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EFFECT OF HEDGING ON YIELD OF LEMON AND LIME TREES[1]

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Abstract. **Mature 'Bearss' lemon and 'Persian' lime trees, planted alternately at 15 feet in rows and 20 feet between rows, were hedged at a 30° angle from the vertical in fall after harvest, with 8 feet between tree skirts at base. Hedging was alternated between east and west sides of tree rows in alternate years. Thus, a given side was pruned only once every 2 years. Yield of both lemons and limes from the most recently pruned side of trees was significantly less each year than from the opposite half pruned a year earlier. Yields on the east half of trees tended to be greater, although usually not statistically different, from those on the west half, regardless of when hedged. Wider tree spacing with lighter pruning are suggested for increased yields per acre.**

Close planting of citrus in Florida to increase yields per unit area of land, especially while trees are young, has become common. As these high density plantings grow older, hedging (pruning of side branches) is necessary to allow for movement of grove equipment in maintenance and harvesting operations. Topping of trees has also become increasingly common because of difficulties in properly spraying and harvesting fruit from tall trees. Besides, low-headed trees are less subject to wind damage than tall trees. This is an important consideration especially in sections where hurricanes may occur frequently.

Lemon and lime trees grow vigorously in Florida. With spacings closer than 20 to 25 feet apart they start crowding to the point of requiring hedging at about 5 or 6 years of age in well managed groves. Hedging removes bearing wood and may offset any gains in yield per acre made by close planting. Tucker and Wardowski (4) suggested spacings of lemons in Florida of 25 x 25 or 25 x 30 feet instead of closer plantings, but had no yield data to support the recommendation for wide rather than close spacings. Rodney and Harris (3) reported no difference in yield per acre from 'Lisbon' lemon trees in Arizona planted at 22 x 23 feet which were hedged and topped to control tree size, and from the same planting where no pruning was necessary because alternate trees had been removed. Campbell (2) found with hedged and topped 'Tahiti' ('Persian') lime trees in Florida that yields per acre increased with tree planting density in the early life of the planting, but tended to level off at about 8 years of age. In a fertilizer experiment with 72 mature 'Persian' lime trees per acre, where there was no hedging, Young and Koo (5) found the yield per acre to be about the same as from mature trees in a similar experiment planted 145 per acre, but hedged and topped for tree size control (6). In the latter experiment field observations indicated that yields in the second year after hedging were substantially greater than in the first year after hedging.

These observations prompted a study to determine the difference in yield from close planted, mature lemon and lime trees in the first and second year after hedging. The results of that investigation are reported in this paper.

Materials and Methods

The trees were certified disease-free 'Bearss' lemon (*Citrus limon* L.) and 'Persian' lime (*C. latifolia* Tanaka) on rough lemon (*C. limonia* Os-

Florida Agricultural Experiment Stations Journal Series No. 7018.

[1]The cooperation of Dr. A. E. Willson and Mr. E. C. Lundberg, Foods Division, Coca Cola Company, by providing harvest labor and equipment used in this study is acknowledged with gratitude.

beck) rootstock. They had been in the field about 9 years at the time of the first harvest reported here. They were planted in 5-row beds with a spacing of 20 feet between rows. Lemon trees were planted alternately with lime trees 15 feet apart in the north-south rows (145 trees/A). Ditches at a spacing of 135 feet and averaging about 8 feet deep, ran parallel to the rows. The soil was a Felda-Sunniland-Bradenton alfisol sandy loam complex, with underlying calcareous material worked into the surface soil in the process of bedding. The beds were crowned with the center about 12 inches above the soil surface at the ditch edge.

The lime trees had been under experimental fertilizer treatments in 5-tree plots across the beds, with the lemon trees serving as buffers, from February 1967 through June 1972. Subsequently, the lemon and lime trees were fertilized uniformly. The experimental fertilizer treatment pattern had been such that the distribution of all fertilizer elements was uniform between the hedging treatments on both lemon and lime trees. Therefore, mineral nutrition was not a source of experimental variability. Fertilization was adequate for vigorous vegetative growth on both varieties prior to and during course of this study.

Annual mechanical hedging of the east and west sides of trees at an angle of 5° from vertical was started in the fall of 1969, with hedging and topping in 1971. Beginning in the fall of 1972, the tree sides on alternate north-south middles were hedged, but not topped, in alternate years at an angle of 30° from verticle, with 8 feet between tree skirts at base. Thus, a given side was pruned only once every 2 years.

Fourteen trees each of lemon and lime were selected for yield records. They represented the average size of the trees in the planting. These 28 trees were distributed at random among the 3 middle rows of the 5-row beds so as to have inside trees with comparable size trees adjacent on all 4 sides, giving uniform exposure.

Both lemons and limes were harvested once a year in the fall before hedging in 1973 and 1974. Yields from each tree by weight were recorded separately for the east and west halves.

Results and Discussion

Yields were significantly less the first year after hedging than in the second year after hedging for both lemons and limes in 1973 and 1974 (Table 1). The difference in yields was significantly greater on lemons than on limes, as shown by a species X hedging interaction (Table 1). Lemon trees in Florida grow more vigorously than lime trees. Reduction of bearing wood, and consequently in yield, by hedging was greater on lemon than on lime trees. Nevertheless, the lemon trees produced more fruit than the lime trees, regardless of when hedged. Part of this was due to the generally slightly larger size of lemon trees. However, some of the difference resulted from harvesting only once a year. Lemons will remain on the tree and continue to increase in size well after maturity, whereas limes will drop when mature. There was an estimated loss with limes of 25 to 30% through dropping when harvested only once a year. The loss with lemons was insignificant. The percentage drop did not seem to be related to time of hedging.

The east side of both lemon and lime trees rather consistently produced more fruit than the west side, regardless of when hedged (Table 1). However, except for a species X exposure interaction in 1973 for lemons harvested from the 2-year-old hedged portion, the differences were not statistically significant. Nevertheless, there is some logic perhaps for better yields on the east side. Irrigation water delivery from volume guns was from the east side. More irrigation water may have reached the east than the west sides of trees during critical periods.

When the trees later used in this study were about 7 years old considerable amounts of bearing wood were removed by hedging to expedite grove operations. Total harvest of limes up to this time averaged about 325 pounds per tree (6). Yield figures for the lemon trees for this period are not available, but it is safe to assume they were as great or greater than for limes. If instead of hedging, alternate trees had been removed, as is sometimes done to reduce density in close plantings when crowding occurs, it is improbable that net returns, at current rates, from the fruit would have covered the initial cost of the trees, their care, removal, and disposal. With some citrus this apparently has been a profitable practice, but with lemons and limes the period of bearing before critical crowding occurs is too short to profit from close planting and later thinning.

By the fall of 1971, when the first hedging directly affecting yields of trees in the present study was done, the top size of the trees had become reasonably well stabilized by a combination of competition, hedging, and topping. The average yearly harvest of limes for 1973 and 1974 (including 1 and 2-year old hedged sides) was about

Table 1. Effect of time between hedging and harvest, species, and east-west exposure of hedged surface on yield of lemon and lime trees.

		Pounds[z] per tree		
		1973	1974	1973 + 1974
Harvested 1st year after hedging:	Lemon	212	147	359
	Lime	152	119	271
		**	**	**
Harvested 2nd year after hedging:	Lemon	466	419	885
	Lime	200	223	423
		**	**	**
Species:	Lemon	339	283	622
	Lime	176	171	347
		**	**	**
Exposure:	East side hedged	275	240	515
	West side hedged	240	214	454
		n.s.	n.s.	n.s.
Interaction:	Species X Hedging	**	**	**
	Species X Exposure	*	n.s.	n.s.

Statistical significance: n.s. not significant
* significant at 5% level
** significant at 1% level

[z]Calculated from weight per half tree.

173 pounds per tree (Table 1), or about 25,085 pounds per acre. With trees of similar size (5), but planted at 20 x 30 feet and not hedged, the average yearly harvest for 1964 through 1966 was 435 pounds per tree, or about 31,300 pounds per acre. Thus, with hedging no more often than every second year on the 15 x 20 foot planting, economics favors the 20 x 30 foot planting by about 25% more fruit per acre, plus no hedging costs. While no lower density planting of lemons in Florida was available for yield comparisons as with limes, results obtained in Arizona (3) by removal of alternate lemon trees indicate that the effect on lemon yield would be similar to that on limes.

The substantial increase in yield with time between hedging and harvest raises a question on the economic practicability of lemon and lime tree spacing in Florida so close that drastic hedging is required annually for tree size control, beginning at about 7 years of age. For any given spacing of established trees, maximum yields should be obtained where, without pruning, the canopies barely or do not quite meet on the sides. This optimum spacing is approached and becomes fairly well stabilized with lemons and limes in Florida on sand and loam at an age of around 7 or 8 years where trees are planted at 25 x 25 or 20 x 30 feet. This is an agreement with spacings recommended by Tucker and Wardowski (4). With such spacings, any necessary hedging will be infrequent and light. Thus, not only are yields at least equal to those from more dense plantings, but expense of

hedging is reduced. Furthermore, the cost of establishing the lower density planting is less because of fewer trees to plant and maintain.

Lemon and lime trees on the shallow limestone soils (Rockdale series) of south Dade County do not grow as large as on the deeper sandy and loam soils, unless fertilized excesively, because of the limited soil volume for rooting. Lemons planted 25 feet apart on Rockdale soil and limes at 20 feet can be maintained at a satisfactory size with hedging and topping only once every 2 or 3 years.

Where it is desired to maintain hedgerow plantings of lemons or limes because of ease of harvesting and pest control, a hedging innovation developed by Cain (1) for apples appears to justify trial. This is a hydraulic "slotting saw" mounted on a boom of a fork lift tractor. With tree sides hedged at an angle of around 20 to 30 degrees from the vertical, the saw cuts a slot 16 to 24 inches wide horizontally in the side canopy of the tree. In successive years the slot is moved from the bottom towards the top, with shallower cuts being made each year, and the cycle repeated as necessary. This is reported to promote fruiting on apples by permitting the entrance of light and the regeneration of fruiting wood. It seems that the same benefits should occur on lemons and limes.

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ANNUAL TOP RENEWAL OF HIGH DENSITY NECTARINES AND PEACHES

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Abstract. **A study to evaluate high density spacing and timing of mechanical pruning of peaches and nectarines in Florida was initiated in 1973. The tops of trees were completely removed at different dates in 1974 approximately 38 cm (15 inches) above the soil level. 'Sunred' nectarine trees planted at the rate of 2023 trees/acre and topped in January produced the equivalent of 454 bushels/acre in 1975 and post-harvest topped trees over 300 bushels. Successively later topping dates resulted in delayed defoliation, decreased trunk diameter, delayed bloom and larger fruit but smaller yields. Scale, shot hole borer, and rust damage, severe on non-topped trees, were not a problem on topped trees.**

In recent years the apple industry has been experiencing a marked shift in cultural practices, especially in tree spacing. The economics of production have dictated a turn to growing systems which enable the orchardist to bring trees into maximum production as early as possible (8). The availability and use of dwarfing rootstocks for apples and pears and compact growing scion cultivars have in large part made this possible (1,6,7). Progress with peaches in this direction has not been as great primarily due to a lack of dwarfing stocks compatible with many of the scion cultivars (4) and the relatively early maximum bearing potential of the trees. Although compact growing scion cultivars are not commonly grown, summer as well as winter pruning of closely planted peach trees can be employed to control the size of the trees (3,5). In the South the chronic problem of short tree life of peach trees coupled with increasingly expensive labor requirements makes it imperative to bring an orchard into full production as early as possible and to maximize mechanization of cultural operations.

This study was designed to evaluate the effect of topping closely planted peach trees at various intervals during the growing season on yield, pest control and other cultural practices.