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TREE SKIRTING EFFECTS ON YIELD AND QUALITY OF VALENCIA ORANGES

JODIE D. WHITNEY[1]
University of Florida, IFAS
Agricultural and Biological Engineering Department
Citrus Research and Education Center
700 Experiment Station Road
Lake Alfred, FL 33850

T. A. WHEATON, W. S. CASTLE AND D. P. H. TUCKER
University of Florida, IFAS
Department of Horticultural Sciences
Citrus Research and Education Center
700 Experiment Station Road
Lake Alfred, FL 33850

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Abstract. **A five-year experiment was conducted on 10-feet-tall Valencia trees on Swingle rootstock to determine the effects of skirting (lower limb removal) at 20 and 36 inches above ground level on yields and fruit quality. Average yields were not significantly affected by skirting at 20 and 36 inches. Fruit from the bottom of the unskirted trees showed significantly increased rind blemishes, were generally smaller in size, but had juice qualities at least equivalent to other fruit on the tree.**

Tree skirting or the removal of lower branches of the citrus tree canopy has been a popular practice among fresh fruit growers in Florida for over a decade. However, many growers have not skirted trees because of the additional production cost, concerns about yield reductions, and the perceived value of skirts to provide additional cold protection. The growers who have adopted skirting practices claim under tree irrigation maintenance is easier and better, boom-applied production practices are more efficient with less damage to equipment and lower fruit, and spinner-distributed granular fertilizer applications are more uniform. More recently, interest in mechanical harvesting of processed oranges has required growers to skirt trees to accommodate shake-catch systems. In California, Burns et al. (1970) reported that skirting at 2 and 3 ft high had minimal effects on citrus tree yields. Similarly in Australia, El-Zeftawi (1976) reported that skirting at 3 ft high had minimal effects on yields. No published work in Florida citrus has addressed the impacts of skirting.

Tree skirting studies were initiated in 1995 to determine the yield and fruit quality effects of skirting. Whitney et al., 2003 reported on a five-year study in mature 'Valencia' orange trees 15 ft tall in which case the yield effects were minimal. This paper reports the yield and fruit quality results on a five-year study in smaller 10-ft-tall Valencia orange trees.

Materials and Methods

This long-term study was initiated in 1995 in 7-year-old 'Valencia' trees on Swingle rootstock near Indiantown, Fla. The trees were approximately 10 ft tall, spaced 25 × 12.5 ft on 2-row beds, and none of the adjacent canopies in row were touching. Four treatments, listed in Table 1, were replicated 5 times (except for Treatment 4 which was replicated 4 times) in a randomized complete block design to evaluate skirting at 20 and 36 inches above ground level on fruit yield and quality. Each replicate plot consisted of 3 trees for record purposes with one or more buffer trees between adjacent plots.

As indicated in Table 1, initial skirting for Treatments 2, 3, and 4 was conducted in August 1995, and repeated as maintenance skirting in June 1997 and Dec. 1998. Each time the trees were skirted, the young 'Valencia' fruit removed were counted and converted to mature fruit equivalents, which were based on individual mature fruit weight averages in the plot the following harvest season. Prior to harvest each year from 1996 through 2000, a 30-lb fruit sample was picked from the bottom of the canopies (within 1 ft of ground) of each Treatment 1 plot (hereafter referred to as the "skirt" sample or Treatment 0). During harvest, a 30-lb sample was taken from the harvested fruit of each plot. This means that two samples (including the skirt sample or Treatment 0) were taken from the Treatment 1 plot trees. Fruit yield in each 3-tree plot was measured by weighing with an electronic scale on a goat truck. At the Lake Alfred CREC, the 1996 fruit samples from Treatment 1, Treatment 2, and the skirt samples were visually examined for external rind blemishes (stem end rot, greasy spot, green color, melanose, oleocellosis, rust mite, windscar, mechanical injury) and other characteristics detrimental to fresh fruit quality. In 1997, all fruit samples were vi-

Table 1. Treatments[z] in the experiment.

Treatment no.	Description
1	Check. Trees were not skirted and fruit were harvested manually.
2	At a point on the lower canopy farthest from the tree row and centered on the tree trunk, lower limbs up to 20 inches above ground were removed from the canopy, and the height was gradually reduced to 15 to 18 inches above ground at the trunk by a mechanical skirter. Some selective pruning was required with the initial application of the skirting treatment in 1995. The fruit were harvested manually.
3	Same as Treatment 2 except lower limbs up to 36 inches above ground were removed from the canopy at the farthest point from the trunk.
4	Same as Treatment 3 except trunk shaker-catchframe system was used to harvest the fruit in 1996, and manually harvested thereafter.

[z]Skirting for Treatments 2, 3, and 4 was conducted 8/95, 6/97, and 12/98.

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[1]Corresponding author.

sually examined for the same rind blemishes. For 1997 through 2000, all fruit samples were run through a commercial electronic grader to measure the weight, size (diameter), and specific gravity of individual fruit. Subsequent to these measurements important to fresh fruit quality, juice characteristics including % juice, % acid, brix, ratio, and lb solids/box were measured on all samples using commercial "test house" equipment. Tree canopy heights were measured for each plot tree after the 1996 and 2000 harvests.

Results and Discussion

Yield. Figure 1 summarizes the yield effects of the four skirting treatments in the experiment. The three skirting events are shown as young fruit removal (yfr) and are represented as negative mature fruit equivalents of yield that were removed by the treatments. The initial skirting at 36 inches (Treatments 3 and 4) in 1995 significantly (P = 0.05) reduced 1996 yields by an average of 17% compared with Treatment 1. In 1997, the yields of the skirted trees rebounded above the unskirted trees, and even though there was a 100 box per acre difference between the minimum (Treatment 1) and maximum yield (Treatment 4), the differences were not statistically significant. Treatments 2, 3, and 4 were skirted again in June of 1997, and the 1998 yields were very similar for all treatments. In December of 1998, Treatments 2, 3, and 4 were skirted again, and the 1999 yield of Treatment 4 was significantly less (P = 0.05) than Treatments 1 and 2. In 2000, the fifth and final year of the experiment, the yield of all skirted trees again rebounded above the unskirted trees, but none of the differences were statistically significant. Overall, however, the 5-year yield averages (96-00) for all treatments were essentially the same (Fig. 1). The initial skirting in 1995 removed (yfr in mature fruit equivalent) from 11 to 13% of the 1997 yield for Treatments 2, 3, and 4. This is in agreement with the range reported by Burns et al. (1970) in the percentage of fruit removed by skirting. For the three skirting treatments, the average number of young Valencia removed each time the trees were skirted was 40 fruit/tree.

Fruit quality. In 1996 and 1997, the fruit samples showed marked differences between treatments in rind blemishes (Table 2). In 1996, evidence of greasy spot, melanose, rust mite, windscar, and mechanical injury was significantly (P = 0.05) higher in the skirt samples (Treatment 0, from canopy bottom of Treatment 1 trees) than in the fruit from the skirted trees (Treatment 2). Again in 1997, the percentages of fruit with the same rind blemishes were generally higher (except for mechanical injury) in the fruit of the skirt samples, and significantly (P = 0.05) higher than all the skirted trees for melanose and rust mite. In 1997, fruit in the skirt samples were noticeably softer than fruit in the other samples.

Table 3 shows three physical characteristics of the fruit for years 1997 through 2000 and the 4-year means. In 3 of the 4 years, fruit in the skirt samples were significantly smaller in diameter than fruit from the skirted trees. Likewise, individual fruit weights in the skirt samples were significantly less than those in the skirted samples for 2 of the 4 years. Specific gravities of fruit in the skirt samples were generally among the

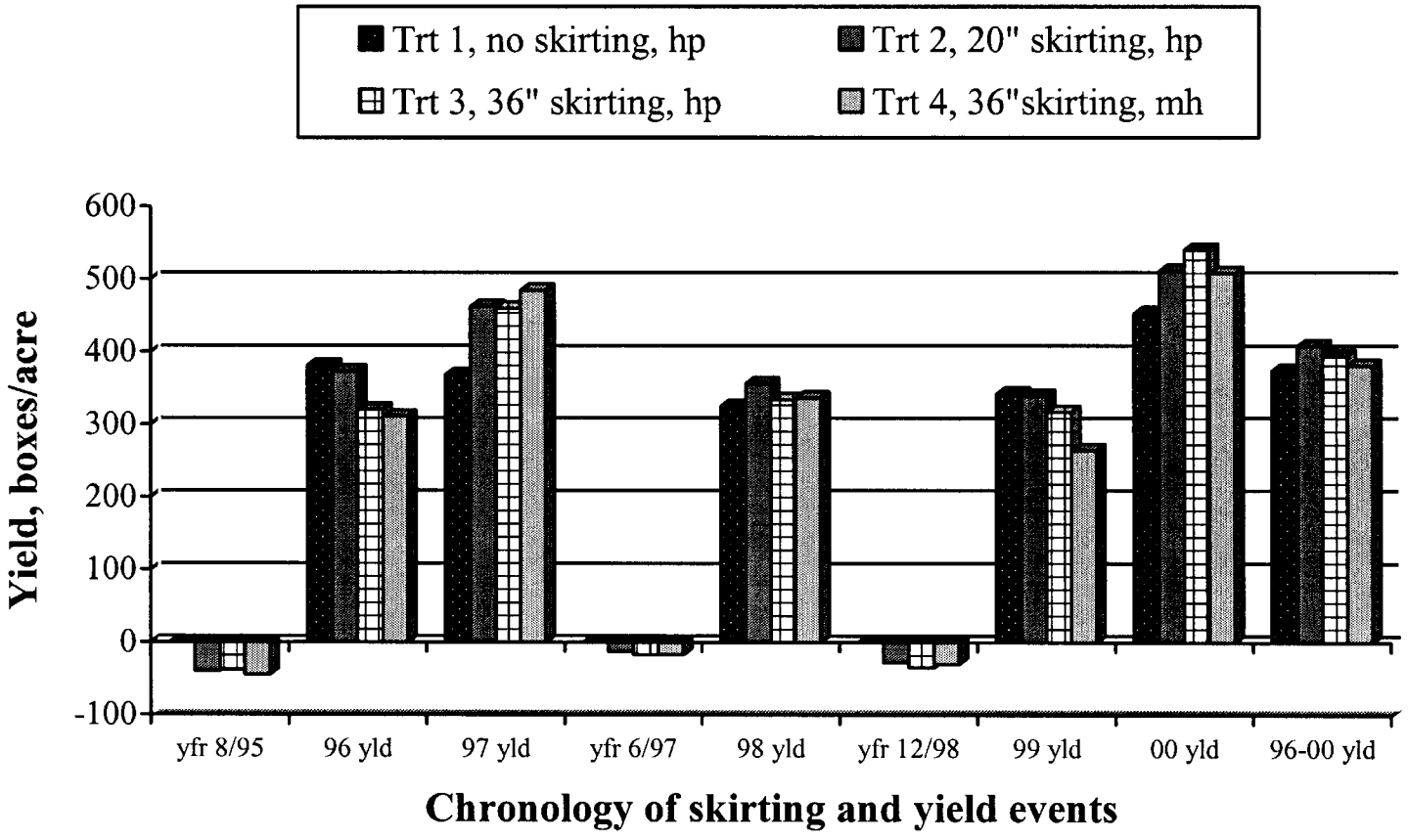

Fig. 1. Young fruit removal (yfr) associated with skirting and mature fruit yield (yld) of the four treatments in experiment. hp—handpick; mh—mechanically harvested.

Table 2. Mean percentages of fruit in samples with rind blemish characteristics.

Treatment[z]	Rind blemish				
	Greasy spot	Melanose	Rust mite	Windscar	Mechanical injury
			1996		
0 (skirt, hp)	39.2 a[y]	26.2 a	24.6 a	14.6 a	2.2 a
1 (no skirting, hp)	37.2 ab	25.6 a	5.2 b	14.2 a	0.8 ab
2 (20 inch skirt, hp)	22.0 b	17.4 b	5.2 b	9.2 b	0.4 b
			1997		
0 (skirt, hp)	26.6 a	32.0 a	31.4 a	21.4 a	0.0 a
1 (no skirting, hp)	11.8 b	15.8 b	10.2 b	8.6 a	0.0 a
2 (20 inch skirt, hp)	21.0 a	17.4 b	18.4 b	16.0 a	0.4 a
3 (36 inch skirt, hp)	16.6 b	20.8 b	9.6 b	13.6 a	1.0 a
4 (36 inch skirt, mh)	18.0 ab	20.0 b	10.3 b	20.7 a	0.0 a

[z]Treatment 0 was the skirt sample handpicked (hp) from bottom (0-12 inches) of Treatment 1 canopy; fruit harvested by handpicking (hp) from Treatment 1-3 trees; Treatment 4 fruit harvested mechanically (mh) in 1996, and handpicked (hp) thereafter.
[y]Means followed by the same letter are not significantly different at the 5% level by Duncan's New Multiple Range Test.

highest and were significantly (P = 0.05) higher than fruit in the skirted samples for 2 of the 4 years. The 4-year means show the skirt fruit were the smallest in diameter and weight, but had the highest specific gravity.

Some of the juice quality means were significantly (P = 0.05) different in 1996, 1997, and 1999, and are shown in Table 4 with the 5-year means. Overall with the 5-year means, the skirt fruit had the highest % juice, % acid, and lb solids/

Table 3. Physical characteristic means of the fruit in samples.

Treatment[z]	Diam of individual fruit, inch	Weight of individual fruit, lb	Specific gravity of individual fruit
		1997	
0 (skirt, hp)	2.78 b[y]	0.37 b	0.90 a
1 (no skirting, hp)	2.91 a	0.41 a	0.89 a
2 (20 inch skirt, hp)	2.94 a	0.43 a	0.91 a
3 (36 inch skirt, hp)	2.98 a	0.45 a	0.88 a
4 (36 inch skirt, mh)	3.00 a	0.46 a	0.87 a
		1998	
0 (skirt, hp)	2.68 b	0.37 b	1.10 a
1 (no skirting, hp)	2.85 a	0.42 ab	1.02 b
2 (20 inch skirt, hp)	2.84 a	0.42 ab	1.03 b
3 (36 inch skirt, hp)	2.86 a	0.43 a	1.02 b
4 (36 inch skirt, mh)	2.86 a	0.43 a	1.03 b
		1999	
0 (skirt, hp)	2.84 c	0.43 c	0.98 a
1 (no skirting, hp)	2.95 b	0.46 bc	0.94 b
2 (20 inch skirt, hp)	3.06 a[y]	0.51 a	0.92 b
3 (36 inch skirt, hp)	2.97 b	0.47 b	0.94 b
4 (36 inch skirt, mh)	3.02 ab	0.49 ab	0.93 b
		2000	
0 (skirt, hp)	2.84 b	0.45 b	1.02 ab
1 (no skirting, hp)	2.80 b	0.43 b	1.03 ab
2 (20 inch skirt, hp)	2.94 ab	0.49 ab	1.02 ab
3 (36 inch skirt, hp)	2.83 b	0.45 b	1.09 a
4 (36 inch skirt, mh)	3.10 a	0.55 a	0.98 b
		1997-2000	
0 (skirt, hp)	2.79	0.41	1.00
1 (no skirting, hp)	2.88	0.43	0.97
2 (20 inch skirt, hp)	2.95	0.46	0.97
3 (36 inch skirt, hp)	2.91	0.45	0.98
4 (36 inch skirt, mh)	3.00	0.48	0.95

[z]Treatment 0 was skirt sample handpicked (hp) from bottom (0-12 inches) of Treatment 1 canopy; fruit harvested by handpicking (hp) from Treatment 1-3 trees; Treatment 4 fruit harvested mechanically (mh) in 1996, and handpicked (hp) thereafter.
[y]Means followed by the same letter are not significantly different at the 5% level by Duncan's New Multiple Range Test.

Table 4. Statistically significant juice quality means by year and 5-yr means.

Year	Treatment[z]	% juice	% acid	Brix	Ratio	Lb solids per box
1996	0 (skirt, hp)	63.1 a[y]	0.69 b		18.59 a	
	1 (no skirting, hp)	59.9 b	0.69 b		17.89 ab	
	2 (20 inch skirt, hp	61.1 ab	0.75 a		16.67 b	
	3 (36 inch skirt, hp)	58.8 b	0.70 b		17.47 ab	
	4 (36 inch skirt, mh)				17.39 ab	
1997	0 (skirt, hp)				19.44 ab	7.22 a
	1 (no skirting, hp)				21.54 a	7.17 ab
	2 (20 inch skirt, hp				20.31 ab	6.98 ab
	3 (36 inch skirt, hp)				19.46 ab	6.81 ab
	4 (36 inch skirt, mh)				19.00 b	6.59 b
1999	0 (skirt, hp)				18.85 b	
	1 (no skirting, hp)				21.42 a	
	2 (20 inch skirt, hp				19.27 b	
	3 (36 inch skirt, hp)				19.00 b	
	4 (36 inch skirt, mh)				19.05 b	
1996-2000	0 (skirt, hp)	61.89	0.68	12.81	18.96	7.10
	1 (no skirting, hp)	60.97	0.65	12.84	20.06	7.02
	2 (20 inch skirt, hp)	61.20	0.67	12.42	18.74	6.84
	3 (36 inch skirt, hp)	60.66	0.67	12.38	18.56	6.79
	4 (36 inch skirt, mh)	60.36	0.65	12.18	18.74	6.62

[z]Treatment 0 was skirt sample handpicked (hp) from bottom (0-12 inches) of Treatment 1 canopy; fruit harvested by handpicking (hp) from Treatment 1-3 trees; Treatment 4 fruit harvested mechanically (mh) in 1996, and handpicked (hp) thereafter.
[y]Means followed by the same letter are not significantly different at the 5% level by Duncan's New Multiple Range Test.

box. These attributes suggest that skirt fruit have good juice quality characteristics, and are in general agreement with the fact that higher juice content and lb solids per box are usually associated with smaller, more dense fruit as shown in Table 3.

These data suggest that the characteristics of skirt fruit were inferior in terms of fresh fruit quality, generally being smaller and having more surface blemishes. In contrast, however, skirt fruit exhibited good juice quality characteristics associated with processing, having high juice content and lb solids per box.

Tree height. No significant differences in tree height between treatments were observed in 1996 and 2000. All trees grew approximately 3 ft in height over the 4 years, from an average of 10.6 ft in 1996 to 13.6 ft in 2000 (data not shown).

Conclusions

1. Skirting up to a height of 3 ft on 10-ft-tall Valencia/Swingle trees did not reduce average yields over a 5-year period.
2. Fruit from tree skirts within 1 ft of ground level were generally inferior in fresh fruit quality compared to fruit from skirted trees, but juice quality characteristics associated with processing were not inferior.

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