

Lemon Picking with a Grape

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From 40 to 90 percent of the mature lemon fruit on young close-set or trellis-grown trees have been removed mechanically by a grape harvester in 3 years of field trials in Ventura County. Abscission chemicals to loosen the fruit and growth inhibitors to retard the tree foliage proved helpful.

Harvesting lemons by hand has been the accepted method since the inception of the lemon industry. However, with increasing labor costs and possible labor shortages, various mechanical harvest methods are under trial.

Mechanical shake harvest trials were begun in Ventura County in 1970 and have been continued up to the present time. Unfortunately, these trials have not produced the desired percentage of fruit removal without damage to fruit or foliage.

Many of the newer lemon plantings involve more trees per acre — often close-set in the rows. To test the concept of trellis-grown lemons, a trial was initiated in 1965 near Somis. This trial showed that lemons could be grown on trellises — with appreciable hand pruning and machine topping and hedging. Many acres of grapes and berries in the U.S. are grown on trellises and harvested mechanically. Using this as background, a grape harvester was first tried in the Somis trial in 1972. Subsequent trials on a close-set lemon grove near Santa Paula were conducted in 1973 and 1974.

The mechanical grape harvester used in the 1972 trial was a Chisholm-Ryder model O-W, which is designed for the harvesting of grapes grown on the conven-



Fig. 1. Chisholm-Ryder grape harvester removing lemons from close-set trees near Santa Paula. Fruit is conveyed into cushioned bed of pickup truck. Close-set row of young lemons was previously mechanically hedged and topped.

Harvester

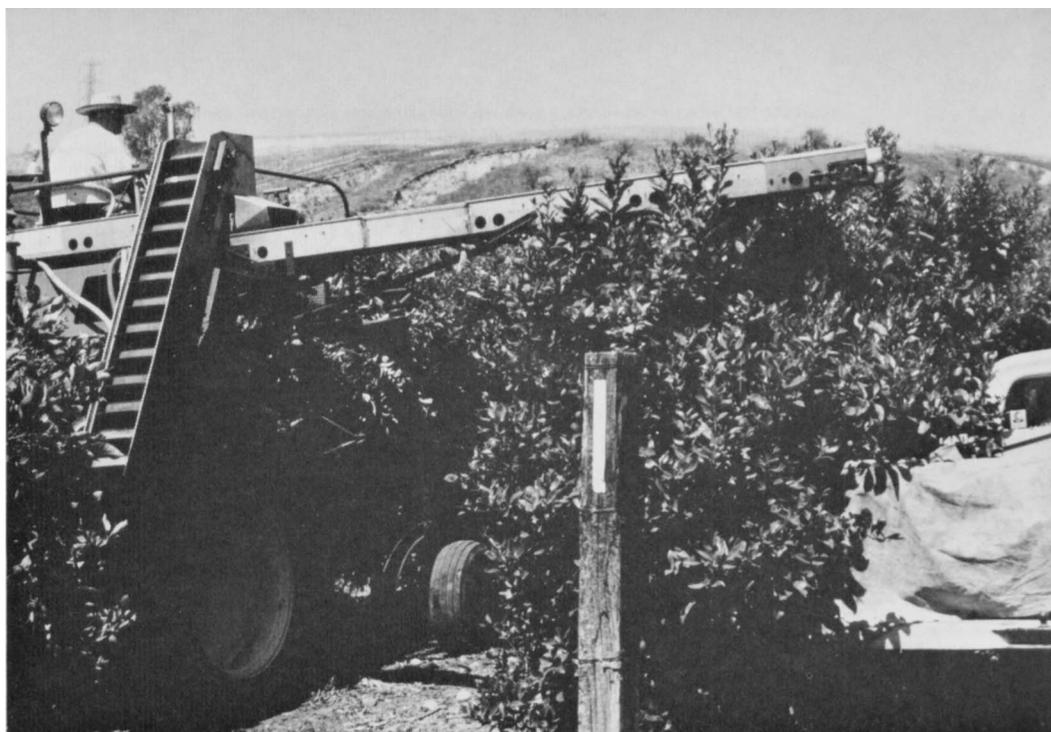


Fig. 2. Grape harvester removing lemons from trellis-grown trees near Somis. Fruit was conveyed over the top of adjacent row into pickup truck.

tional type of trellis. This self-propelled harvester has a high clearance frame, is diesel-powered with 10-speed transmission for speeds from 0.9 to 17.0 miles per hour.

In the 1973 and 1974 trials, a Chisholm-Ryder model G-W was used. This is a combination machine capable of harvesting grapes on the conventional trellis as well as the Geneva Double Curtain trellis.

The grape harvester straddles the rows of trees that were trellised or close-planted in the rows (fig. 1). These had been previously shaped into almost solid hedges approximately 5 feet wide and 7 feet tall. The lemons were removed by a side-shaking motion of fiberglass harvesting arms on each side of the machine. The lemons were caught on a conveyer-belt collector, elevated, and moved by conveyer belt to final collection in the padded bed of a pickup truck.

1972 trials

The trees in this trial were 7-year-old, trellis-grown Lisbon lemons on *C. macrophylla* rootstock. The trees were planted 10 feet apart in the rows and the rows were 15 feet apart. The trellis wires and end posts were removed from four rows of 18 trees each, before mechanical harvesting.

On May 3, 1972, two of the four rows to be harvested were sprayed with the growth inhibitor Niagara 10637 at 2500 ppm. This inhibitor has been found to effectively retard the top regrowth of lemons. Inhibi-

tion of top and side foliage was obvious within 1 month.

Also, 1 week before harvest, two half-rows (nine trees each) were sprayed with a fruit abscission chemical, Upjohn ActiAid at 15 ppm. This spray also included 1500 ppm of surfactant.

Just before mechanical harvest, pull tests were made on fruit previously sprayed with abscisic acid, inhibitor, or both, and on non-sprayed check trees. Data presented in the table show a significant reduction in pull force with fruit sprayed with the abscisic acid (10.2 pounds). Somewhat less pull force was necessary when both the abscisic acid and inhibitor were used (9.4 pounds). The average pull force for the nonsprayed check fruit was 18.4 pounds. The inhibitor spray alone averaged 18.0 pounds. These pull force differences during actual machine harvest were not measurable.

The harvesting trial was on June 16, 1972. Due to the relatively narrow width of the shaker arms, two passes over the tree rows were necessary — the same direction each time. Fruit was conveyed over the top of the adjacent row into the cushioned bed of a pickup truck (fig. 2). In the first pass, an area at the top of the trees approximately 30 inches high was shaken. The next pass covered the fruit lower

on the trees. Due to the overlapping, movable plates which catch the fruit, it was necessary to prune the skirts and lower limbs of each tree to a height of 24 inches. After machine harvesting, a commercial hand-harvesting crew removed the remaining fruit on the trees.

Results

The mechanical grape picker removed approximately 50 percent of the mature fruit. An average of 65 percent of the fruit were removed without stems or were similar to hand clipped, 35 percent had some stem left on the fruit.

Immediately following harvest, fruit damage did not appear excessive, but during storage a number of very small abrasions caused excessive spoilage.

There was appreciable limb and foliage damage on the trees, due to the action of the shaker tines. Extended limbs were subsequently pruned to eliminate any that pointed in the opposite direction than that in which the harvester traveled.

1973 Trials

The second trial was conducted at the A. J. West Ranch near Santa Paula, with 3-year-old Monroe Lisbon and Allen Eureka lemon trees,

Treatment	Pounds pull force*	Number of fruit with button left after pull test**
ActiAid (abscisic acid)	10.2	4
ActiAid + NIA 10637 (inhibitor)	9.4	4
Check	18.4	8
NIA 10637	18.0	8

* Average of 10 fruit.

** Ten fruit per treatment.

alternately planted in the row — all on *C. macrophylla* rootstock. The trees were planted 11 feet apart in the rows and the rows were 22 feet apart. All trees in the row were mechanically hedged 5 feet wide and topped 7 feet high. The row of 67 trees was divided into seven-tree plots with two guard trees at each end excluded from the treatments. There were six different treatments of seven trees each, plus a check with three replications. The checks were hand harvested and had no skirt pruning. All the rest but one had skirts pruned to various heights (24 to 30 inches). Due to the low skirts, the catching frame was unable to properly fit under the tree if skirts were not pruned to at least 24 inches high. All trees except the checks were machine harvested at various ground speeds ($\frac{1}{4}$ to $\frac{1}{2}$ miles per hour) and beater head movements (350 to 500 per minute) — plus different shaker widths. These varied from 5 to 16 inches wide at the bottom and 23 to 27 inches wide at the top.

Results

The hand-harvested check plots averaged 13 field boxes per seven trees. All machine-harvested treatments except the one with no skirt pruning averaged 6.3 field boxes per seven trees. This difference is attributed to the loss of fruit from the skirt pruning. Hand harvesting of the skirt prunings yielded an additional 7 field boxes per plot. After machine harvesting, the commercial fruit left on the trees was hand harvested. This averaged 2.9 field boxes per seven trees. Hypothetically, the 6.3 field boxes removed by the grape harvester, plus the 7.0 field boxes on the skirts, plus the 2.9 field boxes left on the trees totaled 16.2 field boxes per plot on the machine-harvested plots. However, part of that difference between the hand harvested 13.0 field boxes and the 16.2 field

boxes included noncommercial fruit removed by the machine. Using the 6.3 field boxes removed by the machine compared to the hand-harvested 13.0 field boxes resulted in a 48 percent machine removal.

Removal of so much bloom and small fruit by the machine drastically reduced subsequent yield for that season. It was observed that the mechanical harvester removed more fruit from Lisbon trees than the Eureka trees — which had more inside fruit. To evaluate the influence of removal of bloom and small fruit by the grape harvester in 1973, yields were compared in February 1974. The row of 67 trees involved in the mechanical harvest trials in 1973 yielded 13 field boxes. An adjacent check row yielded 36 field boxes.

Packinghouse evaluation

A total of 37 field boxes picked by the grape harvester were processed by the packinghouse. The fruit was allowed to stand on the dock for 1 week to help in the elimination of fruit that were damaged.

In processing the fruit, 10 boxes were eliminated. Out of the 27 boxes left, 16 were graded Sunkist, 11 Choice. However, many of these fruit had to be hand-clipped before they would go through the electronic color sorter. One week after storage, there were 4.4 percent rots in the Sunkist grade and 13.7 percent rots in the Choice.

1974 trials

The third trial was also conducted at the West Ranch in a similar row to the 1973 trial. The trees were then 4 years old and beginning to form more of a hedge. The row to be machine harvested was mechanically hedged 5 feet wide and topped to 7 feet in height 4 months previous to harvest.

In this trial, all 67 trees in the row were skirt pruned 24 inches high. Machine speed varied somewhat, but averaged $\frac{3}{8}$ miles per hour. Shaker head speed averaged 425 movements per minute. The shaker head width was 12 inches wide at the bottom and 21 inches wide at the top.

Results

In the row that was machine harvested, there were a total of 71 field boxes of fruit removed. In an adjacent check row that was hand harvested, a total of 36 field boxes was removed. The almost two-fold increased numbers of field boxes of fruit removed by the machine is explained by the nonselective removal of all sizes of fruit.

Conclusion

These trials showed that lemons can be removed mechanically by a grape harvester, although there was no selectivity of fruit size and much of the fruit was damaged during removal. Removal of all sizes in one harvest would mean lessening of harvest for at least two seasons. Also, it is necessary to prune or modify trees to allow the harvester to straddle the row.

It is doubtful that the available grape harvester will commercially pick lemons in the foreseeable future.

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