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HARVESTING CITRUS FRUIT WITH AN OSCILLATING AIR BLAST

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Citrus is the largest single tree fruit crop grown in the United States. The Florida Crop and Livestock Reporting Service valued the 1960-61 citrus crop in Florida alone at $356,976,000 (13)*. With large acreages being planted each year, and with harvesting labor problems continually rising, increased emphasis is being placed on methods of mechanically harvesting this crop.

Consideration has been given to the fresh fruit and the processing industries. For fresh fruit, the possible use of pickers' aids and movable platforms have been studied (4,5,9). The slightly increased productivity achieved with these has not demonstrated a desirable economic advantage over present methods.

Processing fruit lends itself more readily to mechanization. Emphasis on the utilization of citrus fruit in Florida has shifted in recent years from fresh fruit to processed fruit products (13). Several attempts at mechanically harvesting citrus have been made, but none have been successful. The spindle picker (6) was able to pick the fruit on the outside of the tree canopy, but resulted in a low proportion of fruit removal. The shake and catch method has shown greater promise (6). The two main deterrents to the commercial use of this method are (a) low per cent fruit removal; (b) removal of some of the small green Valencia fruit along with the mature fruit.

The use of pulsating air discharged through a round 8 inch duct was studied by Adrian (2) on prunes. He found that air velocities in excess of 150 mph (13,200 fpm) with release of air within one foot of the limb removed 40 to 50 per cent of the fruit from the tree.

Quackenbush et al. (12) and Abu-Gheida et al. (1) investigated the feasibility of using an upward pulsating air stream to separate several types of fruit from the peduncle and lower it gently to prevent bruising. The principal problem with this method was the excessive air volume required, since the whole cross-sectional area of the tree had to be subjected to air velocities of 7,000 to 8,000 feet per minute.

The purpose of this study was to investigate the possibility of using a high-volume, high-velocity oscillating air blast for harvesting citrus.

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* Numbers in parentheses refer to the appended references.

Description of Equipment.--A machine (Fig. 1) was constructed that discharged air from a vaneaxial fan through a rectangular outlet one foot wide by six feet high at velocities up to 10,000 fpm. Vertically oscillating vanes eight inches deep and seven inches apart were located at the outlet. The angular displacement of the vanes was arbitrarily set at 60°. The unit was mounted on a trailer equipped with a pantograph mechanism. This permitted harvesting of tall trees by making several passes at different heights. The unit was pulled through the test groves at a constant speed of about 1/4 mph with the air being discharged normal to the direction of travel. Controls were incorporated to vary the air velocity and the oscillation rates.

Effect of Air Velocity and Oscillation Rate.--Data in Table 1 show the effect of air velocity and oscillating rate on leaf damage and per cent fruit removal. Leaf damage was rated on a visual basis. No attempts were made to correlate this rating with the long range effects on the tree.

Table 1. Effect of air velocity and rate of oscillation on per cent fruit removal and leaf damage.

Date of Harvest	Variety	No. Trees in Test	Source Velocity (fpm)	Oscillating Rate (osc./min.)	% Removal	Leaf Damage
Dec. 21, 1961	Hamlin	4	9930	60	94.0	Heavy
Jan. 18, 1962	Pineapple	4	9930	60	93.7	Heavy
Feb. 6, 1962	Pineapple	6	9930	100	65.5	Medium
Feb. 6, 1962	Pineapple	6	8666	100	41.6	Light
Feb. 13, 1962	Pineapple	5	9930	70	83.0	Medium
Feb. 13, 1962	Pineapple	5	8666	70	73.0	Light
Feb. 21, 1962	Marsh Grapefruit	4	9530	70	95.6	Light
March 7, 1962	Pineapple	1	9930	70	91.0	Medium
March 26 through April 6	Valencias	1	8666	50	40.0	Light
"	Valencias	2	8666	60	51.5	Light
"	Valencias	2	8666	70	44.5	Light
"	Valencias	2	8666	80	46.0	Light
"	Valencias	2	9530	50	66.5	Medium
"	Valencias	3	9530	60	61.0	Medium
"	Valencias	3	9530	70	55.5	Medium
"	Valencias	3	9530	80	57.2	Heavy
"	Valencias	2	9930	50	64.0	Heavy
"	Valencias	3	9930	60	64.0	Heavy
"	Valencias	3	9930	70	67.6	Heavy
"	Valencias	3	9930	80	66.5	Heavy