. Single nut weights for the 1989 CDI and the following two seasons of full irrigation. An asterisk indicates significant difference at the 5% confidence level between the CDI and the 100% ETc trees for a given year. NSD indicates no significant difference.