Conclusions

From the results of the trials on mechanical pruning of orange, the following conclusions can be drawn:

- mechanical pruning alone reduces the working time by 99,1 percent vs the conventional pruning.
- aided pruning with pneumatic tools reduces the working time by 46,3 percent, and can give a better answer to the vegetative and phytosanitary needs of the trees.
- mechanical pruning (D) with topping and hedging associated to an inner thinning with pneumatic clippers assures a saving of working time of about 85 percent.
- the qualitative characters of production are not significantly influenced by the various types of pruning.

Literature cited

1. Blandini, G., F. Petrone and S. Sizinna, 1981 – Trials of mechanical pruning machines in Italian citriculture. *Proc. Int. Soc. Citriculture.* 180-184.
2. Fisher, J. 1977 – Hedging and topping. *Citrus Industry Mag.* 58(5): 4-12.
3. Giuffrida, A., E. Melita and M. Romeo, 1976 – Prove di potatura meccanica degli agrumi. *Frutticoltura* 41: 1/23-1/28.
5. Raciti, G., P. Spina, A. Scuderi and F. Intrigliolo, 1981 - Three years of mechanical pruning of citrus in Italy. *Proc. Int. Soc. Citriculture.* 175-180.
6. Turpin, J. W., 1987 – The place of hedging in the management of citrus orchards. *Australian Citrus News* 49: 6-7.

CROSS HEDGING, TREE REMOVAL, AND TOPPING AFFECT FRUIT YIELD AND QUALITY OF CITRUS HEDGEROWS

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Additional index words. Pruning, spacing, tree size, tree height

Abstract. **Citrus planted at close in-row spacings may be allowed to grow together in a continuous hedgerow, or individual or multiple tree units may be maintained by cross hedging or tree removal. Several experiments conducted over a 5-year period demonstrated these alternative tree management treatments influence fruit yield, size and quality of Florida oranges. Cross hedging reduced yield in most experiments for the duration of the tests. Tree removal substantially reduced yield the first year with less reduction in subsequent years. Treatment effects on fruit quality were generally small although juice acidity was affected in some experiments. Cross hedging or tree removal treatments were generally inferior to hedgerows for optimizing production of Florida oranges for processing. Annual topping to control tree height generally reduced fruit yield.**

Introduction

There is a trend in Florida and other citrus producing areas to plant trees closer together, particularly in the row[6]. Instead of traditional in-row spacings of 7 to 8 m which result in individual trees, spacings of 3 to 5 m in the row are common in many newer plantings. These closer in-row spacings result in more trees/ha and consequently provide improved fruit yield on a per ha basis and better economic return in the early years of the planting[2,3]. As these trees mature, however, they grow together to form a continuous hedgerow. Concern has been expressed by growers that formation of a continuous hedgerow lowers light penetration, reduces area of fruiting surface, and results in reduced yield. Problems in high density plantings with close in-row spacings have been reported[1].

Calculations show, however, that hedgerows of mature trees develop a large fruiting surface, canopy volume, and yield potential[7]. Calculated canopy surface area was similar for individual trees and a hedgerow. Calculated canopy bearing volume (the outer 1 m shell of the canopy) was greater for a hedgerow than for individual trees at similar between-row spacings. This type of model suggests the hedgerow should be an efficient production system not only for young plantings, but for mature plantings as well.

In the current study, several tree management options for hedgerows were compared to determine the potential of modifying hedgerows for citrus production under Florida conditions. Options included: 1. Maitain a continuous hedgerow; 2. Cross hedge (prune between adjacent trees in the row) to maintain a space between each tree or between groups of trees; 3. Remove some trees to provide space between individual trees or groups of trees.

Control of tree height by mechanical topping is a common practice for Florida citrus to aid harvesting and provide better spray coverage and larger fruit size[4]. Little is known about the effects of topping on fruit yield and quality. Topping decisions may be more critical for trees at close in-row spacings.

A study comparing tree management options for hedgerows was carried out over a period of 5 years in several Florida orange groves. Hedgerows, cross hedging, tree removal, and topping treatments were evaluated for yield response and effects on fruit quality, size, and external color. The study also included evaluation of tree management treatments on mechanical harvesting efficiency using an air harvester and/or trunk shaker. Mechanical harvesting results are not considered in this paper, however, but were reported previously for the first year of the experiment[9]

Materials and Methods

Tree management experiments were initiated for planting with close in-row spacings in the 1979/80 season and conductec over 5 years at four sites representative of major citrus growin areas of Florida. Twelve experiments were conducted o plantings of early/midseason and late maturing standard swee orange cultivars on conventional rootstocks. A general descriptio of the experiments, cultivar, tree age and spacing, and site i provided in Table 1. Trees ranged in age from 7 to 28 year at the beginning of the experiments, and sites ranged fron northern to southern areas of Florida citrus production. Th spacing between rows at all sites was 7.6 m and the aisle fo equipment movement was maintained at a normal 2 m width Spacing of trees in the row ranged from 2.7 to 5.3 m representative of the relatively closer in-row spacings currentl being planted.

Cross hedging was accomplished by driving a mechanica hedging machine across the row to prune between trees. A spac 1.2 m wide was made at the base of the tree. Saws were set at a angle of 10° from vertical, making a sloping cut and wider spac between trees as height increased. Cross hedging was used i various experiments to create either a 1-tree unit (cross hedgin on both sides of one tree), or a 2-tree unit (leaving two tree together by cross hedging between every other tree). All cros hedging was done on a biennial basis; i.e., required pruning cut were made every other year on alternate sides of a 1-tree o 2-tree unit. Cross hedging was carried out in the spring or earl summer except for late summer in Experiments 11 and 12

Tree removal was accomplished by cutting trees off at groun level. Trees were removed to provide 1-tree units (every othe tree removed), or units of three or four trees separated by removed tree. For the 4-tree units, trees on each end of th

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Table 1 Tree management experiments begun in 1979

Experiment	Site	Citrus area	Orange cultivar	In-row spacing m	Tree age in 1979 yr
1 Tree removal	Mt. Dora	North Ridge	Parson Brown	3	14
2 Cross hedge and flat top	Mt. Dora	North Ridge	Parson Brown	3	14
3 Cross hedge	Mt. Dora	North Ridge	Parson Brown	4.6	14
4 Cross hedge	Mt. Dora	North Ridge	Valencia	4.6	28
5 Cross hedge	Clermont	Central Ridge	Pineapple	5.3	25
6 Flat top	Clermont	Central Ridge	Pineapple	5.3	25
7 Cross hedge	Clermont	Central Ridge	Valencia	5.3	25
8 Flat top	Clermont	Central Ridge	Valencia	5.3	25
9 Gable top	Lucerne Park	Central Ridge	Hamlin	2.7	12
10 Tree removal	Lucerne Park	Central Ridge	Hamlin	2.7	12
11 Cross hedge	LaBelle	South Flatwood	Hamlin	4.6	14
12 Cross hedge	LaBelle	South Flatwood	Valencia	4.6	7

unit were harvested separately from the two center trees, allowing calculation of yield for either a 2-tree or 4-tree unit.

Tree topping for height control was performed using mechanical pruning equipment designed to make a flat cut across the top of the tree, or to provide a gable or slopping top on the tree. Topping was carried out annually to maintain the desired height. These experiments were designed to compare two or three topping heights and did not include a non-topped cotrol.

Yield data were obtained each year by weighing the harvested fruit from each plot. At the time of harvest, a random sample of 60 to 100 fruit was taken from each plot for determination of average fruit size (measured as average fruit weight), external fruit color, percent juice, juice brix (soluble solids), acidity, and brix/acid ratio. External fruit color was determined on a 20 fruit sample using a Hunter Color Difference Meter, an instrument providing a color index for light reflected from the fruit surface. Juice quality factors were determined using the standard automatic extraction and computerized test equipment found in Florida processing plants.

In one experiment, trunk circumference of the trees was measured periodically to determine the effect of tree removal in a hedgerow on the rate of tree growth. In another experiment, vegetative regrowth following topping was determined by measuring length of three regrowth shoots from the top center of each tree.

Individual plots of 2 to 4 trees were arranged in a randomized block experimental design and replicated 5 to 8 times. Statements made about significant differences refer to the statistical F test at the 0.05 level.

Results and Discussion

A large amount of data was collected from these 12 experiments over a 5-year period. It is not possible to provide detailed results for all experiments, so part of the results are presented as summaries. Effects of cross hedging, tree removal, and topping are considered separately.

Severe freezes occurred during 3 of the 5 years and damaged fruit and trees in January 1981, January 1982, and December 1983. Damage varied from substantial at the northern experimental sites to minor at the southern site. Although yields were considerably reduced by the freezes (there was no return crop at one site after the 1982 freeze), the effects of the hedgerow management treatments on fruit yield and quality could still be observed. The large annual fluctuations in yield at the northern sites probably resulted from a light crop the year following a freeze, and a return heavy crop after the trees recovered. Trees at the southern LaBelle site were never severly damaged by cold during the experimental period.

Cross hedging. Cross hedging treatments were included in seven experiments located at three sites and generally reduced fruit yield (Fig. 1-3). Reductions in yield ranged from 0 to 35% and were observed in over 50% of the plots during the 5-year period. Yield was reduced each year in some experiments, and only some years in other experiments. There was only one experiment where no reduction in yield was observed. There were no consistent increases in yield due to cross hedging in any of the experiments.

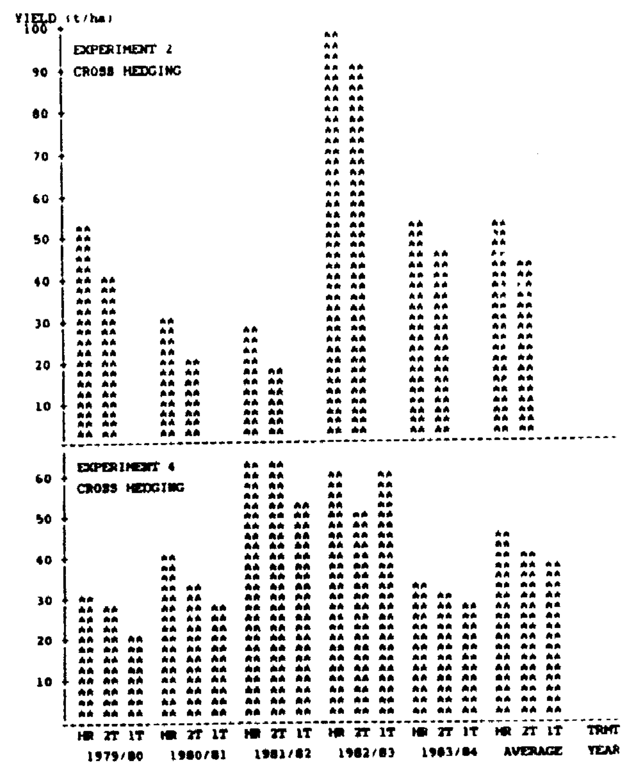

Fig. 1 Fruit yield of hedgerow (HR), 2-tree (2T), and 1-tree (1T) units created by cross hedging in two experiments at the Mt. Dora site.

At the Mt. Dora site (Fig. 1), cross hedging reduced yield each year in Experiment 2. This block consisted of trees at an in-row spacing of 3 m, a spacing clearly too close for cross hedging which left a 1.2 m space between trees. Cross hedging did not reduce yield in Experiment 3, however (data not shown). These trees were not as large and were spaced 4.6 m in the row. Similarly, cross hedging in Experiment 4 reduced yield only 1 year for the 2-tree unit. However, yield was reduced most years when cross hedged to provide 1-tree units. The effect of cross hedging was greater for 'Valencias' in Experiment 4 than for the early-maturing cultivar in Experiment 3.

At the Clermont site (Fig. 2), yield was generally reduced by cross hedging. Reduction was greatest for the 1-tree unit in 'Pineapple' oranges, but was similar for 1- and 2-tree units for the 'Valencia' expériment. Although these trees were planted 5.3 m apart in the row, trees were large and had grown together to form a continuous hedgerow.

At the LaBelle site (Fig. 3), yield reductions due to cross hedging were common, but not as consistent or severe as in some of the other experiments. Yield reduction was greater in the 'Hamlin' (Experiment 11) than in the 'Valencia' trees

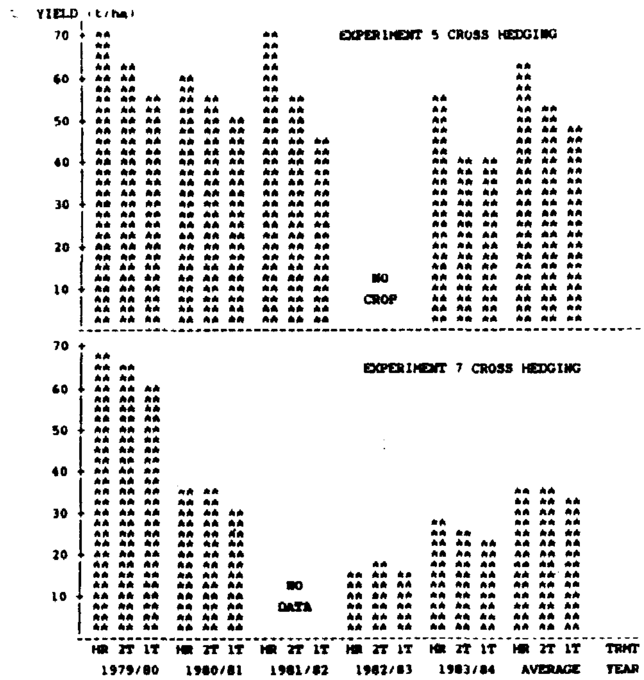

Fig. 2 Fruit yield of hedgerow (HR), 2-tree (wT), and 1-tree (1T) units created by cross hedging in two experiments at the Clermont site.

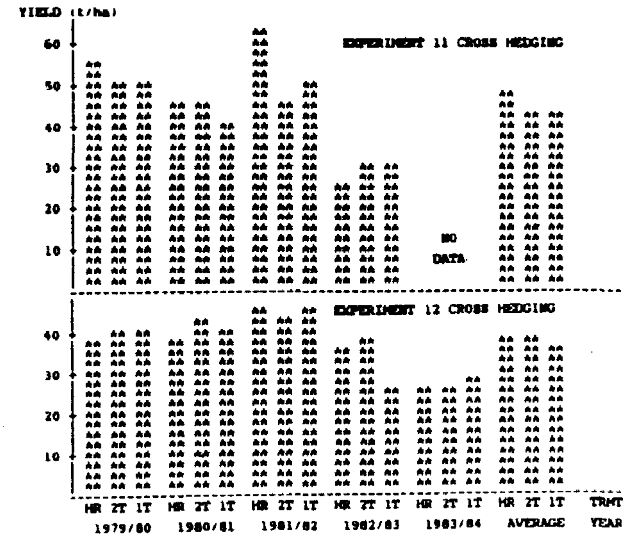

Fig. 3 Fruit yield of hedgerow (HR), 2-tree (2T), and 1-tree (1T) units created by cross hedging in two experiments at the LaBelle site.

(Experiment 12). Although the in-row spacing was the same for both cultivars, the 'Hamlin' trees were older, larger, and substantial canopy was removed during cross hedging. The 'valencias' were only 7 years old at the beginning of the experiment and had not grown together in the row. Thus very little canopy was removed during cross hedging which resulted in no yield reduction during the early years of the experiment.

Table 2 Effects of cross hedging to provide 2-tree (w-T) and 1-tree (1-T) units. Symbols show significant increase (+) or decrease (–) compared to the hedgerow plots. Missing data shown by (.). Blank space indicates no significant effect

	Experiment and treatment											
	2	3	4		5		7		11		12	
Year	2T	2T	2T	1T	2T	1T	2T	1T	2T	1T	2T	1T
	Yield t/ha											
1979/80	–			–	–	–	–	–	–	–		
1980/81	–	–	–	–	–	–		–		–		
1981/82				–	–	–	.	.	–	–	–	–
1982/83	–				.	.	+				–	–
1983/84				–	–	–	–	–	.	.		
	Fruit size g/fruit											
1979/80										+		
1980/81	+							–				
1981/82							.	.				
1982/83	+				.	.						
1983/84									.	.		
	Juice brix %											
1979/80												
1980/81												
1981/82		–					.	.				
1982/83	–				.	.			–			
1983/84	–								.	.	–	–
	Juice acid %											
1979/80	–				–	–		–				
1980/81			–	–				–				+
1981/82							.	.	–			
1982/83	–				.	.			–	–		+
1983/84							–	–	.	.		

Fruit size, juice quality, and external fruit color were not strongly influenced by cross hedging (Table 2). Significant effects were occasionally observed, but were not consistent among years or experiments and were generally small. Since there is generally an inverse relationship between yield and fruit size[8], it is surprising the general reduction in yield due to cross hedging was not associated with an increase in fru size. Perhaps the reduction in canopy and subsequent vegetativ following cross hedging decreased reserves available for fru growth. Juice brix was rarely affected by cross hedging, bu juice acidity was reduced in a number of instances which woul result in a higher brix/acid ratio and possible earlier maturit for fruit in cross hedged plots. External fruit color was not influenced by cross hedging. It was anticipated the increased light penetration due to cross hedging might have improved fruit color. The relatively narrow space between trees produced little fruit the initial season after cross hedging, however, and considerable shading and occurred by the second season of the biennial cross hedging program.

Cross hedging appeared to increase freeze damage at the Clermont site following the 1981 and 1982 freezes. These were both radiation-type freezes, and the open spaces between trees may have allowed more radiation loss which resulted in colder leaf and wood temperatures. In addition, the ability of the tree to withstand freezing temperatures may have been reduced by cross hedging.

Weed growth appeared to be greater in the spaces left by cross hedging. The continuous canopy provided by the hedgerow provides considerable shading which competes with weed growth. Thus, cross hedging may also increase weed pressure and require a more comprehensive weed control program.

The results obtained from the cross hedging experiments failed to demonstrate any benefit of cross hedging on fruit yield or quality. Yield was substantially reduced for blocks with large trees at close in-row spacings. Cross hedging was less detrimental to smaller trees at wider in-row spacings. No consistent increase in yield due to cross hedging was observed in any of these experiments. Since these experiments are representative of the cultivars, production practices, and soils used in various areas of Florida, it is apparent that cross hedging is not a beneficial practice for Florida citrus production on trees planted less than 6 m apart in the row.

Tree removal. Tree removal treatments were included in two experiments. At the Mt. Dora site, tree removal reduced production per ha in 3 out of 5 years (Fig. 4). Production on

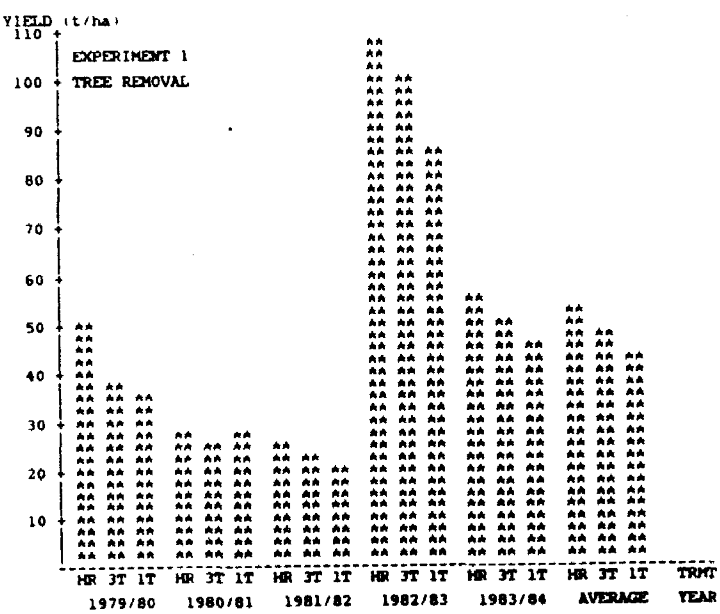

Fig. 4 Fruit yield of hedgerow (HR), 3-tree (3T), and 1-tree (1T) units created by tree removal in Experiment 1 at the Mt. Dora site.

a per tree basis was higher for remaining trees adjacent to removed tree spaces. There was considerable compensation even during the first year after tree removal. For example, in the 1979/80 season, removal of every other tree to form 1-tree units reduced yield by only 25% instead of the 50% reduction that might be anticipated by removing 50% of the trees.

At the Lucerne Park site, tree removal reduced yield the first year following tree removal, but not in subsequent years (Fig. 5). Production ranged from 60 to 100 t/ha during the last 3 years of this experiment and was similar for 2-tree, 4-tree, and hedgerow plots. Again, compensation occurred the first year after tree removal as yield reduction for the 2-tree unit was only 15% compared to the 33% reduction expected by the

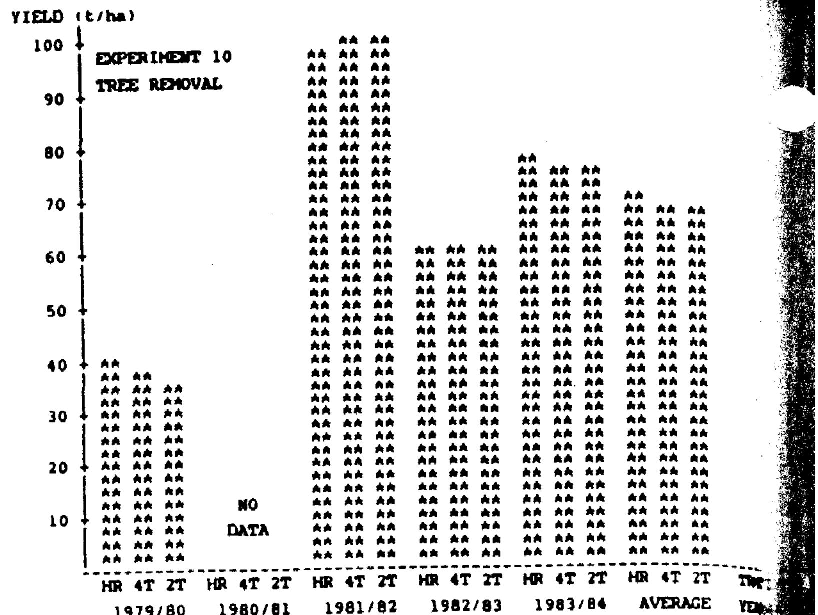

Fig. 5 Fruit yield of hedgerow (HR), 4-tree (4T), and 2-tree (2T) units created by tree removal in Experiment 10 at the Lucerne Park site.

removal of 33% of the trees.

Few effects on fruit size, juice quality, or external fruit color were observed. As with the cross hedging, tree removal did not increase fruit size corresponding to the reduction in crop load or yield (Table 3). No effects on juice brix were observed.

Table 3 Effects of tree removal to provide 4-tree (4T), 3-tree (3T), 2-tree (2T), and 1-tree (1T) units. Symbols show significant increase (+) or decrease (–) compared to control. Missing data shown by (.). Blank space indicates no significant effect

	Experiment and treatment			
	1		10	
Year	3T	1T	4T	2T
	Yield t/ha			
1979/80	–	–		
1980/81				
1981/82				
1982/83	–	–		
1983/84	–	–		
	Fruit size g/fruit			
1979/80	+	+		
1980/81			.	
1981/82	–	–		
1982/83			+	+
1983/84				
	Juice brix %			
1979/80				
1980/81			.	
1981/82				
1982/83				
1983/84				
	Juice acid %			
1979/80	–			
1980/81	–		.	.
1981/82				
1982/83				
1983/84	–			

Juice acidity was lower 3 of 5 years for the 1-tree units in Experimental 1, suggesting slightly earlier maturity on these trees.

Trunk circumference measurements made each year on trees in Experiment 1 showed the increased growth rates of trees following the removal of adjacent trees (Fig. 6). Average increase in trunk circumference over the 5 years was greatest for the

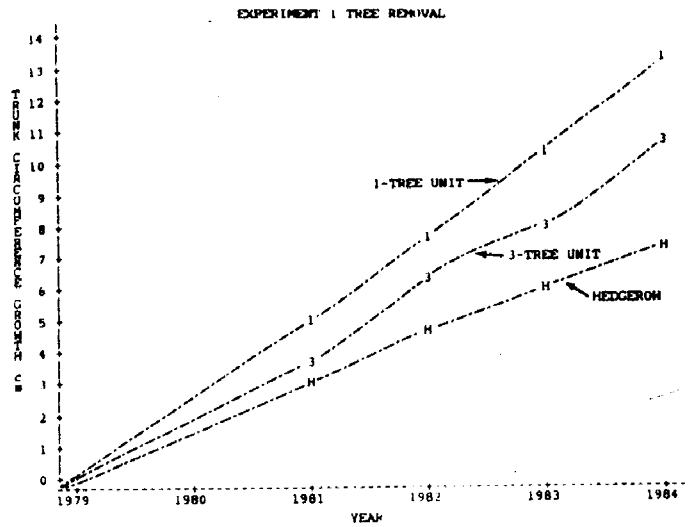

Fig. 6 Trunk circumference growth of hedgerow (HR), 3-tree (3T), and 1-tree (1T) units created by tree removal in Experiment 1 at the Mt. Dora site.

1-tree unit, intermediate for the 3-tree unit, and lowest for the hedgerow. Competition of trees in the hedgerow appears to effectively reduce the growth rate of individual trees.

At both sites, tree canopy rapidly expanded into the area of the removed tree, and with time, this growth would reform a continuous hedgerow. The close in-row Tree spacing in both groves meant that even with tree removal, the gap between trees was not very wide. Unless cross hedging was begun, trees would probably reform a continuous hedgerow within 5 to 50 years after a tree was removed.

Weed growth also appeared to be a more serious problem where trees had been removed. As with cross hedging, tree removal may increase weed pressure.

The results obtained in both of these tree removal experiments failed to demonstrate any yield benefit from interrupting the hedgerow by removing individual trees. In one experiment, yield was generally reduced. In the other experiment, yield was reduced only the first year. There was no obvious explanation for the different response in these two experiments. Production per tree was increased by tree removal in both experiments, but production per ha was either reduced or not affected. There was never an indication of improved production per ha as a result of tree removal. In-row spacing in both these experiments was 3 m or less. Tree removal in plantings with trees planted at greater in-row spacing would be expected to be even more detrimental to yield. Although tree removal does not appear

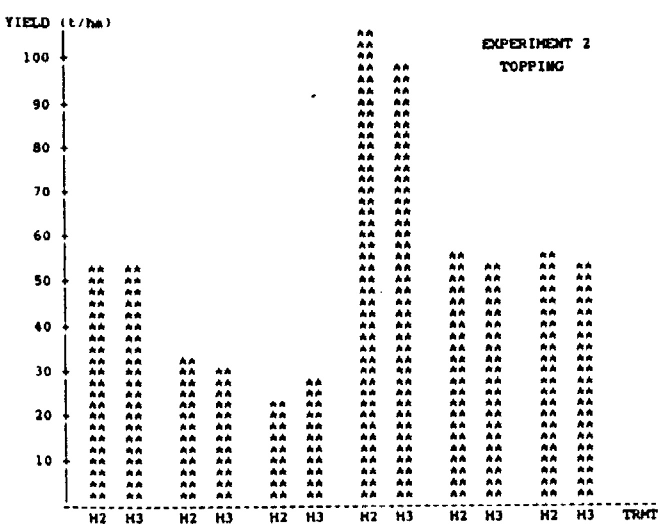

Fig. 7 Fruit yield of trees topped annually at 4.6 m (H2) and 5.5 m (H3) heights in Experiment 2 at the Mt. Dora site.

to be a beneficial practice for fruit production in Florida, i may be less detrimental than cross hedging as a means fo providing spaces in a hedgerow of trees at close in-row spacing However, the continuous hedgerow appears an optimal syster for fruit production under Florida conditions.

Tree topping. Tree topping treatments were included in fou experiments at three sites. In each experiment, the maximur topping height removed very little canopy. Pruning was mor severe at the lower heights. Thus, the comparison is betwee minor topping at the maximum height and more severe toppin at the lower heights.

At the Mt. Dora site, average yield over the 5 years did no differ significantly for the 4.6 and 5.5 m topping heights (Fig. 7 Some of the trees at the beginning of the experiment had barel reached the 5.5 m height, so pruning was not severe for eithe of the topping heights.

Yield was reduced at the lower topping height several season at the Clermont site (Fig. 8). In Experiment 6, average yield wa

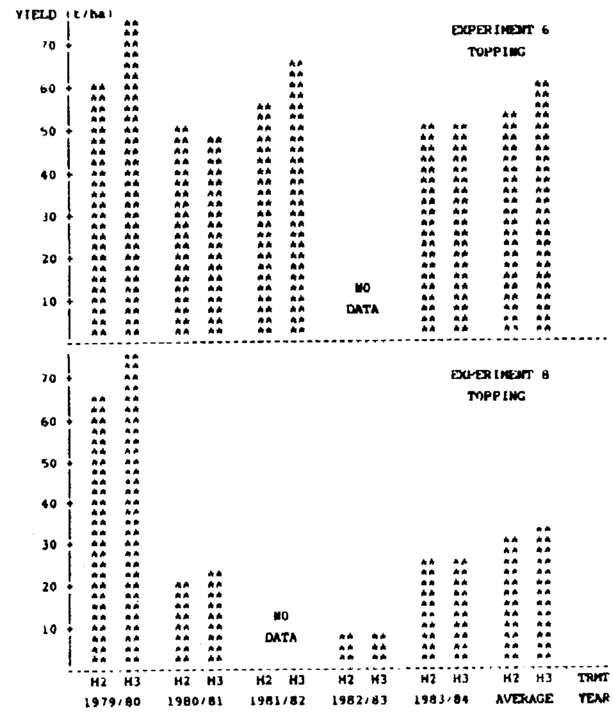

Fig. 8 Fruit yield of trees topped annually at 4.3 m (H2) and 5.2 m (H heights in two experiments at the Clermont site.

reduced 12% for the lower height. In both Experiments 6 a 8, greatest yield reduction from topping at the lower heig occurred during the first season.

The greatest yield reductions from topping occurred at t

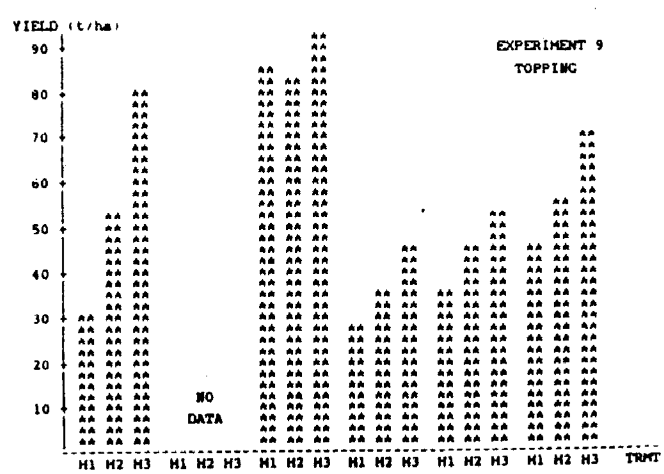

Fig. 9 Fruit yield of trees topped annually at 3.7 m (H1), 4.6 m (H and 5.5 m (H3) heights in Experiment 9 at the Lucerne Park s

Lucener Park site where three topping heights were compared (Fig. 9) and where topping treatments were most severe. There were reductions in yield each season associated with the most severe topping. The greatest yield reductions occurred in the first season. Compared with topping at 5.5 m, first season yield reductions were 35% for the 4.6 m and 65% for the 3.7 m heights, respectively.

In general, topping height had no consistent effects on fruit size, fruit color, or juice quality except for brix. Fruit size was increased, however, corresponding to the reduced crop at lower topping heights in Experiment 9. Juice brix was generally lower for the lower topping heights (Fig. 10).

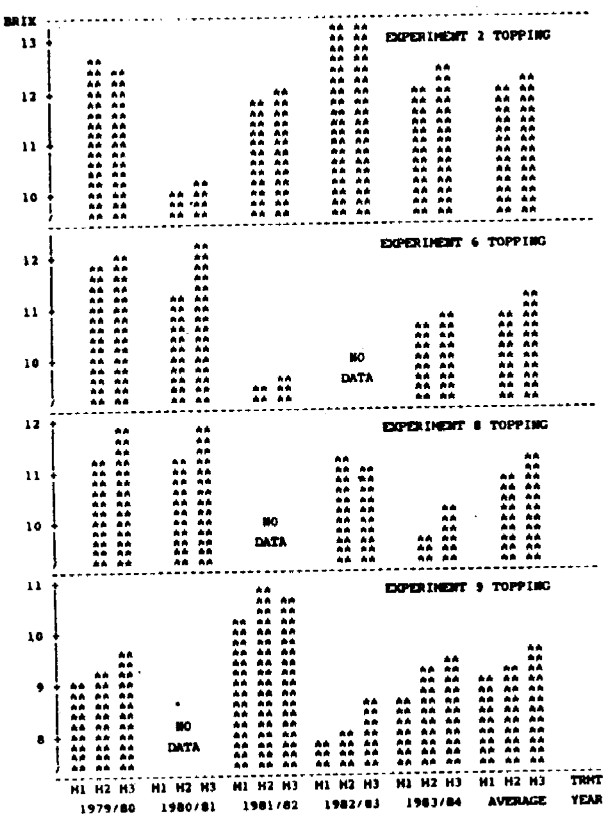

Fig. 10 Juice brix of fruit from trees topped at low (H1), intermediate (H2), and tall (H3) heights. See text for actual heights which varied slightly among experiments.

Differences were not large, but were significantly lower most seasons in Experiments 6, 8, and 9. The same pattern also existed in Experiment 2. The average reduction at lower topping heights was about 0.5 brix units.

Vegetative regrowth following topping was measured several seasons in Experiment 9. Regrowth was rapid and vigorous so annual topping was not an effective method of reducing tree height. It was frequently difficult to visually identify topping treatments a year after topping because of the extensive regrowth. Length of regrowth following the first topping was inversaly related to topping height. Average length of regrowth shoots ranged from 1.5 m for the 3.7 m topping height to less than 1 m for a topping height of 5.5 m. In subsequent seasons, length of regrowth was slightly reduced and did not vary among topping heights. The regrowth failed to flower or fruit during the season after topping, so only nonfruiting growth was being removed each season.

Citrus trees growing in a hedgerow have fruit concentrated in the top central portion of the tree. We expected to move this heavy fruiting zone lower by a regular topping practice. Although minor topping did not have a big impact on yield, attempts to reduce tree height to less than 4 m greatly reduced yield. Yield differences among heights were greatest the first year, indicating some compensation and movement of the fruiting zone to a lower height in subsequent years. However, substantial yield reductions at lower heights were apparent throughout Experiment 9.

The reduced brix at lower topping heights had not been observed previously. Juice brix is highest for fruit located in the top of the tree[5]. Topping may reduce average brix by eliminating this high-brix fruit. Alternatively, brix may be reduced by competition between vegetative regrowth and fruit development. The reduction in brix coupled with the reduced yield for trees topped at lower heights resulted in significant reduction in kg juice solids produced per ha.

Summary. Cross hedging, tree removal, and topping were all detrimental to fruit yield in the hedgerow plantings used in these experiments. Fruit size, color, and juice quality were minimally affected by these treatments, except for a reduction in brix associated with topping at lower heights.

Based on this study, the hedgerow is a desirable production system for mature trees, confirming the yield potential predicted by calculation of canopy surface area and bearing volume[7]. The benefits of initial higher tree density with more efficient fruit production during the early years of the planting, combined with continued high production potential at maturity, demonstrates the advantage of the hedgerow for Florida oranges. Neither production nor fruit quality benefited from interrupting the hedgerow by cross hedging or partial tree removal.

Literature cited

1. Boswell, S. B. and D. R. Atkin. 1978. Comparison of two 'Washington' navel plantings at several densities: A vigorous scion-rootstock combination vs. a less vigorous combination. *Proc. Fla. State Hort. Soc.* 91:40-43.
2. Hutton, R. J. and B. R. Cullis. 1982. Elevated productivity from close planted dwarf orange plantings. *Compact Fruit Tree.* 15: 182-196.
3. Koo, R. C. J. and R. P. Muraro. 1982. Effect of tree spacing on fruit production and net return of Pineapple oranges. *Proc. Fla. State Hort. Soc.* 95:29-33.
4. Phillips, R. L. 1978. Tree size control. Hedging and topping citrus in high density plantings. *Proc. Fla. State Hort. Soc.* 91:43-46.
5. Reitz, H. J. and J. W. Sites. 1948. Relation between position on tree and analysis of citrus fruit with special reference to sampling and meeting internal grades. *Proc. Fla. State Hort. Soc.* 61:80-90.
6. Tucker, D. P. H. and T. A. Wheaton. 1978. Trends in higher citrus planting densities. *Proc. Fla. State Hort. Soc.* 91:36-40.
7. Wheaton, T. A., W. S. Castle, D. P. H. Tucker, and J. D. Whitney. 1978. Citrus-concepts higher density plantings for Florida. *Proc. Fla. State Hort. Soc.* 91:27-33.
8. Wheaton, T. A. and I. Stewart. 1973. Fruit thinning of tangerines with naphtaleneacetic acid. *Proc. Fla. State Hort. Soc.* 86:48-52.
9. Whitney, J. D., T. A. Wheaton, W. S. Castle, and D. P. H. Tucker. 1983. Citrus tree size management affects fruit yields and mechanical harvesting efficiency. *Trans. Amer Soc. Agric. Eng* 26: 704-709.

FRUIT DEVELOPMENT AS AN INDICATOR OF THE IRRIGATION NEEDS OF CITRUS TREES[1]

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Additional key words. Grapefruit, irrigation, drought, fruit development, fruit dry matter.

Abstract. **Fruit growth has been suggested as a reliable indicator for determining irrigation frequency. In the past, a decline in the growth rate to about one-half of the normal rate was considered and indication for the need for irrigation. In recent**