Shaker Removal Methods Affect 'Valencia' Yield, 2nd Year

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Abstract. Five fruit removal methods were evaluated on three harvest dates under simulated commercial conditions to determine their influence on the subsequent yields of 'Valencia' oranges sprayed with RELEASE abscission chemical. Yield increased unexpectedly for treatment plots harvested on April 25 during the natural young fruit drop period, but fruit yields were reduced for treatment plots harvested on May 15 and June 5 after the young fruit drop period. Fruit removal methods affected subsequent yield, but harvest date had a greater influence.

The Florida citrus industry produced approximately 8.4 million tons (7.6 t) of oranges on 594,300 acres (240,500 ha) during the 1976-77 season (6). About 40 per cent of this production was from 'Valencia' cultivar which normally reaches maturity suitable for processing after bloom has occurred and young fruit have formed. This young crop of fruit increases in weight as the harvest season progresses (3). Mature 'Valencia' fruit is very desirable for processing, and approximately 96 per cent

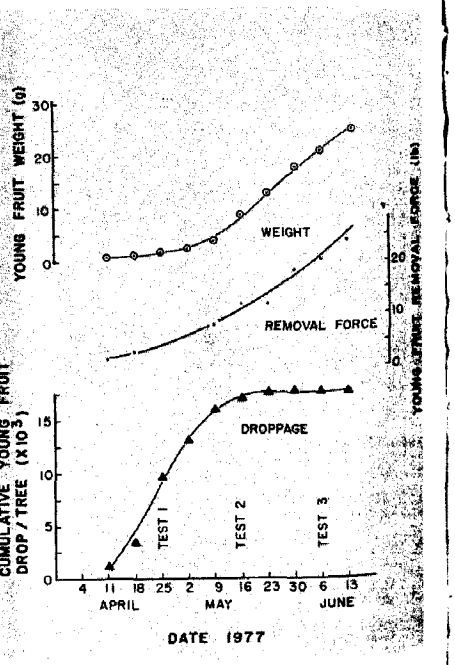

Figure 1. Young fruit weight, removal force, and droppage during the 1977 'Valencia' harvest season. Test 1 was conducted during the young fruit drop period, and Tests 2 and 3 were made after the droppage rate was negligible.

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of the production is used in this manner (6). In harvesting 'Valencia' fruit, care should be exercised to prevent removal or injury to the young fruit, which will be next year's crop.

Several mechanical harvesting systems with shakers to remove the fruit have been developed and demonstrated for oranges (4, 7, 8). However, acceptance of these systems for 'Valencia' oranges has been limited by their excessive removal of the young fruit, which has caused a yield reduction in the following season. An abscission chemical, RELEASE (5 - chloro - 3 - methyl - 4 - nitro - 1H - pyrazole), manufactured by Abbott Laboratories, has shown good potential for improving these systems by selectively loosening only the mature fruit (9).

The effectiveness of mechanical shakers used in conjunction with an abscission chemical in 'Valencia' oranges depends primarily on 1) correct application of the chemical to obtain uniformity of mature fruit loosening, 2) type of shaker used and its operation, and 3) stage of young fruit development at harvest. The effectiveness of abscission chemicals is dependent on weather and on the condition of the trees at the time of application. During the 'Valencia' season, there is a period when the mature fruit becomes less responsive to the abscission chemical (usually in May and early June) and a higher than normal application rate is required (9). Also, a period of natural young fruit drop occurs at the beginning of the season and diminishes to a low level about May 5 to May 20 when the young fruit weight is eight to 12 g.

A three-year study was begun in 1976 to evaluate several fruit removal methods under simulated commercial conditions for their effectiveness in the selective removal of 'Valencia' oranges. The 1976 harvest resulted in a subsequent yield reduction for all removal methods and harvest dates; however, the first harvest date was on May 13, which was several weeks into the harvest season and near the end of the period of natural young fruit drop (5). The second year's harvest included a test at the beginning of the 'Valencia' harvest season to evaluate the effects of the removal methods on subsequent fruit yields when harvesting during the period of natural young fruit drop. The results of the 1977 harvest tests and subsequent yields are covered in this report.

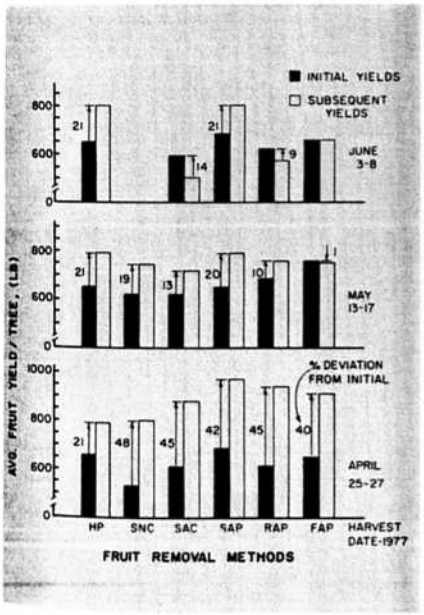

Figure 2. The initial and subsequent plot yields and the deviation of the subsequent from initial plot yields for handpicked and five fruit removal methods for 1977 season. The removal method code is: S—slider crank shaker; N—no abscission chemical; A—abscission chemical; R—rotating weight shaker; C—catchframe; P—ground pickup; F—air shaker.

Materials and Methods

An experiment was established in a 'Valencia' orange grove typical of many older groves grown on the ridge section of Florida. The grove was situated on slightly rolling terrain with trees on rough lemon rootstock, spaced 25 feet x 25 feet (7.6 m x 7.6m) and ranging in height from 20 feet to

Table 1. Description of fruit removal methods.

Fruit removal and handling methods[z]	Description	Fruit removal rate trees/hr
SNC	Slider crank limb shaker mounted on catchframe (3). Shaker speed variable to 300 cpm (cycles per min) or 5 Hz with 400 lb (818.5 kg) unbalanced wt.	10
SAC	Same as above, except, RELEASE abscission chemical applied.	12
SAP	Slider crank limb shaker (mfg. Roberts Harvester) mounted on self-propelled carriage (6). Shaker speed variable to 250 cpm (4.2 Hz) with 600 lb (272.2 kg) unbalanced wt.—RELEASE applied.	17
RAP	Rotating weight limb shaker mounted on self-propelled carriage (6). Shaker speed variable to 300 cpm (5 Hz) with 240 lb (108.9 kg) unbalanced wt.—RELEASE applied.	17
FAP	Three-fan air shaker (7). Outlet velocity to 120 mph (193 km/h) at 70 cpm (1.2 Hz) oscillation rate —RELEASE applied.	90

[z](Code) S—slider crank shaker; N—no abscission chemical; A—abscission chemical; R—rotating weight shaker; C—catchframe; P—ground pickup; F—air shaker.

Table 2. Performance of RELEASE used in 5 removal methods in Tests 1, 2, and 3.

Removal methods[z]	Date harvested	Rate[y] ppm	FRF[x] lb	(N)	Preharvest fruit drop %	Fruit removal %
			Test 1			
SNC	April 26	0	13.45	(59.8)	--	89.0
SAC	April 25	250	5.81	(25.8)	4.8	94.0
SAP	April 27	350	2.08	(9.3)	36.2	97.3
RAP	April 27	350	2.64	(11.7)	39.4	97.0
FAP	April 25	350	2.08	(9.3)	34.4	95.9
			Test 2			
SNC	May 13	0	--		--	91.1
SAC	May 16	275	—		—	96.2
SAP	May 17	350	—		—	93.8
RAP	May 17	350	—		—	97.1
FAP	May 17	350	—		—	86.9
			Test 3			
SNC	Omitted					
SAC	June 8	275	6.29	(28.0)	6.7	93.0
SAP	June 8	350	5.21	(23.2)	21.9	92.3
RAP	June 3[w]	350	5.42	(24.1)	16.1	95.4
FAP	June 3[w]	350	5.39	(24.0)	20.3	81.8

[z]S--slider crank shaker; N--no abscission chemical; A--abscission chemical; R--rotating weight shaker; C--catchframe; P--ground pickup; F -- air shaker.

[y]RELEASE applied at 15 gal/tree (56.8ℓ) of mixture, 2.5 ml/gal (0.66 ml/ℓ) of Ortho X-77 surfactant.

[x]FRF--fruit removal force. Data taken on 5 trees/treatment, 10 readings/tree.

[w]Plot resprayed again with 175 ppm of RELEASE because of rain.

25 feet (6.1 m to 7.6 m). The trees were hedged to a seven foot (2.1 m) wide middle, and undesirable limbs were removed in 1975. This operation reduced the 1976 average yield from 10 to seven boxes (408 kg to 286 kg) per tree.

The experiment consisted of five fruit removal methods (Table 1) evaluated on three different harvest dates (tests) spaced over the 1977 harvest season extending from April to July. In each test, removal methods were assigned to plots consisting of 43 to 45 trees in single rows. Three single-row plots were handpicked each season to measure the seasonal effect on fruit yields. The effect of the removal methods on fruit yield was determined from the subsequent year's plot yield. The deviation of fruit yields from the initial plot yields (initial plot yields are the plot yields the first season (1976) and contain no treatment effects) are compared with the deviation of the handpicked plots (check) from initial handpicked plot

yields.

The abscission chemical RELEASE was applied with a modified AgTec sprayer, manufactured by Ag-Chem Equipment Company, Inc., four to five days prior to harvest. The spray mixture contained RELEASE in water at amounts for desired concentration and Ortho X-77 surfactant at 2.5 ml per gallon (3.78 ℓ) of mixture. The material was applied at a rate of 15 gallons (56.8 ℓ) per tree. The concentration of RELEASE used was governed by predicted weather and tree response (Table 2). For the shaker catchframe plus RELEASE methods (SAC), RELEASE was applied at a concentration intended to give maximum fruit loosening with a minimum preharvest drop. For other methods, preharvest drop was not a consideration as all the fruit were dropped to the ground and not caught on a catchframe.

Performance data were collected by dividing each plot to five eight-tree groups and randomly selecting one tree in each group for taking measurements of fruit removal force (FRF) and fruit drop before harvest and the amount of fruit left on tree after harvest. An average of the five measurements was used to calculate values for each plot. Fruit were caught on a catchframe in removal methods SNC and SAC, whereas the other removal methods had a rake-pickup system to gather the fruit (1). Fruit yield for the plots was determined by weighing fruit recovered by the system and correcting for fruit left on the trees.

The fruit removal devices were operated to remove above 90 per cent of the mature fruit with a minimum removal of young fruit. Actual operation was left to the discretion of an experienced operator.

The average weight, fruit removal force, and droppage of young fruit in the research grove were determined each week (Figure 1). Test one was conducted during the main young fruit drop period whereas Tests two and three were after the period when young fruit weight and removal force were rapidly increasing.

Results and Discussion

The performance of RELEASE and the removal methods are given in Table 2. Good fruit loosening was obtained with 350 ppm of RELEASE for removal methods SAP, RAP, and FAP in Test one. Trees in methods RAP and FAP in Test three were resprayed with 175 ppm of RELEASE because the first application was washed off with rain. Preharvest fruit drop and FRF data were not available for Test two. The use of a reduced rate of RELEASE (250 ppm) in method SAC gave an increased FRF and a corresponding reduced preharvest fruit drop. Fruit removal was above 90 per cent for all methods except FAP in Tests two and three. The SNC method was not included in Test three because of the large amount of young fruit removal in Tests one and two.

Figure 2 shows the initial (1976) and subsequent (1978) yields per tree for the harvest treatments on three dates in 1977. The deviation between the initial and subsequent yields for the treatments ranged from 48 per cent to −14 per cent of the initial yields. The deviation was 21 per cent for the handpicked treatment and averaged 44 per cent, 12 per cent, and −1 per cent for all machine treatments for the April 25, May 23, and June 3 harvest dates, respectively. Subsequent yield deviations from the initial yields were greater than those for the handpicked treatment for the April 25 harvest date during the young fruit drop period when the weight of the young fruit was still small (Figure 1). After the young fruit drop period (May 13 and June 3 harvest date), subsequent yield deviations of the machine harvested plots were less than those of the handpicked plots except for the SNC and SAP treatments, which were approximately the same. Similar results were obtained for the SAP treatment in the May 1976 season (5), partly because of better transmission and control of the shaking forces in the fruiting area of the tree than in other machine treatments.

These results support previous observations that 'Valencia' oranges can be harvested early in the season before the young fruit drop is completed without reducing subsequent fruit yields (2, 3). The increase of machine treatment yields above those of handpicked yields on the April 25 harvest date could be explained only by the fact that more young fruit remained on the trees as a result of the shaker treatment than would have otherwise been left in the natural droppage of young fruit. Also, the effect of the abscission chemical appeared to be minimal during this period. Additional research is needed to explain this deviation from the expected results. The self-propelled slider-crank shaker with abscission chemical caused the least yield reduction from harvesting after the young fruit drop period. Although there were differences in the effect of removal methods on fruit yield, the date of harvest had the greatest influence.

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