SECOND YEAR RECOVERY OF HEDGEROW WALNUTS FROM SUSTAINED DEFICIT IRRIGATION

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ABSTRACT

Hedgerow walnuts (cv. Chico) that were irrigated at 33 and 66% ETc from 1986-88 suffered marketable nut yield reductions of 32 and 50%. Upon returning these trees to full irrigation in 1989, tree growth and water relations immediately recovered but yields were little changed. Harvest yields completely recovered this year (after two years of full irrigation). This indicates that hedgerow walnuts have the potential for rapid recovery from lengthy periods of water deficits. This fast production recovery from severe water stress was possible due to the absence of stress-induced disease or insect pressures. It must be emphasized that the absence of the secondary stress pressures of disease or insects is cultivar and site dependent. "Chico" is more tolerant of heat and water stress-related problems than other cultivars. Trunk diseases such as deep bark canker that occur in many water stressed orchards were not evident in this study.

OBJECTIVES

To evaluate hedgerow walnut tree performance in the second season after returning to full irrigation following three years of sustained deficit irrigation.

PROCEDURES

Hedgerow trees (cv. Chico) at the Kearney Ag. Center were irrigated at 33, 66, and 100% of ETc (full potential water use) from 1986-88, inclusive. These irrigation regimes were each replicated three times on plots that contained 16 trees including borders. Eight trees per plot were monitored. During the three year imposition of water deficits, production-related effects were evaluated as well as changes in tree growth and water status. In 1989, the trees were returned to full irrigation (100% ETc) based on previously-determined crop coefficients (Kc) and reference crop water use (ETo).

Irrigation was accomplished with low volume sprinklers located in the tree row 5.5 ft from each tree. Water was applied two to four times per week. In 1990, 39.4 inches of water were applied. The orchard received 1.0 lb N/tree as UN32 through the irrigation system in mid May.

To verify that the trees were fully irrigated, predawn leaf water potential was determined six times over the season with a pressure chamber. Single leaves on each of four trees per plot for a total of 12 per former irrigation regime were monitored.

Trunk growth was monitored generally every two weeks with a microdendrometer. The trees were pruned mechanically in the late fall by side hedging alternate sides of each row every year.

Harvest took place on September 18 and individual tree weights were determined. Composite nut samples (one per plot) were collected, hulled, and dried. These samples were analyzed by Diamond Walnut Growers, Inc. to determine individual nut weights, component weights (shell and kernel), and commercial nut size and quality.

RESULTS AND DISCUSSION

Plant Water Status

Leaf water potentials (predawn) taken over the season for all treatments (100% ETc and the former 33 and 66% ETc plots from 1986-88) are shown in Figure 1. Values generally did not exceed -2.0 bars (1 bar is 0.1 MPa). An exception occurred in late June when values were less than -3.5 bars. There were no statistically significant differences in predawn LWP between any of the '86-88 irrigation treatments indicating that the previously stressed trees had no "memory" of their stress history in terms of predawn LWP after two years.

Trunk Growth

Trunk growth rates peaked in late May for all plots (Figure 2). Growth rates were generally higher for the previously stressed trees. This was also the case last year which was attributed to lighter nut load on trees in the old 33 and 66% ETc plots resulting in a greater assimilate allocation to vegetative growth. However, yields and nut loads this season were similar across the entire block indicating that more radial trunk growth occurred in the previously stressed trees even with presumably equivalent reproductive sinks. Comparisons of trunk expansion on a cross-sectional growth basis would show less difference due to larger trunks in the 100% trees.

Nut Yield

Harvest yields were not statistically significantly different between previous irrigation treatments (Table 2). In fact, the old 33 and 66% ETc trees had modestly higher yields. This indicates that trees previously severely stressed over three years (the 33% ETc treatments suffered a 50% decline in yield in

year three) returned to full production after just two years of full irrigation. The relative rates of orchard decline and recovery are clearly illustrated in Figure 3.

Fruit Load

Fruit loads (Table 1) were not stastically significantly different for the previous irrigation treatments. Again, full recovery was achieved after two years of full irrigation. Last year, relative nut loads were much lower in the old 33 and 66% ETc plots reflecting the carryover effects of the three year stress period. The rapid recovery in vegetative growth observed last year provided the fruiting positions necessary to achieve full nut load recovery this year. The time course influence of irrigation levels over the past five years on nut load (the most sensitive yield component affected by tree water stress based on our previous work) including the steep increase this year is shown in Figure 4.

Nut Size

Individual nut weights were similar for all plots (Table 1). The modestly higher nut load in the old 33 ETc plot resulted in slightly smaller nuts on average. However, commercial nut size characterization showed significantly more "Jumbo" nuts in the old 33 and 66% ETc trees (Table 2). The shift in nut size distribution toward larger sizes suggests that size may be affected by the stress levels and crop loads of as many as two previous seasons; not just the previous season. Stress and recovery period response of individual nut weight is shown in Figure 5.

Nut Quality

Commercial nut quality parameters were generally not significantly different for the previous irrigation regimes (Table 3). One clear exception was the higher edible yield for the past 33 and 66% ETc treatments. This was due primarily to a higher percent kernel which occurred for the first time this year.

CONCLUSIONS

After three years of irrigating at 33 and 66% ETc (1.3 and 2.6 acre ft/acre, respectively, for an average weather year), markeable nut yields were reduced by 32 and 50%, respectively. Upon renewal of full irrigation, yields recovered after two years. This relatively fast recovery from severe water stress was possible due to the immediate recovery in tree growth in the season following the stress period. Rapid shoot growth occurred because the orchard was free of stress-induced disease or insect pressures. It must be emphasized that the absence of these

secondary stress effects (disease and insects) is cultivar and site dependent. "Chico" is more tolerant of heat and water stress-related problems than other cultivars.

Table 1. Harvest, fruit load, and canopy-growth related data.

Former Treatment	Yield dry in-shell[1/] (lbs/tree)	Fruit load (nuts/tree)	Nut weight[2/] (gm/nut)	% Kernel
100% ETc	25.9	1040	10.5 ab	47.3 a
66% ETc	28.0	1097	10.8 b	47.6 a
33% ETc	29.9	1208	10.4 a	49.1 b
	NS	NS	*	*

1/ 8% water content by weight.
2/ Oven dry.

* Asterisk beneath columns indicates significant differences at the 5% confidence level between numbers followed by different letters. NS indicates no significant differences in the column.

Table 2. Commercial nut size categories.

Former Treatment	Jumbo	Large	Medium	Baby	PeeWee
	---------- % ----------				
100% ETc	39.0 a	26.7 a	21.9	12.2	0.2
66% ETc	57.9 b	14.3 b	17.4	10.4	0
33% ETc	53.6 b	21.5 a	15.6	9.3	0
	*	*	NS	NS	NS

* Asterisk beneath columns indicates significant differences at the 5% confidence level between numbers followed by different letters. NS indicates no significant differences in the column.

Table 3. Commercial harvest quality parameters.

Former Treatment	Edible yield[1/]	Large sound[1/]	Off-grade[2/]	Internal damage[3/]	Insect damage[1/] (% by #)	RLI #1[4/]
	---------- % by weight ----------					
100% ETc	46.1 a	68.5	0.1	2.1	0	308
66% ETc	46.8 b	74.9	0.7	1.7	0.2	288
33% ETc	48.7 c	76.2	0.8	1.1	0	295
	*	NS	NS	NS	NS	NS

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.

* Asterisk beneath columns indicates significant differences at the 5% confidence level between numbers followed by different letters. NS indicates no significant differences in the column.

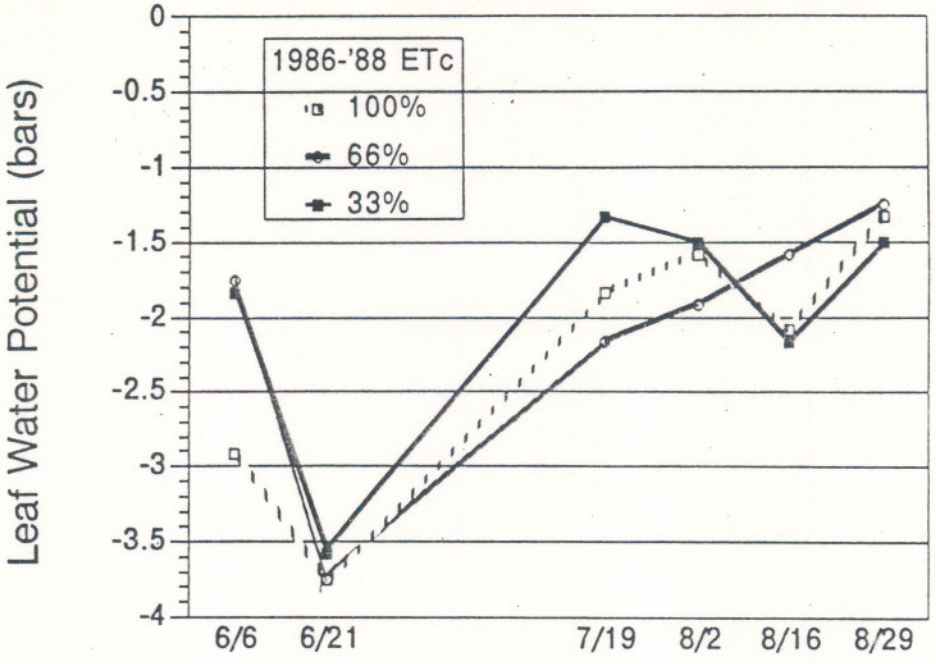

Figure 1. Predawn leaf water potential over the season for the old ETc regimes.

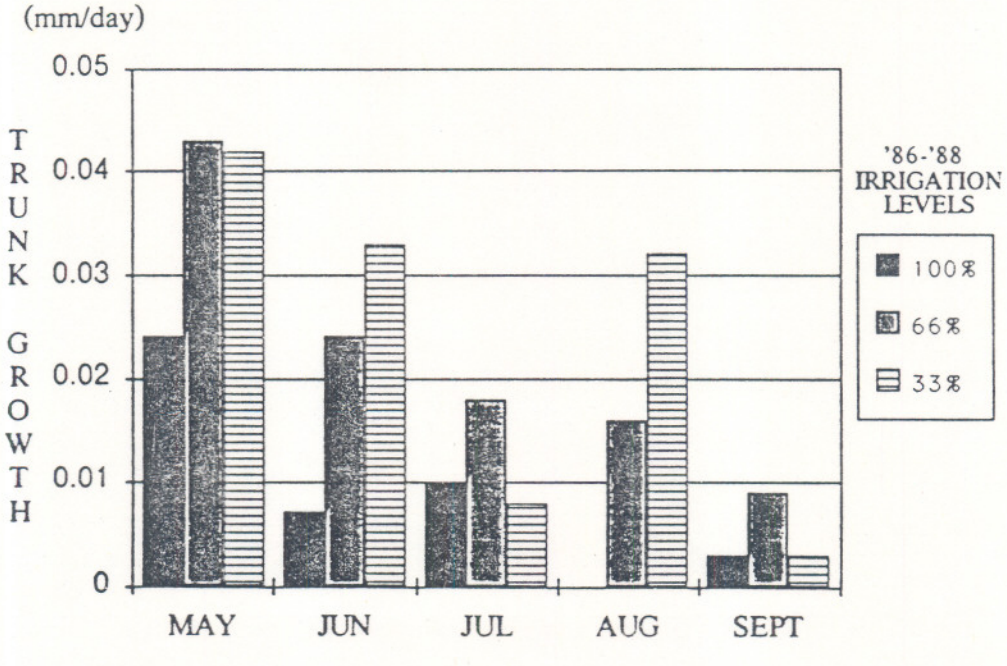

Figure 2. Radial trunk growth rate over the season for the old ETc regimes.

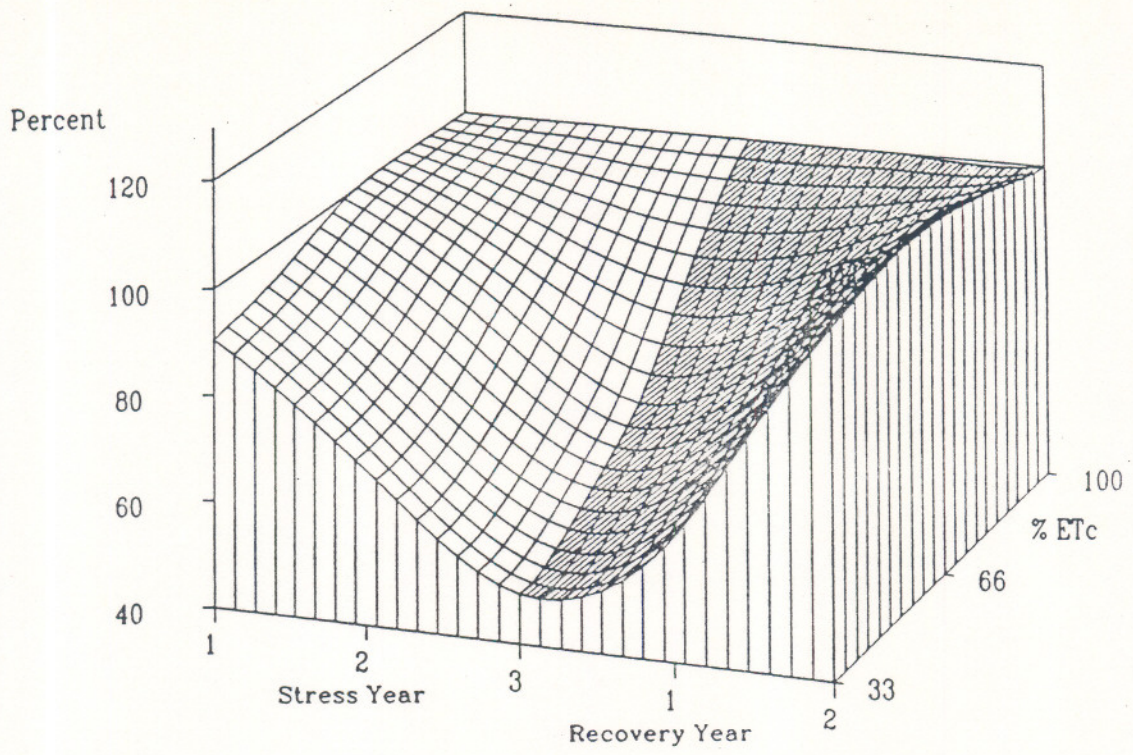

Figure 3. Relationship between relative yield (dry in-shell), time, and irrigation level.

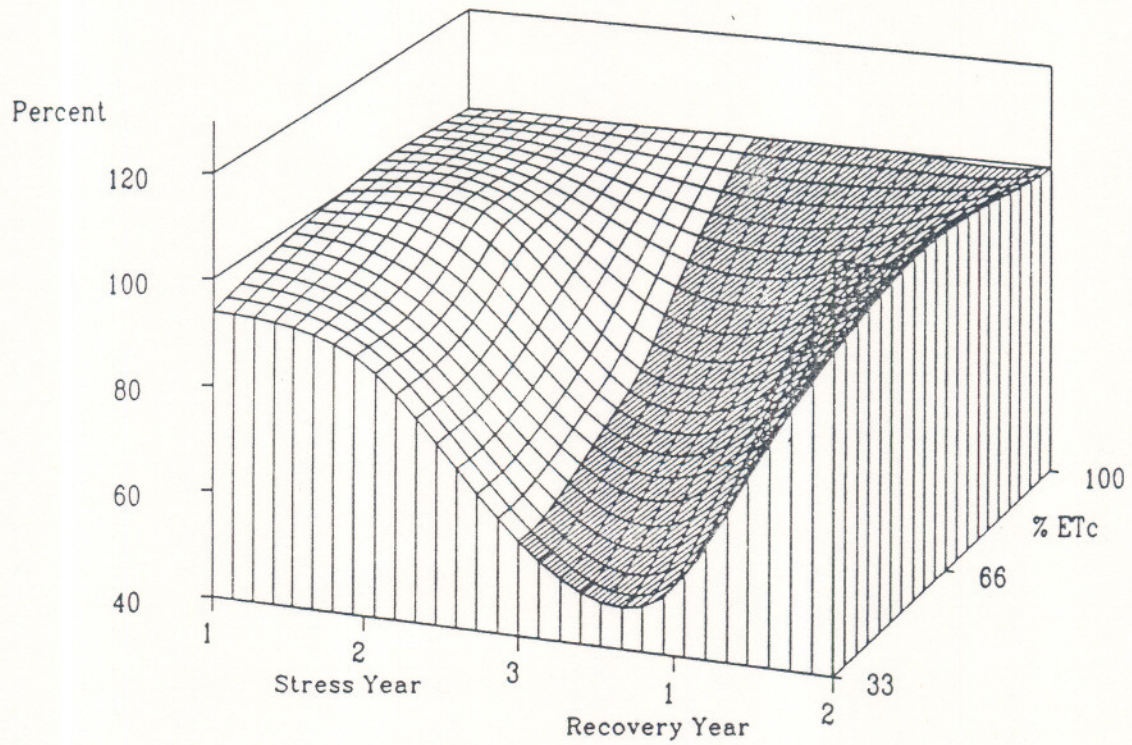

Figure 4. Relationship between relative tree nut load (number per tree), time, and irrigation level.

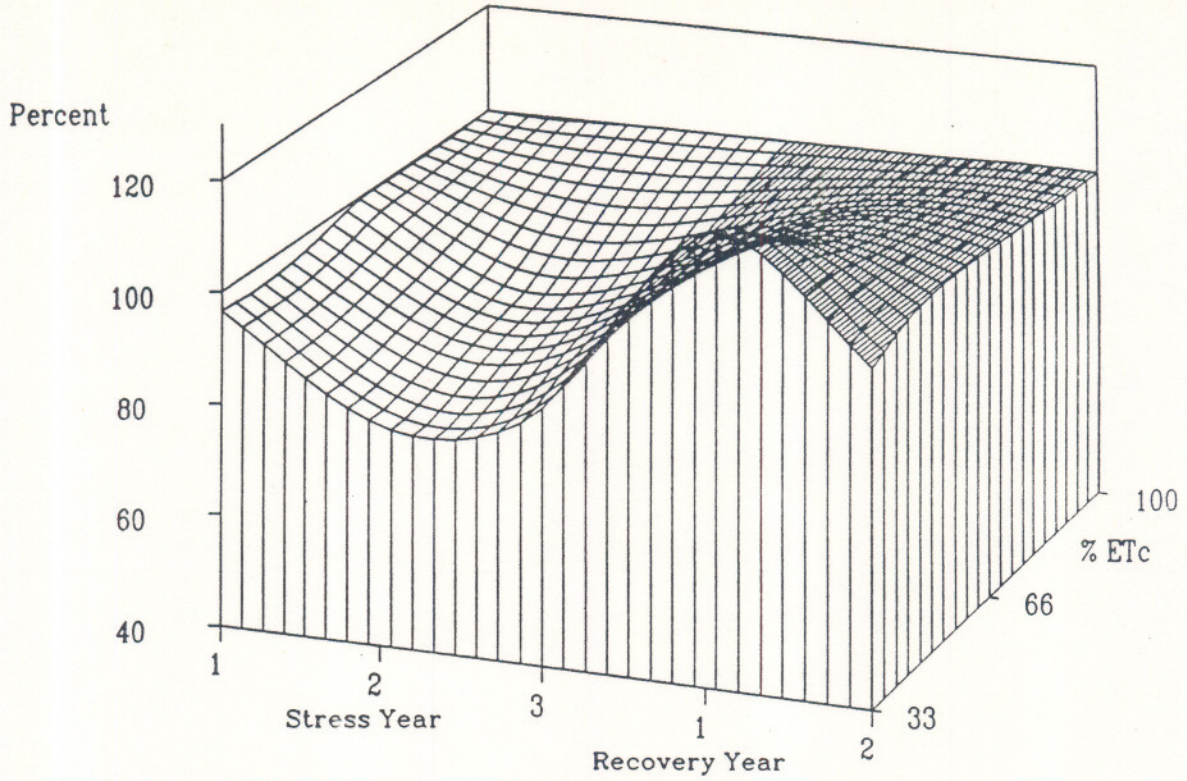

Figure 5. Relationship between relative individual nut weight, time, and irrigation level.