Harvesting 'Valencia' Oranges with a Vertical Foliage Shaker

Abstract. Harvest tests were conducted on 'Valencia' orange trees on April 25, May 15, and June 5, 1972, with a vertical foliage shaker. The percentage of mature fruit removed for all shaker treatments averaged 77.0, 78.2, and 83.9%, respectively, for the 3 harvest dates.

The trees were handpicked in April 1973, to obtain fruit yield and quality data. The 1972 shaker harvesting treatments reduced the 1973 mature fruit weight yields an average of 11, 16, and 27%, respectively, for the 3 harvest dates, when compared with fruit yields from trees that were handpicked. Internal quality of the fruit was not significantly affected by any of the shaker harvesting treatments. As stated previously, shaker harvesting removed 77.0, 78.2, and 83.9%, respectively, of the mature fruit on the 3 harvest dates in 1972. However, based on the percentage of mature fruit left on the trees in 1972, and considering the 1973 yield reductions of 11, 16, and 27% because of shaking, the shaker harvesting treatments mechanically recovered 69, 66, and 61%, respectively, of the potential 1973 fruit weight and lb-solids yield from the trees which were shaker harvested on the 3 harvesting dates in 1972.

Increased size and weight of individual fruit in 1973 were associated with the most severe shaker treatments at the latter 1972 harvest date. Mature fruit peel blemishes in 1973 due to mechanical injury to the young fruit in 1972 (other than insect or disease), were 3 times greater in the shaker treatments than in the handpicked checks.

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Introduction

One of the greatest deterrents to the adaptation of mechanical harvesting of Florida oranges destined for processing, is that a satisfactory mechanical system has not been developed for harvesting 'Valencia' oranges. Various shaker concepts for mass removal have been tested (1, 2); however, in most cases, yield reductions in the following year have been experienced due to excessive removal of young fruit. One of the most selective concepts in terms of preserving subsequent 'Valencia' fruit yields, is the foliage shaker (1, 3).

The objective of the test described in this paper was to further evaluate a vertical foliage shaker with 2 modes of shaking and 2 shaking periods at 3 dates of harvest in 'Valencia' oranges.

Materials and Methods

The vertical foliage shaker is shown in Fig. 1. The prime mover and most of the shaker mast was manufactured by ITF Corporation, Longwood, Florida (3), and loaned to the Agricultural Research and Education Center for the duration of this experiment. The drive for the shaker mast was designed and constructed by personnel at the AREC.

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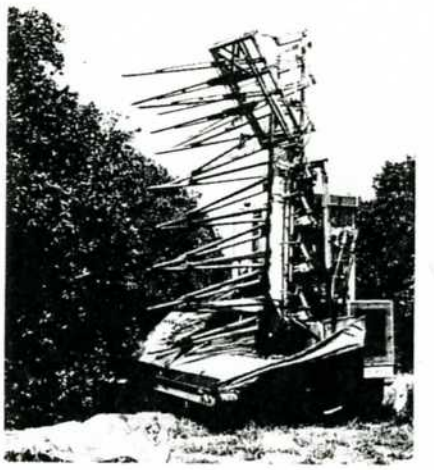

Fig. 1. Vertical foliage shaker used in 'Valencia' harvest experiment.

Table 1. Treatments in Valencia harvest experiment.

Treatment No.	Stroke *Design	Duration of shake per clamp, sec
1	Near-sinusoidal	10
2	Near-sinusoidal	20
3	Quick-return at bottom	10
4	Quick-return at bottom	20
5	Handpick check	-

* Length of stroke = 8 in. at approximately 200 cpm.

Table 2. Number of young Valencia fruit removed in 1972 harvest and reduction of mature fruit in 1973.

Attribute	Harvest Date		
	April	May	June
Average no. young fruit removed per tree in 1972 harvest, Treatment 1 through 4.	2926	434	705
Average 1973 reduction in no. of mature fruit per tree for treatments 1 through 4, when compared to Treatment 5.	352	785	1013

One mode of the shaker drive was a near-sinusoidal motion of the shaker mast, and the other was a quick-return motion which could conceivably give more "snap" to the mature oranges as they were shaken. The shaker was operated by engaging the horizontal arms of the machine across a cord length of the tree circumference, and shaking the foliage in a vertical plane. Approximately six entries were made with the machine around the tree circumference. A 10 and 20-sec shaking period were also compared for both shaking modes to determine whether an increase in mature fruit removal could be attained without significantly increasing the removal of young fruit.

The 'Valencia' orange trees used in the experiment were very uniform, ranging between 15 and 20 ft high, with low skirts, a high percentage of inside fruit, and many fruiting limbs. The experiment was designed to compare 4 shaker treatments with a hand-picked check (Table 1), and involved 90 trees in a randomized, complete block design. Each shaker treatment was replicated 6 times for each of 3 harvesting dates — April 25, May 15, and June 5, 1972.

In 1973, all 90 trees were hand-picked during the week of April 23, and the fruit was processed through the packinghouse to get data on yields, internal quality, sizes, counts, off-bloom, and peel scars.

Results

1972 — Some characteristics of young and mature 'Valencia' oranges in the harvesting experiment, are shown in Fig. 2. The average diameters of the fruit at the 3 harvest dates were 0.22, 0.57, and 1.24 in., respectively.

Mature and young fruit removal results are depicted in Fig. 3 and 4, for all 4 vertical foliage shaker treatments. Treatment No. 2 provided greater removal of both fruit types, except for young fruit removed on May 15, at which time Treatment No. 4 removed the greatest number of young fruit. Treatment No. 3 removed the least amount of both fruit types. The near-sinusoidal stroke, removed an average of 2% more mature fruit than did the quick-return stroke, and the 20-sec shake duration removed an average of 4% more mature fruit than did the 10-sec shake duration.

Mature fruit removal increased somewhat at the later harvest dates. This cannot be explained by the change in bonding force (Fig. 2). However, it might be explained, in part, by the fact that a greater number of shaker clamps per tree were used at the later harvest dates. The average number of shaker clamps per tree were 5.5, 6.0, and 6.0, respectively, for the 3 harvest dates.

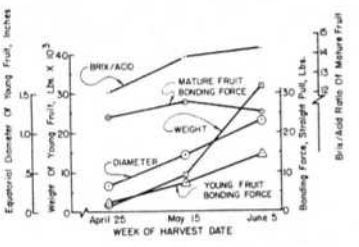

Fig. 2. Some characteristics of the mature and young 'Valencias' fruit.

The average mature fruit removal for all 4 vertical foliage shaker treatments was 79.7%. Much of the mature fruit left on the tree was inside fruit. Mature fruit yield per tree averaged 766 lb.

Localized bark peeling occurred on some limbs where the metal clamping tine contacted the limb during shaking.

1973 — A statistical analysis of the 1973 handpicked yield showed that the internal quality parameters of % juice by weight, % soluble solids (Brix), % acid, Brix/ acid ratio, and lb-solids per box were not significantly different for any of the harvest dates or harvest treatments.

Even though the 1972 yield data were quite uniform, an analysis of covariance was conducted in the 1973 yields using the 1972 yield as the independent variable. The analysis indicated that the 2 sets of yield data were linearly related, and that the covariance adjustment was beneficial to the analysis. The 1973 yields were

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adjusted as follows:

1973 adjusted yield = 1973 yield - 0.6615 (1972 yield - 766) Results of the 1973 adjusted yields are shown in Fig. 5. Yields associated with Treatment No. 3 were consistently as high or higher than the other shaker treatments for all dates. Shaker stroke type did not significantly affect yields, but yields were slightly less for the near-sinusoidal stroke. The 20-sec shake duration (Treatments No. 2 & 4) significantly reduced yields compared to the 10-sec shake duration (Treatments No. 1 & 3), with the reductions being greater at the later harvest dates. The shaker treatments (1 through 4) reduced 1973 yields when compared to the handpick check (Treatment No. 5) by an average of 11, 16 and 27% at the April, May, and June harvest dates, respectively.

Table 2 shows the relationship between the average number of young fruit removed (per tree) in 1972 for the shaker treatments (1 through 4), and the 1973 reduction in the number of mature fruit (per tree) for the shaker treatments when compared to the handpicked check (Treatment No. 5). These data indicate that the 1973 yield reductions in the number of mature fruit were 12, 181, and 144%, of the number of young fruit removed in 1972 at the respective April, May, and June harvest dates. This implies that the shaker may have damaged a significant number of young fruit left on the tree during May and June of the 1972 harvest, and many of these damaged fruit may have dropped off prior to the 1973 harvest.

An important economic variable, which cannot be ignored in processed fruit, is the quantity of the lb-solids harvested per acre. This should be one basis for comparing harvest methods. These values (Fig. 6) were calculated for each treatment by multiplying the respective adjusted lb-solids/ acre (1973) by the per cent mature fruit removals in 1972. Removal for the handpicked check (Treatment No. 5) was assumed to be 100%. Overall, Treatment No. 2 was best among the shaker treatments, and was superior at the April and May harvest dates. Treatment No. 1 was slightly superior at the June harvest. Results were not significantly affected by stroke type. At the April harvest date, the 20-sec shake duration was superior to that of the 10-sec shake. At the May harvest date, the two durations gave comparable results, while the 10-sec shake was best at the June harvest date. The per cent of lb-solids harvested with Treatment No. 1 through 4, averaged 67, 67, and 61% of that harvested by hand (Treatment No. 5) at the 3 harvest dates, respectively.

The percentage of the 1973 fruit with mechanical scars on the peel was 40 and 14%, respectively, for Treatment No. 1 through 4, and for Treatment No. 5.

Discussion

The results in this paper represent basically one shaker setting, in one grove condition, for one season. In some respects, the trees in this experiment were ideal for the foliage shaker. They had not been hedged or topped, and had a normal rounded canopy; limbs were numerous and not excessively large in the vicinity of the outer canopy; adequate space existed around the trees for proper positioning of the shaker. Some tree characteristics, however, were disadvantageous for the foliage shaker. For example, as with many other 'Valencia' trees during the 1972 harvest season, considerable inside fruit existed and the shaking action applied by the foliage shaker in the outer tree canopy was not sufficient to remove much of the inside fruit. Many of the limbs were long and willowy, with fruit set along much of their length and the shaking action applied on the outer portion of the limbs was apparently not transmitted efficiently along the limb's length. Mature fruit removal from these trees was not as high as desired, but would have been difficult with any other type of shaker. Other tests (1) have reported better removal with a different foliage shaker under different grove conditions.

Yield reductions in 1973 were caused by all 1972 shaker treatments at all 3 harvest dates. These reductions increased for the later harvest dates, and were greater than those reported in other tests (1). It should be remembered, however, that even though the more severe shaker treatments generally caused the greatest yield reductions, these same treatments were capable of harvesting a higher lb-solids/ acre at the April and May harvest dates, because their higher removal of mature

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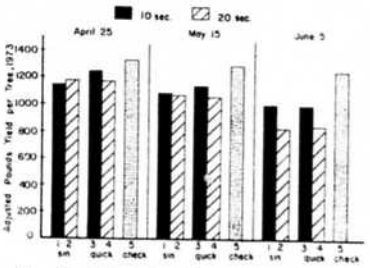

Fig. 5. Adjusted pounds yield per tree for Treatments (numbered, see Table 1) in 'Valencia' oranges.

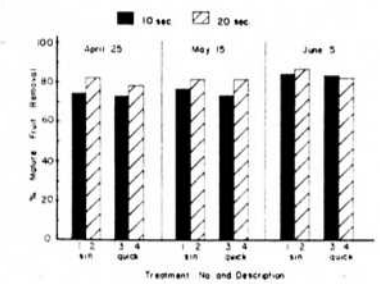

Fig. 3. Percentage mature fruit removal for the vertical foliage shaker treatments (numbered, see Table 1) in 'Valencia' oranges.

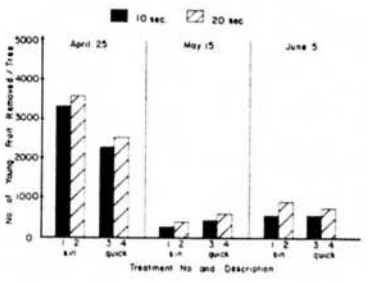

Fig. 4. Number of young fruit removed per tree by vertical foliage shaker treatments (numbered, see Table 1) in 'Valencia' oranges.

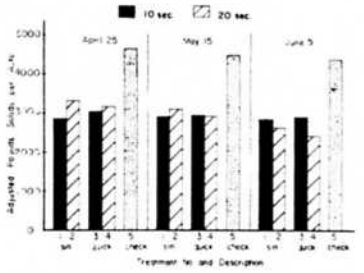

Fig. 6. Pounds solids per acre which could be harvested by treatments (numbered, see Table 1) in 'Valencia' oranges.

Correction of Citrus Seedling Stunting on Fumigated Soils by Phosphate Application

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Abstract. Stunted citrus seedlings grown in fumigated seedbeds have been reported in a number of nurseries in Florida. Affected plants exhibited small, bronze colored leaves which sometimes abscised prematurely. Preliminary investigations eliminated bromide toxicity as the immediate cause; however, leaf analysis consistently showed deficient levels of P in stunted plants and adequate levels in apparently healthy plants. The stunting phenomenon was not associated with deficient soil P levels. Foliar and soil P applications resulted in improved leaf color, increased leaf P and chlorophyll contents and a striking growth response.

Citrus nurserymen in Florida must fumigate seedbeds prior to planting in order to have their stock qualify under the State's new 'Premium Quality Nursery Tree Program,' and methyl bromide at a rate of 1 lb/ 100 sq ft is generally used for this purpose. During the past 2 years some nurserymen reported adverse effects from the use of methyl bromide following the recommended interval between treatment and planting. Germination was not affected but growth was sharply curtailed shortly after emergence. The stunted plants had abnormally small, dull yellow or bronze colored leaves. Eventually the lower leaves exhibited tip scorch-

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Shaker

fruit more than offset the subsequent yield reductions. This was not the case at the last harvest date (June 5), when less severe shaking action was desirable. The best shaker treatments mechanically removed 72, 70, and 66% of the potential (handpicked check) yield of lb-solids, (Fig. 6) at the April, May, and June dates. These percentages could undoubtedly be increased with (a) improved shaking modes, (b) trees and fruiting better suited for the foliage shaker, (c) and some degree of mature fruit loosening by an effective abscission chemical.

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2 Cooperative research by the University of Florida, Agricultural Research and Education Center, Lake Alfred; State of Florida, Department of Citrus; and the U. S. Department of Agriculture.
Presented at 1973 annual meeting of Florida State Horticultural Society in Miami Beach.
3 Mention of commercial organizations or products in this report is solely to provide specific information. It does not constitute endorsement by the U. S. Department of Agriculture over other organizations or products not mentioned.

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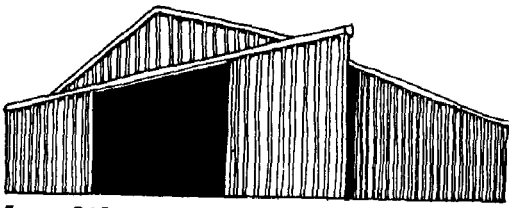

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