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Effects of pre-bloom pruning on leaf nutrient status, growth and cropping of the avocado cv Hass

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SYNOPSIS
Trees with very low fruit load were tip-pruned before the first unopened flowers were clearly visible. Early heavy pruning clearly increased yield and productivity. None of the treatments affected the leaf mineral nutrient status.

INTRODUCTION

Pruning as a way of regulating crop production, has been little used in avocado. Miller (1960) was able to control alternate cropping by pre-bloom shoot tipping, but total yield was not improved.

The avocado cv Hass is highly alternating when grown in the southern coast of Spain (Farré, 1983). A similar situation seems to prevail in California (Rock, 1974) and Israel (J Ashkenazi, personal communication).

In Spain, the process normally starts on young trees with a high yield, followed by low bloom and yield the next season. On adult trees, heat or water stress may change the cycle. Well-managed orchards seem to suffer worst from alternate bearing. The excess bloom in the 'on' year, produces an early leaf drop at full bloom (April to May) and a delayed and poor shoot growth in June to July. If temperatures in June reach 30°C, the exposed side of branches may die.

MATERIALS AND METHODS

An experiment to regulate growth and cropping, was started in March 1983. The trees, Hass on Topa-Topa, had been planted in 1975 at 7 x 4 m spacing and thinned in 1982 to 7 x 8 m.

The well-drained shale soil had a pH of 7 and no $CaCO_3$. The orchard received 100 kg N and 400-600 kg K_20 per hectare per year, as well as two foliar zinc sprays.

The trees were drip irrigated with 10 drippers per tree in 1983 and 12 thereafter. From May to October, water was applied daily in order to keep soil yr above -15 kPa. In November to April, when evaporative demand was lower, soil *yr* was allowed to reach -50 kPa.

The selected trees had a very light or no crop in the season 1982-83 and were therefore expected to carry a very heavy bloom. The following treatments were applied on a randomised block design with single tree plots and nine replicates:

Early heavy pruning
Early light pruning
Late heavy pruning
Late light pruning
Fruit thinning in late June
Unpruned control.

The early pruning was done between March 2-8 and late pruning between March 18-30. Late pruning was timed to coincide with the appearance of the first unopened flowers.

The light pruning involved cutting away the previous year's summer growth, while heavy pruning included part of the spring growth. In both treatments short (less than 25 cm) branches were pruned less than the thicker and more vigorous ones. Pruning was always more severe at the top and south sides of the trees, where flower bud formation is heavier. Fruit thinning was done late in June, whenever the density of growing fruits was above one per 25 cm shoot. Medium branches were shaken by hand until the desired density was achieved.

Yield, number of fruits and trunk cross-sectional area at 25 cm height were measured annually. The percentage increase in trunk cross-sectional area was arc sinus transformed before statistical analysis.

Spring growth leaf blades were analysed every year in September to November.

RESULTS

The results shown below cover the first three seasons:

Number of trees in need of pruning

Table 1 shows the percentage of trees that needed pruning in the three years of the experiment. Only trees with little fruit and a very high number of fruit buds were pruned. It is clear that the 'late light' pruned trees were reversing to the alternate cropping pattern, while the behaviour was less clear for the other pruning treatments.

Yield

Table 2 shows that yields in the 'off' year were increased by the pruning treatments. In the 'on' years, there were no clear-cut differences, although the yields of the controls were always the lowest. When the first two years are pooled together, the positive effect of heavy pruning is clearly seen.

Productivity

A similar situation is shown in Table 3 for productivity (yield per unit trunk area). The last column figures represent the mean for the three seasons. Here the 'early heavy' and the 'late light' pruned trees are significantly above the control or thinned trees.

Fruit size
No marked differences in mean fruit weight were apparent in any of the 'on' years. In the 'off' years, mean fruit size was highest in the control trees, but their yields were very low (Table 4).

Vegetative growth
Table 5 shows the trunk cross-sectional area increased in the three years of the experiment. Although none of the differences was significant, growth was biggest in the control trees.

TABLE 1 Trees in need of pruning (%).

	1983	1984	1985	1986
Early heavy	100	0	22,2	22,2
Early light	100	0	55,5	33,3
Late heavy	100	0	44,4	33,3
Late light	100	0	55,5	0

TABLE 2 Yield (kg tree^{-1} year^{-1})

	1984	1985	1986	Mean 1984-85
Early heavy	173,3	127,6	146,3	150,0
Early light	167,7	91,6	152,1	129,6
Late heavy	184,5	105,5	154,6	145,0
Late light	163,8	57,5	168,6	110,6
Thinned	153,9	61,4	156,6	107,7
Control	158,6	40,5	143,1	99,6
LSD (P<0,05)	ns	57,5	ns	38,4
LSD (P<0,01)		82,4		

TABLE 3 Yield per unit trunk area tree(g cm^{-2}).

	1984	1985	1986	Mean 1984/85/86
Early heavy	393,7	266,6	262,1	307,4
Early light	334,9	175,9	228,0	246,2
Late heavy	340,1	176,6	222,2	246,3
Late light	417,9	139,5	335,3	297,5
Thinned	326,6	115,3	265,8	235,8
Control	334,9	78,1	234,6	215,8
LSD (P<0,05)	87,7	132,2	ns	53,9
LSD (P<0,01)		176,5		72,1

TABLE 4 Mean fruit weight (g).

	1984	1985	1986
Early heavy	244,9	218,6	206,9
Early light	237,1	214,1	204,3
Late heavy	245,0	219.3	223,3
Late light	229,9	220,9	201,0
Thinned	217,1	219,9	182,7
Control	225,9	247,8	207,3
LSD (P<0,05)	27,8	ns	ns

TABLE 5 Increase in trunk cross sectional area (%).

	February 1983 to January 1986
Early heavy	47,0
Early light	52,6
Late heavy	49,2
Late light	49,4
Thinned	45,2
Control	57,9

DISCUSSION

From the results shown in this report, it can be said that under the growing conditions of southern Spain, alternate cropping in the cv Hass can be reduced by pre-bloom pruning before the 'on' year. Yield and productivity of the tree can be increased, opening the way to higher yields per unit area. Even in the 'on' year, yields of the pruned trees were slightly higher than control, which is unusual in pruning experiments (Moss *et al,* 1977). This may be due to the lighter pruning applied, compared to the hedging normally done with heavy machinery. The method presented here could be considered as a way to thin

blossoms, because the amount of wood pruned is very small. Blossom thinning has been shown to control alternate bearing and increase yields in apple (Singh, 1948).

Fruit size was not improved by pruning in this experiment. Ashkenazi (personal communication) has been able to increase mean fruit size of the cv Hass considerably by very heavy pruning in Israel, but yield was slightly reduced.

Fruit thinning late in June had practically no effect on either growth or yield. This indicates that the basic mechanism governing biennial bearing was already operative. Although it was not measured, shoot growth and leaf area were by this time considerably bigger in pruned trees, probably improving its photosynthetic ability. Research is in progress to study the basic mechanisms operating in the alternate bearing of the avocado. The similar leaf mineral nutrient status in the different treatments probably reflects the ability of the tree to keep a constant root-shoot ratio.

Resulting from research during the project, early heavy pre-bloom pruning of Hass trees is recommended in southern Spain after an 'off' year.

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