The data from experiments during the last 3 years suggest that 'Hamlin' oranges are loosened effectively with several individual chemicals or combinations of these chemicals, including Acti-Aid, Release, and Sweep. Also, the data show that no advantage was gained by Release and Pik-Off combinations. Acti-Aid is the only chemical cleared for loosening citrus fruit. Release, Pik-Off and Sweep have been cleared for experimental use only. The results presented here show that combinations of Pik-Off, Acti-Aid plus Sweep with surfactants may be just as efficient as other combination sprays of Acti-Aid, Release and Sweep (7). During the 'nonresponsive' period in May or early June, the Pik-Off combinations were not effective but other combinations also gave variable results. Fruit with slight cold damage is an exception. By lowering the amount of Acti-Aid and Pik-Off in the combinations with Sweep less severe fruit damage and less defoliation result compared to higher concns of single chemicals.

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SHAKER REMOVAL METHODS AFFECT 'VALENCIA' ORANGE YIELD[1,2]

G. E. COPPOCK
Florida Department of Citrus,
IFAS, Agricultural Research and Education Center,
P. O. Box 1088, Lake Alfred, FL 33850

D. B. CHURCHILL, H. R. SUMNER, AND S. L. HEDDEN
USDA, Agricultural Research Service,
IFAS, Agricultural Research and Education Center,
P. O. Box 1088, Lake Alfred, FL 33850

Additional index words. citrus, mechanical harvesting.

Abstract. **During the 1976 'Valencia' orange harvest season, 5 fruit removal methods were evaluated at 3 harvest dates for their effectiveness in loosening mature fruit and for their effect on subsequent fruit yields. The abscission chemical RELEASE[3] (5-chloro-3-methyl-4-nitro-1H-pyrazole) was used in some cases. Fruit removal force was reduced with RELEASE, but effectivness of the material decreased when rain occurrd shortly after application. Fruit yields were reduced from 4 to 36% with the greater reductions occurring later in the season. Fruit yields were reduced the least in trees when sprayed with RELEASE and harvested with limb shakers mounted on a self-propelled carriage. A comparable yield reduction of 12% occurred with the shaker catchframe plus RELEASE and the air shaker plus RELEASE in a May 11 test. However, the air shaker reducd yield about 25% more in a May 20 test. Less reduction in yield occurred when RELEASE was used in comparison to no use of the chemical in shaker catchframe tests conducted May 11 and May 20.**

Several mechanical shaker systems have been developed and demonstrated for removing fruit from citrus trees (2, 3, 4). Acceptance of these methods by the industry has been limited. The predominant reason has been their poor efficiency in the selective removal of mature 'Valencia' oranges without excessive removal of the next year's young fruit. The abscission chemical RELEASE, manufactured by Abbott Laboratories, showed excellent potential for improving these removal methods by selectively loosening only the mature fruit (5).

With 'Valencia', the efficiency of mechanical shakers in combination with an abscission chemical depends primarily on 1) correct application of the chemical to obtain uniformity of mature fruit loosening, 2) type of shaker and its operation, and 3) stage of young fruit development. 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 usually a period when the mature fruit becomes less responsive to the abscission chemical and a higher than normal application rate is required (5).

The objective of the research reported in this paper was to evaluate several fruit removal methods, under simulated commercial conditions, for their relative effectiveness in the selective removal of mature 'Valencia' oranges. Factors evaluated were the degree of fruit loosening and the effect of removal methods on subsequent fruit yield. This report includes the first year's (1976) results of an anticipated 4-year research program.

Materials and Methods

The experiment was established in a 'Valencia' orange grove leased by the Florida Department of Citrus (FDOC) and located near the Agricultural Research and Education Center (AREC) Lake Alfred. The grove was situated on slightly rolling terrain with trees on rough lemon rootstock, spaced 25 ft x 25 ft and ranging in height from 20 ft to 25 ft.

[1]Acknowledgments are made to W. C. Wilson, Florida Department of Citrus, for the application of the abscission chemical, to J. D. Whitney, University of Florida, for supervising the air shaker operation and to J. R. Donhaiser, Florida Department of Citrus, for assembling tree and weather data in the research grove.

[2]Cooperative research by Florida Department of Citrus, University of Florida and USDA, Agricultural Research Service.

Florida Agricultural Experiment Stations Journal Series No. 818.

[3]Trade names are used in this publication solely for the purpose of providing specific information. Mention of a trade name does not constitute a guarantee or warranty of the product by the U.S. Department of Agriculture or an endorsement by the Department over other products not mentioned.

Hedging to a 7-ft wide middle and removal of undesirable limbs in 1975 reduced the 1976 average yield from 10 to 7 boxes per tree.

The experiment consisted of 5 fruit removal methods (Table 1) evaluated on 3 different dates (tests) during the 1976 season. In each test removal methods were consigned to plots consisting of 43 to 45 trees in single rows. The effect of the fruit removal methods on yield was determined by yield of the plots in the 1977 season. Three plots were handpicked each season and the difference in average yields between seasons was used to adjust 1976 removal plot yields for seasonal difference.

Table 1. Description of fruit removal methods used in Tests 1, 2 and 3.

Fruit removal method[z]	Description
SNC	Slider crank limb shaker mounted on catchframe. Maximum shaker speed 300 cpm with 400 lb. unbalanced weight (FDOC experimental).
SAC	Same as above except RELEASE was applied.
SAP	Slider crank limb shaker (manufactured by Roberts Harvester) mounted on self-propelled carriage (USDA)—maximum shaker speed 250 cpm with 600 lb. unbalanced weight—RELEASE abscission chemical applied.
RAP	Rotating weight limb shaker (USDA) mounted on self-propelled carriage (USDA)—maximum shaker speed 300 cpm with 240 lb. unbalanced weight—RELEASE abscission chemical applied.
FAP	Three-fan air shaker (AREC) with outlet velocity of 120 mph and 70 cpm oscillation rate—RELEASE abscission Chemical applied.

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

The abscission chemical was applied with the FDOC experimental sprayer 4 to 5 days prior to harvest. The chemical was applied in a solution containing 2.5 ml per gal of Ortho X-77 surfactant at a rate of 10 gal per tree. Concentrations of RELEASE depended on predicted weather and tree response (Table 2). For the shaker catchframe plus RELEASE method (SAC), RELEASE was applied at a concn intended to give maximum fruit loosening with a minimum preharvest drop. For all other methods, preharvest drop was not a consideration as fruit was dropped directly to the ground and not caught on a catchframe.

Each plot was divided into 5, 8-tree groups and one tree was randomly selected in each group for taking measurements before harvest of fruit removal force and of fruit drop. After harvest the amount of fruit left on tree, and fruit left on ground was determined. Fruit was caught on a catchframe in removal methods SNC and SAC, while in the other removal methods it was gathered and loaded with a fruit rake-pickup system.

The fruit removal devices were operated to remove more than 90% of the mature fruit, but a minimum of young fruit. Actual operation was left to the discretion of an experienced operator.

The average change in weight, fruit removal force, and droppage of the young fruit in the research grove, were determined and are shown in Fig. 1, along with the condition of those factors at each test. All tests were conducted after the main young fruit drop period and at a time when the fruit weight and removal force were rapidly increasing.

Results and Discussion

The data on the performance of RELEASE for 5 removal methods are given in Table 2. A 1.0-inch rain fell 10 hr following the application of RELEASE in Test 1. The degree of loosening at 300 and 400 ppm did not seem to be reduced but the 250 ppm sprayed plot was resprayed. In Test 2 a 0.5-inch rain fell following application of the chemical and all plots were resprayed. In Test 3 no rain fell. No evaluation of FAP method was made because RELEASE was applied early in the morning before the dew had dried and was not effective. The SNC method was not included in Test 3 because of the large number of young fruit removed with this method in Tests 1 and 2. The lower application rate (250 ppm) used in the SAC method failed to give a lower preharvest fruit drop as had been anticipated. The need to respray in Tests 1 and 2 and the variability in the response of the trees contributed greatly to the unreliable performance of RELEASE.

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

Removal methods	Date Sprayed	Date Resprayed	Date Harvested	Rate[y] ppm	FRF[x] lb.	Preharv drop %	Fruit removal %
			TEST 1				
SNC			May 11		13.1		93.3
SAC	May 7	May 10	May 12	250	6.5	22	96.6
SAP	May 7		May 12	300	6.9	6	95.6
RAP	May 7		May 11	300	7.6	10	96.1
FAP	May 7		May 11	400	4.3	23	95.4
			TEST 2				
SNC			May 20		15.1		93.6
SAC	May 14	May 17	May 20	250	5.2	18	97.7
SAP	May 14	May 17	May 20	250	4.9	36	96.1
RAP	May 14	May 17	May 20	250	3.3	29	98.0
FAP	May 14	May 17	May 20	250	4.3	36	93.6
			TEST 3				
SNC			Omitted				
SAC	June 5		June 8	250	2.9	13	96.7
SAP	June 5		June 9	300	3.0	20	94.6
RAP	June 5		June 9	300	5.0	12	92.7
FAP			Omitted				

[z]Removal methods explained in Table 1.
[y]RELEASE applied at 10 gal/tree of mixture containing 2.5 ml/gal of Ortho X-77 surfactant.
[x]FRF—Fruit removal force. Data taken on 5 trees/treatment, 10 readings/tree.

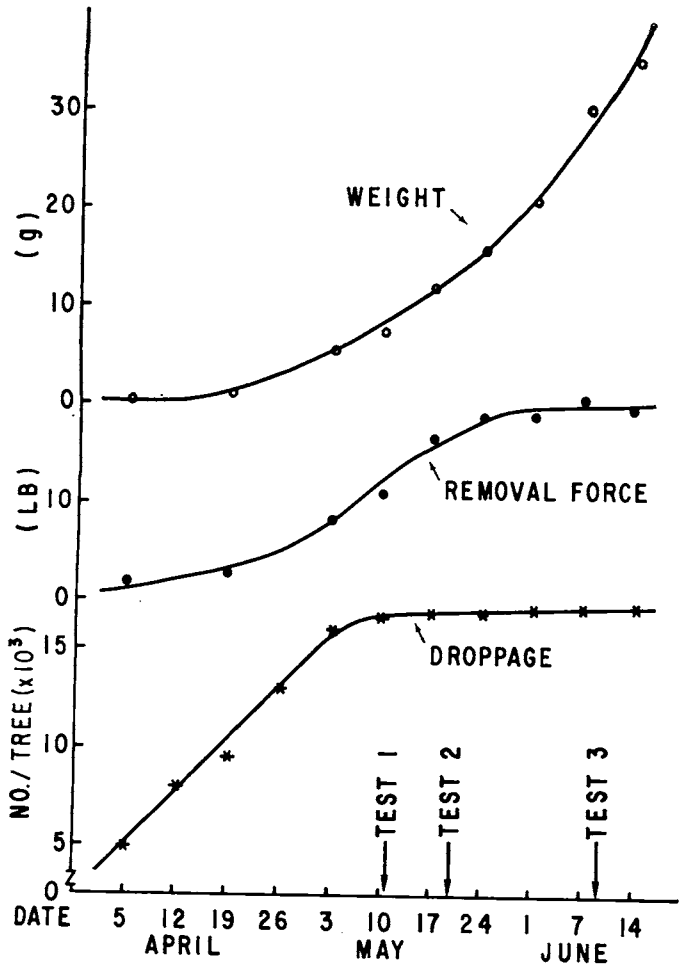

Fig. 1. The change in weight, removal force and droppage of young fruit during the normal 'Valencia' harvest season in the research grove for 1976.

Fig. 2 shows the seasonal adjusted 1976 fruit yields and the subsequent year (1977) yields for the removal methods in the 3 tests. The 1976 plot yields were adjusted for seasonal differences as determined from average yields of handpicked plots each season. Seasonal adjusted 1976 yield = average yield of 1977 handpicked plots (30,235 lb) ÷ average yield of 1976 handpicked plots (29,445 lb) x 1976 plot yield for removal methods.

The 1977 yields were reduced from the 1976 seasonal adjusted yields by 4 to 36%. The reduction was greater in tests conducted later in the season. RAP and SAP methods caused the least reduction in yield in Tests 1 and 2. This can be attributed in part to transmission and better control of the shaking forces in the fruiting areas of the tree. In Test 1 yield reduction with the SAC method was comparable to that of the FAP method, but the FAP method reduced the yield about 25% more than the SAC method in Test 2. The shaker and catchframe with RELEASE (SAC) reduced the yield less than without RELEASE (SNC).

These tests show a yield reduction by all removal methods, however, there is evidence in these studies and in previous tests (1) that the reduction would have been less if fruit had been harvested prior to the end of the main young fruit drop period for the next season's crop when the young fruit weight was less.

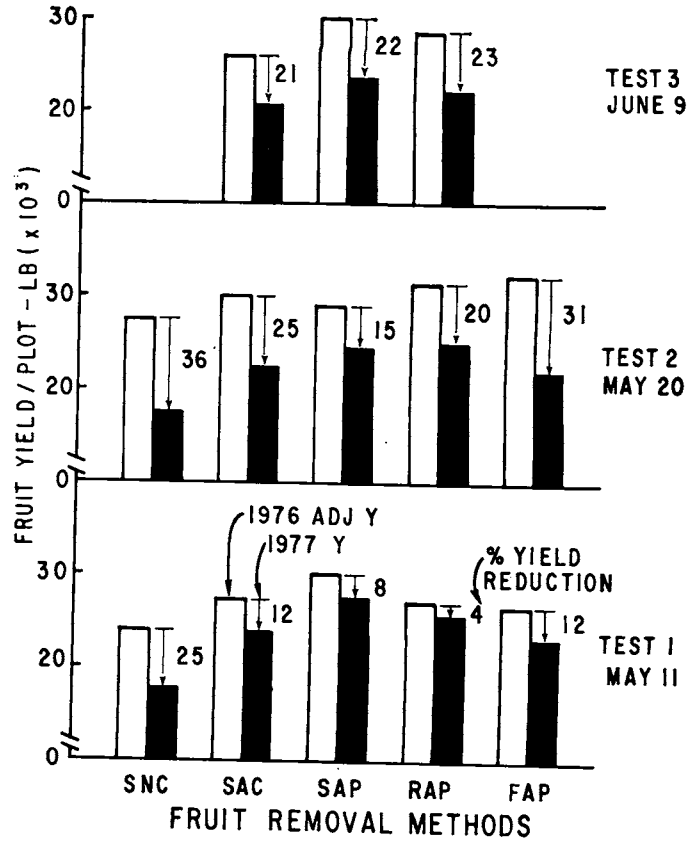

Fig. 2. Comparison of plot yields from 5 fruit removal methods for 1976 and 1977 seasons. The 1976 yields were adjusted for seasonal differences. Removal methods are explained in Table 1.

From the results of this experiment the potential for the selective harvest of 'Valencia' oranges is not promising. However, it should be noted that these results were obtained during only one season and can be expected to vary from season to season due to weather conditions and changes in harvesting technology.

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